Sun Valley
Area Drainage Master Plan

Step 2

Proposed Alternatives
Analysis Report

Volume 3

WAGNER WASH
SUB-AREA

Flood Control District of Maricopa County

September 2006

SUN VALLEY AREA DRAINAGE MASTER PLAN

STEP 2 PROPOSED ALTERNATIVES REPORT
WAGNER WASH SUB-AREA
VOLUME 3

Flood Control District of Maricopa County

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ENCLOSED DATA CD INCLUDES:

- Digital Copy of Report in PDF Format
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- Excel Files of Design Analyses
- HEC-1 Model Files

1 ABSTRACT / EXECUTIVE SUMMARY

Structural and non-structural alternatives were developed and evaluated as part of Step 2 of the Sun Valley Area Drainage Master Plan (SVADMP). This is the second of a three step process to develop a drainage master plan for the Sun Valley area. Four flood control alternative strategies were identified in Step 1 of the ADMP process. Those four strategies were further refined in Step 2. The refined alternatives included both non-structural and environmentally friendly, aesthetically compatible structural flood control measures.

In order to achieve this refinement, the area was divided into seven geographic sub-areas based on the type and nature of flooding and the distribution of alluvial fan landforms in the study area. This volume presents the results for one of those sub-areas, the Wagner Wash sub-area. Seven different flood control alternatives were developed and evaluated including apex strategy variations including avoidance, on-line and off-line detention basins, and conveyance. Earthen and concrete excavated channels were also compared with a leveed natural corridor for the downfan conveyance structures. Multiple alignment alternatives were also investigated for four of the six piedmont sub-areas. Non-structural approaches were incorporated wherever possible.

Figure 1 Sun Valley Piedmont

Figure 2 Skyline Fan

Engineering and landscape compatibility enhancement costs were estimated for all of the proposed alternatives piedmont sub-areas. The proposed alternatives were evaluated for their flood control function, economic costs, environmental impacts, permitting issues, visual and aesthetic characteristics, and recreation and multiple-use opportunities. Preference for natural leveed corridors downstream of on-line detention basins along multiple alignments was expressed by the project team, stakeholders, and the public for the piedmont sub-areas including the Wagner Wash sub-area (this volume).

The recommended alternatives will be carried forward for further refinement of the engineering elements and the cost estimates in Step 3. Special attention will be given to maximizing non-structural, floodplain management approaches along the preferred leveed corridor alignments. Stakeholders and the public will continue to be consulted as to their feedback in attempt to incorporate existing and imminent developer plans into the drainage master plan for the Sun Valley area.

2 INTRODUCTION

2.1 Report Organization

The Step 2 Proposed Alternative Analysis Report is presented in seven (7) volumes. Volume 1 provides an overview of the ADMP, explains the ADMP process and the alternatives analysis, summarizes the Step 2 evaluation and results, and provides recommendations for the Step 3 refinements to the recommended alternative. Volume 1 also provides a discussion of general area-wide flood control issues and potential solutions as well as specific issues and potential solutions for the area north of the Central Arizona Project Canal. The so-called North of CAP sub-area is included in Volume 1 for two reasons: first, the sub-area is not dominated by large alluvial fans like the piedmont sub-areas in the remainder of the study area; second, the recommendations for the North of CAP sub-area are predominantly non-structural in nature.

Volumes 2 through 7 present the proposed alternatives for the piedmont sub-areas as follows:

2) CAP (Volume 2),

3) Wagner Wash (this volume),

4) Hassayampa River (Volume 4),

5) White Tanks Wash (Volume 5),

6) FRS #1 (Volume 6), and

7) FRS #2 & #3 (Volume 7).

The alternatives presented in Volumes 2 though 7 are primarily structural in nature. Therefore, the discussion of design methods, calculations, and results are more involved, and require additional information in their presentation. Volumes 2 through 7 also include site specific data, hydraulic analyses, and cost estimates for each of the proposed alternatives.

It is intended that each Volume of the Step 2 report be able to stand alone so that a reader, such as an interested stakeholder, unfamiliar with the ADMP, or uninterested in other sub-areas, can understand the overall study as well as the details of an individual sub-area of particular interest to them. Excessive detail associated with the design calculations are left out of Volume 1 in order to provide a more digestible document for the reader interested in the Proposed Alternatives Analysis as a whole.

The advantages of this type of report organization are:

- The reduction of reproducible materials required for interested users or stakeholders.
- It provides a condensed overview of the ADMP process and Proposed Alternatives Analyses.
- It narrows the focus to a specific sub-area while still providing an overall comprehensive summary of the Step 2 process and Alternatives descriptions.

2.2 Project Background

The Sun Valley area, located in western Maricopa County, Arizona, is presently experiencing the first stages of accelerated urbanization (Figure 3). Future development is anticipated to occur on the largely undisturbed alluvial fans and piedmont surfaces comprising the western slope of the White Tank Mountains (Figure 4). The upland areas and adjacent watershed drain to the Hassayampa River to the west and the Buckeye Flood Retarding Structure (FRS) Numbers 1, 2, & 3 along Interstate 10 to the south.

The purpose of the SVADMP is to develop a conceptual drainage plan to serve as a roadmap that jurisdictional authorities and developers can use in planning flood control measures to mitigate flood hazards up to the 100-year event. The SVADMP incorporates development plans for the area and jurisdictional drainage policies to develop a preferred regional flood control solution.

The major objectives of the project include the following:

- Plan regional flood hazard mitigation;
- Preparation of approximate alluvial fan floodplain delineations, meeting Federal Emergency Management Agency (FEMA) and Flood Control District of Maricopa County (District) standards, for those alluvial fans in the study area not previously delineated;
- Coordination between the ADMP regional flood control measures and the design of drainage features within the master planned community developments within the study area;
- Preparation of preliminary design of flood control facilities in areas not within master planned communities; and
- Design of landscape aesthetics and visual character in accordance with the District's *Landscape Aesthetics and Multi-Use Consultant Handbook (April 2003).*

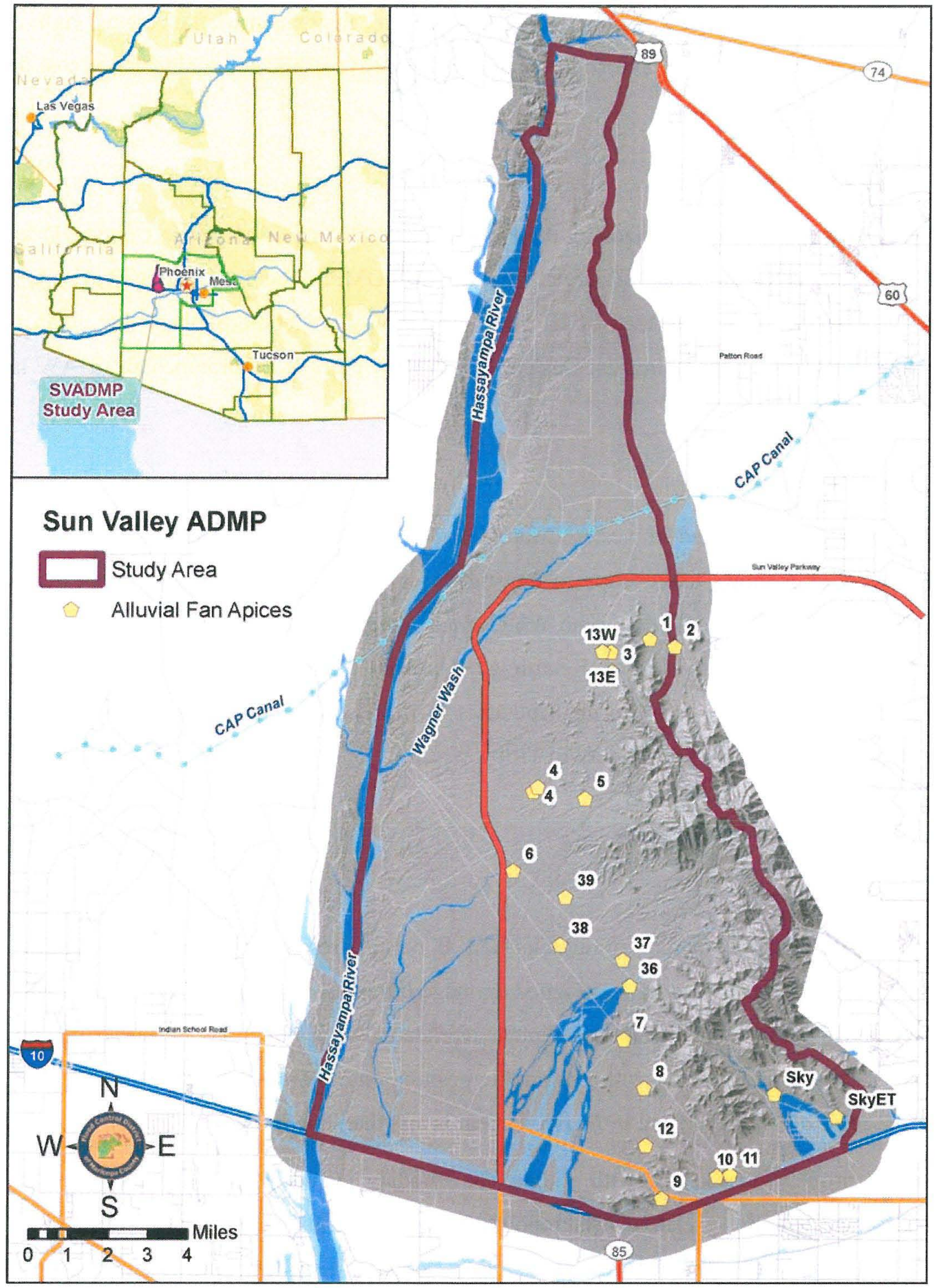

Figure 3 Location of Study Area

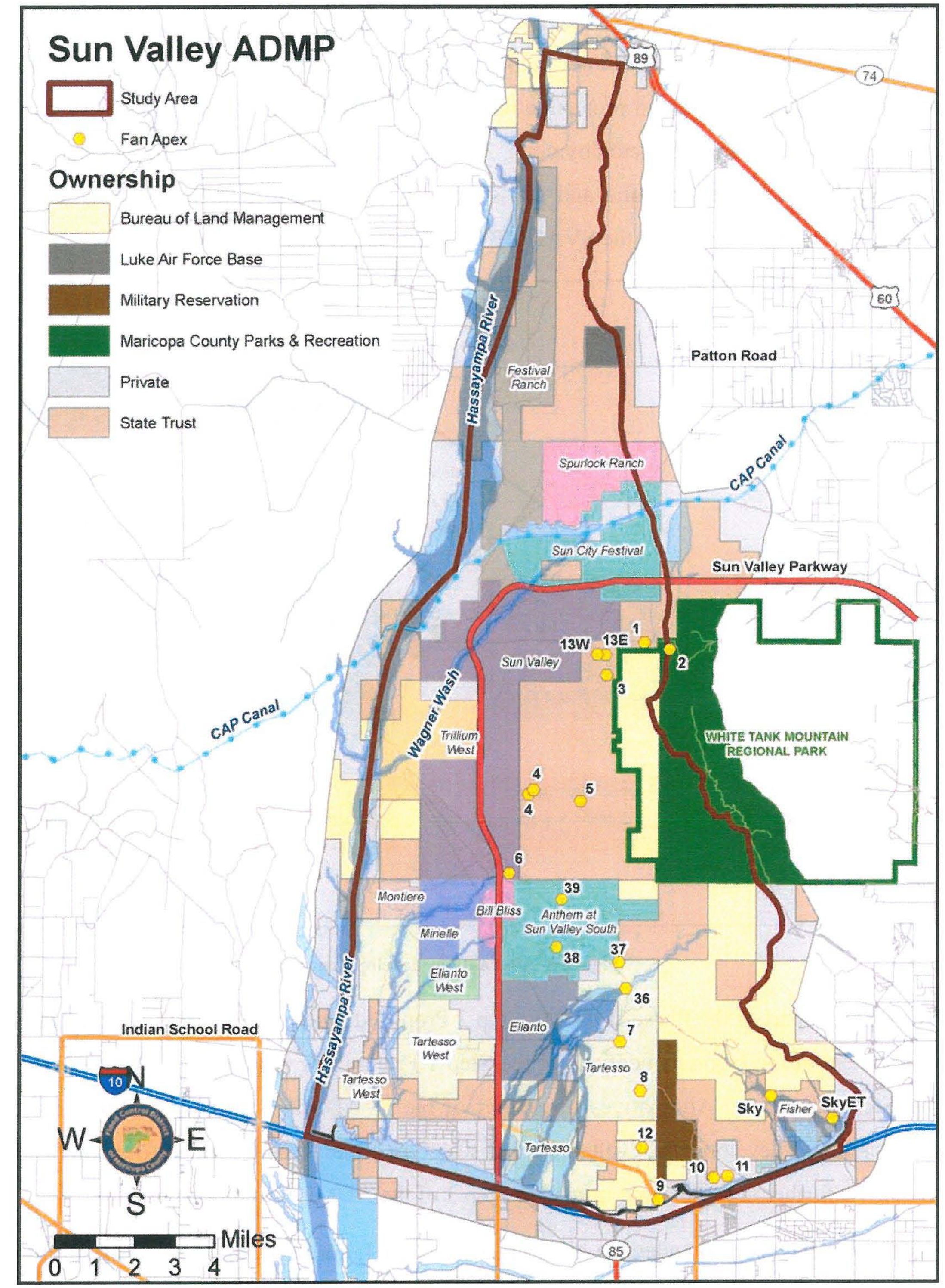

Figure 4 Future developments in the ADMP study area

Previously, the Phase I Buckeye/Sun Valley Area Drainage Master Study (ADMS), conducted by PBS&J, documented and analyzed existing conditions and identified drainage and flooding problems in the study area for the purpose of initial formulation of flood protection alternatives. The Phase II Sun Valley Area Drainage Master Plan builds on the Phase I findings by employing a 3-step process with the goal of developing a Recommended Alternative, consisting of both structural and non-structural measures, to address flood hazards in the study area. Figure 5 shows a flowchart illustrating the SVADMP alternatives development process.

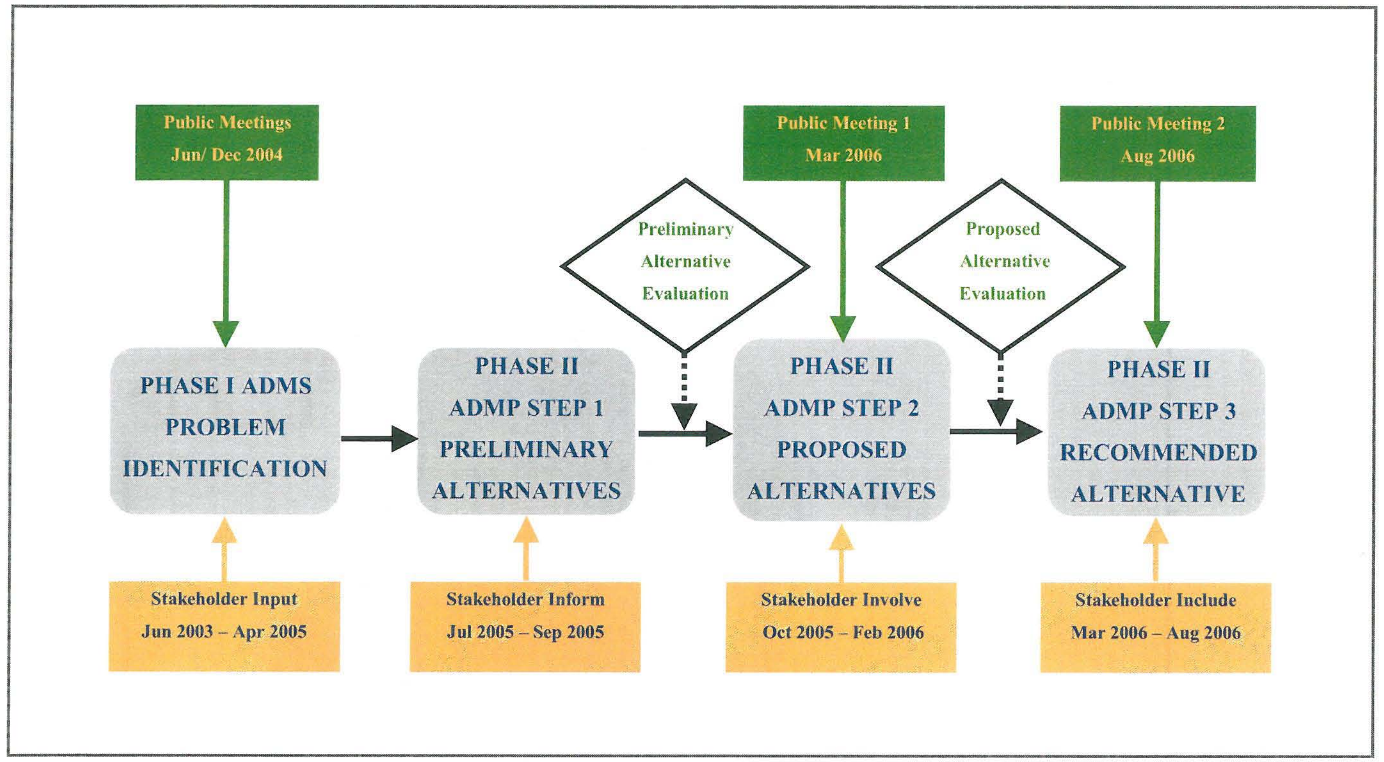

Figure 5 Alternatives development process

This report is part of the Phase II ADMP Step 2 Proposed Alternatives formulation process which focuses on further development of the recommendations of the Step 1 Preliminary Alternatives. The purpose of this study is to evaluate the Step 2 Proposed Alternatives in support of the SVADMP. The Step 2 Proposed Alternatives Report outlines the alternatives development, evaluation, and selection of the Recommended Alternative. The Recommended Alternative will be further evaluated and refined in Step 3 of the ADMP formulation process.

Based upon the recommendations resulting from Step 1, further evaluation of the Preliminary Alternatives was performed at Step 2 to determine engineering feasibility and approximate costs. The Step 1 Preliminary Alternative measures are combined to formulate the conceptual design of regional, whole-fan Step 2 Proposed Alternatives. The concept designs of the Step 2 Proposed Alternatives are presented as part of this study along with cost estimates. The cost estimates include engineering design, major construction items, right-of-way acquisition, major utility relocations, landscape compatibility aesthetic improvements, and maintenance cost for a 50-year design life.

2.3 Authority for Study

The current study was authorized by the Flood Control District of Maricopa County (District) under contract FCD 2004C049 as part of the scope of services for the SVADMP. The Town of Buckeye, Arizona was a project participant. The ADMP was performed by JE Fuller/ Hydrology & Geomorphology, Inc., with subconsultants C.L. Williams Consulting, Inc., Logan Simpson Design, Inc., AMEC Earth & Environmental, EDAW Inc., and Richard H. French, Ph.D., P.E.

2.4 Location of Study Area

The study area is located in western Maricopa County, Arizona and includes a total watershed area of 183 square miles. Figure 3 shows the location of the study area. Most of the study area is located within the Town of Buckeye. The study area is bounded by the White Tank Mountains and Trilby Wash on the east, the Hassayampa River on the west, the Buckeye Flood Retarding Structures on the south and Gates Road to the north. The watercourses within the study area are all tributaries to the Hassayampa River or the Buckeye Flood Retarding Structures, except Fan 2 which is a tributary to Trilby Wash.

3 ADMP Process

3.1 Process Overview

The highly dynamic nature of alluvial fan flooding presents significant challenges for the design of engineered flood control measures. The designed drainage infrastructure must effectively and efficiently convey 100-year discharges without creating unwanted sediment aggradation or degradation. Further complexity is added as flood hazards change in type and severity with geographic position on the fan whether the area of interest is located at the apex, mid-fan, or near the outfall; and if the flood event is less than the 100-year event.

Known problems associated with alluvial fan flooding include spatial uncertainty of the flow distribution, lack of containment within the relatively flat topographic relief laterally across the fan, avulsive movement of defined flow paths, flooding along undefined flow paths, sheet flooding, distributary flow, scour, and landform aggradation (Figure 6). In addition, steep channel slopes between fan apices and fan toes result in high flow velocities with enough energy to move significant volumes of sediment and debris during large floods (Figure 6).

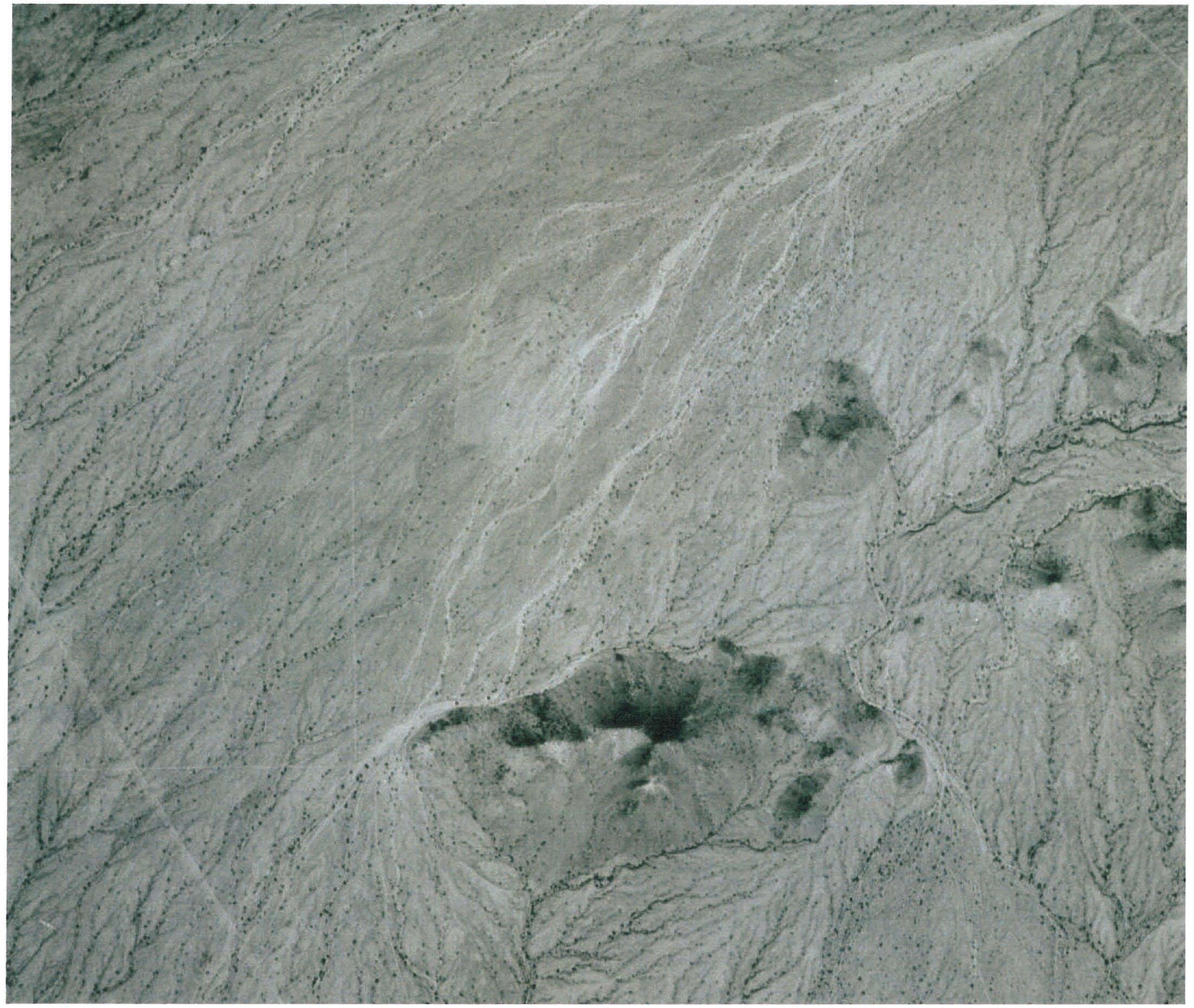

Figure 6 Aerial view of active portion Fan 36 in the FRS 1 Sub-area dated 1954

The Step 1 Preliminary Alternatives Evaluation presented the outline for the alternatives to be analyzed as part of the Step 2 Proposed Alternatives Evaluation. The Step 1 Preliminary Alternatives Evaluation process identified five areas within each fan starting from upstream to downstream: 1) Apex, 2) Up Fan 3) Parkway 4) Down Fan and 5) Outfall (Figure 7). Flooding and drainage characteristics vary for each of these component areas of the alluvial fan landform. This classification permits the design process to identify potential flood control measures specific to each of these areas which, in combination, comprise a whole-fan solution. The whole-fan solution provides a regional flood control system which acts as a major trunk drainage system for the adjacent watersheds. The trunk system is designed to convey runoff and sediment inflows from the apex plus that generated from the fan surface itself. Note that most, but not all, of the alluvial fans considered in this study have all the five component areas (Figure 8). However, the overall design considerations are similar for all the fans.

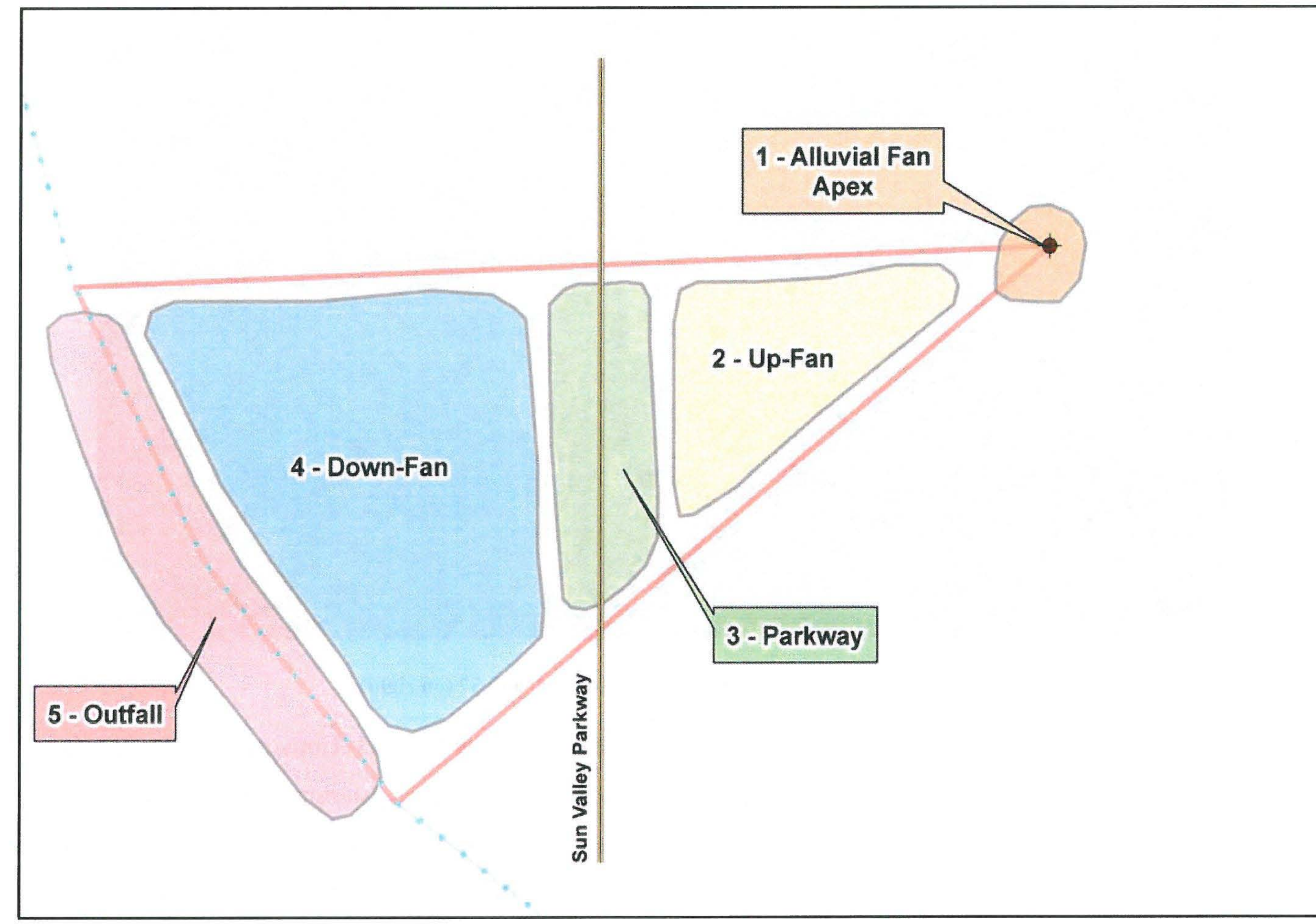

Figure 7 Fan Area Classification

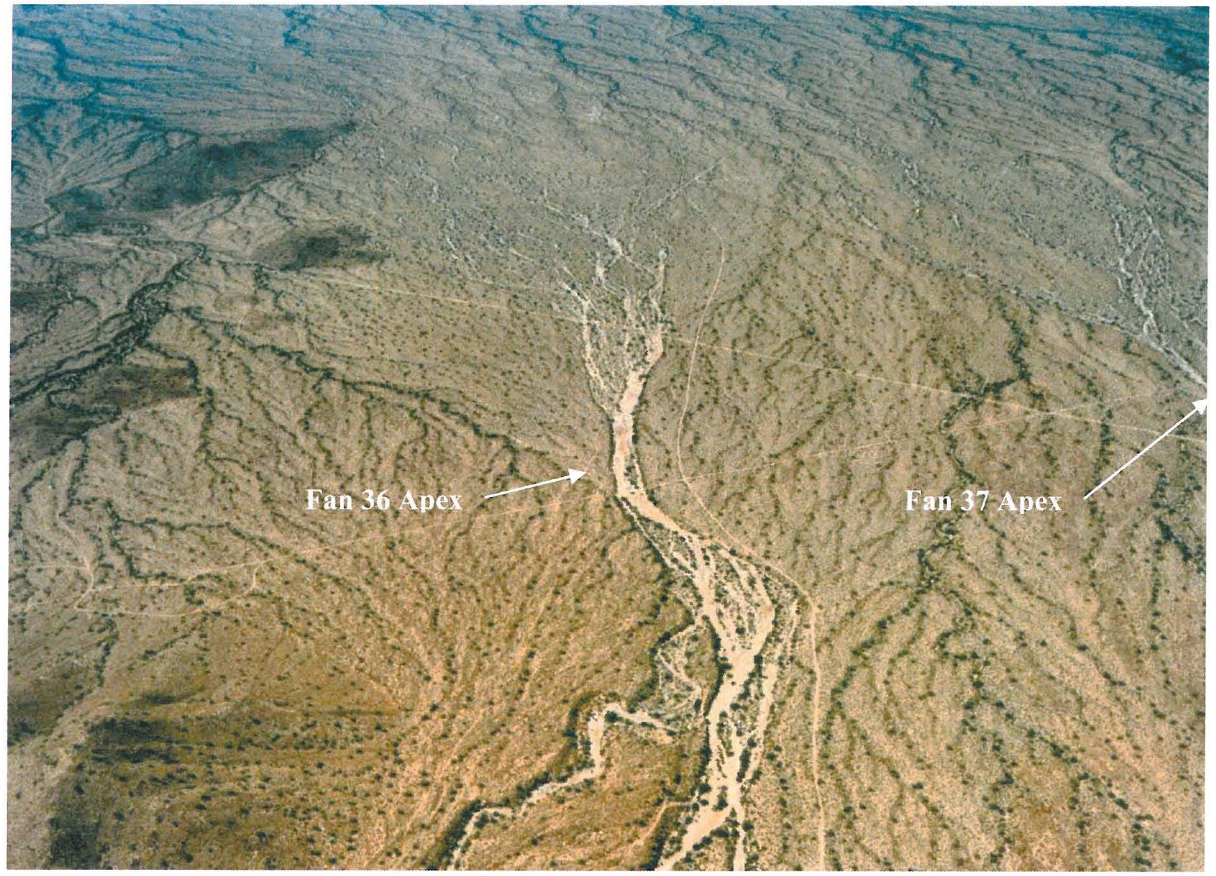

Figure 8 View downstream of Fan 36 (center) and 37 (on right)

The Step 1 process also identified the following design strategies: 1) Conveyance, 2) Storage, 3) Management, and 4) No Measure. These strategies apply to each of the five areas starting from apex to the outfall and form the basis of the Preliminary Alternatives. Four major alternatives were identified based on these strategies: Alternative A, Alternative B, Alternative C, and Alternative D. These four alternatives consist of different combinations of strategies for each of the different areas from apex to outfall. Each alternative can be described as a particular set of strategies applicable to different areas of the fan. In this study, these four alternatives are considered as part of the Step 2 Proposed Alternatives Evaluation process through refinement of the Step 1 concepts.

In order to address alluvial fan flooding hazards in the Sun Valley study area, regional whole-fan alternatives consisting of a suite of structural and non-structural measures will be required. The major structures considered in the Step 2 design approach are detention basins and open channel conveyance corridors. Detention basins reflect the Step 1 Storage strategy, while the channel corridors reflect the Step 1 Conveyance strategy.

Non-structural measures are also considered for the SVADMP alternatives. The Step 1 Management strategy includes development guidelines, floodplain delineation studies, flood detection network recommendations, and/or voluntary flood-prone property acquisition to mitigate impacts to current downstream private landowners and to prevent/mitigate impacts of future development. Management strategies are addressed in the Step 2 Proposed Alternatives Report.

The Step 1 process also defined the No Measure strategy including enforcement of existing regulations and the permitting process, allowing developers to address flood control issues within their parcel footprints in a manner compliant with existing regulations and approved by the District through permitting process. Thus, the No Measure strategy represents a non-structural solution in that no regional flood control solution is a part of this strategy.

The Alternatives A, B, C, and D formulated in the Step 2 process consist of particular combinations of detention basins, conveyance corridors, developer-planned drainage improvements, and 'no measure' options applied to different areas of the alluvial fan starting upstream at the apex to the downstream outfall. The formulation of the alternatives in terms of the specific combinations of structural and non-structural measures selected for the various portions of the alluvial fans are driven by the selection of the measures at the fan apices. For example, Alternative B includes a detention basin located at the fan apex to control flow and sediment discharges to downfan areas. Open channel corridors along multiple alignments contain and convey design discharges through the up-fan area. Off-line detention basins are considered as part of cross and/or lateral drainage improvements at Sun Valley Parkway, outletting through culverts to the down-fan area conveyance corridors to outfall structures.

During the Step 2 process, Alternative B was further subdivided into five similar, but unique alternatives named B1, B2, B3, B4, and B5. This was done primarily to evaluate the following: 1) influence of size of the apex detention basin on the design of the downfan system; 2) different channel cross-section types; and 3) various channel alignments. Further details on each alternative are presented in Section 4.3.

3.2 Additional Process Background for Step 2 Alternatives Formulation

During the initial Step 2 analyses, multiple stakeholder and team meetings were held to discuss the alternatives development. Stakeholders included in the process are listed in Table 1. The stakeholder process included Stakeholder Workgroup meetings as well as numerous individual meetings with stakeholders and the project team. Specific input was received about the potential challenges to direct impacts to existing riparian areas as a result of implementation of the alternatives. In addition, concerns were raised about the scale of proposed facilities. As a result, the so-called 'companion channel' and 'leveed corridor' alternatives were generated for evaluation in Step 2. These alternatives are described further in Section 4.3. Another result of these meetings was to limit detention basin depths to no greater than 11 feet to reduce concerns about relative scale of the basins to neighboring developed features like houses.

Table 1 SVADMP Stakeholders

Meeting No.	Date	Agency	Purpose
1	3/7/2005	MCDOT	Sun Valley Parkway Corridor Study
2	7/14/2005	Fisher/ Williams	Skyline Wash coordination
3	8/10/2005	MCDOT	Sun Valley Parkway Corridor Study and culvert analysis
4	8/16/2005	Agency and Private Sector Stakeholders	Stakeholder Working Group Meeting 1
5	8/25/2005	MCDOT	Sun Valley Parkway Corridor Study
6	8/31/2005	Town of Buckeye	Project coordination, implementation, maintenance
7	9/7/2005	AZ Game & Fish	Project coordination, implementation
8	9/28/2005	CAP	Project coordination, implementation
9	9/30/2005	FRS #1 Sub-area Developers/ Engineers	Project coordination, data collection, implementation
10	10/3/2005	Area 4 N of CAP Sub-area Developers/ Engineers	Project coordination, data collection, implementation
11	10/18/2005	Hassayampa Sub-area Developers/ Engineers	Project coordination, data collection, implementation
12	10/19/2005	Town of Buckeye	Project coordination, implementation, maintenance
13	10/24/2005	ASLD/ Consultant	Project coordination, data collection, implementation
14	11/9/2005	ASLD/ Consultant	Project coordination, data collection, implementation
15	11/9/2005	Town of Buckeye	Project coordination, implementation, maintenance
16	11/22/2005	Fisher/ Williams	Skyline Wash coordination
17	11/29/2005	Public and Private Sector Stakeholders	Stakeholder Working Group Meeting 2
18	12/16/2005	Pulte/CMX	Fan 38 coordination
19	1/26/2006	Developers/ Engineers	Feedback regarding Step 2 alternatives
20	1/26/2006	Town of Buckeye	Project coordination, implementation, maintenance
21	2/8/2006	Town of Buckeye	Project coordination, implementation, maintenance
22	2/9/2006	ASLD/ Consultant	Project coordination, data collection, implementation
23	2/28/2006	Vistoso/ Carter Burgess	Project coordination, data collection, implementation
24	3/8/2005	General Public	Public Meeting 1
25	3/23/2006	Vistoso/ Carter Burgess	Project coordination, data collection, implementation
26	3/23/2006	Lennar/ CVL	Rec Alt coordination, data collection, implementation
27	3/23/2006	Capitol Pacific Homes/ CVL	Rec Alt coordination, data collection, implementation
28	3/28/2006	Stardust/ DEA	Rec Alt coordination, data collection, implementation
29	3/30/2006	Pulte/CMX	Rec Alt coordination, data collection, implementation
30	4/5/2006	Communities Southwest/ WRG	Rec Alt coordination, data collection, implementation
31	4/12/2006	Town of Buckeye	Rec Alt coordination, data collection, implementation
32	4/20/2006	ASLD/ Consultant	Rec Alt coordination, data collection, implementation
33	4/20/2006	MCDOT/ Consultant	Rec Alt coordination, data collection, implementation
34	5/1/2006	Stardust/ DEA	Project coordination

3.3 Landscape Character Assessment

The scope of work for the ADMP specifically states that the alternatives to be developed for the ADMP in Step 2 "are environmentally friendly and blend with the natural landscape of the area following the District's *Policy for the Treatment and Landscape of Flood Control Projects*". The alternatives presented in Section 4.3 all include enhancement elements to ensure that the proposed alternatives meet these objectives. In addition, the cost estimates also include the costs associated with these landscape enhancements.

3.4 Stakeholder and Public Involvement

The District and ADMP project team conducted an extensive stakeholder and public involvement process as part of the ADMP in general, and Step 2 in particular. Numerous group and individual meetings were held with the impacted parties in the area (Table 1). Input was received and two-way communication conducted to ensure clear understanding by the project team and the stakeholders as to the nature of the proposed alternatives and project progress. Ultimately, the close interaction of the project team and stakeholders had a significant impact on the nature and the evaluation of the proposed alternatives for the SVADMP.

4 DESCRIPTION OF ALTERNATIVES

Flood control alternatives for the SVADMP area included both structural and non-structural solutions. Given the landscape compatibility assessment, non-structural solutions are generally preferred whenever possible. However, for the areas impacted by active alluvial fans, the degree, extent, and uncertainties associated with the flood hazards are considered too extreme to make fully non-structural alternatives feasible. Therefore, for the areas impacted by large active alluvial fan flooding, structural measures are central to the proposed flood control alternatives evaluated in Step 2 of the ADMP.

The study area was divided geographically into sub-areas to focus the attention of appropriate structural or non-structural flood control alternatives for each sub-area. The area north of the Central Arizona Project (CAP) Canal is not impacted by large, widespread alluvial fan flooding and was therefore addressed separately. Most of the remainder of the study area south of the CAP is impacted by large active alluvial fans along the White Tank Mountains piedmont. This area south of the CAP was the focus of most of the ADMP alternatives development and evaluation tasks. In addition to the sub-area specific flood control alternatives, be they structural or non-structural, other general flood hazard related issues exist across the study area. These issues are addressed through a category called "areawide" issues.

The following sections describe the structural and non-structural flood control alternatives evaluated in Step 2 of the SVADMP for the Wagner Wash sub-area. The North of CAP sub-area is addressed in Volume 1. Additional details on the other piedmont sub-areas are provided in Volumes 2 and 4-7 of the Step 2 Proposed Alternatives Report.

4.1 Areawide

A number of general, or areawide, flood hazard related issues were identified and addressed in the Step 2 portion of the ADMP. Many apply to the Wagner Wash sub-area. Again, non-structural flood control alternatives are preferred. Therefore, many of the areawide issues are addressed with a non-structural approach. In other cases, areawide issues related to existing or potential future structural flood control measures. The following areawide items were noted:

Piecemeal solutions – Engineers do not recommend piecemeal construction of flood control projects (except for construction phasing) due to potential for conflicts in design and construction practice, inability to tie in to previously constructed sections, and the potential for permanent gaps. Other concerns with piecemeal flood control solutions include reflective scour, flanking of partial systems, first-come, first-serve inequities, landscape aesthetics, timing issues or other unplanned phasing complications, and potential changes in the regulatory environment whether it be FEMA, Section 404 Clean Water Act, or local ordinance changes. Piecemeal flood control solutions apply to any system including floodway fringe encroachments and channelization. Therefore, whenever structural solutions are proposed to address localized flood or erosion problems in the area, special attention should be paid to address the incompatibility concerns arising from piecemeal solutions.

Stock tanks - Stock tanks present several potential challenges and issues for future development in the area. Though stock tanks are structural flood control facilities of a sort, they are rarely engineered and pose a potential hazard in the event of an embankment failure. The failure of a stock tank can create a larger magnitude flood wave than had the tank not been present. Seventeen stock tanks were identified in the area. Thirteen of those are located north of the CAP Canal. As part of the SVADMP, it is therefore recommended that stock tanks be removed whenever possible as an area develops.

Other floodprone areas (i.e. non-fan floodplains) – It should be remembered that while much of the area is dominated by alluvial fans and their associated flood and sedimentation hazards, other locations within the study area are subject to riverine or sheetflooding conditions. It is recommended that floodplain management be the preferred approach to address future development in areas not specifically impacted by the large active alluvial fans in the area.

ADMS Development Guidelines – The Development Guidelines from the Buckeye / Sun Valley ADMS were reviewed as part of the ADMP proposed alternatives development. The review revealed that the suggested guidelines were focused on single lot development and were not especially applicable to master planned community development as they generally promote application of non-structural flood control measures. The SVADMP study area will be almost exclusively developed as a series of large master planned communities many directly impacted by large active alluvial fans. Therefore, the majority of the development guidelines from the ADMS are not recommended for application to the ADMP. However, the Development Guidelines from the Buckeye / Sun Valley ADMS do specifically identify a goal for flood control features for the area that provides a regional solution, controlling the apex of the active alluvial fans and conveyance of flow through the entire fan. The structural solutions in the Step 2 proposed alternatives for the piedmont sub-areas all achieve this objective.

Flood warning – Another areawide flood hazard mitigation measure could be the development of a flood warning system for the area. Instead of, or in addition to, other structural or non-structural flood control measures, flood detection technologies could be deployed in the study area to warn existing and future residents of the forecast or occurrence of severe weather. Recommendations for the placement of flood detection equipment and/or the development of a flood response plan are part of the Step 3 Recommended Alternative for the ADMP. However, a detailed flood response plan is not part of this project.

4.2 Sub-Areas

To aid the Step 2 alternatives development and evaluation beyond the areawide issues, seven sub-areas within the SVADMP study area were identified:

1) North of CAP (Volume 1)
2) CAP (Volume 2),
3) Wagner Wash (this volume),
4) Hassayampa River (Volume 4),
5) White Tanks Wash (Volume 5),
6) FRS #1 (Volume 6), and
7) FRS #2 & #3 (Volume 7).

The sub-areas are based on the outfall locations and the fans discharging to a particular outfall location. For example, fans that drain to Wagner Wash are included in the Wagner Wash sub-area. The sub-areas also represent the hydrologic watershed for the particular outfall location. The sub-area boundaries and fan apices are shown in Figure 9.

This report presents the details of the Step 2 Proposed Alternatives for the Wagner Wash sub-area. Volume 1 provides an overview of the Step 2 Proposed Alternatives for the entire study area. Additional details for the other five alluvial fan sub-areas south of the CAP Canal are presented in separate companion reports (Step 2, Volumes 2 and 4-7).

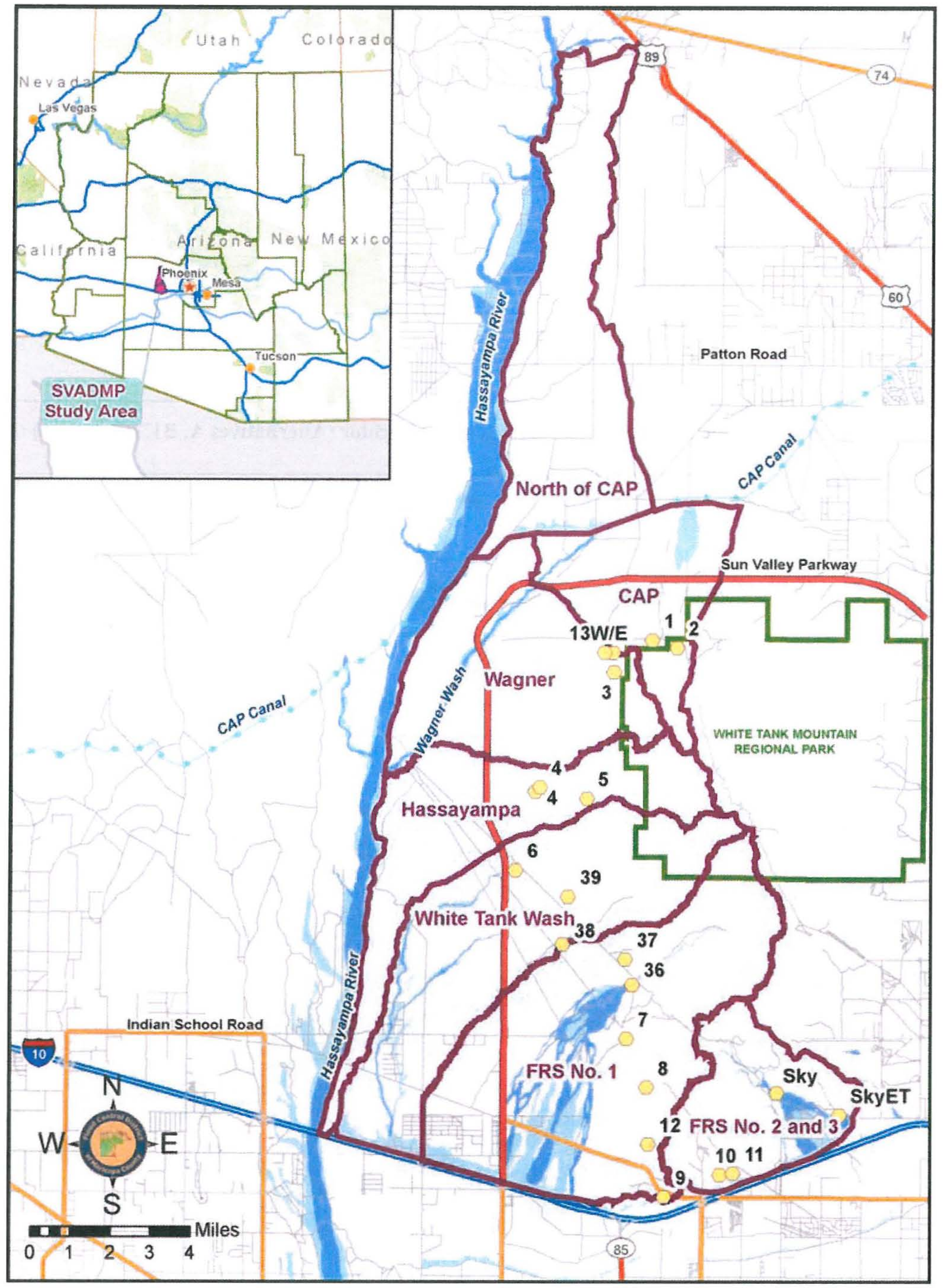

Figure 9 ADMP Sub-Areas

4.3 Piedmont Sub-Areas Alternatives Classification

The Step 1 Preliminary Alternatives Evaluation classified the Alternatives into 4 categories, namely Alternative A, Alternative B, Alternative C, and Alternative D. In this study, the concepts developed during Step 1 process were expanded and refined. Alternative B was further subcategorized into B1, B2, B3, B4, and B5 as listed below. Table 2 provides brief descriptions of the four alternatives.

Table 2 Descriptions of Alternatives

Alternative	Description
A	No measure at apex / Leveed channel section
B1	Big on-line detention basin / Small leveed channel section
B2	Small on-line detention basin / Big leveed channel section
B3	On-line detention basin / Earthen 'companion' channel
B4	On-line detention basin / Leveed channel section along different alignments
B5	Off-line detention basin / Leveed channel section
C	No measure at apex / Concrete 'companion' channel
D	No measure (Whole Fan)

Again, while the flood control alternatives for the active fans in the piedmont sub-areas focused on structural mitigation of the alluvial fan flood and sedimentation hazards, non-structural elements were included wherever possible. In addition, some of the alternatives have greater or lesser degrees of non-structural elements which varies by sub-area. The following sections provide an overview of each of the types of alternatives A-D for the piedmont sub-areas south of the CAP Canal. Additional details for all of the individual piedmont sub-areas are provided in Volumes 2 and 4-7 of the Step 2 Proposed Alternatives Evaluation Report.

4.3.1 Alternative A

The area downstream of the apex represents a region of significant alluvial fan instability. The alluvial fan instability, in turn, results in the uncertainty of flow paths. The region of significant alluvial fan instability can be identified to a reasonable extent. The Step 1 process defines the Alternative A to represent "No Measure" at the apex. The main design objective of this alternative is to allow the natural geomorphic processes to occur within a designated active area downstream of the apex. This provides a largely non-structural approach to the treatment of the alluvial fan hazards near the apex. Downstream of the region of active fan processes, flows will be controlled by structural means; that is, captured via diversion levees/dikes, and collector channels. Once collected, the flows are routed downstream using leveed channel sections, culverts, and detention basins (if needed) until the flows reach the outfalls. In some cases, like Wagner and White Tanks Wash sub-areas, the outfall is a large existing riverine riparian wash system. In these cases a non-structural, floodplain management approach is inherent to the alternative for these reaches.

The advantage of Alternative A is that it minimizes environmental impacts near the apex by preserving existing natural conditions. The main disadvantage is the cost of land set aside to allow for the natural alluvial fan processes.

4.3.2 Alternative B

Alternative B is based on a structural flood control strategy at the apex. The objective of Alternative B is to capture all of the upstream flow at the apex using on-line detention basins. The presence of a detention basin at the apex eliminates the downstream alluvial fan uncertainties. Once collected into the detention basins, flows are routed downstream using open channels, culverts, and additional detention basins (if needed) until the flows reach the outfalls. Again, for Wagner and White Tank Wash within the study area, a non-structural, floodplain management approach is included in the B alternatives for those sub-areas.

This approach increases channel stability by eliminating flow path uncertainty beginning at the apex. This alternative also offers better management of sedimentation issues by capturing incoming sediment directly into the basin. In addition, the alternative provides a continuous, comprehensive flood control trunk system which minimizes the impacts of phasing of developments in the Sun Valley Area.

Alternative B is classified into further sub-categories based on 1) sizing of structures, 2) different channel cross-section types, and 3) different alignment of channels. Alternatives B1, B2, B3, B4, B5 and C represent different combinations of these sub-categories (See Table 3 for details).

Sizing of Basins

The effect of basin size at the apex is evaluated by comparing the effects of a big excavated basin to that of a smaller basin at the apex. The variation in the sizing of the basin at the apex influences the size of the downstream structures. For example, the smaller upstream basin results in a wider channel immediately downstream. The evaluation of basin size is applied to the fans in the CAP and White Tank Wash sub-areas because of their straightforward channel alignment options. Alternatives B1 and B2 represent the big and small basin options and a comparison between these two alternatives was performed to evaluate the effects of basin size on the overall design.

Variations in Channel Cross-sections

<u>Leveed Channel Corridor Section</u> – The existing natural corridor is laterally contained on two sides using a levee. The levee ensures flow containment within the natural corridor while allowing the channel to naturally adjust to the higher discharges resulting from flow concentrations. Figure 10 shows a schematic of the cross-section for the earthen levee natural channel corridor. Walls could be also considered instead of earthen levees to provide flow containment for the natural channel sections. Figure 13 shows the natural channel section with walls as the alternative bank structure. The channels for the A, B1, B2, B4 and B5 alternatives are designed with an earthen leveed natural channel section.

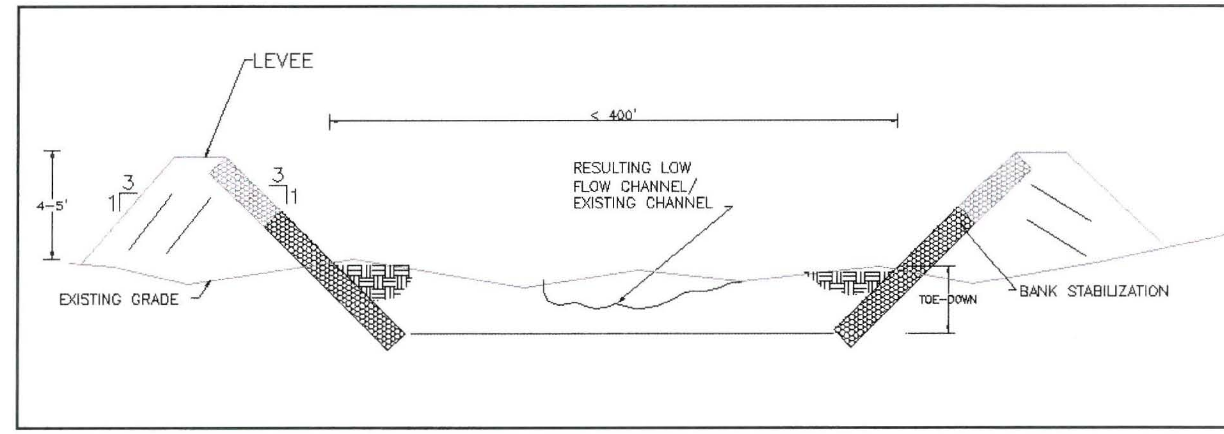

Figure 10 Concept Cross Section for Earthen Leveed Corridor (Alternatives A, B1, B2, B4, B5) (Not to scale)

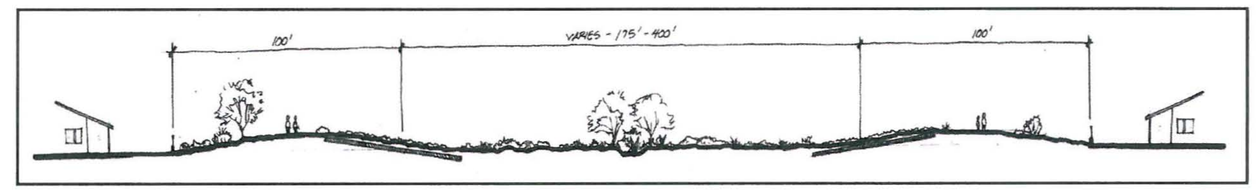

Figure 11 Concept Cross Section for Earthen Leveed Corridor with Landscape Compatibility Enhancements (Alternatives A, B1, B2, B4, B5) (Not to scale)

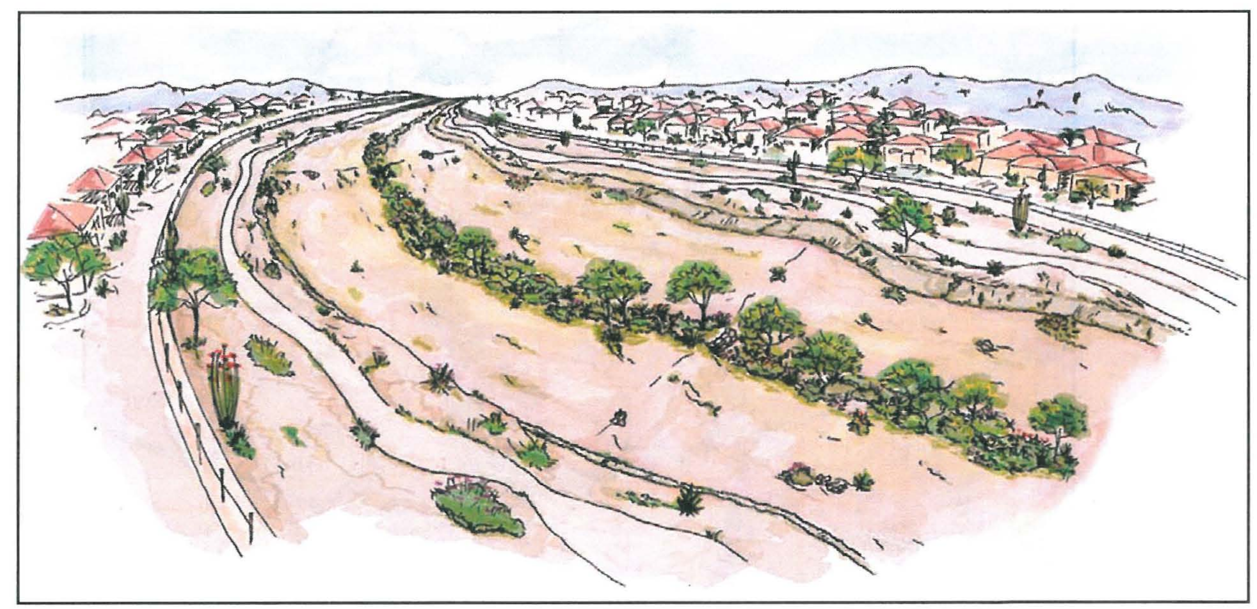

Figure 12 Oblique View of Earthen Leveed Corridor with Landscape Compatibility Enhancements (Not to scale)

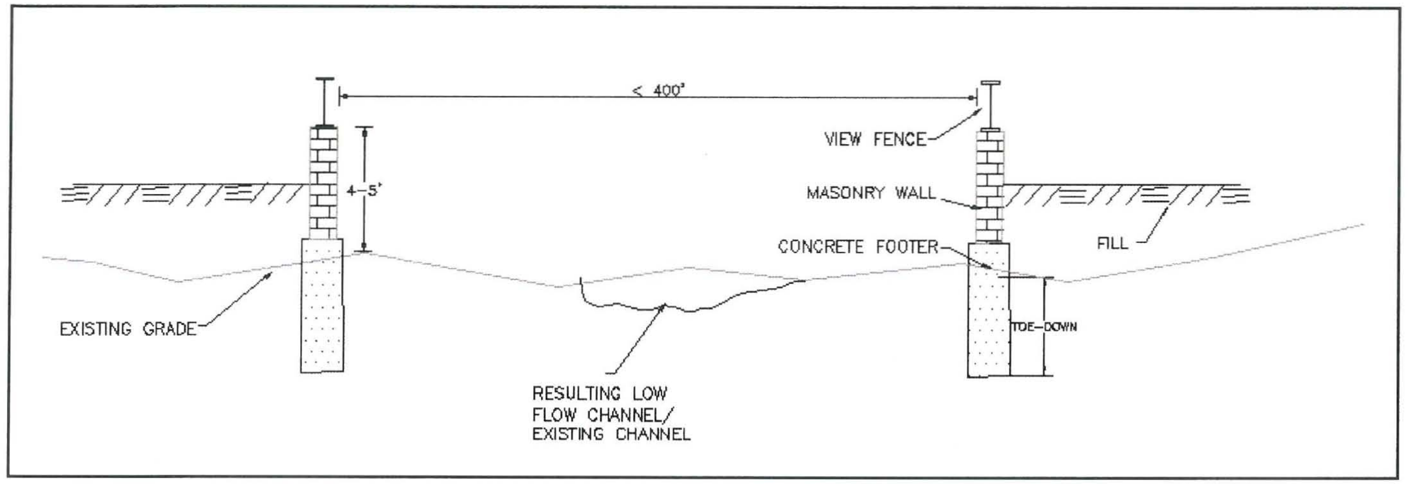

Figure 13 Concept Cross Section for Leveed Corridor with Walls (Alternatives A, B1, B2, B4, B5) (Not to scale)

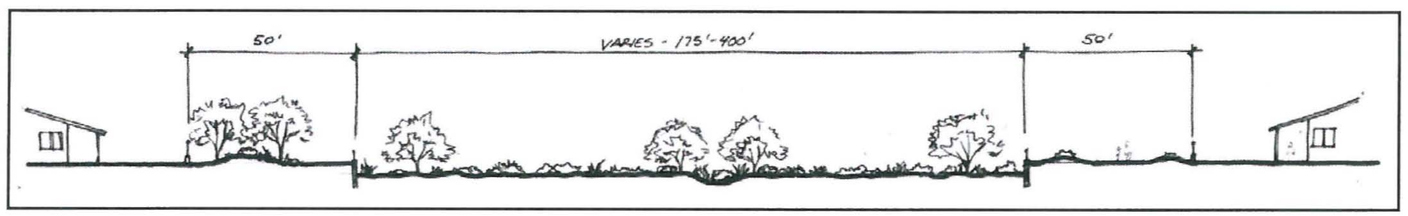

Figure 14 Concept Cross Section for Leveed Corridor with Walls & Landscape Compatibility Enhancements (Alternatives A, B1, B2, B4, B5) (Not to scale)

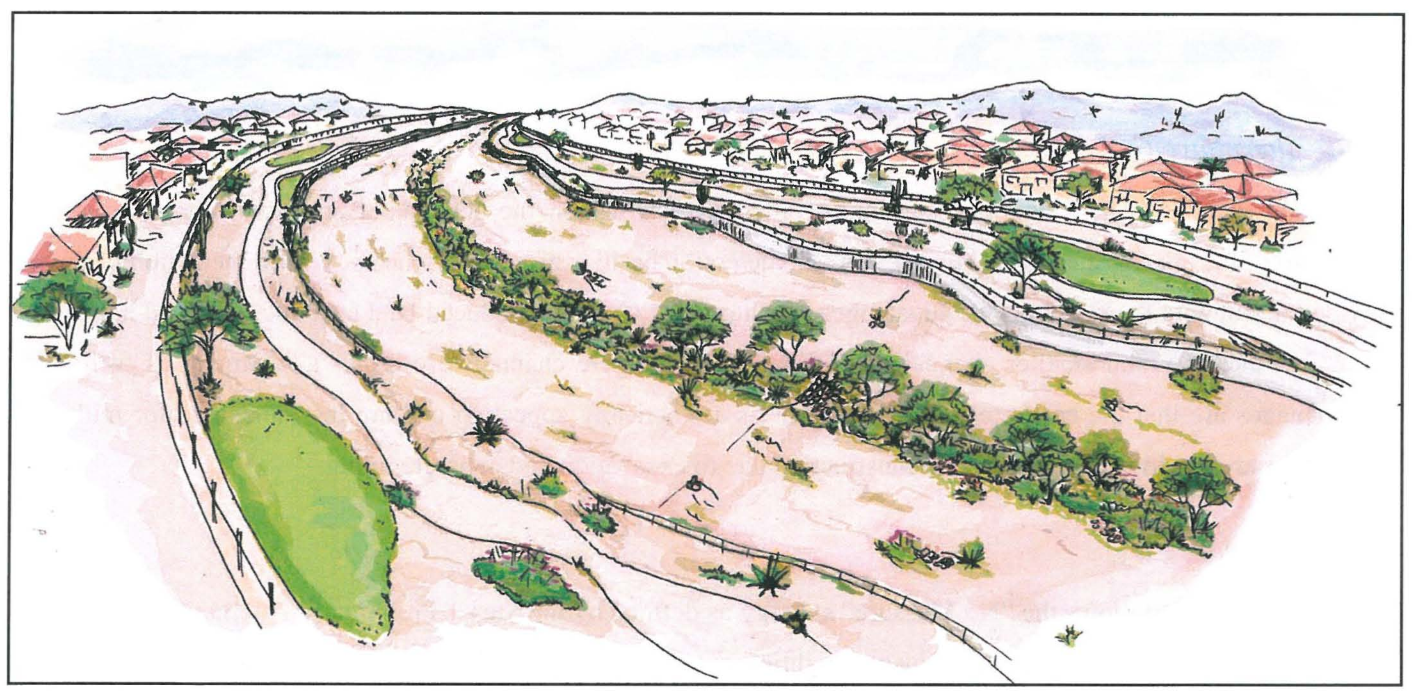

Figure 15 Oblique View of Walled Corridor with Landscape Compatibility Enhancements (Not to scale)

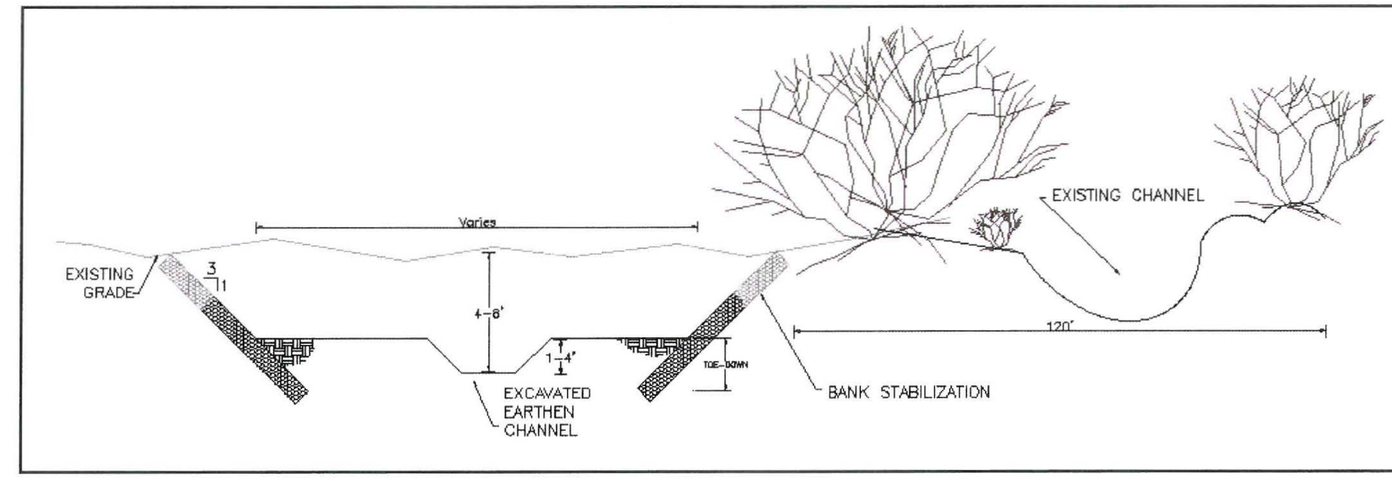

Figure 16 Concept Cross Section for Earthen Companion Channel (Alternative B3) (Not to scale)

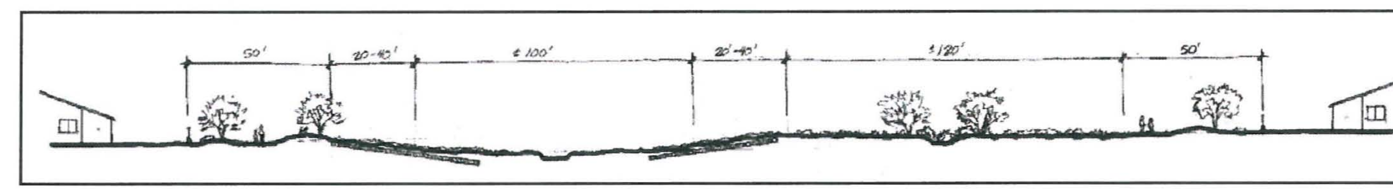

Figure 17 Concept Cross Section for Earthen Companion Channel with Landscape Compatibility Enhancements (Alt B3) (Not to scale)

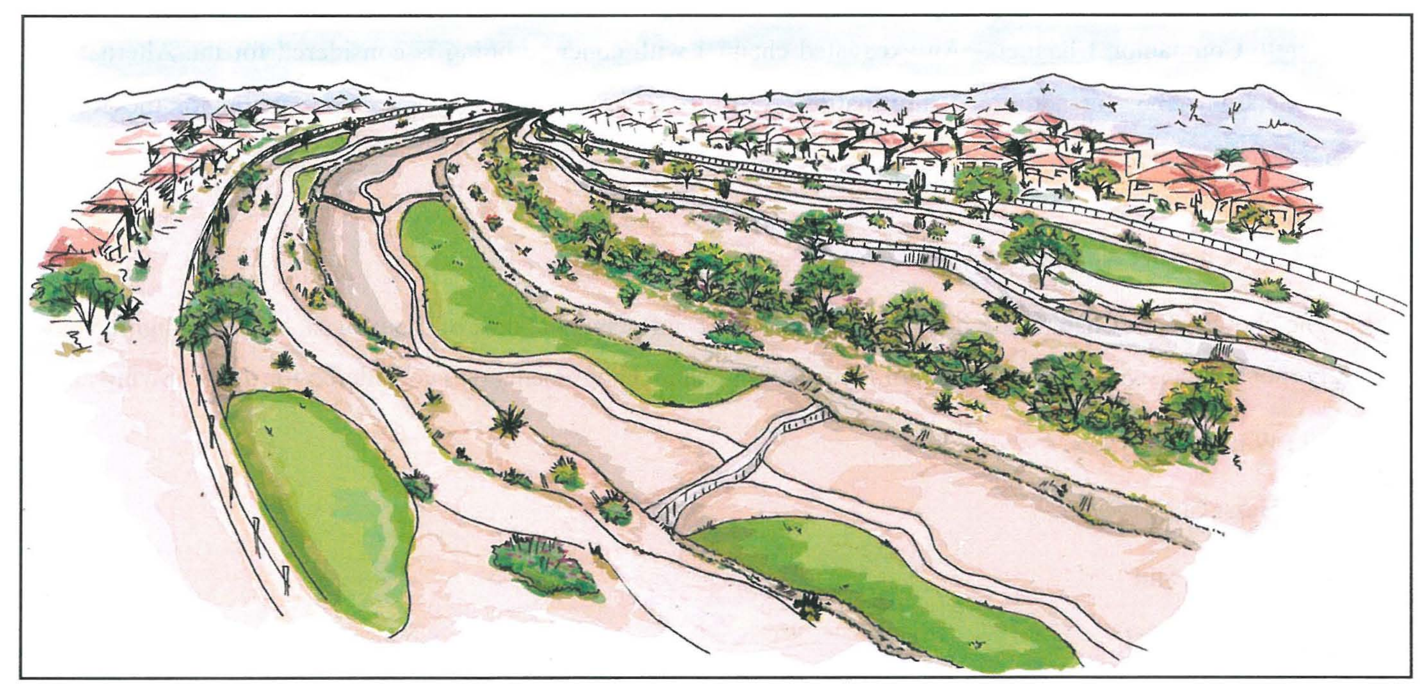

Figure 18 Oblique View of Earthen Excavated Companion Channel with Landscape Compatibility Enhancements (Not to scale)

Earthen Companion Channel – An excavated channel with earthen lining is located adjacent to the existing corridor to convey the flow. The channel is placed adjacent to the existing corridor so that the natural watercourse habitat is not disturbed. Figure 16 shows the concept cross-section for the earthen companion channel. The earthen companion channels are incorporated in Alternative B3.

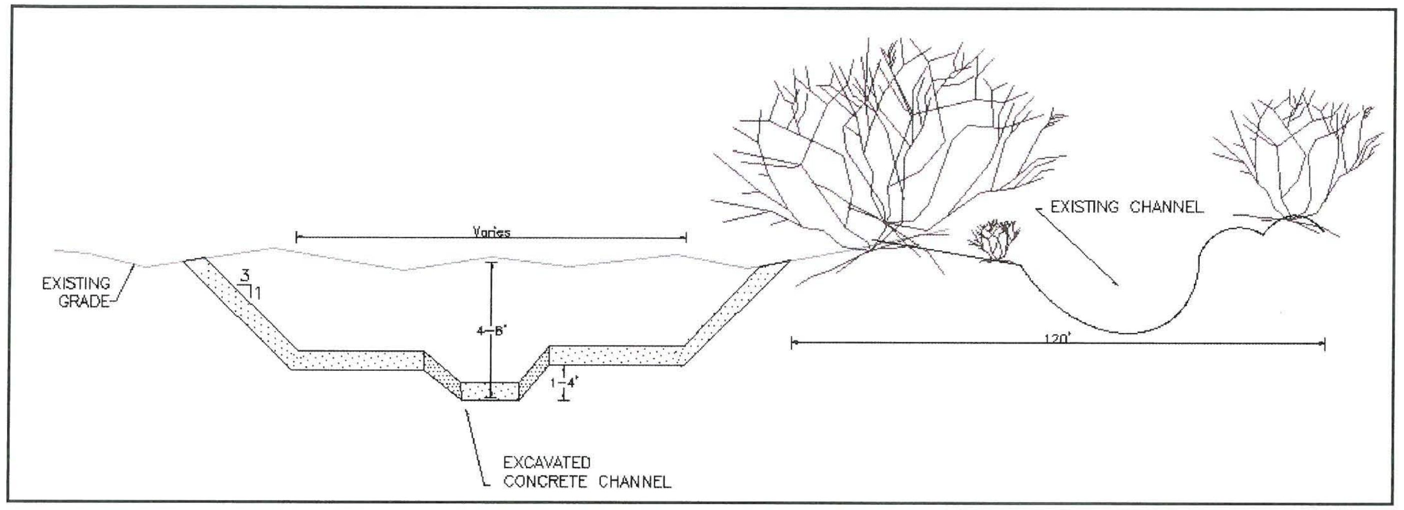

Figure 19 Concept Cross Section for Concrete Companion Channel (Alternative C) (Not to scale)

Concrete Companion Channel – An excavated channel with concrete lining is considered for the Alternative C (See Section 4.3.3. for additional information). Figure 19 shows the concept cross-section for the concrete companion channel.

Variations in Channel Alignments

The choice of the channel alignment can significantly influence the cost of the project. Longer alignments are typically more expensive. The evaluation of the different channel alignments was considered for the following areas:

1) Wagner Wash,

2) Hassayampa River,

3) FRS #1, and

4) FRS #2 & #3.

These sub-areas provide clear possibilities for channel alignment variations. To the contrary, multiple channel alignment were not considered for the CAP and White Tank Wash sub-areas because of their straightforward channel alignment options. The evaluation of the variations in channel alignment was considered as Alternative B4 which was subdivided into B4-1, B4-2 and B4-3 to represent three different channel alignment variations. The other design considerations for Alternative B4 are similar to Alternative B1. Table 3 shows the various design options chosen for each piedmont sub-area.

Table 3 Design Options for Alternatives

Subarea	A	B1	B2	B3	B4	B5	C
CAP	SA, LVC	BB, LVC	SB, LVC	BB, EXCEC	N/A	OB, LVC	BB, EXCCC
Wagner Wash	SA, LVC	N/A	SB, LVC	BB, EXCEC	BB, LVC, 3 Alignments	N/A	BB, EXCCC
White Tank Wash	SA, LVC	BB, LVC	SB, LVC	BB, EXCEC	N/A	N/A	BB, EXCCC
Hassayampa River	SA, LVC	N/A	SB, LVC	BB, EXCEC	BB, LVC, 3 Alignments	N/A	BB, EXCCC
FRS #1	SA, LVC	N/A	SB, LVC	BB, EXCEC	BB, LVC, 3 Alignments	N/A	BB, EXCCC
FRS #2 and #3	SA, LVC	N/A	SB, LVC	BB, EXCEC	BB, LVC, 3 Alignments	N/A	BB, EXCCC

LVC - Leveed Channel, EXCEC - Excavated Earthen Channel, EXCCC - Excavated Concrete Channel
SA - Sedimentation Area, BB - Big On-line Basin, SB - Small On-line Basin, OB - Small Off-line Basin
Note: CAP and White Tank Wash have only one alignment.

Alternative B5 considers an off-line basin at the apex instead of an on-line basin. The off-line basin is designed to be a small basin with the main purpose of reducing the peak flow approximately by 10%. This alternative is similar to Alternative B2 with the only difference being the off-line basin at the apex instead of an on-line basin. Alternative B5 was considered for CAP sub-area and provides a means for evaluating the effectiveness of an off-line basin at the apex.

4.3.3 Alternative C

Alternative C is a structural flood control alternative based on the concept of an excavated concrete-lined channel from the apex to the outfall (Figure 19). No detention basin is provided at the apex. Sedimentation basins are provided throughout the system. The advantages of Alternative C include reduced land cost due to lack of a detention basin near the apex and smaller channel land areas. The concrete channels are easier to maintain as well. The disadvantages are that the concrete channels are not as aesthetically appealing and are less amenable for multi-use. Another disadvantage is the high cost of construction due to excavation and concrete lining.

4.3.4 Alternative D

Alternative D follows the "No Measure" strategy as defined by the Step 1 Preliminary Alternatives Evaluation. This alternative relies on existing drainage facilities or new master-planned communities developing their own drainage infrastructure. Current drainage ordinances and floodplain regulations are enforced to ensure adequate flood hazard mitigation measures. Enforcement options can be enhanced by developing new alluvial fan floodplain delineations.

The major advantage of this alternative is that no immediate and expensive action is needed from the District. The main disadvantage compared to the other alternatives is that there will be no regional whole-fan flood control system leading to unnecessary redundancies, unintentional system discontinuities, and/or potential planning problems. This measure is also likely to leave portions of unstable, active alluvial fan areas open and undeveloped.

5 Step 2 Approach

5.1 Data Collection

5.1.1 Field Survey Information

Refer to the Flood Control District of Maricopa County (District) for field survey information associated with the 10-foot topographic mapping used in the current study.

5.1.2 Mapping

The District provided 10-foot contour mapping and DTM data for use in the hydrologic and hydraulic calculations. That work was done under separate contract for the District in 2000/2001. The flight dates of that mapping were 12-16-00, 12-17-00, and 12-27-00. A triangulated irregular network (TIN) was developed in ArcGIS software using the 10-ft topographic contours. The TIN and the contours were used to obtain all the elevation data used in this study.

5.1.3 Aerial Photographs

The Flood Control District provided aerial photographs for use in the GIS applications.

5.1.4 Existing Culvert Data at Sun Valley Parkway Crossings

The as-builts for the existing culverts at the Sun Valley Parkway were obtained from MCDOT.

5.1.5 Sediment Gradations

Sediment gradations used in this study are based on data collected by Coe and Van Loo, Consultants Inc (CVL). These are the only set of sediment gradation data available at the time of preparation of this report. Additional sediment samples are being collected as part of this study and will be included in the Step 3 refinements of the alternatives.

Upon analyzing the CVL data, the following values were selected for the sediment gradation parameters:

D50 = 1mm	D16 = 0.15 mm	D65 = 1.5 mm
D90 = 5 mm	D84 = 3.5 mm	

5.2 Process Overview and Summary of Design Criteria

The following sections provide a brief overview of the design procedures for each structure type and each alternative. The alternatives themselves are described in Section 6 and Section 10. The design procedures vary by structure type and alternative. However, there is significant commonality between alternatives. Table 4 shows a summary of the design criteria used for each of the Step 2 alternatives. All structures are designed for the maximum peak flow or volume from the 100-year 6-hour or 24-hour event.

Using the criteria shown in Table 4, the structural elements for each sub-area were designed using the following general approach:

- Identify the fan apex/upstream area location and the preferred channel alignment from the apex to the outfall. For Wagner, Hassayampa, FRS 1 and FRS 2 & 3 sub-areas, the preferred channel alignment is one of the alignments in B4-1, B4-2, or B4-3. The alignments for the CAP and White Tank Wash sub-areas are the same for all alternatives.
- Identify the set-aside area (A) or design the detention basin (B) near apex location
- Route flow from the apex to Sun Valley Parkway by designing a leveed corridor (A, B1, B2, B4, B5) or excavated channel (B3, C) along the preferred alignment.
- Design an off-line basin upstream of the culvert location at Sun Valley Parkway if the culvert capacity is not adequate. Off-line basin capacity is the volume of flow above the culvert capacity.
- Route the flows from Sun Valley Parkway to the outfall by designing a leveed corridor or excavated channel along the preferred alignment.
- Prepare cost estimates (see section 9.1) for the land cost, construction cost, landscaping cost, and maintenance cost for the base condition and for the landscape compatibility enhancements.

Sediment is controlled at the apex for all alternatives. For the areas downstream of the alluvial fan apex, sedimentation is controlled in two ways. First, sedimentation basins are provided longitudinally along the channels based on the sediment yield from the contributing area to the design reach. Second, grade control structures are included for the leveed corridors (A, B1, B2, B4, B5) and the excavated earthen channels (B3). All earth bottom corridors also include bank and toe protection from scour.

Table 4 Summary of Design Criteria for Step 2 Alternatives

Alternative	Apex Treatment	Basin Geometry Criteria	Downstream Channel	Hydraulic Criteria
A	Active Area Set-aside	N/A	levee/wall	≈ 4 ft levee height; 4 - 6 ft/s; ≤ 400 foot width
B1	On-line Basin; 10% outflow	Z = 3:1 Function; Z = 6:1 Form; D < 12 ft	levee/wall	≈ 4 ft levee height; 4 - 6 ft/s; ≤ 400 foot width
B2	On-line Basin; 90% outflow	Z = 3:1 Function; Z = 6:1 Form; D < 12 ft	levee/wall	≈ 4 ft levee height; 4 - 6 ft/s; ≤ 400 foot width
B3	On-line Basin; 10% outflow	Z = 3:1 Function; Z = 6:1 Form; D < 12 ft	excavated earthen channel	≈ regime w, d, v
B4	On-line Basin; 10% outflow	Z = 3:1 Function; Z = 6:1 Form; D < 12 ft	levee/wall	≈ 4 ft levee height; 4 - 6 ft/s; ≤ 400 foot width
B5	Off-line Basin; 90% bypass flow	Z = 3:1 Function; Z = 6:1 Form; D < 12 ft	levee/wall	≈ 4 ft levee height; 4 - 6 ft/s; ≤ 400 foot width
C	Sediment Basin Only	N/A	excavated concrete channel	Fr < 0.86; 2-year < 2 ft or 5 ft/s
Note: All channels include longitudinal sediment basins based on sediment yield from contributing area.				

Additional details regarding the design considerations associated with each structural element are discussed briefly in the following sections with additional details also provided in Sections 6, 7, and 8.

5.3 Open Channel Design Considerations

Open channels are used for the "conveyance" strategy as recommended by the Step 1 Preliminary Alternatives process. The channels are aligned along existing natural watercourse corridors in order to preserve the existing natural habitat. Most of the alternatives use the existing channel contained within the earthen levees for conveyance. The exceptions to this are the two alternatives where channel excavation is considered. These are Alternative B3 (Earthen excavated channel) and Alternative C (Concrete excavated channel) which are located approximately parallel and adjacent to the natural corridor. In these cases, a portion of the flows in the excavated channel may have to be diverted into the existing watercourse corridor to preserve the natural habitat.

The channel types are classified into 1) Leveed channel corridor, 2) Excavated channel, and 3) Existing channel. The leveed channel corridor uses the existing watercourse corridor with levees on both sides to contain the flow. The excavated channel can have an earthen or concrete lining and is designed to be excavated below existing ground. The existing channel is any existing channel that is used as part of the design alternative.

The channels are designed to act as a regional flood control trunk system and are sized to convey local drainage as well as sediment from the adjacent watershed area. As part of the Step 2 design process, four discharge values are analyzed to ensure the applicability of the design to a range of flows. The four flows are simply ratios of the 100-year peak flows: 10%, 25%, 75% and 100%. The 10% flow can be expected to approximately represent the 2-year flow, the 25% represent the 10-year flow, and 75% represent the 50-year flow.

Per the District's Hydraulics Manual, minimum freeboard for the open channel is set as the greater of 1 foot and $0.25\,(y + V^2/2g)$. For channels with levees, the FEMA freeboard requirement of 3 feet is applied for the concept designs.

Excavated channels are designed for subcritical flow with Froude numbers less than 0.86. Subcritical design results in flows with lower velocity and are favorable from public safety point of view. The design slopes are flatter than the existing slopes to achieve the subcritical flow.

Velocity in the leveed channel corridors is designed to be 4 to 6 ft/sec. This velocity range is expected to adequately move sediment downstream without being so large as to cause excessive erosion. The width of the leveed natural channel is also restricted to 400 ft. Flow depth in the leveed channel is restricted to 1-2 ft unless the velocity and/or width requirement could not be met simultaneously.

A side slope of 3H:1V is assumed for both the main channel as well as the low flow channel for the base design.

5.4 Inline Sedimentation Basin and Drop Structure Design Considerations

Drop structures and inline sedimentation basins are included to control sedimentation issues. The on-line detention basins collect both sediment and flow volume while the off-line basins collect only the flow volume. As a result, the on-line detention basins also function as sedimentation traps near the fan apices. Inline sedimentation basins are placed within the channels acting as sediment traps to collect any additional sediment influx exceeding the capacity of the designed channel. Excessive sediment influx is possible at all the tributary confluences as well as at confluences of any other inflow that may occur in the future. Sediment yield from the upstream reach as well as adjacent watershed provides estimates of sediments entering the channels and is used to size the inline sedimentation basins. Sedimentation basins/traps are distributed along the reach to avoid serious sedimentation problems at any specific location.

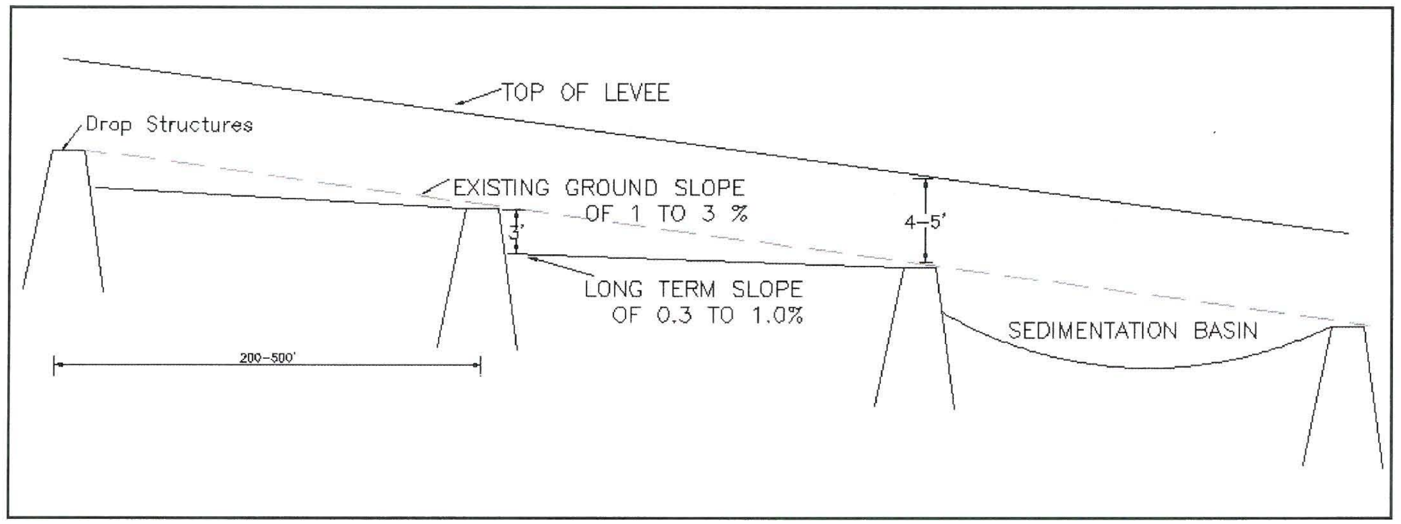

Figure 20 Concept Profile View of Leveed Channel Corridor (Alternatives A, B1, B2, B4, B5) (Not to scale)

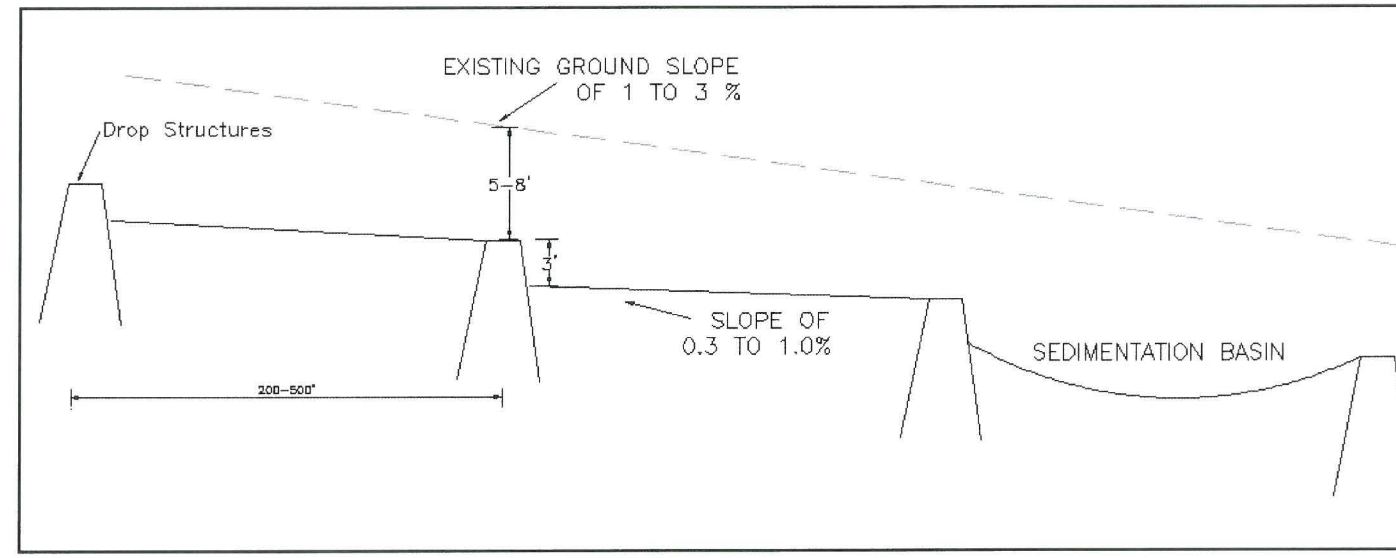

Figure 21 Concept Profile View of Excavated Channel (Alternatives B3 and C) (Not to scale)

The drop structures are designed to be 3 feet high and are spaced accordingly. The 3-foot drop provides a reasonable height from a multiple-use point of view. For the purpose of comparing alternatives considered in the Step 2 process, grade control structures for all alternatives except the concrete excavated channel were assumed to be made of riprap. The riprap is assumed to be buried. The number of drop structures was determined by using the difference between the existing slope and the design slope for excavated channels or anticipated long-term slope for the leveed corridors. The drop structures were spaced to achieve the elevation difference caused by the difference between the existing slope and the design or long-term slope. Figure 20 shows the concept profile view of the leveed channel corridor which is part of A, B1, B2, and B5 alternatives. Figure 21 shows the concept profile view of the excavated channel which is part of the B3 and C alternatives.

5.5 On-line Detention Basin Design Considerations

The on-line detention basins are located mostly at the apices to control the flow and sediment arriving at the fan apices. The basin volume is provided entirely through excavation and is designed to be entirely below existing ground. Raised embankments are not used to provide basin storage volume. Rectangular basins with constant side slopes are considered for the purpose of the base design analyses and sizing. In reality, these would be shaped differently to better fit into the natural setting depending on landscaping and other requirements. The adjustments and cost estimates for these landscape compatibility enhancements are described in Section 9.2. The rectangular basins provide an approximate idea of the required size of basin in terms of storage volume and the minimum land footprint needed to obtain that volume. Figure 22 shows the concept plan view of the on-line basins and Figure 24 shows the concept profile view. Figure 23 and Figure 25 show the on-line basins with landscape compatibility enhancements.

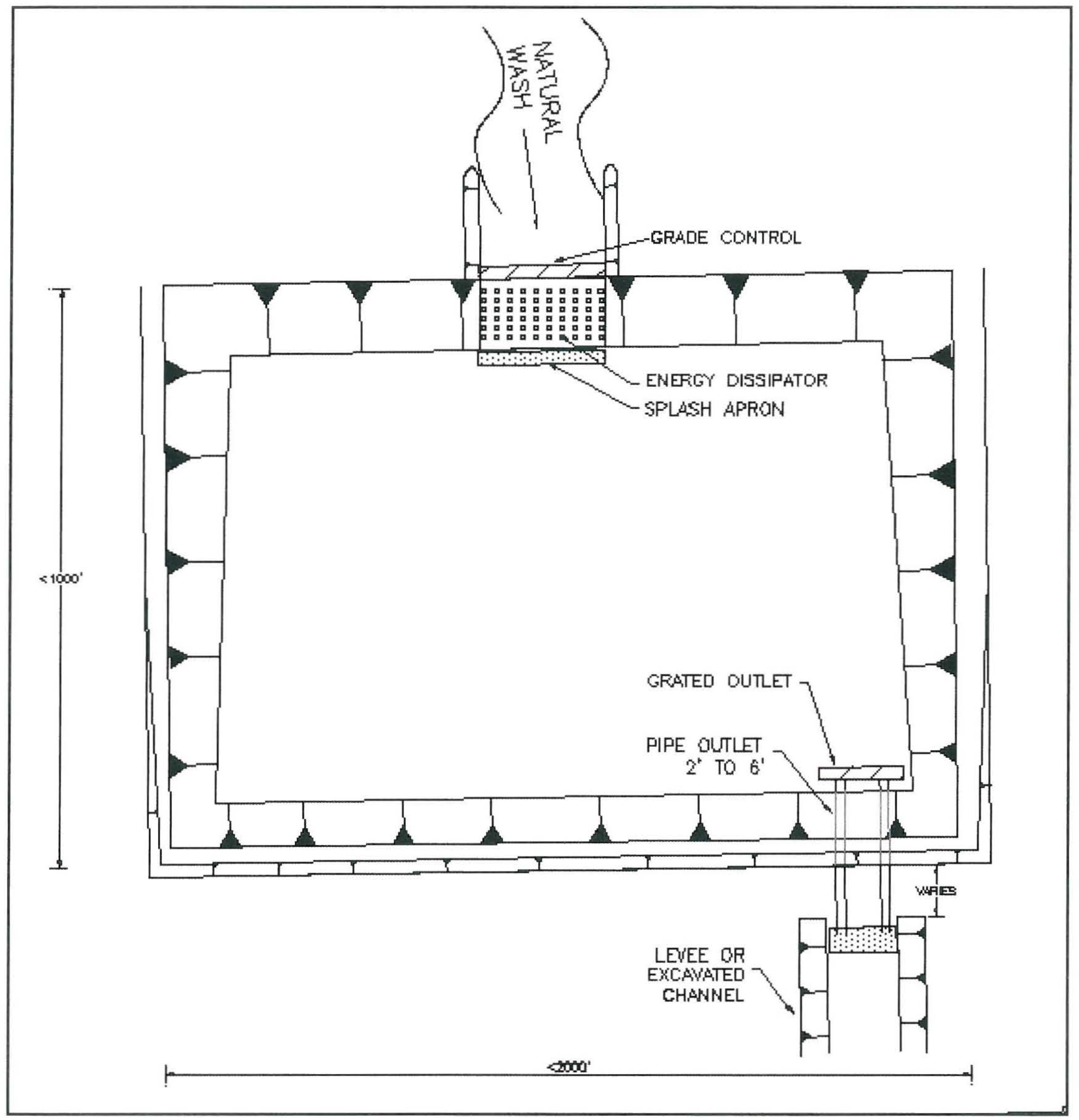

Figure 22 Concept Plan View of On-line Basins for B Alternatives (Not to scale)

Figure 23 Concept Plan View of On-line Basins for B Alternatives with Landscape Compatibility Enhancements (Not to scale)

The big basin option is designed to have a peak outflow of approximately 10% of the peak 100-year design inflow, representing approximately the 2-year flow. The small basin option is designed to have a peak outflow of approximately 90 % of the peak 100-year design inflow.

Pipe outlets are designed to drain the basins. Multiple pipes are needed when the basins are small compared to the total flow volume entering the basins. Appropriate hydraulic equations are used to determine the stage–discharge relationships. Sediment yield from the upstream watershed is used to estimate inflowing sediment volume.

The existing topographic slope was determined from the 10-ft topographic mapping contours. The existing slopes near the apices are approximately 2-3%. These steep slopes result in considerable elevation differences between the upstream and downstream ends of the basins. Basins are designed to have longer dimensions perpendicular to flow direction to minimize the cut-slope exposure on the upstream side of the basins. This gives a minimum basin dimension along the topographic slope and reduces the visual impact of the basins.

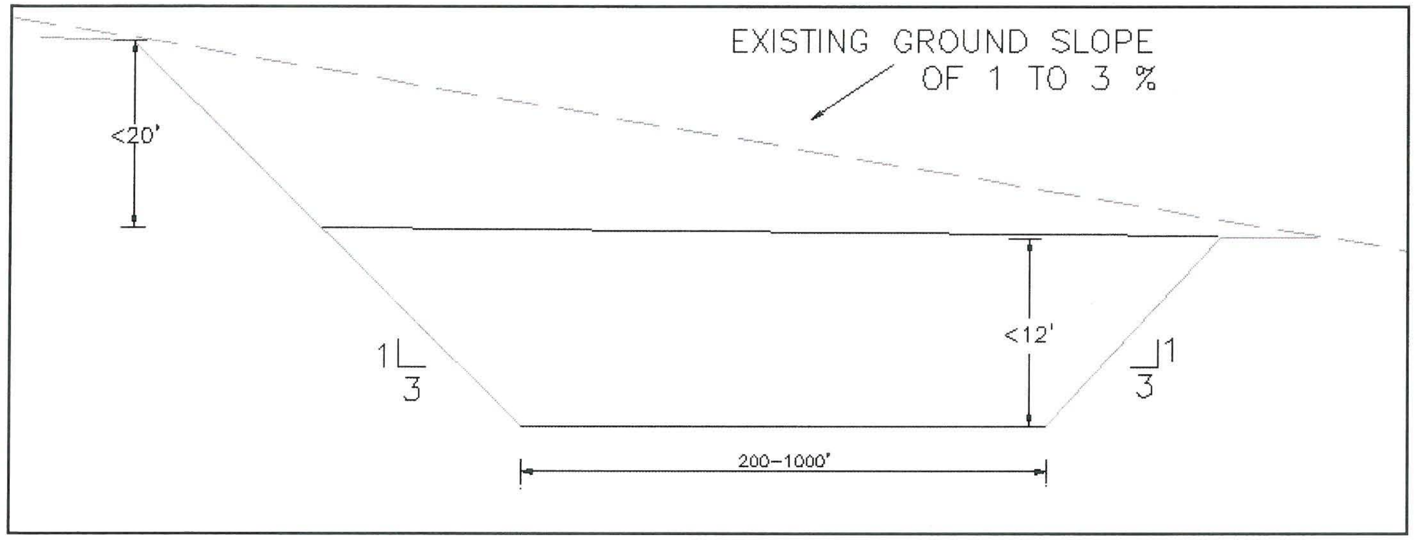

Figure 24 Concept Profile View of On-line Basins (Not to scale)

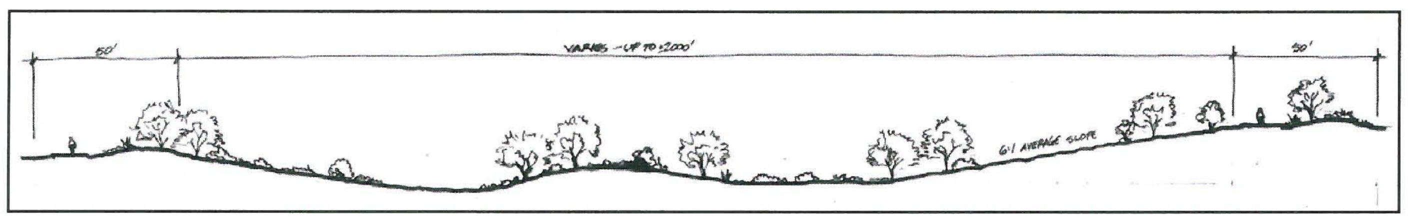

Figure 25 Concept Profile View of On-line Basins with Landscape Compatibility Enhancements (Not to scale)

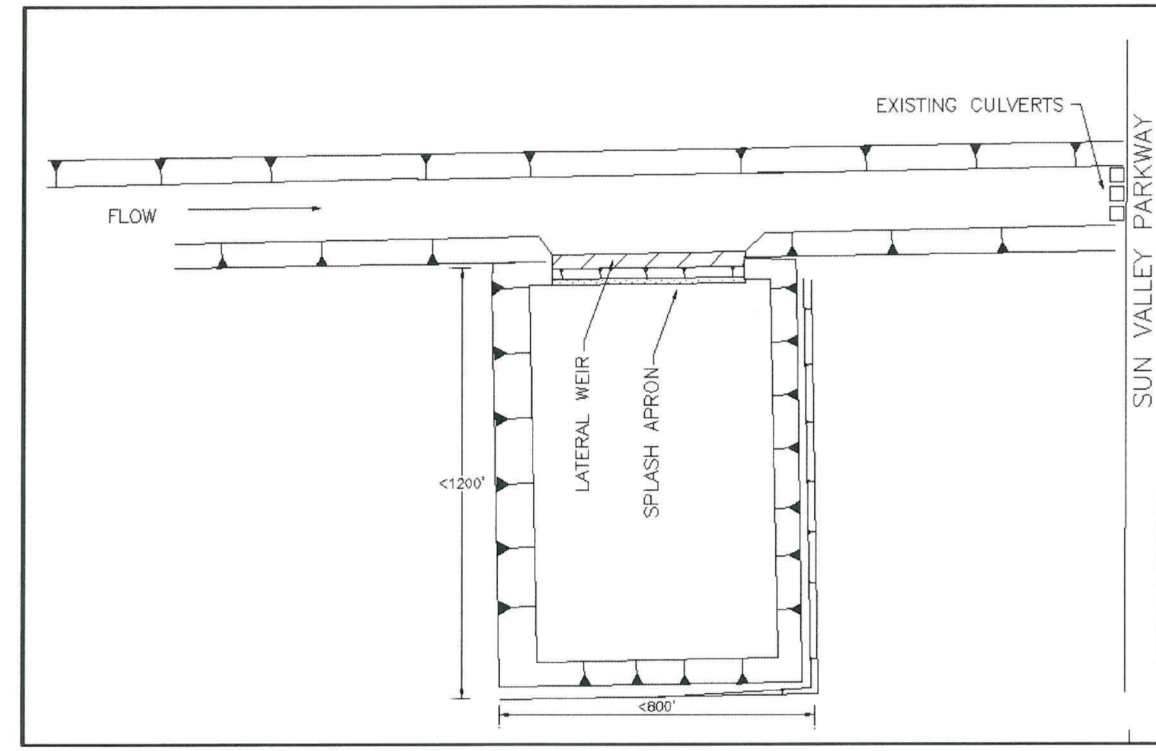

Figure 26 Concept Plan View of Off-line Basins (Not to scale)

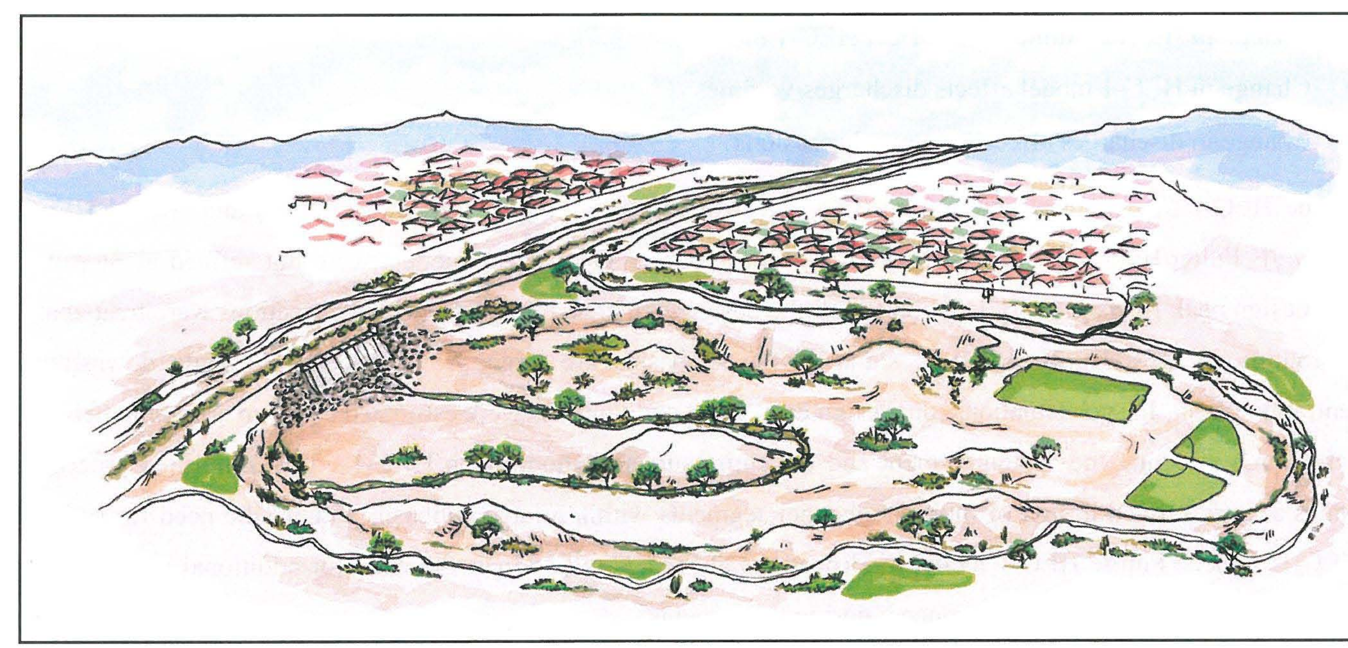

Figure 27 Concept Plan View of Off-line Basins with Landscape Compatibility Enhancements (Not to scale)

The basins are designed to be up to 12 feet in depth. This depth includes a freeboard of 1 ft. An initial side slope of 3H:1V is assumed for the base design. Shallower side slopes are included in the landscape compatibility enhancements.

5.6 Off-line Detention Basin Design Considerations

Off-line detention basins are provided in locations where there is a need to reduce peak flows. These locations include: a) upstream of culverts to reduce flow to culvert hydraulic capacity, b) tributary confluences, and c) at the downstream end at outfall locations. Most of these basins will be located downstream of the apices except for Alternative B5 where an off-line basin is located near the apex.

The flow from the open channel will enter the off-line detention basins via a weir. Figure 26 shows the concept plan view of the off-line basins. Figure 27 shows the off-line basin with landscape compatibility enhancements. The Step 2 design process estimated the volume to be diverted using an inflow-outflow diversion relationship. The weirs were not sized in the Step 2 design process.

5.7 Hydrology

The design of the open channels as well as the detention basins are based on the 100-year peak discharges. HEC-1 modeling is used to determine the peak discharges as well as the flow volume passing through the designed structures. The existing conditions hydrology model is used for the estimation of the peak discharges used in the design. The flows computed from existing conditions model are higher than the future conditions model due to retention requirements. Thus, using the flows computed from the existing conditions model represents a more conservative design approach. In addition, the phasing of the developments is unknown. As a result, it is prudent to be conservative and use the existing conditions hydrology to ensure effective continuous functioning of the flood control system.

A separate HEC-1 model was developed for each sub-area for the 100-year 24-hour and 100-year 6-hour storms for each alternative. For the purpose of the design, the maximum of the values obtained from the 24-hour and 6-hour results were used to ensure adequate functionality under 6-hour and 24-hour storm scenarios. This means that the design analyses sometimes use the 6 hour value and vice-versa depending on whichever is larger.

The procedure to estimate peak flow and flow volume was iterative in nature: The iteration steps can be briefly described as follows:

- Change in structure dimensions affect HEC-1 model
- Change in HEC-1 model affects discharges/volumes
- Change in discharges affect structure dimensions

The HEC-1 models used here are based on the Area 3 HEC-1 model by PBS&J (2005) and Area 4 HEC-1 model by JE Fuller/Hydrology & Geomorphology, Inc (2005). The HEC-1 models were not refined at Step 2 to provide design peak flows at every location for all the design elements. Long open channel sections were treated as a single routing in HEC-1. In addition, some of the subbasins are large providing only a single downstream concentration point. In such situations, the design discharges and volumes were estimated using an area-ratio between the actual area affecting the design element and the entire subbasin modeled in HEC-1. This simplified procedure facilitates a more refined design of multiple channel segments within a large subbasin without the need for refining the HEC-1 model. Future HEC-1 model modifications at Step 3 will address the need for additional concentration points to generate peak flow data for concept design refinements.

5.8 Sediment Yield

Sediment contributions from the watershed adjacent to the design element were estimated using sediment yield. The sediment yield was estimated assuming a 3-year maintenance period plus a single 100-year event. An annual sediment yield of 0.3 ac-ft/sq. mi./year and a 100-year event sediment yield of 1 ac-ft/sq. mi. was assumed for this purpose. These values were derived based on examination of numerous previous studies conducted throughout Maricopa County. The total sediment volume was estimated as the sum of 3 average years' sediment volume and one 100-year event volume. The estimation of the contributing watershed area is performed using GIS. The sediment volume entering a particular design element was then estimated using the sediment contributing area and the sediment yield estimates.

5.9 On-line Detention Basin Analyses

The design considerations for the on-line detention basins are described in detail in Section 5.5. The analyses use rectangular basins with constant side slopes (3H:1V). The sediment yield estimates were used to estimate incoming sediment volume. One foot of freeboard was applied to accommodate the flow volume as well as the sediment volume. A stage-storage-discharge relationship was calculated and this relationship entered into the HEC-1 model using SE-SV-SQ records. The stage-storage relationship was determined from the basin design dimensions. The stage-discharge relationship was determined from pipe outlet equations. The HEC-1 model was then run to estimate the peak volume stored in the basin. The basin dimensions were then resized to hold this maximum volume at peak flow as predicted by HEC-1. In addition, the designed basin depth should be larger than the peak stage as predicted by HEC-1. The estimated sediment yield was added to the depth required to evaluate the adequacy of the basin design. The process was repeated in an iterative fashion until a satisfactory design was achieved.

5.10 Open Channel Analyses

5.10.1 Hydraulics

The hydraulic analyses for open channel design were performed using Manning's equation (normal-depth assumption). An 8-point cross-section was used to represent the channel cross-section dimensions. A Manning's n-value of 0.045 was used for all the alternatives except Alternative C where the designed channel has concrete lining. In places where the existing channel is used, analyses were performed to ensure adequate conveyance and freeboard for the estimated flows entering the channels.

It is anticipated that the leveed conveyance corridors, a low-flow channel will form between the levees in the long term. The low-flow channel dimensions were estimated using regime theory described in Section 5.10.2.

Calculations were also performed to evaluate the hydraulic conditions expected to occur after the leveed corridor develops a low-flow channel. The earthen excavated channels (Alternative B3) were also sized to approximate the estimated regime dimensions.

5.10.2 Regime Theory

Regime theory was used to arrive at approximate estimates of gross dimensions as a function of discharge, d50 etc. The regime theory was specifically used to estimate the dimensions of the low-flow channel. The low-flow channel is expected to form in the long-term for the leveed corridors over time.

In addition, regime theory was used to design the main channel as well as the low-flow channels for the excavated earthen channels (Alternative B3). The main parameters evaluated by the regime theory are: width, depth, and velocity. The design approach aims to match the regime value estimates approximately and does not match all three parameters exactly. The values estimated by regime theory were used as guidance/starting point for the design dimensions and are interpreted as the dimension the channel wants to be or will evolve into in the long-term. The main goal is to not deviate too much from regime theory wherever possible.

Following procedures are considered to estimate the Regime Theory:

- Bray - Equation #1
- Bray - Equation #2
- Hey
- Ackers & Charlton/Lacey
- Parker
- Chang
- Kellerhals
- AMAFCA/Schumm
- Moody & Odem
- BUREC

Bray Equation #1. Bray (1979) developed equations for the geometry of alluvial gravel-bed rivers based the 2-year discharge.

$$W = 2.38\ Q_2^{0.527}$$

$$d = 0.266\ Q_2^{0.33}$$

$$V_m = 8.0\ d^{0.6}\ S_o^{0.29}$$

Where:

W = surface flow width (ft.)

Q_2 = 2-year discharge (cfs.)

d = flow depth (ft.)

V_m = mean channel velocity (ft./sec.)

S_o = channel slope (ft./ft.)

Bray Equation #2. Bray later modified his channel geometry relationships (Hey et. al., 1982) for gravel-bed rivers to include bankfull discharge and the bed material size.

$$W = 2.08\ Q_{bf}^{0.528}\ D_{50}^{-0.07}$$

$$d = 0.256\ Q_{bf}^{0.331}\ D_{50}^{-0.025}$$

$$V_m = 1.87\ Q_{bf}^{0.14}\ D_{50}^{0.095}$$

$$S_o = 0.0965\ Q_{bf}^{-0.334}\ D_{50}^{0.586}$$

Where:

W = surface flow width (ft.)

Q_{bf} = Bankfull discharge (cfs.)

D_{50} = medium bed sediment diameter (ft.)

d = flow depth (ft.)

V_m = mean channel velocity (ft./sec.)

S_o = channel slope (ft./ft.)

Hey Equation. Hey (1982) developed regime equations for gravel bed rivers in England that relate stable channel geometry to bankfull discharge and bedload transport rate.

$$WP = 2.2\ Q_{bf}^{-0.54}\ D_{50}^{-0.05}$$

$$R = 0.161\ Q_{bf}^{0.41}\ D_{50}^{-0.15}$$

$$d_{max} = 0.252\ Q_{bf}^{0.38}\ D_{50}^{-0.16}$$

$$S_o = 0.679\ Q_{bf}^{-0.53}\ Q_s^{-0.13}\ D_{50}^{0.97}$$

Where:

WP = Wetted perimeter (m)

Q_{bf} = Bankfull discharge (m)

$D50$ = Median sediment diameter (m.)

R = Hydraulic radius (m)

d_{max} = Maximum channel depth (m)

S_o = Channel slope (m/m)

Q_s = Bedload sediment discharge (%)

Parker Equation. Parker (1979) examined gravel bed rivers to obtain his channel geometry equations. He found that, unlike the bed material in sand bed streams, the gravel and cobble bed material in coarse bedded streams is moved only during larger flows. He also noted that the banks of gravel bed streams tended to be more stable and straighter than streams with finer bed materials (MacBroom, 1981). Parker's equations use a dimensionless discharge parameter (Q_*), as described below.

$$W_{bf} = 0.173\ Q_*^{0.5}\ D_{50}$$
$$d = 0.010\ Q_*^{0.415}\ D_{50}$$
$$S_e = 0.223\ Q_*^{-0.410}$$

Where:

W_{bf} = bankfull width, width at top of bank (ft)

$Q_* = 0.039\ V_m\ d^{-1}\ D_{50} / ((\rho_s-1)/\rho)\ g\ d)^{½})$ (dimensionless)

V_m = mean velocity (ft./sec.)

ρ_s = density of sediment (lbs/ft^2)

ρ = density of water (lbs/ft^2)

g = gravitation coefficient (32.2 ft./sec.^{2})

D_{50} = mean sediment diameter (ft.)

d = average channel depth (ft)

S_e = energy slope (ft./ft.)

Ackers & Charlton Equation. The Ackers and Charlton (1971) equations were based on data from flume studies which used sand bed materials.

$$W = K_{ac}\ Q^{0.42}$$

Where:

W = surface channel width (ft.)

Q = discharge (cfs)

K_{ac} = a coefficient varying from 3.6 for straight channels to 7.2 for meandering channels

Lacey Equation. The Lacey equation (1929) was developed to describe the geometry of silt-laden canals in India. However, Bray reported (1979) that in gravel rivers in Canada, the Lacey equation was as accurate for predicting velocity as the Manning's equation.

$$V = 0.8Q^{0.167}$$

Where V = mean channel velocity (ft./sec.)

Q = discharge (cfs)

Chang Equation. Chang's (1988) gravel bed equations for channel geometry support his FLUVIAL-12 sediment transport model, which attempts to simulate channel change from sediment continuity data using minimum stream power concepts. Chang provides equations for channel width, depth, and slope.

$$S_o = 0.000442\ D_{50}^{1.15} / Q_{bf}^{0.42}$$
$$W = [1.905 + 0.249(\ln(0.001065\ D_{50}^{1.15} / (S_o\ Q_{bf}^{0.42}))^2]\ Q_{bf}^{0.47}$$
$$d = [0.2077 + 0.0418(\ln(0.000442\ D_{50} / (S_o\ Q_{bf}^{0.42})))^{1.15}]\ Q_{bf}^{0.42}$$

Where:

S_o = channel slope (ft./ft.)

$D50$ = median sediment diameter (mm.)

Q_{bf} = bankfull discharge (cfs)

W = channel width (ft)

d = average channel depth (ft)

Kellerhals Equations. Kellerhals (1967) developed equations for the equilibrium channel width and depth in gravel bed rivers. The Kellerhals equations use the dominant discharge, which is also referred to as the channel-forming or effective discharge.

$$W = 1.8\ Q_{dd}^{0.5}$$
$$d = 0.166\ Q_{dd}^{0.4}\ K_n^{-0.12}$$

Where:

W = channel width (ft)

Q_{dd} = dominant discharge (cfs)

d = average channel depth (ft)

K_n = Nikuradse's sand grain roughness coefficient

Schumm Equation. Schumm (1961) preferred to examine the width/depth ratio of semi-arid streams, rather than either parameter separately. Schumm's equation is based on the percentage of fine-grained material in the channel banks.

$$F = 255\ M^{-1.08}$$

Where:

F = width/depth ratio

M = percentage of silt/clay in the bed.

AMAFCA Equations. The AMAFCA (1994) equations for width and equilibrium slope were developed from empirical and theoretical data for application to the arroyo systems of northern New Mexico.

$$W = 0.5\ F^{0.6}\ Fr^{-0.4}\ Q^{0.4}$$
$$S_o = 18.28\ n^2\ F^{0.133}\ Fr^{2.133}\ Q^{-0.133}$$

Where:

W = width of channel (ft.)

F = width/depth ratio

Fr = main channel Froude number

Q = discharge (cfs.)

S_o = channel slope (ft./ft.)

n = Manning's n value for channel

Moody & Odem Equations. Moody and Odem (1999) completed an investigation of bankfull channel geometry relationships on a variety of stream types in Arizona using Rosgen channel classification methods. Channel geometry relationships were defined for a number of regions in Arizona.

$$Q_{bf} = 52.334\ DA^{0.5766}$$
$$A = 11.428\ DA^{0.5291}$$
$$TW = 12.301\ DA^{0.3756}$$
$$d = 0.9455\ DA^{0.1506}$$

Where:

Q_{bf} = Bankfull discharge (cfs)

DA = Watershed drainage area (mi^2)

A = Section flow area at bankfull discharge (ft.)

TW = Flow width at bankfull discharge (ft.)

d = Average flow depth at bankfull discharge (ft.)

BUREC Equation. The Bureau of Reclamation (Lane and Carlson, 1953) developed relationships that describe stable channel dimensions for canals cut into coarse grained alluvium.

$$d_{max} = (Q_{bf}/2 \tan\phi)^{0.5}$$
$$A = 2\ d_{max}^2 / \tan\phi$$
$$V_m = 1/n\ (d_{max} \cos\phi / (0.5\ \pi\ (1 - \cos\phi))^{0.667}\ S_e^{0.5}$$
$$TW = d_{max}\ \pi / \tan\phi$$

Where:

d_{max} = Maximum depth of flow (ft.)

Q_{bf} = Bankfull discharge (cfs)

ϕ = Angle of repose of bank material

V_m = mean flow velocity (ft./sec.)

n = Mannings n value

S_e = Energy slope (ft./ft.)

TW = Top width of flow (ft.)

5.10.3 Allowable Velocity

Allowable velocity calculations are performed to evaluate the effectiveness of the channel lining. The allowable velocity is interpreted as the velocity below which no erosion will occur. The leveed corridors are designed to have velocities less than 6 ft/sec so that erosion does not pose a significant threat. The allowable velocity is not a factor in the alternatives with the concrete channels.

Following procedures used to estimate:

- Fortier & Scobey (as modified in Chow)
- BUREC
- Neill (gravel/cobble)
- USACE Table
- FHWA Table

Fortier & Scobey Table Fortier and Scobey (1926) published one of the first tables of permissible velocity in 1926. Their data, based on records of seasoned stable canals, was later republished by a number of federal agencies and other organizations including the FHWA, ASCE, and Chow (MacBroom, 1981). The Fortier and Scobey data (Table 5) distinguish erosion hazards for clear water, silt-laden water, and water transporting sand and gravel (bedload). Their data presumably do not account for the stabilizing effect of bank vegetation.

Table 5 Fortier & Scobey Table of Permissible Canal Velocities (ft/s)

Bank Material	Clear Water	Silt-Laden	Sand/Gravel Bedload
Sandy Loam	1.75	2.50	2.00
Firm Loam	2.50	3.50	2.25
Fine Gravel	2.50	5.00	3.75
Stiff Clay	3.75	5.00	3.00
Coarse Gravel	4.00	5.50	6.50
Cobbles	5.00	5.50	6.50

BUREC/Mavis & Laushey Equation The BUREC (1974) recommends that permissible velocity be estimated using a modification of the Mavis and Laushey equation (Jurnikis, 1971), which was developed by bridge engineers in Great Britain (MacBroom, 1981). The BUREC equation is a function of grain size, and is most applicable to bed material.

$$V_b = 0.64\ D^{(4/9)} \quad \text{for } D < 6.0 \text{ mm}$$

$$V_b = 0.5\ D^{1/2} \quad \text{for } D > 6.0 \text{ mm}$$

Where:

V_b = competent velocity (ft/sec)

D = particle diameter (mm)

Neill Equation Neill (1975) developed equations that are a function of flow depth and grain size for permissible velocities on gravel and cobble bed streams, with a separate equation for cohesive soils.

$$V_b = 3.15\ d^{(1/3)}\ D^{(2/3)} \quad \text{(non-cohesive soils)}$$

$$V_b = 7.5\ d^{(1/6)}\ \tau_c^{1/2} \quad \text{(for cohesive soils)}$$

Where:

V_b = competent velocity (ft/sec)

d = flow depth (ft)

D = grain size (ft)

τ_c = critical shear stress (lb/ft^2)

USACOE Permissible Velocity The Corps of Engineers (1970; 1995) has established suggested maximum velocities for design of non-scouring flood control channels, as shown in Table 6.

Table 6 Suggested Maximum Permissible Mean Channel Velocities (USACOE, 1995)

Channel Material	Mean Velocity (ft/sec)
Fine Sand	2.0
Fine Gravel	6.0
Grass-Lined Banks (< 5% Slope, Sandy Silt, Bermuda Grass)	8.0
Poor Rock (Sedimentary)	10.0
Good Rock (Igneous or Metamorphic)	20.0

The Corps of Engineers (1990) has also developed criteria relating flow depth and velocity to the beginning of movement of granular bed materials and erosion of cohesive bank materials, as summarized in Table 7.

Table 7 Corps of Engineers Erosive Velocity Data

Grain Size (mm)	Flow Depth (ft)	Velocity (ft/sec)	Cohesiveness	Flow Depth (ft)	Velocity (ft/sec)
1 (sand)	5 10	2.5 4.0	Very Soft	5 10	2.0 2.5
10 (gravel)	5 10	4.5 5.5	Average	5 10	3.5 4.0
100 (cobbles)	5 10	9.5 10.5	Very Stiff	5 10	5.5 6.0

5.10.4 Equilibrium Slope

The equilibrium slope is defined as the slope at which the channel bed is in equilibrium. It is interpreted as the slope the channel would evolve into, provided continuous flows for a long period of time and provides an idea as to what the design slope should be.

Following equations are computed:

- Schoklitsch
- MPM
- Shields
- Lane's Tractive Force
- Average BUREC
- Bray
- Henderson
- BUREC
- Simplified AMAFCA

Equilibrium slope[1] is defined as the slope which causes the channel's sediment transport capacity to equal the incoming sediment supply (ADWR, 1985). If the slope is too steep, channel velocities will be high and net erosion will occur. If the slope is too flat, channel velocities will be low and net deposition will occur. The equilibrium slope is the slope that the undisturbed, natural channel will tend towards over the long term. While there are philosophical and practical problems with applying equilibrium slope concepts to ephemeral streams with variable channel geometry and high flash flood potential, or streams where the natural hydrology has been altered by urbanization, equilibrium slope equations provide a useful order-of-magnitude assessment of the likelihood of vertical channel adjustments.

5.10.5 Methodology

Design reach-averaged data required for application of equilibrium slope equations to the study area were derived from the following sources:

- Hydraulic data – normal-depth computations
- Hydrologic data - HEC-1 modeling and area weighting

[1] Equilibrium slope is also referred to as stable slope or limiting slope.

- Topographic data – 10-foot contour data and DTM

Most equilibrium slope equations are based on the mean annual flood, the "channel-forming," or "bankfull" discharge. On many perennial alluvial streams, particularly in humid climates, the mean annual flood and the channel-forming and bankfull discharges are nearly equivalent. However, on ephemeral streams where flow events are rare, the channel-forming discharge is often difficult to determine. To account for the discrepancies in what flow rate is appropriate for equilibrium slope analyses, and to assess the trend of expected slope adjustments during floods, a range of discharges were used in the equilibrium slope equations to assess the expected slope adjustment over a range of discharges. Four ratios of the 100-year peak discharge estimate were examined: 10%, 25%, 75%, and 100%. The 10% flow was assumed to approximate the 2-5-year flood. The 25% flow was assumed to approximate the 10-year event. The 2-year event approximates the mean annual flood calculated on a probability-weighted basis. The 10-year event better approximates bankfull conditions in many ephemeral stream reaches. The following equilibrium slope equations were applied to the study reach:

- Albuquerque Metropolitan Arroyo Flood Control Authority (AMAFCA) Equations
- BUREC Equation
- Bray Equation
- Henderson Equation

The BUREC (Pemberton and Lara, 1984) published a manual for computing scour and channel degradation downstream of dams or other structures that interrupt the natural sediment supply to the downstream channel. The BUREC manual describes the following four approaches for estimating equilibrium slope:

- Schoklitsch Equation
- Meyer-Peter Muller Equation
- Shield's Diagram Method
- Lane's Tractive Force Method

The latter four equations listed above are zero bed sediment discharge (clear water) equations, and represent minimum slopes that would occur if sediment supply were disrupted, such as might occur downstream of a large in-stream sand and gravel mine, a dam, or an on-line detention basin.

5.10.6 AMAFCA Equation

The AMAFCA (1994) equation for the maximum equilibrium slope is based on the sediment transport characteristics of the reach.

$$S_L = \left(\frac{a}{q_s}\right)^{\frac{10}{3(c-b)}} q^{\frac{2(2b+3c)}{3(c-b)}} \left(\frac{n}{1.49}\right)$$

Where:

S_L = channel slope (ft./ft.)
q_s = unit sediment transport (cfs/ft)
q = water discharge (cfs)
n = Manning's roughness
a, b, c = power function coefficients from sediment transport function

A simplified version of the AMAFCA Equation is written for wide, rectangular channels, similar to the design channels for the ADMP study, based on the assumptions that steep, wide, rectangular alluvial streams flow at or close to critical depth and that sediment supply is transport limited.[1]

$$S_s = 18.28\, n^2\, F^{0.133}\, F_r^{2.133}\, Q_{dd}^{-0.133}$$

Where:

S_s = Stable slope (ft/ft)
n = Manning's roughness value for the channel
F = Width/depth ratio of the channel
F_r = Froude number for the channel
Q_{dd} = Dominant discharge (cfs)

5.10.7 BUREC Equation

The BUREC published an equation for stable slope based on theoretical considerations of sediment transport (MacBroom, 1981).

$$S_L = (0.00021\, D_{50}\, W_{bf} / Q)^{0.75}$$

[1] Transport limited means that the sediment inflow equals or exceeds the reach transport capacity.

Where:

S_L = Stable slope (ft/ft)

D_{50} = Bed sediment diameter (ft)

W_{bf} = Channel width (ft)

Q = Discharge (cfs)

5.10.8 Bray Equation

Bray's (1979) equation for equilibrium slope is based on regime analysis of perennial gravel bed streams in Alberta, Canada.

$$S_L = 0.965\ Q_2^{-0.344}\ D_{50}^{0.58}$$

Where:

S_L = Equilibrium slope (ft/ft)

D_{50} = Mean bed sediment diameter (ft)

Q_2 = 2-year discharge (cfs)

5.10.9 Henderson Equation

To generate an equation for the slope of stable channels, Henderson (1961) modified the Lane (1952) equations using a threshold theory of shear stress concept.

$$S_L = 0.44\ D_{90}^{1.15}\ Q^{-0.46}$$

Where:

S_L = Stable slope (ft/ft)

D_{90} = Bed sediment diameter for which 90 percent is smaller (ft)

Q = Discharge (cfs)

5.10.10 Schoklitsch Equation

The Schoklitsch (Shulits, 1935) equation is based on the concept of zero bedload transport.

$$S_L = K_s\ (D\ W_{bf}/Q)^{3/4}$$

Where:

S_L = Stable slope (ft/ft)

K_s = 0.00174

W_{bf} = Bankfull width (ft)

D = Mean bed sediment diameter (mm)

Q = Dominant discharge (cfs)

5.10.11 Meyer-Peter, Muller Equation

The Meyer-Peter, Muller (1948) equation is based on the incipient motion theory, or the point of initiation of sediment transport.

$$S_L = K_{mpm}\ (Q/Q_{bf})\ (n_s/D_{90}^{1/6})^{3/2}\ D\ /\ d$$

Where:

S_L = Stable slope (ft/ft)

K_{mpm} = 0.19

Q/Q_{bf} = Ratio of total flow to flow over the channel

Q_{bf} = Dominant discharge (cfs)

n_s = Manning's n for the stream bed

D_{90} = Bed sediment diameter for which 90 percent is smaller (mm)

D = Mean sediment diameter (mm)

d = Channel depth (ft)

5.10.12 Shields Diagram Method

The Shields diagram (1936) for determining the boundary condition for no sediment transport can be used to define an equation for stable slope.

$$R_* = U_*\ D\ /\ \upsilon$$

$$U_* = (S_L\ R\ g)^{1/2}$$

$$T_* = \tau_c\ /\ ((\gamma_s - \gamma_w)\ D\ )$$

Where:

S_L = Stable slope (ft/ft)

R_* = Boundary Reynold's number

$U_* = $ Shear velocity $= (S_L\ R\ g)^{\wedge 0.5}$

D = Mean sediment diameter (mm)

υ = Kinematic velocity of water (ft/sec^2)

R = Hydraulic radius for wide channels (ft)

g = Gravitational constant = 32.2 ft/sec^2

T_* = Dimensionless shear stress

τ_c = Critical shear stress (lb/ft^2)

γ_s = Specific weight of sediment (lb/ft^3)

γ_w = Specific weight of water (lb/ft^3)

5.10.13 Lane's Tractive Force Method

Lane's equation for stable slope uses critical tractive force relationships.

$$S_L = (\tau_c/\gamma_w)\ d$$

Where:

S_L = Stable slope (ft/ft)

d = Mean flow depth (ft)

τ_c = Critical shear stress (lb/ft^2)

γ_w = Specific weight of water (lb/ft^3)

Among the equations used, AMAFCA is the only one that is for live-bed while all others are for clear water. The clear water equations predict slopes are smaller than the AMAFCA equation which generally predicts higher values of slope. The slope influences the hydraulics significantly and can directly impact the velocity in channel which affects the sedimentation issues. However, the range of equilibrium slope estimates from the equations investigated varies greatly. In order to arrive at a slope for use in the Step 2 hydraulic and design process, the average of the clear water equations (Schkoklitsch, MPM, Shields, and Lane) was taken and averaged with the results from the Simplified AMAFCA, Bray, and Henderson equations. The resulting average slope was assumed representative of the long-term slope to develop in the leveed corridors. In addition, this result was used to compute the grade control requirements for the leveed corridors. Finally, this slope was also used to for the hydraulic design of the earthen excavated channels (B3).

5.10.14Sediment Transport Capacity

The sediment transport capacity is used to estimate of the rate of sediment transport in tons/day. The sediment transport capacity can be used to ensure the adequate sediment continuity and provides channel sediment trend when compared with the inflowing sediment transport load. It can also be used to estimate sediment volume using maximum sediment concentrations and the flow volume.

The following equations are computed:

- Zeller Fullerton
- Ackers White
- Colby
- Einstein
- Engelund/Hansen
- Kalinske
- Laursen
- MPM
- Rottner
- Schoklitsch
- Toffaleti
- Yang

The calculations are performed based on procedures in Yang, 1995. It may be noted that each these equations have been developed under different circumstances and may not be entirely valid for all the conditions proposed in the design. However, the sediment transport capacity values are used as a gross estimate of sediment flux and to provide qualitative estimates of sedimentation and erosion possibilities.

5.10.15Scour and Toe Protection

The toe-down for the levee and other bank protection are estimated using the general scour estimates. The Pima County General Scour Equations are used for this purpose. It is assumed that the bend scour is negligible as most of the designed channels have somewhat straight alignments. The long-term scour is estimated from equilibrium slope and the local scour is defined low flow channel depth.

Scour calculations in this report are performed using procedures outlined in the City of Tucson's *Standards Manual for Drainage Design and Floodplain Management* - Chapter VI - Erosion and Sedimentation (1989; hereafter, "the COT Manual"). The following equation for depth of scour in a stream is given in the COT Manual:

$$Z_t = 1.3\,(Z_{gs} + \tfrac{1}{2} Z_a + Z_{ls} + Z_{bs} + Z_{lft})$$

where:

Z_t = Design scour depth, excluding long-term degradation or aggradation (ft)
Z_{gs} = General scour depth (ft)
Z_a = Anti-dune trough depth (ft)
Z_{ls} = Local scour depth (ft)
Z_{bs} = Bend scour depth (ft)
Z_{lft} = Low-flow thalweg depth (ft)
1.3 = Safety factor to account for non-uniform flow distribution

General scour, Z_{gs}, is the component of scour that represents the mobile portion of the bed-material of the channel bottom. General scour was estimated using the following equation:

$$Z_{gs} = Y_{max}\,[(0.0685\,V_m^{0.8})/(Y_h^{0.4}\,S_e^{0.3})-1]$$

where:

Z_{gs} = General scour depth (ft)
V_m = Average velocity of flow at design discharge (ft/sec)
Y_{max} = Maximum depth of flow at design discharge (ft)
Y_h = Hydraulic depth of flow at design discharge, (ft)
S_e = Energy slope (ft/ft)

Where Z_{gs} was determined to be negative, the general scour component was assumed to be zero, in keeping with the recommended practice in the COT Manual.

Anti-dune trough depth, Za, is the component of scour caused by movement of dune shaped bed forms along the bottom of the channel. The anti-dune trough depth was estimated using the following equation:

$$Z_a = 0.0137\,V^2_m$$

where:

V_m = Average velocity of flow at design discharge (ft/sec)

Bend scour, Z_{bs}, occurs on the outside of bends in a stream channel, and is caused by spiral transverse currents. Bend scour was estimated using the following equation:

$$Z_{bs} = 0.0685\,Y_{max}\,V_m^{0.8}\,Y_h^{-0.4}\,S_e^{-0.3}\,\{2.1\,[\sin^2(\alpha/2)/\cos\alpha]^{0.2} - 1\}$$

where:

Z_{bs} = Bend-scour component of total scour depth (ft), and
= 0 when $r_c/T > 10.0$, or $\alpha < 17.8^o$
= computed value when $0.5 < r_c/T < 10.0$, or $17.8^o < \alpha < 60^o$
= computed value when $\alpha = 60^o$ when $r_c/T < 0.5$, or $\alpha > 60^o$
Y_{max} = Maximum depth of flow immediately upstream of the bend (ft)
V_m = Average velocity of flow immediately upstream of the bend (ft/sec)
Y_h = Hydraulic depth of flow immediately upstream of the bend (ft)
S_e = Energy slope immediately upstream of the bend (ft/ft)
α = Angle formed by the projection of the channel centerline from the point of curvature to a point which meets a line tangent to the outer bank of the channel (degrees)
r_c = radius of curvature along centerline of channel (ft)
T = channel top width (ft)

The bend angle was computed from the arccosine of the reciprocal of the sinuosity. A sinuosity of 1.1 was assumed for all design reaches. The thalweg depth used for the scour depth calculation was set as low-flow channel depth for both the leveed corridors and the excavated earthen channel.

Scour depth below drop structures was estimated using the following equation from Schoklitsch (1935):

$$D_s = 4.75\,h^{0.2}\,q^{0.57} / d_{90}^{0.32}$$

where:

D_s = Scour depth below downstream water surface (m)
h = Drop height (m)
q = Unit discharge ($m^3/s/m$)
d_{90} = Bed material size for which 90% of the sample is finer (mm)

5.11 Off-line Detention Basins

Off-line detention basins were included in situations where the flow needs to be limited to accommodate downstream capacity of existing channels, culverts or delineated floodplains. These basins are modeled as diversions in HEC-1 using the DI/DQ records. At the culvert locations along Sun Valley Parkway, the purpose of the off-line basin is to reduce the flow capacity to the maximum capacity of the culvert. The maximum capacity of the culvert is determined using HY8 results as the flow rate that occurs when the upstream water surface elevation is 1 foot above the culvert top elevation. At other locations, flows higher than certain desired values are diverted and the inflow/outflow relations are the design parameters.

6 DESIGN PROCEDURES

The details of the design procedure for all the alternatives and structural elements are presented in this section. The alternatives are described in Section 10.

6.1 Alternative A

- Identify the fan apex/upstream area location and the preferred channel alignment from the apex to the outfall. For Wagner, Hassayampa, FRS 1 and FRS 2 & 3 sub-areas, the preferred channel alignment is one of the alignments in B4-1, B4-2, or B4-3. The alignments for the CAP and White Tank Wash sub-areas are the same for all alternatives.
- Set aside adequate area for active alluvial fan processes to occur. This up-fan area is immediately downstream of the apex. The areas used were taken from delineations prepared by Ayres (2005) as part of the Buckeye/Sun Valley ADMS.
- Design collector channels downstream of the sedimentation area to collect all the flows from the upstream watershed (See section 6.11).
- Route flow from collector channels to Sun Valley Parkway by designing leveed natural channel along the preferred channel alignment (See section 6.10).
- Design off-line basin upstream of the culvert location if the culvert capacity is not adequate. Off-line basin capacity is the volume of flow above the culvert capacity (See section 6.9).
- Route the flows to the outfall by designing leveed natural channel (See section 6.10).
- Design off-line basin upstream of the outfall location if the capacity of the outfall is not adequate. Off-line basin capacity is the volume of flow greater than capacity of the outfall (See section 6.9).

6.2 Alternative B1

- This alternative is only considered for CAP and White Tank Wash sub-areas. Alternative B4 is equivalent to B1 alternative for Wagner, Hassayampa, FRS 1 and FRS 2 & 3 sub-areas (see section 6.5).
- Identify the fan apex/upstream area location and the preferred channel alignment from the apex to the outfall.
- Design big on-line basin near apex location using the following criterion: Peak Outflow ≈ 10% Peak Inflow.
- Route flow from big on-line basin to Sun Valley Parkway by designing leveed natural channel along the preferred channel alignment (See section 6.10).
- Design off-line basin upstream of the culvert location if the culvert capacity is not adequate. Off-line basin capacity is the volume of flow above the culvert capacity (See section 6.9).
- Route the flows from Sun Valley Parkway to the outfall by designing leveed natural channel along the preferred channel alignment (See section 6.10).
- Design off-line basin upstream of the outfall location if the capacity of the outfall is not adequate. Off-line basin capacity is the volume of flow greater than capacity of the outfall (See section 6.9).

6.3 Alternative B2

- Identify the fan apex/upstream area location and the preferred channel alignment from the apex to the outfall. For Wagner, Hassayampa, FRS 1 and FRS 2 & 3 sub-areas, the preferred channel alignment is one of the alignments in B4-1, B4-2, or B4-3. The alignments for the CAP and White Tank Wash sub-areas are the same for all alternatives.
- Design small on-line basin near apex location using the following criterion: Peak Outflow ≈ 90% Peak Inflow
- Route flow from small on-line basin to Sun Valley Parkway by designing leveed natural channel along the preferred channel alignment (See section 6.10).

- Design off-line basin upstream of the culvert location if the culvert capacity is not adequate. Off-line basin capacity is the volume of flow above the culvert capacity (See section 6.9).
- Route the flows from Sun Valley Parkway to the outfall by designing leveed natural channel along the preferred channel alignment (See section 6.10).
- Design off-line basin upstream of the outfall location if the capacity of the outfall is not adequate. Off-line basin capacity is the volume of flow greater than capacity of the outfall (See section 6.9).

6.4 Alternative B3

- Identify fan apex/upstream area location and preferred channel alignment from the apex to the outfall. For Wagner, Hassayampa, FRS 1 and FRS 2 & 3 sub-areas, the preferred channel alignment is one of the alignments in B4-1, B4-2, or B4-3. The alignments for the CAP and White Tank Wash sub-areas are the same for all alternatives.
- Design big on-line basin near apex location using the following criterion: Peak Outflow ≈ 10% Peak Inflow.
- Route flow from big on-line basin to Sun Valley Parkway by designing excavated earthen channel along the preferred channel alignment (See section 6.11).
- Design off-line basin upstream of the culvert location if the culvert capacity is not adequate. Off-line basin capacity is the volume of flow above the culvert capacity (See section 6.9).
- Route the flows from Sun Valley Parkway to the outfall by designing excavated earthen channel along the preferred channel alignment (See section 6.11).
- Design off-line basin upstream of the outfall location if the capacity of the outfall is not adequate. Off-line basin capacity is the volume of flow greater than capacity of the outfall (See section 6.9).

6.5 Alternative B4

- This alternative is only considered for Wagner, Hassayampa, FRS 1, and FRS 2 & 3 sub-areas. Alternative B1 is equivalent to B4 alternative for CAP and White Tank Wash sub-areas (see section 6.2).
- Alternatives B4-1, B4-2, and B4-3 represent the three channel alignments considered. Perform all the design procedure steps for B1 (See Section 6.2) using each of the three channel alignments.
- Select preferred alignment based on evaluation criteria such as cost, feasibility, etc.
- Perform design for Alternatives B2, B3, and C for the preferred alignment.

6.6 Alternative B5

- This alternative is only considered for CAP sub-area.
- Identify the fan apex/upstream area location and the preferred channel alignment from the apex to the outfall. For Wagner, Hassayampa, FRS 1 and FRS 2 & 3 sub-areas, the preferred channel alignment is one of the alignments in B4-1, B4-2, or B4-3. The alignments for the CAP and White Tank Wash sub-areas are the same for all alternatives.
- Design small off-line basin near apex location using the following criterion: Peak Outflow ≈ 90% Peak Inflow
- Route flow from small off-line basin to Sun Valley Parkway by designing leveed natural channel along the preferred channel alignment (See section 6.10).
- Design off-line basin upstream of the culvert location if the culvert capacity is not adequate. Off-line basin capacity is the volume of flow above the culvert capacity (See section 6.9).
- Route the flows from Sun Valley Parkway to the outfall by designing leveed natural channel along the preferred channel alignment (See section 6.10).
- Design off-line basin upstream of the outfall location if the capacity of the outfall is not adequate. Off-line basin capacity is the volume of flow greater than capacity of the outfall (See section 6.9).

6.7 Alternative C

- Identify the fan apex/upstream area location and the preferred channel alignment from the apex to the outfall. For Wagner, Hassayampa, FRS 1 and FRS 2 & 3 sub-areas, the preferred channel alignment is one of the alignments in B4-1, B4-2, or B4-3. The alignments for the CAP and White Tank Wash sub-areas are the same for all alternatives.
- Route flow from the apex to Sun Valley Parkway by designing excavated concrete channel along the preferred channel alignment (See section 6.12).
- Design off-line basin upstream of the culvert location if the culvert capacity is not adequate. Off-line basin capacity is the volume of flow above the culvert capacity (See section 6.9).

- Route the flows from Sun Valley Parkway to the outfall by designing excavated concrete channel along the preferred channel alignment (See section 6.12).
- Design off-line basin upstream of the outfall location if the capacity of the outfall is not adequate. Off-line basin capacity is the volume of flow greater than capacity of the outfall (See section 6.9).

6.8 On-line Basin Design Procedure

- Determine upstream sediment contributing area.
- Using this area, estimate sediment yield (see Section 5.8).
- Identity upstream reaches that bring sediment into the on-line basin. Determine sediment volume using flow volume from HEC-1 and sediment concentration at the upstream reach (sediment volume = flow volume x sediment concentration). Repeat this step for all upstream reaches.
- Determine topographic slope at the proposed location of the basin. This slope is used to determine the elevation difference at the upstream and downstream ends of the basin. The elevation difference is restricted to a maximum value of 20 ft.
- Determine basin dimensions: Length, width and depth. Side slopes are fixed at 3H:1V. Freeboard is fixed at 1 foot. These parameters determine the total volume provided as well as total head available for the outflow.
- Determine outlet structure type, size/number and invert elevation. These parameters along with the basin dimensions determine stage-storage-outflow relation.
- Update the stage-storage-outflow relation in HEC-1 6-hour and 24-hour models.
- Run the 6-hour and 24-hour HEC-1 models
- Obtain the maximum peak flow volume and peak stage from HEC-1 results
- Compare with designed basin volume and basin depth (includes freeboard and sediment) to see if they are adequate.
- Modify basin dimensions and outlet structure parameters and repeat the process until the basin volume and depth are adequate.

6.9 Off-line Basin Design Procedure

- Determine topographic slope at the proposed location of the basin. This slope is used to determine the elevation difference at the upstream and downstream ends of the basin. The elevation difference is restricted to a maximum value of 20 ft.
- Determine basin dimensions: Length, width and depth. Side slopes are fixed at 3H:1V. Freeboard is fixed at 1 foot. These parameters determine the total volume provided as well as total head available for the outflow.
- If the off-line basin is at a location upstream of a culvert, import the HY8 results for the culvert into an inflow-outflow table (see section 5.11). If the off-line basin is at a location upstream of an outfall, then setup an inflow-outflow table to divert all flows exceeding the capacity of the channel into the off-line basin.
- Update the inflow-outflow relation in HEC-1 6-hour and 24-hour models.
- Run the 6-hour and 24-hour HEC-1 models
- Obtain the diverted flow rate and volume from HEC-1 results
- Compare with designed basin volume and basin depth (includes freeboard) to see if they are adequate.
- Modify basin dimensions and repeat the process until the basin volume and depth are adequate.

6.10 Leveed Natural Channel Design Procedure

- Identify the channel alignment and determine the length and existing slope along the proposed alignment.
- Select Manning's n values. A value of 0.045 is assumed for the leveed natural channels.
- Determine sediment gradation parameters such as D_{50}, etc.
- Determine upstream drainage area. This is used in the Moody & Odem Regime Equations.
- Determine the adjacent area that can contribute to the sediment volume entering the reach. Using this area, estimate sediment yield (see Section 5.8).

- Identity upstream reaches, basins, and adjacent watershed areas that bring flow into the channel. The HEC-1 model KK IDs for these components are identified and appropriate weighting factors (see section 5.7) are applied to arrive at the 100-year peak flow for the proposed channel.
- Identity upstream reaches that bring sediment into the channel. Determine sediment flux entering channel from these upstream channels.
- Establish an initial width and depth of the leveed channel and set up the conveyance cross-section. Depth of flow in the initial cross section is targeted at about 1 foot and velocity of the 75 percent and 100 percent flow rates are greater than 4 feet per second but less than 6 feet per second. The bottom width may not exceed 400 feet.
- Determine the average equilibrium slope (see section 5.10.4) for the selected cross-section, existing slope and sediment gradation data.
- Set the long-term slope based on the average equilibrium slope.
- Determine the velocity, flow depth, and Froude number.
- The velocity in the initial cross section should be approximately 4-6 ft/sec. The flow depth should be in the range of 1 to 2 feet and the Froude number less than 0.86. The available freeboard must be larger than the required freeboard. Repeat sizing width and depth of the channel until these conditions are satisfied.
- Determine the shape of the long-term low-flow channel using hydraulics results for the long-term slope. The shape of the long-term low-flow channel is determined by the regime theory results for the 10% and 25% peak flow results for width, depth, and velocity.
- Determine sediment transport capacity for the channel as designed (see section 5.10.14). If the sediment influx is larger than the sediment transport capacity, deposition is anticipated. Erosion is anticipated otherwise.
- Perform allowable velocity calculations (see section 5.10.3) to determine that the channel, as designed, would be stable.
- Determine the number of drop structures needed (see section 5) using the length of the channel, existing slope, and the long-term design slope. A 3-foot drop height is assumed for all drop structures.
- Determine number of sedimentation basins needed using the estimates of the sediment volume entering the channel.
- Determine the toe down required for bank protection. The toe down is computed based on the estimated scour depth computed (see section 5.10.15).
- Determine any additional ROW area needed. These are needed in the estimation of the land costs.
- Perform cost estimates (see section 9.1) to arrive at the land cost, construction cost, landscaping cost and maintenance cost. The channel costs are estimated for the following: (a) land cost for the channel area, (b) land cost for the levee area, (c) other additional right of way area, (d) toe protection using riprap, e) levee fill, f) levee lining, g) drop structures using riprap, and h) sedimentation basins.

6.11 Excavated Earthen Channel Design Procedure

- Identify the channel alignment and determine the length and existing slope along the proposed alignment.
- Select Manning's n values. A value of 0.045 is used for the earthen excavated channel.
- Determine sediment gradation parameters such as D_{50}, etc.
- Determine upstream drainage area. This is used in the Moody & Odem Regime Equations.
- Determine the adjacent area that can contribute to the sediment volume entering the reach. Using this area, estimate sediment yield (see Section 5.8).
- Identity upstream reaches, basins, and adjacent watershed areas that bring flow into the channel. The HEC-1 model KK IDs for these components are identified and appropriate weighting factors (see section 5.7) are applied to arrive at the 100-year peak flow for the proposed channel.
- Identity upstream reaches that bring sediment into the channel. Determine sediment flux entering channel from these upstream channels.
- Establish an initial width and depth of the excavated channel and set up the conveyance cross-section.
- Determine the average equilibrium slope (see section 5.10.4) for the selected cross-section, existing slope and sediment gradation data.
- Determine the design slope based on the equilibrium slope. For the B3 Alternative, the hydraulics of only the design (long-term) slope are evaluated as the channel will be constructed to this slope.

- Determine the velocity, flow depth, and Froude number.
- The flow width and depth are approximately set based on regime theory. The flow depth should be less than 8 feet and the Froude number less than 0.86. The available freeboard must be larger than the required freeboard. Repeat sizing width and depth of the channel until these conditions are satisfied.
- Determine sediment transport capacity for the channel as designed (see section 5.10.14). If the sediment influx is larger than the sediment transport capacity, deposition is anticipated. Erosion is anticipated otherwise.
- Perform allowable velocity calculations (see section 5.10.3) to determine that the channel, as designed, would be stable.
- Determine the number of drop structures needed (see section 5) using the length of the channel, the existing slope and the design (long-term) slope. A 3-foot drop height is assumed for all drop structures.
- Determine number of sedimentation basins needed using the estimates of the sediment volume entering the channel.
- Determine any additional ROW area needed. These are needed in the estimation of the land costs. A 120-foot preservation corridor is assumed for all excavated channel alternatives except for collector channels associated with Alternative A.
- Perform cost estimates (see section 9.1) to determine the land cost, construction cost, landscaping cost and maintenance cost. The channel costs are estimated for the following: (a) land cost for the channel area, (b) land cost for the adjacent natural preservation corridor, (c) other additional right of way area (d) channel excavation costs, (e) toe protection using riprap, f) drop structures using riprap, and g) sedimentation basins. Excavation costs are determined based on the channel cross sectional area and the difference between the existing slope and design channel slope.

6.12 Excavated Concrete Channel Design Procedure

- Identify the channel alignment and determine the length and existing slope along the proposed alignment.
- Select Manning's n values. A value of 0.02 is used for the concrete excavated channels.
- Determine sediment gradation parameters such as D_{50}, etc.
- Determine upstream drainage area. This is used in the Moody & Odem Regime Equations.
- Determine the adjacent area that can contribute to the sediment volume entering the reach. Using this area, estimate sediment yield (see Section 5.8).
- Identity upstream reaches, basins, and adjacent watershed areas that bring flow into the channel. The HEC-1 model KK IDs for these components are identified and appropriate weighting factors (see section 5.7) are applied to arrive at the 100-year peak flow for the proposed channel.
- Identity upstream reaches that bring sediment into the channel. Determine sediment flux entering channel from these upstream channels.
- Establish an initial width and depth of the excavated channel and set up the conveyance cross-section.
- Determine the average equilibrium slope (see section 5.10.4) for the selected cross-section, existing slope and sediment gradation data.
- Determine the slope based on the Froude number. The Froude number should be set less than 0.86. The initial slope and the long-term slope are set as the same value.
- Determine the velocity, flow depth, and Froude number.
- The flow depth should be less than 8 feet. The available freeboard must be larger than the required freeboard. Low flow channels are sized such that the 10 percent and 25 percent depth and velocity are not considered too highly dangerous for adults possibly caught within the channel based on criteria in ACER TM-11 (USBR, 1988). Generally, velocity is kept below 5 feet per second and depth less than 2 feet wherever possible. Repeat sizing width and depth of the channel until these conditions are satisfied.
- Determine sediment transport capacity for the channel as designed (see section 5.10.14). If the sediment influx is larger than the sediment transport capacity, deposition is anticipated. Erosion is anticipated otherwise.
- Determine the number of drop structures needed (see section 5) using the length of the channel, existing slope and the design slope. A 3-foot drop height is assumed for all drop structures.
- Determine number of sedimentation basins needed using the estimates of the sediment volume entering the channel.

- Determine any additional ROW area needed. These are needed in the estimation of the land costs. A 120-foot preservation corridor is assumed for all excavated channel alternatives except for collector channels associated with Alternative A.
- Perform cost estimates (see section 9.1) to arrive at the land cost, construction cost, landscaping cost and maintenance cost. The channel costs are estimated for the following: (a) land cost for the channel area, (b) land cost for the adjacent natural corridor, (c) other additional right of way area (d) channel excavation costs, e) drop structures using concrete, and f) sedimentation basins. Excavation costs are determined based on the channel cross sectional area and the difference between the existing slope and design channel slope.

7 LANDSCAPE COMPATIBILITY ENHANCEMENTS

In order to ensure that the proposed structural flood control measures are compatible with the future landscape character of the area, some enhancements to the engineering design concepts are required. In 1993, the District adopted a "Policy for the Aesthetic treatment and Landscaping of Flood Control projects". This policy aims at planning and designing flood control projects that are compatible with the visual character of the adjacent landscape. In addition, the policy also aims at the integration of the recreational activities into the planning and design of the flood control facilities.

The design aspects of landscape compatibility enhancement are the enhancements imposed on a base engineering design to achieve compatibility with this policy. In particular, the enhancements require modifications to engineering structures to blend them into the landscape by integrating non-rectilinear forms, appropriate scale, etc. The landscape enhancements result in additional costs to the project when compared to the costs of the base engineering design. The details pertaining to the design aspects of the enhancements as well as the cost differential for the enhancements are presented in this section. The hydraulics and sediment transport calculations are performed only for the base engineering design and not for the landscape compatibility enhanced design. These calculations for the landscape compatibility enhanced design will be incorporated at the Step 3 design refinement process.

7.1 Landscape Compatibility Enhancements to Leveed Channel

The landscape compatibility enhancement to the levee consists of the flattening of the levee side slope, increase of the top-width of the levee as well the height of the levee. Height adjustments to earth and walled levees were also added to vary to the profile of these structures in the landscape. The levee side slope will vary between 4:1 to 8:1. The height increase in the levee will vary along the length of the levee between 0 to 2 ft. The top-width of earth levees was increased from 14 feet in the base design to 20 feet in the enhanced design. The estimation of project cost increases due to landscape compatibility enhancements were performed by using an average side slope of 6:1 and an average increase in the levee height of 1 ft. These adjustments result in increased fill volume, increased levee lining, as well as increased land area. The increase in the land area, in turn, increases the landscape and maintenance costs. The increase in the levee lining costs is a result of the increased exposed levee surface area.

If a walled corridor channel is adopted instead of a levee, an additional land buffer of 50 ft is applied to each side of the channel. In addition, an average increase of 1 foot is incorporated to the wall height to reflect the vertical variation required to provide landscape compatibility.

7.2 Landscape Compatibility Enhancements to Excavated Channel

The landscape compatibility enhancements for the excavated channel involve a decrease in the side slope of the channel and an additional 50 ft buffer area parallel to all channels. The side slope for the enhanced design will vary between 4:1 to 8:1. For purpose of the cost estimates for the landscape compatibility enhancement components, the average side slope was decreased from 3:1 to 6:1. The decrease in the side slope increases the total land area needed which, in turn, increases the landscape and maintenance costs.

7.3 Landscape Compatibility Enhancements to On-line/Off-line Basins

The landscape compatibility enhancements for the detention basins include a decrease in the side slope, a buffer area around the basins and architectural enhancements to inlet and outlet structures. The side slope for the enhanced design will vary between 4:1 to 8:1. For purpose of the cost estimates, the average side slopes of the basins are decreased from 3:1 to 6:1. The slope change was performed along with an adjustment to the longer dimension of the basin so there is no change in net storage volume between the base design and the enhanced design. However, due to decreased slope, the excavation volume will be higher for the enhanced design. The change in the longer dimension of the basin will also contribute to an increase in the land costs. In addition, a buffer of 50 feet was added around the perimeter of all detention basins. This change also increases the land area resulting in increased land costs. Finally, additional costs were included for architectural enhancements to the inlet and outlet structures which are assumed to be 20% of base cost for the inlet structure and 5% for the outlet structure.

7.4 Landscape Compatibility Enhancements to Drop Structures

The landscape compatibility enhancement for the drop structures results in longer length for the drop structures. A 10% increase in the length of the drop structures was applied to achieve the enhancement. Architectural enhancements to the drop structure materials are also anticipated.

8 WAGNER WASH SUB-AREA SPECIFIC DESIGN CONSIDERATIONS

The Wagner Wash sub-area is located on the northwestern slope of the White Tank Mountains piedmont. Three major alluvial fans, designated Fan 13 (E and W), Fan 3, and an unnamed fan emanating from subbasin S165, drain from the White Tank Mountain Regional Park onto the piedmont in this sub-area. Two secondary areas of large channel divides (distributary channels) are also located in the southern portion of the sub-area in subbasins S175 and S180. The entire sub-area drains into Wagner Wash. The piedmont below portions of Fan 13 and the S165 fan is bisected by the Sun Valley Parkway. Existing runoff from Fans 13 and 3 enters Wagner Wash between the two Sun Valley Parkway crossings. Runoff from the remainder of the sub-area, including the S165 fan, flow to Wagner Wash via existing drainage facilities along the Sun Valley Parkway. Those facilities consist of culverts of various sizes beneath the roadway at various locations. All of the design concepts for the Wagner sub-area alternatives incorporate the existing culverts without modification. Therefore, design flow rates for channels or conveyance corridors downstream of the Parkway are limited to the existing culvert capacities by off-line detention facilities at or near the Sun Valley Parkway. Culvert capacities were computed assuming a headwater depth equal to one foot greater than the internal culvert height as indicated on the design plan sheets for the Parkway. Except for the C Alternative, the existing culverts have sufficient capacity to handle flows directed to them by the proposed alternatives.

The alternatives for Wagner Wash were alignment alternatives. Three alignment alternatives were explored to control flooding from the three major alluvial fans. The B4-1 Alternative detains flows from Fan 3 and directs the outflow to join the detained outflow from Fans 13E and 13W. The combined outflows are discharged to a corridor to Wagner Wash which passes through the northern portion of the sub-area. The fan from S165 is detained and routed via a corridor across a subbasin divide into S175 where it joins a corridor which prevents a large distributary channel split and continues west to Sun Valley Parkway. Downstream of the Parkway, this corridor joins another from S180 which controls two additional splits within that subwatershed. The corridors from S165 to S175 are achieved by means of an excavated channel. Elsewhere, the corridors for the B4-1 Alternative are leveed sections.

The B4-2 Alternative is similar to the B4-1 Alternative except that detained flows from Fan 3 are directed south and west where they join the S165 corridor. The B4-2 Alternative was selected for application of the small basin (B2) and excavated companion channel alternatives (B3 and C). The B4-3 Alternative provides separate outfall corridors for Fan 13 (E & W combined), Fan 3, and the S165 fan. The detained outflows from S165 are combined with the S175 corridor as in Alternatives B4-1 and B4-2.

Alternative A is similar to B4-3 except that the S165 fan is not combined across subbasin divides with S175. Active alluvial fan areas were derived from the unstable delineations performed for the ADMS by Ayers (2005).

9 STEP 2 COST ESTIMATES

9.1 Base Cost Estimates

Base costs for each alternative were estimated by establishing unit costs for the various design components. The total cost for each component was obtained by multiplying the quantities involved with the unit costs. The cost components considered in the design are: 1) Land Cost, 2) Construction Cost, 3) Landscaping Cost, and 4) Maintenance Cost.

For the channels, the cost estimates are categorized into the following: (a) Levee (Alternatives A, B1, B2, B4, B5), (b) Levee Lining (Alternatives A, B1, B2, B4, B5), (c) Channel Excavation (Alternatives B3, C), (d) Channel Lining (Alternative C) (e) Toe Protection (f) Drop Structures (Alternatives A, B1, B2, B3, B4, B5), (g) Sedimentation Basins and (h) Other. The "Other" category is included for the purpose of including any other miscellaneous cost. Table 8 summarizes the channel materials selected for the purpose of cost estimation of the alternatives.

Table 8 Cost Estimate Categories for Channels

Channel Type	Channel Lining	Toe Protection	Levee Fill	Levee Lining	Drop Structures	Sedimentation Basins
Leveed Natural	None	Riprap	Yes	Riprap	Riprap	Yes
Earthen Excavated	None	Riprap	No	None	Riprap	Yes
Concrete Excavated	Concrete	None	No	None	Concrete	Yes

Similarly for the basins, the costs are categorized into: (a) basin, b) inlet, (c) outlet, and (d) other.

The four cost components are estimated for all the cost categories. A summation of all cost components provides the total cost for the particular channel or basin. The costs for all design elements (channels and basins) are totaled to provide the total cost for the particular alternative in a sub-area.

The procedures adopted in estimating the cost for each component are presented below. The details of the calculations performed as presented in Appendix A. The summary of the unit costs for all the components is presented in Table 9.

9.1.1 Land Cost

The land cost is the major cost component in most of the alternatives. The land cost is estimated using a unit cost of $100,000 per acre except for one design reach through existing homes in sub-area FRS #1. A land cost of

$250,000 per acre was applied to that reach. The land areas considered in the estimates are: 1) on-line basin footprint, 2) off-line basin footprint, 3) channel area between the levees (A, B1, B2, B4, B5), 4) excavated channel area (B3, C), 5) adjacent natural preservation corridor (B3, C), 6) area occupied by levee and/or access road (A, B1, B2, B4, B5), and 7) area set-aside for natural active fan processes to occur (A).

9.1.2 Construction Cost

The construction costs are estimated mainly based on unit costs for materials and excavation costs. The unit material cost includes all costs associated with material fully constructed in place. For example, a unit cost of $75 for riprap drop structures includes the cost of material as well the cost of constructing the drop structure. A contingency cost of 25% is applied to the estimated base construction cost. Similarly, the cost for the engineering design is set at 5% of the base construction cost. The sum of the base construction cost, contingency cost and the design cost provides the total construction cost.

9.1.3 Landscaping Cost

The landscaping costs are also applied as unit costs for the cost categories where landscaping is needed. The landscaping costs are mostly based on "per area" unit cost with the areas estimated using the design parameters. A landscaping cost of $1 per square foot was assumed based on an assumption of 60% of the area landscaped at $1.50 per square foot and 40% of the area naturally seeded at $0.06 per square foot. Landscaping costs were applied only to the disturbed areas impacted by the structural elements of the alternatives. For example, the surface area of the excavated earthen channels (B3) was assumed to require landscaping. Similarly, the external slopes of the levees were assumed to require landscaping. This landscape cost is for basic reestablishment of vegetation on disturbed areas. It does not include the cost of landscape enhancements required for compatibility of the structural flood control measures with the future landscape character of the area. Landscape compatibility enhancement costs are discussed in Section 9.2.

9.1.4 Maintenance Cost

The maintenance costs are based on a 3-year maintenance cycle. The costs are estimated for a design life of 50 years. The costs include maintenance costs for a period of 50 years assuming that maintenance will be performed every 3 years.

Table 9 Summary of Unit Costs

	Construction Units	Construction Cost	Landscape Units	Landscape Cost	Maintenance Units	3 Year Maintenance Cost
Levee						
Fill	cu. Yd	$ 7.00	sq. Yd	$ 9.00	sq. Yd	$ 0.70
Wall	sq. Yd	$ 215.00	sq. Yd	$ -	sq. Yd	$ 4.50
Toe Protection						
Riprap	cu. Yd	$ 75.00	sq. Yd	$ -	sq. Yd	$ 1.50
Gabions	cu. Yd	$ 85.00	sq. Yd	$ -	sq. Yd	$ 1.70
Soil Cement	cu. Yd	$ 50.00	sq. Yd	$ -	sq. Yd	$ 1.50
Concrete	cu. Yd	$ 155.00	sq. Yd	$ -	sq. Yd	$ 2.35
Levee Lining						
Riprap	cu. Yd	$ 75.00	sq. Yd	$ -	sq. Yd	$ 1.25
Gabions	cu. Yd	$ 85.00	sq. Yd	$ -	sq. Yd	$ 1.50
Soil Cement	cu. Yd	$ 75.00	sq. Yd	$ -	sq. Yd	$ 1.80
Concrete	cu. Yd	$ 155.00	sq. Yd	$ -	sq. Yd	$ 2.00
Channel Lining						
Riprap	cu. Yd	$ 75.00	sq. Yd	$ -	sq. Yd	$ 2.00
Gabions	cu. Yd	$ 85.00	sq. Yd	$ -	sq. Yd	$ 2.25
Soil Cement	cu. Yd	$ 75.00	sq. Yd	$ -	sq. Yd	$ 3.00
Concrete	cu. Yd	$ 155.00	sq. Yd	$ -	sq. Yd	$ 2.50
Drop Structure						
Riprap	cu. Yd	$ 75.00	sq. Yd	$ -	sq. Yd	$ 2.00
Gabions	cu. Yd	$ 85.00	sq. Yd	$ -	sq. Yd	$ 2.25
Soil Cement	cu. Yd	$ 75.00	sq. Yd	$ -	sq. Yd	$ 3.00
Concrete	cu. Yd	$ 155.00	sq. Yd	$ -	sq. Yd	$ 2.50
Basin Inlet						
Riprap	cu. Yd	$ 75.00	sq. Yd	$ -	sq. Yd	$ 2.00
Concrete	cu. Yd	$ 155.00	sq. Yd	$ -	sq. Yd	$ 2.50
Pipes						
24" RGRCP	LF	$ 55.00	sq. Yd	$ -		$ 0.55
30" & 36" RGR	LF	$ 82.00	sq. Yd	$ -		$ 1.20
42" & 48" RGR	LF	$ 160.00	sq. Yd	$ -		$ 2.40
54" & 60" RGR	LF	$ 183.00	sq. Yd	$ -		$ 2.75

	Construction Units	Construction Cost	Landscape Units	Landscape Cost	Maintenance Units	3 Year Maintenance Cost
Channel						
Excavated Channel	$ 10.00	cu. Yd	sq. Yd	$ 9.00	sq. Yd	$ 0.50
Sedimentation Basin						
Sedimentation Basi	$ 10.00	cu. Yd	sq. Yd	$ -	sq. Yd	$ 0.50
Basin						
Excavated Basin	$ 4.00	cu. Yd	sq. Yd	$ 9.00	sq. Yd	$ 0.50
Outlet Cost	Based on 100'x12' Weir					
None	EA	$ -	sq. Yd	$ -	sq. Yd	$ -
Concrete Weir	EA	$ 15,000.00	sq. Yd	$ -	sq. Yd	$ 2.50
Riprap Weir	EA	$ 10,000.00	sq. Yd	$ -	sq. Yd	$ 2.00
Pipe	LF	$ 160.00	sq. Yd	$ -	sq. Yd	$ 1.00

9.2 Landscape Compatibility Enhancement Costs

In order to ensure that the proposed structural flood control measures are compatible with the future landscape character of the area, some enhancements to the base engineering design concepts were required. In particular, the engineering structures require modifications to blend them into the landscape (i.e. irregular form, etc). Additional costs will be incurred to ensure that the proposed structural flood control measures conform with the future landscape character of the Sun Valley area. The additional costs were estimated based on increased land area, construction, and maintenance requirements for the enhanced structures. Details of the computation of the landscape compatibility enhancement costs are provided in Section 7.

10 WAGNER WASH SUB-AREA DESIGN SUMMARY

The design summary of all the alternatives for the Wagner Wash sub-area is presented in the following sections. Table 10 shows a summary of the cost estimates for each alternative for the Wagner Wash sub-area. Table 11 shows a summary of the landscape enhanced costs for the Wagner Wash sub-area.

Table 10 Base Cost Summary

Alternative	Land Area	Land Cost	Constr. Cost	Lndscp Cost	Maint. Cost	Total Cost	Land Cost %	Constr. Cost %	Lndscp Cost %	Maint. Cost %
A	857	$ 85,540	$ 32,059	$ 6,074	$ 16,995	$ 140,668	61%	23%	4%	12%
B2	329	$ 32,920	$ 20,863	$ 4,203	$ 10,271	$ 68,257	48%	31%	6%	15%
B3	274	$ 27,410	$ 94,468	$ 5,605	$ 6,368	$ 133,851	20%	71%	4%	5%
B41	296	$ 29,690	$ 21,011	$ 4,629	$ 10,187	$ 65,517	45%	32%	7%	16%
B42	301	$ 30,190	$ 21,538	$ 4,769	$ 10,697	$ 67,194	45%	32%	7%	16%
B43	439	$ 43,910	$ 27,918	$ 5,724	$ 13,116	$ 90,669	48%	31%	6%	14%
C	250	$ 24,909	$ 103,481	$ 4,517	$ 9,847	$ 142,753	17%	72%	3%	7%

Table 11 Landscape Enhanced Cost Summary

		Costs (in $1000)					Percentage Cost Increase				
Alt.	Land Area (acres)	Land Cost	Constr. Cost	Lndscp Cost	Maint. Cost	Total Cost	Land Cost %	Constr. Cost %	Lndscp Cost %	Maint. Cost %	Total Cost
A	938	$ 93,810	$ 53,694	$ 12,161	$ 32,333	$ 191,998	10%	67%	100%	90%	36%
B2	394	$ 39,270	$ 36,266	$ 8,797	$ 21,588	$ 105,921	19%	74%	109%	110%	55%
B3	376	$ 37,600	$ 119,071	$ 7,684	$ 8,326	$ 172,681	37%	26%	37%	31%	29%
B41	367	$ 36,650	$ 35,597	$ 9,372	$ 21,186	$ 102,804	23%	69%	102%	108%	57%
B42	374	$ 37,320	$ 37,018	$ 9,703	$ 22,326	$ 106,368	24%	72%	103%	109%	58%
B43	525	$ 52,420	$ 47,342	$ 11,714	$ 27,494	$ 138,971	19%	70%	105%	110%	53%
C	339	$ 33,940	$ 142,135	$ 6,095	$ 15,735	$ 197,905	36%	37%	35%	60%	39%

The cost estimates reveal the following information from the alternative comparisons.

Alignment alternatives – As discussed in Section 8, three alignment alternatives were considered to control flooding on the major alluvial fans in the Wagner Wash sub-area. The B4-1 Alternative detains flows from Fan 3 and directs the outflow to join the detained outflow from Fans 13E and 13W. The combined outflows are discharged in a single corridor to Wagner Wash through the northern portion of the sub-area. The fan from S165 is detained and routed via a second corridor across a subbasin divide into S175 where it continues to Sun Valley Parkway and then to Wagner Wash. The B4-2 Alternative is similar to the B4-1 Alternative except that detained flows from Fan 3 are directed south and west where they join the S165 corridor. Fans 13E and 13W are controlled separately and discharge to a second corridor. The B4-3 Alternative provides separate outfall corridors for Fan 13 (E & W combined), Fan 3, and the S165 fan.

The costs of the B4-1 and B4-2 Alternatives are very similar due to their similar corridor lengths. The B4-3 Alternative alignments were longer and therefore more expensive. The B4-2 Alternative was therefore selected for application of the small basin (B2) and excavated companion channel alternatives (B3 and C).

Sizing alternatives - The large on-line basin (B4-2) alternative is approximately the same cost as the small on-line basin (B2). The off-line basin (B5) was not explicitly analyzed for the Wagner sub-area because it was shown to have a similar cost to the small on-line basin in the CAP sub-area analysis (see Volume 2). The reasons for this result are: 1) the downstream reach peak discharges are driven by the on-fan runoff and 2) land cost is the largest portion of the total cost for the leveed corridor alternatives.

Other apex or conveyance strategies – The A alternative and excavated channel alternatives (B3 and C) are the most expensive alternatives; even more expensive than the multiple leveed corridors with apex basins. In the case of the A alternative, the land cost associated with the active alluvial fan area makes this approach much more expensive than the apex basin alternatives. The active fan area is recovered for potential development. For the excavated channel alternatives, the construction costs are much greater than the land area saved. Additionally, these alternatives include a 120-foot preservation corridor as part of the land cost which offsets some of the potential cost savings when compared to the leveed corridor alternatives.

Landscape compatibility enhancements – The landscape compatibility enhancements include costs for additional land requirements, construction requirements (excavation and fill), increased landscaping area, and increased maintenance (due to the larger areas requiring maintenance). The increased costs for landscape compatibility enhancements average about 40 percent for all alternatives, ranging from about 30 to 60 percent. The increased costs are greatest for the B4-1 and B4-2 alternatives and least for the B3 alternative for the Wagner Wash sub-area.

Wall vs. Earth Levee – The relative cost differences for the walled corridor versus the earthen levee corridor were also evaluated. A comparison of the per unit channel length was performed for an example reach. Table 12 shows the results of this comparison. The costs for the wall do not include any fill behind the wall. That is, the wall serves as the levee by itself without any backfill "uphill" of the wall. The walled levee ranges from about 45 to 80 percent less expensive than the earthen levee option depending on levee height. The cost differential is greater the taller the levee. The differences in cost are due to additional construction costs, landscape compatibility enhancement costs, and land costs associated with the earthen levee. The primary reason the cost difference increases with levee height is related to the size of the levee footprint. The earth levee footprint grows with increasing height whereas the wall footprint (and 50-foot landscape enhancement buffer) does not. The larger levee footprint results in larger construction, land, landscaping, enhancement, and maintenance costs.

Table 12 Walled vs. Earth Levee Cost Comparison

	Levee			Wall			
Levee/Wall Height (ft)	Base Cost per foot	LC Enh. Cost per foot	Total Cost per foot	Base Cost per foot	LC Enh. Cost per foot	Total Cost per foot	Percentage Difference
3.5	$ 611	$ 672	$ 1,284	$ 381	$ 512	$ 893	44%
4	$ 675	$ 734	$ 1,409	$ 421	$ 512	$ 932	51%
4.5	$ 725	$ 814	$ 1,539	$ 460	$ 512	$ 972	58%
5	$ 795	$ 876	$ 1,671	$ 499	$ 512	$ 1,011	65%
5.5	$ 847	$ 975	$ 1,822	$ 539	$ 512	$ 1,050	73%
6	$ 915	$ 1,045	$ 1,960	$ 578	$ 512	$ 1,090	80%

10.1 Summary

Engineering cost estimates for the Step 2 Proposed Alternatives were computed. The apex basin alternatives with leveed corridors are generally the least expensive alternatives compared the excavated channel alternatives or apex avoidance strategy.

In addition, the additional costs associated with meeting the landscape aesthetic requirements were also estimated. The results indicate that the landscape compatible alternatives are about 40 percent more expensive than the base engineering costs. In addition, the cost of the earthen levee were compared to a walled levee. Those calculations showed that the walled levee approach is significantly less expensive compared to the earthen levee.

The following sections provide a summary of each alternative for the Wagner Wash sub-area along with bulleted lists of the key features, advantages, disadvantages, and opportunities associated with each alternative. Additional details of the design calculations, hydrologic models, and cost estimates are provided in Appendix A for each alternative. The summary sheets are followed by the alternatives evaluation in Section 11.

10.2 ALTERNATIVE A - Summary Sheet for Wagner Wash Sub-Area

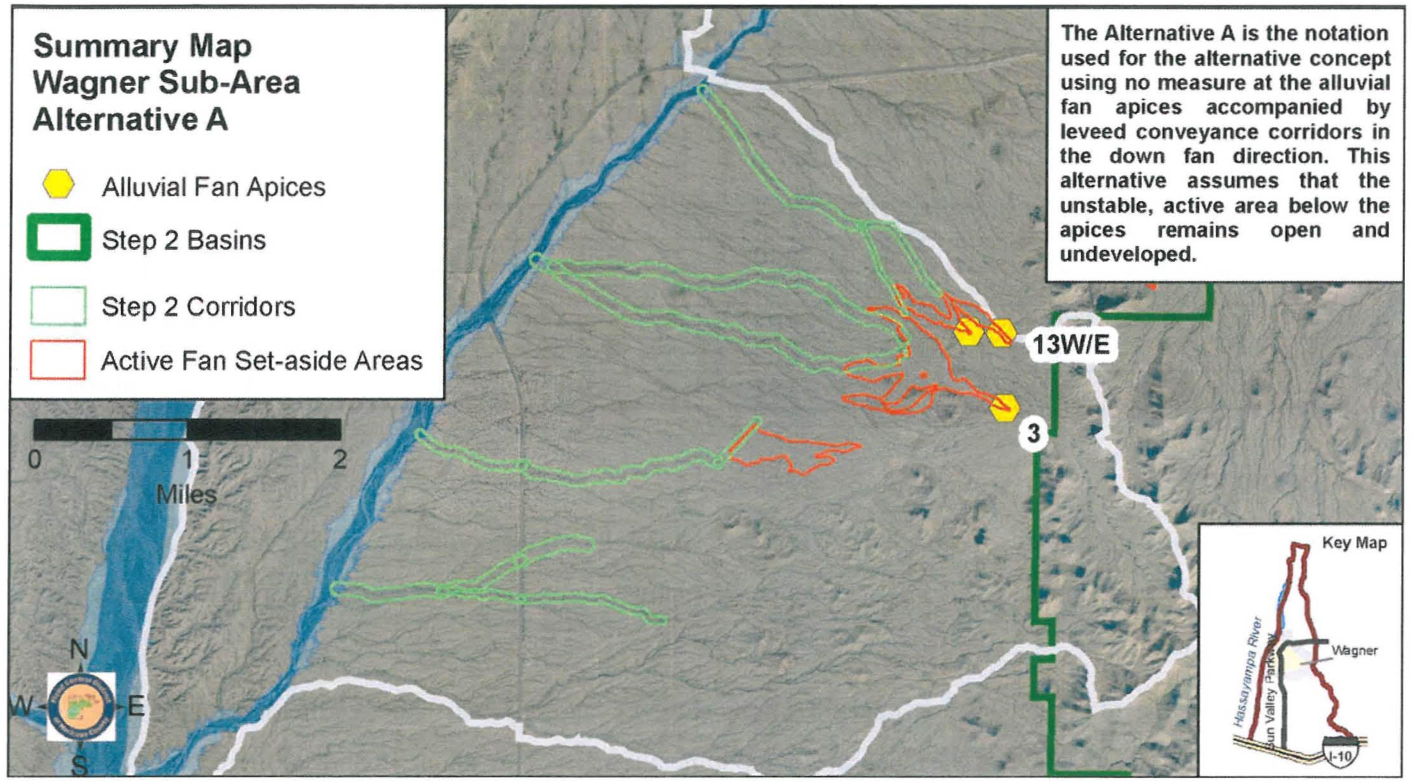

Figure 28 Summary Map of Alternative A for the Wagner Wash Sub-Area

10.2.1 Description for Alternative A

The main design objective of the A Alternative is to allow the natural geomorphic processes to occur within a designated active area downstream of the apex. The objective then is to control the flow path downstream of the region of uncertainty. The flows will be captured in the up-fan area by excavated collector channels and/or diversion levees. Once collected, the flows are routed downstream using leveed corridors similar to the B alternatives.

10.2.2 Key Features

- $140.7 million is the estimated total cost
- 258 acres of active fan set aside area
- 13.9 miles of corridors
- 598 acres needed for corridor right of way, excluding the active fan set aside area

10.2.3 Advantages

- Provides for continued natural fan processes near apices
- Effectively manages active alluvial fan sedimentation issues
- Provides trunk system which minimizes the impacts of development phasing
- Provide additional open space area near Regional Park boundary
- Achieves context sensitivity of new facilities
- Requires no structural measures on Wagner Wash
- Minimizes disruption of flows delivered to Wagner Wash

10.2.4 Disadvantages

- Costly structures
- Fill requirements exceed excavation volume
- Large right of way demand

10.2.5 Opportunities

- Provides multiple connections from Wagner Wash to Regional Park for recreation
- Provides multiple connections from Wagner Wash to Regional Park for wildlife

10.3 ALTERNATIVE B2 - Summary Sheet for Wagner Wash Sub-Area

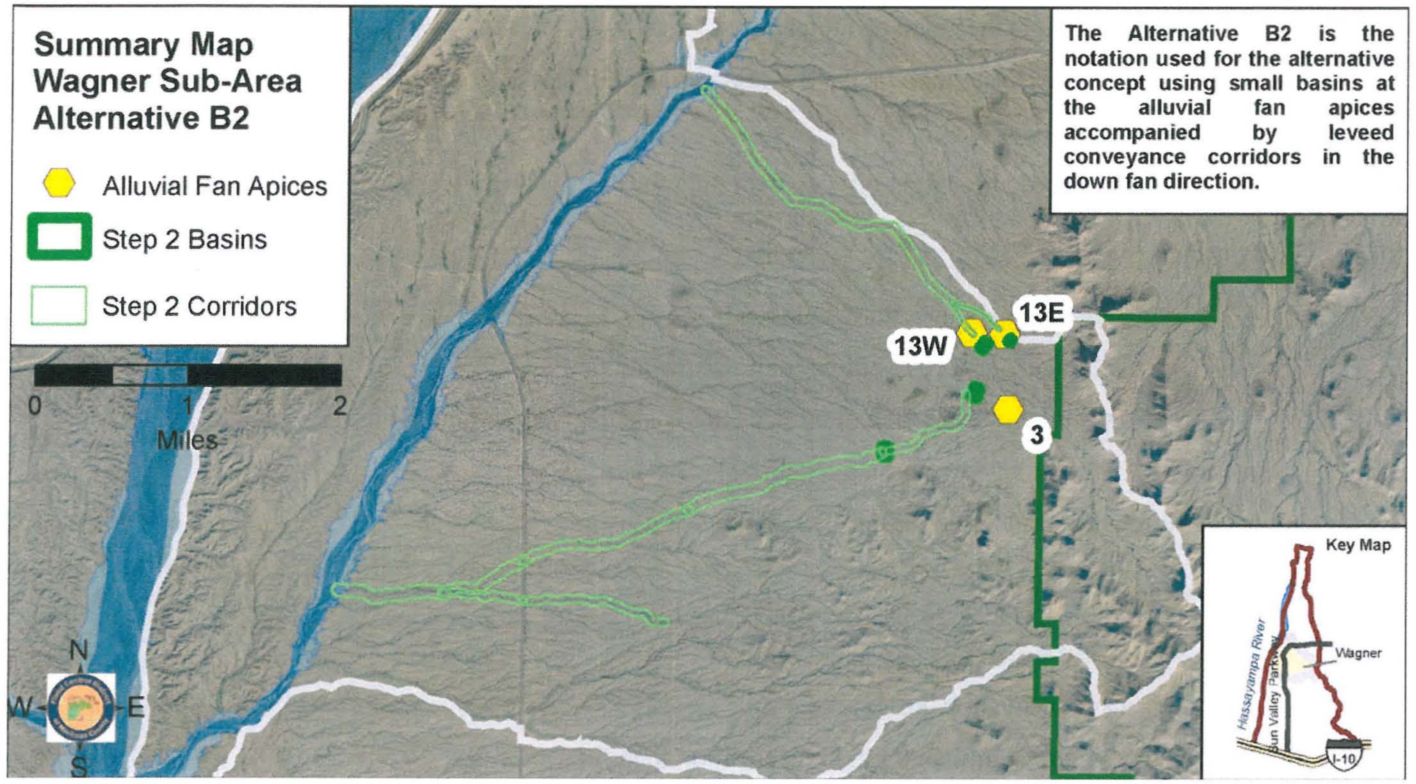

Figure 29 Summary Map of Alternative B2 for the Wagner Wash Sub-Area

10.3.1 Description for Alternative B2

The purpose of Alternative B is to capture the upstream flow at the apex using on-line detention basins. The presence of the detention basins eliminates the downstream alluvial fan uncertainties by controlling flood flow and sediment at the alluvial fan apices downstream to the Wagner Wash. Alternative B2 is based on using a relatively smaller on-line detention basin at the apex accompanied by leveed corridor channel sections in the down fan direction. The B2 Alternative was evaluated for the alignment from the B4-2 Alternative.

Outflows from Fans 13E and 13W are collected into common leveed corridors and routed downstream to Wagner Wash. No structural measures are proposed to Wagner Wash. Outflows from Fan 3 are routed to another active area further south (S165) and then further south and west crossing a ridge though a short reach of excavated channel and continuing on toward Sun Valley Parkway. The existing culverts at the Parkway have sufficient capacity to pass the 100-year peak discharge without need for additional detention basins for the two southern corridors.

10.3.2 Key Features

- $68.3 million is the estimated total cost
- Four on-line basins with a total excavation volume of .42 ac-ft
- 9.0 miles of corridors
- 324 acres needed for right of way

10.3.3 Advantages

- Eliminates flow path uncertainty at the apices.
- Effectively manages active alluvial fan sedimentation issues
- Provides trunk system which minimizes the impacts of development phasing
- Minimizes length of corridor required
- Achieves context sensitivity of new facilities
- Requires no structural measures on Wagner Wash

10.3.4 Disadvantages

- Large costly structures
- Requires more fill than provided by the basin excavation
- Requires excavation of two reaches to cross subwatershed divides to combine outflow corridors
- Directs a portion of the mountain runoff to an inflow point further downstream on Wagner Wash

10.3.5 Opportunities

- Provides connection from Wagner Wash to Regional Park

10.4 ALTERNATIVE B3 - Summary Sheet for Wagner Wash Sub-Area

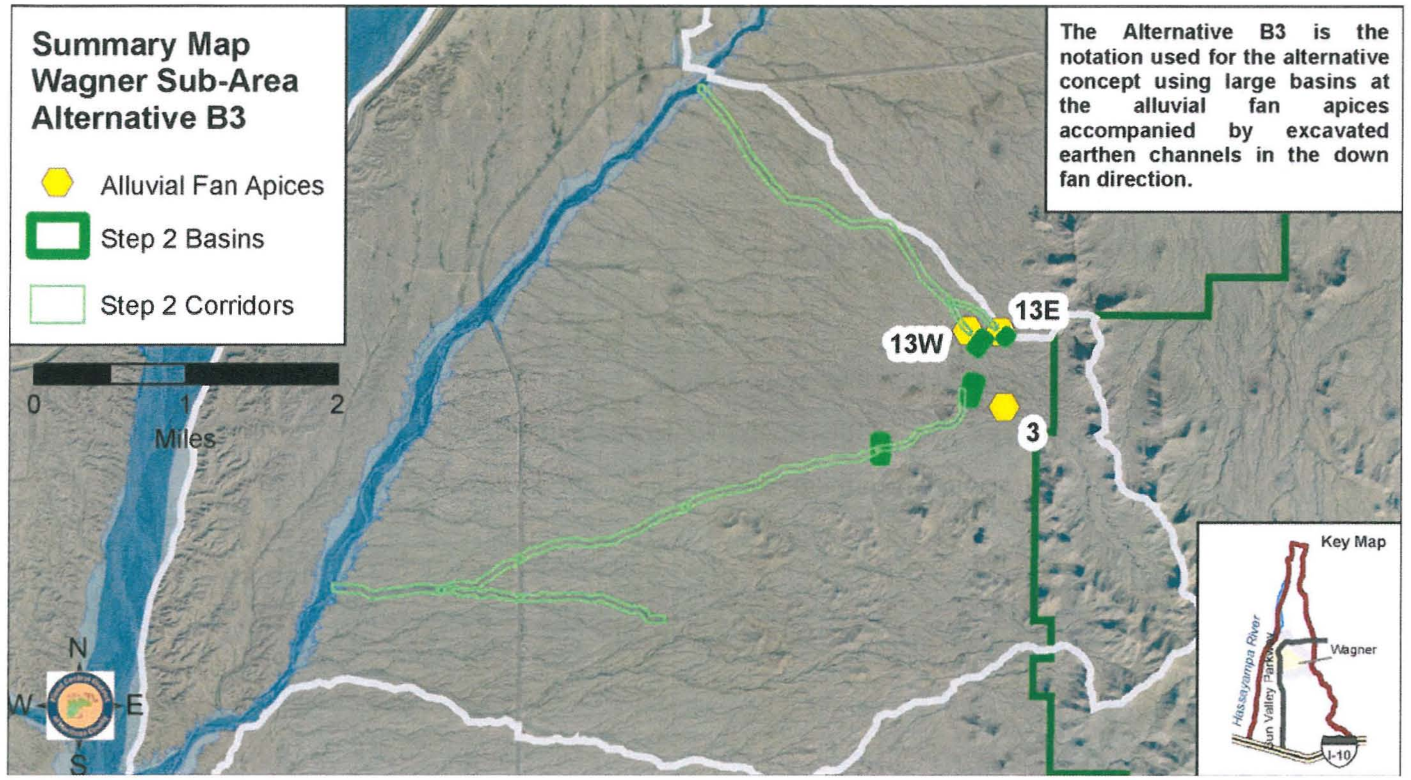

Figure 30 Summary Map of Alternative B3 for the Wagner Wash Sub-Area

10.4.1 Description for Alternative B3

The purpose of Alternative B is to capture the upstream flow at the apex using on-line detention basins. The presence of the detention basins eliminates the downstream alluvial fan uncertainties by controlling flood flow and sediment at the alluvial fan apices downstream to the Wagner Wash. Alternative B3 is based on using a relatively larger on-line detention basin at the apex accompanied by excavated earthen channel sections in the down fan direction. The excavated earthen channels are complemented with a 120-foot wide adjacent riparian preservation corridor. The B3 Alternative was evaluated for the alignment from the B4-2 Alternative.

Outflows from Fans 13E and 13W are collected into a common excavated earthen channel and routed downstream to Wagner Wash. No structural measures are proposed to Wagner Wash. Outflows from Fan 3 are routed to another active area further south (S165) and then further south and west crossing a ridge though a short reach of excavated channel and continuing on toward Sun Valley Parkway. The existing culverts at the Parkway have sufficient capacity to pass the 100-year peak discharge without need for additional detention basins for the two southern corridors.

10.4.2 Key Features

- $133.9 million is the estimated total cost
- Four on-line basins with a total excavation volume of 214 ac-ft
- 9.0 miles of corridors
- 2257 acres needed for right of way, including the riparian preservation corridor

10.4.3 Advantages

- Eliminates flow path uncertainty at the apices
- Effectively manages active alluvial fan sedimentation issues
- Provides trunk system which minimizes the impacts of development phasing
- Preserves riparian corridor in undisturbed state
- Requires no structural measures on Wagner Wash

10.4.4 Disadvantages

- Large costly structures
- Significant excavation costs
- Requires more significantly more excavation than fill
- Requires excavation of two reaches to cross subwatershed divides to combine outflow corridors
- Directs a portion of the mountain runoff to an inflow point further downstream on Wagner Wash

10.4.5 Opportunities

- Provides connection from Wagner Wash to Regional Park

10.5 ALTERNATIVE B4-1 - Summary Sheet for Wagner Wash Sub-Area

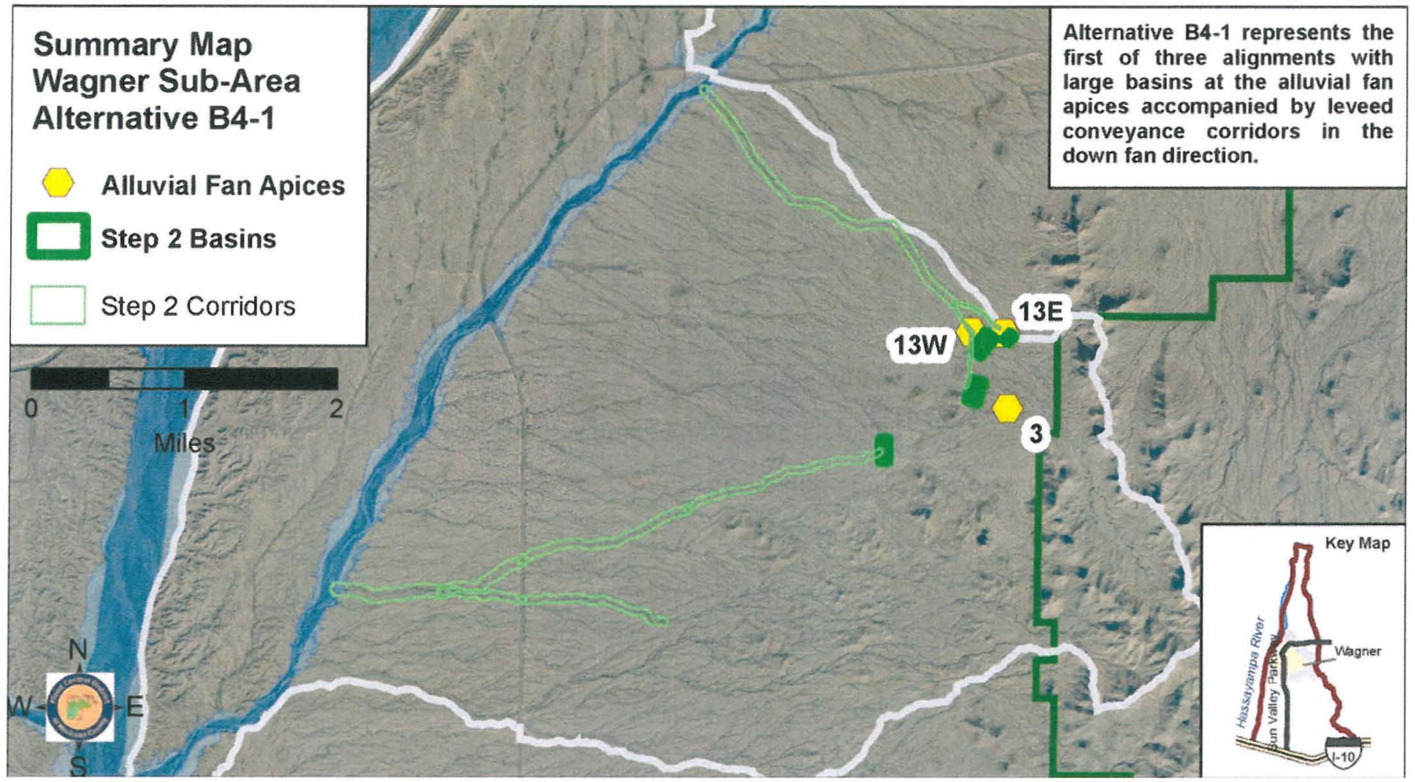

Figure 31 Summary Map of Alternative B4-1 for the Wagner Wash Sub-Area

10.5.1 Description for Alternative B4-1

The purpose of Alternative B is to capture the upstream flow at the apex using on-line detention basins. The presence of the detention basins eliminates the downstream alluvial fan uncertainties by controlling the flood flow and sediment at the alluvial fan apices downstream to the Wagner Wash. Alternative B4-1 is based on using a relatively larger on-line detention basin at the apex accompanied by leveed corridor channel sections in the down fan direction. It is the first of three corridor alignments considered as part of the Alternative B4 series.

The B4-1 Alternative for the Wagner sub-area detains runoff from Fan 3 and directs the outflow to Fan 13W. The combined outflows from Fans 13E and 13W are controlled within a corridor that directs flows north and west to Wagner Wash. No structural measures are proposed to Wagner Wash. A second set of leveed corridors are provided in the southern portion of the sub-area to control additional distributary flow uncertainty in that area. Flows are controlled and combined downstream of Sun Valley Parkway where they continue west to Wagner Wash within leveed corridors. A portion of the channel from the distributary flow area at S165 requires excavation to cross a subwatershed boundary for it to be combined with the neighboring corridor to the south.

10.5.2 Key Features

- $65.5 million is the estimated total cost
- Four on-line basins with a total excavation volume of .259 ac-ft
- 8.4 miles of corridors
- 275 acres needed for right of way

10.5.3 Advantages

- Eliminates flow path uncertainty at the apices
- Effectively manages active alluvial fan sedimentation issues
- Provides trunk system which minimizes the impacts of development phasing
- Nearly balanced cut & fill requirements
- Requires no structural measures on Wagner Wash
- Directs mountain runoff to upstream reaches of Wagner Wash

10.5.4 Disadvantages

- Large costly structures
- Requires excavation of two reaches to cross subwatershed divides to combine outflow corridors

10.5.5 Opportunities

- Provides connection from Wagner Wash to Regional Park

10.6 ALTERNATIVE B4-2 - Summary Sheet for Wagner Wash Sub-Area

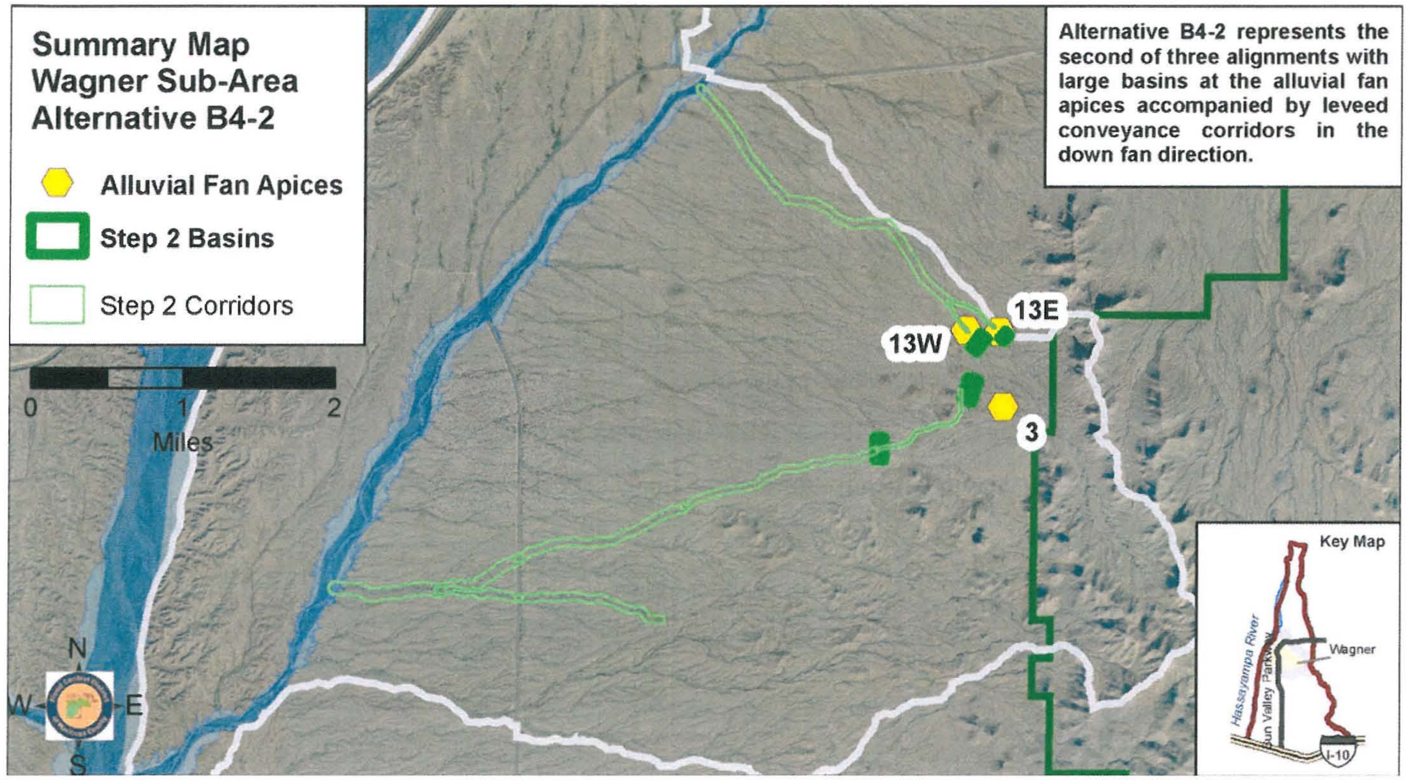

Figure 32 Summary Map of Alternative B4-2 for the Wagner Wash Sub-Area

10.6.1 Description for Alternative B4-2

The purpose of Alternative B is to capture the upstream flow at the apex using on-line detention basins. The presence of the detention basins eliminates the downstream alluvial fan uncertainties by controlling the flood flow and sediment from the alluvial fan apices to the outfall. Alternative B4-2 is based on using a relatively larger on-line detention basin at the apex accompanied by leveed channel sections in the down fan direction. It is the second of three corridor alignments considered as part of the Alternative B4 series.

The B4-2 Alternative for the Wagner sub-area detains from Fan 3 and directs the outflow to the southern corridor system which provides control for several distributary flow locations in that area. Flows are controlled and combined downstream of Sun Valley Parkway where they continue west to Wagner Wash. Fans 13E and 13W are controlled detaining water and sediment flows with inline detention basins. Outflows are directed to a corridor that directs flows north and west to Wagner Wash. No structural measures are proposed to Wagner Wash.

Outflows from the on-line detention basin at Fan 3 are directed to a second set of leveed corridors are provided in the southern portion of the sub-area to control additional distributary flow uncertainty in that area. Flows are controlled and combined downstream of Sun Valley Parkway where they continue west to Wagner Wash within leveed corridors. A portion of the channel from the distributary flow area at S165 requires excavation to cross a subwatershed boundary for it to be combined with the neighboring corridor to the south.

10.6.2 Key Features

- $67.2 million is the estimated total cost
- Four on-line basins with a total excavation volume of .213 ac-ft
- 9.0 miles of corridors
- 283 acres needed for right of way

10.6.3 Advantages

- Eliminates flow path uncertainty at the apices
- Effectively manages active alluvial fan sedimentation issues
- Provides trunk system which minimizes the impacts of development phasing
- Nearly balanced cut & fill requirements
- Requires no structural measures on Wagner Wash

10.6.4 Disadvantages

- Large costly structures
- Requires excavation of two reaches to cross subwatershed divides to combine outflow corridors
- Directs a portion of the mountain runoff to an inflow point further downstream on Wagner Wash

10.6.5 Opportunities

- Provides connection from Wagner Wash to Regional Park

10.7 ALTERNATIVE B4-3 - Summary Sheet for Wagner Wash Sub-Area

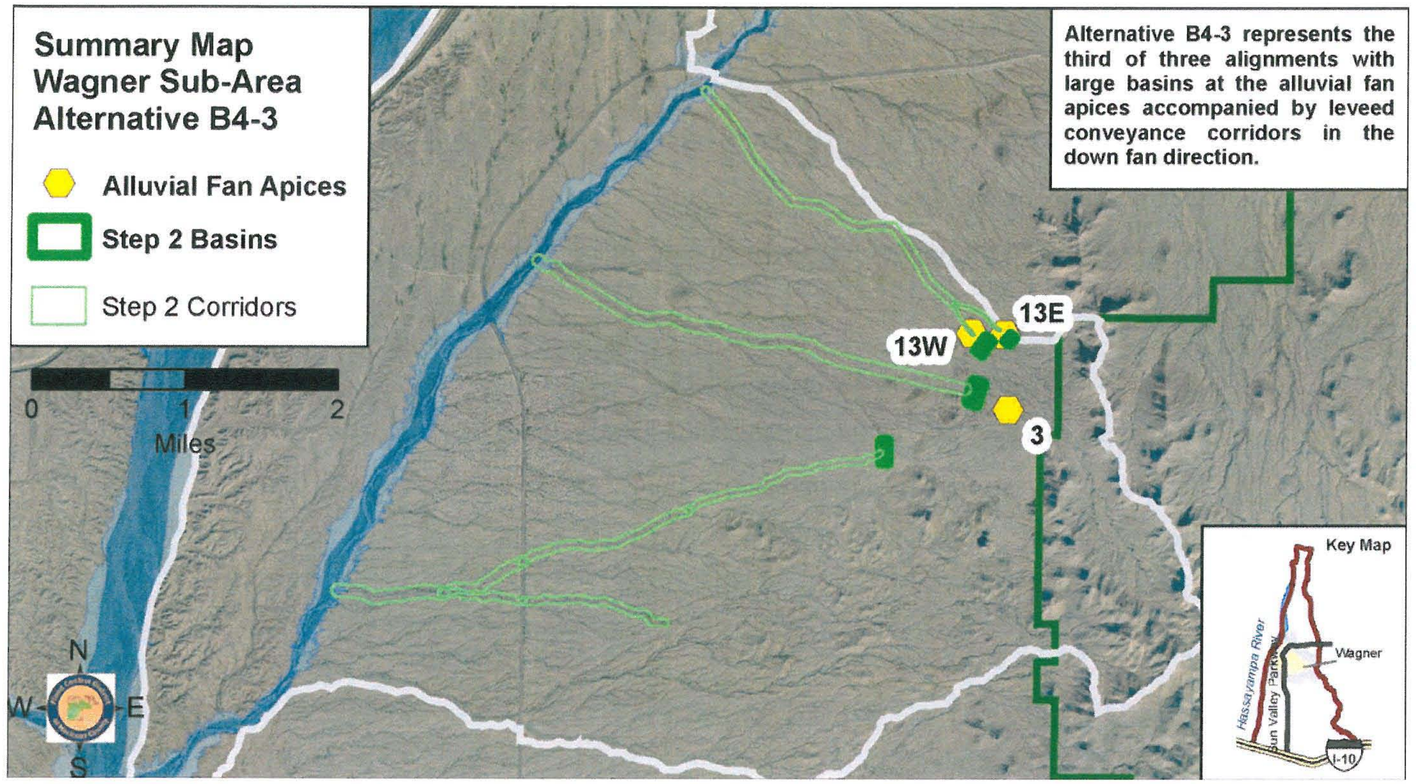

Figure 33 Summary Map of Alternative B4-3 for the Wagner Wash Sub-Area

10.7.1 Description for Alternative B4-3

The purpose of Alternative B is to capture the upstream flow at the apex using on-line detention basins. The presence of the detention basins eliminates the downstream alluvial fan uncertainties by controlling the flood flow and sediment from the alluvial fan apices to the outfall. Alternative B4-3 is based on using a relatively larger on-line detention basin at the apex accompanied by leveed channel sections in the down fan direction. It is the third of three corridor alignments considered as part of the Alternative B4 series.

The B4-3 Alternative for the Wagner sub-area detains runoff of water and sediment from each fan and discharges the outflows in independent corridors for each fan. Fans 13E and 13W are controlled detaining water and sediment flows with inline detention basins. Outflows are directed to a corridor that directs flows north and west to Wagner Wash. Fan 3 is controlled by an on-line detention basin at the apex and directs the outflow west to Wagner Wash. No structural measures are proposed to Wagner Wash.

A third set of leveed corridors are provided in the southern portion of the sub-area to control additional distributary flow uncertainty in that area. Flows are controlled and combined downstream of Sun Valley Parkway where they continue west to Wagner Wash within leveed corridors. A portion of the channel from the distributary flow area at S165 requires excavation to cross a subwatershed boundary for it to be combined with the neighboring corridor to the south.

10.7.2 Key Features

- $90.7 million is the estimated total cost
- Four on-line basins with a total excavation volume of .208 ac-ft
- 11.2 miles of corridors
- 421 acres needed for right of way

10.7.3 Advantages

- Eliminates flow path uncertainty at the apices
- Effectively manages active alluvial fan sedimentation issues
- Provides trunk system which minimizes the impacts of development phasing
- Provides multiple corridors
- Minimizes disruption of flows delivered to Wagner Wash
- Requires no structural measures on Wagner Wash

10.7.4 Disadvantages

- Large costly structures.
- Additional corridor mileage
- Fifty percent greater fill than cut needed
- Large right of way requirements
- Requires excavation of two reaches to cross subwatershed divides to combine outflow corridors

10.7.5 Opportunities

- Provides multiple connections from Wagner Wash to Regional Park for recreation
- Provides multiple connections from Wagner Wash to Regional Park for wildlife

10.8 ALTERNATIVE C - Summary Sheet for Wagner Wash Sub-Area

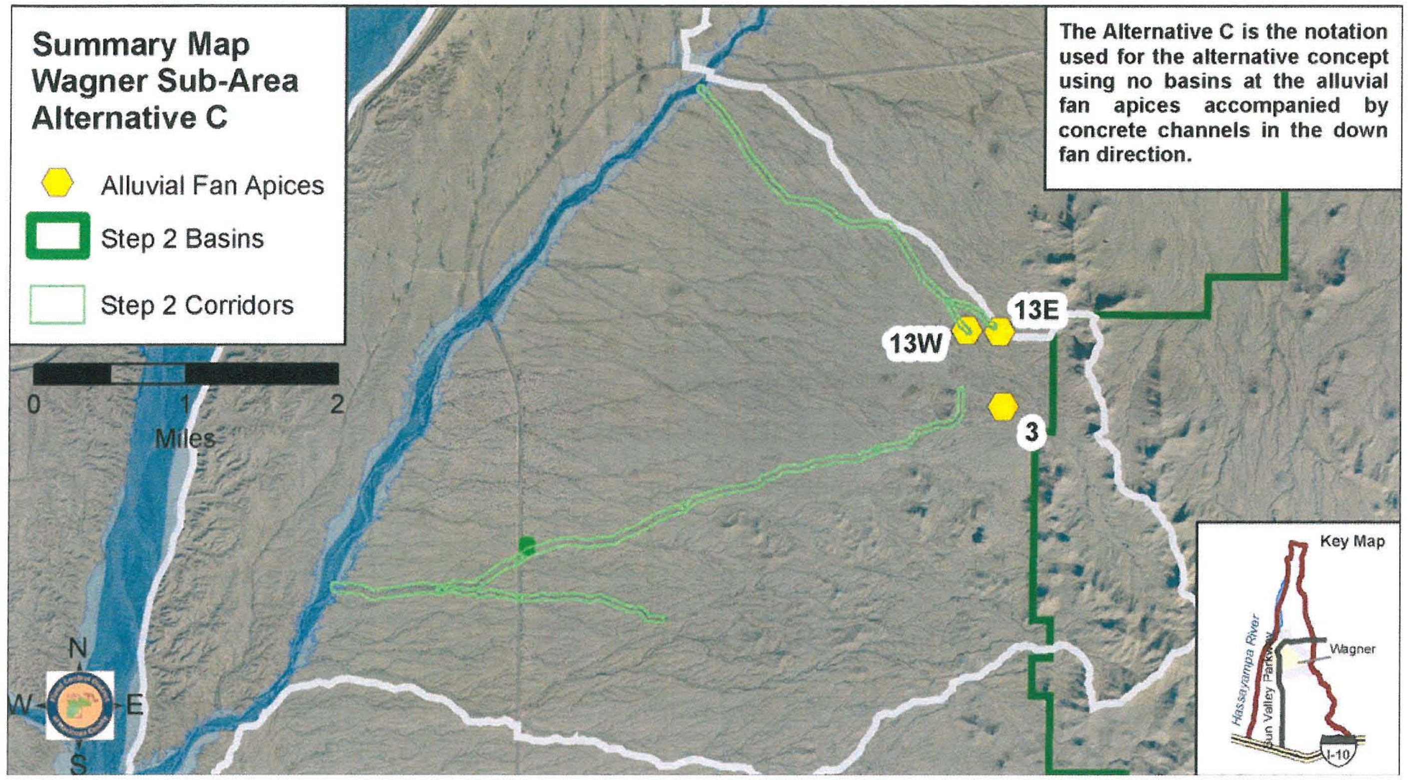

Figure 34 Summary Map of Alternative C for the Wagner Wash Sub-Area

10.8.1 Description for Alternative C

Alternative C is based on the concept of an excavated concrete-lined channel from the apex to the outfall, without providing any detention basin is at the apex. To address sedimentation associated with the alluvial fan systems, sedimentation basins are provided throughout the system. The excavated concrete channels are complemented with a 120-foot wide adjacent riparian preservation corridor. The C Alternative is based on the alignment from the B4-2 Alternative.

Outflows from Fans 13E and 13W are collected into a common excavated concrete channel and routed downstream to Wagner Wash. No structural measures are proposed to Wagner Wash. Outflows from Fan 3 are routed to another active area further south (S165) and then further south and west crossing a ridge though a short reach of excavated channel and continuing on toward Sun Valley Parkway. Because no detention is provided at the fan apices, the existing culverts at the Parkway do not have sufficient capacity to pass the 100-year peak discharge. Therefore, a small off-line detention basin is required for one of the two southern corridors to limit flow to the culvert capacity.

10.8.2 Key Features

- $142.8 million is the estimated total cost
- One off-line basin at Sun Valley Parkway with an excavation volume of 4 ac-ft
- 9.0 miles of corridors
- 249 acres needed for right of way, including the riparian preservation corridor

10.8.3 Advantages

- Eliminates flow path uncertainty at the apices
- Effectively manages active alluvial fan sedimentation issues
- Provides trunk system which minimizes the impacts of development phasing
- Preserves riparian corridor in undisturbed state
- Requires no structural measures on Wagner Wash

10.8.4 Disadvantages

- Costly structures
- Significant excavation costs
- Requires more significantly more excavation than fill
- Requires excavation of two reaches to cross subwatershed divides to combine outflow corridors
- Directs a portion of the mountain runoff to an inflow point further downstream on Wagner Wash
- Potential aesthetic concerns even with architectural treatments and preservation corridor
- Potential safety concerns to persons caught in channels during flooding

10.8.5 Opportunities

- Provides connection from Wagner Wash to Regional Park

10.9 ALTERNATIVE D - Summary Sheet for Wagner Wash Sub-Area

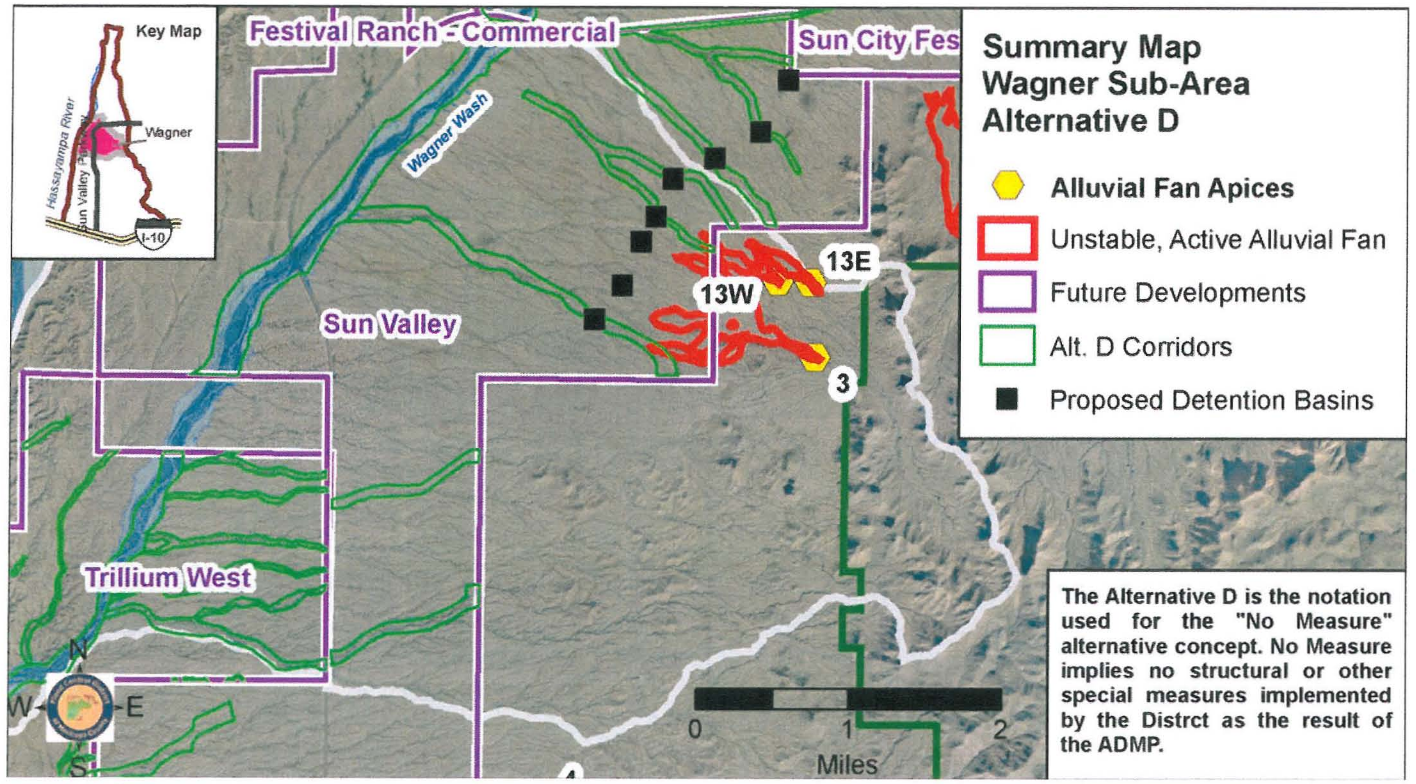

Figure 35 Summary Map of Alternative D for the Wagner Wash Sub-Area

10.9.1 Description for Alternative D

Alternative D relies on existing drainage facilities or new master-planned communities developing their own drainage infrastructure. Current drainage ordinances and floodplain regulations are enforced to ensure adequate flood hazard mitigation measures. Enforcement options can be enhanced by developing new alluvial fan floodplain delineations.

The major advantage of this alternative is that no immediate and expensive action is needed from the District. The main disadvantage compared to the other alternatives is that there will be no regional whole-fan flood control system leading to unnecessary redundancies and/or potential planning problems. This measure is also likely to leave portions of unstable, active alluvial fan areas open and undeveloped.

In the Wagner Wash Sub-Area, the Sun Valley and Trillium West master planned developments plan groundbreaking within two years. Drainage corridors shown for theses developments master drainage plans are shown on the map above. No modifications to the existing Sun Valley Parkway channel were assumed for Alternative D.

Note how some of the proposed plans contain elements of both the A and B alternatives. Input from the stakeholder workgroup suggests that many of the corridors are likely to be walled corridor cross sections.

10.9.2 Key Features

- Hazards addressed entirely by future development

10.9.3 Advantages

- Requires no direct District expenditures

10.9.4 Disadvantages

- Discontinuity of solutions across development boundaries
- Unnecessary redundancies in flood control solutions
- Long-term maintenance assurances
- Concerns with timing and phasing of development and flood control mitigation measures
- Potential challenges for FEMA approval of LOMRs on alluvial fans
- Potentially large areas of development within FEMA floodplains
- May not achieve context sensitivity

10.9.5 Opportunities

- Development pays for all required drainage infrastructure

11 ALTERNATIVES EVALUATION

11.1 Evaluation Criteria

Criteria to evaluate the Step 2 alternatives were developed though a series of meetings with the project team. Table 13 shows twenty-three criteria in three broad categories that were selected for evaluation of the Step 2 alternatives. The same evaluation criteria were used for all of the ADMP piedmont sub-areas including the Wagner Wash sub-area.

Table 13 Step 2 Alternative Evaluation Criteria

Public Safety Criteria (Function)	
1) **Public Safety Enhancement** • Improve Public Infrastructure • Reduce Flood Level • Number of People Impacted	2) **Level of Damage Reduction** • Dollar Costs Saved/Reduced • Flood Frequency Impacted
3) **Transportation Impacts** • Collector or Arterial Roadway • Only Access • Number of People Impacted	4) **Upstream/Downstream Impacts** • Stand Alone • Systematic Solution
5) **Relative Risk of Failure** • Lower than average • Average • Greater than average	6) **Eliminates Flood Problem** • Partial Solution • Whole Solution
7) **Design Certainty** • Captures apex flow •	8) **Constructability** • Excavation excess •
Economic Criteria (Common)	
9) **Comparative Benefit Cost** • Dollars • Number of People • Regional Solution • Recoverable Flood Plain	10) **ROW Acquisition Necessary** • Existing ROW Available • Amount Needed • Private or Public Land
11) **Condemnation Required** • Yes • No	12) **Cost of Implementation (in $1,000)** • < than $50,000 • < than $500,000 • < than $1,000,000
13) **Maintenance Cost** • Lessened • Increased • Neutral • Comparative to Other Measure	14) **Potential Cost Sharing Partner** • Already Contacted • Already Willing • Possibly
Social/ Environmental/ Aesthetic/ Multi-Use Criteria (Form)	
15) **Public Support** • Known • Anticipated • Unknown	16) **Public Acceptance** • Known • Anticipated • Applicable • Unknown
17) **Addresses Public Complaint/Concern** • Response From Public • Unknown	18) **Private Acceptance** • Known • Anticipated • Applicable • Unknown
19) **Environmental Impacts** • Habitat • Hazmat • Cultural • 404	20) **Complexity of Environmental Permitting** • Minimal • Average • Significant
21) **Visual Resource Impacts/ Aesthetic Compatibility** • Incompatible • Partially Compatible • Fully Compatible	22) **Multi-Use Opportunities** • Minimal • Average • Significant
23) **F.C. Method Consistency with Buckeye Recreation Master Plan** • Incompatible • Partially Compatible • Fully Compatible	

11.2 Evaluation Results

Table 14 through Table 17 present the scored results of the evaluation meetings held with the project team. Table 17 presents a summary of the recommended alternative for the Wagner Wash sub-area resulting from the process.

The alternatives evaluation was divided into two steps: 1) strategy evaluation and 2) evaluation by sub-area. In each of the two steps, the evaluation criteria listed in Table 13 were used to assign a lumped score for each of the three primary categories (Public Safety, Economic, and Social/Environmental/Aesthetic/Multi-use).

11.2.1 Strategy Evaluation

The relative merits and disadvantages of the alternatives are discussed in this section without considering any Wagner Wash sub-area specific issues. The evaluation criteria are presented for the type of treatment at the apices as well as the type of channel cross-section.

<u>Alternative A - Sedimentation Area at Apex</u>

The main design objective of the A Alternative is to allow the natural geomorphic processes to occur within a designated active alluvial fan area downstream of the apex. This designated active alluvial fan area is the highlight of this alternative and distinguishes this alternative with other alternatives where basins are used at the apices to control alluvial fan uncertainties. Therefore, the discussion below focuses mainly on the designated alluvial fan area. Most of the downstream impacts are expected to be similar to that in other alternatives.

Public Safety:

- The lack of basins could result in no significant reduction in the peak discharges. Thus, the risk of failure in the downstream is not reduced due to lack of reduction in the peak discharges.
- Area set aside could be a potential hazard to public if access is not adequately restricted.
- Sediment deposition will occur in the area. Deposition within the collector channels must be handled through maintenance. If proper maintenance is not performed, channel capacity may be reduced leading to overflow.
- Area set aside may be used for other purposes. This might include transportation; though roadways are not recommended within the set aside area.
- The designated active area is not available for development. Therefore the land costs for the A Alternative can be significant, especially for the larger alluvial fans. In addition, the risk of impacts to downstream areas is higher (compared to other alternatives with the basins at the apex) due to uncertainties associated with the designated sedimentation area.

Economics:

- The set aside land area is usually large enough to significantly impact the land costs, especially for the larger alluvial fans.
- The construction cost will be significantly less compared to the basin-based alternatives where large excavation volumes can be expected to result in larger costs.
- The area required is large when compared to other alternatives.
- The peak discharges downstream of the apex region are larger compared to other alternatives where the presence of basins reduces the peak flows. The larger peak flows result in the need for larger structures downstream increasing the cost of the project.
- The lack of basins near the apex means that the fill material available from excavation is minimal. Therefore, the opportunity to re-use the excavated dirt as fill material is not present in this alternative.

Social/ Environmental/ Aesthetic/ Multi-Use Criteria

- The designated alluvial area is set aside to allow natural sedimentation process to occur. As a result, this area is not conducive for all types of recreational multi-use.
- This alternative is favorable from habitat preservation point of view since the existing natural corridor is mostly preserved in the designated sedimentation area. The collector channels require some disturbance to the natural habitat. However, they are not significant compared to the area of disturbance in the basin-based alternatives.
- This alternative may fair better in 404 permitting process.
- Preservation of the existing corridor as well as lack of major engineered structures provides minimal visual resources impacts. Since the existing corridor is preserved, the aesthetic compatibility is better compared to the basin-based alternatives. Cultural and hazmat impacts are also expected to be minimal applying a similar reasoning.

<u>Alternative B - Big Basin/Small Basin/Off-line/On-line</u>

The main objective Alternatives B2, B3, B4-1, B4-2, and B4-3 is to evaluate the effectiveness of basins at the apices as flood control measures. The B2 alternative represents the big-basin option while the B3 represents a smaller basin. Both are on-line basin options. The B4 Alternatives is a small off-line basin for water and an in-line sediment only basin. The basin at the apex is the highlight of these alternatives and distinguishes them from other alternatives where basins are not used at the apices to control alluvial fan uncertainties and/or reduce peak discharges. Therefore, the discussion below focuses mainly on the basins at the apices. Most of the downstream impacts are expected to be similar to that in other alternatives.

Public Safety:

- The basin alternatives provide design certainty from the flood control point of view by capturing the flows at the apices and metering them downstream in a controlled fashion.

- The on-line basins are generally preferred to off-line basins as they provide a higher degree of certainty with respect to the control of the active alluvial fan.
- The presence of the basin results in lowered peak discharges. Lower peak discharges correlate to lower risk of failure and public endangerment downstream. However, flows will last longer resulting in increased duration of flood exposure to the public. Lower peak discharges also reduce the number of people potentially impacted by a flood event.
- The failure of the basin itself could be more dangerous than a conveyance only strategy because of reduced conveyance downstream. Significant development can be anticipated to occur near the washes that carry the outflow from the basins and hence more at risk in the event of a basin failure or discharges in excess of the basin design. However, the possibility of failure of the basin is considered low. As a result, the presence of the basin at the apex can be, in overall, considered as a reduction in potential downstream flood related risks.
- The large basin (B1 Alternative) can be expected to influence the bigger flood events with significant reduction in the peak discharges. The presence of the basin may not influence smaller events and the smaller flows could go through the basins relatively unhindered. The significant reduction in the peak discharges will potentially benefit a larger area.
- For the small basin (B2 Alternative), the reduction of peak discharge at the apex is not as high as in large basins (B1 Alternative). The downstream peak flows can still be quite large compared to upstream peak flows. As a result, the potential downstream risks in terms of area of benefit as well as number of people benefited are also larger. However, a small basin will be more beneficial when compared to Alternatives A and C where there are no basins at the apices.
- Sedimentation is expected to occur within the basins requiring regular maintenance. However, if unusually high sedimentation occurs during a large flood event, the storage capacity of the basins can be reduced causing a flooding problem for the downstream properties. Risk from failure of the sedimentation capacity is greater for the off-line basin.
- There is a potential risk exposure to public if the basins are designed to accommodate recreational uses. Flood water will enter at least a portion of the basin during even smaller floods posing a potential danger to recreationists within the basins.

Economics:

- The big basins (B1) cover a larger area compared to B2 and B5 alternatives. However, the right of way (ROW) area needed will be smaller when compared to that of the A alternative where much larger area is designated as the sedimentation area.
- The basins can be designed as multi-use recreational facilities. The land area set aside for the construction of the basins could also act in lieu of the open space requirements. These multi-purpose uses of the land may reduce the apparent cost of the land.
- The land area at the apices is not presently developed. Therefore, condemnation of existing developed properties may not be needed to facilitate the construction of the basins.
- Excavation is the major part of the construction of the basins. Given the long period of deposition at the apices, the excavation process may be relatively easy. However, construction of the basins could become difficult if significant bed rock is encountered during excavation.
- The excavation excess can be potentially used as fill material for the levees. The big basin (B1) alternative will produce more excess material compared to the B2 alternative. The availability of fill material for the construction of levees can be a significant benefit in terms of construction costs.
- The big basin (B1) alternative has larger maintenance costs compared to the smaller basin (B2 or B5) alternatives. The differences are directly related to the size of the basins and volume of flows captured.

Social/ Environmental/ Aesthetic/ Multi-Use Criteria

- The basins provide considerable opportunity for recreational and other multiple-uses.
- Significant excavation will be needed to construct the basins. The basins will be larger for the B1 alternative and will have larger impact on the visual and aesthetic compatibility. The basins will have to be enhanced to achieve compatibility with the landscape of the area which will require additional expenditures.
- The basin excavations can be expected to impact the natural habitat as well.
- The excavations may also have cultural implications and exact excavation locations may have to be determined if cultural impacts are determined. However, native people's activities in the area were generally limited to hunting and gathering. No known habitations exist in the area.
- If developed recreational facilities are not part of a basin, the larger basins provide potential open space area for future wildlife habitat.
- Hazmat impacts at the basin locations are mostly unknown, but are not expected to be a significant limitation.
- The disturbance to the existing corridor is likely to play a key role in the 404 permitting process. Mitigation of the environmental impacts must the planned and designed to aid in the approval of the 404 permitting process.

<u>Leveed Corridors</u>

The leveed corridor is designed as the flow conveyance from the upstream apex to the downstream outfall. Existing washes are contained between designed earthen levees and/or walls on both sides to provide adequate conveyance.

Public Safety:

- The levees/walls provide engineered means of flow conveyance. The inclusion of adequate freeboard ensures the design certainty for flows up to the 100-year flow event. In other words, the flows (up to the 100-year event) can be expected to be conveyed from the apex to the outfall in a predictable controlled fashion as long as the levee/walls function as designed. This flow containment provides an improvement in public safety compared to existing conditions where the naturally existing banks may or may not provide adequate flow containment or erosion protection.
- The 100-year event design flow could be significantly higher than the flow capacity of the existing channel. While the levees will contain flow within the designed channel corridor, changes can be anticipated in the

channel cross-section due to the change in the flow rates. The smaller events could lead to a meandering channel as well as a flatter low flow channel slope. While the channel configuration can be expected to transform due to changes in flow conditions, flow containment will still be achieved through levees and the freeboard. The designed levees/walls satisfy the FEMA freeboard requirement of at least 3 feet above the 100-year water surface elevation.

- Drastic events such as levee failures could result in catastrophic impact to the properties adjacent to the selected conveyance paths. The conveyance relies on the successful functioning of the levees unless adequate conveyance capacity already exists.
- The presence of levees at road crossings requires an elevated bridge over the corridor to facilitate transportation requirements while in the case of excavated channels bridges need not be elevated above existing ground. A bridge could be avoided if the local topography allows for easy crossing of the levees. In such cases, a dip crossing could be used. Dip crossings can provide considerable cost savings compared to bridges. However, from public safety point of view, dip crossings are not preferred because of the risk they pose to motorists during flooding. Bridges provide higher certainty in transportation access during flood events.

Economics:

- The excavation excess material can be used to construct the levees. This presents an opportunity to avoid hauling away the excavated material as well as hauling in of fill material. This can potentially lead to significant cost savings.
- The selected conveyance paths are located along existing wash corridors with existing flood hazards. Therefore, at least part of the area may have been located in a floodway with limited development options potentially reducing land acquisition costs.
- It is possible that adequate conveyance is available based on existing topography at several locations along the selected conveyance paths. This could eliminate the need for a levee while providing the necessary flow containment. In such situations, there would be a considerable cost savings as well as reduction in risk. Channel banks may still require erosion protection but flow containment will likely be not compromised.
- The structures such as levees, walls, grade control structures, as well as, sedimentation basins will require regular maintenance to ensure continuous and proper functioning. Sedimentation basins shall be located where significant deposition is expected. Any deposited material should be removed on a periodic basis or after a significant flood event. Erosion can be expected to be contained by the grade control structures and bank protection. However, localized erosion problems may still arise requiring monitoring and repair as needed.
- It is possible that the land set aside for the leveed corridor can also be used to satisfy the open space requirements. This could result in significant cost savings.

Social/ Environmental/ Aesthetic/ Multi-Use Criteria

- The leveed corridor leaves most of the existing corridor undisturbed. The construction of the levee and the grade control structures can be expected to disturb only parts of the corridor. Typically, the levees are less than 5 ft tall and 200 to 400 ft apart. This makes this option visually compatible with the existing surrounding and also quite favorable from the environmental permitting and cultural point of view.
- The top of levees presents the possibility of use as a trail. Other multi-use opportunities will be very limited in nature since the existing corridor is relatively not influenced by the design.
- The walled corridor option includes parallel buffer areas that could also provide multiple use opportunities adjacent to the conveyance area.

<u>Excavated Channel – Earthen (B3) and Concrete (C)</u>

The excavated channel is designed as a companion channel to the existing wash corridor which is preserved. Two types of excavated channels were evaluated: an earthen excavated channel (B3), and a concrete excavated channel (C).

Public Safety:

- The entire flood conveyance channel is below ground and is designed to have a freeboard of at least 1 ft for the 100 year event. The channel, thus, has adequate conveyance for all flows up to the 100-year flow. The conveyance as designed could be reduced by significant deposition or increase in vegetation. However, these changes must be quite dramatic to pose a significant risk of overflow.
- The excavated channels will deliver flow faster than the channel with natural cross-section. Faster flows pose a more serious public safety problem if people or animals get caught in the flow.
- The banks of the earthen excavated channel (B3) are protected from failure through bank and toe protection. In the event of bank protection failure, the channel may shift location and cause damage to adjacent property. While this scenario represents a structural failure, flow is likely to be still contained. Therefore, such a potential failure does not pose a widespread, significant public safety problem.
- The concrete channel (C) could also experience a lining failure, but is considered less likely than for an earthen channel.
- The channel is designed to a slope that is flatter than the existing slope. The designed slope is maintained by grade control. Grade control failure could lead to similar channel location changes as in B3. Another consequence of failure could be damage to underground utilities. Again, the concrete channel would be expected to have a lower chance of experiencing drop structure failure.

Economics:

- The excavation volume is exorbitantly high and represents a significant portion of the total cost of the excavated channel alternatives. Hauling away of the excavated excess could be major obstacle. Concrete channels, in addition, require concrete lining of the entire channel cross-section. The establishment of concrete lining is also very expensive and could form a significant portion of the total project cost.
- The land needed for the excavated channel and the adjacent existing corridor is generally similar to the levee/wall corridor needs. Therefore, the excavated channels do not significantly lower land costs.
- The excavated channels provide the opportunity to avoid the construction of the bridges at road crossings. The conveyance is below ground and could be handled by structures such as box culverts. The adjacent preserved wash would also need to be crossed in some fashion.

- Sedimentation basins will be located in places where significant deposition is anticipated. Periodic maintenance is needed to clear the collected sediment deposits.
- The earthen excavated channel may encounter localized erosion while this is not a problem in concrete channels. Monitoring and erosion maintenance of the excavated channels will be needed to ensure long-term functionality of the channels.

Social/ Environmental/ Aesthetic/ Multi-Use Criteria

- The excavated channel is located adjacent to an existing wash corridor. This will leave the existing corridor completely undisturbed. This is favorable for habitat preservation. The visual impacts can be significant since the excavated channel, particularly with concrete lining, is considered less aesthetically pleasing than the levee/wall corridor.
- The environmental impacts could be minimal since the channel is located separately from the corridor. However, the existing corridor must be provided with an irrigation mechanism to ensure sustainability of the natural habitat. Flow could come from the flood channel or adjacent tributary areas.
- The excavated channel provides possibilities for multiple-use such as trails.

Alternative D

The "No Measure" alternative relies on existing drainage and floodplain regulations to manage the alluvial fan flood and sedimentation hazards. Individual developments would provide flood hazard mitigation measures for their own properties.

Public Safety:

- Hazards will be addressed entirely by future development. Local communities will have to review and approve all proposed drainage facilities.
- The potential for a discontinuity of solutions across development boundaries exists.
- Long-term maintenance of any constructed facilities is potentially less certain.

Economics:

- Developers would pay for their own improvements. Costs are likely to be passed on to the individual residential and commercial property buyers.
- Because of the distribution of land ownership and the timing/phasing of individual development, there exists the potential for some unnecessary redundancies in future flood control solutions.
- Long-term maintenance assurances needed for some facilities may require public expenditures.
- Depending on the phasing of development and the selected flood control solutions, the potential exists for large areas of development to be constructed within FEMA floodplains.

Social/ Environmental/ Aesthetic/ Multi-Use Criteria

- Continuity of trails and other multiple-use elements of flood control facilities is not assured.
- Aesthetic treatment will be left to individual developments.
- The cumulative impacts of development may not be recognized in environmental permitting or mitigation requirements.

Outcome

Public Safety

Alternative A has a designated sedimentation area at the apices compared to other alternatives which have basins. The presence of the basins provides design certainty aiding in the control of the flows coming down the hills at the apices. This key advantage makes the basin based alternatives more preferable over Alternative A. Alternative C represents the concrete channel option without any detention at the apex. This alternative is favored slightly better compared to Alternatives A and D as it would have higher design certainty due to the concrete channels starting all the way from the apex. Alternative B5 represents the off-line basin option at the apex. This alternative ranks lower than the on-line basin alternatives. This is mainly due to uncertainties related to the functionality of the side-weirs/gates to split and let the larger flows enter the off-line basins. The on-line basins, on the other hand, have a well defined inlet taking the flow into the basins. In addition, the longer dimension of the on-line basins is perpendicular to the flow direction. This reduces the uncertainty of flow not entering the on-line basin.

For the purpose of discussing public safety aspects, the types of channel cross-sections can be categorized as leveed corridors or excavated channels. The excavated channel can have earthen or concrete lining. All the alternatives except C and D are ranked similarly. Alternative C represents the concrete channel option is ranked lower. The concrete channels tend to be narrower and deeper than the other alternatives with higher velocities. The higher velocities have negative influence on public safety with the possibility of larger damage when some type failure occurs. In addition, there is higher probability of people getting stuck in the flood waters. These factors resulted in a lowered ranking for the concrete channel.

Alternative D represents the developer initiated flood control measure. This alternative has a considerable uncertainty over the implementation of adequate and reliable system-wide flood control as it leaves the development of solutions to third parties. The continuity of the design certainty from an upstream development and the immediately downstream development may not be well determined due differences in developer priorities, phasing, and other issues. As a result, Alternative D ranks lower than the leveed corridor while it still ranks higher than the concrete channel alternative (C). In conclusion, the leveed corridor arises as the preferred alternative from the channel cross-section point of view.

Economics

The cost estimates for the various alternatives were used to determine the relative merits of each alternative in terms of economics. Land cost, excavation cost, levee-fill cost, and the channel-lining cost represent the major cost contributors. Alternatives B3 and C represent excavated earthen and concrete channels. The channel excavation costs for these alternatives are significantly higher than the levee-fill costs for the leveed-corridor alternatives. This is a direct result of the large lengths of the channels to convey the flow from the apices to the outfall. This makes the excavated channel alternatives less favorable compared to leveed corridor alternatives from the cost point of view. In addition to the excavation costs, Alternative C also involves the channel lining cost even though Alternative C has not only a sedimentation basin at the apex. The motivating notion behind Alternative C is to avoid having a basin at the apex and, instead, conveying the flow quickly through the concrete channel. Due to large lengths of the channels, lining the channel with concrete is significantly more expensive than placing a basin at the apex. These factors makes Alternative C economically less favorable compared the earthen excavated channel or the other alternatives where a basin is present at the apices.

Alternative A represents the non-structural solution at the apex with the designated sedimentation area. As the designated sedimentation is not amenable for any other use, the cost of land set aside is not subsidized by additional usage. The designated sedimentation areas are significantly large due to hydraulic and sedimentation uncertainties at the apices. As a result, Alternative A fairs unfavorably with regards to cost. In conclusion, the alternatives with basins at the apices and leveed-corridors as the means of conveyance represent the preferred alternative in terms of cost.

Social/ Environmental/ Aesthetic/ Multi-Use Criteria

The on-line basins and the excavated channel alternatives scored lower than the other alternatives for the social, environmental, aesthetic, and multi-use criteria. Excavation was viewed as having a greater environmental and aesthetic impact than the alternatives without excavation. The D Alternative was viewed as having a relatively higher score because of the perception that a greater number of corridors would be provided than compared to the regional facilities proposed in the other alternatives. However, this scoring did not reflect the fact that the "extra" corridors would be required for preservation as part of the development plan with or without the regional facility.

Summary

Table 14 shows the weighted scoring results from the strategy evaluation process. The result was a clear preference for the basin alternatives at the apices with the levee/wall corridors as the conveyance mechanism downstream (alternatives B1, B2, B4, & B5). The B4 alternatives represent the alignment variations which were evaluated in the sub-area specific evaluation described in Section 11 and are strategically similar to the B1 alternative. The B5 alternative, though scoring the same as B1 and B2, is considered less preferable due to the potential public safety and performance concerns. Therefore, the sub-area specific evaluation focused on the B1 and B2 options with an emphasis on the relative strengths and weaknesses of the various alignments. The D Alternative was carried forward to the sub-area evaluation as a requirement of the ADMP process.

Table 14 Strategy Selection Matrix

Alternative Measure		Evaluation Criteria			Ranking
Alternative Measure	Alternative	Public Safety	Economic	Social/Environmental	Total Score
Example (Rank 1-3 where 1 = least preferred)	A	3	2	1	6 of possible 9
APEX	A	1	1	3	5
	B1/B2	3	3	2	8
	B3	3	1	2	6
	B4	3	3	2	8
	B5	2	3	3	8
	C	2	1	1	4
	D	1	2	3	6
CROSS SECTION	A	3	1	2	6
	B1/B2	3	3	2	8
	B3	3	1	2	6
	B4	3	3	2	8
	B5	3	3	2	8
	C	2	1	1	4
	D	2	2	3	7
Combined Score for Apex and Cross Section	A				11
	B1/B2				16
	B3				12
	B4				16
	B5				16
	C				8
	D				13
Primary Preferred Alternative	B1/B2/B5/B4				
Secondary Preferred Alternative	D				

11.2.2 Sub-Area Evaluation

The Wagner Wash sub-area was primarily an alignment variation alternative evaluation. In addition to the alignments, the small basin (B2) and off-line basin (B5) apex strategies were also carried over to the sub-area evaluation for the Wagner sub-area.

During the sub-area evaluation process, the nine "Form" criteria were lumped into four related categories: Environmental, Permitting, Visual/Aesthetic, & Recreation/Multiple Use which were used to assess the preferred alternative for the sub-area. Table 15 shows the results of the social, environmental, aesthetic, and multi-use criteria evaluation using the four "Form" categories. Table 16 shows the results of the public safety and economic criteria evaluation. Table 17 shows the results preferred alternative for each sub-area based on the outcome from the evaluation of both "Form" and "Function" by the project team.

The B4-3 alternative was selected as the preferred alternative according to the Form criteria. The important merits were the larger basin size and connectivity opportunities to the Regional Park. A larger basin was felt to provide greater recreational and/or habitat opportunities than the smaller basin alternatives. The B4-1/B4-2 alternatives were preferred according to the Function evaluation due to their relatively lower cost.

Table 15 Alternative Evaluation Matrix by Sub-area (Form)

Alternative Measure		Function Criteria	Economic Criteria	Form Criteria				Ranking	
Alternative Measure	Alt.	Public Safety	Economic	Environmental	Permitting	Visual/ Aesthetic	Recreation / Multi-Use	Total Score	Preferred Alternative
Example (Rank from 1-3; 1 = least preferred)	B5	3	3	3	2	1	1	7 of possible 12	
Wagner Wash Sub-Area	B4-1			2	1	2	2	7	B4-3
	B4-2			2	1	2	2	7	
	B4-3			3	1	3	3	10	
	B5			3	1	2	2	8	
	D			2	3	2	2	9	

Table 16 Alternative Evaluation Matrix by Sub-area (Function)

Alternative Measure	Alternative	Public Safety	Economic	Social/ Environmental	Total Score	Preferred Alternative
Example (Rank from 1-3 where 1 = least preferred)	B1	3	2	1	6 of possible 9	
Wagner Wash Sub-Area	B2	2	3		5	B4-1/B4-2
	B5	1	3		4	
	B4-1	3	3		6	
	B4-2	3	3		6	
	B4-3	3	2		5	
	D	1	1		2	

Table 17 Alternative Evaluation Matrix by Sub-area (Combined)

Alternative Measure		Preferred Alternative		Preliminary Recommended Alternative
Alternative Measure	Alternative	Form	Function	
Wagner Wash Sub-Area	B2	B4-3	B4-1/B4-2	B4-3
	B5			
	B4-1			
	B4-2			
	B4-3			
	D			

11.2.3 Preliminary Recommended Alternative for Wagner Wash Sub-area

The B4-3 alternative was selected as the recommended alternative for the Wagner Wash sub-area. Non-structural elements also comprise portions of the recommended alternative; in particular the delineated floodplains of Wagner Wash.

12 RECOMMENDATIONS FOR STEP 3 FOR THE WAGNER WASH SUB-AREA

Based on the outcome of the Step 2 alternatives evaluation a number of items for consideration in the refinement of the recommended alterative are suggested for Step 3 for the Wagner Wash sub-area. These recommendations are based on input received during the development of the proposed alternatives, the team evaluation process, and input from stakeholders and the public.

- On-line big basins are the preferred solution to control alluvial fan uncertainties at the apices.
- Multiple downstream levee/wall corridors are preferred whenever possible.
- There is a need to balance earthwork by project. For Step 3, a project will be considered the apex-to-outfall system for an individual alluvial fan (or fan complex if hydraulically connected). For the Wagner sub-area this means Fan 13E/W, Fan 3, and S165 should be evaluated separately when evaluating the earthwork balance requirements/opportunities.
- Existing channel conveyance should be quantified and incorporated into the recommended alternative designs. This could result in the elimination of some levee/wall reaches where the existing conveyance is adequate or natural lateral containment exists on one or more sides of the corridor. This will also maximize the use of non-structural or nearly non-structural reach management elements.
- The required landscape compatibility enhancements should be included explicitly in the hydrologic and hydraulic design.
- Incorporate the specific sediment data collected in Step 2 into the design calculations.
- Identify the area benefited using the Stage 3 delineations.
- Refine the design details including riprap sizing calculations and the evaluation of basin inlet structures (e.g., energy dissipaters, collection dikes/ ditches, off-line basin outlet structures, etc.)
- Refine the hydrologic models to include more HEC-1 subreaches, ideally one subreach per design reach.
- Discretize the quantities and costs by individual fan system (by "project")

13 SUMMARY

The proposed alternatives for the Wagner Wash sub-area of SVADMP were developed and evaluated in Step 2 of the ADMP process. The alternatives included both non-structural and environmentally friendly and aesthetically compatible structural flood control measures. Engineering and landscape compatibility enhancement costs were estimated for all of the proposed alternatives piedmont sub-areas. The proposed alternatives were evaluated for their flood control function, economic costs, environmental impacts, permitting issues, visual and aesthetic characteristics, and recreation and multiple-use opportunities. Preference for natural leveed corridors downstream of on-line detention basins along multiple corridors was expressed by the project team, stakeholders, and the public.

The recommended alternatives will be carried forward for further refinement of the engineering elements and the cost estimates. Special attention will be given to maximizing non-structural, floodplain management approaches along the preferred leveed corridor alignments. Stakeholders and the public will continue to be consulted as to their feedback in attempt to incorporate existing and imminent developer plans into the drainage master plan for the Sun Valley area.

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Appendix A

Design Analyses

Structure ID	Type	Flow Rate (cfs)	ROW Area (acres)	Exc. Vol. (ac. ft)	Fill Vol. (ac. ft)	Base Design Geometry: Length (stor-ft; chl-mi)	ROW Width (ft)	Depth (ft)	Base Costs (in $1000): Land Cost	Constr. Cost	Lndscp Cost	50 Yr Maint. Cost	Total Cost	Base Cost Percentages: Land Cost %	Constr. Cost %	Lndscp Cost %	50 Yr Maint. Cost %	% of Total Cost
C135L10-A	Leveed Chl.	726	36	0	19	0.8	216	4	$ 3,600	$ 1,526	$ 309	$ 739	$ 6,174	58%	25%	5%	12%	4%
S13010	Leveed Chl.	524	41	0	16	0.7	176	4	$ 4,100	$ 1,059	$ 268	$ 582	$ 6,009	68%	18%	4%	10%	4%
C135L30-A	Leveed Chl.	1001	60	0	43	1.4	342	5	$ 5,950	$ 2,916	$ 636	$ 1,543	$ 11,045	54%	26%	6%	14%	8%
C155L10	Leveed Chl.	1774	277	0	66	2.6	426	4	$27,730	$ 6,230	$ 1,078	$ 2,839	$ 37,877	73%	16%	3%	7%	27%
S17010	Excavated Chl.	1510	83	35	5	0.4	170	4	$ 8,270	$ 1,168	$ 261	$ 469	$ 10,167	81%	11%	3%	5%	7%
S17020	Leveed Chl.	1792	66	0	43	1.4	382	5	$ 6,550	$ 3,253	$ 628	$ 1,545	$ 11,975	55%	27%	5%	13%	9%
170R10	Leveed Chl.	1973	27	0	21	0.8	295	8	$ 2,700	$ 2,039	$ 427	$ 1,792	$ 6,957	39%	29%	6%	26%	5%
RR17510	Leveed Chl.	1397	25	0	17	0.6	362	5	$ 2,520	$ 1,412	$ 255	$ 668	$ 4,855	52%	29%	5%	14%	3%
S18010	Leveed Chl.	1039	31	0	29	1	262	5	$ 3,100	$ 2,107	$ 434	$ 1,107	$ 6,747	46%	31%	6%	16%	5%
RR18010	Leveed Chl.	1124	17	0	16	0.5	262	5	$ 1,700	$ 1,167	$ 237	$ 595	$ 3,699	46%	32%	6%	16%	3%
C180R10	Leveed Chl.	1859	38	0	21	0.7	442	5	$ 3,780	$ 1,892	$ 313	$ 987	$ 6,972	54%	27%	4%	14%	5%
C155L20	Leveed Chl.	1774	129	0	63	2.5	426	4	$12,850	$ 5,882	$ 1,025	$ 2,716	$ 22,473	57%	26%	5%	12%	16%
C17510B-A	Leveed Chl.	1278	27	0	14	0.5	480	5	$ 2,690	$ 1,409	$ 205	$ 1,413	$ 5,717	47%	25%	4%	25%	4%
	TOTAL		857	35	373				$85,540	$ 32,059	$ 6,074	$ 16,995	**$ 140,668**	61%	23%	4%	12%	100%
All Channels			857	35	373	13.9			$85,540	$ 32,059	$ 6,074	$ 16,995	$ 140,668	61%	23%	4%	12%	100%
All Online Basins			0	0	0				$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
All Offline Basins			0	0	0				$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%

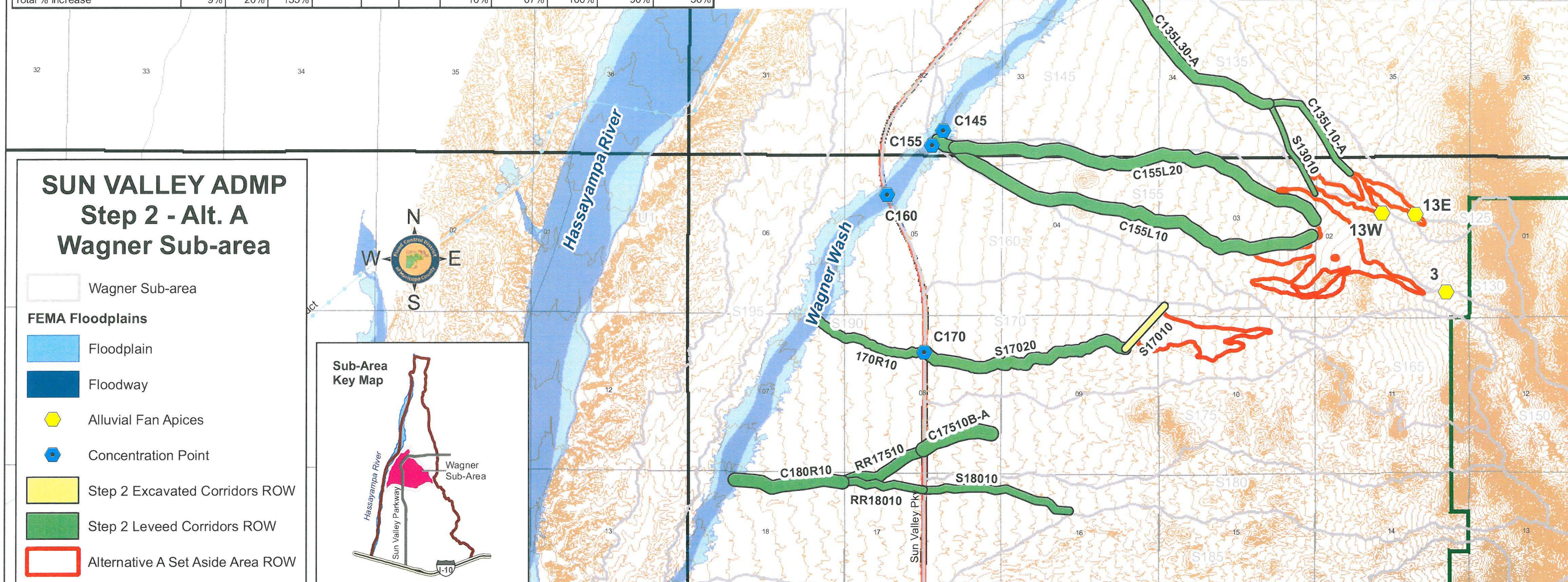
Channel Cost per mile (in $1000)	$10,120	Basins Cost per ac. ft. (in $1000)	$0.00

Cost Increase for Landscape Compatibility Enhancement over Base Costs

	ROW Area	Exc. Vol.	Fill Vol.	Land Cost	Constr. Cost	Lndscp Cost	50 Yr Maint. Cost	Total Cost
All Channels % increase	9%	20%	135%	10%	67%	100%	90%	36%
All Online Basins % increase	0%	0%	0%	0%	0%	0%	0%	0%
All Offline Basins % increase	0%	0%	0%	0%	0%	0%	0%	0%
Total % increase	9%	20%	135%	10%	67%	100%	90%	36%

The Alternative A is the notation used for the alternative concept using no measure at the alluvial fan apices accompanied by leveed conveyance corridors in the down fan direction. This alternative assumes that the unstable, active area below the apices remains open and undeveloped.

SUN VALLEY ADMP
Step 2 - Alt. A
Wagner Sub-area



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Costs Summary

						Base Design Geometry			Base Costs (in $1000)					Base Cost Percentages				
Structure ID	Type	Flow Rate (cfs)	ROW Area (acres)	Exc. Vol. (ac. ft)	Fill Vol. (ac. ft)	Length (stor-ft; chl-mi)	ROW Width (ft)	Depth (ft)	Land Cost	Constr. Cost	Lndscp Cost	50 Yr Maint. Cost	Total Cost	Land Cost %	Constr. Cost %	Lndscp Cost %	50 Yr Maint. Cost %	% of Total Cost
C135L10-A	Leveed Chl.	726	36	0	19	0.8	216	4	$ 3,600	$ 1,526	$ 309	$ 739	$ 6,174	58%	25%	5%	12%	4%
S13010	Leveed Chl.	524	41	0	16	0.7	176	4	$ 4,100	$ 1,059	$ 268	$ 582	$ 6,009	68%	18%	4%	10%	4%
C135L30-A	Leveed Chl.	1001	60	0	43	1.4	342	5	$ 5,950	$ 2,916	$ 636	$ 1,543	$ 11,045	54%	26%	6%	14%	8%
C155L10	Leveed Chl.	1774	277	0	66	2.6	426	4	$ 27,730	$ 6,230	$ 1,078	$ 2,839	$ 37,877	73%	16%	3%	7%	27%
S17010	Excavated Chl.	1510	83	35	5	0.4	170	4	$ 8,270	$ 1,168	$ 261	$ 469	$ 10,167	81%	11%	3%	5%	7%
S17020	Leveed Chl.	1792	66	0	43	1.4	382	5	$ 6,550	$ 3,253	$ 628	$ 1,545	$ 11,975	55%	27%	5%	13%	9%
170R10	Leveed Chl.	1973	27	0	21	0.8	295	8	$ 2,700	$ 2,039	$ 427	$ 1,792	$ 6,957	39%	29%	6%	26%	5%
RR17510	Leveed Chl.	1397	25	0	17	0.6	362	5	$ 2,520	$ 1,412	$ 255	$ 668	$ 4,855	52%	29%	5%	14%	3%
S18010	Leveed Chl.	1039	31	0	29	1	262	5	$ 3,100	$ 2,107	$ 434	$ 1,107	$ 6,747	46%	31%	6%	16%	5%
RR18010	Leveed Chl.	1124	17	0	16	0.5	262	5	$ 1,700	$ 1,167	$ 237	$ 595	$ 3,699	46%	32%	6%	16%	3%
C180R10	Leveed Chl.	1859	38	0	21	0.7	442	5	$ 3,780	$ 1,892	$ 313	$ 987	$ 6,972	54%	27%	4%	14%	5%
C155L20	Leveed Chl.	1774	129	0	63	2.5	426	4	$ 12,850	$ 5,882	$ 1,025	$ 2,716	$ 22,473	57%	26%	5%	12%	16%
C17510B-A	Leveed Chl.	1278	27	0	14	0.5	480	5	$ 2,690	$ 1,409	$ 205	$ 1,413	$ 5,717	47%	25%	4%	25%	4%
		TOTAL	857	35	373				$ 85,540	$ 32,059	$ 6,074	$ 16,995	**$ 140,668**	61%	23%	4%	12%	100%
All Channels			857	35	373	13.9			$ 85,540	$ 32,059	$ 6,074	$ 16,995	$ 140,668	61%	23%	4%	12%	100%
All Online Basins			0	0	0				$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
All Offline Basins			0	0	0				$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
Channel Cost per mile (in $1000)			$10,120		Basins Cost per ac. ft. (in $1000)				$0.00									

Cost Summary - Landscape Compatibility Enhanced (LCE)

						LCE Design Geometry			LCE Costs (in $1000)					LCE Cost Percentages				
Structure ID	Type	Flow Rate (cfs)	ROW Area (acres)	Exc. Vol. (ac. ft)	Fill Vol. (ac. ft)	Length (stor-ft; chl-mi)	ROW Width (ft)	Depth (ft)	Land Cost	Constr. Cost	Lndscp Cost	50 Yr Maint. Cost	Total Cost	Land Cost %	Constr. Cost %	Lndscp Cost %	50 Yr Maint. Cost %	% of Total Cost
C135L10-A	Leveed Chl.	726	40	0	46	0.8	264	4	$ 4,040	$ 2,675	$ 642	$ 1,554	$ 8,911	45%	30%	7%	17%	5%
S13010	Leveed Chl.	524	45	0	39	0.7	224	4	$ 4,480	$ 2,029	$ 556	$ 1,286	$ 8,351	54%	24%	7%	15%	4%
C135L30-A	Leveed Chl.	1001	68	0	102	1.4	393	5	$ 6,840	$ 5,382	$ 1,318	$ 3,315	$ 16,854	41%	32%	8%	20%	9%
C155L10	Leveed Chl.	1774	293	0	159	2.6	474	4	$ 29,250	$ 10,315	$ 2,239	$ 5,691	$ 47,495	62%	22%	5%	12%	25%
S17010	Excavated Chl.	1510	87	42	11	0.4	338	4	$ 8,710	$ 1,605	$ 390	$ 713	$ 11,418	76%	14%	3%	6%	6%
S17020	Leveed Chl.	1792	74	0	100	1.4	433	5	$ 7,430	$ 5,708	$ 1,300	$ 3,295	$ 17,733	42%	32%	7%	19%	9%
170R10	Leveed Chl.	1973	30	0	39	0.8	323	8	$ 2,950	$ 2,624	$ 598	$ 2,261	$ 8,434	35%	31%	7%	27%	4%
RR17510	Leveed Chl.	1397	29	0	41	0.6	413	5	$ 2,880	$ 2,412	$ 528	$ 1,380	$ 7,200	40%	34%	7%	19%	4%
S18010	Leveed Chl.	1039	37	0	69	1	313	5	$ 3,700	$ 3,786	$ 899	$ 2,314	$ 10,699	35%	35%	8%	22%	6%
RR18010	Leveed Chl.	1124	20	0	38	0.5	313	5	$ 2,030	$ 2,088	$ 492	$ 1,256	$ 5,865	35%	36%	8%	21%	3%
C180R10	Leveed Chl.	1859	42	0	50	0.7	493	5	$ 4,220	$ 3,117	$ 647	$ 1,859	$ 9,843	43%	32%	7%	19%	5%
C155L20	Leveed Chl.	1774	143	0	151	2.5	474	4	$ 14,300	$ 9,760	$ 2,128	$ 5,427	$ 31,615	45%	31%	7%	17%	16%
C17510B-A	Leveed Chl.	1278	30	0	33	0.5	531	5	$ 2,980	$ 2,193	$ 424	$ 1,982	$ 7,580	39%	29%	6%	26%	4%
		TOTAL	938	42	878				$ 93,810	$ 53,694	$ 12,161	$ 32,333	**$ 191,998**	49%	28%	6%	17%	100%
All Channels			938	42	878	13.9			$ 93,810	$ 53,694	$ 12,161	$ 32,333	$ 191,998	49%	28%	6%	17%	100%
All Online Basins			0	0	0				$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
All Offline Basins			0	0	0				$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
Channel Cost per mile (in $1000)			$13,813		Basins Cost per ac. ft. (in $1000)				$0.00									
All Channels % increase			9%	20%	135%				10%	67%	100%	90%	36%					
All Online Basins % increase			0%	0%	0%				0%	0%	0%	0%	0%					
All Offline Basins % increase			0%	0%	0%				0%	0%	0%	0%	0%					
Total % increase			9%	20%	135%				10%	67%	100%	90%	36%					

Hydrology - 6-hr Storm HEC1 Model Results

KK CARD	Type	Peak Flow	Peak Stage (ft)	Peak Storage	Time	Cum.Area (sq. miles)	MAX. Average Flow (cfs)				MAX. Average Rainfall Depth (Inches)				Total Runoff Volume (ac. ft)			
							6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR
S100	BASIN	4347			4.6	6.99	899	225	75	32	1.195	1.195	1.195	1.195	446	446	446	446
S102	BASIN	2790			4.3	3.23	417	104	35	15	1.198	1.198	1.198	1.198	207	207	207	207
C102	COMBINE	5993			4.5	10.23	1198	300	100	43	1.089	1.089	1.089	1.089	594	594	594	594
RR102	STORAGE	127	1552	1143.35	6.7	10.23	122	104	72	41	0.11	0.376	0.784	1.029	60	205	428	561
D102	DIVERT	63			6.7	10.23	61	52	36	20	0.055	0.188	0.392	0.515	30	103	214	281
100105	ROUTE	59	100.2	20.4	12.5	10.23	58	51	36	20	0.053	0.185	0.389	0.512	29	101	212	279
S105	BASIN	2863			4.5	4.37	495	124	41	18	1.053	1.053	1.053	1.053	245	245	245	245
CF02	RETRIEVE	63			6.7	10.23	61	52	36	20	0.055	0.188	0.392	0.515	30	103	214	281
102105	ROUTE	63	100.4	8.6	8	10.23	60	51	36	20	0.055	0.187	0.39	0.513	30	102	213	280
C105U	COMBINE	2863			4.5	14.6	549	226	120	64	0.35	0.577	0.921	1.128	272	449	717	878
S110	BASIN	662			4.2	0.43	76	19	6	3	1.639	1.64	1.64	1.64	38	38	38	38
11015I	ROUTE	570	101.8	9.19	4.4	0.43	76	19	6	3	1.637	1.64	1.64	1.64	38	38	38	38
15I15R	ROUTE	506	102.1	19.34	4.8	0.43	76	19	6	3	1.635	1.64	1.64	1.64	38	38	38	38
S115	BASIN	1605			4.5	2.25	296	74	25	11	1.223	1.224	1.224	1.224	147	147	147	147
C115	COMBINE	1813			4.6	2.68	350	88	29	13	1.215	1.219	1.219	1.219	173	174	174	174
115120	ROUTE	1781	102.7	21.9	4.7	2.68	350	88	29	13	1.215	1.219	1.219	1.219	173	174	174	174
S120	BASIN	1838			4.3	2	256	64	21	9	1.189	1.189	1.189	1.189	127	127	127	127
C120	COMBINE	2678			4.5	4.68	545	137	46	20	1.083	1.087	1.087	1.087	270	271	271	271
C105D	COMBINE	4029			4.5	19.28	821	275	127	64	0.396	0.53	0.737	0.863	407	545	758	888
120135	ROUTE	4027	104.4	16.85	4.5	19.28	821	275	127	64	0.396	0.53	0.737	0.863	407	545	758	888
S125	BASIN	202			4	0.09	14	4	1	1	1.424	1.425	1.425	1.425	7	7	7	7
R125A	ROUTE	146	100.4	3.15	4.2	0.09	14	4	1	1	1.423	1.425	1.425	1.425	7	7	7	7
12535I	ROUTE	94	100.3	3.78	4.6	0.09	14	4	1	1	1.422	1.425	1.425	1.425	7	7	7	7
S130	BASIN	524			4.1	0.31	48	12	4	2	1.425	1.426	1.426	1.426	24	24	24	24
R130A	ROUTE	455	100.8	6.87	4.2	0.31	47	12	4	2	1.424	1.426	1.426	1.426	24	24	24	24
13035I	ROUTE	387	100.9	7.29	4.4	0.31	47	12	4	2	1.423	1.426	1.426	1.426	24	24	24	24
C135I	COMBINE	364			4.5	1.18	54	14	5	2	0.427	0.428	0.428	0.428	27	27	27	27
35I135	ROUTE	217	100.4	17.48	5.3	1.18	54	14	5	2	0.426	0.428	0.428	0.428	27	27	27	27
S135	BASIN	1102			4.2	0.88	111	28	9	4	1.175	1.175	1.175	1.175	55	55	55	55
C135L	COMBINE	830			4.2	2.06	145	36	12	5	0.653	0.654	0.654	0.654	72	72	72	72
C135	COMBINE	4171			4.5	21.34	881	288	131	66	0.384	0.502	0.684	0.796	437	571	779	906
135145	ROUTE	3749	103.8	146.97	5	21.34	870	286	131	66	0.379	0.498	0.683	0.795	431	567	777	905
S140	BASIN	1913			4.1	1.37	188	47	16	7	1.27	1.27	1.27	1.27	93	93	93	93
140145	ROUTE	1623	101.9	39.36	4.4	1.37	188	47	16	7	1.27	1.27	1.27	1.27	93	93	93	93
S145	BASIN	1702			4.2	1.76	193	48	16	7	1.021	1.021	1.021	1.021	96	96	96	96
C145	COMBINE	4073			4.9	24.47	1037	325	143	71	0.394	0.494	0.651	0.747	514	645	850	974
145155	ROUTE	4072	105.7	11.22	4.9	24.47	1036	325	143	71	0.394	0.494	0.651	0.746	514	645	850	974
S150	BASIN	836			4.3	0.77	126	31	10	5	1.51	1.513	1.513	1.513	62	62	62	62
R150A	ROUTE	779	101	14.71	4.5	0.77	126	31	10	5	1.508	1.513	1.513	1.513	62	62	62	62
150155	ROUTE	449	100.5	53.41	5.6	0.77	125	31	10	5	1.499	1.513	1.513	1.513	62	62	62	62
S155	BASIN	1626			4.3	1.83	223	56	19	8	1.131	1.132	1.132	1.132	111	111	111	111
C155L	COMBINE	1457			4.3	2.61	313	79	26	11	1.118	1.134	1.134	1.134	155	158	158	158
C155	COMBINE	4266			4.8	27.07	1193	363	155	76	0.41	0.499	0.637	0.722	592	720	920	1042
155160	ROUTE	4256	104.5	32.27	4.9	27.07	1191	363	155	76	0.409	0.498	0.637	0.722	591	720	920	1042
S160	BASIN	1347			4.2	1.14	133	33	11	5	1.079	1.079	1.079	1.079	66	66	66	66
C160	COMBINE	4292			4.9	27.44	1241	375	159	77	0.42	0.509	0.645	0.729	615	744	944	1066

Hydrology - 6-hr Storm HEC1 Model Results

KK CARD	Type	Peak Flow	Peak Stage (ft)	Peak Storage	Time	Cum.Area (sq. miles)	MAX. Average Flow (cfs)				MAX. Average Rainfall Depth (Inches)				Total Runoff Volume (ac. ft)			
							6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR
S165	BASIN	1008			4.1	0.62	94	23	8	3	1.416	1.417	1.417	1.417	47	47	47	47
R165A	ROUTE	802	101.2	20.33	4.4	0.62	94	23	8	3	1.414	1.417	1.417	1.417	46	47	47	47
165170	ROUTE	444	100.6	37.12	5.1	0.62	94	23	8	3	1.411	1.417	1.417	1.417	46	47	47	47
S170	BASIN	1686			4.2	1.46	178	44	15	6	1.127	1.127	1.127	1.127	88	88	88	88
C170		1488			4.2	2.08	245	61	20	9	1.095	1.097	1.097	1.097	121	122	122	122
170R	ROUTE	1438	98.1	21.68	4.3	2.08	245	61	20	9	1.094	1.097	1.097	1.097	121	122	122	122
C170R	COMBINE	4256			5	29.52	1334	398	166	81	0.42	0.502	0.627	0.704	662	790	988	1108
170180	ROUTE	4166	102.8	112.2	5.4	29.52	1322	397	166	80	0.416	0.5	0.627	0.704	656	787	987	1108
S175	BASIN	1203			4.5	1.8	226	56	19	8	1.165	1.166	1.166	1.166	112	112	112	112
175R	ROUTE	1153	101	19.26	4.6	1.8	226	56	19	8	1.164	1.166	1.166	1.166	112	112	112	112
S180	BASIN	1032			4.5	1.44	181	45	15	7	1.167	1.169	1.169	1.169	90	90	90	90
180R	ROUTE	775	101	34.58	4.8	1.44	180	45	15	7	1.16	1.169	1.169	1.169	89	90	90	90
C180RI	COMBINE	1561			4.7	3.24	360	90	30	13	1.03	1.036	1.036	1.036	178	179	179	179
RI180R	ROUTE	1512	101.1	33.44	4.9	3.24	359	90	30	13	1.029	1.036	1.036	1.036	178	179	179	179
C180R	COMBINE	4686			5.3	32.76	1477	434	177	85	0.419	0.493	0.604	0.671	732	861	1055	1173
180185	ROUTE	4678	103	52.29	5.4	32.76	1470	433	177	85	0.417	0.492	0.603	0.671	729	859	1054	1173
S185	BASIN	1450			4.5	2.42	288	72	24	10	1.106	1.107	1.107	1.107	143	143	143	143
185R	ROUTE	1302	102.5	41.84	4.9	2.42	288	72	24	10	1.105	1.107	1.107	1.107	143	143	143	143
C185R	COMBINE	5005			5.2	35.19	1576	459	185	89	0.416	0.486	0.588	0.65	781	911	1103	1220
185190	ROUTE	4989	102.6	42.45	5.3	35.19	1571	459	185	89	0.415	0.485	0.588	0.65	779	910	1103	1220
S190	BASIN	2084			4.5	4.05	391	98	33	14	0.896	0.896	0.896	0.896	194	194	194	194
C190	COMBINE	5156			5.2	39.24	1682	488	194	92	0.399	0.463	0.553	0.608	834	968	1157	1272
190195	ROUTE	5055	103.1	77.58	5.5	39.24	1674	487	194	92	0.397	0.462	0.553	0.608	830	967	1157	1272
S195	BASIN	1001			4.6	1.81	203	51	17	7	1.046	1.046	1.046	1.046	101	101	101	101
C195	COMBINE	5107			5.5	41.05	1722	500	198	94	0.39	0.453	0.538	0.591	854	991	1179	1293

Hydrology - 24-hr Storm HEC1 Model Results

KK CARD	Type	Peak Flow	Peak Stage (ft)	Peak Storage	Time	Cum.Area (sq. miles)	MAX. Average Flow (cfs) 6-HR	24-HR	72-HR	MAX-HR	MAX. Average Rainfall Depth (Inches) 6-HR	24-HR	72-HR	MAX-HR	Total Runoff Volume (ac. ft) 6-HR	24-HR	72-HR	MAX-HR
S100	BASIN	5214			12.5	6.99	965	241	80	35	1.282	1.282	1.282	1.282	478	478	478	478
S102	BASIN	3434			12.3	3.23	420	105	35	15	1.207	1.207	1.207	1.207	208	208	208	208
C102	COMBINE	7803			12.4	10.23	1367	342	114	49	1.243	1.243	1.243	1.243	678	678	678	678
RR102	STORAGE	149	1552.1	1201.44	14.4	10.23	141	119	82	46	0.128	0.431	0.895	1.163	70	235	488	634
D102	DIVERT	75			14.4	10.23	71	59	41	23	0.064	0.215	0.448	0.581	35	118	244	317
100105	ROUTE	70	100.2	24.2	20.3	10.23	67	58	41	23	0.061	0.211	0.444	0.578	33	115	242	315
S105	BASIN	3466			12.5	4.37	531	133	44	19	1.129	1.129	1.129	1.129	263	263	263	263
CF02	RETRIEVE	75			14.4	10.23	71	59	41	23	0.064	0.215	0.448	0.581	35	118	244	317
102105	ROUTE	74	100.4	9.55	15.6	10.23	70	59	41	23	0.064	0.214	0.445	0.58	35	117	243	316
C105U	COMBINE	3466			12.5	14.6	587	238	125	66	0.374	0.606	0.958	1.164	291	472	746	906
S110	BASIN	532			12.1	0.43	62	16	5	2	1.35	1.422	1.422	1.422	31	33	33	33
11015I	ROUTE	456	101.7	7.4	12.4	0.43	62	16	5	2	1.35	1.421	1.422	1.422	31	33	33	33
15I15R	ROUTE	412	101.9	16.62	12.7	0.43	62	16	5	2	1.349	1.421	1.422	1.422	31	33	33	33
S115	BASIN	1693			12.5	2.25	287	73	24	11	1.186	1.209	1.209	1.209	142	145	145	145
C115	COMBINE	1937			12.6	2.68	346	89	30	13	1.201	1.232	1.233	1.233	171	176	176	176
115120	ROUTE	1900	102.8	22.91	12.7	2.68	346	89	30	13	1.201	1.232	1.233	1.233	171	176	176	176
S120	BASIN	2032			12.3	2	247	62	21	9	1.146	1.158	1.158	1.158	122	124	124	124
C120	COMBINE	3202			12.4	4.68	585	149	50	22	1.162	1.185	1.186	1.186	290	296	296	296
C105D	COMBINE	6217			12.4	19.28	1091	359	163	82	0.526	0.692	0.943	1.092	541	712	969	1123
120135	ROUTE	6220	105.1	23.77	12.5	19.28	1091	359	163	82	0.526	0.692	0.943	1.092	541	711	969	1123
S125	BASIN	161			12	0.09	12	3	1	0	1.197	1.258	1.258	1.258	6	6	6	6
R125A	ROUTE	115	100.4	2.64	12.2	0.09	12	3	1	0	1.197	1.257	1.258	1.258	6	6	6	6
12535I	ROUTE	70	100.2	3.19	12.6	0.09	12	3	1	0	1.196	1.257	1.258	1.258	6	6	6	6
S130	BASIN	415			12.1	0.31	39	10	3	1	1.169	1.217	1.217	1.217	19	20	20	20
R130A	ROUTE	359	100.7	5.8	12.2	0.31	39	10	3	1	1.169	1.217	1.217	1.217	19	20	20	20
13035I	ROUTE	302	100.8	6.26	12.5	0.31	39	10	3	1	1.168	1.216	1.217	1.217	19	20	20	20
C135I	COMBINE	337			12.5	1.18	50	13	4	2	0.39	0.407	0.407	0.407	25	26	26	26
35I135	ROUTE	196	100.4	16.35	13.3	1.18	49	13	4	2	0.39	0.407	0.407	0.407	25	26	26	26
S135	BASIN	1015			12.2	0.88	99	25	8	4	1.048	1.048	1.048	1.048	49	49	49	49
C135L	COMBINE	1001			12.2	2.06	146	37	12	5	0.661	0.671	0.671	0.671	73	74	74	74
C135	COMBINE	6650			12.4	21.34	1214	389	173	86	0.529	0.678	0.903	1.037	602	772	1027	1180
135145	ROUTE	5883	104.6	212.08	12.8	21.34	1202	386	172	86	0.524	0.673	0.901	1.036	596	766	1025	1179
S140	BASIN	2029			12.1	1.37	172	43	14	6	1.164	1.164	1.164	1.164	85	85	85	85
140145	ROUTE	1632	101.9	39.52	12.4	1.37	172	43	14	6	1.164	1.164	1.164	1.164	85	85	85	85
S145	BASIN	1945			12.2	1.76	193	48	16	7	1.022	1.022	1.022	1.022	96	96	96	96
C145	COMBINE	6533			12.7	24.47	1505	461	197	96	0.572	0.701	0.899	1.017	746	915	1173	1327
145155	ROUTE	6539	106.9	17.8	12.8	24.47	1505	461	197	96	0.572	0.701	0.899	1.017	746	915	1173	1327
S150	BASIN	729			12.3	0.77	107	29	10	4	1.291	1.374	1.375	1.375	53	57	57	57
R150A	ROUTE	670	100.9	13.19	12.5	0.77	107	29	10	4	1.291	1.374	1.375	1.375	53	57	57	57
150155	ROUTE	357	100.4	47.08	13.7	0.77	107	29	10	4	1.285	1.372	1.375	1.375	53	57	57	57
S155	BASIN	1781			12.3	1.83	218	55	18	8	1.105	1.117	1.117	1.117	108	109	109	109
C155L	COMBINE	1774			12.3	2.61	318	83	28	12	1.135	1.178	1.18	1.18	158	164	164	164
C155	COMBINE	7006			12.7	27.07	1777	530	220	106	0.61	0.728	0.906	1.013	881	1051	1308	1463
155160	ROUTE	6982	105.5	51.18	12.8	27.07	1775	530	220	106	0.61	0.728	0.906	1.013	880	1051	1308	1463
S160	BASIN	1342			12.1	1.14	124	31	10	4	1.01	1.01	1.01	1.01	62	62	62	62
C160	COMBINE	7083			12.8	27.44	1878	555	228	110	0.636	0.753	0.929	1.035	931	1102	1360	1514
160170	ROUTE	6945	103.4	130.86	13	27.44	1868	554	228	110	0.633	0.751	0.928	1.034	926	1099	1359	1514

Hydrology - 24-hr Storm HEC1 Model Results

KK CARD	Type	Peak Flow	Peak Stage (ft)	Peak Storage	Time	Cum.Area (sq. miles)	MAX. Average Flow (cfs)				MAX. Average Rainfall Depth (Inches)				Total Runoff Volume (ac. ft)			
							6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR
S165	BASIN	842			12.1	0.62	78	20	7	3	1.183	1.219	1.219	1.219	39	40	40	40
R165A	ROUTE	658	101.1	17.69	12.4	0.62	78	20	7	3	1.183	1.218	1.219	1.219	39	40	40	40
165170	ROUTE	337	100.5	31.75	13.2	0.62	78	20	7	3	1.181	1.218	1.219	1.219	39	40	40	40
S170	BASIN	1802			12.1	1.46	169	42	14	6	1.075	1.075	1.075	1.075	84	84	84	84
C170		1792			12.1	2.08	245	62	21	9	1.093	1.105	1.105	1.105	121	123	123	123
170R	ROUTE	1729	98.4	24.46	12.3	2.08	244	62	21	9	1.092	1.105	1.105	1.105	121	123	123	123
C170R	COMBINE	7135			13	29.52	2070	605	245	117	0.652	0.762	0.926	1.024	1026	1199	1458	1613
170180	ROUTE	7015	103.5	181.69	13.2	29.52	2055	603	245	117	0.647	0.759	0.925	1.024	1019	1195	1456	1612
S175	BASIN	1278			12.5	1.8	217	55	18	8	1.119	1.131	1.131	1.131	108	109	109	109
175R	ROUTE	1198	101	19.69	12.6	1.8	217	55	18	8	1.119	1.131	1.131	1.131	108	109	109	109
S180	BASIN	1039			12.5	1.44	171	44	15	6	1.1	1.123	1.124	1.124	85	86	86	86
180R	ROUTE	744	101	33.75	12.8	1.44	170	44	15	6	1.094	1.123	1.124	1.124	84	86	86	86
C180RI	COMBINE	1835			12.6	3.24	382	97	32	14	1.093	1.113	1.114	1.114	189	193	193	193
RI180R	ROUTE	1740	101.2	36.53	12.8	3.24	381	97	32	14	1.092	1.113	1.114	1.114	189	193	193	193
C180R	COMBINE	8167			13.1	32.76	2374	683	271	129	0.674	0.775	0.923	1.012	1177	1354	1613	1769
180185	ROUTE	8155	104	81.25	13.2	32.76	2367	681	271	128	0.672	0.774	0.923	1.012	1174	1352	1612	1769
S185	BASIN	1655			12.5	2.42	288	73	24	10	1.105	1.117	1.117	1.117	143	144	144	144
185R	ROUTE	1411	102.6	45.16	12.9	2.42	287	73	24	10	1.104	1.117	1.117	1.117	143	144	144	144
C185R	COMBINE	9110			13.1	35.19	2598	740	290	137	0.687	0.782	0.921	1.005	1288	1468	1728	1885
185190	ROUTE	9090	103.5	67.18	13.2	35.19	2593	739	290	137	0.685	0.781	0.921	1.004	1286	1466	1728	1885
S190	BASIN	2590			12.5	4.05	448	112	37	16	1.027	1.027	1.027	1.027	222	222	222	222
C190	COMBINE	9871			13.1	39.24	2935	827	320	150	0.696	0.784	0.909	0.984	1456	1641	1903	2060
190195	ROUTE	9742	104.1	131.95	13.3	39.24	2927	827	320	150	0.694	0.783	0.909	0.984	1451	1639	1902	2060
S195	BASIN	1039			12.6	1.81	202	51	17	7	1.041	1.041	1.041	1.041	100	100	100	100
C195	COMBINE	10103			13.2	41.05	3081	866	333	155	0.698	0.784	0.904	0.976	1528	1717	1980	2137

Channels Hydraulics Summary

		Design Geometry						Hydraulics										
Structure ID	Type	Initial Slope (ft/ft)	Long-term Slope (ft/ft)	Length (stor-ft; chl-mi)	Width (ft)	Depth (ft)	Chnl Mannings n	Flow Rate (cfs)	Wetted Perimeter (ft)	Wetted XS Area (ft)	Hydraulic Radius (ft)	Hydraulic Depth (ft)	Flow Depth (ft)	Freeboard (ft)	Top Width (ft)	Velocity (ft/s)	Froude Number	Shear Stress (lb/sq. ft)
C135L10-A	Leveed	0.0209	0.0080	0.80	3	4.0	0.045	726	146.6	149.7	1.0	1.0	1.0	3.0	146	4.9	0.85	0.52
S13010	Leveed	0.0185	0.0185	0.70	3	4.0	0.045	524	106.9	112.5	1.1	1.1	1.1	2.9	107	4.7	0.80	1.26
C135L30-A	Leveed	0.0138	0.0060	1.40	3	4.5	0.045	1001	266.3	260.9	1.0	1.0	1.0	3.5	266	3.8	0.68	0.37
C155L10	Leveed	0.0167	0.0060	2.60	3	4.0	0.045	1774	357.0	390.8	1.1	1.1	1.1	2.9	357	4.5	0.76	0.41
S17010	Excavated	0.0089	0.0040	0.40	3	4.0	0.045	1510	94.8	320.2	3.4	3.4	3.9	0.1	94	4.7	0.45	0.98
S17020	Leveed	0.0134	0.0050	1.40	3	4.5	0.045	1792	308.2	395.5	1.3	1.3	1.3	3.2	308	4.5	0.70	0.41
170R10	Leveed	0.0137	0.0134	0.80	3	7.5	0.045	1973	126.3	291.3	2.3	2.3	2.6	4.9	126	6.8	0.78	2.16
RR17510	Leveed	0.0164	0.0060	0.60	3	4.5	0.045	1397	287.0	311.8	1.1	1.1	1.1	3.4	287	4.5	0.76	0.41
S18010	Leveed	0.0146	0.0060	1.00	3	4.5	0.045	1039	187.9	228.2	1.2	1.2	1.2	3.3	187	4.6	0.73	0.46
RR18010	Leveed	0.0153	0.0060	0.50	3	4.5	0.045	1124	188.1	236.0	1.3	1.3	1.3	3.2	188	4.8	0.75	0.48
C180R10	Leveed	0.0122	0.0045	0.70	3	4.5	0.045	1859	367.8	446.3	1.2	1.2	1.2	3.3	367	4.2	0.67	0.34
C155L20	Leveed	0.0163	0.0060	2.50	3	4.0	0.045	1774	357.0	393.5	1.1	1.1	1.1	2.9	357	4.5	0.76	0.42
C17510B-A	Leveed	0.0112	0.0112	0.50	3	4.5	0.045	1278	406.0	380.3	0.9	0.9	0.9	3.6	406	3.4	0.61	0.66

Basins Hydraulics Summary

			Design Geometry				Hydraulics					
Structure ID	Type	Adjacent Topo. Slope	Length (stor-ft; chl-mi)	Width (ft)	Depth (ft)	Storage Volume Provided	Peak Storage (ac. Ft)	Total Vol. Entering Basin (ac.	Peak Inflow into Basin (cfs)	Peak Outflow (cfs)	Peak Stage (ft)	Freeboard (ft)

Open Channel

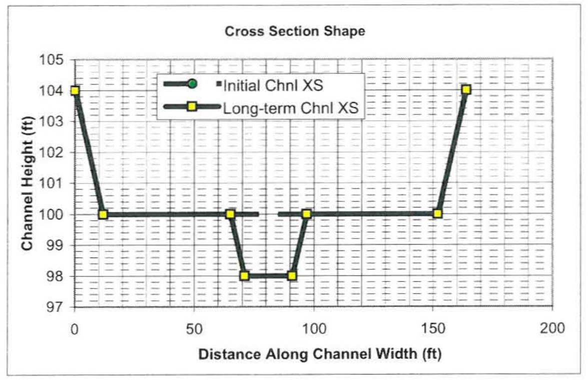
Structure ID	C135L10-A		HEC1 ID	12535I

Longitundal Geometry

Length	3964.3	ft
U/S Elev	1684.0	ft
D/S Elev	1601.3	ft
Initial Channel Slope	0.0209	ft/ft
Long-term Channel Slope	0.0080	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	3



Initial Channel XS Geometry

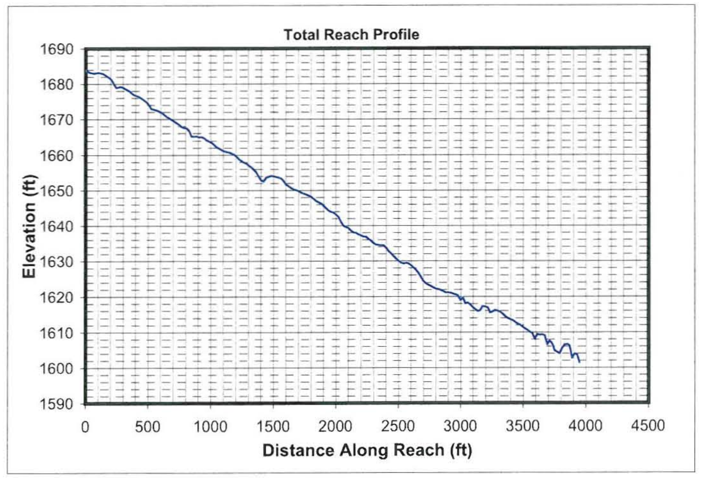
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	0	3	140	4	3	0	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	12	12	152	152	152	164
Y	104	100	100	100	100	100	100	104

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	53	3	20	6	3	55	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	65	71	91	97	152	164
Y	104	100	100	98	98	100	100	104



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	S125	S130							TOTAL
HEC1 Peak-Flow	202	524							726
Weighting Factor	1.00	1.00							
Flow into Channel	202	524							726

Reach Sediment Inflow Characteristics

U/S Contributing ID									TOTAL
HEC1 Flow Volume (ac. ft)									0
Sediment Conc. (ppm)									
Sediment Volume (ac. ft)									0.00
Weighting Factor									
Weighted Sed. Vol. (ac. ft)									0.00

Hydrology

Drainage Area	0.09	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	726	cfs	
Long-term Max. Chnl Capacity	4907	cfs	
Q2 Channel	73	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	164	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
73	141.7	37.1	0.3	100.0	100.3	2.0	0.3	141.6	0.3	0.13	0.67
182	142.9	64.5	0.5	100.0	100.5	2.8	0.5	142.7	0.5	0.23	0.74
545	145.6	125.6	0.9	100.0	100.9	4.3	0.9	145.3	0.9	0.44	0.82
726	146.6	149.7	1.0	100.0	101.0	4.9	1.0	146.3	1.0	0.52	0.85

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
73	26.9	25.4	0.9	98.0	99.1	2.9	1.1	26.6	1.0	0.55	0.51
182	31.7	47.0	1.5	98.0	99.8	3.9	1.8	31.1	1.5	0.92	0.55
545	145.8	167.6	1.1	98.0	100.8	3.2	2.8	144.9	1.2	1.40	0.53
726	147.2	199.9	1.4	98.0	101.0	3.6	3.0	146.2	1.4	1.51	0.55

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
73										0
182										0
545										0
726										0

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow) Permissive Velocity (ft/s): Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	BUREC Erosive?	Neill (gravel/cobble) Non-cohesive: Erosive?	All'ble Vel (ft/s)	Cohesive: Erosive?	All'ble Vel (ft/s)	USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
73	1.74	0.9825	0.9334	Erosive	Erosive	Erosive	0.2	Stable	5.5	Stable	Stable
182	1.74	1.1505	1.0930	Erosive	Erosive	Erosive	0.2	Stable	7.7	Stable	Stable
545	1.74	1.3504	1.2829	Erosive	Erosive	Erosive	0.3	Stable	9.1	Stable	Stable
726	1.74	1.4025	1.3324	Erosive	Erosive	Erosive	0.3	Stable	9.7	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

Discharge (cfs)	Channel Width (ft) 73	182	545	726	Flow Depth (ft) 73	182	545	726	Velocity (ft/s) 73	182	545	726
Bray - Equation #1	23	37	66	77	1.1	1.5	2.2	2.4	2.9	3.3	3.8	4.0
Bray - Equation #2	30	48	86	101	1.2	1.7	2.4	2.6	2.0	2.2	2.6	2.7
Hey	6	11	21	24	3.3	4.7	7.1	7.9				
Ackers & Charlton/Lacey	22	32	51	57					1.6	1.9	2.3	2.4
Parker	59	93	160	185	0.8	1.2	1.9	2.1				
Chang	41	73	141	168	0.1	0.0	-0.3	-0.5				
Kellerhals	15	24	42	48	1.5	2.2	3.4	3.8	3.1	3.4	3.8	3.9
AMAFCA/Schumm	27	31	145	146								
Moody & Odem	5	5	5	5	0.7	0.7	0.7	0.7				
BUREC	12.1	17.1	25.8	28.8	3	5	7	8	2.9	3.6	4.8	5.2
Average	24	37	74	84	1.5	2.1	3.0	3.3	2.5	2.9	3.5	3.6
Values As Designed	27	31	145	146	1.1	1.8	2.8	3.0	2.9	3.9	3.2	3.6
Difference with Design	-3	6	-71	-62	0.4	0.2	0.2	0.3	-0.3	-1.0	0.2	0.0

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
73	802	526	1185	1546	2308	285	249	127	3840	267	853	1090
182	3299	1677	3458	7298	3412	1174	792	638	10033	885	3545	3292
545	17917	6029	10367	46666	5186	5514	2568	3242	30680	4117	16693	13544
726	27825	8312	13569	75729	5758	8191	3424	4804	41004	6202	24558	19943

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
73	4101	2688	6058	7900	11792	1455	1272	647	19623	1365	4358	5569
182	6742	3428	7068	14918	6974	2399	1619	1305	20509	1810	7246	6729
545	12208	4108	7064	31796	3534	3757	1750	2209	20904	2805	11374	9228
726	14219	4248	6934	38699	2943	4186	1750	2455	20954	3169	12550	10191

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
73	520	256	434	1022	552	127	95	114	933	119	602	434
182	1952	748	1176	4344	871	447	263	424	2395	426	2146	1381
545	4706	1991	3377	9593	3418	1124	766	1039	7094	1037	5354	3591
726	7303	2834	4663	15543	3845	1696	1058	1600	9540	1583	8127	5254

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
73	2660	1306	2219	5223	2820	648	485	581	4769	606	3076	2218
182	3990	1529	2405	8880	1781	913	538	867	4895	871	4387	2823
545	3206	1356	2301	6536	2329	766	522	708	4833	707	3648	2447
726	3732	1448	2383	7943	1965	867	541	818	4875	809	4153	2685

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
73	0.0029	0.0046	138	0.42	0.047	0.0010	30	0.036	0.0007	0.0159	0.0010	0.0023	0.0084	0.0005	0.0032	0.0208	0.0080
182	0.0015	0.0027	181	0.55	0.050	0.0006	31	0.036	0.0004	0.0159	0.0006	0.0013	0.0084	0.0004	0.0016	0.0208	0.0077
545	0.0006	0.0014	250	0.76	0.053	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0006	0.0084	0.0002	0.0007	0.0208	0.0075
726	0.0005	0.0012	272	0.83	0.054	0.0003	32	0.036	0.0002	0.0159	0.0002	0.0005	0.0084	0.0002	0.0006	0.0208	0.0075

Drop Structures

Design Slope	0.0080	ft/ft
Total Drop Needed	51.1	ft
Height of Drop Structure	3	ft
No . of Drop Structures	18	
Distance between structs.	220	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.16	sq. mi
Total Sediment Yield Volume	0.30	ac ft

Sedimentation Basins

Length	220 ft	Depth	3 ft
Width	164 ft	Side slope	3 ft/ft
Total Volume per Basin		2.26	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
73	1.1	-0.3	0.1	24.6	1.1	1.0	2.9	0.0080	0.1	1.5	2.0	4.8
182	1.1	-0.5	0.2	24.6	1.8	1.5	3.9	0.0080	0.2	1.5	2.0	4.9
545	1.1	-0.8	0.1	24.6	2.8	1.2	3.2	0.0080	0.3	1.5	2.0	5.0
726	1.1	-0.8	0.2	24.6	3.0	1.4	3.6	0.0080	0.3	1.5	2.0	5.1

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	94	cfs
Stage at Peak Flow	100.3	ft
Flow Volume	7.0	ac. ft

Freeboard

Max. Flow Depth	1.0	ft
Channel Depth as designed	4.0	ft
Available Freeboard	3.0	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	0.30	ac. ft
Outflowing Sediment Volume	0.01	ac. ft
Deposited(+)/Eroded(-) Volume	0.29	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	3964	3964
Side Slope (?H:1V)	3	3
Channel Width (ft)	164	164
Channel XS Area (sq. ft)	660	660
Channel Perimeter (ft)	166	166

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	3964	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	1321	sq. Yd
Volume	3964	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	3964	3964
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4	5
Left Levee Surface Area (sq. Yd)	17177	35676
Left Levee Volume (cu. Yd)	15269	36704
Right Levee Length (ft)	3964	3964
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4	5
Right Levee Surface Area (sq. Yd)	17177	35676
Right Levee Volume (cu. Yd)	15269	36704
Total Levee Surface Area (sq. Yd)	34354	71352
Total Levee Volume (cu. Yd)	30538	73408

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	3964	3964
Left Levee Lining Width (ft)	13	30
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	5726	13213
Left Levee Lining Volume (cu. Yd)	2863	6607
Right Levee Length (ft)	3964	3964
Right Levee Lining Width (ft)	13	30
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	5726	13213
Right Levee Lining Volume (cu. Yd)	2863	6607
Total Lining Area (sq. Yd)	11452	26427
Total Lining Volume (cu. Yd)	5726	13214

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	164	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	5.9	ft
Structure Height	8.9	ft
Number of Structures	18	
Volume per structure	162	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 12,150	
Area per structure	55	sq. Yd
Total Area	984	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	3646	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 14,584	
Other Cost	$ -	
Total cost per basin	$ 14,584	
Area per basin	4,013	sq. Yd
Total Area	4,013	sq. Yd

Structure Type	Structure Cost														
		Excavation/Construction				Landscape				Maintenance					
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost		
Levee	Fill	30,538	cu. Yd	$ 7.00	$ 213,766	34,354	sq. Yd	$ 9.00	$ 309,186	34,354	sq. Yd	$ 11.67	$ 400,797		
Levee - LC Enhancement	Fill	42,870	cu. Yd	$ 7.00	$ 300,090	36,998	sq. Yd	$ 9.00	$ 332,982	42,870	sq. Yd	$ 11.67	$ 500,150		
Levee Lining	Riprap	5,726	cu. Yd	$ 75.00	$ 429,450	11,452	sq. Yd	$ -	$ -	11,452	sq. Yd	$ 20.83	$ 238,574		
Levee Lining -LC Enhancement	Riprap	7,488	cu. Yd	$ 75.00	$ 561,600	14,975	sq. Yd	$ -	$ -	14,975	sq. Yd	$ 20.83	$ 311,981		
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -		
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -		
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -		
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -		
Toe Protection	Riprap	3,964	cu. Yd	$ 75.00	$ 297,300	1,321	sq. Yd	$ -	$ -	1,321	sq. Yd	$ 25.00	$ 33,025		
Drop Structures	Riprap	18	EA	$ 12,150.00	$ 218,700	984	sq. Yd	$ -	$ -	984	sq. Yd	$ 33.33	$ 32,800		
Drop Str. - LC Enhancement	Riprap	18	EA	$ 1,215.00	$ 21,870	98	sq. Yd	$ -	$ -	98	sq. Yd	$ 33.33	$ 3,280		
Sedimentation Basins		1	EA	$ 14,584.00	$ 14,584	4,013	sq. Yd	$ -	$ -	4,013	sq. Yd	$ 8.33	$ 33,442		
Other					$ -				$ -				$ -		

Base Landscape Cost	$ 309,186	
LC Enhancement Cost	$ 332,982	
Total Landscape Cost	$ 642,168	

Base Maintenance Cost	$ 738,637
LC Enhancement Cost	$ 815,411
Total Maintenance Cost	$ 1,554,049

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,173,800	$ 883,560	$ 2,057,360
Contingency Cost (25% of Construction Cost)	$ 293,450	$ 220,890	$ 514,340
Engineering Design Cost (5% of Construction Cost)	$ 58,690	$ 44,178	$ 102,868
Total Construction Cost	$ 1,525,940	$ 1,148,628	$ 2,674,568

Land Cost

Channel Length	3964 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	164	14.9	$100,000	$ 1,490,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	52	4.7	$100,000	$ 470,000
Levee LC Enhancement	48	4.4	$100,000	$ 440,000
Active fan set aside for Fan 13E	0	16.4	$100,000	$ 1,640,000
Total	264	40.4		$ 4,040,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	36	$100,000	$ 3,600,000
LC Enhancement Cost	acre	4.4	$100,000	$ 440,000
Total Land Cost	acre	40.4	$100,000	$ 4,040,000

Total Cost

Base Total Cost	$ 6,173,763
Total Landscape Enhancement Cost	$ 2,737,021
Total Cost Including LC Enh.	$ 8,910,785

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

Open Channel

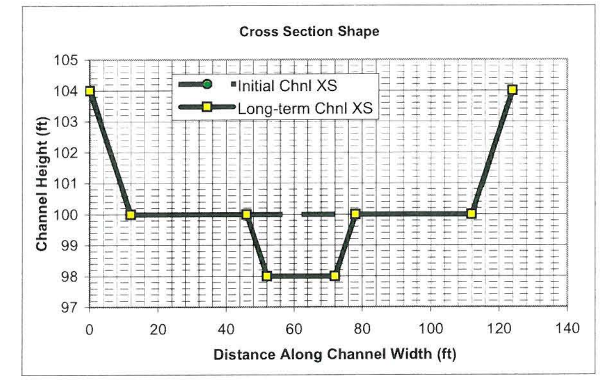
Structure ID	S13010	HEC1 ID	13035I

Longitundal Geometry

Length	3433.0	ft
U/S Elev	1664.8	ft
D/S Elev	1601.4	ft
Initial Channel Slope	0.0185	ft/ft
Long-term Channel Slope	0.0185	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	2



Initial Channel XS Geometry

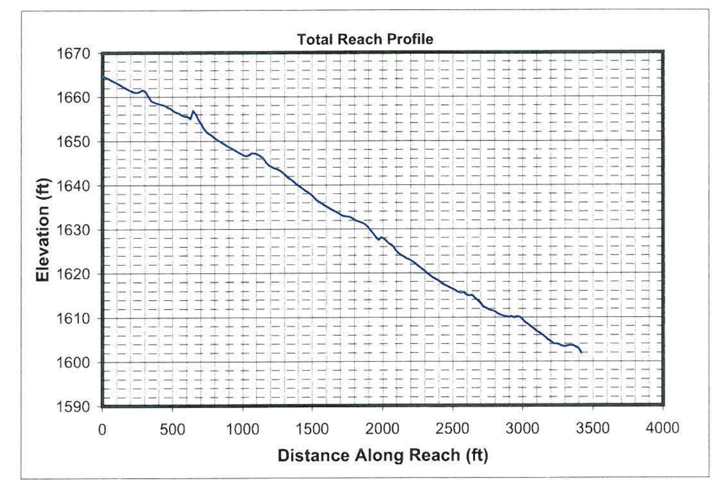
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	0	3	100	4	3	0	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	12	12	112	112	112	124
Y	104	100	100	100	100	100	100	104

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	34	3	20	6	3	34	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	46	52	72	78	112	124
Y	104	100	100	98	98	100	100	104



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	S130									TOTAL
HEC1 Peak-Flow	524									524
Weighting Factor	1.00									
Flow into Channel	524									524

Reach Sediment Inflow Characteristics

U/S Contributing ID										TOTAL
HEC1 Flow Volume (ac. ft)										0
Sediment Conc. (ppm)										
Sediment Volume (ac. ft)										0.00
Weighting Factor										
Weighted Sed. Vol. (ac. ft)										0.00

Hydrology

Drainage Area	0.635	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	524	cfs	
Long-term Max. Chnl Capacity	5646	cfs	
Q2 Channel	52	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	124	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
52	101.7	27.7	0.3	100.0	100.3	1.9	0.3	101.7	0.3	0.32	0.64
131	103.0	48.3	0.5	100.0	100.5	2.7	0.5	102.9	0.5	0.55	0.70
393	105.8	94.3	0.9	100.0	100.9	4.2	0.9	105.5	0.9	1.06	0.78
524	106.9	112.5	1.1	100.0	101.1	4.7	1.1	106.5	1.1	1.26	0.80

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
52	24.5	15.7	0.6	98.0	98.7	3.3	0.7	24.2	0.6	0.82	0.73
131	27.6	28.5	1.0	98.0	99.2	4.6	1.2	27.2	1.0	1.39	0.79
393	103.2	93.3	0.9	98.0	100.4	4.2	2.4	102.4	0.9	2.78	0.78
524	104.3	111.4	1.1	98.0	100.6	4.7	2.6	103.5	1.1	2.98	0.80

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
52										0
131										0
393										0
524										0

Allowable Velocity

Channel Lining	Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow) Permissive Velocity (ft/s) Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	BUREC Erosive?	Neill (gravel/cobble) Non-cohesive Erosive?	All'ble Vel (ft/s)	Cohesive Erosive?	All'ble Vel (ft/s)	USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
52	1.74	0.9949	0.9451	Erosive	Erosive	Erosive	0.2	Stable	6.3	Stable	Stable
131	1.74	1.1623	1.1042	Erosive	Erosive	Erosive	0.2	Stable	8.9	Stable	Stable
393	1.74	1.3608	1.2928	Erosive	Erosive	Erosive	0.3	Stable	12.3	Stable	Stable
524	1.74	1.4123	1.3417	Erosive	Erosive	Erosive	0.3	Stable	13.1	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

Discharge (cfs)	Channel Width (ft) 52	131	393	524	Flow Depth (ft) 52	131	393	524	Velocity (ft/s) 52	131	393	524
Bray - Equation #1	19	31	55	65	1.0	1.3	1.9	2.1	2.8	3.1	3.6	3.8
Bray - Equation #2	25	41	73	85	1.1	1.5	2.1	2.3	1.9	2.1	2.5	2.6
Hey	5	9	17	20	2.9	4.1	6.2	7.0				
Ackers & Charlton/Lacey	19	28	44	50					1.5	1.8	2.2	2.3
Parker	50	79	136	157	0.7	1.0	1.7	1.9				
Chang	45	78	150	178	-0.1	-0.3	-0.7	-0.8				
Kellerhals	13	21	36	41	1.3	1.9	3.0	3.3	3.0	3.3	3.7	3.8
AMAFCA/Schumm	24	27	103	104								
Moody & Odem	10	10	10	10	0.9	0.9	0.9	0.9				
BUREC	9.2	12.9	19.5	21.8	2	3	5	6	3.7	4.6	6.1	6.5
Average	22	34	64	73	1.3	1.8	2.6	2.8	2.6	3.0	3.6	3.8
Values As Designed	24	27	102	104	0.7	1.2	2.4	2.6	3.3	4.6	4.2	4.7
Difference with Design	-2	6	-38	-30	0.6	0.5	0.1	0.2	-0.8	-1.6	-0.6	-0.9

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
52	490	323	703	914	1555	161	146	74	2275	160	517	665
131	2008	1048	2128	4305	2324	686	484	389	5991	534	2193	2008
393	10849	3813	6573	27374	3573	3248	1599	2022	18381	2495	10471	8218
524	16828	5270	8565	44333	3979	4823	2139	3008	24577	3762	15450	12067

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
52	3466	2285	4976	6473	11010	1138	1033	523	16107	1132	3662	4710
131	5687	2969	6027	12191	6582	1944	1370	1103	16967	1513	6210	5688
393	10242	3600	6205	25842	3373	3066	1509	1909	17352	2356	9885	7758
524	11915	3731	6064	31389	2817	3415	1514	2129	17401	2663	10939	8543

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
52	1064	461	907	2498	674	345	205	209	2437	263	1112	925
131	4083	1287	2127	10921	1013	1182	527	735	6161	927	3783	2977
393	10958	3552	6540	28004	3512	3275	1592	2036	18440	2527	10541	8271
524	16985	4951	8528	45335	3912	4862	2127	3024	24653	3808	15539	12157

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
52	7532	3262	6420	17685	4775	2446	1454	1477	17257	1863	7875	6549
131	11564	3645	6024	30928	2868	3349	1492	2081	17447	2624	10714	8431
393	10345	3353	6174	26436	3316	3092	1502	1922	17408	2385	9951	7808
524	12026	3505	6038	32098	2770	3442	1506	2141	17455	2696	11002	8607

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
52	0.0029	0.0044	132	0.40	0.047	0.0009	30	0.035	0.0007	0.0159	0.0009	0.0022	0.0093	0.0006	0.0033	0.0184	0.0076
131	0.0015	0.0026	173	0.53	0.049	0.0006	30	0.036	0.0004	0.0159	0.0005	0.0012	0.0093	0.0004	0.0017	0.0184	0.0073
393	0.0006	0.0014	239	0.73	0.052	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0006	0.0093	0.0002	0.0007	0.0184	0.0072
524	0.0005	0.0011	260	0.79	0.053	0.0003	32	0.036	0.0002	0.0159	0.0002	0.0005	0.0093	0.0002	0.0006	0.0184	0.0071

Drop Structures

Design Slope	0.0185	ft/ft
Total Drop Needed	0.0	ft
Height of Drop Structure	3	ft
No . of Drop Structures	0	
Distance between structs.	N/A	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.64	sq. mi
Total Sediment Yield Volume	1.21	ac ft

Sedimentation Basins

Length	0 ft	Depth	3 ft
Width	124 ft	Side slope	3 ft/ft
Total Volume per Basin		0.00	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		0	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
52	1.1	-0.2	0.2	24.6	0.7	0.6	3.3	0.0185	0.1	1.5	2.0	4.7
131	1.1	-0.3	0.3	24.6	1.2	1.0	4.6	0.0185	0.1	1.5	2.0	4.9
393	1.1	-0.6	0.2	24.6	2.4	0.9	4.2	0.0185	0.3	1.5	2.0	5.1
524	1.1	-0.6	0.3	24.6	2.6	1.1	4.7	0.0185	0.3	1.5	2.0	5.1

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	387	cfs
Stage at Peak Flow	100.9	ft
Flow Volume	24.0	ac. ft

Freeboard

Max. Flow Depth	1.1	ft
Channel Depth as designed	4.0	ft
Available Freeboard	2.9	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	1.21	ac. ft
Outflowing Sediment Volume	0.08	ac. ft
Deposited(+)/Eroded(-) Volume	1.13	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	3433	3433
Side Slope (?H:1V)	3	3
Channel Width (ft)	124	124
Channel XS Area (sq. ft)	500	500
Channel Perimeter (ft)	126	126

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	3433	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	1144	sq. Yd
Volume	3433	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	3433	3433
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4	5
Left Levee Surface Area (sq. Yd)	14876	30897
Left Levee Volume (cu. Yd)	13223	31787
Right Levee Length (ft)	3433	3433
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4	5
Right Levee Surface Area (sq. Yd)	14876	30897
Right Levee Volume (cu. Yd)	13223	31787
Total Levee Surface Area (sq. Yd)	29752	61794
Total Levee Volume (cu. Yd)	26446	63574

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	3433	3433
Left Levee Lining Width (ft)	13	30
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	4959	11443
Left Levee Lining Volume (cu. Yd)	2479	5722
Right Levee Length (ft)	3433	3433
Right Levee Lining Width (ft)	13	30
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	4959	11443
Right Levee Lining Volume (cu. Yd)	2479	5722
Total Lining Area (sq. Yd)	9918	22887
Total Lining Volume (cu. Yd)	4958	11444

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	124	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	5.9	ft
Structure Height	8.9	ft
Number of Structures	0	
Volume per structure	123	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 9,225	
Area per structure	41	sq. Yd
Total Area	0	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	0	
Total Volume per Basin	0	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ -	
Other Cost	$ -	
Total cost per basin	$ -	
Area per basin	0	sq. Yd
Total Area	0	sq. Yd

Structure Type	Structure Cost													
		Excavation/Construction				Landscape				Maintenance				
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost	
Levee	Fill	26,446	cu. Yd	$ 7.00	$ 185,122	29,752	sq. Yd	$ 9.00	$ 267,768	29,752	sq. Yd	$ 11.67	$ 347,107	
Levee - LC Enhancement	Fill	37,128	cu. Yd	$ 7.00	$ 259,896	32,042	sq. Yd	$ 9.00	$ 288,378	37,128	sq. Yd	$ 11.67	$ 433,160	
Levee Lining	Riprap	4,958	cu. Yd	$ 75.00	$ 371,850	9,918	sq. Yd	$ -	$ -	9,918	sq. Yd	$ 20.83	$ 206,616	
Levee Lining -LC Enhancement	Riprap	6,486	cu. Yd	$ 75.00	$ 486,450	12,969	sq. Yd	$ -	$ -	12,969	sq. Yd	$ 20.83	$ 270,190	
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -	
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -	
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	
Toe Protection	Riprap	3,433	cu. Yd	$ 75.00	$ 257,475	1,144	sq. Yd	$ -	$ -	1,144	sq. Yd	$ 25.00	$ 28,600	
Drop Structures	Riprap	0	EA	$ 9,225.00	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ 33.33	$ -	
Drop Str. - LC Enhancement	Riprap	0	EA	$ 922.50	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ 33.33	$ -	
Sedimentation Basins		0	EA	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ 8.33	$ -	
Other					$ -				$ -				$ -	

Base Landscape Cost	$ 267,768	
LC Enhancement Cost	$ 288,378	
Total Landscape Cost	$ 556,146	

Base Maintenance Cost	$ 582,322
LC Enhancement Cost	$ 703,350
Total Maintenance Cost	$ 1,285,672

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 814,447	$ 746,346	$ 1,560,793
Contingency Cost (25% of Construction Cost)	$ 203,612	$ 186,587	$ 390,198
Engineering Design Cost (5% of Construction Cost)	$ 40,722	$ 37,317	$ 78,040
Total Construction Cost	$ 1,058,781	$ 970,250	$ 2,029,031

Land Cost

Channel Length	3433 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	124	9.8	$100,000	$ 980,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	52	4.1	$100,000	$ 410,000
Levee LC Enhancement	48	3.8	$100,000	$ 380,000
Active fan set aside for Fan 13W	0	27.1	$100,000	$ 2,710,000
Total	224	44.8		$ 4,480,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	41	$100,000	$ 4,100,000
LC Enhancement Cost	acre	3.8	$100,000	$ 380,000
Total Land Cost	acre	44.8	$100,000	$ 4,480,000

Total Cost

Base Total Cost	$ 6,008,872
Total Landscape Enhancement Cost	$ 2,341,978
Total Cost Including LC Enh.	$ 8,350,849

Open Channel

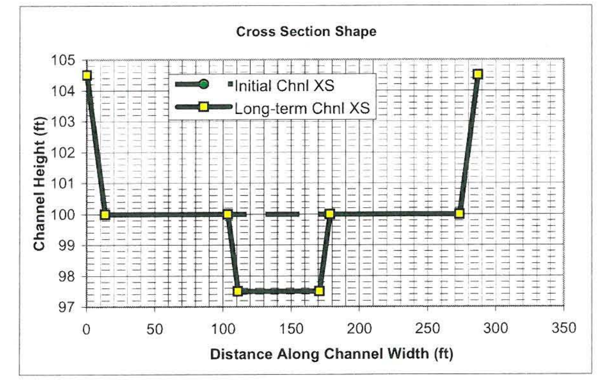
Structure ID	C135L30-A		HEC1 ID	351135

Longitundal Geometry

Length	7571.7	ft
U/S Elev	1601.3	ft
D/S Elev	1496.9	ft
Initial Channel Slope	0.0138	ft/ft
Long-term Channel Slope	0.0060	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	5



Initial Channel XS Geometry

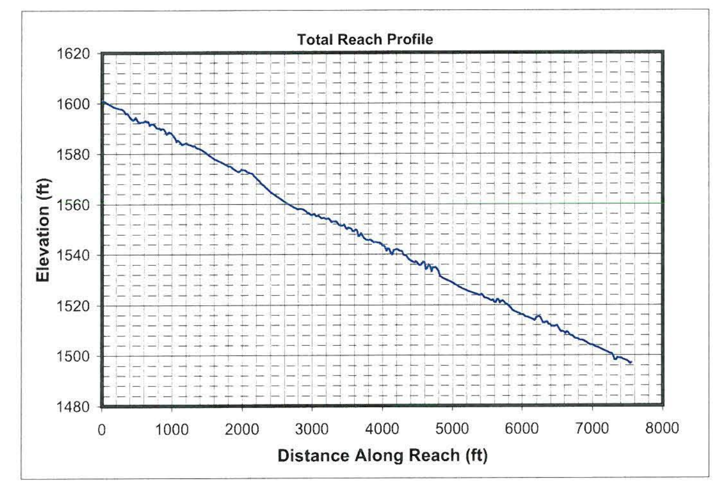
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	260	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	273.5	273.5	273.5	287
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	90	3	60	7	3	95	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	103.5	111	171	178.5	273.5	287
Y	104.5	100	100	97.5	97.5	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	C135L									TOTAL
HEC1 Peak-Flow	1001									1001
Weighting Factor	1.00									
Flow into Channel	1001									1001

Reach Sediment Inflow Characteristics

U/S Contributing ID	12535I_C135L10-A	13035I_S13010								TOTAL
HEC1 Flow Volume (ac. ft)	7.00	24.00								31
Sediment Conc. (ppm)	2823	8607								
Sediment Volume (ac. ft)	0.01	0.08								0.09
Weighting Factor	1	1								
Weighted Sed. Vol. (ac. ft)	0.01	0.08								0.09

Hydrology

Drainage Area	1.282	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	1001	cfs	
Long-term Max. Chnl Capacity	10268	cfs	
Q2 Channel	100	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	287	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
100	261.6	65.1	0.2	100.0	100.2	1.5	0.2	261.5	0.2	0.09	0.54
250	262.7	113.0	0.4	100.0	100.4	2.2	0.4	262.6	0.4	0.16	0.59
751	265.3	219.2	0.8	100.0	100.8	3.4	0.8	265.0	0.8	0.31	0.66
1001	266.3	260.9	1.0	100.0	101.0	3.8	1.0	266.0	1.0	0.37	0.68

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
100	64.9	47.8	0.7	97.5	98.3	2.1	0.8	64.6	0.7	0.29	0.43
250	68.4	84.6	1.2	97.5	98.8	3.0	1.3	67.9	1.2	0.50	0.47
751	263.5	280.7	1.1	97.5	100.4	2.7	2.9	262.6	1.1	1.10	0.46
1001	264.8	334.2	1.3	97.5	100.6	3.0	3.1	263.8	1.3	1.17	0.47

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
	12535I_C135L10-A	13035I_S13010								
100	434	925								1359
250	1381	2977								4358
751	3591	8271								11862
1001	5254	12157								17411

Allowable Velocity

Channel Lining	Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
100	1.74	0.9668	0.9185	Erosive	Erosive	Erosive	0.2	Stable	3.8	Stable	Stable
250	1.74	1.1355	1.0787	Erosive	Erosive	Erosive	0.2	Stable	5.5	Stable	Stable
751	1.74	1.3370	1.2701	Erosive	Erosive	Erosive	0.3	Stable	7.9	Stable	Stable
1001	1.74	1.3896	1.3201	Erosive	Erosive	Erosive	0.3	Stable	8.4	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	**100**	**250**	**751**	**1001**	**100**	**250**	**751**	**1001**	**100**	**250**	**751**	**1001**
Bray - Equation #1	27	44	78	91	1.2	1.7	2.4	2.7	3.0	3.4	4.0	4.2
Bray - Equation #2	35	57	102	119	1.4	1.8	2.6	2.9	2.1	2.4	2.7	2.9
Hey	8	13	25	29	3.7	5.3	8.0	8.9				
Ackers & Charlton/Lacey	25	37	58	66					1.7	2.0	2.4	2.5
Parker	69	109	188	217	0.9	1.4	2.2	2.4				
Chang	46	80	157	186	0.1	0.0	-0.3	-0.4				
Kellerhals	18	28	49	57	1.7	2.5	3.8	4.3	3.2	3.5	4.0	4.1
AMAFCA/Schumm	65	68	263	264								
Moody & Odem	14	14	14	14	1.0	1.0	1.0	1.0				
BUREC	14.4	20.4	30.7	34.2	4	5	8	9	2.8	3.5	4.7	5.0
Average	32	47	96	108	1.7	2.4	3.5	3.9	2.6	3.0	3.6	3.7
Values As Designed	65	68	263	264	0.8	1.3	2.9	3.1	2.1	3.0	2.7	3.0
Difference with Design	-33	-21	-166	-156	1.0	1.1	0.6	0.7	0.5	0.0	0.9	0.7

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
100	530	354	623	876	2917	106	120	53	2555	181	496	801
250	2186	1299	2665	4145	4547	662	559	393	7136	594	2429	2420
751	11935	5099	9227	26666	7158	3444	2102	2415	22407	2789	12765	9637
1001	18583	7142	12399	43376	7988	5164	2862	3688	30043	4226	19206	14061

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
100	1966	1311	2311	3245	10812	394	444	197	9471	671	1838	2969
250	3241	1925	3951	6146	6741	982	828	583	10579	881	3601	3587
751	5898	2520	4560	13178	3537	1702	1039	1193	11073	1378	6308	4762
1001	6887	2647	4596	16076	2961	1914	1061	1367	11135	1566	7118	5212

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
100	359	206	335	590	895	69	66	69	770	82	403	350
250	1436	689	1076	2704	1387	310	235	332	2080	307	1682	1113
751	3767	1817	3190	6798	4812	812	661	849	6143	817	4414	3098
1001	5863	2645	4323	11050	5451	1265	951	1357	8334	1249	6859	4486

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
100	1332	765	1241	2188	3316	255	246	255	2854	306	1493	1295
250	2128	1021	1596	4009	2057	460	348	492	3084	456	2493	1649
751	1862	898	1577	3360	2378	401	326	420	3036	404	2181	1531
1001	2173	980	1602	4095	2020	469	352	503	3089	463	2542	1663

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
100	0.0036	0.0049	109	0.33	0.045	0.0010	29	0.035	0.0007	0.0159	0.0010	0.0026	0.0075	0.0005	0.0038	0.0137	0.0061
250	0.0018	0.0028	143	0.44	0.048	0.0006	30	0.036	0.0004	0.0159	0.0006	0.0014	0.0075	0.0003	0.0019	0.0138	0.0057
751	0.0008	0.0015	199	0.61	0.050	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0007	0.0075	0.0002	0.0008	0.0138	0.0055
1001	0.0006	0.0012	216	0.66	0.051	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0006	0.0075	0.0002	0.0007	0.0138	0.0055

Drop Structures

Design Slope	0.0060	ft/ft
Total Drop Needed	59.0	ft
Height of Drop Structure	3	ft
No . of Drop Structures	20	
Distance between structs.	379	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.55	sq. mi
Total Sediment Yield Volume	1.05	ac ft

Sedimentation Basins

Length	379 ft	Depth	3 ft
Width	287 ft	Side slope	3 ft/ft
Total Volume per Basin		7.08	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

Discharge	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
100	1.1	-0.3	0.1	24.6	0.8	0.7	2.1	0.0060	0.1	1.5	1.0	3.4
250	1.1	-0.4	0.1	24.6	1.3	1.2	3.0	0.0060	0.1	1.5	1.0	3.5
751	1.1	-0.9	0.1	24.6	2.9	1.1	2.7	0.0060	0.3	1.5	1.0	3.7
1001	1.1	-1.0	0.1	24.6	3.1	1.3	3.0	0.0060	0.3	1.5	1.0	3.8

Toe Protection Needed	4.0	ft

HEC1 Results For Open Channel

Peak Flow	217	cfs
Stage at Peak Flow	100.4	ft
Flow Volume	27.0	ac. ft

Freeboard

Max. Flow Depth	1.0	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.5	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	1.14	ac. ft
Outflowing Sediment Volume	0.02	ac. ft
Deposited(+)/Eroded(-) Volume	1.12	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	7572	7572
Side Slope (?H:1V)	3	3
Channel Width (ft)	287	287
Channel XS Area (sq. ft)	1399.5	1399.5
Channel Perimeter (ft)	289	289

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	7572	ft
Thickness	1.5	ft
Protection Depth	4	ft
Tie-in Length/Depth	3.0	ft
Total Depth	7.0	ft
Area needed	2524	sq. Yd
Volume	5889	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	7572	7572
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	35336	73196
Left Levee Volume (cu. Yd)	34775	81890
Right Levee Length (ft)	7572	7572
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	35336	73196
Right Levee Volume (cu. Yd)	34775	81890
Total Levee Surface Area (sq. Yd)	70672	146392
Total Levee Volume (cu. Yd)	69550	163780

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	7572	7572
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	11779	27764
Left Levee Lining Volume (cu. Yd)	5889	13882
Right Levee Length (ft)	7572	7572
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	11779	27764
Right Levee Lining Volume (cu. Yd)	5889	13882
Total Lining Area (sq. Yd)	23557	55528
Total Lining Volume (cu. Yd)	11778	27764

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	287	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	5.0	ft
Structure Height	8.0	ft
Number of Structures	20	
Volume per structure	257	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 19,275	
Area per structure	96	sq. Yd
Total Area	1,913	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	11422	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 45,688	
Other Cost	$ -	
Total cost per basin	$ 45,688	
Area per basin	12,073	sq. Yd
Total Area	12,073	sq. Yd

Structure Type	Structure Cost													
		Excavation/Construction				Landscape				Maintenance				
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	69,550	cu. Yd	$ 7.00	$ 486,850	70,672	sq. Yd	$ 9.00	$ 636,048	70,672	sq. Yd	$ 11.67	$ 824,507
Levee - LC Enhancement	Fill	94,230	cu. Yd	$ 7.00	$ 659,610	75,720	sq. Yd	$ 9.00	$ 681,480	94,230	sq. Yd	$ 11.67	$ 1,099,350
Levee Lining	Riprap	11,778	cu. Yd	$ 75.00	$ 883,350	23,557	sq. Yd	$ -	$ -	23,557	sq. Yd	$ 20.83	$ 490,778
Levee Lining -LC Enhancement	Riprap	15,986	cu. Yd	$ 75.00	$ 1,198,950	31,971	sq. Yd	$ -	$ -	31,971	sq. Yd	$ 20.83	$ 666,056
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	5,889	cu. Yd	$ 75.00	$ 441,675	2,524	sq. Yd	$ -	$ -	2,524	sq. Yd	$ 25.00	$ 63,100
Drop Structures	Riprap	20	EA	$ 19,275.00	$ 385,500	1,913	sq. Yd	$ -	$ -	1,913	sq. Yd	$ 33.33	$ 63,767
Drop Str. - LC Enhancement	Riprap	20	EA	$ 1,927.50	$ 38,550	191	sq. Yd	$ -	$ -	191	sq. Yd	$ 33.33	$ 6,377
Sedimentation Basins		1	EA	$ 45,688.00	$ 45,688	12,073	sq. Yd	$ -	$ -	12,073	sq. Yd	$ 8.33	$ 100,608
Other					$ -				$ -				$ -

Landscape Cost		Maintenance Cost	
Base Landscape Cost	$ 636,048	Base Maintenance Cost	$ 1,542,759
LC Enhancement Cost	$ 681,480	LC Enhancement Cost	$ 1,771,782
Total Landscape Cost	$ 1,317,528	Total Maintenance Cost	$ 3,314,542

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 2,243,063	$ 1,897,110	$ 4,140,173
Contingency Cost (25% of Construction Cost)	$ 560,766	$ 474,278	$ 1,035,043
Engineering Design Cost (5% of Construction Cost)	$ 112,153	$ 94,856	$ 207,009
Total Construction Cost	$ 2,915,982	$ 2,466,243	$ 5,382,225

Land Cost

Channel Length	7572 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	287	49.9	$100,000	$ 4,990,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	9.6	$100,000	$ 960,000
Levee LC Enhancement	51	8.9	$100,000	$ 890,000
Other	0	0	$100,000	$ -
Total	393	68.4		$ 6,840,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	59.5	$100,000	$ 5,950,000
LC Enhancement Cost	acre	8.9	$100,000	$ 890,000
Total Land Cost	acre	68.4	$100,000	$ 6,840,000

Total Cost

Base Total Cost	$ 11,044,789
Total Landscape Enhancement Cost	$ 5,809,505
Total Cost Including LC Enh.	$ 16,854,295

JE FULLER
HYDROLOGY & GEOMORPHOLOGY INC

Sub-area: Wagner Wash, Alternative: A
Open Channel Structure ID: C135L30-A

Open Channel

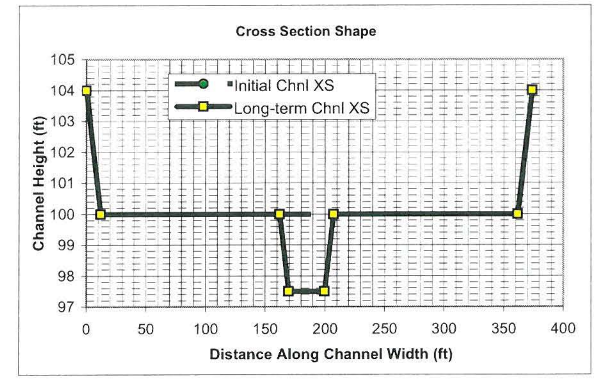
Structure ID	C155L10		HEC1 ID	150155

Longitundal Geometry

Length	13819.3	ft
U/S Elev	1682.1	ft
D/S Elev	1451.9	ft
Initial Channel Slope	0.0167	ft/ft
Long-term Channel Slope	0.0060	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	9



Initial Channel XS Geometry

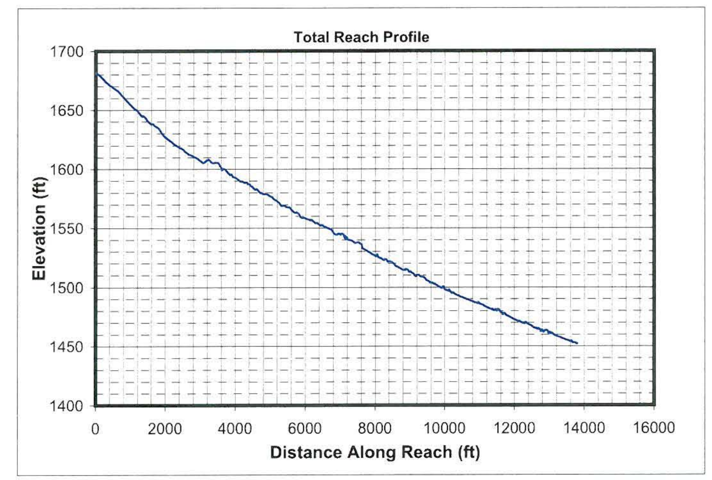
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	0	3	350	4	3	0	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	12	12	362	362	362	374
Y	104	100	100	100	100	100	100	104

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	150	3	30	6.5	3	155	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	162	169.5	199.5	207	362	374
Y	104	100	100	97.5	97.5	100	100	104



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	C155L									TOTAL
HEC1 Peak-Flow	1774									1774
Weighting Factor	1.00									
Flow into Channel	1774									1774

Reach Sediment Inflow Characteristics

U/S Contributing ID										TOTAL
HEC1 Flow Volume (ac. ft)										0
Sediment Conc. (ppm)										
Sediment Volume (ac. ft)										0.00
Weighting Factor										
Weighted Sed. Vol. (ac. ft)										0.00

Hydrology

Drainage Area	2.606	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	1774	cfs	
Long-term Max. Chnl Capacity	10128	cfs	
Q2 Channel	177	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	374	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
177	351.8	97.6	0.3	100.0	100.3	1.8	0.3	351.7	0.3	0.10	0.61
444	353.0	169.4	0.5	100.0	100.5	2.6	0.5	352.9	0.5	0.18	0.67
1331	355.9	328.4	0.9	100.0	100.9	4.1	0.9	355.6	0.9	0.35	0.74
1774	357.0	390.8	1.1	100.0	101.1	4.5	1.1	356.6	1.1	0.41	0.76

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
177	40.1	55.6	1.4	97.5	99.1	3.2	1.6	39.6	1.4	0.60	0.47
444	353.3	230.1	0.7	97.5	100.4	1.9	2.9	352.3	0.7	1.08	0.42
1331	357.1	446.8	1.3	97.5	101.0	3.0	3.5	356.0	1.3	1.31	0.47
1774	358.6	531.9	1.5	97.5	101.2	3.3	3.7	357.4	1.5	1.40	0.48

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
177										0
444										0
1331										0
1774										0

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow) Permissive Velocity (ft/s): Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	BUREC Erosive?	Neill (gravel/cobble) Non-cohesive: Erosive?	All'ble Vel (ft/s)	Cohesive: Erosive?	All'ble Vel (ft/s)	USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
177	1.74	1.0003	0.9503	Erosive	Erosive	Erosive	0.2	Stable	6.1	Stable	Stable
444	1.74	1.1692	1.1107	Erosive	Erosive	Erosive	0.2	Stable	7.3	Stable	Stable
1331	1.74	1.3709	1.3024	Erosive	Erosive	Erosive	0.3	Stable	8.9	Stable	Stable
1774	1.74	1.4236	1.3525	Erosive	Erosive	Erosive	0.3	Stable	9.5	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

Discharge (cfs)	Channel Width (ft) 177	444	1331	1774	Flow Depth (ft) 177	444	1331	1774	Velocity (ft/s) 177	444	1331	1774
Bray - Equation #1	36	59	105	123	1.5	2.0	2.9	3.2	3.3	3.7	4.3	4.5
Bray - Equation #2	48	78	138	161	1.6	2.2	3.2	3.5	2.2	2.5	3.0	3.1
Hey	11	18	34	40	4.6	6.5	9.9	11.1				
Ackers & Charlton/Lacey	32	47	74	83					1.9	2.2	2.7	2.8
Parker	92	145	251	289	1.2	1.7	2.7	3.1				
Chang	65	114	221	263	0.1	-0.1	-0.6	-0.8				
Kellerhals	24	38	66	76	2.2	3.1	4.8	5.4	3.4	3.8	4.2	4.3
AMAFCA/Schumm	40	353	356	358								
Moody & Odem	18	18	18	18	1.1	1.1	1.1	1.1				
BUREC	17.9	25.2	38.1	42.4	5	7	10	11	3.3	4.1	5.4	5.8
Average	38	89	130	145	2.1	2.9	4.3	4.8	2.8	3.3	3.9	4.1
Values As Designed	40	352	356	357	1.6	2.9	3.5	3.7	3.2	1.9	3.0	3.3
Difference with Design	-1	-263	-226	-212	0.5	0.0	0.8	1.0	-0.4	1.3	0.9	0.8

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	**Zeller Fullerton**	**Ackers White**	**Einstein**	**Engelund/Hansen**	**Kalinske**	**Laursen**	**MPM**	**Rottner**	**Schoklitsch**	**Toffaleti**	**Yang**	**Average**
177	1422	943	2001	2574	5033	430	406	203	6500	460	1483	1950
444	5865	3142	6322	12190	7551	1935	1420	1135	17289	1548	6476	5898
1331	32050	11633	20028	78501	11549	9342	4799	6107	53255	7336	31705	24209
1774	49905	16128	25999	127742	12818	13922	6438	9138	71239	11111	47056	35591

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	**Zeller Fullerton**	**Ackers White**	**Einstein**	**Engelund/Hansen**	**Kalinske**	**Laursen**	**MPM**	**Rottner**	**Schoklitsch**	**Toffaleti**	**Yang**	**Average**
177	2974	1972	4185	5382	10525	899	848	424	13594	962	3102	4079
444	4907	2629	5289	10197	6317	1619	1188	950	14463	1295	5418	4934
1331	8937	3244	5585	21889	3220	2605	1338	1703	14850	2045	8841	6751
1774	10437	3373	5437	26715	2681	2912	1346	1911	14898	2324	9841	7443

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	**Zeller Fullerton**	**Ackers White**	**Einstein**	**Engelund/Hansen**	**Kalinske**	**Laursen**	**MPM**	**Rottner**	**Schoklitsch**	**Toffaleti**	**Yang**	**Average**
177	1119	507	767	2196	878	240	172	261	1489	239	1306	834
444	1424	760	1282	2262	4402	245	252	247	3302	335	1544	1459
1331	7737	3483	5746	14534	7308	1669	1261	1789	11069	1648	9053	5936
1774	12046	5018	7845	23634	8237	2560	1777	2802	14953	2529	13934	8667

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	**Zeller Fullerton**	**Ackers White**	**Einstein**	**Engelund/Hansen**	**Kalinske**	**Laursen**	**MPM**	**Rottner**	**Schoklitsch**	**Toffaleti**	**Yang**	**Average**
177	2341	1059	1605	4593	1836	502	359	546	3114	500	2731	1744
444	1191	636	1072	1892	3683	205	210	207	2762	280	1292	1221
1331	2157	971	1602	4053	2038	466	352	499	3086	460	2524	1655
1774	2519	1050	1641	4943	1723	535	372	586	3127	529	2914	1812

Equilibrium Slope Calculations

Discharge	**Schoklitsch**	**MPM**	**Shields**							**Lane's Tractive Force**		**Average BUREC**	**Bray**	**Henderson**	**BUREC**	**Simplified AMAFCA**	**Average**
Q (cfs)	**SL (ft/ft)**	**SL (ft/ft)**	**R*o**	**U***	**T*o**	**Slo (ft/ft)**	**R*f**	**T*f**	**Slf (ft/ft)**	**Tc (Fig. 4)**	**SL (ft/ft)**	**SL (ft/ft)**	**SL (ft/ft)**	**SL (ft/ft)**	**SL (ft/ft)**	**Ss (ft/ft)**	**SL (ft/ft)**
177	0.0029	0.0044	127	0.39	0.046	0.0009	30	0.035	0.0007	0.0159	0.0009	0.0022	0.0062	0.0004	0.0031	0.0166	0.0063
444	0.0015	0.0025	166	0.51	0.049	0.0006	30	0.036	0.0004	0.0159	0.0005	0.0012	0.0062	0.0002	0.0015	0.0166	0.0061
1331	0.0006	0.0013	231	0.70	0.052	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0006	0.0062	0.0001	0.0007	0.0167	0.0059
1774	0.0005	0.0011	251	0.77	0.053	0.0003	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0062	0.0001	0.0005	0.0167	0.0059

Drop Structures

Design Slope	0.0060	ft/ft
Total Drop Needed	147.3	ft
Height of Drop Structure	3	ft
No . of Drop Structures	50	
Distance between structs.	276	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	2.61	sq. mi
Total Sediment Yield Volume	4.95	ac ft

Sedimentation Basins

Length	276 ft	Depth	3 ft
Width	374 ft	Side slope	3 ft/ft
Total Volume per Basin		6.72	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		3	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	**COT/PC**	**General**	**Antidune**	**Bend**	**Max. Depth**	**Hyd. Depth**	**Avg Vel**	**Se**	**Scour**	**Scour**	**channel**	**Total**
Q (cfs)	**Sinuosity**	**Zgs (ft)**	**Za (ft)**	**Angle (deg)**	**Ymax (ft)**	**Yh (ft)**	**Vm (ft/s)**		**Zbs (ft)**	**Zls (ft)**	**Zlft (ft)**	**Zt (ft)**
177	1.1	-0.5	0.1	24.6	1.6	1.4	3.2	0.0060	0.2	1.5	2.5	5.5
444	1.1	-1.0	0.1	24.6	2.9	0.7	1.9	0.0060	0.3	1.5	2.5	5.6
1331	1.1	-1.1	0.1	24.6	3.5	1.3	3.0	0.0060	0.4	1.5	2.5	5.8
1774	1.1	-1.1	0.2	24.6	3.7	1.5	3.3	0.0060	0.4	1.5	2.5	5.8

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	449	cfs
Stage at Peak Flow	100.5	ft
Flow Volume	62.0	ac. ft

Freeboard

Max. Flow Depth	1.1	ft
Channel Depth as designed	4.0	ft
Available Freeboard	2.9	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	4.95	ac. ft
Outflowing Sediment Volume	0.04	ac. ft
Deposited(+)/Eroded(-) Volume	4.91	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	13819	13819
Side Slope (?H:1V)	3	3
Channel Width (ft)	374	374
Channel XS Area (sq. ft)	1541.8	1541.8
Channel Perimeter (ft)	376	376

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	13819	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	4606	sq. Yd
Volume	13819	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	13819	13819
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4	5
Left Levee Surface Area (sq. Yd)	59882	124371
Left Levee Volume (cu. Yd)	53229	127954
Right Levee Length (ft)	13819	13819
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4	5
Right Levee Surface Area (sq. Yd)	59882	124371
Right Levee Volume (cu. Yd)	53229	127954
Total Levee Surface Area (sq. Yd)	119764	248742
Total Levee Volume (cu. Yd)	106458	255908

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	13819	13819
Left Levee Lining Width (ft)	13	30
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	19961	46063
Left Levee Lining Volume (cu. Yd)	9980	23032
Right Levee Length (ft)	13819	13819
Right Levee Lining Width (ft)	13	30
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	19961	46063
Right Levee Lining Volume (cu. Yd)	9980	23032
Total Lining Area (sq. Yd)	39922	92127
Total Lining Volume (cu. Yd)	19960	46064

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	374	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	5.9	ft
Structure Height	8.9	ft
Number of Structures	50	
Volume per structure	369	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 27,675	
Area per structure	125	sq. Yd
Total Area	6,233	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	3	
Total Volume per Basin	10842	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 43,368	
Other Cost	$ -	
Total cost per basin	$ 43,368	
Area per basin	11,485	sq. Yd
Total Area	34,455	sq. Yd

Structure Cost

Structure Type	Structure Type	Excavation/Construction Quantity	Units	Unit Cost	Cost Subtotal	Landscape Quantity	Units	Unit Cost	Landscape Cost	Maintenance Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	106,458	cu. Yd	$ 7.00	$ 745,206	119,764	sq. Yd	$ 9.00	$ 1,077,876	119,764	sq. Yd	$ 11.67	$ 1,397,247
Levee - LC Enhancement	Fill	149,450	cu. Yd	$ 7.00	$ 1,046,150	128,978	sq. Yd	$ 9.00	$ 1,160,802	149,450	sq. Yd	$ 11.67	$ 1,743,583
Levee Lining	Riprap	19,960	cu. Yd	$ 75.00	$ 1,497,000	39,922	sq. Yd	$ -	$ -	39,922	sq. Yd	$ 20.83	$ 831,699
Levee Lining -LC Enhancement	Riprap	26,104	cu. Yd	$ 75.00	$ 1,957,800	52,205	sq. Yd	$ -	$ -	52,205	sq. Yd	$ 20.83	$ 1,087,606
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	13,819	cu. Yd	$ 75.00	$ 1,036,425	4,606	sq. Yd	$ -	$ -	4,606	sq. Yd	$ 25.00	$ 115,150
Drop Structures	Riprap	50	EA	$ 27,675.00	$ 1,383,750	6,233	sq. Yd	$ -	$ -	6,233	sq. Yd	$ 33.33	$ 207,767
Drop Str. - LC Enhancement	Riprap	50	EA	$ 2,767.50	$ 138,375	623	sq. Yd	$ -	$ -	623	sq. Yd	$ 33.33	$ 20,777
Sedimentation Basins		3	EA	$ 43,368.00	$ 130,104	34,455	sq. Yd	$ -	$ -	34,455	sq. Yd	$ 8.33	$ 287,125
Other					$ -				$ -				$ -

Base Landscape Cost	$ 1,077,876	Base Maintenance Cost	$ 2,838,987
LC Enhancement Cost	$ 1,160,802	LC Enhancement Cost	$ 2,851,966
Total Landscape Cost	$ 2,238,678	Total Maintenance Cost	$ 5,690,954

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 4,792,485	$ 3,142,325	$ 7,934,810
Contingency Cost (25% of Construction Cost)	$ 1,198,121	$ 785,581	$ 1,983,703
Engineering Design Cost (5% of Construction Cost)	$ 239,624	$ 157,116	$ 396,741
Total Construction Cost	$ 6,230,231	$ 4,085,023	$ 10,315,253

Land Cost

Channel Length	13819 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	374	118.6	$100,000	$ 11,860,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	52	16.5	$100,000	$ 1,650,000
Levee LC Enhancement	48	15.2	$100,000	$ 1,520,000
Active fan area set aside for Fan 3	0	142.2	$100,000	$ 14,220,000
Total	474	292.5		$ 29,250,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	277.3	$100,000	$ 27,730,000
LC Enhancement Cost	acre	15.2	$100,000	$ 1,520,000
Total Land Cost	acre	292.5	$100,000	$ 29,250,000

Total Cost

Base Total Cost	$ 37,877,094
Total Landscape Enhancement Cost	$ 9,617,791
Total Cost Including LC Enh.	$ 47,494,885

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

Sub-area: Wagner Wash, Alternative: A
Open Channel Structure ID: C155L10

Open Channel

Structure ID	S17010	HEC1 ID	165170

Longitundal Geometry

Length	1959.3	ft
U/S Elev	1580.6	ft
D/S Elev	1563.1	ft
Initial Channel Slope	0.0089	ft/ft
Long-term Channel Slope	0.0040	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	6

Initial Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	0	3	70	4	3	0	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	12	12	82	82	82	94
Y	104	100	100	100	100	100	100	104

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	0	3	70	4	3	0	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	12	12	82	82	82	94
Y	104	100	100	100	100	100	100	104

Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	S165	S170								TOTAL
HEC1 Peak-Flow	1008	1802								2810
Weighting Factor	1.00	0.28								
Flow into Channel	1008	502								1510

Reach Sediment Inflow Characteristics

U/S Contributing ID										TOTAL
HEC1 Flow Volume (ac. ft)										0
Sediment Conc. (ppm)										
Sediment Volume (ac. ft)										0.00
Weighting Factor										
Weighted Sed. Vol. (ac. ft)										0.00

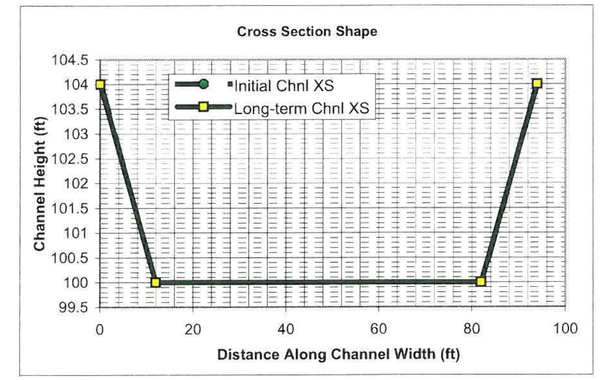
Hydrology

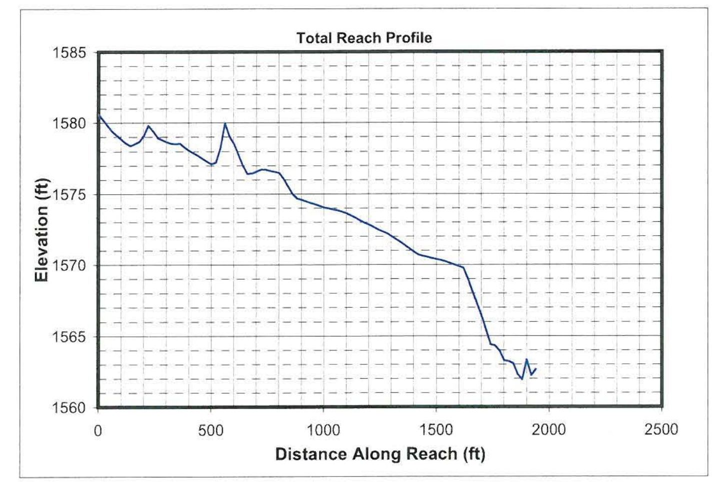
Drainage Area	1.024	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	1510	cfs	
Long-term Max. Chnl Capacity	1566	cfs	
Q2 Channel	151	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	94	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			





Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
151	76.4	73.8	1.0	100.0	101.0	2.0	1.0	76.1	1.0	0.25	0.37
378	81.0	130.9	1.6	100.0	101.7	2.9	1.7	80.4	1.6	0.43	0.40
1133	91.0	265.1	2.9	100.0	103.3	4.3	3.3	89.9	2.9	0.83	0.44
1510	94.8	320.2	3.4	100.0	103.9	4.7	3.9	93.5	3.4	0.98	0.45

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
151	76.4	73.8	1.0	100.0	101.0	2.0	1.0	76.1	1.0	0.25	0.37
378	81.0	130.9	1.6	100.0	101.7	2.9	1.7	80.4	1.6	0.43	0.40
1133	91.0	265.1	2.9	100.0	103.3	4.3	3.3	89.9	2.9	0.83	0.44
1510	94.8	320.2	3.4	100.0	103.9	4.7	3.9	93.5	3.4	0.98	0.45

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
151										0
378										0
1133										0
1510										0

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow) Permissive Velocity (ft/s): Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	BUREC Erosive?	Neill (gravel/cobble) Non-cohesive: Erosive?	Non-cohesive: All'ble Vel (ft/s)	Cohesive: Erosive?	Cohesive: All'ble Vel (ft/s)	USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
151	1.74	1.3861	1.3168	Erosive	Erosive	Erosive	0.3	Stable	3.7	Stable	Stable
378	1.74	1.5456	1.4683	Erosive	Erosive	Erosive	0.4	Stable	5.4	Stable	Stable
1133	1.74	1.7289	1.6425	Erosive	Erosive	Erosive	0.5	Stable	8.2	Stable	Stable
1510	1.74	1.7723	1.6836	Erosive	Erosive	Erosive	0.5	Stable	9.1	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

Discharge (cfs)	Channel Width (ft) 151	378	1133	1510	Flow Depth (ft) 151	378	1133	1510	Velocity (ft/s) 151	378	1133	1510
Bray - Equation #1	33	54	97	113	1.4	1.9	2.8	3.0	3.2	3.6	4.2	4.4
Bray - Equation #2	44	71	127	148	1.6	2.1	3.0	3.3	2.2	2.5	2.9	3.0
Hey	10	17	31	36	4.3	6.1	9.3	10.4				
Ackers & Charlton/Lacey	30	44	69	78					1.8	2.2	2.6	2.7
Parker	84	133	231	267	1.1	1.6	2.6	2.9				
Chang	51	90	176	210	0.2	0.1	-0.2	-0.3				
Kellerhals	22	35	61	70	2.0	2.9	4.5	5.1	3.4	3.7	4.1	4.2
AMAFCA/Schumm	76	81	90	94								
Moody & Odem	12	12	12	12	0.9	0.9	0.9	0.9				
BUREC	18.2	25.6	38.7	43.1	5	7	10	12	2.7	3.4	4.4	4.8
Average	38	56	93	107	2.1	2.8	4.2	4.6	2.7	3.1	3.7	3.8
Values As Designed	76	80	90	94	1.0	1.7	3.3	3.9	2.0	2.9	4.3	4.7
Difference with Design	-38	-24	3	14	1.0	1.1	0.9	0.7	0.6	0.2	-0.6	-0.9

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
151	353	239	458	1803	1715	76	52	72	2259	176	866	734
378	1408	789	1420	8228	2520	406	207	352	5843	646	3496	2301
1133	7189	2890	4548	49224	3979	2081	738	1744	17798	3018	16027	9931
1510	10952	3998	5902	78070	4498	3383	999	2570	23777	4493	23426	14733

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
151	868	587	1124	4430	4214	186	128	177	5551	433	2128	1803
378	1384	776	1395	8086	2477	399	203	346	5742	635	3436	2262
1133	2355	947	1490	16126	1303	682	242	571	5830	989	5250	3253
1510	2691	982	1450	19181	1105	831	246	632	5842	1104	5756	3620

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
151	353	198	267	542	943	51	52	72	602	71	394	322
378	1408	684	1001	2475	1490	256	207	352	1676	284	1682	1047
1133	7189	2581	3283	14808	2480	1232	738	1744	5263	847	8195	4396
1510	10952	3589	4385	23486	2830	1818	999	2570	7058	929	12157	6434

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
151	868	485	655	1333	2316	124	128	177	1480	175	967	792
378	1384	673	984	2433	1464	252	203	346	1647	279	1653	1029
1133	2355	845	1075	4851	812	404	242	571	1724	277	2685	1440
1510	2691	882	1077	5770	695	447	246	632	1734	228	2987	1581

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
151	0.0010	0.0013	173	0.53	0.049	0.0003	30	0.036	0.0002	0.0159	0.0003	0.0007	0.0065	0.0004	0.0012	0.0040	0.0029
378	0.0005	0.0007	223	0.68	0.052	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0004	0.0065	0.0003	0.0006	0.0040	0.0028
1133	0.0003	0.0004	300	0.91	0.054	0.0001	32	0.036	0.0001	0.0159	0.0001	0.0002	0.0065	0.0002	0.0003	0.0039	0.0027
1510	0.0002	0.0004	323	0.98	0.055	0.0001	32	0.036	0.0001	0.0159	0.0001	0.0002	0.0065	0.0001	0.0002	0.0039	0.0027

Drop Structures

Design Slope	0.0040	ft/ft
Total Drop Needed	9.6	ft
Height of Drop Structure	3	ft
No . of Drop Structures	4	
Distance between structs.	490	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	1.02	sq. mi
Total Sediment Yield Volume	1.95	ac ft

Sedimentation Basins

Length	490 ft	Depth	3 ft
Width	94 ft	Side slope	3 ft/ft
Total Volume per Basin		2.82	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		3	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
151	1.1	-0.4	0.1	24.6	1.0	1.0	2.0	0.0040	0.1	1.5	2.5	5.4
378	1.1	-0.5	0.1	24.6	1.7	1.6	2.9	0.0040	0.2	1.5	2.5	5.5
1133	1.1	-0.8	0.3	24.6	3.3	2.9	4.3	0.0040	0.4	1.5	2.5	5.9
1510	1.1	-0.9	0.3	24.6	3.9	3.4	4.7	0.0040	0.5	1.5	2.5	6.0

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	444	cfs
Stage at Peak Flow	100.6	ft
Flow Volume	47.0	ac. ft

Freeboard

Max. Flow Depth	3.9	ft
Channel Depth as designed	4.0	ft
Available Freeboard	0.1	ft
Required Freeboard	1.1	ft

Sediment Volume

Inflowing Sediment Volume	1.95	ac. ft
Outflowing Sediment Volume	0.03	ac. ft
Deposited(+)/Eroded(-) Volume	1.92	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	1959	1959
Side Slope (?H:1V)	3	6
Channel Width (ft)	94	118
Channel XS Area (sq. ft)	328	376
Channel Perimeter (ft)	95	118

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	56595	68451
Excavated Area (sq. Yd)	20461	25685

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	1959	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	327	sq. Yd
Volume	980	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	1959	1959
Left Levee Top Width (ft)	0	0
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	0	0
Left Levee Surface Area (sq. Yd)	0	0
Left Levee Volume (cu. Yd)	0	0
Right Levee Length (ft)	1959	1959
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4	5
Right Levee Surface Area (sq. Yd)	8489	17631
Right Levee Volume (cu. Yd)	7546	18139
Total Levee Surface Area (sq. Yd)	8489	17631
Total Levee Volume (cu. Yd)	7546	18139

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	1959	1959
Left Levee Lining Width (ft)	0	0
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	0	0
Left Levee Lining Volume (cu. Yd)	0	0
Right Levee Length (ft)	1959	1959
Right Levee Lining Width (ft)	13	30
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	2830	6530
Right Levee Lining Volume (cu. Yd)	1415	3265
Total Lining Area (sq. Yd)	2830	6530
Total Lining Volume (cu. Yd)	1415	3265

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	94	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	11.5	ft
Structure Height	14.5	ft
Number of Structures	4	
Volume per structure	152	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 11,400	
Area per structure	31	sq. Yd
Total Area	125	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	3	
Total Volume per Basin	4550	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 18,200	
Other Cost	$ -	
Total cost per basin	$ 18,200	
Area per basin	5,116	sq. Yd
Total Area	15,348	sq. Yd

Structure Type	Structure Cost													
		Excavation/Construction				Landscape				Maintenance				
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	7,546	cu. Yd	$ 7.00	$ 52,822	8,489	sq. Yd	$ 9.00	$ 76,401	8,489	sq. Yd	$ 11.67	$ 99,038
Levee - LC Enhancement	Fill	10,593	cu. Yd	$ 7.00	$ 74,151	9,142	sq. Yd	$ 9.00	$ 82,278	10,593	sq. Yd	$ 11.67	$ 123,585
Levee Lining	Riprap	1,415	cu. Yd	$ 75.00	$ 106,125	2,830	sq. Yd	$ -	$ -	2,830	sq. Yd	$ 20.83	$ 58,951
Levee Lining -LC Enhancement	Riprap	1,850	cu. Yd	$ 75.00	$ 138,750	3,700	sq. Yd	$ -	$ -	3,700	sq. Yd	$ 20.83	$ 77,090
Excavated Channel	Excavated	56,595	cu. Yd	$ 10.00	$ 565,950	20,461	sq. Yd	$ 9.00	$ 184,149	20,461	sq. Yd	$ 8.33	$ 170,508
Exc. Chl - LC Enhancement	Excavated	11,856	cu. Yd	$ 10.00	$ 118,560	5,224	sq. Yd	$ 9.00	$ 47,016	5,224	sq. Yd	$ 8.33	$ 43,533
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	980	cu. Yd	$ 75.00	$ 73,500	327	sq. Yd	$ -	$ -	327	sq. Yd	$ 25.00	$ 8,175
Drop Structures	Riprap	4	EA	$ 11,400.00	$ 45,600	125	sq. Yd	$ -	$ -	125	sq. Yd	$ 33.33	$ 4,167
Drop Str. - LC Enhancement	Riprap	4	EA	$ 1,140.00	$ 4,560	13	sq. Yd	$ -	$ -	13	sq. Yd	$ 33.33	$ 417
Sedimentation Basins		3	EA	$ 18,200.00	$ 54,600	15,348	sq. Yd	$ -	$ -	15,348	sq. Yd	$ 8.33	$ 127,900
Other					$ -				$ -				$ -

Base Landscape Cost	$ 260,550	
LC Enhancement Cost	$ 129,294	
Total Landscape Cost	$ 389,844	

Base Maintenance Cost	$ 468,740
LC Enhancement Cost	$ 244,625
Total Maintenance Cost	$ 713,365

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 898,597	$ 336,021	$ 1,234,618
Contingency Cost (25% of Construction Cost)	$ 224,649	$ 84,005	$ 308,655
Engineering Design Cost (5% of Construction Cost)	$ 44,930	$ 16,801	$ 61,731
Total Construction Cost	$ 1,168,176	$ 436,827	$ 1,605,003

Land Cost

Channel Length	1959 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	120	5.4	$100,000	$ 540,000
LC Enhancement Buffer	50	2.2	$100,000	$ 220,000
Channel	94	4.2	$100,000	$ 420,000
Channel LC Enhancement	24	1.1	$100,000	$ 110,000
Levee	26	1.2	$100,000	$ 120,000
Levee LC Enhancement	24	1.1	$100,000	$ 110,000
Active fan set aside for Fan S165	0	71.9	$100,000	$ 7,190,000
Total	338	87.1		$ 8,710,000

Right of Way

Preservation Corridor Width	120	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	50	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	82.7	$100,000	$ 8,270,000
LC Enhancement Cost	acre	4.4	$100,000	$ 440,000
Total Land Cost	acre	87.1	$100,000	$ 8,710,000

Total Cost

Base Total Cost	$ 10,167,466
Total Landscape Enhancement Cost	$ 1,250,747
Total Cost Including LC Enh.	$ 11,418,212

Open Channel

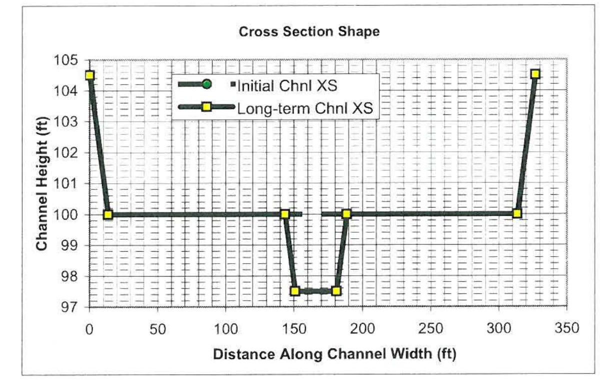
Structure ID	S17020	HEC1 ID	165170

Longitundal Geometry

Length	7473.7	ft
U/S Elev	1563.1	ft
D/S Elev	1462.8	ft
Initial Channel Slope	0.0134	ft/ft
Long-term Channel Slope	0.0050	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	6



Initial Channel XS Geometry

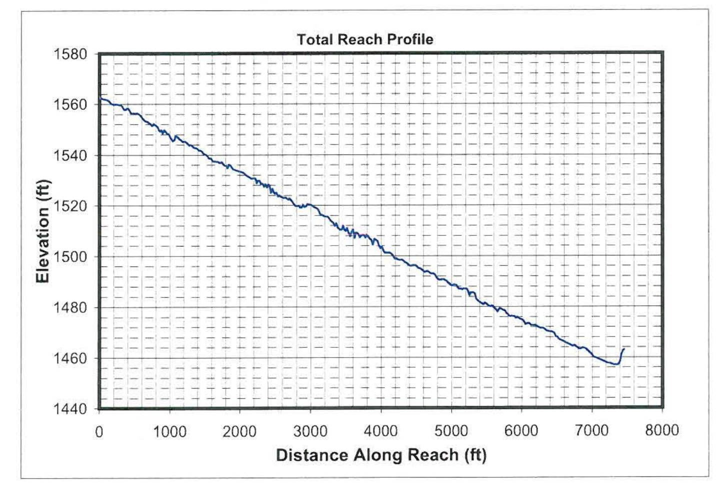
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	300	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	313.5	313.5	313.5	327
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	130	3	30	7	3	125	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	143.5	151	181	188.5	313.5	327
Y	104.5	100	100	97.5	97.5	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	C170									TOTAL
HEC1 Peak-Flow	1792									1792
Weighting Factor	1.00									
Flow into Channel	1792									1792

Reach Sediment Inflow Characteristics

U/S Contributing ID	165170_S17010									TOTAL
HEC1 Flow Volume (ac. ft)	47.00									47
Sediment Conc. (ppm)	1581									
Sediment Volume (ac. ft)	0.03									0.03
Weighting Factor	1									
Weighted Sed. Vol. (ac. ft)	0.03									0.03

Hydrology

Drainage Area	1.887	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	1792	cfs	
Long-term Max. Chnl Capacity	9699	cfs	
Q2 Channel	179	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	327	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
179	302.1	98.6	0.3	100.0	100.3	1.8	0.3	302.0	0.3	0.10	0.56
448	303.6	171.1	0.6	100.0	100.6	2.6	0.6	303.4	0.6	0.18	0.61
1344	306.9	332.3	1.1	100.0	101.1	4.0	1.1	306.6	1.1	0.34	0.68
1792	308.2	395.5	1.3	100.0	101.3	4.5	1.3	307.8	1.3	0.41	0.70

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
179	40.7	59.5	1.5	97.5	99.2	3.0	1.7	40.2	1.5	0.53	0.44
448	303.7	230.1	0.8	97.5	100.5	1.9	3.0	302.7	0.8	0.92	0.39
1344	308.2	447.6	1.5	97.5	101.2	3.0	3.7	307.0	1.5	1.14	0.44
1792	309.9	533.1	1.7	97.5	101.4	3.4	3.9	308.7	1.7	1.23	0.45

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
	165170_S17010									
179	322									322
448	1047									1047
1344	4396									4396
1792	6434									6434

Allowable Velocity

Channel Lining	Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow) Permissive Velocity (ft/s)				BUREC	Neill (gravel/cobble) Non-cohesive		Cohesive		USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
179	1.74	1.0503	0.9978	Erosive	Erosive	Erosive	0.2	Stable	5.8	Stable	Stable
448	1.74	1.2188	1.1578	Erosive	Erosive	Erosive	0.3	Stable	6.9	Stable	Stable
1344	1.74	1.4203	1.3492	Erosive	Erosive	Erosive	0.3	Stable	8.5	Stable	Stable
1792	1.74	1.4728	1.3991	Erosive	Erosive	Erosive	0.3	Stable	9.1	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	**179**	**448**	**1344**	**1792**	**179**	**448**	**1344**	**1792**	**179**	**448**	**1344**	**1792**
Bray - Equation #1	37	59	106	123	1.5	2.0	2.9	3.2	3.3	3.7	4.3	4.5
Bray - Equation #2	48	78	139	162	1.6	2.2	3.2	3.5	2.2	2.6	3.0	3.1
Hey	11	18	34	40	4.6	6.6	10.0	11.1				
Ackers & Charlton/Lacey	32	47	74	84					1.9	2.2	2.7	2.8
Parker	92	145	252	291	1.2	1.7	2.8	3.1				
Chang	61	108	210	250	0.1	0.0	-0.4	-0.6				
Kellerhals	24	38	66	76	2.2	3.1	4.8	5.4	3.4	3.8	4.2	4.3
AMAFCA/Schumm	40	303	307	309								
Moody & Odem	16	16	16	16	1.0	1.0	1.0	1.0				
BUREC	18.6	26.2	39.6	44.1	5	7	11	12	3.0	3.8	5.0	5.4
Average	38	84	124	139	2.2	3.0	4.4	4.8	2.8	3.2	3.8	4.0
Values As Designed	40	303	307	309	1.7	3.0	3.7	3.9	3.0	1.9	3.0	3.4
Difference with Design	-2	-219	-183	-169	0.5	0.0	0.7	0.9	-0.2	1.3	0.8	0.7

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
179	1164	754	1521	2040	4139	311	301	167	4682	349	1221	1514
448	4813	2560	4955	9657	6251	1455	1096	951	12565	1213	5384	4627
1344	26150	9553	15911	62039	9627	7062	3750	5139	38844	5860	26610	19140
1792	40713	13275	20610	100883	10702	10531	5044	7705	51984	8914	39604	28179

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
179	2411	1560	3148	4223	8570	644	623	346	9694	722	2527	3133
448	3985	2120	4104	7997	5177	1205	908	788	10406	1004	4459	3832
1344	7219	2637	4392	17125	2658	1949	1035	1419	10723	1618	7345	5284
1792	8429	2748	4267	20886	2216	2180	1044	1595	10762	1845	8199	5834

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
179	875	413	618	1637	815	175	133	211	1130	183	1036	657
448	1219	647	998	1894	3687	187	196	223	2500	275	1328	1196
1344	6612	2983	4678	12138	6162	1323	1015	1587	8466	1368	7811	4922
1792	10286	4302	6364	19718	6957	2033	1436	2480	11450	2103	12036	7197

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
179	1812	854	1280	3389	1687	363	276	436	2339	380	2146	1360
448	1010	536	827	1569	3053	155	162	184	2070	228	1100	990
1344	1825	824	1291	3351	1701	365	280	438	2337	378	2156	1359
1792	2130	891	1317	4082	1440	421	297	514	2370	435	2492	1490

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
179	0.0026	0.0037	123	0.38	0.046	0.0008	29	0.035	0.0006	0.0159	0.0008	0.0019	0.0062	0.0004	0.0027	0.0134	0.0055
448	0.0013	0.0022	162	0.49	0.049	0.0005	30	0.036	0.0003	0.0159	0.0005	0.0011	0.0062	0.0002	0.0014	0.0134	0.0052
1344	0.0006	0.0011	224	0.68	0.052	0.0003	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0062	0.0001	0.0006	0.0134	0.0051
1792	0.0005	0.0009	244	0.74	0.052	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0004	0.0062	0.0001	0.0005	0.0134	0.0050

Drop Structures

Design Slope	0.0050	ft/ft
Total Drop Needed	63.0	ft
Height of Drop Structure	3	ft
No . of Drop Structures	21	
Distance between structs.	356	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.86	sq. mi
Total Sediment Yield Volume	1.64	ac ft

Sedimentation Basins

Length	356 ft	Depth	3 ft
Width	327 ft	Side slope	3 ft/ft
Total Volume per Basin		7.60	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
179	1.1	-0.5	0.1	24.6	1.7	1.5	3.0	0.0050	0.2	1.5	2.5	5.5
448	1.1	-1.1	0.1	24.6	3.0	0.8	1.9	0.0050	0.3	1.5	2.5	5.6
1344	1.1	-1.1	0.1	24.6	3.7	1.5	3.0	0.0050	0.4	1.5	2.5	5.8
1792	1.1	-1.1	0.2	24.6	3.9	1.7	3.4	0.0050	0.4	1.5	2.5	5.9

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	444	cfs
Stage at Peak Flow	100.6	ft
Flow Volume	47.0	ac. ft

Freeboard

Max. Flow Depth	1.3	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.2	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	1.67	ac. ft
Outflowing Sediment Volume	0.03	ac. ft
Deposited(+)/Eroded(-) Volume	1.64	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	7474	7474
Side Slope (?H:1V)	3	3
Channel Width (ft)	327	327
Channel XS Area (sq. ft)	1504.5	1504.5
Channel Perimeter (ft)	329	329

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	7474	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	2491	sq. Yd
Volume	7474	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	7474	7474
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	34879	72249
Left Levee Volume (cu. Yd)	34325	80830
Right Levee Length (ft)	7474	7474
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	34879	72249
Right Levee Volume (cu. Yd)	34325	80830
Total Levee Surface Area (sq. Yd)	69758	144498
Total Levee Volume (cu. Yd)	68650	161660

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	7474	7474
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	11626	27405
Left Levee Lining Volume (cu. Yd)	5813	13702
Right Levee Length (ft)	7474	7474
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	11626	27405
Right Levee Lining Volume (cu. Yd)	5813	13702
Total Lining Area (sq. Yd)	23252	54809
Total Lining Volume (cu. Yd)	11626	27404

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	327	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	6.4	ft
Structure Height	9.4	ft
Number of Structures	21	
Volume per structure	343	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 25,725	
Area per structure	109	sq. Yd
Total Area	2,289	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	12261	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 49,044	
Other Cost	$ -	
Total cost per basin	$ 49,044	
Area per basin	12,931	sq. Yd
Total Area	12,931	sq. Yd

Structure Cost

Structure Type	Structure Type	Excavation/Construction Quantity	Units	Unit Cost	Cost Subtotal	Landscape Quantity	Units	Unit Cost	Landscape Cost	Maintenance Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	68,650	cu. Yd	$ 7.00	$ 480,550	69,758	sq. Yd	$ 9.00	$ 627,822	69,758	sq. Yd	$ 11.67	$ 813,843
Levee - LC Enhancement	Fill	93,010	cu. Yd	$ 7.00	$ 651,070	74,740	sq. Yd	$ 9.00	$ 672,660	93,010	sq. Yd	$ 11.67	$ 1,085,117
Levee Lining	Riprap	11,626	cu. Yd	$ 75.00	$ 871,950	23,252	sq. Yd	$ -	$ -	23,252	sq. Yd	$ 20.83	$ 484,426
Levee Lining -LC Enhancement	Riprap	15,778	cu. Yd	$ 75.00	$ 1,183,350	31,557	sq. Yd	$ -	$ -	31,557	sq. Yd	$ 20.83	$ 657,435
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	7,474	cu. Yd	$ 75.00	$ 560,550	2,491	sq. Yd	$ -	$ -	2,491	sq. Yd	$ 25.00	$ 62,275
Drop Structures	Riprap	21	EA	$ 25,725.00	$ 540,225	2,289	sq. Yd	$ -	$ -	2,289	sq. Yd	$ 33.33	$ 76,300
Drop Str. - LC Enhancement	Riprap	21	EA	$ 2,572.50	$ 54,023	229	sq. Yd	$ -	$ -	229	sq. Yd	$ 33.33	$ 7,630
Sedimentation Basins		1	EA	$ 49,044.00	$ 49,044	12,931	sq. Yd	$ -	$ -	12,931	sq. Yd	$ 8.33	$ 107,758
Other					$ -				$ -				$ -

Base Landscape Cost	$ 627,822
LC Enhancement Cost	$ 672,660
Total Landscape Cost	$ 1,300,482

Base Maintenance Cost	$ 1,544,603
LC Enhancement Cost	$ 1,750,182
Total Maintenance Cost	$ 3,294,784

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 2,502,319	$ 1,888,443	$ 4,390,762
Contingency Cost (25% of Construction Cost)	$ 625,580	$ 472,111	$ 1,097,690
Engineering Design Cost (5% of Construction Cost)	$ 125,116	$ 94,422	$ 219,538
Total Construction Cost	$ 3,253,015	$ 2,454,975	$ 5,707,990

Land Cost

Channel Length	7474 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	327	56.1	$100,000	$ 5,610,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	9.4	$100,000	$ 940,000
Levee LC Enhancement	51	8.8	$100,000	$ 880,000
Other	0	0	$100,000	$ -
Total	433	74.3		$ 7,430,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

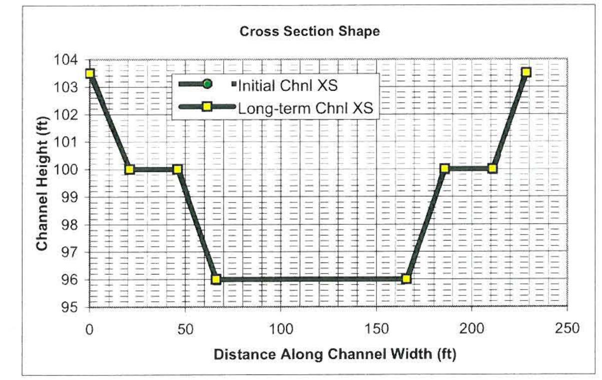
Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	65.5	$100,000	$ 6,550,000
LC Enhancement Cost	acre	8.8	$100,000	$ 880,000
Total Land Cost	acre	74.3	$100,000	$ 7,430,000

Total Cost

Base Total Cost	$ 11,975,439
Total Landscape Enhancement Cost	$ 5,757,817
Total Cost Including LC Enh.	$ 17,733,256

Open Channel

Structure ID	170R10	HEC1 ID	170R



Longitundal Geometry

Length	3986.4	ft
U/S Elev	1462.8	ft
D/S Elev	1408.0	ft
Initial Channel Slope	0.0137	ft/ft
Long-term Channel Slope	0.0134	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	3

Initial Channel XS Geometry

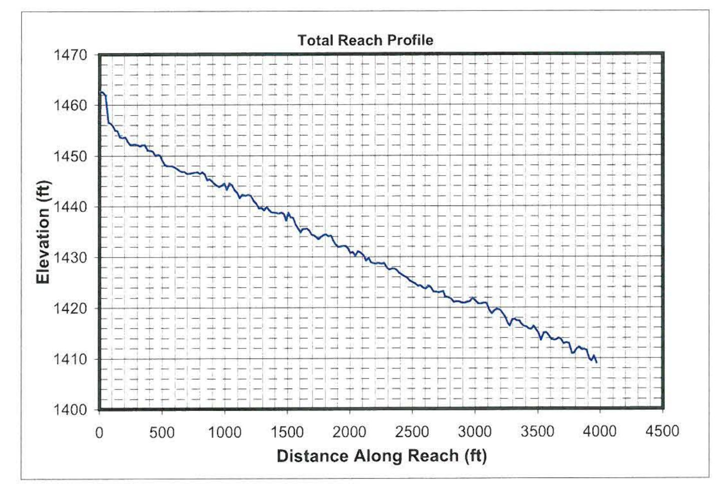
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
6	3.5	25	5	100	7.5	5	25	3.5	5

PT. ID	1	2	3	4	5	6	7	8
X	0	21	46	66	166	186	211	228.5
Y	103.5	100	100	96	96	100	100	103.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
0.045	0.045	0.045							
6	3.5	25	5	100	7.5	5	25	3.5	5

PT. ID	1	2	3	4	5	6	7	8
X	0	21	46	66	166	186	211	228.5
Y	103.5	100	100	96	96	100	100	103.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	C170	S190								TOTAL
HEC1 Peak-Flow	1792	2590								4382
Weighting Factor	1.00	0.07								
Flow into Channel	1792	181								1973

Reach Sediment Inflow Characteristics

U/S Contributing ID	165170_S17020									TOTAL
HEC1 Flow Volume (ac. ft)	47.00									47
Sediment Conc. (ppm)	1490									
Sediment Volume (ac. ft)	0.03									0.03
Weighting Factor	1									
Weighted Sed. Vol. (ac. ft)	0.03									0.03

Hydrology

Drainage Area	2.364	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	1973	cfs	
Long-term Max. Chnl Capacity	14078	cfs	
Q2 Channel	197	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	228.5	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
197	106.8	68.4	0.6	96.0	96.7	2.9	0.7	106.6	0.6	0.55	0.63
493	111.6	120.7	1.1	96.0	97.1	4.1	1.1	111.4	1.1	0.95	0.69
1480	122.2	241.9	2.0	96.0	98.2	6.1	2.2	121.8	2.0	1.82	0.76
1973	126.3	291.3	2.3	96.0	98.6	6.8	2.6	125.8	2.3	2.16	0.78

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
197	106.8	68.9	0.6	96.0	96.7	2.9	0.7	106.7	0.6	0.56	0.63
493	111.7	121.6	1.1	96.0	97.1	4.1	1.1	111.5	1.1	0.96	0.68
1480	122.4	243.8	2.0	96.0	98.2	6.1	2.2	122.0	2.0	1.84	0.76
1973	126.5	293.6	2.3	96.0	98.6	6.7	2.6	126.0	2.3	2.17	0.78

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
	165170_S17020									
197	657									657
493	1196									1196
1480	4922									4922
1973	7197									7197

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
197	1.74	1.2585	1.1956	Erosive	Erosive	Erosive	0.3	Stable	5.2	Stable	Stable
493	1.74	1.4201	1.3491	Erosive	Erosive	Erosive	0.3	Stable	7.5	Stable	Stable
1480	1.74	1.6070	1.5267	Erosive	Erosive	Erosive	0.4	Stable	11.4	Stable	Stable
1973	1.74	1.6544	1.5716	Erosive	Erosive	Erosive	0.4	Stable	12.7	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

Discharge (cfs)	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
	197	493	1480	1973	197	493	1480	1973	197	493	1480	1973
Bray - Equation #1	39	62	111	130	1.5	2.1	3.0	3.3	3.3	3.8	4.4	4.6
Bray - Equation #2	51	82	146	171	1.7	2.3	3.3	3.6	2.3	2.6	3.0	3.1
Hey	12	19	36	42	4.8	6.8	10.3	11.5				
Ackers & Charlton/Lacey	33	49	77	87					1.9	2.3	2.7	2.8
Parker	96	153	264	305	1.2	1.8	2.9	3.2				
Chang	90	156	300	355	-0.3	-0.6	-1.4	-1.6				
Kellerhals	25	40	69	80	2.3	3.2	5.0	5.7	3.5	3.8	4.2	4.4
AMAFCA/Schumm	107	112	122	126								
Moody & Odem	17	17	17	17	1.1	1.1	1.1	1.1				
BUREC	16.0	22.6	34.1	38.0	4	6	9	10	4.5	5.7	7.5	8.0
Average	49	71	118	135	2.1	2.9	4.2	4.6	3.1	3.6	4.4	4.6
Values As Designed	107	111	122	126	0.7	1.1	2.2	2.6	2.9	4.1	6.1	6.7
Difference with Design	-58	-40	-4	9	1.4	1.7	2.0	2.0	0.2	-0.4	-1.7	-2.1

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
197	2471	1219	2286	5170	2435	744	520	499	5784	606	2737	2225
493	9941	3581	5966	23794	3546	2697	1413	1941	14757	2230	10051	7265
1480	51700	12143	16970	144647	5506	11966	4243	8450	44677	9088	43174	32051
1973	79213	16572	22917	230603	6191	19444	5605	12199	59639	9814	62330	47684

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
197	4647	2292	4299	9721	4579	1399	978	938	10877	1140	5147	4183
493	7477	2693	4487	17897	2667	2028	1063	1460	11100	1677	7560	5465
1480	12962	3044	4255	36266	1380	3000	1064	2119	11201	2279	10824	8036
1973	14895	3116	4309	43362	1164	3656	1054	2294	11214	1845	11720	8966

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
197	2387	1184	2214	4962	2408	713	503	483	5568	584	2652	2151
493	9603	3487	5817	22833	3511	2589	1372	1886	14214	2152	9767	7021
1480	49925	11845	16483	138754	5458	11492	4126	8231	43047	8743	42057	30924
1973	76486	16172	22226	221180	6139	18528	5453	11888	57466	9444	60752	45976

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
197	4489	2227	4164	9330	4528	1341	946	908	10469	1099	4987	4044
493	7223	2623	4375	17174	2641	1948	1032	1419	10691	1619	7346	5281
1480	12517	2970	4133	34788	1368	2881	1034	2064	10793	2192	10544	7753
1973	14382	3041	4179	41590	1154	3484	1025	2235	10806	1776	11424	8645

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields								Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)		Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
197	0.0011	0.0019	175	0.53	0.049	0.0004	30	0.036	0.0003		0.0159	0.0004	0.0009	0.0060	0.0003	0.0019	0.0137	0.0052
493	0.0006	0.0011	227	0.69	0.052	0.0003	31	0.036	0.0002		0.0159	0.0002	0.0005	0.0060	0.0002	0.0010	0.0137	0.0051
1480	0.0003	0.0006	307	0.94	0.055	0.0001	32	0.036	0.0001		0.0159	0.0001	0.0003	0.0060	0.0001	0.0004	0.0137	0.0050
1973	0.0002	0.0005	331	1.01	0.056	0.0001	32	0.036	0.0001		0.0159	0.0001	0.0002	0.0060	0.0001	0.0003	0.0137	0.0050

Drop Structures

Design Slope	0.0134	ft/ft
Total Drop Needed	1.3	ft
Height of Drop Structure	3	ft
No . of Drop Structures	1	
Distance between structs.	3986	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.28	sq. mi
Total Sediment Yield Volume	0.54	ac ft

Sedimentation Basins

Length	3986 ft	Depth	3 ft
Width	228.5 ft	Side slope	3 ft/ft
Total Volume per Basin		60.13	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
197	1.1	-0.2	0.1	24.6	0.7	0.6	2.9	0.0134	0.1	1.5	1.0	3.4
493	1.1	-0.3	0.2	24.6	1.1	1.1	4.1	0.0134	0.1	1.5	1.0	3.6
1480	1.1	-0.4	0.5	24.6	2.2	2.0	6.1	0.0134	0.3	1.5	1.0	3.9
1973	1.1	-0.5	0.6	24.6	2.6	2.3	6.7	0.0134	0.3	1.5	1.0	4.1

Toe Protection Needed	5.0	ft

HEC1 Results For Open Channel

Peak Flow	1729	cfs
Stage at Peak Flow	98.4	ft
Flow Volume	123.0	ac. ft

Freeboard

Max. Flow Depth	2.6	ft
Channel Depth as designed	7.5	ft
Available Freeboard	4.9	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	0.57	ac. ft
Outflowing Sediment Volume	0.40	ac. ft
Deposited(+)/Eroded(-) Volume	0.16	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	3986	3986
Side Slope (?H:1V)	3	3
Channel Width (ft)	228.5	228.5
Channel XS Area (sq. ft)	1212.4	1212.4
Channel Perimeter (ft)	230	230

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	3986	ft
Thickness	1.5	ft
Protection Depth	5	ft
Tie-in Length/Depth	3.0	ft
Total Depth	8.0	ft
Area needed	1329	sq. Yd
Volume	3543	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	3986	3986
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	6	6
Left Levee Height (ft)	3.5	4.5
Left Levee Surface Area (sq. Yd)	25245	33217
Left Levee Volume (cu. Yd)	18011	31297
Right Levee Length (ft)	3986	3986
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	5	6
Right Levee Height (ft)	3.5	4.5
Right Levee Surface Area (sq. Yd)	22144	33217
Right Levee Volume (cu. Yd)	16239	31297
Total Levee Surface Area (sq. Yd)	47389	66434
Total Levee Volume (cu. Yd)	34250	62594

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	3986	3986
Left Levee Lining Width (ft)	21	27
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	9301	11958
Left Levee Lining Volume (cu. Yd)	4650	5979
Right Levee Length (ft)	3986	3986
Right Levee Lining Width (ft)	18	27
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	7972	11958
Right Levee Lining Volume (cu. Yd)	3986	5979
Total Lining Area (sq. Yd)	17273	23916
Total Lining Volume (cu. Yd)	8636	11958

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	228.5	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	11.3	ft
Structure Height	14.3	ft
Number of Structures	1	
Volume per structure	364	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 27,300	
Area per structure	76	sq. Yd
Total Area	76	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	97010	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 388,040	
Other Cost	$ -	
Total cost per basin	$ 388,040	
Area per basin	101,211	sq. Yd
Total Area	101,211	sq. Yd

Structure Cost

Structure Type	Excavation/Construction					Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	34,250	cu. Yd	$ 7.00	$ 239,750	47,389	sq. Yd	$ 9.00	$ 426,501	47,389	sq. Yd	$ 11.67	$ 552,872
Levee - LC Enhancement	Fill	28,344	cu. Yd	$ 7.00	$ 198,408	19,045	sq. Yd	$ 9.00	$ 171,405	28,344	sq. Yd	$ 11.67	$ 330,680
Levee Lining	Riprap	8,636	cu. Yd	$ 75.00	$ 647,700	17,273	sq. Yd	$ -	$ -	17,273	sq. Yd	$ 20.83	$ 359,847
Levee Lining -LC Enhancement	Riprap	3,322	cu. Yd	$ 75.00	$ 249,150	6,643	sq. Yd	$ -	$ -	6,643	sq. Yd	$ 20.83	$ 138,403
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	3,543	cu. Yd	$ 75.00	$ 265,725	1,329	sq. Yd	$ -	$ -	1,329	sq. Yd	$ 25.00	$ 33,225
Drop Structures	Riprap	1	EA	$ 27,300.00	$ 27,300	76	sq. Yd	$ -	$ -	76	sq. Yd	$ 33.33	$ 2,533
Drop Str. - LC Enhancement	Riprap	1	EA	$ 2,730.00	$ 2,730	8	sq. Yd	$ -	$ -	8	sq. Yd	$ 33.33	$ 253
Sedimentation Basins		1	EA	$ 388,040.00	$ 388,040	101,211	sq. Yd	$ -	$ -	101,211	sq. Yd	$ 8.33	$ 843,425
Other					$ -				$ -				$ -

Base Landscape Cost	$ 426,501
LC Enhancement Cost	$ 171,405
Total Landscape Cost	$ 597,906

Base Maintenance Cost	$ 1,791,902
LC Enhancement Cost	$ 469,336
Total Maintenance Cost	$ 2,261,238

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,568,515	$ 450,288	$ 2,018,803
Contingency Cost (25% of Construction Cost)	$ 392,129	$ 112,572	$ 504,701
Engineering Design Cost (5% of Construction Cost)	$ 78,426	$ 22,514	$ 100,940
Total Construction Cost	$ 2,039,070	$ 585,374	$ 2,624,444

Land Cost

Channel Length	3986 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	228.5	20.9	$100,000	$ 2,090,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	66.5	6.1	$100,000	$ 610,000
Levee LC Enhancement	27.5	2.5	$100,000	$ 250,000
Other	0	0	$100,000	$ -
Total	322.5	29.5		$ 2,950,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	27	$100,000	$ 2,700,000
LC Enhancement Cost	acre	2.5	$100,000	$ 250,000
Total Land Cost	acre	29.5	$100,000	$ 2,950,000

Total Cost

Base Total Cost	$ 6,957,473
Total Landscape Enhancement Cost	$ 1,476,116
Total Cost Including LC Enh.	$ 8,433,588

Open Channel

Structure ID	RR17510		HEC1 ID	175R

Longitundal Geometry

Length	3035.2	ft
U/S Elev	1462.9	ft
D/S Elev	1413.1	ft
Initial Channel Slope	0.0164	ft/ft
Long-term Channel Slope	0.0060	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	2

Initial Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	280	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	293.5	293.5	293.5	307
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	105	3	30	7.5	3	127	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	118.5	127.5	157.5	166.5	293.5	307
Y	104.5	100	100	97	97	100	100	104.5

Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	S175	S190								TOTAL
HEC1 Peak-Flow	1278	2590								3868
Weighting Factor	1.00	0.05								
Flow into Channel	1278	119								1397

Reach Sediment Inflow Characteristics

U/S Contributing ID	175R_C17510B-A									TOTAL
HEC1 Flow Volume (ac. ft)	112.00									112
Sediment Conc. (ppm)	6367									
Sediment Volume (ac. ft)	0.27									0.27
Weighting Factor	1									
Weighted Sed. Vol. (ac. ft)	0.27									0.27

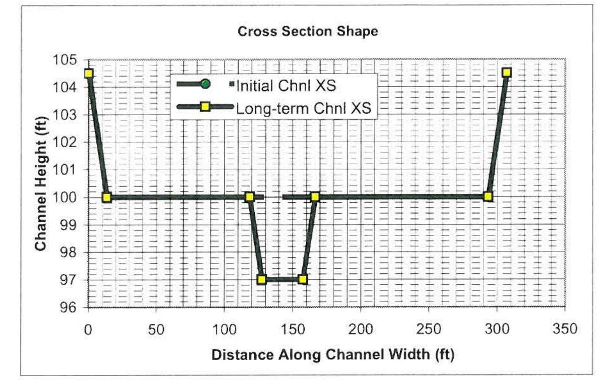
Hydrology

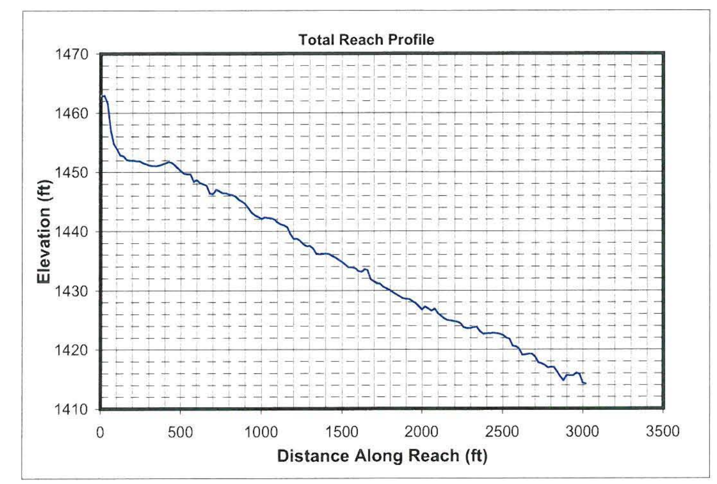
Drainage Area	0.949	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	1397	cfs	
Long-term Max. Chnl Capacity	10268	cfs	
Q2 Channel	140	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	307	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			





Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
140	281.8	77.8	0.3	100.0	100.3	1.8	0.3	281.7	0.3	0.10	0.60
349	283.0	135.0	0.5	100.0	100.5	2.6	0.5	282.9	0.5	0.18	0.66
1048	285.9	261.9	0.9	100.0	100.9	4.0	0.9	285.6	0.9	0.35	0.74
1397	287.0	311.8	1.1	100.0	101.1	4.5	1.1	286.6	1.1	0.41	0.76

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
140	38.8	47.6	1.2	97.0	98.4	2.9	1.4	38.3	1.2	0.52	0.46
349	44.9	87.4	1.9	97.0	99.4	4.0	2.4	44.1	2.0	0.88	0.50
1048	286.3	354.3	1.2	97.0	100.8	3.0	3.8	285.0	1.2	1.44	0.47
1397	287.8	422.0	1.5	97.0	101.1	3.3	4.1	286.5	1.5	1.53	0.48

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
	175R_C17510B-A									
140	1056									1056
349	3408									3408
1048	14848									14848
1397	21933									21933

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow) Permissive Velocity (ft/s) Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	BUREC Erosive?	Neill (gravel/cobble) Non-cohesive Erosive?	All'ble Vel (ft/s)	Cohesive Erosive?	All'ble Vel (ft/s)	USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
140	1.74	0.9987	0.9488	Erosive	Erosive	Erosive	0.2	Stable	5.6	Stable	Stable
349	1.74	1.1674	1.1090	Erosive	Erosive	Erosive	0.2	Stable	7.9	Stable	Stable
1048	1.74	1.3688	1.3004	Erosive	Erosive	Erosive	0.3	Stable	9.3	Stable	Stable
1397	1.74	1.4214	1.3503	Erosive	Erosive	Erosive	0.3	Stable	9.9	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

Discharge (cfs)	Channel Width (ft) 140	349	1048	1397	Flow Depth (ft) 140	349	1048	1397	Velocity (ft/s) 140	349	1048	1397
Bray - Equation #1	32	52	93	108	1.4	1.9	2.7	3.0	3.2	3.6	4.2	4.4
Bray - Equation #2	42	68	122	142	1.5	2.1	3.0	3.2	2.2	2.5	2.9	3.0
Hey	9	16	30	35	4.2	6.0	9.1	10.1				
Ackers & Charlton/Lacey	29	42	67	75					1.8	2.1	2.6	2.7
Parker	81	128	222	257	1.1	1.6	2.5	2.8				
Chang	56	98	191	228	0.1	0.0	-0.4	-0.6				
Kellerhals	21	34	58	67	2.0	2.8	4.4	4.9	3.3	3.7	4.1	4.2
AMAFCA/Schumm	38	44	285	287								
Moody & Odem	12	12	12	12	0.9	0.9	0.9	0.9				
BUREC	16.4	23.1	34.8	38.8	4	6	9	10	3.1	3.9	5.1	5.5
Average	34	52	112	125	1.9	2.7	3.9	4.3	2.7	3.1	3.8	3.9
Values As Designed	38	44	285	286	1.4	2.4	3.8	4.1	2.9	4.0	3.0	3.3
Difference with Design	-5	8	-173	-161	0.5	0.3	0.1	0.3	-0.2	-0.9	0.8	0.6

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
140	1085	721	1525	1950	3962	322	306	152	4974	352	1126	1498
349	4472	2416	4875	9229	5962	1468	1088	863	13264	1182	4947	4524
1048	24391	8970	15535	59351	9147	7104	3700	4675	40901	5594	24310	18516
1397	37980	12447	20150	96537	10160	10590	4969	7007	54720	8473	36110	27195

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
140	2881	1914	4050	5177	10522	854	814	403	13209	934	2990	3977
349	4750	2566	5179	9804	6334	1559	1156	917	14090	1256	5255	4806
1048	8637	3176	5501	21016	3239	2515	1310	1656	14483	1981	8608	6556
1397	10086	3306	5351	25637	2698	2812	1320	1861	14532	2250	9590	7222

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
140	789	379	597	1496	781	171	129	182	1161	170	926	616
349	2986	1119	1616	6431	1223	608	362	680	2987	626	3342	1998
1048	6025	2713	4516	11310	5813	1301	987	1392	8709	1287	7055	4646
1397	9375	3911	6157	18379	6557	1995	1393	2182	11767	1973	10859	6777

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
140	2095	1007	1586	3974	2073	453	344	484	3082	452	2459	1637
349	3172	1189	1716	6832	1299	646	385	722	3173	665	3550	2123
1048	2134	961	1599	4005	2058	461	349	493	3084	456	2498	1645
1397	2490	1039	1635	4881	1741	530	370	579	3125	524	2884	1800

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
140	0.0029	0.0044	125	0.38	0.046	0.0009	29	0.035	0.0007	0.0159	0.0009	0.0022	0.0067	0.0004	0.0031	0.0163	0.0064
349	0.0015	0.0025	165	0.50	0.049	0.0006	30	0.036	0.0004	0.0159	0.0005	0.0012	0.0067	0.0003	0.0016	0.0164	0.0061
1048	0.0007	0.0013	228	0.70	0.052	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0006	0.0067	0.0002	0.0007	0.0164	0.0060
1397	0.0005	0.0011	248	0.76	0.053	0.0003	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0067	0.0001	0.0006	0.0164	0.0059

Drop Structures

Design Slope	0.0060	ft/ft
Total Drop Needed	31.5	ft
Height of Drop Structure	3	ft
No . of Drop Structures	11	
Distance between structs.	276	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.19	sq. mi
Total Sediment Yield Volume	0.36	ac ft

Sedimentation Basins

Length	276 ft	Depth	3 ft
Width	307 ft	Side slope	3 ft/ft
Total Volume per Basin		5.48	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
140	1.1	-0.4	0.1	24.6	1.4	1.2	2.9	0.0060	0.1	1.5	3.0	6.1
349	1.1	-0.6	0.2	24.6	2.4	2.0	4.0	0.0060	0.3	1.5	3.0	6.3
1048	1.1	-1.2	0.1	24.6	3.8	1.2	3.0	0.0060	0.4	1.5	3.0	6.5
1397	1.1	-1.2	0.2	24.6	4.1	1.5	3.3	0.0060	0.4	1.5	3.0	6.5

Toe Protection Needed	7.0	ft

HEC1 Results For Open Channel

Peak Flow	1198	cfs
Stage at Peak Flow	101.0	ft
Flow Volume	112.0	ac. ft

Freeboard

Max. Flow Depth	1.1	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.4	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	0.62	ac. ft
Outflowing Sediment Volume	0.09	ac. ft
Deposited(+)/Eroded(-) Volume	0.53	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	3035	3035
Side Slope (?H:1V)	3	3
Channel Width (ft)	307	307
Channel XS Area (sq. ft)	1437.8	1437.8
Channel Perimeter (ft)	309	309

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	3035	ft
Thickness	1.5	ft
Protection Depth	7	ft
Tie-in Length/Depth	3.0	ft
Total Depth	10.0	ft
Area needed	1012	sq. Yd
Volume	3372	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	3035	3035
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	14163	29338
Left Levee Volume (cu. Yd)	13939	32823
Right Levee Length (ft)	3035	3035
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	14163	29338
Right Levee Volume (cu. Yd)	13939	32823
Total Levee Surface Area (sq. Yd)	28326	58676
Total Levee Volume (cu. Yd)	27878	65646

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	3035	3035
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	4721	11128
Left Levee Lining Volume (cu. Yd)	2361	5564
Right Levee Length (ft)	3035	3035
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	4721	11128
Right Levee Lining Volume (cu. Yd)	2361	5564
Total Lining Area (sq. Yd)	9442	22257
Total Lining Volume (cu. Yd)	4722	11128

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	307	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	5.8	ft
Structure Height	8.8	ft
Number of Structures	11	
Volume per structure	301	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 22,575	
Area per structure	102	sq. Yd
Total Area	1,126	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	8841	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 35,364	
Other Cost	$ -	
Total cost per basin	$ 35,364	
Area per basin	9,412	sq. Yd
Total Area	9,412	sq. Yd

Structure Cost

Structure Type	Structure Type	Excavation/Construction Quantity	Units	Unit Cost	Cost Subtotal	Landscape Quantity	Units	Unit Cost	Landscape Cost	Maintenance Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	27,878	cu. Yd	$ 7.00	$ 195,146	28,326	sq. Yd	$ 9.00	$ 254,934	28,326	sq. Yd	$ 11.67	$ 330,470
Levee - LC Enhancement	Fill	37,768	cu. Yd	$ 7.00	$ 264,376	30,350	sq. Yd	$ 9.00	$ 273,150	37,768	sq. Yd	$ 11.67	$ 440,627
Levee Lining	Riprap	4,722	cu. Yd	$ 75.00	$ 354,150	9,442	sq. Yd	$ -	$ -	9,442	sq. Yd	$ 20.83	$ 196,713
Levee Lining -LC Enhancement	Riprap	6,406	cu. Yd	$ 75.00	$ 480,450	12,814	sq. Yd	$ -	$ -	12,814	sq. Yd	$ 20.83	$ 266,968
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	3,372	cu. Yd	$ 75.00	$ 252,900	1,012	sq. Yd	$ -	$ -	1,012	sq. Yd	$ 25.00	$ 25,300
Drop Structures	Riprap	11	EA	$ 22,575.00	$ 248,325	1,126	sq. Yd	$ -	$ -	1,126	sq. Yd	$ 33.33	$ 37,533
Drop Str. - LC Enhancement	Riprap	11	EA	$ 2,257.50	$ 24,833	113	sq. Yd	$ -	$ -	113	sq. Yd	$ 33.33	$ 3,753
Sedimentation Basins		1	EA	$ 35,364.00	$ 35,364	9,412	sq. Yd	$ -	$ -	9,412	sq. Yd	$ 8.33	$ 78,433
Other					$ -				$ -				$ -

Base Landscape Cost	$ 254,934	Base Maintenance Cost	$ 668,450
LC Enhancement Cost	$ 273,150	LC Enhancement Cost	$ 711,348
Total Landscape Cost	$ 528,084	Total Maintenance Cost	$ 1,379,797

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,085,885	$ 769,659	$ 1,855,544
Contingency Cost (25% of Construction Cost)	$ 271,471	$ 192,415	$ 463,886
Engineering Design Cost (5% of Construction Cost)	$ 54,294	$ 38,483	$ 92,777
Total Construction Cost	$ 1,411,651	$ 1,000,556	$ 2,412,207

Land Cost

Channel Length	3035 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	307	21.4	$100,000	$ 2,140,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	3.8	$100,000	$ 380,000
Levee LC Enhancement	51	3.6	$100,000	$ 360,000
Other	0	0	$100,000	$ -
Total	413	28.8		$ 2,880,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	25.2	$100,000	$ 2,520,000
LC Enhancement Cost	acre	3.6	$100,000	$ 360,000
Total Land Cost	acre	28.8	$100,000	$ 2,880,000

Total Cost

Base Total Cost	$ 4,855,034
Total Landscape Enhancement Cost	$ 2,345,054
Total Cost Including LC Enh.	$ 7,200,088

Open Channel

Structure ID	S18010		HEC1 ID	180R

Longitundal Geometry

Length	5165.4	ft
U/S Elev	1531.6	ft
D/S Elev	1456.3	ft
Initial Channel Slope	0.0146	ft/ft
Long-term Channel Slope	0.0060	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	2

Initial Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	180	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	193.5	193.5	193.5	207
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	75	3	25	6.5	3	68	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	88.5	94.5	119.5	125.5	193.5	207
Y	104.5	100	100	98	98	100	100	104.5

Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

										TOTAL
Contributing HEC1 ID	S180									
HEC1 Peak-Flow	1039									1039
Weighting Factor	1.00									
Flow into Channel	1039									1039

Reach Sediment Inflow Characteristics

U/S Contributing ID										TOTAL
HEC1 Flow Volume (ac. ft)										0
Sediment Conc. (ppm)										
Sediment Volume (ac. ft)										0.00
Weighting Factor										
Weighted Sed. Vol. (ac. ft)										0.00

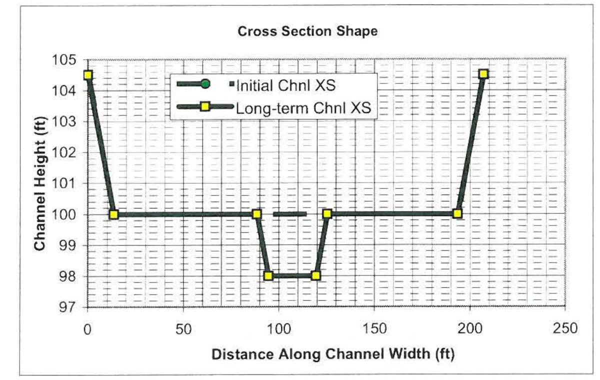
Hydrology

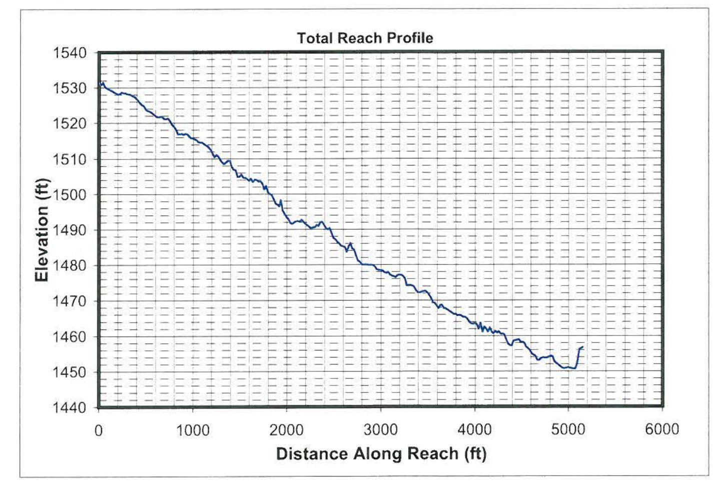
Drainage Area	1.44	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	1039	cfs	
Long-term Max. Chnl Capacity	6482	cfs	
Q2 Channel	104	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	207	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			





Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
104	182.0	56.6	0.3	100.0	100.3	1.8	0.3	181.9	0.3	0.12	0.58
260	183.4	98.4	0.5	100.0	100.5	2.6	0.5	183.2	0.5	0.20	0.64
779	186.6	191.5	1.0	100.0	101.0	4.1	1.0	186.3	1.0	0.39	0.71
1039	187.9	228.2	1.2	100.0	101.2	4.6	1.2	187.5	1.2	0.46	0.73

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
104	33.2	37.4	1.1	98.0	99.3	2.8	1.3	32.8	1.1	0.48	0.46
260	183.0	128.3	0.7	98.0	100.4	2.0	2.4	182.2	0.7	0.89	0.43
779	187.2	250.3	1.3	98.0	101.0	3.1	3.0	186.2	1.3	1.13	0.47
1039	188.8	298.5	1.6	98.0	101.3	3.5	3.3	187.7	1.6	1.23	0.49

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
104										0
260										0
779										0
1039										0

Allowable Velocity

Channel Lining	Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow) Permissive Velocity (ft/s) Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	BUREC Erosive?	Neill (gravel/cobble) Non-cohesive Erosive?	All'ble Vel (ft/s)	Cohesive Erosive?	All'ble Vel (ft/s)	USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
104	1.74	1.0357	0.9839	Erosive	Erosive	Erosive	0.2	Stable	5.3	Stable	Stable
260	1.74	1.2036	1.1434	Erosive	Erosive	Erosive	0.3	Stable	6.7	Stable	Stable
779	1.74	1.4040	1.3338	Erosive	Erosive	Erosive	0.3	Stable	8.4	Stable	Stable
1039	1.74	1.4561	1.3833	Erosive	Erosive	Erosive	0.3	Stable	9.0	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	**104**	**260**	**779**	**1039**	**104**	**260**	**779**	**1039**	**104**	**260**	**779**	**1039**
Bray - Equation #1	28	45	80	93	1.2	1.7	2.4	2.7	3.0	3.4	4.0	4.2
Bray - Equation #2	36	58	104	122	1.4	1.9	2.7	2.9	2.1	2.4	2.8	2.9
Hey	8	13	25	30	3.8	5.3	8.1	9.0				
Ackers & Charlton/Lacey	25	37	59	67					1.7	2.0	2.4	2.6
Parker	70	111	192	221	1.0	1.4	2.2	2.5				
Chang	47	82	160	191	0.1	0.0	-0.3	-0.4				
Kellerhals	18	29	50	58	1.7	2.5	3.9	4.4	3.2	3.6	4.0	4.1
AMAFCA/Schumm	33	182	186	188								
Moody & Odem	14	14	14	14	1.0	1.0	1.0	1.0				
BUREC	14.6	20.7	31.2	34.7	4	6	8	9	2.8	3.6	4.7	5.1
Average	29	59	90	102	1.8	2.4	3.5	3.9	2.6	3.0	3.6	3.8
Values As Designed	33	182	186	188	1.3	2.4	3.0	3.3	2.8	2.0	3.1	3.5
Difference with Design	-3	-123	-96	-86	0.5	0.0	0.5	0.6	-0.2	1.0	0.5	0.3

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
104	741	482	992	1319	2564	209	199	107	3099	227	779	974
260	3058	1620	3171	6234	3863	955	708	601	8270	781	3400	2969
779	16554	5998	10090	39882	5956	4595	2397	3209	25511	3738	16636	12233
1039	25724	8320	13086	64745	6628	6841	3219	4799	34133	5670	24696	17987

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
104	2645	1722	3541	4711	9157	748	712	384	11064	810	2780	3480
260	4368	2314	4529	8904	5518	1364	1012	858	11812	1116	4856	4241
779	7881	2856	4804	18988	2836	2188	1141	1528	12146	1780	7920	5824
1039	9186	2971	4673	23119	2367	2443	1149	1714	12188	2025	8818	6423

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
104	543	270	441	1010	629	117	93	124	856	118	638	440
260	890	477	838	1445	2423	164	162	165	1974	206	986	885
779	4803	2119	3379	9211	4007	1032	754	1116	6520	1020	5605	3597
1039	7459	3036	4643	14933	4520	1571	1054	1732	8793	1563	8575	5262

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
104	1938	966	1574	3605	2247	419	331	443	3057	423	2278	1571
260	1271	681	1197	2064	3461	235	231	235	2819	295	1409	1264
779	2287	1009	1609	4385	1908	492	359	532	3104	486	2669	1712
1039	2663	1084	1658	5332	1614	561	377	618	3140	558	3062	1879

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
104	0.0026	0.0039	125	0.38	0.046	0.0008	30	0.035	0.0006	0.0159	0.0008	0.0020	0.0074	0.0005	0.0029	0.0145	0.0061
260	0.0013	0.0023	165	0.50	0.049	0.0005	30	0.036	0.0003	0.0159	0.0005	0.0011	0.0074	0.0003	0.0015	0.0146	0.0059
779	0.0006	0.0012	228	0.69	0.052	0.0003	31	0.036	0.0002	0.0159	0.0002	0.0006	0.0074	0.0002	0.0006	0.0146	0.0057
1039	0.0005	0.0010	248	0.76	0.053	0.0002	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0074	0.0002	0.0005	0.0146	0.0056

Drop Structures

Design Slope	0.0060	ft/ft
Total Drop Needed	44.3	ft
Height of Drop Structure	3	ft
No . of Drop Structures	15	
Distance between structs.	344	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	1.44	sq. mi
Total Sediment Yield Volume	2.74	ac ft

Sedimentation Basins

Length	344 ft	Depth	3 ft
Width	207 ft	Side slope	3 ft/ft
Total Volume per Basin		4.57	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		2	

Scour and Toe Protection (Not applicable for concrete channel)

Discharge		Pima County General Scour Equations							Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
104	1.1	-0.4	0.1	24.6	1.3	1.1	2.8	0.0060	0.1	1.5	2.0	4.8
260	1.1	-0.8	0.1	24.6	2.4	0.7	2.0	0.0060	0.2	1.5	2.0	4.9
779	1.1	-0.9	0.1	24.6	3.0	1.3	3.1	0.0060	0.3	1.5	2.0	5.1
1039	1.1	-0.9	0.2	24.6	3.3	1.6	3.5	0.0060	0.4	1.5	2.0	5.1

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	775	cfs
Stage at Peak Flow	101.0	ft
Flow Volume	90.0	ac. ft

Freeboard

Max. Flow Depth	1.2	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.3	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	2.74	ac. ft
Outflowing Sediment Volume	0.06	ac. ft
Deposited(+)/Eroded(-) Volume	2.67	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	5165	5165
Side Slope (?H:1V)	3	3
Channel Width (ft)	207	207
Channel XS Area (sq. ft)	932.8	932.8
Channel Perimeter (ft)	209	209

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	5165	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	1722	sq. Yd
Volume	5165	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	5165	5165
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	24103	49928
Left Levee Volume (cu. Yd)	23721	55859
Right Levee Length (ft)	5165	5165
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	24103	49928
Right Levee Volume (cu. Yd)	23721	55859
Total Levee Surface Area (sq. Yd)	48206	99856
Total Levee Volume (cu. Yd)	47442	111718

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	5165	5165
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	8034	18938
Left Levee Lining Volume (cu. Yd)	4017	9469
Right Levee Length (ft)	5165	5165
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	8034	18938
Right Levee Lining Volume (cu. Yd)	4017	9469
Total Lining Area (sq. Yd)	16069	37877
Total Lining Volume (cu. Yd)	8034	18938

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	207	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	6.3	ft
Structure Height	9.3	ft
Number of Structures	15	
Volume per structure	213	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 15,975	
Area per structure	69	sq. Yd
Total Area	1,035	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	2	
Total Volume per Basin	7373	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 29,492	
Other Cost	$ -	
Total cost per basin	$ 29,492	
Area per basin	7,920	sq. Yd
Total Area	15,840	sq. Yd

Structure Cost

Structure Type	Structure Type	Excavation/Construction Quantity	Units	Unit Cost	Cost Subtotal	Landscape Quantity	Units	Unit Cost	Landscape Cost	Maintenance Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	47,442	cu. Yd	$ 7.00	$ 332,094	48,206	sq. Yd	$ 9.00	$ 433,854	48,206	sq. Yd	$ 11.67	$ 562,403
Levee - LC Enhancement	Fill	64,276	cu. Yd	$ 7.00	$ 449,932	51,650	sq. Yd	$ 9.00	$ 464,850	64,276	sq. Yd	$ 11.67	$ 749,887
Levee Lining	Riprap	8,034	cu. Yd	$ 75.00	$ 602,550	16,069	sq. Yd	$ -	$ -	16,069	sq. Yd	$ 20.83	$ 334,769
Levee Lining -LC Enhancement	Riprap	10,904	cu. Yd	$ 75.00	$ 817,800	21,808	sq. Yd	$ -	$ -	21,808	sq. Yd	$ 20.83	$ 454,329
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	5,165	cu. Yd	$ 75.00	$ 387,375	1,722	sq. Yd	$ -	$ -	1,722	sq. Yd	$ 25.00	$ 43,050
Drop Structures	Riprap	15	EA	$ 15,975.00	$ 239,625	1,035	sq. Yd	$ -	$ -	1,035	sq. Yd	$ 33.33	$ 34,500
Drop Str. - LC Enhancement	Riprap	15	EA	$ 1,597.50	$ 23,963	104	sq. Yd	$ -	$ -	104	sq. Yd	$ 33.33	$ 3,450
Sedimentation Basins		2	EA	$ 29,492.00	$ 58,984	15,840	sq. Yd	$ -	$ -	15,840	sq. Yd	$ 8.33	$ 132,000
Other					$ -				$ -				$ -

Base Landscape Cost	$ 433,854
LC Enhancement Cost	$ 464,850
Total Landscape Cost	$ 898,704

Base Maintenance Cost	$ 1,106,722
LC Enhancement Cost	$ 1,207,665
Total Maintenance Cost	$ 2,314,387

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,620,628	$ 1,291,695	$ 2,912,323
Contingency Cost (25% of Construction Cost)	$ 405,157	$ 322,924	$ 728,081
Engineering Design Cost (5% of Construction Cost)	$ 81,031	$ 64,585	$ 145,616
Total Construction Cost	$ 2,106,816	$ 1,679,203	$ 3,786,019

Land Cost

Channel Length	5165 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	207	24.5	$100,000	$ 2,450,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	6.5	$100,000	$ 650,000
Levee LC Enhancement	51	6	$100,000	$ 600,000
Other	0	0	$100,000	$ -
Total	313	37		$ 3,700,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	31	$100,000	$ 3,100,000
LC Enhancement Cost	acre	6	$100,000	$ 600,000
Total Land Cost	acre	37	$100,000	$ 3,700,000

Total Cost

Base Total Cost	$ 6,747,392
Total Landscape Enhancement Cost	$ 3,951,718
Total Cost Including LC Enh.	$ 10,699,110

Open Channel

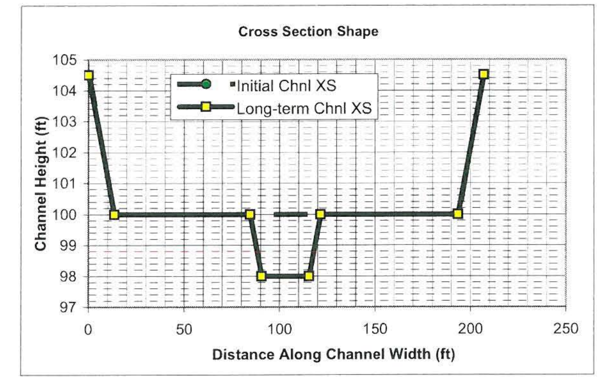
Structure ID	RR18010	HEC1 ID	180R

Longitundal Geometry

Length	2824.7	ft
U/S Elev	1456.3	ft
D/S Elev	1413.1	ft
Initial Channel Slope	0.0153	ft/ft
Long-term Channel Slope	0.0060	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	2



Initial Channel XS Geometry

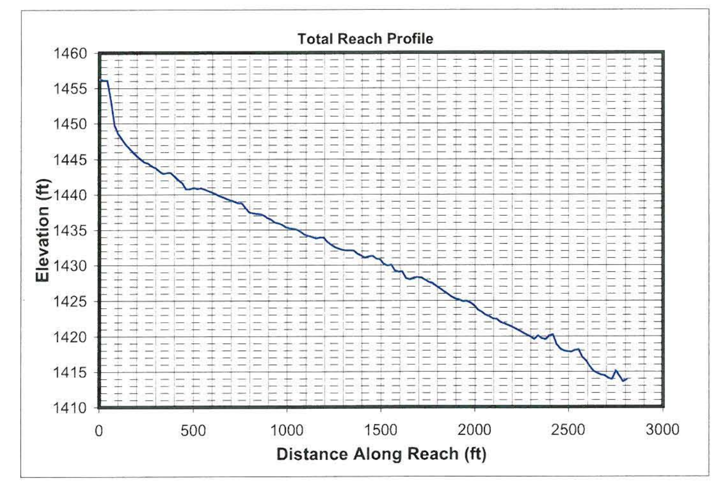
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	180	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	193.5	193.5	193.5	207
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	71	3	25	6.5	3	72	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	84.5	90.5	115.5	121.5	193.5	207
Y	104.5	100	100	98	98	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	S180	S190								TOTAL
HEC1 Peak-Flow	1039	2590								3629
Weighting Factor	1.00	0.03								
Flow into Channel	1039	85								1124

Reach Sediment Inflow Characteristics

U/S Contributing ID	180R_S18010									TOTAL
HEC1 Flow Volume (ac. ft)	90.00									90
Sediment Conc. (ppm)	1879									
Sediment Volume (ac. ft)	0.06									0.06
Weighting Factor	1									
Weighted Sed. Vol. (ac. ft)	0.06									0.06

Hydrology

Drainage Area	1.573	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	1124	cfs	
Long-term Max. Chnl Capacity	6482	cfs	
Q2 Channel	112	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	207	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
112	182.0	58.5	0.3	100.0	100.3	1.9	0.3	181.9	0.3	0.12	0.60
281	183.5	101.7	0.6	100.0	100.6	2.8	0.6	183.4	0.6	0.21	0.65
843	186.8	198.1	1.1	100.0	101.1	4.3	1.1	186.5	1.1	0.40	0.73
1124	188.1	236.0	1.3	100.0	101.3	4.8	1.3	187.7	1.3	0.48	0.75

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
112	33.6	39.4	1.2	98.0	99.4	2.9	1.4	33.1	1.2	0.51	0.46
281	183.2	134.5	0.7	98.0	100.4	2.1	2.4	182.4	0.7	0.90	0.43
843	187.6	262.6	1.4	98.0	101.1	3.2	3.1	186.6	1.4	1.16	0.48
1124	189.3	313.2	1.7	98.0	101.4	3.6	3.4	188.2	1.7	1.26	0.49

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
	180R_S18010									
112	440									440
281	885									885
843	3597									3597
1124	5262									5262

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
112	1.74	1.0458	0.9935	Erosive	Erosive	Erosive	0.2	Stable	5.5	Stable	Stable
281	1.74	1.2137	1.1530	Erosive	Erosive	Erosive	0.3	Stable	6.8	Stable	Stable
843	1.74	1.4140	1.3433	Erosive	Erosive	Erosive	0.3	Stable	8.5	Stable	Stable
1124	1.74	1.4661	1.3928	Erosive	Erosive	Erosive	0.3	Stable	9.2	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	**112**	**281**	**843**	**1124**	**112**	**281**	**843**	**1124**	**112**	**281**	**843**	**1124**
Bray - Equation #1	29	46	83	96	1.3	1.7	2.5	2.8	3.1	3.5	4.1	4.2
Bray - Equation #2	38	61	109	127	1.4	1.9	2.7	3.0	2.1	2.4	2.8	2.9
Hey	8	14	26	31	3.9	5.5	8.3	9.3				
Ackers & Charlton/Lacey	26	38	61	69					1.8	2.1	2.5	2.6
Parker	73	115	199	230	1.0	1.4	2.3	2.6				
Chang	49	86	168	200	0.1	0.0	-0.3	-0.5				
Kellerhals	19	30	52	60	1.8	2.6	4.0	4.5	3.3	3.6	4.0	4.1
AMAFCA/Schumm	33	183	187	188								
Moody & Odem	15	15	15	15	1.0	1.0	1.0	1.0				
BUREC	15.1	21.3	32.1	35.8	4	6	9	10	2.9	3.7	4.8	5.2
Average	30	61	93	105	1.8	2.5	3.6	4.0	2.6	3.0	3.6	3.8
Values As Designed	33	182	187	188	1.4	2.4	3.1	3.4	2.9	2.1	3.2	3.6
Difference with Design	-3	-121	-93	-83	0.5	0.1	0.5	0.7	-0.2	0.9	0.4	0.2

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
112	893	574	1193	1630	2732	268	246	138	3651	270	955	1141
281	3685	1888	3662	7698	4081	1166	831	729	9655	935	4067	3491
843	19938	6898	11367	49229	6254	5534	2752	3785	29673	4477	19567	14498
1124	30986	9547	14802	79909	6952	8231	3684	5636	39683	6789	28950	21379

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
112	2947	1895	3937	5379	9019	885	812	455	12051	891	3151	3766
281	4865	2493	4835	10164	5388	1539	1097	963	12748	1234	5369	4609
843	8775	3036	5003	21665	2752	2435	1211	1666	13059	1970	8612	6380
1124	10228	3151	4886	26376	2295	2717	1216	1860	13098	2241	9556	7057

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
112	609	298	478	1145	655	132	102	140	930	132	716	485
281	1004	535	937	1650	2520	192	185	192	2160	231	1126	976
843	5418	2340	3681	10512	4142	1159	828	1261	7078	1146	6302	3988
1124	8411	3344	5070	17038	4668	1759	1153	1947	9538	1757	9616	5845

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
112	2010	984	1579	3780	2162	435	337	462	3070	437	2362	1602
281	1326	706	1237	2179	3327	254	244	254	2852	305	1486	1288
843	2384	1030	1620	4626	1823	510	364	555	3115	504	2773	1755
1124	2776	1104	1673	5624	1541	581	380	643	3148	580	3174	1929

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
112	0.0025	0.0038	131	0.40	0.047	0.0008	30	0.035	0.0006	0.0159	0.0008	0.0019	0.0072	0.0004	0.0028	0.0152	0.0062
281	0.0013	0.0022	171	0.52	0.049	0.0005	30	0.036	0.0003	0.0159	0.0005	0.0011	0.0072	0.0003	0.0014	0.0153	0.0060
843	0.0006	0.0011	237	0.72	0.052	0.0003	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0072	0.0002	0.0006	0.0153	0.0058
1124	0.0005	0.0010	258	0.79	0.053	0.0002	32	0.036	0.0002	0.0159	0.0002	0.0004	0.0072	0.0002	0.0005	0.0153	0.0058

Drop Structures

Design Slope	0.0060	ft/ft
Total Drop Needed	26.2	ft
Height of Drop Structure	3	ft
No . of Drop Structures	9	
Distance between structs.	314	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.13	sq. mi
Total Sediment Yield Volume	0.25	ac ft

Sedimentation Basins

Length	314 ft	Depth	3 ft
Width	207 ft	Side slope	3 ft/ft
Total Volume per Basin		4.16	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
112	1.1	-0.4	0.1	24.6	1.4	1.2	2.9	0.0060	0.1	1.5	2.0	4.8
281	1.1	-0.8	0.1	24.6	2.4	0.7	2.1	0.0060	0.2	1.5	2.0	4.9
843	1.1	-0.9	0.1	24.6	3.1	1.4	3.2	0.0060	0.3	1.5	2.0	5.1
1124	1.1	-0.9	0.2	24.6	3.4	1.7	3.6	0.0060	0.4	1.5	2.0	5.1

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	775	cfs
Stage at Peak Flow	101.0	ft
Flow Volume	90.0	ac. ft

Freeboard

Max. Flow Depth	1.3	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.2	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	0.32	ac. ft
Outflowing Sediment Volume	0.07	ac. ft
Deposited(+)/Eroded(-) Volume	0.25	ac. ft

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

Sub-area: Wagner Wash, Alternative: A
Open Channel Structure ID: RR18010

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	2825	2825
Side Slope (?H:1V)	3	3
Channel Width (ft)	207	207
Channel XS Area (sq. ft)	932.8	932.8
Channel Perimeter (ft)	209	209

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	2825	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	942	sq. Yd
Volume	2825	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	2825	2825
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	13183	27308
Left Levee Volume (cu. Yd)	12974	30552
Right Levee Length (ft)	2825	2825
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	13183	27308
Right Levee Volume (cu. Yd)	12974	30552
Total Levee Surface Area (sq. Yd)	26366	54616
Total Levee Volume (cu. Yd)	25948	61104

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	2825	2825
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	4394	10358
Left Levee Lining Volume (cu. Yd)	2197	5179
Right Levee Length (ft)	2825	2825
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	4394	10358
Right Levee Lining Volume (cu. Yd)	2197	5179
Total Lining Area (sq. Yd)	8789	20717
Total Lining Volume (cu. Yd)	4394	10358

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	207	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	6.5	ft
Structure Height	9.5	ft
Number of Structures	9	
Volume per structure	219	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 16,425	
Area per structure	69	sq. Yd
Total Area	621	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	6711	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 26,844	
Other Cost	$ -	
Total cost per basin	$ 26,844	
Area per basin	7,219	sq. Yd
Total Area	7,219	sq. Yd

Structure Cost

Structure Type	Structure Type	Excavation/Construction Quantity	Units	Unit Cost	Cost Subtotal	Landscape Quantity	Units	Unit Cost	Landscape Cost	Maintenance Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	25,948	cu. Yd	$ 7.00	$ 181,636	26,366	sq. Yd	$ 9.00	$ 237,294	26,366	sq. Yd	$ 11.67	$ 307,603
Levee - LC Enhancement	Fill	35,156	cu. Yd	$ 7.00	$ 246,092	28,250	sq. Yd	$ 9.00	$ 254,250	35,156	sq. Yd	$ 11.67	$ 410,153
Levee Lining	Riprap	4,394	cu. Yd	$ 75.00	$ 329,550	8,789	sq. Yd	$ -	$ -	8,789	sq. Yd	$ 20.83	$ 183,102
Levee Lining -LC Enhancement	Riprap	5,964	cu. Yd	$ 75.00	$ 447,300	11,928	sq. Yd	$ -	$ -	11,928	sq. Yd	$ 20.83	$ 248,495
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	2,825	cu. Yd	$ 75.00	$ 211,875	942	sq. Yd	$ -	$ -	942	sq. Yd	$ 25.00	$ 23,550
Drop Structures	Riprap	9	EA	$ 16,425.00	$ 147,825	621	sq. Yd	$ -	$ -	621	sq. Yd	$ 33.33	$ 20,700
Drop Str. - LC Enhancement	Riprap	9	EA	$ 1,642.50	$ 14,783	62	sq. Yd	$ -	$ -	62	sq. Yd	$ 33.33	$ 2,070
Sedimentation Basins		1	EA	$ 26,844.00	$ 26,844	7,219	sq. Yd	$ -	$ -	7,219	sq. Yd	$ 8.33	$ 60,158
Other					$ -				$ -				$ -

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 897,730	$ 708,175	$ 1,605,905
Contingency Cost (25% of Construction Cost)	$ 224,433	$ 177,044	$ 401,476
Engineering Design Cost (5% of Construction Cost)	$ 44,887	$ 35,409	$ 80,295
Total Construction Cost	$ 1,167,049	$ 920,627	$ 2,087,676

Base Landscape Cost	$ 237,294
LC Enhancement Cost	$ 254,250
Total Landscape Cost	$ 491,544

Base Maintenance Cost	$ 595,114
LC Enhancement Cost	$ 660,719
Total Maintenance Cost	$ 1,255,832

Land Cost

Channel Length	2825 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	207	13.4	$100,000	$ 1,340,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	3.6	$100,000	$ 360,000
Levee LC Enhancement	51	3.3	$100,000	$ 330,000
Other	0	0	$100,000	$ -
Total	313	20.3		$ 2,030,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	17	$100,000	$ 1,700,000
LC Enhancement Cost	acre	3.3	$100,000	$ 330,000
Total Land Cost	acre	20.3	$100,000	$ 2,030,000

Total Cost

Base Total Cost	$ 3,699,457
Total Landscape Enhancement Cost	$ 2,165,596
Total Cost Including LC Enh.	$ 5,865,052

Open Channel

Structure ID	C180R10		HEC1 ID	RI180R

Longitundal Geometry

Length	3720.6	ft
U/S Elev	1413.1	ft
D/S Elev	1367.6	ft
Initial Channel Slope	0.0122	ft/ft
Long-term Channel Slope	0.0045	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	3

Initial Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	360	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	373.5	373.5	373.5	387
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	159	3	30	7.5	3	153	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	172.5	181.5	211.5	220.5	373.5	387
Y	104.5	100	100	97	97	100	100	104.5

Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	RI180R	S190							TOTAL
HEC1 Peak-Flow	1740	2590							4330
Weighting Factor	1.00	0.05							
Flow into Channel	1740	119							1859

Reach Sediment Inflow Characteristics

U/S Contributing ID	180R_RR18010	175R_RR17510							TOTAL
HEC1 Flow Volume (ac. ft)	90.00	112.00							202
Sediment Conc. (ppm)	1929	2123							
Sediment Volume (ac. ft)	0.07	0.09							0.16
Weighting Factor	1	1							
Weighted Sed. Vol. (ac. ft)	0.07	0.09							0.16

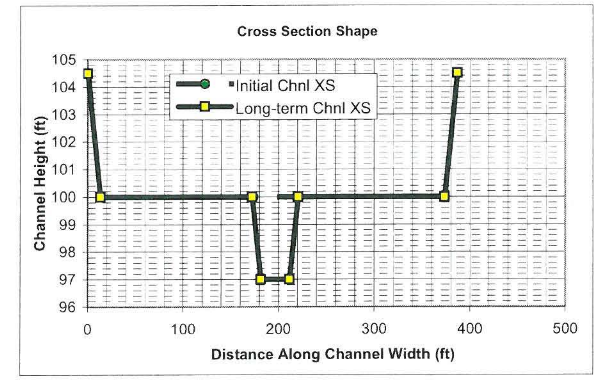
Hydrology

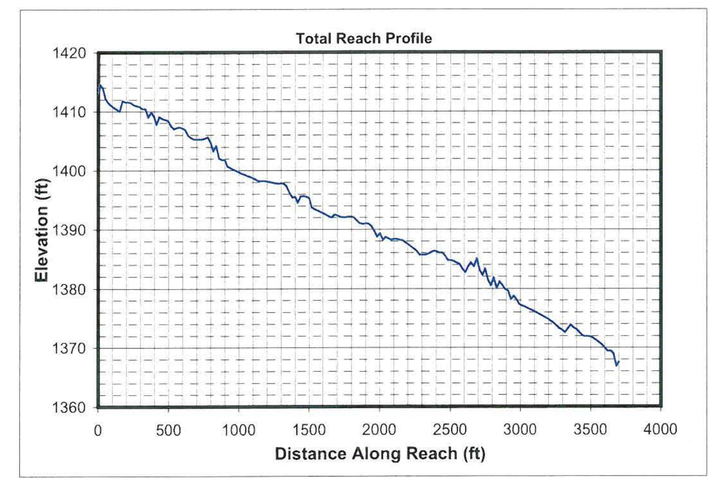
Drainage Area	3.24	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	1859	cfs	
Long-term Max. Chnl Capacity	11071	cfs	
Q2 Channel	186	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	387	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			





JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

Sub-area: Wagner Wash, Alternative: A
Open Channel Structure ID: C180R10

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
186	362.0	111.4	0.3	100.0	100.3	1.7	0.3	361.9	0.3	0.09	0.53
465	363.4	193.3	0.5	100.0	100.5	2.4	0.5	363.2	0.5	0.15	0.58
1394	366.5	375.0	1.0	100.0	101.0	3.7	1.0	366.2	1.0	0.29	0.65
1859	367.8	446.3	1.2	100.0	101.2	4.2	1.2	367.4	1.2	0.34	0.67

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
186	41.3	63.1	1.5	97.0	98.8	2.9	1.8	40.7	1.5	0.50	0.42
465	361.2	127.3	0.4	97.0	100.0	3.6	3.0	360.2	0.4	0.85	1.08
1394	367.8	506.9	1.4	97.0	101.1	2.8	4.1	366.4	1.4	1.14	0.41
1859	369.4	603.4	1.6	97.0	101.3	3.1	4.3	368.0	1.6	1.22	0.42

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)								TOTAL
	180R_RR18010	175R_RR17510							
186	485	616							1102
465	976	1998							2974
1394	3988	4646							8634
1859	5845	6777							12623

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
186	1.74	1.0323	0.9807	Erosive	Erosive	Erosive	0.2	Stable	5.7	Stable	Stable
465	1.74	1.2009	1.1408	Erosive	Erosive	Erosive	0.3	Stable	5.8	Stable	Stable
1394	1.74	1.4028	1.3326	Erosive	Erosive	Erosive	0.3	Stable	8.5	Stable	Stable
1859	1.74	1.4554	1.3827	Erosive	Erosive	Erosive	0.3	Stable	9.0	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	**186**	**465**	**1394**	**1859**	**186**	**465**	**1394**	**1859**	**186**	**465**	**1394**	**1859**
Bray - Equation #1	37	61	108	126	1.5	2.1	3.0	3.3	3.3	3.7	4.4	4.5
Bray - Equation #2	49	79	142	165	1.7	2.3	3.2	3.6	2.3	2.6	3.0	3.1
Hey	11	19	35	41	4.7	6.6	10.1	11.3				
Ackers & Charlton/Lacey	32	47	75	85					1.9	2.2	2.7	2.8
Parker	94	148	257	296	1.2	1.8	2.8	3.1				
Chang	61	106	208	247	0.2	0.0	-0.3	-0.5				
Kellerhals	25	39	67	78	2.2	3.2	4.9	5.5	3.4	3.8	4.2	4.3
AMAFCA/Schumm	41	361	367	368								
Moody & Odem	19	19	19	19	1.1	1.1	1.1	1.1				
BUREC	19.2	27.1	40.9	45.6	5	7	11	12	3.0	3.7	4.9	5.3
Average	39	91	132	147	2.2	3.0	4.5	4.9	2.8	3.2	3.8	4.0
Values As Designed	41	360	366	368	1.8	3.0	4.1	4.3	2.9	3.6	2.8	3.1
Difference with Design	-2	-270	-235	-221	0.4	0.0	0.4	0.6	-0.2	-0.4	1.1	0.9

Initial Channel Sediment Transport Capacity

Discharge (cfs)	Sediment Load (tons/day)											
	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
186	980	639	1159	1640	4373	217	228	120	4063	301	979	1336
465	4056	2278	4559	7768	6726	1179	954	780	11170	1033	4561	4097
1394	22076	8758	15256	49981	10488	5937	3439	4488	34866	4983	23355	16693
1859	34378	12232	19672	81322	11681	8881	4659	6794	46715	7585	35003	24447

Discharge (cfs)	Sediment Concentrations (ppm by weight)											
	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
186	1957	1275	2314	3272	8728	434	456	240	8108	600	1954	2667
465	3238	1818	3639	6201	5369	941	762	622	8917	825	3641	3270
1394	5874	2330	4059	13300	2791	1580	915	1194	9278	1326	6215	4442
1859	6861	2441	3926	16229	2331	1772	930	1356	9323	1514	6986	4879

Long-term Channel Sediment Transport Capacity

Discharge (cfs)	Sediment Load (tons/day)											
	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
186	794	380	564	1450	792	152	119	195	994	164	946	595
465	27557	6490	8808	2145	1806	3809	5877	5020	2076	2999	3066	6332
1394	5491	2601	4154	9593	6571	1046	863	1323	7357	1130	6515	4240
1859	8549	3790	5729	15597	7449	1636	1248	2102	10000	1735	10141	6180

Discharge (cfs)	Sediment Concentrations (ppm by weight)											
	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
186	1584	758	1126	2895	1580	304	238	389	1983	328	1887	1188
465	21998	5181	7031	1712	1442	3041	4692	4007	1657	2394	2448	5055
1394	1461	692	1105	2553	1748	278	230	352	1958	301	1734	1128
1859	1706	756	1143	3113	1487	327	249	420	1996	346	2024	1233

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
186	0.0029	0.0039	114	0.35	0.046	0.0008	29	0.035	0.0006	0.0159	0.0008	0.0021	0.0061	0.0004	0.0030	0.0122	0.0052
465	0.0014	0.0023	150	0.46	0.048	0.0005	30	0.036	0.0004	0.0159	0.0005	0.0011	0.0061	0.0002	0.0015	0.0122	0.0049
1394	0.0006	0.0012	208	0.63	0.051	0.0003	31	0.036	0.0002	0.0159	0.0002	0.0006	0.0061	0.0001	0.0007	0.0122	0.0048
1859	0.0005	0.0010	227	0.69	0.052	0.0002	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0061	0.0001	0.0005	0.0122	0.0047

Drop Structures

Design Slope	0.0045	ft/ft
Total Drop Needed	28.8	ft
Height of Drop Structure	3	ft
No . of Drop Structures	10	
Distance between structs.	372	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	2.88	sq. mi
Total Sediment Yield Volume	5.47	ac ft

Sedimentation Basins

Length	372 ft	Depth	3 ft
Width	387 ft	Side slope	3 ft/ft
Total Volume per Basin		9.45	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		2	

Scour and Toe Protection (Not applicable for concrete channel)

Discharge	COT/PC	Pima County General Scour Equations							Bend	LongTerm	Thalweg	Total
		General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
186	1.1	-0.6	0.1	24.6	1.8	1.5	2.9	0.0045	0.2	1.5	3.0	6.2
465	1.1	1.5	0.2	24.6	3.0	0.4	3.6	0.0045	0.7	1.5	3.0	8.7
1394	1.1	-1.3	0.1	24.6	4.1	1.4	2.8	0.0045	0.4	1.5	3.0	6.5
1859	1.1	-1.3	0.1	24.6	4.3	1.6	3.1	0.0045	0.5	1.5	3.0	6.5

Toe Protection Needed	9.0	ft

HEC1 Results For Open Channel

Peak Flow	1740	cfs
Stage at Peak Flow	101.2	ft
Flow Volume	193.0	ac. ft

Freeboard

Max. Flow Depth	1.2	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.3	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	5.63	ac. ft
Outflowing Sediment Volume	0.37	ac. ft
Deposited(+)/Eroded(-) Volume	5.26	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	3721	3721
Side Slope (?H:1V)	3	3
Channel Width (ft)	387	387
Channel XS Area (sq. ft)	1797.8	1797.8
Channel Perimeter (ft)	389	389

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	3721	ft
Thickness	1.5	ft
Protection Depth	9	ft
Tie-in Length/Depth	3.0	ft
Total Depth	12.0	ft
Area needed	1240	sq. Yd
Volume	4961	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	3721	3721
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	17365	35970
Left Levee Volume (cu. Yd)	17089	40242
Right Levee Length (ft)	3721	3721
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	17365	35970
Right Levee Volume (cu. Yd)	17089	40242
Total Levee Surface Area (sq. Yd)	34730	71940
Total Levee Volume (cu. Yd)	34178	80484

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	3721	3721
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	5788	13644
Left Levee Lining Volume (cu. Yd)	2894	6822
Right Levee Length (ft)	3721	3721
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	5788	13644
Right Levee Lining Volume (cu. Yd)	2894	6822
Total Lining Area (sq. Yd)	11576	27287
Total Lining Volume (cu. Yd)	5788	13644

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	387	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	5.9	ft
Structure Height	8.9	ft
Number of Structures	10	
Volume per structure	384	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 28,800	
Area per structure	129	sq. Yd
Total Area	1,290	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	2	
Total Volume per Basin	15246	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 60,984	
Other Cost	$ -	
Total cost per basin	$ 60,984	
Area per basin	15,999	sq. Yd
Total Area	31,998	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	34,178	cu. Yd	$ 7.00	$ 239,246	34,730	sq. Yd	$ 9.00	$ 312,570	34,730	sq. Yd	$ 11.67	$ 405,183
Levee - LC Enhancement	Fill	46,306	cu. Yd	$ 7.00	$ 324,142	37,210	sq. Yd	$ 9.00	$ 334,890	46,306	sq. Yd	$ 11.67	$ 540,237
Levee Lining	Riprap	5,788	cu. Yd	$ 75.00	$ 434,100	11,576	sq. Yd	$ -	$ -	11,576	sq. Yd	$ 20.83	$ 241,176
Levee Lining -LC Enhancement	Riprap	7,856	cu. Yd	$ 75.00	$ 589,200	15,711	sq. Yd	$ -	$ -	15,711	sq. Yd	$ 20.83	$ 327,310
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	4,961	cu. Yd	$ 75.00	$ 372,075	1,240	sq. Yd	$ -	$ -	1,240	sq. Yd	$ 25.00	$ 31,000
Drop Structures	Riprap	10	EA	$ 28,800.00	$ 288,000	1,290	sq. Yd	$ -	$ -	1,290	sq. Yd	$ 33.33	$ 43,000
Drop Str. - LC Enhancement	Riprap	10	EA	$ 2,880.00	$ 28,800	129	sq. Yd	$ -	$ -	129	sq. Yd	$ 33.33	$ 4,300
Sedimentation Basins		2	EA	$ 60,984.00	$ 121,968	31,998	sq. Yd	$ -	$ -	31,998	sq. Yd	$ 8.33	$ 266,650
Other					$ -				$ -				$ -

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,455,389	$ 942,142	$ 2,397,531
Contingency Cost (25% of Construction Cost)	$ 363,847	$ 235,536	$ 599,383
Engineering Design Cost (5% of Construction Cost)	$ 72,769	$ 47,107	$ 119,877
Total Construction Cost	$ 1,892,006	$ 1,224,785	$ 3,116,790

Base Landscape Cost	$ 312,570	Base Maintenance Cost	$ 987,009
LC Enhancement Cost	$ 334,890	LC Enhancement Cost	$ 871,847
Total Landscape Cost	$ 647,460	Total Maintenance Cost	$ 1,858,856

Land Cost

Channel Length	3721 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	387	33.1	$100,000	$ 3,310,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	4.7	$100,000	$ 470,000
Levee LC Enhancement	51	4.4	$100,000	$ 440,000
Other	0	0	$100,000	$ -
Total	493	42.2		$ 4,220,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	37.8	$100,000	$ 3,780,000
LC Enhancement Cost	acre	4.4	$100,000	$ 440,000
Total Land Cost	acre	42.2	$100,000	$ 4,220,000

Total Cost

Base Total Cost	$ 6,971,585
Total Landscape Enhancement Cost	$ 2,871,521
Total Cost Including LC Enh.	$ 9,843,106

Open Channel

Structure ID	C155L20		HEC1 ID	C155L20

Longitundal Geometry

Length	13137.4	ft
U/S Elev	1673.3	ft
D/S Elev	1459.2	ft
Initial Channel Slope	0.0163	ft/ft
Long-term Channel Slope	0.0060	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	

Initial Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	0	3	350	4	3	0	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	12	12	362	362	362	374
Y	104	100	100	100	100	100	100	104

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	150	3	30	6.5	3	155	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	162	169.5	199.5	207	362	374
Y	104	100	100	97.5	97.5	100	100	104

Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	C155L									TOTAL
HEC1 Peak-Flow	1774									1774
Weighting Factor	1.00									
Flow into Channel	1774									1774

Reach Sediment Inflow Characteristics

U/S Contributing ID										TOTAL
HEC1 Flow Volume (ac. ft)										0
Sediment Conc. (ppm)										
Sediment Volume (ac. ft)										0.00
Weighting Factor										
Weighted Sed. Vol. (ac. ft)										0.00

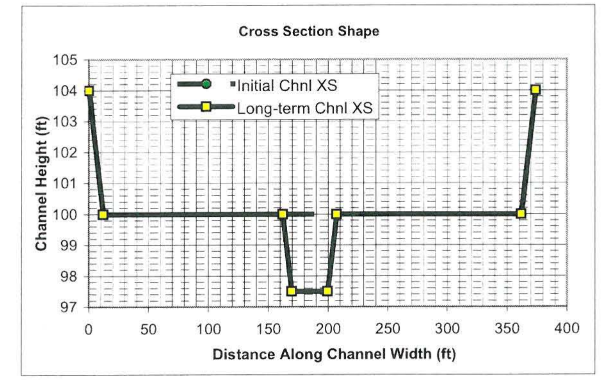
Hydrology

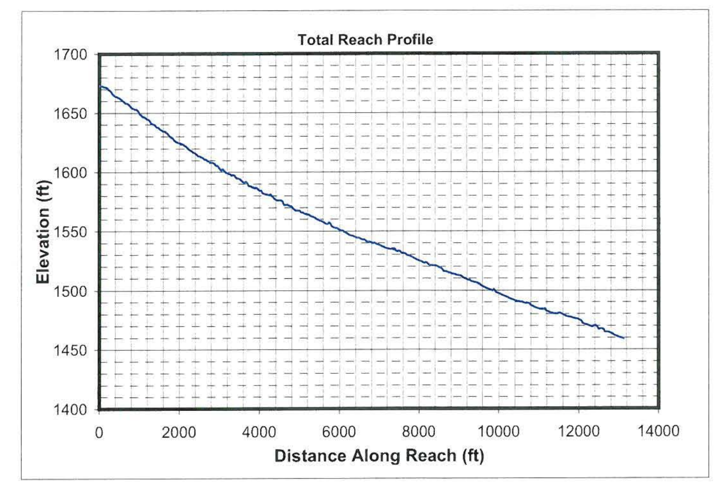
Drainage Area	2.606	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	1774	cfs	
Long-term Max. Chnl Capacity	10128	cfs	
Q2 Channel	177	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	374	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			





Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
177	351.8	98.3	0.3	100.0	100.3	1.8	0.3	351.7	0.3	0.10	0.60
444	353.1	170.6	0.5	100.0	100.5	2.6	0.5	352.9	0.5	0.18	0.66
1331	355.9	330.6	0.9	100.0	100.9	4.0	0.9	355.6	0.9	0.35	0.74
1774	357.0	393.5	1.1	100.0	101.1	4.5	1.1	356.7	1.1	0.42	0.76

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
177	40.1	55.6	1.4	97.5	99.1	3.2	1.6	39.6	1.4	0.60	0.47
444	353.3	230.1	0.7	97.5	100.4	1.9	2.9	352.3	0.7	1.08	0.42
1331	357.1	446.8	1.3	97.5	101.0	3.0	3.5	356.0	1.3	1.31	0.47
1774	358.6	531.9	1.5	97.5	101.2	3.3	3.7	357.4	1.5	1.40	0.48

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
177										0
444										0
1331										0
1774										0

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow) Permissive Velocity (ft/s): Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	BUREC Erosive?	Neill (gravel/cobble) Non-cohesive: Erosive?	All'ble Vel (ft/s)	Cohesive: Erosive?	All'ble Vel (ft/s)	USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
177	1.74	1.0024	0.9523	Erosive	Erosive	Erosive	0.2	Stable	6.1	Stable	Stable
444	1.74	1.1712	1.1127	Erosive	Erosive	Erosive	0.2	Stable	7.3	Stable	Stable
1331	1.74	1.3730	1.3043	Erosive	Erosive	Erosive	0.3	Stable	8.9	Stable	Stable
1774	1.74	1.4257	1.3544	Erosive	Erosive	Erosive	0.3	Stable	9.5	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

Discharge (cfs)	Channel Width (ft) 177	444	1331	1774	Flow Depth (ft) 177	444	1331	1774	Velocity (ft/s) 177	444	1331	1774
Bray - Equation #1	36	59	105	123	1.5	2.0	2.9	3.2	3.3	3.7	4.3	4.5
Bray - Equation #2	48	78	138	161	1.6	2.2	3.2	3.5	2.2	2.5	3.0	3.1
Hey	11	18	34	40	4.6	6.5	9.9	11.1				
Ackers & Charlton/Lacey	32	47	74	83					1.9	2.2	2.7	2.8
Parker	92	145	251	289	1.2	1.7	2.7	3.1				
Chang	65	114	221	263	0.1	-0.1	-0.6	-0.8				
Kellerhals	24	38	66	76	2.2	3.1	4.8	5.4	3.4	3.8	4.2	4.3
AMAFCA/Schumm	40	353	356	358								
Moody & Odem	18	18	18	18	1.1	1.1	1.1	1.1				
BUREC	17.9	25.2	38.1	42.4	5	7	10	11	3.3	4.1	5.4	5.8
Average	38	89	130	145	2.1	2.9	4.3	4.8	2.8	3.3	3.9	4.1
Values As Designed	40	352	356	357	1.6	2.9	3.5	3.7	3.2	1.9	3.0	3.3
Difference with Design	-1	-263	-226	-212	0.5	0.0	0.8	1.0	-0.4	1.3	0.9	0.8

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
177	1378	914	1930	2479	4970	409	389	195	6263	444	1434	1891
444	5684	3059	6150	11744	7471	1860	1375	1100	16693	1497	6290	5720
1331	31058	11355	19566	75624	11440	9004	4669	5947	51461	7105	30897	23466
1774	48363	15752	25382	123059	12701	13421	6268	8908	68846	10766	45891	34487

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
177	2883	1911	4036	5185	10393	856	813	407	13098	929	2999	3955
444	4755	2559	5145	9824	6249	1556	1150	920	13964	1253	5262	4785
1331	8660	3166	5456	21087	3190	2511	1302	1658	14350	1981	8615	6543
1774	10114	3294	5308	25736	2656	2807	1311	1863	14398	2251	9597	7212

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
177	1119	507	767	2196	878	240	172	261	1489	239	1306	834
444	1424	760	1282	2262	4402	245	252	247	3302	335	1544	1459
1331	7737	3483	5746	14534	7308	1669	1261	1789	11069	1648	9053	5936
1774	12046	5018	7845	23634	8237	2560	1777	2802	14953	2529	13934	8667

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
177	2341	1059	1605	4593	1836	502	359	546	3114	500	2731	1744
444	1191	636	1072	1892	3683	205	210	207	2762	280	1292	1221
1331	2157	971	1602	4053	2038	466	352	499	3086	460	2524	1655
1774	2519	1050	1641	4943	1723	535	372	586	3127	529	2914	1812

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
177	0.0029	0.0043	126	0.38	0.046	0.0009	30	0.035	0.0007	0.0159	0.0009	0.0022	0.0062	0.0004	0.0031	0.0162	0.0063
444	0.0015	0.0025	165	0.50	0.049	0.0005	30	0.036	0.0004	0.0159	0.0005	0.0012	0.0062	0.0002	0.0015	0.0163	0.0060
1331	0.0006	0.0013	229	0.70	0.052	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0006	0.0062	0.0001	0.0007	0.0163	0.0058
1774	0.0005	0.0011	249	0.76	0.053	0.0003	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0062	0.0001	0.0005	0.0163	0.0058

Drop Structures

Design Slope	0.0060	ft/ft
Total Drop Needed	135.2	ft
Height of Drop Structure	3	ft
No . of Drop Structures	46	
Distance between structs.	286	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	2.61	sq. mi
Total Sediment Yield Volume	4.95	ac ft

Sedimentation Basins

Length	286 ft	Depth	3 ft
Width	374 ft	Side slope	3 ft/ft
Total Volume per Basin		6.95	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		3	

Scour and Toe Protection (Not applicable for concrete channel)

Discharge	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
177	1.1	-0.5	0.1	24.6	1.6	1.4	3.2	0.0060	0.2	1.5	2.5	5.5
444	1.1	-1.0	0.1	24.6	2.9	0.7	1.9	0.0060	0.3	1.5	2.5	5.6
1331	1.1	-1.1	0.1	24.6	3.5	1.3	3.0	0.0060	0.4	1.5	2.5	5.8
1774	1.1	-1.1	0.2	24.6	3.7	1.5	3.3	0.0060	0.4	1.5	2.5	5.8

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	449	cfs
Stage at Peak Flow	100.5	ft
Flow Volume	62.0	ac. ft

Freeboard

Max. Flow Depth	1.1	ft
Channel Depth as designed	4.0	ft
Available Freeboard	2.9	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	4.95	ac. ft
Outflowing Sediment Volume	0.04	ac. ft
Deposited(+)/Eroded(-) Volume	4.91	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	13137	13137
Side Slope (?H:1V)	3	3
Channel Width (ft)	374	374
Channel XS Area (sq. ft)	1541.8	1541.8
Channel Perimeter (ft)	376	376

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	13137	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	4379	sq. Yd
Volume	13137	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	13137	13137
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4	5
Left Levee Surface Area (sq. Yd)	56927	118233
Left Levee Volume (cu. Yd)	50602	121639
Right Levee Length (ft)	13137	13137
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4	5
Right Levee Surface Area (sq. Yd)	56927	118233
Right Levee Volume (cu. Yd)	50602	121639
Total Levee Surface Area (sq. Yd)	113854	236466
Total Levee Volume (cu. Yd)	101204	243278

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	13137	13137
Left Levee Lining Width (ft)	13	30
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	18976	43790
Left Levee Lining Volume (cu. Yd)	9488	21895
Right Levee Length (ft)	13137	13137
Right Levee Lining Width (ft)	13	30
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	18976	43790
Right Levee Lining Volume (cu. Yd)	9488	21895
Total Lining Area (sq. Yd)	37951	87580
Total Lining Volume (cu. Yd)	18976	43790

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	374	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	5.9	ft
Structure Height	8.9	ft
Number of Structures	46	
Volume per structure	369	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 27,675	
Area per structure	125	sq. Yd
Total Area	5,735	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	3	
Total Volume per Basin	11213	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 44,852	
Other Cost	$ -	
Total cost per basin	$ 44,852	
Area per basin	11,868	sq. Yd
Total Area	35,604	sq. Yd

Structure Cost

Structure Type	Structure Type	Excavation/Construction Quantity	Units	Unit Cost	Cost Subtotal	Landscape Quantity	Units	Unit Cost	Landscape Cost	Maintenance Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	101,204	cu. Yd	$ 7.00	$ 708,428	113,854	sq. Yd	$ 9.00	$ 1,024,686	113,854	sq. Yd	$ 11.67	$ 1,328,297
Levee - LC Enhancement	Fill	142,074	cu. Yd	$ 7.00	$ 994,518	122,612	sq. Yd	$ 9.00	$ 1,103,508	142,074	sq. Yd	$ 11.67	$ 1,657,530
Levee Lining	Riprap	18,976	cu. Yd	$ 75.00	$ 1,423,200	37,951	sq. Yd	$ -	$ -	37,951	sq. Yd	$ 20.83	$ 790,653
Levee Lining -LC Enhancement	Riprap	24,814	cu. Yd	$ 75.00	$ 1,861,050	49,629	sq. Yd	$ -	$ -	49,629	sq. Yd	$ 20.83	$ 1,033,931
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	13,137	cu. Yd	$ 75.00	$ 985,275	4,379	sq. Yd	$ -	$ -	4,379	sq. Yd	$ 25.00	$ 109,475
Drop Structures	Riprap	46	EA	$ 27,675.00	$ 1,273,050	5,735	sq. Yd	$ -	$ -	5,735	sq. Yd	$ 33.33	$ 191,167
Drop Str. - LC Enhancement	Riprap	46	EA	$ 2,767.50	$ 127,305	574	sq. Yd	$ -	$ -	574	sq. Yd	$ 33.33	$ 19,117
Sedimentation Basins		3	EA	$ 44,852.00	$ 134,556	35,604	sq. Yd	$ -	$ -	35,604	sq. Yd	$ 8.33	$ 296,700
Other					$ -				$ -				$ -

Landscape		Maintenance	
Base Landscape Cost	$ 1,024,686	Base Maintenance Cost	$ 2,716,291
LC Enhancement Cost	$ 1,103,508	LC Enhancement Cost	$ 2,710,577
Total Landscape Cost	$ 2,128,194	Total Maintenance Cost	$ 5,426,868

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 4,524,509	$ 2,982,873	$ 7,507,382
Contingency Cost (25% of Construction Cost)	$ 1,131,127	$ 745,718	$ 1,876,846
Engineering Design Cost (5% of Construction Cost)	$ 226,225	$ 149,144	$ 375,369
Total Construction Cost	$ 5,881,862	$ 3,877,735	$ 9,759,597

Land Cost

Channel Length	13137 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	374	112.8	$100,000	$ 11,280,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	52	15.7	$100,000	$ 1,570,000
Levee LC Enhancement	48	14.5	$100,000	$ 1,450,000
Other	0	0	$100,000	$ -
Total	474	143		$ 14,300,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	128.5	$100,000	$ 12,850,000
LC Enhancement Cost	acre	14.5	$100,000	$ 1,450,000
Total Land Cost	acre	143	$100,000	$ 14,300,000

Total Cost

Base Total Cost	$ 22,472,839
Total Landscape Enhancement Cost	$ 9,141,820
Total Cost Including LC Enh.	$ 31,614,659

Open Channel

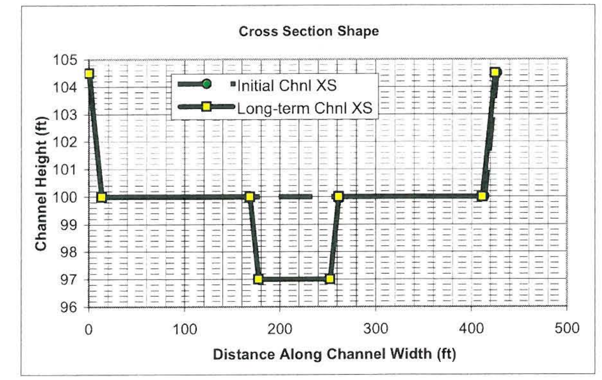
Structure ID	C17510B-A		HEC1 ID	C17510B-A

Longitundal Geometry

Length	2439.2	ft
U/S Elev	1490.2	ft
D/S Elev	1462.9	ft
Initial Channel Slope	0.0112	ft/ft
Long-term Channel Slope	0.0112	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	



Initial Channel XS Geometry

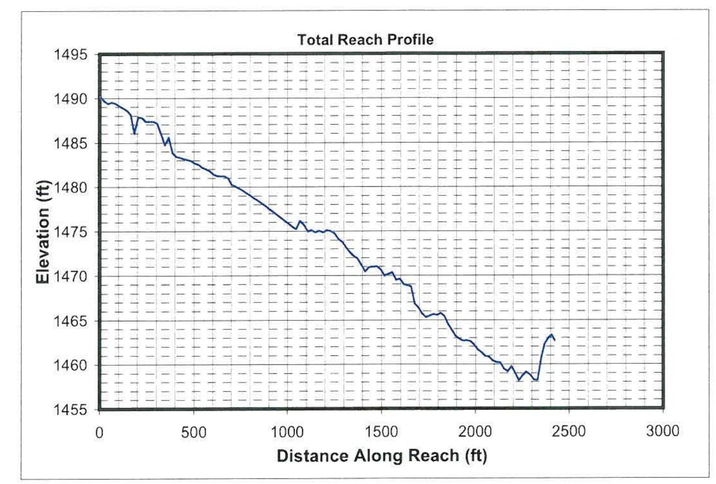
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	400	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	413.5	413.5	413.5	427
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	155	3	75	7.5	3	150	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	168.5	177.5	252.5	261.5	411.5	425
Y	104.5	100	100	97	97	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

										TOTAL
Contributing HEC1 ID	S175									
HEC1 Peak-Flow	1278									1278
Weighting Factor	1.00									
Flow into Channel	1278									1278

Reach Sediment Inflow Characteristics

U/S Contributing ID										TOTAL
HEC1 Flow Volume (ac. ft)										0
Sediment Conc. (ppm)										
Sediment Volume (ac. ft)										0.00
Weighting Factor										
Weighted Sed. Vol. (ac. ft)										0.00

Hydrology

Drainage Area	0.771	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	1278	cfs	
Long-term Max. Chnl Capacity	21330	cfs	
Q2 Channel	128	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	425	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

Sub-area: Wagner Wash, Alternative: A
Open Channel Structure ID: C17510B-A

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
128	401.5	95.2	0.2	100.0	100.2	1.3	0.2	401.4	0.2	0.17	0.49
320	402.6	165.1	0.4	100.0	100.4	1.9	0.4	402.5	0.4	0.29	0.53
959	405.0	319.7	0.8	100.0	100.8	3.0	0.8	404.8	0.8	0.56	0.59
1278	406.0	380.3	0.9	100.0	100.9	3.4	0.9	405.7	0.9	0.66	0.61

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
128	79.1	49.7	0.6	97.0	97.6	2.6	0.6	78.9	0.6	0.45	0.57
320	82.1	87.4	1.1	97.0	98.1	3.7	1.1	81.7	1.1	0.78	0.62
959	88.5	174.2	2.0	97.0	99.1	5.5	2.1	87.8	2.0	1.49	0.69
1278	91.0	209.3	2.3	97.0	99.5	6.1	2.5	90.2	2.3	1.77	0.71

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
128										0
320										0
959										0
1278										0

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuosity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
128	1.74	0.9517	0.9041	Erosive	Erosive	Erosive	0.2	Stable	4.7	Stable	Stable
320	1.74	1.1207	1.0647	Erosive	Erosive	Erosive	0.2	Stable	6.7	Stable	Stable
959	1.74	1.3227	1.2566	Erosive	Erosive	Erosive	0.3	Stable	10.3	Stable	Stable
1278	1.74	1.3756	1.3068	Erosive	Erosive	Erosive	0.3	Stable	11.5	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	**128**	**320**	**959**	**1278**	**128**	**320**	**959**	**1278**	**128**	**320**	**959**	**1278**
Bray - Equation #1	31	50	89	103	1.3	1.8	2.6	2.9	3.1	3.5	4.1	4.3
Bray - Equation #2	40	65	116	136	1.5	2.0	2.9	3.2	2.1	2.4	2.8	3.0
Hey	9	15	28	33	4.1	5.8	8.8	9.8				
Ackers & Charlton/Lacey	28	41	64	73					1.8	2.1	2.5	2.6
Parker	78	123	213	246	1.0	1.5	2.4	2.7				
Chang	66	114	220	261	-0.1	-0.3	-0.9	-1.1				
Kellerhals	20	32	56	64	1.9	2.7	4.2	4.8	3.3	3.6	4.1	4.2
AMAFCA/Schumm	79	82	88	90								
Moody & Odem	11	11	11	11	0.9	0.9	0.9	0.9				
BUREC	14.1	19.9	30.0	33.4	4	5	8	9	3.8	4.8	6.3	6.7
Average	38	55	92	105	1.8	2.5	3.6	4.0	2.8	3.3	4.0	4.2
Values As Designed	79	82	88	90	0.6	1.1	2.1	2.5	2.6	3.7	5.5	6.1
Difference with Design	-41	-26	4	15	1.2	1.3	1.5	1.5	0.3	-0.4	-1.5	-1.9

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
128	461	285	427	701	3542	24	56	28	2127	162	365	743
320	1901	1183	2274	3320	5740	486	459	303	6426	521	2054	2243
959	10407	4979	8809	21411	9287	2876	2004	2167	20759	2438	11649	8799
1278	16214	7054	12161	34860	10412	4360	2779	3382	27926	3699	17774	12784

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
128	1338	827	1241	2034	10281	70	162	82	6173	469	1059	2158
320	2207	1374	2641	3855	6666	564	533	352	7462	605	2385	2604
959	4028	1927	3410	8288	3595	1113	776	839	8035	944	4509	3406
1278	4707	2048	3530	10120	3023	1266	807	982	8107	1074	5160	3711

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
128	1119	599	1136	2179	1547	314	245	225	2711	274	1268	1056
320	4514	1818	3108	10088	2276	1184	703	934	6990	1016	4851	3408
959	23609	6307	8661	62022	3536	5316	2166	4233	21259	4622	21593	14848
1278	36241	8642	11502	99255	3969	7832	2870	6154	28396	4985	31418	21933

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
128	3249	1738	3297	6324	4492	912	711	652	7869	796	3681	3065
320	5242	2112	3610	11714	2643	1375	816	1084	8116	1180	5633	3957
959	9138	2441	3352	24006	1369	2058	838	1638	8229	1789	8358	5747
1278	10521	2509	3339	28813	1152	2273	833	1786	8243	1447	9121	6367

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
128	0.0041	0.0051	96	0.29	0.044	0.0010	29	0.035	0.0008	0.0159	0.0011	0.0028	0.0069	0.0004	0.0043	0.0112	0.0053
320	0.0021	0.0030	126	0.39	0.046	0.0006	30	0.035	0.0005	0.0159	0.0006	0.0015	0.0069	0.0003	0.0022	0.0112	0.0050
959	0.0009	0.0015	175	0.53	0.049	0.0003	30	0.036	0.0002	0.0159	0.0003	0.0008	0.0069	0.0002	0.0009	0.0112	0.0048
1278	0.0007	0.0013	191	0.58	0.050	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0006	0.0069	0.0001	0.0008	0.0112	0.0047

Drop Structures

Design Slope	0.0112	ft/ft
Total Drop Needed	0.1	ft
Height of Drop Structure	3	ft
No . of Drop Structures	1	
Distance between structs.	2439	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.77	sq. mi
Total Sediment Yield Volume	1.46	ac ft

Sedimentation Basins

Length	2439 ft	Depth	3 ft
Width	427 ft	Side slope	3 ft/ft
Total Volume per Basin		69.96	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
128	1.1	-0.2	0.1	24.6	0.6	0.6	2.6	0.0112	0.1	1.5	1.0	3.4
320	1.1	-0.3	0.2	24.6	1.1	1.1	3.7	0.0112	0.1	1.5	1.0	3.5
959	1.1	-0.5	0.4	24.6	2.1	2.0	5.5	0.0112	0.3	1.5	1.0	3.9
1278	1.1	-0.5	0.5	24.6	2.5	2.3	6.1	0.0112	0.3	1.5	1.0	4.0

Toe Protection Needed	4.0	ft

HEC1 Results For Open Channel

Peak Flow	1198	cfs
Stage at Peak Flow	101.0	ft
Flow Volume	112.0	ac. ft

Freeboard

Max. Flow Depth	0.9	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.6	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	1.46	ac. ft
Outflowing Sediment Volume	0.27	ac. ft
Deposited(+)/Eroded(-) Volume	1.20	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	2439	2439
Side Slope (?H:1V)	3	3
Channel Width (ft)	425	425
Channel XS Area (sq. ft)	2103.8	2103.8
Channel Perimeter (ft)	427	427

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	2439	ft
Thickness	1.5	ft
Protection Depth	4	ft
Tie-in Length/Depth	3.0	ft
Total Depth	7.0	ft
Area needed	813	sq. Yd
Volume	1897	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	2439	2439
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	11382	23577
Left Levee Volume (cu. Yd)	11201	26377
Right Levee Length (ft)	2439	2439
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	11382	23577
Right Levee Volume (cu. Yd)	11201	26377
Total Levee Surface Area (sq. Yd)	22764	47154
Total Levee Volume (cu. Yd)	22402	52754

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	2439	2439
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	3794	8943
Left Levee Lining Volume (cu. Yd)	1897	4472
Right Levee Length (ft)	2439	2439
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	3794	8943
Right Levee Lining Volume (cu. Yd)	1897	4472
Total Lining Area (sq. Yd)	7588	17886
Total Lining Volume (cu. Yd)	3794	8944

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	425	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	10.7	ft
Structure Height	13.7	ft
Number of Structures	1	
Volume per structure	647	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 48,525	
Area per structure	142	sq. Yd
Total Area	142	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	112869	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 451,476	
Other Cost	$ -	
Total cost per basin	$ 451,476	
Area per basin	115,729	sq. Yd
Total Area	115,729	sq. Yd

Structure Cost

Structure Type	Structure Type	Excavation/Construction Quantity	Units	Unit Cost	Cost Subtotal	Landscape Quantity	Units	Unit Cost	Landscape Cost	Maintenance Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	22,402	cu. Yd	$ 7.00	$ 156,814	22,764	sq. Yd	$ 9.00	$ 204,876	22,764	sq. Yd	$ 11.67	$ 265,580
Levee - LC Enhancement	Fill	30,352	cu. Yd	$ 7.00	$ 212,464	24,390	sq. Yd	$ 9.00	$ 219,510	30,352	sq. Yd	$ 11.67	$ 354,107
Levee Lining	Riprap	3,794	cu. Yd	$ 75.00	$ 284,550	7,588	sq. Yd	$ -	$ -	7,588	sq. Yd	$ 20.83	$ 158,083
Levee Lining -LC Enhancement	Riprap	5,150	cu. Yd	$ 75.00	$ 386,250	10,298	sq. Yd	$ -	$ -	10,298	sq. Yd	$ 20.83	$ 214,542
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	1,897	cu. Yd	$ 75.00	$ 142,275	813	sq. Yd	$ -	$ -	813	sq. Yd	$ 25.00	$ 20,325
Drop Structures	Riprap	1	EA	$ 48,525.00	$ 48,525	142	sq. Yd	$ -	$ -	142	sq. Yd	$ 33.33	$ 4,733
Drop Str. - LC Enhancement	Riprap	1	EA	$ 4,852.50	$ 4,853	14	sq. Yd	$ -	$ -	14	sq. Yd	$ 33.33	$ 473
Sedimentation Basins		1	EA	$ 451,476.00	$ 451,476	115,729	sq. Yd	$ -	$ -	115,729	sq. Yd	$ 8.33	$ 964,408
Other					$ -				$ -				$ -

Base Landscape Cost	$ 204,876	
LC Enhancement Cost	$ 219,510	
Total Landscape Cost	$ 424,386	

Base Maintenance Cost	$ 1,413,130
LC Enhancement Cost	$ 569,122
Total Maintenance Cost	$ 1,982,252

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,083,640	$ 603,567	$ 1,687,207
Contingency Cost (25% of Construction Cost)	$ 270,910	$ 150,892	$ 421,802
Engineering Design Cost (5% of Construction Cost)	$ 54,182	$ 30,178	$ 84,360
Total Construction Cost	$ 1,408,732	$ 784,636	$ 2,193,368

Land Cost

Channel Length	2439 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	425	23.8	$100,000	$ 2,380,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	3.1	$100,000	$ 310,000
Levee LC Enhancement	51	2.9	$100,000	$ 290,000
Other	0	0	$100,000	$ -
Total	531	29.8		$ 2,980,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	26.9	$100,000	$ 2,690,000
LC Enhancement Cost	acre	2.9	$100,000	$ 290,000
Total Land Cost	acre	29.8	$100,000	$ 2,980,000

Total Cost

Base Total Cost	$ 5,716,738
Total Landscape Enhancement Cost	$ 1,863,268
Total Cost Including LC Enh.	$ 7,580,006

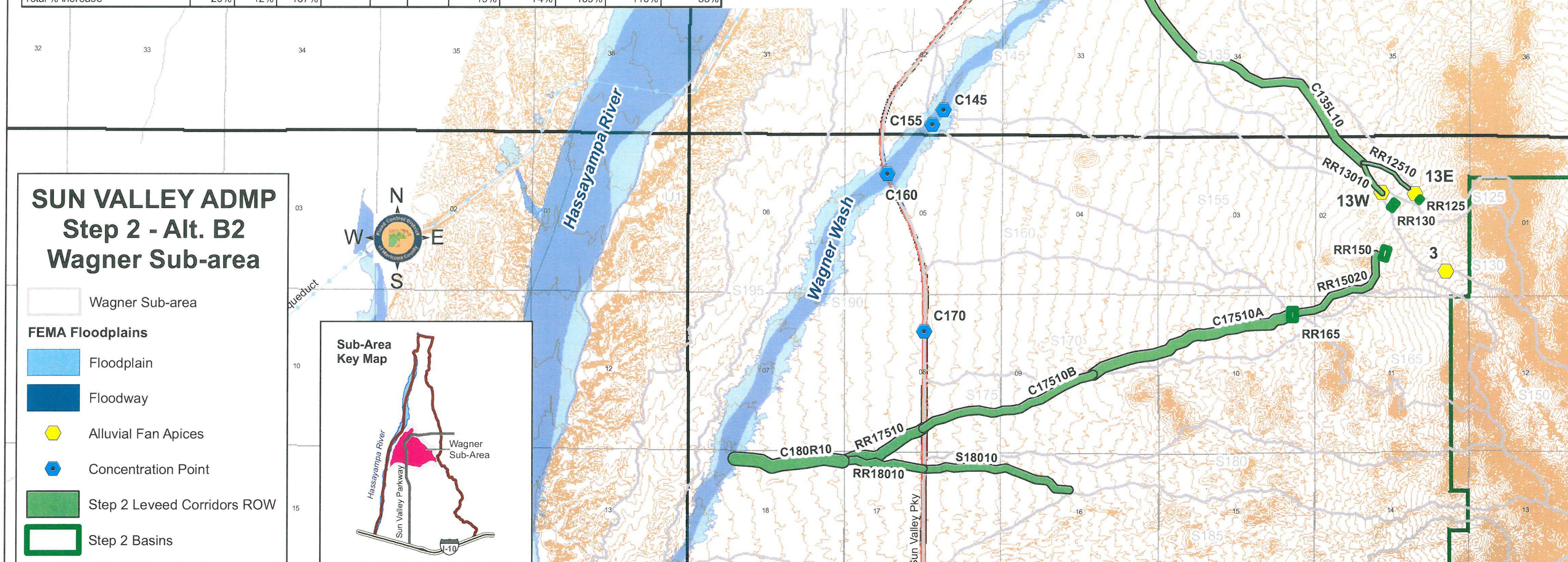
Structure ID	Type	Flow Rate (cfs)	ROW Area (acres)	Exc. Vol. (ac. ft)	Fill Vol. (ac. ft)	Base Design Geometry: Length (stor-ft; chl-mi)	ROW Width (ft)	Depth (ft)	Base Costs (in $1000): Land Cost	Constr. Cost	Lndscp Cost	50 Yr Maint. Cost	Total Cost	Base Cost Percentages: Land Cost %	Constr. Cost %	Lndscp Cost %	50 Yr Maint. Cost %	% of Total Cost
RR125	Online Basin	184	0	2	0	150	100	5	$ 30	$ 70	$ 15	$ 25	$ 140	21%	50%	11%	18%	0%
RR12510	Leveed Chl.	224	5	0	9	0.4	116	4	$ 490	$ 603	$ 145	$ 332	$ 1,570	31%	38%	9%	21%	2%
RR130	Online Basin	447	1	7	0	300	170	5	$ 120	$ 124	$ 51	$ 61	$ 356	34%	35%	14%	17%	1%
RR13010	Leveed Chl.	447	5	0	6	0.2	161	4	$ 460	$ 464	$ 96	$ 236	$ 1,256	37%	37%	8%	19%	2%
C135L10	Leveed Chl.	1001	78	0	69	2.3	282	5	$ 7,830	$ 5,025	$ 1,016	$ 2,429	$ 16,300	48%	31%	6%	15%	24%
RR150	Online Basin	724	2	16	0	400	225	6	$ 210	$ 213	$ 90	$ 100	$ 613	34%	35%	15%	16%	1%
RR15020	Leveed Chl.	833	23	0	23	0.8	242	5	$ 2,270	$ 1,750	$ 343	$ 898	$ 5,261	43%	33%	7%	17%	8%
RR165	Online Basin	876	2	17	0	400	240	6	$ 220	$ 233	$ 96	$ 104	$ 653	34%	36%	15%	16%	1%
C17510A	Leveed Chl.	1616	62	0	40	1.3	382	5	$ 6,200	$ 3,300	$ 594	$ 1,466	$ 11,561	54%	29%	5%	13%	17%
C17510B	Leveed Chl.	1278	40	0	35	1.2	282	5	$ 3,990	$ 2,672	$ 518	$ 1,384	$ 8,565	47%	31%	6%	16%	13%
RR17510	Leveed Chl.	1397	25	0	17	0.6	362	5	$ 2,520	$ 1,412	$ 255	$ 668	$ 4,855	52%	29%	5%	14%	7%
S18010	Leveed Chl.	1039	31	0	29	1	262	5	$ 3,100	$ 2,107	$ 434	$ 1,107	$ 6,747	46%	31%	6%	16%	10%
RR18010	Leveed Chl.	1124	17	0	16	0.5	262	5	$ 1,700	$ 1,167	$ 237	$ 595	$ 3,699	46%	32%	6%	16%	5%
C180R10	Leveed Chl.	2151	38	0	21	0.7	442	5	$ 3,780	$ 1,723	$ 313	$ 864	$ 6,680	57%	26%	5%	13%	10%
		TOTAL	329	42	265				$32,920	$ 20,863	$ 4,203	$ 10,271	**$ 68,257**	48%	31%	6%	15%	100%
All Channels			324	0	265	9.0			$32,340	$ 20,223	$ 3,951	$ 9,980	$ 66,495	49%	30%	6%	15%	97%
All Online Basins			5	42	0				$ 580	$ 640	$ 252	$ 290	$ 1,762	33%	36%	14%	16%	3%
All Offline Basins			0	0	0				$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%

Channel Cost per mile (in $1000)	$7,388	Basins Cost per ac. ft. (in $1000)	$6.00

Cost Increase for Landscape Compatibility Enhancement over Base Costs

	ROW Area	Exc. Vol.	Fill Vol.	Length	ROW Width	Depth	Land Cost	Constr. Cost	Lndscp Cost	50 Yr Maint. Cost	Total Cost
All Channels % increase	17%	0%	137%				17%	76%	107%	110%	54%
All Online Basins % increase	200%	12%	0%				143%	7%	143%	118%	90%
All Offline Basins % increase	0%	0%	0%				0%	0%	0%	0%	0%
Total % increase	20%	12%	137%				19%	74%	109%	110%	55%

The Alternative B2 is the notation used for the alternative concept using small basins at the alluvial fan apices accompanied by leveed conveyance corridors in the down fan direction.



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Costs Summary

Structure ID	Type	Flow Rate (cfs)	ROW Area (acres)	Exc. Vol. (ac. ft)	Fill Vol. (ac. ft)	Base Design Geometry: Length (stor-ft; chl-mi)	ROW Width (ft)	Depth (ft)	Base Costs (in $1000): Land Cost	Constr. Cost	Lndscp Cost	50 Yr Maint. Cost	Total Cost	Base Cost Percentages: Land Cost %	Constr. Cost %	Lndscp Cost %	50 Yr Maint. Cost %	% of Total Cost
RR125	Online Basin	184	0	2	0	150	100	5	$ 30	$ 70	$ 15	$ 25	$ 140	21%	50%	11%	18%	0%
RR12510	Leveed Chl.	224	5	0	9	0.4	116	4	$ 490	$ 603	$ 145	$ 332	$ 1,570	31%	38%	9%	21%	2%
RR130	Online Basin	447	1	7	0	300	170	5	$ 120	$ 124	$ 51	$ 61	$ 356	34%	35%	14%	17%	1%
RR13010	Leveed Chl.	447	5	0	6	0.2	161	4	$ 460	$ 464	$ 96	$ 236	$ 1,256	37%	37%	8%	19%	2%
C135L10	Leveed Chl.	1001	78	0	69	2.3	282	5	$ 7,830	$ 5,025	$ 1,016	$ 2,429	$ 16,300	48%	31%	6%	15%	24%
RR150	Online Basin	724	2	16	0	400	225	6	$ 210	$ 213	$ 90	$ 100	$ 613	34%	35%	15%	16%	1%
RR15020	Leveed Chl.	833	23	0	23	0.8	242	5	$ 2,270	$ 1,750	$ 343	$ 898	$ 5,261	43%	33%	7%	17%	8%
RR165	Online Basin	876	2	17	0	400	240	6	$ 220	$ 233	$ 96	$ 104	$ 653	34%	36%	15%	16%	1%
C17510A	Leveed Chl.	1616	62	0	40	1.3	382	5	$ 6,200	$ 3,300	$ 594	$ 1,466	$ 11,561	54%	29%	5%	13%	17%
C17510B	Leveed Chl.	1278	40	0	35	1.2	282	5	$ 3,990	$ 2,672	$ 518	$ 1,384	$ 8,565	47%	31%	6%	16%	13%
RR17510	Leveed Chl.	1397	25	0	17	0.6	362	5	$ 2,520	$ 1,412	$ 255	$ 668	$ 4,855	52%	29%	5%	14%	7%
S18010	Leveed Chl.	1039	31	0	29	1	262	5	$ 3,100	$ 2,107	$ 434	$ 1,107	$ 6,747	46%	31%	6%	16%	10%
RR18010	Leveed Chl.	1124	17	0	16	0.5	262	5	$ 1,700	$ 1,167	$ 237	$ 595	$ 3,699	46%	32%	6%	16%	5%
C180R10	Leveed Chl.	2151	38	0	21	0.7	442	5	$ 3,780	$ 1,723	$ 313	$ 864	$ 6,680	57%	26%	5%	13%	10%
		TOTAL	329	42	265				$ 32,920	$ 20,863	$ 4,203	$ 10,271	**$ 68,257**	48%	31%	6%	15%	100%
All Channels			324	0	265	9.0			$ 32,340	$ 20,223	$ 3,951	$ 9,980	$ 66,495	49%	30%	6%	15%	97%
All Online Basins			5	42	0				$ 580	$ 640	$ 252	$ 290	$ 1,762	33%	36%	14%	16%	3%
All Offline Basins			0	0	0				$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
Channel Cost per mile (in $1000)			$7,388		Basins Cost per ac. ft. (in $1000)				$6.00									

Cost Summary - Landscape Compatibility Enhanced (LCE)

Structure ID	Type	Flow Rate (cfs)	ROW Area (acres)	Exc. Vol. (ac. ft)	Fill Vol. (ac. ft)	LCE Design Geometry: Length (stor-ft; chl-mi)	ROW Width (ft)	Depth (ft)	LCE Costs (in $1000): Land Cost	Constr. Cost	Lndscp Cost	50 Yr Maint. Cost	Total Cost	LCE Cost Percentages: Land Cost %	Constr. Cost %	Lndscp Cost %	50 Yr Maint. Cost %	% of Total Cost
RR125	Online Basin	184	2	2	0	340	200	5	$ 150	$ 73	$ 68	$ 77	$ 368	41%	20%	19%	21%	0%
RR12510	Leveed Chl.	224	7	0	21	0.4	164	4	$ 690	$ 1,133	$ 300	$ 713	$ 2,836	24%	40%	11%	25%	3%
RR130	Online Basin	447	3	9	0	510	270	5	$ 320	$ 135	$ 138	$ 144	$ 736	43%	18%	19%	20%	1%
RR13010	Leveed Chl.	447	6	0	14	0.2	209	4	$ 600	$ 821	$ 200	$ 490	$ 2,110	28%	39%	9%	23%	2%
C135L10	Leveed Chl.	1001	93	0	162	2.3	333	5	$ 9,250	$ 8,978	$ 2,105	$ 5,260	$ 25,593	36%	35%	8%	21%	24%
RR150	Online Basin	724	5	18	0	620	325	6	$ 470	$ 232	$ 202	$ 206	$ 1,109	42%	21%	18%	19%	1%
RR15020	Leveed Chl.	833	28	0	55	0.8	293	5	$ 2,750	$ 3,085	$ 710	$ 1,854	$ 8,399	33%	37%	8%	22%	8%
RR165	Online Basin	876	5	18	0	600	340	6	$ 470	$ 246	$ 204	$ 207	$ 1,127	42%	22%	18%	18%	1%
C17510A	Leveed Chl.	1616	70	0	95	1.3	433	5	$ 7,030	$ 5,648	$ 1,231	$ 3,126	$ 17,036	41%	33%	7%	18%	16%
C17510B	Leveed Chl.	1278	47	0	83	1.2	333	5	$ 4,710	$ 4,683	$ 1,073	$ 2,827	$ 13,294	35%	35%	8%	21%	13%
RR17510	Leveed Chl.	1397	29	0	41	0.6	413	5	$ 2,880	$ 2,412	$ 528	$ 1,380	$ 7,200	40%	34%	7%	19%	7%
S18010	Leveed Chl.	1039	37	0	69	1	313	5	$ 3,700	$ 3,786	$ 899	$ 2,314	$ 10,699	35%	35%	8%	22%	10%
RR18010	Leveed Chl.	1124	20	0	38	0.5	313	5	$ 2,030	$ 2,088	$ 492	$ 1,256	$ 5,865	35%	36%	8%	21%	6%
C180R10	Leveed Chl.	2151	42	0	50	0.7	493	5	$ 4,220	$ 2,946	$ 647	$ 1,736	$ 9,549	44%	31%	7%	18%	9%
		TOTAL	394	47	628				$ 39,270	$ 36,266	$ 8,797	$ 21,588	**$ 105,921**	37%	34%	8%	20%	100%
All Channels			379	0	628	9.0			$ 37,860	$ 35,580	$ 8,186	$ 20,955	$ 102,581	37%	35%	8%	20%	97%
All Online Basins			15	47	0				$ 1,410	$ 686	$ 611	$ 633	$ 3,340	42%	21%	18%	19%	3%
All Offline Basins			0	0	0				$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
Channel Cost per mile (in $1000)			$11,398		Basins Cost per ac. ft. (in $1000)				$13.00									
All Channels % increase			17%	0%	137%				17%	76%	107%	110%	54%					
All Online Basins % increase			200%	12%	0%				143%	7%	143%	118%	90%					
All Offline Basins % increase			0%	0%	0%				0%	0%	0%	0%	0%					
Total % increase			20%	12%	137%				19%	74%	109%	110%	55%					

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

Sub-area: Wagner Wash, Alternative: B2
Cost Summary

Hydrology - 6-hr Storm HEC1 Model Results

KK CARD	Type	Peak Flow	Peak Stage (ft)	Peak Storage	Time	Cum.Area (sq. miles)	MAX. Average Flow (cfs)				MAX. Average Rainfall Depth (Inches)				Total Runoff Volume (ac. ft)			
							6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR
S100	BASIN	4347			4.6	6.99	899	225	75	32	1.195	1.195	1.195	1.195	446	446	446	446
S102	BASIN	2790			4.3	3.23	417	104	35	15	1.198	1.198	1.198	1.198	207	207	207	207
C102	COMBINE	5993			4.5	10.23	1198	300	100	43	1.089	1.089	1.089	1.089	594	594	594	594
RR102	STORAGE	127	1552	1143.35	6.7	10.23	122	104	72	41	0.11	0.376	0.784	1.029	60	205	428	561
D102	DIVERT	63			6.7	10.23	61	52	36	20	0.055	0.188	0.392	0.515	30	103	214	281
100105	ROUTE	59	100.2	20.4	12.5	10.23	58	51	36	20	0.053	0.185	0.389	0.512	29	101	212	279
S105	BASIN	2863			4.5	4.37	495	124	41	18	1.053	1.053	1.053	1.053	245	245	245	245
CF02	RETRIEVE	63			6.7	10.23	61	52	36	20	0.055	0.188	0.392	0.515	30	103	214	281
102105	ROUTE	63	100.4	8.6	8	10.23	60	51	36	20	0.055	0.187	0.39	0.513	30	102	213	280
C105U	COMBINE	2863			4.5	14.6	549	226	120	64	0.35	0.577	0.921	1.128	272	449	717	878
S110	BASIN	662			4.2	0.43	76	19	6	3	1.639	1.64	1.64	1.64	38	38	38	38
11015I	ROUTE	570	101.8	9.19	4.4	0.43	76	19	6	3	1.637	1.64	1.64	1.64	38	38	38	38
15I15R	ROUTE	506	102.1	19.34	4.8	0.43	76	19	6	3	1.635	1.64	1.64	1.64	38	38	38	38
S115	BASIN	1605			4.5	2.25	296	74	25	11	1.223	1.224	1.224	1.224	147	147	147	147
C115	COMBINE	1813			4.6	2.68	350	88	29	13	1.215	1.219	1.219	1.219	173	174	174	174
115120	ROUTE	1781	102.7	21.9	4.7	2.68	350	88	29	13	1.215	1.219	1.219	1.219	173	174	174	174
S120	BASIN	1838			4.3	2	256	64	21	9	1.189	1.189	1.189	1.189	127	127	127	127
C120	COMBINE	2678			4.5	4.68	545	137	46	20	1.083	1.087	1.087	1.087	270	271	271	271
C105D	COMBINE	4029			4.5	19.28	821	275	127	64	0.396	0.53	0.737	0.863	407	545	758	888
120135	ROUTE	4027	104.4	16.85	4.5	19.28	821	275	127	64	0.396	0.53	0.737	0.863	407	545	758	888
S125	BASIN	202			4	0.09	14	4	1	1	1.424	1.425	1.425	1.425	7	7	7	7
RR125	STORAGE	184	2.3	0.46	4	0.09	14	4	1	1	1.424	1.425	1.425	1.425	7	7	7	7
12535I	ROUTE	171	100.8	1.54	4.1	0.09	14	4	1	1	1.423	1.425	1.425	1.425	7	7	7	7
S130	BASIN	524			4.1	0.31	48	12	4	2	1.425	1.426	1.426	1.426	24	24	24	24
RR130	STORAGE	447	3.4	3.03	4.2	0.31	48	12	4	2	1.425	1.426	1.426	1.426	24	24	24	24
13035I	ROUTE	436	101	2.42	4.3	0.31	48	12	4	2	1.425	1.426	1.426	1.426	24	24	24	24
C135I	COMBINE	478			4.2	1.18	54	14	5	2	0.428	0.428	0.428	0.428	27	27	27	27
35I135	ROUTE	248	100.5	26.6	5.1	1.18	54	14	5	2	0.426	0.428	0.428	0.428	27	27	27	27
S135	BASIN	1102			4.2	0.88	111	28	9	4	1.175	1.175	1.175	1.175	55	55	55	55
C135L	COMBINE	830			4.2	2.06	145	36	12	5	0.653	0.654	0.654	0.654	72	72	72	72
C135	COMBINE	4171			4.5	21.34	881	288	131	66	0.384	0.502	0.684	0.796	437	571	779	906
135145	ROUTE	3750	103.8	147	5	21.34	870	286	131	66	0.379	0.498	0.683	0.795	431	567	777	905
S140	BASIN	1913			4.1	1.37	188	47	16	7	1.27	1.27	1.27	1.27	93	93	93	93
140145	ROUTE	1623	101.9	39.36	4.4	1.37	188	47	16	7	1.27	1.27	1.27	1.27	93	93	93	93
S145	BASIN	1702			4.2	1.76	193	48	16	7	1.021	1.021	1.021	1.021	96	96	96	96
C145	COMBINE	4074			4.9	24.47	1037	325	143	71	0.394	0.494	0.651	0.747	514	645	850	974
145155	ROUTE	4073	105.7	11.22	4.9	24.47	1036	325	143	71	0.394	0.494	0.651	0.746	514	645	850	974
S155	BASIN	1626			4.3	1.83	223	56	19	8	1.131	1.132	1.132	1.132	111	111	111	111
C155	COMBINE	4306			4.8	26.3	1135	349	150	74	0.401	0.493	0.636	0.724	563	691	893	1016
155160	ROUTE	4296	104.5	32.56	4.9	26.3	1134	348	150	74	0.401	0.492	0.636	0.724	562	691	892	1016
S160	BASIN	1347			4.2	1.14	133	33	11	5	1.079	1.079	1.079	1.079	66	66	66	66
C160	COMBINE	4293			4.9	27.44	1174	358	153	75	0.398	0.485	0.622	0.705	582	710	910	1032
160170	ROUTE	4197	102.7	80.55	5.1	27.44	1168	356	153	75	0.396	0.483	0.62	0.704	579	707	908	1030
S170	BASIN	1686			4.2	1.46	178	44	15	6	1.127	1.127	1.127	1.127	88	88	88	88
170R	ROUTE	1544	103.3	29.21	4.4	1.46	178	44	15	6	1.127	1.127	1.127	1.127	88	88	88	88
C170R	COMBINE	4314			5	28.9	1234	372	157	77	0.397	0.479	0.608	0.686	612	738	937	1058

Hydrology - 6-hr Storm HEC1 Model Results

		Peak	Peak	Peak		Cum.Area	MAX. Average Flow (cfs)				MAX. Average Rainfall Depth (Inches)				Total Runoff Volume (ac. ft)			
KK CARD	Type	Flow	Stage (ft)	Storage	Time	(sq. miles)	6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR
S150	BASIN	836			4.3	0.77	126	31	10	5	1.51	1.513	1.513	1.513	62	62	62	62
RR150	STORAGE	724	4	6.27	4.5	0.77	126	31	10	5	1.51	1.513	1.513	1.513	62	62	62	62
150165	ROUTE	653	100.9	13.78	4.6	0.77	125	31	10	5	1.502	1.513	1.513	1.513	62	62	62	62
S165	BASIN	1008			4.1	0.62	94	23	8	3	1.416	1.417	1.417	1.417	47	47	47	47
C165	COMBINE	968			4.2	1.39	200	50	17	7	1.336	1.345	1.345	1.345	99	100	100	100
RR165	STORAGE	876	4.3	7.45	4.5	1.39	200	50	17	7	1.336	1.345	1.345	1.345	99	100	100	100
165175	ROUTE	810	101	60.03	5.1	1.39	199	50	17	7	1.33	1.345	1.345	1.345	99	100	100	100
S175	BASIN	1203			4.5	1.8	226	56	19	8	1.165	1.166	1.166	1.166	112	112	112	112
C175	COMBINE	1204			5	3.19	379	96	32	14	1.104	1.118	1.118	1.118	188	190	190	190
175R	ROUTE	1190	101	19.61	5.1	3.19	378	96	32	14	1.1	1.118	1.118	1.118	187	190	190	190
S180	BASIN	1032			4.5	1.44	181	45	15	7	1.167	1.169	1.169	1.169	90	90	90	90
180R	ROUTE	775	101	34.58	4.8	1.44	180	45	15	7	1.16	1.169	1.169	1.169	89	90	90	90
C180RI	COMBINE	1631			5	4.63	501	127	42	18	1.006	1.02	1.02	1.02	249	252	252	252
RI180R	ROUTE	1609	101.1	34.76	5.2	4.63	499	127	42	18	1	1.02	1.02	1.02	247	252	252	252
C180R	COMBINE	4858			5.3	33.54	1469	430	176	85	0.407	0.477	0.585	0.651	728	854	1046	1164
180185	ROUTE	4840	103	53.67	5.5	33.54	1462	430	176	85	0.405	0.476	0.585	0.651	725	852	1046	1164
S185	BASIN	1450			4.5	2.42	288	72	24	10	1.106	1.107	1.107	1.107	143	143	143	143
185R	ROUTE	1302	102.5	41.84	4.9	2.42	288	72	24	10	1.105	1.107	1.107	1.107	143	143	143	143
C185R	COMBINE	5091			5.3	35.96	1569	456	184	88	0.406	0.471	0.571	0.632	778	904	1095	1211
185190	ROUTE	5090	102.6	43.09	5.4	35.96	1564	455	184	88	0.404	0.471	0.571	0.631	775	903	1094	1211
S190	BASIN	2084			4.5	4.05	391	98	33	14	0.896	0.896	0.896	0.896	194	194	194	194
C190	COMBINE	5262			5.3	39.24	1690	488	194	92	0.401	0.463	0.553	0.608	838	968	1157	1272
190195	ROUTE	5178	103.1	79.44	5.5	39.24	1683	487	194	92	0.399	0.462	0.553	0.608	835	967	1157	1272
S195	BASIN	1001			4.6	1.81	203	51	17	7	1.046	1.046	1.046	1.046	101	101	101	101
C195	COMBINE	5225			5.5	41.05	1732	500	198	94	0.392	0.453	0.538	0.591	859	991	1179	1293

Hydrology - 24-hr Storm HEC1 Model Results

		Peak	Peak	Peak		Cum.Area	MAX. Average Flow (cfs)				MAX. Average Rainfall Depth (Inches)				Total Runoff Volume (ac. ft)			
KK CARD	Type	Flow	Stage (ft)	Storage	Time	(sq. miles)	6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR
S100	BASIN	5214			12.5	6.99	965	241	80	35	1.282	1.282	1.282	1.282	478	478	478	478
S102	BASIN	3434			12.3	3.23	420	105	35	15	1.207	1.207	1.207	1.207	208	208	208	208
C102	COMBINE	7803			12.4	10.23	1367	342	114	49	1.243	1.243	1.243	1.243	678	678	678	678
RR102	STORAGE	149	1552.1	1201.44	14.4	10.23	141	119	82	46	0.128	0.431	0.895	1.163	70	235	488	634
D102	DIVERT	75			14.4	10.23	71	59	41	23	0.064	0.215	0.448	0.581	35	118	244	317
100105	ROUTE	70	100.2	24.2	20.3	10.23	67	58	41	23	0.061	0.211	0.444	0.578	33	115	242	315
S105	BASIN	3466			12.5	4.37	531	133	44	19	1.129	1.129	1.129	1.129	263	263	263	263
CF02	RETRIEVE	75			14.4	10.23	71	59	41	23	0.064	0.215	0.448	0.581	35	118	244	317
102105	ROUTE	74	100.4	9.55	15.6	10.23	70	59	41	23	0.064	0.214	0.445	0.58	35	117	243	316
C105U	COMBINE	3466			12.5	14.6	587	238	125	66	0.374	0.606	0.958	1.164	291	472	746	906
S110	BASIN	532			12.1	0.43	62	16	5	2	1.35	1.422	1.422	1.422	31	33	33	33
110151	ROUTE	456	101.7	7.4	12.4	0.43	62	16	5	2	1.35	1.421	1.422	1.422	31	33	33	33
15I15R	ROUTE	412	101.9	16.62	12.7	0.43	62	16	5	2	1.349	1.421	1.422	1.422	31	33	33	33
S115	BASIN	1693			12.5	2.25	287	73	24	11	1.186	1.209	1.209	1.209	142	145	145	145
C115	COMBINE	1937			12.6	2.68	346	89	30	13	1.201	1.232	1.233	1.233	171	176	176	176
115120	ROUTE	1900	102.8	22.91	12.7	2.68	346	89	30	13	1.201	1.232	1.233	1.233	171	176	176	176
S120	BASIN	2032			12.3	2	247	62	21	9	1.146	1.158	1.158	1.158	122	124	124	124
C120	COMBINE	3202			12.4	4.68	585	149	50	22	1.162	1.185	1.186	1.186	290	296	296	296
C105D	COMBINE	6217			12.4	19.28	1091	359	163	82	0.526	0.692	0.943	1.092	541	712	969	1123
120135	ROUTE	6220	105.1	23.77	12.5	19.28	1091	359	163	82	0.526	0.692	0.943	1.092	541	711	969	1123
S125	BASIN	161			12	0.09	12	3	1	0	1.197	1.258	1.258	1.258	6	6	6	6
RR125	STORAGE	152	1.6	0.32	12	0.09	12	3	1	0	1.197	1.258	1.258	1.258	6	6	6	6
12535I	ROUTE	139	100.7	1.35	12.1	0.09	12	3	1	0	1.197	1.257	1.258	1.258	6	6	6	6
S130	BASIN	415			12.1	0.31	39	10	3	1	1.169	1.217	1.217	1.217	19	20	20	20
RR130	STORAGE	370	2.4	2.03	12.2	0.31	39	10	3	1	1.169	1.217	1.217	1.217	19	20	20	20
13035I	ROUTE	361	100.9	2.16	12.2	0.31	39	10	3	1	1.169	1.217	1.217	1.217	19	20	20	20
C135I	COMBINE	478			12.2	1.18	50	13	4	2	0.39	0.407	0.407	0.407	25	26	26	26
35I135	ROUTE	222	100.4	24.59	13.2	1.18	49	13	4	2	0.39	0.407	0.407	0.407	25	26	26	26
S135	BASIN	1015			12.2	0.88	99	25	8	4	1.048	1.048	1.048	1.048	49	49	49	49
C135L	COMBINE	1001			12.2	2.06	146	37	12	5	0.661	0.671	0.671	0.671	73	74	74	74
C135	COMBINE	6650			12.4	21.34	1214	389	173	86	0.529	0.678	0.903	1.037	602	772	1027	1180
135145	ROUTE	5884	104.6	212.11	12.8	21.34	1202	386	172	86	0.524	0.673	0.901	1.036	596	766	1025	1179
S140	BASIN	2029			12.1	1.37	172	43	14	6	1.164	1.164	1.164	1.164	85	85	85	85
140145	ROUTE	1632	101.9	39.52	12.4	1.37	172	43	14	6	1.164	1.164	1.164	1.164	85	85	85	85
S145	BASIN	1945			12.2	1.76	193	48	16	7	1.022	1.022	1.022	1.022	96	96	96	96
C145	COMBINE	6533			12.7	24.47	1505	461	197	96	0.572	0.701	0.899	1.017	747	915	1173	1327
145155	ROUTE	6539	106.9	17.8	12.8	24.47	1505	461	197	96	0.572	0.701	0.899	1.017	746	915	1173	1327
S155	BASIN	1781			12.3	1.83	218	55	18	8	1.105	1.117	1.117	1.117	108	109	109	109
C155	COMBINE	7021			12.7	26.3	1688	507	212	103	0.597	0.716	0.9	1.009	837	1005	1262	1416
155160	ROUTE	6997	105.5	51.28	12.8	26.3	1686	506	212	103	0.596	0.716	0.9	1.009	836	1004	1262	1416
S160	BASIN	1342			12.1	1.14	124	31	10	4	1.01	1.01	1.01	1.01	62	62	62	62
C160	COMBINE	7078			12.8	27.44	1785	531	220	106	0.605	0.719	0.895	1	885	1053	1310	1464
160170	ROUTE	6941	103.4	130.79	13	27.44	1778	529	220	106	0.602	0.717	0.895	1	882	1050	1309	1463
S170	BASIN	1802			12.1	1.46	169	42	14	6	1.075	1.075	1.075	1.075	84	84	84	84
170R	ROUTE	1638	103.4	30.32	12.3	1.46	169	42	14	6	1.075	1.075	1.075	1.075	84	84	84	84
C170R	COMBINE	7196			13	28.9	1916	563	231	111	0.616	0.725	0.893	0.993	950	1118	1377	1531
170180	ROUTE	7085	103.6	183.28	13.1	28.9	1907	562	231	111	0.613	0.723	0.892	0.992	946	1114	1375	1530

Hydrology - 24-hr Storm HEC1 Model Results

KK CARD	Type	Peak Flow	Peak Stage (ft)	Peak Storage	Time	Cum.Area (sq. miles)	MAX. Average Flow (cfs)				MAX. Average Rainfall Depth (Inches)				Total Runoff Volume (ac. ft)			
							6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR
S150	BASIN	729			12.3	0.77	107	29	10	4	1.291	1.374	1.375	1.375	53	57	57	57
RR150	STORAGE	639	3.2	4.95	12.5	0.77	107	29	10	4	1.291	1.374	1.375	1.375	53	57	57	57
150165	ROUTE	563	100.8	12.55	12.6	0.77	107	29	10	4	1.288	1.373	1.375	1.375	53	57	57	57
S165	BASIN	842			12.1	0.62	78	20	7	3	1.183	1.219	1.219	1.219	39	40	40	40
C165	COMBINE	981			12.1	1.39	183	48	16	7	1.226	1.289	1.291	1.291	91	96	96	96
RR165	STORAGE	841	3.9	6.8	12.3	1.39	183	48	16	7	1.226	1.289	1.291	1.291	91	96	96	96
165175	ROUTE	747	100.9	57.16	13.1	1.39	182	48	16	7	1.22	1.288	1.291	1.291	90	96	96	96
S175	BASIN	1278			12.5	1.8	217	55	18	8	1.119	1.131	1.131	1.131	108	109	109	109
C175	COMBINE	1278			12.5	3.19	392	102	34	15	1.143	1.184	1.186	1.186	195	202	202	202
175R	ROUTE	1245	101	20.14	13.1	3.19	391	102	34	15	1.139	1.184	1.186	1.186	194	202	202	202
S180	BASIN	1039			12.5	1.44	171	44	15	6	1.1	1.123	1.124	1.124	85	86	86	86
180R	ROUTE	744	101	33.75	12.8	1.44	170	44	15	6	1.094	1.123	1.124	1.124	84	86	86	86
C180RI	COMBINE	1849			13	4.63	555	144	48	21	1.112	1.152	1.154	1.154	275	285	285	285
RI180R	ROUTE	1828	101.2	37.6	13.1	4.63	552	144	48	21	1.107	1.152	1.154	1.154	274	285	285	285
C180R	COMBINE	8564			13.2	33.54	2375	681	271	128	0.658	0.755	0.9	0.987	1177	1351	1610	1766
180185	ROUTE	8544	104.1	84.43	13.3	33.54	2368	680	270	128	0.656	0.754	0.899	0.987	1174	1349	1609	1765
S185	BASIN	1655			12.5	2.42	288	73	24	10	1.105	1.117	1.117	1.117	143	144	144	144
185R	ROUTE	1411	102.6	45.16	12.9	2.42	287	73	24	10	1.104	1.117	1.117	1.117	143	144	144	144
C185R	COMBINE	9412			13.2	35.96	2599	739	290	137	0.672	0.764	0.899	0.981	1289	1465	1725	1882
185190	ROUTE	9393	103.6	68.83	13.2	35.96	2594	738	290	137	0.671	0.763	0.899	0.981	1286	1464	1724	1881
S190	BASIN	2590			12.5	4.05	448	112	37	16	1.027	1.027	1.027	1.027	222	222	222	222
C190	COMBINE	10112			13.1	39.24	2943	827	320	150	0.697	0.784	0.909	0.984	1459	1641	1903	2060
190195	ROUTE	10024	104.2	134.91	13.3	39.24	2934	826	320	150	0.695	0.783	0.909	0.984	1455	1639	1902	2060
S195	BASIN	1039			12.6	1.81	202	51	17	7	1.041	1.041	1.041	1.041	100	100	100	100
C195	COMBINE	10340			13.3	41.05	3089	866	333	155	0.7	0.784	0.904	0.976	1531	1717	1980	2137

Channels Hydraulics Summary

		Design Geometry						Hydraulics										
Structure ID	Type	Initial Slope (ft/ft)	Long-term Slope (ft/ft)	Length (stor-ft; chl-mi)	Width (ft)	Depth (ft)	Chnl Mannings n	Flow Rate (cfs)	Wetted Perimeter (ft)	Wetted XS Area (ft)	Hydraulic Radius (ft)	Hydraulic Depth (ft)	Flow Depth (ft)	Freeboard (ft)	Top Width (ft)	Velocity (ft/s)	Froude Number	Shear Stress (lb/sq. ft)
RR12510	Leveed	0.0265	0.0100	0.40	3	4.0	0.045	224	46.4	43.4	0.9	0.9	1.0	3.0	46	5.2	0.94	0.63
RR13010	Leveed	0.0252	0.0090	0.20	3	4.0	0.045	447	91.3	87.4	1.0	1.0	1.0	3.0	91	5.1	0.92	0.56
C135L10	Leveed	0.0165	0.0060	2.30	3	4.5	0.045	1001	206.9	223.4	1.1	1.1	1.1	3.4	207	4.5	0.76	0.41
RR15020	Leveed	0.0206	0.0075	0.80	3	4.5	0.045	833	166.7	171.7	1.0	1.0	1.1	3.4	166	4.9	0.84	0.49
C17510A	Leveed	0.0182	0.0065	1.30	3	4.5	0.045	1616	307.1	339.0	1.1	1.1	1.1	3.4	307	4.8	0.80	0.45
C17510B	Leveed	0.0135	0.0050	1.20	3	4.5	0.045	1278	208.5	275.5	1.3	1.3	1.3	3.2	208	4.6	0.71	0.42
RR17510	Leveed	0.0164	0.0060	0.60	3	4.5	0.045	1397	287.0	311.8	1.1	1.1	1.1	3.4	287	4.5	0.76	0.41
S18010	Leveed	0.0146	0.0060	1.00	3	4.5	0.045	1039	187.9	228.2	1.2	1.2	1.2	3.3	187	4.6	0.73	0.46
RR18010	Leveed	0.0153	0.0060	0.50	3	4.5	0.045	1124	188.1	236.0	1.3	1.3	1.3	3.2	188	4.8	0.75	0.48
C180R10	Leveed	0.0122	0.0050	0.70	3	4.5	0.045	2151	368.5	487.5	1.3	1.3	1.3	3.2	368	4.4	0.68	0.42

Basins Hydraulics Summary

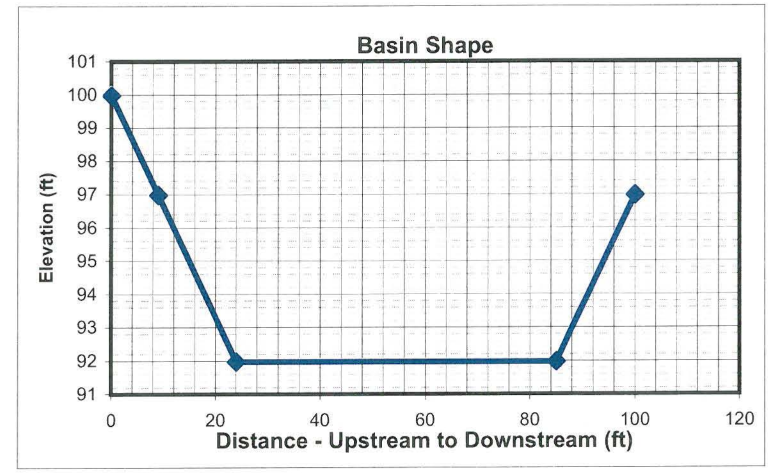
			Design Geometry				Hydraulics					
Structure ID	Type	Adjacent Topo. Slope	Length (stor-ft; chl-mi)	Width (ft)	Depth (ft)	Storage Volume Provided	Peak Storage (ac. Ft)	Total Vol. Entering Basin (ac.	Peak Inflow into Basin (cfs)	Peak Outflow (cfs)	Peak Stage (ft)	Freeboard (ft)
RR125	Online Basin	0.0300	150	100	5.0	0.9	0.5	7.0	202	184	2.3	2.7
RR130	Online Basin	0.0280	300	170	5.0	3.6	3.0	24.0	524	447	3.4	1.6
RR150	Online Basin	0.0270	400	225	6.0	8.1	6.3	62.0	836	724	4.0	2.0
RR165	Online Basin	0.0220	400	240	6.0	8.8	7.5	100.0	981	876	4.3	1.7

Online Basin

HEC1 ID	RR125

HEC1 Results Used to Determine Sediment Volume From Upstream

Contributing HEC1 ID							Total Volume (ac. ft)
Inflow Volume (ac. ft)							0
Volume Fraction							
Weighted Volume							0
Sediment Conc. (ppm)							
Sediment Volume (ac. ft)							0.00
Weighting Factor							
Weighted Sed. Vol. (ac. ft)							0.00



Sediment Yield

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.1	sq. mi
Total Sediment Yield Volume	0.2	ac ft

Required Minimum Sediment Volume

Sediment Volume	0.2	ac. ft

Geometry	Base	LC Enhanced
Topography slope (ft/ft)	0.03	0.03
Basin Length (ft)	150	240
Basin Width (ft)	100	100
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	5	5
Freeboard (ft)	1	1
Effective Basin Width (ft)	91	82
Top Area (acres)	0.3	0.6
U/S-D/S Height Difference (ft)	3.0	3.0
Excess Area on Upstream (acres)	0.0	0.1

			Base	LC Enhanced
Bottom Length (ft)	120	Allocated Storage Volume (ac. ft)	0.9	0.9
Bottom Width (ft)	61	Total Available Volume (ac. ft) (incl. Freeboard)	1.2	1.3
		Total Excavation Volume (ac. ft)	1.7	2.1

HEC1 Results

	6-hr Event	24-hr Event	Maximum
Total Flow Volume entering Basin (ac. ft)	7.0	6	7.0
Peak Inflow (cfs)	202	161	202.0
Peak Outflow (cfs)	184	152	184.0
Stage at Peak Outflow (ft)	2.3	1.6	2.3
Volume at Peak Outflow (ac. ft)	0.5	0.32	0.5

Volume Check

Total Volume needed	0.7	ac. ft
Total Volume Provided	0.9	ac. ft

Volume OK?	Yes

Stage Check

Depth Needed	3.3	ft
Depth Provided	5	ft

Depth OK?	Yes

Basin Outlet

Outlet Coeff	0.60	(0.6 for Orifice, 3.0 for Weir)
D (Orifice) or W (Weir)	4.00	ft
Invert Elevation	0.00	ft
Number of pipes	2	

Stage-Storage-Discharge

Elevation	0	0.5	1	1.5	2	2.5	3	4	5	6
Volume	0.00	0.09	0.18	0.28	0.39	0.50	0.62	0.89	1.19	1.52
Outflow	0.0	85.6	121.0	148.2	171.1	191.3	209.6	242.0	270.6	296.4

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
LC Enhancement Buffer	53000	sq. ft
Other		sq. ft

Additional ROW Length	0	ft
Additional ROW Width	0	ft
Landscaping Buffer Length	100	ft
Landscaping Buffer Width	100	ft

Base Total ROW Length	150	ft
Base Total ROW Width	100	ft
LC Enh. Total ROW Length	340	ft
LC Enh. Total ROW Length	200	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	2743	3388
Excavated Area (sq. Yd)	1667	7556

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	25	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	281	sq. Yd
Material Volume	141	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	200	ft
Unit Cost	160	per ft
Cost per outlet	$32,000	
Other Cost	$ -	
Total Cost	$32,000	
Outlet Area	133	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Basin		2,743	cu. Yd	$ 4.00	$ 10,972	1,667	sq. Yd	$ 9.00	$ 15,003	1,667	sq. Yd	$ 8.33	$ 13,892
Basin - LC Enhancement		645	cu. Yd	$ 4.00	$ 2,580	5,889	sq. Yd	$ 9.00	$ 53,001	5,889	sq. Yd	$ 8.33	$ 49,075
Inlet	Riprap	141	sq. Yd	$ 75.00	$ 10,575	281	sq. Yd	$ -	$ -	281	sq. Yd	$ 33.33	$ 9,367
Inlet - LC Enhancement (20%Inlet)					$ 2,115				$ -				$ 1,873
Outlet	Pipe	1	EA	$ 32,000	$ 32,000	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhancement (5% Outlet)					$ 1,600				$ -				$ 111
Other					$ -				$ -				$ -

Base Landscape Cost	$ 15,003	Base Maintenance Cost	$ 25,475
LC Enh. Landscape Cost	$ 53,001	LC Enh. Maintenance Cost	$ 51,059
Total Landscape Cost	$ 68,004	Total Maintenance Cost	$ 76,534

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 53,547	$ 2,580	$ 56,127
Contingency Cost (25% of Construction Cost)	$ 13,387	$ 645	$ 14,032
Engineering Design Cost (5% of Construction Cost)	$ 2,677	$ 129	$ 2,806
Total Construction Cost	$ 69,611	$ 3,354	$ 72,965

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	1.2	$100,000	$ 120,000
Basin	0.3	$100,000	$ 30,000
Other		$100,000	$ -
Total	1.5	$100,000	$ 150,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	0.3	$100,000	$ 30,000
LC Enhancement Cost	acre	1.2	$100,000	$ 120,000
Total Land Cost	acre	1.5	$100,000	$ 150,000

Total Cost

Base Total Cost	$ 140,089
Total LC Enhancement Cost	$ 227,414
Total Cost Including LC Enh.	$ 367,503

Open Channel

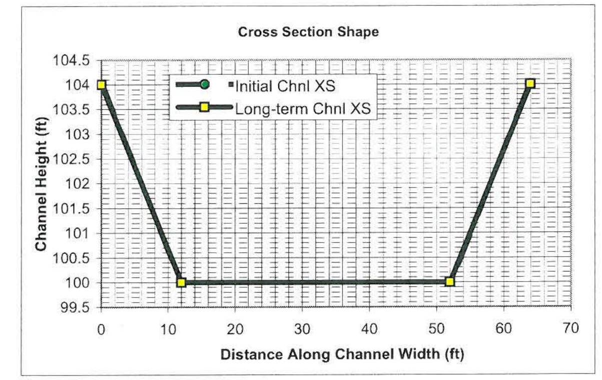
Structure ID	RR12510	HEC1 ID	12535I

Longitundal Geometry

Length	1852.5	ft
U/S Elev	1746.1	ft
D/S Elev	1697.0	ft
Initial Channel Slope	0.0265	ft/ft
Long-term Channel Slope	0.0100	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	1



Initial Channel XS Geometry

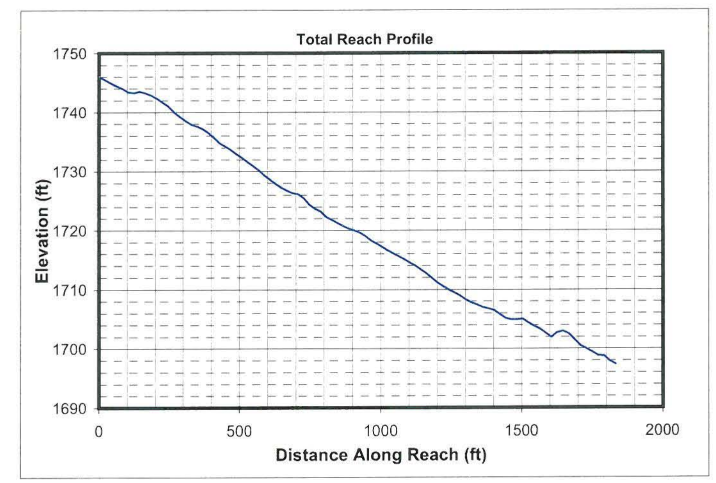
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	0	3	40	4	3	0	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	12	12	52	52	52	64
Y	104	100	100	100	100	100	100	104

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	0	3	40	4	3	0	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	12	12	52	52	52	64
Y	104	100	100	100	100	100	100	104



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	RR125	S135								TOTAL
HEC1 Peak-Flow	184	1102								1286
Weighting Factor	1.00	0.04								
Flow into Channel	184	40								224

Reach Sediment Inflow Characteristics

U/S Contributing ID										TOTAL
HEC1 Flow Volume (ac. ft)										0
Sediment Conc. (ppm)										
Sediment Volume (ac. ft)										0.00
Weighting Factor										
Weighted Sed. Vol. (ac. ft)										0.00

Hydrology

Drainage Area	0.157	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	224	cfs	
Long-term Max. Chnl Capacity	1491	cfs	
Q2 Channel	22	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	64	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
22	41.6	10.5	0.3	100.0	100.3	2.1	0.3	41.5	0.3	0.16	0.75
56	42.8	18.3	0.4	100.0	100.4	3.1	0.4	42.7	0.4	0.28	0.82
168	45.4	36.2	0.8	100.0	100.9	4.6	0.9	45.1	0.8	0.53	0.91
224	46.4	43.4	0.9	100.0	101.0	5.2	1.0	46.1	0.9	0.63	0.94

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
22	42.2	14.1	0.3	100.0	100.3	1.6	0.3	42.1	0.3	0.21	0.48
56	43.7	24.7	0.6	100.0	100.6	2.3	0.6	43.6	0.6	0.37	0.53
168	47.2	49.3	1.0	100.0	101.1	3.4	1.1	46.8	1.1	0.71	0.59
224	48.5	59.2	1.2	100.0	101.3	3.8	1.3	48.1	1.2	0.84	0.60

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
22										0
56										0
168										0
224										0

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
22	1.74	0.9700	0.9215	Erosive	Erosive	Erosive	0.2	Stable	2.9	Stable	Stable
56	1.74	1.1348	1.0780	Erosive	Erosive	Erosive	0.2	Stable	4.1	Stable	Stable
168	1.74	1.3278	1.2614	Erosive	Erosive	Erosive	0.3	Stable	6.4	Stable	Stable
224	1.74	1.3773	1.3084	Erosive	Erosive	Erosive	0.3	Stable	7.1	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	**22**	**56**	**168**	**224**	**22**	**56**	**168**	**224**	**22**	**56**	**168**	**224**
Bray - Equation #1	12	20	35	41	0.7	1.0	1.5	1.6	2.4	2.8	3.2	3.4
Bray - Equation #2	16	26	46	54	0.8	1.1	1.6	1.8	1.7	1.9	2.2	2.3
Hey	3	5	10	12	2.1	3.0	4.5	5.0				
Ackers & Charlton/Lacey	13	20	31	35					1.3	1.6	1.9	2.0
Parker	33	51	89	103	0.5	0.7	1.2	1.3				
Chang	22	38	75	89	0.1	0.0	-0.1	-0.2				
Kellerhals	9	13	23	27	0.9	1.4	2.1	2.4	2.8	3.1	3.4	3.5
AMAFCA/Schumm	42	44	47	48								
Moody & Odem	6	6	6	6	0.7	0.7	0.7	0.7				
BUREC	7.5	10.6	15.9	17.7	2	3	4	5	2.4	3.0	3.9	4.2
Average	16	23	38	43	1.0	1.4	2.0	2.2	2.1	2.5	2.9	3.1
Values As Designed	42	44	47	48	0.3	0.6	1.1	1.3	1.6	2.3	3.4	3.8
Difference with Design	-26	-20	-9	-5	0.6	0.8	0.8	0.8	0.5	0.2	-0.5	-0.7

Initial Channel Sediment Transport Capacity

Discharge (cfs)	Sediment Load (tons/day) Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
22	353	223	537	731	782	142	114	61	1731	120	377	470
56	1433	679	1457	3406	1150	545	333	275	4459	389	1478	1419
168	7602	2359	4116	21199	1771	2481	1040	1302	13554	1752	6613	5799
224	11708	3231	5437	34064	1981	3664	1380	1905	18102	2612	9612	8518

Discharge (cfs)	Sediment Concentrations (ppm by weight) Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
22	5844	3690	8889	12108	12960	2354	1883	1010	28676	1983	6240	7785
56	9495	4496	9654	22565	7619	3614	2208	1821	29541	2576	9791	9398
168	16788	5210	9089	46815	3911	5480	2298	2876	29932	3869	14604	12806
224	19391	5351	9006	56418	3281	6068	2286	3155	29982	4326	15920	14108

Long-term Channel Sediment Transport Capacity

Discharge (cfs)	Sediment Load (tons/day) Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
22	91	57	92	145	459	15	17	10	346	27	87	122
56	368	211	398	673	730	97	83	70	977	92	416	374
168	1924	824	1385	4140	1201	495	315	409	3083	435	2129	1486
224	2953	1152	1913	6626	1363	736	430	619	4137	655	3183	2161

Discharge (cfs)	Sediment Concentrations (ppm by weight) Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
22	1503	949	1522	2407	7596	248	287	168	5735	444	1448	2028
56	2438	1400	2634	4460	4835	640	551	462	6473	610	2753	2478
168	4250	1820	3059	9143	2653	1092	696	903	6808	960	4702	3281
224	4891	1908	3169	10974	2257	1219	712	1025	6851	1085	5272	3578

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
22	0.0028	0.0048	152	0.46	0.048	0.0010	30	0.036	0.0007	0.0159	0.0010	0.0023	0.0124	0.0009	0.0038	0.0263	0.0105
56	0.0014	0.0028	198	0.60	0.050	0.0006	31	0.036	0.0004	0.0159	0.0006	0.0013	0.0124	0.0006	0.0019	0.0263	0.0102
168	0.0006	0.0015	271	0.82	0.053	0.0004	32	0.036	0.0002	0.0159	0.0003	0.0007	0.0124	0.0004	0.0008	0.0263	0.0099
224	0.0005	0.0013	293	0.89	0.054	0.0003	32	0.036	0.0002	0.0159	0.0003	0.0006	0.0124	0.0003	0.0007	0.0263	0.0099

Drop Structures

Design Slope	0.0100	ft/ft
Total Drop Needed	30.5	ft
Height of Drop Structure	3	ft
No . of Drop Structures	11	
Distance between structs.	168	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.03	sq. mi
Total Sediment Yield Volume	0.06	ac ft

Sedimentation Basins

Length	168 ft	Depth	3 ft
Width	64 ft	Side slope	3 ft/ft
Total Volume per Basin		0.61	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

Discharge	COT/PC	Pima County General Scour Equations General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Bend Scour	LongTerm Scour	Thalweg channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
22	1.1	-0.1	0.0	24.6	0.3	0.3	1.6	0.0100	0.0	1.5	1.0	3.3
56	1.1	-0.2	0.1	24.6	0.6	0.6	2.3	0.0100	0.1	1.5	1.0	3.4
168	1.1	-0.3	0.2	24.6	1.1	1.1	3.4	0.0100	0.1	1.5	1.0	3.5
224	1.1	-0.4	0.2	24.6	1.3	1.2	3.8	0.0100	0.2	1.5	1.0	3.6

Toe Protection Needed	4.0	ft

HEC1 Results For Open Channel

Peak Flow	171	cfs
Stage at Peak Flow	100.8	ft
Flow Volume	7.0	ac. ft

Freeboard

Max. Flow Depth	1.0	ft
Channel Depth as designed	4.0	ft
Available Freeboard	3.0	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	0.06	ac. ft
Outflowing Sediment Volume	0.01	ac. ft
Deposited(+)/Eroded(-) Volume	0.05	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	1853	1853
Side Slope (?H:1V)	3	3
Channel Width (ft)	64	64
Channel XS Area (sq. ft)	208	208
Channel Perimeter (ft)	65	65

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	1853	ft
Thickness	1.5	ft
Protection Depth	4	ft
Tie-in Length/Depth	3.0	ft
Total Depth	7.0	ft
Area needed	618	sq. Yd
Volume	1441	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	1853	1853
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4	5
Left Levee Surface Area (sq. Yd)	8030	16677
Left Levee Volume (cu. Yd)	7137	17157
Right Levee Length (ft)	1853	1853
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4	5
Right Levee Surface Area (sq. Yd)	8030	16677
Right Levee Volume (cu. Yd)	7137	17157
Total Levee Surface Area (sq. Yd)	16060	33354
Total Levee Volume (cu. Yd)	14274	34314

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	1853	1853
Left Levee Lining Width (ft)	13	30
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	2677	6177
Left Levee Lining Volume (cu. Yd)	1338	3088
Right Levee Length (ft)	1853	1853
Right Levee Lining Width (ft)	13	30
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	2677	6177
Right Levee Lining Volume (cu. Yd)	1338	3088
Total Lining Area (sq. Yd)	5353	12353
Total Lining Volume (cu. Yd)	2676	6176

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	64	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	5.7	ft
Structure Height	8.7	ft
Number of Structures	11	
Volume per structure	62	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 4,650	
Area per structure	21	sq. Yd
Total Area	235	sq. Yd

Sedimentation Basins		
Include Sed. Basins (Yes/No)	Yes	
Number of basins	1	
Total Volume per Basin	984	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 3,936	
Other Cost	$ -	
Total cost per basin	$ 3,936	
Area per basin	1,198	sq. Yd
Total Area	1,198	sq. Yd

Structure Cost

Structure Type	Structure Type	Excavation/Construction Quantity	Units	Unit Cost	Cost Subtotal	Landscape Quantity	Units	Unit Cost	Landscape Cost	Maintenance Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	14,274	cu. Yd	$ 7.00	$ 99,918	16,060	sq. Yd	$ 9.00	$ 144,540	16,060	sq. Yd	$ 11.67	$ 187,367
Levee - LC Enhancement	Fill	20,040	cu. Yd	$ 7.00	$ 140,280	17,294	sq. Yd	$ 9.00	$ 155,646	20,040	sq. Yd	$ 11.67	$ 233,800
Levee Lining	Riprap	2,676	cu. Yd	$ 75.00	$ 200,700	5,353	sq. Yd	$ -	$ -	5,353	sq. Yd	$ 20.83	$ 111,523
Levee Lining -LC Enhancement	Riprap	3,500	cu. Yd	$ 75.00	$ 262,500	7,000	sq. Yd	$ -	$ -	7,000	sq. Yd	$ 20.83	$ 145,838
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	1,441	cu. Yd	$ 75.00	$ 108,075	618	sq. Yd	$ -	$ -	618	sq. Yd	$ 25.00	$ 15,450
Drop Structures	Riprap	11	EA	$ 4,650.00	$ 51,150	235	sq. Yd	$ -	$ -	235	sq. Yd	$ 33.33	$ 7,833
Drop Str. - LC Enhancement	Riprap	11	EA	$ 465.00	$ 5,115	24	sq. Yd	$ -	$ -	24	sq. Yd	$ 33.33	$ 783
Sedimentation Basins		1	EA	$ 3,936.00	$ 3,936	1,198	sq. Yd	$ -	$ -	1,198	sq. Yd	$ 8.33	$ 9,983
Other					$ -				$ -				$ -

Base Landscape Cost	$ 144,540	Base Maintenance Cost	$ 332,156
LC Enhancement Cost	$ 155,646	LC Enhancement Cost	$ 380,421
Total Landscape Cost	$ 300,186	Total Maintenance Cost	$ 712,578

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 463,779	$ 407,895	$ 871,674
Contingency Cost (25% of Construction Cost)	$ 115,945	$ 101,974	$ 217,919
Engineering Design Cost (5% of Construction Cost)	$ 23,189	$ 20,395	$ 43,584
Total Construction Cost	$ 602,913	$ 530,264	$ 1,133,176

Land Cost

Channel Length 1853 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	64	2.7	$100,000	$ 270,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	52	2.2	$100,000	$ 220,000
Levee LC Enhancement	48	2	$100,000	$ 200,000
Other	0	0	$100,000	$ -
Total	164	6.9		$ 690,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	4.9	$100,000	$ 490,000
LC Enhancement Cost	acre	2	$100,000	$ 200,000
Total Land Cost	acre	6.9	$100,000	$ 690,000

Total Cost

Base Total Cost	$ 1,569,609
Total Landscape Enhancement Cost	$ 1,266,331
Total Cost Including LC Enh.	$ 2,835,940

Online Basin

HEC1 ID	RR130

HEC1 Results Used to Determine Sediment Volume From Upstream

Contributing HEC1 ID							Total Volume (ac. ft)
Inflow Volume (ac. ft)							0
Volume Fraction							
Weighted Volume							0
Sediment Conc. (ppm)							
Sediment Volume (ac. ft)							0.00
Weighting Factor							
Weighted Sed. Vol. (ac. ft)							0.00

Sediment Yield

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.3	sq. mi
Total Sediment Yield Volume	0.6	ac ft

Required Minimum Sediment Volume

Sediment Volume	0.6	ac. ft

Geometry

Geometry	Base	LC Enhanced
Topography slope (ft/ft)	0.028	0.028
Basin Length (ft)	300	410
Basin Width (ft)	170	170
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	5	5
Freeboard (ft)	1	1
Effective Basin Width (ft)	156	141
Top Area (acres)	1.2	1.6
U/S-D/S Height Difference (ft)	4.8	4.8
Excess Area on Upstream (acres)	0.1	0.3

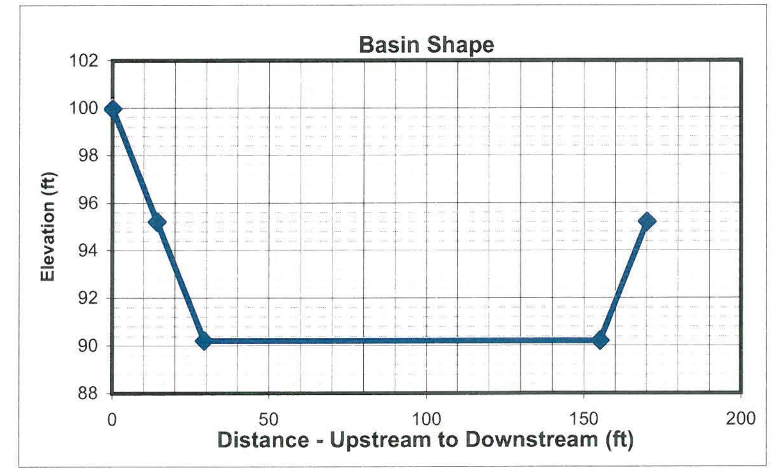
			Base	LC Enhanced
Bottom Length (ft)	270	Allocated Storage Volume (ac. ft)	3.6	3.6
Bottom Width (ft)	126	Total Available Volume (ac. ft) (incl. Freeboard)	4.6	4.9
		Total Excavation Volume (ac. ft)	7.4	8.7

Basin Outlet

Outlet Coeff	0.60	(0.6 for Orifice, 3.0 for Weir)
D (Orifice) or W (Weir)	4.00	ft
Invert Elevation	0.00	ft
Number of pipes	4	

Stage-Storage-Discharge

Elevation	0	1	2	3	4	5	6	7	9	11
Volume	0.00	0.81	1.67	2.60	3.58	4.62	5.73	6.90	9.44	12.26
Outflow	0.0	242.0	342.3	419.2	484.1	541.2	592.8	640.3	726.1	802.7



HEC1 Results

	6-hr Event	24-hr Event	Maximum
Total Flow Volume entering Basin (ac. ft)	24.0	20	24.0
Peak Inflow (cfs)	524	415	524.0
Peak Outflow (cfs)	447	370	447.0
Stage at Peak Outflow (ft)	3.4	2.4	3.4
Volume at Peak Outflow (ac. ft)	3.0	2.03	3.0

Volume Check

Total Volume needed	3.6	ac. ft
Total Volume Provided	3.6	ac. ft
Volume OK?	Yes	

Stage Check

Depth Needed	4.4	ft
Depth Provided	5	ft
Depth OK?	Yes	

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
LC Enhancement Buffer	86700	sq. ft
Other		sq. ft

Additional ROW Length	0	ft
Additional ROW Width	0	ft
Landscaping Buffer Length	100	ft
Landscaping Buffer Width	100	ft

Base Total ROW Length	300	ft
Base Total ROW Width	170	ft
LC Enh. Total ROW Length	510	ft
LC Enh. Total ROW Length	270	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	11939	14036
Excavated Area (sq. Yd)	5667	15300

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	31	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	344	sq. Yd
Material Volume	172	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	217	ft
Unit Cost	160	per ft
Cost per outlet	$34,720	
Other Cost	$ -	
Total Cost	$34,720	
Outlet Area	133	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Basin		11,939	cu. Yd	$ 4.00	$ 47,756	5,667	sq. Yd	$ 9.00	$ 51,003	5,667	sq. Yd	$ 8.33	$ 47,225
Basin - LC Enhancement		2,097	cu. Yd	$ 4.00	$ 8,388	9,633	sq. Yd	$ 9.00	$ 86,697	9,633	sq. Yd	$ 8.33	$ 80,275
Inlet	Riprap	172	sq. Yd	$ 75.00	$ 12,900	344	sq. Yd	$ -	$ -	344	sq. Yd	$ 33.33	$ 11,467
Inlet - LC Enhancement (20%Inlet)					$ 2,580				$ -				$ 2,293
Outlet	Pipe	1	EA	$ 34,720	$ 34,720	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhancement (5% Outlet)					$ 1,736				$ -				$ 111
Other					$ -				$ -				$ -

Base Landscape Cost	$ 51,003	Base Maintenance Cost	$ 60,908
LC Enh. Landscape Cost	$ 86,697	LC Enh. Maintenance Cost	$ 82,679
Total Landscape Cost	$ 137,700	Total Maintenance Cost	$ 143,588

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 95,376	$ 8,388	$ 103,764
Contingency Cost (25% of Construction Cost)	$ 23,844	$ 2,097	$ 25,941
Engineering Design Cost (5% of Construction Cost)	$ 4,769	$ 419	$ 5,188
Total Construction Cost	$ 123,989	$ 10,904	$ 134,893

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	2.0	$100,000	$ 200,000
Basin	1.2	$100,000	$ 120,000
Other		$100,000	$ -
Total	3.2	$100,000	$ 320,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	1.2	$100,000	$ 120,000
LC Enhancement Cost	acre	2.0	$100,000	$ 200,000
Total Land Cost	acre	3.2	$100,000	$ 320,000

Total Cost

Base Total Cost	$ 355,900
Total LC Enhancement Cost	$ 380,281
Total Cost Including LC Enh.	$ 736,181

Open Channel

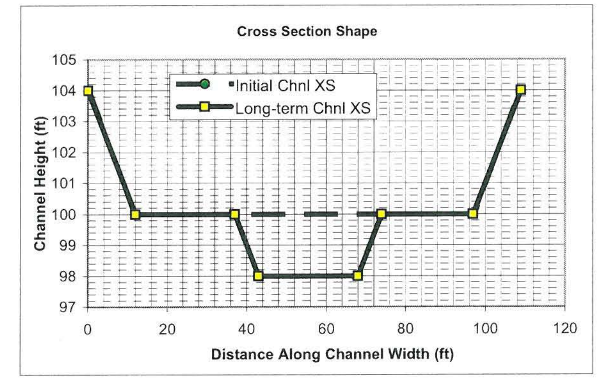
Structure ID	RR13010		HEC1 ID	13035I

Longitundal Geometry

Length	1235.4	ft
U/S Elev	1728.2	ft
D/S Elev	1697.0	ft
Initial Channel Slope	0.0252	ft/ft
Long-term Channel Slope	0.0090	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	1



Initial Channel XS Geometry

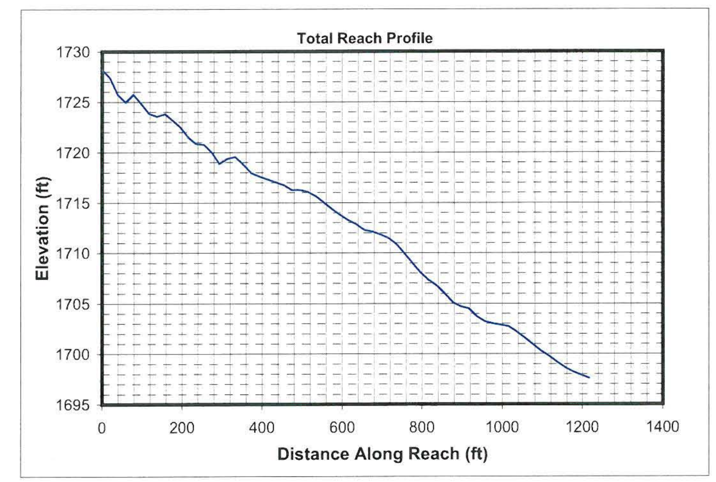
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	0	3	85	4	3	0	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	12	12	97	97	97	109
Y	104	100	100	100	100	100	100	104

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	25	3	25	6	3	23	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	37	43	68	74	97	109
Y	104	100	100	98	98	100	100	104



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

										TOTAL
Contributing HEC1 ID	RR130									
HEC1 Peak-Flow	447									447
Weighting Factor	1.00									
Flow into Channel	447									447

Reach Sediment Inflow Characteristics

U/S Contributing ID										TOTAL
HEC1 Flow Volume (ac. ft)										0
Sediment Conc. (ppm)										
Sediment Volume (ac. ft)										0.00
Weighting Factor										
Weighted Sed. Vol. (ac. ft)										0.00

Hydrology

Drainage Area	0.31	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	447	cfs	
Long-term Max. Chnl Capacity	3595	cfs	
Q2 Channel	45	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	109	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
45	86.6	21.5	0.2	100.0	100.3	2.1	0.3	86.5	0.2	0.14	0.73
112	87.7	37.5	0.4	100.0	100.4	3.0	0.4	87.6	0.4	0.24	0.80
335	90.3	73.3	0.8	100.0	100.8	4.6	0.8	90.0	0.8	0.47	0.89
447	91.3	87.4	1.0	100.0	101.0	5.1	1.0	91.0	1.0	0.56	0.92

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
45	29.4	19.0	0.6	98.0	98.7	2.3	0.7	29.2	0.7	0.39	0.51
112	32.6	34.3	1.1	98.0	99.2	3.3	1.2	32.2	1.1	0.67	0.56
335	88.4	99.0	1.1	98.0	100.4	3.4	2.4	87.6	1.1	1.36	0.56
447	89.7	118.3	1.3	98.0	100.6	3.8	2.6	88.9	1.3	1.49	0.58

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
45										0
112										0
335										0
447										0

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
45	1.74	0.9664	0.9181	Erosive	Erosive	Erosive	0.2	Stable	4.4	Stable	Stable
112	1.74	1.1337	1.0770	Erosive	Erosive	Erosive	0.2	Stable	6.2	Stable	Stable
335	1.74	1.3319	1.2653	Erosive	Erosive	Erosive	0.3	Stable	8.9	Stable	Stable
447	1.74	1.3833	1.3141	Erosive	Erosive	Erosive	0.3	Stable	9.6	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

Discharge (cfs)	Channel Width (ft) 45	112	335	447	Flow Depth (ft) 45	112	335	447	Velocity (ft/s) 45	112	335	447
Bray - Equation #1	18	29	51	59	0.9	1.3	1.8	2.0	2.7	3.1	3.6	3.7
Bray - Equation #2	23	37	67	78	1.0	1.4	2.0	2.2	1.8	2.1	2.5	2.6
Hey	5	8	16	18	2.7	3.9	5.9	6.6				
Ackers & Charlton/Lacey	18	26	41	47					1.5	1.8	2.1	2.2
Parker	46	73	126	145	0.7	1.0	1.5	1.7				
Chang	32	56	109	130	0.1	0.0	-0.2	-0.3				
Kellerhals	12	19	33	38	1.2	1.8	2.8	3.1	3.0	3.3	3.6	3.8
AMAFCA/Schumm	29	32	88	89								
Moody & Odem	8	8	8	8	0.8	0.8	0.8	0.8				
BUREC	9.9	13.9	21.1	23.5	3	4	6	6	2.7	3.4	4.4	4.8
Average	20	30	56	64	1.3	1.7	2.5	2.8	2.3	2.7	3.2	3.4
Values As Designed	29	32	88	89	0.7	1.2	2.4	2.6	2.3	3.3	3.4	3.8
Difference with Design	-9	-2	-32	-25	0.6	0.5	0.1	0.2	0.0	-0.5	-0.1	-0.4

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
45	645	415	995	1308	1561	254	208	109	3197	220	688	873
112	2644	1282	2726	6157	2285	995	626	508	8264	718	2756	2633
335	14263	4507	7815	39102	3465	4597	1972	2470	25157	3280	12585	10838
447	22111	6189	10308	63295	3850	6818	2619	3634	33605	4918	18389	15976

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
45	5352	3441	8256	10859	12956	2104	1730	901	26530	1828	5707	7242
112	8777	4256	9050	20441	7587	3304	2077	1688	27435	2383	9149	8741
335	15784	4988	8649	43271	3834	5087	2182	2734	27840	3630	13927	11993
447	18352	5137	8555	52534	3195	5659	2174	3016	27891	4082	15263	13260

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
45	278	155	285	510	501	70	59	55	668	67	317	270
112	1077	479	796	2259	778	270	180	234	1742	243	1216	843
335	3429	1410	2424	7263	2198	849	551	742	5241	765	3838	2610
447	5302	1995	3351	11719	2477	1272	755	1131	7038	1163	5781	3817

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
45	2303	1287	2367	4231	4160	582	493	455	5542	559	2628	2237
112	3577	1591	2641	7499	2584	895	598	775	5783	807	4037	2799
335	3794	1560	2682	8037	2432	939	609	821	5800	847	4247	2888
447	4400	1656	2782	9726	2055	1056	626	939	5842	965	4798	3168

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
45	0.0029	0.0049	147	0.45	0.048	0.0010	30	0.036	0.0008	0.0159	0.0010	0.0024	0.0098	0.0007	0.0034	0.0251	0.0095
112	0.0014	0.0028	193	0.59	0.050	0.0006	31	0.036	0.0004	0.0159	0.0006	0.0013	0.0098	0.0004	0.0017	0.0251	0.0092
335	0.0006	0.0015	266	0.81	0.053	0.0004	32	0.036	0.0002	0.0159	0.0003	0.0007	0.0098	0.0003	0.0008	0.0252	0.0090
447	0.0005	0.0013	289	0.88	0.054	0.0003	32	0.036	0.0002	0.0159	0.0003	0.0006	0.0098	0.0002	0.0006	0.0251	0.0089

Drop Structures

Design Slope	0.0090	ft/ft
Total Drop Needed	20.1	ft
Height of Drop Structure	3	ft
No . of Drop Structures	7	
Distance between structs.	176	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.03	sq. mi
Total Sediment Yield Volume	0.06	ac ft

Sedimentation Basins

Length	176 ft	Depth	3 ft
Width	109 ft	Side slope	3 ft/ft
Total Volume per Basin		1.16	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
45	1.1	-0.2	0.1	24.6	0.7	0.7	2.3	0.0090	0.1	1.5	2.0	4.7
112	1.1	-0.4	0.1	24.6	1.2	1.1	3.3	0.0090	0.1	1.5	2.0	4.8
335	1.1	-0.7	0.2	24.6	2.4	1.1	3.4	0.0090	0.3	1.5	2.0	5.0
447	1.1	-0.7	0.2	24.6	2.6	1.3	3.8	0.0090	0.3	1.5	2.0	5.1

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	436	cfs
Stage at Peak Flow	101.0	ft
Flow Volume	24.0	ac. ft

Freeboard

Max. Flow Depth	1.0	ft
Channel Depth as designed	4.0	ft
Available Freeboard	3.0	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	0.06	ac. ft
Outflowing Sediment Volume	0.03	ac. ft
Deposited(+)/Eroded(-) Volume	0.03	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	1235	1235
Side Slope (?H:1V)	3	3
Channel Width (ft)	109	109
Channel XS Area (sq. ft)	450	450
Channel Perimeter (ft)	111	111

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	1235	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	412	sq. Yd
Volume	1235	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	1235	1235
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4	5
Left Levee Surface Area (sq. Yd)	5352	11115
Left Levee Volume (cu. Yd)	4757	11435
Right Levee Length (ft)	1235	1235
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4	5
Right Levee Surface Area (sq. Yd)	5352	11115
Right Levee Volume (cu. Yd)	4757	11435
Total Levee Surface Area (sq. Yd)	10704	22230
Total Levee Volume (cu. Yd)	9514	22870

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	1235	1235
Left Levee Lining Width (ft)	13	30
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	1784	4117
Left Levee Lining Volume (cu. Yd)	892	2058
Right Levee Length (ft)	1235	1235
Right Levee Lining Width (ft)	13	30
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	1784	4117
Right Levee Lining Volume (cu. Yd)	892	2058
Total Lining Area (sq. Yd)	3568	8233
Total Lining Volume (cu. Yd)	1784	4116

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	109	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	5.9	ft
Structure Height	8.9	ft
Number of Structures	7	
Volume per structure	108	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 8,100	
Area per structure	36	sq. Yd
Total Area	254	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	1871	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 7,484	
Other Cost	$ -	
Total cost per basin	$ 7,484	
Area per basin	2,137	sq. Yd
Total Area	2,137	sq. Yd

Structure Cost

Structure Type	Structure Type	Excavation/Construction Quantity	Units	Unit Cost	Cost Subtotal	Landscape Quantity	Units	Unit Cost	Landscape Cost	Maintenance Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	9,514	cu. Yd	$ 7.00	$ 66,598	10,704	sq. Yd	$ 9.00	$ 96,336	10,704	sq. Yd	$ 11.67	$ 124,880
Levee - LC Enhancement	Fill	13,356	cu. Yd	$ 7.00	$ 93,492	11,526	sq. Yd	$ 9.00	$ 103,734	13,356	sq. Yd	$ 11.67	$ 155,820
Levee Lining	Riprap	1,784	cu. Yd	$ 75.00	$ 133,800	3,568	sq. Yd	$ -	$ -	3,568	sq. Yd	$ 20.83	$ 74,329
Levee Lining -LC Enhancement	Riprap	2,332	cu. Yd	$ 75.00	$ 174,900	4,666	sq. Yd	$ -	$ -	4,666	sq. Yd	$ 20.83	$ 97,199
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	1,235	cu. Yd	$ 75.00	$ 92,625	412	sq. Yd	$ -	$ -	412	sq. Yd	$ 25.00	$ 10,300
Drop Structures	Riprap	7	EA	$ 8,100.00	$ 56,700	254	sq. Yd	$ -	$ -	254	sq. Yd	$ 33.33	$ 8,467
Drop Str. - LC Enhancement	Riprap	7	EA	$ 810.00	$ 5,670	25	sq. Yd	$ -	$ -	25	sq. Yd	$ 33.33	$ 847
Sedimentation Basins		1	EA	$ 7,484.00	$ 7,484	2,137	sq. Yd	$ -	$ -	2,137	sq. Yd	$ 8.33	$ 17,808
Other					$ -				$ -				$ -

Base Landscape Cost	$ 96,336
LC Enhancement Cost	$ 103,734
Total Landscape Cost	$ 200,070

Base Maintenance Cost	$ 235,784
LC Enhancement Cost	$ 253,866
Total Maintenance Cost	$ 489,649

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 357,207	$ 274,062	$ 631,269
Contingency Cost (25% of Construction Cost)	$ 89,302	$ 68,516	$ 157,817
Engineering Design Cost (5% of Construction Cost)	$ 17,860	$ 13,703	$ 31,563
Total Construction Cost	$ 464,369	$ 356,281	$ 820,650

Land Cost

Channel Length	1235 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	109	3.1	$100,000	$ 310,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	52	1.5	$100,000	$ 150,000
Levee LC Enhancement	48	1.4	$100,000	$ 140,000
Other	0	0	$100,000	$ -
Total	209	6		$ 600,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	4.6	$100,000	$ 460,000
LC Enhancement Cost	acre	1.4	$100,000	$ 140,000
Total Land Cost	acre	6	$100,000	$ 600,000

Total Cost

Base Total Cost	$ 1,256,489
Total Landscape Enhancement Cost	$ 853,880
Total Cost Including LC Enh.	$ 2,110,369

Open Channel

Structure ID	C135L10	HEC1 ID	35I135

Longitundal Geometry

Length	12096.9	ft
U/S Elev	1697.0	ft
D/S Elev	1496.9	ft
Initial Channel Slope	0.0165	ft/ft
Long-term Channel Slope	0.0060	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	8

Initial Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	200	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	213.5	213.5	213.5	227
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	80	3	30	7	3	75	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	93.5	101	131	138.5	213.5	227
Y	104.5	100	100	97.5	97.5	100	100	104.5

Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	C135L									TOTAL
HEC1 Peak-Flow	1001									1001
Weighting Factor	1.00									
Flow into Channel	1001									1001

Reach Sediment Inflow Characteristics

U/S Contributing ID	12535I_RR12510	13035I_RR13010								TOTAL
HEC1 Flow Volume (ac. ft)	7.00	24.00								31
Sediment Conc. (ppm)	3578	3168								
Sediment Volume (ac. ft)	0.01	0.03								0.04
Weighting Factor	1	1								
Weighted Sed. Vol. (ac. ft)	0.01	0.03								0.04

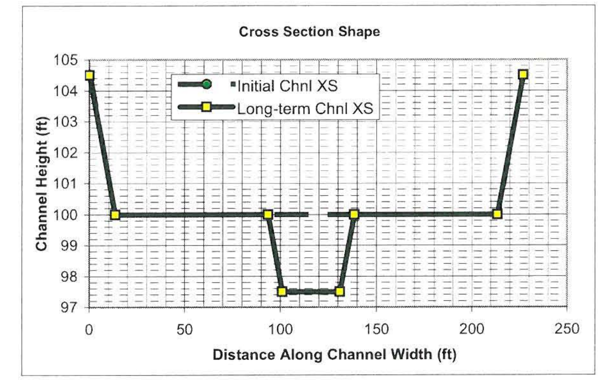
Hydrology

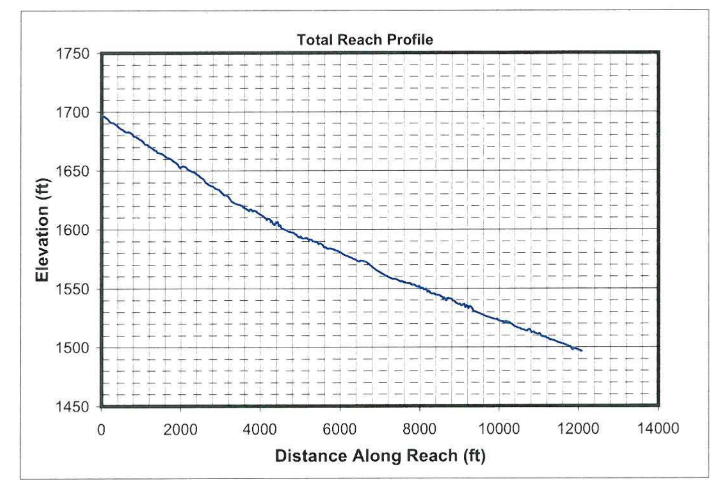
Drainage Area	2.06	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	1001	cfs	
Long-term Max. Chnl Capacity	7480	cfs	
Q2 Channel	100	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	227	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			





Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
100	201.7	55.6	0.3	100.0	100.3	1.8	0.3	201.7	0.3	0.10	0.60
250	203.0	96.5	0.5	100.0	100.5	2.6	0.5	202.9	0.5	0.18	0.66
751	205.8	187.5	0.9	100.0	100.9	4.0	0.9	205.5	0.9	0.35	0.74
1001	206.9	223.4	1.1	100.0	101.1	4.5	1.1	206.6	1.1	0.41	0.76

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
100	37.2	38.3	1.0	97.5	98.6	2.6	1.1	36.9	1.0	0.43	0.45
250	42.3	69.9	1.7	97.5	99.4	3.6	1.9	41.7	1.7	0.73	0.49
751	205.8	254.3	1.2	97.5	100.8	3.0	3.3	204.8	1.2	1.23	0.47
1001	207.3	303.0	1.5	97.5	101.0	3.3	3.5	206.2	1.5	1.32	0.48

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
	12535I_RR12510	13035I_RR13010								
100	122	270								392
250	374	843								1217
751	1486	2610								4095
1001	2161	3817								5977

Allowable Velocity

Channel Lining	Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow) Permissive Velocity (ft/s) Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	BUREC Erosive?	Neill (gravel/cobble) Non-cohesive Erosive?	Non-cohesive All'ble Vel (ft/s)	Cohesive Erosive?	Cohesive All'ble Vel (ft/s)	USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
100	1.74	0.9980	0.9481	Erosive	Erosive	Erosive	0.2	Stable	4.9	Stable	Stable
250	1.74	1.1664	1.1081	Erosive	Erosive	Erosive	0.2	Stable	7.0	Stable	Stable
751	1.74	1.3672	1.2988	Erosive	Erosive	Erosive	0.3	Stable	8.6	Stable	Stable
1001	1.74	1.4195	1.3485	Erosive	Erosive	Erosive	0.3	Stable	9.2	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	**100**	**250**	**751**	**1001**	**100**	**250**	**751**	**1001**	**100**	**250**	**751**	**1001**
Bray - Equation #1	27	44	78	91	1.2	1.7	2.4	2.7	3.0	3.4	4.0	4.2
Bray - Equation #2	35	57	102	119	1.4	1.8	2.6	2.9	2.1	2.4	2.7	2.9
Hey	8	13	25	29	3.7	5.3	8.0	8.9				
Ackers & Charlton/Lacey	25	37	58	66					1.7	2.0	2.4	2.5
Parker	69	109	188	217	0.9	1.4	2.2	2.4				
Chang	46	80	157	186	0.1	0.0	-0.3	-0.4				
Kellerhals	18	28	49	57	1.7	2.5	3.8	4.3	3.2	3.5	4.0	4.1
AMAFCA/Schumm	37	42	205	206								
Moody & Odem	16	16	16	16	1.1	1.1	1.1	1.1				
BUREC	14.4	20.4	30.7	34.2	4	5	8	9	2.8	3.5	4.7	5.0
Average	29	45	91	102	1.8	2.4	3.5	3.9	2.6	3.0	3.6	3.7
Values As Designed	37	42	205	206	1.1	1.9	3.3	3.5	2.6	3.6	3.0	3.3
Difference with Design	-7	3	-114	-104	0.6	0.4	0.2	0.3	0.0	-0.6	0.6	0.4

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
100	787	523	1109	1419	2853	235	224	111	3620	256	818	1087
250	3242	1749	3532	6711	4294	1068	790	626	9643	858	3585	3282
751	17648	6482	11241	43046	6600	5156	2679	3378	29723	4053	17564	13415
1001	27456	8991	14583	69946	7337	7681	3597	5059	39764	6133	26069	19692

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
100	2918	1939	4112	5261	10573	872	828	411	13415	947	3033	4028
250	4807	2593	5237	9949	6366	1583	1171	928	14296	1272	5314	4865
751	8721	3203	5555	21272	3261	2548	1324	1669	14688	2003	8680	6630
1001	10176	3332	5405	25924	2719	2847	1333	1875	14738	2273	9662	7299

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
100	483	250	413	873	662	104	85	108	816	106	566	406
250	1846	761	1118	3800	1039	387	253	428	2124	390	2117	1297
751	4304	1954	3232	8088	4172	930	705	994	6239	921	5042	3326
1001	6689	2815	4405	13126	4712	1425	995	1557	8430	1410	7753	4847

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
100	1789	927	1531	3236	2453	384	317	400	3024	393	2097	1505
250	2737	1128	1657	5633	1540	574	375	635	3149	579	3138	1922
751	2127	966	1597	3997	2062	459	349	491	3083	455	2491	1643
1001	2479	1043	1633	4865	1747	528	369	577	3124	523	2874	1796

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
100	0.0029	0.0044	126	0.38	0.046	0.0009	30	0.035	0.0007	0.0159	0.0009	0.0022	0.0075	0.0005	0.0032	0.0165	0.0067
250	0.0015	0.0025	165	0.50	0.049	0.0006	30	0.036	0.0004	0.0159	0.0005	0.0012	0.0075	0.0003	0.0016	0.0165	0.0064
751	0.0007	0.0013	229	0.70	0.052	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0006	0.0075	0.0002	0.0007	0.0165	0.0062
1001	0.0005	0.0011	249	0.76	0.053	0.0003	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0075	0.0002	0.0006	0.0165	0.0062

Drop Structures

Design Slope	0.0060	ft/ft
Total Drop Needed	127.6	ft
Height of Drop Structure	3	ft
No . of Drop Structures	43	
Distance between structs.	281	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.81	sq. mi
Total Sediment Yield Volume	1.55	ac ft

Sedimentation Basins

Length	281 ft	Depth	3 ft
Width	227 ft	Side slope	3 ft/ft
Total Volume per Basin		4.09	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		2	

Scour and Toe Protection (Not applicable for concrete channel)

		Pima County General Scour Equations							Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
100	1.1	-0.4	0.1	24.6	1.1	1.0	2.6	0.0060	0.1	1.5	2.5	5.4
250	1.1	-0.6	0.2	24.6	1.9	1.7	3.6	0.0060	0.2	1.5	2.5	5.6
751	1.1	-1.0	0.1	24.6	3.3	1.2	3.0	0.0060	0.4	1.5	2.5	5.7
1001	1.1	-1.0	0.1	24.6	3.5	1.5	3.3	0.0060	0.4	1.5	2.5	5.8

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	248	cfs
Stage at Peak Flow	100.5	ft
Flow Volume	27.0	ac. ft

Freeboard

Max. Flow Depth	1.1	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.4	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	1.58	ac. ft
Outflowing Sediment Volume	0.02	ac. ft
Deposited(+)/Eroded(-) Volume	1.57	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	12097	12097
Side Slope (?H:1V)	3	3
Channel Width (ft)	227	227
Channel XS Area (sq. ft)	1054.5	1054.5
Channel Perimeter (ft)	229	229

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	12097	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	4032	sq. Yd
Volume	12097	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	12097	12097
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	56453	116938
Left Levee Volume (cu. Yd)	55557	130827
Right Levee Length (ft)	12097	12097
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	56453	116938
Right Levee Volume (cu. Yd)	55557	130827
Total Levee Surface Area (sq. Yd)	112906	233876
Total Levee Volume (cu. Yd)	111114	261654

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	12097	12097
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	18818	44356
Left Levee Lining Volume (cu. Yd)	9409	22178
Right Levee Length (ft)	12097	12097
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	18818	44356
Right Levee Lining Volume (cu. Yd)	9409	22178
Total Lining Area (sq. Yd)	37635	88711
Total Lining Volume (cu. Yd)	18818	44356

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	227	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	5.8	ft
Structure Height	8.8	ft
Number of Structures	43	
Volume per structure	222	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 16,650	
Area per structure	76	sq. Yd
Total Area	3,254	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	2	
Total Volume per Basin	6599	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 26,396	
Other Cost	$ -	
Total cost per basin	$ 26,396	
Area per basin	7,096	sq. Yd
Total Area	14,192	sq. Yd

Structure Cost

Structure Type	Structure Type	Excavation/Construction Quantity	Units	Unit Cost	Cost Subtotal	Landscape Quantity	Units	Unit Cost	Landscape Cost	Maintenance Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	111,114	cu. Yd	$ 7.00	$ 777,798	112,906	sq. Yd	$ 9.00	$ 1,016,154	112,906	sq. Yd	$ 11.67	$ 1,317,237
Levee - LC Enhancement	Fill	150,540	cu. Yd	$ 7.00	$ 1,053,780	120,970	sq. Yd	$ 9.00	$ 1,088,730	150,540	sq. Yd	$ 11.67	$ 1,756,300
Levee Lining	Riprap	18,818	cu. Yd	$ 75.00	$ 1,411,350	37,635	sq. Yd	$ -	$ -	37,635	sq. Yd	$ 20.83	$ 784,065
Levee Lining -LC Enhancement	Riprap	25,538	cu. Yd	$ 75.00	$ 1,915,350	51,076	sq. Yd	$ -	$ -	51,076	sq. Yd	$ 20.83	$ 1,064,088
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	12,097	cu. Yd	$ 75.00	$ 907,275	4,032	sq. Yd	$ -	$ -	4,032	sq. Yd	$ 25.00	$ 100,800
Drop Structures	Riprap	43	EA	$ 16,650.00	$ 715,950	3,254	sq. Yd	$ -	$ -	3,254	sq. Yd	$ 33.33	$ 108,467
Drop Str. - LC Enhancement	Riprap	43	EA	$ 1,665.00	$ 71,595	325	sq. Yd	$ -	$ -	325	sq. Yd	$ 33.33	$ 10,847
Sedimentation Basins		2	EA	$ 26,396.00	$ 52,792	14,192	sq. Yd	$ -	$ -	14,192	sq. Yd	$ 8.33	$ 118,267
Other					$ -				$ -				$ -

Base Landscape Cost	$ 1,016,154	Base Maintenance Cost	$ 2,428,835
LC Enhancement Cost	$ 1,088,730	LC Enhancement Cost	$ 2,831,235
Total Landscape Cost	$ 2,104,884	Total Maintenance Cost	$ 5,260,069

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 3,865,165	$ 3,040,725	$ 6,905,890
Contingency Cost (25% of Construction Cost)	$ 966,291	$ 760,181	$ 1,726,473
Engineering Design Cost (5% of Construction Cost)	$ 193,258	$ 152,036	$ 345,295
Total Construction Cost	$ 5,024,715	$ 3,952,943	$ 8,977,657

Land Cost

Channel Length	12097 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	227	63	$100,000	$ 6,300,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	15.3	$100,000	$ 1,530,000
Levee LC Enhancement	51	14.2	$100,000	$ 1,420,000
Other	0	0	$100,000	$ -
Total	333	92.5		$ 9,250,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	78.3	$100,000	$ 7,830,000
LC Enhancement Cost	acre	14.2	$100,000	$ 1,420,000
Total Land Cost	acre	92.5	$100,000	$ 9,250,000

Total Cost

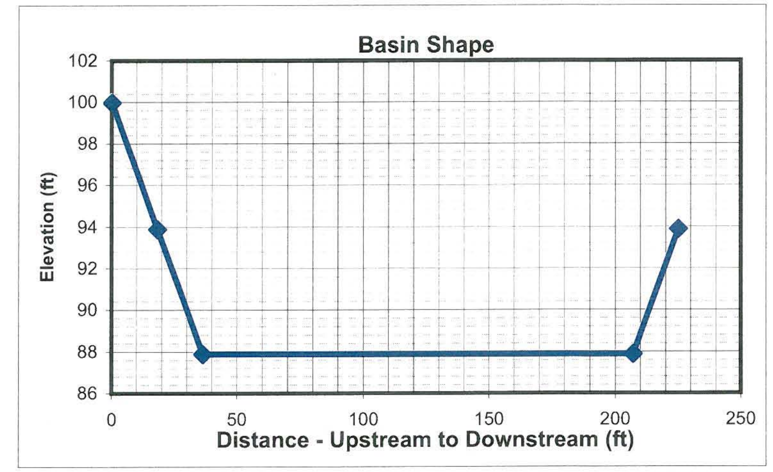
Base Total Cost	$ 16,299,703
Total Landscape Enhancement Cost	$ 9,292,907
Total Cost Including LC Enh.	$ 25,592,610

Online Basin

HEC1 ID	RR150

HEC1 Results Used to Determine Sediment Volume From Upstream

Contributing HEC1 ID							Total Volume (ac. ft)
Inflow Volume (ac. ft)							0
Volume Fraction							
Weighted Volume							0
Sediment Conc. (ppm)							
Sediment Volume (ac. ft)							0.00
Weighting Factor							
Weighted Sed. Vol. (ac. ft)							0.00



Sediment Yield

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.9	sq. mi
Total Sediment Yield Volume	1.7	ac ft

Required Minimum Sediment Volume

Sediment Volume	1.7	ac. ft

Geometry	Base	LC Enhanced
Topography slope (ft/ft)	0.027	0.027
Basin Length (ft)	400	520
Basin Width (ft)	225	225
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	6	6
Freeboard (ft)	1	1
Effective Basin Width (ft)	207	189
Top Area (acres)	2.1	2.7
U/S-D/S Height Difference (ft)	6.1	6.1
Excess Area on Upstream (acres)	0.2	0.4

			Base	LC Enhanced
Bottom Length (ft)	364	Allocated Storage Volume (ac. ft)	8.1	8.1
Bottom Width (ft)	171	Total Available Volume (ac. ft) (incl. Freeboard)	10.0	10.3
		Total Excavation Volume (ac. ft)	16.2	18.4

HEC1 Results

	6-hr Event	24-hr Event	Maximum
Total Flow Volume entering Basin (ac. ft)	62.0	57	62.0
Peak Inflow (cfs)	836	729	836.0
Peak Outflow (cfs)	724	639	724.0
Stage at Peak Outflow (ft)	4.0	3.2	4.0
Volume at Peak Outflow (ac. ft)	6.3	4.95	6.3

Volume Check

Total Volume needed	8.0	ac. ft
Total Volume Provided	8.1	ac. ft
Volume OK?	Yes	

Stage Check

Depth Needed	5.0	ft
Depth Provided	6	ft
Depth OK?	Yes	

Basin Outlet

Outlet Coeff	0.60	(0.6 for Orifice, 3.0 for Weir)
D (Orifice) or W (Weir)	4.00	ft
Invert Elevation	0.00	ft
Number of pipes	6	

Stage-Storage-Discharge

Elevation	0	1	2	4	5	6	8	9	10	11
Volume	0.00	1.47	3.01	6.32	8.10	9.96	13.93	16.05	18.25	20.54
Outflow	0.0	363.0	513.4	726.1	811.8	889.3	1026.8	1089.1	1148.0	1204.1

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
LC Enhancement Buffer	111500	sq. ft
Other		sq. ft

Additional ROW Length	0	ft
Additional ROW Width	0	ft
Landscaping Buffer Length	100	ft
Landscaping Buffer Width	100	ft

Base Total ROW Length	400	ft
Base Total ROW Width	225	ft
LC Enh. Total ROW Length	620	ft
LC Enh. Total ROW Length	325	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	26136	29685
Excavated Area (sq. Yd)	10000	22389

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	38	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	425	sq. Yd
Material Volume	213	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	273	ft
Unit Cost	160	per ft
Cost per outlet	$43,680	
Other Cost	$ -	
Total Cost	$43,680	
Outlet Area	133	sq. Yd

Structure Type	Structure Cost													
		Excavation/Construction				Landscape				Maintenance				
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Basin		26,136	cu. Yd	$ 4.00	$ 104,544	10,000	sq. Yd	$ 9.00	$ 90,000	10,000	sq. Yd	$ 8.33	$ 83,333
Basin - LC Enhancement		3,549	cu. Yd	$ 4.00	$ 14,196	12,389	sq. Yd	$ 9.00	$ 111,501	12,389	sq. Yd	$ 8.33	$ 103,242
Inlet	Riprap	213	sq. Yd	$ 75.00	$ 15,975	425	sq. Yd	$ -	$ -	425	sq. Yd	$ 33.33	$ 14,167
Inlet - LC Enhancement (20%Inlet)					$ 3,195				$ -				$ 2,833
Outlet	Pipe	1	EA	$ 43,680	$ 43,680	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhancement (5% Outlet)					$ 2,184				$ -				$ 111
Other					$ -				$ -				$ -

Base Landscape Cost	$ 90,000	
LC Enh. Landscape Cost	$ 111,501	
Total Landscape Cost	$ 201,501	

Base Maintenance Cost	$ 99,717
LC Enh. Maintenance Cost	$ 106,186
Total Maintenance Cost	$ 205,903

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 164,199	$ 14,196	$ 178,395
Contingency Cost (25% of Construction Cost)	$ 41,050	$ 3,549	$ 44,599
Engineering Design Cost (5% of Construction Cost)	$ 8,210	$ 710	$ 8,920
Total Construction Cost	$ 213,459	$ 18,455	$ 231,914

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	2.6	$100,000	$ 260,000
Basin	2.1	$100,000	$ 210,000
Other		$100,000	$ -
Total	4.7	$100,000	$ 470,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	2.1	$100,000	$ 210,000
LC Enhancement Cost	acre	2.6	$100,000	$ 260,000
Total Land Cost	acre	4.7	$100,000	$ 470,000

Total Cost

Base Total Cost	$ 613,175
Total LC Enhancement Cost	$ 496,142
Total Cost Including LC Enh.	$ 1,109,317

Open Channel

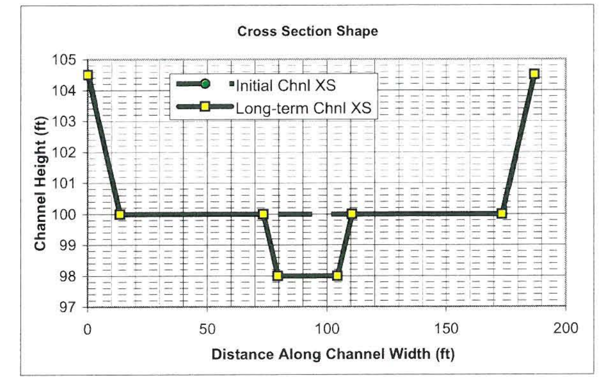
Structure ID	RR15020		HEC1 ID	150165

Longitundal Geometry

Length	4081.6	ft
U/S Elev	1760.1	ft
D/S Elev	1675.9	ft
Initial Channel Slope	0.0206	ft/ft
Long-term Channel Slope	0.0075	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	1



Initial Channel XS Geometry

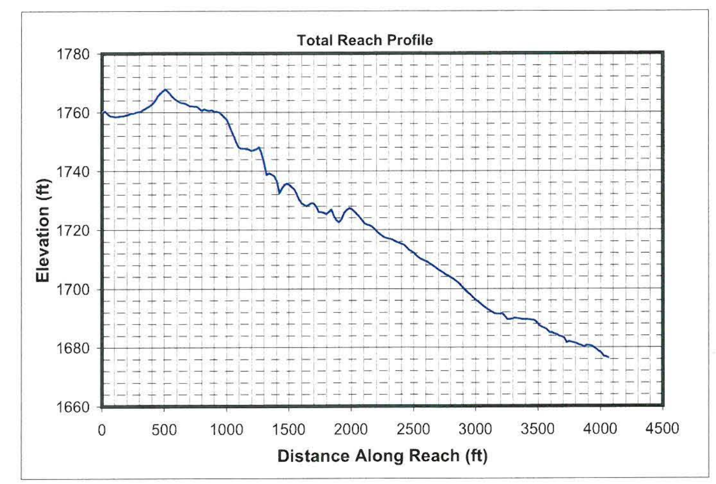
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	160	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	173.5	173.5	173.5	187
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	60	3	25	6.5	3	63	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	73.5	79.5	104.5	110.5	173.5	187
Y	104.5	100	100	98	98	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	RR150	S155								TOTAL
HEC1 Peak-Flow	724	1781								2505
Weighting Factor	1.00	0.06								
Flow into Channel	724	109								833

Reach Sediment Inflow Characteristics

U/S Contributing ID										TOTAL
HEC1 Flow Volume (ac. ft)										0
Sediment Conc. (ppm)										
Sediment Volume (ac. ft)										0.00
Weighting Factor										
Weighted Sed. Vol. (ac. ft)										0.00

Hydrology

Drainage Area	0.886	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	833	cfs	
Long-term Max. Chnl Capacity	6544	cfs	
Q2 Channel	83	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	187	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
83	161.7	42.6	0.3	100.0	100.3	2.0	0.3	161.6	0.3	0.12	0.67
208	162.9	74.1	0.5	100.0	100.5	2.8	0.5	162.8	0.5	0.21	0.73
625	165.6	144.1	0.9	100.0	100.9	4.3	0.9	165.3	0.9	0.41	0.82
833	166.7	171.7	1.0	100.0	101.1	4.9	1.1	166.3	1.0	0.49	0.84

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
83	31.7	30.1	0.9	98.0	99.1	2.8	1.1	31.4	1.0	0.50	0.50
208	36.5	55.1	1.5	98.0	99.8	3.8	1.8	35.9	1.5	0.85	0.54
625	165.8	195.3	1.2	98.0	100.8	3.2	2.8	164.9	1.2	1.32	0.52
833	167.3	232.9	1.4	98.0	101.0	3.6	3.0	166.3	1.4	1.43	0.53

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
83										0
208										0
625										0
833										0

Allowable Velocity

Channel Lining	Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
83	1.74	0.9846	0.9354	Erosive	Erosive	Erosive	0.2	Stable	5.3	Stable	Stable
208	1.74	1.1528	1.0952	Erosive	Erosive	Erosive	0.2	Stable	7.4	Stable	Stable
625	1.74	1.3531	1.2855	Erosive	Erosive	Erosive	0.3	Stable	8.9	Stable	Stable
833	1.74	1.4053	1.3350	Erosive	Erosive	Erosive	0.3	Stable	9.5	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	**83**	**208**	**625**	**833**	**83**	**208**	**625**	**833**	**83**	**208**	**625**	**833**
Bray - Equation #1	24	40	71	82	1.2	1.6	2.3	2.5	2.9	3.3	3.9	4.1
Bray - Equation #2	32	52	93	108	1.3	1.7	2.5	2.7	2.0	2.3	2.7	2.8
Hey	7	12	22	26	3.5	4.9	7.4	8.3				
Ackers & Charlton/Lacey	23	34	54	61					1.7	2.0	2.3	2.5
Parker	63	99	172	198	0.9	1.3	2.0	2.3				
Chang	44	77	150	179	0.1	0.0	-0.4	-0.5				
Kellerhals	16	26	45	52	1.6	2.3	3.6	4.0	3.2	3.5	3.9	4.0
AMAFCA/Schumm	31	36	165	166								
Moody & Odem	12	12	12	12	0.9	0.9	0.9	0.9				
BUREC	12.9	18.2	27.5	30.7	3	5	7	8	2.9	3.7	4.9	5.2
Average	27	41	81	92	1.6	2.2	3.2	3.6	2.6	3.0	3.5	3.7
Values As Designed	31	36	165	166	1.1	1.8	2.8	3.0	2.8	3.8	3.2	3.6
Difference with Design	-5	5	-84	-75	0.5	0.4	0.4	0.5	-0.2	-0.8	0.3	0.1

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
83	908	595	1336	1745	2623	320	281	143	4322	301	965	1231
208	3735	1901	3909	8241	3878	1323	895	723	11298	1000	4018	3720
625	20306	6839	11734	52772	5888	6223	2905	3680	34554	4661	18956	15320
833	31569	9434	15360	85690	6535	9251	3876	5458	46182	7027	27906	22572

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
83	4043	2650	5951	7770	11681	1426	1250	636	19247	1342	4298	5481
208	6654	3386	6964	14682	6908	2357	1595	1289	20127	1782	7159	6628
625	12059	4061	6968	31338	3497	3695	1725	2186	20519	2768	11257	9098
833	14060	4202	6841	38164	2910	4120	1726	2431	20569	3130	12429	10053

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
83	540	271	461	1033	624	128	99	118	966	122	627	453
208	2052	803	1242	4463	975	461	279	453	2489	444	2280	1449
625	4966	2132	3570	9951	3788	1160	808	1109	7367	1086	5690	3784
833	7710	3041	4924	16133	4262	1755	1120	1712	9915	1659	8659	5535

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
83	2403	1206	2053	4600	2780	571	441	526	4303	543	2790	2020
208	3655	1431	2212	7952	1737	821	498	807	4433	791	4062	2582
625	2949	1266	2120	5909	2249	689	480	659	4375	645	3379	2247
833	3434	1355	2193	7185	1898	782	499	762	4416	739	3856	2465

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
83	0.0029	0.0046	137	0.42	0.047	0.0010	30	0.036	0.0007	0.0159	0.0010	0.0023	0.0080	0.0005	0.0032	0.0206	0.0078
208	0.0014	0.0027	180	0.55	0.050	0.0006	31	0.036	0.0004	0.0159	0.0006	0.0013	0.0080	0.0003	0.0016	0.0206	0.0075
625	0.0006	0.0014	249	0.76	0.053	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0006	0.0080	0.0002	0.0007	0.0206	0.0074
833	0.0005	0.0012	271	0.83	0.053	0.0003	32	0.036	0.0002	0.0159	0.0002	0.0005	0.0080	0.0002	0.0006	0.0206	0.0073

Drop Structures

Design Slope	0.0075	ft/ft
Total Drop Needed	53.6	ft
Height of Drop Structure	3	ft
No . of Drop Structures	18	
Distance between structs.	227	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.89	sq. mi
Total Sediment Yield Volume	1.68	ac ft

Sedimentation Basins

Length	227 ft	Depth	3 ft
Width	187 ft	Side slope	3 ft/ft
Total Volume per Basin		2.67	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		3	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
83	1.1	-0.3	0.1	24.6	1.1	1.0	2.8	0.0075	0.1	1.5	2.0	4.8
208	1.1	-0.5	0.2	24.6	1.8	1.5	3.8	0.0075	0.2	1.5	2.0	4.9
625	1.1	-0.8	0.1	24.6	2.8	1.2	3.2	0.0075	0.3	1.5	2.0	5.0
833	1.1	-0.9	0.2	24.6	3.0	1.4	3.6	0.0075	0.3	1.5	2.0	5.1

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	653	cfs
Stage at Peak Flow	100.9	ft
Flow Volume	62.0	ac. ft

Freeboard

Max. Flow Depth	1.1	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.4	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	1.68	ac. ft
Outflowing Sediment Volume	0.06	ac. ft
Deposited(+)/Eroded(-) Volume	1.62	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	4082	4082
Side Slope (?H:1V)	3	3
Channel Width (ft)	187	187
Channel XS Area (sq. ft)	842.8	842.8
Channel Perimeter (ft)	189	189

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	4082	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	1361	sq. Yd
Volume	4082	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	4082	4082
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	19049	39459
Left Levee Volume (cu. Yd)	18747	44146
Right Levee Length (ft)	4082	4082
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	19049	39459
Right Levee Volume (cu. Yd)	18747	44146
Total Levee Surface Area (sq. Yd)	38098	78918
Total Levee Volume (cu. Yd)	37494	88292

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	4082	4082
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	6350	14967
Left Levee Lining Volume (cu. Yd)	3175	7484
Right Levee Length (ft)	4082	4082
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	6350	14967
Right Levee Lining Volume (cu. Yd)	3175	7484
Total Lining Area (sq. Yd)	12700	29935
Total Lining Volume (cu. Yd)	6350	14968

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	187	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	5.9	ft
Structure Height	8.9	ft
Number of Structures	18	
Volume per structure	185	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 13,875	
Area per structure	62	sq. Yd
Total Area	1,122	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	3	
Total Volume per Basin	4308	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 17,232	
Other Cost	$ -	
Total cost per basin	$ 17,232	
Area per basin	4,711	sq. Yd
Total Area	14,133	sq. Yd

Structure Type	Structure Cost													
		Excavation/Construction				Landscape				Maintenance				
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost	
Levee	Fill	37,494	cu. Yd	$ 7.00	$ 262,458	38,098	sq. Yd	$ 9.00	$ 342,882	38,098	sq. Yd	$ 11.67	$ 444,477	
Levee - LC Enhancement	Fill	50,798	cu. Yd	$ 7.00	$ 355,586	40,820	sq. Yd	$ 9.00	$ 367,380	50,798	sq. Yd	$ 11.67	$ 592,643	
Levee Lining	Riprap	6,350	cu. Yd	$ 75.00	$ 476,250	12,700	sq. Yd	$ -	$ -	12,700	sq. Yd	$ 20.83	$ 264,574	
Levee Lining -LC Enhancement	Riprap	8,618	cu. Yd	$ 75.00	$ 646,350	17,235	sq. Yd	$ -	$ -	17,235	sq. Yd	$ 20.83	$ 359,065	
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -	
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -	
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	
Toe Protection	Riprap	4,082	cu. Yd	$ 75.00	$ 306,150	1,361	sq. Yd	$ -	$ -	1,361	sq. Yd	$ 25.00	$ 34,025	
Drop Structures	Riprap	18	EA	$ 13,875.00	$ 249,750	1,122	sq. Yd	$ -	$ -	1,122	sq. Yd	$ 33.33	$ 37,400	
Drop Str. - LC Enhancement	Riprap	18	EA	$ 1,387.50	$ 24,975	112	sq. Yd	$ -	$ -	112	sq. Yd	$ 33.33	$ 3,740	
Sedimentation Basins		3	EA	$ 17,232.00	$ 51,696	14,133	sq. Yd	$ -	$ -	14,133	sq. Yd	$ 8.33	$ 117,775	
Other					$ -				$ -				$ -	

Base Landscape Cost	$ 342,882	
LC Enhancement Cost	$ 367,380	
Total Landscape Cost	$ 710,262	
Base Maintenance Cost	$ 898,251	
LC Enhancement Cost	$ 955,448	
Total Maintenance Cost	$ 1,853,699	

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,346,304	$ 1,026,911	$ 2,373,215
Contingency Cost (25% of Construction Cost)	$ 336,576	$ 256,728	$ 593,304
Engineering Design Cost (5% of Construction Cost)	$ 67,315	$ 51,346	$ 118,661
Total Construction Cost	$ 1,750,195	$ 1,334,984	$ 3,085,180

Land Cost

Channel Length	4082 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	187	17.5	$100,000	$ 1,750,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	5.2	$100,000	$ 520,000
Levee LC Enhancement	51	4.8	$100,000	$ 480,000
Other	0	0	$100,000	$ -
Total	293	27.5		$ 2,750,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	22.7	$100,000	$ 2,270,000
LC Enhancement Cost	acre	4.8	$100,000	$ 480,000
Total Land Cost	acre	27.5	$100,000	$ 2,750,000

Total Cost

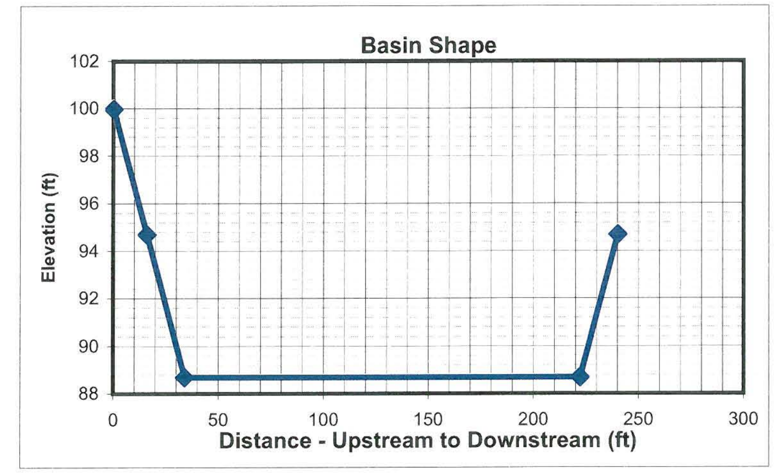
Base Total Cost	$ 5,261,328
Total Landscape Enhancement Cost	$ 3,137,812
Total Cost Including LC Enh.	$ 8,399,140

Online Basin

HEC1 ID	RR165

HEC1 Results Used to Determine Sediment Volume From Upstream

Contributing HEC1 ID	150165						Total Volume (ac. ft)
Inflow Volume (ac. ft)	62						62
Volume Fraction	1						
Weighted Volume	62						62
Sediment Conc. (ppm)	2582						
Sediment Volume (ac. ft)	0.06						0.06
Weighting Factor	1						
Weighted Sed. Vol. (ac. ft)	0.06						0.06



Sediment Yield

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.6	sq. mi
Total Sediment Yield Volume	1.2	ac ft

Required Minimum Sediment Volume

Sediment Volume	1.3	ac. ft

Geometry	Base	LC Enhanced
Topography slope (ft/ft)	0.022	0.022
Basin Length (ft)	400	500
Basin Width (ft)	240	240
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	6	6
Freeboard (ft)	1	1
Effective Basin Width (ft)	224	208
Top Area (acres)	2.2	2.8
U/S-D/S Height Difference (ft)	5.3	5.3
Excess Area on Upstream (acres)	0.2	0.4

			Base	LC Enhanced
Bottom Length (ft)	364	Allocated Storage Volume (ac. ft)	8.8	8.8
Bottom Width (ft)	188	Total Available Volume (ac. ft) (incl. Freeboard)	10.9	11.1
		Total Excavation Volume (ac. ft)	16.7	18.3

HEC1 Results

	6-hr Event	24-hr Event	Maximum
Total Flow Volume entering Basin (ac. ft)	100.0	96	100.0
Peak Inflow (cfs)	968	981	981.0
Peak Outflow (cfs)	876	841	876.0
Stage at Peak Outflow (ft)	4.3	3.9	4.3
Volume at Peak Outflow (ac. ft)	7.5	6.8	7.5

Volume Check

Total Volume needed	8.8	ac. ft
Total Volume Provided	8.8	ac. ft
Volume OK?	Yes	

Stage Check

Depth Needed	5.3	ft
Depth Provided	6	ft
Depth OK?	Yes	

Basin Outlet

Outlet Coeff	0.60	(0.6 for Orifice, 3.0 for Weir)
D (Orifice) or W (Weir)	4.00	ft
Invert Elevation	0.00	ft
Number of pipes	7	

Stage-Storage-Discharge

Elevation	0	1	2	3	4	5	6	8	10	12
Volume	0.00	1.61	3.30	5.06	6.91	8.84	10.85	15.14	19.79	24.80
Outflow	0.0	423.5	599.0	733.6	847.1	947.1	1037.5	1198.0	1339.4	1467.2

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
LC Enhancement Buffer	108000	sq. ft
Other		sq. ft

Additional ROW Length	0	ft
Additional ROW Width	0	ft
Landscaping Buffer Length	100	ft
Landscaping Buffer Width	100	ft

Base Total ROW Length	400	ft
Base Total ROW Width	240	ft
LC Enh. Total ROW Length	600	ft
LC Enh. Total ROW Length	340	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	26943	29524
Excavated Area (sq. Yd)	10667	22667

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	36	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	397	sq. Yd
Material Volume	199	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	353	ft
Unit Cost	160	per ft
Cost per outlet	$56,480	
Other Cost	$ -	
Total Cost	$56,480	
Outlet Area	133	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Basin		26,943	cu. Yd	$ 4.00	$ 107,772	10,667	sq. Yd	$ 9.00	$ 96,003	10,667	sq. Yd	$ 8.33	$ 88,892
Basin - LC Enhancement		2,581	cu. Yd	$ 4.00	$ 10,324	12,000	sq. Yd	$ 9.00	$ 108,000	12,000	sq. Yd	$ 8.33	$ 100,000
Inlet	Riprap	199	sq. Yd	$ 75.00	$ 14,925	397	sq. Yd	$ -	$ -	397	sq. Yd	$ 33.33	$ 13,233
Inlet - LC Enhancement (20%Inlet)					$ 2,985				$ -				$ 2,647
Outlet	Pipe	1	EA	$ 56,480	$ 56,480	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhancement (5% Outlet)					$ 2,824				$ -				$ 111
Other					$ -				$ -				$ -

Base Landscape Cost	$ 96,003	Base Maintenance Cost	$ 104,342
LC Enh. Landscape Cost	$ 108,000	LC Enh. Maintenance Cost	$ 102,758
Total Landscape Cost	$ 204,003	Total Maintenance Cost	$ 207,099

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 179,177	$ 10,324	$ 189,501
Contingency Cost (25% of Construction Cost)	$ 44,794	$ 2,581	$ 47,375
Engineering Design Cost (5% of Construction Cost)	$ 8,959	$ 516	$ 9,475
Total Construction Cost	$ 232,930	$ 13,421	$ 246,351

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	2.5	$100,000	$ 250,000
Basin	2.2	$100,000	$ 220,000
Other		$100,000	$ -
Total	4.7	$100,000	$ 470,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	2.2	$100,000	$ 220,000
LC Enhancement Cost	acre	2.5	$100,000	$ 250,000
Total Land Cost	acre	4.7	$100,000	$ 470,000

Total Cost

Base Total Cost	$ 653,275
Total LC Enhancement Cost	$ 474,179
Total Cost Including LC Enh.	$ 1,127,453

Open Channel

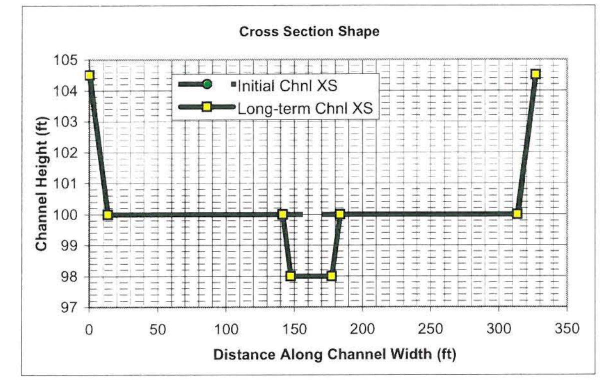
Structure ID	C17510A		HEC1 ID	165175

Longitundal Geometry

Length	7076.2	ft
U/S Elev	1674.9	ft
D/S Elev	1546.4	ft
Initial Channel Slope	0.0182	ft/ft
Long-term Channel Slope	0.0065	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	8



Initial Channel XS Geometry

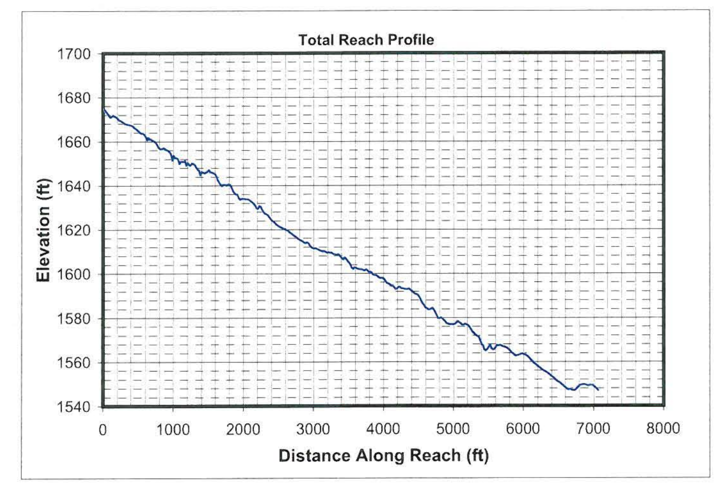
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	300	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	313.5	313.5	313.5	327
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	128	3	30	6.5	3	130	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	141.5	147.5	177.5	183.5	313.5	327
Y	104.5	100	100	98	98	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	RR165	S170								TOTAL
HEC1 Peak-Flow	876	1802								2678
Weighting Factor	1.00	0.41								
Flow into Channel	876	740								1616

Reach Sediment Inflow Characteristics

U/S Contributing ID										TOTAL
HEC1 Flow Volume (ac. ft)										0
Sediment Conc. (ppm)										
Sediment Volume (ac. ft)										0.00
Weighting Factor										
Weighted Sed. Vol. (ac. ft)										0.00

Hydrology

Drainage Area	1.991	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	1616	cfs	
Long-term Max. Chnl Capacity	10797	cfs	
Q2 Channel	162	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	327	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
162	301.8	84.6	0.3	100.0	100.3	1.9	0.3	301.7	0.3	0.11	0.64
404	303.1	146.9	0.5	100.0	100.5	2.8	0.5	302.9	0.5	0.20	0.70
1212	305.9	284.8	0.9	100.0	100.9	4.3	0.9	305.6	0.9	0.38	0.78
1616	307.1	339.0	1.1	100.0	101.1	4.8	1.1	306.7	1.1	0.45	0.80

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
162	39.4	51.0	1.3	98.0	99.5	3.2	1.5	38.9	1.3	0.60	0.49
404	303.3	199.9	0.7	98.0	100.4	2.0	2.4	302.5	0.7	0.98	0.44
1212	307.2	388.4	1.3	98.0	101.0	3.1	3.0	306.3	1.3	1.23	0.49
1616	308.8	462.5	1.5	98.0	101.3	3.5	3.3	307.7	1.5	1.33	0.50

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
162										0
404										0
1212										0
1616										0

Allowable Velocity

Channel Lining	Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow) Permissive Velocity (ft/s): Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	BUREC Erosive?	Neill (gravel/cobble) Non-cohesive: Erosive?	All'ble Vel (ft/s)	Cohesive: Erosive?	All'ble Vel (ft/s)	USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
162	1.74	1.0034	0.9533	Erosive	Erosive	Erosive	0.2	Stable	6.1	Stable	Stable
404	1.74	1.1722	1.1136	Erosive	Erosive	Erosive	0.2	Stable	6.9	Stable	Stable
1212	1.74	1.3737	1.3050	Erosive	Erosive	Erosive	0.3	Stable	8.7	Stable	Stable
1616	1.74	1.4263	1.3550	Erosive	Erosive	Erosive	0.3	Stable	9.3	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	**162**	**404**	**1212**	**1616**	**162**	**404**	**1212**	**1616**	**162**	**404**	**1212**	**1616**
Bray - Equation #1	35	56	100	117	1.4	2.0	2.8	3.1	3.2	3.7	4.3	4.4
Bray - Equation #2	45	74	132	153	1.6	2.2	3.1	3.4	2.2	2.5	2.9	3.1
Hey	10	17	32	38	4.5	6.3	9.6	10.7				
Ackers & Charlton/Lacey	30	45	71	80					1.9	2.2	2.6	2.7
Parker	87	138	239	276	1.1	1.7	2.6	3.0				
Chang	63	110	214	255	0.1	-0.1	-0.6	-0.8				
Kellerhals	23	36	63	72	2.1	3.0	4.7	5.2	3.4	3.7	4.1	4.3
AMAFCA/Schumm	39	303	307	308								
Moody & Odem	16	16	16	16	1.0	1.0	1.0	1.0				
BUREC	17.0	24.0	36.2	40.4	5	6	10	11	3.3	4.1	5.4	5.8
Average	37	82	121	136	2.0	2.8	4.1	4.6	2.8	3.2	3.9	4.1
Values As Designed	39	303	306	308	1.5	2.4	3.0	3.3	3.2	2.0	3.1	3.5
Difference with Design	-2	-221	-185	-172	0.6	0.4	1.1	1.3	-0.4	1.2	0.8	0.6

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
162	1509	989	2144	2819	4656	494	446	231	6854	486	1600	2021
404	6218	3212	6466	13345	6917	2106	1473	1211	18039	1637	6786	6128
1212	33953	11702	19838	85857	10506	10016	4855	6295	55325	7739	32537	25329
1616	52854	16177	25881	139662	11649	14910	6490	9370	73968	11708	48083	37341

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
162	3464	2269	4922	6471	10688	1134	1024	530	15735	1115	3674	4639
404	5710	2950	5937	12255	6352	1934	1353	1112	16565	1503	6232	5628
1212	10393	3582	6073	26281	3216	3066	1486	1927	16935	2369	9960	7753
1616	12134	3714	5942	32063	2674	3423	1490	2151	16982	2688	11039	8573

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
162	1095	498	769	2166	868	243	172	251	1531	237	1271	827
404	1494	800	1452	2450	4079	289	283	271	3483	352	1655	1510
1212	8125	3560	5797	15726	6689	1802	1302	1859	11461	1741	9425	6135
1616	12644	5102	7986	25559	7524	2742	1818	2888	15450	2669	14428	8983

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
162	2513	1142	1767	4973	1993	557	396	577	3516	544	2918	1900
404	1372	735	1334	2250	3745	266	260	249	3199	324	1520	1387
1212	2487	1090	1775	4814	2047	551	399	569	3508	533	2885	1878
1616	2903	1171	1833	5868	1727	630	417	663	3547	613	3312	2062

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
162	0.0028	0.0043	133	0.40	0.047	0.0009	30	0.035	0.0007	0.0159	0.0009	0.0022	0.0064	0.0004	0.0030	0.0181	0.0068
404	0.0014	0.0025	175	0.53	0.049	0.0006	30	0.036	0.0004	0.0159	0.0005	0.0012	0.0064	0.0002	0.0015	0.0181	0.0065
1212	0.0006	0.0013	242	0.74	0.052	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0006	0.0064	0.0001	0.0007	0.0182	0.0063
1616	0.0005	0.0011	264	0.80	0.053	0.0003	32	0.036	0.0002	0.0159	0.0002	0.0005	0.0064	0.0001	0.0005	0.0181	0.0063

Drop Structures

Design Slope	0.0065	ft/ft
Total Drop Needed	82.5	ft
Height of Drop Structure	3	ft
No . of Drop Structures	28	
Distance between structs.	253	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.60	sq. mi
Total Sediment Yield Volume	1.14	ac ft

Sedimentation Basins

Length	253 ft	Depth	3 ft
Width	327 ft	Side slope	3 ft/ft
Total Volume per Basin		5.34	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

Discharge	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
162	1.1	-0.4	0.1	24.6	1.5	1.3	3.2	0.0065	0.2	1.5	2.0	4.8
404	1.1	-0.9	0.1	24.6	2.4	0.7	2.0	0.0065	0.2	1.5	2.0	4.9
1212	1.1	-0.9	0.1	24.6	3.0	1.3	3.1	0.0065	0.3	1.5	2.0	5.1
1616	1.1	-0.9	0.2	24.6	3.3	1.5	3.5	0.0065	0.4	1.5	2.0	5.1

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	810	cfs
Stage at Peak Flow	101.0	ft
Flow Volume	100.0	ac. ft

Freeboard

Max. Flow Depth	1.1	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.4	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	1.14	ac. ft
Outflowing Sediment Volume	0.08	ac. ft
Deposited(+)/Eroded(-) Volume	1.06	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	7076	7076
Side Slope (?H:1V)	3	3
Channel Width (ft)	327	327
Channel XS Area (sq. ft)	1482.8	1482.8
Channel Perimeter (ft)	329	329

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	7076	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	2359	sq. Yd
Volume	7076	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	7076	7076
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	33021	68401
Left Levee Volume (cu. Yd)	32497	76526
Right Levee Length (ft)	7076	7076
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	33021	68401
Right Levee Volume (cu. Yd)	32497	76526
Total Levee Surface Area (sq. Yd)	66042	136802
Total Levee Volume (cu. Yd)	64994	153052

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	7076	7076
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	11007	25945
Left Levee Lining Volume (cu. Yd)	5504	12973
Right Levee Length (ft)	7076	7076
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	11007	25945
Right Levee Lining Volume (cu. Yd)	5504	12973
Total Lining Area (sq. Yd)	22014	51891
Total Lining Volume (cu. Yd)	11008	25946

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	327	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	6.1	ft
Structure Height	9.1	ft
Number of Structures	28	
Volume per structure	330	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 24,750	
Area per structure	109	sq. Yd
Total Area	3,052	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	8615	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 34,460	
Other Cost	$ -	
Total cost per basin	$ 34,460	
Area per basin	9,182	sq. Yd
Total Area	9,182	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	64,994	cu. Yd	$ 7.00	$ 454,958	66,042	sq. Yd	$ 9.00	$ 594,378	66,042	sq. Yd	$ 11.67	$ 770,490
Levee - LC Enhancement	Fill	88,058	cu. Yd	$ 7.00	$ 616,406	70,760	sq. Yd	$ 9.00	$ 636,840	88,058	sq. Yd	$ 11.67	$ 1,027,343
Levee Lining	Riprap	11,008	cu. Yd	$ 75.00	$ 825,600	22,014	sq. Yd	$ -	$ -	22,014	sq. Yd	$ 20.83	$ 458,630
Levee Lining -LC Enhancement	Riprap	14,938	cu. Yd	$ 75.00	$ 1,120,350	29,876	sq. Yd	$ -	$ -	29,876	sq. Yd	$ 20.83	$ 622,426
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	7,076	cu. Yd	$ 75.00	$ 530,700	2,359	sq. Yd	$ -	$ -	2,359	sq. Yd	$ 25.00	$ 58,975
Drop Structures	Riprap	28	EA	$ 24,750.00	$ 693,000	3,052	sq. Yd	$ -	$ -	3,052	sq. Yd	$ 33.33	$ 101,733
Drop Str. - LC Enhancement	Riprap	28	EA	$ 2,475.00	$ 69,300	305	sq. Yd	$ -	$ -	305	sq. Yd	$ 33.33	$ 10,173
Sedimentation Basins		1	EA	$ 34,460.00	$ 34,460	9,182	sq. Yd	$ -	$ -	9,182	sq. Yd	$ 8.33	$ 76,517
Other					$ -				$ -				$ -

Base Landscape Cost	$ 594,378	
LC Enhancement Cost	$ 636,840	
Total Landscape Cost	$ 1,231,218	

Base Maintenance Cost	$ 1,466,345
LC Enhancement Cost	$ 1,659,943
Total Maintenance Cost	$ 3,126,287

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 2,538,718	$ 1,806,056	$ 4,344,774
Contingency Cost (25% of Construction Cost)	$ 634,680	$ 451,514	$ 1,086,194
Engineering Design Cost (5% of Construction Cost)	$ 126,936	$ 90,303	$ 217,239
Total Construction Cost	$ 3,300,333	$ 2,347,873	$ 5,648,206

Land Cost

Channel Length	7076 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	327	53.1	$100,000	$ 5,310,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	8.9	$100,000	$ 890,000
Levee LC Enhancement	51	8.3	$100,000	$ 830,000
Other	0	0	$100,000	$ -
Total	433	70.3		$ 7,030,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	62	$100,000	$ 6,200,000
LC Enhancement Cost	acre	8.3	$100,000	$ 830,000
Total Land Cost	acre	70.3	$100,000	$ 7,030,000

Total Cost

Base Total Cost	$ 11,561,056
Total Landscape Enhancement Cost	$ 5,474,655
Total Cost Including LC Enh.	$ 17,035,711

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

Sub-area: Wagner Wash, Alternative: B2
Open Channel Structure ID: C17510A

Open Channel

Structure ID	C17510B	HEC1 ID	165175

Longitundal Geometry

Length	6169.2	ft
U/S Elev	1546.4	ft
D/S Elev	1462.9	ft
Initial Channel Slope	0.0135	ft/ft
Long-term Channel Slope	0.0050	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	8

Initial Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	200	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	213.5	213.5	213.5	227
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	80	3	30	7.5	3	72	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	93.5	102.5	132.5	141.5	213.5	227
Y	104.5	100	100	97	97	100	100	104.5

Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	C175									TOTAL
HEC1 Peak-Flow	1278									1278
Weighting Factor	1.00									
Flow into Channel	1278									1278

Reach Sediment Inflow Characteristics

U/S Contributing ID	165175_C17510A									TOTAL
HEC1 Flow Volume (ac. ft)	100.00									100
Sediment Conc. (ppm)	2062									
Sediment Volume (ac. ft)	0.08									0.08
Weighting Factor	1									
Weighted Sed. Vol. (ac. ft)	0.08									0.08

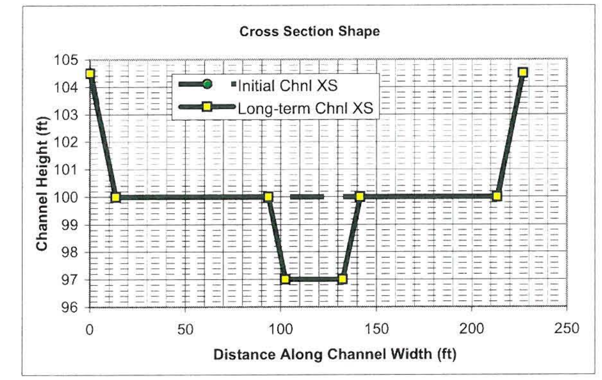
Hydrology

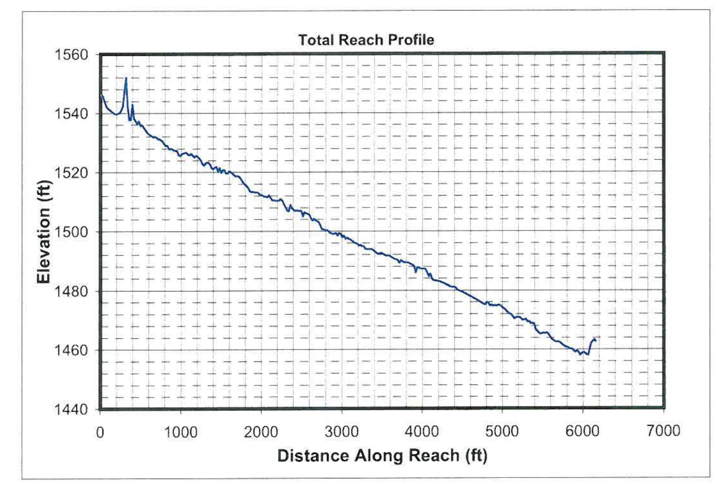
Drainage Area	3.19	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	1278	cfs	
Long-term Max. Chnl Capacity	7078	cfs	
Q2 Channel	128	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	227	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			





Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
128	202.2	68.4	0.3	100.0	100.3	1.9	0.3	202.0	0.3	0.11	0.57
320	203.7	118.8	0.6	100.0	100.6	2.7	0.6	203.5	0.6	0.18	0.62
959	207.2	231.2	1.1	100.0	101.1	4.1	1.1	206.8	1.1	0.35	0.69
1278	208.5	275.5	1.3	100.0	101.3	4.6	1.3	208.1	1.3	0.42	0.71

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
128	38.8	47.6	1.2	97.0	98.4	2.7	1.4	38.4	1.2	0.43	0.42
320	44.9	87.5	1.9	97.0	99.4	3.7	2.4	44.2	2.0	0.74	0.46
959	207.0	311.7	1.5	97.0	101.0	3.1	4.0	205.8	1.5	1.24	0.44
1278	208.9	371.7	1.8	97.0	101.3	3.4	4.3	207.5	1.8	1.33	0.45

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
	165175_C17510A									
128	827									827
320	1510									1510
959	6135									6135
1278	8983									8983

Allowable Velocity

Channel Lining	Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuosity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
128	1.74	1.0614	1.0083	Erosive	Erosive	Erosive	0.2	Stable	5.1	Stable	Stable
320	1.74	1.2293	1.1679	Erosive	Erosive	Erosive	0.3	Stable	7.2	Stable	Stable
959	1.74	1.4298	1.3583	Erosive	Erosive	Erosive	0.3	Stable	8.9	Stable	Stable
1278	1.74	1.4819	1.4078	Erosive	Erosive	Erosive	0.3	Stable	9.5	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	128	320	959	1278	128	320	959	1278	128	320	959	1278
Bray - Equation #1	31	50	89	103	1.3	1.8	2.6	2.9	3.1	3.5	4.1	4.3
Bray - Equation #2	40	65	116	136	1.5	2.0	2.9	3.2	2.1	2.4	2.8	3.0
Hey	9	15	28	33	4.1	5.8	8.8	9.8				
Ackers & Charlton/Lacey	28	41	64	73					1.8	2.1	2.5	2.6
Parker	78	123	213	246	1.0	1.5	2.4	2.7				
Chang	50	88	171	204	0.2	0.1	-0.3	-0.4				
Kellerhals	20	32	56	64	1.9	2.7	4.2	4.8	3.3	3.6	4.1	4.2
AMAFCA/Schumm	38	44	206	208								
Moody & Odem	19	19	19	19	1.1	1.1	1.1	1.1				
BUREC	16.4	23.1	34.9	38.8	4	6	9	10	2.8	3.5	4.6	5.0
Average	33	50	100	112	1.9	2.7	3.9	4.3	2.6	3.1	3.6	3.8
Values As Designed	38	44	206	208	1.4	2.4	4.0	4.3	2.7	3.7	3.1	3.4
Difference with Design	-5	6	-106	-95	0.5	0.3	-0.1	0.0	-0.1	-0.6	0.6	0.4

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	**Zeller Fullerton**	**Ackers White**	**Einstein**	**Engelund/Hansen**	**Kalinske**	**Laursen**	**MPM**	**Rottner**	**Schoklitsch**	**Toffaleti**	**Yang**	**Average**
128	870	558	1127	1544	2870	240	227	130	3414	257	924	1106
320	3590	1872	3583	7293	4320	1086	802	715	9110	898	4009	3389
959	19439	6928	11373	46668	6653	5219	2707	3788	28099	4340	19582	14072
1278	30224	9611	14761	75772	7401	7772	3634	5661	37594	6596	29071	20736

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	**Zeller Fullerton**	**Ackers White**	**Einstein**	**Engelund/Hansen**	**Kalinske**	**Laursen**	**MPM**	**Rottner**	**Schoklitsch**	**Toffaleti**	**Yang**	**Average**
128	2526	1621	3271	4481	8333	696	660	378	9911	746	2681	3210
320	4169	2174	4160	8469	5016	1262	931	830	10578	1043	4655	3935
959	7524	2681	4402	18063	2575	2020	1048	1466	10876	1680	7580	5447
1278	8774	2790	4285	21996	2148	2256	1055	1643	10913	1915	8439	6020

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	**Zeller Fullerton**	**Ackers White**	**Einstein**	**Engelund/Hansen**	**Kalinske**	**Laursen**	**MPM**	**Rottner**	**Schoklitsch**	**Toffaleti**	**Yang**	**Average**
128	534	271	424	952	686	106	88	125	790	113	631	429
320	2020	822	1148	4091	1090	394	259	485	2059	418	2342	1375
959	4857	2154	3338	9037	4241	971	731	1169	6059	1006	5736	3573
1278	7542	3096	4556	14649	4792	1486	1030	1818	8186	1544	8805	5228

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	**Zeller Fullerton**	**Ackers White**	**Einstein**	**Engelund/Hansen**	**Kalinske**	**Laursen**	**MPM**	**Rottner**	**Schoklitsch**	**Toffaleti**	**Yang**	**Average**
128	1549	787	1231	2763	1993	308	254	363	2294	329	1833	1246
320	2346	955	1333	4750	1265	457	301	563	2391	485	2720	1597
959	1880	834	1292	3498	1641	376	283	453	2345	389	2220	1383
1278	2189	899	1323	4253	1391	431	299	528	2376	448	2556	1518

Equilibrium Slope Calculations

Discharge	**Schoklitsch**	**MPM**	**Shields**							**Lane's Tractive Force**		**Average BUREC**	**Bray**	**Henderson**	**BUREC**	**Simplified AMAFCA**	**Average**
Q (cfs)	**SL (ft/ft)**	**SL (ft/ft)**	**R*o**	**U***	**T*o**	**Slo (ft/ft)**	**R*f**	**T*f**	**Slf (ft/ft)**	**Tc (Fig. 4)**	**SL (ft/ft)**	**SL (ft/ft)**	**SL (ft/ft)**	**SL (ft/ft)**	**SL (ft/ft)**	**Ss (ft/ft)**	**SL (ft/ft)**
128	0.0025	0.0036	126	0.38	0.046	0.0007	30	0.035	0.0006	0.0159	0.0008	0.0018	0.0069	0.0004	0.0027	0.0135	0.0057
320	0.0012	0.0021	165	0.50	0.049	0.0005	30	0.036	0.0003	0.0159	0.0004	0.0010	0.0069	0.0003	0.0013	0.0135	0.0054
959	0.0006	0.0011	229	0.70	0.052	0.0003	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0069	0.0002	0.0006	0.0135	0.0053
1278	0.0004	0.0009	249	0.76	0.053	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0004	0.0069	0.0001	0.0005	0.0135	0.0053

Drop Structures

Design Slope	0.0050	ft/ft
Total Drop Needed	52.7	ft
Height of Drop Structure	3	ft
No . of Drop Structures	18	
Distance between structs.	343	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	1.80	sq. mi
Total Sediment Yield Volume	3.42	ac ft

Sedimentation Basins

Length	343 ft	Depth	3 ft
Width	227 ft	Side slope	3 ft/ft
Total Volume per Basin		5.01	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		3	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations											
Discharge	**COT/PC**	**General**	**Antidune**	**Bend**	**Max. Depth**	**Hyd. Depth**	**Avg Vel**	**Se**	**Bend Scour**	**LongTerm Scour**	**Thalweg channel**	**Total**
Q (cfs)	**Sinuosity**	**Zgs (ft)**	**Za (ft)**	**Angle (deg)**	**Ymax (ft)**	**Yh (ft)**	**Vm (ft/s)**		**Zbs (ft)**	**Zls (ft)**	**Zlft (ft)**	**Zt (ft)**
128	1.1	-0.4	0.1	24.6	1.4	1.2	2.7	0.0050	0.1	1.5	3.0	6.1
320	1.1	-0.7	0.2	24.6	2.4	2.0	3.7	0.0050	0.3	1.5	3.0	6.3
959	1.1	-1.2	0.1	24.6	4.0	1.5	3.1	0.0050	0.4	1.5	3.0	6.5
1278	1.1	-1.2	0.2	24.6	4.3	1.8	3.4	0.0050	0.5	1.5	3.0	6.6

Toe Protection Needed	7.0	ft

HEC1 Results For Open Channel

Peak Flow	810	cfs
Stage at Peak Flow	101.0	ft
Flow Volume	100.0	ac. ft

Freeboard

Max. Flow Depth	1.3	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.2	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	3.50	ac. ft
Outflowing Sediment Volume	0.06	ac. ft
Deposited(+)/Eroded(-) Volume	3.44	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	6169	6169
Side Slope (?H:1V)	3	3
Channel Width (ft)	227	227
Channel XS Area (sq. ft)	1077.8	1077.8
Channel Perimeter (ft)	229	229

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	6169	ft
Thickness	1.5	ft
Protection Depth	7	ft
Tie-in Length/Depth	3.0	ft
Total Depth	10.0	ft
Area needed	2056	sq. Yd
Volume	6854	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	6169	6169
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	28789	59634
Left Levee Volume (cu. Yd)	28332	66717
Right Levee Length (ft)	6169	6169
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	28789	59634
Right Levee Volume (cu. Yd)	28332	66717
Total Levee Surface Area (sq. Yd)	57578	119268
Total Levee Volume (cu. Yd)	56664	133434

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	6169	6169
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	9596	22620
Left Levee Lining Volume (cu. Yd)	4798	11310
Right Levee Length (ft)	6169	6169
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	9596	22620
Right Levee Lining Volume (cu. Yd)	4798	11310
Total Lining Area (sq. Yd)	19192	45239
Total Lining Volume (cu. Yd)	9596	22620

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	227	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	6.7	ft
Structure Height	9.7	ft
Number of Structures	18	
Volume per structure	243	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 18,225	
Area per structure	76	sq. Yd
Total Area	1,362	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	3	
Total Volume per Basin	8083	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 32,332	
Other Cost	$ -	
Total cost per basin	$ 32,332	
Area per basin	8,644	sq. Yd
Total Area	25,932	sq. Yd

Structure Cost

Structure Type	Structure Type	Excavation/Construction Quantity	Units	Unit Cost	Cost Subtotal	Landscape Quantity	Units	Unit Cost	Landscape Cost	Maintenance Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	56,664	cu. Yd	$ 7.00	$ 396,648	57,578	sq. Yd	$ 9.00	$ 518,202	57,578	sq. Yd	$ 11.67	$ 671,743
Levee - LC Enhancement	Fill	76,770	cu. Yd	$ 7.00	$ 537,390	61,690	sq. Yd	$ 9.00	$ 555,210	76,770	sq. Yd	$ 11.67	$ 895,650
Levee Lining	Riprap	9,596	cu. Yd	$ 75.00	$ 719,700	19,192	sq. Yd	$ -	$ -	19,192	sq. Yd	$ 20.83	$ 399,843
Levee Lining -LC Enhancement	Riprap	13,024	cu. Yd	$ 75.00	$ 976,800	26,047	sq. Yd	$ -	$ -	26,047	sq. Yd	$ 20.83	$ 542,644
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	6,854	cu. Yd	$ 75.00	$ 514,050	2,056	sq. Yd	$ -	$ -	2,056	sq. Yd	$ 25.00	$ 51,400
Drop Structures	Riprap	18	EA	$ 18,225.00	$ 328,050	1,362	sq. Yd	$ -	$ -	1,362	sq. Yd	$ 33.33	$ 45,400
Drop Str. - LC Enhancement	Riprap	18	EA	$ 1,822.50	$ 32,805	136	sq. Yd	$ -	$ -	136	sq. Yd	$ 33.33	$ 4,540
Sedimentation Basins		3	EA	$ 32,332.00	$ 96,996	25,932	sq. Yd	$ -	$ -	25,932	sq. Yd	$ 8.33	$ 216,100
Other					$ -				$ -				$ -

Base Landscape Cost	$ 518,202	
LC Enhancement Cost	$ 555,210	
Total Landscape Cost	$ 1,073,412	

Base Maintenance Cost	$ 1,384,486
LC Enhancement Cost	$ 1,442,834
Total Maintenance Cost	$ 2,827,319

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 2,055,444	$ 1,546,995	$ 3,602,439
Contingency Cost (25% of Construction Cost)	$ 513,861	$ 386,749	$ 900,610
Engineering Design Cost (5% of Construction Cost)	$ 102,772	$ 77,350	$ 180,122
Total Construction Cost	$ 2,672,077	$ 2,011,094	$ 4,683,171

Land Cost

Channel Length	6169 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	227	32.1	$100,000	$ 3,210,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	7.8	$100,000	$ 780,000
Levee LC Enhancement	51	7.2	$100,000	$ 720,000
Other	0	0	$100,000	$ -
Total	333	47.1		$ 4,710,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

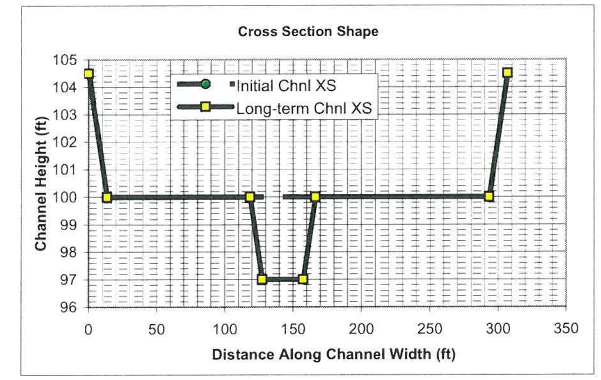
Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	39.9	$100,000	$ 3,990,000
LC Enhancement Cost	acre	7.2	$100,000	$ 720,000
Total Land Cost	acre	47.1	$100,000	$ 4,710,000

Total Cost

Base Total Cost	$ 8,564,765
Total Landscape Enhancement Cost	$ 4,729,137
Total Cost Including LC Enh.	$ 13,293,902

Open Channel

Structure ID	RR17510		HEC1 ID	175R



Longitundal Geometry

Length	3035.2	ft
U/S Elev	1462.9	ft
D/S Elev	1413.1	ft
Initial Channel Slope	0.0164	ft/ft
Long-term Channel Slope	0.0060	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	2

Initial Channel XS Geometry

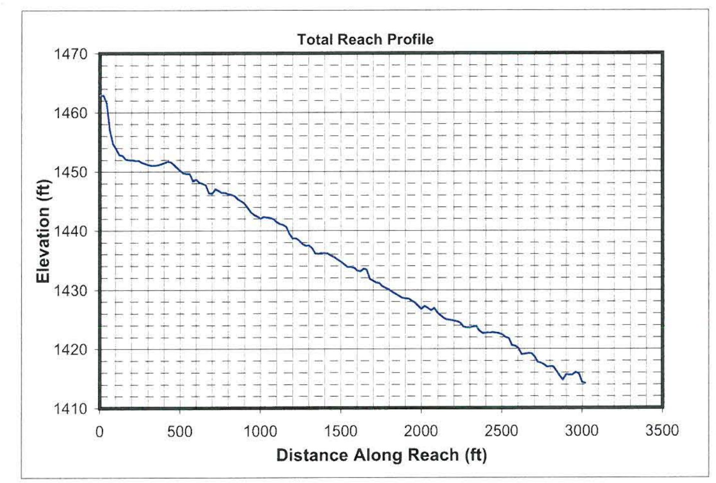
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	280	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	293.5	293.5	293.5	307
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	105	3	30	7.5	3	127	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	118.5	127.5	157.5	166.5	293.5	307
Y	104.5	100	100	97	97	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	C175	S190								TOTAL
HEC1 Peak-Flow	1278	2590								3868
Weighting Factor	1.00	0.05								
Flow into Channel	1278	119								1397

Reach Sediment Inflow Characteristics

U/S Contributing ID	165175_C17510 B									TOTAL
HEC1 Flow Volume (ac. ft)	100.00									100
Sediment Conc. (ppm)	1597									
Sediment Volume (ac. ft)	0.06									0.06
Weighting Factor	1									
Weighted Sed. Vol. (ac. ft)	0.06									0.06

Hydrology

Drainage Area	2.607	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	1397	cfs	
Long-term Max. Chnl Capacity	10268	cfs	
Q2 Channel	140	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	307	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
140	281.8	77.8	0.3	100.0	100.3	1.8	0.3	281.7	0.3	0.10	0.60
349	283.0	135.0	0.5	100.0	100.5	2.6	0.5	282.9	0.5	0.18	0.66
1048	285.9	261.9	0.9	100.0	100.9	4.0	0.9	285.6	0.9	0.35	0.74
1397	287.0	311.8	1.1	100.0	101.1	4.5	1.1	286.6	1.1	0.41	0.76

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
140	38.8	47.6	1.2	97.0	98.4	2.9	1.4	38.3	1.2	0.52	0.46
349	44.9	87.4	1.9	97.0	99.4	4.0	2.4	44.1	2.0	0.88	0.50
1048	286.3	354.3	1.2	97.0	100.8	3.0	3.8	285.0	1.2	1.44	0.47
1397	287.8	422.0	1.5	97.0	101.1	3.3	4.1	286.5	1.5	1.53	0.48

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
	165175_C17510B									
140	429									429
349	1375									1375
1048	3573									3573
1397	5228									5228

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
140	1.74	0.9987	0.9488	Erosive	Erosive	Erosive	0.2	Stable	5.6	Stable	Stable
349	1.74	1.1674	1.1090	Erosive	Erosive	Erosive	0.2	Stable	7.9	Stable	Stable
1048	1.74	1.3688	1.3004	Erosive	Erosive	Erosive	0.3	Stable	9.3	Stable	Stable
1397	1.74	1.4214	1.3503	Erosive	Erosive	Erosive	0.3	Stable	9.9	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

Discharge (cfs)	Channel Width (ft) 140	349	1048	1397	Flow Depth (ft) 140	349	1048	1397	Velocity (ft/s) 140	349	1048	1397
Bray - Equation #1	32	52	93	108	1.4	1.9	2.7	3.0	3.2	3.6	4.2	4.4
Bray - Equation #2	42	68	122	142	1.5	2.1	3.0	3.2	2.2	2.5	2.9	3.0
Hey	9	16	30	35	4.2	6.0	9.1	10.1				
Ackers & Charlton/Lacey	29	42	67	75					1.8	2.1	2.6	2.7
Parker	81	128	222	257	1.1	1.6	2.5	2.8				
Chang	56	98	191	228	0.1	0.0	-0.4	-0.6				
Kellerhals	21	34	58	67	2.0	2.8	4.4	4.9	3.3	3.7	4.1	4.2
AMAFCA/Schumm	38	44	285	287								
Moody & Odem	18	18	18	18	1.1	1.1	1.1	1.1				
BUREC	16.4	23.1	34.8	38.8	4	6	9	10	3.1	3.9	5.1	5.5
Average	34	52	112	126	2.0	2.7	3.9	4.4	2.7	3.1	3.8	3.9
Values As Designed	38	44	285	286	1.4	2.4	3.8	4.1	2.9	4.0	3.0	3.3
Difference with Design	-4	8	-173	-161	0.6	0.3	0.1	0.3	-0.2	-0.9	0.8	0.6

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
140	1085	721	1525	1950	3962	322	306	152	4974	352	1126	1498
349	4472	2416	4875	9229	5962	1468	1088	863	13264	1182	4947	4524
1048	24391	8970	15535	59351	9147	7104	3700	4675	40901	5594	24310	18516
1397	37980	12447	20150	96537	10160	10590	4969	7007	54720	8473	36110	27195

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
140	2881	1914	4050	5177	10522	854	814	403	13209	934	2990	3977
349	4750	2566	5179	9804	6334	1559	1156	917	14090	1256	5255	4806
1048	8637	3176	5501	21016	3239	2515	1310	1656	14483	1981	8608	6556
1397	10086	3306	5351	25637	2698	2812	1320	1861	14532	2250	9590	7222

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
140	789	379	597	1496	781	171	129	182	1161	170	926	616
349	2986	1119	1616	6431	1223	608	362	680	2987	626	3342	1998
1048	6025	2713	4516	11310	5813	1301	987	1392	8709	1287	7055	4646
1397	9375	3911	6157	18379	6557	1995	1393	2182	11767	1973	10859	6777

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
140	2095	1007	1586	3974	2073	453	344	484	3082	452	2459	1637
349	3172	1189	1716	6832	1299	646	385	722	3173	665	3550	2123
1048	2134	961	1599	4005	2058	461	349	493	3084	456	2498	1645
1397	2490	1039	1635	4881	1741	530	370	579	3125	524	2884	1800

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
140	0.0029	0.0044	125	0.38	0.046	0.0009	29	0.035	0.0007	0.0159	0.0009	0.0022	0.0067	0.0004	0.0031	0.0163	0.0064
349	0.0015	0.0025	165	0.50	0.049	0.0006	30	0.036	0.0004	0.0159	0.0005	0.0012	0.0067	0.0003	0.0016	0.0164	0.0061
1048	0.0007	0.0013	228	0.70	0.052	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0006	0.0067	0.0002	0.0007	0.0164	0.0060
1397	0.0005	0.0011	248	0.76	0.053	0.0003	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0067	0.0001	0.0006	0.0164	0.0059

Drop Structures

Design Slope	0.0060	ft/ft
Total Drop Needed	31.5	ft
Height of Drop Structure	3	ft
No . of Drop Structures	11	
Distance between structs.	276	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.19	sq. mi
Total Sediment Yield Volume	0.36	ac ft

Sedimentation Basins

Length	276 ft	Depth	3 ft
Width	307 ft	Side slope	3 ft/ft
Total Volume per Basin		5.48	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
140	1.1	-0.4	0.1	24.6	1.4	1.2	2.9	0.0060	0.1	1.5	3.0	6.1
349	1.1	-0.6	0.2	24.6	2.4	2.0	4.0	0.0060	0.3	1.5	3.0	6.3
1048	1.1	-1.2	0.1	24.6	3.8	1.2	3.0	0.0060	0.4	1.5	3.0	6.5
1397	1.1	-1.2	0.2	24.6	4.1	1.5	3.3	0.0060	0.4	1.5	3.0	6.5

Toe Protection Needed	7.0	ft

HEC1 Results For Open Channel

Peak Flow	1245	cfs
Stage at Peak Flow	101.0	ft
Flow Volume	202.0	ac. ft

Freeboard

Max. Flow Depth	1.1	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.4	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	0.42	ac. ft
Outflowing Sediment Volume	0.16	ac. ft
Deposited(+)/Eroded(-) Volume	0.25	ac. ft

JE FULLER
HYDROLOGY & GEOMORPHOLOGY, INC.

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	3035	3035
Side Slope (?H:1V)	3	3
Channel Width (ft)	307	307
Channel XS Area (sq. ft)	1437.8	1437.8
Channel Perimeter (ft)	309	309

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	3035	ft
Thickness	1.5	ft
Protection Depth	7	ft
Tie-in Length/Depth	3.0	ft
Total Depth	10.0	ft
Area needed	1012	sq. Yd
Volume	3372	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	3035	3035
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	14163	29338
Left Levee Volume (cu. Yd)	13939	32823
Right Levee Length (ft)	3035	3035
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	14163	29338
Right Levee Volume (cu. Yd)	13939	32823
Total Levee Surface Area (sq. Yd)	28326	58676
Total Levee Volume (cu. Yd)	27878	65646

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	3035	3035
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	4721	11128
Left Levee Lining Volume (cu. Yd)	2361	5564
Right Levee Length (ft)	3035	3035
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	4721	11128
Right Levee Lining Volume (cu. Yd)	2361	5564
Total Lining Area (sq. Yd)	9442	22257
Total Lining Volume (cu. Yd)	4722	11128

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	307	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	5.8	ft
Structure Height	8.8	ft
Number of Structures	11	
Volume per structure	301	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 22,575	
Area per structure	102	sq. Yd
Total Area	1,126	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	8841	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 35,364	
Other Cost	$ -	
Total cost per basin	$ 35,364	
Area per basin	9,412	sq. Yd
Total Area	9,412	sq. Yd

Structure Type	Structure Type	Excavation/Construction Quantity	Units	Unit Cost	Cost Subtotal	Landscape Quantity	Units	Unit Cost	Landscape Cost	Maintenance Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	27,878	cu. Yd	$ 7.00	$ 195,146	28,326	sq. Yd	$ 9.00	$ 254,934	28,326	sq. Yd	$ 11.67	$ 330,470
Levee - LC Enhancement	Fill	37,768	cu. Yd	$ 7.00	$ 264,376	30,350	sq. Yd	$ 9.00	$ 273,150	37,768	sq. Yd	$ 11.67	$ 440,627
Levee Lining	Riprap	4,722	cu. Yd	$ 75.00	$ 354,150	9,442	sq. Yd	$ -	$ -	9,442	sq. Yd	$ 20.83	$ 196,713
Levee Lining -LC Enhancement	Riprap	6,406	cu. Yd	$ 75.00	$ 480,450	12,814	sq. Yd	$ -	$ -	12,814	sq. Yd	$ 20.83	$ 266,968
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	3,372	cu. Yd	$ 75.00	$ 252,900	1,012	sq. Yd	$ -	$ -	1,012	sq. Yd	$ 25.00	$ 25,300
Drop Structures	Riprap	11	EA	$ 22,575.00	$ 248,325	1,126	sq. Yd	$ -	$ -	1,126	sq. Yd	$ 33.33	$ 37,533
Drop Str. - LC Enhancement	Riprap	11	EA	$ 2,257.50	$ 24,833	113	sq. Yd	$ -	$ -	113	sq. Yd	$ 33.33	$ 3,753
Sedimentation Basins		1	EA	$ 35,364.00	$ 35,364	9,412	sq. Yd	$ -	$ -	9,412	sq. Yd	$ 8.33	$ 78,433
Other					$ -				$ -				$ -

Base Landscape Cost	$ 254,934
LC Enhancement Cost	$ 273,150
Total Landscape Cost	$ 528,084

Base Maintenance Cost	$ 668,450
LC Enhancement Cost	$ 711,348
Total Maintenance Cost	$ 1,379,797

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,085,885	$ 769,659	$ 1,855,544
Contingency Cost (25% of Construction Cost)	$ 271,471	$ 192,415	$ 463,886
Engineering Design Cost (5% of Construction Cost)	$ 54,294	$ 38,483	$ 92,777
Total Construction Cost	$ 1,411,651	$ 1,000,556	$ 2,412,207

Land Cost

Channel Length	3035 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	307	21.4	$100,000	$ 2,140,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	3.8	$100,000	$ 380,000
Levee LC Enhancement	51	3.6	$100,000	$ 360,000
Other	0	0	$100,000	$ -
Total	413	28.8		$ 2,880,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	25.2	$100,000	$ 2,520,000
LC Enhancement Cost	acre	3.6	$100,000	$ 360,000
Total Land Cost	acre	28.8	$100,000	$ 2,880,000

Total Cost

Base Total Cost	$ 4,855,034
Total Landscape Enhancement Cost	$ 2,345,054
Total Cost Including LC Enh.	$ 7,200,088

Open Channel

Structure ID	S18010		HEC1 ID	180R

Longitundal Geometry

Length	5165.4	ft
U/S Elev	1531.6	ft
D/S Elev	1456.3	ft
Initial Channel Slope	0.0146	ft/ft
Long-term Channel Slope	0.0060	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	2

Initial Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	180	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	193.5	193.5	193.5	207
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	75	3	25	6.5	3	68	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	88.5	94.5	119.5	125.5	193.5	207
Y	104.5	100	100	98	98	100	100	104.5

Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	S180									TOTAL
HEC1 Peak-Flow	1039									1039
Weighting Factor	1.00									
Flow into Channel	1039									1039

Reach Sediment Inflow Characteristics

U/S Contributing ID										TOTAL
HEC1 Flow Volume (ac. ft)										0
Sediment Conc. (ppm)										
Sediment Volume (ac. ft)										0.00
Weighting Factor										
Weighted Sed. Vol. (ac. ft)										0.00

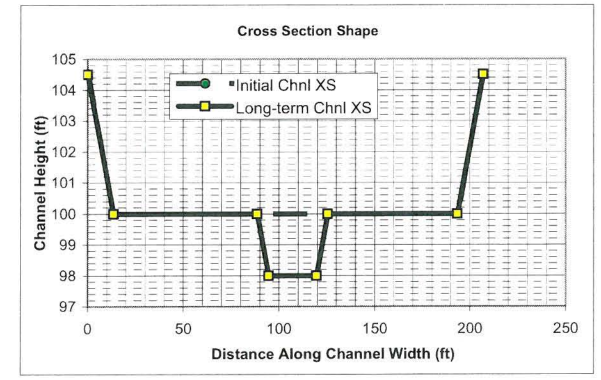
Hydrology

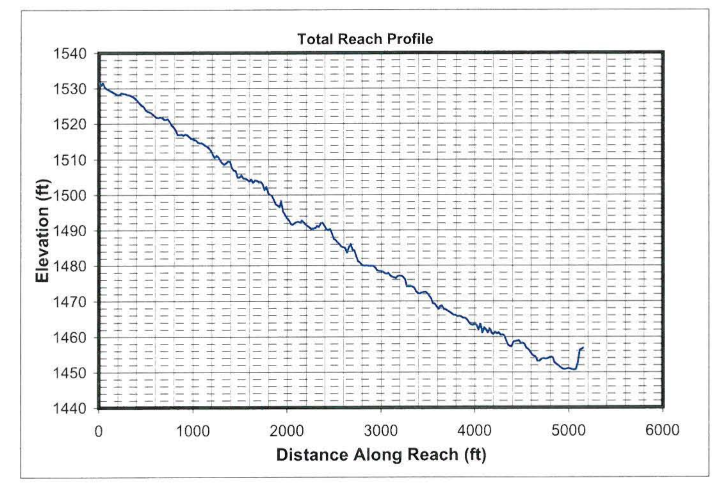
Drainage Area	1.44	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	1039	cfs	
Long-term Max. Chnl Capacity	6482	cfs	
Q2 Channel	104	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	207	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			





Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
104	182.0	56.6	0.3	100.0	100.3	1.8	0.3	181.9	0.3	0.12	0.58
260	183.4	98.4	0.5	100.0	100.5	2.6	0.5	183.2	0.5	0.20	0.64
779	186.6	191.5	1.0	100.0	101.0	4.1	1.0	186.3	1.0	0.39	0.71
1039	187.9	228.2	1.2	100.0	101.2	4.6	1.2	187.5	1.2	0.46	0.73

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
104	33.2	37.4	1.1	98.0	99.3	2.8	1.3	32.8	1.1	0.48	0.46
260	183.0	128.3	0.7	98.0	100.4	2.0	2.4	182.2	0.7	0.89	0.43
779	187.2	250.3	1.3	98.0	101.0	3.1	3.0	186.2	1.3	1.13	0.47
1039	188.8	298.5	1.6	98.0	101.3	3.5	3.3	187.7	1.6	1.23	0.49

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
104										0
260										0
779										0
1039										0

Allowable Velocity

Channel Lining	Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
104	1.74	1.0357	0.9839	Erosive	Erosive	Erosive	0.2	Stable	5.3	Stable	Stable
260	1.74	1.2036	1.1434	Erosive	Erosive	Erosive	0.3	Stable	6.7	Stable	Stable
779	1.74	1.4040	1.3338	Erosive	Erosive	Erosive	0.3	Stable	8.4	Stable	Stable
1039	1.74	1.4561	1.3833	Erosive	Erosive	Erosive	0.3	Stable	9.0	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	**104**	**260**	**779**	**1039**	**104**	**260**	**779**	**1039**	**104**	**260**	**779**	**1039**
Bray - Equation #1	28	45	80	93	1.2	1.7	2.4	2.7	3.0	3.4	4.0	4.2
Bray - Equation #2	36	58	104	122	1.4	1.9	2.7	2.9	2.1	2.4	2.8	2.9
Hey	8	13	25	30	3.8	5.3	8.1	9.0				
Ackers & Charlton/Lacey	25	37	59	67					1.7	2.0	2.4	2.6
Parker	70	111	192	221	1.0	1.4	2.2	2.5				
Chang	47	82	160	191	0.1	0.0	-0.3	-0.4				
Kellerhals	18	29	50	58	1.7	2.5	3.9	4.4	3.2	3.6	4.0	4.1
AMAFCA/Schumm	33	182	186	188								
Moody & Odem	14	14	14	14	1.0	1.0	1.0	1.0				
BUREC	14.6	20.7	31.2	34.7	4	6	8	9	2.8	3.6	4.7	5.1
Average	29	59	90	102	1.8	2.4	3.5	3.9	2.6	3.0	3.6	3.8
Values As Designed	33	182	186	188	1.3	2.4	3.0	3.3	2.8	2.0	3.1	3.5
Difference with Design	-3	-123	-96	-86	0.5	0.0	0.5	0.6	-0.2	1.0	0.5	0.3

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
104	741	482	992	1319	2564	209	199	107	3099	227	779	974
260	3058	1620	3171	6234	3863	955	708	601	8270	781	3400	2969
779	16554	5998	10090	39882	5956	4595	2397	3209	25511	3738	16636	12233
1039	25724	8320	13086	64745	6628	6841	3219	4799	34133	5670	24696	17987

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
104	2645	1722	3541	4711	9157	748	712	384	11064	810	2780	3480
260	4368	2314	4529	8904	5518	1364	1012	858	11812	1116	4856	4241
779	7881	2856	4804	18988	2836	2188	1141	1528	12146	1780	7920	5824
1039	9186	2971	4673	23119	2367	2443	1149	1714	12188	2025	8818	6423

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
104	543	270	441	1010	629	117	93	124	856	118	638	440
260	890	477	838	1445	2423	164	162	165	1974	206	986	885
779	4803	2119	3379	9211	4007	1032	754	1116	6520	1020	5605	3597
1039	7459	3036	4643	14933	4520	1571	1054	1732	8793	1563	8575	5262

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
104	1938	966	1574	3605	2247	419	331	443	3057	423	2278	1571
260	1271	681	1197	2064	3461	235	231	235	2819	295	1409	1264
779	2287	1009	1609	4385	1908	492	359	532	3104	486	2669	1712
1039	2663	1084	1658	5332	1614	561	377	618	3140	558	3062	1879

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
104	0.0026	0.0039	125	0.38	0.046	0.0008	30	0.035	0.0006	0.0159	0.0008	0.0020	0.0074	0.0005	0.0029	0.0145	0.0061
260	0.0013	0.0023	165	0.50	0.049	0.0005	30	0.036	0.0003	0.0159	0.0005	0.0011	0.0074	0.0003	0.0015	0.0146	0.0059
779	0.0006	0.0012	228	0.69	0.052	0.0003	31	0.036	0.0002	0.0159	0.0002	0.0006	0.0074	0.0002	0.0006	0.0146	0.0057
1039	0.0005	0.0010	248	0.76	0.053	0.0002	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0074	0.0002	0.0005	0.0146	0.0056

Drop Structures

Design Slope	0.0060	ft/ft
Total Drop Needed	44.3	ft
Height of Drop Structure	3	ft
No . of Drop Structures	15	
Distance between structs.	344	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	1.44	sq. mi
Total Sediment Yield Volume	2.74	ac ft

Sedimentation Basins

Length	344 ft	Depth	3 ft
Width	207 ft	Side slope	3 ft/ft
Total Volume per Basin		4.57	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		2	

Scour and Toe Protection (Not applicable for concrete channel)

		Pima County General Scour Equations							Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
104	1.1	-0.4	0.1	24.6	1.3	1.1	2.8	0.0060	0.1	1.5	2.0	4.8
260	1.1	-0.8	0.1	24.6	2.4	0.7	2.0	0.0060	0.2	1.5	2.0	4.9
779	1.1	-0.9	0.1	24.6	3.0	1.3	3.1	0.0060	0.3	1.5	2.0	5.1
1039	1.1	-0.9	0.2	24.6	3.3	1.6	3.5	0.0060	0.4	1.5	2.0	5.1

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	775	cfs
Stage at Peak Flow	101.0	ft
Flow Volume	90.0	ac. ft

Freeboard

Max. Flow Depth	1.2	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.3	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	2.74	ac. ft
Outflowing Sediment Volume	0.06	ac. ft
Deposited(+)/Eroded(-) Volume	2.67	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	5165	5165
Side Slope (?H:1V)	3	3
Channel Width (ft)	207	207
Channel XS Area (sq. ft)	932.8	932.8
Channel Perimeter (ft)	209	209

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	5165	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	1722	sq. Yd
Volume	5165	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	5165	5165
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	24103	49928
Left Levee Volume (cu. Yd)	23721	55859
Right Levee Length (ft)	5165	5165
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	24103	49928
Right Levee Volume (cu. Yd)	23721	55859
Total Levee Surface Area (sq. Yd)	48206	99856
Total Levee Volume (cu. Yd)	47442	111718

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	5165	5165
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	8034	18938
Left Levee Lining Volume (cu. Yd)	4017	9469
Right Levee Length (ft)	5165	5165
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	8034	18938
Right Levee Lining Volume (cu. Yd)	4017	9469
Total Lining Area (sq. Yd)	16069	37877
Total Lining Volume (cu. Yd)	8034	18938

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	207	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	6.3	ft
Structure Height	9.3	ft
Number of Structures	15	
Volume per structure	213	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 15,975	
Area per structure	69	sq. Yd
Total Area	1,035	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	2	
Total Volume per Basin	7373	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 29,492	
Other Cost	$ -	
Total cost per basin	$ 29,492	
Area per basin	7,920	sq. Yd
Total Area	15,840	sq. Yd

Structure Cost

Structure Type	Structure Type	Excavation/Construction Quantity	Units	Unit Cost	Cost Subtotal	Landscape Quantity	Units	Unit Cost	Landscape Cost	Maintenance Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	47,442	cu. Yd	$ 7.00	$ 332,094	48,206	sq. Yd	$ 9.00	$ 433,854	48,206	sq. Yd	$ 11.67	$ 562,403
Levee - LC Enhancement	Fill	64,276	cu. Yd	$ 7.00	$ 449,932	51,650	sq. Yd	$ 9.00	$ 464,850	64,276	sq. Yd	$ 11.67	$ 749,887
Levee Lining	Riprap	8,034	cu. Yd	$ 75.00	$ 602,550	16,069	sq. Yd	$ -	$ -	16,069	sq. Yd	$ 20.83	$ 334,769
Levee Lining -LC Enhancement	Riprap	10,904	cu. Yd	$ 75.00	$ 817,800	21,808	sq. Yd	$ -	$ -	21,808	sq. Yd	$ 20.83	$ 454,329
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	5,165	cu. Yd	$ 75.00	$ 387,375	1,722	sq. Yd	$ -	$ -	1,722	sq. Yd	$ 25.00	$ 43,050
Drop Structures	Riprap	15	EA	$ 15,975.00	$ 239,625	1,035	sq. Yd	$ -	$ -	1,035	sq. Yd	$ 33.33	$ 34,500
Drop Str. - LC Enhancement	Riprap	15	EA	$ 1,597.50	$ 23,963	104	sq. Yd	$ -	$ -	104	sq. Yd	$ 33.33	$ 3,450
Sedimentation Basins		2	EA	$ 29,492.00	$ 58,984	15,840	sq. Yd	$ -	$ -	15,840	sq. Yd	$ 8.33	$ 132,000
Other					$ -				$ -				$ -

Base Landscape Cost	$ 433,854
LC Enhancement Cost	$ 464,850
Total Landscape Cost	$ 898,704

Base Maintenance Cost	$ 1,106,722
LC Enhancement Cost	$ 1,207,665
Total Maintenance Cost	$ 2,314,387

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,620,628	$ 1,291,695	$ 2,912,323
Contingency Cost (25% of Construction Cost)	$ 405,157	$ 322,924	$ 728,081
Engineering Design Cost (5% of Construction Cost)	$ 81,031	$ 64,585	$ 145,616
Total Construction Cost	$ 2,106,816	$ 1,679,203	$ 3,786,019

Land Cost

Channel Length	5165 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	207	24.5	$100,000	$ 2,450,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	6.5	$100,000	$ 650,000
Levee LC Enhancement	51	6	$100,000	$ 600,000
Other	0	0	$100,000	$ -
Total	313	37		$ 3,700,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	31	$100,000	$ 3,100,000
LC Enhancement Cost	acre	6	$100,000	$ 600,000
Total Land Cost	acre	37	$100,000	$ 3,700,000

Total Cost

Base Total Cost	$ 6,747,392
Total Landscape Enhancement Cost	$ 3,951,718
Total Cost Including LC Enh.	$ 10,699,110

Open Channel

Structure ID	RR18010		HEC1 ID	180R

Longitundal Geometry

Length	2824.7	ft
U/S Elev	1456.3	ft
D/S Elev	1413.1	ft
Initial Channel Slope	0.0153	ft/ft
Long-term Channel Slope	0.0060	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	2

Initial Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	180	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	193.5	193.5	193.5	207
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	71	3	25	6.5	3	72	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	84.5	90.5	115.5	121.5	193.5	207
Y	104.5	100	100	98	98	100	100	104.5

Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	S180	S190								TOTAL
HEC1 Peak-Flow	1039	2590								3629
Weighting Factor	1.00	0.03								
Flow into Channel	1039	85								1124

Reach Sediment Inflow Characteristics

U/S Contributing ID	180R_S18010									TOTAL
HEC1 Flow Volume (ac. ft)	90.00									90
Sediment Conc. (ppm)	1879									
Sediment Volume (ac. ft)	0.06									0.06
Weighting Factor	1									
Weighted Sed. Vol. (ac. ft)	0.06									0.06

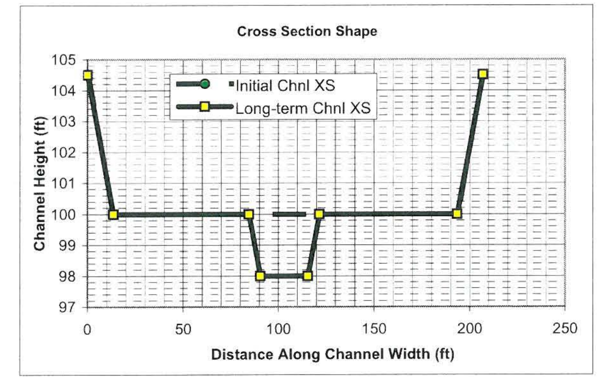
Hydrology

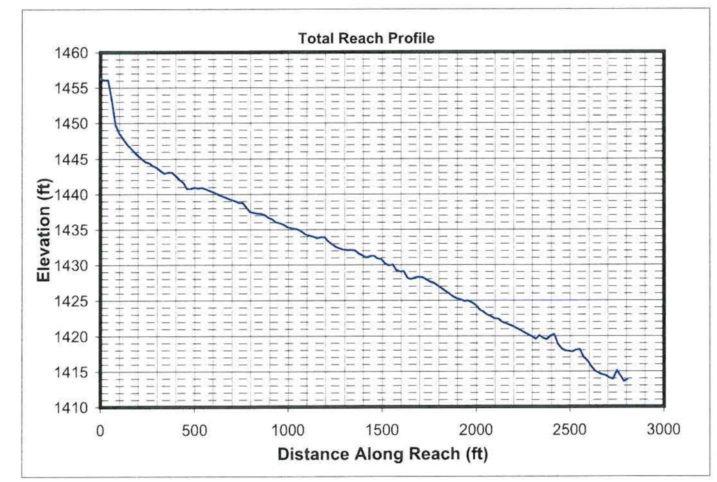
Drainage Area	1.573	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	1124	cfs	
Long-term Max. Chnl Capacity	6482	cfs	
Q2 Channel	112	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	207	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			





Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
112	182.0	58.5	0.3	100.0	100.3	1.9	0.3	181.9	0.3	0.12	0.60
281	183.5	101.7	0.6	100.0	100.6	2.8	0.6	183.4	0.6	0.21	0.65
843	186.8	198.1	1.1	100.0	101.1	4.3	1.1	186.5	1.1	0.40	0.73
1124	188.1	236.0	1.3	100.0	101.3	4.8	1.3	187.7	1.3	0.48	0.75

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
112	33.6	39.4	1.2	98.0	99.4	2.9	1.4	33.1	1.2	0.51	0.46
281	183.2	134.5	0.7	98.0	100.4	2.1	2.4	182.4	0.7	0.90	0.43
843	187.6	262.6	1.4	98.0	101.1	3.2	3.1	186.6	1.4	1.16	0.48
1124	189.3	313.2	1.7	98.0	101.4	3.6	3.4	188.2	1.7	1.26	0.49

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
	180R_S18010									
112	440									440
281	885									885
843	3597									3597
1124	5262									5262

Allowable Velocity

Channel Lining	Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
112	1.74	1.0458	0.9935	Erosive	Erosive	Erosive	0.2	Stable	5.5	Stable	Stable
281	1.74	1.2137	1.1530	Erosive	Erosive	Erosive	0.3	Stable	6.8	Stable	Stable
843	1.74	1.4140	1.3433	Erosive	Erosive	Erosive	0.3	Stable	8.5	Stable	Stable
1124	1.74	1.4661	1.3928	Erosive	Erosive	Erosive	0.3	Stable	9.2	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	112	281	843	1124	112	281	843	1124	112	281	843	1124
Bray - Equation #1	29	46	83	96	1.3	1.7	2.5	2.8	3.1	3.5	4.1	4.2
Bray - Equation #2	38	61	109	127	1.4	1.9	2.7	3.0	2.1	2.4	2.8	2.9
Hey	8	14	26	31	3.9	5.5	8.3	9.3				
Ackers & Charlton/Lacey	26	38	61	69					1.8	2.1	2.5	2.6
Parker	73	115	199	230	1.0	1.4	2.3	2.6				
Chang	49	86	168	200	0.1	0.0	-0.3	-0.5				
Kellerhals	19	30	52	60	1.8	2.6	4.0	4.5	3.3	3.6	4.0	4.1
AMAFCA/Schumm	33	183	187	188								
Moody & Odem	15	15	15	15	1.0	1.0	1.0	1.0				
BUREC	15.1	21.3	32.1	35.8	4	6	9	10	2.9	3.7	4.8	5.2
Average	30	61	93	105	1.8	2.5	3.6	4.0	2.6	3.0	3.6	3.8
Values As Designed	33	182	187	188	1.4	2.4	3.1	3.4	2.9	2.1	3.2	3.6
Difference with Design	-3	-121	-93	-83	0.5	0.1	0.5	0.7	-0.2	0.9	0.4	0.2

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
112	893	574	1193	1630	2732	268	246	138	3651	270	955	1141
281	3685	1888	3662	7698	4081	1166	831	729	9655	935	4067	3491
843	19938	6898	11367	49229	6254	5534	2752	3785	29673	4477	19567	14498
1124	30986	9547	14802	79909	6952	8231	3684	5636	39683	6789	28950	21379

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
112	2947	1895	3937	5379	9019	885	812	455	12051	891	3151	3766
281	4865	2493	4835	10164	5388	1539	1097	963	12748	1234	5369	4609
843	8775	3036	5003	21665	2752	2435	1211	1666	13059	1970	8612	6380
1124	10228	3151	4886	26376	2295	2717	1216	1860	13098	2241	9556	7057

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
112	609	298	478	1145	655	132	102	140	930	132	716	485
281	1004	535	937	1650	2520	192	185	192	2160	231	1126	976
843	5418	2340	3681	10512	4142	1159	828	1261	7078	1146	6302	3988
1124	8411	3344	5070	17038	4668	1759	1153	1947	9538	1757	9616	5845

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
112	2010	984	1579	3780	2162	435	337	462	3070	437	2362	1602
281	1326	706	1237	2179	3327	254	244	254	2852	305	1486	1288
843	2384	1030	1620	4626	1823	510	364	555	3115	504	2773	1755
1124	2776	1104	1673	5624	1541	581	380	643	3148	580	3174	1929

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
112	0.0025	0.0038	131	0.40	0.047	0.0008	30	0.035	0.0006	0.0159	0.0008	0.0019	0.0072	0.0004	0.0028	0.0152	0.0062
281	0.0013	0.0022	171	0.52	0.049	0.0005	30	0.036	0.0003	0.0159	0.0005	0.0011	0.0072	0.0003	0.0014	0.0153	0.0060
843	0.0006	0.0011	237	0.72	0.052	0.0003	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0072	0.0002	0.0006	0.0153	0.0058
1124	0.0005	0.0010	258	0.79	0.053	0.0002	32	0.036	0.0002	0.0159	0.0002	0.0004	0.0072	0.0002	0.0005	0.0153	0.0058

Drop Structures

Design Slope	0.0060	ft/ft
Total Drop Needed	26.2	ft
Height of Drop Structure	3	ft
No . of Drop Structures	9	
Distance between structs.	314	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.13	sq. mi
Total Sediment Yield Volume	0.25	ac ft

Sedimentation Basins

Length	314 ft	Depth	3 ft
Width	207 ft	Side slope	3 ft/ft
Total Volume per Basin		4.16	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
112	1.1	-0.4	0.1	24.6	1.4	1.2	2.9	0.0060	0.1	1.5	2.0	4.8
281	1.1	-0.8	0.1	24.6	2.4	0.7	2.1	0.0060	0.2	1.5	2.0	4.9
843	1.1	-0.9	0.1	24.6	3.1	1.4	3.2	0.0060	0.3	1.5	2.0	5.1
1124	1.1	-0.9	0.2	24.6	3.4	1.7	3.6	0.0060	0.4	1.5	2.0	5.1

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	775	cfs
Stage at Peak Flow	101.0	ft
Flow Volume	90.0	ac. ft

Freeboard

Max. Flow Depth	1.3	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.2	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	0.32	ac. ft
Outflowing Sediment Volume	0.07	ac. ft
Deposited(+)/Eroded(-) Volume	0.25	ac. ft

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	2825	2825
Side Slope (?H:1V)	3	3
Channel Width (ft)	207	207
Channel XS Area (sq. ft)	932.8	932.8
Channel Perimeter (ft)	209	209

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	2825	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	942	sq. Yd
Volume	2825	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	2825	2825
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	13183	27308
Left Levee Volume (cu. Yd)	12974	30552
Right Levee Length (ft)	2825	2825
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	13183	27308
Right Levee Volume (cu. Yd)	12974	30552
Total Levee Surface Area (sq. Yd)	26366	54616
Total Levee Volume (cu. Yd)	25948	61104

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	2825	2825
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	4394	10358
Left Levee Lining Volume (cu. Yd)	2197	5179
Right Levee Length (ft)	2825	2825
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	4394	10358
Right Levee Lining Volume (cu. Yd)	2197	5179
Total Lining Area (sq. Yd)	8789	20717
Total Lining Volume (cu. Yd)	4394	10358

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	207	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	6.5	ft
Structure Height	9.5	ft
Number of Structures	9	
Volume per structure	219	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 16,425	
Area per structure	69	sq. Yd
Total Area	621	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	6711	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 26,844	
Other Cost	$ -	
Total cost per basin	$ 26,844	
Area per basin	7,219	sq. Yd
Total Area	7,219	sq. Yd

Structure Cost

Structure Type	Structure Type	Excavation/Construction Quantity	Units	Unit Cost	Cost Subtotal	Landscape Quantity	Units	Unit Cost	Landscape Cost	Maintenance Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	25,948	cu. Yd	$ 7.00	$ 181,636	26,366	sq. Yd	$ 9.00	$ 237,294	26,366	sq. Yd	$ 11.67	$ 307,603
Levee - LC Enhancement	Fill	35,156	cu. Yd	$ 7.00	$ 246,092	28,250	sq. Yd	$ 9.00	$ 254,250	35,156	sq. Yd	$ 11.67	$ 410,153
Levee Lining	Riprap	4,394	cu. Yd	$ 75.00	$ 329,550	8,789	sq. Yd	$ -	$ -	8,789	sq. Yd	$ 20.83	$ 183,102
Levee Lining -LC Enhancement	Riprap	5,964	cu. Yd	$ 75.00	$ 447,300	11,928	sq. Yd	$ -	$ -	11,928	sq. Yd	$ 20.83	$ 248,495
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	2,825	cu. Yd	$ 75.00	$ 211,875	942	sq. Yd	$ -	$ -	942	sq. Yd	$ 25.00	$ 23,550
Drop Structures	Riprap	9	EA	$ 16,425.00	$ 147,825	621	sq. Yd	$ -	$ -	621	sq. Yd	$ 33.33	$ 20,700
Drop Str. - LC Enhancement	Riprap	9	EA	$ 1,642.50	$ 14,783	62	sq. Yd	$ -	$ -	62	sq. Yd	$ 33.33	$ 2,070
Sedimentation Basins		1	EA	$ 26,844.00	$ 26,844	7,219	sq. Yd	$ -	$ -	7,219	sq. Yd	$ 8.33	$ 60,158
Other					$ -				$ -				$ -

Base Landscape Cost	$ 237,294	
LC Enhancement Cost	$ 254,250	
Total Landscape Cost	$ 491,544	
Base Maintenance Cost	$ 595,114	
LC Enhancement Cost	$ 660,719	
Total Maintenance Cost	$ 1,255,832	

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 897,730	$ 708,175	$ 1,605,905
Contingency Cost (25% of Construction Cost)	$ 224,433	$ 177,044	$ 401,476
Engineering Design Cost (5% of Construction Cost)	$ 44,887	$ 35,409	$ 80,295
Total Construction Cost	$ 1,167,049	$ 920,627	$ 2,087,676

Land Cost

Channel Length	2825 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	207	13.4	$100,000	$ 1,340,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	3.6	$100,000	$ 360,000
Levee LC Enhancement	51	3.3	$100,000	$ 330,000
Other	0	0	$100,000	$ -
Total	313	20.3		$ 2,030,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	17	$100,000	$ 1,700,000
LC Enhancement Cost	acre	3.3	$100,000	$ 330,000
Total Land Cost	acre	20.3	$100,000	$ 2,030,000

Total Cost

Base Total Cost	$ 3,699,457
Total Landscape Enhancement Cost	$ 2,165,596
Total Cost Including LC Enh.	$ 5,865,052

Open Channel

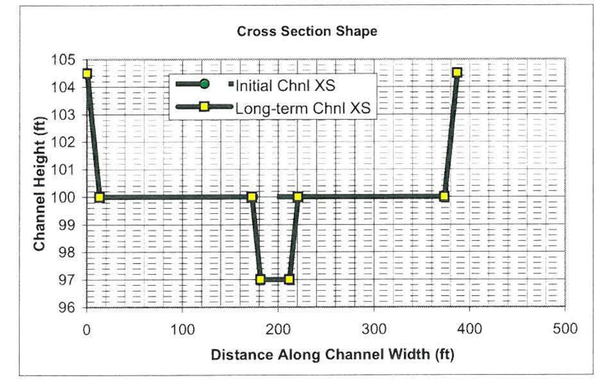
Structure ID	C180R10		HEC1 ID	RI180R

Longitundal Geometry

Length	3720.6	ft
U/S Elev	1413.1	ft
D/S Elev	1367.6	ft
Initial Channel Slope	0.0122	ft/ft
Long-term Channel Slope	0.0050	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	3



Initial Channel XS Geometry

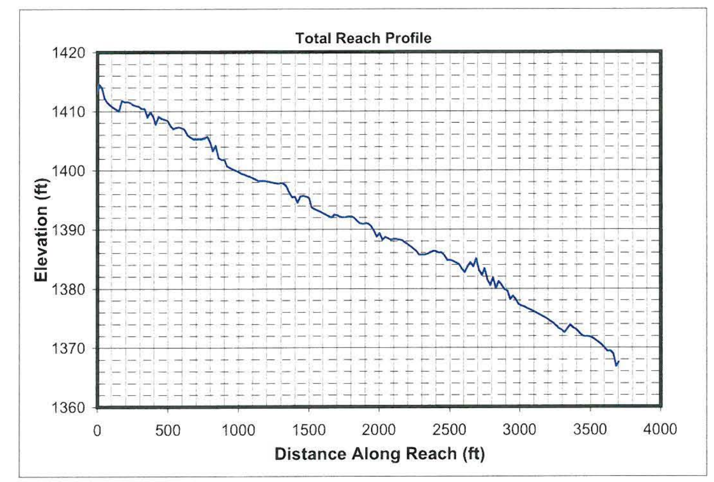
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	360	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	373.5	373.5	373.5	387
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	159	3	30	7.5	3	153	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	172.5	181.5	211.5	220.5	373.5	387
Y	104.5	100	100	97	97	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	RI180R	S190								TOTAL
HEC1 Peak-Flow	1828	2590								4418
Weighting Factor	1.00	0.12								
Flow into Channel	1828	323								2151

Reach Sediment Inflow Characteristics

U/S Contributing ID	175R_RR17510	180R_RR18010								TOTAL
HEC1 Flow Volume (ac. ft)	202.00	90.00								292
Sediment Conc. (ppm)	2123	1929								
Sediment Volume (ac. ft)	0.16	0.07								0.23
Weighting Factor	1	1								
Weighted Sed. Vol. (ac. ft)	0.16	0.07								0.23

Hydrology

Drainage Area	4.63	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	2151	cfs	
Long-term Max. Chnl Capacity	11669	cfs	
Q2 Channel	215	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	387	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

Sub-area: Wagner Wash, Alternative: B2
Open Channel Structure ID: C180R10

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
215	362.1	121.7	0.3	100.0	100.3	1.8	0.3	362.0	0.3	0.11	0.54
538	363.7	211.0	0.6	100.0	100.6	2.5	0.6	363.5	0.6	0.18	0.59
1613	367.1	409.6	1.1	100.0	101.1	3.9	1.1	366.8	1.1	0.35	0.66
2151	368.5	487.5	1.3	100.0	101.3	4.4	1.3	368.0	1.3	0.42	0.68

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
215	41.9	67.1	1.6	97.0	98.9	3.2	1.9	41.3	1.6	0.59	0.44
538	363.8	276.0	0.8	97.0	100.4	1.9	3.4	362.6	0.8	1.07	0.39
1613	368.3	536.3	1.5	97.0	101.2	3.0	4.2	366.9	1.5	1.30	0.44
2151	370.0	638.6	1.7	97.0	101.4	3.4	4.4	368.6	1.7	1.38	0.45

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
	175R_RR17510	180R_RR18010								
215	616	485								1102
538	1998	976								2974
1613	4646	3988								8634
2151	6777	5845								12623

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
215	1.74	1.0592	1.0062	Erosive	Erosive	Erosive	0.2	Stable	6.2	Stable	Stable
538	1.74	1.2277	1.1663	Erosive	Erosive	Erosive	0.3	Stable	7.4	Stable	Stable
1613	1.74	1.4295	1.3580	Erosive	Erosive	Erosive	0.3	Stable	9.1	Stable	Stable
2151	1.74	1.4821	1.4080	Erosive	Erosive	Erosive	0.3	Stable	9.7	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

Discharge (cfs)	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
	215	538	1613	2151	215	538	1613	2151	215	538	1613	2151
Bray - Equation #1	40	65	117	136	1.6	2.2	3.1	3.4	3.4	3.8	4.4	4.6
Bray - Equation #2	53	86	153	178	1.7	2.4	3.4	3.7	2.3	2.6	3.1	3.2
Hey	12	20	38	44	5.0	7.0	10.7	11.9				
Ackers & Charlton/Lacey	34	50	80	90					2.0	2.3	2.7	2.9
Parker	101	159	276	319	1.3	1.9	3.0	3.3				
Chang	69	120	234	279	0.1	-0.1	-0.5	-0.7				
Kellerhals	26	42	72	83	2.3	3.4	5.2	5.9	3.5	3.8	4.3	4.4
AMAFCA/Schumm	41	363	367	369								
Moody & Odem	22	22	22	22	1.2	1.2	1.2	1.2				
BUREC	19.9	28.1	42.4	47.2	5	7	11	13	3.2	4.0	5.3	5.7
Average	42	96	140	157	2.3	3.2	4.7	5.2	2.9	3.3	4.0	4.2
Values As Designed	41	363	367	369	1.9	3.4	4.2	4.4	3.2	1.9	3.0	3.4
Difference with Design	1	-267	-227	-212	0.4	-0.3	0.5	0.7	-0.3	1.4	1.0	0.8

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
215	1229	793	1531	2101	4707	300	299	169	4807	363	1272	1597
538	5083	2747	5310	9949	7161	1481	1150	1005	13031	1268	5723	4901
1613	27632	10381	17357	63978	11081	7285	4015	5546	40449	6165	28701	20236
2151	43036	14460	22419	104077	12325	10878	5417	8346	54159	9393	42855	29760

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
215	2119	1367	2641	3623	8119	517	516	292	8291	626	2194	2755
538	3507	1895	3663	6864	4940	1021	794	693	8990	875	3948	3381
1613	6355	2387	3992	14713	2548	1675	923	1276	9302	1418	6600	4654
2151	7423	2494	3867	17951	2126	1876	934	1439	9341	1620	7392	5133

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
215	1141	515	747	2189	893	228	166	276	1368	238	1346	828
538	1465	774	1200	2277	4422	225	235	268	3002	330	1597	1436
1613	7958	3567	5617	14614	7377	1593	1220	1910	10164	1646	9400	5915
2151	12386	5144	7644	23755	8324	2447	1726	2986	13746	2532	14489	8653

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
215	1968	888	1289	3776	1541	393	286	476	2359	410	2322	1428
538	1011	534	828	1571	3051	156	162	185	2071	228	1102	991
1613	1830	820	1292	3361	1697	366	281	439	2337	379	2162	1360
2151	2136	887	1318	4097	1436	422	298	515	2371	437	2499	1492

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
215	0.0026	0.0036	119	0.36	0.046	0.0007	29	0.035	0.0006	0.0159	0.0008	0.0019	0.0058	0.0003	0.0027	0.0122	0.0051
538	0.0013	0.0021	157	0.48	0.048	0.0005	30	0.036	0.0003	0.0159	0.0004	0.0010	0.0058	0.0002	0.0014	0.0122	0.0048
1613	0.0006	0.0011	217	0.66	0.051	0.0002	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0058	0.0001	0.0006	0.0122	0.0047
2151	0.0005	0.0009	237	0.72	0.052	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0004	0.0058	0.0001	0.0005	0.0122	0.0046

Drop Structures

Design Slope	0.0050	ft/ft
Total Drop Needed	26.9	ft
Height of Drop Structure	3	ft
No . of Drop Structures	9	
Distance between structs.	413	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.19	sq. mi
Total Sediment Yield Volume	0.36	ac ft

Sedimentation Basins

Length	413 ft	Depth	3 ft
Width	387 ft	Side slope	3 ft/ft
Total Volume per Basin		10.53	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
215	1.1	-0.6	0.1	24.6	1.9	1.6	3.2	0.0050	0.2	1.5	3.0	6.2
538	1.1	-1.2	0.1	24.6	3.4	0.8	1.9	0.0050	0.3	1.5	3.0	6.3
1613	1.1	-1.3	0.1	24.6	4.2	1.5	3.0	0.0050	0.4	1.5	3.0	6.5
2151	1.1	-1.3	0.2	24.6	4.4	1.7	3.4	0.0050	0.5	1.5	3.0	6.6

Toe Protection Needed	7.0	ft

HEC1 Results For Open Channel

Peak Flow	1828	cfs
Stage at Peak Flow	101.2	ft
Flow Volume	285.0	ac. ft

Freeboard

Max. Flow Depth	1.3	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.2	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	0.58	ac. ft
Outflowing Sediment Volume	0.16	ac. ft
Deposited(+)/Eroded(-) Volume	0.42	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	3721	3721
Side Slope (?H:1V)	3	3
Channel Width (ft)	387	387
Channel XS Area (sq. ft)	1797.8	1797.8
Channel Perimeter (ft)	389	389

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	3721	ft
Thickness	1.5	ft
Protection Depth	7	ft
Tie-in Length/Depth	3.0	ft
Total Depth	10.0	ft
Area needed	1240	sq. Yd
Volume	4134	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	3721	3721
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	17365	35970
Left Levee Volume (cu. Yd)	17089	40242
Right Levee Length (ft)	3721	3721
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	17365	35970
Right Levee Volume (cu. Yd)	17089	40242
Total Levee Surface Area (sq. Yd)	34730	71940
Total Levee Volume (cu. Yd)	34178	80484

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	3721	3721
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	5788	13644
Left Levee Lining Volume (cu. Yd)	2894	6822
Right Levee Length (ft)	3721	3721
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	5788	13644
Right Levee Lining Volume (cu. Yd)	2894	6822
Total Lining Area (sq. Yd)	11576	27287
Total Lining Volume (cu. Yd)	5788	13644

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	387	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	6.5	ft
Structure Height	9.5	ft
Number of Structures	9	
Volume per structure	406	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 30,450	
Area per structure	129	sq. Yd
Total Area	1,161	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	16988	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 67,952	
Other Cost	$ -	
Total cost per basin	$ 67,952	
Area per basin	17,776	sq. Yd
Total Area	17,776	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	34,178	cu. Yd	$ 7.00	$ 239,246	34,730	sq. Yd	$ 9.00	$ 312,570	34,730	sq. Yd	$ 11.67	$ 405,183
Levee - LC Enhancement	Fill	46,306	cu. Yd	$ 7.00	$ 324,142	37,210	sq. Yd	$ 9.00	$ 334,890	46,306	sq. Yd	$ 11.67	$ 540,237
Levee Lining	Riprap	5,788	cu. Yd	$ 75.00	$ 434,100	11,576	sq. Yd	$ -	$ -	11,576	sq. Yd	$ 20.83	$ 241,176
Levee Lining -LC Enhancement	Riprap	7,856	cu. Yd	$ 75.00	$ 589,200	15,711	sq. Yd	$ -	$ -	15,711	sq. Yd	$ 20.83	$ 327,310
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	4,134	cu. Yd	$ 75.00	$ 310,050	1,240	sq. Yd	$ -	$ -	1,240	sq. Yd	$ 25.00	$ 31,000
Drop Structures	Riprap	9	EA	$ 30,450.00	$ 274,050	1,161	sq. Yd	$ -	$ -	1,161	sq. Yd	$ 33.33	$ 38,700
Drop Str. - LC Enhancement	Riprap	9	EA	$ 3,045.00	$ 27,405	116	sq. Yd	$ -	$ -	116	sq. Yd	$ 33.33	$ 3,870
Sedimentation Basins		1	EA	$ 67,952.00	$ 67,952	17,776	sq. Yd	$ -	$ -	17,776	sq. Yd	$ 8.33	$ 148,133
Other					$ -				$ -				$ -

Base Landscape Cost	$ 312,570
LC Enhancement Cost	$ 334,890
Total Landscape Cost	$ 647,460

Base Maintenance Cost	$ 864,193
LC Enhancement Cost	$ 871,417
Total Maintenance Cost	$ 1,735,609

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,325,398	$ 940,747	$ 2,266,145
Contingency Cost (25% of Construction Cost)	$ 331,350	$ 235,187	$ 566,536
Engineering Design Cost (5% of Construction Cost)	$ 66,270	$ 47,037	$ 113,307
Total Construction Cost	$ 1,723,017	$ 1,222,971	$ 2,945,989

Land Cost

Channel Length	3721 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	387	33.1	$100,000	$ 3,310,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	4.7	$100,000	$ 470,000
Levee LC Enhancement	51	4.4	$100,000	$ 440,000
Other	0	0	$100,000	$ -
Total	493	42.2		$ 4,220,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	37.8	$100,000	$ 3,780,000
LC Enhancement Cost	acre	4.4	$100,000	$ 440,000
Total Land Cost	acre	42.2	$100,000	$ 4,220,000

Total Cost

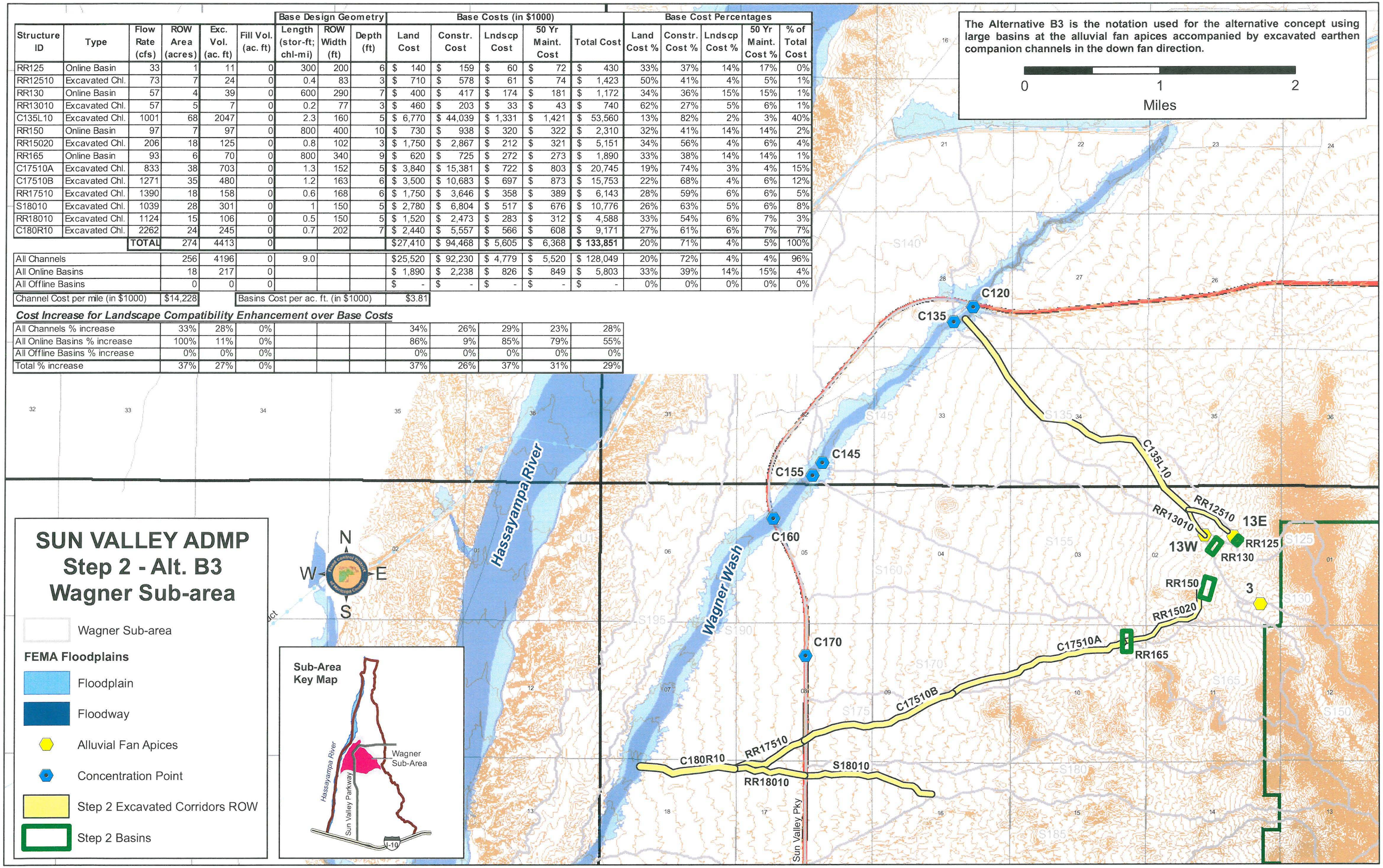
Base Total Cost	$ 6,679,780
Total Landscape Enhancement Cost	$ 2,869,278
Total Cost Including LC Enh.	$ 9,549,058

Structure ID	Type	Flow Rate (cfs)	ROW Area (acres)	Exc. Vol. (ac. ft)	Fill Vol. (ac. ft)	Base Design Geometry: Length (stor-ft; chl-mi)	ROW Width (ft)	Depth (ft)	Base Costs (in $1000): Land Cost	Constr. Cost	Lndscp Cost	50 Yr Maint. Cost	Total Cost	Base Cost Percentages: Land Cost %	Constr. Cost %	Lndscp Cost %	50 Yr Maint. Cost %	% of Total Cost
RR125	Online Basin	33	1	11	0	300	200	6	$ 140	$ 159	$ 60	$ 72	$ 430	33%	37%	14%	17%	0%
RR12510	Excavated Chl.	73	7	24	0	0.4	83	3	$ 710	$ 578	$ 61	$ 74	$ 1,423	50%	41%	4%	5%	1%
RR130	Online Basin	57	4	39	0	600	290	7	$ 400	$ 417	$ 174	$ 181	$ 1,172	34%	36%	15%	15%	1%
RR13010	Excavated Chl.	57	5	7	0	0.2	77	3	$ 460	$ 203	$ 33	$ 43	$ 740	62%	27%	5%	6%	1%
C135L10	Excavated Chl.	1001	68	2047	0	2.3	160	5	$ 6,770	$ 44,039	$ 1,331	$ 1,421	$ 53,560	13%	82%	2%	3%	40%
RR150	Online Basin	97	7	97	0	800	400	10	$ 730	$ 938	$ 320	$ 322	$ 2,310	32%	41%	14%	14%	2%
RR15020	Excavated Chl.	206	18	125	0	0.8	102	3	$ 1,750	$ 2,867	$ 212	$ 321	$ 5,151	34%	56%	4%	6%	4%
RR165	Online Basin	93	6	70	0	800	340	9	$ 620	$ 725	$ 272	$ 273	$ 1,890	33%	38%	14%	14%	1%
C17510A	Excavated Chl.	833	38	703	0	1.3	152	5	$ 3,840	$ 15,381	$ 722	$ 803	$ 20,745	19%	74%	3%	4%	15%
C17510B	Excavated Chl.	1271	35	480	0	1.2	163	6	$ 3,500	$ 10,683	$ 697	$ 873	$ 15,753	22%	68%	4%	6%	12%
RR17510	Excavated Chl.	1390	18	158	0	0.6	168	6	$ 1,750	$ 3,646	$ 358	$ 389	$ 6,143	28%	59%	6%	6%	5%
S18010	Excavated Chl.	1039	28	301	0	1	150	5	$ 2,780	$ 6,804	$ 517	$ 676	$ 10,776	26%	63%	5%	6%	8%
RR18010	Excavated Chl.	1124	15	106	0	0.5	150	5	$ 1,520	$ 2,473	$ 283	$ 312	$ 4,588	33%	54%	6%	7%	3%
C180R10	Excavated Chl.	2262	24	245	0	0.7	202	7	$ 2,440	$ 5,557	$ 566	$ 608	$ 9,171	27%	61%	6%	7%	7%
		TOTAL	274	4413	0				$27,410	$ 94,468	$ 5,605	$ 6,368	**$ 133,851**	20%	71%	4%	5%	100%
All Channels			256	4196	0	9.0			$25,520	$ 92,230	$ 4,779	$ 5,520	$ 128,049	20%	72%	4%	4%	96%
All Online Basins			18	217	0				$ 1,890	$ 2,238	$ 826	$ 849	$ 5,803	33%	39%	14%	15%	4%
All Offline Basins			0	0	0				$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%

Channel Cost per mile (in $1000)	$14,228	Basins Cost per ac. ft. (in $1000)	$3.81

Cost Increase for Landscape Compatibility Enhancement over Base Costs

	ROW Area	Exc. Vol.	Fill Vol.				Land Cost	Constr. Cost	Lndscp Cost	50 Yr Maint. Cost	Total Cost
All Channels % increase	33%	28%	0%				34%	26%	29%	23%	28%
All Online Basins % increase	100%	11%	0%				86%	9%	85%	79%	55%
All Offline Basins % increase	0%	0%	0%				0%	0%	0%	0%	0%
Total % increase	37%	27%	0%				37%	26%	37%	31%	29%



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Costs Summary

Structure ID	Type	Flow Rate (cfs)	ROW Area (acres)	Exc. Vol. (ac. ft)	Fill Vol. (ac. ft)	Base Design Geometry: Length (stor-ft; chl-mi)	ROW Width (ft)	Depth (ft)	Base Costs (in $1000): Land Cost	Constr. Cost	Lndscp Cost	50 Yr Maint. Cost	Total Cost	Base Cost Percentages: Land Cost %	Constr. Cost %	Lndscp Cost %	50 Yr Maint. Cost %	% of Total Cost
RR125	Online Basin	33	1	11	0	300	200	6	$ 140	$ 159	$ 60	$ 72	$ 430	33%	37%	14%	17%	0%
RR12510	Excavated Chl.	73	7	24	0	0.4	83	3	$ 710	$ 578	$ 61	$ 74	$ 1,423	50%	41%	4%	5%	1%
RR130	Online Basin	57	4	39	0	600	290	7	$ 400	$ 417	$ 174	$ 181	$ 1,172	34%	36%	15%	15%	1%
RR13010	Excavated Chl.	57	5	7	0	0.2	77	3	$ 460	$ 203	$ 33	$ 43	$ 740	62%	27%	5%	6%	1%
C135L10	Excavated Chl.	1001	68	2047	0	2.3	160	5	$ 6,770	$ 44,039	$ 1,331	$ 1,421	$ 53,560	13%	82%	2%	3%	40%
RR150	Online Basin	97	7	97	0	800	400	10	$ 730	$ 938	$ 320	$ 322	$ 2,310	32%	41%	14%	14%	2%
RR15020	Excavated Chl.	206	18	125	0	0.8	102	3	$ 1,750	$ 2,867	$ 212	$ 321	$ 5,151	34%	56%	4%	6%	4%
RR165	Online Basin	93	6	70	0	800	340	9	$ 620	$ 725	$ 272	$ 273	$ 1,890	33%	38%	14%	14%	1%
C17510A	Excavated Chl.	833	38	703	0	1.3	152	5	$ 3,840	$ 15,381	$ 722	$ 803	$ 20,745	19%	74%	3%	4%	15%
C17510B	Excavated Chl.	1271	35	480	0	1.2	163	6	$ 3,500	$ 10,683	$ 697	$ 873	$ 15,753	22%	68%	4%	6%	12%
RR17510	Excavated Chl.	1390	18	158	0	0.6	168	6	$ 1,750	$ 3,646	$ 358	$ 389	$ 6,143	28%	59%	6%	6%	5%
S18010	Excavated Chl.	1039	28	301	0	1	150	5	$ 2,780	$ 6,804	$ 517	$ 676	$ 10,776	26%	63%	5%	6%	8%
RR18010	Excavated Chl.	1124	15	106	0	0.5	150	5	$ 1,520	$ 2,473	$ 283	$ 312	$ 4,588	33%	54%	6%	7%	3%
C180R10	Excavated Chl.	2262	24	245	0	0.7	202	7	$ 2,440	$ 5,557	$ 566	$ 608	$ 9,171	27%	61%	6%	7%	7%
		TOTAL	274	4413	0				$ 27,410	$ 94,468	$ 5,605	$ 6,368	**$ 133,851**	20%	71%	4%	5%	100%
All Channels			256	4196	0	9.0			$ 25,520	$ 92,230	$ 4,779	$ 5,520	$ 128,049	20%	72%	4%	4%	96%
All Online Basins			18	217	0				$ 1,890	$ 2,238	$ 826	$ 849	$ 5,803	33%	39%	14%	15%	4%
All Offline Basins			0	0	0				$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
Channel Cost per mile (in $1000)			$14,228		Basins Cost per ac. ft. (in $1000)				$3.81									

Cost Summary - Landscape Compatibility Enhanced (LCE)

Structure ID	Type	Flow Rate (cfs)	ROW Area (acres)	Exc. Vol. (ac. ft)	Fill Vol. (ac. ft)	LCE Design Geometry: Length (stor-ft; chl-mi)	ROW Width (ft)	Depth (ft)	LCE Costs (in $1000): Land Cost	Constr. Cost	Lndscp Cost	50 Yr Maint. Cost	Total Cost	LCE Cost Percentages: Land Cost %	Constr. Cost %	Lndscp Cost %	50 Yr Maint. Cost %	% of Total Cost
RR125	Online Basin	33	4	12	0	510	300	6	$ 350	$ 174	$ 153	$ 161	$ 838	42%	21%	18%	19%	0%
RR12510	Excavated Chl.	73	10	34	0	0.4	232	3	$ 980	$ 802	$ 89	$ 100	$ 1,970	50%	41%	5%	5%	1%
RR130	Online Basin	57	8	44	0	870	390	7	$ 780	$ 460	$ 339	$ 338	$ 1,917	41%	24%	18%	18%	1%
RR13010	Excavated Chl.	57	6	11	0	0.2	226	3	$ 640	$ 289	$ 52	$ 60	$ 1,041	61%	28%	5%	6%	1%
C135L10	Excavated Chl.	1001	90	2599	0	2.3	324	5	$ 8,990	$ 55,681	$ 1,694	$ 1,762	$ 68,127	13%	82%	2%	3%	39%
RR150	Online Basin	97	13	108	0	1110	500	10	$ 1,270	$ 1,032	$ 555	$ 545	$ 3,401	37%	30%	16%	16%	2%
RR15020	Excavated Chl.	206	24	168	0	0.8	254	3	$ 2,390	$ 3,767	$ 286	$ 390	$ 6,833	35%	55%	4%	6%	4%
RR165	Online Basin	93	11	77	0	1100	440	9	$ 1,110	$ 780	$ 484	$ 474	$ 2,848	39%	27%	17%	17%	2%
C17510A	Excavated Chl.	833	51	886	0	1.3	313	5	$ 5,090	$ 19,254	$ 913	$ 983	$ 26,239	19%	73%	3%	4%	15%
C17510B	Excavated Chl.	1271	47	616	0	1.2	330	6	$ 4,680	$ 13,564	$ 901	$ 1,064	$ 20,208	23%	67%	4%	5%	12%
RR17510	Excavated Chl.	1390	23	201	0	0.6	335	6	$ 2,330	$ 4,557	$ 458	$ 483	$ 7,828	30%	58%	6%	6%	5%
S18010	Excavated Chl.	1039	37	389	0	1	314	5	$ 3,730	$ 8,664	$ 671	$ 821	$ 13,886	27%	62%	5%	6%	8%
RR18010	Excavated Chl.	1124	20	137	0	0.5	314	5	$ 2,030	$ 3,122	$ 367	$ 392	$ 5,911	34%	53%	6%	7%	3%
C180R10	Excavated Chl.	2262	32	309	0	0.7	378	7	$ 3,230	$ 6,926	$ 722	$ 755	$ 11,633	28%	60%	6%	6%	7%
		TOTAL	376	5591	0				$ 37,600	$ 119,071	$ 7,684	$ 8,326	**$ 172,681**	22%	69%	4%	5%	100%
All Channels			340	5350	0	9.0			$ 34,090	$ 116,626	$ 6,152	$ 6,809	$ 163,678	21%	71%	4%	4%	95%
All Online Basins			36	241	0				$ 3,510	$ 2,445	$ 1,531	$ 1,517	$ 9,004	39%	27%	17%	17%	5%
All Offline Basins			0	0	0				$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
Channel Cost per mile (in $1000)			$18,186		Basins Cost per ac. ft. (in $1000)				$6.35									
All Channels % increase			33%	28%	0%				34%	26%	29%	23%	28%					
All Online Basins % increase			100%	11%	0%				86%	9%	85%	79%	55%					
All Offline Basins % increase			0%	0%	0%				0%	0%	0%	0%	0%					
Total % increase			37%	27%	0%				37%	26%	37%	31%	29%					

Hydrology - 6-hr Storm HEC1 Model Results

		Peak	Peak	Peak		Cum.Area	MAX. Average Flow (cfs)				MAX. Average Rainfall Depth (Inches)				Total Runoff Volume (ac. ft)			
KK CARD	Type	Flow	Stage (ft)	Storage	Time	(sq. miles)	6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR
S100	BASIN	4347			4.6	6.99	899	225	75	32	1.195	1.195	1.195	1.195	446	446	446	446
S102	BASIN	2790			4.3	3.23	417	104	35	15	1.198	1.198	1.198	1.198	207	207	207	207
C102	COMBINE	5993			4.5	10.23	1198	300	100	43	1.089	1.089	1.089	1.089	594	594	594	594
RR102	STORAGE	127	1552	1143.35	6.7	10.23	122	104	72	41	0.11	0.376	0.784	1.029	60	205	428	561
D102	DIVERT	63			6.7	10.23	61	52	36	20	0.055	0.188	0.392	0.515	30	103	214	281
100105	ROUTE	59	100.2	20.4	12.5	10.23	58	51	36	20	0.053	0.185	0.389	0.512	29	101	212	279
S105	BASIN	2863			4.5	4.37	495	124	41	18	1.053	1.053	1.053	1.053	245	245	245	245
CF02	RETRIEVE	63			6.7	10.23	61	52	36	20	0.055	0.188	0.392	0.515	30	103	214	281
102105	ROUTE	63	100.4	8.6	8	10.23	60	51	36	20	0.055	0.187	0.39	0.513	30	102	213	280
C105U	COMBINE	2863			4.5	14.6	549	226	120	64	0.35	0.577	0.921	1.128	272	449	717	878
S110	BASIN	662			4.2	0.43	76	19	6	3	1.639	1.64	1.64	1.64	38	38	38	38
11015I	ROUTE	570	101.8	9.19	4.4	0.43	76	19	6	3	1.637	1.64	1.64	1.64	38	38	38	38
15I15R	ROUTE	506	102.1	19.34	4.8	0.43	76	19	6	3	1.635	1.64	1.64	1.64	38	38	38	38
S115	BASIN	1605			4.5	2.25	296	74	25	11	1.223	1.224	1.224	1.224	147	147	147	147
C115	COMBINE	1813			4.6	2.68	350	88	29	13	1.215	1.219	1.219	1.219	173	174	174	174
115120	ROUTE	1781	102.7	21.9	4.7	2.68	350	88	29	13	1.215	1.219	1.219	1.219	173	174	174	174
S120	BASIN	1838			4.3	2	256	64	21	9	1.189	1.189	1.189	1.189	127	127	127	127
C120	COMBINE	2678			4.5	4.68	545	137	46	20	1.083	1.087	1.087	1.087	270	271	271	271
C105D	COMBINE	4029			4.5	19.28	821	275	127	64	0.396	0.53	0.737	0.863	407	545	758	888
120135	ROUTE	4027	104.4	16.85	4.5	19.28	821	275	127	64	0.396	0.53	0.737	0.863	407	545	758	888
S125	BASIN	202			4	0.09	14	4	1	1	1.424	1.425	1.425	1.425	7	7	7	7
RR125	STORAGE	33	4.8	4.9	4.4	0.09	14	4	1	1	1.411	1.425	1.425	1.425	7	7	7	7
12535I	ROUTE	33	99.8	0.35	4.5	0.09	14	4	1	1	1.41	1.425	1.425	1.425	7	7	7	7
S130	BASIN	524			4.1	0.31	48	12	4	2	1.425	1.426	1.426	1.426	24	24	24	24
RR130	STORAGE	57	5.8	18.5	4.8	0.31	42	12	4	2	1.251	1.426	1.426	1.426	21	24	24	24
13035I	ROUTE	57	100.3	0.36	4.8	0.31	42	12	4	2	1.249	1.426	1.426	1.426	21	24	24	24
C135I	COMBINE	83			4.7	1.18	49	14	5	2	0.39	0.428	0.428	0.428	25	27	27	27
35I135	ROUTE	81	98.9	5.95	5.5	1.18	48	14	5	2	0.377	0.428	0.428	0.428	24	27	27	27
S135	BASIN	1102			4.2	0.88	111	28	9	4	1.175	1.175	1.175	1.175	55	55	55	55
C135L	COMBINE	829			4.2	2.06	136	36	12	5	0.614	0.654	0.654	0.654	67	72	72	72
C135	COMBINE	4170			4.5	21.34	877	288	131	66	0.382	0.502	0.684	0.796	435	571	779	906
135145	ROUTE	3747	103.8	146.9	5	21.34	866	286	131	66	0.377	0.498	0.683	0.795	429	567	777	905
S140	BASIN	1913			4.1	1.37	188	47	16	7	1.27	1.27	1.27	1.27	93	93	93	93
140145	ROUTE	1624	101.9	39.38	4.4	1.37	187	47	16	7	1.27	1.27	1.27	1.27	93	93	93	93
S145	BASIN	1702			4.2	1.76	193	48	16	7	1.021	1.021	1.021	1.021	96	96	96	96
C145	COMBINE	4072			4.9	24.47	1032	325	143	71	0.392	0.494	0.651	0.747	512	645	850	974
145155	ROUTE	4071	105.7	11.21	4.9	24.47	1032	325	143	71	0.392	0.494	0.651	0.746	512	645	850	974
S155	BASIN	1626			4.3	1.83	223	56	19	8	1.131	1.132	1.132	1.132	111	111	111	111
C155	COMBINE	4304			4.8	26.3	1130	349	150	74	0.4	0.493	0.636	0.724	561	691	893	1016
155160	ROUTE	4294	104.5	32.54	4.9	26.3	1129	348	150	74	0.399	0.492	0.636	0.724	560	691	892	1016
S160	BASIN	1347			4.2	1.14	133	33	11	5	1.079	1.079	1.079	1.079	66	66	66	66
C160	COMBINE	4291			4.9	27.44	1169	358	153	75	0.396	0.485	0.622	0.705	580	710	910	1032
160170	ROUTE	4195	102.7	80.51	5.1	27.44	1162	356	153	75	0.394	0.483	0.62	0.704	576	707	908	1030
S170	BASIN	1686			4.2	1.46	178	44	15	6	1.127	1.127	1.127	1.127	88	88	88	88
170R	ROUTE	1489	1E+08	1E+08	4.4	1.46	178	44	15	6	1.127	1.127	1.127	1.127	88	88	88	88
C170R	COMBINE	4313			5	28.9	1228	372	157	77	0.395	0.479	0.608	0.686	609	738	937	1058

Hydrology - 6-hr Storm HEC1 Model Results

		Peak	Peak	Peak		Cum.Area	MAX. Average Flow (cfs)				MAX. Average Rainfall Depth (Inches)				Total Runoff Volume (ac. ft)			
KK CARD	Type	Flow	Stage (ft)	Storage	Time	(sq. miles)	6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR
S150	BASIN	836			4.3	0.77	126	31	10	5	1.51	1.513	1.513	1.513	62	62	62	62
RR150	STORAGE	97	8.2	48.3	5.5	0.77	83	31	10	5	0.997	1.513	1.513	1.513	41	62	62	62
150165	ROUTE	96	100.3	2.19	5.8	0.77	82	31	10	5	0.99	1.513	1.513	1.513	41	62	62	62
S165	BASIN	1008			4.1	0.62	94	23	8	3	1.416	1.417	1.417	1.417	47	47	47	47
C165	COMBINE	808			4.1	1.39	155	50	17	7	1.036	1.344	1.345	1.345	77	100	100	100
RR165	STORAGE	93	7.5	38	6.1	1.39	91	50	17	7	0.612	1.342	1.345	1.345	45	100	100	100
165175	ROUTE	93	99	7.2	6.7	1.39	91	50	17	7	0.611	1.342	1.345	1.345	45	99	100	100
S175	BASIN	1203			4.5	1.8	226	56	19	8	1.165	1.166	1.166	1.166	112	112	112	112
C175	COMBINE	1032			4.5	3.19	272	96	32	14	0.794	1.116	1.118	1.118	135	190	190	190
175R	ROUTE	1010	100.7	10.43	4.6	3.19	272	96	32	14	0.791	1.116	1.118	1.118	135	190	190	190
S180	BASIN	1032			4.5	1.44	181	45	15	7	1.167	1.169	1.169	1.169	90	90	90	90
180R	ROUTE	860	101	25.48	4.7	1.44	181	45	15	7	1.164	1.169	1.169	1.169	90	90	90	90
C180RI	COMBINE	1553			4.6	4.63	403	127	42	18	0.809	1.019	1.02	1.02	200	252	252	252
RI180R	ROUTE	1529	100.9	19.84	4.8	4.63	402	127	42	18	0.806	1.019	1.02	1.02	199	252	252	252
C180R	COMBINE	4687			5.2	33.54	1406	430	176	85	0.39	0.477	0.585	0.651	697	853	1046	1164
180185	ROUTE	4675	103	52.27	5.3	33.54	1401	429	176	85	0.388	0.476	0.585	0.651	695	851	1046	1164
S185	BASIN	1450			4.5	2.42	288	72	24	10	1.106	1.107	1.107	1.107	143	143	143	143
185R	ROUTE	1302	102.5	41.84	4.9	2.42	288	72	24	10	1.105	1.107	1.107	1.107	143	143	143	143
C185R	COMBINE	5050			5.2	35.96	1510	456	184	88	0.391	0.471	0.571	0.632	749	904	1095	1211
185190	ROUTE	5031	102.6	42.72	5.3	35.96	1505	455	184	88	0.389	0.471	0.571	0.631	746	903	1094	1211
S190	BASIN	2084			4.5	4.05	391	98	33	14	0.896	0.896	0.896	0.896	194	194	194	194
C190	COMBINE	5292			5.2	39.24	1634	488	194	92	0.387	0.462	0.553	0.608	810	968	1157	1272
190195	ROUTE	5177	103.1	79.43	5.4	39.24	1627	487	194	92	0.386	0.462	0.553	0.608	807	967	1156	1272
S195	BASIN	1001			4.6	1.81	203	51	17	7	1.046	1.046	1.046	1.046	101	101	101	101
C195	COMBINE	5251			5.4	41.05	1677	500	198	94	0.38	0.453	0.538	0.591	832	991	1179	1293

Hydrology - 24-hr Storm HEC1 Model Results

KK CARD	Type	Peak Flow	Peak Stage (ft)	Peak Storage	Time	Cum.Area (sq. miles)	MAX. Average Flow (cfs)				MAX. Average Rainfall Depth (Inches)				Total Runoff Volume (ac. ft)			
							6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR
S100	BASIN	5214			12.5	6.99	965	241	80	35	1.282	1.282	1.282	1.282	478	478	478	478
S102	BASIN	3434			12.3	3.23	420	105	35	15	1.207	1.207	1.207	1.207	208	208	208	208
C102	COMBINE	7803			12.4	10.23	1367	342	114	49	1.243	1.243	1.243	1.243	678	678	678	678
RR102	STORAGE	149	1552.1	1201.44	14.4	10.23	141	119	82	46	0.128	0.431	0.895	1.163	70	235	488	634
D102	DIVERT	75			14.4	10.23	71	59	41	23	0.064	0.215	0.448	0.581	35	118	244	317
100105	ROUTE	70	100.2	24.2	20.3	10.23	67	58	41	23	0.061	0.211	0.444	0.578	33	115	242	315
S105	BASIN	3466			12.5	4.37	531	133	44	19	1.129	1.129	1.129	1.129	263	263	263	263
CF02	RETRIEVE	75			14.4	10.23	71	59	41	23	0.064	0.215	0.448	0.581	35	118	244	317
102105	ROUTE	74	100.4	9.55	15.6	10.23	70	59	41	23	0.064	0.214	0.445	0.58	35	117	243	316
C105U	COMBINE	3466			12.5	14.6	587	238	125	66	0.374	0.606	0.958	1.164	291	472	746	906
S110	BASIN	532			12.1	0.43	62	16	5	2	1.35	1.422	1.422	1.422	31	33	33	33
110151	ROUTE	456	101.7	7.4	12.4	0.43	62	16	5	2	1.35	1.421	1.422	1.422	31	33	33	33
15115R	ROUTE	412	101.9	16.62	12.7	0.43	62	16	5	2	1.349	1.421	1.422	1.422	31	33	33	33
S115	BASIN	1693			12.5	2.25	287	73	24	11	1.186	1.209	1.209	1.209	142	145	145	145
C115	COMBINE	1937			12.6	2.68	346	89	30	13	1.201	1.232	1.233	1.233	171	176	176	176
115120	ROUTE	1900	102.8	22.91	12.7	2.68	346	89	30	13	1.201	1.232	1.233	1.233	171	176	176	176
S120	BASIN	2032			12.3	2	247	62	21	9	1.146	1.158	1.158	1.158	122	124	124	124
C120	COMBINE	3202			12.4	4.68	585	149	50	22	1.162	1.185	1.186	1.186	290	296	296	296
C105D	COMBINE	6217			12.4	19.28	1091	359	163	82	0.526	0.692	0.943	1.092	541	712	969	1123
120135	ROUTE	6220	105.1	23.77	12.5	19.28	1091	359	163	82	0.526	0.692	0.943	1.092	541	711	969	1123
S125	BASIN	161			12	0.09	12	3	1	0	1.197	1.258	1.258	1.258	6	6	6	6
RR125	STORAGE	30	4	4	12.4	0.09	12	3	1	0	1.193	1.257	1.258	1.258	6	6	6	6
125351	ROUTE	30	99.8	0.33	12.5	0.09	12	3	1	0	1.192	1.257	1.258	1.258	6	6	6	6
S130	BASIN	415			12.1	0.31	39	10	3	1	1.169	1.217	1.217	1.217	19	20	20	20
RR130	STORAGE	51	4.7	14.6	12.7	0.31	36	10	3	1	1.068	1.215	1.217	1.217	18	20	20	20
130351	ROUTE	51	100.2	0.33	12.8	0.31	36	10	3	1	1.066	1.215	1.217	1.217	18	20	20	20
C135I	COMBINE	79			12.6	1.18	46	13	4	2	0.363	0.407	0.407	0.407	23	26	26	26
351135	ROUTE	77	98.9	5.75	13.4	1.18	45	13	4	2	0.352	0.406	0.407	0.407	22	26	26	26
S135	BASIN	1015			12.2	0.88	99	25	8	4	1.048	1.048	1.048	1.048	49	49	49	49
C135L	COMBINE	1001			12.2	2.06	138	37	12	5	0.624	0.671	0.671	0.671	69	74	74	74
C135	COMBINE	6649			12.4	21.34	1208	389	173	86	0.526	0.678	0.903	1.037	599	772	1028	1180
135145	ROUTE	5881	104.6	212.02	12.8	21.34	1194	386	172	86	0.52	0.673	0.901	1.036	592	766	1025	1179
S140	BASIN	2029			12.1	1.37	172	43	14	6	1.164	1.164	1.164	1.164	85	85	85	85
140145	ROUTE	1633	101.9	39.54	12.4	1.37	172	43	14	6	1.163	1.164	1.164	1.164	85	85	85	85
S145	BASIN	1945			12.2	1.76	193	48	16	7	1.022	1.022	1.022	1.022	96	96	96	96
C145	COMBINE	6532			12.7	24.47	1497	461	197	96	0.569	0.701	0.899	1.017	742	915	1173	1327
145155	ROUTE	6537	106.9	17.8	12.8	24.47	1497	461	197	96	0.569	0.701	0.899	1.017	742	915	1173	1327
S155	BASIN	1781			12.3	1.83	218	55	18	8	1.105	1.117	1.117	1.117	108	109	109	109
C155	COMBINE	7020			12.7	26.3	1679	507	212	103	0.594	0.716	0.9	1.009	833	1005	1262	1416
155160	ROUTE	6996	105.5	51.28	12.8	26.3	1678	506	212	103	0.593	0.716	0.9	1.009	832	1004	1262	1416
S160	BASIN	1342			12.1	1.14	124	31	10	4	1.01	1.01	1.01	1.01	62	62	62	62
C160	COMBINE	7077			12.8	27.44	1776	531	220	106	0.602	0.719	0.895	1	881	1053	1310	1464
160170	ROUTE	6939	103.4	130.76	13	27.44	1767	529	220	106	0.599	0.717	0.895	1	876	1050	1309	1463
S170	BASIN	1802			12.1	1.46	169	42	14	6	1.075	1.075	1.075	1.075	84	84	84	84
170R	ROUTE	1558	1E+08	1E+08	12.4	1.46	169	42	14	6	1.075	1.075	1.075	1.075	84	84	84	84
C170R	COMBINE	7196			13	28.9	1905	563	231	111	0.613	0.725	0.893	0.993	945	1118	1377	1531
170180	ROUTE	7095	103.6	183.51	13.1	28.9	1894	562	231	111	0.609	0.723	0.892	0.992	939	1114	1375	1530

Hydrology - 24-hr Storm HEC1 Model Results

KK CARD	Type	Peak Flow	Peak Stage (ft)	Peak Storage	Time	Cum.Area (sq. miles)	MAX. Average Flow (cfs)				MAX. Average Rainfall Depth (Inches)				Total Runoff Volume (ac. ft)			
							6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR
S150	BASIN	729			12.3	0.77	107	29	10	4	1.291	1.374	1.375	1.375	53	57	57	57
RR150	STORAGE	89	6.9	39.9	13.5	0.77	75	28	10	4	0.906	1.365	1.375	1.375	37	56	57	57
150165	ROUTE	88	100.2	2.03	13.8	0.77	75	28	10	4	0.9	1.364	1.375	1.375	37	56	57	57
S165	BASIN	842			12.1	0.62	78	20	7	3	1.183	1.219	1.219	1.219	39	40	40	40
C165	COMBINE	852			12.1	1.39	146	48	16	7	0.973	1.282	1.291	1.291	72	95	96	96
RR165	STORAGE	90	7	35.2	13.9	1.39	88	48	16	7	0.59	1.276	1.291	1.291	44	95	96	96
165175	ROUTE	90	99	7.05	14.5	1.39	88	48	16	7	0.589	1.276	1.291	1.291	44	95	96	96
S175	BASIN	1278			12.5	1.8	217	55	18	8	1.119	1.131	1.131	1.131	108	109	109	109
C175	COMBINE	1271			12.5	3.19	286	101	34	15	0.832	1.177	1.186	1.186	142	200	202	202
175R	ROUTE	1220	100.9	12.07	12.5	3.19	285	101	34	15	0.829	1.177	1.186	1.186	141	200	202	202
S180	BASIN	1039			12.5	1.44	171	44	15	6	1.1	1.123	1.124	1.124	85	86	86	86
180R	ROUTE	838	101	25.01	12.7	1.44	170	44	15	6	1.098	1.123	1.124	1.124	84	86	86	86
C180RI	COMBINE	1993			12.6	4.63	450	143	48	21	0.902	1.145	1.154	1.154	223	283	285	285
RI180R	ROUTE	1939	101.2	23.84	12.7	4.63	448	143	48	21	0.899	1.145	1.154	1.154	222	283	285	285
C180R	COMBINE	8244			13	33.54	2271	681	271	128	0.629	0.755	0.9	0.987	1126	1351	1610	1766
180185	ROUTE	8227	104	81.84	13.1	33.54	2265	680	270	128	0.628	0.754	0.9	0.987	1123	1349	1609	1765
S185	BASIN	1655			12.5	2.42	288	73	24	10	1.105	1.117	1.117	1.117	143	144	144	144
185R	ROUTE	1411	102.6	45.16	12.9	2.42	287	73	24	10	1.104	1.117	1.117	1.117	143	144	144	144
C185R	COMBINE	9216			13	35.96	2498	739	290	137	0.646	0.764	0.9	0.981	1239	1465	1725	1882
185190	ROUTE	9204	103.5	67.8	13.1	35.96	2493	738	290	137	0.644	0.763	0.899	0.981	1236	1464	1725	1881
S190	BASIN	2590			12.5	4.05	448	112	37	16	1.027	1.027	1.027	1.027	222	222	222	222
C190	COMBINE	10056			13	39.24	2840	827	320	150	0.673	0.784	0.909	0.984	1408	1641	1903	2060
190195	ROUTE	9939	104.2	134.02	13.2	39.24	2832	827	320	150	0.671	0.783	0.909	0.984	1404	1640	1903	2060
S195	BASIN	1039			12.6	1.81	202	51	17	7	1.041	1.041	1.041	1.041	100	100	100	100
C195	COMBINE	10316			13.2	41.05	2986	866	333	155	0.676	0.784	0.904	0.976	1481	1717	1980	2137

Channels Hydraulics Summary

		Design Geometry						Hydraulics										
Structure ID	Type	Initial Slope (ft/ft)	Long-term Slope (ft/ft)	Length (stor-ft; chl-mi)	Width (ft)	Depth (ft)	Chnl Mannings n	Flow Rate (cfs)	Wetted Perimeter (ft)	Wetted XS Area (ft)	Hydraulic Radius (ft)	Hydraulic Depth (ft)	Flow Depth (ft)	Freeboard (ft)	Top Width (ft)	Velocity (ft/s)	Froude Number	Shear Stress (lb/sq. ft)
RR12510	Excavated	0.0265	0.0100	0.40	3	2.5	0.045	73	27.6	24.1	0.9	0.9	1.5	1.0	27	3.0	0.57	0.94
RR13010	Excavated	0.0252	0.0120	0.20	3	2.5	0.045	57	21.8	17.9	0.8	0.8	1.6	0.9	21	3.2	0.61	1.16
C135L10	Excavated	0.0165	0.0060	2.30	3	5.0	0.045	1001	104.2	230.1	2.2	2.2	3.8	1.2	103	4.3	0.51	1.43
RR15020	Excavated	0.0206	0.0090	0.80	3	3.0	0.045	206	46.8	57.3	1.2	1.2	2.0	1.0	46	3.6	0.57	1.14
C17510A	Excavated	0.0182	0.0070	1.30	3	4.5	0.045	833	96.6	190.9	2.0	2.0	3.4	1.1	95	4.4	0.54	1.49
C17510B	Excavated	0.0135	0.0050	1.20	3	5.5	0.045	1271	107.5	284.0	2.6	2.7	4.3	1.2	106	4.5	0.48	1.35
RR17510	Excavated	0.0164	0.0060	0.60	3	5.5	0.045	1390	113.3	289.7	2.6	2.6	4.5	1.0	112	4.8	0.53	1.67
S18010	Excavated	0.0146	0.0060	1.00	3	5.0	0.045	1039	95.2	227.0	2.4	2.4	4.0	1.0	94	4.6	0.52	1.49
RR18010	Excavated	0.0153	0.0060	0.50	3	5.0	0.045	1124	96.0	238.8	2.5	2.5	4.1	0.9	95	4.7	0.52	1.54
C180R10	Excavated	0.0122	0.0045	0.70	3	7.0	0.045	2262	145.3	467.4	3.2	3.3	5.6	1.4	143	4.8	0.47	1.57

Basins Hydraulics Summary

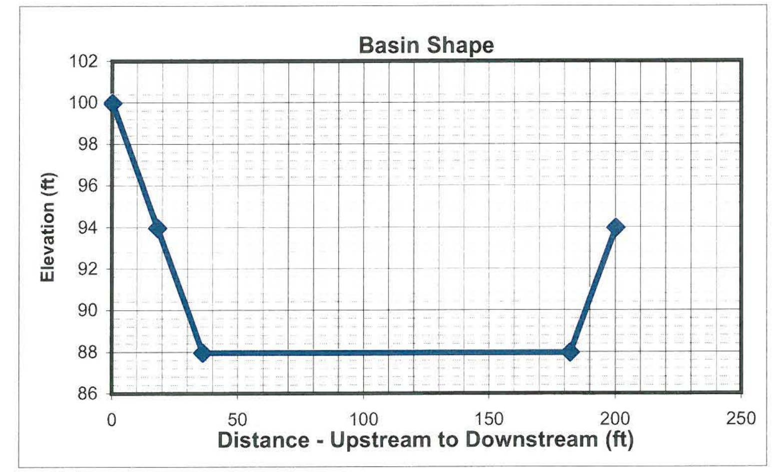
			Design Geometry				Hydraulics					
Structure ID	Type	Adjacent Topo. Slope	Length (stor-ft; chl-mi)	Width (ft)	Depth (ft)	Storage Volume Provided	Peak Storage (ac. Ft)	Total Vol. Entering Basin (ac.	Peak Inflow into Basin (cfs)	Peak Outflow (cfs)	Peak Stage (ft)	Freeboard (ft)
RR125	Online Basin	0.0300	300	200	6.0	5.2	4.9	7.0	202	33	4.8	1.2
RR130	Online Basin	0.0280	600	290	7.0	19.2	18.5	24.0	524	57	5.8	1.2
RR150	Online Basin	0.0270	800	400	9.5	50.5	48.3	62.0	836	97	8.2	1.3
RR165	Online Basin	0.0220	800	340	9.0	40.8	38.0	100.0	852	93	7.5	1.5

Online Basin

HEC1 ID	RR125

HEC1 Results Used to Determine Sediment Volume From Upstream

Contributing HEC1 ID							Total Volume (ac. ft)
Inflow Volume (ac. ft)							0
Volume Fraction							
Weighted Volume							0
Sediment Conc. (ppm)							
Sediment Volume (ac. ft)							0.00
Weighting Factor							
Weighted Sed. Vol. (ac. ft)							0.00



Sediment Yield

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.1	sq. mi
Total Sediment Yield Volume	0.2	ac ft

Required Minimum Sediment Volume

Sediment Volume	0.2	ac. ft

Geometry	Base	LC Enhanced
Topography slope (ft/ft)	0.03	0.03
Basin Length (ft)	300	410
Basin Width (ft)	200	200
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	6	6
Freeboard (ft)	1	1
Effective Basin Width (ft)	182	164
Top Area (acres)	1.4	1.9
U/S-D/S Height Difference (ft)	6.0	6.0
Excess Area on Upstream (acres)	0.1	0.3

			Base	LC Enhanced
Bottom Length (ft)	264	Allocated Storage Volume (ac. ft)	5.2	5.2
Bottom Width (ft)	146	Total Available Volume (ac. ft) (incl. Freeboard)	6.4	6.7
		Total Excavation Volume (ac. ft)	10.5	12.3

HEC1 Results

	6-hr Event	24-hr Event	Maximum
Total Flow Volume entering Basin (ac. ft)	7.0	6	7.0
Peak Inflow (cfs)	202	161	202.0
Peak Outflow (cfs)	33	30	33.0
Stage at Peak Outflow (ft)	4.8	4	4.8
Volume at Peak Outflow (ac. ft)	4.9	4	4.9

Volume Check

Total Volume needed	5.1	ac. ft
Total Volume Provided	5.2	ac. ft
Volume OK?	Yes	

Stage Check

Depth Needed	5.8	ft
Depth Provided	6	ft
Depth OK?	Yes	

Basin Outlet

Outlet Coeff	0.60	(0.6 for Orifice, 3.0 for Weir)
D (Orifice) or W (Weir)	2.00	ft
Invert Elevation	0.00	ft
Number of pipes	1	

Stage-Storage-Discharge

Elevation	0	0.5	1	2	3	4	5	6	7	8
Volume	0.00	0.45	0.91	1.88	2.92	4.01	5.16	6.39	7.67	9.03
Outflow	0.0	10.7	15.1	21.4	26.2	30.3	33.8	37.1	40.0	42.8

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
LC Enhancement Buffer	93000	sq. ft
Other		sq. ft

Additional ROW Length	0	ft
Additional ROW Width	0	ft
Landscaping Buffer Length	100	ft
Landscaping Buffer Width	100	ft

Base Total ROW Length	300	ft
Base Total ROW Width	200	ft
LC Enh. Total ROW Length	510	ft
LC Enh. Total ROW Length	300	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	16940	19844
Excavated Area (sq. Yd)	6667	17000

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	38	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	422	sq. Yd
Material Volume	211	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	240	ft
Unit Cost	160	per ft
Cost per outlet	$38,400	
Other Cost	$ -	
Total Cost	$38,400	
Outlet Area	133	sq. Yd

Structure Type	Structure Cost	Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Basin		16,940	cu. Yd	$ 4.00	$ 67,760	6,667	sq. Yd	$ 9.00	$ 60,003	6,667	sq. Yd	$ 8.33	$ 55,558
Basin - LC Enhancement		2,904	cu. Yd	$ 4.00	$ 11,616	10,333	sq. Yd	$ 9.00	$ 92,997	10,333	sq. Yd	$ 8.33	$ 86,108
Inlet	Riprap	211	sq. Yd	$ 75.00	$ 15,825	422	sq. Yd	$ -	$ -	422	sq. Yd	$ 33.33	$ 14,067
Inlet - LC Enhancement (20%Inlet)					$ 3,165				$ -				$ 2,813
Outlet	Pipe	1	EA	$ 38,400	$ 38,400	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhancement (5% Outlet)					$ 1,920				$ -				$ 111
Other					$ -				$ -				$ -

Base Landscape Cost		$ 60,003
LC Enh. Landscape Cost		$ 92,997
Total Landscape Cost		$ 153,000

Base Maintenance Cost	$ 71,842
LC Enh. Maintenance Cost	$ 89,033
Total Maintenance Cost	$ 160,874

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 121,985	$ 11,616	$ 133,601
Contingency Cost (25% of Construction Cost)	$ 30,496	$ 2,904	$ 33,400
Engineering Design Cost (5% of Construction Cost)	$ 6,099	$ 581	$ 6,680
Total Construction Cost	$ 158,581	$ 15,101	$ 173,681

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	2.1	$100,000	$ 210,000
Basin	1.4	$100,000	$ 140,000
Other		$100,000	$ -
Total	3.5	$100,000	$ 350,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	1.4	$100,000	$ 140,000
LC Enhancement Cost	acre	2.1	$100,000	$ 210,000
Total Land Cost	acre	3.5	$100,000	$ 350,000

Total Cost

Base Total Cost	$ 430,425
Total LC Enhancement Cost	$ 407,130
Total Cost Including LC Enh.	$ 837,555

Open Channel

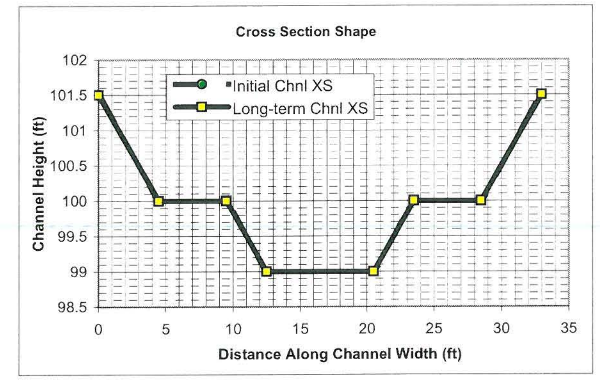
Structure ID	RR12510		HEC1 ID	12535I

Longitundal Geometry

Length	1852.5	ft
U/S Elev	1746.1	ft
D/S Elev	1697.0	ft
Initial Channel Slope	0.0265	ft/ft
Long-term Channel Slope	0.0100	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	1



Initial Channel XS Geometry

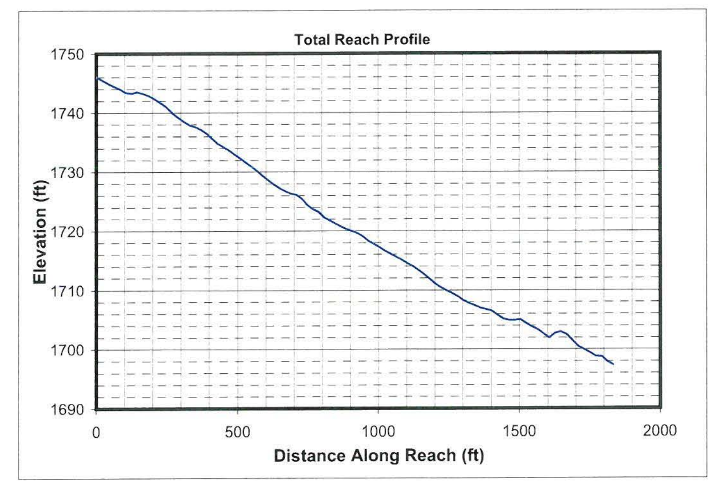
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	1.5	5	3	8	2.5	3	5	1.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	4.5	9.5	12.5	20.5	23.5	28.5	33
Y	101.5	100	100	99	99	100	100	101.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	1.5	5	3	8	2.5	3	5	1.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	4.5	9.5	12.5	20.5	23.5	28.5	33
Y	101.5	100	100	99	99	100	100	101.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	RR125	S135								TOTAL
HEC1 Peak-Flow	33	1102								1135
Weighting Factor	1.00	0.04								
Flow into Channel	33	40								73

Reach Sediment Inflow Characteristics

U/S Contributing ID										TOTAL
HEC1 Flow Volume (ac. ft)										0
Sediment Conc. (ppm)										
Sediment Volume (ac. ft)										0.00
Weighting Factor										
Weighted Sed. Vol. (ac. ft)										0.00

Hydrology

Drainage Area	0.157	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	73	cfs	
Long-term Max. Chnl Capacity	242	cfs	
Q2 Channel	7	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	33	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

Sub-area: Wagner Wash, Alternative: B3
Open Channel Structure ID: RR12510

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
7	10.8	4.2	0.4	99.0	99.4	1.8	0.4	10.7	0.4	0.28	0.49
18	12.8	7.7	0.6	99.0	99.8	2.4	0.8	12.5	0.6	0.47	0.53
55	26.6	20.0	0.8	99.0	100.4	2.7	1.4	26.2	0.8	0.85	0.55
73	27.6	24.1	0.9	99.0	100.5	3.0	1.5	27.1	0.9	0.94	0.57

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
7	10.8	4.2	0.4	99.0	99.4	1.8	0.4	10.7	0.4	0.28	0.49
18	12.8	7.7	0.6	99.0	99.8	2.4	0.8	12.5	0.6	0.47	0.53
55	26.6	20.0	0.8	99.0	100.4	2.7	1.4	26.2	0.8	0.85	0.55
73	27.6	24.1	0.9	99.0	100.5	3.0	1.5	27.1	0.9	0.94	0.57

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
7										0
18										0
55										0
73										0

Allowable Velocity

Channel Lining	Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
7	1.74	1.1054	1.0501	Erosive	Erosive	Erosive	0.2	Stable	3.4	Stable	Stable
18	1.74	1.2461	1.1838	Erosive	Erosive	Erosive	0.3	Stable	4.7	Stable	Stable
55	1.74	1.3126	1.2470	Erosive	Erosive	Erosive	0.3	Stable	6.6	Stable	Stable
73	1.74	1.3596	1.2916	Erosive	Erosive	Erosive	0.3	Stable	7.1	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	**7**	**18**	**55**	**73**	**7**	**18**	**55**	**73**	**7**	**18**	**55**	**73**
Bray - Equation #1	7	11	20	23	0.5	0.7	1.0	1.1	2.1	2.4	2.8	2.9
Bray - Equation #2	9	14	26	30	0.6	0.8	1.1	1.2	1.4	1.6	1.9	2.0
Hey	1	3	5	6	1.4	1.9	2.9	3.3				
Ackers & Charlton/Lacey	8	12	19	22					1.1	1.3	1.6	1.6
Parker	19	29	51	59	0.3	0.5	0.7	0.8				
Chang	11	19	38	45	0.1	0.1	0.0	0.0				
Kellerhals	5	8	13	15	0.6	0.9	1.3	1.5	2.5	2.7	3.0	3.1
AMAFCA/Schumm	11	13	26	27								
Moody & Odem	6	6	6	6	0.7	0.7	0.7	0.7				
BUREC	4.9	6.9	10.5	11.7	1	2	3	3	1.8	2.2	2.9	3.2
Average	8	12	21	24	0.7	0.9	1.3	1.5	1.8	2.1	2.4	2.6
Values As Designed	11	13	26	27	0.4	0.8	1.4	1.5	1.8	2.4	2.7	3.0
Difference with Design	-3	0	-5	-3	0.2	0.2	0.0	0.0	0.0	-0.3	-0.3	-0.5

Initial Channel Sediment Transport Capacity

Discharge (cfs)	Sediment Load (tons/day)											
	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
7	33	26	70	243	271	11	7	5	570	22	85	122
18	125	83	211	1030	421	58	28	25	1456	71	331	349
55	459	265	659	3980	998	222	92	96	4393	243	1184	1145
73	702	374	907	6333	1127	342	129	149	5874	357	1758	1641

Discharge (cfs)	Sediment Concentrations (ppm by weight)											
	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
7	1690	1334	3559	12325	13766	583	363	233	28986	1122	4332	6208
18	2543	1690	4295	20936	8553	1187	560	498	29602	1442	6727	7094
55	3113	1798	4464	26971	6763	1507	625	650	29766	1650	8022	7757
73	3567	1902	4607	32185	5730	1740	656	759	29851	1813	8933	8340

Long-term Channel Sediment Transport Capacity

Discharge (cfs)	Sediment Load (tons/day)											
	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
7	33	21	37	56	133	7	7	5	118	9	34	42
18	125	69	133	239	223	33	28	25	321	31	143	125
55	459	225	423	924	542	123	92	96	985	110	525	410
73	702	321	575	1470	623	186	129	149	1327	164	796	586

Discharge (cfs)	Sediment Concentrations (ppm by weight)											
	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
7	1690	1052	1871	2860	6760	352	363	233	6013	478	1750	2129
18	2543	1408	2713	4858	4526	676	560	498	6535	637	2900	2532
55	3113	1525	2866	6259	3676	834	625	650	6675	746	3561	2775
73	3567	1629	2922	7469	3165	944	656	759	6746	836	4044	2976

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
7	0.0023	0.0031	188	0.57	0.050	0.0007	31	0.036	0.0005	0.0159	0.0007	0.0016	0.0180	0.0016	0.0054	0.0098	0.0078
18	0.0013	0.0020	236	0.72	0.052	0.0005	31	0.036	0.0003	0.0159	0.0004	0.0010	0.0180	0.0010	0.0027	0.0098	0.0074
55	0.0010	0.0016	263	0.80	0.053	0.0004	32	0.036	0.0003	0.0159	0.0003	0.0008	0.0180	0.0006	0.0012	0.0098	0.0073
73	0.0008	0.0014	283	0.86	0.054	0.0003	32	0.036	0.0002	0.0159	0.0003	0.0007	0.0180	0.0005	0.0010	0.0098	0.0072

Drop Structures

Design Slope	0.0100	ft/ft
Total Drop Needed	30.5	ft
Height of Drop Structure	3	ft
No . of Drop Structures	11	
Distance between structs.	168	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.03	sq. mi
Total Sediment Yield Volume	0.06	ac ft

Sedimentation Basins

Length	168 ft	Depth	3 ft
Width	33 ft	Side slope	3 ft/ft
Total Volume per Basin		0.27	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

Discharge	Pima County General Scour Equations				Max. Depth	Hyd. Depth	Avg Vel	Se	Bend Scour	LongTerm Scour	Thalweg channel	Total
Q (cfs)	COT/PC Sinuosity	General Zgs (ft)	Antidune Za (ft)	Bend Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
7	1.1	-0.2	0.0	24.6	0.4	0.4	1.8	0.0100	0.0	0.0	1.0	1.4
18	1.1	-0.3	0.1	24.6	0.8	0.6	2.4	0.0100	0.1	0.0	1.0	1.4
55	1.1	-0.4	0.1	24.6	1.4	0.8	2.7	0.0100	0.1	0.0	1.0	1.6
73	1.1	-0.5	0.1	24.6	1.5	0.9	3.0	0.0100	0.2	0.0	1.0	1.6

Toe Protection Needed	2.0	ft

HEC1 Results For Open Channel

Peak Flow	33	cfs
Stage at Peak Flow	99.8	ft
Flow Volume	7.0	ac. ft

Freeboard

Max. Flow Depth	1.5	ft
Channel Depth as designed	2.5	ft
Available Freeboard	1.0	ft
Required Freeboard	1	ft

Sediment Volume

Inflowing Sediment Volume	0.06	ac. ft
Outflowing Sediment Volume	0.01	ac. ft
Deposited(+)/Eroded(-) Volume	0.05	ac. ft

JE FULLER
HYDROLOGY & GEOMORPHOLOGY, INC

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	1853	1853
Side Slope (?H:1V)	3	6
Channel Width (ft)	33	48
Channel XS Area (sq. ft)	53.8	72.55
Channel Perimeter (ft)	34	49

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	38275	55281
Excavated Area (sq. Yd)	6794	9883

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	1853	ft
Thickness	1.5	ft
Protection Depth	2	ft
Tie-in Length/Depth	3.0	ft
Total Depth	5.0	ft
Area needed	309	sq. Yd
Volume	515	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	None	None
Left Levee Length (ft)	0	0
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	N/A	6
Left Levee Height (ft)	0	1
Left Levee Surface Area (sq. Yd)	0	0
Left Levee Volume (cu. Yd)	0	0
Right Levee Length (ft)	0	0
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	N/A	6
Right Levee Height (ft)	0	1
Right Levee Surface Area (sq. Yd)	0	0
Right Levee Volume (cu. Yd)	0	0
Total Levee Surface Area (sq. Yd)	0	0
Total Levee Volume (cu. Yd)	0	0

Levee Lining	Base	LC Enhanced
Lining Type	None	None
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	1853	1853
Left Levee Lining Width (ft)	0	0
Left Levee Lining Thickness (ft)	0	0
Left Levee Lining Area (sq. Yd)	0	0
Left Levee Lining Volume (cu. Yd)	0	0
Right Levee Length (ft)	1853	1853
Right Levee Lining Width (ft)	0	0
Right Levee Lining Thickness (ft)	0	0
Right Levee Lining Area (sq. Yd)	0	0
Right Levee Lining Volume (cu. Yd)	0	0
Total Lining Area (sq. Yd)	0	0
Total Lining Volume (cu. Yd)	0	0

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	33	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	4.2	ft
Structure Height	7.2	ft
Number of Structures	11	
Volume per structure	26	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 1,950	
Area per structure	11	sq. Yd
Total Area	121	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	436	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 1,744	
Other Cost	$ -	
Total cost per basin	$ 1,744	
Area per basin	618	sq. Yd
Total Area	618	sq. Yd

Structure Cost

Structure Type	Structure Type	Excavation/Construction Quantity	Units	Unit Cost	Cost Subtotal	Landscape Quantity	Units	Unit Cost	Landscape Cost	Maintenance Quantity	Units	Unit Cost	Maintenance Cost
Levee	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining -LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Excavated Channel	Excavated	38,275	cu. Yd	$ 10.00	$ 382,750	6,794	sq. Yd	$ 9.00	$ 61,146	6,794	sq. Yd	$ 8.33	$ 56,617
Exc. Chl - LC Enhancement	Excavated	17,006	cu. Yd	$ 10.00	$ 170,060	3,089	sq. Yd	$ 9.00	$ 27,801	3,089	sq. Yd	$ 8.33	$ 25,742
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	515	cu. Yd	$ 75.00	$ 38,625	309	sq. Yd	$ -	$ -	309	sq. Yd	$ 25.00	$ 7,725
Drop Structures	Riprap	11	EA	$ 1,950.00	$ 21,450	121	sq. Yd	$ -	$ -	121	sq. Yd	$ 33.33	$ 4,033
Drop Str. - LC Enhancement	Riprap	11	EA	$ 195.00	$ 2,145	12	sq. Yd	$ -	$ -	12	sq. Yd	$ 33.33	$ 403
Sedimentation Basins		1	EA	$ 1,744.00	$ 1,744	618	sq. Yd	$ -	$ -	618	sq. Yd	$ 8.33	$ 5,150
Other					$ -				$ -				$ -

Base Landscape Cost	$ 61,146	Base Maintenance Cost	$ 73,525
LC Enhancement Cost	$ 27,801	LC Enhancement Cost	$ 26,145
Total Landscape Cost	$ 88,947	Total Maintenance Cost	$ 99,670

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 444,569	$ 172,205	$ 616,774
Contingency Cost (25% of Construction Cost)	$ 111,142	$ 43,051	$ 154,194
Engineering Design Cost (5% of Construction Cost)	$ 22,228	$ 8,610	$ 30,839
Total Construction Cost	$ 577,940	$ 223,867	$ 801,806

Land Cost

Channel Length	1853 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	134	5.7	$100,000	$ 570,000
LC Enhancement Buffer	50	2.1	$100,000	$ 210,000
Channel	33	1.4	$100,000	$ 140,000
Channel LC Enhancement	15	0.6	$100,000	$ 60,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	232	9.8		$ 980,000

Right of Way

Preservation Corridor Width	120	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	50	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	7.1	$100,000	$ 710,000
LC Enhancement Cost	acre	2.7	$100,000	$ 270,000
Total Land Cost	acre	9.8	$100,000	$ 980,000

Total Cost

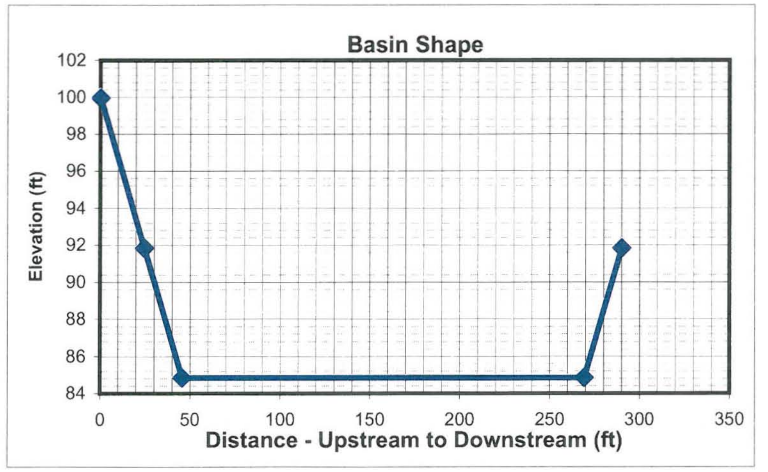
Base Total Cost	$ 1,422,611
Total Landscape Enhancement Cost	$ 547,813
Total Cost Including LC Enh.	$ 1,970,423

Online Basin

HEC1 ID	RR130

HEC1 Results Used to Determine Sediment Volume From Upstream

Contributing HEC1 ID							Total Volume (ac. ft)
Inflow Volume (ac. ft)							0
Volume Fraction							
Weighted Volume							0
Sediment Conc. (ppm)							
Sediment Volume (ac. ft)							0.00
Weighting Factor							
Weighted Sed. Vol. (ac. ft)							0.00



Sediment Yield

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.3	sq. mi
Total Sediment Yield Volume	0.6	ac ft

Required Minimum Sediment Volume

Sediment Volume	0.6	ac. ft

Geometry

	Base	LC Enhanced
Topography slope (ft/ft)	0.028	0.028
Basin Length (ft)	600	770
Basin Width (ft)	290	290
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	7	7
Freeboard (ft)	1	1
Effective Basin Width (ft)	266	241
Top Area (acres)	4.0	5.1
U/S-D/S Height Difference (ft)	8.1	8.1
Excess Area on Upstream (acres)	0.3	0.9

			Base	LC Enhanced
Bottom Length (ft)	558	Allocated Storage Volume (ac. ft)	19.2	19.3
Bottom Width (ft)	224	Total Available Volume (ac. ft) (incl. Freeboard)	22.8	23.4
		Total Excavation Volume (ac. ft)	39.1	44.2

HEC1 Results

	6-hr Event	24-hr Event	Maximum
Total Flow Volume entering Basin (ac. ft)	24.0	20	24.0
Peak Inflow (cfs)	524	415	524.0
Peak Outflow (cfs)	57	51	57.0
Stage at Peak Outflow (ft)	5.8	4.7	5.8
Volume at Peak Outflow (ac. ft)	18.5	14.6	18.5

Volume Check

Total Volume needed	19.1	ac. ft
Total Volume Provided	19.2	ac. ft
Volume OK?	Yes	

Stage Check

Depth Needed	6.8	ft
Depth Provided	7	ft
Depth OK?	Yes	

Basin Outlet

Outlet Coeff	0.60	(0.6 for Orifice, 3.0 for Weir)
D (Orifice) or W (Weir)	2.50	ft
Invert Elevation	0.00	ft
Number of pipes	1	

Stage-Storage-Discharge

Elevation	0	1	2	3	4	5	6	7	8	9
Volume	0.00	2.92	5.96	9.10	12.36	15.73	19.21	22.82	26.54	30.39
Outflow	0.0	23.6	33.4	40.9	47.3	52.9	57.9	62.5	66.9	70.9

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
LC Enhancement Buffer	165300	sq. ft
Other		sq. ft

Additional ROW Length	0	ft
Additional ROW Width	0	ft
Landscaping Buffer Length	100	ft
Landscaping Buffer Width	100	ft

Base Total ROW Length	600	ft
Base Total ROW Width	290	ft
LC Enh. Total ROW Length	870	ft
LC Enh. Total ROW Length	390	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	63081	71309
Excavated Area (sq. Yd)	19333	37700

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	48	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	531	sq. Yd
Material Volume	266	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	304	ft
Unit Cost	160	per ft
Cost per outlet	$48,640	
Other Cost	$ -	
Total Cost	$48,640	
Outlet Area	133	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Basin		63,081	cu. Yd	$ 4.00	$ 252,324	19,333	sq. Yd	$ 9.00	$ 173,997	19,333	sq. Yd	$ 8.33	$ 161,108
Basin - LC Enhancement		8,228	cu. Yd	$ 4.00	$ 32,912	18,367	sq. Yd	$ 9.00	$ 165,303	18,367	sq. Yd	$ 8.33	$ 153,058
Inlet	Riprap	266	sq. Yd	$ 75.00	$ 19,950	531	sq. Yd	$ -	$ -	531	sq. Yd	$ 33.33	$ 17,700
Inlet - LC Enhancement (20%Inlet)					$ 3,990				$ -				$ 3,540
Outlet	Pipe	1	EA	$ 48,640	$ 48,640	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhancement (5% Outlet)					$ 2,432				$ -				$ 111
Other					$ -				$ -				$ -

Base Landscape Cost	$ 173,997	Base Maintenance Cost	$ 181,025
LC Enh. Landscape Cost	$ 165,303	LC Enh. Maintenance Cost	$ 156,709
Total Landscape Cost	$ 339,300	Total Maintenance Cost	$ 337,734

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 320,914	$ 32,912	$ 353,826
Contingency Cost (25% of Construction Cost)	$ 80,229	$ 8,228	$ 88,457
Engineering Design Cost (5% of Construction Cost)	$ 16,046	$ 1,646	$ 17,691
Total Construction Cost	$ 417,188	$ 42,786	$ 459,974

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	3.8	$100,000	$ 380,000
Basin	4.0	$100,000	$ 400,000
Other		$100,000	$ -
Total	7.8	$100,000	$ 780,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	4.0	$100,000	$ 400,000
LC Enhancement Cost	acre	3.8	$100,000	$ 380,000
Total Land Cost	acre	7.8	$100,000	$ 780,000

Total Cost

Base Total Cost	$ 1,172,210
Total LC Enhancement Cost	$ 744,798
Total Cost Including LC Enh.	$ 1,917,008

Open Channel

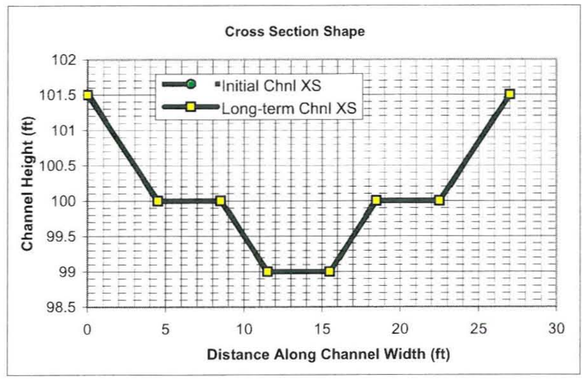
Structure ID	RR13010	HEC1 ID	13035I

Longitundal Geometry

Length	1235.4	ft
U/S Elev	1728.2	ft
D/S Elev	1697.0	ft
Initial Channel Slope	0.0252	ft/ft
Long-term Channel Slope	0.0120	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	1



Initial Channel XS Geometry

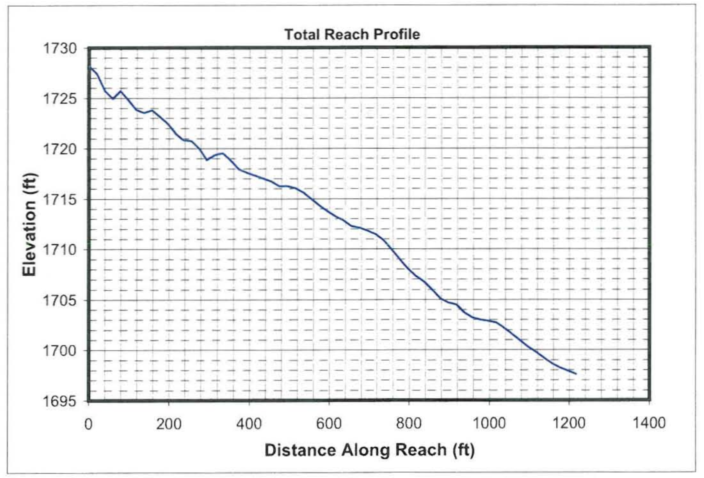
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	1.5	4	3	4	2.5	3	4	1.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	4.5	8.5	11.5	15.5	18.5	22.5	27
Y	101.5	100	100	99	99	100	100	101.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	1.5	4	3	4	2.5	3	4	1.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	4.5	8.5	11.5	15.5	18.5	22.5	27
Y	101.5	100	100	99	99	100	100	101.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

										TOTAL
Contributing HEC1 ID	RR130									
HEC1 Peak-Flow	57									57
Weighting Factor	1.00									
Flow into Channel	57									57

Reach Sediment Inflow Characteristics

U/S Contributing ID										TOTAL
HEC1 Flow Volume (ac. ft)										0
Sediment Conc. (ppm)										
Sediment Volume (ac. ft)										0.00
Weighting Factor										
Weighted Sed. Vol. (ac. ft)										0.00

Hydrology

Drainage Area	0.31	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	57	cfs	
Long-term Max. Chnl Capacity	191	cfs	
Q2 Channel	6	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	27	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
6	7.3	2.9	0.4	99.0	99.5	2.0	0.5	7.1	0.4	0.39	0.54
14	9.4	5.6	0.6	99.0	99.8	2.6	0.8	9.1	0.6	0.64	0.58
43	20.9	14.8	0.7	99.0	100.4	2.9	1.4	20.4	0.7	1.05	0.60
57	21.8	17.9	0.8	99.0	100.6	3.2	1.6	21.3	0.8	1.16	0.61

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
6	7.3	2.9	0.4	99.0	99.5	2.0	0.5	7.1	0.4	0.39	0.54
14	9.4	5.6	0.6	99.0	99.8	2.6	0.8	9.1	0.6	0.64	0.58
43	20.9	14.8	0.7	99.0	100.4	2.9	1.4	20.4	0.7	1.05	0.60
57	21.8	17.9	0.8	99.0	100.6	3.2	1.6	21.3	0.8	1.16	0.61

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (identified using HEC1 ID)									TOTAL
6										0
14										0
43										0
57										0

Allowable Velocity

Channel Lining	Natural - Fine Gravel										
Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
6	1.74	1.1184	1.0625	Erosive	Erosive	Erosive	0.2	Stable	4.0	Stable	Stable
14	1.74	1.2437	1.1815	Erosive	Erosive	Erosive	0.3	Stable	5.5	Stable	Stable
43	1.74	1.2962	1.2314	Erosive	Erosive	Erosive	0.3	Stable	7.3	Stable	Stable
57	1.74	1.3417	1.2746	Erosive	Erosive	Erosive	0.3	Stable	7.9	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	**6**	**14**	**43**	**57**	**6**	**14**	**43**	**57**	**6**	**14**	**43**	**57**
Bray - Equation #1	6	10	17	20	0.5	0.6	0.9	1.0	2.0	2.3	2.7	2.8
Bray - Equation #2	8	13	23	26	0.5	0.7	1.0	1.1	1.4	1.6	1.8	1.9
Hey	1	2	5	5	1.2	1.8	2.7	3.0				
Ackers & Charlton/Lacey	7	11	17	20					1.1	1.2	1.5	1.6
Parker	16	26	45	52	0.3	0.4	0.7	0.7				
Chang	10	18	34	41	0.1	0.1	0.0	0.0				
Kellerhals	4	7	12	14	0.5	0.8	1.2	1.4	2.4	2.7	3.0	3.1
AMAFCA/Schumm	7	9	20	21								
Moody & Odem	8	8	8	8	0.8	0.8	0.8	0.8				
BUREC	4.3	6.1	9.2	10.3	1	2	2	3	1.8	2.2	3.0	3.2
Average	7	11	19	22	0.6	0.9	1.2	1.4	1.7	2.0	2.4	2.5
Values As Designed	7	9	20	21	0.5	0.8	1.4	1.6	2.0	2.6	2.9	3.2
Difference with Design	0	2	-1	0	0.1	0.0	-0.2	-0.2	-0.2	-0.6	-0.5	-0.7

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
6	36	26	68	202	180	14	9	6	416	20	77	96
14	128	77	186	807	296	58	28	26	1058	62	274	273
43	457	242	583	2967	736	206	92	94	3189	208	950	884
57	695	340	802	4695	836	312	127	144	4265	305	1403	1266

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
6	2338	1673	4401	13131	11728	929	575	378	27068	1283	4989	6227
14	3339	2000	4844	21003	7703	1499	740	666	27550	1612	7132	7099
43	3966	2101	5056	25748	6383	1790	800	817	27675	1808	8242	7672
57	4524	2213	5220	30556	5443	2032	829	940	27757	1985	9130	8239

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
6	36	22	44	66	107	10	9	6	128	10	39	43
14	128	67	134	264	183	37	28	26	336	33	146	126
43	457	215	412	973	463	131	92	94	1021	112	515	408
57	695	303	565	1539	532	196	127	144	1373	167	771	583

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
6	2338	1424	2864	4305	6934	626	575	378	8329	662	2546	2816
14	3339	1754	3482	6885	4773	969	740	666	8754	857	3797	3274
43	3966	1862	3578	8441	4017	1138	800	817	8864	973	4467	3538
57	4524	1974	3677	10017	3465	1273	829	940	8936	1084	5020	3794

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
6	0.0021	0.0030	187	0.57	0.050	0.0007	31	0.036	0.0005	0.0159	0.0006	0.0015	0.0196	0.0017	0.0056	0.0116	0.0086
14	0.0012	0.0020	228	0.69	0.052	0.0005	31	0.036	0.0003	0.0159	0.0004	0.0010	0.0196	0.0011	0.0028	0.0115	0.0083
43	0.0010	0.0017	249	0.76	0.053	0.0004	31	0.036	0.0003	0.0159	0.0004	0.0008	0.0196	0.0007	0.0012	0.0117	0.0082
57	0.0008	0.0014	268	0.82	0.053	0.0004	32	0.036	0.0002	0.0159	0.0003	0.0007	0.0196	0.0006	0.0010	0.0116	0.0081

Drop Structures

Design Slope	0.0120	ft/ft
Total Drop Needed	16.4	ft
Height of Drop Structure	3	ft
No . of Drop Structures	6	
Distance between structs.	206	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.03	sq. mi
Total Sediment Yield Volume	0.06	ac ft

Sedimentation Basins

Length	206 ft	Depth	3 ft
Width	27 ft	Side slope	3 ft/ft
Total Volume per Basin		0.25	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge Q (cfs)	COT/PC Sinuosity	General Zgs (ft)	Antidune Za (ft)	Bend Angle (deg)	Max. Depth Ymax (ft)	Hyd. Depth Yh (ft)	Avg Vel Vm (ft/s)	Se	Scour Zbs (ft)	Scour Zls (ft)	channel Zlft (ft)	Total Zt (ft)
6	1.1	-0.2	0.1	24.6	0.5	0.4	2.0	0.0120	0.1	0.0	1.0	1.4
14	1.1	-0.3	0.1	24.6	0.8	0.6	2.6	0.0120	0.1	0.0	1.0	1.5
43	1.1	-0.4	0.1	24.6	1.4	0.7	2.9	0.0120	0.1	0.0	1.0	1.6
57	1.1	-0.5	0.1	24.6	1.6	0.8	3.2	0.0120	0.2	0.0	1.0	1.6

Toe Protection Needed	2.0	ft

HEC1 Results For Open Channel

Peak Flow	57	cfs
Stage at Peak Flow	100.3	ft
Flow Volume	24.0	ac. ft

Freeboard

Max. Flow Depth	1.6	ft
Channel Depth as designed	2.5	ft
Available Freeboard	0.9	ft
Required Freeboard	1	ft

Sediment Volume

Inflowing Sediment Volume	0.06	ac. ft
Outflowing Sediment Volume	0.03	ac. ft
Deposited(+)/Eroded(-) Volume	0.03	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	1235	1235
Side Slope (?H:1V)	3	6
Channel Width (ft)	27	42
Channel XS Area (sq. ft)	40.8	59.55
Channel Perimeter (ft)	28	43

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	11964	18431
Excavated Area (sq. Yd)	3705	5763

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	1235	ft
Thickness	1.5	ft
Protection Depth	2	ft
Tie-in Length/Depth	3.0	ft
Total Depth	5.0	ft
Area needed	206	sq. Yd
Volume	343	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	None	None
Left Levee Length (ft)	0	0
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	N/A	6
Left Levee Height (ft)	0	1
Left Levee Surface Area (sq. Yd)	0	0
Left Levee Volume (cu. Yd)	0	0
Right Levee Length (ft)	0	0
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	N/A	6
Right Levee Height (ft)	0	1
Right Levee Surface Area (sq. Yd)	0	0
Right Levee Volume (cu. Yd)	0	0
Total Levee Surface Area (sq. Yd)	0	0
Total Levee Volume (cu. Yd)	0	0

Levee Lining	Base	LC Enhanced
Lining Type	None	None
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	1235	1235
Left Levee Lining Width (ft)	0	0
Left Levee Lining Thickness (ft)	0	0
Left Levee Lining Area (sq. Yd)	0	0
Left Levee Lining Volume (cu. Yd)	0	0
Right Levee Length (ft)	1235	1235
Right Levee Lining Width (ft)	0	0
Right Levee Lining Thickness (ft)	0	0
Right Levee Lining Area (sq. Yd)	0	0
Right Levee Lining Volume (cu. Yd)	0	0
Total Lining Area (sq. Yd)	0	0
Total Lining Volume (cu. Yd)	0	0

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	27	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	4.1	ft
Structure Height	7.1	ft
Number of Structures	6	
Volume per structure	21	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 1,575	
Area per structure	9	sq. Yd
Total Area	54	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	403	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 1,612	
Other Cost	$ -	
Total cost per basin	$ 1,612	
Area per basin	618	sq. Yd
Total Area	618	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining -LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Excavated Channel	Excavated	11,964	cu. Yd	$ 10.00	$ 119,640	3,705	sq. Yd	$ 9.00	$ 33,345	3,705	sq. Yd	$ 8.33	$ 30,875
Exc. Chl - LC Enhancement	Excavated	6,467	cu. Yd	$ 10.00	$ 64,670	2,058	sq. Yd	$ 9.00	$ 18,522	2,058	sq. Yd	$ 8.33	$ 17,150
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	343	cu. Yd	$ 75.00	$ 25,725	206	sq. Yd	$ -	$ -	206	sq. Yd	$ 25.00	$ 5,150
Drop Structures	Riprap	6	EA	$ 1,575.00	$ 9,450	54	sq. Yd	$ -	$ -	54	sq. Yd	$ 33.33	$ 1,800
Drop Str. - LC Enhancement	Riprap	6	EA	$ 157.50	$ 945	5	sq. Yd	$ -	$ -	5	sq. Yd	$ 33.33	$ 180
Sedimentation Basins		1	EA	$ 1,612.00	$ 1,612	618	sq. Yd	$ -	$ -	618	sq. Yd	$ 8.33	$ 5,150
Other					$ -				$ -				$ -

Base Landscape Cost	$ 33,345	Base Maintenance Cost	$ 42,975
LC Enhancement Cost	$ 18,522	LC Enhancement Cost	$ 17,330
Total Landscape Cost	$ 51,867	Total Maintenance Cost	$ 60,305

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 156,427	$ 65,615	$ 222,042
Contingency Cost (25% of Construction Cost)	$ 39,107	$ 16,404	$ 55,511
Engineering Design Cost (5% of Construction Cost)	$ 7,821	$ 3,281	$ 11,102
Total Construction Cost	$ 203,355	$ 85,300	$ 288,655

Land Cost

Channel Length	1235 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	134	3.8	$100,000	$ 380,000
LC Enhancement Buffer	50	1.4	$100,000	$ 140,000
Channel	27	0.8	$100,000	$ 80,000
Channel LC Enhancement	15	0.4	$100,000	$ 40,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	226	6.4		$ 640,000

Right of Way

Preservation Corridor Width	120	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	50	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	4.6	$100,000	$ 460,000
LC Enhancement Cost	acre	1.8	$100,000	$ 180,000
Total Land Cost	acre	6.4	$100,000	$ 640,000

Total Cost

Base Total Cost	$ 739,675
Total Landscape Enhancement Cost	$ 301,152
Total Cost Including LC Enh.	$ 1,040,827

Open Channel

Structure ID	C135L10		HEC1 ID	351135

Longitundal Geometry

Length	12096.9	ft
U/S Elev	1697.0	ft
D/S Elev	1496.9	ft
Initial Channel Slope	0.0165	ft/ft
Long-term Channel Slope	0.0060	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	8

Initial Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	3	30	3	20	5	3	30	3	3

PT. ID	1	2	3	4	5	6	7	8
X	0	9	39	45	65	71	101	110
Y	103	100	100	98	98	100	100	103

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	3	30	3	20	5	3	30	3	3

PT. ID	1	2	3	4	5	6	7	8
X	0	9	39	45	65	71	101	110
Y	103	100	100	98	98	100	100	103

Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

										TOTAL
Contributing HEC1 ID	C135L									TOTAL
HEC1 Peak-Flow	1001									1001
Weighting Factor	1.00									
Flow into Channel	1001									1001

Reach Sediment Inflow Characteristics

U/S Contributing ID	125351_RR12510	130351_RR130 10								TOTAL
HEC1 Flow Volume (ac. ft)	7.00	24.00								31
Sediment Conc. (ppm)	2976	3794								
Sediment Volume (ac. ft)	0.01	0.03								0.04
Weighting Factor	1	1								
Weighted Sed. Vol. (ac. ft)	0.01	0.03								0.04

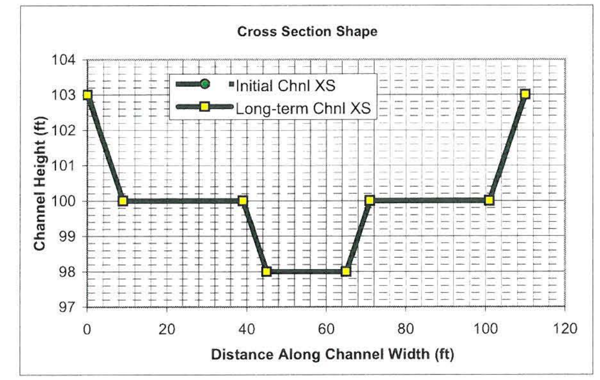
Hydrology

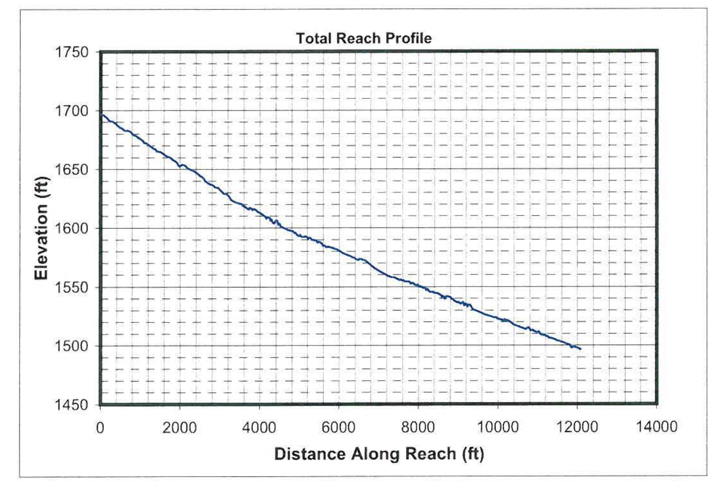
Drainage Area	2.06	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	1001	cfs	
Long-term Max. Chnl Capacity	1969	cfs	
Q2 Channel	100	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	110	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			





JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

Sub-area: Wagner Wash, Alternative: B3
Open Channel Structure ID: C135L10

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
100	29.0	34.7	1.2	98.0	99.4	2.9	1.4	28.6	1.2	0.53	0.46
250	95.7	96.8	1.0	98.0	100.5	2.6	2.5	94.9	1.0	0.93	0.45
751	101.8	191.9	1.9	98.0	101.5	3.9	3.5	100.7	1.9	1.29	0.50
1001	104.2	230.1	2.2	98.0	101.8	4.3	3.8	103.0	2.2	1.43	0.51

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
100	29.0	34.7	1.2	98.0	99.4	2.9	1.4	28.6	1.2	0.53	0.46
250	95.7	96.8	1.0	98.0	100.5	2.6	2.5	94.9	1.0	0.93	0.45
751	101.8	191.9	1.9	98.0	101.5	3.9	3.5	100.7	1.9	1.29	0.50
1001	104.2	230.1	2.2	98.0	101.8	4.3	3.8	103.0	2.2	1.43	0.51

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)								TOTAL
	12535I_RR12510	13035I_RR13010							
100	42	43							85
250	125	126							250
751	410	408							817
1001	586	583							1169

Allowable Velocity

Channel Lining	Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
100	1.74	1.4551	1.3824	Erosive	Erosive	Erosive	0.3	Stable	5.7	Stable	Stable
250	1.74	1.4016	1.3316	Erosive	Erosive	Erosive	0.3	Stable	7.2	Stable	Stable
751	1.74	1.5942	1.5145	Erosive	Erosive	Erosive	0.4	Stable	9.5	Stable	Stable
1001	1.74	1.6435	1.5613	Erosive	Erosive	Erosive	0.4	Stable	10.3	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	**100**	**250**	**751**	**1001**	**100**	**250**	**751**	**1001**	**100**	**250**	**751**	**1001**
Bray - Equation #1	27	44	78	91	1.2	1.7	2.4	2.7	3.0	3.4	4.0	4.2
Bray - Equation #2	35	57	102	119	1.4	1.8	2.6	2.9	2.1	2.4	2.7	2.9
Hey	8	13	25	29	3.7	5.3	8.0	8.9				
Ackers & Charlton/Lacey	25	37	58	66					1.7	2.0	2.4	2.5
Parker	69	109	188	217	0.9	1.4	2.2	2.4				
Chang	46	80	157	186	0.1	0.0	-0.3	-0.4				
Kellerhals	18	28	49	57	1.7	2.5	3.8	4.3	3.2	3.5	4.0	4.1
AMAFCA/Schumm	29	95	101	103								
Moody & Odem	16	16	16	16	1.1	1.1	1.1	1.1				
BUREC	14.4	20.4	30.7	34.2	4	5	8	9	2.8	3.5	4.7	5.0
Average	29	50	80	92	1.8	2.4	3.5	3.9	2.6	3.0	3.6	3.7
Values As Designed	29	95	101	103	1.4	2.5	3.5	3.8	2.9	2.6	3.9	4.3
Difference with Design	0	-45	-20	-11	0.3	-0.1	0.0	0.0	-0.3	0.4	-0.4	-0.6

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
100	549	317	672	4775	1085	219	91	127	3961	294	1551	1240
250	1191	710	1646	9799	3256	460	212	265	9856	659	3428	2862
751	6281	2701	5262	60798	4932	2771	782	1434	29930	3017	15967	12171
1001	9670	3765	6827	97606	5503	4497	1064	2147	39968	4485	23397	18084

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
100	2035	1173	2489	17696	4022	812	338	469	14680	1088	5748	4596
250	1766	1053	2440	14527	4828	682	315	393	14611	976	5082	4243
751	3104	1335	2600	30045	2437	1369	387	709	14790	1491	7891	6014
1001	3584	1395	2530	36176	2040	1667	394	796	14813	1662	8672	6703

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
100	549	266	425	1043	573	119	91	127	830	119	645	435
250	1191	590	1023	2140	1681	255	212	265	2036	262	1395	1005
751	6281	2337	3467	13276	2724	1284	782	1434	6412	1310	7056	4215
1001	9670	3281	4686	21314	3076	1911	1064	2147	8601	1859	10551	6196

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
100	2035	987	1576	3864	2123	441	338	469	3075	443	2392	1613
250	1766	875	1517	3172	2492	379	315	393	3018	388	2068	1489
751	3104	1155	1713	6561	1346	635	387	709	3169	647	3487	2083
1001	3584	1216	1737	7899	1140	708	394	796	3188	689	3911	2297

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
100	0.0007	0.0010	262	0.80	0.053	0.0002	32	0.036	0.0002	0.0159	0.0002	0.0005	0.0075	0.0005	0.0019	0.0059	0.0036
250	0.0008	0.0012	241	0.73	0.052	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0006	0.0075	0.0003	0.0009	0.0059	0.0036
751	0.0004	0.0006	329	1.00	0.055	0.0002	32	0.036	0.0001	0.0159	0.0001	0.0003	0.0075	0.0002	0.0004	0.0059	0.0035
1001	0.0003	0.0005	356	1.08	0.056	0.0001	32	0.036	0.0001	0.0159	0.0001	0.0003	0.0075	0.0002	0.0003	0.0059	0.0035

Drop Structures

Design Slope	0.0060	ft/ft
Total Drop Needed	127.6	ft
Height of Drop Structure	3	ft
No . of Drop Structures	43	
Distance between structs.	281	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.81	sq. mi
Total Sediment Yield Volume	1.55	ac ft

Sedimentation Basins

Length	281 ft	Depth	3 ft
Width	110 ft	Side slope	3 ft/ft
Total Volume per Basin		1.90	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		3	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
100	1.1	-0.4	0.1	24.6	1.4	1.2	2.9	0.0060	0.2	0.0	2.0	2.9
250	1.1	-0.8	0.1	24.6	2.5	1.0	2.6	0.0060	0.3	0.0	2.0	3.0
751	1.1	-0.9	0.2	24.6	3.5	1.9	3.9	0.0060	0.4	0.0	2.0	3.2
1001	1.1	-1.0	0.3	24.6	3.8	2.2	4.3	0.0060	0.4	0.0	2.0	3.3

Toe Protection Needed	4.0	ft

HEC1 Results For Open Channel

Peak Flow	81	cfs
Stage at Peak Flow	98.9	ft
Flow Volume	27.0	ac. ft

Freeboard

Max. Flow Depth	3.8	ft
Channel Depth as designed	5.0	ft
Available Freeboard	1.2	ft
Required Freeboard	1	ft

Sediment Volume

Inflowing Sediment Volume	1.59	ac. ft
Outflowing Sediment Volume	0.02	ac. ft
Deposited(+)/Eroded(-) Volume	1.57	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	12097	12097
Side Slope (?H:1V)	3	6
Channel Width (ft)	110	140
Channel XS Area (sq. ft)	355	430
Channel Perimeter (ft)	112	141

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	3302826	4193822
Excavated Area (sq. Yd)	147852	188176

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	12097	ft
Thickness	1.5	ft
Protection Depth	4	ft
Tie-in Length/Depth	3.0	ft
Total Depth	7.0	ft
Area needed	2016	sq. Yd
Volume	4704	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	None	None
Left Levee Length (ft)	0	0
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	N/A	6
Left Levee Height (ft)	0	1
Left Levee Surface Area (sq. Yd)	0	0
Left Levee Volume (cu. Yd)	0	0
Right Levee Length (ft)	0	0
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	N/A	6
Right Levee Height (ft)	0	1
Right Levee Surface Area (sq. Yd)	0	0
Right Levee Volume (cu. Yd)	0	0
Total Levee Surface Area (sq. Yd)	0	0
Total Levee Volume (cu. Yd)	0	0

Levee Lining	Base	LC Enhanced
Lining Type	None	None
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	12097	12097
Left Levee Lining Width (ft)	0	0
Left Levee Lining Thickness (ft)	0	0
Left Levee Lining Area (sq. Yd)	0	0
Left Levee Lining Volume (cu. Yd)	0	0
Right Levee Length (ft)	12097	12097
Right Levee Lining Width (ft)	0	0
Right Levee Lining Thickness (ft)	0	0
Right Levee Lining Area (sq. Yd)	0	0
Right Levee Lining Volume (cu. Yd)	0	0
Total Lining Area (sq. Yd)	0	0
Total Lining Volume (cu. Yd)	0	0

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	110	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	8.6	ft
Structure Height	11.6	ft
Number of Structures	43	
Volume per structure	142	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 10,650	
Area per structure	37	sq. Yd
Total Area	1,577	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	3	
Total Volume per Basin	3065	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 12,260	
Other Cost	$ -	
Total cost per basin	$ 12,260	
Area per basin	3,438	sq. Yd
Total Area	10,314	sq. Yd

Structure Type	Structure Cost													
		Excavation/Construction				Landscape				Maintenance				
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining -LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Excavated Channel	Excavated	3,302,826	cu. Yd	$ 10.00	$ 33,028,260	147,852	sq. Yd	$ 9.00	$ 1,330,668	147,852	sq. Yd	$ 8.33	$ 1,232,100
Exc. Chl - LC Enhancement	Excavated	890,996	cu. Yd	$ 10.00	$ 8,909,960	40,324	sq. Yd	$ 9.00	$ 362,916	40,324	sq. Yd	$ 8.33	$ 336,033
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	4,704	cu. Yd	$ 75.00	$ 352,800	2,016	sq. Yd	$ -	$ -	2,016	sq. Yd	$ 25.00	$ 50,400
Drop Structures	Riprap	43	EA	$ 10,650.00	$ 457,950	1,577	sq. Yd	$ -	$ -	1,577	sq. Yd	$ 33.33	$ 52,567
Drop Str. - LC Enhancement	Riprap	43	EA	$ 1,065.00	$ 45,795	158	sq. Yd	$ -	$ -	158	sq. Yd	$ 33.33	$ 5,257
Sedimentation Basins		3	EA	$ 12,260.00	$ 36,780	10,314	sq. Yd	$ -	$ -	10,314	sq. Yd	$ 8.33	$ 85,950
Other					$ -				$ -				$ -

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 33,875,790	$ 8,955,755	$ 42,831,545
Contingency Cost (25% of Construction Cost)	$ 8,468,948	$ 2,238,939	$ 10,707,886
Engineering Design Cost (5% of Construction Cost)	$ 1,693,790	$ 447,788	$ 2,141,577
Total Construction Cost	$ 44,038,527	$ 11,642,482	$ 55,681,009

Base Landscape Cost	$ 1,330,668	Base Maintenance Cost	$ 1,421,017
LC Enhancement Cost	$ 362,916	LC Enhancement Cost	$ 341,290
Total Landscape Cost	$ 1,693,584	Total Maintenance Cost	$ 1,762,307

Land Cost

Channel Length	12097 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	134	37.2	$100,000	$ 3,720,000
LC Enhancement Buffer	50	13.9	$100,000	$ 1,390,000
Channel	110	30.5	$100,000	$ 3,050,000
Channel LC Enhancement	30	8.3	$100,000	$ 830,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	324	89.9		$ 8,990,000

Right of Way

Preservation Corridor Width	120	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	50	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	67.7	$100,000	$ 6,770,000
LC Enhancement Cost	acre	22.2	$100,000	$ 2,220,000
Total Land Cost	acre	89.9	$100,000	$ 8,990,000

Total Cost

Base Total Cost	$ 53,560,212
Total Landscape Enhancement Cost	$ 14,566,688
Total Cost Including LC Enh.	$ 68,126,899

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

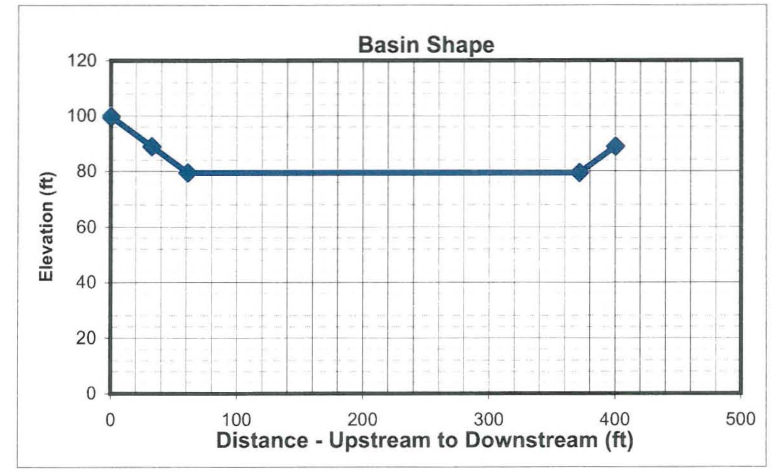
Sub-area: Wagner Wash, Alternative: B3
Open Channel Structure ID: C135L10

Online Basin

HEC1 ID	RR150

HEC1 Results Used to Determine Sediment Volume From Upstream

Contributing HEC1 ID							Total Volume (ac. ft)
Inflow Volume (ac. ft)							0
Volume Fraction							
Weighted Volume							0
Sediment Conc. (ppm)							
Sediment Volume (ac. ft)							0.00
Weighting Factor							
Weighted Sed. Vol. (ac. ft)							0.00



Sediment Yield

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.9	sq. mi
Total Sediment Yield Volume	1.7	ac ft

Required Minimum Sediment Volume

Sediment Volume	1.7	ac. ft

Geometry

	Base	LC Enhanced
Topography slope (ft/ft)	0.027	0.027
Basin Length (ft)	800	1010
Basin Width (ft)	400	400
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	9.5	9.5
Freeboard (ft)	1	1
Effective Basin Width (ft)	368	335
Top Area (acres)	7.3	9.3
U/S-D/S Height Difference (ft)	10.8	10.8
Excess Area on Upstream (acres)	0.6	1.5

			Base	LC Enhanced
Bottom Length (ft)	743	Allocated Storage Volume (ac. ft)	50.5	50.4
Bottom Width (ft)	311	Total Available Volume (ac. ft) (incl. Freeboard)	57.2	58
		Total Excavation Volume (ac. ft)	96.9	108.1

HEC1 Results

	6-hr Event	24-hr Event	Maximum
Total Flow Volume entering Basin (ac. ft)	62.0	57	62.0
Peak Inflow (cfs)	836	729	836.0
Peak Outflow (cfs)	97	89	97.0
Stage at Peak Outflow (ft)	8.2	6.9	8.2
Volume at Peak Outflow (ac. ft)	48.3	39.9	48.3

Volume Check

Total Volume needed	50.0	ac. ft
Total Volume Provided	50.5	ac. ft
Volume OK?	Yes	

Stage Check

Depth Needed	9.2	ft
Depth Provided	9.5	ft
Depth OK?	Yes	

Basin Outlet

Outlet Coeff	0.60	(0.6 for Orifice, 3.0 for Weir)
D (Orifice) or W (Weir)	3.00	ft
Invert Elevation	0.00	ft
Number of pipes	1	

Stage-Storage-Discharge

Elevation	0	1	2	4	6	7	8	9	10	11
Volume	0.00	5.38	10.90	22.40	34.50	40.78	47.22	53.82	60.58	67.50
Outflow	0.0	34.0	48.1	68.1	83.4	90.0	96.3	102.1	107.6	112.9

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
LC Enhancement Buffer	235000	sq. ft
Other		sq. ft

Additional ROW Length	0	ft
Additional ROW Width	0	ft
Landscaping Buffer Length	100	ft
Landscaping Buffer Width	100	ft

Base Total ROW Length	800	ft
Base Total ROW Width	400	ft
LC Enh. Total ROW Length	1110	ft
LC Enh. Total ROW Length	500	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	156332	174401
Excavated Area (sq. Yd)	35556	61667

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	64	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	713	sq. Yd
Material Volume	357	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	432	ft
Unit Cost	160	per ft
Cost per outlet	$69,120	
Other Cost	$ -	
Total Cost	$69,120	
Outlet Area	133	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Basin		156,332	cu. Yd	$ 4.00	$ 625,328	35,556	sq. Yd	$ 9.00	$ 320,004	35,556	sq. Yd	$ 8.33	$ 296,300
Basin - LC Enhancement		18,069	cu. Yd	$ 4.00	$ 72,276	26,111	sq. Yd	$ 9.00	$ 234,999	26,111	sq. Yd	$ 8.33	$ 217,592
Inlet	Riprap	357	sq. Yd	$ 75.00	$ 26,775	713	sq. Yd	$ -	$ -	713	sq. Yd	$ 33.33	$ 23,767
Inlet - LC Enhancement (20%Inlet)					$ 5,355				$ -				$ 4,753
Outlet	Pipe	1	EA	$ 69,120	$ 69,120	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhancement (5% Outlet)					$ 3,456				$ -				$ 111
Other					$ -				$ -				$ -

Base Landscape Cost	$ 320,004	Base Maintenance Cost	$ 322,283
LC Enh. Landscape Cost	$ 234,999	LC Enh. Maintenance Cost	$ 222,456
Total Landscape Cost	$ 555,003	Total Maintenance Cost	$ 544,739

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 721,223	$ 72,276	$ 793,499
Contingency Cost (25% of Construction Cost)	$ 180,306	$ 18,069	$ 198,375
Engineering Design Cost (5% of Construction Cost)	$ 36,061	$ 3,614	$ 39,675
Total Construction Cost	$ 937,590	$ 93,959	$ 1,031,549

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	5.4	$100,000	$ 540,000
Basin	7.3	$100,000	$ 730,000
Other		$100,000	$ -
Total	12.7	$100,000	$ 1,270,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	7.3	$100,000	$ 730,000
LC Enhancement Cost	acre	5.4	$100,000	$ 540,000
Total Land Cost	acre	12.7	$100,000	$ 1,270,000

Total Cost

Base Total Cost	$ 2,309,877
Total LC Enhancement Cost	$ 1,091,414
Total Cost Including LC Enh.	$ 3,401,291

Open Channel

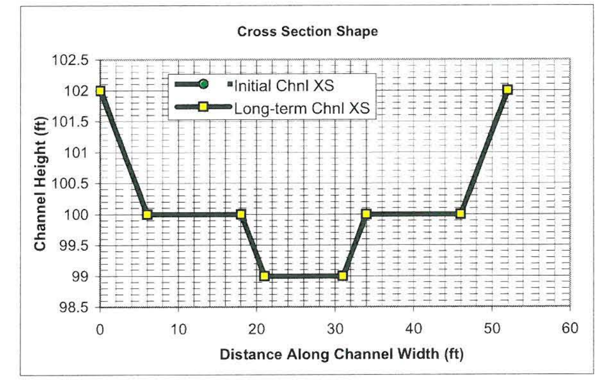
Structure ID	RR15020		HEC1 ID	150165

Longitundal Geometry

Length	4081.6	ft
U/S Elev	1760.1	ft
D/S Elev	1675.9	ft
Initial Channel Slope	0.0206	ft/ft
Long-term Channel Slope	0.0090	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	1



Initial Channel XS Geometry

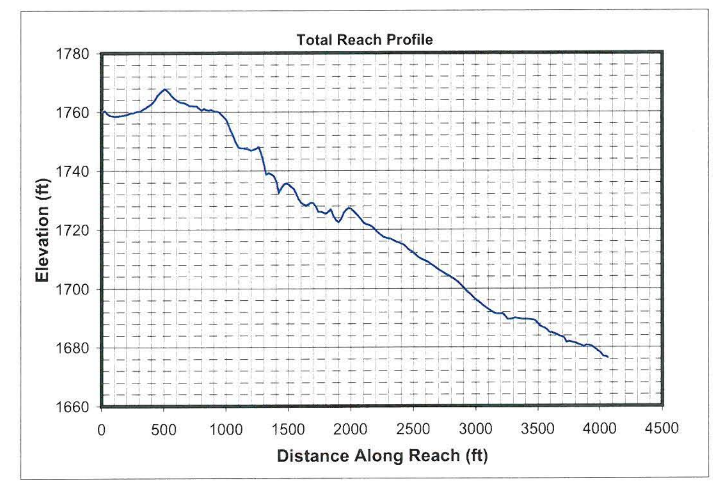
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	2	12	3	10	3	3	12	2	3

PT. ID	1	2	3	4	5	6	7	8
X	0	6	18	21	31	34	46	52
Y	102	100	100	99	99	100	100	102

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	2	12	3	10	3	3	12	2	3

PT. ID	1	2	3	4	5	6	7	8
X	0	6	18	21	31	34	46	52
Y	102	100	100	99	99	100	100	102



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	RR150	S155								TOTAL
HEC1 Peak-Flow	97	1781								1878
Weighting Factor	1.00	0.06								
Flow into Channel	97	109								206

Reach Sediment Inflow Characteristics

U/S Contributing ID										TOTAL
HEC1 Flow Volume (ac. ft)										0
Sediment Conc. (ppm)										
Sediment Volume (ac. ft)										0.00
Weighting Factor										
Weighted Sed. Vol. (ac. ft)										0.00

Hydrology

Drainage Area	0.886	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	206	cfs	
Long-term Max. Chnl Capacity	520	cfs	
Q2 Channel	21	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	52	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
21	14.7	9.0	0.6	99.0	99.7	2.3	0.7	14.4	0.6	0.42	0.51
52	42.0	23.9	0.6	99.0	100.3	2.2	1.3	41.6	0.6	0.71	0.50
155	45.5	47.7	1.0	99.0	100.8	3.2	1.8	44.9	1.1	1.02	0.55
206	46.8	57.3	1.2	99.0	101.0	3.6	2.0	46.2	1.2	1.14	0.57

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
21	14.7	9.0	0.6	99.0	99.7	2.3	0.7	14.4	0.6	0.42	0.51
52	42.0	23.9	0.6	99.0	100.3	2.2	1.3	41.6	0.6	0.71	0.50
155	45.5	47.7	1.0	99.0	100.8	3.2	1.8	44.9	1.1	1.02	0.55
206	46.8	57.3	1.2	99.0	101.0	3.6	2.0	46.2	1.2	1.14	0.57

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
21										0
52										0
155										0
206										0

Allowable Velocity

Channel Lining	Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
21	1.74	1.2513	1.1887	Erosive	Erosive	Erosive	0.3	Stable	4.5	Stable	Stable
52	1.74	1.2243	1.1631	Erosive	Erosive	Erosive	0.3	Stable	5.8	Stable	Stable
155	1.74	1.4139	1.3432	Erosive	Erosive	Erosive	0.3	Stable	7.7	Stable	Stable
206	1.74	1.4621	1.3890	Erosive	Erosive	Erosive	0.3	Stable	8.3	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	**21**	**52**	**155**	**206**	**21**	**52**	**155**	**206**	**21**	**52**	**155**	**206**
Bray - Equation #1	12	19	34	39	0.7	1.0	1.4	1.6	2.4	2.7	3.2	3.3
Bray - Equation #2	15	25	44	52	0.8	1.1	1.6	1.7	1.7	1.9	2.2	2.3
Hey	3	5	10	12	2.0	2.9	4.4	4.9				
Ackers & Charlton/Lacey	13	19	30	34					1.3	1.5	1.9	1.9
Parker	31	49	85	99	0.5	0.7	1.1	1.3				
Chang	20	35	68	82	0.1	0.1	-0.1	-0.1				
Kellerhals	8	13	22	26	0.9	1.3	2.0	2.3	2.8	3.0	3.4	3.5
AMAFCA/Schumm	14	42	45	46								
Moody & Odem	12	12	12	12	0.9	0.9	0.9	0.9				
BUREC	7.4	10.4	15.8	17.5	2	3	4	5	2.2	2.8	3.7	3.9
Average	14	23	37	42	1.0	1.4	2.0	2.2	2.1	2.4	2.9	3.0
Values As Designed	14	42	45	46	0.7	1.3	1.8	2.0	2.3	2.2	3.2	3.6
Difference with Design	-1	-19	-8	-4	0.3	0.1	0.1	0.1	-0.2	0.2	-0.4	-0.6

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
21	121	80	197	775	422	48	26	23	1121	63	289	288
52	284	185	488	1756	1150	109	62	52	2791	151	674	700
155	1479	728	1621	10767	1793	623	248	321	8537	674	3298	2735
206	2269	1021	2166	17215	2014	948	341	489	11410	997	4870	3976

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
21	2182	1449	3553	13951	7596	866	471	422	20188	1143	5200	5184
52	2043	1329	3513	12650	8287	785	448	378	20107	1090	4855	5044
155	3553	1748	3892	25855	4305	1497	596	770	20499	1618	7920	6568
206	4087	1838	3900	31004	3628	1707	615	880	20550	1796	8771	7161

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
21	121	68	126	223	241	30	26	23	306	30	138	121
52	284	156	301	506	649	69	62	52	755	71	319	293
155	1479	640	1097	3104	1082	371	248	321	2407	335	1672	1160
206	2269	904	1511	4962	1231	553	341	489	3234	505	2510	1683

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
21	2182	1231	2275	4021	4336	546	471	422	5510	540	2483	2183
52	2043	1122	2172	3647	4675	499	448	378	5440	511	2296	2112
155	3553	1538	2635	7453	2599	890	596	770	5781	804	4014	2785
206	4087	1628	2721	8937	2217	997	615	880	5825	909	4521	3031

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
21	0.0013	0.0019	210	0.64	0.051	0.0004	31	0.036	0.0003	0.0159	0.0004	0.0010	0.0127	0.0010	0.0035	0.0088	0.0059
52	0.0015	0.0021	202	0.61	0.051	0.0005	31	0.036	0.0003	0.0159	0.0004	0.0011	0.0127	0.0006	0.0018	0.0089	0.0058
155	0.0007	0.0011	274	0.83	0.054	0.0003	32	0.036	0.0002	0.0159	0.0002	0.0006	0.0127	0.0004	0.0008	0.0089	0.0056
206	0.0006	0.0010	296	0.90	0.054	0.0002	32	0.036	0.0002	0.0159	0.0002	0.0005	0.0127	0.0003	0.0006	0.0088	0.0056

Drop Structures

Design Slope	0.0090	ft/ft
Total Drop Needed	47.4	ft
Height of Drop Structure	3	ft
No . of Drop Structures	16	
Distance between structs.	255	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.89	sq. mi
Total Sediment Yield Volume	1.68	ac ft

Sedimentation Basins

Length	255 ft	Depth	3 ft
Width	52 ft	Side slope	3 ft/ft
Total Volume per Basin		0.73	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		8	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
21	1.1	-0.3	0.1	24.6	0.7	0.6	2.3	0.0090	0.1	0.0	1.0	1.4
52	1.1	-0.4	0.1	24.6	1.3	0.6	2.2	0.0090	0.1	0.0	1.0	1.5
155	1.1	-0.5	0.1	24.6	1.8	1.1	3.2	0.0090	0.2	0.0	1.0	1.6
206	1.1	-0.6	0.2	24.6	2.0	1.2	3.6	0.0090	0.2	0.0	1.0	1.7

Toe Protection Needed	2.0	ft

HEC1 Results For Open Channel

Peak Flow	96	cfs
Stage at Peak Flow	100.3	ft
Flow Volume	62.0	ac. ft

Freeboard

Max. Flow Depth	2.0	ft
Channel Depth as designed	3.0	ft
Available Freeboard	1.0	ft
Required Freeboard	1	ft

Sediment Volume

Inflowing Sediment Volume	1.68	ac. ft
Outflowing Sediment Volume	0.07	ac. ft
Deposited(+)/Eroded(-) Volume	1.61	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	4082	4082
Side Slope (?H:1V)	3	6
Channel Width (ft)	52	70
Channel XS Area (sq. ft)	105	132
Channel Perimeter (ft)	53	71

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	202403	271052
Excavated Area (sq. Yd)	23585	31749

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	4082	ft
Thickness	1.5	ft
Protection Depth	2	ft
Tie-in Length/Depth	3.0	ft
Total Depth	5.0	ft
Area needed	680	sq. Yd
Volume	1134	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	None	None
Left Levee Length (ft)	0	0
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	N/A	6
Left Levee Height (ft)	0	1
Left Levee Surface Area (sq. Yd)	0	0
Left Levee Volume (cu. Yd)	0	0
Right Levee Length (ft)	0	0
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	N/A	6
Right Levee Height (ft)	0	1
Right Levee Surface Area (sq. Yd)	0	0
Right Levee Volume (cu. Yd)	0	0
Total Levee Surface Area (sq. Yd)	0	0
Total Levee Volume (cu. Yd)	0	0

Levee Lining	Base	LC Enhanced
Lining Type	None	None
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	4082	4082
Left Levee Lining Width (ft)	0	0
Left Levee Lining Thickness (ft)	0	0
Left Levee Lining Area (sq. Yd)	0	0
Left Levee Lining Volume (cu. Yd)	0	0
Right Levee Length (ft)	4082	4082
Right Levee Lining Width (ft)	0	0
Right Levee Lining Thickness (ft)	0	0
Right Levee Lining Area (sq. Yd)	0	0
Right Levee Lining Volume (cu. Yd)	0	0
Total Lining Area (sq. Yd)	0	0
Total Lining Volume (cu. Yd)	0	0

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	52	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	5.5	ft
Structure Height	8.5	ft
Number of Structures	16	
Volume per structure	49	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 3,675	
Area per structure	17	sq. Yd
Total Area	277	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	8	
Total Volume per Basin	1178	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 4,712	
Other Cost	$ -	
Total cost per basin	$ 4,712	
Area per basin	1,474	sq. Yd
Total Area	11,792	sq. Yd

Structure Cost

Structure Type		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining -LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Excavated Channel	Excavated	202,403	cu. Yd	$ 10.00	$ 2,024,030	23,585	sq. Yd	$ 9.00	$ 212,265	23,585	sq. Yd	$ 8.33	$ 196,542
Exc. Chl - LC Enhancement	Excavated	68,649	cu. Yd	$ 10.00	$ 686,490	8,164	sq. Yd	$ 9.00	$ 73,476	8,164	sq. Yd	$ 8.33	$ 68,033
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	1,134	cu. Yd	$ 75.00	$ 85,050	680	sq. Yd	$ -	$ -	680	sq. Yd	$ 25.00	$ 17,000
Drop Structures	Riprap	16	EA	$ 3,675.00	$ 58,800	277	sq. Yd	$ -	$ -	277	sq. Yd	$ 33.33	$ 9,233
Drop Str. - LC Enhancement	Riprap	16	EA	$ 367.50	$ 5,880	28	sq. Yd	$ -	$ -	28	sq. Yd	$ 33.33	$ 923
Sedimentation Basins		8	EA	$ 4,712.00	$ 37,696	11,792	sq. Yd	$ -	$ -	11,792	sq. Yd	$ 8.33	$ 98,267
Other					$ -				$				$ -

Base Landscape Cost	$ 212,265	
LC Enhancement Cost	$ 73,476	
Total Landscape Cost	$ 285,741	

Base Maintenance Cost	$ 321,042
LC Enhancement Cost	$ 68,957
Total Maintenance Cost	$ 389,998

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 2,205,576	$ 692,370	$ 2,897,946
Contingency Cost (25% of Construction Cost)	$ 551,394	$ 173,093	$ 724,487
Engineering Design Cost (5% of Construction Cost)	$ 110,279	$ 34,619	$ 144,897
Total Construction Cost	$ 2,867,249	$ 900,081	$ 3,767,330

Land Cost

Channel Length	4082 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	134	12.6	$100,000	$ 1,260,000
LC Enhancement Buffer	50	4.7	$100,000	$ 470,000
Channel	52	4.9	$100,000	$ 490,000
Channel LC Enhancement	18	1.7	$100,000	$ 170,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	254	23.9		$ 2,390,000

Right of Way

Preservation Corridor Width	120	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	50	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	17.5	$100,000	$ 1,750,000
LC Enhancement Cost	acre	6.4	$100,000	$ 640,000
Total Land Cost	acre	23.9	$100,000	$ 2,390,000

Total Cost

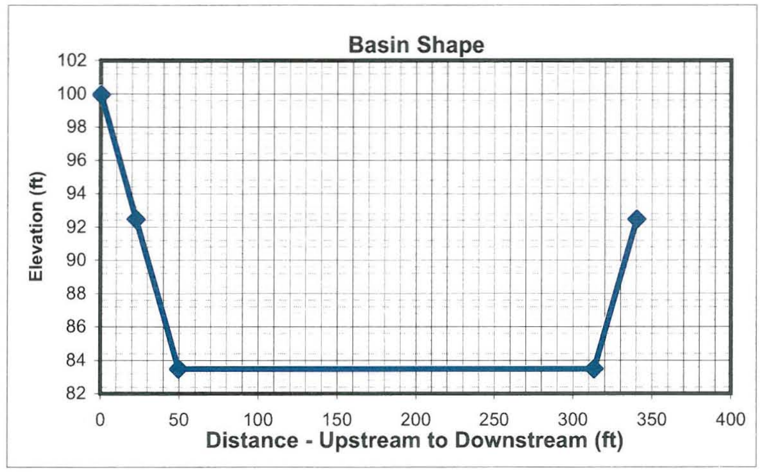
Base Total Cost	$ 5,150,555
Total Landscape Enhancement Cost	$ 1,682,514
Total Cost Including LC Enh.	$ 6,833,069

Online Basin

HEC1 ID	RR165

HEC1 Results Used to Determine Sediment Volume From Upstream

Contributing HEC1 ID	150165						Total Volume (ac. ft)
Inflow Volume (ac. ft)	62						62
Volume Fraction	1						
Weighted Volume	62						62
Sediment Conc. (ppm)	3031						
Sediment Volume (ac. ft)	0.07						0.07
Weighting Factor	1						
Weighted Sed. Vol. (ac. ft)	0.07						0.07



Sediment Yield

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.6	sq. mi
Total Sediment Yield Volume	1.2	ac ft

Required Minimum Sediment Volume

Sediment Volume	1.3	ac. ft

Geometry	Base	LC Enhanced
Topography slope (ft/ft)	0.022	0.022
Basin Length (ft)	800	1000
Basin Width (ft)	340	340
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	9	9
Freeboard (ft)	1	1
Effective Basin Width (ft)	318	295
Top Area (acres)	6.2	7.8
U/S-D/S Height Difference (ft)	7.5	7.5
Excess Area on Upstream (acres)	0.4	1.0

			Base	LC Enhanced
Bottom Length (ft)	746	Allocated Storage Volume (ac. ft)	40.8	40.7
Bottom Width (ft)	264	Total Available Volume (ac. ft) (incl. Freeboard)	46.5	47.3
		Total Excavation Volume (ac. ft)	69.9	76.5

HEC1 Results

	6-hr Event	24-hr Event	Maximum
Total Flow Volume entering Basin (ac. ft)	100.0	96	100.0
Peak Inflow (cfs)	808	852	852.0
Peak Outflow (cfs)	93	90	93.0
Stage at Peak Outflow (ft)	7.5	7	7.5
Volume at Peak Outflow (ac. ft)	38.0	35.2	38.0

Volume Check

Total Volume needed	39.3	ac. ft
Total Volume Provided	40.8	ac. ft
Volume OK?	Yes	

Stage Check

Depth Needed	8.5	ft
Depth Provided	9	ft
Depth OK?	Yes	

Basin Outlet

Outlet Coeff	0.60	(0.6 for Orifice, 3.0 for Weir)
D (Orifice) or W (Weir)	3.00	ft
Invert Elevation	0.00	ft
Number of pipes	1	

Stage-Storage-Discharge

Elevation	0	1	3	5	6	7	8	9	10	11
Volume	0.00	4.59	14.20	24.38	29.69	35.15	40.76	46.53	52.44	58.52
Outflow	0.0	34.0	59.0	76.1	83.4	90.0	96.3	102.1	107.6	112.9

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

Sub-area: Wagner Wash, Alternative: B3
Online Basin Structure ID: RR165

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
LC Enhancement Buffer	212000	sq. ft
Other		sq. ft

Additional ROW Length	0	ft
Additional ROW Width	0	ft
Landscaping Buffer Length	100	ft
Landscaping Buffer Width	100	ft

Base Total ROW Length	800	ft
Base Total ROW Width	340	ft
LC Enh. Total ROW Length	1100	ft
LC Enh. Total ROW Length	440	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	112772	123420
Excavated Area (sq. Yd)	30222	53778

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	52	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	580	sq. Yd
Material Volume	290	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	529	ft
Unit Cost	160	per ft
Cost per outlet	$84,640	
Other Cost	$ -	
Total Cost	$84,640	
Outlet Area	133	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Basin		112,772	cu. Yd	$ 4.00	$ 451,088	30,222	sq. Yd	$ 9.00	$ 271,998	30,222	sq. Yd	$ 8.33	$ 251,850
Basin - LC Enhancement		10,648	cu. Yd	$ 4.00	$ 42,592	23,556	sq. Yd	$ 9.00	$ 212,004	23,556	sq. Yd	$ 8.33	$ 196,300
Inlet	Riprap	290	sq. Yd	$ 75.00	$ 21,750	580	sq. Yd	$ -	$ -	580	sq. Yd	$ 33.33	$ 19,333
Inlet - LC Enhancement (20%Inlet)					$ 4,350				$ -				$ 3,867
Outlet	Pipe	1	EA	$ 84,640	$ 84,640	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhancement (5% Outlet)					$ 4,232				$ -				$ 111
Other					$ -				$ -				$ -

Base Landscape Cost	$ 271,998	Base Maintenance Cost	$ 273,400
LC Enh. Landscape Cost	$ 212,004	LC Enh. Maintenance Cost	$ 200,278
Total Landscape Cost	$ 484,002	Total Maintenance Cost	$ 473,678

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 557,478	$ 42,592	$ 600,070
Contingency Cost (25% of Construction Cost)	$ 139,370	$ 10,648	$ 150,018
Engineering Design Cost (5% of Construction Cost)	$ 27,874	$ 2,130	$ 30,004
Total Construction Cost	$ 724,721	$ 55,370	$ 780,091

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	4.9	$100,000	$ 490,000
Basin	6.2	$100,000	$ 620,000
Other		$100,000	$ -
Total	11.1	$100,000	$ 1,110,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	6.2	$100,000	$ 620,000
LC Enhancement Cost	acre	4.9	$100,000	$ 490,000
Total Land Cost	acre	11.1	$100,000	$ 1,110,000

Total Cost

Base Total Cost	$ 1,890,119
Total LC Enhancement Cost	$ 957,651
Total Cost Including LC Enh.	$ 2,847,771

Open Channel

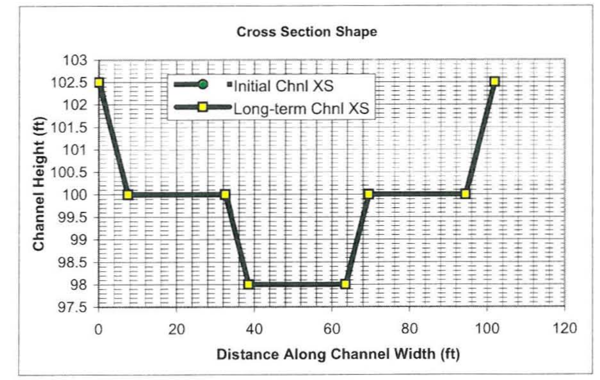
Structure ID	C17510A		HEC1 ID	165175

Longitundal Geometry

Length	7076.2	ft
U/S Elev	1674.9	ft
D/S Elev	1546.4	ft
Initial Channel Slope	0.0182	ft/ft
Long-term Channel Slope	0.0070	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	8



Initial Channel XS Geometry

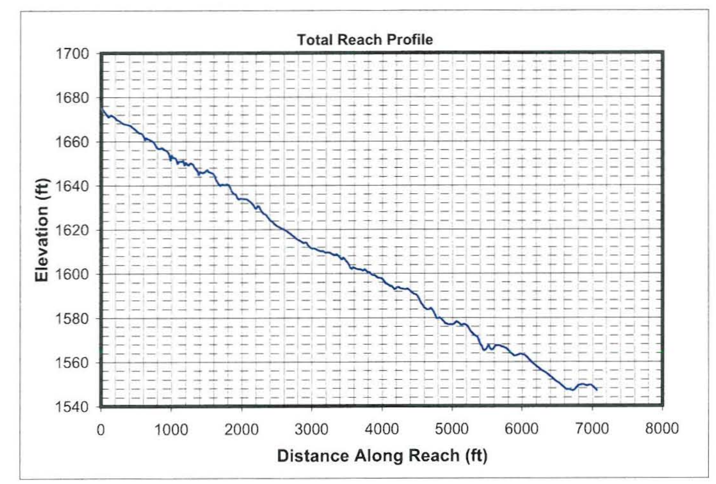
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	2.5	25	3	25	4.5	3	25	2.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	7.5	32.5	38.5	63.5	69.5	94.5	102
Y	102.5	100	100	98	98	100	100	102.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	2.5	25	3	25	4.5	3	25	2.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	7.5	32.5	38.5	63.5	69.5	94.5	102
Y	102.5	100	100	98	98	100	100	102.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	RR165	S170								TOTAL
HEC1 Peak-Flow	93	1802								1895
Weighting Factor	1.00	0.41								
Flow into Channel	93	740								833

Reach Sediment Inflow Characteristics

U/S Contributing ID										TOTAL
HEC1 Flow Volume (ac. ft)										0
Sediment Conc. (ppm)										
Sediment Volume (ac. ft)										0.00
Weighting Factor										
Weighted Sed. Vol. (ac. ft)										0.00

Hydrology

Drainage Area	1.991	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	833	cfs	
Long-term Max. Chnl Capacity	1674	cfs	
Q2 Channel	83	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	102	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
83	31.9	30.8	1.0	98.0	99.1	2.7	1.1	31.5	1.0	0.48	0.48
208	36.7	56.4	1.5	98.0	99.8	3.7	1.8	36.1	1.6	0.81	0.52
625	94.5	159.2	1.7	98.0	101.1	3.9	3.1	93.5	1.7	1.34	0.53
833	96.6	190.9	2.0	98.0	101.4	4.4	3.4	95.5	2.0	1.49	0.54

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
83	31.9	30.8	1.0	98.0	99.1	2.7	1.1	31.5	1.0	0.48	0.48
208	36.7	56.4	1.5	98.0	99.8	3.7	1.8	36.1	1.6	0.81	0.52
625	94.5	159.2	1.7	98.0	101.1	3.9	3.1	93.5	1.7	1.34	0.53
833	96.6	190.9	2.0	98.0	101.4	4.4	3.4	95.5	2.0	1.49	0.54

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
83										0
208										0
625										0
833										0

Allowable Velocity

Channel Lining	Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
83	1.74	1.3880	1.3186	Erosive	Erosive	Erosive	0.3	Stable	5.2	Stable	Stable
208	1.74	1.5332	1.4566	Erosive	Erosive	Erosive	0.4	Stable	7.3	Stable	Stable
625	1.74	1.5597	1.4817	Erosive	Erosive	Erosive	0.4	Stable	9.5	Stable	Stable
833	1.74	1.6091	1.5287	Erosive	Erosive	Erosive	0.4	Stable	10.3	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

Discharge (cfs)	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
	83	208	625	833	83	208	625	833	83	208	625	833
Bray - Equation #1	24	40	71	82	1.2	1.6	2.3	2.5	2.9	3.3	3.9	4.1
Bray - Equation #2	32	52	93	108	1.3	1.7	2.5	2.7	2.0	2.3	2.7	2.8
Hey	7	12	22	26	3.5	4.9	7.4	8.3				
Ackers & Charlton/Lacey	23	34	54	61					1.7	2.0	2.3	2.5
Parker	63	99	172	198	0.9	1.3	2.0	2.3				
Chang	43	76	147	175	0.1	0.0	-0.3	-0.4				
Kellerhals	16	26	45	52	1.6	2.3	3.6	4.0	3.2	3.5	3.9	4.0
AMAFCA/Schumm	32	36	94	96								
Moody & Odem	16	16	16	16	1.0	1.0	1.0	1.0				
BUREC	13.1	18.5	27.9	31.1	3	5	7	8	2.9	3.6	4.7	5.1
Average	27	41	74	85	1.6	2.2	3.2	3.6	2.5	2.9	3.5	3.7
Values As Designed	32	36	93	95	1.1	1.8	3.1	3.4	2.7	3.7	3.9	4.4
Difference with Design	-5	5	-19	-11	0.5	0.4	0.2	0.2	-0.2	-0.8	-0.4	-0.7

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
83	489	294	646	3841	1114	198	89	108	3781	256	1305	1102
208	1857	855	1715	16577	1668	764	255	417	9539	877	4511	3549
625	6102	2577	5083	55175	4531	2716	785	1352	28647	2809	14413	11290
833	9398	3590	6602	88630	5053	4401	1065	2023	38254	4175	21106	16754

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
83	2178	1311	2877	17107	4961	882	397	480	16841	1142	5810	4908
208	3309	1523	3056	29532	2971	1362	455	743	16994	1562	8037	6322
625	3623	1530	3019	32765	2690	1613	466	803	17011	1668	8559	6704
833	4186	1599	2940	39474	2250	1960	474	901	17037	1860	9400	7462

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
83	489	249	424	919	605	113	89	108	866	110	570	413
208	1857	744	1132	3966	949	410	255	417	2238	400	2090	1314
625	6102	2252	3489	13202	2596	1319	785	1352	6740	1295	6751	4171
833	9398	3158	4626	21206	2928	1961	1065	2023	9036	1974	10076	6132

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
83	2178	1108	1887	4093	2693	502	397	480	3858	489	2539	1838
208	3309	1325	2017	7066	1691	730	455	743	3987	713	3723	2342
625	3623	1337	2072	7840	1542	783	466	803	4002	769	4009	2477
833	4186	1406	2060	9445	1304	873	474	901	4024	879	4488	2731

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
83	0.0008	0.0012	247	0.75	0.053	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0006	0.0080	0.0005	0.0020	0.0069	0.0040
208	0.0005	0.0008	311	0.95	0.055	0.0002	32	0.036	0.0001	0.0159	0.0002	0.0004	0.0080	0.0003	0.0010	0.0069	0.0039
625	0.0004	0.0007	326	0.99	0.055	0.0002	32	0.036	0.0001	0.0159	0.0001	0.0003	0.0080	0.0002	0.0004	0.0069	0.0039
833	0.0003	0.0006	353	1.08	0.056	0.0002	32	0.036	0.0001	0.0159	0.0001	0.0003	0.0080	0.0002	0.0004	0.0069	0.0038

Drop Structures

Design Slope	0.0070	ft/ft
Total Drop Needed	79.0	ft
Height of Drop Structure	3	ft
No . of Drop Structures	27	
Distance between structs.	262	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.60	sq. mi
Total Sediment Yield Volume	1.14	ac ft

Sedimentation Basins

Length	262 ft	Depth	3 ft
Width	102 ft	Side slope	3 ft/ft
Total Volume per Basin		1.62	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		3	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
83	1.1	-0.3	0.1	24.6	1.1	1.0	2.7	0.0070	0.1	0.0	2.0	2.8
208	1.1	-0.5	0.2	24.6	1.8	1.6	3.7	0.0070	0.2	0.0	2.0	3.0
625	1.1	-0.8	0.2	24.6	3.1	1.7	3.9	0.0070	0.3	0.0	2.0	3.2
833	1.1	-0.9	0.3	24.6	3.4	2.0	4.4	0.0070	0.4	0.0	2.0	3.3

Toe Protection Needed	4.0	ft

HEC1 Results For Open Channel

Peak Flow	93	cfs
Stage at Peak Flow	99.0	ft
Flow Volume	100.0	ac. ft

Freeboard

Max. Flow Depth	3.4	ft
Channel Depth as designed	4.5	ft
Available Freeboard	1.1	ft
Required Freeboard	1	ft

Sediment Volume

Inflowing Sediment Volume	1.14	ac. ft
Outflowing Sediment Volume	0.10	ac. ft
Deposited(+)/Eroded(-) Volume	1.04	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	7076	7076
Side Slope (?H:1V)	3	6
Channel Width (ft)	102	129
Channel XS Area (sq. ft)	298.2	358.95
Channel Perimeter (ft)	104	130

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	1133858	1429231
Excavated Area (sq. Yd)	80195	101423

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	7076	ft
Thickness	1.5	ft
Protection Depth	4	ft
Tie-in Length/Depth	3.0	ft
Total Depth	7.0	ft
Area needed	1179	sq. Yd
Volume	2752	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	None	None
Left Levee Length (ft)	0	0
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	N/A	6
Left Levee Height (ft)	0	1
Left Levee Surface Area (sq. Yd)	0	0
Left Levee Volume (cu. Yd)	0	0
Right Levee Length (ft)	0	0
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	N/A	6
Right Levee Height (ft)	0	1
Right Levee Surface Area (sq. Yd)	0	0
Right Levee Volume (cu. Yd)	0	0
Total Levee Surface Area (sq. Yd)	0	0
Total Levee Volume (cu. Yd)	0	0

Levee Lining	Base	LC Enhanced
Lining Type	None	None
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	7076	7076
Left Levee Lining Width (ft)	0	0
Left Levee Lining Thickness (ft)	0	0
Left Levee Lining Area (sq. Yd)	0	0
Left Levee Lining Volume (cu. Yd)	0	0
Right Levee Length (ft)	7076	7076
Right Levee Lining Width (ft)	0	0
Right Levee Lining Thickness (ft)	0	0
Right Levee Lining Area (sq. Yd)	0	0
Right Levee Lining Volume (cu. Yd)	0	0
Total Lining Area (sq. Yd)	0	0
Total Lining Volume (cu. Yd)	0	0

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	102	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	8.1	ft
Structure Height	11.1	ft
Number of Structures	27	
Volume per structure	126	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 9,450	
Area per structure	34	sq. Yd
Total Area	918	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	3	
Total Volume per Basin	2614	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 10,456	
Other Cost	$ -	
Total cost per basin	$ 10,456	
Area per basin	2,970	sq. Yd
Total Area	8,910	sq. Yd

Structure Cost

Structure Type	Excavation/Construction					Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining -LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Excavated Channel	Excavated	1,133,858	cu. Yd	$ 10.00	$ 11,338,580	80,195	sq. Yd	$ 9.00	$ 721,755	80,195	sq. Yd	$ 8.33	$ 668,292
Exc. Chl - LC Enhancement	Excavated	295,373	cu. Yd	$ 10.00	$ 2,953,730	21,228	sq. Yd	$ 9.00	$ 191,052	21,228	sq. Yd	$ 8.33	$ 176,900
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	2,752	cu. Yd	$ 75.00	$ 206,400	1,179	sq. Yd	$ -	$ -	1,179	sq. Yd	$ 25.00	$ 29,475
Drop Structures	Riprap	27	EA	$ 9,450.00	$ 255,150	918	sq. Yd	$ -	$ -	918	sq. Yd	$ 33.33	$ 30,600
Drop Str. - LC Enhancement	Riprap	27	EA	$ 945.00	$ 25,515	92	sq. Yd	$ -	$ -	92	sq. Yd	$ 33.33	$ 3,060
Sedimentation Basins		3	EA	$ 10,456.00	$ 31,368	8,910	sq. Yd	$ -	$ -	8,910	sq. Yd	$ 8.33	$ 74,250
Other					$ -				$ -				$ -

Base Landscape Cost	$ 721,755	Base Maintenance Cost	$ 802,617
LC Enhancement Cost	$ 191,052	LC Enhancement Cost	$ 179,960
Total Landscape Cost	$ 912,807	Total Maintenance Cost	$ 982,577

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 11,831,498	$ 2,979,245	$ 14,810,743
Contingency Cost (25% of Construction Cost)	$ 2,957,875	$ 744,811	$ 3,702,686
Engineering Design Cost (5% of Construction Cost)	$ 591,575	$ 148,962	$ 740,537
Total Construction Cost	$ 15,380,947	$ 3,873,019	$ 19,253,966

Land Cost

Channel Length	7076 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	134	21.8	$100,000	$ 2,180,000
LC Enhancement Buffer	50	8.1	$100,000	$ 810,000
Channel	102	16.6	$100,000	$ 1,660,000
Channel LC Enhancement	27	4.4	$100,000	$ 440,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	313	50.9		$ 5,090,000

Right of Way

Preservation Corridor Width	120	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	50	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	38.4	$100,000	$ 3,840,000
LC Enhancement Cost	acre	12.5	$100,000	$ 1,250,000
Total Land Cost	acre	50.9	$100,000	$ 5,090,000

Total Cost

Base Total Cost	$ 20,745,319
Total Landscape Enhancement Cost	$ 5,494,031
Total Cost Including LC Enh.	$ 26,239,350

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

Open Channel

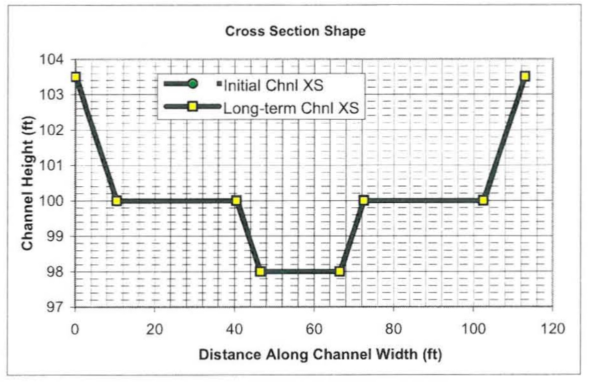
Structure ID	C17510B	HEC1 ID	165175

Longitundal Geometry

Length	6169.2	ft
U/S Elev	1546.4	ft
D/S Elev	1462.9	ft
Initial Channel Slope	0.0135	ft/ft
Long-term Channel Slope	0.0050	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	8



Initial Channel XS Geometry

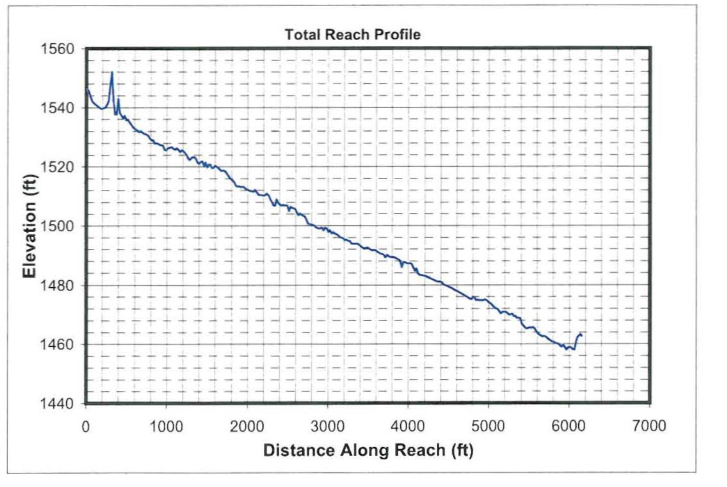
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	3.5	30	3	20	5.5	3	30	3.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	10.5	40.5	46.5	66.5	72.5	102.5	113
Y	103.5	100	100	98	98	100	100	103.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	3.5	30	3	20	5.5	3	30	3.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	10.5	40.5	46.5	66.5	72.5	102.5	113
Y	103.5	100	100	98	98	100	100	103.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	C175								TOTAL
HEC1 Peak-Flow	1271								1271
Weighting Factor	1.00								
Flow into Channel	1271								1271

Reach Sediment Inflow Characteristics

U/S Contributing ID	165175_C17510A								TOTAL
HEC1 Flow Volume (ac. ft)	100.00								100
Sediment Conc. (ppm)	2731								
Sediment Volume (ac. ft)	0.10								0.10
Weighting Factor	1								
Weighted Sed. Vol. (ac. ft)	0.10								0.10

Hydrology

Drainage Area	3.19	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	1271	cfs	
Long-term Max. Chnl Capacity	2250	cfs	
Q2 Channel	127	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	113	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

Sub-area: Wagner Wash, Alternative: B3
Open Channel Structure ID: C17510B

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
127	30.9	43.3	1.4	98.0	99.7	2.9	1.7	30.3	1.4	0.54	0.43
318	97.1	118.7	1.2	98.0	100.7	2.7	2.7	96.3	1.2	0.84	0.42
953	104.6	236.4	2.3	98.0	101.9	4.0	3.9	103.3	2.3	1.21	0.47
1271	107.5	284.0	2.6	98.0	102.3	4.5	4.3	106.1	2.7	1.35	0.48

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
127	30.9	43.3	1.4	98.0	99.7	2.9	1.7	30.3	1.4	0.54	0.43
318	97.1	118.7	1.2	98.0	100.7	2.7	2.7	96.3	1.2	0.84	0.42
953	104.6	236.4	2.3	98.0	101.9	4.0	3.9	103.3	2.3	1.21	0.47
1271	107.5	284.0	2.6	98.0	102.3	4.5	4.3	106.1	2.7	1.35	0.48

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
	165175_C17510A									
127	413									413
318	1314									1314
953	4171									4171
1271	6132									6132

Allowable Velocity

Channel Lining	Natural - Fine Gravel										
Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
127	1.74	1.5054	1.4301	Erosive	Erosive	Erosive	0.4	Stable	5.8	Stable	Stable
318	1.74	1.4601	1.3871	Erosive	Erosive	Erosive	0.3	Stable	7.1	Stable	Stable
953	1.74	1.6506	1.5681	Erosive	Erosive	Erosive	0.4	Stable	9.5	Stable	Stable
1271	1.74	1.6992	1.6142	Erosive	Erosive	Erosive	0.4	Stable	10.3	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	**127**	**318**	**953**	**1271**	**127**	**318**	**953**	**1271**	**127**	**318**	**953**	**1271**
Bray - Equation #1	31	50	88	103	1.3	1.8	2.6	2.9	3.1	3.5	4.1	4.3
Bray - Equation #2	40	65	116	135	1.5	2.0	2.9	3.1	2.1	2.4	2.8	3.0
Hey	9	15	28	33	4.1	5.8	8.7	9.7				
Ackers & Charlton/Lacey	28	40	64	72					1.8	2.1	2.5	2.6
Parker	77	122	212	245	1.0	1.5	2.4	2.7				
Chang	50	87	171	203	0.2	0.1	-0.3	-0.4				
Kellerhals	20	32	56	64	1.9	2.7	4.2	4.7	3.3	3.6	4.0	4.2
AMAFCA/Schumm	30	96	103	106								
Moody & Odem	19	19	19	19	1.1	1.1	1.1	1.1				
BUREC	16.3	23.0	34.8	38.8	4	6	9	10	2.8	3.5	4.6	5.0
Average	32	55	89	102	1.9	2.6	3.9	4.3	2.6	3.0	3.6	3.8
Values As Designed	30	96	103	106	1.7	2.7	3.9	4.3	2.9	2.7	4.0	4.5
Difference with Design	2	-41	-14	-4	0.2	-0.1	0.0	-0.1	-0.3	0.4	-0.4	-0.7

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
127	595	338	680	4950	1128	217	92	143	3720	315	1693	1261
318	1326	775	1676	10491	3284	470	218	310	9262	718	3830	2942
953	6948	2932	5365	64579	5013	2784	802	1634	28140	3312	17768	12662
1271	10672	4082	6960	103389	5609	4505	1089	2435	37580	4926	26022	18843

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
127	1736	986	1984	14450	3291	633	269	417	10860	919	4942	3681
318	1548	905	1957	12249	3834	549	255	362	10814	838	4472	3435
953	2704	1141	2088	25134	1951	1083	312	636	10952	1289	6915	4928
1271	3115	1191	2032	30179	1637	1315	318	711	10970	1438	7596	5500

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
127	595	285	435	1110	600	119	92	143	799	126	706	455
318	1326	647	1054	2353	1714	264	218	310	1963	281	1568	1064
953	6948	2545	3556	14482	2796	1316	802	1634	6188	1345	7878	4499
1271	10672	3568	4810	23185	3166	1955	1089	2435	8302	1461	11765	6583

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
127	1736	832	1270	3241	1751	348	269	417	2331	367	2061	1329
318	1548	756	1231	2747	2002	308	255	362	2292	328	1830	1242
953	2704	991	1384	5636	1088	512	312	636	2409	524	3066	1751
1271	3115	1041	1404	6768	924	571	318	711	2423	427	3434	1921

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
127	0.0006	0.0008	257	0.78	0.053	0.0002	32	0.036	0.0001	0.0159	0.0002	0.0004	0.0069	0.0004	0.0016	0.0049	0.0032
318	0.0007	0.0010	240	0.73	0.052	0.0002	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0069	0.0003	0.0008	0.0049	0.0032
953	0.0003	0.0005	326	0.99	0.055	0.0001	32	0.036	0.0001	0.0159	0.0001	0.0003	0.0069	0.0002	0.0004	0.0049	0.0031
1271	0.0003	0.0005	352	1.07	0.056	0.0001	32	0.036	0.0001	0.0159	0.0001	0.0002	0.0069	0.0001	0.0003	0.0049	0.0031

Drop Structures

Design Slope	0.0050	ft/ft
Total Drop Needed	52.7	ft
Height of Drop Structure	3	ft
No . of Drop Structures	18	
Distance between structs.	343	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	1.80	sq. mi
Total Sediment Yield Volume	3.42	ac ft

Sedimentation Basins

Length	343 ft	Depth	3 ft
Width	113 ft	Side slope	3 ft/ft
Total Volume per Basin		2.39	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		5	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend Scour	LongTerm Scour	Thalweg channel	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se				Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
127	1.1	-0.5	0.1	24.6	1.7	1.4	2.9	0.0050	0.2	0.0	2.0	2.9
318	1.1	-0.9	0.1	24.6	2.7	1.2	2.7	0.0050	0.3	0.0	2.0	3.0
953	1.1	-1.0	0.2	24.6	3.9	2.3	4.0	0.0050	0.4	0.0	2.0	3.3
1271	1.1	-1.1	0.3	24.6	4.3	2.7	4.5	0.0050	0.5	0.0	2.0	3.4

Toe Protection Needed	4.0	ft

Freeboard

Max. Flow Depth	4.3	ft
Channel Depth as designed	5.5	ft
Available Freeboard	1.2	ft
Required Freeboard	1.2	ft

Sediment Volume

Inflowing Sediment Volume	3.52	ac. ft
Outflowing Sediment Volume	0.07	ac. ft
Deposited(+)/Eroded(-) Volume	3.45	ac. ft

HEC1 Results For Open Channel

Peak Flow	93	cfs
Stage at Peak Flow	99.0	ft
Flow Volume	100.0	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	6169	6169
Side Slope (?H:1V)	3	6
Channel Width (ft)	113	146
Channel XS Area (sq. ft)	410.8	501.55
Channel Perimeter (ft)	115	147

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	774432	993918
Excavated Area (sq. Yd)	77455	100075

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	6169	ft
Thickness	1.5	ft
Protection Depth	4	ft
Tie-in Length/Depth	3.0	ft
Total Depth	7.0	ft
Area needed	1028	sq. Yd
Volume	2399	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	None	None
Left Levee Length (ft)	0	0
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	N/A	6
Left Levee Height (ft)	0	1
Left Levee Surface Area (sq. Yd)	0	0
Left Levee Volume (cu. Yd)	0	0
Right Levee Length (ft)	0	0
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	N/A	6
Right Levee Height (ft)	0	1
Right Levee Surface Area (sq. Yd)	0	0
Right Levee Volume (cu. Yd)	0	0
Total Levee Surface Area (sq. Yd)	0	0
Total Levee Volume (cu. Yd)	0	0

Levee Lining	Base	LC Enhanced
Lining Type	None	None
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	6169	6169
Left Levee Lining Width (ft)	0	0
Left Levee Lining Thickness (ft)	0	0
Left Levee Lining Area (sq. Yd)	0	0
Left Levee Lining Volume (cu. Yd)	0	0
Right Levee Length (ft)	6169	6169
Right Levee Lining Width (ft)	0	0
Right Levee Lining Thickness (ft)	0	0
Right Levee Lining Area (sq. Yd)	0	0
Right Levee Lining Volume (cu. Yd)	0	0
Total Lining Area (sq. Yd)	0	0
Total Lining Volume (cu. Yd)	0	0

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	113	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	9.7	ft
Structure Height	12.7	ft
Number of Structures	18	
Volume per structure	160	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 12,000	
Area per structure	38	sq. Yd
Total Area	678	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	5	
Total Volume per Basin	3856	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 15,424	
Other Cost	$ -	
Total cost per basin	$ 15,424	
Area per basin	4,303	sq. Yd
Total Area	21,515	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining -LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Excavated Channel	Excavated	774,432	cu. Yd	$ 10.00	$ 7,744,320	77,455	sq. Yd	$ 9.00	$ 697,095	77,455	sq. Yd	$ 8.33	$ 645,458
Exc. Chl - LC Enhancement	Excavated	219,486	cu. Yd	$ 10.00	$ 2,194,860	22,620	sq. Yd	$ 9.00	$ 203,580	22,620	sq. Yd	$ 8.33	$ 188,500
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	2,399	cu. Yd	$ 75.00	$ 179,925	1,028	sq. Yd	$ -	$ -	1,028	sq. Yd	$ 25.00	$ 25,700
Drop Structures	Riprap	18	EA	$ 12,000.00	$ 216,000	678	sq. Yd	$ -	$ -	678	sq. Yd	$ 33.33	$ 22,600
Drop Str. - LC Enhancement	Riprap	18	EA	$ 1,200.00	$ 21,600	68	sq. Yd	$ -	$ -	68	sq. Yd	$ 33.33	$ 2,260
Sedimentation Basins		5	EA	$ 15,424.00	$ 77,120	21,515	sq. Yd	$ -	$ -	21,515	sq. Yd	$ 8.33	$ 179,292
Other					$ -				$ -				$ -

Base Landscape Cost	$ 697,095	Base Maintenance Cost	$ 873,050
LC Enhancement Cost	$ 203,580	LC Enhancement Cost	$ 190,760
Total Landscape Cost	$ 900,675	Total Maintenance Cost	$ 1,063,810

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 8,217,365	$ 2,216,460	$ 10,433,825
Contingency Cost (25% of Construction Cost)	$ 2,054,341	$ 554,115	$ 2,608,456
Engineering Design Cost (5% of Construction Cost)	$ 410,868	$ 110,823	$ 521,691
Total Construction Cost	$ 10,682,575	$ 2,881,398	$ 13,563,973

Land Cost

Channel Length	6169 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	134	19	$100,000	$ 1,900,000
LC Enhancement Buffer	50	7.1	$100,000	$ 710,000
Channel	113	16	$100,000	$ 1,600,000
Channel LC Enhancement	33	4.7	$100,000	$ 470,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	330	46.8		$ 4,680,000

Right of Way

Preservation Corridor Width	120	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	50	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	35	$100,000	$ 3,500,000
LC Enhancement Cost	acre	11.8	$100,000	$ 1,180,000
Total Land Cost	acre	46.8	$100,000	$ 4,680,000

Total Cost

Base Total Cost	$ 15,752,720
Total Landscape Enhancement Cost	$ 4,455,738
Total Cost Including LC Enh.	$ 20,208,458

Open Channel

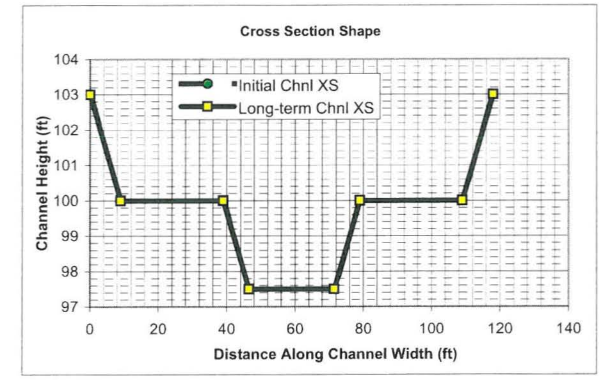
Structure ID	RR17510	HEC1 ID	175R

Longitundal Geometry

Length	3035.2	ft
U/S Elev	1462.9	ft
D/S Elev	1413.1	ft
Initial Channel Slope	0.0164	ft/ft
Long-term Channel Slope	0.0060	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	2



Initial Channel XS Geometry

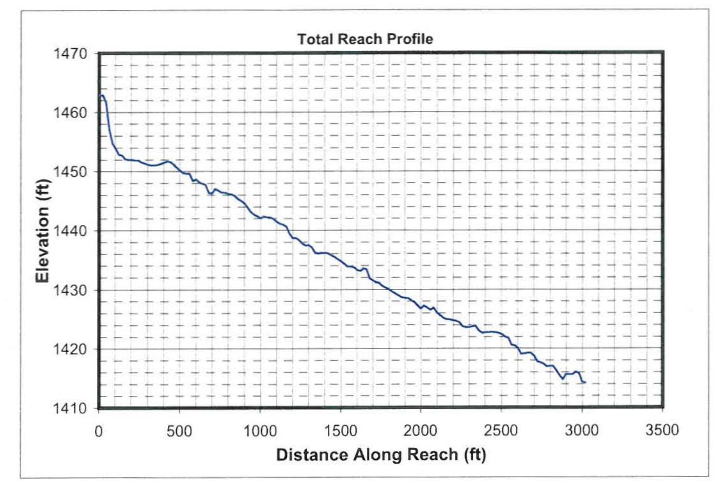
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	3	30	3	25	5.5	3	30	3	3

PT. ID	1	2	3	4	5	6	7	8
X	0	9	39	46.5	71.5	79	109	118
Y	103	100	100	97.5	97.5	100	100	103

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	3	30	3	25	5.5	3	30	3	3

PT. ID	1	2	3	4	5	6	7	8
X	0	9	39	46.5	71.5	79	109	118
Y	103	100	100	97.5	97.5	100	100	103



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	C175	S190								TOTAL
HEC1 Peak-Flow	1271	2590								3861
Weighting Factor	1.00	0.05								
Flow into Channel	1271	119								1390

Reach Sediment Inflow Characteristics

U/S Contributing ID	165175_C17510B									TOTAL
HEC1 Flow Volume (ac. ft)	100.00									100
Sediment Conc. (ppm)	1921									
Sediment Volume (ac. ft)	0.07									0.07
Weighting Factor	1									
Weighted Sed. Vol. (ac. ft)	0.07									0.07

Hydrology

Drainage Area	2.607	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	1390	cfs	
Long-term Max. Chnl Capacity	2371	cfs	
Q2 Channel	139	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	118	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
139	34.7	45.3	1.3	97.5	99.0	3.1	1.5	34.2	1.3	0.57	0.47
348	103.3	121.6	1.2	97.5	100.4	2.9	2.9	102.4	1.2	1.08	0.46
1043	110.5	241.4	2.2	97.5	101.5	4.3	4.0	109.2	2.2	1.51	0.51
1390	113.3	289.7	2.6	97.5	102.0	4.8	4.5	111.8	2.6	1.67	0.53

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
139	34.7	45.3	1.3	97.5	99.0	3.1	1.5	34.2	1.3	0.57	0.47
348	103.3	121.6	1.2	97.5	100.4	2.9	2.9	102.4	1.2	1.08	0.46
1043	110.5	241.4	2.2	97.5	101.5	4.3	4.0	109.2	2.2	1.51	0.51
1390	113.3	289.7	2.6	97.5	102.0	4.8	4.5	111.8	2.6	1.67	0.53

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
	165175_C17510 B									
139	455									455
348	1064									1064
1043	4499									4499
1390	6583									6583

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
139	1.74	1.4824	1.4083	Erosive	Erosive	Erosive	0.3	Stable	6.0	Stable	Stable
348	1.74	1.4484	1.3760	Erosive	Erosive	Erosive	0.3	Stable	8.0	Stable	Stable
1043	1.74	1.6401	1.5581	Erosive	Erosive	Erosive	0.4	Stable	10.5	Stable	Stable
1390	1.74	1.6891	1.6046	Erosive	Erosive	Erosive	0.4	Stable	11.4	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

Discharge (cfs)	Channel Width (ft) 139	348	1043	1390	Flow Depth (ft) 139	348	1043	1390	Velocity (ft/s) 139	348	1043	1390
Bray - Equation #1	32	52	93	108	1.4	1.9	2.7	3.0	3.2	3.6	4.2	4.4
Bray - Equation #2	42	68	122	142	1.5	2.0	2.9	3.2	2.2	2.5	2.9	3.0
Hey	9	16	30	35	4.2	6.0	9.0	10.1				
Ackers & Charlton/Lacey	29	42	67	75					1.8	2.1	2.6	2.7
Parker	81	128	222	256	1.1	1.6	2.5	2.8				
Chang	56	98	191	227	0.1	0.0	-0.4	-0.6				
Kellerhals	21	34	58	67	2.0	2.8	4.4	4.9	3.3	3.7	4.1	4.2
AMAFCA/Schumm	34	103	109	112								
Moody & Odem	18	18	18	18	1.1	1.1	1.1	1.1				
BUREC	16.3	23.0	34.8	38.7	4	6	9	10	3.1	3.9	5.1	5.4
Average	34	58	94	108	2.0	2.7	3.9	4.4	2.7	3.1	3.8	3.9
Values As Designed	34	102	109	112	1.5	2.9	4.0	4.5	3.1	2.9	4.3	4.8
Difference with Design	0	-44	-15	-4	0.4	-0.2	-0.1	-0.1	-0.4	0.3	-0.6	-0.9

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
139	829	455	947	7257	1359	332	131	193	5433	432	2289	1787
348	1896	1049	2330	16005	3820	749	318	436	13550	1007	5320	4225
1043	9973	3892	7096	98982	5772	4573	1107	2219	41040	4615	24055	18484
1390	15340	5402	9274	158727	6440	7364	1493	3290	54787	6857	35045	27638

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
139	2214	1216	2529	19369	3628	885	351	515	14502	1152	6110	4770
348	2024	1120	2488	17087	4078	800	339	465	14467	1075	5680	4511
1043	3549	1385	2525	35225	2054	1627	394	790	14605	1642	8560	6578
1390	4094	1442	2475	42365	1719	1966	399	878	14623	1830	9354	7377

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
139	829	386	596	1607	729	179	131	193	1161	179	971	633
348	1896	884	1484	3544	2022	410	318	436	2875	410	2226	1501
1043	9973	3396	4892	21919	3241	1975	1107	2219	8954	1963	10906	6413
1390	15340	4741	6319	35148	3654	2927	1493	3290	11995	2126	16205	9385

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
139	2214	1031	1591	4289	1946	477	351	515	3100	477	2593	1689
348	2024	944	1585	3784	2159	438	339	465	3070	437	2377	1602
1043	3549	1208	1741	7800	1153	703	394	790	3187	699	3881	2282
1390	4094	1266	1687	9381	975	781	399	878	3202	567	4325	2505

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
139	0.0006	0.0009	272	0.83	0.054	0.0002	32	0.036	0.0001	0.0159	0.0002	0.0005	0.0067	0.0004	0.0015	0.0059	0.0034
348	0.0007	0.0010	259	0.79	0.053	0.0002	32	0.036	0.0002	0.0159	0.0002	0.0005	0.0067	0.0003	0.0008	0.0059	0.0034
1043	0.0003	0.0005	352	1.07	0.056	0.0001	32	0.036	0.0001	0.0159	0.0001	0.0003	0.0067	0.0002	0.0003	0.0059	0.0033
1390	0.0003	0.0005	381	1.16	0.057	0.0001	33	0.036	0.0001	0.0159	0.0001	0.0002	0.0067	0.0001	0.0003	0.0059	0.0033

Drop Structures

Design Slope	0.0060	ft/ft
Total Drop Needed	31.5	ft
Height of Drop Structure	3	ft
No . of Drop Structures	11	
Distance between structs.	276	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.19	sq. mi
Total Sediment Yield Volume	0.36	ac ft

Sedimentation Basins

Length	276 ft	Depth	3 ft
Width	118 ft	Side slope	3 ft/ft
Total Volume per Basin		2.01	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
139	1.1	-0.5	0.1	24.6	1.5	1.3	3.1	0.0060	0.2	0.0	2.5	3.5
348	1.1	-0.9	0.1	24.6	2.9	1.2	2.9	0.0060	0.3	0.0	2.5	3.7
1043	1.1	-1.0	0.3	24.6	4.0	2.2	4.3	0.0060	0.5	0.0	2.5	4.0
1390	1.1	-1.1	0.3	24.6	4.5	2.6	4.8	0.0060	0.5	0.0	2.5	4.1

Toe Protection Needed	5.0	ft

HEC1 Results For Open Channel

Peak Flow	1220	cfs
Stage at Peak Flow	100.9	ft
Flow Volume	202.0	ac. ft

Freeboard

Max. Flow Depth	4.5	ft
Channel Depth as designed	5.5	ft
Available Freeboard	1.0	ft
Required Freeboard	1.2	ft

Sediment Volume

Inflowing Sediment Volume	0.43	ac. ft
Outflowing Sediment Volume	0.19	ac. ft
Deposited(+)/Eroded(-) Volume	0.24	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	3035	3035
Side Slope (?H:1V)	3	6
Channel Width (ft)	118	151
Channel XS Area (sq. ft)	408.2	498.95
Channel Perimeter (ft)	120	152

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	255069	323771
Excavated Area (sq. Yd)	39792	50921

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	3035	ft
Thickness	1.5	ft
Protection Depth	5	ft
Tie-in Length/Depth	3.0	ft
Total Depth	8.0	ft
Area needed	506	sq. Yd
Volume	1349	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	None	None
Left Levee Length (ft)	0	0
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	N/A	6
Left Levee Height (ft)	0	1
Left Levee Surface Area (sq. Yd)	0	0
Left Levee Volume (cu. Yd)	0	0
Right Levee Length (ft)	0	0
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	N/A	6
Right Levee Height (ft)	0	1
Right Levee Surface Area (sq. Yd)	0	0
Right Levee Volume (cu. Yd)	0	0
Total Levee Surface Area (sq. Yd)	0	0
Total Levee Volume (cu. Yd)	0	0

Levee Lining	Base	LC Enhanced
Lining Type	None	None
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	3035	3035
Left Levee Lining Width (ft)	0	0
Left Levee Lining Thickness (ft)	0	0
Left Levee Lining Area (sq. Yd)	0	0
Left Levee Lining Volume (cu. Yd)	0	0
Right Levee Length (ft)	3035	3035
Right Levee Lining Width (ft)	0	0
Right Levee Lining Thickness (ft)	0	0
Right Levee Lining Area (sq. Yd)	0	0
Right Levee Lining Volume (cu. Yd)	0	0
Total Lining Area (sq. Yd)	0	0
Total Lining Volume (cu. Yd)	0	0

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	118	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	9.9	ft
Structure Height	12.9	ft
Number of Structures	11	
Volume per structure	169	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 12,675	
Area per structure	39	sq. Yd
Total Area	433	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	3243	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 12,972	
Other Cost	$ -	
Total cost per basin	$ 12,972	
Area per basin	3,618	sq. Yd
Total Area	3,618	sq. Yd

Structure Type	Structure Type	Excavation/Construction Quantity	Units	Unit Cost	Cost Subtotal	Landscape Quantity	Units	Unit Cost	Landscape Cost	Maintenance Quantity	Units	Unit Cost	Maintenance Cost
Levee	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining -LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Excavated Channel	Excavated	255,069	cu. Yd	$ 10.00	$ 2,550,690	39,792	sq. Yd	$ 9.00	$ 358,128	39,792	sq. Yd	$ 8.33	$ 331,600
Exc. Chl - LC Enhancement	Excavated	68,702	cu. Yd	$ 10.00	$ 687,020	11,129	sq. Yd	$ 9.00	$ 100,161	11,129	sq. Yd	$ 8.33	$ 92,742
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	1,349	cu. Yd	$ 75.00	$ 101,175	506	sq. Yd	$ -	$ -	506	sq. Yd	$ 25.00	$ 12,650
Drop Structures	Riprap	11	EA	$ 12,675.00	$ 139,425	433	sq. Yd	$ -	$ -	433	sq. Yd	$ 33.33	$ 14,433
Drop Str. - LC Enhancement	Riprap	11	EA	$ 1,267.50	$ 13,943	43	sq. Yd	$ -	$ -	43	sq. Yd	$ 33.33	$ 1,443
Sedimentation Basins		1	EA	$ 12,972.00	$ 12,972	3,618	sq. Yd	$ -	$ -	3,618	sq. Yd	$ 8.33	$ 30,150
Other					$ -				$ -				$ -

Base Landscape Cost	$ 358,128	Base Maintenance Cost	$ 388,833
LC Enhancement Cost	$ 100,161	LC Enhancement Cost	$ 94,185
Total Landscape Cost	$ 458,289	Total Maintenance Cost	$ 483,018

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 2,804,262	$ 700,963	$ 3,505,225
Contingency Cost (25% of Construction Cost)	$ 701,066	$ 175,241	$ 876,306
Engineering Design Cost (5% of Construction Cost)	$ 140,213	$ 35,048	$ 175,261
Total Construction Cost	$ 3,645,541	$ 911,251	$ 4,556,792

Land Cost

Channel Length	3035 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	134	9.3	$100,000	$ 930,000
LC Enhancement Buffer	50	3.5	$100,000	$ 350,000
Channel	118	8.2	$100,000	$ 820,000
Channel LC Enhancement	33	2.3	$100,000	$ 230,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	335	23.3		$ 2,330,000

Right of Way

Preservation Corridor Width	120	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	50	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	17.5	$100,000	$ 1,750,000
LC Enhancement Cost	acre	5.8	$100,000	$ 580,000
Total Land Cost	acre	23.3	$100,000	$ 2,330,000

Total Cost

Base Total Cost	$ 6,142,502
Total Landscape Enhancement Cost	$ 1,685,597
Total Cost Including LC Enh.	$ 7,828,099

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

Sub-area: Wagner Wash, Alternative: B3
Open Channel Structure ID: RR17510

Open Channel

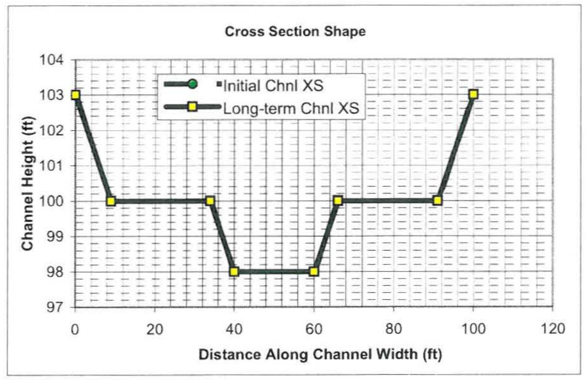
Structure ID	S18010	HEC1 ID	180R

Longitundal Geometry

Length	5165.4	ft
U/S Elev	1531.6	ft
D/S Elev	1456.3	ft
Initial Channel Slope	0.0146	ft/ft
Long-term Channel Slope	0.0060	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	2



Initial Channel XS Geometry

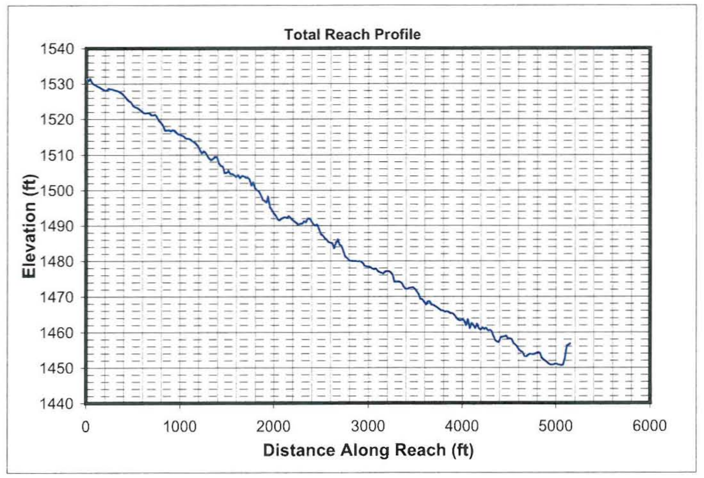
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	3	25	3	20	5	3	25	3	3

PT. ID	1	2	3	4	5	6	7	8
X	0	9	34	40	60	66	91	100
Y	103	100	100	98	98	100	100	103

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	3	25	3	20	5	3	25	3	3

PT. ID	1	2	3	4	5	6	7	8
X	0	9	34	40	60	66	91	100
Y	103	100	100	98	98	100	100	103



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	S180									TOTAL
HEC1 Peak-Flow	1039									1039
Weighting Factor	1.00									
Flow into Channel	1039									1039

Reach Sediment Inflow Characteristics

U/S Contributing ID										TOTAL
HEC1 Flow Volume (ac. ft)										0
Sediment Conc. (ppm)										
Sediment Volume (ac. ft)										0.00
Weighting Factor										
Weighted Sed. Vol. (ac. ft)										0.00

Hydrology

Drainage Area	1.44	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	1039	cfs	
Long-term Max. Chnl Capacity	1809	cfs	
Q2 Channel	104	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	100	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

Sub-area: Wagner Wash, Alternative: B3
Open Channel Structure ID: S18010

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
104	29.2	35.5	1.2	98.0	99.5	2.9	1.5	28.7	1.2	0.55	0.46
260	85.9	94.8	1.1	98.0	100.5	2.7	2.5	85.1	1.1	0.94	0.46
779	92.6	188.9	2.0	98.0	101.6	4.1	3.6	91.5	2.1	1.34	0.51
1039	95.2	227.0	2.4	98.0	102.0	4.6	4.0	93.9	2.4	1.49	0.52

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
104	29.2	35.5	1.2	98.0	99.5	2.9	1.5	28.7	1.2	0.55	0.46
260	85.9	94.8	1.1	98.0	100.5	2.7	2.5	85.1	1.1	0.94	0.46
779	92.6	188.9	2.0	98.0	101.6	4.1	3.6	91.5	2.1	1.34	0.51
1039	95.2	227.0	2.4	98.0	102.0	4.6	4.0	93.9	2.4	1.49	0.52

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
104										0
260										0
779										0
1039										0

Allowable Velocity

Channel Lining	Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuosity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
104	1.74	1.4609	1.3878	Erosive	Erosive	Erosive	0.3	Stable	5.7	Stable	Stable
260	1.74	1.4288	1.3574	Erosive	Erosive	Erosive	0.3	Stable	7.4	Stable	Stable
779	1.74	1.6191	1.5381	Erosive	Erosive	Erosive	0.4	Stable	9.8	Stable	Stable
1039	1.74	1.6675	1.5842	Erosive	Erosive	Erosive	0.4	Stable	10.6	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

Discharge (cfs)	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
	104	260	779	1039	104	260	779	1039	104	260	779	1039
Bray - Equation #1	28	45	80	93	1.2	1.7	2.4	2.7	3.0	3.4	4.0	4.2
Bray - Equation #2	36	58	104	122	1.4	1.9	2.7	2.9	2.1	2.4	2.8	2.9
Hey	8	13	25	30	3.8	5.3	8.1	9.0				
Ackers & Charlton/Lacey	25	37	59	67					1.7	2.0	2.4	2.6
Parker	70	111	192	221	1.0	1.4	2.2	2.5				
Chang	47	82	160	191	0.1	0.0	-0.3	-0.4				
Kellerhals	18	29	50	58	1.7	2.5	3.9	4.4	3.2	3.6	4.0	4.1
AMAFCA/Schumm	29	85	92	94								
Moody & Odem	14	14	14	14	1.0	1.0	1.0	1.0				
BUREC	14.6	20.7	31.2	34.7	4	6	8	9	2.8	3.6	4.7	5.1
Average	29	50	81	92	1.8	2.4	3.5	3.9	2.6	3.0	3.6	3.8
Values As Designed	29	85	91	94	1.5	2.5	3.6	4.0	2.9	2.7	4.1	4.6
Difference with Design	0	-36	-11	-2	0.3	-0.1	0.0	-0.1	-0.3	0.3	-0.5	-0.8

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
104	579	324	659	4189	1026	213	95	134	3394	285	1475	1125
260	1337	752	1630	9320	2855	485	231	304	8459	668	3439	2680
779	6994	2819	5130	57302	4368	2744	819	1577	25694	3083	15826	11487
1039	10739	3918	6671	91704	4890	4422	1109	2345	34313	4588	23140	17076

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
104	2068	1157	2355	14958	3663	761	340	478	12119	1019	5266	4017
260	1910	1074	2328	13311	4077	693	329	434	12083	954	4912	3828
779	3330	1342	2442	27281	2080	1306	390	751	12233	1468	7535	5469
1039	3835	1399	2382	32745	1746	1579	396	837	12252	1638	8263	6097

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
104	579	279	442	1106	584	125	95	134	863	126	681	456
260	1337	643	1104	2460	1606	289	231	304	2135	291	1570	1088
779	6994	2490	3663	15125	2603	1407	819	1577	6677	1455	7753	4597
1039	10739	3482	4781	24205	2944	2085	1109	2345	8949	1745	11534	6720

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
104	2068	995	1578	3948	2086	448	340	478	3081	450	2431	1627
260	1910	918	1577	3513	2294	413	329	434	3050	416	2242	1554
779	3330	1186	1744	7201	1239	670	390	751	3179	693	3691	2188
1039	3835	1243	1707	8643	1051	745	396	837	3195	623	4118	2399

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
104	0.0007	0.0010	248	0.76	0.053	0.0002	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0074	0.0005	0.0017	0.0059	0.0036
260	0.0008	0.0011	236	0.72	0.052	0.0003	31	0.036	0.0002	0.0159	0.0002	0.0006	0.0074	0.0003	0.0009	0.0059	0.0036
779	0.0003	0.0006	321	0.98	0.055	0.0001	32	0.036	0.0001	0.0159	0.0001	0.0003	0.0074	0.0002	0.0004	0.0059	0.0034
1039	0.0003	0.0005	347	1.06	0.056	0.0001	32	0.036	0.0001	0.0159	0.0001	0.0002	0.0074	0.0002	0.0003	0.0059	0.0034

Drop Structures

Design Slope	0.0060	ft/ft
Total Drop Needed	44.3	ft
Height of Drop Structure	3	ft
No . of Drop Structures	15	
Distance between structs.	344	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	1.44	sq. mi
Total Sediment Yield Volume	2.74	ac ft

Sedimentation Basins

Length	344 ft	Depth	3 ft
Width	100 ft	Side slope	3 ft/ft
Total Volume per Basin		2.10	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		5	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
104	1.1	-0.5	0.1	24.6	1.5	1.2	2.9	0.0060	0.2	0.0	2.0	2.9
260	1.1	-0.8	0.1	24.6	2.5	1.1	2.7	0.0060	0.3	0.0	2.0	3.0
779	1.1	-0.9	0.2	24.6	3.6	2.1	4.1	0.0060	0.4	0.0	2.0	3.3
1039	1.1	-1.0	0.3	24.6	4.0	2.4	4.6	0.0060	0.5	0.0	2.0	3.4

Toe Protection Needed	4.0	ft

HEC1 Results For Open Channel

Peak Flow	860	cfs
Stage at Peak Flow	101.0	ft
Flow Volume	90.0	ac. ft

Freeboard

Max. Flow Depth	4.0	ft
Channel Depth as designed	5.0	ft
Available Freeboard	1.0	ft
Required Freeboard	1.1	ft

Sediment Volume

Inflowing Sediment Volume	2.74	ac. ft
Outflowing Sediment Volume	0.08	ac. ft
Deposited(+)/Eroded(-) Volume	2.65	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	5165	5165
Side Slope (?H:1V)	3	6
Channel Width (ft)	100	130
Channel XS Area (sq. ft)	325	400
Channel Perimeter (ft)	102	131

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	486117	627648
Excavated Area (sq. Yd)	57389	74606

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	5165	ft
Thickness	1.5	ft
Protection Depth	4	ft
Tie-in Length/Depth	3.0	ft
Total Depth	7.0	ft
Area needed	861	sq. Yd
Volume	2009	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	None	None
Left Levee Length (ft)	0	0
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	N/A	6
Left Levee Height (ft)	0	1
Left Levee Surface Area (sq. Yd)	0	0
Left Levee Volume (cu. Yd)	0	0
Right Levee Length (ft)	0	0
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	N/A	6
Right Levee Height (ft)	0	1
Right Levee Surface Area (sq. Yd)	0	0
Right Levee Volume (cu. Yd)	0	0
Total Levee Surface Area (sq. Yd)	0	0
Total Levee Volume (cu. Yd)	0	0

Levee Lining	Base	LC Enhanced
Lining Type	None	None
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	5165	5165
Left Levee Lining Width (ft)	0	0
Left Levee Lining Thickness (ft)	0	0
Left Levee Lining Area (sq. Yd)	0	0
Left Levee Lining Volume (cu. Yd)	0	0
Right Levee Length (ft)	5165	5165
Right Levee Lining Width (ft)	0	0
Right Levee Lining Thickness (ft)	0	0
Right Levee Lining Area (sq. Yd)	0	0
Right Levee Lining Volume (cu. Yd)	0	0
Total Lining Area (sq. Yd)	0	0
Total Lining Volume (cu. Yd)	0	0

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	100	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	9.3	ft
Structure Height	12.3	ft
Number of Structures	15	
Volume per structure	137	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 10,275	
Area per structure	33	sq. Yd
Total Area	500	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	5	
Total Volume per Basin	3388	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 13,552	
Other Cost	$ -	
Total cost per basin	$ 13,552	
Area per basin	3,826	sq. Yd
Total Area	19,130	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining -LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Excavated Channel	Excavated	486,117	cu. Yd	$ 10.00	$ 4,861,170	57,389	sq. Yd	$ 9.00	$ 516,501	57,389	sq. Yd	$ 8.33	$ 478,242
Exc. Chl - LC Enhancement	Excavated	141,531	cu. Yd	$ 10.00	$ 1,415,310	17,217	sq. Yd	$ 9.00	$ 154,953	17,217	sq. Yd	$ 8.33	$ 143,475
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	2,009	cu. Yd	$ 75.00	$ 150,675	861	sq. Yd	$ -	$ -	861	sq. Yd	$ 25.00	$ 21,525
Drop Structures	Riprap	15	EA	$ 10,275.00	$ 154,125	500	sq. Yd	$ -	$ -	500	sq. Yd	$ 33.33	$ 16,667
Drop Str. - LC Enhancement	Riprap	15	EA	$ 1,027.50	$ 15,413	50	sq. Yd	$ -	$ -	50	sq. Yd	$ 33.33	$ 1,667
Sedimentation Basins		5	EA	$ 13,552.00	$ 67,760	19,130	sq. Yd	$ -	$ -	19,130	sq. Yd	$ 8.33	$ 159,417
Other					$ -				$ -				$ -

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 5,233,730	$ 1,430,723	$ 6,664,453
Contingency Cost (25% of Construction Cost)	$ 1,308,433	$ 357,681	$ 1,666,113
Engineering Design Cost (5% of Construction Cost)	$ 261,687	$ 71,536	$ 333,223
Total Construction Cost	$ 6,803,849	$ 1,859,939	$ 8,663,788

Base Landscape Cost	$ 516,501
LC Enhancement Cost	$ 154,953
Total Landscape Cost	$ 671,454

Base Maintenance Cost	$ 675,850
LC Enhancement Cost	$ 145,142
Total Maintenance Cost	$ 820,992

Land Cost

Channel Length	5165 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	134	15.9	$100,000	$ 1,590,000
LC Enhancement Buffer	50	5.9	$100,000	$ 590,000
Channel	100	11.9	$100,000	$ 1,190,000
Channel LC Enhancement	30	3.6	$100,000	$ 360,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	314	37.3		$ 3,730,000

Right of Way

Preservation Corridor Width	120	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	50	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	27.8	$100,000	$ 2,780,000
LC Enhancement Cost	acre	9.5	$100,000	$ 950,000
Total Land Cost	acre	37.3	$100,000	$ 3,730,000

Total Cost

Base Total Cost	$ 10,776,200
Total Landscape Enhancement Cost	$ 3,110,034
Total Cost Including LC Enh.	$ 13,886,234

Open Channel

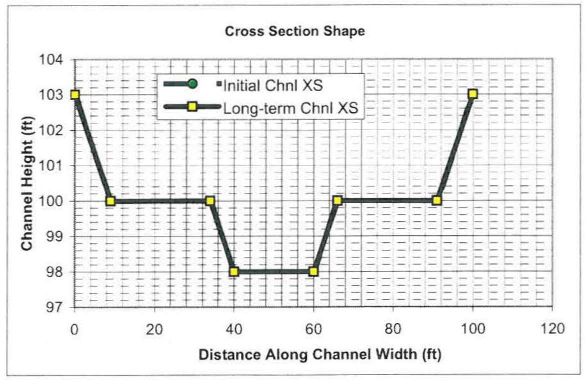
Structure ID	RR18010		HEC1 ID	180R

Longitundal Geometry

Length	2824.7	ft
U/S Elev	1456.3	ft
D/S Elev	1413.1	ft
Initial Channel Slope	0.0153	ft/ft
Long-term Channel Slope	0.0060	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	2



Initial Channel XS Geometry

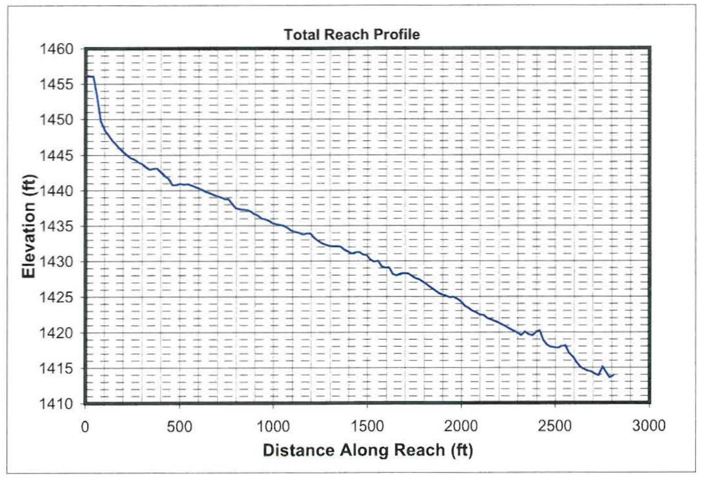
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	3	25	3	20	5	3	25	3	3

PT. ID	1	2	3	4	5	6	7	8
X	0	9	34	40	60	66	91	100
Y	103	100	100	98	98	100	100	103

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	3	25	3	20	5	3	25	3	3

PT. ID	1	2	3	4	5	6	7	8
X	0	9	34	40	60	66	91	100
Y	103	100	100	98	98	100	100	103



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	S180	S190								TOTAL
HEC1 Peak-Flow	1039	2590								3629
Weighting Factor	1.00	0.03								
Flow into Channel	1039	85								1124

Reach Sediment Inflow Characteristics

U/S Contributing ID	180R_S18010									TOTAL
HEC1 Flow Volume (ac. ft)	90.00									90
Sediment Conc. (ppm)	2399									
Sediment Volume (ac. ft)	0.08									0.08
Weighting Factor	1									
Weighted Sed. Vol. (ac. ft)	0.08									0.08

Hydrology

Drainage Area	1.573	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	1124	cfs	
Long-term Max. Chnl Capacity	1809	cfs	
Q2 Channel	112	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	100	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
112	29.6	37.5	1.3	98.0	99.5	3.0	1.5	29.2	1.3	0.57	0.47
281	86.2	99.6	1.2	98.0	100.6	2.8	2.6	85.4	1.2	0.96	0.46
843	93.3	198.6	2.1	98.0	101.7	4.2	3.7	92.1	2.2	1.38	0.51
1124	96.0	238.8	2.5	98.0	102.1	4.7	4.1	94.7	2.5	1.54	0.52

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
112	29.6	37.5	1.3	98.0	99.5	3.0	1.5	29.2	1.3	0.57	0.47
281	86.2	99.6	1.2	98.0	100.6	2.8	2.6	85.4	1.2	0.96	0.46
843	93.3	198.6	2.1	98.0	101.7	4.2	3.7	92.1	2.2	1.38	0.51
1124	96.0	238.8	2.5	98.0	102.1	4.7	4.1	94.7	2.5	1.54	0.52

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
	180R_S18010									
112	456									456
281	1088									1088
843	4597									4597
1124	6720									6720

Allowable Velocity

Channel Lining	Natural - Fine Gravel										
Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
112	1.74	1.4729	1.3993	Erosive	Erosive	Erosive	0.3	Stable	5.9	Stable	Stable
281	1.74	1.4427	1.3706	Erosive	Erosive	Erosive	0.3	Stable	7.5	Stable	Stable
843	1.74	1.6324	1.5508	Erosive	Erosive	Erosive	0.4	Stable	10.0	Stable	Stable
1124	1.74	1.6807	1.5966	Erosive	Erosive	Erosive	0.4	Stable	10.9	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	112	281	843	1124	112	281	843	1124	112	281	843	1124
Bray - Equation #1	29	46	83	96	1.3	1.7	2.5	2.8	3.1	3.5	4.1	4.2
Bray - Equation #2	38	61	109	127	1.4	1.9	2.7	3.0	2.1	2.4	2.8	2.9
Hey	8	14	26	31	3.9	5.5	8.3	9.3				
Ackers & Charlton/Lacey	26	38	61	69					1.8	2.1	2.5	2.6
Parker	73	115	199	230	1.0	1.4	2.3	2.6				
Chang	49	86	168	200	0.1	0.0	-0.3	-0.5				
Kellerhals	19	30	52	60	1.8	2.6	4.0	4.5	3.3	3.6	4.0	4.1
AMAFCA/Schumm	29	86	92	95								
Moody & Odem	15	15	15	15	1.0	1.0	1.0	1.0				
BUREC	15.1	21.3	32.1	35.8	4	6	9	10	2.9	3.7	4.8	5.2
Average	30	51	84	96	1.8	2.5	3.6	4.0	2.6	3.0	3.6	3.8
Values As Designed	29	85	92	95	1.5	2.6	3.7	4.1	3.0	2.8	4.2	4.7
Difference with Design	1	-34	-8	1	0.3	-0.1	0.0	-0.1	-0.4	0.2	-0.6	-0.9

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
112	649	358	734	5089	1094	247	105	151	3948	327	1705	1310
281	1506	836	1816	11400	3026	567	255	345	9846	769	4005	3125
843	7866	3105	5606	69949	4623	3303	891	1760	29857	3530	18189	13516
1124	12069	4309	7310	111863	5175	5310	1203	2608	39864	5244	26520	20134

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
112	2141	1182	2424	16796	3610	815	345	497	13032	1078	5628	4323
281	1988	1104	2398	15051	3995	748	336	456	12999	1015	5288	4125
843	3462	1367	2467	30784	2034	1454	392	774	13140	1553	8005	5948
1124	3984	1422	2413	36923	1708	1753	397	861	13158	1731	8754	6646

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
112	649	306	479	1252	608	140	105	151	937	141	762	503
281	1506	712	1198	2804	1665	326	255	345	2321	326	1769	1202
843	7866	2731	3974	17204	2692	1568	891	1760	7234	1632	8648	5109
1124	12069	3811	5130	27512	3044	2320	1203	2608	9693	1785	12840	7456

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
112	2141	1011	1582	4131	2008	463	345	497	3091	464	2514	1659
281	1988	940	1581	3702	2198	430	336	456	3064	431	2335	1587
843	3462	1202	1749	7571	1185	690	392	774	3184	718	3806	2248
1124	3984	1258	1693	9081	1005	766	397	861	3199	589	4238	2461

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
112	0.0006	0.0009	259	0.79	0.053	0.0002	32	0.036	0.0001	0.0159	0.0002	0.0005	0.0072	0.0004	0.0016	0.0059	0.0035
281	0.0007	0.0010	247	0.75	0.053	0.0002	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0072	0.0003	0.0008	0.0059	0.0035
843	0.0003	0.0006	336	1.02	0.056	0.0001	32	0.036	0.0001	0.0159	0.0001	0.0003	0.0072	0.0002	0.0004	0.0059	0.0034
1124	0.0003	0.0005	363	1.11	0.056	0.0001	33	0.036	0.0001	0.0159	0.0001	0.0002	0.0072	0.0002	0.0003	0.0059	0.0034

Drop Structures

Design Slope	0.0060	ft/ft
Total Drop Needed	26.2	ft
Height of Drop Structure	3	ft
No . of Drop Structures	9	
Distance between structs.	314	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.13	sq. mi
Total Sediment Yield Volume	0.25	ac ft

Sedimentation Basins

Length	314 ft	Depth	3 ft
Width	100 ft	Side slope	3 ft/ft
Total Volume per Basin		1.91	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

Discharge	COT/PC	Pima County General Scour Equations General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Bend Scour	LongTerm Scour	Thalweg channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
112	1.1	-0.5	0.1	24.6	1.5	1.3	3.0	0.0060	0.2	0.0	2.0	2.9
281	1.1	-0.8	0.1	24.6	2.6	1.2	2.8	0.0060	0.3	0.0	2.0	3.0
843	1.1	-0.9	0.2	24.6	3.7	2.2	4.2	0.0060	0.4	0.0	2.0	3.3
1124	1.1	-1.0	0.3	24.6	4.1	2.5	4.7	0.0060	0.5	0.0	2.0	3.4

Toe Protection Needed	4.0	ft

HEC1 Results For Open Channel

Peak Flow	860	cfs
Stage at Peak Flow	101.0	ft
Flow Volume	90.0	ac. ft

Freeboard

Max. Flow Depth	4.1	ft
Channel Depth as designed	5.0	ft
Available Freeboard	0.9	ft
Required Freeboard	1.1	ft

Sediment Volume

Inflowing Sediment Volume	0.33	ac. ft
Outflowing Sediment Volume	0.08	ac. ft
Deposited(+)/Eroded(-) Volume	0.25	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	2825	2825
Side Slope (?H:1V)	3	6
Channel Width (ft)	100	130
Channel XS Area (sq. ft)	325	400
Channel Perimeter (ft)	102	131

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	171222	220234
Excavated Area (sq. Yd)	31389	40806

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	2825	ft
Thickness	1.5	ft
Protection Depth	4	ft
Tie-in Length/Depth	3.0	ft
Total Depth	7.0	ft
Area needed	471	sq. Yd
Volume	1099	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	None	None
Left Levee Length (ft)	0	0
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	N/A	6
Left Levee Height (ft)	0	1
Left Levee Surface Area (sq. Yd)	0	0
Left Levee Volume (cu. Yd)	0	0
Right Levee Length (ft)	0	0
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	N/A	6
Right Levee Height (ft)	0	1
Right Levee Surface Area (sq. Yd)	0	0
Right Levee Volume (cu. Yd)	0	0
Total Levee Surface Area (sq. Yd)	0	0
Total Levee Volume (cu. Yd)	0	0

Levee Lining	Base	LC Enhanced
Lining Type	None	None
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	2825	2825
Left Levee Lining Width (ft)	0	0
Left Levee Lining Thickness (ft)	0	0
Left Levee Lining Area (sq. Yd)	0	0
Left Levee Lining Volume (cu. Yd)	0	0
Right Levee Length (ft)	2825	2825
Right Levee Lining Width (ft)	0	0
Right Levee Lining Thickness (ft)	0	0
Right Levee Lining Area (sq. Yd)	0	0
Right Levee Lining Volume (cu. Yd)	0	0
Total Lining Area (sq. Yd)	0	0
Total Lining Volume (cu. Yd)	0	0

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	100	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	9.7	ft
Structure Height	12.7	ft
Number of Structures	9	
Volume per structure	141	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 10,575	
Area per structure	33	sq. Yd
Total Area	300	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	3081	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 12,324	
Other Cost	$ -	
Total cost per basin	$ 12,324	
Area per basin	3,487	sq. Yd
Total Area	3,487	sq. Yd

Structure Cost

Structure Type	Structure Type	Excavation/Construction Quantity	Units	Unit Cost	Cost Subtotal	Landscape Quantity	Units	Unit Cost	Landscape Cost	Maintenance Quantity	Units	Unit Cost	Maintenance Cost
Levee	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining -LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Excavated Channel	Excavated	171,222	cu. Yd	$ 10.00	$ 1,712,220	31,389	sq. Yd	$ 9.00	$ 282,501	31,389	sq. Yd	$ 8.33	$ 261,575
Exc. Chl - LC Enhancement	Excavated	49,012	cu. Yd	$ 10.00	$ 490,120	9,417	sq. Yd	$ 9.00	$ 84,753	9,417	sq. Yd	$ 8.33	$ 78,475
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	1,099	cu. Yd	$ 75.00	$ 82,425	471	sq. Yd	$ -	$ -	471	sq. Yd	$ 25.00	$ 11,775
Drop Structures	Riprap	9	EA	$ 10,575.00	$ 95,175	300	sq. Yd	$ -	$ -	300	sq. Yd	$ 33.33	$ 10,000
Drop Str. - LC Enhancement	Riprap	9	EA	$ 1,057.50	$ 9,518	30	sq. Yd	$ -	$ -	30	sq. Yd	$ 33.33	$ 1,000
Sedimentation Basins		1	EA	$ 12,324.00	$ 12,324	3,487	sq. Yd	$ -	$ -	3,487	sq. Yd	$ 8.33	$ 29,058
Other					$ -				$ -				$ -

Base Landscape Cost	$ 282,501
LC Enhancement Cost	$ 84,753
Total Landscape Cost	$ 367,254

Base Maintenance Cost	$ 312,408
LC Enhancement Cost	$ 79,475
Total Maintenance Cost	$ 391,883

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,902,144	$ 499,638	$ 2,401,782
Contingency Cost (25% of Construction Cost)	$ 475,536	$ 124,909	$ 600,445
Engineering Design Cost (5% of Construction Cost)	$ 95,107	$ 24,982	$ 120,089
Total Construction Cost	$ 2,472,787	$ 649,529	$ 3,122,316

Land Cost

Channel Length	2825 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	134	8.7	$100,000	$ 870,000
LC Enhancement Buffer	50	3.2	$100,000	$ 320,000
Channel	100	6.5	$100,000	$ 650,000
Channel LC Enhancement	30	1.9	$100,000	$ 190,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	314	20.3		$ 2,030,000

Right of Way

Preservation Corridor Width	120	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	50	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	15.2	$100,000	$ 1,520,000
LC Enhancement Cost	acre	5.1	$100,000	$ 510,000
Total Land Cost	acre	20.3	$100,000	$ 2,030,000

Total Cost

Base Total Cost	$ 4,587,697
Total Landscape Enhancement Cost	$ 1,323,757
Total Cost Including LC Enh.	$ 5,911,453

Open Channel

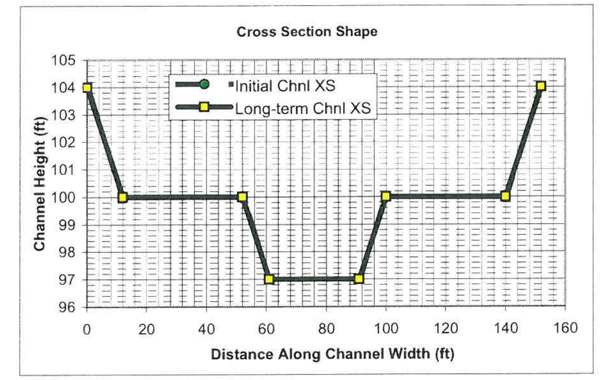
Structure ID	C180R10		HEC1 ID	RI180R

Longitundal Geometry

Length	3720.6	ft
U/S Elev	1413.1	ft
D/S Elev	1367.6	ft
Initial Channel Slope	0.0122	ft/ft
Long-term Channel Slope	0.0045	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	3



Initial Channel XS Geometry

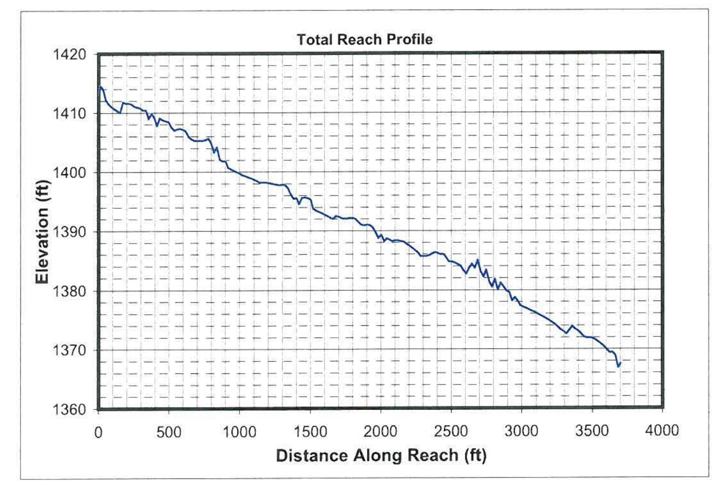
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	40	3	30	7	3	40	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	52	61	91	100	140	152
Y	104	100	100	97	97	100	100	104

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	40	3	30	7	3	40	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	52	61	91	100	140	152
Y	104	100	100	97	97	100	100	104



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	RI180R	S190	TOTAL
HEC1 Peak-Flow	1939	2590	4529
Weighting Factor	1.00	0.12	
Flow into Channel	1939	323	2262

Reach Sediment Inflow Characteristics

U/S Contributing ID	175R_RR17510	180R_RR18010	TOTAL
HEC1 Flow Volume (ac. ft)	202.00	90.00	292
Sediment Conc. (ppm)	2505	2461	
Sediment Volume (ac. ft)	0.19	0.08	0.27
Weighting Factor	1	1	
Weighted Sed. Vol. (ac. ft)	0.19	0.08	0.27

Hydrology

Drainage Area	4.63	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	2262	cfs	
Long-term Max. Chnl Capacity	4031	cfs	
Q2 Channel	226	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	152	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
226	42.6	71.9	1.7	97.0	99.0	3.1	2.0	42.0	1.7	0.56	0.42
566	132.8	196.3	1.5	97.0	100.6	2.9	3.6	131.7	1.5	1.01	0.42
1697	141.8	389.5	2.7	97.0	102.0	4.4	5.0	140.2	2.8	1.41	0.46
2262	145.3	467.4	3.2	97.0	102.6	4.8	5.6	143.5	3.3	1.57	0.47

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
226	42.6	71.9	1.7	97.0	99.0	3.1	2.0	42.0	1.7	0.56	0.42
566	132.8	196.3	1.5	97.0	100.6	2.9	3.6	131.7	1.5	1.01	0.42
1697	141.8	389.5	2.7	97.0	102.0	4.4	5.0	140.2	2.8	1.41	0.46
2262	145.3	467.4	3.2	97.0	102.6	4.8	5.6	143.5	3.3	1.57	0.47

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)								TOTAL
	175R_RR17510	180R_RR18010							
226	633	503							1135
566	1501	1202							2703
1697	6413	5109							11522
2262	9385	7456							16841

Allowable Velocity

Channel Lining	Natural - Fine Gravel										
Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
226	1.74	1.5613	1.4832	Erosive	Erosive	Erosive	0.4	Stable	6.1	Stable	Stable
566	1.74	1.5185	1.4426	Erosive	Erosive	Erosive	0.4	Stable	8.1	Stable	Stable
1697	1.74	1.7105	1.6250	Erosive	Erosive	Erosive	0.4	Stable	10.6	Stable	Stable
2262	1.74	1.7528	1.6652	Erosive	Erosive	Erosive	0.5	Stable	11.4	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	**226**	**566**	**1697**	**2262**	**226**	**566**	**1697**	**2262**	**226**	**566**	**1697**	**2262**
Bray - Equation #1	41	67	120	139	1.6	2.2	3.2	3.5	3.4	3.8	4.5	4.7
Bray - Equation #2	54	88	157	183	1.8	2.4	3.5	3.8	2.3	2.6	3.1	3.2
Hey	12	21	39	46	5.1	7.2	10.9	12.1				
Ackers & Charlton/Lacey	35	52	82	92					2.0	2.3	2.8	2.9
Parker	103	163	283	327	1.3	1.9	3.0	3.4				
Chang	68	120	234	278	0.2	0.0	-0.5	-0.6				
Kellerhals	27	43	74	86	2.4	3.4	5.3	6.0	3.5	3.8	4.3	4.4
AMAFCA/Schumm	42	132	140	144								
Moody & Odem	22	22	22	22	1.2	1.2	1.2	1.2				
BUREC	20.7	29.2	44.0	49.1	6	8	12	13	3.1	3.9	5.1	5.5
Average	43	74	120	137	2.4	3.3	4.8	5.3	2.9	3.3	4.0	4.1
Values As Designed	42	132	140	143	2.0	3.6	5.0	5.6	3.1	2.9	4.4	4.8
Difference with Design	1	-58	-21	-7	0.4	-0.4	-0.2	-0.3	-0.3	0.4	-0.4	-0.7

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
226	1055	569	1092	8874	1634	372	151	261	5689	548	3001	2113
566	2357	1304	2676	18954	4728	815	360	575	14173	1250	6829	4911
1697	12411	4876	8328	117352	7154	4918	1279	2919	42996	5821	31306	21760
2262	19096	6777	10851	188254	7983	7943	1731	4327	57410	8676	45773	32620

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
226	1730	933	1790	14555	2680	610	247	428	9331	898	4922	3466
566	1546	855	1756	12435	3102	535	236	377	9298	820	4480	3222
1697	2714	1066	1821	25663	1564	1076	280	638	9403	1273	6846	4759
2262	3132	1112	1780	30876	1309	1303	284	710	9416	1423	7507	5350

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
226	1055	483	691	1981	876	202	151	261	1221	217	1254	763
566	2357	1097	1720	4231	2492	451	360	575	3011	485	2805	1780
1697	12411	4251	5725	26195	4011	2207	1279	2919	9435	1609	13925	7633
2262	19096	5945	7439	42021	4526	3275	1731	4327	12648	1741	20765	11229

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
226	1730	791	1133	3249	1436	331	247	428	2003	356	2057	1251
566	1546	720	1129	2776	1635	296	236	377	1975	318	1840	1168
1697	2714	930	1252	5728	877	483	280	638	2063	352	3045	1669
2262	3132	975	1220	6892	742	537	284	710	2074	286	3406	1842

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
226	0.0005	0.0007	267	0.81	0.053	0.0002	32	0.036	0.0001	0.0159	0.0001	0.0004	0.0057	0.0003	0.0013	0.0044	0.0027
566	0.0006	0.0008	250	0.76	0.053	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0004	0.0057	0.0002	0.0007	0.0045	0.0027
1697	0.0003	0.0004	341	1.04	0.056	0.0001	32	0.036	0.0001	0.0159	0.0001	0.0002	0.0057	0.0001	0.0003	0.0044	0.0026
2262	0.0002	0.0004	369	1.13	0.057	0.0001	33	0.036	0.0001	0.0159	0.0001	0.0002	0.0057	0.0001	0.0002	0.0044	0.0026

Drop Structures

Design Slope	0.0045	ft/ft
Total Drop Needed	28.8	ft
Height of Drop Structure	3	ft
No . of Drop Structures	10	
Distance between structs.	372	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.19	sq. mi
Total Sediment Yield Volume	0.35	ac ft

Sedimentation Basins

Length	372 ft	Depth	3 ft
Width	152 ft	Side slope	3 ft/ft
Total Volume per Basin		3.58	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
226	1.1	-0.6	0.1	24.6	2.0	1.7	3.1	0.0045	0.2	0.0	3.0	4.3
566	1.1	-1.1	0.1	24.6	3.6	1.5	2.9	0.0045	0.4	0.0	3.0	4.5
1697	1.1	-1.3	0.3	24.6	5.0	2.8	4.4	0.0045	0.6	0.0	3.0	4.8
2262	1.1	-1.3	0.3	24.6	5.6	3.3	4.8	0.0045	0.7	0.0	3.0	5.0

Toe Protection Needed	5.0	ft

HEC1 Results For Open Channel

Peak Flow	1939	cfs
Stage at Peak Flow	101.2	ft
Flow Volume	285.0	ac. ft

Freeboard

Max. Flow Depth	5.6	ft
Channel Depth as designed	7.0	ft
Available Freeboard	1.4	ft
Required Freeboard	1.5	ft

Sediment Volume

Inflowing Sediment Volume	0.63	ac. ft
Outflowing Sediment Volume	0.20	ac. ft
Deposited(+)/Eroded(-) Volume	0.43	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	3721	3721
Side Slope (?H:1V)	3	6
Channel Width (ft)	152	194
Channel XS Area (sq. ft)	677	824
Channel Perimeter (ft)	154	195

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	394530	498023
Excavated Area (sq. Yd)	62844	80208

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	3721	ft
Thickness	1.5	ft
Protection Depth	5	ft
Tie-in Length/Depth	3.0	ft
Total Depth	8.0	ft
Area needed	620	sq. Yd
Volume	1654	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	None	None
Left Levee Length (ft)	0	0
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	N/A	6
Left Levee Height (ft)	0	1
Left Levee Surface Area (sq. Yd)	0	0
Left Levee Volume (cu. Yd)	0	0
Right Levee Length (ft)	0	0
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	N/A	6
Right Levee Height (ft)	0	1
Right Levee Surface Area (sq. Yd)	0	0
Right Levee Volume (cu. Yd)	0	0
Total Levee Surface Area (sq. Yd)	0	0
Total Levee Volume (cu. Yd)	0	0

Levee Lining	Base	LC Enhanced
Lining Type	None	None
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	3721	3721
Left Levee Lining Width (ft)	0	0
Left Levee Lining Thickness (ft)	0	0
Left Levee Lining Area (sq. Yd)	0	0
Left Levee Lining Volume (cu. Yd)	0	0
Right Levee Length (ft)	3721	3721
Right Levee Lining Width (ft)	0	0
Right Levee Lining Thickness (ft)	0	0
Right Levee Lining Area (sq. Yd)	0	0
Right Levee Lining Volume (cu. Yd)	0	0
Total Lining Area (sq. Yd)	0	0
Total Lining Volume (cu. Yd)	0	0

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	152	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	11.4	ft
Structure Height	14.4	ft
Number of Structures	10	
Volume per structure	243	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 18,225	
Area per structure	51	sq. Yd
Total Area	507	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	5776	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 23,104	
Other Cost	$ -	
Total cost per basin	$ 23,104	
Area per basin	6,284	sq. Yd
Total Area	6,284	sq. Yd

Structure Cost

Structure Type	Structure Type	Excavation/Construction Quantity	Units	Unit Cost	Cost Subtotal	Landscape Quantity	Units	Unit Cost	Landscape Cost	Maintenance Quantity	Units	Unit Cost	Maintenance Cost
Levee	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining -LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Excavated Channel	Excavated	394,530	cu. Yd	$ 10.00	$ 3,945,300	62,844	sq. Yd	$ 9.00	$ 565,596	62,844	sq. Yd	$ 8.33	$ 523,700
Exc. Chl - LC Enhancement	Excavated	103,493	cu. Yd	$ 10.00	$ 1,034,930	17,364	sq. Yd	$ 9.00	$ 156,276	17,364	sq. Yd	$ 8.33	$ 144,700
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	1,654	cu. Yd	$ 75.00	$ 124,050	620	sq. Yd	$ -	$ -	620	sq. Yd	$ 25.00	$ 15,500
Drop Structures	Riprap	10	EA	$ 18,225.00	$ 182,250	507	sq. Yd	$ -	$ -	507	sq. Yd	$ 33.33	$ 16,900
Drop Str. - LC Enhancement	Riprap	10	EA	$ 1,822.50	$ 18,225	51	sq. Yd	$ -	$ -	51	sq. Yd	$ 33.33	$ 1,690
Sedimentation Basins		1	EA	$ 23,104.00	$ 23,104	6,284	sq. Yd	$ -	$ -	6,284	sq. Yd	$ 8.33	$ 52,367
Other					$				$				$ -

Base Landscape Cost	$ 565,596	
LC Enhancement Cost	$ 156,276	
Total Landscape Cost	$ 721,872	

Base Maintenance Cost	$ 608,467
LC Enhancement Cost	$ 146,390
Total Maintenance Cost	$ 754,857

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 4,274,704	$ 1,053,155	$ 5,327,859
Contingency Cost (25% of Construction Cost)	$ 1,068,676	$ 263,289	$ 1,331,965
Engineering Design Cost (5% of Construction Cost)	$ 213,735	$ 52,658	$ 266,393
Total Construction Cost	$ 5,557,115	$ 1,369,102	$ 6,926,217

Land Cost

Channel Length	3721 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	134	11.4	$100,000	$ 1,140,000
LC Enhancement Buffer	50	4.3	$100,000	$ 430,000
Channel	152	13	$100,000	$ 1,300,000
Channel LC Enhancement	42	3.6	$100,000	$ 360,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	378	32.3		$ 3,230,000

Right of Way

Preservation Corridor Width	120	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	50	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	24.4	$100,000	$ 2,440,000
LC Enhancement Cost	acre	7.9	$100,000	$ 790,000
Total Land Cost	acre	32.3	$100,000	$ 3,230,000

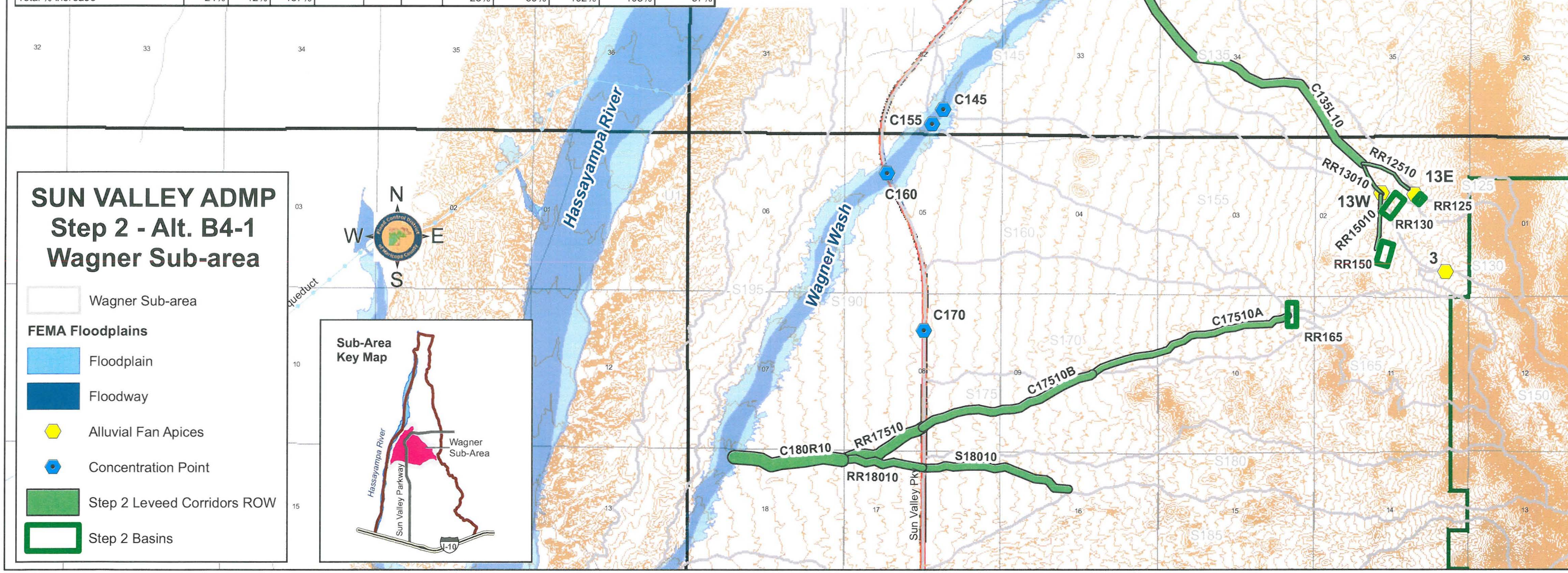
Total Cost

Base Total Cost	$ 9,171,178
Total Landscape Enhancement Cost	$ 2,461,768
Total Cost Including LC Enh.	$ 11,632,945

Structure ID	Type	Flow Rate (cfs)	ROW Area (acres)	Exc. Vol. (ac. ft)	Fill Vol. (ac. ft)	Base Design Geometry: Length (stor-ft; chl-mi)	Base Design Geometry: ROW Width (ft)	Base Design Geometry: Depth (ft)	Base Costs (in $1000): Land Cost	Base Costs (in $1000): Constr. Cost	Base Costs (in $1000): Lndscp Cost	Base Costs (in $1000): 50 Yr Maint. Cost	Base Costs (in $1000): Total Cost	Base Cost Percentages: Land Cost %	Base Cost Percentages: Constr. Cost %	Base Cost Percentages: Lndscp Cost %	Base Cost Percentages: 50 Yr Maint. Cost %	Base Cost Percentages: % of Total Cost
RR125	Online Basin	33	1	10	0	300	200	6	$ 140	$ 163	$ 60	$ 71	$ 434	32%	38%	14%	16%	1%
RR12510	Leveed Chl.	73	4	0	9	0.4	101	4	$ 430	$ 572	$ 145	$ 328	$ 1,475	29%	39%	10%	22%	2%
RR150	Online Basin	99	7	94	0	760	400	10	$ 700	$ 922	$ 304	$ 308	$ 2,234	31%	41%	14%	14%	3%
RR15010	Leveed Chl.	208	3	0	6	0.2	116	4	$ 330	$ 401	$ 96	$ 225	$ 1,052	31%	38%	9%	21%	2%
RR130	Online Basin	42	7	95	0	800	400	9	$ 730	$ 916	$ 320	$ 322	$ 2,288	32%	40%	14%	14%	3%
RR13010	Leveed Chl.	82	3	0	6	0.2	101	4	$ 290	$ 382	$ 96	$ 222	$ 990	29%	39%	10%	22%	2%
C135L10	Leveed Chl.	1003	78	0	69	2.3	282	5	$ 7,830	$ 5,025	$ 1,016	$ 2,429	$ 16,300	48%	31%	6%	15%	25%
RR165	Online Basin	100	6	62	0	800	300	10	$ 550	$ 675	$ 240	$ 244	$ 1,709	32%	40%	14%	14%	3%
C17510A	Leveed Chl.	840	36	0	40	1.3	222	5	$ 3,600	$ 2,859	$ 594	$ 1,419	$ 8,473	42%	34%	7%	17%	13%
C17510B	Leveed Chl.	1274	40	0	35	1.2	282	5	$ 3,990	$ 2,672	$ 518	$ 1,384	$ 8,565	47%	31%	6%	16%	13%
RR17510	Leveed Chl.	1393	25	0	17	0.6	362	5	$ 2,520	$ 1,412	$ 255	$ 668	$ 4,855	52%	29%	5%	14%	7%
RR18010	Leveed Chl.	1124	17	0	16	0.5	262	5	$ 1,700	$ 1,167	$ 237	$ 595	$ 3,699	46%	32%	6%	16%	6%
C180R10	Leveed Chl.	2385	38	0	21	0.7	442	5	$ 3,780	$ 1,738	$ 313	$ 864	$ 6,695	56%	26%	5%	13%	10%
S18010	Leveed Chl.	1039	31	0	29	1	262	5	$ 3,100	$ 2,107	$ 434	$ 1,107	$ 6,747	46%	31%	6%	16%	10%
		TOTAL	296	261	248				$29,690	$ 21,011	$ 4,629	$ 10,187	**$ 65,517**	45%	32%	7%	16%	100%
All Channels			275	0	248	8.4			$27,570	$ 18,334	$ 3,705	$ 9,242	$ 58,851	47%	31%	6%	16%	90%
All Online Basins			21	261	0				$ 2,120	$ 2,677	$ 924	$ 945	$ 6,666	32%	40%	14%	14%	10%
All Offline Basins			0	0	0				$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
Channel Cost per mile (in $1000)			$7,006		Basins Cost per ac. ft. (in $1000)				$3.54									

Cost Increase for Landscape Compatibility Enhancement over Base Costs

	ROW Area	Exc. Vol.	Fill Vol.	Length	ROW Width	Depth	Land Cost	Constr. Cost	Lndscp Cost	50 Yr Maint. Cost	Total Cost
All Channels % increase	19%	0%	137%				19%	78%	107%	111%	57%
All Online Basins % increase	90%	12%	0%				84%	10%	84%	77%	53%
All Offline Basins % increase	0%	0%	0%				0%	0%	0%	0%	0%
Total % increase	24%	12%	137%				23%	69%	102%	108%	57%



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Costs Summary

Structure ID	Type	Flow Rate (cfs)	ROW Area (acres)	Exc. Vol. (ac. ft)	Fill Vol. (ac. ft)	Base Design Geometry Length (stor-ft; chl-mi)	ROW Width (ft)	Depth (ft)	Base Costs (in $1000) Land Cost	Constr. Cost	Lndscp Cost	50 Yr Maint. Cost	Total Cost	Base Cost Percentages Land Cost %	Constr. Cost %	Lndscp Cost %	50 Yr Maint. Cost %	% of Total Cost
RR125	Online Basin	33	1	10	0	300	200	6	$ 140	$ 163	$ 60	$ 71	$ 434	32%	38%	14%	16%	1%
RR12510	Leveed Chl.	73	4	0	9	0.4	101	4	$ 430	$ 572	$ 145	$ 328	$ 1,475	29%	39%	10%	22%	2%
RR150	Online Basin	99	7	94	0	760	400	10	$ 700	$ 922	$ 304	$ 308	$ 2,234	31%	41%	14%	14%	3%
RR15010	Leveed Chl.	208	3	0	6	0.2	116	4	$ 330	$ 401	$ 96	$ 225	$ 1,052	31%	38%	9%	21%	2%
RR130	Online Basin	42	7	95	0	800	400	9	$ 730	$ 916	$ 320	$ 322	$ 2,288	32%	40%	14%	14%	3%
RR13010	Leveed Chl.	82	3	0	6	0.2	101	4	$ 290	$ 382	$ 96	$ 222	$ 990	29%	39%	10%	22%	2%
C135L10	Leveed Chl.	1003	78	0	69	2.3	282	5	$ 7,830	$ 5,025	$ 1,016	$ 2,429	$ 16,300	48%	31%	6%	15%	25%
RR165	Online Basin	100	6	62	0	800	300	10	$ 550	$ 675	$ 240	$ 244	$ 1,709	32%	40%	14%	14%	3%
C17510A	Leveed Chl.	840	36	0	40	1.3	222	5	$ 3,600	$ 2,859	$ 594	$ 1,419	$ 8,473	42%	34%	7%	17%	13%
C17510B	Leveed Chl.	1274	40	0	35	1.2	282	5	$ 3,990	$ 2,672	$ 518	$ 1,384	$ 8,565	47%	31%	6%	16%	13%
RR17510	Leveed Chl.	1393	25	0	17	0.6	362	5	$ 2,520	$ 1,412	$ 255	$ 668	$ 4,855	52%	29%	5%	14%	7%
RR18010	Leveed Chl.	1124	17	0	16	0.5	262	5	$ 1,700	$ 1,167	$ 237	$ 595	$ 3,699	46%	32%	6%	16%	6%
C180R10	Leveed Chl.	2385	38	0	21	0.7	442	5	$ 3,780	$ 1,738	$ 313	$ 864	$ 6,695	56%	26%	5%	13%	10%
S18010	Leveed Chl.	1039	31	0	29	1	262	5	$ 3,100	$ 2,107	$ 434	$ 1,107	$ 6,747	46%	31%	6%	16%	10%
		TOTAL	296	261	248				$ 29,690	$ 21,011	$ 4,629	$ 10,187	**$ 65,517**	45%	32%	7%	16%	100%
All Channels			275	0	248	8.4			$ 27,570	$ 18,334	$ 3,705	$ 9,242	$ 58,851	47%	31%	6%	16%	90%
All Online Basins			21	261	0				$ 2,120	$ 2,677	$ 924	$ 945	$ 6,666	32%	40%	14%	14%	10%
All Offline Basins			0	0	0				$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
Channel Cost per mile (in $1000)			$7,006		Basins Cost per ac. ft. (in $1000)				$3.54									

Cost Summary - Landscape Compatibility Enhanced (LCE)

Structure ID	Type	Flow Rate (cfs)	ROW Area (acres)	Exc. Vol. (ac. ft)	Fill Vol. (ac. ft)	LCE Design Geometry Length (stor-ft; chl-mi)	ROW Width (ft)	Depth (ft)	LCE Costs (in $1000) Land Cost	Constr. Cost	Lndscp Cost	50 Yr Maint. Cost	Total Cost	LCE Cost Percentages Land Cost %	Constr. Cost %	Lndscp Cost %	50 Yr Maint. Cost %	% of Total Cost
RR125	Online Basin	33	4	11	0	500	300	6	$ 350	$ 175	$ 150	$ 157	$ 832	42%	21%	18%	19%	1%
RR12510	Leveed Chl.	73	6	0	21	0.4	149	4	$ 630	$ 1,100	$ 300	$ 708	$ 2,738	23%	40%	11%	26%	3%
RR150	Online Basin	99	12	106	0	1070	500	10	$ 1,230	$ 1,019	$ 535	$ 527	$ 3,311	37%	31%	16%	16%	3%
RR15010	Leveed Chl.	208	5	0	14	0.2	164	4	$ 470	$ 754	$ 200	$ 478	$ 1,902	25%	40%	11%	25%	2%
RR130	Online Basin	42	13	107	0	1110	500	9	$ 1,270	$ 1,016	$ 555	$ 545	$ 3,386	38%	30%	16%	16%	3%
RR13010	Leveed Chl.	82	4	0	14	0.2	149	4	$ 430	$ 733	$ 200	$ 475	$ 1,838	23%	40%	11%	26%	2%
C135L10	Leveed Chl.	1003	93	0	162	2.3	333	5	$ 9,250	$ 8,978	$ 2,105	$ 5,260	$ 25,593	36%	35%	8%	21%	25%
RR165	Online Basin	100	11	69	0	1140	400	10	$ 1,050	$ 729	$ 456	$ 448	$ 2,683	39%	27%	17%	17%	3%
C17510A	Leveed Chl.	840	44	0	95	1.3	273	5	$ 4,430	$ 5,163	$ 1,231	$ 3,074	$ 13,898	32%	37%	9%	22%	14%
C17510B	Leveed Chl.	1274	47	0	83	1.2	333	5	$ 4,710	$ 4,683	$ 1,073	$ 2,827	$ 13,294	35%	35%	8%	21%	13%
RR17510	Leveed Chl.	1393	29	0	41	0.6	413	5	$ 2,880	$ 2,412	$ 528	$ 1,380	$ 7,200	40%	34%	7%	19%	7%
RR18010	Leveed Chl.	1124	20	0	38	0.5	313	5	$ 2,030	$ 2,088	$ 492	$ 1,256	$ 5,865	35%	36%	8%	21%	6%
C180R10	Leveed Chl.	2385	42	0	50	0.7	493	5	$ 4,220	$ 2,962	$ 647	$ 1,736	$ 9,565	44%	31%	7%	18%	9%
S18010	Leveed Chl.	1039	37	0	69	1	313	5	$ 3,700	$ 3,786	$ 899	$ 2,314	$ 10,699	35%	35%	8%	22%	10%
		TOTAL	367	293	587				$ 36,650	$ 35,597	$ 9,372	$ 21,186	**$ 102,804**	36%	35%	9%	21%	100%
All Channels			327	0	587	8.4			$ 32,750	$ 32,658	$ 7,676	$ 19,509	$ 92,593	35%	35%	8%	21%	90%
All Online Basins			40	293	0				$ 3,900	$ 2,939	$ 1,696	$ 1,676	$ 10,211	38%	29%	17%	16%	10%
All Offline Basins			0	0	0				$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
Channel Cost per mile (in $1000)			$11,023		Basins Cost per ac. ft. (in $1000)				$5.79									
All Channels % increase			19%	0%	137%				19%	78%	107%	111%	57%					
All Online Basins % increase			90%	12%	0%				84%	10%	84%	77%	53%					
All Offline Basins % increase			0%	0%	0%				0%	0%	0%	0%	0%					
Total % increase			24%	12%	137%				23%	69%	102%	108%	57%					

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

Sub-area: Wagner Wash, Alternative: B41
Cost Summary

KK CARD	Type	Peak Flow	Peak Stage (ft)	Peak Storage	Time	Cum.Area (sq. miles)	MAX. Average Flow (cfs)				MAX. Average Rainfall Depth (Inches)				Total Runoff Volume (ac. ft)			
							6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR
S100	BASIN	4347			4.6	6.99	899	225	75	32	1.195	1.195	1.195	1.195	446	446	446	446
S102	BASIN	2790			4.3	3.23	417	104	35	15	1.198	1.198	1.198	1.198	207	207	207	207
C102	COMBINE	5993			4.5	10.23	1198	300	100	43	1.089	1.089	1.089	1.089	594	594	594	594
RR102	STORAGE	127	1552	1143.35	6.7	10.23	122	104	72	41	0.11	0.376	0.784	1.029	60	205	428	561
D102	DIVERT	63			6.7	10.23	61	52	36	20	0.055	0.188	0.392	0.515	30	103	214	281
100105	ROUTE	59	100.2	20.4	12.5	10.23	58	51	36	20	0.053	0.185	0.389	0.512	29	101	212	279
S105	BASIN	2863			4.5	4.37	495	124	41	18	1.053	1.053	1.053	1.053	245	245	245	245
CF02	RETRIEVE	63			6.7	10.23	61	52	36	20	0.055	0.188	0.392	0.515	30	103	214	281
102105	ROUTE	63	100.4	8.6	8	10.23	60	51	36	20	0.055	0.187	0.39	0.513	30	102	213	280
C105U	COMBINE	2863			4.5	14.6	549	226	120	64	0.35	0.577	0.921	1.128	272	449	717	878
S110	BASIN	662			4.2	0.43	76	19	6	3	1.639	1.64	1.64	1.64	38	38	38	38
11015I	ROUTE	570	101.8	9.19	4.4	0.43	76	19	6	3	1.637	1.64	1.64	1.64	38	38	38	38
15I15R	ROUTE	506	102.1	19.34	4.8	0.43	76	19	6	3	1.635	1.64	1.64	1.64	38	38	38	38
S115	BASIN	1605			4.5	2.25	296	74	25	11	1.223	1.224	1.224	1.224	147	147	147	147
C115	COMBINE	1813			4.6	2.68	350	88	29	13	1.215	1.219	1.219	1.219	173	174	174	174
115120	ROUTE	1781	102.7	21.9	4.7	2.68	350	88	29	13	1.215	1.219	1.219	1.219	173	174	174	174
S120	BASIN	1838			4.3	2	256	64	21	9	1.189	1.189	1.189	1.189	127	127	127	127
C120	COMBINE	2678			4.5	4.68	545	137	46	20	1.083	1.087	1.087	1.087	270	271	271	271
C105D	COMBINE	4029			4.5	19.28	821	275	127	64	0.396	0.53	0.737	0.863	407	545	758	888
120135	ROUTE	4027	104.4	16.85	4.5	19.28	821	275	127	64	0.396	0.53	0.737	0.863	407	545	758	888
S125	BASIN	202			4	0.09	14	4	1	1	1.424	1.425	1.425	1.425	7	7	7	7
RR125	STORAGE	33	4.8	4.92	4.4	0.09	14	4	1	1	1.409	1.425	1.425	1.425	7	7	7	7
12535I	ROUTE	33	100.4	0.47	4.6	0.09	14	4	1	1	1.408	1.425	1.425	1.425	7	7	7	7
S150	BASIN	836			4.3	0.77	126	31	10	5	1.51	1.513	1.513	1.513	62	62	62	62
RR150	STORAGE	99	8.5	47.3	5.5	0.77	85	31	10	5	1.019	1.513	1.513	1.513	42	62	62	62
150130	ROUTE	99	100.6	0.74	5.5	0.77	85	31	10	5	1.018	1.513	1.513	1.513	42	62	62	62
S130	BASIN	524			4.1	0.31	48	12	4	2	1.425	1.426	1.426	1.426	24	24	24	24
C130	COMBINE	453			4.1	1.08	120	41	14	6	1.025	1.402	1.402	1.402	59	81	81	81
RR130	STORAGE	42	7.7	45.43	12.4	1.08	42	35	14	6	0.357	1.195	1.402	1.402	21	69	81	81
13035I	ROUTE	42	100.5	0.36	12.5	1.08	42	35	14	6	0.357	1.194	1.402	1.402	21	69	81	81
C135I	COMBINE	59			4.9	1.18	47	37	15	6	0.372	1.181	1.372	1.372	23	74	86	86
35I135	ROUTE	53	100.2	9.04	7.6	1.18	45	37	15	6	0.358	1.167	1.372	1.372	23	73	86	86
S135	BASIN	1102			4.2	0.88	111	28	9	4	1.175	1.175	1.175	1.175	55	55	55	55
C135L	COMBINE	829			4.2	2.06	124	57	21	9	0.561	1.034	1.158	1.158	62	114	127	127
C135	COMBINE	4170			4.5	21.34	873	305	137	69	0.38	0.531	0.718	0.829	433	605	817	944
135145	ROUTE	3745	103.8	146.84	5	21.34	861	302	137	69	0.375	0.527	0.716	0.829	427	600	815	943
S140	BASIN	1913			4.1	1.37	188	47	16	7	1.27	1.27	1.27	1.27	93	93	93	93
140145	ROUTE	1624	101.9	39.38	4.4	1.37	187	47	16	7	1.27	1.27	1.27	1.27	93	93	93	93
S145	BASIN	1702			4.2	1.76	193	48	16	7	1.021	1.021	1.021	1.021	96	96	96	96
C145	COMBINE	4072			4.9	24.47	1026	341	149	73	0.39	0.518	0.679	0.775	509	677	886	1011
145155	ROUTE	4071	105.7	11.21	4.9	24.47	1026	341	149	73	0.39	0.518	0.679	0.775	509	676	886	1011
S155	BASIN	1626			4.3	1.83	223	56	19	8	1.131	1.132	1.132	1.132	111	111	111	111
C155	COMBINE	4304			4.8	26.3	1124	364	156	76	0.397	0.515	0.662	0.75	558	722	929	1052
155160	ROUTE	4294	104.5	32.54	4.9	26.3	1123	364	156	76	0.397	0.514	0.662	0.75	557	722	928	1051
S160	BASIN	1347			4.2	1.14	133	33	11	5	1.079	1.079	1.079	1.079	66	66	66	66
C160	COMBINE	4291			4.9	27.44	1163	373	159	78	0.394	0.506	0.646	0.73	577	740	946	1068

Hydrology - 6-hr Storm HEC1 Model Results

KK CARD	Type	Peak Flow	Peak Stage (ft)	Peak Storage	Time	Cum.Area (sq. miles)	MAX. Average Flow (cfs)				MAX. Average Rainfall Depth (Inches)				Total Runoff Volume (ac. ft)			
							6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR
S170	BASIN	1686			4.2	1.46	178	44	15	6	1.127	1.127	1.127	1.127	88	88	88	88
170R	ROUTE	1489	1E+08	1E+08	4.4	1.46	178	44	15	6	1.127	1.127	1.127	1.127	88	88	88	88
C170R	COMBINE	4313			5	28.9	1221	387	163	79	0.393	0.498	0.63	0.709	605	767	972	1093
170180	ROUTE	4223	102.8	113.73	5.3	28.9	1213	385	163	79	0.39	0.496	0.63	0.709	601	765	971	1092
S165	BASIN	1008			4.1	0.62	94	23	8	3	1.416	1.417	1.417	1.417	47	47	47	47
RR165	STORAGE	100	8.7	37.57	4.8	0.62	77	23	8	3	1.162	1.417	1.417	1.417	38	47	47	47
165175	ROUTE	90	100.3	15.66	6.9	0.62	72	23	8	3	1.088	1.417	1.417	1.417	36	47	47	47
S175	BASIN	1203			4.5	1.8	226	56	19	8	1.165	1.166	1.166	1.166	112	112	112	112
C175	COMBINE	1104			4.5	2.42	260	73	24	11	0.999	1.122	1.122	1.122	129	145	145	145
175R	ROUTE	1065	100.9	18.37	4.6	2.42	257	73	24	11	0.988	1.122	1.122	1.122	127	145	145	145
S180	BASIN	1032			4.5	1.44	181	45	15	7	1.167	1.169	1.169	1.169	90	90	90	90
180R	ROUTE	1001	101.2	14.2	4.5	1.44	181	45	15	7	1.166	1.169	1.169	1.169	90	90	90	90
C180RI	COMBINE	1725			4.6	3.86	389	106	35	15	0.937	1.017	1.017	1.017	193	209	209	209
RI180R	ROUTE	1665	101.1	35.52	4.8	3.86	385	106	35	15	0.927	1.017	1.017	1.017	191	209	209	209
C180R	COMBINE	4733			5.2	32.76	1389	431	177	85	0.394	0.489	0.604	0.671	689	855	1055	1173
180185	ROUTE	4723	103	52.67	5.3	32.76	1383	430	177	85	0.392	0.488	0.603	0.671	686	853	1054	1173
S185	BASIN	1450			4.5	2.42	288	72	24	10	1.106	1.107	1.107	1.107	143	143	143	143
185R	ROUTE	1302	102.5	41.84	4.9	2.42	288	72	24	10	1.105	1.107	1.107	1.107	143	143	143	143
C185R	COMBINE	5111			5.2	35.19	1492	456	185	89	0.394	0.482	0.588	0.65	740	905	1103	1220
185190	ROUTE	5091	102.6	43.09	5.3	35.19	1487	456	185	89	0.393	0.482	0.588	0.65	737	904	1103	1220
S190	BASIN	2084			4.5	4.05	391	98	33	14	0.896	0.896	0.896	0.896	194	194	194	194
C190	COMBINE	5311			5.2	39.24	1605	485	194	92	0.38	0.46	0.553	0.608	796	962	1157	1272
190195	ROUTE	5167	103.1	79.27	5.4	39.24	1598	484	194	92	0.379	0.459	0.553	0.608	792	960	1156	1272
S195	BASIN	1001			4.6	1.81	203	51	17	7	1.046	1.046	1.046	1.046	101	101	101	101
C195	COMBINE	5240			5.4	41.05	1649	496	198	94	0.373	0.45	0.538	0.591	818	985	1179	1293

Hydrology - 24-hr Storm HEC1 Model Results

		Peak	Peak	Peak		Cum.Area	MAX. Average Flow (cfs)				MAX. Average Rainfall Depth (Inches)				Total Runoff Volume (ac. ft)			
KK CARD	Type	Flow	Stage (ft)	Storage	Time	(sq. miles)	6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR
S100	BASIN	5214			12.5	6.99	965	241	80	35	1.282	1.282	1.282	1.282	478	478	478	478
S102	BASIN	3434			12.3	3.23	420	105	35	15	1.207	1.207	1.207	1.207	208	208	208	208
C102	COMBINE	7803			12.4	10.23	1367	342	114	49	1.243	1.243	1.243	1.243	678	678	678	678
RR102	STORAGE	149	1552.1	1201.44	14.4	10.23	141	119	82	46	0.128	0.431	0.895	1.163	70	235	488	634
D102	DIVERT	75			14.4	10.23	71	59	41	23	0.064	0.215	0.448	0.581	35	118	244	317
100105	ROUTE	70	100.2	24.2	20.3	10.23	67	58	41	23	0.061	0.211	0.444	0.578	33	115	242	315
S105	BASIN	3466			12.5	4.37	531	133	44	19	1.129	1.129	1.129	1.129	263	263	263	263
CF02	RETRIEVE	75			14.4	10.23	71	59	41	23	0.064	0.215	0.448	0.581	35	118	244	317
102105	ROUTE	74	100.4	9.55	15.6	10.23	70	59	41	23	0.064	0.214	0.445	0.58	35	117	243	316
C105U	COMBINE	3466			12.5	14.6	587	238	125	66	0.374	0.606	0.958	1.164	291	472	746	906
S110	BASIN	532			12.1	0.43	62	16	5	2	1.35	1.422	1.422	1.422	31	33	33	33
11015I	ROUTE	456	101.7	7.4	12.4	0.43	62	16	5	2	1.35	1.421	1.422	1.422	31	33	33	33
15I15R	ROUTE	412	101.9	16.62	12.7	0.43	62	16	5	2	1.349	1.421	1.422	1.422	31	33	33	33
S115	BASIN	1693			12.5	2.25	287	73	24	11	1.186	1.209	1.209	1.209	142	145	145	145
C115	COMBINE	1937			12.6	2.68	346	89	30	13	1.201	1.232	1.233	1.233	171	176	176	176
115120	ROUTE	1900	102.8	22.91	12.7	2.68	346	89	30	13	1.201	1.232	1.233	1.233	171	176	176	176
S120	BASIN	2032			12.3	2	247	62	21	9	1.146	1.158	1.158	1.158	122	124	124	124
C120	COMBINE	3202			12.4	4.68	585	149	50	22	1.162	1.185	1.186	1.186	290	296	296	296
C105D	COMBINE	6217			12.4	19.28	1091	359	163	82	0.526	0.692	0.943	1.092	541	712	969	1123
120135	ROUTE	6220	105.1	23.77	12.5	19.28	1091	359	163	82	0.526	0.692	0.943	1.092	541	711	969	1123
S125	BASIN	161			12	0.09	12	3	1	0	1.197	1.258	1.258	1.258	6	6	6	6
RR125	STORAGE	30	4	4.1	12.4	0.09	12	3	1	0	1.192	1.257	1.258	1.258	6	6	6	6
12535I	ROUTE	30	100.4	0.44	12.5	0.09	12	3	1	0	1.191	1.257	1.258	1.258	6	6	6	6
S150	BASIN	729			12.3	0.77	107	29	10	4	1.291	1.374	1.375	1.375	53	57	57	57
RR150		91			13.4	0.77	77	28	10	4	0.926	1.366	1.375	1.375	38	56	57	57
150130	ROUTE	91	100.6	0.7	13.5	0.77	77	28	10	4	0.925	1.366	1.375	1.375	38	56	57	57
S130	BASIN	415			12.1	0.31	39	10	3	1	1.169	1.217	1.217	1.217	19	20	20	20
C130	COMBINE	441			12.1	1.08	111	38	13	6	0.948	1.309	1.317	1.317	55	76	76	76
RR130	STORAGE	40	7	41.1	20.1	1.08	40	33	13	6	0.343	1.133	1.317	1.317	20	66	76	76
13035I	ROUTE	40	100.5	0.35	20.2	1.08	40	33	13	6	0.343	1.133	1.317	1.317	20	65	76	76
C135I	COMBINE	57			12.9	1.18	45	36	14	6	0.358	1.128	1.303	1.303	23	71	82	82
35I135	ROUTE	51	100.2	8.7	15.6	1.18	44	35	14	6	0.344	1.115	1.303	1.303	22	70	82	82
S135	BASIN	1015			12.2	0.88	99	25	8	4	1.048	1.048	1.048	1.048	49	49	49	49
C135L	COMBINE	1003			12.2	2.06	128	58	22	9	0.576	1.049	1.179	1.179	63	115	130	130
C135	COMBINE	6650			12.4	21.34	1198	409	181	89	0.522	0.713	0.948	1.082	594	812	1078	1232
135145	ROUTE	5882	104.6	212.05	12.8	21.34	1185	406	181	89	0.516	0.708	0.946	1.081	587	806	1076	1231
S140	BASIN	2029			12.1	1.37	172	43	14	6	1.164	1.164	1.164	1.164	85	85	85	85
140145	ROUTE	1633	101.9	39.54	12.4	1.37	172	43	14	6	1.163	1.164	1.164	1.164	85	85	85	85
S145	BASIN	1945			12.2	1.76	193	48	16	7	1.022	1.022	1.022	1.022	96	96	96	96
C145	COMBINE	6533			12.7	24.47	1487	481	206	100	0.565	0.731	0.938	1.056	737	954	1224	1378
145155	ROUTE	6538	106.9	17.8	12.8	24.47	1487	481	206	100	0.565	0.731	0.938	1.056	737	954	1224	1377
S155	BASIN	1781			12.3	1.83	218	55	18	8	1.105	1.117	1.117	1.117	108	109	109	109
C155	COMBINE	7022			12.7	26.3	1669	526	221	107	0.59	0.744	0.936	1.046	828	1044	1313	1467
155160	ROUTE	6998	105.5	51.29	12.8	26.3	1667	526	221	107	0.589	0.744	0.936	1.045	827	1043	1312	1466
S160	BASIN	1342			12.1	1.14	124	31	10	4	1.01	1.01	1.01	1.01	62	62	62	62
C160	COMBINE	7079			12.8	27.44	1766	550	229	110	0.598	0.746	0.93	1.035	876	1091	1361	1514
160170	ROUTE	6941	103.4	130.79	13	27.44	1756	548	228	110	0.595	0.743	0.929	1.034	871	1088	1360	1514

Hydrology - 24-hr Storm HEC1 Model Results

		Peak	Peak	Peak		Cum.Area	MAX. Average Flow (cfs)				MAX. Average Rainfall Depth (Inches)				Total Runoff Volume (ac. ft)			
KK CARD	Type	Flow	Stage (ft)	Storage	Time	(sq. miles)	6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR
S170	BASIN	1802			12.1	1.46	169	42	14	6	1.075	1.075	1.075	1.075	84	84	84	84
170R	ROUTE	1558	1E+08	1E+08	12.4	1.46	169	42	14	6	1.075	1.075	1.075	1.075	84	84	84	84
C170R	COMBINE	7198			13	28.9	1894	582	240	115	0.609	0.749	0.926	1.025	939	1155	1427	1581
170180	ROUTE	7098	103.6	183.57	13.1	28.9	1882	580	240	115	0.605	0.747	0.925	1.025	933	1151	1425	1580
S165	BASIN	842			12.1	0.62	78	20	7	3	1.183	1.219	1.219	1.219	39	40	40	40
RR165	STORAGE	91	7.2	30.3	12.7	0.62	68	20	7	3	1.023	1.217	1.219	1.219	34	40	40	40
165175	ROUTE	79	100.2	14.7	15.1	0.62	64	20	7	3	0.961	1.217	1.219	1.219	32	40	40	40
S175	BASIN	1278			12.5	1.8	217	55	18	8	1.119	1.131	1.131	1.131	108	109	109	109
C175	COMBINE	1274			12.5	2.42	261	74	25	11	1.005	1.14	1.142	1.142	130	147	147	147
175R	ROUTE	1194	101	19.65	12.6	2.42	259	74	25	11	0.994	1.14	1.142	1.142	128	147	147	147
S180	BASIN	1039			12.5	1.44	171	44	15	6	1.1	1.123	1.124	1.124	85	86	86	86
180R	ROUTE	1003	101.2	14.22	12.5	1.44	171	44	15	6	1.099	1.123	1.124	1.124	85	86	86	86
C180RI	COMBINE	2157			12.5	3.86	423	116	39	17	1.019	1.12	1.122	1.122	210	231	231	231
RI180R	ROUTE	2062	101.3	40.38	12.7	3.86	419	116	39	17	1.008	1.12	1.122	1.122	208	231	231	231
C180R	COMBINE	8241			13	32.76	2236	677	271	129	0.634	0.768	0.924	1.012	1109	1342	1614	1769
180185	ROUTE	8233	104	81.89	13.1	32.76	2228	675	271	128	0.632	0.766	0.923	1.012	1105	1339	1613	1769
S185	BASIN	1655			12.5	2.42	288	73	24	10	1.105	1.117	1.117	1.117	143	144	144	144
185R	ROUTE	1411	102.6	45.16	12.9	2.42	287	73	24	10	1.104	1.117	1.117	1.117	143	144	144	144
C185R	COMBINE	9266			13	35.19	2460	734	291	137	0.65	0.775	0.921	1.005	1220	1455	1729	1885
185190	ROUTE	9245	103.6	68.02	13.1	35.19	2454	733	290	137	0.649	0.774	0.921	1.004	1217	1453	1728	1885
S190	BASIN	2590			12.5	4.05	448	112	37	16	1.027	1.027	1.027	1.027	222	222	222	222
C190	COMBINE	10120			13	39.24	2798	820	320	150	0.663	0.777	0.91	0.984	1388	1627	1903	2060
190195	ROUTE	9977	104.2	134.42	13.2	39.24	2790	819	320	150	0.661	0.776	0.909	0.984	1383	1625	1903	2060
S195	BASIN	1039			12.6	1.81	202	51	17	7	1.041	1.041	1.041	1.041	100	100	100	100
C195	COMBINE	10354			13.2	41.05	2945	858	333	155	0.667	0.778	0.905	0.976	1460	1702	1980	2137

Channels Hydraulics Summary

		Design Geometry						Hydraulics										
Structure ID	Type	Initial Slope (ft/ft)	Long-term Slope (ft/ft)	Length (stor-ft; chl-mi)	Width (ft)	Depth (ft)	Chnl Mannings n	Flow Rate (cfs)	Wetted Perimeter (ft)	Wetted XS Area (ft)	Hydraulic Radius (ft)	Hydraulic Depth (ft)	Flow Depth (ft)	Freeboard (ft)	Top Width (ft)	Velocity (ft/s)	Froude Number	Shear Stress (lb/sq. ft)
RR12510	Leveed	0.0265	0.0110	0.40	3	4.0	0.045	73	29.3	18.4	0.6	0.6	0.7	3.3	29	4.0	0.88	0.47
RR15010	Leveed	0.0252	0.0100	0.20	3	4.0	0.045	208	46.2	42.1	0.9	0.9	1.0	3.0	46	4.9	0.91	0.61
RR13010	Leveed	0.0252	0.0120	0.20	3	4.0	0.045	82	29.7	20.2	0.7	0.7	0.7	3.3	29	4.1	0.87	0.55
C135L10	Leveed	0.0165	0.0060	2.30	3	4.5	0.045	1003	207.0	223.6	1.1	1.1	1.1	3.4	207	4.5	0.76	0.41
C17510A	Leveed	0.0182	0.0070	1.30	3	4.5	0.045	840	147.5	170.7	1.2	1.2	1.2	3.3	147	4.9	0.80	0.52
C17510B	Leveed	0.0135	0.0050	1.20	3	4.5	0.045	1274	208.5	274.9	1.3	1.3	1.3	3.2	208	4.6	0.71	0.42
RR17510	Leveed	0.0164	0.0060	0.60	3	4.5	0.045	1393	286.9	311.2	1.1	1.1	1.1	3.4	287	4.5	0.76	0.41
RR18010	Leveed	0.0153	0.0060	0.50	3	4.5	0.045	1124	188.1	236.0	1.3	1.3	1.3	3.2	188	4.8	0.75	0.48
C180R10	Leveed	0.0122	0.0050	0.70	3	4.5	0.045	2385	369.0	518.9	1.4	1.4	1.4	3.1	369	4.6	0.68	0.44
S18010	Leveed	0.0146	0.0060	1.00	3	4.5	0.045	1039	187.9	228.2	1.2	1.2	1.2	3.3	187	4.6	0.73	0.46

Basins Hydraulics Summary

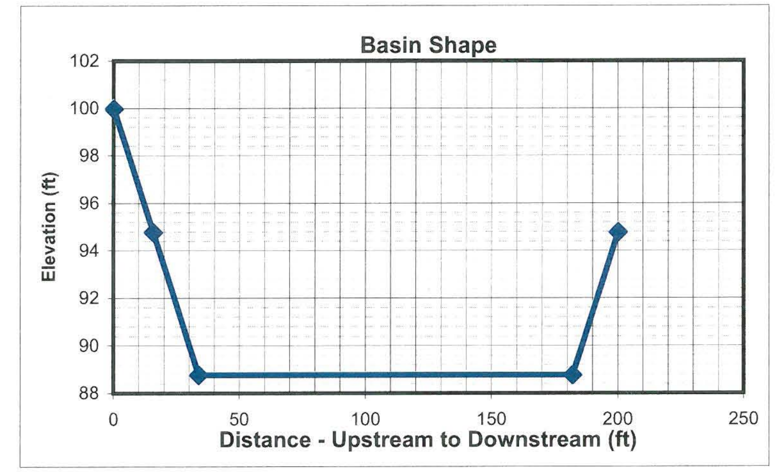
			Design Geometry				Hydraulics					
Structure ID	Type	Adjacent Topo. Slope	Length (stor-ft; chl-mi)	Width (ft)	Depth (ft)	Storage Volume Provided	Peak Storage (ac. Ft)	Total Vol. Entering Basin (ac.	Peak Inflow into Basin (cfs)	Peak Outflow (cfs)	Peak Stage (ft)	Freeboard (ft)
RR125	Online Basin	0.0260	300	200	6.0	5.2	4.9	7.0	202	33	4.8	1.2
RR150	Online Basin	0.0270	760	400	10.0	50.4	47.3	62.0	836	99	8.5	1.5
RR130	Online Basin	0.0280	800	400	9.0	47.6	45.4	81.0	453	42	7.7	1.3
RR165	Online Basin	0.0220	800	300	10.0	39.2	37.6	47.0	1008	100	8.7	1.3

Online Basin

HEC1 ID	RR125

HEC1 Results Used to Determine Sediment Volume From Upstream

Contributing HEC1 ID							Total Volume (ac. ft)
Inflow Volume (ac. ft)							0
Volume Fraction							
Weighted Volume							0
Sediment Conc. (ppm)							
Sediment Volume (ac. ft)							0.00
Weighting Factor							
Weighted Sed. Vol. (ac. ft)							0.00



Sediment Yield

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.1	sq. mi
Total Sediment Yield Volume	0.2	ac ft

Required Minimum Sediment Volume

Sediment Volume	0.2	ac. ft

Geometry	Base	LC Enhanced
Topography slope (ft/ft)	0.026	0.026
Basin Length (ft)	300	400
Basin Width (ft)	200	200
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	6	6
Freeboard (ft)	1	1
Effective Basin Width (ft)	184	169
Top Area (acres)	1.4	1.8
U/S-D/S Height Difference (ft)	5.2	5.2
Excess Area on Upstream (acres)	0.1	0.3

			Base	LC Enhanced
Bottom Length (ft)	264	Allocated Storage Volume (ac. ft)	5.2	5.3
Bottom Width (ft)	148	Total Available Volume (ac. ft) (incl. Freeboard)	6.5	6.7
		Total Excavation Volume (ac. ft)	10.1	11.5

HEC1 Results

	6-hr Event	24-hr Event	Maximum
Total Flow Volume entering Basin (ac. ft)	7.0	6	7.0
Peak Inflow (cfs)	202	161	202.0
Peak Outflow (cfs)	33	30	33.0
Stage at Peak Outflow (ft)	4.8	4	4.8
Volume at Peak Outflow (ac. ft)	4.9	4.1	4.9

Volume Check

Total Volume needed	5.1	ac. ft
Total Volume Provided	5.2	ac. ft
Volume OK?	Yes	

Stage Check

Depth Needed	5.8	ft
Depth Provided	6	ft
Depth OK?	Yes	

Basin Outlet

Outlet Coeff	0.60	(0.6 for Orifice, 3.0 for Weir)
D (Orifice) or W (Weir)	2.00	ft
Invert Elevation	0.00	ft
Number of pipes	1	

Stage-Storage-Discharge

Elevation	0	0.5	1	1.5	2	3	4	5	6	7
Volume	0.00	0.46	0.93	1.41	1.91	2.95	4.06	5.23	6.46	7.76
Outflow	0.0	10.7	15.1	18.5	21.4	26.2	30.3	33.8	37.1	40.0

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
LC Enhancement Buffer	90000	sq. ft
Other		sq. ft

Additional ROW Length	0	ft
Additional ROW Width	0	ft
Landscaping Buffer Length	100	ft
Landscaping Buffer Width	100	ft

Base Total ROW Length	300	ft
Base Total ROW Width	200	ft
LC Enh. Total ROW Length	500	ft
LC Enh. Total ROW Length	300	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	16295	18553
Excavated Area (sq. Yd)	6667	16667

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	35	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	394	sq. Yd
Material Volume	197	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	286	ft
Unit Cost	160	per ft
Cost per outlet	$45,760	
Other Cost	$ -	
Total Cost	$45,760	
Outlet Area	133	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Basin		16,295	cu. Yd	$ 4.00	$ 65,180	6,667	sq. Yd	$ 9.00	$ 60,003	6,667	sq. Yd	$ 8.33	$ 55,558
Basin - LC Enhancement		2,258	cu. Yd	$ 4.00	$ 9,032	10,000	sq. Yd	$ 9.00	$ 90,000	10,000	sq. Yd	$ 8.33	$ 83,333
Inlet	Riprap	197	sq. Yd	$ 75.00	$ 14,775	394	sq. Yd	$ -	$ -	394	sq. Yd	$ 33.33	$ 13,133
Inlet - LC Enhancement (20%Inlet)					$ 2,955				$ -				$ 2,627
Outlet	Pipe	1	EA	$ 45,760	$ 45,760	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhancement (5% Outlet)					$ 2,288				$ -				$ 111
Other					$ -				$ -				$ -

Base Landscape Cost	$ 60,003	
LC Enh. Landscape Cost	$ 90,000	
Total Landscape Cost	$ 150,003	

Base Maintenance Cost	$ 70,908
LC Enh. Maintenance Cost	$ 86,071
Total Maintenance Cost	$ 156,979

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 125,715	$ 9,032	$ 134,747
Contingency Cost (25% of Construction Cost)	$ 31,429	$ 2,258	$ 33,687
Engineering Design Cost (5% of Construction Cost)	$ 6,286	$ 452	$ 6,737
Total Construction Cost	$ 163,430	$ 11,742	$ 175,171

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	2.1	$100,000	$ 210,000
Basin	1.4	$100,000	$ 140,000
Other		$100,000	$ -
Total	3.5	$100,000	$ 350,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	1.4	$100,000	$ 140,000
LC Enhancement Cost	acre	2.1	$100,000	$ 210,000
Total Land Cost	acre	3.5	$100,000	$ 350,000

Total Cost

Base Total Cost	$ 434,341
Total LC Enhancement Cost	$ 397,812
Total Cost Including LC Enh.	$ 832,153

Open Channel

Structure ID	RR12510		HEC1 ID	12535I

Longitundal Geometry

Length	1852.5	ft
U/S Elev	1746.1	ft
D/S Elev	1697.0	ft
Initial Channel Slope	0.0265	ft/ft
Long-term Channel Slope	0.0110	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	1

Initial Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	0	3	25	4	3	0	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	12	12	37	37	37	49
Y	104	100	100	100	100	100	100	104

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	0	3	25	4	3	0	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	12	12	37	37	37	49
Y	104	100	100	100	100	100	100	104

Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	RR125	S135								TOTAL
HEC1 Peak-Flow	33	1102								1135
Weighting Factor	1.00	0.04								
Flow into Channel	33	40								73

Reach Sediment Inflow Characteristics

U/S Contributing ID										TOTAL
HEC1 Flow Volume (ac. ft)										0
Sediment Conc. (ppm)										
Sediment Volume (ac. ft)										0.00
Weighting Factor										
Weighted Sed. Vol. (ac. ft)										0.00

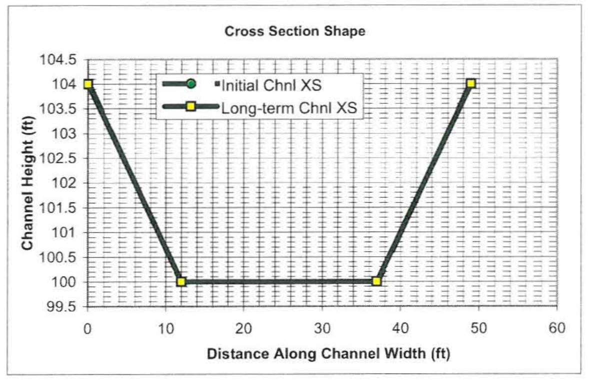
Hydrology

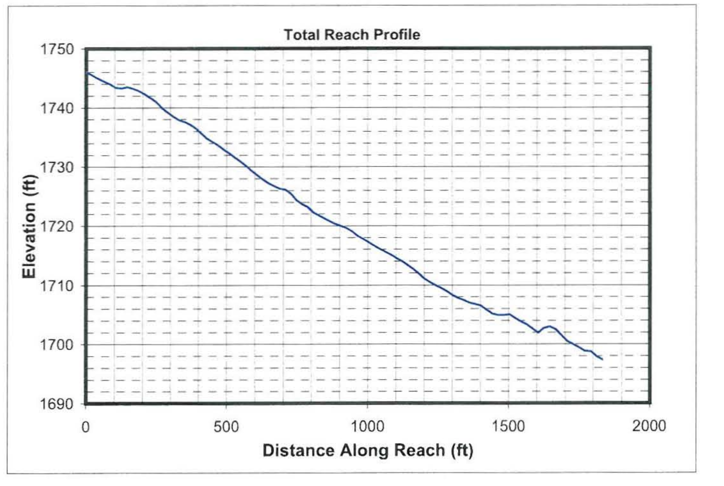
Drainage Area	0.157	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	73	cfs	
Long-term Max. Chnl Capacity	1055	cfs	
Q2 Channel	7	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	49	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			





Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
7	26.1	4.4	0.2	100.0	100.2	1.6	0.2	26.0	0.2	0.12	0.71
18	26.9	7.8	0.3	100.0	100.3	2.4	0.3	26.8	0.3	0.21	0.77
55	28.6	15.4	0.5	100.0	100.6	3.6	0.6	28.5	0.5	0.39	0.85
73	29.3	18.4	0.6	100.0	100.7	4.0	0.7	29.1	0.6	0.47	0.88

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
7	26.4	5.8	0.2	100.0	100.2	1.3	0.2	26.4	0.2	0.15	0.47
18	27.5	10.2	0.4	100.0	100.4	1.8	0.4	27.3	0.4	0.27	0.52
55	29.7	20.3	0.7	100.0	100.7	2.7	0.7	29.5	0.7	0.51	0.57
73	30.6	24.4	0.8	100.0	100.9	3.0	0.9	30.3	0.8	0.61	0.59

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
7										0
18										0
55										0
73										0

Allowable Velocity

Channel Lining	Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
7	1.74	0.8490	0.8066	Erosive	Erosive	Erosive	0.2	Stable	2.3	Stable	Stable
18	1.74	1.0134	0.9627	Erosive	Erosive	Erosive	0.2	Stable	3.3	Stable	Stable
55	1.74	1.2056	1.1454	Erosive	Erosive	Erosive	0.3	Stable	5.0	Stable	Stable
73	1.74	1.2549	1.1922	Erosive	Erosive	Erosive	0.3	Stable	5.6	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	**7**	**18**	**55**	**73**	**7**	**18**	**55**	**73**	**7**	**18**	**55**	**73**
Bray - Equation #1	7	11	20	23	0.5	0.7	1.0	1.1	2.1	2.4	2.8	2.9
Bray - Equation #2	9	14	26	30	0.6	0.8	1.1	1.2	1.4	1.6	1.9	2.0
Hey	1	3	5	6	1.4	1.9	2.9	3.3				
Ackers & Charlton/Lacey	8	12	19	22					1.1	1.3	1.6	1.6
Parker	19	29	51	59	0.3	0.5	0.7	0.8				
Chang	11	20	39	46	0.1	0.1	0.0	0.0				
Kellerhals	5	8	13	15	0.6	0.9	1.3	1.5	2.5	2.7	3.0	3.1
AMAFCA/Schumm	26	27	30	30								
Moody & Odem	6	6	6	6	0.7	0.7	0.7	0.7				
BUREC	4.8	6.8	10.3	11.5	1	2	3	3	1.8	2.3	3.0	3.3
Average	10	14	22	25	0.7	0.9	1.3	1.5	1.8	2.1	2.5	2.6
Values As Designed	26	27	29	30	0.2	0.4	0.7	0.9	1.3	1.8	2.7	3.0
Difference with Design	-17	-14	-8	-5	0.5	0.5	0.6	0.6	0.5	0.3	-0.2	-0.4

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
7	80	58	138	151	365	29	28	10	538	36	79	137
18	326	192	441	701	557	131	98	59	1426	103	349	399
55	1725	704	1421	4352	884	624	335	324	4388	438	1691	1535
73	2653	972	1839	6985	995	923	449	484	5869	647	2492	2210

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
7	4082	2963	7009	7659	18529	1473	1407	510	27319	1831	3995	6980
18	6622	3908	8973	14252	11327	2664	1994	1208	28981	2096	7103	8103
55	11689	4770	9632	29487	5993	4227	2267	2196	29733	2965	11455	10401
73	13482	4942	9345	35497	5058	4688	2283	2460	29829	3287	12667	11231

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
7	24	14	21	35	211	0	2	1	110	9	17	40
18	95	60	113	162	355	22	22	14	347	27	99	120
55	499	257	477	996	608	139	105	102	1137	121	566	455
73	765	365	648	1593	695	210	147	160	1532	181	860	651

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
7	1199	705	1055	1782	10734	0	86	53	5607	443	850	2047
18	1935	1224	2302	3298	7211	448	449	275	7048	551	2023	2433
55	3380	1742	3229	6748	4119	941	708	692	7703	819	3836	3083
73	3889	1853	3294	8093	3532	1069	745	813	7787	918	4373	3306

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
7	0.0045	0.0071	125	0.38	0.046	0.0015	29	0.035	0.0011	0.0159	0.0015	0.0036	0.0180	0.0016	0.0073	0.0263	0.0124
18	0.0023	0.0042	163	0.50	0.049	0.0009	30	0.036	0.0006	0.0159	0.0009	0.0020	0.0180	0.0010	0.0037	0.0263	0.0118
55	0.0011	0.0022	222	0.68	0.052	0.0005	31	0.036	0.0004	0.0159	0.0005	0.0010	0.0180	0.0006	0.0016	0.0263	0.0115
73	0.0009	0.0019	240	0.73	0.052	0.0005	31	0.036	0.0003	0.0159	0.0004	0.0009	0.0180	0.0005	0.0013	0.0262	0.0114

Drop Structures

Design Slope	0.0110	ft/ft
Total Drop Needed	28.7	ft
Height of Drop Structure	3	ft
No . of Drop Structures	10	
Distance between structs.	185	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.03	sq. mi
Total Sediment Yield Volume	0.06	ac ft

Sedimentation Basins

Length	185 ft	Depth	3 ft
Width	49 ft	Side slope	3 ft/ft
Total Volume per Basin		0.49	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
7	1.1	-0.1	0.0	24.6	0.2	0.2	1.3	0.0110	0.0	1.5	1.0	3.3
18	1.1	-0.1	0.0	24.6	0.4	0.4	1.8	0.0110	0.0	1.5	1.0	3.3
55	1.1	-0.2	0.1	24.6	0.7	0.7	2.7	0.0110	0.1	1.5	1.0	3.4
73	1.1	-0.3	0.1	24.6	0.9	0.8	3.0	0.0110	0.1	1.5	1.0	3.5

Toe Protection Needed	4.0	ft

HEC1 Results For Open Channel

Peak Flow	33	cfs
Stage at Peak Flow	100.4	ft
Flow Volume	7.0	ac. ft

Freeboard

Max. Flow Depth	0.7	ft
Channel Depth as designed	4.0	ft
Available Freeboard	3.3	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	0.06	ac. ft
Outflowing Sediment Volume	0.01	ac. ft
Deposited(+)/Eroded(-) Volume	0.05	ac. ft

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

Sub-area: Wagner Wash, Alternative: B41
Open Channel Structure ID: RR12510

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	1853	1853
Side Slope (?H:1V)	3	3
Channel Width (ft)	49	49
Channel XS Area (sq. ft)	148	148
Channel Perimeter (ft)	50	50

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	1853	ft
Thickness	1.5	ft
Protection Depth	4	ft
Tie-in Length/Depth	3.0	ft
Total Depth	7.0	ft
Area needed	618	sq. Yd
Volume	1441	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	1853	1853
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4	5
Left Levee Surface Area (sq. Yd)	8030	16677
Left Levee Volume (cu. Yd)	7137	17157
Right Levee Length (ft)	1853	1853
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4	5
Right Levee Surface Area (sq. Yd)	8030	16677
Right Levee Volume (cu. Yd)	7137	17157
Total Levee Surface Area (sq. Yd)	16060	33354
Total Levee Volume (cu. Yd)	14274	34314

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	1853	1853
Left Levee Lining Width (ft)	13	30
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	2677	6177
Left Levee Lining Volume (cu. Yd)	1338	3088
Right Levee Length (ft)	1853	1853
Right Levee Lining Width (ft)	13	30
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	2677	6177
Right Levee Lining Volume (cu. Yd)	1338	3088
Total Lining Area (sq. Yd)	5353	12353
Total Lining Volume (cu. Yd)	2676	6176

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	49	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	3.9	ft
Structure Height	6.9	ft
Number of Structures	10	
Volume per structure	38	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 2,850	
Area per structure	16	sq. Yd
Total Area	163	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	791	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 3,164	
Other Cost	$ -	
Total cost per basin	$ 3,164	
Area per basin	1,009	sq. Yd
Total Area	1,009	sq. Yd

Structure Cost

Structure Type	Structure Type	Excavation/Construction Quantity	Units	Unit Cost	Cost Subtotal	Landscape Quantity	Units	Unit Cost	Landscape Cost	Maintenance Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	14,274	cu. Yd	$ 7.00	$ 99,918	16,060	sq. Yd	$ 9.00	$ 144,540	16,060	sq. Yd	$ 11.67	$ 187,367
Levee - LC Enhancement	Fill	20,040	cu. Yd	$ 7.00	$ 140,280	17,294	sq. Yd	$ 9.00	$ 155,646	20,040	sq. Yd	$ 11.67	$ 233,800
Levee Lining	Riprap	2,676	cu. Yd	$ 75.00	$ 200,700	5,353	sq. Yd	$ -	$ -	5,353	sq. Yd	$ 20.83	$ 111,523
Levee Lining -LC Enhancement	Riprap	3,500	cu. Yd	$ 75.00	$ 262,500	7,000	sq. Yd	$ -	$ -	7,000	sq. Yd	$ 20.83	$ 145,838
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	1,441	cu. Yd	$ 75.00	$ 108,075	618	sq. Yd	$ -	$ -	618	sq. Yd	$ 25.00	$ 15,450
Drop Structures	Riprap	10	EA	$ 2,850.00	$ 28,500	163	sq. Yd	$ -	$ -	163	sq. Yd	$ 33.33	$ 5,433
Drop Str. - LC Enhancement	Riprap	10	EA	$ 285.00	$ 2,850	16	sq. Yd	$ -	$ -	16	sq. Yd	$ 33.33	$ 543
Sedimentation Basins		1	EA	$ 3,164.00	$ 3,164	1,009	sq. Yd	$ -	$ -	1,009	sq. Yd	$ 8.33	$ 8,408
Other					$ -				$ -				$ -

Base Landscape Cost	$ 144,540	Base Maintenance Cost	$ 328,181
LC Enhancement Cost	$ 155,646	LC Enhancement Cost	$ 380,181
Total Landscape Cost	$ 300,186	Total Maintenance Cost	$ 708,363

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 440,357	$ 405,630	$ 845,987
Contingency Cost (25% of Construction Cost)	$ 110,089	$ 101,408	$ 211,497
Engineering Design Cost (5% of Construction Cost)	$ 22,018	$ 20,282	$ 42,299
Total Construction Cost	$ 572,464	$ 527,319	$ 1,099,783

Land Cost

Channel Length	1853 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	49	2.1	$100,000	$ 210,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	52	2.2	$100,000	$ 220,000
Levee LC Enhancement	48	2	$100,000	$ 200,000
Other	0	0	$100,000	$ -
Total	149	6.3		$ 630,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	4.3	$100,000	$ 430,000
LC Enhancement Cost	acre	2	$100,000	$ 200,000
Total Land Cost	acre	6.3	$100,000	$ 630,000

Total Cost

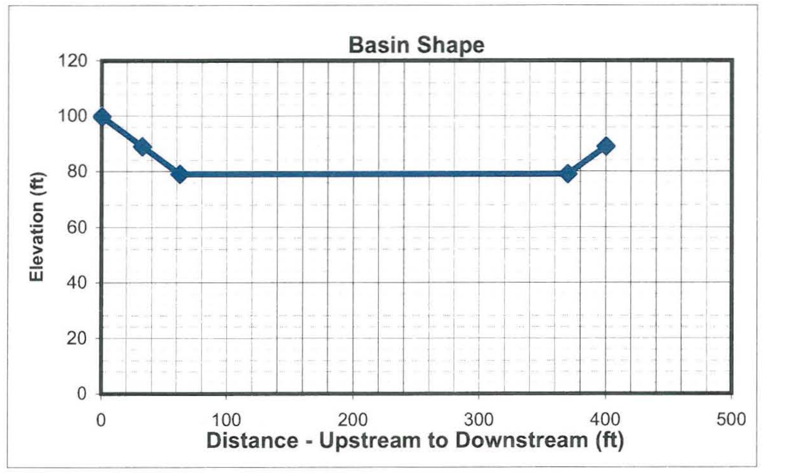
Base Total Cost	$ 1,475,186
Total Landscape Enhancement Cost	$ 1,263,146
Total Cost Including LC Enh.	$ 2,738,332

Online Basin

HEC1 ID	RR150

HEC1 Results Used to Determine Sediment Volume From Upstream

Contributing HEC1 ID							Total Volume (ac. ft)
Inflow Volume (ac. ft)							0
Volume Fraction							
Weighted Volume							0
Sediment Conc. (ppm)							
Sediment Volume (ac. ft)							0.00
Weighting Factor							
Weighted Sed. Vol. (ac. ft)							0.00



Sediment Yield

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.9	sq. mi
Total Sediment Yield Volume	1.7	ac ft

Required Minimum Sediment Volume

Sediment Volume	1.7	ac. ft

Geometry	Base	LC Enhanced
Topography slope (ft/ft)	0.027	0.027
Basin Length (ft)	760	970
Basin Width (ft)	400	400
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	10	10
Freeboard (ft)	1	1
Effective Basin Width (ft)	368	335
Top Area (acres)	7.0	8.9
U/S-D/S Height Difference (ft)	10.8	10.8
Excess Area on Upstream (acres)	0.6	1.5

			Base	LC Enhanced
Bottom Length (ft)	700	Allocated Storage Volume (ac. ft)	50.4	50.4
Bottom Width (ft)	308	Total Available Volume (ac. ft) (incl. Freeboard)	56.7	57.7
		Total Excavation Volume (ac. ft)	94.4	105.9

HEC1 Results

	6-hr Event	24-hr Event	Maximum
Total Flow Volume entering Basin (ac. ft)	62.0	57	62.0
Peak Inflow (cfs)	836	729	836.0
Peak Outflow (cfs)	99	91	99.0
Stage at Peak Outflow (ft)	8.5	0	8.5
Volume at Peak Outflow (ac. ft)	47.3	0	47.3

Volume Check

Total Volume needed	49.0	ac. ft
Total Volume Provided	50.4	ac. ft

Volume OK?	Yes

Stage Check

Depth Needed	9.5	ft
Depth Provided	10	ft

Depth OK?	Yes

Basin Outlet

Outlet Coeff	0.60	(0.6 for Orifice, 3.0 for Weir)
D (Orifice) or W (Weir)	3.00	ft
Invert Elevation	0.00	ft
Number of pipes	1	

Stage-Storage-Discharge

Elevation	0	1	2	4	6	7	8	9	10	11
Volume	0.00	5.02	10.18	20.93	32.26	38.14	44.18	50.37	56.71	63.21
Outflow	0.0	34.0	48.1	68.1	83.4	90.0	96.3	102.1	107.6	112.9

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
LC Enhancement Buffer	231000	sq. ft
Other		sq. ft

Additional ROW Length	0	ft
Additional ROW Width	0	ft
Landscaping Buffer Length	100	ft
Landscaping Buffer Width	100	ft

Base Total ROW Length	760	ft
Base Total ROW Width	400	ft
LC Enh. Total ROW Length	1070	ft
LC Enh. Total ROW Length	500	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	152299	170852
Excavated Area (sq. Yd)	33778	59444

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	66	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	731	sq. Yd
Material Volume	366	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	455	ft
Unit Cost	160	per ft
Cost per outlet	$72,800	
Other Cost	$ -	
Total Cost	$72,800	
Outlet Area	133	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Basin		152,299	cu. Yd	$ 4.00	$ 609,196	33,778	sq. Yd	$ 9.00	$ 304,002	33,778	sq. Yd	$ 8.33	$ 281,483
Basin - LC Enhancement		18,553	cu. Yd	$ 4.00	$ 74,212	25,666	sq. Yd	$ 9.00	$ 230,994	25,666	sq. Yd	$ 8.33	$ 213,883
Inlet	Riprap	366	sq. Yd	$ 75.00	$ 27,450	731	sq. Yd	$ -	$ -	731	sq. Yd	$ 33.33	$ 24,367
Inlet - LC Enhancement (20%Inlet)					$ 5,490				$ -				$ 4,873
Outlet	Pipe	1	EA	$ 72,800	$ 72,800	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhancement (5% Outlet)					$ 3,640				$ -				$ 111
Other					$ -				$ -				$ -

Base Landscape Cost	$ 304,002	Base Maintenance Cost	$ 308,067
LC Enh. Landscape Cost	$ 230,994	LC Enh. Maintenance Cost	$ 218,868
Total Landscape Cost	$ 534,996	Total Maintenance Cost	$ 526,934

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 709,446	$ 74,212	$ 783,658
Contingency Cost (25% of Construction Cost)	$ 177,362	$ 18,553	$ 195,915
Engineering Design Cost (5% of Construction Cost)	$ 35,472	$ 3,711	$ 39,183
Total Construction Cost	$ 922,280	$ 96,476	$ 1,018,755

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	5.3	$100,000	$ 530,000
Basin	7.0	$100,000	$ 700,000
Other		$100,000	$ -
Total	12.3	$100,000	$ 1,230,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	7.0	$100,000	$ 700,000
LC Enhancement Cost	acre	5.3	$100,000	$ 530,000
Total Land Cost	acre	12.3	$100,000	$ 1,230,000

Total Cost

Base Total Cost	$ 2,234,348
Total LC Enhancement Cost	$ 1,076,337
Total Cost Including LC Enh.	$ 3,310,686

Open Channel

Structure ID	RR15010		HEC1 ID	150130

Longitundal Geometry

Length	1235.4	ft
U/S Elev	1728.2	ft
D/S Elev	1697.0	ft
Initial Channel Slope	0.0252	ft/ft
Long-term Channel Slope	0.0100	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	1

Initial Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	0	3	40	4	3	0	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	12	12	52	52	52	64
Y	104	100	100	100	100	100	100	104

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	0	3	40	4	3	0	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	12	12	52	52	52	64
Y	104	100	100	100	100	100	100	104

Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	RR150	S155								TOTAL
HEC1 Peak-Flow	99	1781								1880
Weighting Factor	1.00	0.06								
Flow into Channel	99	109								208

Reach Sediment Inflow Characteristics

U/S Contributing ID										TOTAL
HEC1 Flow Volume (ac. ft)										0
Sediment Conc. (ppm)										
Sediment Volume (ac. ft)										0.00
Weighting Factor										
Weighted Sed. Vol. (ac. ft)										0.00

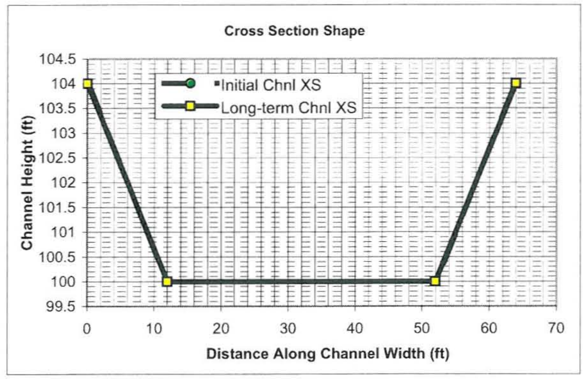
Hydrology

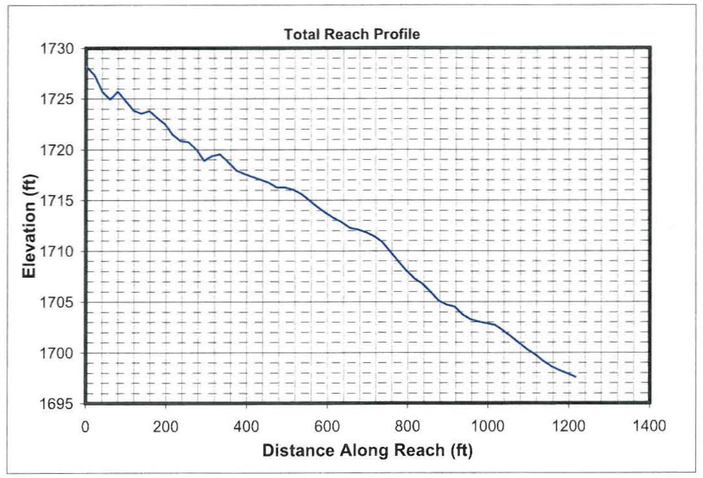
Drainage Area	0.886	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	208	cfs	
Long-term Max. Chnl Capacity	1491	cfs	
Q2 Channel	21	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	64	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			





Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
21	41.6	10.1	0.2	100.0	100.2	2.1	0.2	41.5	0.2	0.16	0.73
52	42.7	17.8	0.4	100.0	100.4	2.9	0.4	42.6	0.4	0.27	0.80
156	45.2	35.1	0.8	100.0	100.8	4.4	0.8	45.0	0.8	0.52	0.89
208	46.2	42.1	0.9	100.0	101.0	4.9	1.0	45.9	0.9	0.61	0.91

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
21	42.1	13.4	0.3	100.0	100.3	1.5	0.3	42.0	0.3	0.20	0.48
52	43.6	23.6	0.5	100.0	100.6	2.2	0.6	43.4	0.5	0.35	0.53
156	46.9	47.0	1.0	100.0	101.1	3.3	1.1	46.5	1.0	0.68	0.58
208	48.1	56.5	1.2	100.0	101.3	3.7	1.3	47.7	1.2	0.80	0.60

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
21										0
52										0
156										0
208										0

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
21	1.74	0.9609	0.9129	Erosive	Erosive	Erosive	0.2	Stable	2.8	Stable	Stable
52	1.74	1.1258	1.0695	Erosive	Erosive	Erosive	0.2	Stable	4.0	Stable	Stable
156	1.74	1.3191	1.2532	Erosive	Erosive	Erosive	0.3	Stable	6.2	Stable	Stable
208	1.74	1.3688	1.3003	Erosive	Erosive	Erosive	0.3	Stable	6.9	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

Discharge (cfs)	Channel Width (ft) 21	52	156	208	Flow Depth (ft) 21	52	156	208	Velocity (ft/s) 21	52	156	208
Bray - Equation #1	12	19	34	40	0.7	1.0	1.4	1.6	2.4	2.7	3.2	3.3
Bray - Equation #2	15	25	45	52	0.8	1.1	1.6	1.7	1.7	1.9	2.2	2.3
Hey	3	5	10	12	2.0	2.9	4.4	4.9				
Ackers & Charlton/Lacey	13	19	30	34					1.3	1.5	1.9	2.0
Parker	31	50	86	99	0.5	0.7	1.1	1.3				
Chang	21	36	71	85	0.1	0.0	-0.1	-0.2				
Kellerhals	8	13	22	26	0.9	1.3	2.0	2.3	2.8	3.0	3.4	3.5
AMAFCA/Schumm	42	43	47	48								
Moody & Odem	12	12	12	12	0.9	0.9	0.9	0.9				
BUREC	7.3	10.3	15.5	17.3	2	3	4	5	2.3	2.9	3.8	4.1
Average	16	23	37	42	1.0	1.3	1.9	2.1	2.1	2.4	2.9	3.0
Values As Designed	42	43	47	48	0.3	0.6	1.1	1.3	1.5	2.2	3.3	3.7
Difference with Design	-26	-20	-9	-5	0.7	0.8	0.9	0.9	0.6	0.2	-0.4	-0.7

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
21	295	191	457	596	739	116	96	49	1485	102	314	403
52	1197	589	1258	2778	1093	453	289	230	3842	329	1254	1210
156	6353	2067	3643	17307	1689	2074	913	1115	11700	1479	5692	4912
208	9786	2836	4791	27820	1891	3063	1214	1636	15630	2206	8299	7197

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
21	5254	3401	8145	10629	13183	2062	1709	875	26484	1814	5592	7195
52	8540	4203	8979	19819	7797	3233	2060	1642	27408	2344	8947	8634
156	15108	4916	8664	41160	4018	4932	2172	2651	27825	3517	13537	11682
208	17455	5059	8545	49621	3372	5463	2166	2919	27878	3934	14802	12838

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
21	81	51	80	128	440	12	15	8	316	24	76	112
52	329	192	359	595	704	86	75	61	902	83	369	341
156	1722	755	1275	3666	1163	446	290	366	2857	391	1917	1350
208	2644	1057	1759	5871	1319	664	397	557	3836	589	2872	1961

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
21	1446	910	1427	2288	7854	213	260	149	5641	435	1357	1998
52	2347	1367	2563	4246	5025	610	535	435	6435	593	2636	2436
156	4095	1795	3033	8719	2766	1060	690	871	6795	930	4558	3210
208	4717	1886	3138	10472	2353	1185	708	993	6841	1051	5123	3497

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
21	0.0029	0.0050	146	0.45	0.048	0.0011	30	0.036	0.0008	0.0159	0.0010	0.0024	0.0127	0.0010	0.0041	0.0251	0.0103
52	0.0015	0.0029	191	0.58	0.050	0.0007	31	0.036	0.0005	0.0159	0.0006	0.0014	0.0127	0.0006	0.0020	0.0251	0.0099
156	0.0007	0.0016	261	0.79	0.053	0.0004	32	0.036	0.0002	0.0159	0.0003	0.0007	0.0127	0.0004	0.0009	0.0251	0.0097
208	0.0006	0.0013	282	0.86	0.054	0.0003	32	0.036	0.0002	0.0159	0.0003	0.0006	0.0127	0.0003	0.0007	0.0250	0.0097

Drop Structures

Design Slope	0.0100	ft/ft
Total Drop Needed	18.8	ft
Height of Drop Structure	3	ft
No . of Drop Structures	7	
Distance between structs.	176	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.11	sq. mi
Total Sediment Yield Volume	0.21	ac ft

Sedimentation Basins

Length	176 ft	Depth	3 ft
Width	64 ft	Side slope	3 ft/ft
Total Volume per Basin		0.64	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

		Pima County General Scour Equations							Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
21	1.1	-0.1	0.0	24.6	0.3	0.3	1.5	0.0100	0.0	1.5	1.0	3.3
52	1.1	-0.2	0.1	24.6	0.6	0.5	2.2	0.0100	0.1	1.5	1.0	3.4
156	1.1	-0.3	0.2	24.6	1.1	1.0	3.3	0.0100	0.1	1.5	1.0	3.5
208	1.1	-0.4	0.2	24.6	1.3	1.2	3.7	0.0100	0.1	1.5	1.0	3.6

Toe Protection Needed	4.0	ft

HEC1 Results For Open Channel

Peak Flow	99	cfs
Stage at Peak Flow	100.6	ft
Flow Volume	62.0	ac. ft

Freeboard

Max. Flow Depth	1.0	ft
Channel Depth as designed	4.0	ft
Available Freeboard	3.0	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	0.21	ac. ft
Outflowing Sediment Volume	0.08	ac. ft
Deposited(+)/Eroded(-) Volume	0.13	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	1235	1235
Side Slope (?H:1V)	3	3
Channel Width (ft)	64	64
Channel XS Area (sq. ft)	208	208
Channel Perimeter (ft)	65	65

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	1235	ft
Thickness	1.5	ft
Protection Depth	4	ft
Tie-in Length/Depth	3.0	ft
Total Depth	7.0	ft
Area needed	412	sq. Yd
Volume	961	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	1235	1235
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4	5
Left Levee Surface Area (sq. Yd)	5352	11115
Left Levee Volume (cu. Yd)	4757	11435
Right Levee Length (ft)	1235	1235
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4	5
Right Levee Surface Area (sq. Yd)	5352	11115
Right Levee Volume (cu. Yd)	4757	11435
Total Levee Surface Area (sq. Yd)	10704	22230
Total Levee Volume (cu. Yd)	9514	22870

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	1235	1235
Left Levee Lining Width (ft)	13	30
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	1784	4117
Left Levee Lining Volume (cu. Yd)	892	2058
Right Levee Length (ft)	1235	1235
Right Levee Lining Width (ft)	13	30
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	1784	4117
Right Levee Lining Volume (cu. Yd)	892	2058
Total Lining Area (sq. Yd)	3568	8233
Total Lining Volume (cu. Yd)	1784	4116

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	64	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	5.5	ft
Structure Height	8.5	ft
Number of Structures	7	
Volume per structure	60	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 4,500	
Area per structure	21	sq. Yd
Total Area	149	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	1033	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 4,132	
Other Cost	$ -	
Total cost per basin	$ 4,132	
Area per basin	1,255	sq. Yd
Total Area	1,255	sq. Yd

Structure Type	Structure Cost: Structure Type	Excavation/Construction: Quantity	Units	Unit Cost	Cost Subtotal	Landscape: Quantity	Units	Unit Cost	Landscape Cost	Maintenance: Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	9,514	cu. Yd	$ 7.00	$ 66,598	10,704	sq. Yd	$ 9.00	$ 96,336	10,704	sq. Yd	$ 11.67	$ 124,880
Levee - LC Enhancement	Fill	13,356	cu. Yd	$ 7.00	$ 93,492	11,526	sq. Yd	$ 9.00	$ 103,734	13,356	sq. Yd	$ 11.67	$ 155,820
Levee Lining	Riprap	1,784	cu. Yd	$ 75.00	$ 133,800	3,568	sq. Yd	$ -	$ -	3,568	sq. Yd	$ 20.83	$ 74,329
Levee Lining -LC Enhancement	Riprap	2,332	cu. Yd	$ 75.00	$ 174,900	4,666	sq. Yd	$ -	$ -	4,666	sq. Yd	$ 20.83	$ 97,199
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	961	cu. Yd	$ 75.00	$ 72,075	412	sq. Yd	$ -	$ -	412	sq. Yd	$ 25.00	$ 10,300
Drop Structures	Riprap	7	EA	$ 4,500.00	$ 31,500	149	sq. Yd	$ -	$ -	149	sq. Yd	$ 33.33	$ 4,967
Drop Str. - LC Enhancement	Riprap	7	EA	$ 450.00	$ 3,150	15	sq. Yd	$ -	$ -	15	sq. Yd	$ 33.33	$ 497
Sedimentation Basins		1	EA	$ 4,132.00	$ 4,132	1,255	sq. Yd	$ -	$ -	1,255	sq. Yd	$ 8.33	$ 10,458
Other					$ -				$ -				$ -

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 308,105	$ 271,542	$ 579,647
Contingency Cost (25% of Construction Cost)	$ 77,026	$ 67,886	$ 144,912
Engineering Design Cost (5% of Construction Cost)	$ 15,405	$ 13,577	$ 28,982
Total Construction Cost	$ 400,537	$ 353,005	$ 753,541

Base Landscape Cost	$ 96,336
LC Enhancement Cost	$ 103,734
Total Landscape Cost	$ 200,070

Base Maintenance Cost	$ 224,934
LC Enhancement Cost	$ 253,516
Total Maintenance Cost	$ 478,449

Land Cost

Channel Length	1235 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	64	1.8	$100,000	$ 180,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	52	1.5	$100,000	$ 150,000
Levee LC Enhancement	48	1.4	$100,000	$ 140,000
Other	0	0	$100,000	$ -
Total	164	4.7		$ 470,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	3.3	$100,000	$ 330,000
LC Enhancement Cost	acre	1.4	$100,000	$ 140,000
Total Land Cost	acre	4.7	$100,000	$ 470,000

Total Cost

Base Total Cost	$ 1,051,806
Total Landscape Enhancement Cost	$ 850,254
Total Cost Including LC Enh.	$ 1,902,061

Online Basin

HEC1 ID	RR130

HEC1 Results Used to Determine Sediment Volume From Upstream

Contributing HEC1 ID	150130						Total Volume (ac. ft)
Inflow Volume (ac. ft)	62						62
Volume Fraction	1						
Weighted Volume	62						62
Sediment Conc. (ppm)	3497						
Sediment Volume (ac. ft)	0.08						0.08
Weighting Factor	1						
Weighted Sed. Vol. (ac. ft)	0.08						0.08

Sediment Yield

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.3	sq. mi
Total Sediment Yield Volume	0.6	ac ft

Required Minimum Sediment Volume

Sediment Volume	0.7	ac. ft

Geometry	Base	LC Enhanced
Topography slope (ft/ft)	0.028	0.028
Basin Length (ft)	800	1010
Basin Width (ft)	400	400
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	9	9
Freeboard (ft)	1	1
Effective Basin Width (ft)	366	333
Top Area (acres)	7.3	9.3
U/S-D/S Height Difference (ft)	11.2	11.2
Excess Area on Upstream (acres)	0.7	1.6

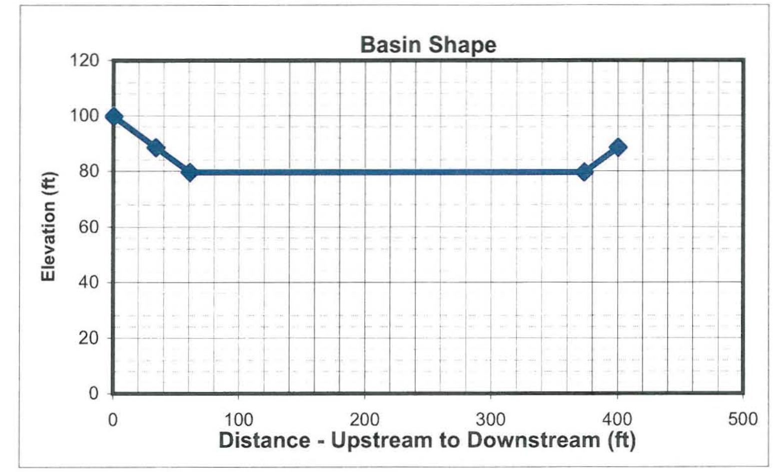
			Base	LC Enhanced
Bottom Length (ft)	746	Allocated Storage Volume (ac. ft)	47.6	47.8
Bottom Width (ft)	312	Total Available Volume (ac. ft) (incl. Freeboard)	54.2	55.3
		Total Excavation Volume (ac. ft)	95.4	107.3

Basin Outlet

Outlet Coeff	0.60	(0.6 for Orifice, 3.0 for Weir)
D (Orifice) or W (Weir)	2.00	ft
Invert Elevation	0.00	ft
Number of pipes	1	

Stage-Storage-Discharge

Elevation	0	1	2	4	6	7	8	9	10	11
Volume	0.00	5.42	10.98	22.56	34.74	41.07	47.55	54.19	60.99	67.96
Outflow	0.0	15.1	21.4	30.3	37.1	40.0	42.8	45.4	47.8	50.2



HEC1 Results

	6-hr Event	24-hr Event	Maximum
Total Flow Volume entering Basin (ac. ft)	81.0	76	81.0
Peak Inflow (cfs)	453	441	453.0
Peak Outflow (cfs)	42	40	42.0
Stage at Peak Outflow (ft)	7.7	7	7.7
Volume at Peak Outflow (ac. ft)	45.4	41.1	45.4

Volume Check

Total Volume needed	46.1	ac. ft
Total Volume Provided	47.6	ac. ft
Volume OK?	Yes	

Stage Check

Depth Needed	8.7	ft
Depth Provided	9	ft
Depth OK?	Yes	

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Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
LC Enhancement Buffer	235000	sq. ft
Other		sq. ft

Additional ROW Length	0	ft
Additional ROW Width	0	ft
Landscaping Buffer Length	100	ft
Landscaping Buffer Width	100	ft

Base Total ROW Length	800	ft
Base Total ROW Width	400	ft
LC Enh. Total ROW Length	1110	ft
LC Enh. Total ROW Length	500	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	153912	173111
Excavated Area (sq. Yd)	35556	61667

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	64	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	710	sq. Yd
Material Volume	355	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	391	ft
Unit Cost	160	per ft
Cost per outlet	$62,560	
Other Cost	$ -	
Total Cost	$62,560	
Outlet Area	133	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Basin		153,912	cu. Yd	$ 4.00	$ 615,648	35,556	sq. Yd	$ 9.00	$ 320,004	35,556	sq. Yd	$ 8.33	$ 296,300
Basin - LC Enhancement		19,199	cu. Yd	$ 4.00	$ 76,796	26,111	sq. Yd	$ 9.00	$ 234,999	26,111	sq. Yd	$ 8.33	$ 217,592
Inlet	Riprap	355	sq. Yd	$ 75.00	$ 26,625	710	sq. Yd	$ -	$ -	710	sq. Yd	$ 33.33	$ 23,667
Inlet - LC Enhancement (20%Inlet)					$ 5,325				$ -				$ 4,733
Outlet	Pipe	1	EA	$ 62,560	$ 62,560	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhancement (5% Outlet)					$ 3,128				$ -				$ 111
Other					$ -				$ -				$ -

Base Landscape Cost	$ 320,004	Base Maintenance Cost	$ 322,183
LC Enh. Landscape Cost	$ 234,999	LC Enh. Maintenance Cost	$ 222,436
Total Landscape Cost	$ 555,003	Total Maintenance Cost	$ 544,619

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 704,833	$ 76,796	$ 781,629
Contingency Cost (25% of Construction Cost)	$ 176,208	$ 19,199	$ 195,407
Engineering Design Cost (5% of Construction Cost)	$ 35,242	$ 3,840	$ 39,081
Total Construction Cost	$ 916,283	$ 99,835	$ 1,016,118

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	5.4	$100,000	$ 540,000
Basin	7.3	$100,000	$ 730,000
Other		$100,000	$ -
Total	12.7	$100,000	$ 1,270,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	7.3	$100,000	$ 730,000
LC Enhancement Cost	acre	5.4	$100,000	$ 540,000
Total Land Cost	acre	12.7	$100,000	$ 1,270,000

Total Cost

Base Total Cost	$ 2,288,470
Total LC Enhancement Cost	$ 1,097,270
Total Cost Including LC Enh.	$ 3,385,740

Open Channel

Structure ID	RR13010	HEC1 ID	13035I

Longitundal Geometry

Length	1235.4	ft
U/S Elev	1728.2	ft
D/S Elev	1697.0	ft
Initial Channel Slope	0.0252	ft/ft
Long-term Channel Slope	0.0120	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	1

Initial Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	0	3	25	4	3	0	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	12	12	37	37	37	49
Y	104	100	100	100	100	100	100	104

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	0	3	25	4	3	0	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	12	12	37	37	37	49
Y	104	100	100	100	100	100	100	104

Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	RR130	S135							TOTAL
HEC1 Peak-Flow	42	1102							1144
Weighting Factor	1.00	0.04							
Flow into Channel	42	40							82

Reach Sediment Inflow Characteristics

U/S Contributing ID	150130_RR1501 0								TOTAL
HEC1 Flow Volume (ac. ft)	62.00								62
Sediment Conc. (ppm)	3497								
Sediment Volume (ac. ft)	0.08								0.08
Weighting Factor	1								
Weighted Sed. Vol. (ac. ft)	0.08								0.08

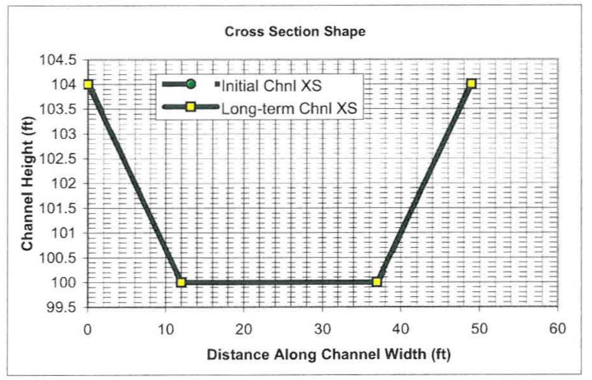
Hydrology

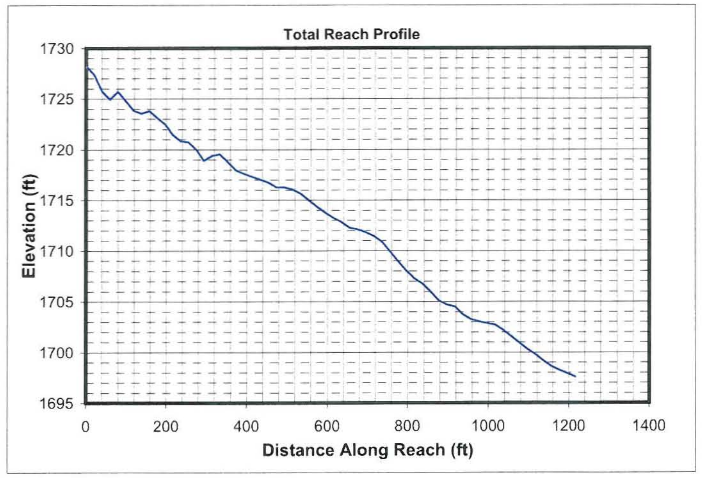
Drainage Area	1.08	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	82	cfs	
Long-term Max. Chnl Capacity	1102	cfs	
Q2 Channel	8	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	49	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			





Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
8	26.2	4.8	0.2	100.0	100.2	1.7	0.2	26.1	0.2	0.14	0.70
21	27.1	8.5	0.3	100.0	100.3	2.4	0.3	27.0	0.3	0.24	0.76
62	29.0	16.8	0.6	100.0	100.6	3.7	0.6	28.8	0.6	0.47	0.84
82	29.7	20.2	0.7	100.0	100.7	4.1	0.7	29.4	0.7	0.55	0.87

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
8	26.5	6.1	0.2	100.0	100.2	1.4	0.2	26.4	0.2	0.18	0.50
21	27.6	10.7	0.4	100.0	100.4	1.9	0.4	27.4	0.4	0.30	0.54
62	29.9	21.3	0.7	100.0	100.8	2.9	0.8	29.7	0.7	0.58	0.60
82	30.8	25.6	0.8	100.0	100.9	3.2	0.9	30.5	0.8	0.69	0.62

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
	150130_RR15010									
8	112									112
21	341									341
62	1350									1350
82	1961									1961

Allowable Velocity

Channel Lining	Natural - Fine Gravel										
Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
8	1.74	0.8743	0.8306	Erosive	Erosive	Erosive	0.2	Stable	2.5	Stable	Stable
21	1.74	1.0383	0.9864	Erosive	Erosive	Erosive	0.2	Stable	3.5	Stable	Stable
62	1.74	1.2297	1.1682	Erosive	Erosive	Erosive	0.3	Stable	5.4	Stable	Stable
82	1.74	1.2787	1.2148	Erosive	Erosive	Erosive	0.3	Stable	6.0	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	8	21	62	82	8	21	62	82	8	21	62	82
Bray - Equation #1	7	12	21	24	0.5	0.7	1.0	1.2	2.1	2.4	2.8	2.9
Bray - Equation #2	9	15	27	32	0.6	0.8	1.2	1.3	1.5	1.7	1.9	2.0
Hey	2	3	6	7	1.4	2.0	3.1	3.4				
Ackers & Charlton/Lacey	9	13	20	23					1.1	1.3	1.6	1.7
Parker	20	31	54	62	0.3	0.5	0.8	0.9				
Chang	12	22	43	51	0.1	0.1	0.0	0.0				
Kellerhals	5	8	14	16	0.6	0.9	1.4	1.6	2.5	2.8	3.1	3.2
AMAFCA/Schumm	26	27	30	31								
Moody & Odem	13	13	13	13	1.0	1.0	1.0	1.0				
BUREC	5.0	7.0	10.6	11.8	1	2	3	3	2.0	2.5	3.2	3.5
Average	11	15	24	27	0.7	1.0	1.4	1.6	1.8	2.1	2.5	2.7
Values As Designed	26	27	30	31	0.2	0.4	0.8	0.9	1.4	1.9	2.9	3.2
Difference with Design	-16	-12	-6	-3	0.5	0.6	0.6	0.6	0.5	0.2	-0.4	-0.6

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
8	90	64	150	169	376	32	30	12	565	38	90	147
21	364	209	470	786	573	143	105	67	1493	111	391	428
62	1919	762	1501	4863	910	675	356	360	4589	479	1873	1662
82	2949	1052	1945	7796	1025	998	477	536	6138	709	2757	2398

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
8	4061	2894	6775	7657	17010	1465	1378	533	25547	1699	4052	6643
21	6579	3786	8512	14225	10374	2589	1907	1216	27018	2012	7078	7754
62	11576	4597	9054	29333	5490	4074	2146	2169	27684	2887	11300	10028
82	13344	4759	8799	35273	4637	4515	2160	2423	27769	3207	12474	10851

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
8	32	20	31	49	240	2	4	2	154	11	26	52
21	128	80	158	228	395	34	32	20	457	36	138	155
62	671	329	602	1394	667	192	136	138	1469	162	752	592
82	1028	463	826	2228	761	288	188	213	1975	242	1135	850

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
8	1439	905	1391	2228	10878	106	197	92	6965	517	1157	2352
21	2321	1452	2853	4119	7149	612	575	365	8269	653	2503	2807
62	4047	1983	3629	8411	4024	1158	819	832	8861	977	4539	3571
82	4651	2095	3736	10080	3442	1302	850	964	8938	1095	5133	3844

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
8	0.0042	0.0066	127	0.39	0.046	0.0014	30	0.035	0.0010	0.0159	0.0014	0.0033	0.0173	0.0015	0.0067	0.0251	0.0118
21	0.0021	0.0039	165	0.50	0.049	0.0008	30	0.036	0.0006	0.0159	0.0008	0.0019	0.0173	0.0010	0.0034	0.0251	0.0113
62	0.0010	0.0021	225	0.69	0.052	0.0005	31	0.036	0.0003	0.0159	0.0004	0.0010	0.0173	0.0006	0.0015	0.0250	0.0110
82	0.0008	0.0018	244	0.74	0.052	0.0004	31	0.036	0.0003	0.0159	0.0004	0.0008	0.0173	0.0005	0.0012	0.0250	0.0109

Drop Structures

Design Slope	0.0120	ft/ft
Total Drop Needed	16.4	ft
Height of Drop Structure	3	ft
No . of Drop Structures	6	
Distance between structs.	206	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.03	sq. mi
Total Sediment Yield Volume	0.06	ac ft

Sedimentation Basins

Length	206 ft	Depth	3 ft
Width	49 ft	Side slope	3 ft/ft
Total Volume per Basin		0.54	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
8	1.1	-0.1	0.0	24.6	0.2	0.2	1.4	0.0120	0.0	1.5	1.0	3.3
21	1.1	-0.1	0.1	24.6	0.4	0.4	1.9	0.0120	0.0	1.5	1.0	3.3
62	1.1	-0.2	0.1	24.6	0.8	0.7	2.9	0.0120	0.1	1.5	1.0	3.4
82	1.1	-0.3	0.1	24.6	0.9	0.8	3.2	0.0120	0.1	1.5	1.0	3.5

Toe Protection Needed	4.0	ft

HEC1 Results For Open Channel

Peak Flow	42	cfs
Stage at Peak Flow	100.5	ft
Flow Volume	81.0	ac. ft

Freeboard

Max. Flow Depth	0.7	ft
Channel Depth as designed	4.0	ft
Available Freeboard	3.3	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	0.14	ac. ft
Outflowing Sediment Volume	0.12	ac. ft
Deposited(+)/Eroded(-) Volume	0.03	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	1235	1235
Side Slope (?H:1V)	3	3
Channel Width (ft)	49	49
Channel XS Area (sq. ft)	148	148
Channel Perimeter (ft)	50	50

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	1235	ft
Thickness	1.5	ft
Protection Depth	4	ft
Tie-in Length/Depth	3.0	ft
Total Depth	7.0	ft
Area needed	412	sq. Yd
Volume	961	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	1235	1235
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4	5
Left Levee Surface Area (sq. Yd)	5352	11115
Left Levee Volume (cu. Yd)	4757	11435
Right Levee Length (ft)	1235	1235
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/t)	3	6
Right Levee Height (ft)	4	5
Right Levee Surface Area (sq. Yd)	5352	11115
Right Levee Volume (cu. Yd)	4757	11435
Total Levee Surface Area (sq. Yd)	10704	22230
Total Levee Volume (cu. Yd)	9514	22870

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	1235	1235
Left Levee Lining Width (ft)	13	30
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	1784	4117
Left Levee Lining Volume (cu. Yd)	892	2058
Right Levee Length (ft)	1235	1235
Right Levee Lining Width (ft)	13	30
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	1784	4117
Right Levee Lining Volume (cu. Yd)	892	2058
Total Lining Area (sq. Yd)	3568	8233
Total Lining Volume (cu. Yd)	1784	4116

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	49	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	4.1	ft
Structure Height	7.1	ft
Number of Structures	6	
Volume per structure	39	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 2,925	
Area per structure	16	sq. Yd
Total Area	98	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	871	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 3,484	
Other Cost	$ -	
Total cost per basin	$ 3,484	
Area per basin	1,121	sq. Yd
Total Area	1,121	sq. Yd

Structure Type	Structure Type	Excavation/Construction Quantity	Units	Unit Cost	Cost Subtotal	Landscape Quantity	Units	Unit Cost	Landscape Cost	Maintenance Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	9,514	cu. Yd	$ 7.00	$ 66,598	10,704	sq. Yd	$ 9.00	$ 96,336	10,704	sq. Yd	$ 11.67	$ 124,880
Levee - LC Enhancement	Fill	13,356	cu. Yd	$ 7.00	$ 93,492	11,526	sq. Yd	$ 9.00	$ 103,734	13,356	sq. Yd	$ 11.67	$ 155,820
Levee Lining	Riprap	1,784	cu. Yd	$ 75.00	$ 133,800	3,568	sq. Yd	$ -	$ -	3,568	sq. Yd	$ 20.83	$ 74,329
Levee Lining -LC Enhancement	Riprap	2,332	cu. Yd	$ 75.00	$ 174,900	4,666	sq. Yd	$ -	$ -	4,666	sq. Yd	$ 20.83	$ 97,199
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	961	cu. Yd	$ 75.00	$ 72,075	412	sq. Yd	$ -	$ -	412	sq. Yd	$ 25.00	$ 10,300
Drop Structures	Riprap	6	EA	$ 2,925.00	$ 17,550	98	sq. Yd	$ -	$ -	98	sq. Yd	$ 33.33	$ 3,267
Drop Str. - LC Enhancement	Riprap	6	EA	$ 292.50	$ 1,755	10	sq. Yd	$ -	$ -	10	sq. Yd	$ 33.33	$ 327
Sedimentation Basins		1	EA	$ 3,484.00	$ 3,484	1,121	sq. Yd	$ -	$ -	1,121	sq. Yd	$ 8.33	$ 9,342
Other					$ -				$ -				$ -

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 293,507	$ 270,147	$ 563,654
Contingency Cost (25% of Construction Cost)	$ 73,377	$ 67,537	$ 140,914
Engineering Design Cost (5% of Construction Cost)	$ 14,675	$ 13,507	$ 28,183
Total Construction Cost	$ 381,559	$ 351,191	$ 732,750

Base Landscape Cost	$ 96,336
LC Enhancement Cost	$ 103,734
Total Landscape Cost	$ 200,070

Base Maintenance Cost	$ 222,117
LC Enhancement Cost	$ 253,346
Total Maintenance Cost	$ 475,463

Land Cost

Channel Length	1235 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	49	1.4	$100,000	$ 140,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	52	1.5	$100,000	$ 150,000
Levee LC Enhancement	48	1.4	$100,000	$ 140,000
Other	0	0	$100,000	$ -
Total	149	4.3		$ 430,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	2.9	$100,000	$ 290,000
LC Enhancement Cost	acre	1.4	$100,000	$ 140,000
Total Land Cost	acre	4.3	$100,000	$ 430,000

Total Cost

Base Total Cost	$ 990,012
Total Landscape Enhancement Cost	$ 848,271
Total Cost Including LC Enh.	$ 1,838,283

Open Channel

Structure ID	C135L10	HEC1 ID	351135

Longitundal Geometry

Length	12096.9	ft
U/S Elev	1697.0	ft
D/S Elev	1496.9	ft
Initial Channel Slope	0.0165	ft/ft
Long-term Channel Slope	0.0060	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	8

Initial Channel XS Geometry

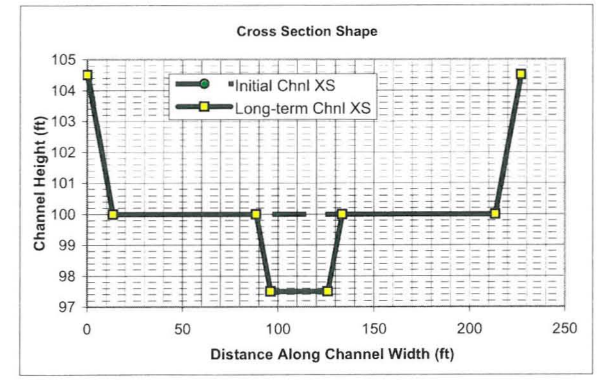
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	200	4.5	3	0	4.5	3

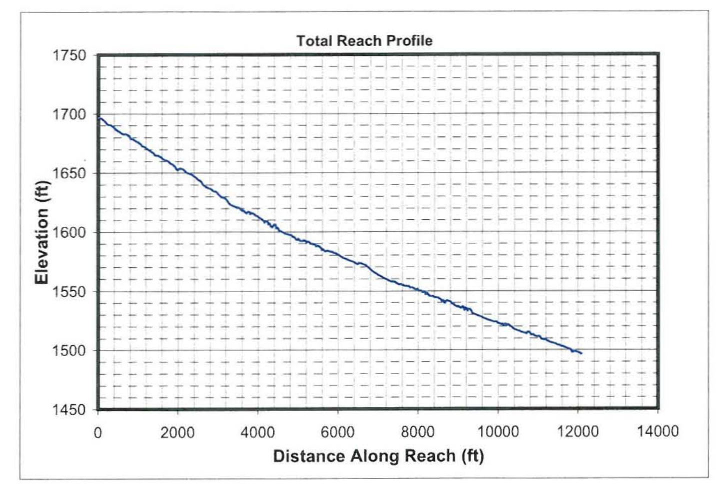
PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	213.5	213.5	213.5	227
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	75	3	30	7	3	80	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	88.5	96	126	133.5	213.5	227
Y	104.5	100	100	97.5	97.5	100	100	104.5





Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	C135L									TOTAL
HEC1 Peak-Flow	1003									1003
Weighting Factor	1.00									
Flow into Channel	1003									1003

Reach Sediment Inflow Characteristics

U/S Contributing ID	12535I_RR12510	13035I_RR130 10								TOTAL
HEC1 Flow Volume (ac. ft)	7.00	81.00								88
Sediment Conc. (ppm)	3306	3844								
Sediment Volume (ac. ft)	0.01	0.12								0.13
Weighting Factor	1	1								
Weighted Sed. Vol. (ac. ft)	0.01	0.12								0.13

Hydrology

Drainage Area	2.06	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	1003	cfs	
Long-term Max. Chnl Capacity	7480	cfs	
Q2 Channel	100	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	227	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
100	201.8	55.6	0.3	100.0	100.3	1.8	0.3	201.7	0.3	0.10	0.60
251	203.0	96.6	0.5	100.0	100.5	2.6	0.5	202.9	0.5	0.18	0.66
752	205.9	187.8	0.9	100.0	100.9	4.0	0.9	205.6	0.9	0.35	0.74
1003	207.0	223.6	1.1	100.0	101.1	4.5	1.1	206.6	1.1	0.41	0.76

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
100	37.3	38.3	1.0	97.5	98.6	2.6	1.1	36.9	1.0	0.43	0.45
251	42.3	70.0	1.7	97.5	99.5	3.6	2.0	41.7	1.7	0.73	0.49
752	205.8	254.6	1.2	97.5	100.8	3.0	3.3	204.8	1.2	1.23	0.47
1003	207.3	303.4	1.5	97.5	101.0	3.3	3.5	206.2	1.5	1.32	0.48

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)								TOTAL
	12535I_RR12510	13035I_RR130 10							
100	40	52							92
251	120	155							275
752	455	592							1047
1003	651	850							1500

Allowable Velocity

Channel Lining	Natural - Fine Gravel			

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
100	1.74	0.9984	0.9484	Erosive	Erosive	Erosive	0.2	Stable	4.9	Stable	Stable
251	1.74	1.1668	1.1084	Erosive	Erosive	Erosive	0.2	Stable	7.0	Stable	Stable
752	1.74	1.3675	1.2992	Erosive	Erosive	Erosive	0.3	Stable	8.6	Stable	Stable
1003	1.74	1.4199	1.3489	Erosive	Erosive	Erosive	0.3	Stable	9.2	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

Discharge (cfs)	Channel Width (ft) 100	251	752	1003	Flow Depth (ft) 100	251	752	1003	Velocity (ft/s) 100	251	752	1003
Bray - Equation #1	27	44	78	91	1.2	1.7	2.4	2.7	3.0	3.4	4.0	4.2
Bray - Equation #2	35	57	102	119	1.4	1.8	2.6	2.9	2.1	2.4	2.7	2.9
Hey	8	13	25	29	3.7	5.3	8.0	8.9				
Ackers & Charlton/Lacey	25	37	58	66					1.7	2.0	2.4	2.5
Parker	69	109	188	218	0.9	1.4	2.2	2.4				
Chang	46	80	157	187	0.1	0.0	-0.3	-0.4				
Kellerhals	18	29	49	57	1.7	2.5	3.8	4.3	3.2	3.5	4.0	4.1
AMAFCA/Schumm	37	42	205	206								
Moody & Odem	16	16	16	16	1.1	1.1	1.1	1.1				
BUREC	14.5	20.4	30.8	34.3	4	5	8	9	2.8	3.6	4.7	5.0
Average	30	45	91	102	1.8	2.4	3.5	3.9	2.6	3.0	3.6	3.7
Values As Designed	37	42	205	206	1.1	2.0	3.3	3.5	2.6	3.6	3.0	3.3
Difference with Design	-7	3	-114	-104	0.6	0.4	0.2	0.3	0.0	-0.6	0.6	0.4

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
100	790	525	1113	1424	2855	236	224	111	3628	256	821	1089
251	3253	1753	3540	6733	4298	1071	792	628	9663	861	3596	3290
752	17702	6497	11261	43191	6605	5171	2685	3388	29783	4064	17613	13451
1003	27540	9011	14610	70181	7342	7702	3605	5073	39844	6151	26140	19745

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
100	2922	1941	4115	5268	10562	874	829	412	13418	948	3037	4030
251	4812	2594	5237	9963	6359	1585	1171	929	14297	1273	5320	4867
752	8731	3204	5554	21301	3257	2550	1324	1671	14689	2004	8686	6634
1003	10187	3333	5404	25959	2716	2849	1333	1876	14738	2275	9669	7304

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
100	484	251	414	876	662	104	86	108	818	106	567	407
251	1851	763	1120	3812	1040	388	253	430	2128	392	2123	1300
752	4317	1959	3239	8116	4176	932	707	998	6252	923	5057	3334
1003	6710	2822	4415	13170	4716	1429	998	1562	8447	1414	7776	4860

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
100	1791	927	1532	3240	2450	385	317	401	3025	393	2099	1505
251	2739	1129	1658	5639	1538	574	375	636	3149	579	3141	1923
752	2129	966	1597	4003	2060	460	349	492	3084	455	2494	1644
1003	2482	1044	1633	4871	1744	529	369	578	3125	523	2876	1798

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
100	0.0029	0.0044	126	0.38	0.046	0.0009	30	0.035	0.0007	0.0159	0.0009	0.0022	0.0075	0.0005	0.0032	0.0165	0.0067
251	0.0015	0.0025	165	0.50	0.049	0.0006	30	0.036	0.0004	0.0159	0.0005	0.0012	0.0075	0.0003	0.0016	0.0165	0.0064
752	0.0007	0.0013	229	0.70	0.052	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0006	0.0075	0.0002	0.0007	0.0165	0.0062
1003	0.0005	0.0011	249	0.76	0.053	0.0003	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0075	0.0002	0.0006	0.0165	0.0062

Drop Structures

Design Slope	0.0060	ft/ft
Total Drop Needed	127.6	ft
Height of Drop Structure	3	ft
No . of Drop Structures	43	
Distance between structs.	281	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.81	sq. mi
Total Sediment Yield Volume	1.55	ac ft

Sedimentation Basins

Length	281 ft	Depth	3 ft
Width	227 ft	Side slope	3 ft/ft
Total Volume per Basin		4.09	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		2	

Scour and Toe Protection (Not applicable for concrete channel)

		Pima County General Scour Equations							Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
100	1.1	-0.4	0.1	24.6	1.1	1.0	2.6	0.0060	0.1	1.5	2.5	5.4
251	1.1	-0.6	0.2	24.6	2.0	1.7	3.6	0.0060	0.2	1.5	2.5	5.6
752	1.1	-1.0	0.1	24.6	3.3	1.2	3.0	0.0060	0.4	1.5	2.5	5.7
1003	1.1	-1.0	0.1	24.6	3.5	1.5	3.3	0.0060	0.4	1.5	2.5	5.8

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	53	cfs
Stage at Peak Flow	100.2	ft
Flow Volume	86.0	ac. ft

Freeboard

Max. Flow Depth	1.1	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.4	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	1.67	ac. ft
Outflowing Sediment Volume	0.06	ac. ft
Deposited(+)/Eroded(-) Volume	1.61	ac. ft

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

Sub-area: Wagner Wash, Alternative: B41
Open Channel Structure ID: C135L10

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	12097	12097
Side Slope (?H:1V)	3	3
Channel Width (ft)	227	227
Channel XS Area (sq. ft)	1054.5	1054.5
Channel Perimeter (ft)	229	229

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	12097	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	4032	sq. Yd
Volume	12097	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	12097	12097
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	56453	116938
Left Levee Volume (cu. Yd)	55557	130827
Right Levee Length (ft)	12097	12097
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	56453	116938
Right Levee Volume (cu. Yd)	55557	130827
Total Levee Surface Area (sq. Yd)	112906	233876
Total Levee Volume (cu. Yd)	111114	261654

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	12097	12097
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	18818	44356
Left Levee Lining Volume (cu. Yd)	9409	22178
Right Levee Length (ft)	12097	12097
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	18818	44356
Right Levee Lining Volume (cu. Yd)	9409	22178
Total Lining Area (sq. Yd)	37635	88711
Total Lining Volume (cu. Yd)	18818	44356

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	227	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	5.8	ft
Structure Height	8.8	ft
Number of Structures	43	
Volume per structure	222	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 16,650	
Area per structure	76	sq. Yd
Total Area	3,254	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	2	
Total Volume per Basin	6599	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 26,396	
Other Cost	$ -	
Total cost per basin	$ 26,396	
Area per basin	7,096	sq. Yd
Total Area	14,192	sq. Yd

Structure Type	Structure Type	Excavation/Construction Quantity	Units	Unit Cost	Cost Subtotal	Landscape Quantity	Units	Unit Cost	Landscape Cost	Maintenance Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	111,114	cu. Yd	$ 7.00	$ 777,798	112,906	sq. Yd	$ 9.00	$ 1,016,154	112,906	sq. Yd	$ 11.67	$ 1,317,237
Levee - LC Enhancement	Fill	150,540	cu. Yd	$ 7.00	$ 1,053,780	120,970	sq. Yd	$ 9.00	$ 1,088,730	150,540	sq. Yd	$ 11.67	$ 1,756,300
Levee Lining	Riprap	18,818	cu. Yd	$ 75.00	$ 1,411,350	37,635	sq. Yd	$ -	$ -	37,635	sq. Yd	$ 20.83	$ 784,065
Levee Lining -LC Enhancement	Riprap	25,538	cu. Yd	$ 75.00	$ 1,915,350	51,076	sq. Yd	$ -	$ -	51,076	sq. Yd	$ 20.83	$ 1,064,088
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	12,097	cu. Yd	$ 75.00	$ 907,275	4,032	sq. Yd	$ -	$ -	4,032	sq. Yd	$ 25.00	$ 100,800
Drop Structures	Riprap	43	EA	$ 16,650.00	$ 715,950	3,254	sq. Yd	$ -	$ -	3,254	sq. Yd	$ 33.33	$ 108,467
Drop Str. - LC Enhancement	Riprap	43	EA	$ 1,665.00	$ 71,595	325	sq. Yd	$ -	$ -	325	sq. Yd	$ 33.33	$ 10,847
Sedimentation Basins		2	EA	$ 26,396.00	$ 52,792	14,192	sq. Yd	$ -	$ -	14,192	sq. Yd	$ 8.33	$ 118,267
Other					$ -				$ -				$ -

Base Landscape Cost	$ 1,016,154	Base Maintenance Cost	$ 2,428,835
LC Enhancement Cost	$ 1,088,730	LC Enhancement Cost	$ 2,831,235
Total Landscape Cost	$ 2,104,884	Total Maintenance Cost	$ 5,260,069

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 3,865,165	$ 3,040,725	$ 6,905,890
Contingency Cost (25% of Construction Cost)	$ 966,291	$ 760,181	$ 1,726,473
Engineering Design Cost (5% of Construction Cost)	$ 193,258	$ 152,036	$ 345,295
Total Construction Cost	$ 5,024,715	$ 3,952,943	$ 8,977,657

Land Cost

Channel Length	12097 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	227	63	$100,000	$ 6,300,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	15.3	$100,000	$ 1,530,000
Levee LC Enhancement	51	14.2	$100,000	$ 1,420,000
Other	0	0	$100,000	$ -
Total	333	92.5		$ 9,250,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	78.3	$100,000	$ 7,830,000
LC Enhancement Cost	acre	14.2	$100,000	$ 1,420,000
Total Land Cost	acre	92.5	$100,000	$ 9,250,000

Total Cost

Base Total Cost	$ 16,299,703
Total Landscape Enhancement Cost	$ 9,292,907
Total Cost Including LC Enh.	$ 25,592,610

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

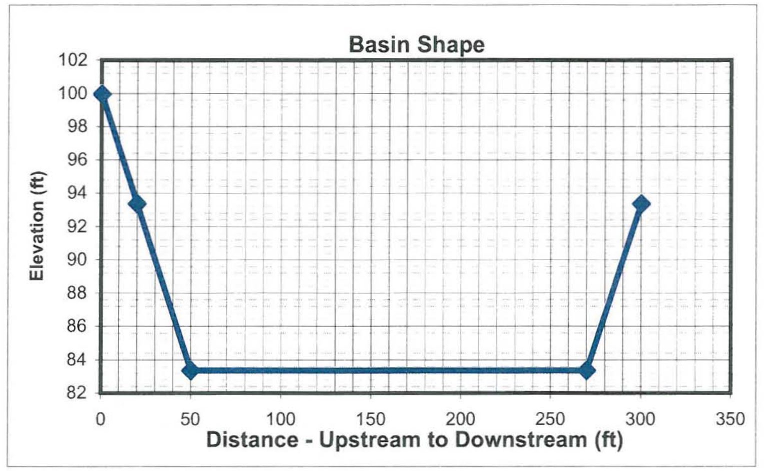
Sub-area: Wagner Wash, Alternative: B41
Open Channel Structure ID: C135L10

Online Basin

HEC1 ID	RR165

HEC1 Results Used to Determine Sediment Volume From Upstream

Contributing HEC1 ID							Total Volume (ac. ft)
Inflow Volume (ac. ft)							0
Volume Fraction							
Weighted Volume							0
Sediment Conc. (ppm)							
Sediment Volume (ac. ft)							0.00
Weighting Factor							
Weighted Sed. Vol. (ac. ft)							0.00



Sediment Yield

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.6	sq. mi
Total Sediment Yield Volume	1.2	ac ft

Required Minimum Sediment Volume

Sediment Volume	1.2	ac. ft

Geometry	Base	LC Enhanced
Topography slope (ft/ft)	0.022	0.022
Basin Length (ft)	800	1040
Basin Width (ft)	300	300
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	10	10
Freeboard (ft)	1	1
Effective Basin Width (ft)	280	260
Top Area (acres)	5.5	7.2
U/S-D/S Height Difference (ft)	6.6	6.6
Excess Area on Upstream (acres)	0.4	1.0

			Base	LC Enhanced
Bottom Length (ft)	740	Allocated Storage Volume (ac. ft)	39.2	39.2
Bottom Width (ft)	220	Total Available Volume (ac. ft) (incl. Freeboard)	44.3	45.3
		Total Excavation Volume (ac. ft)	62.5	68.9

HEC1 Results

	6-hr Event	24-hr Event	Maximum
Total Flow Volume entering Basin (ac. ft)	47.0	40	47.0
Peak Inflow (cfs)	1008	842	1008.0
Peak Outflow (cfs)	100	91	100.0
Stage at Peak Outflow (ft)	8.7	7.2	8.7
Volume at Peak Outflow (ac. ft)	37.6	30.3	37.6

Volume Check

Total Volume needed	38.8	ac. ft
Total Volume Provided	39.2	ac. ft
Volume OK?	Yes	

Stage Check

Depth Needed	9.7	ft
Depth Provided	10	ft
Depth OK?	Yes	

Basin Outlet

Outlet Coeff	0.60	(0.6 for Orifice, 3.0 for Weir)
D (Orifice) or W (Weir)	3.00	ft
Invert Elevation	0.00	ft
Number of pipes	1	

Stage-Storage-Discharge

Elevation	0	1	3	5	6	7	8	9	10	12
Volume	0.00	3.80	11.81	20.37	24.86	29.50	34.27	39.19	44.26	54.85
Outflow	0.0	34.0	59.0	76.1	83.4	90.0	96.3	102.1	107.6	117.9

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
LC Enhancement Buffer	216000	sq. ft
Other		sq. ft

Additional ROW Length	0	ft
Additional ROW Width	0	ft
Landscaping Buffer Length	100	ft
Landscaping Buffer Width	100	ft

Base Total ROW Length	800	ft
Base Total ROW Width	300	ft
LC Enh. Total ROW Length	1140	ft
LC Enh. Total ROW Length	400	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	100833	111159
Excavated Area (sq. Yd)	26667	50667

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	52	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	583	sq. Yd
Material Volume	292	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	588	ft
Unit Cost	160	per ft
Cost per outlet	$94,080	
Other Cost	$ -	
Total Cost	$94,080	
Outlet Area	133	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Basin		100,833	cu. Yd	$ 4.00	$ 403,332	26,667	sq. Yd	$ 9.00	$ 240,003	26,667	sq. Yd	$ 8.33	$ 222,225
Basin - LC Enhancement		10,326	cu. Yd	$ 4.00	$ 41,304	24,000	sq. Yd	$ 9.00	$ 216,000	24,000	sq. Yd	$ 8.33	$ 200,000
Inlet	Riprap	292	sq. Yd	$ 75.00	$ 21,900	583	sq. Yd	$ -	$ -	583	sq. Yd	$ 33.33	$ 19,433
Inlet - LC Enhancement (20%Inlet)					$ 4,380				$ -				$ 3,887
Outlet	Pipe	1	EA	$ 94,080	$ 94,080	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhancement (5% Outlet)					$ 4,704				$ -				$ 111
Other					$ -				$ -				$ -

Base Landscape Cost	$ 240,003	Base Maintenance Cost	$ 243,875
LC Enh. Landscape Cost	$ 216,000	LC Enh. Maintenance Cost	$ 203,998
Total Landscape Cost	$ 456,003	Total Maintenance Cost	$ 447,873

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 519,312	$ 41,304	$ 560,616
Contingency Cost (25% of Construction Cost)	$ 129,828	$ 10,326	$ 140,154
Engineering Design Cost (5% of Construction Cost)	$ 25,966	$ 2,065	$ 28,031
Total Construction Cost	$ 675,106	$ 53,695	$ 728,801

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	5.0	$100,000	$ 500,000
Basin	5.5	$100,000	$ 550,000
Other		$100,000	$ -
Total	10.5	$100,000	$ 1,050,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	5.5	$100,000	$ 550,000
LC Enhancement Cost	acre	5.0	$100,000	$ 500,000
Total Land Cost	acre	10.5	$100,000	$ 1,050,000

Total Cost

Base Total Cost	$ 1,708,984
Total LC Enhancement Cost	$ 973,693
Total Cost Including LC Enh.	$ 2,682,676

Open Channel

Structure ID	C17510A		HEC1 ID	165175

Longitundal Geometry

Length	7076.2	ft
U/S Elev	1674.9	ft
D/S Elev	1546.4	ft
Initial Channel Slope	0.0182	ft/ft
Long-term Channel Slope	0.0070	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	8

Initial Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	140	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	153.5	153.5	153.5	167
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	48	3	30	6.5	3	50	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	61.5	67.5	97.5	103.5	153.5	167
Y	104.5	100	100	98	98	100	100	104.5

Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	RR165	S170								TOTAL
HEC1 Peak-Flow	100	1802								1902
Weighting Factor	1.00	0.41								
Flow into Channel	100	740								840

Reach Sediment Inflow Characteristics

U/S Contributing ID										TOTAL
HEC1 Flow Volume (ac. ft)										0
Sediment Conc. (ppm)										
Sediment Volume (ac. ft)										0.00
Weighting Factor										
Weighted Sed. Vol. (ac. ft)										0.00

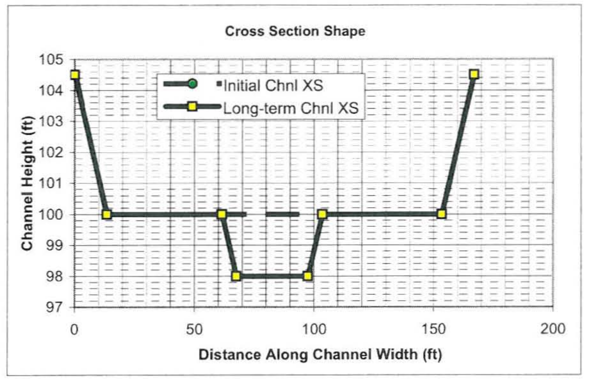
Hydrology

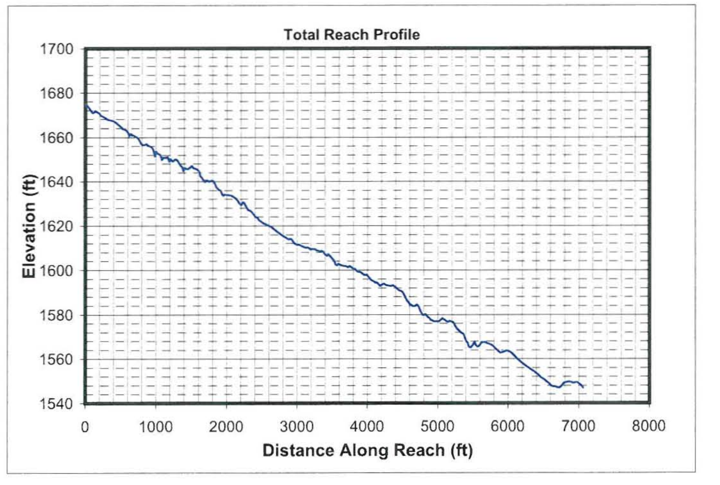
Drainage Area	1.217	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	840	cfs	
Long-term Max. Chnl Capacity	5768	cfs	
Q2 Channel	84	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	167	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			





Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
84	141.9	42.3	0.3	100.0	100.3	2.0	0.3	141.8	0.3	0.13	0.64
210	143.3	73.4	0.5	100.0	100.5	2.9	0.5	143.1	0.5	0.23	0.70
630	146.3	143.2	1.0	100.0	101.0	4.4	1.0	146.0	1.0	0.44	0.78
840	147.5	170.7	1.2	100.0	101.2	4.9	1.2	147.1	1.2	0.52	0.80

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
84	36.2	32.6	0.9	98.0	99.0	2.6	1.0	35.9	0.9	0.43	0.48
210	40.7	59.1	1.5	98.0	99.7	3.6	1.7	40.1	1.5	0.74	0.52
630	145.9	190.4	1.3	98.0	100.8	3.3	2.8	145.0	1.3	1.24	0.51
840	147.5	227.3	1.5	98.0	101.1	3.7	3.1	146.5	1.6	1.35	0.52

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
84										0
210										0
630										0
840										0

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow) Permissive Velocity (ft/s): Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	BUREC Erosive?	Neill (gravel/cobble) Non-cohesive: Erosive?	All'ble Vel (ft/s)	Cohesive: Erosive?	All'ble Vel (ft/s)	USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
84	1.74	1.0221	0.9710	Erosive	Erosive	Erosive	0.2	Stable	4.8	Stable	Stable
210	1.74	1.1897	1.1302	Erosive	Erosive	Erosive	0.3	Stable	6.9	Stable	Stable
630	1.74	1.3895	1.3200	Erosive	Erosive	Erosive	0.3	Stable	8.7	Stable	Stable
840	1.74	1.4413	1.3693	Erosive	Erosive	Erosive	0.3	Stable	9.4	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	**84**	**210**	**630**	**840**	**84**	**210**	**630**	**840**	**84**	**210**	**630**	**840**
Bray - Equation #1	25	40	71	83	1.2	1.6	2.3	2.5	2.9	3.3	3.9	4.1
Bray - Equation #2	32	52	93	109	1.3	1.7	2.5	2.7	2.0	2.3	2.7	2.8
Hey	7	12	22	26	3.5	4.9	7.5	8.3				
Ackers & Charlton/Lacey	23	34	54	61					1.7	2.0	2.3	2.5
Parker	63	100	172	199	0.9	1.3	2.0	2.3				
Chang	43	76	148	176	0.1	0.0	-0.3	-0.4				
Kellerhals	16	26	45	52	1.6	2.3	3.6	4.0	3.2	3.5	3.9	4.0
AMAFCA/Schumm	36	40	145	147								
Moody & Odem	13	13	13	13	1.0	1.0	1.0	1.0				
BUREC	13.1	18.5	28.0	31.2	4	5	7	8	2.9	3.6	4.7	5.1
Average	27	41	79	90	1.6	2.2	3.2	3.6	2.5	2.9	3.5	3.7
Values As Designed	36	40	145	147	1.0	1.7	2.8	3.1	2.6	3.6	3.3	3.7
Difference with Design	-9	1	-66	-57	0.6	0.5	0.4	0.5	0.0	-0.6	0.2	0.0

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
84	828	532	1158	1572	2292	276	243	133	3593	259	889	1071
210	3415	1707	3404	7418	3393	1147	779	669	9405	884	3697	3265
630	18438	6136	10224	47333	5173	5372	2522	3378	28784	4172	17422	13541
840	28640	8468	13380	76770	5747	7982	3366	5007	38473	6304	25655	19981

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
84	3657	2349	5116	6943	10123	1221	1073	587	15868	1145	3928	4728
210	6033	3017	6013	13106	5994	2027	1377	1182	16616	1561	6531	5769
630	10858	3614	6021	27874	3046	3163	1485	1989	16950	2457	10259	7974
840	12650	3740	5910	33907	2538	3525	1487	2212	16992	2784	11331	8825

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
84	463	243	421	851	653	106	87	100	866	105	539	403
210	1785	739	1131	3738	1016	397	256	402	2251	385	2023	1284
630	4898	2063	3341	9856	3407	1107	757	1108	6710	1056	5615	3629
840	7596	2935	4611	15955	3836	1670	1046	1701	9026	1615	8521	5319

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
84	2046	1073	1858	3760	2885	470	384	443	3827	462	2380	1781
210	3153	1306	1997	6604	1795	702	452	711	3976	680	3574	2268
630	2884	1215	1967	5804	2006	652	446	652	3951	622	3306	2137
840	3355	1297	2036	7047	1694	738	462	751	3987	713	3763	2349

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
84	0.0026	0.0041	137	0.42	0.047	0.0009	30	0.036	0.0006	0.0159	0.0009	0.0020	0.0080	0.0005	0.0029	0.0181	0.0072
210	0.0013	0.0024	180	0.55	0.050	0.0005	30	0.036	0.0004	0.0159	0.0005	0.0011	0.0080	0.0003	0.0015	0.0182	0.0069
630	0.0006	0.0012	248	0.76	0.053	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0006	0.0080	0.0002	0.0006	0.0181	0.0067
840	0.0005	0.0010	270	0.82	0.053	0.0003	32	0.036	0.0002	0.0159	0.0002	0.0005	0.0080	0.0002	0.0005	0.0181	0.0067

Drop Structures

Design Slope	0.0070	ft/ft
Total Drop Needed	79.0	ft
Height of Drop Structure	3	ft
No . of Drop Structures	27	
Distance between structs.	262	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.60	sq. mi
Total Sediment Yield Volume	1.14	ac ft

Sedimentation Basins

Length	262 ft	Depth	3 ft
Width	167 ft	Side slope	3 ft/ft
Total Volume per Basin		2.76	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		2	

Scour and Toe Protection (Not applicable for concrete channel)

Discharge	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
84	1.1	-0.3	0.1	24.6	1.0	0.9	2.6	0.0070	0.1	1.5	2.0	4.7
210	1.1	-0.5	0.2	24.6	1.7	1.5	3.6	0.0070	0.2	1.5	2.0	4.9
630	1.1	-0.8	0.1	24.6	2.8	1.3	3.3	0.0070	0.3	1.5	2.0	5.0
840	1.1	-0.8	0.2	24.6	3.1	1.6	3.7	0.0070	0.3	1.5	2.0	5.1

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	90	cfs
Stage at Peak Flow	100.3	ft
Flow Volume	47.0	ac. ft

Freeboard

Max. Flow Depth	1.2	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.3	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	1.14	ac. ft
Outflowing Sediment Volume	0.04	ac. ft
Deposited(+)/Eroded(-) Volume	1.10	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	7076	7076
Side Slope (?H:1V)	3	3
Channel Width (ft)	167	167
Channel XS Area (sq. ft)	762.8	762.8
Channel Perimeter (ft)	169	169

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	7076	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	2359	sq. Yd
Volume	7076	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	7076	7076
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	33021	68401
Left Levee Volume (cu. Yd)	32497	76526
Right Levee Length (ft)	7076	7076
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	33021	68401
Right Levee Volume (cu. Yd)	32497	76526
Total Levee Surface Area (sq. Yd)	66042	136802
Total Levee Volume (cu. Yd)	64994	153052

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	7076	7076
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	11007	25945
Left Levee Lining Volume (cu. Yd)	5504	12973
Right Levee Length (ft)	7076	7076
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	11007	25945
Right Levee Lining Volume (cu. Yd)	5504	12973
Total Lining Area (sq. Yd)	22014	51891
Total Lining Volume (cu. Yd)	11008	25946

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	167	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	6.4	ft
Structure Height	9.4	ft
Number of Structures	27	
Volume per structure	174	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 13,050	
Area per structure	56	sq. Yd
Total Area	1,503	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	2	
Total Volume per Basin	4453	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 17,812	
Other Cost	$ -	
Total cost per basin	$ 17,812	
Area per basin	4,863	sq. Yd
Total Area	9,726	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	64,994	cu. Yd	$ 7.00	$ 454,958	66,042	sq. Yd	$ 9.00	$ 594,378	66,042	sq. Yd	$ 11.67	$ 770,490
Levee - LC Enhancement	Fill	88,058	cu. Yd	$ 7.00	$ 616,406	70,760	sq. Yd	$ 9.00	$ 636,840	88,058	sq. Yd	$ 11.67	$ 1,027,343
Levee Lining	Riprap	11,008	cu. Yd	$ 75.00	$ 825,600	22,014	sq. Yd	$ -	$ -	22,014	sq. Yd	$ 20.83	$ 458,630
Levee Lining -LC Enhancement	Riprap	14,938	cu. Yd	$ 75.00	$ 1,120,350	29,876	sq. Yd	$ -	$ -	29,876	sq. Yd	$ 20.83	$ 622,426
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	7,076	cu. Yd	$ 75.00	$ 530,700	2,359	sq. Yd	$ -	$ -	2,359	sq. Yd	$ 25.00	$ 58,975
Drop Structures	Riprap	27	EA	$ 13,050.00	$ 352,350	1,503	sq. Yd	$ -	$ -	1,503	sq. Yd	$ 33.33	$ 50,100
Drop Str. - LC Enhancement	Riprap	27	EA	$ 1,305.00	$ 35,235	150	sq. Yd	$ -	$ -	150	sq. Yd	$ 33.33	$ 5,010
Sedimentation Basins		2	EA	$ 17,812.00	$ 35,624	9,726	sq. Yd	$ -	$ -	9,726	sq. Yd	$ 8.33	$ 81,050
Other					$ -				$ -				$ -

Base Landscape Cost	$ 594,378	
LC Enhancement Cost	$ 636,840	
Total Landscape Cost	$ 1,231,218	
Base Maintenance Cost	$ 1,419,245	
LC Enhancement Cost	$ 1,654,779	
Total Maintenance Cost	$ 3,074,024	

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 2,199,232	$ 1,771,991	$ 3,971,223
Contingency Cost (25% of Construction Cost)	$ 549,808	$ 442,998	$ 992,806
Engineering Design Cost (5% of Construction Cost)	$ 109,962	$ 88,600	$ 198,561
Total Construction Cost	$ 2,859,002	$ 2,303,588	$ 5,162,590

Land Cost

Channel Length	7076 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	167	27.1	$100,000	$ 2,710,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	8.9	$100,000	$ 890,000
Levee LC Enhancement	51	8.3	$100,000	$ 830,000
Other	0	0	$100,000	$ -
Total	273	44.3		$ 4,430,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	36	$100,000	$ 3,600,000
LC Enhancement Cost	acre	8.3	$100,000	$ 830,000
Total Land Cost	acre	44.3	$100,000	$ 4,430,000

Total Cost

Base Total Cost	$ 8,472,624
Total Landscape Enhancement Cost	$ 5,425,208
Total Cost Including LC Enh.	$ 13,897,832

Open Channel

Structure ID	C17510B	HEC1 ID	165175

Longitundal Geometry

Length	6169.2	ft
U/S Elev	1546.4	ft
D/S Elev	1462.9	ft
Initial Channel Slope	0.0135	ft/ft
Long-term Channel Slope	0.0050	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	8

Initial Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	200	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	213.5	213.5	213.5	227
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	80	3	30	7.5	3	72	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	93.5	102.5	132.5	141.5	213.5	227
Y	104.5	100	100	97	97	100	100	104.5

Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	C175									TOTAL
HEC1 Peak-Flow	1274									1274
Weighting Factor	1.00									
Flow into Channel	1274									1274

Reach Sediment Inflow Characteristics

U/S Contributing ID	165175_C17510A									TOTAL
HEC1 Flow Volume (ac. ft)	47.00									47
Sediment Conc. (ppm)	2349									
Sediment Volume (ac. ft)	0.04									0.04
Weighting Factor	1									
Weighted Sed. Vol. (ac. ft)	0.04									0.04

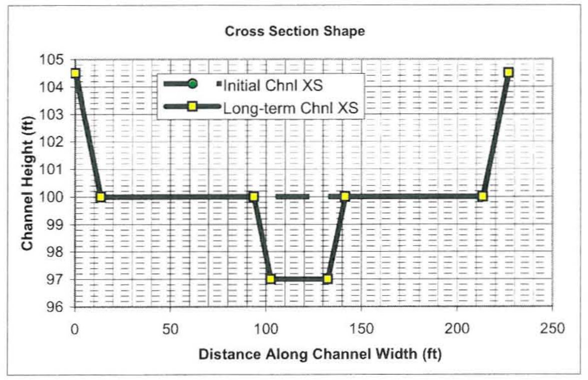
Hydrology

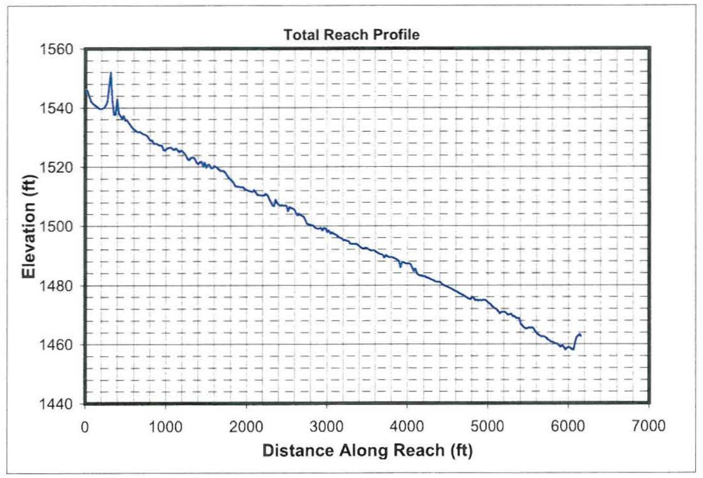
Drainage Area	2.42	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	1274	cfs	
Long-term Max. Chnl Capacity	7078	cfs	
Q2 Channel	127	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	227	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			





Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
127	202.1	68.2	0.3	100.0	100.3	1.9	0.3	202.0	0.3	0.11	0.57
319	203.7	118.5	0.6	100.0	100.6	2.7	0.6	203.5	0.6	0.18	0.62
956	207.2	230.7	1.1	100.0	101.1	4.1	1.1	206.8	1.1	0.35	0.69
1274	208.5	274.9	1.3	100.0	101.3	4.6	1.3	208.1	1.3	0.42	0.71

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
127	38.8	47.5	1.2	97.0	98.4	2.7	1.4	38.3	1.2	0.43	0.42
319	44.9	87.3	1.9	97.0	99.4	3.6	2.4	44.1	2.0	0.73	0.46
956	207.0	311.1	1.5	97.0	101.0	3.1	4.0	205.7	1.5	1.23	0.44
1274	208.9	371.0	1.8	97.0	101.2	3.4	4.2	207.5	1.8	1.32	0.45

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
	165175_C17510A									
127	403									403
319	1284									1284
956	3629									3629
1274	5319									5319

Allowable Velocity

Channel Lining	Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow) Permissive Velocity (ft/s): Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	BUREC Erosive?	Neill (gravel/cobble) Non-cohesive Erosive?	All'ble Vel (ft/s)	Cohesive Erosive?	All'ble Vel (ft/s)	USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
127	1.74	1.0608	1.0077	Erosive	Erosive	Erosive	0.2	Stable	5.1	Stable	Stable
319	1.74	1.2288	1.1673	Erosive	Erosive	Erosive	0.3	Stable	7.2	Stable	Stable
956	1.74	1.4292	1.3578	Erosive	Erosive	Erosive	0.3	Stable	8.9	Stable	Stable
1274	1.74	1.4814	1.4073	Erosive	Erosive	Erosive	0.3	Stable	9.5	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	**127**	**319**	**956**	**1274**	**127**	**319**	**956**	**1274**	**127**	**319**	**956**	**1274**
Bray - Equation #1	31	50	89	103	1.3	1.8	2.6	2.9	3.1	3.5	4.1	4.3
Bray - Equation #2	40	65	116	135	1.5	2.0	2.9	3.1	2.1	2.4	2.8	3.0
Hey	9	15	28	33	4.1	5.8	8.7	9.8				
Ackers & Charlton/Lacey	28	41	64	73					1.8	2.1	2.5	2.6
Parker	78	123	212	245	1.0	1.5	2.4	2.7				
Chang	50	87	171	203	0.2	0.1	-0.3	-0.4				
Kellerhals	20	32	56	64	1.9	2.7	4.2	4.7	3.3	3.6	4.1	4.2
AMAFCA/Schumm	38	44	206	208								
Moody & Odem	17	17	17	17	1.1	1.1	1.1	1.1				
BUREC	16.4	23.1	34.8	38.8	4	6	9	10	2.8	3.5	4.6	5.0
Average	33	50	99	112	1.9	2.6	3.9	4.3	2.6	3.0	3.6	3.8
Values As Designed	38	44	206	207	1.4	2.4	4.0	4.2	2.7	3.6	3.1	3.4
Difference with Design	-6	6	-106	-95	0.5	0.3	-0.1	0.0	-0.1	-0.6	0.6	0.4

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	**Zeller Fullerton**	**Ackers White**	**Einstein**	**Engelund/Hansen**	**Kalinske**	**Laursen**	**MPM**	**Rottner**	**Schoklitsch**	**Toffaleti**	**Yang**	**Average**
127	866	556	1122	1535	2866	238	226	129	3402	256	919	1101
319	3573	1865	3571	7254	4314	1081	799	711	9080	894	3990	3376
956	19346	6903	11341	46422	6645	5197	2698	3771	28010	4321	19498	14014
1274	30079	9577	14719	75373	7392	7738	3623	5636	37475	6566	28947	20648

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	**Zeller Fullerton**	**Ackers White**	**Einstein**	**Engelund/Hansen**	**Kalinske**	**Laursen**	**MPM**	**Rottner**	**Schoklitsch**	**Toffaleti**	**Yang**	**Average**
127	2521	1619	3267	4471	8347	694	658	377	9907	746	2675	3208
319	4162	2172	4159	8450	5025	1260	930	828	10577	1042	4647	3932
956	7512	2680	4404	18025	2580	2018	1048	1464	10876	1678	7570	5441
1274	8759	2789	4286	21949	2153	2253	1055	1641	10913	1912	8430	6013

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	**Zeller Fullerton**	**Ackers White**	**Einstein**	**Engelund/Hansen**	**Kalinske**	**Laursen**	**MPM**	**Rottner**	**Schoklitsch**	**Toffaleti**	**Yang**	**Average**
127	531	270	422	947	685	106	87	124	788	113	628	427
319	2011	819	1144	4071	1088	392	258	483	2052	416	2332	1370
956	4834	2145	3327	8989	4235	967	728	1164	6039	1001	5708	3558
1274	7506	3084	4540	14572	4786	1479	1026	1809	8159	1537	8764	5206

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	**Zeller Fullerton**	**Ackers White**	**Einstein**	**Engelund/Hansen**	**Kalinske**	**Laursen**	**MPM**	**Rottner**	**Schoklitsch**	**Toffaleti**	**Yang**	**Average**
127	1547	786	1230	2758	1996	308	254	362	2294	329	1830	1245
319	2343	954	1333	4742	1267	457	301	563	2391	484	2717	1595
956	1877	833	1292	3490	1644	375	283	452	2345	389	2216	1381
1274	2186	898	1322	4244	1394	431	299	527	2376	448	2552	1516

Equilibrium Slope Calculations

Discharge	**Schoklitsch**	**MPM**	**Shields**							**Lane's Tractive Force**		**Average BUREC**	**Bray**	**Henderson**	**BUREC**	**Simplified AMAFCA**	**Average**
Q (cfs)	**SL (ft/ft)**	**SL (ft/ft)**	**R*o**	**U***	**T*o**	**Slo (ft/ft)**	**R*f**	**T*f**	**Slf (ft/ft)**	**Tc (Fig. 4)**	**SL (ft/ft)**	**SL (ft/ft)**	**SL (ft/ft)**	**SL (ft/ft)**	**SL (ft/ft)**	**Ss (ft/ft)**	**SL (ft/ft)**
127	0.0025	0.0036	126	0.38	0.046	0.0007	30	0.035	0.0006	0.0159	0.0008	0.0018	0.0069	0.0004	0.0027	0.0135	0.0057
319	0.0012	0.0021	165	0.50	0.049	0.0005	30	0.036	0.0003	0.0159	0.0004	0.0010	0.0069	0.0003	0.0014	0.0135	0.0054
956	0.0006	0.0011	229	0.70	0.052	0.0003	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0069	0.0002	0.0006	0.0135	0.0053
1274	0.0004	0.0009	249	0.76	0.053	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0004	0.0069	0.0001	0.0005	0.0135	0.0053

Drop Structures

Design Slope	0.0050	ft/ft
Total Drop Needed	52.7	ft
Height of Drop Structure	3	ft
No . of Drop Structures	18	
Distance between structs.	343	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	1.80	sq. mi
Total Sediment Yield Volume	3.42	ac ft

Sedimentation Basins

Length	343 ft	Depth	3 ft
Width	227 ft	Side slope	3 ft/ft
Total Volume per Basin		5.01	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		3	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								**Bend**	**LongTerm**	**Thalweg**	
Discharge	**COT/PC**	**General**	**Antidune**	**Bend**	**Max. Depth**	**Hyd. Depth**	**Avg Vel**	**Se**	**Scour**	**Scour**	**channel**	**Total**
Q (cfs)	**Sinuosity**	**Zgs (ft)**	**Za (ft)**	**Angle (deg)**	**Ymax (ft)**	**Yh (ft)**	**Vm (ft/s)**		**Zbs (ft)**	**Zls (ft)**	**Zlft (ft)**	**Zt (ft)**
127	1.1	-0.4	0.1	24.6	1.4	1.2	2.7	0.0050	0.1	1.5	3.0	6.1
319	1.1	-0.7	0.2	24.6	2.4	2.0	3.6	0.0050	0.3	1.5	3.0	6.3
956	1.1	-1.2	0.1	24.6	4.0	1.5	3.1	0.0050	0.4	1.5	3.0	6.5
1274	1.1	-1.2	0.2	24.6	4.2	1.8	3.4	0.0050	0.5	1.5	3.0	6.6

Toe Protection Needed	7.0	ft

Freeboard

Max. Flow Depth	1.3	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.2	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	3.46	ac. ft
Outflowing Sediment Volume	0.03	ac. ft
Deposited(+)/Eroded(-) Volume	3.43	ac. ft

HEC1 Results For Open Channel

Peak Flow	90	cfs
Stage at Peak Flow	100.3	ft
Flow Volume	47.0	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	6169	6169
Side Slope (?H:1V)	3	3
Channel Width (ft)	227	227
Channel XS Area (sq. ft)	1077.8	1077.8
Channel Perimeter (ft)	229	229

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	6169	ft
Thickness	1.5	ft
Protection Depth	7	ft
Tie-in Length/Depth	3.0	ft
Total Depth	10.0	ft
Area needed	2056	sq. Yd
Volume	6854	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	6169	6169
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	28789	59634
Left Levee Volume (cu. Yd)	28332	66717
Right Levee Length (ft)	6169	6169
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	28789	59634
Right Levee Volume (cu. Yd)	28332	66717
Total Levee Surface Area (sq. Yd)	57578	119268
Total Levee Volume (cu. Yd)	56664	133434

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	6169	6169
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	9596	22620
Left Levee Lining Volume (cu. Yd)	4798	11310
Right Levee Length (ft)	6169	6169
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	9596	22620
Right Levee Lining Volume (cu. Yd)	4798	11310
Total Lining Area (sq. Yd)	19192	45239
Total Lining Volume (cu. Yd)	9596	22620

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	227	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	6.6	ft
Structure Height	9.6	ft
Number of Structures	18	
Volume per structure	243	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 18,225	
Area per structure	76	sq. Yd
Total Area	1,362	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	3	
Total Volume per Basin	8083	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 32,332	
Other Cost	$ -	
Total cost per basin	$ 32,332	
Area per basin	8,644	sq. Yd
Total Area	25,932	sq. Yd

Structure Cost

Structure Type	Structure Type	Excavation/Construction Quantity	Units	Unit Cost	Cost Subtotal	Landscape Quantity	Units	Unit Cost	Landscape Cost	Maintenance Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	56,664	cu. Yd	$ 7.00	$ 396,648	57,578	sq. Yd	$ 9.00	$ 518,202	57,578	sq. Yd	$ 11.67	$ 671,743
Levee - LC Enhancement	Fill	76,770	cu. Yd	$ 7.00	$ 537,390	61,690	sq. Yd	$ 9.00	$ 555,210	76,770	sq. Yd	$ 11.67	$ 895,650
Levee Lining	Riprap	9,596	cu. Yd	$ 75.00	$ 719,700	19,192	sq. Yd	$ -	$ -	19,192	sq. Yd	$ 20.83	$ 399,843
Levee Lining -LC Enhancement	Riprap	13,024	cu. Yd	$ 75.00	$ 976,800	26,047	sq. Yd	$ -	$ -	26,047	sq. Yd	$ 20.83	$ 542,644
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	6,854	cu. Yd	$ 75.00	$ 514,050	2,056	sq. Yd	$ -	$ -	2,056	sq. Yd	$ 25.00	$ 51,400
Drop Structures	Riprap	18	EA	$ 18,225.00	$ 328,050	1,362	sq. Yd	$ -	$ -	1,362	sq. Yd	$ 33.33	$ 45,400
Drop Str. - LC Enhancement	Riprap	18	EA	$ 1,822.50	$ 32,805	136	sq. Yd	$ -	$ -	136	sq. Yd	$ 33.33	$ 4,540
Sedimentation Basins		3	EA	$ 32,332.00	$ 96,996	25,932	sq. Yd	$ -	$ -	25,932	sq. Yd	$ 8.33	$ 216,100
Other					$ -				$ -				$ -

Base Landscape Cost	$ 518,202	
LC Enhancement Cost	$ 555,210	
Total Landscape Cost	$ 1,073,412	

Base Maintenance Cost	$ 1,384,486
LC Enhancement Cost	$ 1,442,834
Total Maintenance Cost	$ 2,827,319

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 2,055,444	$ 1,546,995	$ 3,602,439
Contingency Cost (25% of Construction Cost)	$ 513,861	$ 386,749	$ 900,610
Engineering Design Cost (5% of Construction Cost)	$ 102,772	$ 77,350	$ 180,122
Total Construction Cost	$ 2,672,077	$ 2,011,094	$ 4,683,171

Land Cost

Channel Length	6169 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	227	32.1	$100,000	$ 3,210,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	7.8	$100,000	$ 780,000
Levee LC Enhancement	51	7.2	$100,000	$ 720,000
Other	0	0	$100,000	$ -
Total	333	47.1		$ 4,710,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	39.9	$100,000	$ 3,990,000
LC Enhancement Cost	acre	7.2	$100,000	$ 720,000
Total Land Cost	acre	47.1	$100,000	$ 4,710,000

Total Cost

Base Total Cost	$ 8,564,765
Total Landscape Enhancement Cost	$ 4,729,137
Total Cost Including LC Enh.	$ 13,293,902

Open Channel

Structure ID	RR17510		HEC1 ID	175R

Longitundal Geometry

Length	3035.2	ft
U/S Elev	1462.9	ft
D/S Elev	1413.1	ft
Initial Channel Slope	0.0164	ft/ft
Long-term Channel Slope	0.0060	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	2

Initial Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	280	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	293.5	293.5	293.5	307
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	105	3	30	7.5	3	127	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	118.5	127.5	157.5	166.5	293.5	307
Y	104.5	100	100	97	97	100	100	104.5

Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	C175	S190								TOTAL
HEC1 Peak-Flow	1274	2590								3864
Weighting Factor	1.00	0.05								
Flow into Channel	1274	119								1393

Reach Sediment Inflow Characteristics

U/S Contributing ID	165175_C17510 B									TOTAL
HEC1 Flow Volume (ac. ft)	47.00									47
Sediment Conc. (ppm)	1595									
Sediment Volume (ac. ft)	0.03									0.03
Weighting Factor	1									
Weighted Sed. Vol. (ac. ft)	0.03									0.03

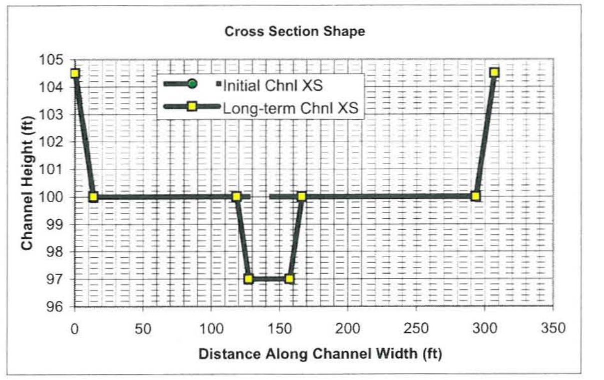
Hydrology

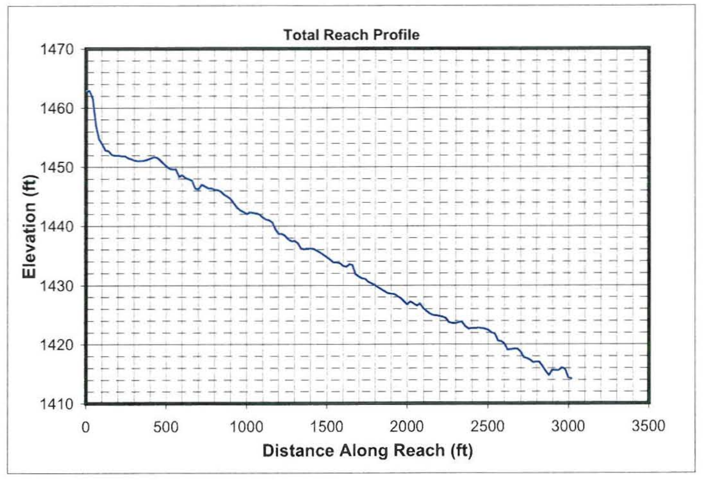
Drainage Area	2.607	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	1393	cfs	
Long-term Max. Chnl Capacity	10268	cfs	
Q2 Channel	139	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	307	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			





Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
139	281.7	77.7	0.3	100.0	100.3	1.8	0.3	281.7	0.3	0.10	0.60
348	283.0	134.8	0.5	100.0	100.5	2.6	0.5	282.9	0.5	0.18	0.66
1045	285.8	261.5	0.9	100.0	100.9	4.0	0.9	285.5	0.9	0.35	0.74
1393	286.9	311.2	1.1	100.0	101.1	4.5	1.1	286.6	1.1	0.41	0.76

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
139	38.8	47.5	1.2	97.0	98.4	2.9	1.4	38.3	1.2	0.52	0.46
348	44.9	87.2	1.9	97.0	99.4	4.0	2.4	44.1	2.0	0.88	0.50
1045	286.3	353.7	1.2	97.0	100.8	3.0	3.8	285.0	1.2	1.44	0.47
1393	287.8	421.3	1.5	97.0	101.1	3.3	4.1	286.4	1.5	1.53	0.48

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
	165175_C17510 B									
139	427									427
348	1370									1370
1045	3558									3558
1393	5206									5206

Allowable Velocity

Channel Lining	Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
139	1.74	0.9982	0.9483	Erosive	Erosive	Erosive	0.2	Stable	5.6	Stable	Stable
348	1.74	1.1669	1.1085	Erosive	Erosive	Erosive	0.2	Stable	7.9	Stable	Stable
1045	1.74	1.3683	1.2999	Erosive	Erosive	Erosive	0.3	Stable	9.3	Stable	Stable
1393	1.74	1.4209	1.3499	Erosive	Erosive	Erosive	0.3	Stable	9.9	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	**139**	**348**	**1045**	**1393**	**139**	**348**	**1045**	**1393**	**139**	**348**	**1045**	**1393**
Bray - Equation #1	32	52	93	108	1.4	1.9	2.7	3.0	3.2	3.6	4.2	4.4
Bray - Equation #2	42	68	122	142	1.5	2.0	2.9	3.2	2.2	2.5	2.9	3.0
Hey	9	16	30	35	4.2	6.0	9.0	10.1				
Ackers & Charlton/Lacey	29	42	67	75					1.8	2.1	2.6	2.7
Parker	81	128	222	256	1.1	1.6	2.5	2.8				
Chang	56	98	191	227	0.1	0.0	-0.4	-0.6				
Kellerhals	21	34	58	67	2.0	2.8	4.4	4.9	3.3	3.7	4.1	4.2
AMAFCA/Schumm	38	44	285	287								
Moody & Odem	18	18	18	18	1.1	1.1	1.1	1.1				
BUREC	16.3	23.0	34.8	38.8	4	6	9	10	3.1	3.9	5.1	5.5
Average	34	52	112	125	2.0	2.7	3.9	4.4	2.7	3.1	3.8	3.9
Values As Designed	38	44	285	286	1.4	2.4	3.8	4.1	2.9	4.0	3.0	3.3
Difference with Design	-4	8	-173	-161	0.6	0.3	0.1	0.3	-0.2	-0.9	0.8	0.6

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
139	1080	718	1519	1940	3957	320	305	151	4958	350	1120	1493
348	4451	2407	4860	9184	5955	1461	1084	859	13225	1177	4925	4508
1045	24284	8940	15496	59064	9137	7076	3689	4656	40782	5571	24213	18446
1393	37813	12407	20097	96070	10150	10548	4955	6979	54561	8438	35969	27090

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
139	2876	1912	4046	5167	10538	852	812	402	13205	933	2983	3975
348	4742	2564	5178	9784	6345	1557	1155	915	14089	1254	5247	4803
1045	8623	3175	5503	20974	3245	2513	1310	1654	14482	1978	8598	6550
1393	10071	3304	5352	25587	2703	2809	1320	1859	14531	2247	9580	7215

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
139	785	378	595	1489	780	170	129	182	1157	170	922	614
348	2974	1115	1611	6403	1221	605	361	677	2979	624	3329	1991
1045	5999	2703	4502	11256	5806	1295	983	1386	8682	1282	7024	4629
1393	9334	3897	6138	18291	6549	1987	1388	2172	11732	1964	10813	6751

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
139	2092	1006	1586	3967	2076	452	344	484	3082	452	2455	1636
348	3168	1188	1716	6821	1301	645	385	721	3173	665	3546	2121
1045	2130	960	1599	3997	2062	460	349	492	3083	455	2494	1644
1393	2486	1038	1635	4871	1744	529	370	579	3125	523	2880	1798

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
139	0.0030	0.0044	125	0.38	0.046	0.0009	29	0.035	0.0007	0.0159	0.0009	0.0022	0.0067	0.0004	0.0032	0.0163	0.0064
348	0.0015	0.0025	164	0.50	0.049	0.0006	30	0.036	0.0004	0.0159	0.0005	0.0012	0.0067	0.0003	0.0016	0.0164	0.0061
1045	0.0007	0.0013	228	0.69	0.052	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0006	0.0067	0.0002	0.0007	0.0164	0.0060
1393	0.0005	0.0011	248	0.76	0.053	0.0003	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0067	0.0001	0.0006	0.0164	0.0059

Drop Structures

Design Slope	0.0060	ft/ft
Total Drop Needed	31.5	ft
Height of Drop Structure	3	ft
No . of Drop Structures	11	
Distance between structs.	276	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.19	sq. mi
Total Sediment Yield Volume	0.36	ac ft

Sedimentation Basins

Length	276 ft	Depth	3 ft
Width	307 ft	Side slope	3 ft/ft
Total Volume per Basin		5.48	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
139	1.1	-0.4	0.1	24.6	1.4	1.2	2.9	0.0060	0.1	1.5	3.0	6.1
348	1.1	-0.6	0.2	24.6	2.4	2.0	4.0	0.0060	0.3	1.5	3.0	6.3
1045	1.1	-1.2	0.1	24.6	3.8	1.2	3.0	0.0060	0.4	1.5	3.0	6.5
1393	1.1	-1.2	0.1	24.6	4.1	1.5	3.3	0.0060	0.4	1.5	3.0	6.5

Toe Protection Needed	7.0	ft

HEC1 Results For Open Channel

Peak Flow	1194	cfs
Stage at Peak Flow	101.0	ft
Flow Volume	147.0	ac. ft

Freeboard

Max. Flow Depth	1.1	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.4	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	0.38	ac. ft
Outflowing Sediment Volume	0.12	ac. ft
Deposited(+)/Eroded(-) Volume	0.27	ac. ft

JE FULLER
HYDROLOGY & GEOMORPHOLOGY, INC

Sub-area: Wagner Wash, Alternative: B41
Open Channel Structure ID: RR17510

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	3035	3035
Side Slope (?H:1V)	3	3
Channel Width (ft)	307	307
Channel XS Area (sq. ft)	1437.8	1437.8
Channel Perimeter (ft)	309	309

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	3035	ft
Thickness	1.5	ft
Protection Depth	7	ft
Tie-in Length/Depth	3.0	ft
Total Depth	10.0	ft
Area needed	1012	sq. Yd
Volume	3372	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	3035	3035
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	14163	29338
Left Levee Volume (cu. Yd)	13939	32823
Right Levee Length (ft)	3035	3035
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	14163	29338
Right Levee Volume (cu. Yd)	13939	32823
Total Levee Surface Area (sq. Yd)	28326	58676
Total Levee Volume (cu. Yd)	27878	65646

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	3035	3035
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	4721	11128
Left Levee Lining Volume (cu. Yd)	2361	5564
Right Levee Length (ft)	3035	3035
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	4721	11128
Right Levee Lining Volume (cu. Yd)	2361	5564
Total Lining Area (sq. Yd)	9442	22257
Total Lining Volume (cu. Yd)	4722	11128

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	307	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	5.8	ft
Structure Height	8.8	ft
Number of Structures	11	
Volume per structure	301	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 22,575	
Area per structure	102	sq. Yd
Total Area	1,126	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	8841	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 35,364	
Other Cost	$ -	
Total cost per basin	$ 35,364	
Area per basin	9,412	sq. Yd
Total Area	9,412	sq. Yd

Structure Cost

Structure Type	Structure Type	Excavation/Construction Quantity	Units	Unit Cost	Cost Subtotal	Landscape Quantity	Units	Unit Cost	Landscape Cost	Maintenance Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	27,878	cu. Yd	$ 7.00	$ 195,146	28,326	sq. Yd	$ 9.00	$ 254,934	28,326	sq. Yd	$ 11.67	$ 330,470
Levee - LC Enhancement	Fill	37,768	cu. Yd	$ 7.00	$ 264,376	30,350	sq. Yd	$ 9.00	$ 273,150	37,768	sq. Yd	$ 11.67	$ 440,627
Levee Lining	Riprap	4,722	cu. Yd	$ 75.00	$ 354,150	9,442	sq. Yd	$ -	$ -	9,442	sq. Yd	$ 20.83	$ 196,713
Levee Lining -LC Enhancement	Riprap	6,406	cu. Yd	$ 75.00	$ 480,450	12,814	sq. Yd	$ -	$ -	12,814	sq. Yd	$ 20.83	$ 266,968
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	3,372	cu. Yd	$ 75.00	$ 252,900	1,012	sq. Yd	$ -	$ -	1,012	sq. Yd	$ 25.00	$ 25,300
Drop Structures	Riprap	11	EA	$ 22,575.00	$ 248,325	1,126	sq. Yd	$ -	$ -	1,126	sq. Yd	$ 33.33	$ 37,533
Drop Str. - LC Enhancement	Riprap	11	EA	$ 2,257.50	$ 24,833	113	sq. Yd	$ -	$ -	113	sq. Yd	$ 33.33	$ 3,753
Sedimentation Basins		1	EA	$ 35,364.00	$ 35,364	9,412	sq. Yd	$ -	$ -	9,412	sq. Yd	$ 8.33	$ 78,433
Other					$ -				$ -				$ -

Base Landscape Cost	$ 254,934	Base Maintenance Cost	$ 668,450
LC Enhancement Cost	$ 273,150	LC Enhancement Cost	$ 711,348
Total Landscape Cost	$ 528,084	Total Maintenance Cost	$ 1,379,797

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,085,885	$ 769,659	$ 1,855,544
Contingency Cost (25% of Construction Cost)	$ 271,471	$ 192,415	$ 463,886
Engineering Design Cost (5% of Construction Cost)	$ 54,294	$ 38,483	$ 92,777
Total Construction Cost	$ 1,411,651	$ 1,000,556	$ 2,412,207

Land Cost

Channel Length	3035 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	307	21.4	$100,000	$ 2,140,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	3.8	$100,000	$ 380,000
Levee LC Enhancement	51	3.6	$100,000	$ 360,000
Other	0	0	$100,000	$ -
Total	413	28.8		$ 2,880,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	25.2	$100,000	$ 2,520,000
LC Enhancement Cost	acre	3.6	$100,000	$ 360,000
Total Land Cost	acre	28.8	$100,000	$ 2,880,000

Total Cost

Base Total Cost	$ 4,855,034
Total Landscape Enhancement Cost	$ 2,345,054
Total Cost Including LC Enh.	$ 7,200,088

Open Channel

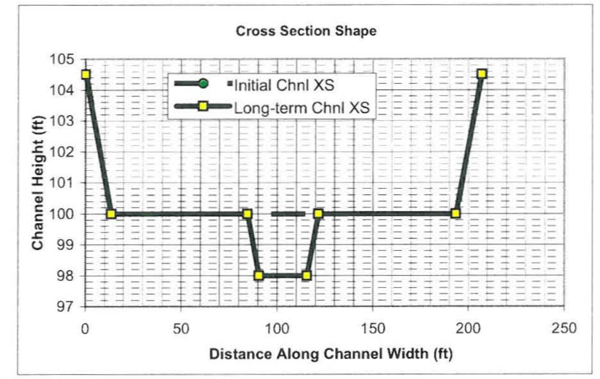
Structure ID	RR18010		HEC1 ID	180R

Longitundal Geometry

Length	2824.7	ft
U/S Elev	1456.3	ft
D/S Elev	1413.1	ft
Initial Channel Slope	0.0153	ft/ft
Long-term Channel Slope	0.0060	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	2



Initial Channel XS Geometry

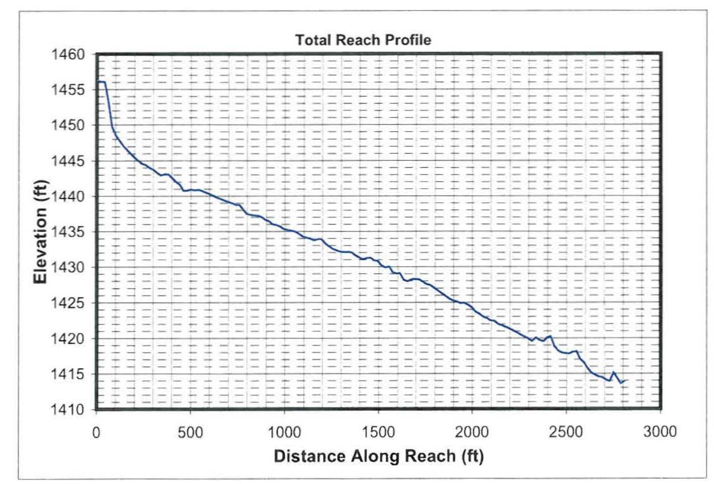
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	180	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	193.5	193.5	193.5	207
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	71	3	25	6.5	3	72	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	84.5	90.5	115.5	121.5	193.5	207
Y	104.5	100	100	98	98	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	S180	S190								TOTAL
HEC1 Peak-Flow	1039	2590								3629
Weighting Factor	1.00	0.03								
Flow into Channel	1039	85								1124

Reach Sediment Inflow Characteristics

U/S Contributing ID	180R_S18010									TOTAL
HEC1 Flow Volume (ac. ft)	90.00									90
Sediment Conc. (ppm)	1879									
Sediment Volume (ac. ft)	0.06									0.06
Weighting Factor	1									
Weighted Sed. Vol. (ac. ft)										0.00

Hydrology

Drainage Area	1.573	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	1124	cfs	
Long-term Max. Chnl Capacity	6482	cfs	
Q2 Channel	112	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	207	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
112	182.0	58.5	0.3	100.0	100.3	1.9	0.3	181.9	0.3	0.12	0.60
281	183.5	101.7	0.6	100.0	100.6	2.8	0.6	183.4	0.6	0.21	0.65
843	186.8	198.1	1.1	100.0	101.1	4.3	1.1	186.5	1.1	0.40	0.73
1124	188.1	236.0	1.3	100.0	101.3	4.8	1.3	187.7	1.3	0.48	0.75

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
112	33.6	39.4	1.2	98.0	99.4	2.9	1.4	33.1	1.2	0.51	0.46
281	183.2	134.5	0.7	98.0	100.4	2.1	2.4	182.4	0.7	0.90	0.43
843	187.6	262.6	1.4	98.0	101.1	3.2	3.1	186.6	1.4	1.16	0.48
1124	189.3	313.2	1.7	98.0	101.4	3.6	3.4	188.2	1.7	1.26	0.49

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
	180R_S18010									
112	440									440
281	885									885
843	3597									3597
1124	5262									5262

Allowable Velocity

Channel Lining	Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
112	1.74	1.0458	0.9935	Erosive	Erosive	Erosive	0.2	Stable	5.5	Stable	Stable
281	1.74	1.2137	1.1530	Erosive	Erosive	Erosive	0.3	Stable	6.8	Stable	Stable
843	1.74	1.4140	1.3433	Erosive	Erosive	Erosive	0.3	Stable	8.5	Stable	Stable
1124	1.74	1.4661	1.3928	Erosive	Erosive	Erosive	0.3	Stable	9.2	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	112	281	843	1124	112	281	843	1124	112	281	843	1124
Bray - Equation #1	29	46	83	96	1.3	1.7	2.5	2.8	3.1	3.5	4.1	4.2
Bray - Equation #2	38	61	109	127	1.4	1.9	2.7	3.0	2.1	2.4	2.8	2.9
Hey	8	14	26	31	3.9	5.5	8.3	9.3				
Ackers & Charlton/Lacey	26	38	61	69					1.8	2.1	2.5	2.6
Parker	73	115	199	230	1.0	1.4	2.3	2.6				
Chang	49	86	168	200	0.1	0.0	-0.3	-0.5				
Kellerhals	19	30	52	60	1.8	2.6	4.0	4.5	3.3	3.6	4.0	4.1
AMAFCA/Schumm	33	183	187	188								
Moody & Odem	15	15	15	15	1.0	1.0	1.0	1.0				
BUREC	15.1	21.3	32.1	35.8	4	6	9	10	2.9	3.7	4.8	5.2
Average	30	61	93	105	1.8	2.5	3.6	4.0	2.6	3.0	3.6	3.8
Values As Designed	33	182	187	188	1.4	2.4	3.1	3.4	2.9	2.1	3.2	3.6
Difference with Design	-3	-121	-93	-83	0.5	0.1	0.5	0.7	-0.2	0.9	0.4	0.2

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
112	893	574	1193	1630	2732	268	246	138	3651	270	955	1141
281	3685	1888	3662	7698	4081	1166	831	729	9655	935	4067	3491
843	19938	6898	11367	49229	6254	5534	2752	3785	29673	4477	19567	14498
1124	30986	9547	14802	79909	6952	8231	3684	5636	39683	6789	28950	21379

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
112	2947	1895	3937	5379	9019	885	812	455	12051	891	3151	3766
281	4865	2493	4835	10164	5388	1539	1097	963	12748	1234	5369	4609
843	8775	3036	5003	21665	2752	2435	1211	1666	13059	1970	8612	6380
1124	10228	3151	4886	26376	2295	2717	1216	1860	13098	2241	9556	7057

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
112	609	298	478	1145	655	132	102	140	930	132	716	485
281	1004	535	937	1650	2520	192	185	192	2160	231	1126	976
843	5418	2340	3681	10512	4142	1159	828	1261	7078	1146	6302	3988
1124	8411	3344	5070	17038	4668	1759	1153	1947	9538	1757	9616	5845

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
112	2010	984	1579	3780	2162	435	337	462	3070	437	2362	1602
281	1326	706	1237	2179	3327	254	244	254	2852	305	1486	1288
843	2384	1030	1620	4626	1823	510	364	555	3115	504	2773	1755
1124	2776	1104	1673	5624	1541	581	380	643	3148	580	3174	1929

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
112	0.0025	0.0038	131	0.40	0.047	0.0008	30	0.035	0.0006	0.0159	0.0008	0.0019	0.0072	0.0004	0.0028	0.0152	0.0062
281	0.0013	0.0022	171	0.52	0.049	0.0005	30	0.036	0.0003	0.0159	0.0005	0.0011	0.0072	0.0003	0.0014	0.0153	0.0060
843	0.0006	0.0011	237	0.72	0.052	0.0003	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0072	0.0002	0.0006	0.0153	0.0058
1124	0.0005	0.0010	258	0.79	0.053	0.0002	32	0.036	0.0002	0.0159	0.0002	0.0004	0.0072	0.0002	0.0005	0.0153	0.0058

Drop Structures

Design Slope	0.0060	ft/ft
Total Drop Needed	26.2	ft
Height of Drop Structure	3	ft
No . of Drop Structures	9	
Distance between structs.	314	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.13	sq. mi
Total Sediment Yield Volume	0.25	ac ft

Sedimentation Basins

Length	314 ft	Depth	3 ft
Width	207 ft	Side slope	3 ft/ft
Total Volume per Basin		4.16	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
112	1.1	-0.4	0.1	24.6	1.4	1.2	2.9	0.0060	0.1	1.5	2.0	4.8
281	1.1	-0.8	0.1	24.6	2.4	0.7	2.1	0.0060	0.2	1.5	2.0	4.9
843	1.1	-0.9	0.1	24.6	3.1	1.4	3.2	0.0060	0.3	1.5	2.0	5.1
1124	1.1	-0.9	0.2	24.6	3.4	1.7	3.6	0.0060	0.4	1.5	2.0	5.1

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	1003	cfs
Stage at Peak Flow	101.2	ft
Flow Volume	90.0	ac. ft

Freeboard

Max. Flow Depth	1.3	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.2	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	0.25	ac. ft
Outflowing Sediment Volume	0.07	ac. ft
Deposited(+)/Eroded(-) Volume	0.19	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	2825	2825
Side Slope (?H:1V)	3	3
Channel Width (ft)	207	207
Channel XS Area (sq. ft)	932.8	932.8
Channel Perimeter (ft)	209	209

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	2825	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	942	sq. Yd
Volume	2825	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	2825	2825
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	13183	27308
Left Levee Volume (cu. Yd)	12974	30552
Right Levee Length (ft)	2825	2825
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	13183	27308
Right Levee Volume (cu. Yd)	12974	30552
Total Levee Surface Area (sq. Yd)	26366	54616
Total Levee Volume (cu. Yd)	25948	61104

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	2825	2825
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	4394	10358
Left Levee Lining Volume (cu. Yd)	2197	5179
Right Levee Length (ft)	2825	2825
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	4394	10358
Right Levee Lining Volume (cu. Yd)	2197	5179
Total Lining Area (sq. Yd)	8789	20717
Total Lining Volume (cu. Yd)	4394	10358

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	207	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	6.5	ft
Structure Height	9.5	ft
Number of Structures	9	
Volume per structure	219	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 16,425	
Area per structure	69	sq. Yd
Total Area	621	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	6711	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 26,844	
Other Cost	$ -	
Total cost per basin	$ 26,844	
Area per basin	7,219	sq. Yd
Total Area	7,219	sq. Yd

Structure Cost

Structure Type	Structure Type	Excavation/Construction Quantity	Units	Unit Cost	Cost Subtotal	Landscape Quantity	Units	Unit Cost	Landscape Cost	Maintenance Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	25,948	cu. Yd	$ 7.00	$ 181,636	26,366	sq. Yd	$ 9.00	$ 237,294	26,366	sq. Yd	$ 11.67	$ 307,603
Levee - LC Enhancement	Fill	35,156	cu. Yd	$ 7.00	$ 246,092	28,250	sq. Yd	$ 9.00	$ 254,250	35,156	sq. Yd	$ 11.67	$ 410,153
Levee Lining	Riprap	4,394	cu. Yd	$ 75.00	$ 329,550	8,789	sq. Yd	$ -	$ -	8,789	sq. Yd	$ 20.83	$ 183,102
Levee Lining -LC Enhancement	Riprap	5,964	cu. Yd	$ 75.00	$ 447,300	11,928	sq. Yd	$ -	$ -	11,928	sq. Yd	$ 20.83	$ 248,495
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	2,825	cu. Yd	$ 75.00	$ 211,875	942	sq. Yd	$ -	$ -	942	sq. Yd	$ 25.00	$ 23,550
Drop Structures	Riprap	9	EA	$ 16,425.00	$ 147,825	621	sq. Yd	$ -	$ -	621	sq. Yd	$ 33.33	$ 20,700
Drop Str. - LC Enhancement	Riprap	9	EA	$ 1,642.50	$ 14,783	62	sq. Yd	$ -	$ -	62	sq. Yd	$ 33.33	$ 2,070
Sedimentation Basins		1	EA	$ 26,844.00	$ 26,844	7,219	sq. Yd	$ -	$ -	7,219	sq. Yd	$ 8.33	$ 60,158
Other					$ -				$ -				$ -

Base Landscape Cost	$ 237,294	Base Maintenance Cost	$ 595,114
LC Enhancement Cost	$ 254,250	LC Enhancement Cost	$ 660,719
Total Landscape Cost	$ 491,544	Total Maintenance Cost	$ 1,255,832

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 897,730	$ 708,175	$ 1,605,905
Contingency Cost (25% of Construction Cost)	$ 224,433	$ 177,044	$ 401,476
Engineering Design Cost (5% of Construction Cost)	$ 44,887	$ 35,409	$ 80,295
Total Construction Cost	$ 1,167,049	$ 920,627	$ 2,087,676

Land Cost

Channel Length	2825 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	207	13.4	$100,000	$ 1,340,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	3.6	$100,000	$ 360,000
Levee LC Enhancement	51	3.3	$100,000	$ 330,000
Other	0	0	$100,000	$ -
Total	313	20.3		$ 2,030,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	17	$100,000	$ 1,700,000
LC Enhancement Cost	acre	3.3	$100,000	$ 330,000
Total Land Cost	acre	20.3	$100,000	$ 2,030,000

Total Cost

Base Total Cost	$ 3,699,457
Total Landscape Enhancement Cost	$ 2,165,596
Total Cost Including LC Enh.	$ 5,865,052

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

Sub-area: Wagner Wash, Alternative: B41
Open Channel Structure ID: RR18010

Open Channel

Structure ID	C180R10		HEC1 ID	RI180R

Longitundal Geometry

Length	3720.6	ft
U/S Elev	1413.1	ft
D/S Elev	1367.6	ft
Initial Channel Slope	0.0122	ft/ft
Long-term Channel Slope	0.0050	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	3

Initial Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	360	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	373.5	373.5	373.5	387
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	159	3	30	7.5	3	153	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	172.5	181.5	211.5	220.5	373.5	387
Y	104.5	100	100	97	97	100	100	104.5

Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	RI180R	S190								TOTAL
HEC1 Peak-Flow	2062	2590								4652
Weighting Factor	1.00	0.12								
Flow into Channel	2062	323								2385

Reach Sediment Inflow Characteristics

U/S Contributing ID	180R_RR18010	175R_RR17510								TOTAL
HEC1 Flow Volume (ac. ft)	90.00	147.00								237
Sediment Conc. (ppm)	1929	2121								
Sediment Volume (ac. ft)	0.07	0.12								0.18
Weighting Factor	1	1								
Weighted Sed. Vol. (ac. ft)	0.07	0.12								0.18

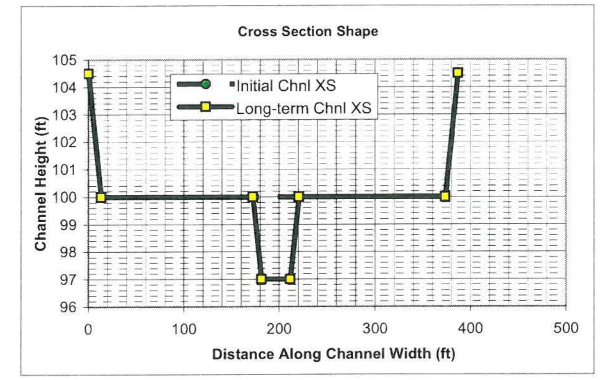
Hydrology

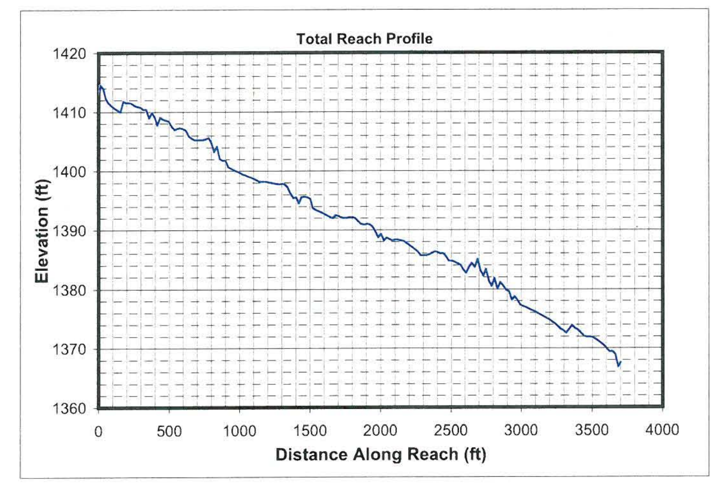
Drainage Area	3.86	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	2385	cfs	
Long-term Max. Chnl Capacity	11669	cfs	
Q2 Channel	239	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	387	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			





Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
239	362.3	129.5	0.4	100.0	100.4	1.8	0.4	362.2	0.4	0.11	0.54
596	363.9	224.5	0.6	100.0	100.6	2.7	0.6	363.7	0.6	0.19	0.60
1789	367.6	436.0	1.2	100.0	101.2	4.1	1.2	367.2	1.2	0.37	0.66
2385	369.0	518.9	1.4	100.0	101.4	4.6	1.4	368.5	1.4	0.44	0.68

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
239	42.6	71.9	1.7	97.0	99.0	3.3	2.0	42.0	1.7	0.62	0.45
596	364.1	293.8	0.8	97.0	100.5	2.0	3.5	362.9	0.8	1.09	0.40
1789	368.9	571.0	1.5	97.0	101.2	3.1	4.2	367.5	1.6	1.33	0.44
2385	370.7	679.9	1.8	97.0	101.5	3.5	4.5	369.3	1.8	1.42	0.46

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)								TOTAL
	180R_RR18010	175R_RR17510							
239	485	614							1099
596	976	1991							2966
1789	3988	4629							8617
2385	5845	6751							12597

Allowable Velocity

Channel Lining	Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow) Permissive Velocity (ft/s)				BUREC	Neill (gravel/cobble) Non-cohesive		Cohesive		USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
239	1.74	1.0782	1.0243	Erosive	Erosive	Erosive	0.2	Stable	6.5	Stable	Stable
596	1.74	1.2467	1.1844	Erosive	Erosive	Erosive	0.3	Stable	7.6	Stable	Stable
1789	1.74	1.4484	1.3760	Erosive	Erosive	Erosive	0.3	Stable	9.3	Stable	Stable
2385	1.74	1.5010	1.4259	Erosive	Erosive	Erosive	0.4	Stable	9.9	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	**239**	**596**	**1789**	**2385**	**239**	**596**	**1789**	**2385**	**239**	**596**	**1789**	**2385**
Bray - Equation #1	43	69	123	143	1.6	2.2	3.2	3.5	3.4	3.9	4.5	4.7
Bray - Equation #2	56	91	162	188	1.8	2.4	3.5	3.9	2.3	2.7	3.1	3.2
Hey	13	22	40	47	5.2	7.3	11.1	12.4				
Ackers & Charlton/Lacey	36	53	84	94					2.0	2.3	2.8	2.9
Parker	106	168	291	336	1.3	2.0	3.1	3.5				
Chang	73	128	250	297	0.1	-0.1	-0.6	-0.8				
Kellerhals	28	44	76	88	2.4	3.5	5.4	6.1	3.5	3.9	4.3	4.4
AMAFCA/Schumm	42	363	368	370								
Moody & Odem	20	20	20	20	1.2	1.2	1.2	1.2				
BUREC	20.7	29.2	44.1	49.1	6	8	12	13	3.3	4.1	5.4	5.8
Average	44	99	146	163	2.4	3.3	4.8	5.4	2.9	3.4	4.0	4.2
Values As Designed	42	363	367	369	2.0	3.5	4.2	4.5	3.3	2.0	3.1	3.5
Difference with Design	2	-264	-222	-206	0.4	-0.2	0.6	0.8	-0.4	1.3	0.9	0.7

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
239	1441	920	1812	2503	4953	369	358	213	5403	416	1523	1810
596	5961	3131	5917	11852	7480	1733	1308	1196	14523	1467	6705	5570
1789	32398	11700	19011	76192	11516	8416	4475	6432	44924	7169	33172	23219
2385	50450	16265	24624	123927	12798	12553	6020	9638	60125	10929	49401	34248

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
239	2242	1431	2819	3894	7704	575	557	331	8405	647	2370	2816
596	3709	1948	3682	7375	4654	1078	814	744	9036	913	4172	3466
1789	6720	2427	3943	15803	2388	1746	928	1334	9317	1487	6880	4816
2385	7848	2530	3830	19278	1991	1953	937	1499	9353	1700	7685	5328

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
239	1325	583	834	2579	941	263	186	321	1522	276	1558	944
596	1718	904	1461	2712	4659	283	285	330	3391	383	1907	1639
1789	9328	4073	6261	17399	7708	1862	1385	2248	11333	1921	10993	6774
2385	14515	5853	8575	28277	8684	2846	1945	3490	15305	2956	16883	9939

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
239	2061	906	1298	4012	1463	409	290	499	2368	429	2424	1469
596	1069	562	909	1687	2899	176	178	205	2110	238	1186	1020
1789	1935	845	1299	3609	1599	386	287	466	2351	398	2280	1405
2385	2258	910	1334	4399	1351	443	303	543	2381	460	2626	1546

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
239	0.0024	0.0034	123	0.38	0.046	0.0007	29	0.035	0.0005	0.0159	0.0007	0.0018	0.0056	0.0003	0.0025	0.0122	0.0050
596	0.0012	0.0020	162	0.49	0.049	0.0004	30	0.036	0.0003	0.0159	0.0004	0.0010	0.0056	0.0002	0.0013	0.0122	0.0048
1789	0.0005	0.0010	224	0.68	0.052	0.0002	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0056	0.0001	0.0006	0.0122	0.0046
2385	0.0004	0.0009	244	0.74	0.052	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0004	0.0056	0.0001	0.0004	0.0122	0.0046

Drop Structures

Design Slope	0.0050	ft/ft
Total Drop Needed	26.9	ft
Height of Drop Structure	3	ft
No . of Drop Structures	9	
Distance between structs.	413	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.19	sq. mi
Total Sediment Yield Volume	0.35	ac ft

Sedimentation Basins

Length	413 ft	Depth	3 ft
Width	387 ft	Side slope	3 ft/ft
Total Volume per Basin		10.53	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
239	1.1	-0.6	0.2	24.6	2.0	1.7	3.3	0.0050	0.2	1.5	3.0	6.2
596	1.1	-1.2	0.1	24.6	3.5	0.8	2.0	0.0050	0.3	1.5	3.0	6.3
1789	1.1	-1.3	0.1	24.6	4.2	1.6	3.1	0.0050	0.5	1.5	3.0	6.5
2385	1.1	-1.3	0.2	24.6	4.5	1.8	3.5	0.0050	0.5	1.5	3.0	6.6

Toe Protection Needed	7.0	ft

HEC1 Results For Open Channel

Peak Flow	2062	cfs
Stage at Peak Flow	101.3	ft
Flow Volume	231.0	ac. ft

Freeboard

Max. Flow Depth	1.4	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.1	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	0.54	ac. ft
Outflowing Sediment Volume	0.13	ac. ft
Deposited(+)/Eroded(-) Volume	0.40	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	3721	3721
Side Slope (?H:1V)	3	3
Channel Width (ft)	387	387
Channel XS Area (sq. ft)	1797.8	1797.8
Channel Perimeter (ft)	389	389

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	3721	ft
Thickness	1.5	ft
Protection Depth	7	ft
Tie-in Length/Depth	3.0	ft
Total Depth	10.0	ft
Area needed	1240	sq. Yd
Volume	4134	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	3721	3721
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	17365	35970
Left Levee Volume (cu. Yd)	17089	40242
Right Levee Length (ft)	3721	3721
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	17365	35970
Right Levee Volume (cu. Yd)	17089	40242
Total Levee Surface Area (sq. Yd)	34730	71940
Total Levee Volume (cu. Yd)	34178	80484

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	3721	3721
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	5788	13644
Left Levee Lining Volume (cu. Yd)	2894	6822
Right Levee Length (ft)	3721	3721
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	5788	13644
Right Levee Lining Volume (cu. Yd)	2894	6822
Total Lining Area (sq. Yd)	11576	27287
Total Lining Volume (cu. Yd)	5788	13644

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	387	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	6.8	ft
Structure Height	9.8	ft
Number of Structures	9	
Volume per structure	423	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 31,725	
Area per structure	129	sq. Yd
Total Area	1,161	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	16988	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 67,952	
Other Cost	$ -	
Total cost per basin	$ 67,952	
Area per basin	17,776	sq. Yd
Total Area	17,776	sq. Yd

Structure Cost

Structure Type	Structure Type	Excavation/Construction Quantity	Units	Unit Cost	Cost Subtotal	Landscape Quantity	Units	Unit Cost	Landscape Cost	Maintenance Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	34,178	cu. Yd	$ 7.00	$ 239,246	34,730	sq. Yd	$ 9.00	$ 312,570	34,730	sq. Yd	$ 11.67	$ 405,183
Levee - LC Enhancement	Fill	46,306	cu. Yd	$ 7.00	$ 324,142	37,210	sq. Yd	$ 9.00	$ 334,890	46,306	sq. Yd	$ 11.67	$ 540,237
Levee Lining	Riprap	5,788	cu. Yd	$ 75.00	$ 434,100	11,576	sq. Yd	$ -	$ -	11,576	sq. Yd	$ 20.83	$ 241,176
Levee Lining -LC Enhancement	Riprap	7,856	cu. Yd	$ 75.00	$ 589,200	15,711	sq. Yd	$ -	$ -	15,711	sq. Yd	$ 20.83	$ 327,310
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	4,134	cu. Yd	$ 75.00	$ 310,050	1,240	sq. Yd	$ -	$ -	1,240	sq. Yd	$ 25.00	$ 31,000
Drop Structures	Riprap	9	EA	$ 31,725.00	$ 285,525	1,161	sq. Yd	$ -	$ -	1,161	sq. Yd	$ 33.33	$ 38,700
Drop Str. - LC Enhancement	Riprap	9	EA	$ 3,172.50	$ 28,553	116	sq. Yd	$ -	$ -	116	sq. Yd	$ 33.33	$ 3,870
Sedimentation Basins		1	EA	$ 67,952.00	$ 67,952	17,776	sq. Yd	$ -	$ -	17,776	sq. Yd	$ 8.33	$ 148,133
Other					$ -				$ -				$ -

Base Landscape Cost	$ 312,570	Base Maintenance Cost	$ 864,193
LC Enhancement Cost	$ 334,890	LC Enhancement Cost	$ 871,417
Total Landscape Cost	$ 647,460	Total Maintenance Cost	$ 1,735,609

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,336,873	$ 941,895	$ 2,278,768
Contingency Cost (25% of Construction Cost)	$ 334,218	$ 235,474	$ 569,692
Engineering Design Cost (5% of Construction Cost)	$ 66,844	$ 47,095	$ 113,938
Total Construction Cost	$ 1,737,935	$ 1,224,463	$ 2,962,398

Land Cost

Channel Length	3721 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	387	33.1	$100,000	$ 3,310,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	4.7	$100,000	$ 470,000
Levee LC Enhancement	51	4.4	$100,000	$ 440,000
Other	0	0	$100,000	$ -
Total	493	42.2		$ 4,220,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	37.8	$100,000	$ 3,780,000
LC Enhancement Cost	acre	4.4	$100,000	$ 440,000
Total Land Cost	acre	42.2	$100,000	$ 4,220,000

Total Cost

Base Total Cost	$ 6,694,697
Total Landscape Enhancement Cost	$ 2,870,770
Total Cost Including LC Enh.	$ 9,565,467

Open Channel

Structure ID	S18010	HEC1 ID	S18010

Longitundal Geometry

Length	5165.4	ft
U/S Elev	1531.6	ft
D/S Elev	1456.3	ft
Initial Channel Slope	0.0146	ft/ft
Long-term Channel Slope	0.0060	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	

Initial Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	180	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	193.5	193.5	193.5	207
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	75	3	25	6.5	3	68	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	88.5	94.5	119.5	125.5	193.5	207
Y	104.5	100	100	98	98	100	100	104.5

Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	S180									TOTAL
HEC1 Peak-Flow	1039									1039
Weighting Factor	1.00									
Flow into Channel	1039									1039

Reach Sediment Inflow Characteristics

U/S Contributing ID										TOTAL
HEC1 Flow Volume (ac. ft)										0
Sediment Conc. (ppm)										
Sediment Volume (ac. ft)										0.00
Weighting Factor										
Weighted Sed. Vol. (ac. ft)										0.00

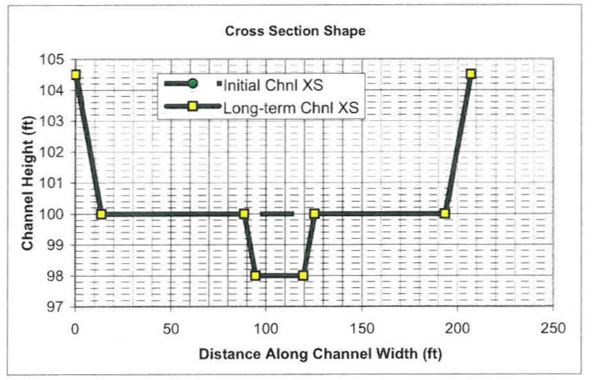
Hydrology

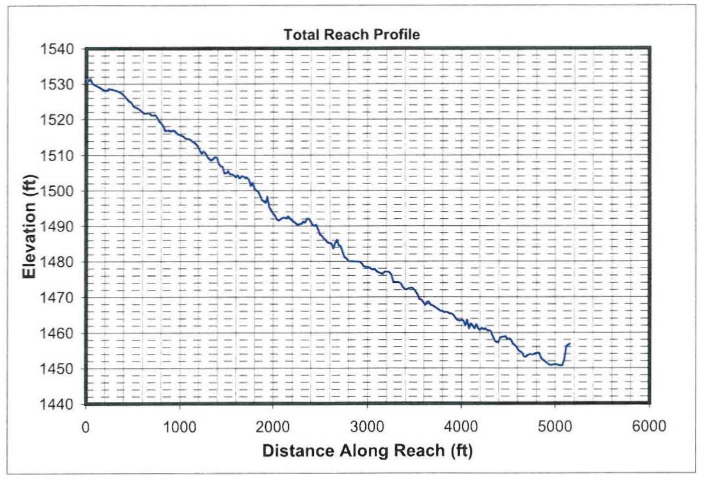
Drainage Area	1.44	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	1039	cfs	
Long-term Max. Chnl Capacity	6482	cfs	
Q2 Channel	104	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	207	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			





Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
104	182.0	56.6	0.3	100.0	100.3	1.8	0.3	181.9	0.3	0.12	0.58
260	183.4	98.4	0.5	100.0	100.5	2.6	0.5	183.2	0.5	0.20	0.64
779	186.6	191.5	1.0	100.0	101.0	4.1	1.0	186.3	1.0	0.39	0.71
1039	187.9	228.2	1.2	100.0	101.2	4.6	1.2	187.5	1.2	0.46	0.73

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
104	33.2	37.4	1.1	98.0	99.3	2.8	1.3	32.8	1.1	0.48	0.46
260	183.0	128.3	0.7	98.0	100.4	2.0	2.4	182.2	0.7	0.89	0.43
779	187.2	250.3	1.3	98.0	101.0	3.1	3.0	186.2	1.3	1.13	0.47
1039	188.8	298.5	1.6	98.0	101.3	3.5	3.3	187.7	1.6	1.23	0.49

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
104										0
260										0
779										0
1039										0

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
104	1.74	1.0357	0.9839	Erosive	Erosive	Erosive	0.2	Stable	5.3	Stable	Stable
260	1.74	1.2036	1.1434	Erosive	Erosive	Erosive	0.3	Stable	6.7	Stable	Stable
779	1.74	1.4040	1.3338	Erosive	Erosive	Erosive	0.3	Stable	8.4	Stable	Stable
1039	1.74	1.4561	1.3833	Erosive	Erosive	Erosive	0.3	Stable	9.0	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	**104**	**260**	**779**	**1039**	**104**	**260**	**779**	**1039**	**104**	**260**	**779**	**1039**
Bray - Equation #1	28	45	80	93	1.2	1.7	2.4	2.7	3.0	3.4	4.0	4.2
Bray - Equation #2	36	58	104	122	1.4	1.9	2.7	2.9	2.1	2.4	2.8	2.9
Hey	8	13	25	30	3.8	5.3	8.1	9.0				
Ackers & Charlton/Lacey	25	37	59	67					1.7	2.0	2.4	2.6
Parker	70	111	192	221	1.0	1.4	2.2	2.5				
Chang	47	82	160	191	0.1	0.0	-0.3	-0.4				
Kellerhals	18	29	50	58	1.7	2.5	3.9	4.4	3.2	3.6	4.0	4.1
AMAFCA/Schumm	33	182	186	188								
Moody & Odem	14	14	14	14	1.0	1.0	1.0	1.0				
BUREC	14.6	20.7	31.2	34.7	4	6	8	9	2.8	3.6	4.7	5.1
Average	29	59	90	102	1.8	2.4	3.5	3.9	2.6	3.0	3.6	3.8
Values As Designed	33	182	186	188	1.3	2.4	3.0	3.3	2.8	2.0	3.1	3.5
Difference with Design	-3	-123	-96	-86	0.5	0.0	0.5	0.6	-0.2	1.0	0.5	0.3

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
104	741	482	992	1319	2564	209	199	107	3099	227	779	974
260	3058	1620	3171	6234	3863	955	708	601	8270	781	3400	2969
779	16554	5998	10090	39882	5956	4595	2397	3209	25511	3738	16636	12233
1039	25724	8320	13086	64745	6628	6841	3219	4799	34133	5670	24696	17987

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
104	2645	1722	3541	4711	9157	748	712	384	11064	810	2780	3480
260	4368	2314	4529	8904	5518	1364	1012	858	11812	1116	4856	4241
779	7881	2856	4804	18988	2836	2188	1141	1528	12146	1780	7920	5824
1039	9186	2971	4673	23119	2367	2443	1149	1714	12188	2025	8818	6423

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
104	543	270	441	1010	629	117	93	124	856	118	638	440
260	890	477	838	1445	2423	164	162	165	1974	206	986	885
779	4803	2119	3379	9211	4007	1032	754	1116	6520	1020	5605	3597
1039	7459	3036	4643	14933	4520	1571	1054	1732	8793	1563	8575	5262

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
104	1938	966	1574	3605	2247	419	331	443	3057	423	2278	1571
260	1271	681	1197	2064	3461	235	231	235	2819	295	1409	1264
779	2287	1009	1609	4385	1908	492	359	532	3104	486	2669	1712
1039	2663	1084	1658	5332	1614	561	377	618	3140	558	3062	1879

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
104	0.0026	0.0039	125	0.38	0.046	0.0008	30	0.035	0.0006	0.0159	0.0008	0.0020	0.0074	0.0005	0.0029	0.0145	0.0061
260	0.0013	0.0023	165	0.50	0.049	0.0005	30	0.036	0.0003	0.0159	0.0005	0.0011	0.0074	0.0003	0.0015	0.0146	0.0059
779	0.0006	0.0012	228	0.69	0.052	0.0003	31	0.036	0.0002	0.0159	0.0002	0.0006	0.0074	0.0002	0.0006	0.0146	0.0057
1039	0.0005	0.0010	248	0.76	0.053	0.0002	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0074	0.0002	0.0005	0.0146	0.0056

Drop Structures

Design Slope	0.0060	ft/ft
Total Drop Needed	44.3	ft
Height of Drop Structure	3	ft
No . of Drop Structures	15	
Distance between structs.	344	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	1.44	sq. mi
Total Sediment Yield Volume	2.74	ac ft

Sedimentation Basins

Length	344 ft	Depth	3 ft
Width	207 ft	Side slope	3 ft/ft
Total Volume per Basin		4.57	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		2	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
104	1.1	-0.4	0.1	24.6	1.3	1.1	2.8	0.0060	0.1	1.5	2.0	4.8
260	1.1	-0.8	0.1	24.6	2.4	0.7	2.0	0.0060	0.2	1.5	2.0	4.9
779	1.1	-0.9	0.1	24.6	3.0	1.3	3.1	0.0060	0.3	1.5	2.0	5.1
1039	1.1	-0.9	0.2	24.6	3.3	1.6	3.5	0.0060	0.4	1.5	2.0	5.1

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	1003	cfs
Stage at Peak Flow	101.2	ft
Flow Volume	90.0	ac. ft

Freeboard

Max. Flow Depth	1.2	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.3	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	2.74	ac. ft
Outflowing Sediment Volume	0.06	ac. ft
Deposited(+)/Eroded(-) Volume	2.67	ac. ft

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

Sub-area: Wagner Wash, Alternative: B41
Open Channel Structure ID: S18010

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	5165	5165
Side Slope (?H:1V)	3	3
Channel Width (ft)	207	207
Channel XS Area (sq. ft)	932.8	932.8
Channel Perimeter (ft)	209	209

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	5165	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	1722	sq. Yd
Volume	5165	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	5165	5165
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	24103	49928
Left Levee Volume (cu. Yd)	23721	55859
Right Levee Length (ft)	5165	5165
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	24103	49928
Right Levee Volume (cu. Yd)	23721	55859
Total Levee Surface Area (sq. Yd)	48206	99856
Total Levee Volume (cu. Yd)	47442	111718

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	5165	5165
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	8034	18938
Left Levee Lining Volume (cu. Yd)	4017	9469
Right Levee Length (ft)	5165	5165
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	8034	18938
Right Levee Lining Volume (cu. Yd)	4017	9469
Total Lining Area (sq. Yd)	16069	37877
Total Lining Volume (cu. Yd)	8034	18938

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	207	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	6.3	ft
Structure Height	9.3	ft
Number of Structures	15	
Volume per structure	213	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 15,975	
Area per structure	69	sq. Yd
Total Area	1,035	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	2	
Total Volume per Basin	7373	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 29,492	
Other Cost	$ -	
Total cost per basin	$ 29,492	
Area per basin	7,920	sq. Yd
Total Area	15,840	sq. Yd

Structure Cost

Structure Type	Structure Type	Excavation/Construction Quantity	Units	Unit Cost	Cost Subtotal	Landscape Quantity	Units	Unit Cost	Landscape Cost	Maintenance Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	47,442	cu. Yd	$ 7.00	$ 332,094	48,206	sq. Yd	$ 9.00	$ 433,854	48,206	sq. Yd	$ 11.67	$ 562,403
Levee - LC Enhancement	Fill	64,276	cu. Yd	$ 7.00	$ 449,932	51,650	sq. Yd	$ 9.00	$ 464,850	64,276	sq. Yd	$ 11.67	$ 749,887
Levee Lining	Riprap	8,034	cu. Yd	$ 75.00	$ 602,550	16,069	sq. Yd	$ -	$ -	16,069	sq. Yd	$ 20.83	$ 334,769
Levee Lining -LC Enhancement	Riprap	10,904	cu. Yd	$ 75.00	$ 817,800	21,808	sq. Yd	$ -	$ -	21,808	sq. Yd	$ 20.83	$ 454,329
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	5,165	cu. Yd	$ 75.00	$ 387,375	1,722	sq. Yd	$ -	$ -	1,722	sq. Yd	$ 25.00	$ 43,050
Drop Structures	Riprap	15	EA	$ 15,975.00	$ 239,625	1,035	sq. Yd	$ -	$ -	1,035	sq. Yd	$ 33.33	$ 34,500
Drop Str. - LC Enhancement	Riprap	15	EA	$ 1,597.50	$ 23,963	104	sq. Yd	$ -	$ -	104	sq. Yd	$ 33.33	$ 3,450
Sedimentation Basins		2	EA	$ 29,492.00	$ 58,984	15,840	sq. Yd	$ -	$ -	15,840	sq. Yd	$ 8.33	$ 132,000
Other					$ -				$ -				$ -

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,620,628	$ 1,291,695	$ 2,912,323
Contingency Cost (25% of Construction Cost)	$ 405,157	$ 322,924	$ 728,081
Engineering Design Cost (5% of Construction Cost)	$ 81,031	$ 64,585	$ 145,616
Total Construction Cost	$ 2,106,816	$ 1,679,203	$ 3,786,019

Base Landscape Cost	$ 433,854	Base Maintenance Cost	$ 1,106,722
LC Enhancement Cost	$ 464,850	LC Enhancement Cost	$ 1,207,665
Total Landscape Cost	$ 898,704	Total Maintenance Cost	$ 2,314,387

Land Cost

Channel Length	5165 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	207	24.5	$100,000	$ 2,450,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	6.5	$100,000	$ 650,000
Levee LC Enhancement	51	6	$100,000	$ 600,000
Other	0	0	$100,000	$ -
Total	313	37		$ 3,700,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	31	$100,000	$ 3,100,000
LC Enhancement Cost	acre	6	$100,000	$ 600,000
Total Land Cost	acre	37	$100,000	$ 3,700,000

Total Cost

Base Total Cost	$ 6,747,392
Total Landscape Enhancement Cost	$ 3,951,718
Total Cost Including LC Enh.	$ 10,699,110

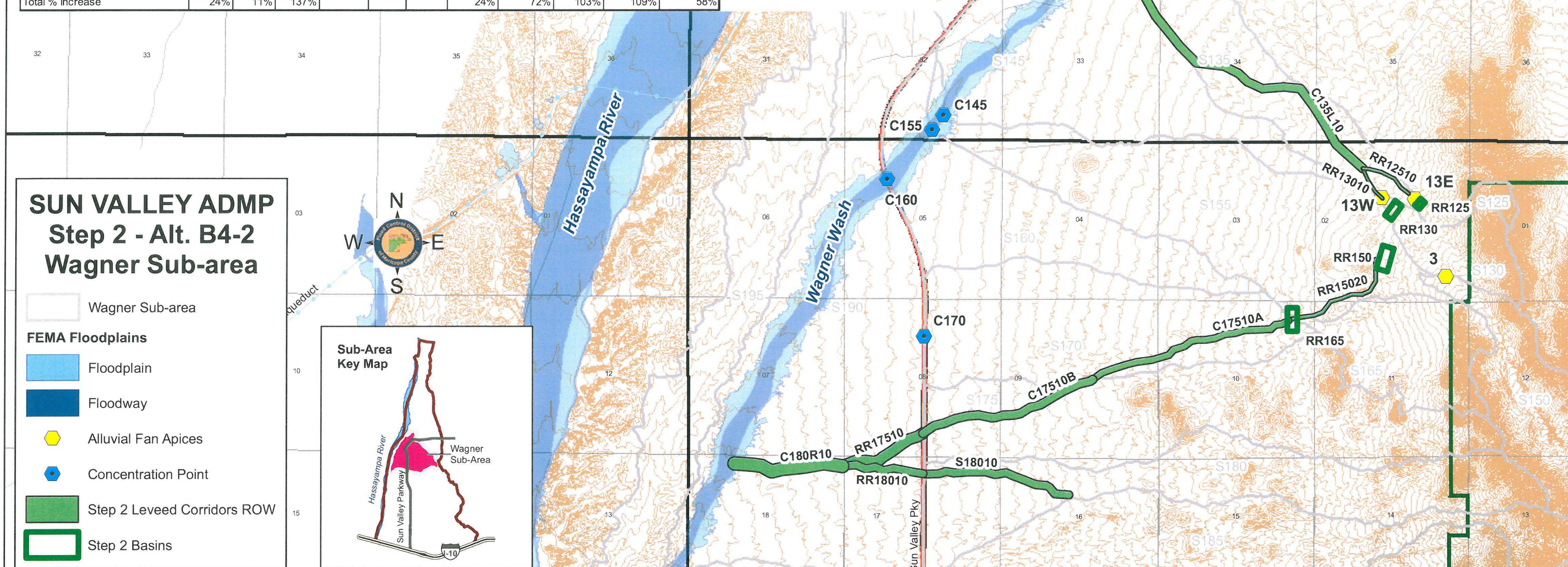
Structure ID	Type	Flow Rate (cfs)	ROW Area (acres)	Exc. Vol. (ac. ft)	Fill Vol. (ac. ft)	Base Design Geometry: Length (stor-ft; chl-mi)	ROW Width (ft)	Depth (ft)	Base Costs (in $1000): Land Cost	Constr. Cost	Lndscp Cost	50 Yr Maint. Cost	Total Cost	Base Cost Percentages: Land Cost %	Constr. Cost %	Lndscp Cost %	50 Yr Maint. Cost %	% of Total Cost
RR125	Online Basin	33	1	10	0	300	200	6	$ 140	$ 163	$ 60	$ 71	$ 434	32%	38%	14%	16%	1%
RR12510	Leveed Chl.	73	4	0	9	0.4	101	4	$ 430	$ 575	$ 145	$ 328	$ 1,477	29%	39%	10%	22%	2%
RR130	Online Basin	57	4	39	0	600	290	7	$ 400	$ 417	$ 174	$ 181	$ 1,172	34%	36%	15%	15%	2%
RR13010	Leveed Chl.	57	3	0	6	0.2	88	4	$ 250	$ 375	$ 96	$ 219	$ 940	27%	40%	10%	23%	1%
C135L10	Leveed Chl.	1001	78	0	69	2.3	282	5	$ 7,830	$ 5,025	$ 1,016	$ 2,429	$ 16,300	48%	31%	6%	15%	24%
RR150	Online Basin	97	7	97	0	800	400	10	$ 730	$ 938	$ 320	$ 322	$ 2,310	32%	41%	14%	14%	3%
RR15020	Leveed Chl.	206	11	0	23	0.8	118	5	$ 1,110	$ 1,413	$ 343	$ 844	$ 3,709	30%	38%	9%	23%	6%
RR165	Online Basin	94	6	67	0	800	330	9	$ 610	$ 700	$ 264	$ 266	$ 1,840	33%	38%	14%	14%	3%
C17510A	Leveed Chl.	834	36	0	40	1.3	222	5	$ 3,600	$ 2,859	$ 594	$ 1,419	$ 8,473	42%	34%	7%	17%	13%
C17510B	Leveed Chl.	1270	40	0	35	1.2	282	5	$ 3,990	$ 2,672	$ 518	$ 1,384	$ 8,565	47%	31%	6%	16%	13%
RR17510	Leveed Chl.	1389	25	0	17	0.6	362	5	$ 2,520	$ 1,411	$ 255	$ 668	$ 4,854	52%	29%	5%	14%	7%
S18010	Leveed Chl.	1039	31	0	29	1	262	5	$ 3,100	$ 2,107	$ 434	$ 1,107	$ 6,747	46%	31%	6%	16%	10%
RR18010	Leveed Chl.	1124	17	0	16	0.5	262	5	$ 1,700	$ 1,167	$ 237	$ 595	$ 3,699	46%	32%	6%	16%	6%
C180R10	Leveed Chl.	2053	38	0	21	0.7	442	5	$ 3,780	$ 1,717	$ 313	$ 864	$ 6,674	57%	26%	5%	13%	10%
		TOTAL	301	213	265				$30,190	$ 21,538	$ 4,769	$ 10,697	**$ 67,194**	45%	32%	7%	16%	100%
All Channels			283	0	265	9.0			$28,310	$ 19,320	$ 3,951	$ 9,857	$ 61,438	46%	31%	6%	16%	91%
All Online Basins			18	213	0				$ 1,880	$ 2,218	$ 818	$ 840	$ 5,756	33%	39%	14%	15%	9%
All Offline Basins			0	0	0				$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
Channel Cost per mile (in $1000)			$6,826		Basins Cost per ac. ft. (in $1000)				$3.84									

Cost Increase for Landscape Compatibility Enhancement over Base Costs

	ROW Area	Exc. Vol.	Fill Vol.	Length	ROW Width	Depth	Land Cost	Constr. Cost	Lndscp Cost	50 Yr Maint. Cost	Total Cost
All Channels % increase	19%	0%	137%				19%	79%	107%	111%	59%
All Online Basins % increase	100%	11%	0%				86%	9%	85%	79%	55%
All Offline Basins % increase	0%	0%	0%				0%	0%	0%	0%	0%
Total % increase	24%	11%	137%				24%	72%	103%	109%	58%

The Alternative B4-2 is the notation used for the alternative concept using large basins at the alluvial fan apices accompanied by leveed conveyance corridors in the down fan direction. It is the second of three alignments considered as part of the Alternative B4 series.

SUN VALLEY ADMP
Step 2 - Alt. B4-2
Wagner Sub-area



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Costs Summary

						Base Design Geometry			Base Costs (in $1000)					Base Cost Percentages				
Structure ID	Type	Flow Rate (cfs)	ROW Area (acres)	Exc. Vol. (ac. ft)	Fill Vol. (ac. ft)	Length (stor-ft; chl-mi)	ROW Width (ft)	Depth (ft)	Land Cost	Constr. Cost	Lndscp Cost	50 Yr Maint. Cost	Total Cost	Land Cost %	Constr. Cost %	Lndscp Cost %	50 Yr Maint. Cost %	% of Total Cost
RR125	Online Basin	33	1	10	0	300	200	6	$ 140	$ 163	$ 60	$ 71	$ 434	32%	38%	14%	16%	1%
RR12510	Leveed Chl.	73	4	0	9	0.4	101	4	$ 430	$ 575	$ 145	$ 328	$ 1,477	29%	39%	10%	22%	2%
RR130	Online Basin	57	4	39	0	600	290	7	$ 400	$ 417	$ 174	$ 181	$ 1,172	34%	36%	15%	15%	2%
RR13010	Leveed Chl.	57	3	0	6	0.2	88	4	$ 250	$ 375	$ 96	$ 219	$ 940	27%	40%	10%	23%	1%
C135L10	Leveed Chl.	1001	78	0	69	2.3	282	5	$ 7,830	$ 5,025	$ 1,016	$ 2,429	$ 16,300	48%	31%	6%	15%	24%
RR150	Online Basin	97	7	97	0	800	400	10	$ 730	$ 938	$ 320	$ 322	$ 2,310	32%	41%	14%	14%	3%
RR15020	Leveed Chl.	206	11	0	23	0.8	118	5	$ 1,110	$ 1,413	$ 343	$ 844	$ 3,709	30%	38%	9%	23%	6%
RR165	Online Basin	94	6	67	0	800	330	9	$ 610	$ 700	$ 264	$ 266	$ 1,840	33%	38%	14%	14%	3%
C17510A	Leveed Chl.	834	36	0	40	1.3	222	5	$ 3,600	$ 2,859	$ 594	$ 1,419	$ 8,473	42%	34%	7%	17%	13%
C17510B	Leveed Chl.	1270	40	0	35	1.2	282	5	$ 3,990	$ 2,672	$ 518	$ 1,384	$ 8,565	47%	31%	6%	16%	13%
RR17510	Leveed Chl.	1389	25	0	17	0.6	362	5	$ 2,520	$ 1,411	$ 255	$ 668	$ 4,854	52%	29%	5%	14%	7%
S18010	Leveed Chl.	1039	31	0	29	1	262	5	$ 3,100	$ 2,107	$ 434	$ 1,107	$ 6,747	46%	31%	6%	16%	10%
RR18010	Leveed Chl.	1124	17	0	16	0.5	262	5	$ 1,700	$ 1,167	$ 237	$ 595	$ 3,699	46%	32%	6%	16%	6%
C180R10	Leveed Chl.	2053	38	0	21	0.7	442	5	$ 3,780	$ 1,717	$ 313	$ 864	$ 6,674	57%	26%	5%	13%	10%
		TOTAL	301	213	265				$ 30,190	$ 21,538	$ 4,769	$ 10,697	**$ 67,194**	45%	32%	7%	16%	100%
All Channels			283	0	265	9.0			$ 28,310	$ 19,320	$ 3,951	$ 9,857	$ 61,438	46%	31%	6%	16%	91%
All Online Basins			18	213	0				$ 1,880	$ 2,218	$ 818	$ 840	$ 5,756	33%	39%	14%	15%	9%
All Offline Basins			0	0	0				$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
Channel Cost per mile (in $1000)			$6,826		Basins Cost per ac. ft. (in $1000)				$3.84									

Cost Summary - Landscape Compatibility Enhanced (LCE)

						LCE Design Geometry			LCE Costs (in $1000)					LCE Cost Percentages				
Structure ID	Type	Flow Rate (cfs)	ROW Area (acres)	Exc. Vol. (ac. ft)	Fill Vol. (ac. ft)	Length (stor-ft; chl-mi)	ROW Width (ft)	Depth (ft)	Land Cost	Constr. Cost	Lndscp Cost	50 Yr Maint. Cost	Total Cost	Land Cost %	Constr. Cost %	Lndscp Cost %	50 Yr Maint. Cost %	% of Total Cost
RR125	Online Basin	33	4	11	0	500	300	6	$ 350	$ 175	$ 150	$ 157	$ 832	42%	21%	18%	19%	1%
RR12510	Leveed Chl.	73	6	0	21	0.4	149	4	$ 630	$ 1,102	$ 300	$ 708	$ 2,741	23%	40%	11%	26%	3%
RR130	Online Basin	57	8	44	0	870	390	7	$ 780	$ 460	$ 339	$ 338	$ 1,917	41%	24%	18%	18%	2%
RR13010	Leveed Chl.	57	4	0	14	0.2	136	4	$ 390	$ 726	$ 200	$ 472	$ 1,788	22%	41%	11%	26%	2%
C135L10	Leveed Chl.	1001	93	0	162	2.3	333	5	$ 9,250	$ 8,978	$ 2,105	$ 5,260	$ 25,593	36%	35%	8%	21%	24%
RR150	Online Basin	97	13	108	0	1110	500	10	$ 1,270	$ 1,032	$ 555	$ 545	$ 3,401	37%	30%	16%	16%	3%
RR15020	Leveed Chl.	206	16	0	55	0.8	169	5	$ 1,590	$ 2,725	$ 710	$ 1,796	$ 6,822	23%	40%	10%	26%	6%
RR165	Online Basin	94	11	73	0	1100	430	9	$ 1,090	$ 751	$ 473	$ 463	$ 2,777	39%	27%	17%	17%	3%
C17510A	Leveed Chl.	834	44	0	95	1.3	273	5	$ 4,430	$ 5,163	$ 1,231	$ 3,074	$ 13,898	32%	37%	9%	22%	13%
C17510B	Leveed Chl.	1270	47	0	83	1.2	333	5	$ 4,710	$ 4,683	$ 1,073	$ 2,827	$ 13,294	35%	35%	8%	21%	12%
RR17510	Leveed Chl.	1389	29	0	41	0.6	413	5	$ 2,880	$ 2,411	$ 528	$ 1,380	$ 7,199	40%	33%	7%	19%	7%
S18010	Leveed Chl.	1039	37	0	69	1	313	5	$ 3,700	$ 3,786	$ 899	$ 2,314	$ 10,699	35%	35%	8%	22%	10%
RR18010	Leveed Chl.	1124	20	0	38	0.5	313	5	$ 2,030	$ 2,088	$ 492	$ 1,256	$ 5,865	35%	36%	8%	21%	6%
C180R10	Leveed Chl.	2053	42	0	50	0.7	493	5	$ 4,220	$ 2,939	$ 647	$ 1,736	$ 9,542	44%	31%	7%	18%	9%
		TOTAL	374	236	628				$ 37,320	$ 37,018	$ 9,703	$ 22,326	**$ 106,368**	35%	35%	9%	21%	100%
All Channels			338	0	628	9.0			$ 33,830	$ 34,600	$ 8,186	$ 20,824	$ 97,440	35%	36%	8%	21%	92%
All Online Basins			36	236	0				$ 3,490	$ 2,418	$ 1,517	$ 1,503	$ 8,928	39%	27%	17%	17%	8%
All Offline Basins			0	0	0				$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
Channel Cost per mile (in $1000)			$10,827		Basins Cost per ac. ft. (in $1000)				$6.43									
All Channels % increase			19%	0%	137%				19%	79%	107%	111%	59%					
All Online Basins % increase			100%	11%	0%				86%	9%	85%	79%	55%					
All Offline Basins % increase			0%	0%	0%				0%	0%	0%	0%	0%					
Total % increase			24%	11%	137%				24%	72%	103%	109%	58%					

Hydrology - 6-hr Storm HEC1 Model Results

		Peak	Peak	Peak		Cum.Area	MAX. Average Flow (cfs)				MAX. Average Rainfall Depth (Inches)				Total Runoff Volume (ac. ft)			
KK CARD	Type	Flow	Stage (ft)	Storage	Time	(sq. miles)	6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR
S100	BASIN	4347			4.6	6.99	899	225	75	32	1.195	1.195	1.195	1.195	446	446	446	446
S102	BASIN	2790			4.3	3.23	417	104	35	15	1.198	1.198	1.198	1.198	207	207	207	207
C102	COMBINE	5993			4.5	10.23	1198	300	100	43	1.089	1.089	1.089	1.089	594	594	594	594
RR102	STORAGE	127	1552	1143.35	6.7	10.23	122	104	72	41	0.11	0.376	0.784	1.029	60	205	428	561
D102	DIVERT	63			6.7	10.23	61	52	36	20	0.055	0.188	0.392	0.515	30	103	214	281
100105	ROUTE	59	100.2	20.4	12.5	10.23	58	51	36	20	0.053	0.185	0.389	0.512	29	101	212	279
S105	BASIN	2863			4.5	4.37	495	124	41	18	1.053	1.053	1.053	1.053	245	245	245	245
CF02	RETRIEVE	63			6.7	10.23	61	52	36	20	0.055	0.188	0.392	0.515	30	103	214	281
102105	ROUTE	63	100.4	8.6	8	10.23	60	51	36	20	0.055	0.187	0.39	0.513	30	102	213	280
C105U	COMBINE	2863			4.5	14.6	549	226	120	64	0.35	0.577	0.921	1.128	272	449	717	878
S110	BASIN	662			4.2	0.43	76	19	6	3	1.639	1.64	1.64	1.64	38	38	38	38
11015I	ROUTE	570	101.8	9.19	4.4	0.43	76	19	6	3	1.637	1.64	1.64	1.64	38	38	38	38
15I15R	ROUTE	506	102.1	19.34	4.8	0.43	76	19	6	3	1.635	1.64	1.64	1.64	38	38	38	38
S115	BASIN	1605			4.5	2.25	296	74	25	11	1.223	1.224	1.224	1.224	147	147	147	147
C115	COMBINE	1813			4.6	2.68	350	88	29	13	1.215	1.219	1.219	1.219	173	174	174	174
115120	ROUTE	1781	102.7	21.9	4.7	2.68	350	88	29	13	1.215	1.219	1.219	1.219	173	174	174	174
S120	BASIN	1838			4.3	2	256	64	21	9	1.189	1.189	1.189	1.189	127	127	127	127
C120	COMBINE	2678			4.5	4.68	545	137	46	20	1.083	1.087	1.087	1.087	270	271	271	271
C105D	COMBINE	4029			4.5	19.28	821	275	127	64	0.396	0.53	0.737	0.863	407	545	758	888
120135	ROUTE	4027	104.4	16.85	4.5	19.28	821	275	127	64	0.396	0.53	0.737	0.863	407	545	758	888
S125	BASIN	202			4	0.09	14	4	1	1	1.424	1.425	1.425	1.425	7	7	7	7
RR125	STORAGE	33	4.8	4.92	4.4	0.09	14	4	1	1	1.409	1.425	1.425	1.425	7	7	7	7
12535I	ROUTE	33	100.4	0.47	4.6	0.09	14	4	1	1	1.408	1.425	1.425	1.425	7	7	7	7
S130	BASIN	524			4.1	0.31	48	12	4	2	1.425	1.426	1.426	1.426	24	24	24	24
RR130	STORAGE	57	5.8	18.5	4.8	0.31	42	12	4	2	1.251	1.426	1.426	1.426	21	24	24	24
13035I	ROUTE	57	100.9	0.36	4.8	0.31	42	12	4	2	1.248	1.426	1.426	1.426	21	24	24	24
C135I	COMBINE	83			4.7	1.18	49	14	5	2	0.39	0.428	0.428	0.428	25	27	27	27
35I135	ROUTE	69	100.2	11.77	7.3	1.18	47	14	5	2	0.371	0.428	0.428	0.428	23	27	27	27
S135	BASIN	1102			4.2	0.88	111	28	9	4	1.175	1.175	1.175	1.175	55	55	55	55
C135L	COMBINE	829			4.2	2.06	131	36	12	5	0.593	0.654	0.654	0.654	65	72	72	72
C135	COMBINE	4170			4.5	21.34	875	288	131	66	0.381	0.502	0.684	0.796	434	571	779	906
135145	ROUTE	3745	103.8	146.84	5	21.34	864	286	131	66	0.376	0.498	0.683	0.795	428	567	777	905
S140	BASIN	1913			4.1	1.37	188	47	16	7	1.27	1.27	1.27	1.27	93	93	93	93
140145	ROUTE	1624	101.9	39.38	4.4	1.37	187	47	16	7	1.27	1.27	1.27	1.27	93	93	93	93
S145	BASIN	1702			4.2	1.76	193	48	16	7	1.021	1.021	1.021	1.021	96	96	96	96
C145	COMBINE	4072			4.9	24.47	1029	325	143	71	0.391	0.494	0.651	0.747	510	645	850	974
145155	ROUTE	4071	105.7	11.21	4.9	24.47	1029	325	143	71	0.391	0.494	0.651	0.746	510	645	850	974
S155	BASIN	1626			4.3	1.83	223	56	19	8	1.131	1.132	1.132	1.132	111	111	111	111
C155	COMBINE	4304			4.8	26.3	1128	349	150	74	0.399	0.493	0.636	0.724	559	691	893	1016
155160	ROUTE	4294	104.5	32.54	4.9	26.3	1126	348	150	74	0.398	0.492	0.636	0.724	558	691	892	1016
S160	BASIN	1347			4.2	1.14	133	33	11	5	1.079	1.079	1.079	1.079	66	66	66	66
C160	COMBINE	4291			4.9	27.44	1166	358	153	75	0.395	0.485	0.622	0.705	578	710	910	1032
160170	ROUTE	4194	102.7	80.49	5.1	27.44	1158	356	153	75	0.392	0.483	0.62	0.704	574	707	908	1030
S170	BASIN	1686			4.2	1.46	178	44	15	6	1.127	1.127	1.127	1.127	88	88	88	88
170R	ROUTE	1489	1E+08	1E+08	4.4	1.46	178	44	15	6	1.127	1.127	1.127	1.127	88	88	88	88
C170R	COMBINE	4313			5	28.9	1224	372	157	77	0.394	0.479	0.608	0.686	607	738	937	1058

JE FULLER
HYDROLOGY & GEOMORPHOLOGY, INC.

Hydrology - 6-hr Storm HEC1 Model Results

KK CARD	Type	Peak Flow	Peak Stage (ft)	Peak Storage	Time	Cum.Area (sq. miles)	MAX. Average Flow (cfs)				MAX. Average Rainfall Depth (Inches)				Total Runoff Volume (ac. ft)			
							6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR
S150	BASIN	836			4.3	0.77	126	31	10	5	1.51	1.513	1.513	1.513	62	62	62	62
RR150	STORAGE	97	8.2	48.3	5.5	0.77	83	31	10	5	0.997	1.513	1.513	1.513	41	62	62	62
150165	ROUTE	96	100.7	2.46	5.8	0.77	82	31	10	5	0.989	1.513	1.513	1.513	41	62	62	62
S165	BASIN	1008			4.1	0.62	94	23	8	3	1.416	1.417	1.417	1.417	47	47	47	47
C165	COMBINE	800			4.1	1.39	154	50	17	7	1.031	1.345	1.345	1.345	76	100	100	100
RR165	STORAGE	94	7.7	37.5	5.8	1.39	92	50	17	7	0.617	1.343	1.345	1.345	46	100	100	100
165175	ROUTE	94	100.3	16.02	7.6	1.39	90	50	17	7	0.605	1.342	1.345	1.345	45	100	100	100
S175	BASIN	1203			4.5	1.8	226	56	19	8	1.165	1.166	1.166	1.166	112	112	112	112
C175	COMBINE	1031			4.5	3.19	256	96	32	14	0.746	1.116	1.118	1.118	127	190	190	190
175R	ROUTE	997	100.9	17.61	4.6	3.19	253	96	32	14	0.736	1.116	1.118	1.118	125	190	190	190
S180	BASIN	1032			4.5	1.44	181	45	15	7	1.167	1.169	1.169	1.169	90	90	90	90
180R	ROUTE	775	101	34.58	4.8	1.44	180	45	15	7	1.16	1.169	1.169	1.169	89	90	90	90
C180RI	COMBINE	1450			4.7	4.63	384	127	42	18	0.77	1.019	1.02	1.02	190	252	252	252
RI180R	ROUTE	1398	101	31.9	5	4.63	379	127	42	18	0.759	1.019	1.02	1.02	188	252	252	252
C180R	COMBINE	4686			5.2	33.54	1385	430	176	85	0.384	0.477	0.585	0.651	687	854	1046	1164
180185	ROUTE	4674	102.9	52.26	5.4	33.54	1378	430	176	85	0.382	0.476	0.585	0.651	683	852	1046	1164
S185	BASIN	1450			4.5	2.42	288	72	24	10	1.106	1.107	1.107	1.107	143	143	143	143
185R	ROUTE	1302	102.5	41.84	4.9	2.42	288	72	24	10	1.105	1.107	1.107	1.107	143	143	143	143
C185R	COMBINE	5009			5.2	35.96	1485	456	184	88	0.384	0.471	0.571	0.632	736	904	1095	1211
185190	ROUTE	4992	102.6	42.47	5.3	35.96	1480	455	184	88	0.383	0.471	0.571	0.631	734	903	1094	1211
S190	BASIN	2084			4.5	4.05	391	98	33	14	0.896	0.896	0.896	0.896	194	194	194	194
C190	COMBINE	5197			5.2	39.24	1607	488	194	92	0.381	0.463	0.553	0.608	797	968	1157	1272
190195	ROUTE	5092	103.1	78.14	5.5	39.24	1600	487	194	92	0.379	0.462	0.553	0.608	793	967	1157	1272
S195	BASIN	1001			4.6	1.81	203	51	17	7	1.046	1.046	1.046	1.046	101	101	101	101
C195	COMBINE	5142			5.5	41.05	1650	500	198	94	0.374	0.453	0.538	0.591	818	991	1179	1293

Hydrology - 24-hr Storm HEC1 Model Results

		Peak	Peak	Peak		Cum.Area	MAX. Average Flow (cfs)				MAX. Average Rainfall Depth (Inches)				Total Runoff Volume (ac. ft)			
KK CARD	Type	Flow	Stage (ft)	Storage	Time	(sq. miles)	6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR
S100	BASIN	5214			12.5	6.99	965	241	80	35	1.282	1.282	1.282	1.282	478	478	478	478
S102	BASIN	3434			12.3	3.23	420	105	35	15	1.207	1.207	1.207	1.207	208	208	208	208
C102	COMBINE	7803			12.4	10.23	1367	342	114	49	1.243	1.243	1.243	1.243	678	678	678	678
RR102	STORAGE	149	1552.1	1201.44	14.4	10.23	141	119	82	46	0.128	0.431	0.895	1.163	70	235	488	634
D102	DIVERT	75			14.4	10.23	71	59	41	23	0.064	0.215	0.448	0.581	35	118	244	317
100105	ROUTE	70	100.2	24.2	20.3	10.23	67	58	41	23	0.061	0.211	0.444	0.578	33	115	242	315
S105	BASIN	3466			12.5	4.37	531	133	44	19	1.129	1.129	1.129	1.129	263	263	263	263
CF02	RETRIEVE	75			14.4	10.23	71	59	41	23	0.064	0.215	0.448	0.581	35	118	244	317
102105	ROUTE	74	100.4	9.55	15.6	10.23	70	59	41	23	0.064	0.214	0.445	0.58	35	117	243	316
C105U	COMBINE	3466			12.5	14.6	587	238	125	66	0.374	0.606	0.958	1.164	291	472	746	906
S110	BASIN	532			12.1	0.43	62	16	5	2	1.35	1.422	1.422	1.422	31	33	33	33
11015I	ROUTE	456	101.7	7.4	12.4	0.43	62	16	5	2	1.35	1.421	1.422	1.422	31	33	33	33
15I15R	ROUTE	412	101.9	16.62	12.7	0.43	62	16	5	2	1.349	1.421	1.422	1.422	31	33	33	33
S115	BASIN	1693			12.5	2.25	287	73	24	11	1.186	1.209	1.209	1.209	142	145	145	145
C115	COMBINE	1937			12.6	2.68	346	89	30	13	1.201	1.232	1.233	1.233	171	176	176	176
115120	ROUTE	1900	102.8	22.91	12.7	2.68	346	89	30	13	1.201	1.232	1.233	1.233	171	176	176	176
S120	BASIN	2032			12.3	2	247	62	21	9	1.146	1.158	1.158	1.158	122	124	124	124
C120	COMBINE	3202			12.4	4.68	585	149	50	22	1.162	1.185	1.186	1.186	290	296	296	296
C105D	COMBINE	6217			12.4	19.28	1091	359	163	82	0.526	0.692	0.943	1.092	541	712	969	1123
120135	ROUTE	6220	105.1	23.77	12.5	19.28	1091	359	163	82	0.526	0.692	0.943	1.092	541	711	969	1123
S125	BASIN	161			12	0.09	12	3	1	0	1.197	1.258	1.258	1.258	6	6	6	6
RR125	STORAGE	30	4	4.1	12.4	0.09	12	3	1	0	1.192	1.257	1.258	1.258	6	6	6	6
12535I	ROUTE	30	100.4	0.44	12.5	0.09	12	3	1	0	1.191	1.257	1.258	1.258	6	6	6	6
S130	BASIN	415			12.1	0.31	39	10	3	1	1.169	1.217	1.217	1.217	19	20	20	20
RR130	STORAGE	51	4.7	14.6	12.7	0.31	36	10	3	1	1.068	1.215	1.217	1.217	18	20	20	20
13035I	ROUTE	51	100.8	0.34	12.8	0.31	36	10	3	1	1.066	1.215	1.217	1.217	18	20	20	20
C135I	COMBINE	79			12.7	1.18	46	13	4	2	0.363	0.407	0.407	0.407	23	26	26	26
35I135	ROUTE	66	100.2	11.26	15.3	1.18	44	13	4	2	0.347	0.406	0.407	0.407	22	26	26	26
S135	BASIN	1015			12.2	0.88	99	25	8	4	1.048	1.048	1.048	1.048	49	49	49	49
C135L	COMBINE	1001			12.2	2.06	134	37	12	5	0.603	0.671	0.671	0.671	66	74	74	74
C135	COMBINE	6649			12.4	21.34	1204	389	173	86	0.524	0.678	0.903	1.037	597	772	1028	1180
135145	ROUTE	5881	104.6	212.02	12.8	21.34	1190	386	172	86	0.518	0.673	0.901	1.036	590	766	1025	1179
S140	BASIN	2029			12.1	1.37	172	43	14	6	1.164	1.164	1.164	1.164	85	85	85	85
140145	ROUTE	1633	101.9	39.54	12.4	1.37	172	43	14	6	1.163	1.164	1.164	1.164	85	85	85	85
S145	BASIN	1945			12.2	1.76	193	48	16	7	1.022	1.022	1.022	1.022	96	96	96	96
C145	COMBINE	6531			12.7	24.47	1492	461	197	96	0.567	0.701	0.899	1.017	740	915	1173	1327
145155	ROUTE	6537	106.9	17.8	12.8	24.47	1492	461	197	96	0.567	0.701	0.899	1.017	740	915	1173	1327
S155	BASIN	1781			12.3	1.83	218	55	18	8	1.105	1.117	1.117	1.117	108	109	109	109
C155	COMBINE	7020			12.7	26.3	1674	507	212	103	0.592	0.716	0.9	1.009	830	1005	1262	1416
155160	ROUTE	6996	105.5	51.28	12.8	26.3	1672	506	212	103	0.591	0.716	0.9	1.009	829	1004	1262	1416
S160	BASIN	1342			12.1	1.14	124	31	10	4	1.01	1.01	1.01	1.01	62	62	62	62
C160	COMBINE	7077			12.8	27.44	1771	531	220	106	0.6	0.719	0.895	1	878	1053	1310	1464
160170	ROUTE	6939	103.4	130.76	13	27.44	1761	529	220	106	0.597	0.717	0.895	1	873	1050	1309	1463
S170	BASIN	1802			12.1	1.46	169	42	14	6	1.075	1.075	1.075	1.075	84	84	84	84
170R	ROUTE	1558	1E+08	1E+08	12.4	1.46	169	42	14	6	1.075	1.075	1.075	1.075	84	84	84	84
C170R	COMBINE	7196			13	28.9	1898	563	231	111	0.611	0.725	0.893	0.993	941	1118	1377	1531
170180	ROUTE	7095	103.6	183.51	13.1	28.9	1886	562	231	111	0.607	0.723	0.892	0.992	935	1114	1375	1530

Hydrology - 24-hr Storm HEC1 Model Results

KK CARD	Type	Peak Flow	Peak Stage (ft)	Peak Storage	Time	Cum.Area (sq. miles)	MAX. Average Flow (cfs) 6-HR	24-HR	72-HR	MAX-HR	MAX. Average Rainfall Depth (Inches) 6-HR	24-HR	72-HR	MAX-HR	Total Runoff Volume (ac. ft) 6-HR	24-HR	72-HR	MAX-HR
S150	BASIN	729			12.3	0.77	107	29	10	4	1.291	1.374	1.375	1.375	53	57	57	57
RR150	STORAGE	89	6.9	39.9	13.5	0.77	75	28	10	4	0.906	1.365	1.375	1.375	37	56	57	57
150165	ROUTE	88	100.7	2.32	13.7	0.77	75	28	10	4	0.898	1.364	1.375	1.375	37	56	57	57
S165	BASIN	842			12.1	0.62	78	20	7	3	1.183	1.219	1.219	1.219	39	40	40	40
C165	COMBINE	845			12.1	1.39	145	48	16	7	0.968	1.282	1.291	1.291	72	95	96	96
RR165	STORAGE	91	7.2	34.8	13.5	1.39	89	48	16	7	0.595	1.277	1.291	1.291	44	95	96	96
165175	ROUTE	91	100.3	15.75	15.5	1.39	87	48	16	7	0.582	1.276	1.291	1.291	43	95	96	96
S175	BASIN	1278			12.5	1.8	217	55	18	8	1.119	1.131	1.131	1.131	108	109	109	109
C175	COMBINE	1270			12.5	3.19	269	101	34	15	0.784	1.177	1.186	1.186	133	200	202	202
175R	ROUTE	1191	101	19.62	12.6	3.19	266	101	34	15	0.774	1.177	1.186	1.186	132	200	202	202
S180	BASIN	1039			12.5	1.44	171	44	15	6	1.1	1.123	1.124	1.124	85	86	86	86
180R	ROUTE	744	101	33.75	12.8	1.44	170	44	15	6	1.094	1.123	1.124	1.124	84	86	86	86
C180RI	COMBINE	1826			12.6	4.63	430	143	48	21	0.863	1.145	1.154	1.154	213	283	285	285
RI180R	ROUTE	1730	101.2	36.4	12.8	4.63	424	143	48	21	0.851	1.145	1.154	1.154	210	283	285	285
C180R	COMBINE	8272			13	33.54	2241	682	271	128	0.621	0.756	0.9	0.987	1111	1352	1610	1766
180185	ROUTE	8246	104	81.99	13.1	33.54	2233	680	271	128	0.619	0.754	0.9	0.987	1107	1349	1610	1765
S185	BASIN	1655			12.5	2.42	288	73	24	10	1.105	1.117	1.117	1.117	143	144	144	144
185R	ROUTE	1411	102.6	45.16	12.9	2.42	287	73	24	10	1.104	1.117	1.117	1.117	143	144	144	144
C185R	COMBINE	9225			13.1	35.96	2462	739	290	137	0.637	0.764	0.9	0.981	1221	1466	1725	1882
185190	ROUTE	9198	103.5	67.77	13.2	35.96	2457	738	290	137	0.635	0.763	0.899	0.981	1218	1464	1725	1881
S190	BASIN	2590			12.5	4.05	448	112	37	16	1.027	1.027	1.027	1.027	222	222	222	222
C190	COMBINE	10015			13.1	39.24	2802	828	320	150	0.664	0.784	0.909	0.984	1389	1641	1903	2060
190195	ROUTE	9866	104.1	133.25	13.3	39.24	2794	827	320	150	0.662	0.783	0.909	0.984	1385	1640	1903	2060
S195	BASIN	1039			12.6	1.81	202	51	17	7	1.041	1.041	1.041	1.041	100	100	100	100
C195	COMBINE	10225			13.2	41.05	2947	866	333	155	0.668	0.784	0.904	0.976	1462	1717	1980	2137

Channels Hydraulics Summary

		Design Geometry						Hydraulics											
Structure ID	Type	Initial Slope (ft/ft)	Long-term Slope (ft/ft)	Length (stor-ft; chl-mi)	Width (ft)	Depth (ft)	Chnl Mannings n	Flow Rate (cfs)	Wetted Perimeter (ft)	Wetted XS Area (ft)	Hydraulic Radius (ft)	Hydraulic Depth (ft)	Flow Depth (ft)	Freeboard (ft)	Top Width (ft)	Velocity (ft/s)	Froude Number	Shear Stress (lb/sq. ft)
RR12510	Leveed	0.0265	0.0100	0.40	3	4.0	0.045	73	29.3	18.4	0.6	0.6	0.7	3.3	29	4.0	0.88	0.43
RR13010	Leveed	0.0252	0.0120	0.20	3	4.0	0.045	57	17.7	13.2	0.7	0.8	0.9	3.1	17	4.3	0.88	0.67
C135L10	Leveed	0.0165	0.0060	2.30	3	4.5	0.045	1001	206.9	223.4	1.1	1.1	1.1	3.4	207	4.5	0.76	0.41
RR15020	Leveed	0.0206	0.0090	0.80	3	4.5	0.045	206	42.9	43.2	1.0	1.0	1.1	3.4	43	4.8	0.84	0.62
C17510A	Leveed	0.0182	0.0070	1.30	3	4.5	0.045	834	147.5	170.0	1.2	1.2	1.2	3.3	147	4.9	0.80	0.52
C17510B	Leveed	0.0135	0.0050	1.20	3	4.5	0.045	1270	208.5	274.4	1.3	1.3	1.3	3.2	208	4.6	0.71	0.42
RR17510	Leveed	0.0164	0.0060	0.60	3	4.5	0.045	1389	286.9	310.7	1.1	1.1	1.1	3.4	287	4.5	0.76	0.41
S18010	Leveed	0.0146	0.0060	1.00	3	4.5	0.045	1039	187.9	228.2	1.2	1.2	1.2	3.3	187	4.6	0.73	0.46
RR18010	Leveed	0.0153	0.0060	0.50	3	4.5	0.045	1124	188.1	236.0	1.3	1.3	1.3	3.2	188	4.8	0.75	0.48
C180R10	Leveed	0.0122	0.0050	0.70	3	4.5	0.045	2053	368.2	473.9	1.3	1.3	1.3	3.2	368	4.3	0.67	0.41

Basins Hydraulics Summary

			Design Geometry				Hydraulics					
Structure ID	Type	Adjacent Topo. Slope	Length (stor-ft; chl-mi)	Width (ft)	Depth (ft)	Storage Volume Provided	Peak Storage (ac. Ft)	Total Vol. Entering Basin (ac.	Peak Inflow into Basin (cfs)	Peak Outflow (cfs)	Peak Stage (ft)	Freeboard (ft)
RR125	Online Basin	0.0260	300	200	6.0	5.2	4.9	7.0	202	33	4.8	1.2
RR130	Online Basin	0.0280	600	290	7.0	19.2	18.5	24.0	524	57	5.8	1.2
RR150	Online Basin	0.0270	800	400	9.5	50.5	48.3	62.0	836	97	8.2	1.3
RR165	Online Basin	0.0220	800	330	9.0	39.3	37.5	100.0	845	94	7.7	1.3

Online Basin

HEC1 ID	RR125

HEC1 Results Used to Determine Sediment Volume From Upstream

Contributing HEC1 ID							Total Volume (ac. ft)
Inflow Volume (ac. ft)							0
Volume Fraction							
Weighted Volume							0
Sediment Conc. (ppm)							
Sediment Volume (ac. ft)							0.00
Weighting Factor							
Weighted Sed. Vol. (ac. ft)							0.00

Sediment Yield

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.1	sq. mi
Total Sediment Yield Volume	0.2	ac ft

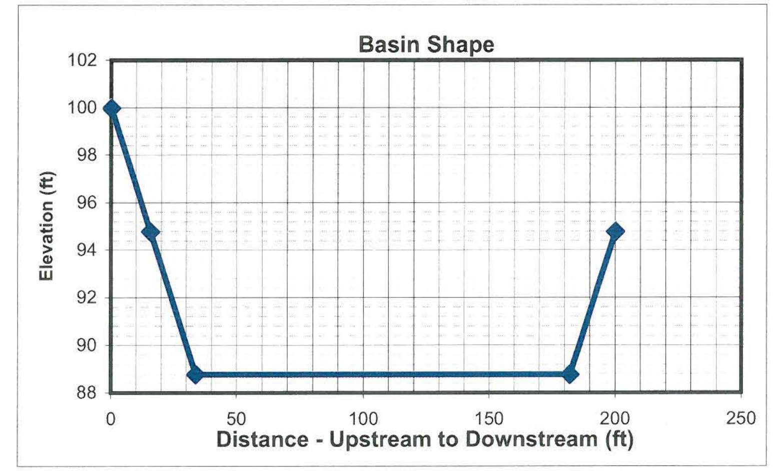
Required Minimum Sediment Volume

Sediment Volume	0.2	ac. ft

Geometry

	Base	LC Enhanced
Topography slope (ft/ft)	0.026	0.026
Basin Length (ft)	300	400
Basin Width (ft)	200	200
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	6	6
Freeboard (ft)	1	1
Effective Basin Width (ft)	184	169
Top Area (acres)	1.4	1.8
U/S-D/S Height Difference (ft)	5.2	5.2
Excess Area on Upstream (acres)	0.1	0.3

			Base	LC Enhanced
Bottom Length (ft)	264	Allocated Storage Volume (ac. ft)	5.2	5.3
Bottom Width (ft)	148	Total Available Volume (ac. ft) (incl. Freeboard)	6.5	6.7
		Total Excavation Volume (ac. ft)	10.1	11.5



HEC1 Results

	6-hr Event	24-hr Event	Maximum
Total Flow Volume entering Basin (ac. ft)	7.0	6	7.0
Peak Inflow (cfs)	202	161	202.0
Peak Outflow (cfs)	33	30	33.0
Stage at Peak Outflow (ft)	4.8	4	4.8
Volume at Peak Outflow (ac. ft)	4.9	4.1	4.9

Volume Check

Total Volume needed	5.1	ac. ft
Total Volume Provided	5.2	ac. ft
Volume OK?	Yes	

Stage Check

Depth Needed	5.8	ft
Depth Provided	6	ft
Depth OK?	Yes	

Basin Outlet

Outlet Coeff	0.60	(0.6 for Orifice, 3.0 for Weir)
D (Orifice) or W (Weir)	2.00	ft
Invert Elevation	0.00	ft
Number of pipes	1	

Stage-Storage-Discharge

Elevation	0	0.5	1	2	3	4	5	6	7	8
Volume	0.00	0.46	0.93	1.91	2.95	4.06	5.23	6.46	7.76	9.13
Outflow	0.0	10.7	15.1	21.4	26.2	30.3	33.8	37.1	40.0	42.8

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
LC Enhancement Buffer	90000	sq. ft
Other		sq. ft

Additional ROW Length	0	ft
Additional ROW Width	0	ft
Landscaping Buffer Length	100	ft
Landscaping Buffer Width	100	ft

Base Total ROW Length	300	ft
Base Total ROW Width	200	ft
LC Enh. Total ROW Length	500	ft
LC Enh. Total ROW Length	300	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	16295	18553
Excavated Area (sq. Yd)	6667	16667

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	35	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	394	sq. Yd
Material Volume	197	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	286	ft
Unit Cost	160	per ft
Cost per outlet	$45,760	
Other Cost	$ -	
Total Cost	$45,760	
Outlet Area	133	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Basin		16,295	cu. Yd	$ 4.00	$ 65,180	6,667	sq. Yd	$ 9.00	$ 60,003	6,667	sq. Yd	$ 8.33	$ 55,558
Basin - LC Enhancement		2,258	cu. Yd	$ 4.00	$ 9,032	10,000	sq. Yd	$ 9.00	$ 90,000	10,000	sq. Yd	$ 8.33	$ 83,333
Inlet	Riprap	197	sq. Yd	$ 75.00	$ 14,775	394	sq. Yd	$ -	$ -	394	sq. Yd	$ 33.33	$ 13,133
Inlet - LC Enhancement (20%Inlet)					$ 2,955				$ -				$ 2,627
Outlet	Pipe	1	EA	$ 45,760	$ 45,760	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhancement (5% Outlet)					$ 2,288				$ -				$ 111
Other					$ -				$ -				$ -

Base Landscape Cost	$ 60,003	
LC Enh. Landscape Cost	$ 90,000	
Total Landscape Cost	$ 150,003	

Base Maintenance Cost	$ 70,908
LC Enh. Maintenance Cost	$ 86,071
Total Maintenance Cost	$ 156,979

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 125,715	$ 9,032	$ 134,747
Contingency Cost (25% of Construction Cost)	$ 31,429	$ 2,258	$ 33,687
Engineering Design Cost (5% of Construction Cost)	$ 6,286	$ 452	$ 6,737
Total Construction Cost	$ 163,430	$ 11,742	$ 175,171

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	2.1	$100,000	$ 210,000
Basin	1.4	$100,000	$ 140,000
Other		$100,000	$ -
Total	3.5	$100,000	$ 350,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	1.4	$100,000	$ 140,000
LC Enhancement Cost	acre	2.1	$100,000	$ 210,000
Total Land Cost	acre	3.5	$100,000	$ 350,000

Total Cost

Base Total Cost	$ 434,341
Total LC Enhancement Cost	$ 397,812
Total Cost Including LC Enh.	$ 832,153

Open Channel

Structure ID	RR12510		HEC1 ID	12535I

Longitundal Geometry

Length	1852.5	ft
U/S Elev	1746.1	ft
D/S Elev	1697.0	ft
Initial Channel Slope	0.0265	ft/ft
Long-term Channel Slope	0.0100	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	1

Initial Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	0	3	25	4	3	0	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	12	12	37	37	37	49
Y	104	100	100	100	100	100	100	104

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	0	3	25	4	3	0	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	12	12	37	37	37	49
Y	104	100	100	100	100	100	100	104

Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	RR125	S135								TOTAL
HEC1 Peak-Flow	33	1102								1135
Weighting Factor	1.00	0.04								
Flow into Channel	33	40								73

Reach Sediment Inflow Characteristics

U/S Contributing ID										TOTAL
HEC1 Flow Volume (ac. ft)										0
Sediment Conc. (ppm)										
Sediment Volume (ac. ft)										0.00
Weighting Factor										
Weighted Sed. Vol. (ac. ft)										0.00

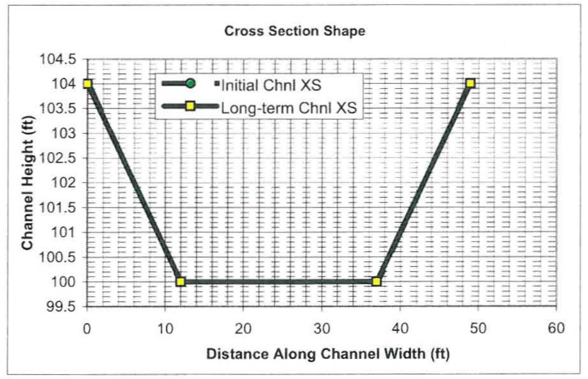
Hydrology

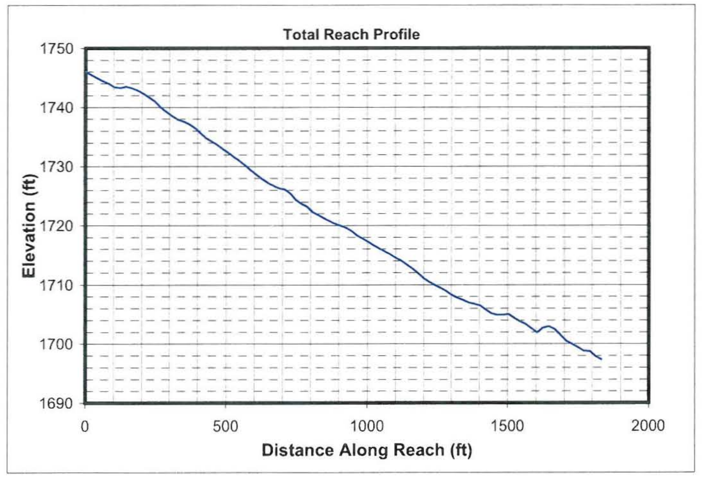
Drainage Area	0.157	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	73	cfs	
Long-term Max. Chnl Capacity	1006	cfs	
Q2 Channel	7	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	49	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			





Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
7	26.1	4.4	0.2	100.0	100.2	1.6	0.2	26.0	0.2	0.11	0.71
18	26.9	7.8	0.3	100.0	100.3	2.4	0.3	26.8	0.3	0.19	0.77
55	28.6	15.4	0.5	100.0	100.6	3.6	0.6	28.5	0.5	0.36	0.85
73	29.3	18.4	0.6	100.0	100.7	4.0	0.7	29.1	0.6	0.43	0.88

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
7	26.5	6.0	0.2	100.0	100.2	1.2	0.2	26.4	0.2	0.14	0.45
18	27.5	10.5	0.4	100.0	100.4	1.7	0.4	27.4	0.4	0.25	0.50
55	29.8	20.9	0.7	100.0	100.8	2.6	0.8	29.6	0.7	0.48	0.55
73	30.7	25.2	0.8	100.0	100.9	2.9	0.9	30.4	0.8	0.57	0.56

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
7										0
18										0
55										0
73										0

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow) Permissive Velocity (ft/s) Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	BUREC Erosive?	Neill (gravel/cobble) Non-cohesive Erosive?	All'ble Vel (ft/s)	Cohesive Erosive?	All'ble Vel (ft/s)	USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
7	1.74	0.8490	0.8066	Erosive	Erosive	Erosive	0.2	Stable	2.2	Stable	Stable
18	1.74	1.0134	0.9627	Erosive	Erosive	Erosive	0.2	Stable	3.2	Stable	Stable
55	1.74	1.2056	1.1454	Erosive	Erosive	Erosive	0.3	Stable	4.9	Stable	Stable
73	1.74	1.2549	1.1922	Erosive	Erosive	Erosive	0.3	Stable	5.5	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

Discharge (cfs)	Channel Width (ft) 7	18	55	73	Flow Depth (ft) 7	18	55	73	Velocity (ft/s) 7	18	55	73
Bray - Equation #1	7	11	20	23	0.5	0.7	1.0	1.1	2.1	2.4	2.8	2.9
Bray - Equation #2	9	14	26	30	0.6	0.8	1.1	1.2	1.4	1.6	1.9	2.0
Hey	1	3	5	6	1.4	1.9	2.9	3.3				
Ackers & Charlton/Lacey	8	12	19	22					1.1	1.3	1.6	1.6
Parker	19	29	51	59	0.3	0.5	0.7	0.8				
Chang	11	19	38	45	0.1	0.1	0.0	0.0				
Kellerhals	5	8	13	15	0.6	0.9	1.3	1.5	2.5	2.7	3.0	3.1
AMAFCA/Schumm	26	27	30	30								
Moody & Odem	6	6	6	6	0.7	0.7	0.7	0.7				
BUREC	4.9	6.9	10.5	11.7	1	2	3	3	1.8	2.2	2.9	3.2
Average	10	14	22	25	0.7	0.9	1.3	1.5	1.8	2.1	2.4	2.6
Values As Designed	26	27	30	30	0.2	0.4	0.8	0.9	1.2	1.7	2.6	2.9
Difference with Design	-17	-14	-8	-6	0.5	0.5	0.6	0.6	0.6	0.3	-0.2	-0.3

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
7	80	58	138	151	365	29	28	10	538	36	79	137
18	326	192	441	701	557	131	98	59	1426	103	349	399
55	1725	704	1421	4352	884	624	335	324	4388	438	1691	1535
73	2653	972	1839	6985	995	923	449	484	5869	647	2492	2210

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
7	4082	2963	7009	7659	18529	1473	1407	510	27319	1831	3995	6980
18	6622	3908	8973	14252	11327	2664	1994	1208	28981	2096	7103	8103
55	11689	4770	9632	29487	5993	4227	2267	2196	29733	2965	11455	10401
73	13482	4942	9345	35497	5058	4688	2283	2460	29829	3287	12667	11231

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
7	21	11	17	30	197	0	1	1	90	7	14	35
18	83	52	91	138	336	17	18	11	295	23	86	105
55	436	229	424	848	582	117	91	90	979	105	498	400
73	668	326	573	1356	666	178	128	141	1321	157	760	570

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
7	1049	583	842	1521	10030	0	38	39	4568	381	696	1795
18	1693	1064	1858	2813	6828	350	364	230	5987	476	1741	2128
55	2955	1551	2874	5749	3941	792	616	607	6632	710	3375	2709
73	3396	1656	2910	6891	3387	904	652	717	6715	796	3860	2899

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
7	0.0045	0.0071	125	0.38	0.046	0.0015	29	0.035	0.0011	0.0159	0.0015	0.0036	0.0180	0.0016	0.0073	0.0263	0.0124
18	0.0023	0.0042	163	0.50	0.049	0.0009	30	0.036	0.0006	0.0159	0.0009	0.0020	0.0180	0.0010	0.0037	0.0263	0.0118
55	0.0011	0.0022	222	0.68	0.052	0.0005	31	0.036	0.0004	0.0159	0.0005	0.0010	0.0180	0.0006	0.0016	0.0263	0.0115
73	0.0009	0.0019	240	0.73	0.052	0.0005	31	0.036	0.0003	0.0159	0.0004	0.0009	0.0180	0.0005	0.0013	0.0262	0.0114

Drop Structures

Design Slope	0.0100	ft/ft
Total Drop Needed	30.5	ft
Height of Drop Structure	3	ft
No . of Drop Structures	11	
Distance between structs.	168	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.03	sq. mi
Total Sediment Yield Volume	0.06	ac ft

Sedimentation Basins

Length	168 ft	Depth	3 ft
Width	49 ft	Side slope	3 ft/ft
Total Volume per Basin		0.44	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge Q (cfs)	COT/PC Sinuosity	General Zgs (ft)	Antidune Za (ft)	Bend Angle (deg)	Max. Depth Ymax (ft)	Hyd. Depth Yh (ft)	Avg Vel Vm (ft/s)	Se	Scour Zbs (ft)	Scour Zls (ft)	channel Zlft (ft)	Total Zt (ft)
7	1.1	-0.1	0.0	24.6	0.2	0.2	1.2	0.0100	0.0	1.5	1.0	3.3
18	1.1	-0.2	0.0	24.6	0.4	0.4	1.7	0.0100	0.0	1.5	1.0	3.3
55	1.1	-0.2	0.1	24.6	0.8	0.7	2.6	0.0100	0.1	1.5	1.0	3.4
73	1.1	-0.3	0.1	24.6	0.9	0.8	2.9	0.0100	0.1	1.5	1.0	3.4

Toe Protection Needed	4.0	ft

HEC1 Results For Open Channel

Peak Flow	33	cfs
Stage at Peak Flow	100.4	ft
Flow Volume	7.0	ac. ft

Freeboard

Max. Flow Depth	0.7	ft
Channel Depth as designed	4.0	ft
Available Freeboard	3.3	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	0.06	ac. ft
Outflowing Sediment Volume	0.01	ac. ft
Deposited(+)/Eroded(-) Volume	0.05	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	1853	1853
Side Slope (?H:1V)	3	3
Channel Width (ft)	49	49
Channel XS Area (sq. ft)	148	148
Channel Perimeter (ft)	50	50

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	1853	ft
Thickness	1.5	ft
Protection Depth	4	ft
Tie-in Length/Depth	3.0	ft
Total Depth	7.0	ft
Area needed	618	sq. Yd
Volume	1441	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	1853	1853
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4	5
Left Levee Surface Area (sq. Yd)	8030	16677
Left Levee Volume (cu. Yd)	7137	17157
Right Levee Length (ft)	1853	1853
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/t)	3	6
Right Levee Height (ft)	4	5
Right Levee Surface Area (sq. Yd)	8030	16677
Right Levee Volume (cu. Yd)	7137	17157
Total Levee Surface Area (sq. Yd)	16060	33354
Total Levee Volume (cu. Yd)	14274	34314

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	1853	1853
Left Levee Lining Width (ft)	13	30
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	2677	6177
Left Levee Lining Volume (cu. Yd)	1338	3088
Right Levee Length (ft)	1853	1853
Right Levee Lining Width (ft)	13	30
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	2677	6177
Right Levee Lining Volume (cu. Yd)	1338	3088
Total Lining Area (sq. Yd)	5353	12353
Total Lining Volume (cu. Yd)	2676	6176

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	49	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	3.9	ft
Structure Height	6.9	ft
Number of Structures	11	
Volume per structure	37	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 2,775	
Area per structure	16	sq. Yd
Total Area	180	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	710	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 2,840	
Other Cost	$ -	
Total cost per basin	$ 2,840	
Area per basin	917	sq. Yd
Total Area	917	sq. Yd

Structure Cost

Structure Type	Structure Type	Excavation/Construction Quantity	Units	Unit Cost	Cost Subtotal	Landscape Quantity	Units	Unit Cost	Landscape Cost	Maintenance Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	14,274	cu. Yd	$ 7.00	$ 99,918	16,060	sq. Yd	$ 9.00	$ 144,540	16,060	sq. Yd	$ 11.67	$ 187,367
Levee - LC Enhancement	Fill	20,040	cu. Yd	$ 7.00	$ 140,280	17,294	sq. Yd	$ 9.00	$ 155,646	20,040	sq. Yd	$ 11.67	$ 233,800
Levee Lining	Riprap	2,676	cu. Yd	$ 75.00	$ 200,700	5,353	sq. Yd	$ -	$ -	5,353	sq. Yd	$ 20.83	$ 111,523
Levee Lining -LC Enhancement	Riprap	3,500	cu. Yd	$ 75.00	$ 262,500	7,000	sq. Yd	$ -	$ -	7,000	sq. Yd	$ 20.83	$ 145,838
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	1,441	cu. Yd	$ 75.00	$ 108,075	618	sq. Yd	$ -	$ -	618	sq. Yd	$ 25.00	$ 15,450
Drop Structures	Riprap	11	EA	$ 2,775.00	$ 30,525	180	sq. Yd	$ -	$ -	180	sq. Yd	$ 33.33	$ 6,000
Drop Str. - LC Enhancement	Riprap	11	EA	$ 277.50	$ 3,053	18	sq. Yd	$ -	$ -	18	sq. Yd	$ 33.33	$ 600
Sedimentation Basins		1	EA	$ 2,840.00	$ 2,840	917	sq. Yd	$ -	$ -	917	sq. Yd	$ 8.33	$ 7,642
Other					$ -				$ -				$ -

Base Landscape Cost	$ 144,540	Base Maintenance Cost	$ 327,981
LC Enhancement Cost	$ 155,646	LC Enhancement Cost	$ 380,238
Total Landscape Cost	$ 300,186	Total Maintenance Cost	$ 708,219

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 442,058	$ 405,833	$ 847,891
Contingency Cost (25% of Construction Cost)	$ 110,515	$ 101,458	$ 211,973
Engineering Design Cost (5% of Construction Cost)	$ 22,103	$ 20,292	$ 42,395
Total Construction Cost	$ 574,675	$ 527,582	$ 1,102,258

Land Cost

Channel Length	1853 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	49	2.1	$100,000	$ 210,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	52	2.2	$100,000	$ 220,000
Levee LC Enhancement	48	2	$100,000	$ 200,000
Other	0	0	$100,000	$ -
Total	149	6.3		$ 630,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	4.3	$100,000	$ 430,000
LC Enhancement Cost	acre	2	$100,000	$ 200,000
Total Land Cost	acre	6.3	$100,000	$ 630,000

Total Cost

Base Total Cost	$ 1,477,197
Total Landscape Enhancement Cost	$ 1,263,466
Total Cost Including LC Enh.	$ 2,740,663

Online Basin

HEC1 ID	RR130

HEC1 Results Used to Determine Sediment Volume From Upstream

Contributing HEC1 ID							Total Volume (ac. ft)
Inflow Volume (ac. ft)							0
Volume Fraction							
Weighted Volume							0
Sediment Conc. (ppm)							
Sediment Volume (ac. ft)							0.00
Weighting Factor							
Weighted Sed. Vol. (ac. ft)							0.00

Sediment Yield

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.3	sq. mi
Total Sediment Yield Volume	0.6	ac ft

Required Minimum Sediment Volume

Sediment Volume	0.6	ac. ft

Geometry	Base	LC Enhanced
Topography slope (ft/ft)	0.028	0.028
Basin Length (ft)	600	770
Basin Width (ft)	290	290
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	7	7
Freeboard (ft)	1	1
Effective Basin Width (ft)	266	241
Top Area (acres)	4.0	5.1
U/S-D/S Height Difference (ft)	8.1	8.1
Excess Area on Upstream (acres)	0.3	0.9

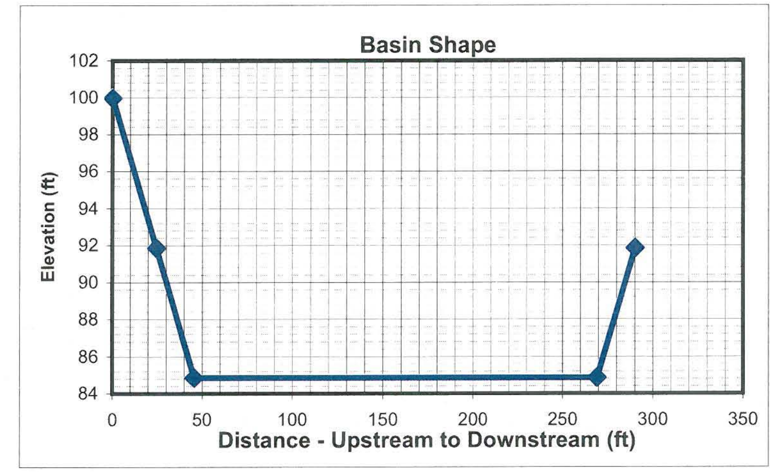
			Base	LC Enhanced
Bottom Length (ft)	558	Allocated Storage Volume (ac. ft)	19.2	19.3
Bottom Width (ft)	224	Total Available Volume (ac. ft) (incl. Freeboard)	22.8	23.4
		Total Excavation Volume (ac. ft)	39.1	44.2

Basin Outlet

Outlet Coeff	0.60	(0.6 for Orifice, 3.0 for Weir)
D (Orifice) or W (Weir)	2.50	ft
Invert Elevation	0.00	ft
Number of pipes	1	

Stage-Storage-Discharge

Elevation	0	1	2	3	4	5	6	7	8	9
Volume	0.00	2.92	5.96	9.10	12.36	15.73	19.21	22.82	26.54	30.39
Outflow	0.0	23.6	33.4	40.9	47.3	52.9	57.9	62.5	66.9	70.9



HEC1 Results

	6-hr Event	24-hr Event	Maximum
Total Flow Volume entering Basin (ac. ft)	24.0	20	24.0
Peak Inflow (cfs)	524	415	524.0
Peak Outflow (cfs)	57	51	57.0
Stage at Peak Outflow (ft)	5.8	4.7	5.8
Volume at Peak Outflow (ac. ft)	18.5	14.6	18.5

Volume Check

Total Volume needed	19.1	ac. ft
Total Volume Provided	19.2	ac. ft
Volume OK?	Yes	

Stage Check

Depth Needed	6.8	ft
Depth Provided	7	ft
Depth OK?	Yes	

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
LC Enhancement Buffer	165300	sq. ft
Other		sq. ft

Additional ROW Length	0	ft
Additional ROW Width	0	ft
Landscaping Buffer Length	100	ft
Landscaping Buffer Width	100	ft

Base Total ROW Length	600	ft
Base Total ROW Width	290	ft
LC Enh. Total ROW Length	870	ft
LC Enh. Total ROW Length	390	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	63081	71309
Excavated Area (sq. Yd)	19333	37700

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	48	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	531	sq. Yd
Material Volume	266	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	304	ft
Unit Cost	160	per ft
Cost per outlet	$48,640	
Other Cost	$ -	
Total Cost	$48,640	
Outlet Area	133	sq. Yd

Structure Type	Structure Cost													
		Excavation/Construction				Landscape				Maintenance				
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Basin		63,081	cu. Yd	$ 4.00	$ 252,324	19,333	sq. Yd	$ 9.00	$ 173,997	19,333	sq. Yd	$ 8.33	$ 161,108
Basin - LC Enhancement		8,228	cu. Yd	$ 4.00	$ 32,912	18,367	sq. Yd	$ 9.00	$ 165,303	18,367	sq. Yd	$ 8.33	$ 153,058
Inlet	Riprap	266	sq. Yd	$ 75.00	$ 19,950	531	sq. Yd	$ -	$ -	531	sq. Yd	$ 33.33	$ 17,700
Inlet - LC Enhancement (20%Inlet)					$ 3,990				$ -				$ 3,540
Outlet	Pipe	1	EA	$ 48,640	$ 48,640	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhancement (5% Outlet)					$ 2,432				$ -				$ 111
Other					$ -				$ -				$ -

Base Landscape Cost	$ 173,997	Base Maintenance Cost	$ 181,025
LC Enh. Landscape Cost	$ 165,303	LC Enh. Maintenance Cost	$ 156,709
Total Landscape Cost	$ 339,300	Total Maintenance Cost	$ 337,734

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 320,914	$ 32,912	$ 353,826
Contingency Cost (25% of Construction Cost)	$ 80,229	$ 8,228	$ 88,457
Engineering Design Cost (5% of Construction Cost)	$ 16,046	$ 1,646	$ 17,691
Total Construction Cost	$ 417,188	$ 42,786	$ 459,974

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	3.8	$100,000	$ 380,000
Basin	4.0	$100,000	$ 400,000
Other		$100,000	$ -
Total	7.8	$100,000	$ 780,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	4.0	$100,000	$ 400,000
LC Enhancement Cost	acre	3.8	$100,000	$ 380,000
Total Land Cost	acre	7.8	$100,000	$ 780,000

Total Cost

Base Total Cost	$ 1,172,210
Total LC Enhancement Cost	$ 744,798
Total Cost Including LC Enh.	$ 1,917,008

Open Channel

Structure ID	RR13010		HEC1 ID	13035I

Longitundal Geometry

Length	1235.4	ft
U/S Elev	1728.2	ft
D/S Elev	1697.0	ft
Initial Channel Slope	0.0252	ft/ft
Long-term Channel Slope	0.0120	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	1

Initial Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	0	3	12	4	3	0	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	12	12	24	24	24	36
Y	104	100	100	100	100	100	100	104

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	0	3	12	4	3	0	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	12	12	24	24	24	36
Y	104	100	100	100	100	100	100	104

Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	RR130									TOTAL
HEC1 Peak-Flow	57									57
Weighting Factor	1.00									
Flow into Channel	57									57

Reach Sediment Inflow Characteristics

U/S Contributing ID										TOTAL
HEC1 Flow Volume (ac. ft)										0
Sediment Conc. (ppm)										
Sediment Volume (ac. ft)										0.00
Weighting Factor										
Weighted Sed. Vol. (ac. ft)										0.00

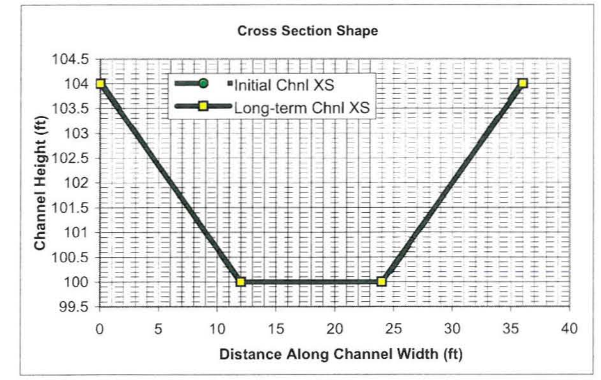
Hydrology

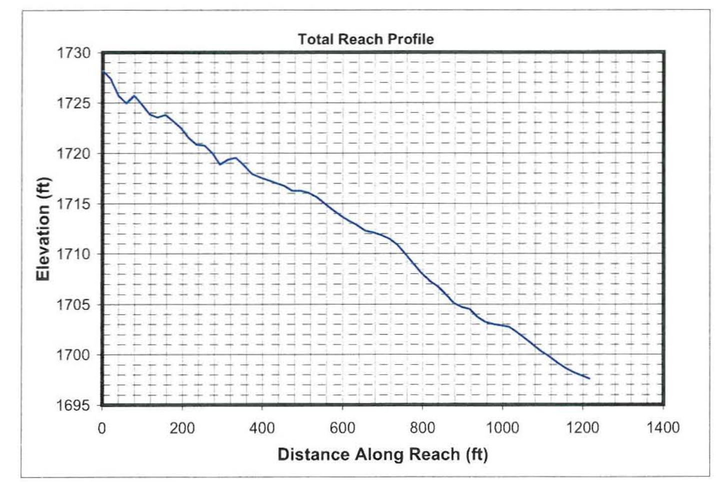
Drainage Area	0.31	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	57	cfs	
Long-term Max. Chnl Capacity	654	cfs	
Q2 Channel	6	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	36	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			





Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
6	13.5	3.0	0.2	100.0	100.2	1.9	0.2	13.4	0.2	0.18	0.72
14	14.5	5.3	0.4	100.0	100.4	2.7	0.4	14.4	0.4	0.30	0.78
43	16.8	10.9	0.6	100.0	100.8	3.9	0.8	16.6	0.7	0.57	0.86
57	17.7	13.2	0.7	100.0	100.9	4.3	0.9	17.4	0.8	0.67	0.88

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
6	13.8	3.8	0.3	100.0	100.3	1.5	0.3	13.7	0.3	0.22	0.51
14	15.2	6.7	0.4	100.0	100.5	2.1	0.5	15.0	0.4	0.37	0.56
43	17.9	13.9	0.8	100.0	100.9	3.1	0.9	17.6	0.8	0.70	0.61
57	19.0	17.0	0.9	100.0	101.1	3.4	1.1	18.6	0.9	0.83	0.62

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
6										0
14										0
43										0
57										0

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow): Permissive Velocity (ft/s): Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	BUREC: Erosive?	Neill (gravel/cobble): Non-cohesive: Erosive?	All'ble Vel (ft/s)	Cohesive: Erosive?	All'ble Vel (ft/s)	USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
6	1.74	0.9310	0.8844	Erosive	Erosive	Erosive	0.2	Stable	2.8	Stable	Stable
14	1.74	1.0875	1.0331	Erosive	Erosive	Erosive	0.2	Stable	4.0	Stable	Stable
43	1.74	1.2654	1.2021	Erosive	Erosive	Erosive	0.3	Stable	6.1	Stable	Stable
57	1.74	1.3100	1.2445	Erosive	Erosive	Erosive	0.3	Stable	6.7	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

Discharge (cfs)	Channel Width (ft): 6	14	43	57	Flow Depth (ft): 6	14	43	57	Velocity (ft/s): 6	14	43	57
Bray - Equation #1	6	10	17	20	0.5	0.6	0.9	1.0	2.0	2.3	2.7	2.8
Bray - Equation #2	8	13	23	26	0.5	0.7	1.0	1.1	1.4	1.6	1.8	1.9
Hey	1	2	5	5	1.2	1.8	2.7	3.0				
Ackers & Charlton/Lacey	7	11	17	20					1.1	1.2	1.5	1.6
Parker	16	26	45	52	0.3	0.4	0.7	0.7				
Chang	10	18	34	41	0.1	0.1	0.0	0.0				
Kellerhals	4	7	12	14	0.5	0.8	1.2	1.4	2.4	2.7	3.0	3.1
AMAFCA/Schumm	14	15	18	19								
Moody & Odem	8	8	8	8	0.8	0.8	0.8	0.8				
BUREC	4.3	6.1	9.2	10.3	1	2	2	3	1.8	2.2	3.0	3.2
Average	8	11	19	21	0.6	0.9	1.2	1.4	1.7	2.0	2.4	2.5
Values As Designed	14	15	18	19	0.3	0.5	0.9	1.1	1.5	2.1	3.1	3.4
Difference with Design	-6	-4	1	3	0.3	0.4	0.3	0.2	0.2	-0.1	-0.7	-0.9

Initial Channel Sediment Transport Capacity

Discharge (cfs)	Sediment Load (tons/day) Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
6	73	49	117	145	222	28	24	11	403	27	77	107
14	289	152	334	656	341	112	76	55	1047	83	308	314
43	1457	535	1015	3849	562	501	246	268	3197	357	1385	1216
57	2207	733	1324	6066	642	731	328	392	4273	524	2010	1748

Discharge (cfs)	Sediment Concentrations (ppm by weight) Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
6	4768	3196	7592	9466	14462	1840	1593	742	26203	1754	5003	6965
14	7527	3970	8692	17077	8881	2916	1982	1434	27256	2173	8029	8176
43	12649	4642	8813	33401	4877	4345	2134	2324	27747	3095	12017	10549
57	14364	4771	8614	39481	4179	4761	2136	2552	27812	3409	13081	11378

Long-term Channel Sediment Transport Capacity

Discharge (cfs)	Sediment Load (tons/day) Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
6	26	17	28	42	147	4	5	2	116	8	24	38
14	101	60	119	187	242	28	25	18	325	27	112	113
43	500	232	422	1079	423	142	95	104	1027	120	557	427
57	754	324	578	1693	490	209	131	156	1378	177	826	611

Discharge (cfs)	Sediment Concentrations (ppm by weight) Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
6	1674	1080	1803	2726	9579	279	332	162	7525	548	1549	2478
14	2619	1566	3106	4868	6298	732	644	459	8467	709	2911	2944
43	4338	2016	3659	9365	3672	1229	827	899	8910	1041	4836	3708
57	4910	2108	3760	11018	3186	1360	849	1018	8969	1155	5376	3974

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
6	0.0033	0.0055	139	0.42	0.047	0.0012	30	0.036	0.0008	0.0159	0.0012	0.0027	0.0196	0.0017	0.0070	0.0250	0.0122
14	0.0018	0.0033	179	0.54	0.050	0.0007	30	0.036	0.0005	0.0159	0.0007	0.0016	0.0196	0.0011	0.0035	0.0249	0.0118
43	0.0009	0.0018	238	0.72	0.052	0.0004	31	0.036	0.0003	0.0159	0.0004	0.0008	0.0196	0.0007	0.0015	0.0248	0.0115
57	0.0007	0.0016	255	0.78	0.053	0.0004	32	0.036	0.0003	0.0159	0.0003	0.0007	0.0196	0.0006	0.0012	0.0247	0.0114

Drop Structures

Design Slope	0.0120	ft/ft
Total Drop Needed	16.4	ft
Height of Drop Structure	3	ft
No . of Drop Structures	6	
Distance between structs.	206	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.03	sq. mi
Total Sediment Yield Volume	0.06	ac ft

Sedimentation Basins

Length	206 ft	Depth	3 ft
Width	36 ft	Side slope	3 ft/ft
Total Volume per Basin		0.37	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

Discharge	COT/PC	Pima County General Scour Equations General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Bend Scour	LongTerm Scour	Thalweg channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
6	1.1	-0.1	0.0	24.6	0.3	0.3	1.5	0.0120	0.0	1.5	1.0	3.3
14	1.1	-0.2	0.1	24.6	0.5	0.4	2.1	0.0120	0.0	1.5	1.0	3.4
43	1.1	-0.3	0.1	24.6	0.9	0.8	3.1	0.0120	0.1	1.5	1.0	3.5
57	1.1	-0.3	0.2	24.6	1.1	0.9	3.4	0.0120	0.1	1.5	1.0	3.5

Toe Protection Needed	4.0	ft

HEC1 Results For Open Channel

Peak Flow	57	cfs
Stage at Peak Flow	100.9	ft
Flow Volume	24.0	ac. ft

Freeboard

Max. Flow Depth	0.9	ft
Channel Depth as designed	4.0	ft
Available Freeboard	3.1	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	0.06	ac. ft
Outflowing Sediment Volume	0.04	ac. ft
Deposited(+)/Eroded(-) Volume	0.02	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	1235	1235
Side Slope (?H:1V)	3	3
Channel Width (ft)	36	36
Channel XS Area (sq. ft)	96	96
Channel Perimeter (ft)	37	37

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	1235	ft
Thickness	1.5	ft
Protection Depth	4	ft
Tie-in Length/Depth	3.0	ft
Total Depth	7.0	ft
Area needed	412	sq. Yd
Volume	961	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	1235	1235
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4	5
Left Levee Surface Area (sq. Yd)	5352	11115
Left Levee Volume (cu. Yd)	4757	11435
Right Levee Length (ft)	1235	1235
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4	5
Right Levee Surface Area (sq. Yd)	5352	11115
Right Levee Volume (cu. Yd)	4757	11435
Total Levee Surface Area (sq. Yd)	10704	22230
Total Levee Volume (cu. Yd)	9514	22870

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	1235	1235
Left Levee Lining Width (ft)	13	30
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	1784	4117
Left Levee Lining Volume (cu. Yd)	892	2058
Right Levee Length (ft)	1235	1235
Right Levee Lining Width (ft)	13	30
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	1784	4117
Right Levee Lining Volume (cu. Yd)	892	2058
Total Lining Area (sq. Yd)	3568	8233
Total Lining Volume (cu. Yd)	1784	4116

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	36	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	4.5	ft
Structure Height	7.5	ft
Number of Structures	6	
Volume per structure	30	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 2,250	
Area per structure	12	sq. Yd
Total Area	72	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	597	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 2,388	
Other Cost	$ -	
Total cost per basin	$ 2,388	
Area per basin	824	sq. Yd
Total Area	824	sq. Yd

Structure Cost

Structure Type	Structure Type	Excavation/Construction Quantity	Units	Unit Cost	Cost Subtotal	Landscape Quantity	Units	Unit Cost	Landscape Cost	Maintenance Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	9,514	cu. Yd	$ 7.00	$ 66,598	10,704	sq. Yd	$ 9.00	$ 96,336	10,704	sq. Yd	$ 11.67	$ 124,880
Levee - LC Enhancement	Fill	13,356	cu. Yd	$ 7.00	$ 93,492	11,526	sq. Yd	$ 9.00	$ 103,734	13,356	sq. Yd	$ 11.67	$ 155,820
Levee Lining	Riprap	1,784	cu. Yd	$ 75.00	$ 133,800	3,568	sq. Yd	$ -	$ -	3,568	sq. Yd	$ 20.83	$ 74,329
Levee Lining -LC Enhancement	Riprap	2,332	cu. Yd	$ 75.00	$ 174,900	4,666	sq. Yd	$ -	$ -	4,666	sq. Yd	$ 20.83	$ 97,199
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	961	cu. Yd	$ 75.00	$ 72,075	412	sq. Yd	$ -	$ -	412	sq. Yd	$ 25.00	$ 10,300
Drop Structures	Riprap	6	EA	$ 2,250.00	$ 13,500	72	sq. Yd	$ -	$ -	72	sq. Yd	$ 33.33	$ 2,400
Drop Str. - LC Enhancement	Riprap	6	EA	$ 225.00	$ 1,350	7	sq. Yd	$ -	$ -	7	sq. Yd	$ 33.33	$ 240
Sedimentation Basins		1	EA	$ 2,388.00	$ 2,388	824	sq. Yd	$ -	$ -	824	sq. Yd	$ 8.33	$ 6,867
Other					$ -				$				$ -

Base Landscape Cost	$ 96,336	
LC Enhancement Cost	$ 103,734	
Total Landscape Cost	$ 200,070	

Base Maintenance Cost	$ 218,775	
LC Enhancement Cost	$ 253,259	
Total Maintenance Cost	$ 472,034	

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 288,361	$ 269,742	$ 558,103
Contingency Cost (25% of Construction Cost)	$ 72,090	$ 67,436	$ 139,526
Engineering Design Cost (5% of Construction Cost)	$ 14,418	$ 13,487	$ 27,905
Total Construction Cost	$ 374,869	$ 350,665	$ 725,534

Land Cost

Channel Length	1235 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	36	1	$100,000	$ 100,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	52	1.5	$100,000	$ 150,000
Levee LC Enhancement	48	1.4	$100,000	$ 140,000
Other	0	0	$100,000	$ -
Total	136	3.9		$ 390,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	2.5	$100,000	$ 250,000
LC Enhancement Cost	acre	1.4	$100,000	$ 140,000
Total Land Cost	acre	3.9	$100,000	$ 390,000

Total Cost

Base Total Cost	$ 939,981
Total Landscape Enhancement Cost	$ 847,658
Total Cost Including LC Enh.	$ 1,787,638

Open Channel

Structure ID	C135L10

HEC1 ID	351135

Longitundal Geometry

Length	12096.9	ft
U/S Elev	1697.0	ft
D/S Elev	1496.9	ft
Initial Channel Slope	0.0165	ft/ft
Long-term Channel Slope	0.0060	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	8

Initial Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	200	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	213.5	213.5	213.5	227
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	80	3	30	7	3	75	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	93.5	101	131	138.5	213.5	227
Y	104.5	100	100	97.5	97.5	100	100	104.5

Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

										TOTAL
Contributing HEC1 ID	C135L									TOTAL
HEC1 Peak-Flow	1001									1001
Weighting Factor	1.00									
Flow into Channel	1001									1001

Reach Sediment Inflow Characteristics

U/S Contributing ID	12535I_RR12510	13035I_RR130 10								TOTAL
HEC1 Flow Volume (ac. ft)	7.00	24.00								31
Sediment Conc. (ppm)	2899	3974								
Sediment Volume (ac. ft)	0.01	0.04								0.04
Weighting Factor	1	1								
Weighted Sed. Vol. (ac. ft)	0.01	0.04								0.04

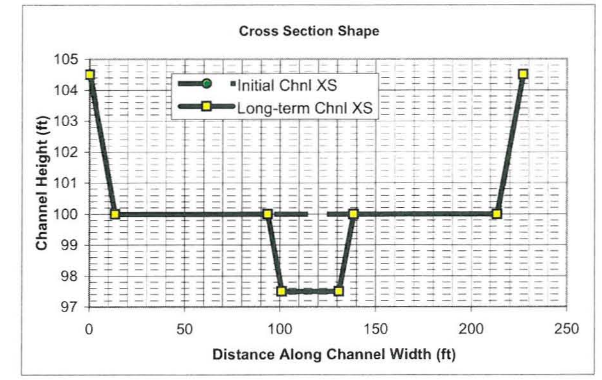
Hydrology

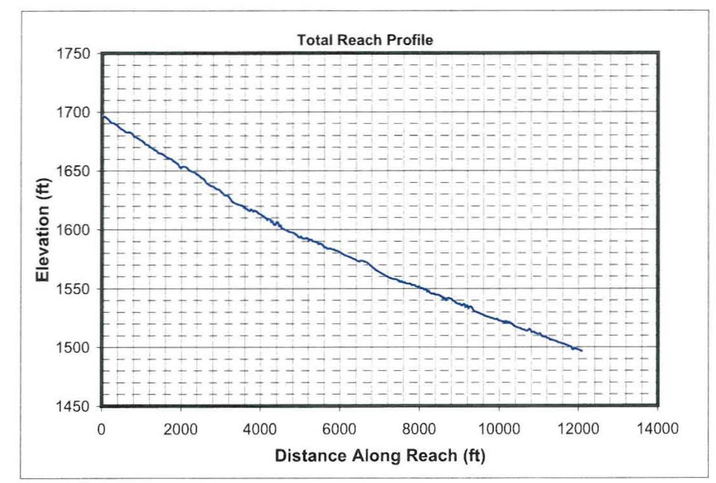
Drainage Area	2.06	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	1001	cfs	
Long-term Max. Chnl Capacity	7480	cfs	
Q2 Channel	100	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	227	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			





Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
100	201.7	55.6	0.3	100.0	100.3	1.8	0.3	201.7	0.3	0.10	0.60
250	203.0	96.5	0.5	100.0	100.5	2.6	0.5	202.9	0.5	0.18	0.66
751	205.8	187.5	0.9	100.0	100.9	4.0	0.9	205.5	0.9	0.35	0.74
1001	206.9	223.4	1.1	100.0	101.1	4.5	1.1	206.6	1.1	0.41	0.76

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
100	37.2	38.3	1.0	97.5	98.6	2.6	1.1	36.9	1.0	0.43	0.45
250	42.3	69.9	1.7	97.5	99.4	3.6	1.9	41.7	1.7	0.73	0.49
751	205.8	254.3	1.2	97.5	100.8	3.0	3.3	204.8	1.2	1.23	0.47
1001	207.3	303.0	1.5	97.5	101.0	3.3	3.5	206.2	1.5	1.32	0.48

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
	12535I_RR12510	13035I_RR13010								
100	35	38								73
250	105	113								218
751	400	427								827
1001	570	611								1181

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
100	1.74	0.9980	0.9481	Erosive	Erosive	Erosive	0.2	Stable	4.9	Stable	Stable
250	1.74	1.1664	1.1081	Erosive	Erosive	Erosive	0.2	Stable	7.0	Stable	Stable
751	1.74	1.3672	1.2988	Erosive	Erosive	Erosive	0.3	Stable	8.6	Stable	Stable
1001	1.74	1.4195	1.3485	Erosive	Erosive	Erosive	0.3	Stable	9.2	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	100	250	751	1001	100	250	751	1001	100	250	751	1001
Bray - Equation #1	27	44	78	91	1.2	1.7	2.4	2.7	3.0	3.4	4.0	4.2
Bray - Equation #2	35	57	102	119	1.4	1.8	2.6	2.9	2.1	2.4	2.7	2.9
Hey	8	13	25	29	3.7	5.3	8.0	8.9				
Ackers & Charlton/Lacey	25	37	58	66					1.7	2.0	2.4	2.5
Parker	69	109	188	217	0.9	1.4	2.2	2.4				
Chang	46	80	157	186	0.1	0.0	-0.3	-0.4				
Kellerhals	18	28	49	57	1.7	2.5	3.8	4.3	3.2	3.5	4.0	4.1
AMAFCA/Schumm	37	42	205	206								
Moody & Odem	16	16	16	16	1.1	1.1	1.1	1.1				
BUREC	14.4	20.4	30.7	34.2	4	5	8	9	2.8	3.5	4.7	5.0
Average	29	45	91	102	1.8	2.4	3.5	3.9	2.6	3.0	3.6	3.7
Values As Designed	37	42	205	206	1.1	1.9	3.3	3.5	2.6	3.6	3.0	3.3
Difference with Design	-7	3	-114	-104	0.6	0.4	0.2	0.3	0.0	-0.6	0.6	0.4

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
100	787	523	1109	1419	2853	235	224	111	3620	256	818	1087
250	3242	1749	3532	6711	4294	1068	790	626	9643	858	3585	3282
751	17648	6482	11241	43046	6600	5156	2679	3378	29723	4053	17564	13415
1001	27456	8991	14583	69946	7337	7681	3597	5059	39764	6133	26069	19692

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
100	2918	1939	4112	5261	10573	872	828	411	13415	947	3033	4028
250	4807	2593	5237	9949	6366	1583	1171	928	14296	1272	5314	4865
751	8721	3203	5555	21272	3261	2548	1324	1669	14688	2003	8680	6630
1001	10176	3332	5405	25924	2719	2847	1333	1875	14738	2273	9662	7299

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
100	483	250	413	873	662	104	85	108	816	106	566	406
250	1846	761	1118	3800	1039	387	253	428	2124	390	2117	1297
751	4304	1954	3232	8088	4172	930	705	994	6239	921	5042	3326
1001	6689	2815	4405	13126	4712	1425	995	1557	8430	1410	7753	4847

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
100	1789	927	1531	3236	2453	384	317	400	3024	393	2097	1505
250	2737	1128	1657	5633	1540	574	375	635	3149	579	3138	1922
751	2127	966	1597	3997	2062	459	349	491	3083	455	2491	1643
1001	2479	1043	1633	4865	1747	528	369	577	3124	523	2874	1796

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
100	0.0029	0.0044	126	0.38	0.046	0.0009	30	0.035	0.0007	0.0159	0.0009	0.0022	0.0075	0.0005	0.0032	0.0165	0.0067
250	0.0015	0.0025	165	0.50	0.049	0.0006	30	0.036	0.0004	0.0159	0.0005	0.0012	0.0075	0.0003	0.0016	0.0165	0.0064
751	0.0007	0.0013	229	0.70	0.052	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0006	0.0075	0.0002	0.0007	0.0165	0.0062
1001	0.0005	0.0011	249	0.76	0.053	0.0003	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0075	0.0002	0.0006	0.0165	0.0062

Drop Structures

Design Slope	0.0060	ft/ft
Total Drop Needed	127.6	ft
Height of Drop Structure	3	ft
No . of Drop Structures	43	
Distance between structs.	281	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.81	sq. mi
Total Sediment Yield Volume	1.55	ac ft

Sedimentation Basins

Length	281 ft	Depth	3 ft
Width	227 ft	Side slope	3 ft/ft
Total Volume per Basin		4.09	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		2	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
100	1.1	-0.4	0.1	24.6	1.1	1.0	2.6	0.0060	0.1	1.5	2.5	5.4
250	1.1	-0.6	0.2	24.6	1.9	1.7	3.6	0.0060	0.2	1.5	2.5	5.6
751	1.1	-1.0	0.1	24.6	3.3	1.2	3.0	0.0060	0.4	1.5	2.5	5.7
1001	1.1	-1.0	0.1	24.6	3.5	1.5	3.3	0.0060	0.4	1.5	2.5	5.8

Toe Protection Needed	6.0	ft

Freeboard

Max. Flow Depth	1.1	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.4	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	1.59	ac. ft
Outflowing Sediment Volume	0.02	ac. ft
Deposited(+)/Eroded(-) Volume	1.57	ac. ft

HEC1 Results For Open Channel

Peak Flow	69	cfs
Stage at Peak Flow	100.2	ft
Flow Volume	27.0	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	12097	12097
Side Slope (?H:1V)	3	3
Channel Width (ft)	227	227
Channel XS Area (sq. ft)	1054.5	1054.5
Channel Perimeter (ft)	229	229

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	12097	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	4032	sq. Yd
Volume	12097	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	12097	12097
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	56453	116938
Left Levee Volume (cu. Yd)	55557	130827
Right Levee Length (ft)	12097	12097
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	56453	116938
Right Levee Volume (cu. Yd)	55557	130827
Total Levee Surface Area (sq. Yd)	112906	233876
Total Levee Volume (cu. Yd)	111114	261654

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	12097	12097
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	18818	44356
Left Levee Lining Volume (cu. Yd)	9409	22178
Right Levee Length (ft)	12097	12097
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	18818	44356
Right Levee Lining Volume (cu. Yd)	9409	22178
Total Lining Area (sq. Yd)	37635	88711
Total Lining Volume (cu. Yd)	18818	44356

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	227	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	5.8	ft
Structure Height	8.8	ft
Number of Structures	43	
Volume per structure	222	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 16,650	
Area per structure	76	sq. Yd
Total Area	3,254	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	2	
Total Volume per Basin	6599	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 26,396	
Other Cost	$ -	
Total cost per basin	$ 26,396	
Area per basin	7,096	sq. Yd
Total Area	14,192	sq. Yd

Structure Type	Structure Type	Excavation/Construction: Quantity	Units	Unit Cost	Cost Subtotal	Landscape: Quantity	Units	Unit Cost	Landscape Cost	Maintenance: Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	111,114	cu. Yd	$ 7.00	$ 777,798	112,906	sq. Yd	$ 9.00	$ 1,016,154	112,906	sq. Yd	$ 11.67	$ 1,317,237
Levee - LC Enhancement	Fill	150,540	cu. Yd	$ 7.00	$ 1,053,780	120,970	sq. Yd	$ 9.00	$ 1,088,730	150,540	sq. Yd	$ 11.67	$ 1,756,300
Levee Lining	Riprap	18,818	cu. Yd	$ 75.00	$ 1,411,350	37,635	sq. Yd	$ -	$ -	37,635	sq. Yd	$ 20.83	$ 784,065
Levee Lining -LC Enhancement	Riprap	25,538	cu. Yd	$ 75.00	$ 1,915,350	51,076	sq. Yd	$ -	$ -	51,076	sq. Yd	$ 20.83	$ 1,064,088
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	12,097	cu. Yd	$ 75.00	$ 907,275	4,032	sq. Yd	$ -	$ -	4,032	sq. Yd	$ 25.00	$ 100,800
Drop Structures	Riprap	43	EA	$ 16,650.00	$ 715,950	3,254	sq. Yd	$ -	$ -	3,254	sq. Yd	$ 33.33	$ 108,467
Drop Str. - LC Enhancement	Riprap	43	EA	$ 1,665.00	$ 71,595	325	sq. Yd	$ -	$ -	325	sq. Yd	$ 33.33	$ 10,847
Sedimentation Basins		2	EA	$ 26,396.00	$ 52,792	14,192	sq. Yd	$ -	$ -	14,192	sq. Yd	$ 8.33	$ 118,267
Other					$ -				$ -				$ -

Base Landscape Cost	$ 1,016,154
LC Enhancement Cost	$ 1,088,730
Total Landscape Cost	$ 2,104,884

Base Maintenance Cost	$ 2,428,835
LC Enhancement Cost	$ 2,831,235
Total Maintenance Cost	$ 5,260,069

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 3,865,165	$ 3,040,725	$ 6,905,890
Contingency Cost (25% of Construction Cost)	$ 966,291	$ 760,181	$ 1,726,473
Engineering Design Cost (5% of Construction Cost)	$ 193,258	$ 152,036	$ 345,295
Total Construction Cost	$ 5,024,715	$ 3,952,943	$ 8,977,657

Land Cost

Channel Length	12097 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	227	63	$100,000	$ 6,300,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	15.3	$100,000	$ 1,530,000
Levee LC Enhancement	51	14.2	$100,000	$ 1,420,000
Other	0	0	$100,000	$ -
Total	333	92.5		$ 9,250,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	78.3	$100,000	$ 7,830,000
LC Enhancement Cost	acre	14.2	$100,000	$ 1,420,000
Total Land Cost	acre	92.5	$100,000	$ 9,250,000

Total Cost

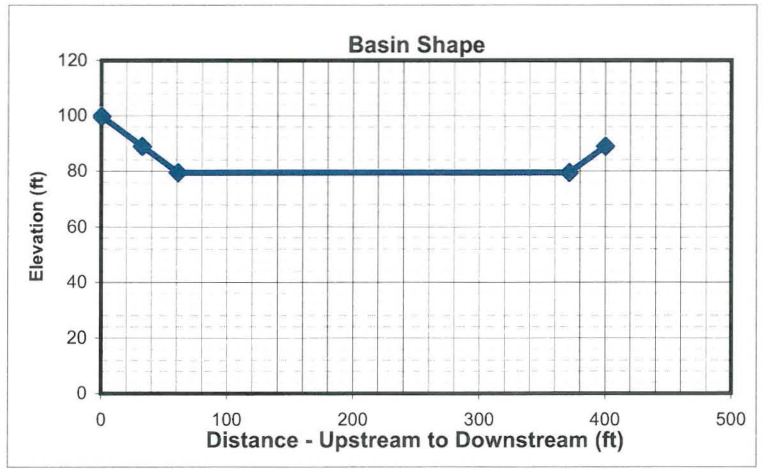
Base Total Cost	$ 16,299,703
Total Landscape Enhancement Cost	$ 9,292,907
Total Cost Including LC Enh.	$ 25,592,610

Online Basin

HEC1 ID	RR150

HEC1 Results Used to Determine Sediment Volume From Upstream

Contributing HEC1 ID							Total Volume (ac. ft)
Inflow Volume (ac. ft)							0
Volume Fraction							
Weighted Volume							0
Sediment Conc. (ppm)							
Sediment Volume (ac. ft)							0.00
Weighting Factor							
Weighted Sed. Vol. (ac. ft)							0.00



Sediment Yield

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.9	sq. mi
Total Sediment Yield Volume	1.7	ac ft

Required Minimum Sediment Volume

Sediment Volume	1.7	ac. ft

Geometry

	Base	LC Enhanced
Topography slope (ft/ft)	0.027	0.027
Basin Length (ft)	800	1010
Basin Width (ft)	400	400
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	9.5	9.5
Freeboard (ft)	1	1
Effective Basin Width (ft)	368	335
Top Area (acres)	7.3	9.3
U/S-D/S Height Difference (ft)	10.8	10.8
Excess Area on Upstream (acres)	0.6	1.5

Bottom Length (ft)	743
Bottom Width (ft)	311

	Base	LC Enhanced
Allocated Storage Volume (ac. ft)	50.5	50.4
Total Available Volume (ac. ft) (incl. Freeboard)	57.2	58
Total Excavation Volume (ac. ft)	96.9	108.1

HEC1 Results

	6-hr Event	24-hr Event	Maximum
Total Flow Volume entering Basin (ac. ft)	62.0	57	62.0
Peak Inflow (cfs)	836	729	836.0
Peak Outflow (cfs)	97	89	97.0
Stage at Peak Outflow (ft)	8.2	6.9	8.2
Volume at Peak Outflow (ac. ft)	48.3	39.9	48.3

Volume Check

Total Volume needed	50.0	ac. ft
Total Volume Provided	50.5	ac. ft
Volume OK?	Yes	

Stage Check

Depth Needed	9.2	ft
Depth Provided	9.5	ft
Depth OK?	Yes	

Basin Outlet

Outlet Coeff	0.60	(0.6 for Orifice, 3.0 for Weir)
D (Orifice) or W (Weir)	3.00	ft
Invert Elevation	0.00	ft
Number of pipes	1	

Stage-Storage-Discharge

Elevation	0	1	2	4	6	7	8	9	10	11
Volume	0.00	5.38	10.90	22.40	34.50	40.78	47.22	53.82	60.58	67.50
Outflow	0.0	34.0	48.1	68.1	83.4	90.0	96.3	102.1	107.6	112.9

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
LC Enhancement Buffer	235000	sq. ft
Other		sq. ft

Additional ROW Length	0	ft
Additional ROW Width	0	ft
Landscaping Buffer Length	100	ft
Landscaping Buffer Width	100	ft

Base Total ROW Length	800	ft
Base Total ROW Width	400	ft
LC Enh. Total ROW Length	1110	ft
LC Enh. Total ROW Length	500	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	156332	174401
Excavated Area (sq. Yd)	35556	61667

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	64	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	713	sq. Yd
Material Volume	357	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	432	ft
Unit Cost	160	per ft
Cost per outlet	$69,120	
Other Cost	$ -	
Total Cost	$69,120	
Outlet Area	133	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Basin		156,332	cu. Yd	$ 4.00	$ 625,328	35,556	sq. Yd	$ 9.00	$ 320,004	35,556	sq. Yd	$ 8.33	$ 296,300
Basin - LC Enhancement		18,069	cu. Yd	$ 4.00	$ 72,276	26,111	sq. Yd	$ 9.00	$ 234,999	26,111	sq. Yd	$ 8.33	$ 217,592
Inlet	Riprap	357	sq. Yd	$ 75.00	$ 26,775	713	sq. Yd	$ -	$ -	713	sq. Yd	$ 33.33	$ 23,767
Inlet - LC Enhancement (20%Inlet)					$ 5,355				$ -				$ 4,753
Outlet	Pipe	1	EA	$ 69,120	$ 69,120	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhancement (5% Outlet)					$ 3,456				$ -				$ 111
Other					$ -				$ -				$ -

Base Landscape Cost	$ 320,004	Base Maintenance Cost	$ 322,283
LC Enh. Landscape Cost	$ 234,999	LC Enh. Maintenance Cost	$ 222,456
Total Landscape Cost	$ 555,003	Total Maintenance Cost	$ 544,739

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 721,223	$ 72,276	$ 793,499
Contingency Cost (25% of Construction Cost)	$ 180,306	$ 18,069	$ 198,375
Engineering Design Cost (5% of Construction Cost)	$ 36,061	$ 3,614	$ 39,675
Total Construction Cost	$ 937,590	$ 93,959	$ 1,031,549

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	5.4	$100,000	$ 540,000
Basin	7.3	$100,000	$ 730,000
Other		$100,000	$ -
Total	12.7	$100,000	$ 1,270,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	7.3	$100,000	$ 730,000
LC Enhancement Cost	acre	5.4	$100,000	$ 540,000
Total Land Cost	acre	12.7	$100,000	$ 1,270,000

Total Cost

Base Total Cost	$ 2,309,877
Total LC Enhancement Cost	$ 1,091,414
Total Cost Including LC Enh.	$ 3,401,291

Open Channel

Structure ID	RR15020		HEC1 ID	150165

Longitundal Geometry

Length	4081.6	ft
U/S Elev	1760.1	ft
D/S Elev	1675.9	ft
Initial Channel Slope	0.0206	ft/ft
Long-term Channel Slope	0.0090	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	1

Initial Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	36	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	49.5	49.5	49.5	63
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	9	3	12	5.5	3	9	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	22.5	25.5	37.5	40.5	49.5	63
Y	104.5	100	100	99	99	100	100	104.5

Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	RR150	S155								TOTAL
HEC1 Peak-Flow	97	1781								1878
Weighting Factor	1.00	0.06								
Flow into Channel	97	109								206

Reach Sediment Inflow Characteristics

U/S Contributing ID										TOTAL
HEC1 Flow Volume (ac. ft)										0
Sediment Conc. (ppm)										
Sediment Volume (ac. ft)										0.00
Weighting Factor										
Weighted Sed. Vol. (ac. ft)										0.00

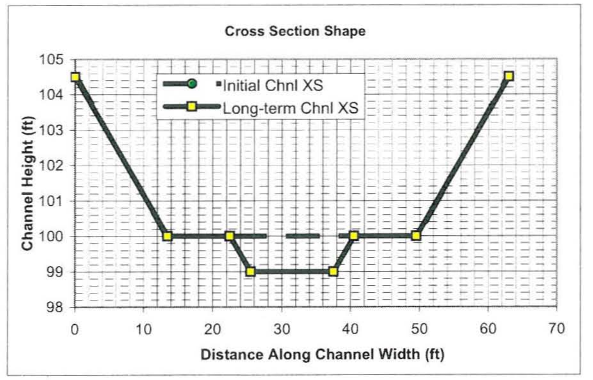
Hydrology

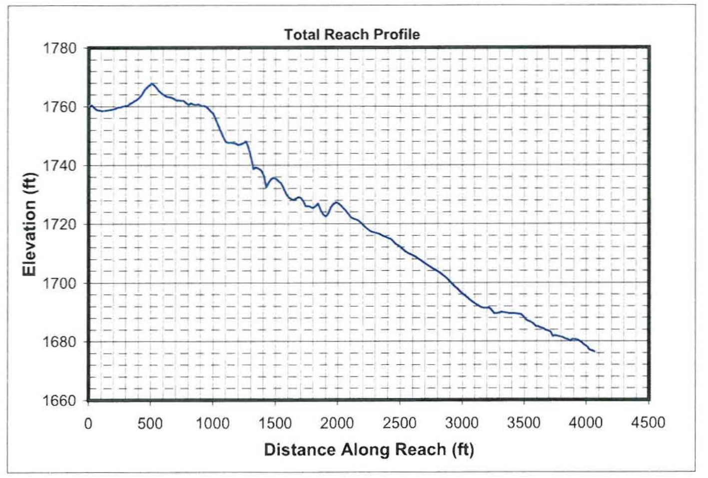
Drainage Area	0.886	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	206	cfs	
Long-term Max. Chnl Capacity	1777	cfs	
Q2 Channel	21	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	63	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			





Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
21	37.8	10.3	0.3	100.0	100.3	2.0	0.3	37.7	0.3	0.16	0.67
52	39.1	18.1	0.5	100.0	100.5	2.8	0.5	38.9	0.5	0.27	0.74
155	41.9	36.0	0.9	100.0	100.9	4.3	0.9	41.6	0.9	0.52	0.81
206	42.9	43.2	1.0	100.0	101.1	4.8	1.1	42.6	1.0	0.62	0.84

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
21	16.3	9.4	0.6	99.0	99.7	2.2	0.7	16.0	0.6	0.38	0.50
52	37.7	22.9	0.6	99.0	100.2	2.3	1.2	37.3	0.6	0.68	0.51
155	41.4	45.9	1.1	99.0	100.8	3.4	1.8	40.8	1.1	1.01	0.56
206	42.8	55.3	1.3	99.0	101.0	3.7	2.0	42.2	1.3	1.14	0.57

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
21										0
52										0
155										0
206										0

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow) Permissive Velocity (ft/s): Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	BUREC Erosive?	Neill (gravel/cobble) Non-cohesive: Erosive?	All'ble Vel (ft/s)	Cohesive: Erosive?	All'ble Vel (ft/s)	USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
21	1.74	0.9957	0.9459	Erosive	Erosive	Erosive	0.2	Stable	4.2	Stable	Stable
52	1.74	1.1595	1.1015	Erosive	Erosive	Erosive	0.2	Stable	5.7	Stable	Stable
155	1.74	1.3507	1.2832	Erosive	Erosive	Erosive	0.3	Stable	7.7	Stable	Stable
206	1.74	1.3996	1.3296	Erosive	Erosive	Erosive	0.3	Stable	8.4	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

Discharge (cfs)	Channel Width (ft) 21	52	155	206	Flow Depth (ft) 21	52	155	206	Velocity (ft/s) 21	52	155	206
Bray - Equation #1	12	19	34	39	0.7	1.0	1.4	1.6	2.4	2.7	3.2	3.3
Bray - Equation #2	15	25	44	52	0.8	1.1	1.6	1.7	1.7	1.9	2.2	2.3
Hey	3	5	10	12	2.0	2.9	4.4	4.9				
Ackers & Charlton/Lacey	13	19	30	34					1.3	1.5	1.9	1.9
Parker	31	49	85	99	0.5	0.7	1.1	1.3				
Chang	20	35	68	82	0.1	0.1	-0.1	-0.1				
Kellerhals	8	13	22	26	0.9	1.3	2.0	2.3	2.8	3.0	3.4	3.5
AMAFCA/Schumm	16	37	41	42								
Moody & Odem	12	12	12	12	0.9	0.9	0.9	0.9				
BUREC	7.4	10.4	15.8	17.5	2	3	4	5	2.2	2.8	3.7	3.9
Average	14	22	36	41	1.0	1.4	2.0	2.2	2.1	2.4	2.9	3.0
Values As Designed	16	37	41	42	0.7	1.2	1.8	2.0	2.2	2.3	3.4	3.7
Difference with Design	-2	-15	-5	-1	0.3	0.1	0.1	0.1	-0.1	0.1	-0.5	-0.7

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	**Zeller Fullerton**	**Ackers White**	**Einstein**	**Engelund/Hansen**	**Kalinske**	**Laursen**	**MPM**	**Rottner**	**Schoklitsch**	**Toffaleti**	**Yang**	**Average**
21	231	149	337	449	628	82	71	37	1073	75	247	307
52	936	470	967	2086	940	331	221	182	2797	250	1005	926
155	4925	1668	2891	12886	1474	1518	712	896	8544	1140	4625	3753
206	7570	2294	3782	20653	1656	2239	949	1320	11418	1704	6761	5486

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	**Zeller Fullerton**	**Ackers White**	**Einstein**	**Engelund/Hansen**	**Kalinske**	**Laursen**	**MPM**	**Rottner**	**Schoklitsch**	**Toffaleti**	**Yang**	**Average**
21	4161	2689	6075	8093	11317	1479	1276	671	19331	1359	4452	5537
52	6740	3385	6968	15027	6773	2382	1594	1308	20147	1801	7243	6670
155	11827	4006	6942	30943	3539	3645	1710	2153	20516	2738	11105	9011
206	13633	4131	6812	37196	2982	4033	1710	2377	20563	3068	12177	9880

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	**Zeller Fullerton**	**Ackers White**	**Einstein**	**Engelund/Hansen**	**Kalinske**	**Laursen**	**MPM**	**Rottner**	**Schoklitsch**	**Toffaleti**	**Yang**	**Average**
21	115	66	122	208	255	28	25	22	303	29	130	118
52	301	163	314	546	612	75	65	58	763	74	341	301
155	1556	656	1109	3317	1022	386	251	337	2415	350	1746	1195
206	2379	922	1528	5284	1164	574	344	509	3241	527	2608	1735

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	**Zeller Fullerton**	**Ackers White**	**Einstein**	**Engelund/Hansen**	**Kalinske**	**Laursen**	**MPM**	**Rottner**	**Schoklitsch**	**Toffaleti**	**Yang**	**Average**
21	2071	1194	2192	3740	4587	510	452	388	5459	518	2337	2132
52	2167	1177	2265	3936	4406	540	470	416	5495	534	2458	2170
155	3735	1575	2663	7964	2453	927	603	809	5798	840	4192	2869
206	4284	1660	2751	9517	2097	1034	619	918	5838	949	4697	3124

Equilibrium Slope Calculations

Discharge	**Schoklitsch**	**MPM**	**Shields**							**Lane's Tractive Force**		**Average BUREC**	**Bray**	**Henderson**	**BUREC**	**Simplified AMAFCA**	**Average**
Q (cfs)	**SL (ft/ft)**	**SL (ft/ft)**	**R*o**	**U***	**T*o**	**Slo (ft/ft)**	**R*f**	**T*f**	**Slf (ft/ft)**	**Tc (Fig. 4)**	**SL (ft/ft)**	**SL (ft/ft)**	**SL (ft/ft)**	**SL (ft/ft)**	**SL (ft/ft)**	**Ss (ft/ft)**	**SL (ft/ft)**
21	0.0027	0.0044	140	0.43	0.047	0.0009	30	0.036	0.0007	0.0159	0.0009	0.0022	0.0127	0.0010	0.0040	0.0205	0.0091
52	0.0014	0.0026	182	0.55	0.050	0.0006	31	0.036	0.0004	0.0159	0.0005	0.0012	0.0127	0.0006	0.0020	0.0205	0.0088
155	0.0006	0.0014	248	0.76	0.053	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0006	0.0127	0.0004	0.0009	0.0204	0.0086
206	0.0005	0.0012	268	0.82	0.053	0.0003	32	0.036	0.0002	0.0159	0.0003	0.0005	0.0127	0.0003	0.0007	0.0204	0.0085

Drop Structures

Design Slope	0.0090	ft/ft
Total Drop Needed	47.4	ft
Height of Drop Structure	3	ft
No . of Drop Structures	16	
Distance between structs.	255	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.89	sq. mi
Total Sediment Yield Volume	1.68	ac ft

Sedimentation Basins

Length	255 ft	Depth	3 ft
Width	63 ft	Side slope	3 ft/ft
Total Volume per Basin		0.92	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		6	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	**COT/PC**	**General**	**Antidune**	**Bend**	**Max. Depth**	**Hyd. Depth**	**Avg Vel**	**Se**	**Scour**	**Scour**	**channel**	**Total**
Q (cfs)	**Sinuosity**	**Zgs (ft)**	**Za (ft)**	**Angle (deg)**	**Ymax (ft)**	**Yh (ft)**	**Vm (ft/s)**		**Zbs (ft)**	**Zls (ft)**	**Zlft (ft)**	**Zt (ft)**
21	1.1	-0.2	0.1	24.6	0.7	0.6	2.2	0.0090	0.1	1.5	1.0	3.4
52	1.1	-0.4	0.1	24.6	1.2	0.6	2.3	0.0090	0.1	1.5	1.0	3.5
155	1.1	-0.5	0.2	24.6	1.8	1.1	3.4	0.0090	0.2	1.5	1.0	3.6
206	1.1	-0.6	0.2	24.6	2.0	1.3	3.7	0.0090	0.2	1.5	1.0	3.7

Toe Protection Needed	4.0	ft

HEC1 Results For Open Channel

Peak Flow	96	cfs
Stage at Peak Flow	100.7	ft
Flow Volume	62.0	ac. ft

Freeboard

Max. Flow Depth	1.1	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.4	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	1.68	ac. ft
Outflowing Sediment Volume	0.07	ac. ft
Deposited(+)/Eroded(-) Volume	1.61	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	4082	4082
Side Slope (?H:1V)	3	3
Channel Width (ft)	63	63
Channel XS Area (sq. ft)	237.8	237.8
Channel Perimeter (ft)	65	65

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	4082	ft
Thickness	1.5	ft
Protection Depth	4	ft
Tie-in Length/Depth	3.0	ft
Total Depth	7.0	ft
Area needed	1361	sq. Yd
Volume	3175	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	4082	4082
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	19049	39459
Left Levee Volume (cu. Yd)	18747	44146
Right Levee Length (ft)	4082	4082
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	19049	39459
Right Levee Volume (cu. Yd)	18747	44146
Total Levee Surface Area (sq. Yd)	38098	78918
Total Levee Volume (cu. Yd)	37494	88292

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	4082	4082
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	6350	14967
Left Levee Lining Volume (cu. Yd)	3175	7484
Right Levee Length (ft)	4082	4082
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	6350	14967
Right Levee Lining Volume (cu. Yd)	3175	7484
Total Lining Area (sq. Yd)	12700	29935
Total Lining Volume (cu. Yd)	6350	14968

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	63	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	5.8	ft
Structure Height	8.8	ft
Number of Structures	16	
Volume per structure	62	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 4,650	
Area per structure	21	sq. Yd
Total Area	336	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	6	
Total Volume per Basin	1484	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 5,936	
Other Cost	$ -	
Total cost per basin	$ 5,936	
Area per basin	1,786	sq. Yd
Total Area	10,716	sq. Yd

Structure Cost

Structure Type	Structure Type	Excavation/Construction Quantity	Units	Unit Cost	Cost Subtotal	Landscape Quantity	Units	Unit Cost	Landscape Cost	Maintenance Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	37,494	cu. Yd	$ 7.00	$ 262,458	38,098	sq. Yd	$ 9.00	$ 342,882	38,098	sq. Yd	$ 11.67	$ 444,477
Levee - LC Enhancement	Fill	50,798	cu. Yd	$ 7.00	$ 355,586	40,820	sq. Yd	$ 9.00	$ 367,380	50,798	sq. Yd	$ 11.67	$ 592,643
Levee Lining	Riprap	6,350	cu. Yd	$ 75.00	$ 476,250	12,700	sq. Yd	$ -	$ -	12,700	sq. Yd	$ 20.83	$ 264,574
Levee Lining -LC Enhancement	Riprap	8,618	cu. Yd	$ 75.00	$ 646,350	17,235	sq. Yd	$ -	$ -	17,235	sq. Yd	$ 20.83	$ 359,065
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	3,175	cu. Yd	$ 75.00	$ 238,125	1,361	sq. Yd	$ -	$ -	1,361	sq. Yd	$ 25.00	$ 34,025
Drop Structures	Riprap	16	EA	$ 4,650.00	$ 74,400	336	sq. Yd	$ -	$ -	336	sq. Yd	$ 33.33	$ 11,200
Drop Str. - LC Enhancement	Riprap	16	EA	$ 465.00	$ 7,440	34	sq. Yd	$ -	$ -	34	sq. Yd	$ 33.33	$ 1,120
Sedimentation Basins		6	EA	$ 5,936.00	$ 35,616	10,716	sq. Yd	$ -	$ -	10,716	sq. Yd	$ 8.33	$ 89,300
Other					$ -				$ -				$ -

Base Landscape Cost	$ 342,882	Base Maintenance Cost	$ 843,576
LC Enhancement Cost	$ 367,380	LC Enhancement Cost	$ 952,828
Total Landscape Cost	$ 710,262	Total Maintenance Cost	$ 1,796,404

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,086,849	$ 1,009,376	$ 2,096,225
Contingency Cost (25% of Construction Cost)	$ 271,712	$ 252,344	$ 524,056
Engineering Design Cost (5% of Construction Cost)	$ 54,342	$ 50,469	$ 104,811
Total Construction Cost	$ 1,412,904	$ 1,312,189	$ 2,725,093

Land Cost

Channel Length	4082 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	63	5.9	$100,000	$ 590,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	5.2	$100,000	$ 520,000
Levee LC Enhancement	51	4.8	$100,000	$ 480,000
Other	0	0	$100,000	$ -
Total	169	15.9		$ 1,590,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	11.1	$100,000	$ 1,110,000
LC Enhancement Cost	acre	4.8	$100,000	$ 480,000
Total Land Cost	acre	15.9	$100,000	$ 1,590,000

Total Cost

Base Total Cost	$ 3,709,361
Total Landscape Enhancement Cost	$ 3,112,397
Total Cost Including LC Enh.	$ 6,821,758

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

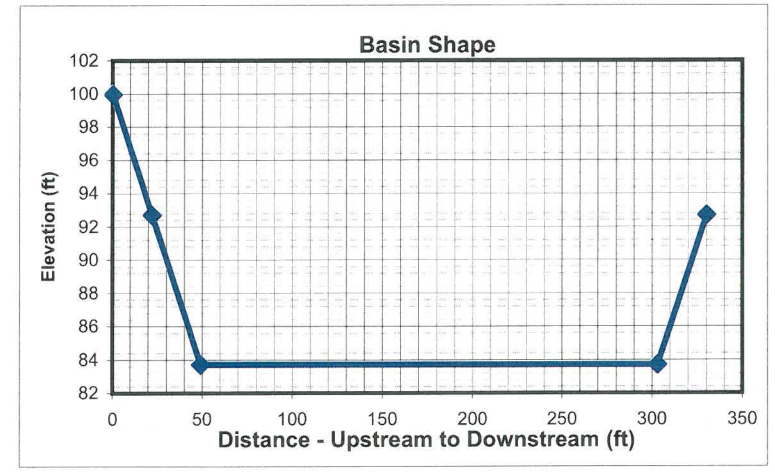
Sub-area: Wagner Wash, Alternative: B42
Open Channel Structure ID: RR15020

Online Basin

HEC1 ID	RR165

HEC1 Results Used to Determine Sediment Volume From Upstream

Contributing HEC1 ID	150165						Total Volume (ac. ft)
Inflow Volume (ac. ft)	62						62
Volume Fraction	1						
Weighted Volume	62						62
Sediment Conc. (ppm)	3124						
Sediment Volume (ac. ft)	0.07						0.07
Weighting Factor	1						
Weighted Sed. Vol. (ac. ft)	0.07						0.07



Sediment Yield

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.6	sq. mi
Total Sediment Yield Volume	1.2	ac ft

Required Minimum Sediment Volume

Sediment Volume	1.3	ac. ft

Geometry	Base	LC Enhanced
Topography slope (ft/ft)	0.022	0.022
Basin Length (ft)	800	1000
Basin Width (ft)	330	330
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	9	9
Freeboard (ft)	1	1
Effective Basin Width (ft)	308	286
Top Area (acres)	6.1	7.6
U/S-D/S Height Difference (ft)	7.3	7.3
Excess Area on Upstream (acres)	0.4	1.0

			Base	LC Enhanced
Bottom Length (ft)	746	Allocated Storage Volume (ac. ft)	39.3	39.2
Bottom Width (ft)	254	Total Available Volume (ac. ft) (incl. Freeboard)	44.9	45.5
		Total Excavation Volume (ac. ft)	67.0	73.1

HEC1 Results

	6-hr Event	24-hr Event	Maximum
Total Flow Volume entering Basin (ac. ft)	100.0	96	100.0
Peak Inflow (cfs)	800	845	845.0
Peak Outflow (cfs)	94	91	94.0
Stage at Peak Outflow (ft)	7.7	7.2	7.7
Volume at Peak Outflow (ac. ft)	37.5	34.8	37.5

Volume Check

Total Volume needed	38.8	ac. ft
Total Volume Provided	39.3	ac. ft
Volume OK?	Yes	

Stage Check

Depth Needed	8.7	ft
Depth Provided	9	ft
Depth OK?	Yes	

Basin Outlet

Outlet Coeff	0.60	(0.6 for Orifice, 3.0 for Weir)
D (Orifice) or W (Weir)	3.00	ft
Invert Elevation	0.00	ft
Number of pipes	1	

Stage-Storage-Discharge

Elevation	0	1	3	5	6	7	8	9	10	11
Volume	0.00	4.42	13.68	23.51	28.64	33.92	39.35	44.93	50.66	56.55
Outflow	0.0	34.0	59.0	76.1	83.4	90.0	96.3	102.1	107.6	112.9

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
LC Enhancement Buffer	209000	sq. ft
Other		sq. ft

Additional ROW Length	0	ft
Additional ROW Width	0	ft
Landscaping Buffer Length	100	ft
Landscaping Buffer Width	100	ft

Base Total ROW Length	800	ft
Base Total ROW Width	330	ft
LC Enh. Total ROW Length	1100	ft
LC Enh. Total ROW Length	430	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	108093	117935
Excavated Area (sq. Yd)	29333	52556

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	52	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	573	sq. Yd
Material Volume	287	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	529	ft
Unit Cost	160	per ft
Cost per outlet	$84,640	
Other Cost	$ -	
Total Cost	$84,640	
Outlet Area	133	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Basin		108,093	cu. Yd	$ 4.00	$ 432,372	29,333	sq. Yd	$ 9.00	$ 263,997	29,333	sq. Yd	$ 8.33	$ 244,442
Basin - LC Enhancement		9,842	cu. Yd	$ 4.00	$ 39,368	23,223	sq. Yd	$ 9.00	$ 209,007	23,223	sq. Yd	$ 8.33	$ 193,525
Inlet	Riprap	287	sq. Yd	$ 75.00	$ 21,525	573	sq. Yd	$ -	$ -	573	sq. Yd	$ 33.33	$ 19,100
Inlet - LC Enhancement (20%Inlet)					$ 4,305				$ -				$ 3,820
Outlet	Pipe	1	EA	$ 84,640	$ 84,640	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhancement (5% Outlet)					$ 4,232				$ -				$ 111
Other					$ -				$ -				$ -

Base Landscape Cost	$ 263,997	Base Maintenance Cost	$ 265,758
LC Enh. Landscape Cost	$ 209,007	LC Enh. Maintenance Cost	$ 197,456
Total Landscape Cost	$ 473,004	Total Maintenance Cost	$ 463,214

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 538,537	$ 39,368	$ 577,905
Contingency Cost (25% of Construction Cost)	$ 134,634	$ 9,842	$ 144,476
Engineering Design Cost (5% of Construction Cost)	$ 26,927	$ 1,968	$ 28,895
Total Construction Cost	$ 700,098	$ 51,178	$ 751,277

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	4.8	$100,000	$ 480,000
Basin	6.1	$100,000	$ 610,000
Other		$100,000	$ -
Total	10.9	$100,000	$ 1,090,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	6.1	$100,000	$ 610,000
LC Enhancement Cost	acre	4.8	$100,000	$ 480,000
Total Land Cost	acre	10.9	$100,000	$ 1,090,000

Total Cost

Base Total Cost	$ 1,839,853
Total LC Enhancement Cost	$ 937,641
Total Cost Including LC Enh.	$ 2,777,495

Open Channel

Structure ID	C17510A	HEC1 ID	165175

Longitundal Geometry

Length	7076.2	ft
U/S Elev	1674.9	ft
D/S Elev	1546.4	ft
Initial Channel Slope	0.0182	ft/ft
Long-term Channel Slope	0.0070	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	8

Initial Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	140	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	153.5	153.5	153.5	167
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	48	3	30	6.5	3	50	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	61.5	67.5	97.5	103.5	153.5	167
Y	104.5	100	100	98	98	100	100	104.5

Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	RR165	S170								TOTAL
HEC1 Peak-Flow	94	1802								1896
Weighting Factor	1.00	0.41								
Flow into Channel	94	740								834

Reach Sediment Inflow Characteristics

U/S Contributing ID										TOTAL
HEC1 Flow Volume (ac. ft)										0
Sediment Conc. (ppm)										
Sediment Volume (ac. ft)										0.00
Weighting Factor										
Weighted Sed. Vol. (ac. ft)										0.00

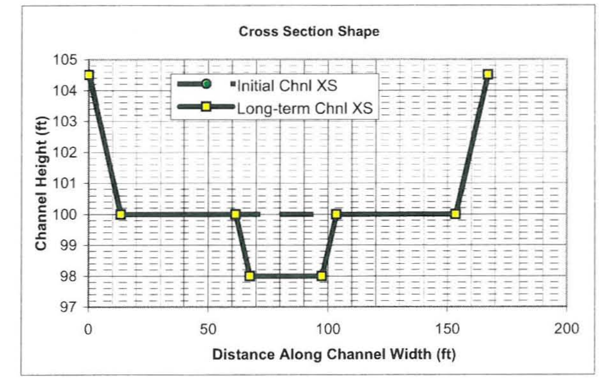
Hydrology

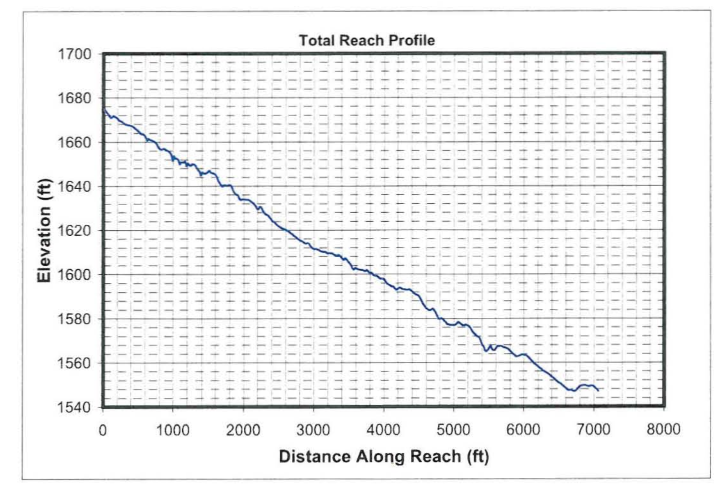
Drainage Area	1.991	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	834	cfs	
Long-term Max. Chnl Capacity	5768	cfs	
Q2 Channel	83	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	167	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			





Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
83	141.9	42.1	0.3	100.0	100.3	2.0	0.3	141.8	0.3	0.13	0.64
209	143.3	73.1	0.5	100.0	100.5	2.9	0.5	143.1	0.5	0.23	0.70
626	146.3	142.6	1.0	100.0	101.0	4.4	1.0	146.0	1.0	0.44	0.78
834	147.5	170.0	1.2	100.0	101.2	4.9	1.2	147.1	1.2	0.52	0.80

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
83	36.2	32.4	0.9	98.0	99.0	2.6	1.0	35.9	0.9	0.43	0.48
209	40.6	58.8	1.4	98.0	99.7	3.5	1.7	40.1	1.5	0.73	0.52
626	145.9	189.6	1.3	98.0	100.8	3.3	2.8	145.0	1.3	1.23	0.51
834	147.5	226.3	1.5	98.0	101.1	3.7	3.1	146.5	1.5	1.34	0.52

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
83										0
209										0
626										0
834										0

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow) Permissive Velocity (ft/s): Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	BUREC Erosive?	Neill (gravel/cobble) Non-cohesive: Erosive?	All'ble Vel (ft/s)	Cohesive: Erosive?	All'ble Vel (ft/s)	USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
83	1.74	1.0208	0.9698	Erosive	Erosive	Erosive	0.2	Stable	4.8	Stable	Stable
209	1.74	1.1884	1.1290	Erosive	Erosive	Erosive	0.3	Stable	6.8	Stable	Stable
626	1.74	1.3882	1.3188	Erosive	Erosive	Erosive	0.3	Stable	8.7	Stable	Stable
834	1.74	1.4401	1.3681	Erosive	Erosive	Erosive	0.3	Stable	9.3	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

Discharge (cfs)	Channel Width (ft) 83	209	626	834	Flow Depth (ft) 83	209	626	834	Velocity (ft/s) 83	209	626	834
Bray - Equation #1	24	40	71	82	1.2	1.6	2.3	2.5	2.9	3.3	3.9	4.1
Bray - Equation #2	32	52	93	108	1.3	1.7	2.5	2.7	2.0	2.3	2.7	2.8
Hey	7	12	22	26	3.5	4.9	7.4	8.3				
Ackers & Charlton/Lacey	23	34	54	61					1.7	2.0	2.3	2.5
Parker	63	99	172	198	0.9	1.3	2.0	2.3				
Chang	43	76	147	175	0.1	0.0	-0.3	-0.4				
Kellerhals	16	26	45	52	1.6	2.3	3.6	4.0	3.2	3.5	3.9	4.0
AMAFCA/Schumm	36	40	145	147								
Moody & Odem	16	16	16	16	1.0	1.0	1.0	1.0				
BUREC	13.1	18.5	27.9	31.1	3	5	7	8	2.9	3.6	4.7	5.1
Average	27	41	79	90	1.6	2.2	3.3	3.6	2.5	2.9	3.5	3.7
Values As Designed	36	40	145	146	1.0	1.7	2.8	3.1	2.6	3.5	3.3	3.7
Difference with Design	-9	1	-66	-57	0.6	0.5	0.4	0.5	0.0	-0.6	0.2	0.0

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
83	819	527	1147	1553	2284	273	240	131	3565	257	879	1061
209	3377	1693	3376	7329	3383	1135	773	661	9336	875	3658	3236
626	18237	6087	10157	46766	5159	5319	2504	3345	28576	4130	17253	13412
834	28319	8399	13287	75849	5733	7902	3342	4958	38196	6239	25409	19785

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
83	3643	2343	5102	6909	10162	1214	1069	583	15859	1143	3910	4722
209	6009	3012	6008	13041	6020	2020	1375	1177	16613	1557	6509	5758
626	10817	3610	6024	27738	3060	3155	1485	1984	16949	2449	10233	7955
834	12598	3736	5911	33741	2550	3515	1486	2205	16991	2775	11303	8801

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
83	458	241	417	841	651	105	86	99	860	104	533	400
209	1766	733	1122	3695	1012	394	254	398	2234	381	2003	1272
626	4845	2045	3314	9738	3397	1096	751	1096	6660	1045	5556	3595
834	7513	2910	4574	15765	3825	1653	1038	1683	8960	1598	8434	5268

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
83	2039	1071	1853	3743	2895	468	384	441	3825	461	2371	1777
209	3143	1304	1996	6575	1801	700	452	709	3975	678	3564	2263
626	2874	1213	1966	5776	2015	650	445	650	3950	620	3295	2132
834	3342	1295	2035	7013	1701	736	462	749	3986	711	3752	2344

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
83	0.0026	0.0041	137	0.42	0.047	0.0009	30	0.036	0.0006	0.0159	0.0009	0.0020	0.0080	0.0005	0.0029	0.0181	0.0072
209	0.0013	0.0024	179	0.55	0.050	0.0005	30	0.036	0.0004	0.0159	0.0005	0.0011	0.0080	0.0003	0.0015	0.0182	0.0069
626	0.0006	0.0012	248	0.75	0.053	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0006	0.0080	0.0002	0.0006	0.0181	0.0067
834	0.0005	0.0010	269	0.82	0.053	0.0003	32	0.036	0.0002	0.0159	0.0002	0.0005	0.0080	0.0002	0.0005	0.0181	0.0067

Drop Structures

Design Slope	0.0070	ft/ft
Total Drop Needed	79.0	ft
Height of Drop Structure	3	ft
No . of Drop Structures	27	
Distance between structs.	262	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.60	sq. mi
Total Sediment Yield Volume	1.14	ac ft

Sedimentation Basins

Length	262 ft	Depth	3 ft
Width	167 ft	Side slope	3 ft/ft
Total Volume per Basin		2.76	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		2	

Scour and Toe Protection (Not applicable for concrete channel)

Discharge	Pima County General Scour Equations								Bend	LongTerm	Thalweg	Total
	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
83	1.1	-0.3	0.1	24.6	1.0	0.9	2.6	0.0070	0.1	1.5	2.0	4.7
209	1.1	-0.5	0.2	24.6	1.7	1.5	3.5	0.0070	0.2	1.5	2.0	4.9
626	1.1	-0.8	0.1	24.6	2.8	1.3	3.3	0.0070	0.3	1.5	2.0	5.0
834	1.1	-0.8	0.2	24.6	3.1	1.5	3.7	0.0070	0.3	1.5	2.0	5.1

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	94	cfs
Stage at Peak Flow	100.3	ft
Flow Volume	100.0	ac. ft

Freeboard

Max. Flow Depth	1.2	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.3	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	1.14	ac. ft
Outflowing Sediment Volume	0.09	ac. ft
Deposited(+)/Eroded(-) Volume	1.05	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	7076	7076
Side Slope (?H:1V)	3	3
Channel Width (ft)	167	167
Channel XS Area (sq. ft)	762.8	762.8
Channel Perimeter (ft)	169	169

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	7076	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	2359	sq. Yd
Volume	7076	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	7076	7076
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	33021	68401
Left Levee Volume (cu. Yd)	32497	76526
Right Levee Length (ft)	7076	7076
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	33021	68401
Right Levee Volume (cu. Yd)	32497	76526
Total Levee Surface Area (sq. Yd)	66042	136802
Total Levee Volume (cu. Yd)	64994	153052

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	7076	7076
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	11007	25945
Left Levee Lining Volume (cu. Yd)	5504	12973
Right Levee Length (ft)	7076	7076
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	11007	25945
Right Levee Lining Volume (cu. Yd)	5504	12973
Total Lining Area (sq. Yd)	22014	51891
Total Lining Volume (cu. Yd)	11008	25946

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	167	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	6.4	ft
Structure Height	9.4	ft
Number of Structures	27	
Volume per structure	174	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 13,050	
Area per structure	56	sq. Yd
Total Area	1,503	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	2	
Total Volume per Basin	4453	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 17,812	
Other Cost	$ -	
Total cost per basin	$ 17,812	
Area per basin	4,863	sq. Yd
Total Area	9,726	sq. Yd

Structure Type	Structure Cost													
		Excavation/Construction				Landscape				Maintenance				
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost	
Levee	Fill	64,994	cu. Yd	$ 7.00	$ 454,958	66,042	sq. Yd	$ 9.00	$ 594,378	66,042	sq. Yd	$ 11.67	$ 770,490	
Levee - LC Enhancement	Fill	88,058	cu. Yd	$ 7.00	$ 616,406	70,760	sq. Yd	$ 9.00	$ 636,840	88,058	sq. Yd	$ 11.67	$ 1,027,343	
Levee Lining	Riprap	11,008	cu. Yd	$ 75.00	$ 825,600	22,014	sq. Yd	$ -	$ -	22,014	sq. Yd	$ 20.83	$ 458,630	
Levee Lining -LC Enhancement	Riprap	14,938	cu. Yd	$ 75.00	$ 1,120,350	29,876	sq. Yd	$ -	$ -	29,876	sq. Yd	$ 20.83	$ 622,426	
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -	
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -	
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	
Toe Protection	Riprap	7,076	cu. Yd	$ 75.00	$ 530,700	2,359	sq. Yd	$ -	$ -	2,359	sq. Yd	$ 25.00	$ 58,975	
Drop Structures	Riprap	27	EA	$ 13,050.00	$ 352,350	1,503	sq. Yd	$ -	$ -	1,503	sq. Yd	$ 33.33	$ 50,100	
Drop Str. - LC Enhancement	Riprap	27	EA	$ 1,305.00	$ 35,235	150	sq. Yd	$ -	$ -	150	sq. Yd	$ 33.33	$ 5,010	
Sedimentation Basins		2	EA	$ 17,812.00	$ 35,624	9,726	sq. Yd	$ -	$ -	9,726	sq. Yd	$ 8.33	$ 81,050	
Other					$ -				$ -				$ -	

Base Landscape Cost	$ 594,378
LC Enhancement Cost	$ 636,840
Total Landscape Cost	$ 1,231,218

Base Maintenance Cost	$ 1,419,245
LC Enhancement Cost	$ 1,654,779
Total Maintenance Cost	$ 3,074,024

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 2,199,232	$ 1,771,991	$ 3,971,223
Contingency Cost (25% of Construction Cost)	$ 549,808	$ 442,998	$ 992,806
Engineering Design Cost (5% of Construction Cost)	$ 109,962	$ 88,600	$ 198,561
Total Construction Cost	$ 2,859,002	$ 2,303,588	$ 5,162,590

Land Cost

Channel Length	7076 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	167	27.1	$100,000	$ 2,710,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	8.9	$100,000	$ 890,000
Levee LC Enhancement	51	8.3	$100,000	$ 830,000
Other	0	0	$100,000	$ -
Total	273	44.3		$ 4,430,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	36	$100,000	$ 3,600,000
LC Enhancement Cost	acre	8.3	$100,000	$ 830,000
Total Land Cost	acre	44.3	$100,000	$ 4,430,000

Total Cost

Base Total Cost	$ 8,472,624
Total Landscape Enhancement Cost	$ 5,425,208
Total Cost Including LC Enh.	$ 13,897,832

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

Sub-area: Wagner Wash, Alternative: B42
Open Channel Structure ID: C17510A

Open Channel

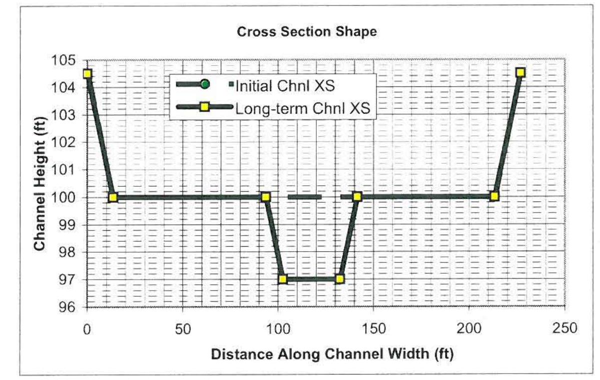
Structure ID	C17510B	HEC1 ID	165175

Longitundal Geometry

Length	6169.2	ft
U/S Elev	1546.4	ft
D/S Elev	1462.9	ft
Initial Channel Slope	0.0135	ft/ft
Long-term Channel Slope	0.0050	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	8



Initial Channel XS Geometry

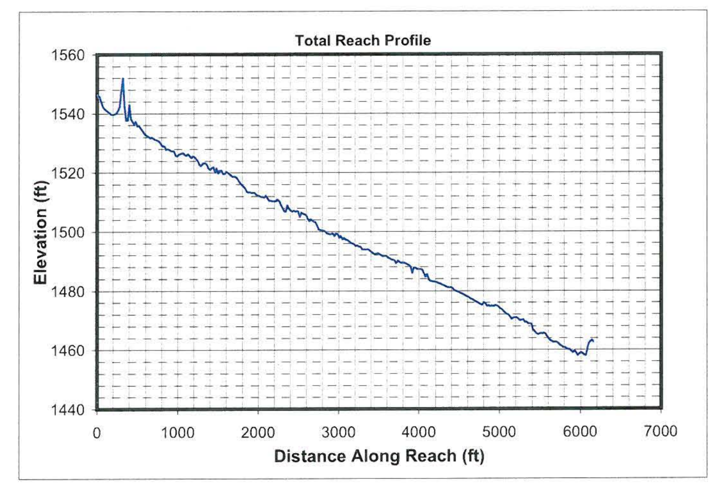
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	200	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	213.5	213.5	213.5	227
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	80	3	30	7.5	3	72	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	93.5	102.5	132.5	141.5	213.5	227
Y	104.5	100	100	97	97	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	C175									TOTAL
HEC1 Peak-Flow	1270									1270
Weighting Factor	1.00									
Flow into Channel	1270									1270

Reach Sediment Inflow Characteristics

U/S Contributing ID	165175_C17510A									TOTAL
HEC1 Flow Volume (ac. ft)	100.00									100
Sediment Conc. (ppm)	2344									
Sediment Volume (ac. ft)	0.09									0.09
Weighting Factor	1									
Weighted Sed. Vol. (ac. ft)	0.09									0.09

Hydrology

Drainage Area	3.19	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	1270	cfs	
Long-term Max. Chnl Capacity	7078	cfs	
Q2 Channel	127	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	227	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
127	202.1	68.1	0.3	100.0	100.3	1.9	0.3	202.0	0.3	0.11	0.57
318	203.7	118.3	0.6	100.0	100.6	2.7	0.6	203.5	0.6	0.18	0.62
953	207.2	230.3	1.1	100.0	101.1	4.1	1.1	206.8	1.1	0.35	0.69
1270	208.5	274.4	1.3	100.0	101.3	4.6	1.3	208.1	1.3	0.42	0.71

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
127	38.8	47.4	1.2	97.0	98.4	2.7	1.4	38.3	1.2	0.43	0.42
318	44.9	87.1	1.9	97.0	99.4	3.6	2.4	44.1	2.0	0.73	0.46
953	207.0	310.5	1.5	97.0	101.0	3.1	4.0	205.7	1.5	1.23	0.44
1270	208.8	370.3	1.8	97.0	101.2	3.4	4.2	207.5	1.8	1.32	0.45

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
	165175_C17510A									
127	400									400
318	1272									1272
953	3595									3595
1270	5268									5268

Allowable Velocity

Channel Lining	Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
127	1.74	1.0602	1.0072	Erosive	Erosive	Erosive	0.2	Stable	5.1	Stable	Stable
318	1.74	1.2282	1.1668	Erosive	Erosive	Erosive	0.3	Stable	7.2	Stable	Stable
953	1.74	1.4287	1.3572	Erosive	Erosive	Erosive	0.3	Stable	8.9	Stable	Stable
1270	1.74	1.4808	1.4067	Erosive	Erosive	Erosive	0.3	Stable	9.5	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	**127**	**318**	**953**	**1270**	**127**	**318**	**953**	**1270**	**127**	**318**	**953**	**1270**
Bray - Equation #1	31	50	88	103	1.3	1.8	2.6	2.9	3.1	3.5	4.1	4.3
Bray - Equation #2	40	65	116	135	1.5	2.0	2.9	3.1	2.1	2.4	2.8	3.0
Hey	9	15	28	33	4.1	5.8	8.7	9.7				
Ackers & Charlton/Lacey	28	40	64	72					1.8	2.1	2.5	2.6
Parker	77	122	212	245	1.0	1.5	2.4	2.7				
Chang	50	87	170	203	0.2	0.1	-0.3	-0.4				
Kellerhals	20	32	56	64	1.9	2.7	4.2	4.7	3.3	3.6	4.0	4.2
AMAFCA/Schumm	38	44	206	208								
Moody & Odem	19	19	19	19	1.1	1.1	1.1	1.1				
BUREC	16.3	23.0	34.8	38.7	4	6	9	10	2.8	3.5	4.6	5.0
Average	33	50	99	112	1.9	2.6	3.9	4.3	2.6	3.0	3.6	3.8
Values As Designed	38	44	206	207	1.4	2.4	4.0	4.2	2.7	3.6	3.1	3.4
Difference with Design	-6	6	-106	-95	0.5	0.3	-0.1	0.0	0.0	-0.6	0.6	0.4

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
127	862	554	1117	1527	2862	237	225	129	3390	255	914	1097
318	3555	1858	3559	7216	4309	1076	796	707	9050	890	3971	3362
953	19253	6878	11310	46176	6637	5174	2689	3755	27921	4301	19413	13955
1270	29935	9543	14676	74975	7384	7705	3611	5612	37356	6536	28824	20560

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
127	2518	1617	3264	4461	8360	693	657	376	9904	745	2669	3206
318	4155	2171	4159	8432	5035	1258	930	827	10575	1040	4640	3929
953	7499	2679	4405	17986	2585	2015	1047	1462	10875	1675	7561	5436
1270	8745	2788	4287	21902	2157	2251	1055	1639	10913	1909	8420	6006

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
127	529	269	421	942	684	105	87	124	785	112	625	426
318	2002	816	1140	4051	1086	390	257	481	2046	414	2322	1364
953	4811	2137	3316	8942	4229	962	726	1158	6019	996	5681	3543
1270	7470	3072	4525	14495	4779	1472	1022	1801	8133	1530	8724	5184

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
127	1545	785	1228	2753	1999	307	254	362	2293	328	1827	1244
318	2340	954	1332	4733	1269	456	300	562	2390	484	2714	1594
953	1874	832	1292	3483	1647	375	283	451	2344	388	2213	1380
1270	2182	898	1322	4234	1396	430	299	526	2376	447	2548	1514

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
127	0.0025	0.0036	126	0.38	0.046	0.0007	30	0.035	0.0006	0.0159	0.0008	0.0018	0.0069	0.0004	0.0027	0.0135	0.0057
318	0.0012	0.0021	165	0.50	0.049	0.0005	30	0.036	0.0003	0.0159	0.0004	0.0010	0.0069	0.0003	0.0014	0.0135	0.0054
953	0.0006	0.0011	228	0.70	0.052	0.0003	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0069	0.0002	0.0006	0.0135	0.0053
1270	0.0004	0.0009	249	0.76	0.053	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0004	0.0069	0.0001	0.0005	0.0135	0.0053

Drop Structures

Design Slope	0.0050	ft/ft
Total Drop Needed	52.7	ft
Height of Drop Structure	3	ft
No . of Drop Structures	18	
Distance between structs.	343	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	1.80	sq. mi
Total Sediment Yield Volume	3.42	ac ft

Sedimentation Basins

Length	343 ft	Depth	3 ft
Width	227 ft	Side slope	3 ft/ft
Total Volume per Basin		5.01	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		3	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
127	1.1	-0.4	0.1	24.6	1.4	1.2	2.7	0.0050	0.1	1.5	3.0	6.1
318	1.1	-0.7	0.2	24.6	2.4	2.0	3.6	0.0050	0.3	1.5	3.0	6.3
953	1.1	-1.2	0.1	24.6	4.0	1.5	3.1	0.0050	0.4	1.5	3.0	6.5
1270	1.1	-1.2	0.2	24.6	4.2	1.8	3.4	0.0050	0.5	1.5	3.0	6.6

Toe Protection Needed	7.0	ft

HEC1 Results For Open Channel

Peak Flow	94	cfs
Stage at Peak Flow	100.3	ft
Flow Volume	100.0	ac. ft

Freeboard

Max. Flow Depth	1.3	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.2	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	3.51	ac. ft
Outflowing Sediment Volume	0.06	ac. ft
Deposited(+)/Eroded(-) Volume	3.45	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	6169	6169
Side Slope (?H:1V)	3	3
Channel Width (ft)	227	227
Channel XS Area (sq. ft)	1077.8	1077.8
Channel Perimeter (ft)	229	229

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	6169	ft
Thickness	1.5	ft
Protection Depth	7	ft
Tie-in Length/Depth	3.0	ft
Total Depth	10.0	ft
Area needed	2056	sq. Yd
Volume	6854	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	6169	6169
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	28789	59634
Left Levee Volume (cu. Yd)	28332	66717
Right Levee Length (ft)	6169	6169
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	28789	59634
Right Levee Volume (cu. Yd)	28332	66717
Total Levee Surface Area (sq. Yd)	57578	119268
Total Levee Volume (cu. Yd)	56664	133434

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	6169	6169
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	9596	22620
Left Levee Lining Volume (cu. Yd)	4798	11310
Right Levee Length (ft)	6169	6169
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	9596	22620
Right Levee Lining Volume (cu. Yd)	4798	11310
Total Lining Area (sq. Yd)	19192	45239
Total Lining Volume (cu. Yd)	9596	22620

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	227	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	6.6	ft
Structure Height	9.6	ft
Number of Structures	18	
Volume per structure	243	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 18,225	
Area per structure	76	sq. Yd
Total Area	1,362	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	3	
Total Volume per Basin	8083	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 32,332	
Other Cost	$ -	
Total cost per basin	$ 32,332	
Area per basin	8,644	sq. Yd
Total Area	25,932	sq. Yd

Structure Type	Structure Type	Excavation/Construction Quantity	Units	Unit Cost	Cost Subtotal	Landscape Quantity	Units	Unit Cost	Landscape Cost	Maintenance Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	56,664	cu. Yd	$ 7.00	$ 396,648	57,578	sq. Yd	$ 9.00	$ 518,202	57,578	sq. Yd	$ 11.67	$ 671,743
Levee - LC Enhancement	Fill	76,770	cu. Yd	$ 7.00	$ 537,390	61,690	sq. Yd	$ 9.00	$ 555,210	76,770	sq. Yd	$ 11.67	$ 895,650
Levee Lining	Riprap	9,596	cu. Yd	$ 75.00	$ 719,700	19,192	sq. Yd	$ -	$ -	19,192	sq. Yd	$ 20.83	$ 399,843
Levee Lining -LC Enhancement	Riprap	13,024	cu. Yd	$ 75.00	$ 976,800	26,047	sq. Yd	$ -	$ -	26,047	sq. Yd	$ 20.83	$ 542,644
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	6,854	cu. Yd	$ 75.00	$ 514,050	2,056	sq. Yd	$ -	$ -	2,056	sq. Yd	$ 25.00	$ 51,400
Drop Structures	Riprap	18	EA	$ 18,225.00	$ 328,050	1,362	sq. Yd	$ -	$ -	1,362	sq. Yd	$ 33.33	$ 45,400
Drop Str. - LC Enhancement	Riprap	18	EA	$ 1,822.50	$ 32,805	136	sq. Yd	$ -	$ -	136	sq. Yd	$ 33.33	$ 4,540
Sedimentation Basins		3	EA	$ 32,332.00	$ 96,996	25,932	sq. Yd	$ -	$ -	25,932	sq. Yd	$ 8.33	$ 216,100
Other					$ -				$ -				$ -

Base Landscape Cost	$ 518,202	
LC Enhancement Cost	$ 555,210	
Total Landscape Cost	$ 1,073,412	

Base Maintenance Cost	$ 1,384,486
LC Enhancement Cost	$ 1,442,834
Total Maintenance Cost	$ 2,827,319

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 2,055,444	$ 1,546,995	$ 3,602,439
Contingency Cost (25% of Construction Cost)	$ 513,861	$ 386,749	$ 900,610
Engineering Design Cost (5% of Construction Cost)	$ 102,772	$ 77,350	$ 180,122
Total Construction Cost	$ 2,672,077	$ 2,011,094	$ 4,683,171

Land Cost

Channel Length	6169 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	227	32.1	$100,000	$ 3,210,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	7.8	$100,000	$ 780,000
Levee LC Enhancement	51	7.2	$100,000	$ 720,000
Other	0	0	$100,000	$ -
Total	333	47.1		$ 4,710,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

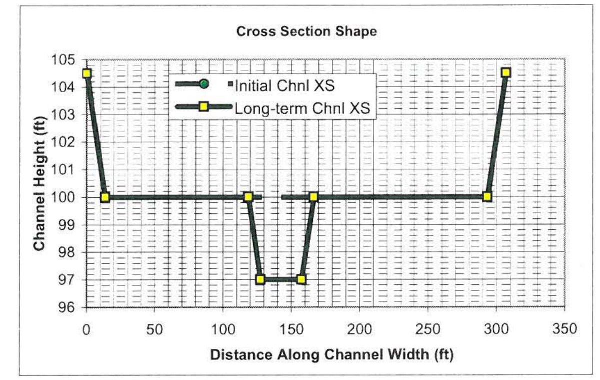
Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	39.9	$100,000	$ 3,990,000
LC Enhancement Cost	acre	7.2	$100,000	$ 720,000
Total Land Cost	acre	47.1	$100,000	$ 4,710,000

Total Cost

Base Total Cost	$ 8,564,765
Total Landscape Enhancement Cost	$ 4,729,137
Total Cost Including LC Enh.	$ 13,293,902

Open Channel

Structure ID	RR17510		HEC1 ID	175R



Longitundal Geometry

Length	3035.2	ft
U/S Elev	1462.9	ft
D/S Elev	1413.1	ft
Initial Channel Slope	0.0164	ft/ft
Long-term Channel Slope	0.0060	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	2

Initial Channel XS Geometry

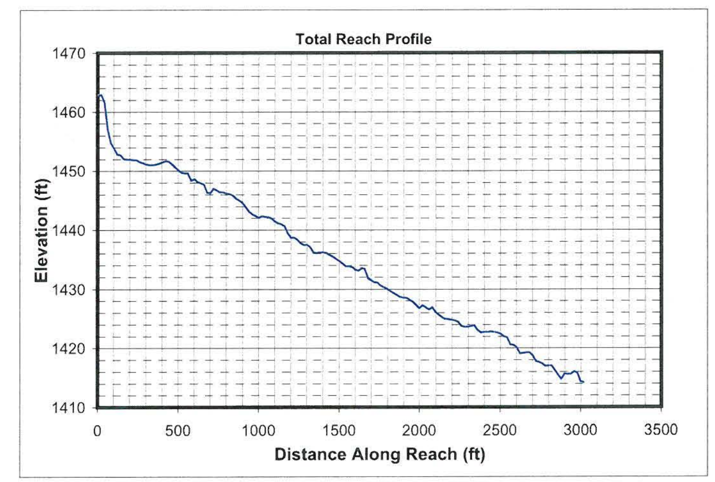
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	280	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	293.5	293.5	293.5	307
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	105	3	30	7.5	3	127	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	118.5	127.5	157.5	166.5	293.5	307
Y	104.5	100	100	97	97	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	C175	S190								TOTAL
HEC1 Peak-Flow	1270	2590								3860
Weighting Factor	1.00	0.05								
Flow into Channel	1270	119								1389

Reach Sediment Inflow Characteristics

U/S Contributing ID	165175_C17510 B									TOTAL
HEC1 Flow Volume (ac. ft)	100.00									100
Sediment Conc. (ppm)	1594									
Sediment Volume (ac. ft)	0.06									0.06
Weighting Factor	1									
Weighted Sed. Vol. (ac. ft)	0.06									0.06

Hydrology

Drainage Area	2.607	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	1389	cfs	
Long-term Max. Chnl Capacity	10268	cfs	
Q2 Channel	139	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	307	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

Sub-area: Wagner Wash, Alternative: B42
Open Channel Structure ID: RR17510

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
139	281.7	77.5	0.3	100.0	100.3	1.8	0.3	281.7	0.3	0.10	0.60
347	283.0	134.6	0.5	100.0	100.5	2.6	0.5	282.9	0.5	0.18	0.66
1042	285.8	261.0	0.9	100.0	100.9	4.0	0.9	285.5	0.9	0.35	0.74
1389	286.9	310.7	1.1	100.0	101.1	4.5	1.1	286.6	1.1	0.41	0.76

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
139	38.8	47.4	1.2	97.0	98.4	2.9	1.4	38.3	1.2	0.52	0.46
347	44.9	87.0	1.9	97.0	99.3	4.0	2.3	44.1	2.0	0.88	0.50
1042	286.3	353.1	1.2	97.0	100.8	3.0	3.8	285.0	1.2	1.44	0.47
1389	287.8	420.5	1.5	97.0	101.1	3.3	4.1	286.4	1.5	1.52	0.48

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
	165175_C17510 B									
139	426									426
347	1364									1364
1042	3543									3543
1389	5184									5184

Allowable Velocity

Channel Lining	Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
139	1.74	0.9976	0.9477	Erosive	Erosive	Erosive	0.2	Stable	5.6	Stable	Stable
347	1.74	1.1664	1.1080	Erosive	Erosive	Erosive	0.2	Stable	7.9	Stable	Stable
1042	1.74	1.3678	1.2994	Erosive	Erosive	Erosive	0.3	Stable	9.3	Stable	Stable
1389	1.74	1.4204	1.3494	Erosive	Erosive	Erosive	0.3	Stable	9.9	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	139	347	1042	1389	139	347	1042	1389	139	347	1042	1389
Bray - Equation #1	32	52	93	108	1.4	1.9	2.7	3.0	3.2	3.6	4.2	4.4
Bray - Equation #2	42	68	122	142	1.5	2.0	2.9	3.2	2.2	2.5	2.9	3.0
Hey	9	16	30	35	4.2	6.0	9.0	10.1				
Ackers & Charlton/Lacey	29	42	67	75					1.8	2.1	2.6	2.7
Parker	81	128	222	256	1.1	1.6	2.5	2.8				
Chang	56	98	191	227	0.1	0.0	-0.4	-0.6				
Kellerhals	21	34	58	67	2.0	2.8	4.4	4.9	3.3	3.7	4.1	4.2
AMAFCA/Schumm	38	44	285	287								
Moody & Odem	18	18	18	18	1.1	1.1	1.1	1.1				
BUREC	16.3	23.0	34.8	38.7	4	6	9	10	3.1	3.9	5.1	5.4
Average	34	52	112	125	2.0	2.7	3.9	4.4	2.7	3.1	3.8	3.9
Values As Designed	38	44	285	286	1.4	2.3	3.8	4.1	2.9	4.0	3.0	3.3
Difference with Design	-4	8	-173	-161	0.6	0.3	0.1	0.3	-0.2	-0.9	0.8	0.6

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
139	1075	715	1513	1931	3951	318	304	150	4942	349	1115	1488
347	4431	2398	4845	9139	5948	1455	1081	855	13185	1173	4903	4492
1042	24177	8911	15456	58778	9127	7047	3678	4637	40663	5548	24117	18376
1389	37646	12367	20044	95604	10139	10506	4941	6951	54403	8403	35828	26985

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
139	2872	1910	4042	5157	10553	850	811	401	13201	932	2977	3973
347	4734	2562	5177	9764	6355	1554	1154	913	14087	1253	5239	4799
1042	8610	3173	5505	20933	3251	2510	1310	1651	14482	1976	8589	6544
1389	10055	3303	5354	25536	2708	2806	1320	1857	14531	2245	9570	7208

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
139	782	376	594	1483	779	169	129	181	1154	169	918	612
347	2962	1112	1605	6374	1220	603	360	674	2970	621	3316	1983
1042	5973	2693	4489	11201	5799	1290	980	1379	8656	1276	6994	4612
1389	9293	3883	6118	18202	6542	1979	1383	2163	11697	1956	10767	6726

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
139	2089	1005	1586	3960	2079	452	343	483	3081	451	2452	1635
347	3164	1188	1715	6810	1303	644	385	720	3173	664	3543	2119
1042	2127	959	1599	3989	2065	459	349	491	3083	454	2491	1642
1389	2482	1037	1634	4862	1747	529	369	578	3124	522	2876	1796

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
139	0.0030	0.0044	125	0.38	0.046	0.0009	29	0.035	0.0007	0.0159	0.0009	0.0022	0.0067	0.0004	0.0032	0.0163	0.0064
347	0.0015	0.0025	164	0.50	0.049	0.0006	30	0.036	0.0004	0.0159	0.0005	0.0012	0.0067	0.0003	0.0016	0.0164	0.0061
1042	0.0007	0.0013	228	0.69	0.052	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0006	0.0067	0.0002	0.0007	0.0164	0.0060
1389	0.0005	0.0011	248	0.76	0.053	0.0003	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0067	0.0001	0.0006	0.0164	0.0059

Drop Structures

Design Slope	0.0060	ft/ft
Total Drop Needed	31.5	ft
Height of Drop Structure	3	ft
No . of Drop Structures	11	
Distance between structs.	276	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.19	sq. mi
Total Sediment Yield Volume	0.36	ac ft

Sedimentation Basins

Length	276 ft	Depth	3 ft
Width	307 ft	Side slope	3 ft/ft
Total Volume per Basin		5.48	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

Discharge	Pima County General Scour Equations								Bend	LongTerm	Thalweg	Total
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
139	1.1	-0.4	0.1	24.6	1.4	1.2	2.9	0.0060	0.1	1.5	3.0	6.1
347	1.1	-0.6	0.2	24.6	2.3	2.0	4.0	0.0060	0.3	1.5	3.0	6.3
1042	1.1	-1.2	0.1	24.6	3.8	1.2	3.0	0.0060	0.4	1.5	3.0	6.5
1389	1.1	-1.2	0.1	24.6	4.1	1.5	3.3	0.0060	0.4	1.5	3.0	6.5

Toe Protection Needed	7.0	ft

HEC1 Results For Open Channel

Peak Flow	1191	cfs
Stage at Peak Flow	101.0	ft
Flow Volume	202.0	ac. ft

Freeboard

Max. Flow Depth	1.1	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.4	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	0.42	ac. ft
Outflowing Sediment Volume	0.16	ac. ft
Deposited(+)/Eroded(-) Volume	0.25	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	3035	3035
Side Slope (?H:1V)	3	3
Channel Width (ft)	307	307
Channel XS Area (sq. ft)	1437.8	1437.8
Channel Perimeter (ft)	309	309

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	3035	ft
Thickness	1.5	ft
Protection Depth	7	ft
Tie-in Length/Depth	3.0	ft
Total Depth	10.0	ft
Area needed	1012	sq. Yd
Volume	3372	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	3035	3035
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	14163	29338
Left Levee Volume (cu. Yd)	13939	32823
Right Levee Length (ft)	3035	3035
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	14163	29338
Right Levee Volume (cu. Yd)	13939	32823
Total Levee Surface Area (sq. Yd)	28326	58676
Total Levee Volume (cu. Yd)	27878	65646

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	3035	3035
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	4721	11128
Left Levee Lining Volume (cu. Yd)	2361	5564
Right Levee Length (ft)	3035	3035
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	4721	11128
Right Levee Lining Volume (cu. Yd)	2361	5564
Total Lining Area (sq. Yd)	9442	22257
Total Lining Volume (cu. Yd)	4722	11128

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	307	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	5.8	ft
Structure Height	8.8	ft
Number of Structures	11	
Volume per structure	300	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 22,500	
Area per structure	102	sq. Yd
Total Area	1,126	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	8841	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 35,364	
Other Cost	$ -	
Total cost per basin	$ 35,364	
Area per basin	9,412	sq. Yd
Total Area	9,412	sq. Yd

Structure Type	Structure Cost	Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	27,878	cu. Yd	$ 7.00	$ 195,146	28,326	sq. Yd	$ 9.00	$ 254,934	28,326	sq. Yd	$ 11.67	$ 330,470
Levee - LC Enhancement	Fill	37,768	cu. Yd	$ 7.00	$ 264,376	30,350	sq. Yd	$ 9.00	$ 273,150	37,768	sq. Yd	$ 11.67	$ 440,627
Levee Lining	Riprap	4,722	cu. Yd	$ 75.00	$ 354,150	9,442	sq. Yd	$ -	$ -	9,442	sq. Yd	$ 20.83	$ 196,713
Levee Lining -LC Enhancement	Riprap	6,406	cu. Yd	$ 75.00	$ 480,450	12,814	sq. Yd	$ -	$ -	12,814	sq. Yd	$ 20.83	$ 266,968
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	3,372	cu. Yd	$ 75.00	$ 252,900	1,012	sq. Yd	$ -	$ -	1,012	sq. Yd	$ 25.00	$ 25,300
Drop Structures	Riprap	11	EA	$ 22,500.00	$ 247,500	1,126	sq. Yd	$ -	$ -	1,126	sq. Yd	$ 33.33	$ 37,533
Drop Str. - LC Enhancement	Riprap	11	EA	$ 2,250.00	$ 24,750	113	sq. Yd	$ -	$ -	113	sq. Yd	$ 33.33	$ 3,753
Sedimentation Basins		1	EA	$ 35,364.00	$ 35,364	9,412	sq. Yd	$ -	$ -	9,412	sq. Yd	$ 8.33	$ 78,433
Other					$ -				$ -				$ -

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,085,060	$ 769,576	$ 1,854,636
Contingency Cost (25% of Construction Cost)	$ 271,265	$ 192,394	$ 463,659
Engineering Design Cost (5% of Construction Cost)	$ 54,253	$ 38,479	$ 92,732
Total Construction Cost	$ 1,410,578	$ 1,000,449	$ 2,411,027

Base Landscape Cost	$ 254,934
LC Enhancement Cost	$ 273,150
Total Landscape Cost	$ 528,084

Base Maintenance Cost	$ 668,450
LC Enhancement Cost	$ 711,348
Total Maintenance Cost	$ 1,379,797

Land Cost

Channel Length	3035 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	307	21.4	$100,000	$ 2,140,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	3.8	$100,000	$ 380,000
Levee LC Enhancement	51	3.6	$100,000	$ 360,000
Other	0	0	$100,000	$ -
Total	413	28.8		$ 2,880,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	25.2	$100,000	$ 2,520,000
LC Enhancement Cost	acre	3.6	$100,000	$ 360,000
Total Land Cost	acre	28.8	$100,000	$ 2,880,000

Total Cost

Base Total Cost	$ 4,853,962
Total Landscape Enhancement Cost	$ 2,344,946
Total Cost Including LC Enh.	$ 7,198,908

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

Sub-area: Wagner Wash, Alternative: B42
Open Channel Structure ID: RR17510

Open Channel

Structure ID	S18010	HEC1 ID	180R

Longitundal Geometry

Length	5165.4	ft
U/S Elev	1531.6	ft
D/S Elev	1456.3	ft
Initial Channel Slope	0.0146	ft/ft
Long-term Channel Slope	0.0060	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	2

Initial Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	180	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	193.5	193.5	193.5	207
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	75	3	25	6.5	3	68	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	88.5	94.5	119.5	125.5	193.5	207
Y	104.5	100	100	98	98	100	100	104.5

Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

										TOTAL
Contributing HEC1 ID	S180									
HEC1 Peak-Flow	1039									1039
Weighting Factor	1.00									
Flow into Channel	1039									1039

Reach Sediment Inflow Characteristics

U/S Contributing ID										TOTAL
HEC1 Flow Volume (ac. ft)										0
Sediment Conc. (ppm)										
Sediment Volume (ac. ft)										0.00
Weighting Factor										
Weighted Sed. Vol. (ac. ft)										0.00

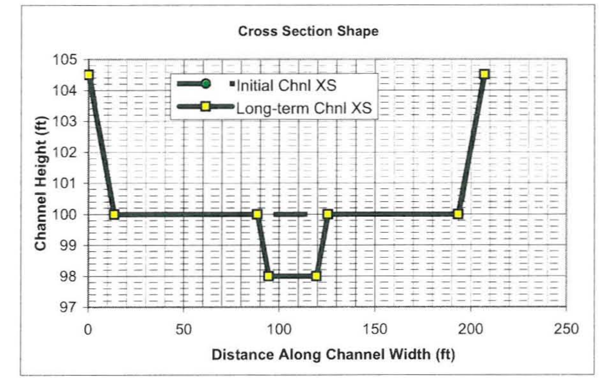
Hydrology

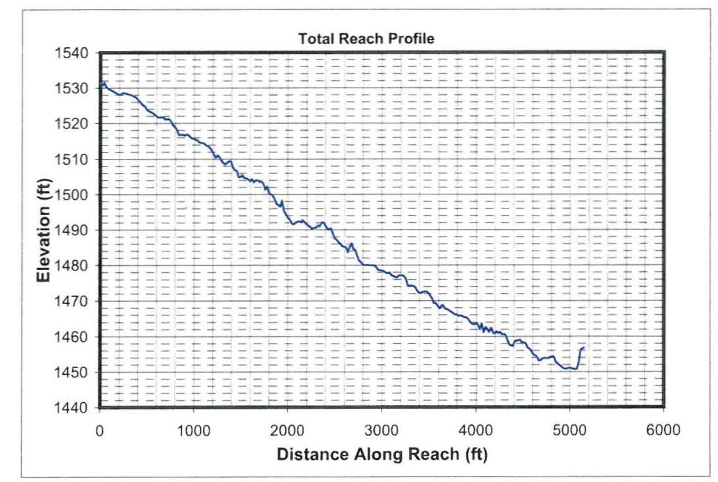
Drainage Area	1.44	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	1039	cfs	
Long-term Max. Chnl Capacity	6482	cfs	
Q2 Channel	104	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	207	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			





Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
104	182.0	56.6	0.3	100.0	100.3	1.8	0.3	181.9	0.3	0.12	0.58
260	183.4	98.4	0.5	100.0	100.5	2.6	0.5	183.2	0.5	0.20	0.64
779	186.6	191.5	1.0	100.0	101.0	4.1	1.0	186.3	1.0	0.39	0.71
1039	187.9	228.2	1.2	100.0	101.2	4.6	1.2	187.5	1.2	0.46	0.73

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
104	33.2	37.4	1.1	98.0	99.3	2.8	1.3	32.8	1.1	0.48	0.46
260	183.0	128.3	0.7	98.0	100.4	2.0	2.4	182.2	0.7	0.89	0.43
779	187.2	250.3	1.3	98.0	101.0	3.1	3.0	186.2	1.3	1.13	0.47
1039	188.8	298.5	1.6	98.0	101.3	3.5	3.3	187.7	1.6	1.23	0.49

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
104										0
260										0
779										0
1039										0

Allowable Velocity

Channel Lining	Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
104	1.74	1.0357	0.9839	Erosive	Erosive	Erosive	0.2	Stable	5.3	Stable	Stable
260	1.74	1.2036	1.1434	Erosive	Erosive	Erosive	0.3	Stable	6.7	Stable	Stable
779	1.74	1.4040	1.3338	Erosive	Erosive	Erosive	0.3	Stable	8.4	Stable	Stable
1039	1.74	1.4561	1.3833	Erosive	Erosive	Erosive	0.3	Stable	9.0	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	**104**	**260**	**779**	**1039**	**104**	**260**	**779**	**1039**	**104**	**260**	**779**	**1039**
Bray - Equation #1	28	45	80	93	1.2	1.7	2.4	2.7	3.0	3.4	4.0	4.2
Bray - Equation #2	36	58	104	122	1.4	1.9	2.7	2.9	2.1	2.4	2.8	2.9
Hey	8	13	25	30	3.8	5.3	8.1	9.0				
Ackers & Charlton/Lacey	25	37	59	67					1.7	2.0	2.4	2.6
Parker	70	111	192	221	1.0	1.4	2.2	2.5				
Chang	47	82	160	191	0.1	0.0	-0.3	-0.4				
Kellerhals	18	29	50	58	1.7	2.5	3.9	4.4	3.2	3.6	4.0	4.1
AMAFCA/Schumm	33	182	186	188								
Moody & Odem	14	14	14	14	1.0	1.0	1.0	1.0				
BUREC	14.6	20.7	31.2	34.7	4	6	8	9	2.8	3.6	4.7	5.1
Average	29	59	90	102	1.8	2.4	3.5	3.9	2.6	3.0	3.6	3.8
Values As Designed	33	182	186	188	1.3	2.4	3.0	3.3	2.8	2.0	3.1	3.5
Difference with Design	-3	-123	-96	-86	0.5	0.0	0.5	0.6	-0.2	1.0	0.5	0.3

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
104	741	482	992	1319	2564	209	199	107	3099	227	779	974
260	3058	1620	3171	6234	3863	955	708	601	8270	781	3400	2969
779	16554	5998	10090	39882	5956	4595	2397	3209	25511	3738	16636	12233
1039	25724	8320	13086	64745	6628	6841	3219	4799	34133	5670	24696	17987

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
104	2645	1722	3541	4711	9157	748	712	384	11064	810	2780	3480
260	4368	2314	4529	8904	5518	1364	1012	858	11812	1116	4856	4241
779	7881	2856	4804	18988	2836	2188	1141	1528	12146	1780	7920	5824
1039	9186	2971	4673	23119	2367	2443	1149	1714	12188	2025	8818	6423

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
104	543	270	441	1010	629	117	93	124	856	118	638	440
260	890	477	838	1445	2423	164	162	165	1974	206	986	885
779	4803	2119	3379	9211	4007	1032	754	1116	6520	1020	5605	3597
1039	7459	3036	4643	14933	4520	1571	1054	1732	8793	1563	8575	5262

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
104	1938	966	1574	3605	2247	419	331	443	3057	423	2278	1571
260	1271	681	1197	2064	3461	235	231	235	2819	295	1409	1264
779	2287	1009	1609	4385	1908	492	359	532	3104	486	2669	1712
1039	2663	1084	1658	5332	1614	561	377	618	3140	558	3062	1879

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
104	0.0026	0.0039	125	0.38	0.046	0.0008	30	0.035	0.0006	0.0159	0.0008	0.0020	0.0074	0.0005	0.0029	0.0145	0.0061
260	0.0013	0.0023	165	0.50	0.049	0.0005	30	0.036	0.0003	0.0159	0.0005	0.0011	0.0074	0.0003	0.0015	0.0146	0.0059
779	0.0006	0.0012	228	0.69	0.052	0.0003	31	0.036	0.0002	0.0159	0.0002	0.0006	0.0074	0.0002	0.0006	0.0146	0.0057
1039	0.0005	0.0010	248	0.76	0.053	0.0002	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0074	0.0002	0.0005	0.0146	0.0056

Drop Structures

Design Slope	0.0060	ft/ft
Total Drop Needed	44.3	ft
Height of Drop Structure	3	ft
No . of Drop Structures	15	
Distance between structs.	344	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	1.44	sq. mi
Total Sediment Yield Volume	2.74	ac ft

Sedimentation Basins

Length	344 ft	Depth	3 ft
Width	207 ft	Side slope	3 ft/ft
Total Volume per Basin		4.57	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		2	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
104	1.1	-0.4	0.1	24.6	1.3	1.1	2.8	0.0060	0.1	1.5	2.0	4.8
260	1.1	-0.8	0.1	24.6	2.4	0.7	2.0	0.0060	0.2	1.5	2.0	4.9
779	1.1	-0.9	0.1	24.6	3.0	1.3	3.1	0.0060	0.3	1.5	2.0	5.1
1039	1.1	-0.9	0.2	24.6	3.3	1.6	3.5	0.0060	0.4	1.5	2.0	5.1

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	775	cfs
Stage at Peak Flow	101.0	ft
Flow Volume	90.0	ac. ft

Freeboard

Max. Flow Depth	1.2	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.3	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	2.74	ac. ft
Outflowing Sediment Volume	0.06	ac. ft
Deposited(+)/Eroded(-) Volume	2.67	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	5165	5165
Side Slope (?H:1V)	3	3
Channel Width (ft)	207	207
Channel XS Area (sq. ft)	932.8	932.8
Channel Perimeter (ft)	209	209

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	5165	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	1722	sq. Yd
Volume	5165	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	5165	5165
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	24103	49928
Left Levee Volume (cu. Yd)	23721	55859
Right Levee Length (ft)	5165	5165
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	24103	49928
Right Levee Volume (cu. Yd)	23721	55859
Total Levee Surface Area (sq. Yd)	48206	99856
Total Levee Volume (cu. Yd)	47442	111718

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	5165	5165
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	8034	18938
Left Levee Lining Volume (cu. Yd)	4017	9469
Right Levee Length (ft)	5165	5165
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	8034	18938
Right Levee Lining Volume (cu. Yd)	4017	9469
Total Lining Area (sq. Yd)	16069	37877
Total Lining Volume (cu. Yd)	8034	18938

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	207	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	6.3	ft
Structure Height	9.3	ft
Number of Structures	15	
Volume per structure	213	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 15,975	
Area per structure	69	sq. Yd
Total Area	1,035	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	2	
Total Volume per Basin	7373	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 29,492	
Other Cost	$ -	
Total cost per basin	$ 29,492	
Area per basin	7,920	sq. Yd
Total Area	15,840	sq. Yd

Structure Type	Structure Cost													
		Excavation/Construction				Landscape				Maintenance				
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost	
Levee	Fill	47,442	cu. Yd	$ 7.00	$ 332,094	48,206	sq. Yd	$ 9.00	$ 433,854	48,206	sq. Yd	$ 11.67	$ 562,403	
Levee - LC Enhancement	Fill	64,276	cu. Yd	$ 7.00	$ 449,932	51,650	sq. Yd	$ 9.00	$ 464,850	64,276	sq. Yd	$ 11.67	$ 749,887	
Levee Lining	Riprap	8,034	cu. Yd	$ 75.00	$ 602,550	16,069	sq. Yd	$ -	$ -	16,069	sq. Yd	$ 20.83	$ 334,769	
Levee Lining -LC Enhancement	Riprap	10,904	cu. Yd	$ 75.00	$ 817,800	21,808	sq. Yd	$ -	$ -	21,808	sq. Yd	$ 20.83	$ 454,329	
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -	
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -	
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	
Toe Protection	Riprap	5,165	cu. Yd	$ 75.00	$ 387,375	1,722	sq. Yd	$ -	$ -	1,722	sq. Yd	$ 25.00	$ 43,050	
Drop Structures	Riprap	15	EA	$ 15,975.00	$ 239,625	1,035	sq. Yd	$ -	$ -	1,035	sq. Yd	$ 33.33	$ 34,500	
Drop Str. - LC Enhancement	Riprap	15	EA	$ 1,597.50	$ 23,963	104	sq. Yd	$ -	$ -	104	sq. Yd	$ 33.33	$ 3,450	
Sedimentation Basins		2	EA	$ 29,492.00	$ 58,984	15,840	sq. Yd	$ -	$ -	15,840	sq. Yd	$ 8.33	$ 132,000	
Other					$ -				$ -				$ -	

Base Landscape Cost	$ 433,854	Base Maintenance Cost	$ 1,106,722
LC Enhancement Cost	$ 464,850	LC Enhancement Cost	$ 1,207,665
Total Landscape Cost	$ 898,704	Total Maintenance Cost	$ 2,314,387

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,620,628	$ 1,291,695	$ 2,912,323
Contingency Cost (25% of Construction Cost)	$ 405,157	$ 322,924	$ 728,081
Engineering Design Cost (5% of Construction Cost)	$ 81,031	$ 64,585	$ 145,616
Total Construction Cost	$ 2,106,816	$ 1,679,203	$ 3,786,019

Land Cost

Channel Length	5165 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	207	24.5	$100,000	$ 2,450,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	6.5	$100,000	$ 650,000
Levee LC Enhancement	51	6	$100,000	$ 600,000
Other	0	0	$100,000	$ -
Total	313	37		$ 3,700,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	31	$100,000	$ 3,100,000
LC Enhancement Cost	acre	6	$100,000	$ 600,000
Total Land Cost	acre	37	$100,000	$ 3,700,000

Total Cost

Base Total Cost	$ 6,747,392
Total Landscape Enhancement Cost	$ 3,951,718
Total Cost Including LC Enh.	$ 10,699,110

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

Sub-area: Wagner Wash, Alternative: B42
Open Channel Structure ID: S18010

Open Channel

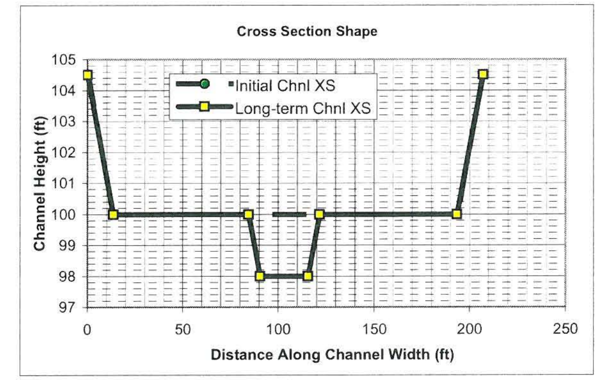
Structure ID	RR18010		HEC1 ID	180R

Longitundal Geometry

Length	2824.7	ft
U/S Elev	1456.3	ft
D/S Elev	1413.1	ft
Initial Channel Slope	0.0153	ft/ft
Long-term Channel Slope	0.0060	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	2



Initial Channel XS Geometry

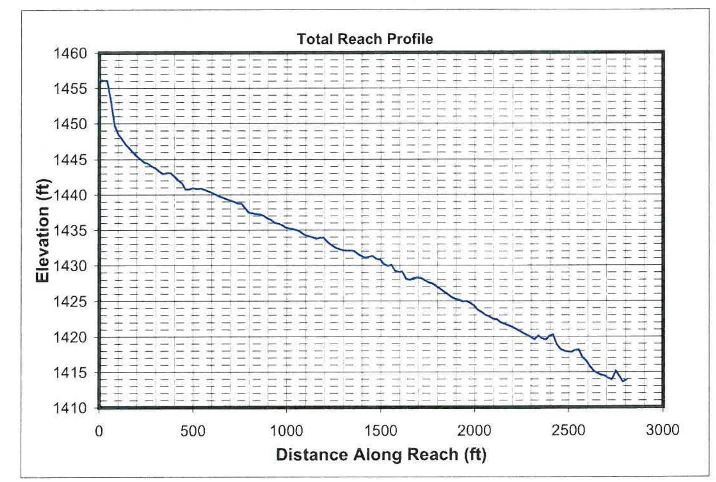
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	180	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	193.5	193.5	193.5	207
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	71	3	25	6.5	3	72	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	84.5	90.5	115.5	121.5	193.5	207
Y	104.5	100	100	98	98	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	S180	S190								TOTAL
HEC1 Peak-Flow	1039	2590								3629
Weighting Factor	1.00	0.03								
Flow into Channel	1039	85								1124

Reach Sediment Inflow Characteristics

U/S Contributing ID	180R_S18010									TOTAL
HEC1 Flow Volume (ac. ft)	90.00									90
Sediment Conc. (ppm)	1879									
Sediment.Volume (ac. ft)	0.06									0.06
Weighting Factor	1									
Weighted Sed. Vol. (ac. ft)	0.06									0.06

Hydrology

Drainage Area	1.573	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	1124	cfs	
Long-term Max. Chnl Capacity	6482	cfs	
Q2 Channel	112	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	207	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
112	182.0	58.5	0.3	100.0	100.3	1.9	0.3	181.9	0.3	0.12	0.60
281	183.5	101.7	0.6	100.0	100.6	2.8	0.6	183.4	0.6	0.21	0.65
843	186.8	198.1	1.1	100.0	101.1	4.3	1.1	186.5	1.1	0.40	0.73
1124	188.1	236.0	1.3	100.0	101.3	4.8	1.3	187.7	1.3	0.48	0.75

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
112	33.6	39.4	1.2	98.0	99.4	2.9	1.4	33.1	1.2	0.51	0.46
281	183.2	134.5	0.7	98.0	100.4	2.1	2.4	182.4	0.7	0.90	0.43
843	187.6	262.6	1.4	98.0	101.1	3.2	3.1	186.6	1.4	1.16	0.48
1124	189.3	313.2	1.7	98.0	101.4	3.6	3.4	188.2	1.7	1.26	0.49

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
	180R_S18010									
112	440									440
281	885									885
843	3597									3597
1124	5262									5262

Allowable Velocity

Channel Lining	Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow) Permissive Velocity (ft/s)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
						Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
112	1.74	1.0458	0.9935	Erosive	Erosive	Erosive	0.2	Stable	5.5	Stable	Stable
281	1.74	1.2137	1.1530	Erosive	Erosive	Erosive	0.3	Stable	6.8	Stable	Stable
843	1.74	1.4140	1.3433	Erosive	Erosive	Erosive	0.3	Stable	8.5	Stable	Stable
1124	1.74	1.4661	1.3928	Erosive	Erosive	Erosive	0.3	Stable	9.2	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	**112**	**281**	**843**	**1124**	**112**	**281**	**843**	**1124**	**112**	**281**	**843**	**1124**
Bray - Equation #1	29	46	83	96	1.3	1.7	2.5	2.8	3.1	3.5	4.1	4.2
Bray - Equation #2	38	61	109	127	1.4	1.9	2.7	3.0	2.1	2.4	2.8	2.9
Hey	8	14	26	31	3.9	5.5	8.3	9.3				
Ackers & Charlton/Lacey	26	38	61	69					1.8	2.1	2.5	2.6
Parker	73	115	199	230	1.0	1.4	2.3	2.6				
Chang	49	86	168	200	0.1	0.0	-0.3	-0.5				
Kellerhals	19	30	52	60	1.8	2.6	4.0	4.5	3.3	3.6	4.0	4.1
AMAFCA/Schumm	33	183	187	188								
Moody & Odem	15	15	15	15	1.0	1.0	1.0	1.0				
BUREC	15.1	21.3	32.1	35.8	4	6	9	10	2.9	3.7	4.8	5.2
Average	30	61	93	105	1.8	2.5	3.6	4.0	2.6	3.0	3.6	3.8
Values As Designed	33	182	187	188	1.4	2.4	3.1	3.4	2.9	2.1	3.2	3.6
Difference with Design	-3	-121	-93	-83	0.5	0.1	0.5	0.7	-0.2	0.9	0.4	0.2

Initial Channel Sediment Transport Capacity

Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
	Sediment Load (tons/day)											
112	893	574	1193	1630	2732	268	246	138	3651	270	955	1141
281	3685	1888	3662	7698	4081	1166	831	729	9655	935	4067	3491
843	19938	6898	11367	49229	6254	5534	2752	3785	29673	4477	19567	14498
1124	30986	9547	14802	79909	6952	8231	3684	5636	39683	6789	28950	21379

Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
	Sediment Concentrations (ppm by weight)											
112	2947	1895	3937	5379	9019	885	812	455	12051	891	3151	3766
281	4865	2493	4835	10164	5388	1539	1097	963	12748	1234	5369	4609
843	8775	3036	5003	21665	2752	2435	1211	1666	13059	1970	8612	6380
1124	10228	3151	4886	26376	2295	2717	1216	1860	13098	2241	9556	7057

Long-term Channel Sediment Transport Capacity

Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
	Sediment Load (tons/day)											
112	609	298	478	1145	655	132	102	140	930	132	716	485
281	1004	535	937	1650	2520	192	185	192	2160	231	1126	976
843	5418	2340	3681	10512	4142	1159	828	1261	7078	1146	6302	3988
1124	8411	3344	5070	17038	4668	1759	1153	1947	9538	1757	9616	5845

Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
	Sediment Concentrations (ppm by weight)											
112	2010	984	1579	3780	2162	435	337	462	3070	437	2362	1602
281	1326	706	1237	2179	3327	254	244	254	2852	305	1486	1288
843	2384	1030	1620	4626	1823	510	364	555	3115	504	2773	1755
1124	2776	1104	1673	5624	1541	581	380	643	3148	580	3174	1929

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
112	0.0025	0.0038	131	0.40	0.047	0.0008	30	0.035	0.0006	0.0159	0.0008	0.0019	0.0072	0.0004	0.0028	0.0152	0.0062
281	0.0013	0.0022	171	0.52	0.049	0.0005	30	0.036	0.0003	0.0159	0.0005	0.0011	0.0072	0.0003	0.0014	0.0153	0.0060
843	0.0006	0.0011	237	0.72	0.052	0.0003	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0072	0.0002	0.0006	0.0153	0.0058
1124	0.0005	0.0010	258	0.79	0.053	0.0002	32	0.036	0.0002	0.0159	0.0002	0.0004	0.0072	0.0002	0.0005	0.0153	0.0058

Drop Structures

Design Slope	0.0060	ft/ft
Total Drop Needed	26.2	ft
Height of Drop Structure	3	ft
No . of Drop Structures	9	
Distance between structs.	314	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.13	sq. mi
Total Sediment Yield Volume	0.25	ac ft

Sedimentation Basins

Length	314 ft	Depth	3 ft
Width	207 ft	Side slope	3 ft/ft
Total Volume per Basin		4.16	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
112	1.1	-0.4	0.1	24.6	1.4	1.2	2.9	0.0060	0.1	1.5	2.0	4.8
281	1.1	-0.8	0.1	24.6	2.4	0.7	2.1	0.0060	0.2	1.5	2.0	4.9
843	1.1	-0.9	0.1	24.6	3.1	1.4	3.2	0.0060	0.3	1.5	2.0	5.1
1124	1.1	-0.9	0.2	24.6	3.4	1.7	3.6	0.0060	0.4	1.5	2.0	5.1

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	775	cfs
Stage at Peak Flow	101.0	ft
Flow Volume	90.0	ac. ft

Freeboard

Max. Flow Depth	1.3	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.2	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	0.32	ac. ft
Outflowing Sediment Volume	0.07	ac. ft
Deposited(+)/Eroded(-) Volume	0.25	ac. ft

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	2825	2825
Side Slope (?H:1V)	3	3
Channel Width (ft)	207	207
Channel XS Area (sq. ft)	932.8	932.8
Channel Perimeter (ft)	209	209

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	2825	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	942	sq. Yd
Volume	2825	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	2825	2825
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	13183	27308
Left Levee Volume (cu. Yd)	12974	30552
Right Levee Length (ft)	2825	2825
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	13183	27308
Right Levee Volume (cu. Yd)	12974	30552
Total Levee Surface Area (sq. Yd)	26366	54616
Total Levee Volume (cu. Yd)	25948	61104

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	2825	2825
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	4394	10358
Left Levee Lining Volume (cu. Yd)	2197	5179
Right Levee Length (ft)	2825	2825
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	4394	10358
Right Levee Lining Volume (cu. Yd)	2197	5179
Total Lining Area (sq. Yd)	8789	20717
Total Lining Volume (cu. Yd)	4394	10358

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	207	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	6.5	ft
Structure Height	9.5	ft
Number of Structures	9	
Volume per structure	219	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 16,425	
Area per structure	69	sq. Yd
Total Area	621	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	6711	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 26,844	
Other Cost	$ -	
Total cost per basin	$ 26,844	
Area per basin	7,219	sq. Yd
Total Area	7,219	sq. Yd

Structure Type	Structure Cost	Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	25,948	cu. Yd	$ 7.00	$ 181,636	26,366	sq. Yd	$ 9.00	$ 237,294	26,366	sq. Yd	$ 11.67	$ 307,603
Levee - LC Enhancement	Fill	35,156	cu. Yd	$ 7.00	$ 246,092	28,250	sq. Yd	$ 9.00	$ 254,250	35,156	sq. Yd	$ 11.67	$ 410,153
Levee Lining	Riprap	4,394	cu. Yd	$ 75.00	$ 329,550	8,789	sq. Yd	$ -	$ -	8,789	sq. Yd	$ 20.83	$ 183,102
Levee Lining -LC Enhancement	Riprap	5,964	cu. Yd	$ 75.00	$ 447,300	11,928	sq. Yd	$ -	$ -	11,928	sq. Yd	$ 20.83	$ 248,495
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	2,825	cu. Yd	$ 75.00	$ 211,875	942	sq. Yd	$ -	$ -	942	sq. Yd	$ 25.00	$ 23,550
Drop Structures	Riprap	9	EA	$ 16,425.00	$ 147,825	621	sq. Yd	$ -	$ -	621	sq. Yd	$ 33.33	$ 20,700
Drop Str. - LC Enhancement	Riprap	9	EA	$ 1,642.50	$ 14,783	62	sq. Yd	$ -	$ -	62	sq. Yd	$ 33.33	$ 2,070
Sedimentation Basins		1	EA	$ 26,844.00	$ 26,844	7,219	sq. Yd	$ -	$ -	7,219	sq. Yd	$ 8.33	$ 60,158
Other					$ -				$ -				$ -

Base Landscape Cost	$ 237,294
LC Enhancement Cost	$ 254,250
Total Landscape Cost	$ 491,544

Base Maintenance Cost	$ 595,114
LC Enhancement Cost	$ 660,719
Total Maintenance Cost	$ 1,255,832

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 897,730	$ 708,175	$ 1,605,905
Contingency Cost (25% of Construction Cost)	$ 224,433	$ 177,044	$ 401,476
Engineering Design Cost (5% of Construction Cost)	$ 44,887	$ 35,409	$ 80,295
Total Construction Cost	$ 1,167,049	$ 920,627	$ 2,087,676

Land Cost

Channel Length	2825 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	207	13.4	$100,000	$ 1,340,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	3.6	$100,000	$ 360,000
Levee LC Enhancement	51	3.3	$100,000	$ 330,000
Other	0	0	$100,000	$ -
Total	313	20.3		$ 2,030,000

Right of Way

Preservation Corridor Width	0 ft
Maintenance Access	0 ft
Landscape Enhancement Buffer	0 ft
Other	0 ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	17	$100,000	$ 1,700,000
LC Enhancement Cost	acre	3.3	$100,000	$ 330,000
Total Land Cost	acre	20.3	$100,000	$ 2,030,000

Total Cost

Base Total Cost	$ 3,699,457
Total Landscape Enhancement Cost	$ 2,165,596
Total Cost Including LC Enh.	$ 5,865,052

Open Channel

Structure ID	C180R10	HEC1 ID	RI180R

Longitundal Geometry

Length	3720.6	ft
U/S Elev	1413.1	ft
D/S Elev	1367.6	ft
Initial Channel Slope	0.0122	ft/ft
Long-term Channel Slope	0.0050	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	3

Initial Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	360	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	373.5	373.5	373.5	387
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	159	3	30	7.5	3	153	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	172.5	181.5	211.5	220.5	373.5	387
Y	104.5	100	100	97	97	100	100	104.5

Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	RI180R	S190								TOTAL
HEC1 Peak-Flow	1730	2590								4320
Weighting Factor	1.00	0.12								
Flow into Channel	1730	323								2053

Reach Sediment Inflow Characteristics

U/S Contributing ID	175R_RR17510	180R_RR18010								TOTAL
HEC1 Flow Volume (ac. ft)	202.00	90.00								292
Sediment Conc. (ppm)	2119	1929								
Sediment Volume (ac. ft)	0.16	0.07								0.23
Weighting Factor	1	1								
Weighted Sed. Vol. (ac. ft)	0.16	0.07								0.23

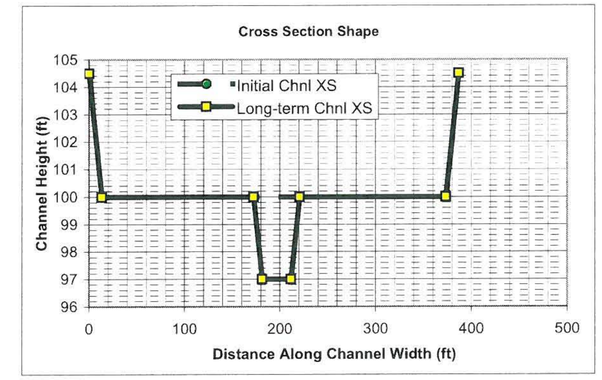
Hydrology

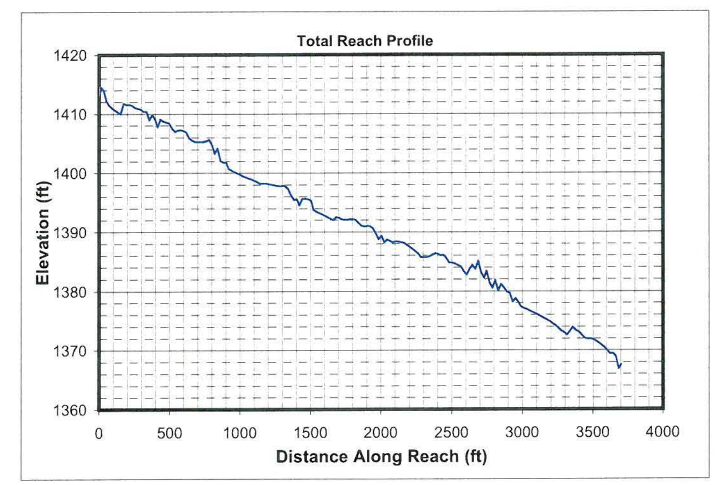
Drainage Area	4.63	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	2053	cfs	
Long-term Max. Chnl Capacity	11669	cfs	
Q2 Channel	205	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	387	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			





Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
205	362.1	118.3	0.3	100.0	100.3	1.7	0.3	362.0	0.3	0.10	0.53
513	363.6	205.2	0.6	100.0	100.6	2.5	0.6	363.4	0.6	0.18	0.59
1540	366.9	398.2	1.1	100.0	101.1	3.9	1.1	366.6	1.1	0.34	0.65
2053	368.2	473.9	1.3	100.0	101.3	4.3	1.3	367.8	1.3	0.41	0.67

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
205	41.6	65.1	1.6	97.0	98.8	3.2	1.8	41.0	1.6	0.57	0.44
513	363.6	268.3	0.7	97.0	100.4	1.9	3.4	362.5	0.7	1.07	0.39
1540	368.0	521.4	1.4	97.0	101.1	3.0	4.1	366.7	1.4	1.28	0.44
2053	369.7	620.7	1.7	97.0	101.4	3.3	4.4	368.3	1.7	1.37	0.45

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
	175R_RR17510	180R_RR18010								
205	612	485								1097
513	1983	976								2959
1540	4612	3988								8600
2053	6726	5845								12571

Allowable Velocity

Channel Lining	Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
205	1.74	1.0506	0.9981	Erosive	Erosive	Erosive	0.2	Stable	6.1	Stable	Stable
513	1.74	1.2192	1.1582	Erosive	Erosive	Erosive	0.3	Stable	7.4	Stable	Stable
1540	1.74	1.4210	1.3499	Erosive	Erosive	Erosive	0.3	Stable	9.0	Stable	Stable
2053	1.74	1.4736	1.3999	Erosive	Erosive	Erosive	0.3	Stable	9.6	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	205	513	1540	2053	205	513	1540	2053	205	513	1540	2053
Bray - Equation #1	39	64	114	132	1.6	2.1	3.1	3.4	3.3	3.8	4.4	4.6
Bray - Equation #2	52	84	150	174	1.7	2.3	3.4	3.7	2.3	2.6	3.0	3.2
Hey	12	20	37	43	4.9	6.9	10.5	11.7				
Ackers & Charlton/Lacey	34	50	79	89					1.9	2.3	2.7	2.9
Parker	98	156	270	311	1.3	1.8	2.9	3.3				
Chang	67	117	228	271	0.1	0.0	-0.5	-0.7				
Kellerhals	26	41	71	82	2.3	3.3	5.1	5.7	3.5	3.8	4.2	4.4
AMAFCA/Schumm	41	363	367	369								
Moody & Odem	22	22	22	22	1.2	1.2	1.2	1.2				
BUREC	19.6	27.6	41.6	46.4	5	7	11	12	3.2	4.0	5.2	5.6
Average	41	94	138	154	2.3	3.1	4.6	5.1	2.8	3.3	3.9	4.1
Values As Designed	41	363	367	368	1.8	3.4	4.1	4.4	3.2	1.9	3.0	3.3
Difference with Design	0	-268	-229	-214	0.4	-0.3	0.5	0.7	-0.3	1.4	1.0	0.8

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
205	1143	740	1401	1941	4599	271	275	152	4557	342	1171	1508
513	4728	2588	5056	9192	7020	1377	1084	927	12407	1187	5324	4626
1540	25718	9834	16664	59124	10889	6825	3822	5185	38576	5759	26877	19025
2053	40056	13709	21497	96187	12116	10196	5163	7817	51661	8772	40179	27941

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
205	2066	1338	2531	3507	8311	490	497	275	8235	617	2116	2726
513	3417	1871	3654	6644	5074	996	784	670	8968	858	3848	3344
1540	6197	2369	4015	14246	2624	1644	921	1249	9295	1388	6476	4584
2053	7239	2477	3885	17382	2190	1843	933	1413	9336	1585	7261	5049

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
205	1066	487	712	2033	873	213	157	258	1303	223	1260	780
513	1364	721	1099	2104	4316	202	215	243	2838	309	1473	1353
1540	7407	3358	5350	13507	7231	1483	1151	1773	9675	1536	8755	5566
2053	11531	4852	7260	21958	8165	2285	1634	2782	13094	2361	13518	8131

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
205	1927	879	1286	3673	1577	385	283	466	2354	402	2277	1410
513	986	521	795	1521	3120	146	156	176	2052	224	1065	978
1540	1785	809	1289	3254	1742	357	277	427	2331	370	2110	1341
2053	2084	877	1312	3968	1475	413	295	503	2366	427	2443	1469

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
205	0.0027	0.0037	118	0.36	0.046	0.0008	29	0.035	0.0006	0.0159	0.0008	0.0019	0.0059	0.0003	0.0028	0.0122	0.0051
513	0.0013	0.0021	155	0.47	0.048	0.0005	30	0.036	0.0003	0.0159	0.0005	0.0011	0.0059	0.0002	0.0014	0.0122	0.0049
1540	0.0006	0.0011	214	0.65	0.051	0.0003	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0059	0.0001	0.0006	0.0122	0.0047
2053	0.0005	0.0009	234	0.71	0.052	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0004	0.0059	0.0001	0.0005	0.0122	0.0047

Drop Structures

Design Slope	0.0050	ft/ft
Total Drop Needed	26.9	ft
Height of Drop Structure	3	ft
No . of Drop Structures	9	
Distance between structs.	413	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.19	sq. mi
Total Sediment Yield Volume	0.35	ac ft

Sedimentation Basins

Length	413 ft	Depth	3 ft
Width	387 ft	Side slope	3 ft/ft
Total Volume per Basin		10.53	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
205	1.1	-0.6	0.1	24.6	1.8	1.6	3.2	0.0050	0.2	1.5	3.0	6.2
513	1.1	-1.2	0.1	24.6	3.4	0.7	1.9	0.0050	0.3	1.5	3.0	6.3
1540	1.1	-1.3	0.1	24.6	4.1	1.4	3.0	0.0050	0.4	1.5	3.0	6.5
2053	1.1	-1.3	0.1	24.6	4.4	1.7	3.3	0.0050	0.5	1.5	3.0	6.6

Toe Protection Needed	7.0	ft

HEC1 Results For Open Channel

Peak Flow	1730	cfs
Stage at Peak Flow	101.2	ft
Flow Volume	285.0	ac. ft

Freeboard

Max. Flow Depth	1.3	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.2	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	0.58	ac. ft
Outflowing Sediment Volume	0.16	ac. ft
Deposited(+)/Eroded(-) Volume	0.42	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	3721	3721
Side Slope (?H:1V)	3	3
Channel Width (ft)	387	387
Channel XS Area (sq. ft)	1797.8	1797.8
Channel Perimeter (ft)	389	389

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	3721	ft
Thickness	1.5	ft
Protection Depth	7	ft
Tie-in Length/Depth	3.0	ft
Total Depth	10.0	ft
Area needed	1240	sq. Yd
Volume	4134	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	3721	3721
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	17365	35970
Left Levee Volume (cu. Yd)	17089	40242
Right Levee Length (ft)	3721	3721
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	17365	35970
Right Levee Volume (cu. Yd)	17089	40242
Total Levee Surface Area (sq. Yd)	34730	71940
Total Levee Volume (cu. Yd)	34178	80484

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	3721	3721
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	5788	13644
Left Levee Lining Volume (cu. Yd)	2894	6822
Right Levee Length (ft)	3721	3721
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	5788	13644
Right Levee Lining Volume (cu. Yd)	2894	6822
Total Lining Area (sq. Yd)	11576	27287
Total Lining Volume (cu. Yd)	5788	13644

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	387	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	6.3	ft
Structure Height	9.3	ft
Number of Structures	9	
Volume per structure	399	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 29,925	
Area per structure	129	sq. Yd
Total Area	1,161	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	16988	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 67,952	
Other Cost	$ -	
Total cost per basin	$ 67,952	
Area per basin	17,776	sq. Yd
Total Area	17,776	sq. Yd

Structure Cost

Structure Type	Structure Type	Excavation/Construction Quantity	Units	Unit Cost	Cost Subtotal	Landscape Quantity	Units	Unit Cost	Landscape Cost	Maintenance Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	34,178	cu. Yd	$ 7.00	$ 239,246	34,730	sq. Yd	$ 9.00	$ 312,570	34,730	sq. Yd	$ 11.67	$ 405,183
Levee - LC Enhancement	Fill	46,306	cu. Yd	$ 7.00	$ 324,142	37,210	sq. Yd	$ 9.00	$ 334,890	46,306	sq. Yd	$ 11.67	$ 540,237
Levee Lining	Riprap	5,788	cu. Yd	$ 75.00	$ 434,100	11,576	sq. Yd	$ -	$ -	11,576	sq. Yd	$ 20.83	$ 241,176
Levee Lining -LC Enhancement	Riprap	7,856	cu. Yd	$ 75.00	$ 589,200	15,711	sq. Yd	$ -	$ -	15,711	sq. Yd	$ 20.83	$ 327,310
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	4,134	cu. Yd	$ 75.00	$ 310,050	1,240	sq. Yd	$ -	$ -	1,240	sq. Yd	$ 25.00	$ 31,000
Drop Structures	Riprap	9	EA	$ 29,925.00	$ 269,325	1,161	sq. Yd	$ -	$ -	1,161	sq. Yd	$ 33.33	$ 38,700
Drop Str. - LC Enhancement	Riprap	9	EA	$ 2,992.50	$ 26,933	116	sq. Yd	$ -	$ -	116	sq. Yd	$ 33.33	$ 3,870
Sedimentation Basins		1	EA	$ 67,952.00	$ 67,952	17,776	sq. Yd	$ -	$ -	17,776	sq. Yd	$ 8.33	$ 148,133
Other					$ -				$ -				$ -

Base Landscape Cost	$ 312,570	
LC Enhancement Cost	$ 334,890	
Total Landscape Cost	$ 647,460	
Base Maintenance Cost	$ 864,193	
LC Enhancement Cost	$ 871,417	
Total Maintenance Cost	$ 1,735,609	

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,320,673	$ 940,275	$ 2,260,948
Contingency Cost (25% of Construction Cost)	$ 330,168	$ 235,069	$ 565,237
Engineering Design Cost (5% of Construction Cost)	$ 66,034	$ 47,014	$ 113,047
Total Construction Cost	$ 1,716,875	$ 1,222,357	$ 2,939,232

Land Cost

Channel Length	3721 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	387	33.1	$100,000	$ 3,310,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	4.7	$100,000	$ 470,000
Levee LC Enhancement	51	4.4	$100,000	$ 440,000
Other	0	0	$100,000	$ -
Total	493	42.2		$ 4,220,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	37.8	$100,000	$ 3,780,000
LC Enhancement Cost	acre	4.4	$100,000	$ 440,000
Total Land Cost	acre	42.2	$100,000	$ 4,220,000

Total Cost

Base Total Cost	$ 6,673,637
Total Landscape Enhancement Cost	$ 2,868,664
Total Cost Including LC Enh.	$ 9,542,301

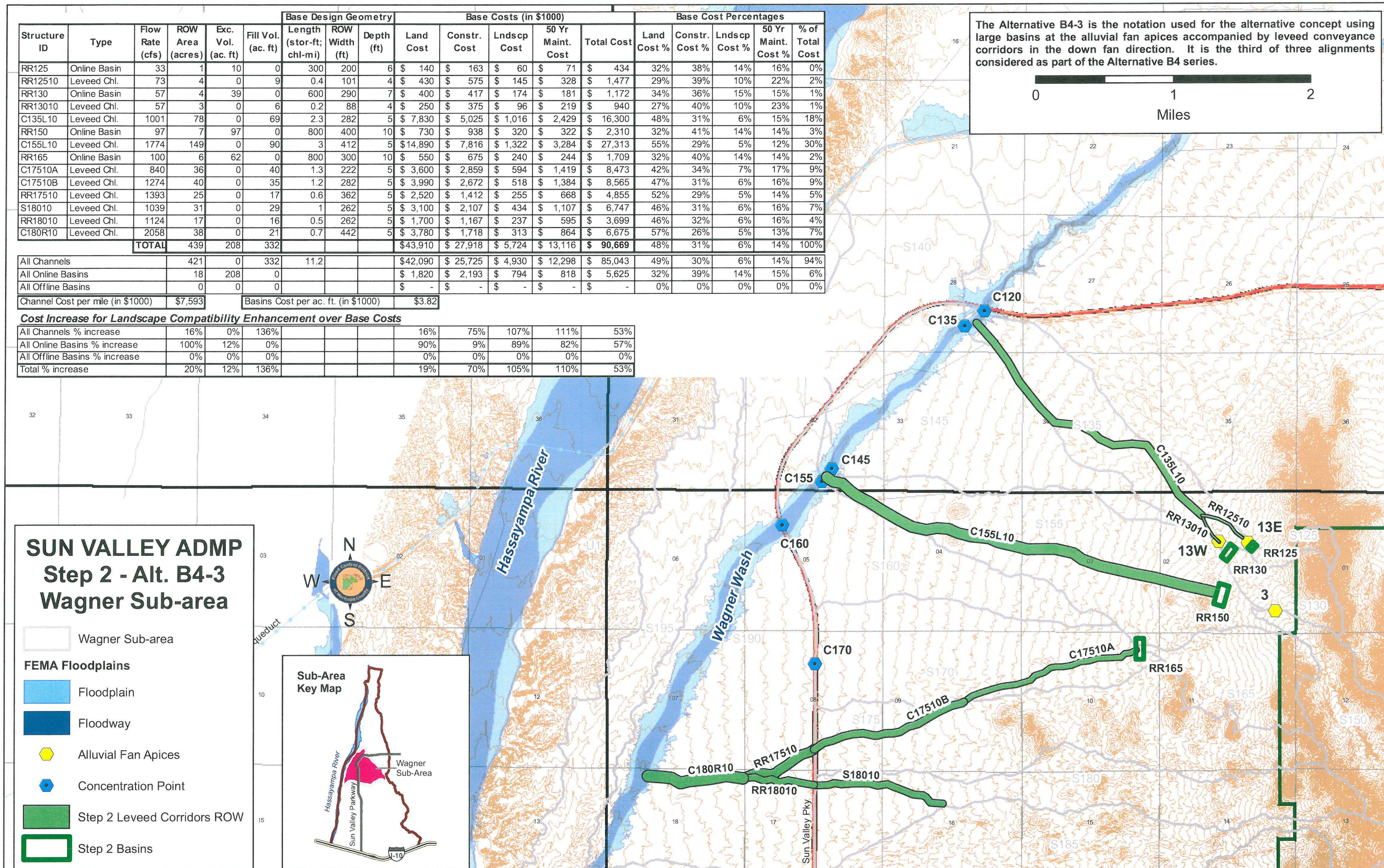
Structure ID	Type	Flow Rate (cfs)	ROW Area (acres)	Exc. Vol. (ac. ft)	Fill Vol. (ac. ft)	Base Design Geometry: Length (stor-ft; chl-mi)	Base Design Geometry: ROW Width (ft)	Base Design Geometry: Depth (ft)	Base Costs (in $1000): Land Cost	Base Costs (in $1000): Constr. Cost	Base Costs (in $1000): Lndscp Cost	Base Costs (in $1000): 50 Yr Maint. Cost	Base Costs (in $1000): Total Cost	Base Cost Percentages: Land Cost %	Base Cost Percentages: Constr. Cost %	Base Cost Percentages: Lndscp Cost %	Base Cost Percentages: 50 Yr Maint. Cost %	Base Cost Percentages: % of Total Cost
RR125	Online Basin	33	1	10	0	300	200	6	$ 140	$ 163	$ 60	$ 71	$ 434	32%	38%	14%	16%	0%
RR12510	Leveed Chl.	73	4	0	9	0.4	101	4	$ 430	$ 575	$ 145	$ 328	$ 1,477	29%	39%	10%	22%	2%
RR130	Online Basin	57	4	39	0	600	290	7	$ 400	$ 417	$ 174	$ 181	$ 1,172	34%	36%	15%	15%	1%
RR13010	Leveed Chl.	57	3	0	6	0.2	88	4	$ 250	$ 375	$ 96	$ 219	$ 940	27%	40%	10%	23%	1%
C135L10	Leveed Chl.	1001	78	0	69	2.3	282	5	$ 7,830	$ 5,025	$ 1,016	$ 2,429	$ 16,300	48%	31%	6%	15%	18%
RR150	Online Basin	97	7	97	0	800	400	10	$ 730	$ 938	$ 320	$ 322	$ 2,310	32%	41%	14%	14%	3%
C155L10	Leveed Chl.	1774	149	0	90	3	412	5	$14,890	$ 7,816	$ 1,322	$ 3,284	$ 27,313	55%	29%	5%	12%	30%
RR165	Online Basin	100	6	62	0	800	300	10	$ 550	$ 675	$ 240	$ 244	$ 1,709	32%	40%	14%	14%	2%
C17510A	Leveed Chl.	840	36	0	40	1.3	222	5	$ 3,600	$ 2,859	$ 594	$ 1,419	$ 8,473	42%	34%	7%	17%	9%
C17510B	Leveed Chl.	1274	40	0	35	1.2	282	5	$ 3,990	$ 2,672	$ 518	$ 1,384	$ 8,565	47%	31%	6%	16%	9%
RR17510	Leveed Chl.	1393	25	0	17	0.6	362	5	$ 2,520	$ 1,412	$ 255	$ 668	$ 4,855	52%	29%	5%	14%	5%
S18010	Leveed Chl.	1039	31	0	29	1	262	5	$ 3,100	$ 2,107	$ 434	$ 1,107	$ 6,747	46%	31%	6%	16%	7%
RR18010	Leveed Chl.	1124	17	0	16	0.5	262	5	$ 1,700	$ 1,167	$ 237	$ 595	$ 3,699	46%	32%	6%	16%	4%
C180R10	Leveed Chl.	2058	38	0	21	0.7	442	5	$ 3,780	$ 1,718	$ 313	$ 864	$ 6,675	57%	26%	5%	13%	7%
		TOTAL	439	208	332				$43,910	$ 27,918	$ 5,724	$ 13,116	**$ 90,669**	48%	31%	6%	14%	100%
All Channels			421	0	332	11.2			$42,090	$ 25,725	$ 4,930	$ 12,298	$ 85,043	49%	30%	6%	14%	94%
All Online Basins			18	208	0				$ 1,820	$ 2,193	$ 794	$ 818	$ 5,625	32%	39%	14%	15%	6%
All Offline Basins			0	0	0				$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%

Channel Cost per mile (in $1000)	$7,593	Basins Cost per ac. ft. (in $1000)	$3.82

Cost Increase for Landscape Compatibility Enhancement over Base Costs

	ROW Area	Exc. Vol.	Fill Vol.	Length	ROW Width	Depth	Land Cost	Constr. Cost	Lndscp Cost	50 Yr Maint. Cost	Total Cost
All Channels % increase	16%	0%	136%				16%	75%	107%	111%	53%
All Online Basins % increase	100%	12%	0%				90%	9%	89%	82%	57%
All Offline Basins % increase	0%	0%	0%				0%	0%	0%	0%	0%
Total % increase	20%	12%	136%				19%	70%	105%	110%	53%

The Alternative B4-3 is the notation used for the alternative concept using large basins at the alluvial fan apices accompanied by leveed conveyance corridors in the down fan direction. It is the third of three alignments considered as part of the Alternative B4 series.



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Costs Summary

						Base Design Geometry			Base Costs (in $1000)					Base Cost Percentages				
Structure ID	Type	Flow Rate (cfs)	ROW Area (acres)	Exc. Vol. (ac. ft)	Fill Vol. (ac. ft)	Length (stor-ft; chl-mi)	ROW Width (ft)	Depth (ft)	Land Cost	Constr. Cost	Lndscp Cost	50 Yr Maint. Cost	Total Cost	Land Cost %	Constr. Cost %	Lndscp Cost %	50 Yr Maint. Cost %	% of Total Cost
RR125	Online Basin	33	1	10	0	300	200	6	$ 140	$ 163	$ 60	$ 71	$ 434	32%	38%	14%	16%	0%
RR12510	Leveed Chl.	73	4	0	9	0.4	101	4	$ 430	$ 575	$ 145	$ 328	$ 1,477	29%	39%	10%	22%	2%
RR130	Online Basin	57	4	39	0	600	290	7	$ 400	$ 417	$ 174	$ 181	$ 1,172	34%	36%	15%	15%	1%
RR13010	Leveed Chl.	57	3	0	6	0.2	88	4	$ 250	$ 375	$ 96	$ 219	$ 940	27%	40%	10%	23%	1%
C135L10	Leveed Chl.	1001	78	0	69	2.3	282	5	$ 7,830	$ 5,025	$ 1,016	$ 2,429	$ 16,300	48%	31%	6%	15%	18%
RR150	Online Basin	97	7	97	0	800	400	10	$ 730	$ 938	$ 320	$ 322	$ 2,310	32%	41%	14%	14%	3%
C155L10	Leveed Chl.	1774	149	0	90	3	412	5	$ 14,890	$ 7,816	$ 1,322	$ 3,284	$ 27,313	55%	29%	5%	12%	30%
RR165	Online Basin	100	6	62	0	800	300	10	$ 550	$ 675	$ 240	$ 244	$ 1,709	32%	40%	14%	14%	2%
C17510A	Leveed Chl.	840	36	0	40	1.3	222	5	$ 3,600	$ 2,859	$ 594	$ 1,419	$ 8,473	42%	34%	7%	17%	9%
C17510B	Leveed Chl.	1274	40	0	35	1.2	282	5	$ 3,990	$ 2,672	$ 518	$ 1,384	$ 8,565	47%	31%	6%	16%	9%
RR17510	Leveed Chl.	1393	25	0	17	0.6	362	5	$ 2,520	$ 1,412	$ 255	$ 668	$ 4,855	52%	29%	5%	14%	5%
S18010	Leveed Chl.	1039	31	0	29	1	262	5	$ 3,100	$ 2,107	$ 434	$ 1,107	$ 6,747	46%	31%	6%	16%	7%
RR18010	Leveed Chl.	1124	17	0	16	0.5	262	5	$ 1,700	$ 1,167	$ 237	$ 595	$ 3,699	46%	32%	6%	16%	4%
C180R10	Leveed Chl.	2058	38	0	21	0.7	442	5	$ 3,780	$ 1,718	$ 313	$ 864	$ 6,675	57%	26%	5%	13%	7%
		TOTAL	439	208	332				$ 43,910	$ 27,918	$ 5,724	$ 13,116	**$ 90,669**	48%	31%	6%	14%	100%
All Channels			421	0	332	11.2			$ 42,090	$ 25,725	$ 4,930	$ 12,298	$ 85,043	49%	30%	6%	14%	94%
All Online Basins			18	208	0				$ 1,820	$ 2,193	$ 794	$ 818	$ 5,625	32%	39%	14%	15%	6%
All Offline Basins			0	0	0				$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
Channel Cost per mile (in $1000)			$7,593		Basins Cost per ac. ft. (in $1000)				$3.82									

Cost Summary - Landscape Compatibility Enhanced (LCE)

						LCE Design Geometry			LCE Costs (in $1000)					LCE Cost Percentages				
Structure ID	Type	Flow Rate (cfs)	ROW Area (acres)	Exc. Vol. (ac. ft)	Fill Vol. (ac. ft)	Length (stor-ft; chl-mi)	ROW Width (ft)	Depth (ft)	Land Cost	Constr. Cost	Lndscp Cost	50 Yr Maint. Cost	Total Cost	Land Cost %	Constr. Cost %	Lndscp Cost %	50 Yr Maint. Cost %	% of Total Cost
RR125	Online Basin	33	4	11	0	500	300	6	$ 350	$ 175	$ 150	$ 157	$ 832	42%	21%	18%	19%	1%
RR12510	Leveed Chl.	73	6	0	21	0.4	149	4	$ 630	$ 1,102	$ 300	$ 708	$ 2,741	23%	40%	11%	26%	2%
RR130	Online Basin	57	8	44	0	870	390	7	$ 780	$ 460	$ 339	$ 338	$ 1,917	41%	24%	18%	18%	1%
RR13010	Leveed Chl.	57	4	0	14	0.2	136	4	$ 390	$ 726	$ 200	$ 472	$ 1,788	22%	41%	11%	26%	1%
C135L10	Leveed Chl.	1001	93	0	162	2.3	333	5	$ 9,250	$ 8,978	$ 2,105	$ 5,260	$ 25,593	36%	35%	8%	21%	18%
RR150	Online Basin	97	13	108	0	1110	500	10	$ 1,270	$ 1,032	$ 555	$ 545	$ 3,401	37%	30%	16%	16%	2%
C155L10	Leveed Chl.	1774	167	0	211	3	463	5	$ 16,730	$ 13,070	$ 2,738	$ 6,980	$ 39,518	42%	33%	7%	18%	28%
RR165	Online Basin	100	11	69	0	1140	400	10	$ 1,050	$ 729	$ 456	$ 448	$ 2,683	39%	27%	17%	17%	2%
C17510A	Leveed Chl.	840	44	0	95	1.3	273	5	$ 4,430	$ 5,163	$ 1,231	$ 3,074	$ 13,898	32%	37%	9%	22%	10%
C17510B	Leveed Chl.	1274	47	0	83	1.2	333	5	$ 4,710	$ 4,683	$ 1,073	$ 2,827	$ 13,294	35%	35%	8%	21%	10%
RR17510	Leveed Chl.	1393	29	0	41	0.6	413	5	$ 2,880	$ 2,412	$ 528	$ 1,380	$ 7,200	40%	34%	7%	19%	5%
S18010	Leveed Chl.	1039	37	0	69	1	313	5	$ 3,700	$ 3,786	$ 899	$ 2,314	$ 10,699	35%	35%	8%	22%	8%
RR18010	Leveed Chl.	1124	20	0	38	0.5	313	5	$ 2,030	$ 2,088	$ 492	$ 1,256	$ 5,865	35%	36%	8%	21%	4%
C180R10	Leveed Chl.	2058	42	0	50	0.7	493	5	$ 4,220	$ 2,940	$ 647	$ 1,736	$ 9,543	44%	31%	7%	18%	7%
		TOTAL	525	232	784				$ 52,420	$ 47,342	$ 11,714	$ 27,494	**$ 138,971**	38%	34%	8%	20%	100%
All Channels			489	0	784	11.2			$ 48,970	$ 44,947	$ 10,214	$ 26,007	$ 130,138	38%	35%	8%	20%	94%
All Online Basins			36	232	0				$ 3,450	$ 2,395	$ 1,500	$ 1,487	$ 8,833	39%	27%	17%	17%	6%
All Offline Basins			0	0	0				$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
Channel Cost per mile (in $1000)			$11,619		Basins Cost per ac. ft. (in $1000)				$6.47									
All Channels % increase			16%	0%	136%				16%	75%	107%	111%	53%					
All Online Basins % increase			100%	12%	0%				90%	9%	89%	82%	57%					
All Offline Basins % increase			0%	0%	0%				0%	0%	0%	0%	0%					
Total % increase			20%	12%	136%				19%	70%	105%	110%	53%					

JE FULLER
HYDROLOGY & GEOMORPHOLOGY, INC.

Sub-area: Wagner Wash, Alternative: B43
Cost Summary

KK CARD	Type	Peak Flow	Peak Stage (ft)	Peak Storage	Time	Cum.Area (sq. miles)	MAX. Average Flow (cfs)				MAX. Average Rainfall Depth (Inches)				Total Runoff Volume (ac. ft)			
							6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR
S100	BASIN	4347			4.6	6.99	899	225	75	32	1.195	1.195	1.195	1.195	446	446	446	446
S102	BASIN	2790			4.3	3.23	417	104	35	15	1.198	1.198	1.198	1.198	207	207	207	207
C102	COMBINE	5993			4.5	10.23	1198	300	100	43	1.089	1.089	1.089	1.089	594	594	594	594
RR102	STORAGE	127	1552	1143.35	6.7	10.23	122	104	72	41	0.11	0.376	0.784	1.029	60	205	428	561
D102	DIVERT	63			6.7	10.23	61	52	36	20	0.055	0.188	0.392	0.515	30	103	214	281
100105	ROUTE	59	100.2	20.4	12.5	10.23	58	51	36	20	0.053	0.185	0.389	0.512	29	101	212	279
S105	BASIN	2863			4.5	4.37	495	124	41	18	1.053	1.053	1.053	1.053	245	245	245	245
CF02	RETRIEVE	63			6.7	10.23	61	52	36	20	0.055	0.188	0.392	0.515	30	103	214	281
102105	ROUTE	63	100.4	8.6	8	10.23	60	51	36	20	0.055	0.187	0.39	0.513	30	102	213	280
C105U	COMBINE	2863			4.5	14.6	549	226	120	64	0.35	0.577	0.921	1.128	272	449	717	878
S110	BASIN	662			4.2	0.43	76	19	6	3	1.639	1.64	1.64	1.64	38	38	38	38
11015I	ROUTE	570	101.8	9.19	4.4	0.43	76	19	6	3	1.637	1.64	1.64	1.64	38	38	38	38
15I15R	ROUTE	506	102.1	19.34	4.8	0.43	76	19	6	3	1.635	1.64	1.64	1.64	38	38	38	38
S115	BASIN	1605			4.5	2.25	296	74	25	11	1.223	1.224	1.224	1.224	147	147	147	147
C115	COMBINE	1813			4.6	2.68	350	88	29	13	1.215	1.219	1.219	1.219	173	174	174	174
115120	ROUTE	1781	102.7	21.9	4.7	2.68	350	88	29	13	1.215	1.219	1.219	1.219	173	174	174	174
S120	BASIN	1838			4.3	2	256	64	21	9	1.189	1.189	1.189	1.189	127	127	127	127
C120	COMBINE	2678			4.5	4.68	545	137	46	20	1.083	1.087	1.087	1.087	270	271	271	271
C105D	COMBINE	4029			4.5	19.28	821	275	127	64	0.396	0.53	0.737	0.863	407	545	758	888
120135	ROUTE	4027	104.4	16.85	4.5	19.28	821	275	127	64	0.396	0.53	0.737	0.863	407	545	758	888
S125	BASIN	202			4	0.09	14	4	1	1	1.424	1.425	1.425	1.425	7	7	7	7
RR125	STORAGE	33	4.8	4.92	4.4	0.09	14	4	1	1	1.409	1.425	1.425	1.425	7	7	7	7
12535I	ROUTE	33	100.4	0.47	4.6	0.09	14	4	1	1	1.408	1.425	1.425	1.425	7	7	7	7
S130	BASIN	524			4.1	0.31	48	12	4	2	1.425	1.426	1.426	1.426	24	24	24	24
RR130	STORAGE	57	5.8	18.5	4.8	0.31	42	12	4	2	1.248	1.426	1.426	1.426	21	24	24	24
13035I	ROUTE	57	100.9	0.36	4.8	0.31	42	12	4	2	1.246	1.426	1.426	1.426	21	24	24	24
C135I	COMBINE	83			4.7	1.18	50	14	5	2	0.391	0.428	0.428	0.428	25	27	27	27
35I135	ROUTE	69	100.2	11.77	7.3	1.18	47	14	5	2	0.373	0.428	0.428	0.428	23	27	27	27
S135	BASIN	1102			4.2	0.88	111	28	9	4	1.175	1.175	1.175	1.175	55	55	55	55
C135L	COMBINE	829			4.2	2.06	132	36	12	5	0.594	0.654	0.654	0.654	65	72	72	72
C135	COMBINE	4170			4.5	21.34	876	288	131	66	0.382	0.502	0.684	0.796	434	571	779	906
135145	ROUTE	3746	103.8	146.87	5	21.34	864	286	131	66	0.376	0.498	0.683	0.795	428	567	777	905
S140	BASIN	1913			4.1	1.37	188	47	16	7	1.27	1.27	1.27	1.27	93	93	93	93
140145	ROUTE	1624	101.9	39.38	4.4	1.37	187	47	16	7	1.27	1.27	1.27	1.27	93	93	93	93
S145	BASIN	1702			4.2	1.76	193	48	16	7	1.021	1.021	1.021	1.021	96	96	96	96
C145	COMBINE	4072			4.9	24.47	1030	325	143	71	0.391	0.494	0.651	0.747	511	645	850	974
145155	ROUTE	4071	105.7	11.21	4.9	24.47	1029	325	143	71	0.391	0.494	0.651	0.746	510	645	850	974
S150	BASIN	836			4.3	0.77	126	31	10	5	1.51	1.513	1.513	1.513	62	62	62	62
RR150	STORAGE	97	8.2	48.3	5.5	0.77	83	31	10	5	0.997	1.513	1.513	1.513	41	62	62	62
150155	ROUTE	83	100.1	17	9.1	0.77	75	31	10	5	0.899	1.512	1.513	1.513	37	62	62	62
S155	BASIN	1626			4.3	1.83	223	56	19	8	1.131	1.132	1.132	1.132	111	111	111	111
C155L	COMBINE	1457			4.3	2.61	252	79	26	11	0.898	1.133	1.134	1.134	125	157	158	158
C155	COMBINE	4265			4.8	27.07	1152	363	155	76	0.396	0.499	0.637	0.722	571	720	920	1042
155160	ROUTE	4256	104.5	32.27	4.9	27.07	1150	363	155	76	0.395	0.498	0.637	0.722	570	720	920	1042
S160	BASIN	1347			4.2	1.14	133	33	11	5	1.079	1.079	1.079	1.079	66	66	66	66
C160	COMBINE	4292			4.9	27.44	1199	375	159	77	0.406	0.509	0.645	0.729	594	744	944	1066

Hydrology - 6-hr Storm HEC1 Model Results

KK CARD	Type	Peak Flow	Peak Stage (ft)	Peak Storage	Time	Cum.Area (sq. miles)	MAX. Average Flow (cfs)				MAX. Average Rainfall Depth (Inches)				Total Runoff Volume (ac. ft)			
							6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR
S170	BASIN	1686			4.2	1.46	178	44	15	6	1.127	1.127	1.127	1.127	88	88	88	88
170R	ROUTE	1489	1E+08	1E+08	4.4	1.46	178	44	15	6	1.127	1.127	1.127	1.127	88	88	88	88
C170R	COMBINE	4319			5	28.9	1253	390	163	79	0.403	0.501	0.63	0.709	622	773	972	1093
170180	ROUTE	4229	102.8	113.9	5.3	28.9	1241	388	163	79	0.399	0.5	0.63	0.709	615	770	971	1092
S165	BASIN	1008			4.1	0.62	94	23	8	3	1.416	1.417	1.417	1.417	47	47	47	47
RR165	STORAGE	100	8.7	37.57	4.8	0.62	77	23	8	3	1.162	1.417	1.417	1.417	38	47	47	47
165175	ROUTE	90	100.3	15.66	6.9	0.62	72	23	8	3	1.088	1.417	1.417	1.417	36	47	47	47
S175	BASIN	1203			4.5	1.8	226	56	19	8	1.165	1.166	1.166	1.166	112	112	112	112
C175	COMBINE	1104			4.5	2.42	260	73	24	11	0.999	1.122	1.122	1.122	129	145	145	145
175R	ROUTE	1065	100.9	18.37	4.6	2.42	257	73	24	11	0.988	1.122	1.122	1.122	127	145	145	145
S180	BASIN	1032			4.5	1.44	181	45	15	7	1.167	1.169	1.169	1.169	90	90	90	90
180R	ROUTE	775	101	34.58	4.8	1.44	180	45	15	7	1.16	1.169	1.169	1.169	89	90	90	90
C180RI	COMBINE	1507			4.7	3.86	389	106	35	15	0.938	1.017	1.017	1.017	193	209	209	209
RI180R	ROUTE	1456	101.1	32.69	4.9	3.86	385	106	35	15	0.927	1.017	1.017	1.017	191	209	209	209
C180R	COMBINE	4731			5.2	32.76	1417	434	177	85	0.402	0.493	0.604	0.671	703	861	1055	1173
180185	ROUTE	4720	103	52.65	5.4	32.76	1410	433	177	85	0.4	0.492	0.603	0.671	699	859	1054	1173
S185	BASIN	1450			4.5	2.42	288	72	24	10	1.106	1.107	1.107	1.107	143	143	143	143
185R	ROUTE	1302	102.5	41.84	4.9	2.42	288	72	24	10	1.105	1.107	1.107	1.107	143	143	143	143
C185R	COMBINE	5055			5.2	35.19	1515	459	185	89	0.4	0.486	0.588	0.65	751	911	1103	1220
185190	ROUTE	5038	102.6	42.76	5.3	35.19	1511	459	185	89	0.399	0.485	0.588	0.65	749	910	1103	1220
S190	BASIN	2084			4.5	4.05	391	98	33	14	0.896	0.896	0.896	0.896	194	194	194	194
C190	COMBINE	5200			5.2	39.24	1622	488	194	92	0.384	0.463	0.553	0.608	804	968	1157	1272
190195	ROUTE	5096	103.1	78.2	5.5	39.24	1615	487	194	92	0.383	0.462	0.553	0.608	801	967	1157	1272
S195	BASIN	1001			4.6	1.81	203	51	17	7	1.046	1.046	1.046	1.046	101	101	101	101
C195	COMBINE	5147			5.5	41.05	1664	500	198	94	0.377	0.453	0.538	0.591	825	991	1179	1293

Hydrology - 24-hr Storm HEC1 Model Results

KK CARD	Type	Peak Flow	Peak Stage (ft)	Peak Storage	Time	Cum.Area (sq. miles)	MAX. Average Flow (cfs)				MAX. Average Rainfall Depth (Inches)				Total Runoff Volume (ac. ft)			
							6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR
S100	BASIN	5214			12.5	6.99	965	241	80	35	1.282	1.282	1.282	1.282	478	478	478	478
S102	BASIN	3434			12.3	3.23	420	105	35	15	1.207	1.207	1.207	1.207	208	208	208	208
C102	COMBINE	7803			12.4	10.23	1367	342	114	49	1.243	1.243	1.243	1.243	678	678	678	678
RR102	STORAGE	149	1552.1	1201.44	14.4	10.23	141	119	82	46	0.128	0.431	0.895	1.163	70	235	488	634
D102	DIVERT	75			14.4	10.23	71	59	41	23	0.064	0.215	0.448	0.581	35	118	244	317
100105	ROUTE	70	100.2	24.2	20.3	10.23	67	58	41	23	0.061	0.211	0.444	0.578	33	115	242	315
S105	BASIN	3466			12.5	4.37	531	133	44	19	1.129	1.129	1.129	1.129	263	263	263	263
CF02	RETRIEVE	75			14.4	10.23	71	59	41	23	0.064	0.215	0.448	0.581	35	118	244	317
102105	ROUTE	74	100.4	9.55	15.6	10.23	70	59	41	23	0.064	0.214	0.445	0.58	35	117	243	316
C105U	COMBINE	3466			12.5	14.6	587	238	125	66	0.374	0.606	0.958	1.164	291	472	746	906
S110	BASIN	532			12.1	0.43	62	16	5	2	1.35	1.422	1.422	1.422	31	33	33	33
11015I	ROUTE	456	101.7	7.4	12.4	0.43	62	16	5	2	1.35	1.421	1.422	1.422	31	33	33	33
15I15R	ROUTE	412	101.9	16.62	12.7	0.43	62	16	5	2	1.349	1.421	1.422	1.422	31	33	33	33
S115	BASIN	1693			12.5	2.25	287	73	24	11	1.186	1.209	1.209	1.209	142	145	145	145
C115	COMBINE	1937			12.6	2.68	346	89	30	13	1.201	1.232	1.233	1.233	171	176	176	176
115120	ROUTE	1900	102.8	22.91	12.7	2.68	346	89	30	13	1.201	1.232	1.233	1.233	171	176	176	176
S120	BASIN	2032			12.3	2	247	62	21	9	1.146	1.158	1.158	1.158	122	124	124	124
C120	COMBINE	3202			12.4	4.68	585	149	50	22	1.162	1.185	1.186	1.186	290	296	296	296
C105D	COMBINE	6217			12.4	19.28	1091	359	163	82	0.526	0.692	0.943	1.092	541	712	969	1123
120135	ROUTE	6220	105.1	23.77	12.5	19.28	1091	359	163	82	0.526	0.692	0.943	1.092	541	711	969	1123
S125	BASIN	161			12	0.09	12	3	1	0	1.197	1.258	1.258	1.258	6	6	6	6
RR125	STORAGE	30	4	4.1	12.4	0.09	12	3	1	0	1.192	1.257	1.258	1.258	6	6	6	6
12535I	ROUTE	30	100.4	0.44	12.5	0.09	12	3	1	0	1.191	1.257	1.258	1.258	6	6	6	6
S130	BASIN	415			12.1	0.31	39	10	3	1	1.169	1.217	1.217	1.217	19	20	20	20
RR130	STORAGE	51	4.7	14.6	12.7	0.31	36	10	3	1	1.074	1.216	1.217	1.217	18	20	20	20
13035I	ROUTE	51	100.8	0.34	12.8	0.31	36	10	3	1	1.073	1.216	1.217	1.217	18	20	20	20
C135I	COMBINE	79			12.7	1.18	46	13	4	2	0.365	0.407	0.407	0.407	23	26	26	26
35I135	ROUTE	66	100.2	11.26	15.3	1.18	44	13	4	2	0.348	0.407	0.407	0.407	22	26	26	26
S135	BASIN	1015			12.2	0.88	99	25	8	4	1.048	1.048	1.048	1.048	49	49	49	49
C135L	COMBINE	1001			12.2	2.06	134	37	12	5	0.603	0.671	0.671	0.671	66	74	74	74
C135	COMBINE	6649			12.4	21.34	1204	389	173	86	0.525	0.678	0.903	1.037	597	772	1027	1180
135145	ROUTE	5881	104.6	212.02	12.8	21.34	1190	386	172	86	0.518	0.673	0.901	1.036	590	766	1025	1179
S140	BASIN	2029			12.1	1.37	172	43	14	6	1.164	1.164	1.164	1.164	85	85	85	85
140145	ROUTE	1633	101.9	39.54	12.4	1.37	172	43	14	6	1.163	1.164	1.164	1.164	85	85	85	85
S145	BASIN	1945			12.2	1.76	193	48	16	7	1.022	1.022	1.022	1.022	96	96	96	96
C145	COMBINE	6531			12.7	24.47	1492	461	197	96	0.567	0.701	0.899	1.017	740	915	1173	1327
145155	ROUTE	6537	106.9	17.8	12.8	24.47	1492	461	197	96	0.567	0.701	0.899	1.017	740	915	1173	1327
S150	BASIN	729			12.3	0.77	107	29	10	4	1.291	1.374	1.375	1.375	53	57	57	57
RR150	STORAGE	89	6.9	39.9	13.5	0.77	76	28	10	4	0.907	1.365	1.375	1.375	37	56	57	57
150155	ROUTE	76	100.1	15.57	17	0.77	68	28	10	4	0.816	1.362	1.375	1.375	34	56	57	57
S155	BASIN	1781			12.3	1.83	218	55	18	8	1.105	1.117	1.117	1.117	108	109	109	109
C155L	COMBINE	1774			12.3	2.61	259	82	28	12	0.926	1.174	1.18	1.18	129	163	164	164
C155	COMBINE	7006			12.7	27.07	1713	530	220	106	0.588	0.728	0.906	1.013	849	1052	1309	1463
155160	ROUTE	6982	105.5	51.18	12.8	27.07	1711	530	220	106	0.587	0.728	0.906	1.013	848	1051	1308	1463
S160	BASIN	1342			12.1	1.14	124	31	10	4	1.01	1.01	1.01	1.01	62	62	62	62
C160	COMBINE	7083			12.8	27.44	1812	556	229	110	0.614	0.753	0.929	1.035	899	1102	1360	1514
160170	ROUTE	6946	103.4	130.87	13	27.44	1800	554	228	110	0.61	0.751	0.929	1.034	893	1099	1359	1514

Hydrology - 24-hr Storm HEC1 Model Results

KK CARD	Type	Peak Flow	Peak Stage (ft)	Peak Storage	Time	Cum.Area (sq. miles)	MAX. Average Flow (cfs)				MAX. Average Rainfall Depth (Inches)				Total Runoff Volume (ac. ft)			
							6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR
S170	BASIN	1802			12.1	1.46	169	42	14	6	1.075	1.075	1.075	1.075	84	84	84	84
170R	ROUTE	1558	1E+08	1E+08	12.4	1.46	169	42	14	6	1.075	1.075	1.075	1.075	84	84	84	84
C170R	COMBINE	7203			13	28.9	1937	588	240	115	0.623	0.757	0.925	1.025	960	1167	1426	1581
170180	ROUTE	7101	103.6	183.64	13.1	28.9	1919	587	239	115	0.617	0.755	0.924	1.025	952	1163	1425	1580
S165	BASIN	842			12.1	0.62	78	20	7	3	1.183	1.219	1.219	1.219	39	40	40	40
RR165	STORAGE	91	7.2	30.3	12.7	0.62	68	20	7	3	1.023	1.217	1.219	1.219	34	40	40	40
165175	ROUTE	79	100.2	14.7	15.1	0.62	64	20	7	3	0.961	1.217	1.219	1.219	32	40	40	40
S175	BASIN	1278			12.5	1.8	217	55	18	8	1.119	1.131	1.131	1.131	108	109	109	109
C175	COMBINE	1274			12.5	2.42	261	74	25	11	1.005	1.14	1.142	1.142	130	147	147	147
175R	ROUTE	1194	101	19.65	12.6	2.42	259	74	25	11	0.994	1.14	1.142	1.142	128	147	147	147
S180	BASIN	1039			12.5	1.44	171	44	15	6	1.1	1.123	1.124	1.124	85	86	86	86
180R	ROUTE	744	101	33.75	12.8	1.44	170	44	15	6	1.094	1.123	1.124	1.124	84	86	86	86
C180RI	COMBINE	1830			12.6	3.86	423	116	39	17	1.019	1.12	1.122	1.122	210	231	231	231
RI180R	ROUTE	1735	101.2	36.46	12.8	3.86	418	116	39	17	1.008	1.12	1.122	1.122	207	231	231	231
C180R	COMBINE	8293			13	32.76	2272	683	271	129	0.645	0.775	0.923	1.012	1127	1355	1613	1769
180185	ROUTE	8267	104	82.17	13.1	32.76	2263	682	271	128	0.642	0.774	0.923	1.012	1122	1352	1613	1769
S185	BASIN	1655			12.5	2.42	288	73	24	10	1.105	1.117	1.117	1.117	143	144	144	144
185R	ROUTE	1411	102.6	45.16	12.9	2.42	287	73	24	10	1.104	1.117	1.117	1.117	143	144	144	144
C185R	COMBINE	9247			13.1	35.19	2491	740	290	137	0.658	0.782	0.921	1.005	1235	1468	1728	1885
185190	ROUTE	9220	103.5	67.89	13.2	35.19	2486	739	290	137	0.657	0.782	0.921	1.004	1233	1467	1728	1885
S190	BASIN	2590			12.5	4.05	448	112	37	16	1.027	1.027	1.027	1.027	222	222	222	222
C190	COMBINE	10017			13.1	39.24	2822	828	320	150	0.669	0.784	0.909	0.984	1399	1641	1903	2060
190195	ROUTE	9869	104.1	133.28	13.3	39.24	2814	827	320	150	0.667	0.783	0.909	0.984	1395	1640	1902	2060
S195	BASIN	1039			12.6	1.81	202	51	17	7	1.041	1.041	1.041	1.041	100	100	100	100
C195	COMBINE	10228			13.2	41.05	2967	866	333	155	0.672	0.784	0.904	0.976	1471	1717	1980	2137

Channels Hydraulics Summary

		Design Geometry						Hydraulics											
Structure ID	Type	Initial Slope (ft/ft)	Long-term Slope (ft/ft)	Length (stor-ft; chl-mi)	Width (ft)	Depth (ft)	Chnl Mannings n	Flow Rate (cfs)	Wetted Perimeter (ft)	Wetted XS Area (ft)	Hydraulic Radius (ft)	Hydraulic Depth (ft)	Flow Depth (ft)	Freeboard (ft)	Top Width (ft)	Velocity (ft/s)	Froude Number	Shear Stress (lb/sq. ft)
RR12510	Leveed	0.0265	0.0100	0.40	3	4.0	0.045	73	29.3	18.4	0.6	0.6	0.7	3.3	29	4.0	0.88	0.43
RR13010	Leveed	0.0252	0.0120	0.20	3	4.0	0.045	57	17.7	13.2	0.7	0.8	0.9	3.1	17	4.3	0.88	0.67
C135L10	Leveed	0.0165	0.0060	2.30	3	4.5	0.045	1001	206.9	223.4	1.1	1.1	1.1	3.4	207	4.5	0.76	0.41
C155L10	Leveed	0.0194	0.0070	3.00	3	4.5	0.045	1774	336.9	364.8	1.1	1.1	1.1	3.4	337	4.9	0.82	0.48
C17510A	Leveed	0.0182	0.0070	1.30	3	4.5	0.045	840	147.5	170.7	1.2	1.2	1.2	3.3	147	4.9	0.80	0.52
C17510B	Leveed	0.0135	0.0050	1.20	3	4.5	0.045	1274	208.5	274.9	1.3	1.3	1.3	3.2	208	4.6	0.71	0.42
RR17510	Leveed	0.0164	0.0060	0.60	3	4.5	0.045	1393	286.9	311.2	1.1	1.1	1.1	3.4	287	4.5	0.76	0.41
S18010	Leveed	0.0146	0.0060	1.00	3	4.5	0.045	1039	187.9	228.2	1.2	1.2	1.2	3.3	187	4.6	0.73	0.46
RR18010	Leveed	0.0153	0.0060	0.50	3	4.5	0.045	1124	188.1	236.0	1.3	1.3	1.3	3.2	188	4.8	0.75	0.48
C180R10	Leveed	0.0122	0.0050	0.70	3	4.5	0.045	2058	368.2	474.6	1.3	1.3	1.3	3.2	368	4.3	0.67	0.41

Basins Hydraulics Summary

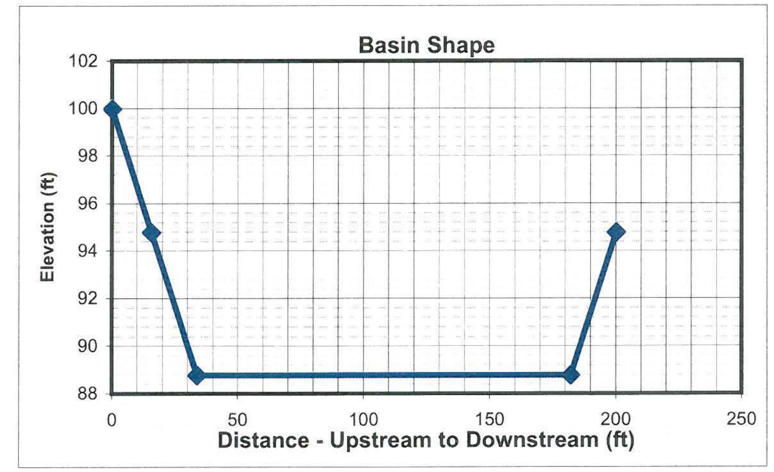
			Design Geometry				Hydraulics					
Structure ID	Type	Adjacent Topo. Slope	Length (stor-ft; chl-mi)	Width (ft)	Depth (ft)	Storage Volume Provided	Peak Storage (ac. Ft)	Total Vol. Entering Basin (ac.	Peak Inflow into Basin (cfs)	Peak Outflow (cfs)	Peak Stage (ft)	Freeboard (ft)
RR125	Online Basin	0.0260	300	200	6.0	5.2	4.9	7.0	202	33	4.8	1.2
RR130	Online Basin	0.0280	600	290	7.0	19.2	18.5	24.0	524	57	5.8	1.2
RR150	Online Basin	0.0270	800	400	9.5	50.5	48.3	62.0	836	97	8.2	1.3
RR165	Online Basin	0.0220	800	300	10.0	39.2	37.6	47.0	1008	100	8.7	1.3

Online Basin

HEC1 ID	RR125

HEC1 Results Used to Determine Sediment Volume From Upstream

Contributing HEC1 ID								Total Volume (ac. ft)
Inflow Volume (ac. ft)								0
Volume Fraction								
Weighted Volume								0
Sediment Conc. (ppm)								
Sediment Volume (ac. ft)								0.00
Weighting Factor								
Weighted Sed. Vol. (ac. ft)								0.00



Sediment Yield

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.1	sq. mi
Total Sediment Yield Volume	0.2	ac ft

Required Minimum Sediment Volume

Sediment Volume	0.2	ac. ft

Geometry	Base	LC Enhanced
Topography slope (ft/ft)	0.026	0.026
Basin Length (ft)	300	400
Basin Width (ft)	200	200
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	6	6
Freeboard (ft)	1	1
Effective Basin Width (ft)	184	169
Top Area (acres)	1.4	1.8
U/S-D/S Height Difference (ft)	5.2	5.2
Excess Area on Upstream (acres)	0.1	0.3

			Base	LC Enhanced
Bottom Length (ft)	264	Allocated Storage Volume (ac. ft)	5.2	5.3
Bottom Width (ft)	148	Total Available Volume (ac. ft) (incl. Freeboard)	6.5	6.7
		Total Excavation Volume (ac. ft)	10.1	11.5

HEC1 Results

	6-hr Event	24-hr Event	Maximum
Total Flow Volume entering Basin (ac. ft)	7.0	6	7.0
Peak Inflow (cfs)	202	161	202.0
Peak Outflow (cfs)	33	30	33.0
Stage at Peak Outflow (ft)	4.8	4	4.8
Volume at Peak Outflow (ac. ft)	4.9	4.1	4.9

Volume Check

Total Volume needed	5.1	ac. ft
Total Volume Provided	5.2	ac. ft
Volume OK?	Yes	

Stage Check

Depth Needed	5.8	ft
Depth Provided	6	ft
Depth OK?	Yes	

Basin Outlet

Outlet Coeff	0.60	(0.6 for Orifice, 3.0 for Weir)
D (Orifice) or W (Weir)	2.00	ft
Invert Elevation	0.00	ft
Number of pipes	1	

Stage-Storage-Discharge

Elevation	0	0.5	1	2	3	4	5	6	7	8
Volume	0.00	0.46	0.93	1.91	2.95	4.06	5.23	6.46	7.76	9.13
Outflow	0.0	10.7	15.1	21.4	26.2	30.3	33.8	37.1	40.0	42.8

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
LC Enhancement Buffer	90000	sq. ft
Other		sq. ft

Additional ROW Length	0	ft
Additional ROW Width	0	ft
Landscaping Buffer Length	100	ft
Landscaping Buffer Width	100	ft

Base Total ROW Length	300	ft
Base Total ROW Width	200	ft
LC Enh. Total ROW Length	500	ft
LC Enh. Total ROW Length	300	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	16295	18553
Excavated Area (sq. Yd)	6667	16667

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	35	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	394	sq. Yd
Material Volume	197	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	286	ft
Unit Cost	160	per ft
Cost per outlet	$45,760	
Other Cost	$ -	
Total Cost	$45,760	
Outlet Area	133	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Basin		16,295	cu. Yd	$ 4.00	$ 65,180	6,667	sq. Yd	$ 9.00	$ 60,003	6,667	sq. Yd	$ 8.33	$ 55,558
Basin - LC Enhancement		2,258	cu. Yd	$ 4.00	$ 9,032	10,000	sq. Yd	$ 9.00	$ 90,000	10,000	sq. Yd	$ 8.33	$ 83,333
Inlet	Riprap	197	sq. Yd	$ 75.00	$ 14,775	394	sq. Yd	$ -	$ -	394	sq. Yd	$ 33.33	$ 13,133
Inlet - LC Enhancement (20%Inlet)					$ 2,955				$ -				$ 2,627
Outlet	Pipe	1	EA	$ 45,760	$ 45,760	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhancement (5% Outlet)					$ 2,288				$ -				$ 111
Other					$ -				$ -				$ -

Base Landscape Cost	$ 60,003	Base Maintenance Cost	$ 70,908
LC Enh. Landscape Cost	$ 90,000	LC Enh. Maintenance Cost	$ 86,071
Total Landscape Cost	$ 150,003	Total Maintenance Cost	$ 156,979

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 125,715	$ 9,032	$ 134,747
Contingency Cost (25% of Construction Cost)	$ 31,429	$ 2,258	$ 33,687
Engineering Design Cost (5% of Construction Cost)	$ 6,286	$ 452	$ 6,737
Total Construction Cost	$ 163,430	$ 11,742	$ 175,171

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	2.1	$100,000	$ 210,000
Basin	1.4	$100,000	$ 140,000
Other		$100,000	$ -
Total	3.5	$100,000	$ 350,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	1.4	$100,000	$ 140,000
LC Enhancement Cost	acre	2.1	$100,000	$ 210,000
Total Land Cost	acre	3.5	$100,000	$ 350,000

Total Cost

Base Total Cost	$ 434,341
Total LC Enhancement Cost	$ 397,812
Total Cost Including LC Enh.	$ 832,153

Open Channel

Structure ID	RR12510	HEC1 ID	12535I

Longitundal Geometry

Length	1852.5	ft
U/S Elev	1746.1	ft
D/S Elev	1697.0	ft
Initial Channel Slope	0.0265	ft/ft
Long-term Channel Slope	0.0100	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	1

Initial Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	0	3	25	4	3	0	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	12	12	37	37	37	49
Y	104	100	100	100	100	100	100	104

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	0	3	25	4	3	0	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	12	12	37	37	37	49
Y	104	100	100	100	100	100	100	104

Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	RR125	S135								TOTAL
HEC1 Peak-Flow	33	1102								1135
Weighting Factor	1.00	0.04								
Flow into Channel	33	40								73

Reach Sediment Inflow Characteristics

U/S Contributing ID										TOTAL
HEC1 Flow Volume (ac. ft)										0
Sediment Conc. (ppm)										
Sediment Volume (ac. ft)										0.00
Weighting Factor										
Weighted Sed. Vol. (ac. ft)										0.00

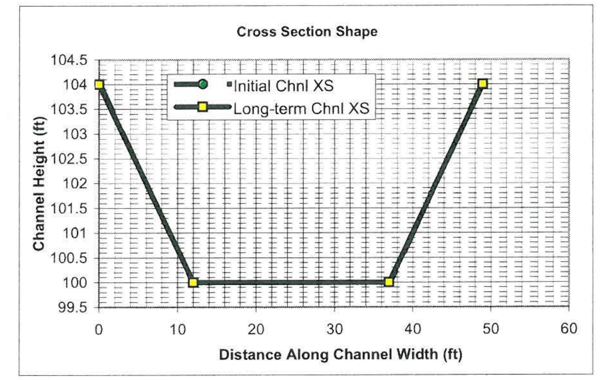
Hydrology

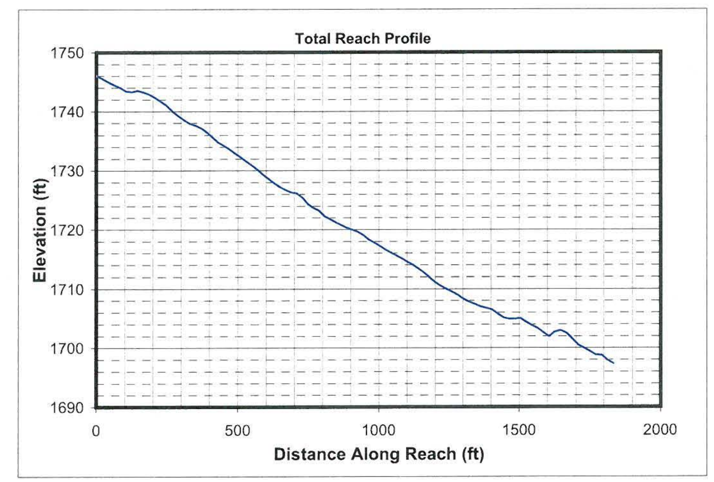
Drainage Area	0.157	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	73	cfs	
Long-term Max. Chnl Capacity	1006	cfs	
Q2 Channel	7	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	49	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			





JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

Sub-area: Wagner Wash, Alternative: B43
Open Channel Structure ID: RR12510

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
7	26.1	4.4	0.2	100.0	100.2	1.6	0.2	26.0	0.2	0.11	0.71
18	26.9	7.8	0.3	100.0	100.3	2.4	0.3	26.8	0.3	0.19	0.77
55	28.6	15.4	0.5	100.0	100.6	3.6	0.6	28.5	0.5	0.36	0.85
73	29.3	18.4	0.6	100.0	100.7	4.0	0.7	29.1	0.6	0.43	0.88

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
7	26.5	6.0	0.2	100.0	100.2	1.2	0.2	26.4	0.2	0.14	0.45
18	27.5	10.5	0.4	100.0	100.4	1.7	0.4	27.4	0.4	0.25	0.50
55	29.8	20.9	0.7	100.0	100.8	2.6	0.8	29.6	0.7	0.48	0.55
73	30.7	25.2	0.8	100.0	100.9	2.9	0.9	30.4	0.8	0.57	0.56

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
7										0
18										0
55										0
73										0

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow) Permissive Velocity (ft/s): Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	BUREC Erosive?	Neill (gravel/cobble) Non-cohesive: Erosive?	All'ble Vel (ft/s)	Cohesive: Erosive?	All'ble Vel (ft/s)	USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
7	1.74	0.8490	0.8066	Erosive	Erosive	Erosive	0.2	Stable	2.2	Stable	Stable
18	1.74	1.0134	0.9627	Erosive	Erosive	Erosive	0.2	Stable	3.2	Stable	Stable
55	1.74	1.2056	1.1454	Erosive	Erosive	Erosive	0.3	Stable	4.9	Stable	Stable
73	1.74	1.2549	1.1922	Erosive	Erosive	Erosive	0.3	Stable	5.5	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	**7**	**18**	**55**	**73**	**7**	**18**	**55**	**73**	**7**	**18**	**55**	**73**
Bray - Equation #1	7	11	20	23	0.5	0.7	1.0	1.1	2.1	2.4	2.8	2.9
Bray - Equation #2	9	14	26	30	0.6	0.8	1.1	1.2	1.4	1.6	1.9	2.0
Hey	1	3	5	6	1.4	1.9	2.9	3.3				
Ackers & Charlton/Lacey	8	12	19	22					1.1	1.3	1.6	1.6
Parker	19	29	51	59	0.3	0.5	0.7	0.8				
Chang	11	19	38	45	0.1	0.1	0.0	0.0				
Kellerhals	5	8	13	15	0.6	0.9	1.3	1.5	2.5	2.7	3.0	3.1
AMAFCA/Schumm	26	27	30	30								
Moody & Odem	6	6	6	6	0.7	0.7	0.7	0.7				
BUREC	4.9	6.9	10.5	11.7	1	2	3	3	1.8	2.2	2.9	3.2
Average	10	14	22	25	0.7	0.9	1.3	1.5	1.8	2.1	2.4	2.6
Values As Designed	26	27	30	30	0.2	0.4	0.8	0.9	1.2	1.7	2.6	2.9
Difference with Design	-17	-14	-8	-6	0.5	0.5	0.6	0.6	0.6	0.3	-0.2	-0.3

Initial Channel Sediment Transport Capacity

Discharge (cfs)	Sediment Load (tons/day) Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
7	80	58	138	151	365	29	28	10	538	36	79	137
18	326	192	441	701	557	131	98	59	1426	103	349	399
55	1725	704	1421	4352	884	624	335	324	4388	438	1691	1535
73	2653	972	1839	6985	995	923	449	484	5869	647	2492	2210

Discharge (cfs)	Sediment Concentrations (ppm by weight) Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
7	4082	2963	7009	7659	18529	1473	1407	510	27319	1831	3995	6980
18	6622	3908	8973	14252	11327	2664	1994	1208	28981	2096	7103	8103
55	11689	4770	9632	29487	5993	4227	2267	2196	29733	2965	11455	10401
73	13482	4942	9345	35497	5058	4688	2283	2460	29829	3287	12667	11231

Long-term Channel Sediment Transport Capacity

Discharge (cfs)	Sediment Load (tons/day) Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
7	21	11	17	30	197	0	1	1	90	7	14	35
18	83	52	91	138	336	17	18	11	295	23	86	105
55	436	229	424	848	582	117	91	90	979	105	498	400
73	668	326	573	1356	666	178	128	141	1321	157	760	570

Discharge (cfs)	Sediment Concentrations (ppm by weight) Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
7	1049	583	842	1521	10030	0	38	39	4568	381	696	1795
18	1693	1064	1858	2813	6828	350	364	230	5987	476	1741	2128
55	2955	1551	2874	5749	3941	792	616	607	6632	710	3375	2709
73	3396	1656	2910	6891	3387	904	652	717	6715	796	3860	2899

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
7	0.0045	0.0071	125	0.38	0.046	0.0015	29	0.035	0.0011	0.0159	0.0015	0.0036	0.0180	0.0016	0.0073	0.0263	0.0124
18	0.0023	0.0042	163	0.50	0.049	0.0009	30	0.036	0.0006	0.0159	0.0009	0.0020	0.0180	0.0010	0.0037	0.0263	0.0118
55	0.0011	0.0022	222	0.68	0.052	0.0005	31	0.036	0.0004	0.0159	0.0005	0.0010	0.0180	0.0006	0.0016	0.0263	0.0115
73	0.0009	0.0019	240	0.73	0.052	0.0005	31	0.036	0.0003	0.0159	0.0004	0.0009	0.0180	0.0005	0.0013	0.0262	0.0114

Drop Structures

Design Slope	0.0100	ft/ft
Total Drop Needed	30.5	ft
Height of Drop Structure	3	ft
No . of Drop Structures	11	
Distance between structs.	168	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.03	sq. mi
Total Sediment Yield Volume	0.06	ac ft

Sedimentation Basins

Length	168 ft	Depth	3 ft
Width	49 ft	Side slope	3 ft/ft
Total Volume per Basin		0.44	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

Discharge	Pima County General Scour Equations								Bend	LongTerm	Thalweg	Total
	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
7	1.1	-0.1	0.0	24.6	0.2	0.2	1.2	0.0100	0.0	1.5	1.0	3.3
18	1.1	-0.2	0.0	24.6	0.4	0.4	1.7	0.0100	0.0	1.5	1.0	3.3
55	1.1	-0.2	0.1	24.6	0.8	0.7	2.6	0.0100	0.1	1.5	1.0	3.4
73	1.1	-0.3	0.1	24.6	0.9	0.8	2.9	0.0100	0.1	1.5	1.0	3.4

Toe Protection Needed	4.0	ft

Freeboard

Max. Flow Depth	0.7	ft
Channel Depth as designed	4.0	ft
Available Freeboard	3.3	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	0.06	ac. ft
Outflowing Sediment Volume	0.01	ac. ft
Deposited(+)/Eroded(-) Volume	0.05	ac. ft

HEC1 Results For Open Channel

Peak Flow	33	cfs
Stage at Peak Flow	100.4	ft
Flow Volume	7.0	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	1853	1853
Side Slope (?H:1V)	3	3
Channel Width (ft)	49	49
Channel XS Area (sq. ft)	148	148
Channel Perimeter (ft)	50	50

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	1853	ft
Thickness	1.5	ft
Protection Depth	4	ft
Tie-in Length/Depth	3.0	ft
Total Depth	7.0	ft
Area needed	618	sq. Yd
Volume	1441	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	1853	1853
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4	5
Left Levee Surface Area (sq. Yd)	8030	16677
Left Levee Volume (cu. Yd)	7137	17157
Right Levee Length (ft)	1853	1853
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4	5
Right Levee Surface Area (sq. Yd)	8030	16677
Right Levee Volume (cu. Yd)	7137	17157
Total Levee Surface Area (sq. Yd)	16060	33354
Total Levee Volume (cu. Yd)	14274	34314

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	1853	1853
Left Levee Lining Width (ft)	13	30
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	2677	6177
Left Levee Lining Volume (cu. Yd)	1338	3088
Right Levee Length (ft)	1853	1853
Right Levee Lining Width (ft)	13	30
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	2677	6177
Right Levee Lining Volume (cu. Yd)	1338	3088
Total Lining Area (sq. Yd)	5353	12353
Total Lining Volume (cu. Yd)	2676	6176

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	49	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	3.9	ft
Structure Height	6.9	ft
Number of Structures	11	
Volume per structure	37	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 2,775	
Area per structure	16	sq. Yd
Total Area	180	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	710	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 2,840	
Other Cost	$ -	
Total cost per basin	$ 2,840	
Area per basin	917	sq. Yd
Total Area	917	sq. Yd

Structure Type	Structure Cost	Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	14,274	cu. Yd	$ 7.00	$ 99,918	16,060	sq. Yd	$ 9.00	$ 144,540	16,060	sq. Yd	$ 11.67	$ 187,367
Levee - LC Enhancement	Fill	20,040	cu. Yd	$ 7.00	$ 140,280	17,294	sq. Yd	$ 9.00	$ 155,646	20,040	sq. Yd	$ 11.67	$ 233,800
Levee Lining	Riprap	2,676	cu. Yd	$ 75.00	$ 200,700	5,353	sq. Yd	$ -	$ -	5,353	sq. Yd	$ 20.83	$ 111,523
Levee Lining -LC Enhancement	Riprap	3,500	cu. Yd	$ 75.00	$ 262,500	7,000	sq. Yd	$ -	$ -	7,000	sq. Yd	$ 20.83	$ 145,838
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	1,441	cu. Yd	$ 75.00	$ 108,075	618	sq. Yd	$ -	$ -	618	sq. Yd	$ 25.00	$ 15,450
Drop Structures	Riprap	11	EA	$ 2,775.00	$ 30,525	180	sq. Yd	$ -	$ -	180	sq. Yd	$ 33.33	$ 6,000
Drop Str. - LC Enhancement	Riprap	11	EA	$ 277.50	$ 3,053	18	sq. Yd	$ -	$ -	18	sq. Yd	$ 33.33	$ 600
Sedimentation Basins		1	EA	$ 2,840.00	$ 2,840	917	sq. Yd	$ -	$ -	917	sq. Yd	$ 8.33	$ 7,642
Other					$ -				$ -				$ -

Base Landscape Cost	$ 144,540	Base Maintenance Cost	$ 327,981
LC Enhancement Cost	$ 155,646	LC Enhancement Cost	$ 380,238
Total Landscape Cost	$ 300,186	Total Maintenance Cost	$ 708,219

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 442,058	$ 405,833	$ 847,891
Contingency Cost (25% of Construction Cost)	$ 110,515	$ 101,458	$ 211,973
Engineering Design Cost (5% of Construction Cost)	$ 22,103	$ 20,292	$ 42,395
Total Construction Cost	$ 574,675	$ 527,582	$ 1,102,258

Land Cost

Channel Length	1853 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	49	2.1	$100,000	$ 210,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	52	2.2	$100,000	$ 220,000
Levee LC Enhancement	48	2	$100,000	$ 200,000
Other	0	0	$100,000	$ -
Total	149	6.3		$ 630,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	4.3	$100,000	$ 430,000
LC Enhancement Cost	acre	2	$100,000	$ 200,000
Total Land Cost	acre	6.3	$100,000	$ 630,000

Total Cost

Base Total Cost	$ 1,477,197
Total Landscape Enhancement Cost	$ 1,263,466
Total Cost Including LC Enh.	$ 2,740,663

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC

Sub-area: Wagner Wash, Alternative: B43
Open Channel Structure ID: RR12510

Online Basin

HEC1 ID	RR130

HEC1 Results Used to Determine Sediment Volume From Upstream

Contributing HEC1 ID							Total Volume (ac. ft)
Inflow Volume (ac. ft)							0
Volume Fraction							
Weighted Volume							0
Sediment Conc. (ppm)							
Sediment Volume (ac. ft)							0.00
Weighting Factor							
Weighted Sed. Vol. (ac. ft)							0.00

Sediment Yield

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.3	sq. mi
Total Sediment Yield Volume	0.6	ac ft

Required Minimum Sediment Volume

Sediment Volume	0.6	ac. ft

Geometry

	Base	LC Enhanced
Topography slope (ft/ft)	0.028	0.028
Basin Length (ft)	600	770
Basin Width (ft)	290	290
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	7	7
Freeboard (ft)	1	1
Effective Basin Width (ft)	266	241
Top Area (acres)	4.0	5.1
U/S-D/S Height Difference (ft)	8.1	8.1
Excess Area on Upstream (acres)	0.3	0.9

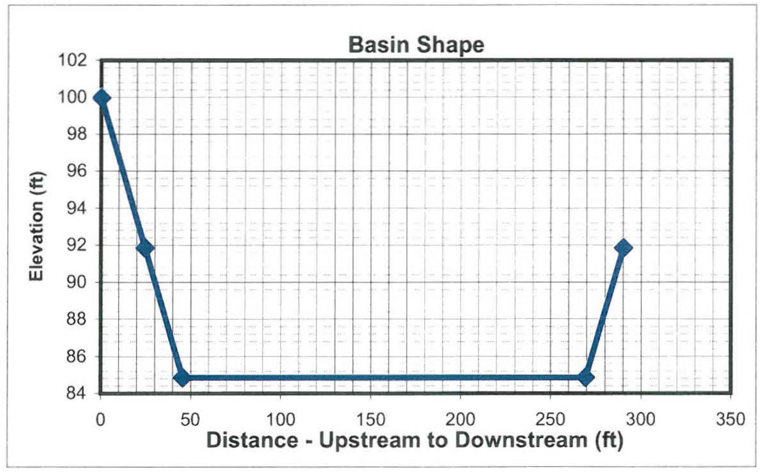
			Base	LC Enhanced
Bottom Length (ft)	558	Allocated Storage Volume (ac. ft)	19.2	19.3
Bottom Width (ft)	224	Total Available Volume (ac. ft) (incl. Freeboard)	22.8	23.4
		Total Excavation Volume (ac. ft)	39.1	44.2

Basin Outlet

Outlet Coeff	0.60	(0.6 for Orifice, 3.0 for Weir)
D (Orifice) or W (Weir)	2.50	ft
Invert Elevation	0.00	ft
Number of pipes	1	

Stage-Storage-Discharge

Elevation	0	0.5	1	2	3	4	5	6	7	8
Volume	0.00	1.45	2.92	5.96	9.10	12.36	15.73	19.21	22.82	26.54
Outflow	0.0	16.7	23.6	33.4	40.9	47.3	52.9	57.9	62.5	66.9



HEC1 Results

	6-hr Event	24-hr Event	Maximum
Total Flow Volume entering Basin (ac. ft)	24.0	20	24.0
Peak Inflow (cfs)	524	415	524.0
Peak Outflow (cfs)	57	51	57.0
Stage at Peak Outflow (ft)	5.8	4.7	5.8
Volume at Peak Outflow (ac. ft)	18.5	14.6	18.5

Volume Check

Total Volume needed	19.1	ac. ft
Total Volume Provided	19.2	ac. ft
Volume OK?	Yes	

Stage Check

Depth Needed	6.8	ft
Depth Provided	7	ft
Depth OK?	Yes	

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
LC Enhancement Buffer	165300	sq. ft
Other		sq. ft

Additional ROW Length	0	ft
Additional ROW Width	0	ft
Landscaping Buffer Length	100	ft
Landscaping Buffer Width	100	ft

Base Total ROW Length	600	ft
Base Total ROW Width	290	ft
LC Enh. Total ROW Length	870	ft
LC Enh. Total ROW Length	390	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	63081	71309
Excavated Area (sq. Yd)	19333	37700

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	48	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	531	sq. Yd
Material Volume	266	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	304	ft
Unit Cost	160	per ft
Cost per outlet	$48,640	
Other Cost	$ -	
Total Cost	$48,640	
Outlet Area	133	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Basin		63,081	cu. Yd	$ 4.00	$ 252,324	19,333	sq. Yd	$ 9.00	$ 173,997	19,333	sq. Yd	$ 8.33	$ 161,108
Basin - LC Enhancement		8,228	cu. Yd	$ 4.00	$ 32,912	18,367	sq. Yd	$ 9.00	$ 165,303	18,367	sq. Yd	$ 8.33	$ 153,058
Inlet	Riprap	266	sq. Yd	$ 75.00	$ 19,950	531	sq. Yd	$ -	$ -	531	sq. Yd	$ 33.33	$ 17,700
Inlet - LC Enhancement (20%Inlet)					$ 3,990				$ -				$ 3,540
Outlet	Pipe	1	EA	$ 48,640	$ 48,640	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhancement (5% Outlet)					$ 2,432				$ -				$ 111
Other					$ -				$ -				$ -

Base Landscape Cost	$ 173,997	
LC Enh. Landscape Cost	$ 165,303	
Total Landscape Cost	$ 339,300	

Base Maintenance Cost	$ 181,025
LC Enh. Maintenance Cost	$ 156,709
Total Maintenance Cost	$ 337,734

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 320,914	$ 32,912	$ 353,826
Contingency Cost (25% of Construction Cost)	$ 80,229	$ 8,228	$ 88,457
Engineering Design Cost (5% of Construction Cost)	$ 16,046	$ 1,646	$ 17,691
Total Construction Cost	$ 417,188	$ 42,786	$ 459,974

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	3.8	$100,000	$ 380,000
Basin	4.0	$100,000	$ 400,000
Other		$100,000	$ -
Total	7.8	$100,000	$ 780,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	4.0	$100,000	$ 400,000
LC Enhancement Cost	acre	3.8	$100,000	$ 380,000
Total Land Cost	acre	7.8	$100,000	$ 780,000

Total Cost

Base Total Cost	$ 1,172,210
Total LC Enhancement Cost	$ 744,798
Total Cost Including LC Enh.	$ 1,917,008

Open Channel

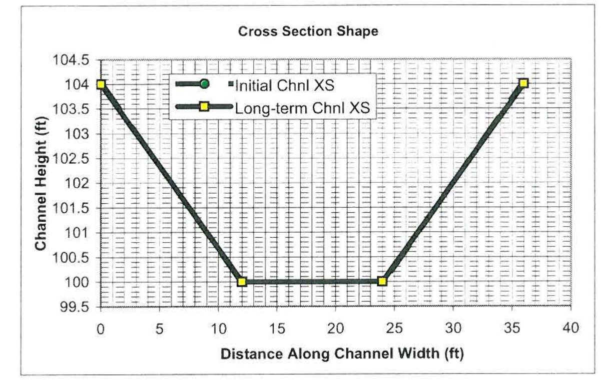
Structure ID	RR13010		HEC1 ID	13035I

Longitundal Geometry

Length	1235.4	ft
U/S Elev	1728.2	ft
D/S Elev	1697.0	ft
Initial Channel Slope	0.0252	ft/ft
Long-term Channel Slope	0.0120	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	1



Initial Channel XS Geometry

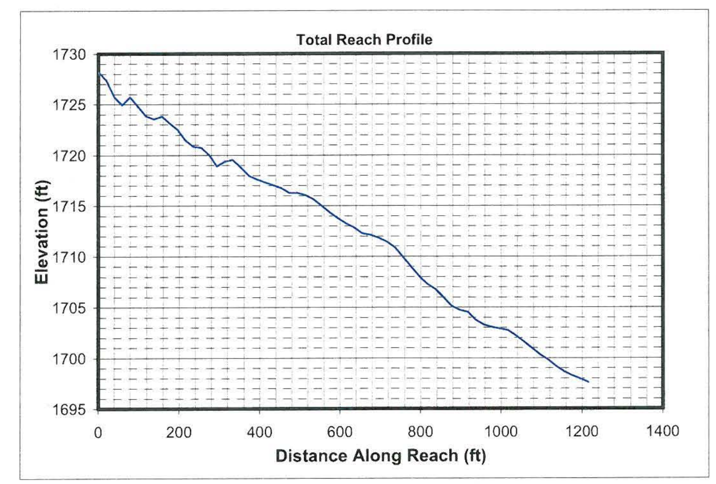
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	0	3	12	4	3	0	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	12	12	24	24	24	36
Y	104	100	100	100	100	100	100	104

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	0	3	12	4	3	0	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	12	12	24	24	24	36
Y	104	100	100	100	100	100	100	104



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	RR130									TOTAL
HEC1 Peak-Flow	57									57
Weighting Factor	1.00									
Flow into Channel	57									57

Reach Sediment Inflow Characteristics

U/S Contributing ID										TOTAL
HEC1 Flow Volume (ac. ft)										0
Sediment Conc. (ppm)										
Sediment Volume (ac. ft)										0.00
Weighting Factor										
Weighted Sed. Vol. (ac. ft)										0.00

Hydrology

Drainage Area	0.31	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	57	cfs	
Long-term Max. Chnl Capacity	654	cfs	
Q2 Channel	6	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	36	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
6	13.5	3.0	0.2	100.0	100.2	1.9	0.2	13.4	0.2	0.18	0.72
14	14.5	5.3	0.4	100.0	100.4	2.7	0.4	14.4	0.4	0.30	0.78
43	16.8	10.9	0.6	100.0	100.8	3.9	0.8	16.6	0.7	0.57	0.86
57	17.7	13.2	0.7	100.0	100.9	4.3	0.9	17.4	0.8	0.67	0.88

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
6	13.8	3.8	0.3	100.0	100.3	1.5	0.3	13.7	0.3	0.22	0.51
14	15.2	6.7	0.4	100.0	100.5	2.1	0.5	15.0	0.4	0.37	0.56
43	17.9	13.9	0.8	100.0	100.9	3.1	0.9	17.6	0.8	0.70	0.61
57	19.0	17.0	0.9	100.0	101.1	3.4	1.1	18.6	0.9	0.83	0.62

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
6										0
14										0
43										0
57										0

Allowable Velocity

Channel Lining	Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow) Permissive Velocity (ft/s) Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	BUREC Erosive?	Neill (gravel/cobble) Non-cohesive Erosive?	All'ble Vel (ft/s)	Cohesive Erosive?	All'ble Vel (ft/s)	USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
6	1.74	0.9310	0.8844	Erosive	Erosive	Erosive	0.2	Stable	2.8	Stable	Stable
14	1.74	1.0875	1.0331	Erosive	Erosive	Erosive	0.2	Stable	4.0	Stable	Stable
43	1.74	1.2654	1.2021	Erosive	Erosive	Erosive	0.3	Stable	6.1	Stable	Stable
57	1.74	1.3100	1.2445	Erosive	Erosive	Erosive	0.3	Stable	6.7	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	**6**	**14**	**43**	**57**	**6**	**14**	**43**	**57**	**6**	**14**	**43**	**57**
Bray - Equation #1	6	10	17	20	0.5	0.6	0.9	1.0	2.0	2.3	2.7	2.8
Bray - Equation #2	8	13	23	26	0.5	0.7	1.0	1.1	1.4	1.6	1.8	1.9
Hey	1	2	5	5	1.2	1.8	2.7	3.0				
Ackers & Charlton/Lacey	7	11	17	20					1.1	1.2	1.5	1.6
Parker	16	26	45	52	0.3	0.4	0.7	0.7				
Chang	10	18	34	41	0.1	0.1	0.0	0.0				
Kellerhals	4	7	12	14	0.5	0.8	1.2	1.4	2.4	2.7	3.0	3.1
AMAFCA/Schumm	14	15	18	19								
Moody & Odem	8	8	8	8	0.8	0.8	0.8	0.8				
BUREC	4.3	6.1	9.2	10.3	1	2	2	3	1.8	2.2	3.0	3.2
Average	8	11	19	21	0.6	0.9	1.2	1.4	1.7	2.0	2.4	2.5
Values As Designed	14	15	18	19	0.3	0.5	0.9	1.1	1.5	2.1	3.1	3.4
Difference with Design	-6	-4	1	3	0.3	0.4	0.3	0.2	0.2	-0.1	-0.7	-0.9

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
6	73	49	117	145	222	28	24	11	403	27	77	107
14	289	152	334	656	341	112	76	55	1047	83	308	314
43	1457	535	1015	3849	562	501	246	268	3197	357	1385	1216
57	2207	733	1324	6066	642	731	328	392	4273	524	2010	1748

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
6	4768	3196	7592	9466	14462	1840	1593	742	26203	1754	5003	6965
14	7527	3970	8692	17077	8881	2916	1982	1434	27256	2173	8029	8176
43	12649	4642	8813	33401	4877	4345	2134	2324	27747	3095	12017	10549
57	14364	4771	8614	39481	4179	4761	2136	2552	27812	3409	13081	11378

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
6	26	17	28	42	147	4	5	2	116	8	24	38
14	101	60	119	187	242	28	25	18	325	27	112	113
43	500	232	422	1079	423	142	95	104	1027	120	557	427
57	754	324	578	1693	490	209	131	156	1378	177	826	611

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
6	1674	1080	1803	2726	9579	279	332	162	7525	548	1549	2478
14	2619	1566	3106	4868	6298	732	644	459	8467	709	2911	2944
43	4338	2016	3659	9365	3672	1229	827	899	8910	1041	4836	3708
57	4910	2108	3760	11018	3186	1360	849	1018	8969	1155	5376	3974

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
6	0.0033	0.0055	139	0.42	0.047	0.0012	30	0.036	0.0008	0.0159	0.0012	0.0027	0.0196	0.0017	0.0070	0.0250	0.0122
14	0.0018	0.0033	179	0.54	0.050	0.0007	30	0.036	0.0005	0.0159	0.0007	0.0016	0.0196	0.0011	0.0035	0.0249	0.0118
43	0.0009	0.0018	238	0.72	0.052	0.0004	31	0.036	0.0003	0.0159	0.0004	0.0008	0.0196	0.0007	0.0015	0.0248	0.0115
57	0.0007	0.0016	255	0.78	0.053	0.0004	32	0.036	0.0003	0.0159	0.0003	0.0007	0.0196	0.0006	0.0012	0.0247	0.0114

Drop Structures

Design Slope	0.0120	ft/ft
Total Drop Needed	16.4	ft
Height of Drop Structure	3	ft
No . of Drop Structures	6	
Distance between structs.	206	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.03	sq. mi
Total Sediment Yield Volume	0.06	ac ft

Sedimentation Basins

Length	206 ft	Depth	3 ft
Width	36 ft	Side slope	3 ft/ft
Total Volume per Basin		0.37	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
6	1.1	-0.1	0.0	24.6	0.3	0.3	1.5	0.0120	0.0	1.5	1.0	3.3
14	1.1	-0.2	0.1	24.6	0.5	0.4	2.1	0.0120	0.0	1.5	1.0	3.4
43	1.1	-0.3	0.1	24.6	0.9	0.8	3.1	0.0120	0.1	1.5	1.0	3.5
57	1.1	-0.3	0.2	24.6	1.1	0.9	3.4	0.0120	0.1	1.5	1.0	3.5

Toe Protection Needed	4.0	ft

HEC1 Results For Open Channel

Peak Flow	57	cfs
Stage at Peak Flow	100.9	ft
Flow Volume	24.0	ac. ft

Freeboard

Max. Flow Depth	0.9	ft
Channel Depth as designed	4.0	ft
Available Freeboard	3.1	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	0.06	ac. ft
Outflowing Sediment Volume	0.04	ac. ft
Deposited(+)/Eroded(-) Volume	0.02	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	1235	1235
Side Slope (?H:1V)	3	3
Channel Width (ft)	36	36
Channel XS Area (sq. ft)	96	96
Channel Perimeter (ft)	37	37

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	1235	ft
Thickness	1.5	ft
Protection Depth	4	ft
Tie-in Length/Depth	3.0	ft
Total Depth	7.0	ft
Area needed	412	sq. Yd
Volume	961	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	1235	1235
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4	5
Left Levee Surface Area (sq. Yd)	5352	11115
Left Levee Volume (cu. Yd)	4757	11435
Right Levee Length (ft)	1235	1235
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4	5
Right Levee Surface Area (sq. Yd)	5352	11115
Right Levee Volume (cu. Yd)	4757	11435
Total Levee Surface Area (sq. Yd)	10704	22230
Total Levee Volume (cu. Yd)	9514	22870

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	1235	1235
Left Levee Lining Width (ft)	13	30
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	1784	4117
Left Levee Lining Volume (cu. Yd)	892	2058
Right Levee Length (ft)	1235	1235
Right Levee Lining Width (ft)	13	30
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	1784	4117
Right Levee Lining Volume (cu. Yd)	892	2058
Total Lining Area (sq. Yd)	3568	8233
Total Lining Volume (cu. Yd)	1784	4116

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	36	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	4.5	ft
Structure Height	7.5	ft
Number of Structures	6	
Volume per structure	30	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 2,250	
Area per structure	12	sq. Yd
Total Area	72	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	597	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 2,388	
Other Cost	$ -	
Total cost per basin	$ 2,388	
Area per basin	824	sq. Yd
Total Area	824	sq. Yd

Structure Type	Structure Cost: Excavation/Construction: Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Landscape: Quantity	Units	Unit Cost	Landscape Cost	Maintenance: Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	9,514	cu. Yd	$ 7.00	$ 66,598	10,704	sq. Yd	$ 9.00	$ 96,336	10,704	sq. Yd	$ 11.67	$ 124,880
Levee - LC Enhancement	Fill	13,356	cu. Yd	$ 7.00	$ 93,492	11,526	sq. Yd	$ 9.00	$ 103,734	13,356	sq. Yd	$ 11.67	$ 155,820
Levee Lining	Riprap	1,784	cu. Yd	$ 75.00	$ 133,800	3,568	sq. Yd	$ -	$ -	3,568	sq. Yd	$ 20.83	$ 74,329
Levee Lining -LC Enhancement	Riprap	2,332	cu. Yd	$ 75.00	$ 174,900	4,666	sq. Yd	$ -	$ -	4,666	sq. Yd	$ 20.83	$ 97,199
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	961	cu. Yd	$ 75.00	$ 72,075	412	sq. Yd	$ -	$ -	412	sq. Yd	$ 25.00	$ 10,300
Drop Structures	Riprap	6	EA	$ 2,250.00	$ 13,500	72	sq. Yd	$ -	$ -	72	sq. Yd	$ 33.33	$ 2,400
Drop Str. - LC Enhancement	Riprap	6	EA	$ 225.00	$ 1,350	7	sq. Yd	$ -	$ -	7	sq. Yd	$ 33.33	$ 240
Sedimentation Basins		1	EA	$ 2,388.00	$ 2,388	824	sq. Yd	$ -	$ -	824	sq. Yd	$ 8.33	$ 6,867
Other					$ -				$ -				$ -

Base Landscape Cost	$ 96,336	Base Maintenance Cost	$ 218,775
LC Enhancement Cost	$ 103,734	LC Enhancement Cost	$ 253,259
Total Landscape Cost	$ 200,070	Total Maintenance Cost	$ 472,034

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 288,361	$ 269,742	$ 558,103
Contingency Cost (25% of Construction Cost)	$ 72,090	$ 67,436	$ 139,526
Engineering Design Cost (5% of Construction Cost)	$ 14,418	$ 13,487	$ 27,905
Total Construction Cost	$ 374,869	$ 350,665	$ 725,534

Land Cost

Channel Length	1235 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	36	1	$100,000	$ 100,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	52	1.5	$100,000	$ 150,000
Levee LC Enhancement	48	1.4	$100,000	$ 140,000
Other	0	0	$100,000	$ -
Total	136	3.9		$ 390,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	2.5	$100,000	$ 250,000
LC Enhancement Cost	acre	1.4	$100,000	$ 140,000
Total Land Cost	acre	3.9	$100,000	$ 390,000

Total Cost

Base Total Cost	$ 939,981
Total Landscape Enhancement Cost	$ 847,658
Total Cost Including LC Enh.	$ 1,787,638

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

Sub-area: Wagner Wash, Alternative: B43
Open Channel Structure ID: RR13010

Open Channel

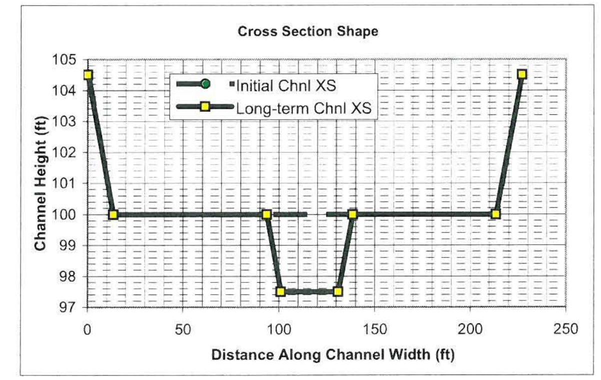
Structure ID	C135L10		HEC1 ID	35I135

Longitundal Geometry

Length	12096.9	ft
U/S Elev	1697.0	ft
D/S Elev	1496.9	ft
Initial Channel Slope	0.0165	ft/ft
Long-term Channel Slope	0.0060	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	8



Initial Channel XS Geometry

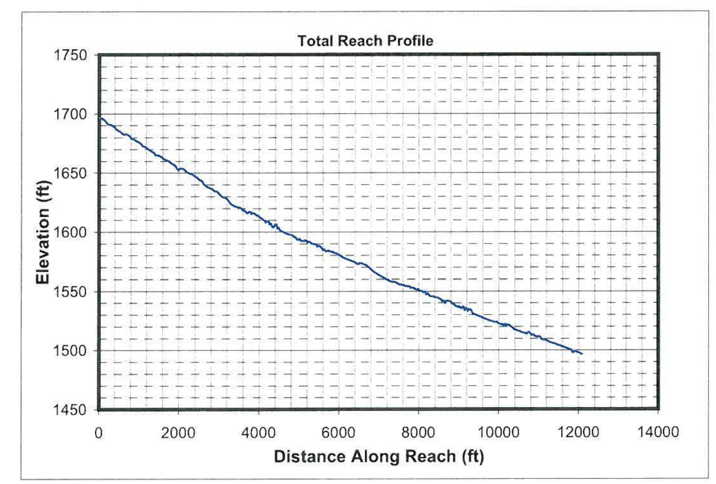
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	200	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	213.5	213.5	213.5	227
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	80	3	30	7	3	75	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	93.5	101	131	138.5	213.5	227
Y	104.5	100	100	97.5	97.5	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	C135L									TOTAL
HEC1 Peak-Flow	1001									1001
Weighting Factor	1.00									
Flow into Channel	1001									1001

Reach Sediment Inflow Characteristics

U/S Contributing ID	12535I_RR12510	13035I_RR130 10								TOTAL
HEC1 Flow Volume (ac. ft)	7.00	24.00								31
Sediment Conc. (ppm)	2899	3974								
Sediment Volume (ac. ft)	0.01	0.04								0.04
Weighting Factor	1	1								
Weighted Sed. Vol. (ac. ft)	0.01	0.04								0.04

Hydrology

Drainage Area	2.06	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	1001	cfs	
Long-term Max. Chnl Capacity	7480	cfs	
Q2 Channel	100	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	227	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

Sub-area: Wagner Wash, Alternative: B43
Open Channel Structure ID: C135L10

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
100	201.7	55.6	0.3	100.0	100.3	1.8	0.3	201.7	0.3	0.10	0.60
250	203.0	96.5	0.5	100.0	100.5	2.6	0.5	202.9	0.5	0.18	0.66
751	205.8	187.5	0.9	100.0	100.9	4.0	0.9	205.5	0.9	0.35	0.74
1001	206.9	223.4	1.1	100.0	101.1	4.5	1.1	206.6	1.1	0.41	0.76

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
100	37.2	38.3	1.0	97.5	98.6	2.6	1.1	36.9	1.0	0.43	0.45
250	42.3	69.9	1.7	97.5	99.4	3.6	1.9	41.7	1.7	0.73	0.49
751	205.8	254.3	1.2	97.5	100.8	3.0	3.3	204.8	1.2	1.23	0.47
1001	207.3	303.0	1.5	97.5	101.0	3.3	3.5	206.2	1.5	1.32	0.48

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
	12535I_RR12510	13035I_RR13010								
100	35	38								73
250	105	113								218
751	400	427								827
1001	570	611								1181

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
100	1.74	0.9980	0.9481	Erosive	Erosive	Erosive	0.2	Stable	4.9	Stable	Stable
250	1.74	1.1664	1.1081	Erosive	Erosive	Erosive	0.2	Stable	7.0	Stable	Stable
751	1.74	1.3672	1.2988	Erosive	Erosive	Erosive	0.3	Stable	8.6	Stable	Stable
1001	1.74	1.4195	1.3485	Erosive	Erosive	Erosive	0.3	Stable	9.2	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

Discharge (cfs)	Channel Width (ft) 100	250	751	1001	Flow Depth (ft) 100	250	751	1001	Velocity (ft/s) 100	250	751	1001
Bray - Equation #1	27	44	78	91	1.2	1.7	2.4	2.7	3.0	3.4	4.0	4.2
Bray - Equation #2	35	57	102	119	1.4	1.8	2.6	2.9	2.1	2.4	2.7	2.9
Hey	8	13	25	29	3.7	5.3	8.0	8.9				
Ackers & Charlton/Lacey	25	37	58	66					1.7	2.0	2.4	2.5
Parker	69	109	188	217	0.9	1.4	2.2	2.4				
Chang	46	80	157	186	0.1	0.0	-0.3	-0.4				
Kellerhals	18	28	49	57	1.7	2.5	3.8	4.3	3.2	3.5	4.0	4.1
AMAFCA/Schumm	37	42	205	206								
Moody & Odem	16	16	16	16	1.1	1.1	1.1	1.1				
BUREC	14.4	20.4	30.7	34.2	4	5	8	9	2.8	3.5	4.7	5.0
Average	29	45	91	102	1.8	2.4	3.5	3.9	2.6	3.0	3.6	3.7
Values As Designed	37	42	205	206	1.1	1.9	3.3	3.5	2.6	3.6	3.0	3.3
Difference with Design	-7	3	-114	-104	0.6	0.4	0.2	0.3	0.0	-0.6	0.6	0.4

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
100	787	523	1109	1419	2853	235	224	111	3620	256	818	1087
250	3242	1749	3532	6711	4294	1068	790	626	9643	858	3585	3282
751	17648	6482	11241	43046	6600	5156	2679	3378	29723	4053	17564	13415
1001	27456	8991	14583	69946	7337	7681	3597	5059	39764	6133	26069	19692

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
100	2918	1939	4112	5261	10573	872	828	411	13415	947	3033	4028
250	4807	2593	5237	9949	6366	1583	1171	928	14296	1272	5314	4865
751	8721	3203	5555	21272	3261	2548	1324	1669	14688	2003	8680	6630
1001	10176	3332	5405	25924	2719	2847	1333	1875	14738	2273	9662	7299

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
100	483	250	413	873	662	104	85	108	816	106	566	406
250	1846	761	1118	3800	1039	387	253	428	2124	390	2117	1297
751	4304	1954	3232	8088	4172	930	705	994	6239	921	5042	3326
1001	6689	2815	4405	13126	4712	1425	995	1557	8430	1410	7753	4847

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
100	1789	927	1531	3236	2453	384	317	400	3024	393	2097	1505
250	2737	1128	1657	5633	1540	574	375	635	3149	579	3138	1922
751	2127	966	1597	3997	2062	459	349	491	3083	455	2491	1643
1001	2479	1043	1633	4865	1747	528	369	577	3124	523	2874	1796

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
100	0.0029	0.0044	126	0.38	0.046	0.0009	30	0.035	0.0007	0.0159	0.0009	0.0022	0.0075	0.0005	0.0032	0.0165	0.0067
250	0.0015	0.0025	165	0.50	0.049	0.0006	30	0.036	0.0004	0.0159	0.0005	0.0012	0.0075	0.0003	0.0016	0.0165	0.0064
751	0.0007	0.0013	229	0.70	0.052	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0006	0.0075	0.0002	0.0007	0.0165	0.0062
1001	0.0005	0.0011	249	0.76	0.053	0.0003	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0075	0.0002	0.0006	0.0165	0.0062

Drop Structures

Design Slope	0.0060	ft/ft
Total Drop Needed	127.6	ft
Height of Drop Structure	3	ft
No . of Drop Structures	43	
Distance between structs.	281	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.81	sq. mi
Total Sediment Yield Volume	1.55	ac ft

Sedimentation Basins

Length	281 ft	Depth	3 ft
Width	227 ft	Side slope	3 ft/ft
Total Volume per Basin		4.09	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		2	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
100	1.1	-0.4	0.1	24.6	1.1	1.0	2.6	0.0060	0.1	1.5	2.5	5.4
250	1.1	-0.6	0.2	24.6	1.9	1.7	3.6	0.0060	0.2	1.5	2.5	5.6
751	1.1	-1.0	0.1	24.6	3.3	1.2	3.0	0.0060	0.4	1.5	2.5	5.7
1001	1.1	-1.0	0.1	24.6	3.5	1.5	3.3	0.0060	0.4	1.5	2.5	5.8

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	69	cfs
Stage at Peak Flow	100.2	ft
Flow Volume	27.0	ac. ft

Freeboard

Max. Flow Depth	1.1	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.4	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	1.59	ac. ft
Outflowing Sediment Volume	0.02	ac. ft
Deposited(+)/Eroded(-) Volume	1.57	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	12097	12097
Side Slope (?H:1V)	3	3
Channel Width (ft)	227	227
Channel XS Area (sq. ft)	1054.5	1054.5
Channel Perimeter (ft)	229	229

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	12097	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	4032	sq. Yd
Volume	12097	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	12097	12097
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	56453	116938
Left Levee Volume (cu. Yd)	55557	130827
Right Levee Length (ft)	12097	12097
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	56453	116938
Right Levee Volume (cu. Yd)	55557	130827
Total Levee Surface Area (sq. Yd)	112906	233876
Total Levee Volume (cu. Yd)	111114	261654

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	12097	12097
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	18818	44356
Left Levee Lining Volume (cu. Yd)	9409	22178
Right Levee Length (ft)	12097	12097
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	18818	44356
Right Levee Lining Volume (cu. Yd)	9409	22178
Total Lining Area (sq. Yd)	37635	88711
Total Lining Volume (cu. Yd)	18818	44356

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	227	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	5.8	ft
Structure Height	8.8	ft
Number of Structures	43	
Volume per structure	222	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 16,650	
Area per structure	76	sq. Yd
Total Area	3,254	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	2	
Total Volume per Basin	6599	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 26,396	
Other Cost	$ -	
Total cost per basin	$ 26,396	
Area per basin	7,096	sq. Yd
Total Area	14,192	sq. Yd

Structure Cost

Structure Type	Structure Type	Excavation/Construction Quantity	Units	Unit Cost	Cost Subtotal	Landscape Quantity	Units	Unit Cost	Landscape Cost	Maintenance Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	111,114	cu. Yd	$ 7.00	$ 777,798	112,906	sq. Yd	$ 9.00	$ 1,016,154	112,906	sq. Yd	$ 11.67	$ 1,317,237
Levee - LC Enhancement	Fill	150,540	cu. Yd	$ 7.00	$ 1,053,780	120,970	sq. Yd	$ 9.00	$ 1,088,730	150,540	sq. Yd	$ 11.67	$ 1,756,300
Levee Lining	Riprap	18,818	cu. Yd	$ 75.00	$ 1,411,350	37,635	sq. Yd	$ -	$ -	37,635	sq. Yd	$ 20.83	$ 784,065
Levee Lining -LC Enhancement	Riprap	25,538	cu. Yd	$ 75.00	$ 1,915,350	51,076	sq. Yd	$ -	$ -	51,076	sq. Yd	$ 20.83	$ 1,064,088
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	12,097	cu. Yd	$ 75.00	$ 907,275	4,032	sq. Yd	$ -	$ -	4,032	sq. Yd	$ 25.00	$ 100,800
Drop Structures	Riprap	43	EA	$ 16,650.00	$ 715,950	3,254	sq. Yd	$ -	$ -	3,254	sq. Yd	$ 33.33	$ 108,467
Drop Str. - LC Enhancement	Riprap	43	EA	$ 1,665.00	$ 71,595	325	sq. Yd	$ -	$ -	325	sq. Yd	$ 33.33	$ 10,847
Sedimentation Basins		2	EA	$ 26,396.00	$ 52,792	14,192	sq. Yd	$ -	$ -	14,192	sq. Yd	$ 8.33	$ 118,267
Other					$ -				$ -				$ -

Base Landscape Cost	$ 1,016,154	Base Maintenance Cost	$ 2,428,835
LC Enhancement Cost	$ 1,088,730	LC Enhancement Cost	$ 2,831,235
Total Landscape Cost	$ 2,104,884	Total Maintenance Cost	$ 5,260,069

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 3,865,165	$ 3,040,725	$ 6,905,890
Contingency Cost (25% of Construction Cost)	$ 966,291	$ 760,181	$ 1,726,473
Engineering Design Cost (5% of Construction Cost)	$ 193,258	$ 152,036	$ 345,295
Total Construction Cost	$ 5,024,715	$ 3,952,943	$ 8,977,657

Land Cost

Channel Length	12097 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	227	63	$100,000	$ 6,300,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	15.3	$100,000	$ 1,530,000
Levee LC Enhancement	51	14.2	$100,000	$ 1,420,000
Other	0	0	$100,000	$ -
Total	333	92.5		$ 9,250,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	78.3	$100,000	$ 7,830,000
LC Enhancement Cost	acre	14.2	$100,000	$ 1,420,000
Total Land Cost	acre	92.5	$100,000	$ 9,250,000

Total Cost

Base Total Cost	$ 16,299,703
Total Landscape Enhancement Cost	$ 9,292,907
Total Cost Including LC Enh.	$ 25,592,610

Online Basin

HEC1 ID	RR150

HEC1 Results Used to Determine Sediment Volume From Upstream

Contributing HEC1 ID							Total Volume (ac. ft)
Inflow Volume (ac. ft)							0
Volume Fraction							
Weighted Volume							0
Sediment Conc. (ppm)							
Sediment Volume (ac. ft)							0.00
Weighting Factor							
Weighted Sed. Vol. (ac. ft)							0.00

Sediment Yield

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.9	sq. mi
Total Sediment Yield Volume	1.7	ac ft

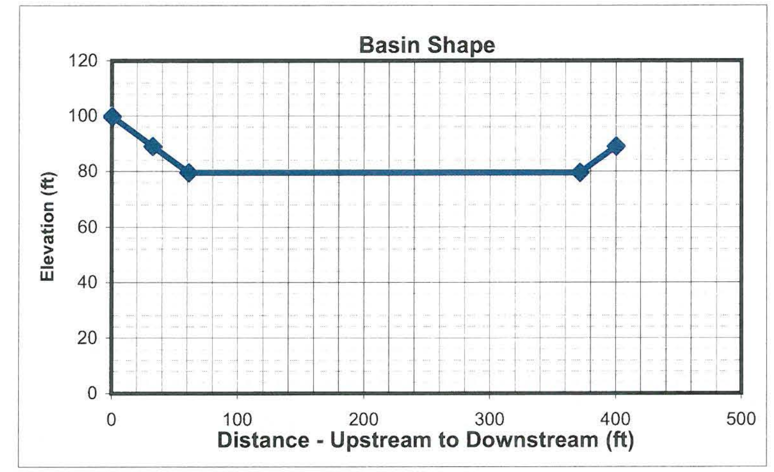
Required Minimum Sediment Volume

Sediment Volume	1.7	ac. ft

Geometry

	Base	LC Enhanced
Topography slope (ft/ft)	0.027	0.027
Basin Length (ft)	800	1010
Basin Width (ft)	400	400
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	9.5	9.5
Freeboard (ft)	1	1
Effective Basin Width (ft)	368	335
Top Area (acres)	7.3	9.3
U/S-D/S Height Difference (ft)	10.8	10.8
Excess Area on Upstream (acres)	0.6	1.5

			Base	LC Enhanced
Bottom Length (ft)	743	Allocated Storage Volume (ac. ft)	50.5	50.4
Bottom Width (ft)	311	Total Available Volume (ac. ft) (incl. Freeboard)	57.2	58
		Total Excavation Volume (ac. ft)	96.9	108.1



HEC1 Results

	6-hr Event	24-hr Event	Maximum
Total Flow Volume entering Basin (ac. ft)	62.0	57	62.0
Peak Inflow (cfs)	836	729	836.0
Peak Outflow (cfs)	97	89	97.0
Stage at Peak Outflow (ft)	8.2	6.9	8.2
Volume at Peak Outflow (ac. ft)	48.3	39.9	48.3

Volume Check

Total Volume needed	50.0	ac. ft
Total Volume Provided	50.5	ac. ft
Volume OK?	Yes	

Stage Check

Depth Needed	9.2	ft
Depth Provided	9.5	ft
Depth OK?	Yes	

Basin Outlet

Outlet Coeff	0.60	(0.6 for Orifice, 3.0 for Weir)
D (Orifice) or W (Weir)	3.00	ft
Invert Elevation	0.00	ft
Number of pipes	1	

Stage-Storage-Discharge

Elevation	0	1	3	5	6	7	8	9	10	12
Volume	0.00	5.38	16.57	28.37	34.50	40.78	47.22	53.82	60.58	74.59
Outflow	0.0	34.0	59.0	76.1	83.4	90.0	96.3	102.1	107.6	117.9

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
LC Enhancement Buffer	235000	sq. ft
Other		sq. ft

Additional ROW Length	0	ft
Additional ROW Width	0	ft
Landscaping Buffer Length	100	ft
Landscaping Buffer Width	100	ft

Base Total ROW Length	800	ft
Base Total ROW Width	400	ft
LC Enh. Total ROW Length	1110	ft
LC Enh. Total ROW Length	500	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	156332	174401
Excavated Area (sq. Yd)	35556	61667

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	64	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	713	sq. Yd
Material Volume	357	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	432	ft
Unit Cost	160	per ft
Cost per outlet	$69,120	
Other Cost	$ -	
Total Cost	$69,120	
Outlet Area	133	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Basin		156,332	cu. Yd	$ 4.00	$ 625,328	35,556	sq. Yd	$ 9.00	$ 320,004	35,556	sq. Yd	$ 8.33	$ 296,300
Basin - LC Enhancement		18,069	cu. Yd	$ 4.00	$ 72,276	26,111	sq. Yd	$ 9.00	$ 234,999	26,111	sq. Yd	$ 8.33	$ 217,592
Inlet	Riprap	357	sq. Yd	$ 75.00	$ 26,775	713	sq. Yd	$ -	$ -	713	sq. Yd	$ 33.33	$ 23,767
Inlet - LC Enhancement (20%Inlet)					$ 5,355				$ -				$ 4,753
Outlet	Pipe	1	EA	$ 69,120	$ 69,120	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhancement (5% Outlet)					$ 3,456				$ -				$ 111
Other					$ -				$ -				$ -

Base Landscape Cost	$ 320,004	Base Maintenance Cost	$ 322,283
LC Enh. Landscape Cost	$ 234,999	LC Enh. Maintenance Cost	$ 222,456
Total Landscape Cost	$ 555,003	Total Maintenance Cost	$ 544,739

Construction Cost Component	**Base**	**LC Enhancement**	**Total**
Construction Cost	$ 721,223	$ 72,276	$ 793,499
Contingency Cost (25% of Construction Cost)	$ 180,306	$ 18,069	$ 198,375
Engineering Design Cost (5% of Construction Cost)	$ 36,061	$ 3,614	$ 39,675
Total Construction Cost	$ 937,590	$ 93,959	$ 1,031,549

Land Cost

Land Cost Component	**Area (acre)**	**Unit Cost**	**Cost**
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	5.4	$100,000	$ 540,000
Basin	7.3	$100,000	$ 730,000
Other		$100,000	$ -
Total	12.7	$100,000	$ 1,270,000

	Units	**Quantity**	**Unit Cost**	**Cost Subtotal**
Base Land Cost	acre	7.3	$100,000	$ 730,000
LC Enhancement Cost	acre	5.4	$100,000	$ 540,000
Total Land Cost	acre	12.7	$100,000	$ 1,270,000

Total Cost

Base Total Cost	$ 2,309,877
Total LC Enhancement Cost	$ 1,091,414
Total Cost Including LC Enh.	$ 3,401,291

Open Channel

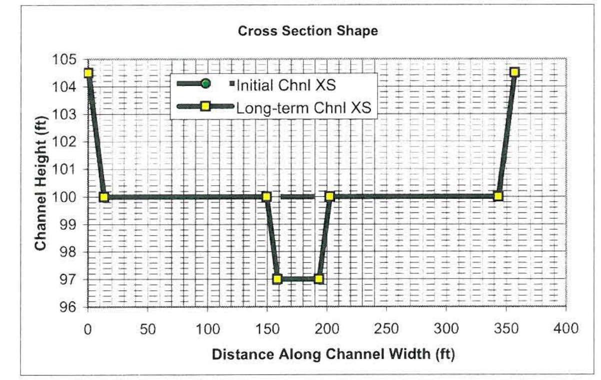
Structure ID	C155L10		HEC1 ID	150155

Longitundal Geometry

Length	15737.6	ft
U/S Elev	1757.2	ft
D/S Elev	1451.9	ft
Initial Channel Slope	0.0194	ft/ft
Long-term Channel Slope	0.0070	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	3



Initial Channel XS Geometry

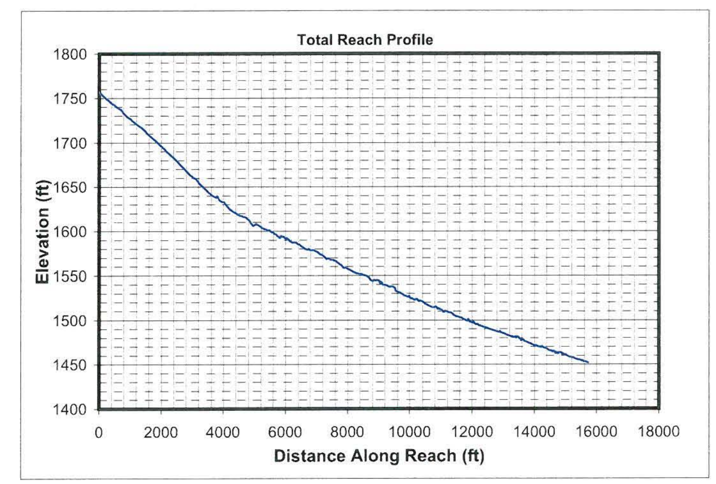
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	330	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	343.5	343.5	343.5	357
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	136	3	35	7.5	3	141	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	149.5	158.5	193.5	202.5	343.5	357
Y	104.5	100	100	97	97	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	C155L									TOTAL
HEC1 Peak-Flow	1774									1774
Weighting Factor	1.00									
Flow into Channel	1774									1774

Reach Sediment Inflow Characteristics

U/S Contributing ID										TOTAL
HEC1 Flow Volume (ac. ft)										0
Sediment Conc. (ppm)										
Sediment Volume (ac. ft)										0.00
Weighting Factor										
Weighted Sed. Vol. (ac. ft)										0.00

Hydrology

Drainage Area	2.61	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	1774	cfs	
Long-term Max. Chnl Capacity	12981	cfs	
Q2 Channel	177	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	357	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
177	331.7	91.1	0.3	100.0	100.3	1.9	0.3	331.7	0.3	0.12	0.65
444	333.0	158.1	0.5	100.0	100.5	2.8	0.5	332.9	0.5	0.21	0.72
1331	335.8	306.5	0.9	100.0	100.9	4.3	0.9	335.5	0.9	0.40	0.80
1774	336.9	364.8	1.1	100.0	101.1	4.9	1.1	336.6	1.1	0.48	0.82

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
177	43.9	55.0	1.3	97.0	98.4	3.2	1.4	43.4	1.3	0.61	0.50
444	50.1	100.6	2.0	97.0	99.4	4.4	2.4	49.3	2.0	1.04	0.54
1331	336.4	416.5	1.2	97.0	100.9	3.2	3.9	335.1	1.2	1.68	0.50
1774	337.9	495.9	1.5	97.0	101.1	3.6	4.1	336.6	1.5	1.79	0.52

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
177										0
444										0
1331										0
1774										0

Allowable Velocity

Channel Lining	Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
177	1.74	0.9971	0.9472	Erosive	Erosive	Erosive	0.2	Stable	6.1	Stable	Stable
444	1.74	1.1659	1.1076	Erosive	Erosive	Erosive	0.2	Stable	8.6	Stable	Stable
1331	1.74	1.3676	1.2992	Erosive	Erosive	Erosive	0.3	Stable	10.1	Stable	Stable
1774	1.74	1.4203	1.3493	Erosive	Erosive	Erosive	0.3	Stable	10.7	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	**177**	**444**	**1331**	**1774**	**177**	**444**	**1331**	**1774**	**177**	**444**	**1331**	**1774**
Bray - Equation #1	36	59	105	123	1.5	2.0	2.9	3.2	3.3	3.7	4.3	4.5
Bray - Equation #2	48	78	138	161	1.6	2.2	3.2	3.5	2.2	2.5	3.0	3.1
Hey	11	18	34	40	4.6	6.5	9.9	11.1				
Ackers & Charlton/Lacey	32	47	74	83					1.9	2.2	2.7	2.8
Parker	92	145	251	289	1.2	1.7	2.7	3.1				
Chang	68	120	232	276	0.0	-0.2	-0.7	-0.9				
Kellerhals	24	38	66	76	2.2	3.1	4.8	5.4	3.4	3.8	4.2	4.3
AMAFCA/Schumm	43	49	336	337								
Moody & Odem	18	18	18	18	1.1	1.1	1.1	1.1				
BUREC	17.4	24.5	37.0	41.2	5	7	10	11	3.5	4.3	5.7	6.1
Average	39	60	129	144	2.1	2.9	4.2	4.7	2.9	3.3	4.0	4.2
Values As Designed	43	49	335	337	1.4	2.4	3.9	4.1	3.2	4.4	3.2	3.6
Difference with Design	-5	10	-206	-192	0.7	0.5	0.4	0.6	-0.4	-1.1	0.8	0.6

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
177	1814	1185	2617	3447	5299	620	548	284	8369	590	1931	2428
444	7478	3808	7731	16326	7834	2588	1769	1454	21926	1979	8092	7362
1331	40840	13768	23345	105104	11853	12238	5765	7454	67122	9315	38445	30477
1774	63615	19015	30539	171022	13130	18220	7696	11076	89721	14082	56710	44984

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
177	3793	2478	5473	7209	11082	1296	1147	594	17501	1233	4038	5077
444	6255	3185	6467	13657	6553	2165	1479	1216	18342	1655	6769	6159
1331	11388	3839	6510	29307	3305	3413	1607	2079	18717	2597	10720	8498
1774	13304	3977	6387	35766	2746	3810	1609	2316	18764	2945	11860	9408

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
177	1324	595	930	2656	997	301	210	300	1885	288	1525	1001
444	5052	1720	2446	11524	1531	1052	564	1085	4813	1065	5402	3296
1331	9893	4199	7003	19550	7590	2250	1583	2236	14122	2137	11389	7450
1774	15401	6007	9661	31787	8524	3414	2200	3461	19017	3276	17387	10921

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
177	2769	1244	1945	5555	2084	630	438	627	3942	602	3189	2093
444	4226	1439	2046	9640	1280	880	472	907	4027	891	4519	2757
1331	2759	1171	1953	5451	2117	627	441	623	3938	596	3176	2077
1774	3221	1256	2020	6648	1783	714	460	724	3977	685	3636	2284

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
177	0.0028	0.0044	136	0.41	0.047	0.0009	30	0.036	0.0007	0.0159	0.0009	0.0022	0.0062	0.0004	0.0029	0.0193	0.0070
444	0.0014	0.0026	179	0.54	0.050	0.0006	30	0.036	0.0004	0.0159	0.0005	0.0012	0.0062	0.0002	0.0015	0.0194	0.0068
1331	0.0006	0.0013	248	0.76	0.053	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0006	0.0062	0.0001	0.0007	0.0194	0.0066
1774	0.0005	0.0011	270	0.82	0.053	0.0003	32	0.036	0.0002	0.0159	0.0002	0.0005	0.0062	0.0001	0.0005	0.0194	0.0066

Drop Structures

Design Slope	0.0070	ft/ft
Total Drop Needed	195.2	ft
Height of Drop Structure	3	ft
No . of Drop Structures	66	
Distance between structs.	238	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	1.72	sq. mi
Total Sediment Yield Volume	3.27	ac ft

Sedimentation Basins

Length	238 ft	Depth	3 ft
Width	357 ft	Side slope	3 ft/ft
Total Volume per Basin		5.50	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		2	

Scour and Toe Protection (Not applicable for concrete channel)

		Pima County General Scour Equations							Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
177	1.1	-0.4	0.1	24.6	1.4	1.3	3.2	0.0070	0.2	1.5	3.0	6.1
444	1.1	-0.6	0.3	24.6	2.4	2.0	4.4	0.0070	0.3	1.5	3.0	6.4
1331	1.1	-1.1	0.1	24.6	3.9	1.2	3.2	0.0070	0.4	1.5	3.0	6.5
1774	1.1	-1.1	0.2	24.6	4.1	1.5	3.6	0.0070	0.5	1.5	3.0	6.6

Toe Protection Needed	7.0	ft

HEC1 Results For Open Channel

Peak Flow	83	cfs
Stage at Peak Flow	100.1	ft
Flow Volume	62.0	ac. ft

Freeboard

Max. Flow Depth	1.1	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.4	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	3.27	ac. ft
Outflowing Sediment Volume	0.06	ac. ft
Deposited(+)/Eroded(-) Volume	3.20	ac. ft

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC

Sub-area: Wagner Wash, Alternative: B43
Open Channel Structure ID: C155L10

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	15738	15738
Side Slope (?H:1V)	3	3
Channel Width (ft)	357	357
Channel XS Area (sq. ft)	1677.8	1677.8
Channel Perimeter (ft)	359	359

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	15738	ft
Thickness	1.5	ft
Protection Depth	7	ft
Tie-in Length/Depth	3.0	ft
Total Depth	10.0	ft
Area needed	5246	sq. Yd
Volume	17487	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	15738	15738
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	73444	152134
Left Levee Volume (cu. Yd)	72278	170204
Right Levee Length (ft)	15738	15738
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	73444	152134
Right Levee Volume (cu. Yd)	72278	170204
Total Levee Surface Area (sq. Yd)	146888	304268
Total Levee Volume (cu. Yd)	144556	340408

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	15738	15738
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	24481	57706
Left Levee Lining Volume (cu. Yd)	12241	28853
Right Levee Length (ft)	15738	15738
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	24481	57706
Right Levee Lining Volume (cu. Yd)	12241	28853
Total Lining Area (sq. Yd)	48963	115412
Total Lining Volume (cu. Yd)	24482	57706

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	357	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	6.1	ft
Structure Height	9.1	ft
Number of Structures	66	
Volume per structure	360	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 27,000	
Area per structure	119	sq. Yd
Total Area	7,854	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	2	
Total Volume per Basin	8873	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 35,492	
Other Cost	$ -	
Total cost per basin	$ 35,492	
Area per basin	9,458	sq. Yd
Total Area	18,916	sq. Yd

Structure Type	Structure Type	Excavation/Construction Quantity	Units	Unit Cost	Cost Subtotal	Landscape Quantity	Units	Unit Cost	Landscape Cost	Maintenance Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	144,556	cu. Yd	$ 7.00	$ 1,011,892	146,888	sq. Yd	$ 9.00	$ 1,321,992	146,888	sq. Yd	$ 11.67	$ 1,713,693
Levee - LC Enhancement	Fill	195,852	cu. Yd	$ 7.00	$ 1,370,964	157,380	sq. Yd	$ 9.00	$ 1,416,420	195,852	sq. Yd	$ 11.67	$ 2,284,940
Levee Lining	Riprap	24,482	cu. Yd	$ 75.00	$ 1,836,150	48,963	sq. Yd	$ -	$ -	48,963	sq. Yd	$ 20.83	$ 1,020,056
Levee Lining -LC Enhancement	Riprap	33,224	cu. Yd	$ 75.00	$ 2,491,800	66,449	sq. Yd	$ -	$ -	66,449	sq. Yd	$ 20.83	$ 1,384,361
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	17,487	cu. Yd	$ 75.00	$ 1,311,525	5,246	sq. Yd	$ -	$ -	5,246	sq. Yd	$ 25.00	$ 131,150
Drop Structures	Riprap	66	EA	$ 27,000.00	$ 1,782,000	7,854	sq. Yd	$ -	$ -	7,854	sq. Yd	$ 33.33	$ 261,800
Drop Str. - LC Enhancement	Riprap	66	EA	$ 2,700.00	$ 178,200	785	sq. Yd	$ -	$ -	785	sq. Yd	$ 33.33	$ 26,180
Sedimentation Basins		2	EA	$ 35,492.00	$ 70,984	18,916	sq. Yd	$ -	$ -	18,916	sq. Yd	$ 8.33	$ 157,633
Other					$ -				$ -				$ -

Base Landscape Cost	$ 1,321,992
LC Enhancement Cost	$ 1,416,420
Total Landscape Cost	$ 2,738,412

Base Maintenance Cost	$ 3,284,332
LC Enhancement Cost	$ 3,695,481
Total Maintenance Cost	$ 6,979,813

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 6,012,551	$ 4,040,964	$ 10,053,515
Contingency Cost (25% of Construction Cost)	$ 1,503,138	$ 1,010,241	$ 2,513,379
Engineering Design Cost (5% of Construction Cost)	$ 300,628	$ 202,048	$ 502,676
Total Construction Cost	$ 7,816,316	$ 5,253,253	$ 13,069,570

Land Cost	
Channel Length	15738 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	357	129	$100,000	$ 12,900,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	19.9	$100,000	$ 1,990,000
Levee LC Enhancement	51	18.4	$100,000	$ 1,840,000
Other	0	0	$100,000	$ -
Total	463	167.3		$ 16,730,000

Right of Way		
Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	148.9	$100,000	$ 14,890,000
LC Enhancement Cost	acre	18.4	$100,000	$ 1,840,000
Total Land Cost	acre	167.3	$100,000	$ 16,730,000

Total Cost	
Base Total Cost	$ 27,312,641
Total Landscape Enhancement Cost	$ 12,205,154
Total Cost Including LC Enh.	$ 39,517,795

Online Basin

HEC1 ID	RR165

HEC1 Results Used to Determine Sediment Volume From Upstream

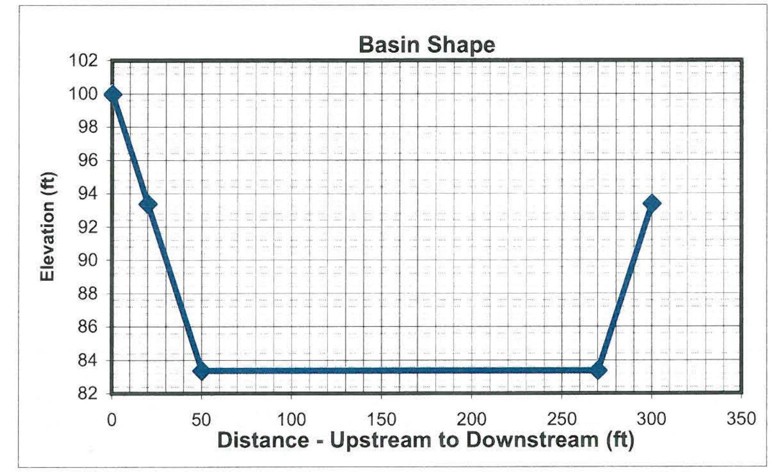
Contributing HEC1 ID							Total Volume (ac. ft)
Inflow Volume (ac. ft)							0
Volume Fraction							
Weighted Volume							0
Sediment Conc. (ppm)							
Sediment Volume (ac. ft)							0.00
Weighting Factor							
Weighted Sed. Vol. (ac. ft)							0.00

Sediment Yield

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.6	sq. mi
Total Sediment Yield Volume	1.2	ac ft

Required Minimum Sediment Volume

Sediment Volume	1.2	ac. ft



Geometry	Base	LC Enhanced
Topography slope (ft/ft)	0.022	0.022
Basin Length (ft)	800	1040
Basin Width (ft)	300	300
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	10	10
Freeboard (ft)	1	1
Effective Basin Width (ft)	280	260
Top Area (acres)	5.5	7.2
U/S-D/S Height Difference (ft)	6.6	6.6
Excess Area on Upstream (acres)	0.4	1.0

			Base	LC Enhanced
Bottom Length (ft)	740	Allocated Storage Volume (ac. ft)	39.2	39.2
Bottom Width (ft)	220	Total Available Volume (ac. ft) (incl. Freeboard)	44.3	45.3
		Total Excavation Volume (ac. ft)	62.5	68.9

HEC1 Results

	6-hr Event	24-hr Event	Maximum
Total Flow Volume entering Basin (ac. ft)	47.0	40	47.0
Peak Inflow (cfs)	1008	842	1008.0
Peak Outflow (cfs)	100	91	100.0
Stage at Peak Outflow (ft)	8.7	7.2	8.7
Volume at Peak Outflow (ac. ft)	37.6	30.3	37.6

Volume Check

Total Volume needed	38.8	ac. ft
Total Volume Provided	39.2	ac. ft
Volume OK?	Yes	

Stage Check

Depth Needed	9.7	ft
Depth Provided	10	ft
Depth OK?	Yes	

Basin Outlet

Outlet Coeff	0.60	(0.6 for Orifice, 3.0 for Weir)
D (Orifice) or W (Weir)	3.00	ft
Invert Elevation	0.00	ft
Number of pipes	1	

Stage-Storage-Discharge

Elevation	0	1	3	5	6	7	8	9	11	13
Volume	0.00	3.80	11.81	20.37	24.86	29.50	34.27	39.19	49.48	60.36
Outflow	0.0	34.0	59.0	76.1	83.4	90.0	96.3	102.1	112.9	122.7

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
LC Enhancement Buffer	216000	sq. ft
Other		sq. ft

Additional ROW Length	0	ft
Additional ROW Width	0	ft
Landscaping Buffer Length	100	ft
Landscaping Buffer Width	100	ft

Base Total ROW Length	800	ft
Base Total ROW Width	300	ft
LC Enh. Total ROW Length	1140	ft
LC Enh. Total ROW Length	400	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	100833	111159
Excavated Area (sq. Yd)	26667	50667

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	52	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	583	sq. Yd
Material Volume	292	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	588	ft
Unit Cost	160	per ft
Cost per outlet	$94,080	
Other Cost	$ -	
Total Cost	$94,080	
Outlet Area	133	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Basin		100,833	cu. Yd	$ 4.00	$ 403,332	26,667	sq. Yd	$ 9.00	$ 240,003	26,667	sq. Yd	$ 8.33	$ 222,225
Basin - LC Enhancement		10,326	cu. Yd	$ 4.00	$ 41,304	24,000	sq. Yd	$ 9.00	$ 216,000	24,000	sq. Yd	$ 8.33	$ 200,000
Inlet	Riprap	292	sq. Yd	$ 75.00	$ 21,900	583	sq. Yd	$ -	$ -	583	sq. Yd	$ 33.33	$ 19,433
Inlet - LC Enhancement (20%Inlet)					$ 4,380				$ -				$ 3,887
Outlet	Pipe	1	EA	$ 94,080	$ 94,080	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhancement (5% Outlet)					$ 4,704				$ -				$ 111
Other					$ -				$ -				$ -

Base Landscape Cost	$ 240,003	Base Maintenance Cost	$ 243,875
LC Enh. Landscape Cost	$ 216,000	LC Enh. Maintenance Cost	$ 203,998
Total Landscape Cost	$ 456,003	Total Maintenance Cost	$ 447,873

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 519,312	$ 41,304	$ 560,616
Contingency Cost (25% of Construction Cost)	$ 129,828	$ 10,326	$ 140,154
Engineering Design Cost (5% of Construction Cost)	$ 25,966	$ 2,065	$ 28,031
Total Construction Cost	$ 675,106	$ 53,695	$ 728,801

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	5.0	$100,000	$ 500,000
Basin	5.5	$100,000	$ 550,000
Other		$100,000	$ -
Total	10.5	$100,000	$ 1,050,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	5.5	$100,000	$ 550,000
LC Enhancement Cost	acre	5.0	$100,000	$ 500,000
Total Land Cost	acre	10.5	$100,000	$ 1,050,000

Total Cost

Base Total Cost	$ 1,708,984
Total LC Enhancement Cost	$ 973,693
Total Cost Including LC Enh.	$ 2,682,676

Open Channel

Structure ID	C17510A		HEC1 ID	165175

Longitundal Geometry

Length	7076.2	ft
U/S Elev	1674.9	ft
D/S Elev	1546.4	ft
Initial Channel Slope	0.0182	ft/ft
Long-term Channel Slope	0.0070	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	8

Initial Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	140	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	153.5	153.5	153.5	167
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	48	3	30	6.5	3	50	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	61.5	67.5	97.5	103.5	153.5	167
Y	104.5	100	100	98	98	100	100	104.5

Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	RR165	S170								TOTAL
HEC1 Peak-Flow	100	1802								1902
Weighting Factor	1.00	0.41								
Flow into Channel	100	740								840

Reach Sediment Inflow Characteristics

U/S Contributing ID										TOTAL
HEC1 Flow Volume (ac. ft)										0
Sediment Conc. (ppm)										
Sediment Volume (ac. ft)										0.00
Weighting Factor										
Weighted Sed. Vol. (ac. ft)										0.00

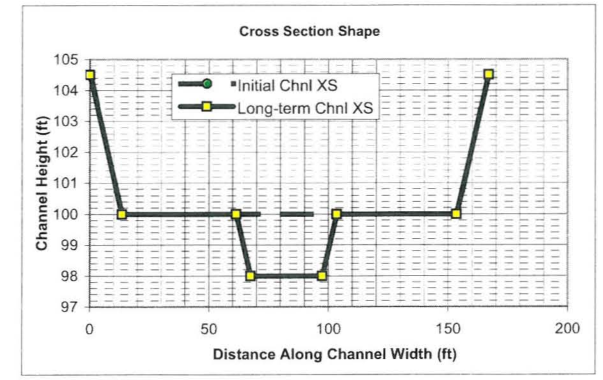
Hydrology

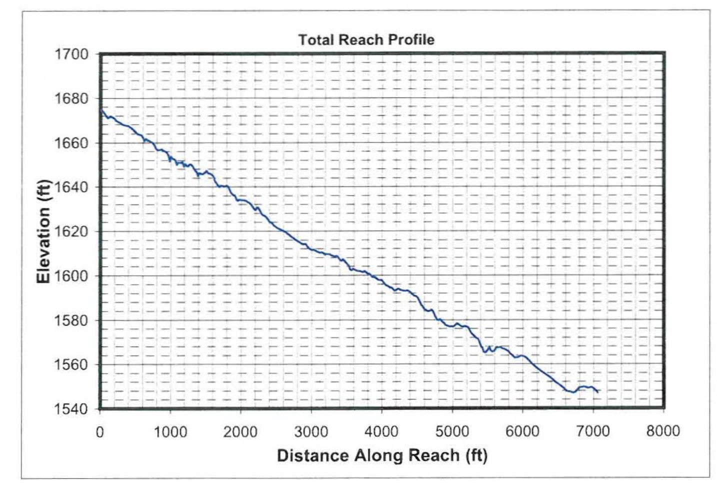
Drainage Area	1.221	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	840	cfs	
Long-term Max. Chnl Capacity	5768	cfs	
Q2 Channel	84	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	167	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			





JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

Sub-area: Wagner Wash, Alternative: B43
Open Channel Structure ID: C17510A

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
84	141.9	42.3	0.3	100.0	100.3	2.0	0.3	141.8	0.3	0.13	0.64
210	143.3	73.4	0.5	100.0	100.5	2.9	0.5	143.1	0.5	0.23	0.70
630	146.3	143.2	1.0	100.0	101.0	4.4	1.0	146.0	1.0	0.44	0.78
840	147.5	170.7	1.2	100.0	101.2	4.9	1.2	147.1	1.2	0.52	0.80

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
84	36.2	32.6	0.9	98.0	99.0	2.6	1.0	35.9	0.9	0.43	0.48
210	40.7	59.1	1.5	98.0	99.7	3.6	1.7	40.1	1.5	0.74	0.52
630	145.9	190.4	1.3	98.0	100.8	3.3	2.8	145.0	1.3	1.24	0.51
840	147.5	227.3	1.5	98.0	101.1	3.7	3.1	146.5	1.6	1.35	0.52

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
84										0
210										0
630										0
840										0

Allowable Velocity

Channel Lining	Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuosity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
84	1.74	1.0221	0.9710	Erosive	Erosive	Erosive	0.2	Stable	4.8	Stable	Stable
210	1.74	1.1897	1.1302	Erosive	Erosive	Erosive	0.3	Stable	6.9	Stable	Stable
630	1.74	1.3895	1.3200	Erosive	Erosive	Erosive	0.3	Stable	8.7	Stable	Stable
840	1.74	1.4413	1.3693	Erosive	Erosive	Erosive	0.3	Stable	9.4	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	**84**	**210**	**630**	**840**	**84**	**210**	**630**	**840**	**84**	**210**	**630**	**840**
Bray - Equation #1	25	40	71	83	1.2	1.6	2.3	2.5	2.9	3.3	3.9	4.1
Bray - Equation #2	32	52	93	109	1.3	1.7	2.5	2.7	2.0	2.3	2.7	2.8
Hey	7	12	22	26	3.5	4.9	7.5	8.3				
Ackers & Charlton/Lacey	23	34	54	61					1.7	2.0	2.3	2.5
Parker	63	100	172	199	0.9	1.3	2.0	2.3				
Chang	43	76	148	176	0.1	0.0	-0.3	-0.4				
Kellerhals	16	26	45	52	1.6	2.3	3.6	4.0	3.2	3.5	3.9	4.0
AMAFCA/Schumm	36	40	145	147								
Moody & Odem	13	13	13	13	1.0	1.0	1.0	1.0				
BUREC	13.1	18.5	28.0	31.2	4	5	7	8	2.9	3.6	4.7	5.1
Average	27	41	79	90	1.6	2.2	3.2	3.6	2.5	2.9	3.5	3.7
Values As Designed	36	40	145	147	1.0	1.7	2.8	3.1	2.6	3.6	3.3	3.7
Difference with Design	-9	1	-66	-57	0.6	0.5	0.4	0.5	0.0	-0.6	0.2	0.0

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
84	828	532	1158	1572	2292	276	243	133	3593	259	889	1071
210	3415	1707	3404	7418	3393	1147	779	669	9405	884	3697	3265
630	18438	6136	10224	47333	5173	5372	2522	3378	28784	4172	17422	13541
840	28640	8468	13380	76770	5747	7982	3366	5007	38473	6304	25655	19981

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
84	3657	2349	5116	6943	10123	1221	1073	587	15868	1145	3928	4728
210	6033	3017	6013	13106	5994	2027	1377	1182	16616	1561	6531	5769
630	10858	3614	6021	27874	3046	3163	1485	1989	16950	2457	10259	7974
840	12650	3740	5910	33907	2538	3525	1487	2212	16992	2784	11331	8825

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
84	463	243	421	851	653	106	87	100	866	105	539	403
210	1785	739	1131	3738	1016	397	256	402	2251	385	2023	1284
630	4898	2063	3341	9856	3407	1107	757	1108	6710	1056	5615	3629
840	7596	2935	4611	15955	3836	1670	1046	1701	9026	1615	8521	5319

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
84	2046	1073	1858	3760	2885	470	384	443	3827	462	2380	1781
210	3153	1306	1997	6604	1795	702	452	711	3976	680	3574	2268
630	2884	1215	1967	5804	2006	652	446	652	3951	622	3306	2137
840	3355	1297	2036	7047	1694	738	462	751	3987	713	3763	2349

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
84	0.0026	0.0041	137	0.42	0.047	0.0009	30	0.036	0.0006	0.0159	0.0009	0.0020	0.0080	0.0005	0.0029	0.0181	0.0072
210	0.0013	0.0024	180	0.55	0.050	0.0005	30	0.036	0.0004	0.0159	0.0005	0.0011	0.0080	0.0003	0.0015	0.0182	0.0069
630	0.0006	0.0012	248	0.76	0.053	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0006	0.0080	0.0002	0.0006	0.0181	0.0067
840	0.0005	0.0010	270	0.82	0.053	0.0003	32	0.036	0.0002	0.0159	0.0002	0.0005	0.0080	0.0002	0.0005	0.0181	0.0067

Drop Structures

Design Slope	0.0070	ft/ft
Total Drop Needed	79.0	ft
Height of Drop Structure	3	ft
No . of Drop Structures	27	
Distance between structs.	262	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.60	sq. mi
Total Sediment Yield Volume	1.14	ac ft

Sedimentation Basins

Length	262 ft	Depth	3 ft
Width	167 ft	Side slope	3 ft/ft
Total Volume per Basin		2.76	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		2	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
84	1.1	-0.3	0.1	24.6	1.0	0.9	2.6	0.0070	0.1	1.5	2.0	4.7
210	1.1	-0.5	0.2	24.6	1.7	1.5	3.6	0.0070	0.2	1.5	2.0	4.9
630	1.1	-0.8	0.1	24.6	2.8	1.3	3.3	0.0070	0.3	1.5	2.0	5.0
840	1.1	-0.8	0.2	24.6	3.1	1.6	3.7	0.0070	0.3	1.5	2.0	5.1

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	90	cfs
Stage at Peak Flow	100.3	ft
Flow Volume	47.0	ac. ft

Freeboard

Max. Flow Depth	1.2	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.3	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	1.14	ac. ft
Outflowing Sediment Volume	0.04	ac. ft
Deposited(+)/Eroded(-) Volume	1.10	ac. ft

JE FULLER HYDROLOGY & GEOMORPHOLOGY INC

Sub-area: Wagner Wash, Alternative: B43
Open Channel Structure ID: C17510A

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	7076	7076
Side Slope (?H:1V)	3	3
Channel Width (ft)	167	167
Channel XS Area (sq. ft)	762.8	762.8
Channel Perimeter (ft)	169	169

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	7076	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	2359	sq. Yd
Volume	7076	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	7076	7076
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	33021	68401
Left Levee Volume (cu. Yd)	32497	76526
Right Levee Length (ft)	7076	7076
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	33021	68401
Right Levee Volume (cu. Yd)	32497	76526
Total Levee Surface Area (sq. Yd)	66042	136802
Total Levee Volume (cu. Yd)	64994	153052

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	7076	7076
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	11007	25945
Left Levee Lining Volume (cu. Yd)	5504	12973
Right Levee Length (ft)	7076	7076
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	11007	25945
Right Levee Lining Volume (cu. Yd)	5504	12973
Total Lining Area (sq. Yd)	22014	51891
Total Lining Volume (cu. Yd)	11008	25946

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	167	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	6.4	ft
Structure Height	9.4	ft
Number of Structures	27	
Volume per structure	174	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 13,050	
Area per structure	56	sq. Yd
Total Area	1,503	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	2	
Total Volume per Basin	4453	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 17,812	
Other Cost	$ -	
Total cost per basin	$ 17,812	
Area per basin	4,863	sq. Yd
Total Area	9,726	sq. Yd

Structure Type	Structure Cost	Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	64,994	cu. Yd	$ 7.00	$ 454,958	66,042	sq. Yd	$ 9.00	$ 594,378	66,042	sq. Yd	$ 11.67	$ 770,490
Levee - LC Enhancement	Fill	88,058	cu. Yd	$ 7.00	$ 616,406	70,760	sq. Yd	$ 9.00	$ 636,840	88,058	sq. Yd	$ 11.67	$ 1,027,343
Levee Lining	Riprap	11,008	cu. Yd	$ 75.00	$ 825,600	22,014	sq. Yd	$ -	$ -	22,014	sq. Yd	$ 20.83	$ 458,630
Levee Lining -LC Enhancement	Riprap	14,938	cu. Yd	$ 75.00	$ 1,120,350	29,876	sq. Yd	$ -	$ -	29,876	sq. Yd	$ 20.83	$ 622,426
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	7,076	cu. Yd	$ 75.00	$ 530,700	2,359	sq. Yd	$ -	$ -	2,359	sq. Yd	$ 25.00	$ 58,975
Drop Structures	Riprap	27	EA	$ 13,050.00	$ 352,350	1,503	sq. Yd	$ -	$ -	1,503	sq. Yd	$ 33.33	$ 50,100
Drop Str. - LC Enhancement	Riprap	27	EA	$ 1,305.00	$ 35,235	150	sq. Yd	$ -	$ -	150	sq. Yd	$ 33.33	$ 5,010
Sedimentation Basins		2	EA	$ 17,812.00	$ 35,624	9,726	sq. Yd	$ -	$ -	9,726	sq. Yd	$ 8.33	$ 81,050
Other					$ -				$ -				$ -

Base Landscape Cost	$ 594,378
LC Enhancement Cost	$ 636,840
Total Landscape Cost	$ 1,231,218

Base Maintenance Cost	$ 1,419,245
LC Enhancement Cost	$ 1,654,779
Total Maintenance Cost	$ 3,074,024

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 2,199,232	$ 1,771,991	$ 3,971,223
Contingency Cost (25% of Construction Cost)	$ 549,808	$ 442,998	$ 992,806
Engineering Design Cost (5% of Construction Cost)	$ 109,962	$ 88,600	$ 198,561
Total Construction Cost	$ 2,859,002	$ 2,303,588	$ 5,162,590

Land Cost

Channel Length	7076 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	167	27.1	$100,000	$ 2,710,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	8.9	$100,000	$ 890,000
Levee LC Enhancement	51	8.3	$100,000	$ 830,000
Other	0	0	$100,000	$ -
Total	273	44.3		$ 4,430,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	36	$100,000	$ 3,600,000
LC Enhancement Cost	acre	8.3	$100,000	$ 830,000
Total Land Cost	acre	44.3	$100,000	$ 4,430,000

Total Cost

Base Total Cost	$ 8,472,624
Total Landscape Enhancement Cost	$ 5,425,208
Total Cost Including LC Enh.	$ 13,897,832

Open Channel

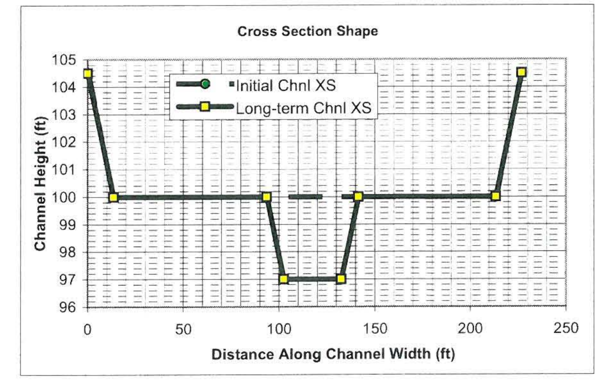
Structure ID	C17510B		HEC1 ID	165175

Longitundal Geometry

Length	6169.2	ft
U/S Elev	1546.4	ft
D/S Elev	1462.9	ft
Initial Channel Slope	0.0135	ft/ft
Long-term Channel Slope	0.0050	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	8



Initial Channel XS Geometry

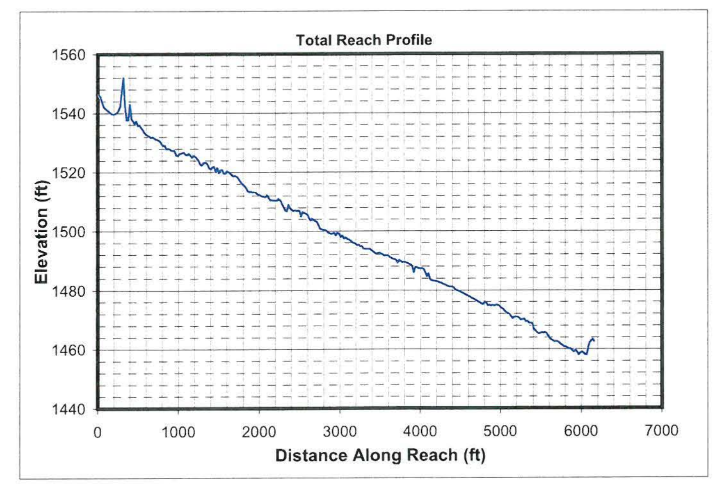
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	200	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	213.5	213.5	213.5	227
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	80	3	30	7.5	3	72	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	93.5	102.5	132.5	141.5	213.5	227
Y	104.5	100	100	97	97	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	C175									TOTAL
HEC1 Peak-Flow	1274									1274
Weighting Factor	1.00									
Flow into Channel	1274									1274

Reach Sediment Inflow Characteristics

U/S Contributing ID	165175_C17510A									TOTAL
HEC1 Flow Volume (ac. ft)	47.00									47
Sediment Conc. (ppm)	2349									
Sediment Volume (ac. ft)	0.04									0.04
Weighting Factor	1									
Weighted Sed. Vol. (ac. ft)	0.04									0.04

Hydrology

Drainage Area	2.42	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	1274	cfs	
Long-term Max. Chnl Capacity	7078	cfs	
Q2 Channel	127	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	227	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

Sub-area: Wagner Wash, Alternative: B43
Open Channel Structure ID: C17510B

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
127	202.1	68.2	0.3	100.0	100.3	1.9	0.3	202.0	0.3	0.11	0.57
319	203.7	118.5	0.6	100.0	100.6	2.7	0.6	203.5	0.6	0.18	0.62
956	207.2	230.7	1.1	100.0	101.1	4.1	1.1	206.8	1.1	0.35	0.69
1274	208.5	274.9	1.3	100.0	101.3	4.6	1.3	208.1	1.3	0.42	0.71

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
127	38.8	47.5	1.2	97.0	98.4	2.7	1.4	38.3	1.2	0.43	0.42
319	44.9	87.3	1.9	97.0	99.4	3.6	2.4	44.1	2.0	0.73	0.46
956	207.0	311.1	1.5	97.0	101.0	3.1	4.0	205.7	1.5	1.23	0.44
1274	208.9	371.0	1.8	97.0	101.2	3.4	4.2	207.5	1.8	1.32	0.45

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
	165175_C17510A									
127	403									403
319	1284									1284
956	3629									3629
1274	5319									5319

Allowable Velocity

Channel Lining	Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow) Permissive Velocity (ft/s)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
						Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
127	1.74	1.0608	1.0077	Erosive	Erosive	Erosive	0.2	Stable	5.1	Stable	Stable
319	1.74	1.2288	1.1673	Erosive	Erosive	Erosive	0.3	Stable	7.2	Stable	Stable
956	1.74	1.4292	1.3578	Erosive	Erosive	Erosive	0.3	Stable	8.9	Stable	Stable
1274	1.74	1.4814	1.4073	Erosive	Erosive	Erosive	0.3	Stable	9.5	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	**127**	**319**	**956**	**1274**	**127**	**319**	**956**	**1274**	**127**	**319**	**956**	**1274**
Bray - Equation #1	31	50	89	103	1.3	1.8	2.6	2.9	3.1	3.5	4.1	4.3
Bray - Equation #2	40	65	116	135	1.5	2.0	2.9	3.1	2.1	2.4	2.8	3.0
Hey	9	15	28	33	4.1	5.8	8.7	9.8				
Ackers & Charlton/Lacey	28	41	64	73					1.8	2.1	2.5	2.6
Parker	78	123	212	245	1.0	1.5	2.4	2.7				
Chang	50	87	171	203	0.2	0.1	-0.3	-0.4				
Kellerhals	20	32	56	64	1.9	2.7	4.2	4.7	3.3	3.6	4.1	4.2
AMAFCA/Schumm	38	44	206	208								
Moody & Odem	17	17	17	17	1.1	1.1	1.1	1.1				
BUREC	16.4	23.1	34.8	38.8	4	6	9	10	2.8	3.5	4.6	5.0
Average	33	50	99	112	1.9	2.6	3.9	4.3	2.6	3.0	3.6	3.8
Values As Designed	38	44	206	207	1.4	2.4	4.0	4.2	2.7	3.6	3.1	3.4
Difference with Design	-6	6	-106	-95	0.5	0.3	-0.1	0.0	-0.1	-0.6	0.6	0.4

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
127	866	556	1122	1535	2866	238	226	129	3402	256	919	1101
319	3573	1865	3571	7254	4314	1081	799	711	9080	894	3990	3376
956	19346	6903	11341	46422	6645	5197	2698	3771	28010	4321	19498	14014
1274	30079	9577	14719	75373	7392	7738	3623	5636	37475	6566	28947	20648

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
127	2521	1619	3267	4471	8347	694	658	377	9907	746	2675	3208
319	4162	2172	4159	8450	5025	1260	930	828	10577	1042	4647	3932
956	7512	2680	4404	18025	2580	2018	1048	1464	10876	1678	7570	5441
1274	8759	2789	4286	21949	2153	2253	1055	1641	10913	1912	8430	6013

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
127	531	270	422	947	685	106	87	124	788	113	628	427
319	2011	819	1144	4071	1088	392	258	483	2052	416	2332	1370
956	4834	2145	3327	8989	4235	967	728	1164	6039	1001	5708	3558
1274	7506	3084	4540	14572	4786	1479	1026	1809	8159	1537	8764	5206

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
127	1547	786	1230	2758	1996	308	254	362	2294	329	1830	1245
319	2343	954	1333	4742	1267	457	301	563	2391	484	2717	1595
956	1877	833	1292	3490	1644	375	283	452	2345	389	2216	1381
1274	2186	898	1322	4244	1394	431	299	527	2376	448	2552	1516

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
127	0.0025	0.0036	126	0.38	0.046	0.0007	30	0.035	0.0006	0.0159	0.0008	0.0018	0.0069	0.0004	0.0027	0.0135	0.0057
319	0.0012	0.0021	165	0.50	0.049	0.0005	30	0.036	0.0003	0.0159	0.0004	0.0010	0.0069	0.0003	0.0014	0.0135	0.0054
956	0.0006	0.0011	229	0.70	0.052	0.0003	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0069	0.0002	0.0006	0.0135	0.0053
1274	0.0004	0.0009	249	0.76	0.053	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0004	0.0069	0.0001	0.0005	0.0135	0.0053

Drop Structures

Design Slope	0.0050	ft/ft
Total Drop Needed	52.7	ft
Height of Drop Structure	3	ft
No . of Drop Structures	18	
Distance between structs.	343	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	1.80	sq. mi
Total Sediment Yield Volume	3.42	ac ft

Sedimentation Basins

Length	343 ft	Depth	3 ft
Width	227 ft	Side slope	3 ft/ft
Total Volume per Basin		5.01	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		3	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
127	1.1	-0.4	0.1	24.6	1.4	1.2	2.7	0.0050	0.1	1.5	3.0	6.1
319	1.1	-0.7	0.2	24.6	2.4	2.0	3.6	0.0050	0.3	1.5	3.0	6.3
956	1.1	-1.2	0.1	24.6	4.0	1.5	3.1	0.0050	0.4	1.5	3.0	6.5
1274	1.1	-1.2	0.2	24.6	4.2	1.8	3.4	0.0050	0.5	1.5	3.0	6.6

Toe Protection Needed	7.0	ft

HEC1 Results For Open Channel

Peak Flow	90	cfs
Stage at Peak Flow	100.3	ft
Flow Volume	47.0	ac. ft

Freeboard

Max. Flow Depth	1.3	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.2	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	3.46	ac. ft
Outflowing Sediment Volume	0.03	ac. ft
Deposited(+)/Eroded(-) Volume	3.43	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	6169	6169
Side Slope (?H:1V)	3	3
Channel Width (ft)	227	227
Channel XS Area (sq. ft)	1077.8	1077.8
Channel Perimeter (ft)	229	229

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	6169	ft
Thickness	1.5	ft
Protection Depth	7	ft
Tie-in Length/Depth	3.0	ft
Total Depth	10.0	ft
Area needed	2056	sq. Yd
Volume	6854	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	6169	6169
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	28789	59634
Left Levee Volume (cu. Yd)	28332	66717
Right Levee Length (ft)	6169	6169
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	28789	59634
Right Levee Volume (cu. Yd)	28332	66717
Total Levee Surface Area (sq. Yd)	57578	119268
Total Levee Volume (cu. Yd)	56664	133434

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	6169	6169
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	9596	22620
Left Levee Lining Volume (cu. Yd)	4798	11310
Right Levee Length (ft)	6169	6169
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	9596	22620
Right Levee Lining Volume (cu. Yd)	4798	11310
Total Lining Area (sq. Yd)	19192	45239
Total Lining Volume (cu. Yd)	9596	22620

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	227	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	6.6	ft
Structure Height	9.6	ft
Number of Structures	18	
Volume per structure	243	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 18,225	
Area per structure	76	sq. Yd
Total Area	1,362	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	3	
Total Volume per Basin	8083	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 32,332	
Other Cost	$ -	
Total cost per basin	$ 32,332	
Area per basin	8,644	sq. Yd
Total Area	25,932	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	56,664	cu. Yd	$ 7.00	$ 396,648	57,578	sq. Yd	$ 9.00	$ 518,202	57,578	sq. Yd	$ 11.67	$ 671,743
Levee - LC Enhancement	Fill	76,770	cu. Yd	$ 7.00	$ 537,390	61,690	sq. Yd	$ 9.00	$ 555,210	76,770	sq. Yd	$ 11.67	$ 895,650
Levee Lining	Riprap	9,596	cu. Yd	$ 75.00	$ 719,700	19,192	sq. Yd	$ -	$ -	19,192	sq. Yd	$ 20.83	$ 399,843
Levee Lining -LC Enhancement	Riprap	13,024	cu. Yd	$ 75.00	$ 976,800	26,047	sq. Yd	$ -	$ -	26,047	sq. Yd	$ 20.83	$ 542,644
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	6,854	cu. Yd	$ 75.00	$ 514,050	2,056	sq. Yd	$ -	$ -	2,056	sq. Yd	$ 25.00	$ 51,400
Drop Structures	Riprap	18	EA	$ 18,225.00	$ 328,050	1,362	sq. Yd	$ -	$ -	1,362	sq. Yd	$ 33.33	$ 45,400
Drop Str. - LC Enhancement	Riprap	18	EA	$ 1,822.50	$ 32,805	136	sq. Yd	$ -	$ -	136	sq. Yd	$ 33.33	$ 4,540
Sedimentation Basins		3	EA	$ 32,332.00	$ 96,996	25,932	sq. Yd	$ -	$ -	25,932	sq. Yd	$ 8.33	$ 216,100
Other					$ -				$ -				$ -

Base Landscape Cost	$ 518,202	
LC Enhancement Cost	$ 555,210	
Total Landscape Cost	$ 1,073,412	

Base Maintenance Cost	$ 1,384,486
LC Enhancement Cost	$ 1,442,834
Total Maintenance Cost	$ 2,827,319

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 2,055,444	$ 1,546,995	$ 3,602,439
Contingency Cost (25% of Construction Cost)	$ 513,861	$ 386,749	$ 900,610
Engineering Design Cost (5% of Construction Cost)	$ 102,772	$ 77,350	$ 180,122
Total Construction Cost	$ 2,672,077	$ 2,011,094	$ 4,683,171

Land Cost

Channel Length	6169 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	227	32.1	$100,000	$ 3,210,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	7.8	$100,000	$ 780,000
Levee LC Enhancement	51	7.2	$100,000	$ 720,000
Other	0	0	$100,000	$ -
Total	333	47.1		$ 4,710,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	39.9	$100,000	$ 3,990,000
LC Enhancement Cost	acre	7.2	$100,000	$ 720,000
Total Land Cost	acre	47.1	$100,000	$ 4,710,000

Total Cost

Base Total Cost	$ 8,564,765
Total Landscape Enhancement Cost	$ 4,729,137
Total Cost Including LC Enh.	$ 13,293,902

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

Sub-area: Wagner Wash, Alternative: B43
Open Channel Structure ID: C17510B

Open Channel

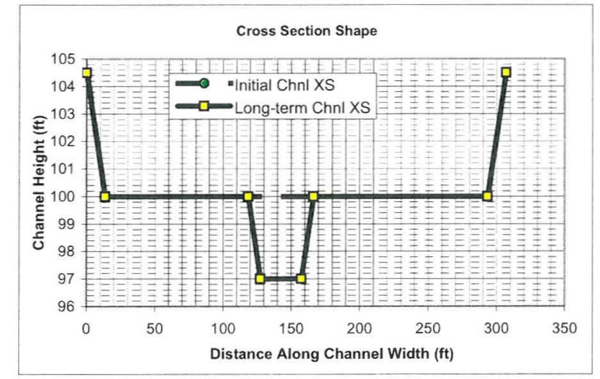
Structure ID	RR17510		HEC1 ID	175R

Longitundal Geometry

Length	3035.2	ft
U/S Elev	1462.9	ft
D/S Elev	1413.1	ft
Initial Channel Slope	0.0164	ft/ft
Long-term Channel Slope	0.0060	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	2



Initial Channel XS Geometry

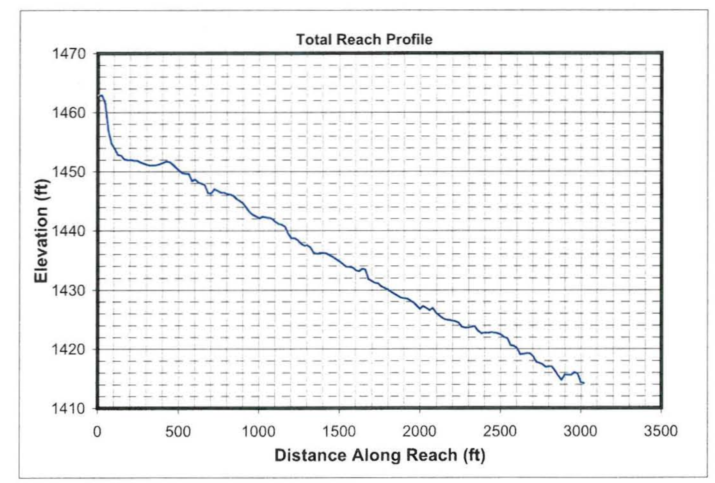
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	280	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	293.5	293.5	293.5	307
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	105	3	30	7.5	3	127	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	118.5	127.5	157.5	166.5	293.5	307
Y	104.5	100	100	97	97	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	C175	S190							TOTAL
HEC1 Peak-Flow	1274	2590							3864
Weighting Factor	1.00	0.05							
Flow into Channel	1274	119							1393

Reach Sediment Inflow Characteristics

U/S Contributing ID	165175_C17510B								TOTAL
HEC1 Flow Volume (ac. ft)	47.00								47
Sediment Conc. (ppm)	1595								
Sediment Volume (ac. ft)	0.03								0.03
Weighting Factor	1								
Weighted Sed. Vol. (ac. ft)	0.03								0.03

Hydrology

Drainage Area	2.607	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	1393	cfs	
Long-term Max. Chnl Capacity	10268	cfs	
Q2 Channel	139	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	307	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
139	281.7	77.7	0.3	100.0	100.3	1.8	0.3	281.7	0.3	0.10	0.60
348	283.0	134.8	0.5	100.0	100.5	2.6	0.5	282.9	0.5	0.18	0.66
1045	285.8	261.5	0.9	100.0	100.9	4.0	0.9	285.5	0.9	0.35	0.74
1393	286.9	311.2	1.1	100.0	101.1	4.5	1.1	286.6	1.1	0.41	0.76

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
139	38.8	47.5	1.2	97.0	98.4	2.9	1.4	38.3	1.2	0.52	0.46
348	44.9	87.2	1.9	97.0	99.4	4.0	2.4	44.1	2.0	0.88	0.50
1045	286.3	353.7	1.2	97.0	100.8	3.0	3.8	285.0	1.2	1.44	0.47
1393	287.8	421.3	1.5	97.0	101.1	3.3	4.1	286.4	1.5	1.53	0.48

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
	165175_C17510B									
139	427									427
348	1370									1370
1045	3558									3558
1393	5206									5206

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow): Permissive Velocity (ft/s): Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	BUREC: Erosive?	Neill (gravel/cobble): Non-cohesive: Erosive?	All'ble Vel (ft/s)	Cohesive: Erosive?	All'ble Vel (ft/s)	USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
139	1.74	0.9982	0.9483	Erosive	Erosive	Erosive	0.2	Stable	5.6	Stable	Stable
348	1.74	1.1669	1.1085	Erosive	Erosive	Erosive	0.2	Stable	7.9	Stable	Stable
1045	1.74	1.3683	1.2999	Erosive	Erosive	Erosive	0.3	Stable	9.3	Stable	Stable
1393	1.74	1.4209	1.3499	Erosive	Erosive	Erosive	0.3	Stable	9.9	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

Discharge (cfs)	Channel Width (ft): 139	348	1045	1393	Flow Depth (ft): 139	348	1045	1393	Velocity (ft/s): 139	348	1045	1393
Bray - Equation #1	32	52	93	108	1.4	1.9	2.7	3.0	3.2	3.6	4.2	4.4
Bray - Equation #2	42	68	122	142	1.5	2.0	2.9	3.2	2.2	2.5	2.9	3.0
Hey	9	16	30	35	4.2	6.0	9.0	10.1				
Ackers & Charlton/Lacey	29	42	67	75					1.8	2.1	2.6	2.7
Parker	81	128	222	256	1.1	1.6	2.5	2.8				
Chang	56	98	191	227	0.1	0.0	-0.4	-0.6				
Kellerhals	21	34	58	67	2.0	2.8	4.4	4.9	3.3	3.7	4.1	4.2
AMAFCA/Schumm	38	44	285	287								
Moody & Odem	18	18	18	18	1.1	1.1	1.1	1.1				
BUREC	16.3	23.0	34.8	38.8	4	6	9	10	3.1	3.9	5.1	5.5
Average	34	52	112	125	2.0	2.7	3.9	4.4	2.7	3.1	3.8	3.9
Values As Designed	38	44	285	286	1.4	2.4	3.8	4.1	2.9	4.0	3.0	3.3
Difference with Design	-4	8	-173	-161	0.6	0.3	0.1	0.3	-0.2	-0.9	0.8	0.6

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
139	1080	718	1519	1940	3957	320	305	151	4958	350	1120	1493
348	4451	2407	4860	9184	5955	1461	1084	859	13225	1177	4925	4508
1045	24284	8940	15496	59064	9137	7076	3689	4656	40782	5571	24213	18446
1393	37813	12407	20097	96070	10150	10548	4955	6979	54561	8438	35969	27090

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
139	2876	1912	4046	5167	10538	852	812	402	13205	933	2983	3975
348	4742	2564	5178	9784	6345	1557	1155	915	14089	1254	5247	4803
1045	8623	3175	5503	20974	3245	2513	1310	1654	14482	1978	8598	6550
1393	10071	3304	5352	25587	2703	2809	1320	1859	14531	2247	9580	7215

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
139	785	378	595	1489	780	170	129	182	1157	170	922	614
348	2974	1115	1611	6403	1221	605	361	677	2979	624	3329	1991
1045	5999	2703	4502	11256	5806	1295	983	1386	8682	1282	7024	4629
1393	9334	3897	6138	18291	6549	1987	1388	2172	11732	1964	10813	6751

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
139	2092	1006	1586	3967	2076	452	344	484	3082	452	2455	1636
348	3168	1188	1716	6821	1301	645	385	721	3173	665	3546	2121
1045	2130	960	1599	3997	2062	460	349	492	3083	455	2494	1644
1393	2486	1038	1635	4871	1744	529	370	579	3125	523	2880	1798

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
139	0.0030	0.0044	125	0.38	0.046	0.0009	29	0.035	0.0007	0.0159	0.0009	0.0022	0.0067	0.0004	0.0032	0.0163	0.0064
348	0.0015	0.0025	164	0.50	0.049	0.0006	30	0.036	0.0004	0.0159	0.0005	0.0012	0.0067	0.0003	0.0016	0.0164	0.0061
1045	0.0007	0.0013	228	0.69	0.052	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0006	0.0067	0.0002	0.0007	0.0164	0.0060
1393	0.0005	0.0011	248	0.76	0.053	0.0003	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0067	0.0001	0.0006	0.0164	0.0059

Drop Structures

Design Slope	0.0060	ft/ft
Total Drop Needed	31.5	ft
Height of Drop Structure	3	ft
No . of Drop Structures	11	
Distance between structs.	276	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.19	sq. mi
Total Sediment Yield Volume	0.36	ac ft

Sedimentation Basins

Length	276 ft	Depth	3 ft
Width	307 ft	Side slope	3 ft/ft
Total Volume per Basin		5.48	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
139	1.1	-0.4	0.1	24.6	1.4	1.2	2.9	0.0060	0.1	1.5	3.0	6.1
348	1.1	-0.6	0.2	24.6	2.4	2.0	4.0	0.0060	0.3	1.5	3.0	6.3
1045	1.1	-1.2	0.1	24.6	3.8	1.2	3.0	0.0060	0.4	1.5	3.0	6.5
1393	1.1	-1.2	0.1	24.6	4.1	1.5	3.3	0.0060	0.4	1.5	3.0	6.5

Toe Protection Needed	7.0	ft

HEC1 Results For Open Channel

Peak Flow	1194	cfs
Stage at Peak Flow	101.0	ft
Flow Volume	147.0	ac. ft

Freeboard

Max. Flow Depth	1.1	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.4	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	0.38	ac. ft
Outflowing Sediment Volume	0.12	ac. ft
Deposited(+)/Eroded(-) Volume	0.27	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	3035	3035
Side Slope (?H:1V)	3	3
Channel Width (ft)	307	307
Channel XS Area (sq. ft)	1437.8	1437.8
Channel Perimeter (ft)	309	309

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	3035	3035
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	14163	29338
Left Levee Volume (cu. Yd)	13939	32823
Right Levee Length (ft)	3035	3035
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	14163	29338
Right Levee Volume (cu. Yd)	13939	32823
Total Levee Surface Area (sq. Yd)	28326	58676
Total Levee Volume (cu. Yd)	27878	65646

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	3035	3035
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	4721	11128
Left Levee Lining Volume (cu. Yd)	2361	5564
Right Levee Length (ft)	3035	3035
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	4721	11128
Right Levee Lining Volume (cu. Yd)	2361	5564
Total Lining Area (sq. Yd)	9442	22257
Total Lining Volume (cu. Yd)	4722	11128

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	3035	ft
Thickness	1.5	ft
Protection Depth	7	ft
Tie-in Length/Depth	3.0	ft
Total Depth	10.0	ft
Area needed	1012	sq. Yd
Volume	3372	cu. Yd

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	307	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	5.8	ft
Structure Height	8.8	ft
Number of Structures	11	
Volume per structure	301	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 22,575	
Area per structure	102	sq. Yd
Total Area	1,126	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	8841	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 35,364	
Other Cost	$ -	
Total cost per basin	$ 35,364	
Area per basin	9,412	sq. Yd
Total Area	9,412	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	27,878	cu. Yd	$ 7.00	$ 195,146	28,326	sq. Yd	$ 9.00	$ 254,934	28,326	sq. Yd	$ 11.67	$ 330,470
Levee - LC Enhancement	Fill	37,768	cu. Yd	$ 7.00	$ 264,376	30,350	sq. Yd	$ 9.00	$ 273,150	37,768	sq. Yd	$ 11.67	$ 440,627
Levee Lining	Riprap	4,722	cu. Yd	$ 75.00	$ 354,150	9,442	sq. Yd	$ -	$ -	9,442	sq. Yd	$ 20.83	$ 196,713
Levee Lining -LC Enhancement	Riprap	6,406	cu. Yd	$ 75.00	$ 480,450	12,814	sq. Yd	$ -	$ -	12,814	sq. Yd	$ 20.83	$ 266,968
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	3,372	cu. Yd	$ 75.00	$ 252,900	1,012	sq. Yd	$ -	$ -	1,012	sq. Yd	$ 25.00	$ 25,300
Drop Structures	Riprap	11	EA	$ 22,575.00	$ 248,325	1,126	sq. Yd	$ -	$ -	1,126	sq. Yd	$ 33.33	$ 37,533
Drop Str. - LC Enhancement	Riprap	11	EA	$ 2,257.50	$ 24,833	113	sq. Yd	$ -	$ -	113	sq. Yd	$ 33.33	$ 3,753
Sedimentation Basins		1	EA	$ 35,364.00	$ 35,364	9,412	sq. Yd	$ -	$ -	9,412	sq. Yd	$ 8.33	$ 78,433
Other					$ -				$ -				$ -

Base Landscape Cost	$ 254,934	
LC Enhancement Cost	$ 273,150	
Total Landscape Cost	$ 528,084	

Base Maintenance Cost	$ 668,450
LC Enhancement Cost	$ 711,348
Total Maintenance Cost	$ 1,379,797

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,085,885	$ 769,659	$ 1,855,544
Contingency Cost (25% of Construction Cost)	$ 271,471	$ 192,415	$ 463,886
Engineering Design Cost (5% of Construction Cost)	$ 54,294	$ 38,483	$ 92,777
Total Construction Cost	$ 1,411,651	$ 1,000,556	$ 2,412,207

Land Cost

Channel Length	3035 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	307	21.4	$100,000	$ 2,140,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	3.8	$100,000	$ 380,000
Levee LC Enhancement	51	3.6	$100,000	$ 360,000
Other	0	0	$100,000	$ -
Total	413	28.8		$ 2,880,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

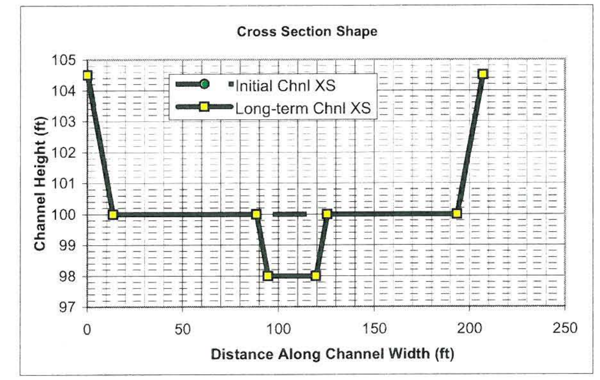
Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	25.2	$100,000	$ 2,520,000
LC Enhancement Cost	acre	3.6	$100,000	$ 360,000
Total Land Cost	acre	28.8	$100,000	$ 2,880,000

Total Cost

Base Total Cost	$ 4,855,034
Total Landscape Enhancement Cost	$ 2,345,054
Total Cost Including LC Enh.	$ 7,200,088

Open Channel

Structure ID	S18010		HEC1 ID	180R



Longitundal Geometry

Length	5165.4	ft
U/S Elev	1531.6	ft
D/S Elev	1456.3	ft
Initial Channel Slope	0.0146	ft/ft
Long-term Channel Slope	0.0060	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	2

Initial Channel XS Geometry

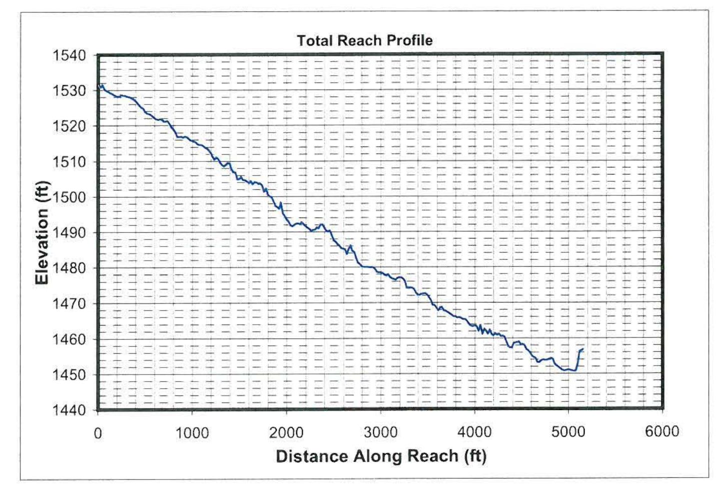
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	180	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	193.5	193.5	193.5	207
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	75	3	25	6.5	3	68	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	88.5	94.5	119.5	125.5	193.5	207
Y	104.5	100	100	98	98	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	S180									TOTAL
HEC1 Peak-Flow	1039									1039
Weighting Factor	1.00									
Flow into Channel	1039									1039

Reach Sediment Inflow Characteristics

U/S Contributing ID										TOTAL
HEC1 Flow Volume (ac. ft)										0
Sediment Conc. (ppm)										
Sediment Volume (ac. ft)										0.00
Weighting Factor										
Weighted Sed. Vol. (ac. ft)										0.00

Hydrology

Drainage Area	1.44	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	1039	cfs	
Long-term Max. Chnl Capacity	6482	cfs	
Q2 Channel	104	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	207	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
104	182.0	56.6	0.3	100.0	100.3	1.8	0.3	181.9	0.3	0.12	0.58
260	183.4	98.4	0.5	100.0	100.5	2.6	0.5	183.2	0.5	0.20	0.64
779	186.6	191.5	1.0	100.0	101.0	4.1	1.0	186.3	1.0	0.39	0.71
1039	187.9	228.2	1.2	100.0	101.2	4.6	1.2	187.5	1.2	0.46	0.73

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
104	33.2	37.4	1.1	98.0	99.3	2.8	1.3	32.8	1.1	0.48	0.46
260	183.0	128.3	0.7	98.0	100.4	2.0	2.4	182.2	0.7	0.89	0.43
779	187.2	250.3	1.3	98.0	101.0	3.1	3.0	186.2	1.3	1.13	0.47
1039	188.8	298.5	1.6	98.0	101.3	3.5	3.3	187.7	1.6	1.23	0.49

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
104										0
260										0
779										0
1039										0

Allowable Velocity

Channel Lining	Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
104	1.74	1.0357	0.9839	Erosive	Erosive	Erosive	0.2	Stable	5.3	Stable	Stable
260	1.74	1.2036	1.1434	Erosive	Erosive	Erosive	0.3	Stable	6.7	Stable	Stable
779	1.74	1.4040	1.3338	Erosive	Erosive	Erosive	0.3	Stable	8.4	Stable	Stable
1039	1.74	1.4561	1.3833	Erosive	Erosive	Erosive	0.3	Stable	9.0	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	**104**	**260**	**779**	**1039**	**104**	**260**	**779**	**1039**	**104**	**260**	**779**	**1039**
Bray - Equation #1	28	45	80	93	1.2	1.7	2.4	2.7	3.0	3.4	4.0	4.2
Bray - Equation #2	36	58	104	122	1.4	1.9	2.7	2.9	2.1	2.4	2.8	2.9
Hey	8	13	25	30	3.8	5.3	8.1	9.0				
Ackers & Charlton/Lacey	25	37	59	67					1.7	2.0	2.4	2.6
Parker	70	111	192	221	1.0	1.4	2.2	2.5				
Chang	47	82	160	191	0.1	0.0	-0.3	-0.4				
Kellerhals	18	29	50	58	1.7	2.5	3.9	4.4	3.2	3.6	4.0	4.1
AMAFCA/Schumm	33	182	186	188								
Moody & Odem	14	14	14	14	1.0	1.0	1.0	1.0				
BUREC	14.6	20.7	31.2	34.7	4	6	8	9	2.8	3.6	4.7	5.1
Average	29	59	90	102	1.8	2.4	3.5	3.9	2.6	3.0	3.6	3.8
Values As Designed	33	182	186	188	1.3	2.4	3.0	3.3	2.8	2.0	3.1	3.5
Difference with Design	-3	-123	-96	-86	0.5	0.0	0.5	0.6	-0.2	1.0	0.5	0.3

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
104	741	482	992	1319	2564	209	199	107	3099	227	779	974
260	3058	1620	3171	6234	3863	955	708	601	8270	781	3400	2969
779	16554	5998	10090	39882	5956	4595	2397	3209	25511	3738	16636	12233
1039	25724	8320	13086	64745	6628	6841	3219	4799	34133	5670	24696	17987

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
104	2645	1722	3541	4711	9157	748	712	384	11064	810	2780	3480
260	4368	2314	4529	8904	5518	1364	1012	858	11812	1116	4856	4241
779	7881	2856	4804	18988	2836	2188	1141	1528	12146	1780	7920	5824
1039	9186	2971	4673	23119	2367	2443	1149	1714	12188	2025	8818	6423

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
104	543	270	441	1010	629	117	93	124	856	118	638	440
260	890	477	838	1445	2423	164	162	165	1974	206	986	885
779	4803	2119	3379	9211	4007	1032	754	1116	6520	1020	5605	3597
1039	7459	3036	4643	14933	4520	1571	1054	1732	8793	1563	8575	5262

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
104	1938	966	1574	3605	2247	419	331	443	3057	423	2278	1571
260	1271	681	1197	2064	3461	235	231	235	2819	295	1409	1264
779	2287	1009	1609	4385	1908	492	359	532	3104	486	2669	1712
1039	2663	1084	1658	5332	1614	561	377	618	3140	558	3062	1879

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
104	0.0026	0.0039	125	0.38	0.046	0.0008	30	0.035	0.0006	0.0159	0.0008	0.0020	0.0074	0.0005	0.0029	0.0145	0.0061
260	0.0013	0.0023	165	0.50	0.049	0.0005	30	0.036	0.0003	0.0159	0.0005	0.0011	0.0074	0.0003	0.0015	0.0146	0.0059
779	0.0006	0.0012	228	0.69	0.052	0.0003	31	0.036	0.0002	0.0159	0.0002	0.0006	0.0074	0.0002	0.0006	0.0146	0.0057
1039	0.0005	0.0010	248	0.76	0.053	0.0002	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0074	0.0002	0.0005	0.0146	0.0056

Drop Structures

Design Slope	0.0060	ft/ft
Total Drop Needed	44.3	ft
Height of Drop Structure	3	ft
No . of Drop Structures	15	
Distance between structs.	344	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	1.44	sq. mi
Total Sediment Yield Volume	2.74	ac ft

Sedimentation Basins

Length	344 ft	Depth	3 ft
Width	207 ft	Side slope	3 ft/ft
Total Volume per Basin		4.57	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		2	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
104	1.1	-0.4	0.1	24.6	1.3	1.1	2.8	0.0060	0.1	1.5	2.0	4.8
260	1.1	-0.8	0.1	24.6	2.4	0.7	2.0	0.0060	0.2	1.5	2.0	4.9
779	1.1	-0.9	0.1	24.6	3.0	1.3	3.1	0.0060	0.3	1.5	2.0	5.1
1039	1.1	-0.9	0.2	24.6	3.3	1.6	3.5	0.0060	0.4	1.5	2.0	5.1

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	775	cfs
Stage at Peak Flow	101.0	ft
Flow Volume	90.0	ac. ft

Freeboard

Max. Flow Depth	1.2	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.3	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	2.74	ac. ft
Outflowing Sediment Volume	0.06	ac. ft
Deposited(+)/Eroded(-) Volume	2.67	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	5165	5165
Side Slope (?H:1V)	3	3
Channel Width (ft)	207	207
Channel XS Area (sq. ft)	932.8	932.8
Channel Perimeter (ft)	209	209

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	5165	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	1722	sq. Yd
Volume	5165	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	5165	5165
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	24103	49928
Left Levee Volume (cu. Yd)	23721	55859
Right Levee Length (ft)	5165	5165
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	24103	49928
Right Levee Volume (cu. Yd)	23721	55859
Total Levee Surface Area (sq. Yd)	48206	99856
Total Levee Volume (cu. Yd)	47442	111718

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	5165	5165
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	8034	18938
Left Levee Lining Volume (cu. Yd)	4017	9469
Right Levee Length (ft)	5165	5165
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	8034	18938
Right Levee Lining Volume (cu. Yd)	4017	9469
Total Lining Area (sq. Yd)	16069	37877
Total Lining Volume (cu. Yd)	8034	18938

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	207	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	6.3	ft
Structure Height	9.3	ft
Number of Structures	15	
Volume per structure	213	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 15,975	
Area per structure	69	sq. Yd
Total Area	1,035	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	2	
Total Volume per Basin	7373	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 29,492	
Other Cost	$ -	
Total cost per basin	$ 29,492	
Area per basin	7,920	sq. Yd
Total Area	15,840	sq. Yd

Structure Type	Structure Type	Excavation/Construction Quantity	Units	Unit Cost	Cost Subtotal	Landscape Quantity	Units	Unit Cost	Landscape Cost	Maintenance Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	47,442	cu. Yd	$ 7.00	$ 332,094	48,206	sq. Yd	$ 9.00	$ 433,854	48,206	sq. Yd	$ 11.67	$ 562,403
Levee - LC Enhancement	Fill	64,276	cu. Yd	$ 7.00	$ 449,932	51,650	sq. Yd	$ 9.00	$ 464,850	64,276	sq. Yd	$ 11.67	$ 749,887
Levee Lining	Riprap	8,034	cu. Yd	$ 75.00	$ 602,550	16,069	sq. Yd	$ -	$ -	16,069	sq. Yd	$ 20.83	$ 334,769
Levee Lining -LC Enhancement	Riprap	10,904	cu. Yd	$ 75.00	$ 817,800	21,808	sq. Yd	$ -	$ -	21,808	sq. Yd	$ 20.83	$ 454,329
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	5,165	cu. Yd	$ 75.00	$ 387,375	1,722	sq. Yd	$ -	$ -	1,722	sq. Yd	$ 25.00	$ 43,050
Drop Structures	Riprap	15	EA	$ 15,975.00	$ 239,625	1,035	sq. Yd	$ -	$ -	1,035	sq. Yd	$ 33.33	$ 34,500
Drop Str. - LC Enhancement	Riprap	15	EA	$ 1,597.50	$ 23,963	104	sq. Yd	$ -	$ -	104	sq. Yd	$ 33.33	$ 3,450
Sedimentation Basins		2	EA	$ 29,492.00	$ 58,984	15,840	sq. Yd	$ -	$ -	15,840	sq. Yd	$ 8.33	$ 132,000
Other					$ -				$ -				$ -

Base Landscape Cost	$ 433,854	
LC Enhancement Cost	$ 464,850	
Total Landscape Cost	$ 898,704	
Base Maintenance Cost	$ 1,106,722	
LC Enhancement Cost	$ 1,207,665	
Total Maintenance Cost	$ 2,314,387	

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,620,628	$ 1,291,695	$ 2,912,323
Contingency Cost (25% of Construction Cost)	$ 405,157	$ 322,924	$ 728,081
Engineering Design Cost (5% of Construction Cost)	$ 81,031	$ 64,585	$ 145,616
Total Construction Cost	$ 2,106,816	$ 1,679,203	$ 3,786,019

Land Cost

Channel Length	5165 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	207	24.5	$100,000	$ 2,450,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	6.5	$100,000	$ 650,000
Levee LC Enhancement	51	6	$100,000	$ 600,000
Other	0	0	$100,000	$ -
Total	313	37		$ 3,700,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	31	$100,000	$ 3,100,000
LC Enhancement Cost	acre	6	$100,000	$ 600,000
Total Land Cost	acre	37	$100,000	$ 3,700,000

Total Cost

Base Total Cost	$ 6,747,392
Total Landscape Enhancement Cost	$ 3,951,718
Total Cost Including LC Enh.	$ 10,699,110

Open Channel

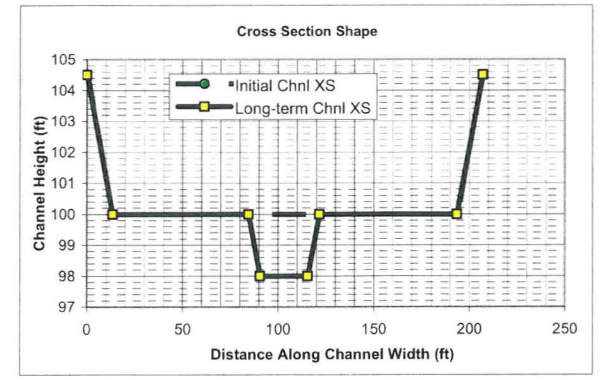
Structure ID	RR18010		HEC1 ID	180R

Longitundal Geometry

Length	2824.7	ft
U/S Elev	1456.3	ft
D/S Elev	1413.1	ft
Initial Channel Slope	0.0153	ft/ft
Long-term Channel Slope	0.0060	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	2



Initial Channel XS Geometry

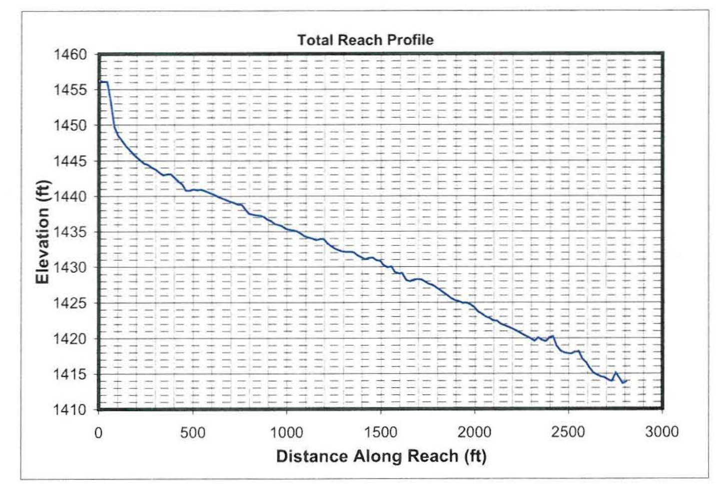
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	180	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	193.5	193.5	193.5	207
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	71	3	25	6.5	3	72	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	84.5	90.5	115.5	121.5	193.5	207
Y	104.5	100	100	98	98	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	S180	S190								TOTAL
HEC1 Peak-Flow	1039	2590								3629
Weighting Factor	1.00	0.03								
Flow into Channel	1039	85								1124

Reach Sediment Inflow Characteristics

U/S Contributing ID	180R_S18010									TOTAL
HEC1 Flow Volume (ac. ft)	90.00									90
Sediment Conc. (ppm)	1879									
Sediment Volume (ac. ft)	0.06									0.06
Weighting Factor	1									
Weighted Sed. Vol. (ac. ft)	0.06									0.06

Hydrology

Drainage Area	1.573	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	1124	cfs	
Long-term Max. Chnl Capacity	6482	cfs	
Q2 Channel	112	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	207	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
112	182.0	58.5	0.3	100.0	100.3	1.9	0.3	181.9	0.3	0.12	0.60
281	183.5	101.7	0.6	100.0	100.6	2.8	0.6	183.4	0.6	0.21	0.65
843	186.8	198.1	1.1	100.0	101.1	4.3	1.1	186.5	1.1	0.40	0.73
1124	188.1	236.0	1.3	100.0	101.3	4.8	1.3	187.7	1.3	0.48	0.75

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
112	33.6	39.4	1.2	98.0	99.4	2.9	1.4	33.1	1.2	0.51	0.46
281	183.2	134.5	0.7	98.0	100.4	2.1	2.4	182.4	0.7	0.90	0.43
843	187.6	262.6	1.4	98.0	101.1	3.2	3.1	186.6	1.4	1.16	0.48
1124	189.3	313.2	1.7	98.0	101.4	3.6	3.4	188.2	1.7	1.26	0.49

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
	180R_S18010									
112	440									440
281	885									885
843	3597									3597
1124	5262									5262

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
112	1.74	1.0458	0.9935	Erosive	Erosive	Erosive	0.2	Stable	5.5	Stable	Stable
281	1.74	1.2137	1.1530	Erosive	Erosive	Erosive	0.3	Stable	6.8	Stable	Stable
843	1.74	1.4140	1.3433	Erosive	Erosive	Erosive	0.3	Stable	8.5	Stable	Stable
1124	1.74	1.4661	1.3928	Erosive	Erosive	Erosive	0.3	Stable	9.2	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	112	281	843	1124	112	281	843	1124	112	281	843	1124
Bray - Equation #1	29	46	83	96	1.3	1.7	2.5	2.8	3.1	3.5	4.1	4.2
Bray - Equation #2	38	61	109	127	1.4	1.9	2.7	3.0	2.1	2.4	2.8	2.9
Hey	8	14	26	31	3.9	5.5	8.3	9.3				
Ackers & Charlton/Lacey	26	38	61	69					1.8	2.1	2.5	2.6
Parker	73	115	199	230	1.0	1.4	2.3	2.6				
Chang	49	86	168	200	0.1	0.0	-0.3	-0.5				
Kellerhals	19	30	52	60	1.8	2.6	4.0	4.5	3.3	3.6	4.0	4.1
AMAFCA/Schumm	33	183	187	188								
Moody & Odem	15	15	15	15	1.0	1.0	1.0	1.0				
BUREC	15.1	21.3	32.1	35.8	4	6	9	10	2.9	3.7	4.8	5.2
Average	30	61	93	105	1.8	2.5	3.6	4.0	2.6	3.0	3.6	3.8
Values As Designed	33	182	187	188	1.4	2.4	3.1	3.4	2.9	2.1	3.2	3.6
Difference with Design	-3	-121	-93	-83	0.5	0.1	0.5	0.7	-0.2	0.9	0.4	0.2

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
112	893	574	1193	1630	2732	268	246	138	3651	270	955	1141
281	3685	1888	3662	7698	4081	1166	831	729	9655	935	4067	3491
843	19938	6898	11367	49229	6254	5534	2752	3785	29673	4477	19567	14498
1124	30986	9547	14802	79909	6952	8231	3684	5636	39683	6789	28950	21379

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
112	2947	1895	3937	5379	9019	885	812	455	12051	891	3151	3766
281	4865	2493	4835	10164	5388	1539	1097	963	12748	1234	5369	4609
843	8775	3036	5003	21665	2752	2435	1211	1666	13059	1970	8612	6380
1124	10228	3151	4886	26376	2295	2717	1216	1860	13098	2241	9556	7057

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
112	609	298	478	1145	655	132	102	140	930	132	716	485
281	1004	535	937	1650	2520	192	185	192	2160	231	1126	976
843	5418	2340	3681	10512	4142	1159	828	1261	7078	1146	6302	3988
1124	8411	3344	5070	17038	4668	1759	1153	1947	9538	1757	9616	5845

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
112	2010	984	1579	3780	2162	435	337	462	3070	437	2362	1602
281	1326	706	1237	2179	3327	254	244	254	2852	305	1486	1288
843	2384	1030	1620	4626	1823	510	364	555	3115	504	2773	1755
1124	2776	1104	1673	5624	1541	581	380	643	3148	580	3174	1929

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
112	0.0025	0.0038	131	0.40	0.047	0.0008	30	0.035	0.0006	0.0159	0.0008	0.0019	0.0072	0.0004	0.0028	0.0152	0.0062
281	0.0013	0.0022	171	0.52	0.049	0.0005	30	0.036	0.0003	0.0159	0.0005	0.0011	0.0072	0.0003	0.0014	0.0153	0.0060
843	0.0006	0.0011	237	0.72	0.052	0.0003	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0072	0.0002	0.0006	0.0153	0.0058
1124	0.0005	0.0010	258	0.79	0.053	0.0002	32	0.036	0.0002	0.0159	0.0002	0.0004	0.0072	0.0002	0.0005	0.0153	0.0058

Drop Structures

Design Slope	0.0060	ft/ft
Total Drop Needed	26.2	ft
Height of Drop Structure	3	ft
No . of Drop Structures	9	
Distance between structs.	314	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.13	sq. mi
Total Sediment Yield Volume	0.25	ac ft

Sedimentation Basins

Length	314 ft	Depth	3 ft
Width	207 ft	Side slope	3 ft/ft
Total Volume per Basin		4.16	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
112	1.1	-0.4	0.1	24.6	1.4	1.2	2.9	0.0060	0.1	1.5	2.0	4.8
281	1.1	-0.8	0.1	24.6	2.4	0.7	2.1	0.0060	0.2	1.5	2.0	4.9
843	1.1	-0.9	0.1	24.6	3.1	1.4	3.2	0.0060	0.3	1.5	2.0	5.1
1124	1.1	-0.9	0.2	24.6	3.4	1.7	3.6	0.0060	0.4	1.5	2.0	5.1

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	775	cfs
Stage at Peak Flow	101.0	ft
Flow Volume	90.0	ac. ft

Freeboard

Max. Flow Depth	1.3	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.2	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	0.32	ac. ft
Outflowing Sediment Volume	0.07	ac. ft
Deposited(+)/Eroded(-) Volume	0.25	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	2825	2825
Side Slope (?H:1V)	3	3
Channel Width (ft)	207	207
Channel XS Area (sq. ft)	932.8	932.8
Channel Perimeter (ft)	209	209

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	2825	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	942	sq. Yd
Volume	2825	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	2825	2825
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	13183	27308
Left Levee Volume (cu. Yd)	12974	30552
Right Levee Length (ft)	2825	2825
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	13183	27308
Right Levee Volume (cu. Yd)	12974	30552
Total Levee Surface Area (sq. Yd)	26366	54616
Total Levee Volume (cu. Yd)	25948	61104

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	2825	2825
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	4394	10358
Left Levee Lining Volume (cu. Yd)	2197	5179
Right Levee Length (ft)	2825	2825
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	4394	10358
Right Levee Lining Volume (cu. Yd)	2197	5179
Total Lining Area (sq. Yd)	8789	20717
Total Lining Volume (cu. Yd)	4394	10358

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	207	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	6.5	ft
Structure Height	9.5	ft
Number of Structures	9	
Volume per structure	219	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 16,425	
Area per structure	69	sq. Yd
Total Area	621	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	6711	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 26,844	
Other Cost	$ -	
Total cost per basin	$ 26,844	
Area per basin	7,219	sq. Yd
Total Area	7,219	sq. Yd

Structure Cost

Structure Type	Structure Type	Excavation/Construction Quantity	Units	Unit Cost	Cost Subtotal	Landscape Quantity	Units	Unit Cost	Landscape Cost	Maintenance Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	25,948	cu. Yd	$ 7.00	$ 181,636	26,366	sq. Yd	$ 9.00	$ 237,294	26,366	sq. Yd	$ 11.67	$ 307,603
Levee - LC Enhancement	Fill	35,156	cu. Yd	$ 7.00	$ 246,092	28,250	sq. Yd	$ 9.00	$ 254,250	35,156	sq. Yd	$ 11.67	$ 410,153
Levee Lining	Riprap	4,394	cu. Yd	$ 75.00	$ 329,550	8,789	sq. Yd	$ -	$ -	8,789	sq. Yd	$ 20.83	$ 183,102
Levee Lining -LC Enhancement	Riprap	5,964	cu. Yd	$ 75.00	$ 447,300	11,928	sq. Yd	$ -	$ -	11,928	sq. Yd	$ 20.83	$ 248,495
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	2,825	cu. Yd	$ 75.00	$ 211,875	942	sq. Yd	$ -	$ -	942	sq. Yd	$ 25.00	$ 23,550
Drop Structures	Riprap	9	EA	$ 16,425.00	$ 147,825	621	sq. Yd	$ -	$ -	621	sq. Yd	$ 33.33	$ 20,700
Drop Str. - LC Enhancement	Riprap	9	EA	$ 1,642.50	$ 14,783	62	sq. Yd	$ -	$ -	62	sq. Yd	$ 33.33	$ 2,070
Sedimentation Basins		1	EA	$ 26,844.00	$ 26,844	7,219	sq. Yd	$ -	$ -	7,219	sq. Yd	$ 8.33	$ 60,158
Other					$ -				$ -				$ -

Base Landscape Cost	$ 237,294
LC Enhancement Cost	$ 254,250
Total Landscape Cost	$ 491,544

Base Maintenance Cost	$ 595,114
LC Enhancement Cost	$ 660,719
Total Maintenance Cost	$ 1,255,832

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 897,730	$ 708,175	$ 1,605,905
Contingency Cost (25% of Construction Cost)	$ 224,433	$ 177,044	$ 401,476
Engineering Design Cost (5% of Construction Cost)	$ 44,887	$ 35,409	$ 80,295
Total Construction Cost	$ 1,167,049	$ 920,627	$ 2,087,676

Land Cost

Channel Length	2825 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	207	13.4	$100,000	$ 1,340,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	3.6	$100,000	$ 360,000
Levee LC Enhancement	51	3.3	$100,000	$ 330,000
Other	0	0	$100,000	$ -
Total	313	20.3		$ 2,030,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	17	$100,000	$ 1,700,000
LC Enhancement Cost	acre	3.3	$100,000	$ 330,000
Total Land Cost	acre	20.3	$100,000	$ 2,030,000

Total Cost

Base Total Cost	$ 3,699,457
Total Landscape Enhancement Cost	$ 2,165,596
Total Cost Including LC Enh.	$ 5,865,052

Open Channel

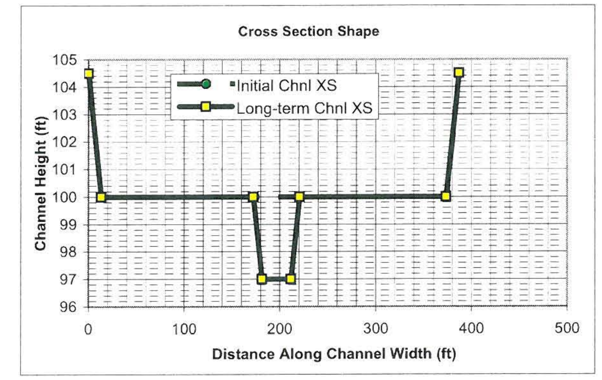
Structure ID	C180R10		HEC1 ID	RI180R

Longitundal Geometry

Length	3720.6	ft
U/S Elev	1413.1	ft
D/S Elev	1367.6	ft
Initial Channel Slope	0.0122	ft/ft
Long-term Channel Slope	0.0050	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	3



Initial Channel XS Geometry

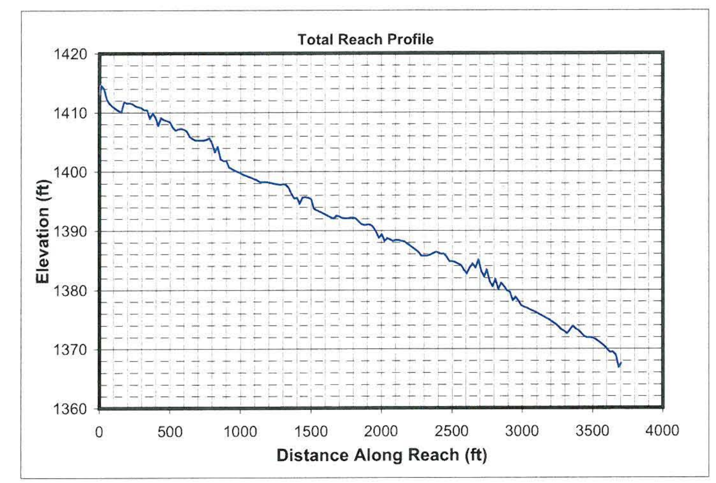
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	360	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	373.5	373.5	373.5	387
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	159	3	30	7.5	3	153	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	172.5	181.5	211.5	220.5	373.5	387
Y	104.5	100	100	97	97	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	RI180R	S190								TOTAL
HEC1 Peak-Flow	1735	2590								4325
Weighting Factor	1.00	0.12								
Flow into Channel	1735	323								2058

Reach Sediment Inflow Characteristics

U/S Contributing ID	175R_RR17510	180R_RR18010								TOTAL
HEC1 Flow Volume (ac. ft)	147.00	90.00								237
Sediment Conc. (ppm)	2121	1929								
Sediment Volume (ac. ft)	0.12	0.07								0.18
Weighting Factor	1	1								
Weighted Sed. Vol. (ac. ft)	0.12	0.07								0.18

Hydrology

Drainage Area	3.86	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	2058	cfs	
Long-term Max. Chnl Capacity	11669	cfs	
Q2 Channel	206	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	387	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
206	362.1	118.5	0.3	100.0	100.3	1.7	0.3	362.0	0.3	0.10	0.54
515	363.6	205.5	0.6	100.0	100.6	2.5	0.6	363.4	0.6	0.18	0.59
1544	366.9	398.8	1.1	100.0	101.1	3.9	1.1	366.6	1.1	0.34	0.65
2058	368.2	474.6	1.3	100.0	101.3	4.3	1.3	367.8	1.3	0.41	0.67

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
206	41.6	65.2	1.6	97.0	98.8	3.2	1.8	41.0	1.6	0.57	0.44
515	363.6	268.7	0.7	97.0	100.4	1.9	3.4	362.5	0.7	1.07	0.39
1544	368.0	522.1	1.4	97.0	101.1	3.0	4.1	366.7	1.4	1.28	0.44
2058	369.7	621.6	1.7	97.0	101.4	3.3	4.4	368.3	1.7	1.37	0.45

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
	175R_RR17510	180R_RR18010								
206	614	485								1099
515	1991	976								2966
1544	4629	3988								8617
2058	6751	5845								12597

Allowable Velocity

Channel Lining	Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow) Permissive Velocity (ft/s) Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	BUREC Erosive?	Neill (gravel/cobble) Non-cohesive Erosive?	All'ble Vel (ft/s)	Cohesive Erosive?	All'ble Vel (ft/s)	USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
206	1.74	1.0511	0.9985	Erosive	Erosive	Erosive	0.2	Stable	6.1	Stable	Stable
515	1.74	1.2196	1.1586	Erosive	Erosive	Erosive	0.3	Stable	7.4	Stable	Stable
1544	1.74	1.4214	1.3503	Erosive	Erosive	Erosive	0.3	Stable	9.0	Stable	Stable
2058	1.74	1.4740	1.4003	Erosive	Erosive	Erosive	0.3	Stable	9.6	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	206	515	1544	2058	206	515	1544	2058	206	515	1544	2058
Bray - Equation #1	39	64	114	133	1.6	2.1	3.1	3.4	3.3	3.8	4.4	4.6
Bray - Equation #2	52	84	150	174	1.7	2.3	3.4	3.7	2.3	2.6	3.0	3.2
Hey	12	20	37	43	4.9	6.9	10.5	11.7				
Ackers & Charlton/Lacey	34	50	79	89					1.9	2.3	2.7	2.9
Parker	99	156	270	312	1.3	1.8	2.9	3.3				
Chang	67	117	228	272	0.1	0.0	-0.5	-0.7				
Kellerhals	26	41	71	82	2.3	3.3	5.1	5.8	3.5	3.8	4.2	4.4
AMAFCA/Schumm	41	363	367	369								
Moody & Odem	20	20	20	20	1.2	1.2	1.2	1.2				
BUREC	19.6	27.6	41.7	46.4	5	7	11	12	3.2	4.0	5.2	5.6
Average	41	94	138	154	2.3	3.1	4.6	5.1	2.8	3.3	3.9	4.1
Values As Designed	41	363	367	368	1.8	3.4	4.1	4.4	3.2	1.9	3.0	3.3
Difference with Design	0	-268	-229	-214	0.4	-0.3	0.5	0.7	-0.3	1.4	1.0	0.8

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
206	1147	743	1407	1949	4604	273	277	153	4570	343	1176	1513
515	4745	2596	5069	9230	7027	1382	1087	931	12439	1192	5344	4640
1544	25814	9861	16699	59368	10899	6848	3832	5203	38671	5779	26969	19086
2058	40207	13747	21544	96583	12127	10231	5176	7844	51788	8804	40314	28033

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
206	2069	1339	2537	3513	8301	492	498	276	8238	618	2120	2727
515	3422	1872	3655	6655	5067	997	784	671	8969	859	3854	3346
1544	6205	2370	4014	14270	2620	1646	921	1251	9295	1389	6482	4588
2058	7248	2478	3884	17411	2186	1844	933	1414	9336	1587	7268	5054

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
206	1070	488	714	2041	874	214	157	259	1306	223	1264	783
515	1369	723	1104	2113	4322	203	216	244	2847	310	1479	1357
1544	7435	3368	5363	13562	7239	1488	1154	1780	9700	1541	8788	5584
2058	11575	4867	7280	22048	8173	2294	1638	2792	13127	2369	13567	8157

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
206	1929	880	1286	3679	1575	385	283	466	2354	403	2279	1411
515	987	522	796	1523	3116	147	156	176	2053	224	1066	979
1544	1787	810	1289	3260	1740	358	277	428	2331	370	2112	1342
2058	2087	877	1312	3975	1473	413	295	503	2366	427	2446	1471

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
206	0.0027	0.0037	118	0.36	0.046	0.0008	29	0.035	0.0006	0.0159	0.0008	0.0019	0.0059	0.0003	0.0028	0.0122	0.0051
515	0.0013	0.0021	155	0.47	0.048	0.0005	30	0.036	0.0003	0.0159	0.0005	0.0011	0.0059	0.0002	0.0014	0.0122	0.0049
1544	0.0006	0.0011	215	0.65	0.051	0.0003	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0059	0.0001	0.0006	0.0122	0.0047
2058	0.0005	0.0009	234	0.71	0.052	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0004	0.0059	0.0001	0.0005	0.0122	0.0047

Drop Structures

Design Slope	0.0050	ft/ft
Total Drop Needed	26.9	ft
Height of Drop Structure	3	ft
No . of Drop Structures	9	
Distance between structs.	413	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.19	sq. mi
Total Sediment Yield Volume	0.35	ac ft

Sedimentation Basins

Length	413 ft	Depth	3 ft
Width	387 ft	Side slope	3 ft/ft
Total Volume per Basin		10.53	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
206	1.1	-0.6	0.1	24.6	1.8	1.6	3.2	0.0050	0.2	1.5	3.0	6.2
515	1.1	-1.2	0.1	24.6	3.4	0.7	1.9	0.0050	0.3	1.5	3.0	6.3
1544	1.1	-1.3	0.1	24.6	4.1	1.4	3.0	0.0050	0.4	1.5	3.0	6.5
2058	1.1	-1.3	0.2	24.6	4.4	1.7	3.3	0.0050	0.5	1.5	3.0	6.6

Toe Protection Needed	7.0	ft

HEC1 Results For Open Channel

Peak Flow	1735	cfs
Stage at Peak Flow	101.2	ft
Flow Volume	231.0	ac. ft

Freeboard

Max. Flow Depth	1.3	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.2	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	0.54	ac. ft
Outflowing Sediment Volume	0.13	ac. ft
Deposited(+)/Eroded(-) Volume	0.41	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	3721	3721
Side Slope (?H:1V)	3	3
Channel Width (ft)	387	387
Channel XS Area (sq. ft)	1797.8	1797.8
Channel Perimeter (ft)	389	389

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	3721	ft
Thickness	1.5	ft
Protection Depth	7	ft
Tie-in Length/Depth	3.0	ft
Total Depth	10.0	ft
Area needed	1240	sq. Yd
Volume	4134	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	3721	3721
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	17365	35970
Left Levee Volume (cu. Yd)	17089	40242
Right Levee Length (ft)	3721	3721
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	17365	35970
Right Levee Volume (cu. Yd)	17089	40242
Total Levee Surface Area (sq. Yd)	34730	71940
Total Levee Volume (cu. Yd)	34178	80484

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	3721	3721
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	5788	13644
Left Levee Lining Volume (cu. Yd)	2894	6822
Right Levee Length (ft)	3721	3721
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	5788	13644
Right Levee Lining Volume (cu. Yd)	2894	6822
Total Lining Area (sq. Yd)	11576	27287
Total Lining Volume (cu. Yd)	5788	13644

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	387	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	6.3	ft
Structure Height	9.3	ft
Number of Structures	9	
Volume per structure	400	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 30,000	
Area per structure	129	sq. Yd
Total Area	1,161	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	16988	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 67,952	
Other Cost	$ -	
Total cost per basin	$ 67,952	
Area per basin	17,776	sq. Yd
Total Area	17,776	sq. Yd

Structure Cost

Structure Type	Structure Type	Excavation/Construction Quantity	Units	Unit Cost	Cost Subtotal	Landscape Quantity	Units	Unit Cost	Landscape Cost	Maintenance Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	34,178	cu. Yd	$ 7.00	$ 239,246	34,730	sq. Yd	$ 9.00	$ 312,570	34,730	sq. Yd	$ 11.67	$ 405,183
Levee - LC Enhancement	Fill	46,306	cu. Yd	$ 7.00	$ 324,142	37,210	sq. Yd	$ 9.00	$ 334,890	46,306	sq. Yd	$ 11.67	$ 540,237
Levee Lining	Riprap	5,788	cu. Yd	$ 75.00	$ 434,100	11,576	sq. Yd	$ -	$ -	11,576	sq. Yd	$ 20.83	$ 241,176
Levee Lining -LC Enhancement	Riprap	7,856	cu. Yd	$ 75.00	$ 589,200	15,711	sq. Yd	$ -	$ -	15,711	sq. Yd	$ 20.83	$ 327,310
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	4,134	cu. Yd	$ 75.00	$ 310,050	1,240	sq. Yd	$ -	$ -	1,240	sq. Yd	$ 25.00	$ 31,000
Drop Structures	Riprap	9	EA	$ 30,000.00	$ 270,000	1,161	sq. Yd	$ -	$ -	1,161	sq. Yd	$ 33.33	$ 38,700
Drop Str. - LC Enhancement	Riprap	9	EA	$ 3,000.00	$ 27,000	116	sq. Yd	$ -	$ -	116	sq. Yd	$ 33.33	$ 3,870
Sedimentation Basins		1	EA	$ 67,952.00	$ 67,952	17,776	sq. Yd	$ -	$ -	17,776	sq. Yd	$ 8.33	$ 148,133
Other					$ -				$ -				$ -

Base Landscape Cost	$ 312,570
LC Enhancement Cost	$ 334,890
Total Landscape Cost	$ 647,460

Base Maintenance Cost	$ 864,193
LC Enhancement Cost	$ 871,417
Total Maintenance Cost	$ 1,735,609

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,321,348	$ 940,342	$ 2,261,690
Contingency Cost (25% of Construction Cost)	$ 330,337	$ 235,086	$ 565,423
Engineering Design Cost (5% of Construction Cost)	$ 66,067	$ 47,017	$ 113,085
Total Construction Cost	$ 1,717,752	$ 1,222,445	$ 2,940,197

Land Cost

Channel Length	3721 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	387	33.1	$100,000	$ 3,310,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	4.7	$100,000	$ 470,000
Levee LC Enhancement	51	4.4	$100,000	$ 440,000
Other	0	0	$100,000	$ -
Total	493	42.2		$ 4,220,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	37.8	$100,000	$ 3,780,000
LC Enhancement Cost	acre	4.4	$100,000	$ 440,000
Total Land Cost	acre	42.2	$100,000	$ 4,220,000

Total Cost

Base Total Cost	$ 6,674,515
Total Landscape Enhancement Cost	$ 2,868,751
Total Cost Including LC Enh.	$ 9,543,266

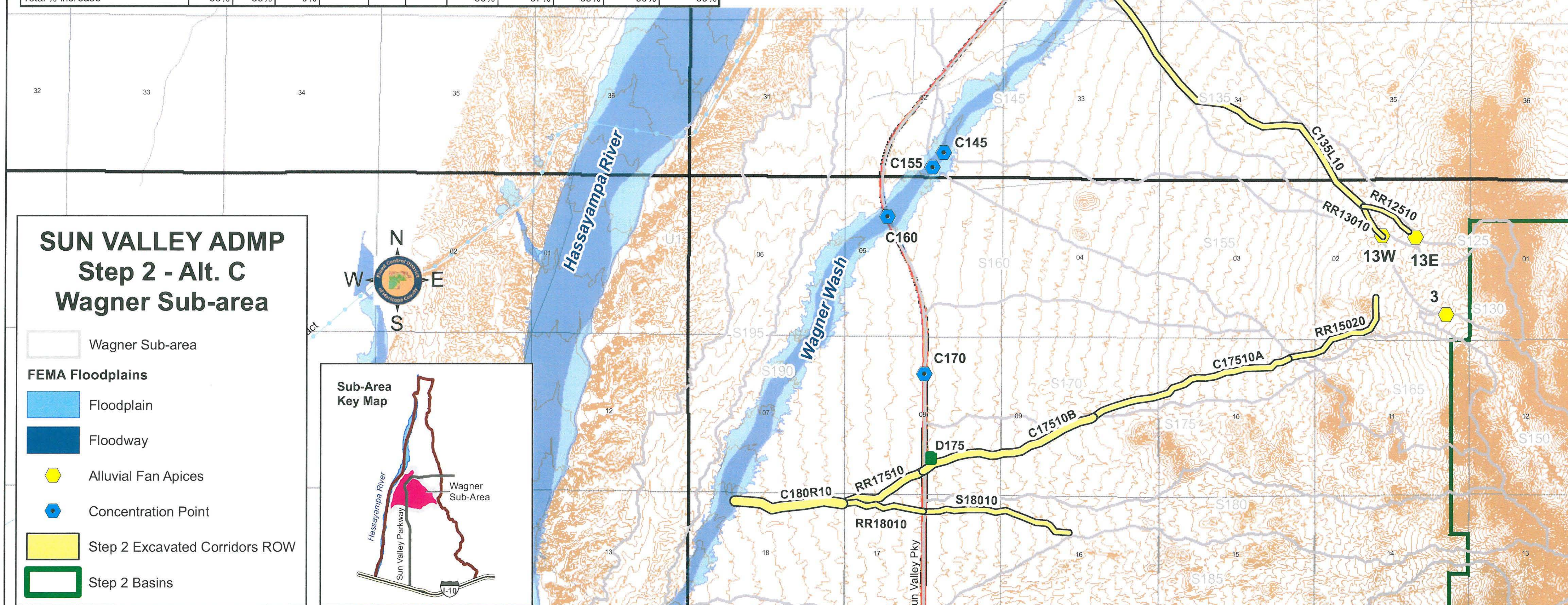
JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

Sub-area: Wagner Wash, Alternative: B43
Open Channel Structure ID: C180R10

Structure ID	Type	Flow Rate (cfs)	ROW Area (acres)	Exc. Vol. (ac. ft)	Fill Vol. (ac. ft)	Base Design Geometry: Length (stor-ft; chl-mi)	ROW Width (ft)	Depth (ft)	Base Costs (in $1000): Land Cost	Constr. Cost	Lndscp Cost	50 Yr Maint. Cost	Total Cost	Base Cost Percentages: Land Cost %	Constr. Cost %	Lndscp Cost %	50 Yr Maint. Cost %	% of Total Cost
RR12510	Excavated Chl.	242	7	27	0	0.4	77	4	$ 680	$ 830	$ 50	$ 276	$ 1,836	37%	45%	3%	15%	1%
RR13010	Excavated Chl.	524	5	20	0	0.2	94	4	$ 500	$ 612	$ 54	$ 205	$ 1,371	36%	45%	4%	15%	1%
C135L10	Excavated Chl.	1380	59	1852	0	2.3	128	6	$ 5,890	$ 40,666	$ 944	$ 2,261	$ 49,761	12%	82%	2%	5%	35%
RR15020	Excavated Chl.	945	19	239	0	0.8	115	5	$ 1,870	$ 5,608	$ 265	$ 717	$ 8,461	22%	66%	3%	8%	6%
C17510A	Excavated Chl.	1748	36	806	0	1.3	136	6	$ 3,580	$ 18,138	$ 609	$ 1,482	$ 23,808	15%	76%	3%	6%	17%
C17510B	Excavated Chl.	2452	39	714	0	1.2	190	5	$ 3,880	$ 15,952	$ 864	$ 1,557	$ 22,253	17%	72%	4%	7%	16%
D175	Offline Basin	2236	1	7	0	280	200	4	$ 129	$ 143	$ 56	$ 63	$ 390	33%	37%	14%	16%	0%
RR17510	Excavated Chl.	2355	19	225	0	0.6	185	5	$ 1,870	$ 5,183	$ 410	$ 690	$ 8,153	23%	64%	5%	8%	6%
S18010	Excavated Chl.	1039	23	249	0	1	113	6	$ 2,340	$ 6,021	$ 325	$ 1,002	$ 9,689	24%	62%	3%	10%	7%
RR18010	Excavated Chl.	1124	13	85	0	0.5	113	6	$ 1,280	$ 2,188	$ 178	$ 480	$ 4,126	31%	53%	4%	12%	3%
C180R10	Excavated Chl.	3439	29	360	0	0.7	255	5	$ 2,890	$ 8,140	$ 763	$ 1,114	$ 12,906	22%	63%	6%	9%	9%
		TOTAL	250	4584	0				$24,909	$103,481	$ 4,517	$ 9,847	**$ 142,753**	17%	72%	3%	7%	100%
All Channels			249	4577	0	9.0			$24,780	$103,338	$ 4,461	$ 9,784	$ 142,364	17%	73%	3%	7%	100%
All Online Basins			0	0	0				$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
All Offline Basins			1	7	0				$ 129	$ 143	$ 56	$ 63	$ 390	33%	37%	14%	16%	0%
Channel Cost per mile (in $1000)			$15,818		Basins Cost per ac. ft. (in $1000)				$8.00									

Cost Increase for Landscape Compatibility Enhancement over Base Costs

All Channels % increase	35%	36%	0%				36%	37%	34%	59%	39%
All Online Basins % increase	0%	0%	0%				0%	0%	0%	0%	0%
All Offline Basins % increase	200%	0%	0%				133%	4%	136%	115%	83%
Total % increase	36%	36%	0%				36%	37%	35%	60%	39%



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Costs Summary

						Base Design Geometry			Base Costs (in $1000)					Base Cost Percentages				
Structure ID	Type	Flow Rate (cfs)	ROW Area (acres)	Exc. Vol. (ac. ft)	Fill Vol. (ac. ft)	Length (stor-ft; chl-mi)	ROW Width (ft)	Depth (ft)	Land Cost	Constr. Cost	Lndscp Cost	50 Yr Maint. Cost	Total Cost	Land Cost %	Constr. Cost %	Lndscp Cost %	50 Yr Maint. Cost %	% of Total Cost
RR12510	Excavated Chl.	242	7	27	0	0.4	77	4	$ 680	$ 830	$ 50	$ 276	$ 1,836	37%	45%	3%	15%	1%
RR13010	Excavated Chl.	524	5	20	0	0.2	94	4	$ 500	$ 612	$ 54	$ 205	$ 1,371	36%	45%	4%	15%	1%
C135L10	Excavated Chl.	1380	59	1852	0	2.3	128	6	$ 5,890	$ 40,666	$ 944	$ 2,261	$ 49,761	12%	82%	2%	5%	35%
RR15020	Excavated Chl.	945	19	239	0	0.8	115	5	$ 1,870	$ 5,608	$ 265	$ 717	$ 8,461	22%	66%	3%	8%	6%
C17510A	Excavated Chl.	1748	36	806	0	1.3	136	6	$ 3,580	$ 18,138	$ 609	$ 1,482	$ 23,808	15%	76%	3%	6%	17%
C17510B	Excavated Chl.	2452	39	714	0	1.2	190	5	$ 3,880	$ 15,952	$ 864	$ 1,557	$ 22,253	17%	72%	4%	7%	16%
D175	Offline Basin	2236	1	7	0	280	200	4	$ 129	$ 143	$ 56	$ 63	$ 390	33%	37%	14%	16%	0%
RR17510	Excavated Chl.	2355	19	225	0	0.6	185	5	$ 1,870	$ 5,183	$ 410	$ 690	$ 8,153	23%	64%	5%	8%	6%
S18010	Excavated Chl.	1039	23	249	0	1	113	6	$ 2,340	$ 6,021	$ 325	$ 1,002	$ 9,689	24%	62%	3%	10%	7%
RR18010	Excavated Chl.	1124	13	85	0	0.5	113	6	$ 1,280	$ 2,188	$ 178	$ 480	$ 4,126	31%	53%	4%	12%	3%
C180R10	Excavated Chl.	3439	29	360	0	0.7	255	5	$ 2,890	$ 8,140	$ 763	$ 1,114	$ 12,906	22%	63%	6%	9%	9%
		TOTAL	250	4584	0				$ 24,909	$ 103,481	$ 4,517	$ 9,847	**$ 142,753**	17%	72%	3%	7%	100%
All Channels			249	4577	0	9.0			$ 24,780	$ 103,338	$ 4,461	$ 9,784	$ 142,364	17%	73%	3%	7%	100%
All Online Basins			0	0	0				$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
All Offline Basins			1	7	0				$ 129	$ 143	$ 56	$ 63	$ 390	33%	37%	14%	16%	0%
Channel Cost per mile (in $1000)			$15,818		Basins Cost per ac. ft. (in $1000)				$8.00									

Cost Summary - Landscape Compatibility Enhanced (LCE)

						LCE Design Geometry			LCE Costs (in $1000)					LCE Cost Percentages				
Structure ID	Type	Flow Rate (cfs)	ROW Area (acres)	Exc. Vol. (ac. ft)	Fill Vol. (ac. ft)	Length (stor-ft; chl-mi)	ROW Width (ft)	Depth (ft)	Land Cost	Constr. Cost	Lndscp Cost	50 Yr Maint. Cost	Total Cost	Land Cost %	Constr. Cost %	Lndscp Cost %	50 Yr Maint. Cost %	% of Total Cost
RR12510	Excavated Chl.	242	10	51	0	0.4	235	4	$ 990	$ 1,497	$ 95	$ 523	$ 3,104	32%	48%	3%	17%	2%
RR13010	Excavated Chl.	524	7	31	0	0.2	252	4	$ 710	$ 945	$ 84	$ 370	$ 2,108	34%	45%	4%	18%	1%
C135L10	Excavated Chl.	1380	82	2628	0	2.3	295	6	$ 8,200	$ 57,917	$ 1,343	$ 3,808	$ 71,268	12%	81%	2%	5%	36%
RR15020	Excavated Chl.	945	26	347	0	0.8	279	5	$ 2,620	$ 8,144	$ 388	$ 1,152	$ 12,305	21%	66%	3%	9%	6%
C17510A	Excavated Chl.	1748	50	1137	0	1.3	306	6	$ 4,970	$ 25,739	$ 863	$ 2,504	$ 34,077	15%	76%	3%	7%	17%
C17510B	Excavated Chl.	2452	50	862	0	1.2	354	5	$ 5,010	$ 19,483	$ 1,049	$ 2,215	$ 27,756	18%	70%	4%	8%	14%
D175	Offline Basin	2236	3	7	0	440	300	4	$ 300	$ 148	$ 132	$ 135	$ 714	42%	21%	18%	19%	0%
RR17510	Excavated Chl.	2355	24	272	0	0.6	349	5	$ 2,430	$ 6,387	$ 501	$ 1,014	$ 10,331	24%	62%	5%	10%	5%
S18010	Excavated Chl.	1039	33	377	0	1	280	6	$ 3,320	$ 9,113	$ 496	$ 1,663	$ 14,592	23%	62%	3%	11%	7%
RR18010	Excavated Chl.	1124	18	128	0	0.5	280	6	$ 1,810	$ 3,316	$ 271	$ 841	$ 6,238	29%	53%	4%	13%	3%
C180R10	Excavated Chl.	3439	36	410	0	0.7	419	5	$ 3,580	$ 9,447	$ 874	$ 1,510	$ 15,412	23%	61%	6%	10%	8%
		TOTAL	339	6250	0				$ 33,940	$ 142,135	$ 6,095	$ 15,735	**$ 197,905**	17%	72%	3%	8%	100%
All Channels			336	6243	0	9.0			$ 33,640	$ 141,987	$ 5,963	$ 15,600	$ 197,190	17%	72%	3%	8%	100%
All Online Basins			0	0	0				$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
All Offline Basins			3	7	0				$ 300	$ 148	$ 132	$ 135	$ 714	42%	21%	18%	19%	0%
Channel Cost per mile (in $1000)			$21,910		Basins Cost per ac. ft. (in $1000)				$18.86									
All Channels % increase			35%	36%	0%				36%	37%	34%	59%	39%					
All Online Basins % increase			0%	0%	0%				0%	0%	0%	0%	0%					
All Offline Basins % increase			200%	0%	0%				133%	4%	136%	115%	83%					
Total % increase			36%	36%	0%				36%	37%	35%	60%	39%					

Hydrology - 6-hr Storm HEC1 Model Results

		Peak	Peak	Peak		Cum.Area	MAX. Average Flow (cfs)				MAX. Average Rainfall Depth (Inches)				Total Runoff Volume (ac. ft)			
KK CARD	Type	Flow	Stage (ft)	Storage	Time	(sq. miles)	6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR
S100	BASIN	4347			4.6	6.99	899	225	75	32	1.195	1.195	1.195	1.195	446	446	446	446
S102	BASIN	2790			4.3	3.23	417	104	35	15	1.198	1.198	1.198	1.198	207	207	207	207
C102	COMBINE	5993			4.5	10.23	1198	300	100	43	1.089	1.089	1.089	1.089	594	594	594	594
RR102	STORAGE	127	1552	1143.35	6.7	10.23	122	104	72	41	0.11	0.376	0.784	1.029	60	205	428	561
D102	DIVERT	63			6.7	10.23	61	52	36	20	0.055	0.188	0.392	0.515	30	103	214	281
100105	ROUTE	59	100.2	20.4	12.5	10.23	58	51	36	20	0.053	0.185	0.389	0.512	29	101	212	279
S105	BASIN	2863			4.5	4.37	495	124	41	18	1.053	1.053	1.053	1.053	245	245	245	245
CF02	RETRIEVE	63			6.7	10.23	61	52	36	20	0.055	0.188	0.392	0.515	30	103	214	281
102105	ROUTE	63	100.4	8.6	8	10.23	60	51	36	20	0.055	0.187	0.39	0.513	30	102	213	280
C105U	COMBINE	2863			4.5	14.6	549	226	120	64	0.35	0.577	0.921	1.128	272	449	717	878
S110	BASIN	662			4.2	0.43	76	19	6	3	1.639	1.64	1.64	1.64	38	38	38	38
11015I	ROUTE	570	101.8	9.19	4.4	0.43	76	19	6	3	1.637	1.64	1.64	1.64	38	38	38	38
15I15R	ROUTE	506	102.1	19.34	4.8	0.43	76	19	6	3	1.635	1.64	1.64	1.64	38	38	38	38
S115	BASIN	1605			4.5	2.25	296	74	25	11	1.223	1.224	1.224	1.224	147	147	147	147
C115	COMBINE	1813			4.6	2.68	350	88	29	13	1.215	1.219	1.219	1.219	173	174	174	174
115120	ROUTE	1781	102.7	21.9	4.7	2.68	350	88	29	13	1.215	1.219	1.219	1.219	173	174	174	174
S120	BASIN	1838			4.3	2	256	64	21	9	1.189	1.189	1.189	1.189	127	127	127	127
C120	COMBINE	2678			4.5	4.68	545	137	46	20	1.083	1.087	1.087	1.087	270	271	271	271
C105D	COMBINE	4029			4.5	19.28	821	275	127	64	0.396	0.53	0.737	0.863	407	545	758	888
120135	ROUTE	4027	104.4	16.85	4.5	19.28	821	275	127	64	0.396	0.53	0.737	0.863	407	545	758	888
S125	BASIN	202			4	0.09	14	4	1	1	1.424	1.425	1.425	1.425	7	7	7	7
12535I	ROUTE	197	101.8	0.63	4	0.09	14	4	1	1	1.424	1.425	1.425	1.425	7	7	7	7
S130	BASIN	524			4.1	0.31	48	12	4	2	1.425	1.426	1.426	1.426	24	24	24	24
13035I	ROUTE	532	101.5	1.05	4.1	0.31	48	12	4	2	1.425	1.426	1.426	1.426	24	24	24	24
C135I	COMBINE	547			4.1	1.18	54	14	5	2	0.428	0.428	0.428	0.428	27	27	27	27
35I135	ROUTE	479	99.9	10.91	4.4	1.18	54	14	5	2	0.428	0.428	0.428	0.428	27	27	27	27
S135	BASIN	1102			4.2	0.88	111	28	9	4	1.175	1.175	1.175	1.175	55	55	55	55
C135L	COMBINE	1184			4.3	2.06	145	36	12	5	0.654	0.654	0.654	0.654	72	72	72	72
C135	COMBINE	4379			4.5	21.34	880	288	131	66	0.384	0.502	0.684	0.796	437	571	779	906
135145	ROUTE	3909	103.9	152.07	5	21.34	870	286	131	66	0.379	0.498	0.683	0.795	432	566	777	905
S140	BASIN	1913			4.1	1.37	188	47	16	7	1.27	1.27	1.27	1.27	93	93	93	93
140145	ROUTE	1624	101.9	39.38	4.4	1.37	187	47	16	7	1.27	1.27	1.27	1.27	93	93	93	93
S145	BASIN	1702			4.2	1.76	193	48	16	7	1.021	1.021	1.021	1.021	96	96	96	96
C145	COMBINE	4238			4.9	24.47	1037	325	143	71	0.394	0.494	0.651	0.747	514	645	850	974
145155	ROUTE	4239	105.8	11.67	4.9	24.47	1037	325	143	71	0.394	0.494	0.651	0.746	514	645	849	974
S155	BASIN	1626			4.3	1.83	223	56	19	8	1.131	1.132	1.132	1.132	111	111	111	111
C155	COMBINE	4470			4.8	26.3	1136	348	150	74	0.401	0.493	0.636	0.724	563	691	893	1016
155160	ROUTE	4459	104.6	33.72	4.9	26.3	1134	348	150	74	0.401	0.492	0.636	0.724	562	691	892	1016
S160	BASIN	1347			4.2	1.14	133	33	11	5	1.079	1.079	1.079	1.079	66	66	66	66
C160	COMBINE	4453			4.9	27.44	1175	358	153	75	0.398	0.485	0.622	0.705	583	710	910	1032
160170	ROUTE	4348	102.8	83.5	5.1	27.44	1169	356	153	75	0.396	0.483	0.62	0.704	580	707	908	1030
S170	BASIN	1686			4.2	1.46	178	44	15	6	1.127	1.127	1.127	1.127	88	88	88	88
170R	ROUTE	1489	1E+08	1E+08	4.4	1.46	178	44	15	6	1.127	1.127	1.127	1.127	88	88	88	88
C170R	COMBINE	4458			5	28.9	1236	372	157	77	0.397	0.479	0.608	0.686	613	738	937	1058
170180	ROUTE	4346	102.9	117.05	5.4	28.9	1230	371	157	77	0.396	0.477	0.607	0.686	610	735	936	1057
S150	BASIN	836			4.3	0.77	126	31	10	5	1.51	1.513	1.513	1.513	62	62	62	62

Hydrology - 6-hr Storm HEC1 Model Results

		Peak	Peak	Peak		Cum.Area	MAX. Average Flow (cfs)				MAX. Average Rainfall Depth (Inches)				Total Runoff Volume (ac. ft)			
KK CARD	Type	Flow	Stage (ft)	Storage	Time	(sq. miles)	6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR
S165	BASIN	1008			4.1	0.62	94	23	8	3	1.416	1.417	1.417	1.417	47	47	47	47
C165	COMBINE	1292			4.2	1.39	201	50	17	7	1.341	1.345	1.345	1.345	99	100	100	100
165175	ROUTE	1237	100	28.5	4.5	1.39	200	50	17	7	1.34	1.345	1.345	1.345	99	100	100	100
S175	BASIN	1203			4.5	1.8	226	56	19	8	1.165	1.166	1.166	1.166	112	112	112	112
C175	COMBINE	2054			4.5	3.19	383	96	32	14	1.114	1.118	1.118	1.118	190	190	190	190
D175	DIVERT	2054			4.5	3.19	383	96	32	14	1.114	1.118	1.118	1.118	190	190	190	190
175R	ROUTE	2032	100.4	10.04	4.5	3.19	383	96	32	14	1.114	1.118	1.118	1.118	190	190	190	190
S180	BASIN	1032			4.5	1.44	181	45	15	7	1.167	1.169	1.169	1.169	90	90	90	90
180R	ROUTE	954	100.9	13.03	4.5	1.44	181	45	15	7	1.165	1.169	1.169	1.169	90	90	90	90
C180RI	COMBINE	2608			4.5	4.63	507	127	42	18	1.017	1.02	1.02	1.02	251	252	252	252
RI180R	ROUTE	2579	100.6	19.15	4.6	4.63	507	127	42	18	1.017	1.02	1.02	1.02	251	252	252	252
C180R	COMBINE	4939			5.1	33.54	1472	429	176	85	0.408	0.476	0.584	0.651	730	851	1044	1164
180185	ROUTE	4934	103	54.46	5.2	33.54	1468	428	175	85	0.407	0.475	0.584	0.651	728	849	1044	1164
S185	BASIN	1450			4.5	2.42	288	72	24	10	1.106	1.107	1.107	1.107	143	143	143	143
185R	ROUTE	1302	102.5	41.84	4.9	2.42	288	72	24	10	1.105	1.107	1.107	1.107	143	143	143	143
C185R	COMBINE	5376			5.1	35.96	1579	455	184	88	0.408	0.471	0.57	0.632	783	902	1094	1211
185190	ROUTE	5360	102.7	44.79	5.2	35.96	1576	454	184	88	0.407	0.47	0.57	0.631	781	901	1093	1211
S190	BASIN	2084			4.5	4.05	391	98	33	14	0.896	0.896	0.896	0.896	194	194	194	194
C190	COMBINE	5657			5.1	39.24	1710	488	194	92	0.405	0.462	0.553	0.608	848	967	1156	1272
190195	ROUTE	5521	103.2	83.81	5.3	39.24	1705	487	194	92	0.404	0.462	0.552	0.608	846	966	1156	1272
S195	BASIN	1001			4.6	1.81	203	51	17	7	1.046	1.046	1.046	1.046	101	101	101	101
C195	COMBINE	5615			5.3	41.05	1755	499	198	94	0.398	0.453	0.538	0.591	870	991	1179	1293

Hydrology - 24-hr Storm HEC1 Model Results

KK CARD	Type	Peak Flow	Peak Stage (ft)	Peak Storage	Time	Cum.Area (sq. miles)	MAX. Average Flow (cfs)				MAX. Average Rainfall Depth (Inches)				Total Runoff Volume (ac. ft)			
							6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR
S100	BASIN	5214			12.5	6.99	965	241	80	35	1.282	1.282	1.282	1.282	478	478	478	478
S102	BASIN	3434			12.3	3.23	420	105	35	15	1.207	1.207	1.207	1.207	208	208	208	208
C102	COMBINE	7803			12.4	10.23	1367	342	114	49	1.243	1.243	1.243	1.243	678	678	678	678
RR102	STORAGE	149	1552.1	1201.44	14.4	10.23	141	119	82	46	0.128	0.431	0.895	1.163	70	235	488	634
D102	DIVERT	75			14.4	10.23	71	59	41	23	0.064	0.215	0.448	0.581	35	118	244	317
100105	ROUTE	70	100.2	24.2	20.3	10.23	67	58	41	23	0.061	0.211	0.444	0.578	33	115	242	315
S105	BASIN	3466			12.5	4.37	531	133	44	19	1.129	1.129	1.129	1.129	263	263	263	263
CF02	RETRIEVE	75			14.4	10.23	71	59	41	23	0.064	0.215	0.448	0.581	35	118	244	317
102105	ROUTE	74	100.4	9.55	15.6	10.23	70	59	41	23	0.064	0.214	0.445	0.58	35	117	243	316
C105U	COMBINE	3466			12.5	14.6	587	238	125	66	0.374	0.606	0.958	1.164	291	472	746	906
S110	BASIN	532			12.1	0.43	62	16	5	2	1.35	1.422	1.422	1.422	31	33	33	33
11015I	ROUTE	456	101.7	7.4	12.4	0.43	62	16	5	2	1.35	1.421	1.422	1.422	31	33	33	33
15I15R	ROUTE	412	101.9	16.62	12.7	0.43	62	16	5	2	1.349	1.421	1.422	1.422	31	33	33	33
S115	BASIN	1693			12.5	2.25	287	73	24	11	1.186	1.209	1.209	1.209	142	145	145	145
C115	COMBINE	1937			12.6	2.68	346	89	30	13	1.201	1.232	1.233	1.233	171	176	176	176
115120	ROUTE	1900	102.8	22.91	12.7	2.68	346	89	30	13	1.201	1.232	1.233	1.233	171	176	176	176
S120	BASIN	2032			12.3	2	247	62	21	9	1.146	1.158	1.158	1.158	122	124	124	124
C120	COMBINE	3202			12.4	4.68	585	149	50	22	1.162	1.185	1.186	1.186	290	296	296	296
C105D	COMBINE	6217			12.4	19.28	1091	359	163	82	0.526	0.692	0.943	1.092	541	712	969	1123
120135	ROUTE	6220	105.1	23.77	12.5	19.28	1091	359	163	82	0.526	0.692	0.943	1.092	541	711	969	1123
S125	BASIN	161			12	0.09	12	3	1	0	1.197	1.258	1.258	1.258	6	6	6	6
12535I	ROUTE	157	101.6	0.53	12	0.09	12	3	1	0	1.197	1.257	1.258	1.258	6	6	6	6
S130	BASIN	415			12.1	0.31	39	10	3	1	1.169	1.217	1.217	1.217	19	20	20	20
13035I	ROUTE	422	101.3	0.89	12.1	0.31	39	10	3	1	1.169	1.217	1.217	1.217	19	20	20	20
C135I	COMBINE	551			12.1	1.18	50	13	4	2	0.39	0.407	0.407	0.407	25	26	26	26
35I135	ROUTE	478	99.9	10.89	12.3	1.18	50	13	4	2	0.39	0.407	0.407	0.407	25	26	26	26
S135	BASIN	1015			12.2	0.88	99	25	8	4	1.048	1.048	1.048	1.048	49	49	49	49
C135L	COMBINE	1380			12.2	2.06	147	37	12	5	0.661	0.671	0.671	0.671	73	74	74	74
C135	COMBINE	7074			12.4	21.34	1214	389	173	86	0.529	0.678	0.903	1.037	602	771	1027	1180
135145	ROUTE	6197	104.7	221.33	12.8	21.34	1202	386	172	86	0.524	0.673	0.901	1.036	596	766	1025	1179
S140	BASIN	2029			12.1	1.37	172	43	14	6	1.164	1.164	1.164	1.164	85	85	85	85
140145	ROUTE	1633	101.9	39.54	12.4	1.37	172	43	14	6	1.163	1.164	1.164	1.164	85	85	85	85
S145	BASIN	1945			12.2	1.76	193	48	16	7	1.022	1.022	1.022	1.022	96	96	96	96
C145	COMBINE	6871			12.7	24.47	1506	461	197	96	0.572	0.701	0.899	1.017	747	915	1173	1327
145155	ROUTE	6860	107	18.67	12.8	24.47	1505	461	197	96	0.572	0.701	0.899	1.017	746	915	1173	1327
S155	BASIN	1781			12.3	1.83	218	55	18	8	1.105	1.117	1.117	1.117	108	109	109	109
C155	COMBINE	7358			12.7	26.3	1688	507	212	103	0.597	0.716	0.9	1.009	837	1005	1262	1416
155160	ROUTE	7332	105.6	53.54	12.8	26.3	1686	506	212	103	0.596	0.716	0.9	1.009	836	1004	1262	1416
S160	BASIN	1342			12.1	1.14	124	31	10	4	1.01	1.01	1.01	1.01	62	62	62	62
C160	COMBINE	7411			12.8	27.44	1785	531	220	106	0.605	0.719	0.895	1	885	1052	1310	1464
160170	ROUTE	7240	103.5	135.54	13	27.44	1779	529	220	106	0.603	0.717	0.895	1	882	1050	1309	1463
S170	BASIN	1802			12.1	1.46	169	42	14	6	1.075	1.075	1.075	1.075	84	84	84	84
170R	ROUTE	1558	1E+08	1E+08	12.4	1.46	169	42	14	6	1.075	1.075	1.075	1.075	84	84	84	84
C170R	COMBINE	7495			13	28.9	1917	563	231	111	0.617	0.725	0.893	0.993	950	1117	1377	1531
170180	ROUTE	7342	103.6	189.1	13.2	28.9	1909	562	231	111	0.614	0.723	0.892	0.992	946	1114	1375	1530
S150	BASIN	729			12.3	0.77	107	29	10	4	1.291	1.374	1.375	1.375	53	57	57	57
150165	ROUTE	714	100.2	4.65	12.4	0.77	107	29	10	4	1.291	1.374	1.375	1.375	53	57	57	57

Hydrology - 24-hr Storm HEC1 Model Results

KK CARD	Type	Peak Flow	Peak Stage (ft)	Peak Storage	Time	Cum.Area (sq. miles)	MAX. Average Flow (cfs)				MAX. Average Rainfall Depth (Inches)				Total Runoff Volume (ac. ft)			
							6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR
S165	BASIN	842			12.1	0.62	78	20	7	3	1.183	1.219	1.219	1.219	39	40	40	40
C165	COMBINE	1275			12.2	1.39	184	48	16	7	1.228	1.29	1.291	1.291	91	96	96	96
165175	ROUTE	1203	99.9	27.79	12.5	1.39	184	48	16	7	1.228	1.289	1.291	1.291	91	96	96	96
S175	BASIN	1278			12.5	1.8	217	55	18	8	1.119	1.131	1.131	1.131	108	109	109	109
C175	COMBINE	2452			12.5	3.19	396	102	34	15	1.152	1.185	1.186	1.186	196	202	202	202
D175	DIVERT	2236			12.4	3.19	390	100	33	14	1.135	1.168	1.169	1.169	193	199	199	199
175R	ROUTE	2236	100.5	10.84	12.5	3.19	390	100	33	14	1.135	1.168	1.169	1.169	193	199	199	199
S180	BASIN	1039			12.5	1.44	171	44	15	6	1.1	1.123	1.124	1.124	85	86	86	86
180R	ROUTE	950	100.9	12.99	12.5	1.44	171	44	15	6	1.099	1.123	1.124	1.124	85	86	86	86
C180RI	COMBINE	3165			12.5	4.63	554	142	47	21	1.112	1.143	1.143	1.143	275	282	283	283
RI180R	ROUTE	3116	100.8	22.13	12.6	4.63	554	142	47	21	1.112	1.143	1.143	1.143	275	282	283	283
C180R	COMBINE	8694			13	33.54	2379	680	270	128	0.66	0.754	0.899	0.987	1180	1348	1608	1766
180185	ROUTE	8675	104.1	85.49	13.1	33.54	2374	679	270	128	0.658	0.753	0.898	0.987	1177	1346	1607	1765
S185	BASIN	1655			12.5	2.42	288	73	24	10	1.105	1.117	1.117	1.117	143	144	144	144
185R	ROUTE	1411	102.6	45.16	12.9	2.42	287	73	24	10	1.104	1.117	1.117	1.117	143	144	144	144
C185R	COMBINE	9702			13	35.96	2611	738	290	137	0.675	0.763	0.899	0.981	1295	1464	1723	1882
185190	ROUTE	9685	103.6	70.42	13.1	35.96	2607	737	290	137	0.674	0.762	0.898	0.981	1293	1462	1723	1881
S190	BASIN	2590			12.5	4.05	448	112	37	16	1.027	1.027	1.027	1.027	222	222	222	222
C190	COMBINE	10633			13	39.24	2964	827	320	150	0.702	0.784	0.909	0.984	1470	1640	1902	2060
190195	ROUTE	10537	104.3	139.9	13.1	39.24	2958	826	319	150	0.701	0.783	0.908	0.984	1467	1638	1901	2060
S195	BASIN	1039			12.6	1.81	202	51	17	7	1.041	1.041	1.041	1.041	100	100	100	100
C195	COMBINE	10982			13.1	41.05	3114	865	333	155	0.705	0.784	0.904	0.976	1544	1716	1979	2137

Channels Hydraulics Summary

		Design Geometry						Hydraulics											
Structure ID	Type	Initial Slope (ft/ft)	Long-term Slope (ft/ft)	Length (stor-ft; chl-mi)	Width (ft)	Depth (ft)	Chnl Mannings n	Flow Rate (cfs)	Wetted Perimeter (ft)	Wetted XS Area (ft)	Hydraulic Radius (ft)	Hydraulic Depth (ft)	Flow Depth (ft)	Freeboard (ft)	Top Width (ft)	Velocity (ft/s)	Froude Number	Shear Stress (lb/sq. ft)
RR12510	Excavated	0.0265	0.0035	0.40	3	4.0	0.020	242	22.7	38.6	1.7	1.8	3.1	0.9	22	6.3	0.83	0.68
RR13010	Excavated	0.0252	0.0035	0.20	3	4.0	0.020	524	36.8	74.4	2.0	2.1	2.7	1.3	36	7.0	0.86	0.58
C135L10	Excavated	0.0165	0.0030	2.30	3	5.5	0.020	1380	71.5	181.7	2.5	2.6	4.2	1.3	70	7.6	0.83	0.79
RR15020	Excavated	0.0206	0.0030	0.80	3	5.0	0.020	945	58.8	133.8	2.3	2.3	3.8	1.2	58	7.1	0.82	0.70
C17510A	Excavated	0.0182	0.0030	1.30	3	6.0	0.020	1748	77.7	216.4	2.8	2.8	4.4	1.6	76	8.1	0.85	0.82
C17510B	Excavated	0.0135	0.0030	1.20	3	5.0	0.020	2452	134.5	330.2	2.5	2.5	3.9	1.1	133	7.4	0.83	0.72
RR17510	Excavated	0.0164	0.0030	0.60	3	5.0	0.020	2355	128.8	316.7	2.5	2.5	3.8	1.2	128	7.4	0.83	0.70
S18010	Excavated	0.0146	0.0030	1.00	3	5.5	0.020	1039	56.6	139.6	2.5	2.5	4.2	1.3	55	7.4	0.83	0.79
RR18010	Excavated	0.0153	0.0030	0.50	3	5.5	0.020	1124	57.5	147.2	2.6	2.6	4.3	1.2	56	7.6	0.83	0.81
C180R10	Excavated	0.0122	0.0030	0.70	3	5.0	0.020	3439	199.9	473.9	2.4	2.4	3.9	1.1	199	7.3	0.83	0.74

Basins Hydraulics Summary

			Design Geometry				Hydraulics					
Structure ID	Type	Adjacent Topo. Slope	Length (stor-ft; chl-mi)	Width (ft)	Depth (ft)	Storage Volume Provided	Peak Storage (ac. Ft)	Total Vol. Entering Basin (ac.	Peak Inflow into Basin (cfs)	Peak Outflow (cfs)	Peak Stage (ft)	Freeboard (ft)
D175	Offline Basin	0.0160	280	200	4.0	3.2	3.0	3.0	216	0	0.0	4.0

Open Channel

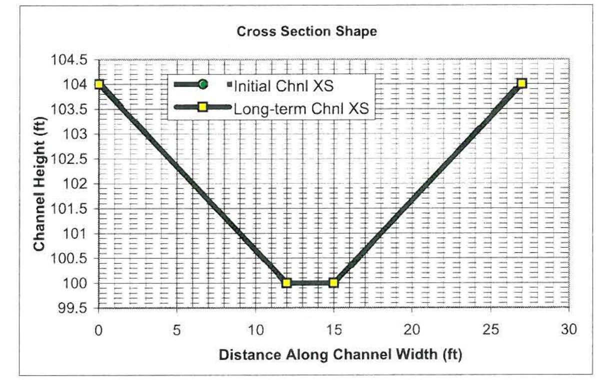
Structure ID	RR12510		HEC1 ID	12535I

Longitundal Geometry

Length	1852.5	ft
U/S Elev	1746.1	ft
D/S Elev	1697.0	ft
Initial Channel Slope	0.0265	ft/ft
Long-term Channel Slope	0.0035	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	1



Initial Channel XS Geometry

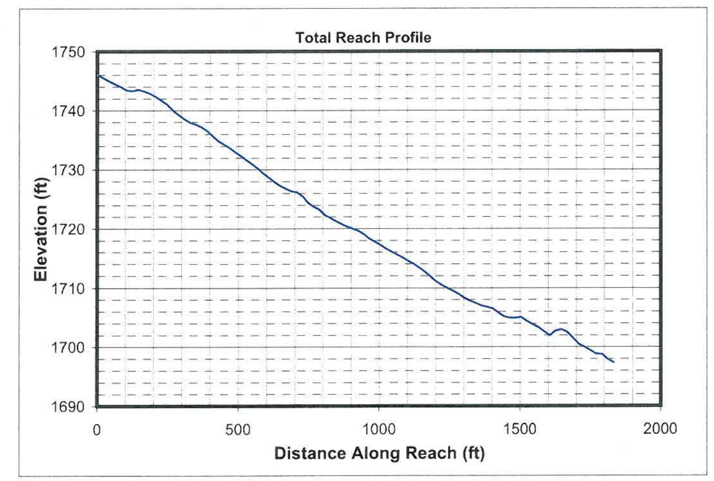
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	0	3	3	4	3	0	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	12	12	15	15	15	27
Y	104	100	100	100	100	100	100	104

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	0	3	3	4	3	0	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	12	12	15	15	15	27
Y	104	100	100	100	100	100	100	104



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.02	0.02	0.02	0.02	0.02	0.02

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	S125	S135							TOTAL
HEC1 Peak-Flow	202	1102							1304
Weighting Factor	1.00	0.04							
Flow into Channel	202	40							242

Reach Sediment Inflow Characteristics

U/S Contributing ID									TOTAL
HEC1 Flow Volume (ac. ft)									0
Sediment Conc. (ppm)									
Sediment Volume (ac. ft)									0.00
Weighting Factor									
Weighted Sed. Vol. (ac. ft)									0.00

Hydrology

Drainage Area	0.09	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	242	cfs	
Long-term Max. Chnl Capacity	436	cfs	
Q2 Channel	24	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	27	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC

Sub-area: Wagner Wash, Alternative: C
Open Channel Structure ID: RR12510

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
24	10.0	7.0	0.7	100.0	101.1	3.5	1.1	9.6	0.7	0.24	0.72
61	13.7	13.7	1.0	100.0	101.7	4.4	1.7	13.2	1.0	0.37	0.76
182	20.5	31.1	1.5	100.0	102.8	5.8	2.8	19.6	1.6	0.60	0.81
242	22.7	38.6	1.7	100.0	103.1	6.3	3.1	21.7	1.8	0.68	0.83

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
24	10.0	7.0	0.7	100.0	101.1	3.5	1.1	9.6	0.7	0.24	0.72
61	13.7	13.7	1.0	100.0	101.7	4.4	1.7	13.2	1.0	0.37	0.76
182	20.5	31.1	1.5	100.0	102.8	5.8	2.8	19.6	1.6	0.60	0.81
242	22.7	38.6	1.7	100.0	103.1	6.3	3.1	21.7	1.8	0.68	0.83

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
24										0
61										0
182										0
242										0

Allowable Velocity

Channel Lining	Concrete

Discharge (cfs)	Fortier & Scobey (as modified in Chow) Permissive Velocity (ft/s): Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	BUREC: Erosive?	Neill (gravel/cobble) Non-cohesive: Erosive?	All'ble Vel (ft/s)	Cohesive: Erosive?	All'ble Vel (ft/s)	USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
24	1.74	1.2960	1.2312	Erosive	Erosive	Erosive	0.3	Erosive	3.5	Stable	Stable
61	1.74	1.4080	1.3376	Erosive	Erosive	Erosive	0.3	Erosive	4.6	Stable	Stable
182	1.74	1.5387	1.4618	Erosive	Erosive	Erosive	0.4	Erosive	6.3	Stable	Stable
242	1.74	1.5725	1.4939	Erosive	Erosive	Erosive	0.4	Erosive	6.8	Stable	Stable

USCOE Allowable Velocity (ft/s)	20
FHWA Allowable Velocity (ft/s)	50

Regime Width

Discharge (cfs)	Channel Width (ft) 24	61	182	242	Flow Depth (ft) 24	61	182	242	Velocity (ft/s) 24	61	182	242
Bray - Equation #1	13	21	37	43	0.8	1.0	1.5	1.7	2.5	2.8	3.3	3.4
Bray - Equation #2	17	27	48	56	0.8	1.1	1.7	1.8	1.7	1.9	2.2	2.3
Hey	3	6	11	13	2.2	3.1	4.7	5.2				
Ackers & Charlton/Lacey	14	20	32	36					1.4	1.6	1.9	2.0
Parker	34	53	93	107	0.5	0.8	1.2	1.4				
Chang	16	28	55	65	0.2	0.3	0.3	0.2				
Kellerhals	9	14	24	28	1.0	1.4	2.2	2.4	2.8	3.1	3.4	3.5
AMAFCA/Schumm	10	13	20	22								
Moody & Odem	5	5	5	5	0.7	0.7	0.7	0.7				
BUREC	6.9	9.8	14.7	16.4	2	3	4	4	3.0	3.7	4.9	5.3
Average	13	20	34	39	1.0	1.4	2.0	2.2	2.3	2.6	3.2	3.3
Values As Designed	10	13	20	22	1.1	1.7	2.8	3.1	3.5	4.4	5.8	6.3
Difference with Design	3	6	14	17	-0.1	-0.3	-0.7	-0.9	-1.2	-1.8	-2.7	-3.0

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
24	114	207	456	2170	356	197	87	94	1946	166	685	589
61	392	561	1072	8262	599	637	222	305	4888	526	2120	1780
182	1720	1809	3181	40544	1122	3168	658	1173	14706	2106	7884	7097
242	2531	2451	4293	61417	1321	4752	872	1657	19617	3028	11057	10272

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
24	1745	3180	6995	33272	5459	3019	1332	1444	29830	2544	10497	9029
61	2407	3441	6574	50667	3676	3906	1359	1870	29972	3228	13000	10918
182	3515	3698	6502	82875	2292	6475	1345	2398	30059	4304	16115	14507
242	3880	3758	6582	94156	2026	7285	1337	2540	30074	4642	16951	15748

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
24	114	152	183	104	81	67	87	94	80	41	113	102
61	392	426	492	397	155	198	222	305	216	53	385	295
182	1720	1415	1400	1948	323	709	658	1173	679	71	1591	1062
242	2531	1929	1843	2951	389	991	872	1657	912	77	2292	1495

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
24	1745	2328	2812	1599	1241	1035	1332	1444	1225	632	1740	1557
61	2407	2612	3017	2435	950	1212	1359	1870	1326	324	2362	1807
182	3515	2892	2861	3982	660	1450	1345	2398	1388	145	3252	2172
242	3880	2957	2826	4524	597	1519	1337	2540	1398	118	3513	2292

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
24	0.0009	0.0005	253	0.77	0.053	0.0004	31	0.036	0.0003	0.0159	0.0004	0.0005	0.0121	0.0009	0.0019	0.0033	0.0042
61	0.0006	0.0003	303	0.92	0.055	0.0003	32	0.036	0.0002	0.0159	0.0002	0.0003	0.0121	0.0006	0.0010	0.0033	0.0041
182	0.0003	0.0002	374	1.14	0.057	0.0002	33	0.036	0.0001	0.0159	0.0002	0.0002	0.0121	0.0004	0.0004	0.0033	0.0040
242	0.0003	0.0002	395	1.20	0.057	0.0002	33	0.036	0.0001	0.0159	0.0001	0.0002	0.0121	0.0003	0.0003	0.0033	0.0040

Drop Structures

Design Slope	0.0035	ft/ft
Total Drop Needed	42.6	ft
Height of Drop Structure	3	ft
No . of Drop Structures	15	
Distance between structs.	124	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.03	sq. mi
Total Sediment Yield Volume	0.06	ac ft

Sedimentation Basins

Length	124 ft	Depth	3 ft
Width	27 ft	Side slope	3 ft/ft
Total Volume per Basin		0.14	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		2	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
24	1.1	0.2	0.2	24.6	1.1	0.7	3.5	0.0035	0.2	0.0	1.0	1.9
61	1.1	0.3	0.3	24.6	1.7	1.0	4.4	0.0035	0.3	0.0	1.0	2.3
182	1.1	0.8	0.5	24.6	2.8	1.6	5.8	0.0035	0.5	0.0	1.0	3.3
242	1.1	0.9	0.5	24.6	3.1	1.8	6.3	0.0035	0.6	0.0	1.0	3.6

Toe Protection Needed	4.0	ft

HEC1 Results For Open Channel

Peak Flow	197	cfs
Stage at Peak Flow	101.8	ft
Flow Volume	7.0	ac. ft

Freeboard

Max. Flow Depth	3.1	ft
Channel Depth as designed	4.0	ft
Available Freeboard	0.9	ft
Required Freeboard	1	ft

Sediment Volume

Inflowing Sediment Volume	0.06	ac. ft
Outflowing Sediment Volume	0.01	ac. ft
Deposited(+)/Eroded(-) Volume	0.05	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	1853	1853
Side Slope (?H:1V)	3	6
Channel Width (ft)	27	51
Channel XS Area (sq. ft)	60	108
Channel Perimeter (ft)	28	51

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	43572	81937
Excavated Area (sq. Yd)	5559	10500

Bank And Channel Lining	Base	LC Enhanced
Lining Type	Concrete	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	1853	1853
Lining Width (ft)	25	49
Lining Thickness (ft)	0.5	0.5
Lining Area (sq. Yd)	5147	10089
Lining Volume (cu. Yd)	858	1682

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	1853	ft
Thickness	1.5	ft
Protection Depth	4	ft
Tie-in Length/Depth	3.0	ft
Total Depth	7.0	ft
Area needed	309	sq. Yd
Volume	721	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	None	None
Left Levee Length (ft)	0	0
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	N/A	6
Left Levee Height (ft)	0	1
Left Levee Surface Area (sq. Yd)	0	0
Left Levee Volume (cu. Yd)	0	0
Right Levee Length (ft)	0	0
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	N/A	6
Right Levee Height (ft)	0	1
Right Levee Surface Area (sq. Yd)	0	0
Right Levee Volume (cu. Yd)	0	0
Total Levee Surface Area (sq. Yd)	0	0
Total Levee Volume (cu. Yd)	0	0

Levee Lining	Base	LC Enhanced
Lining Type	None	None
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	1853	1853
Left Levee Lining Width (ft)	0	0
Left Levee Lining Thickness (ft)	0	0
Left Levee Lining Area (sq. Yd)	0	0
Left Levee Lining Volume (cu. Yd)	0	0
Right Levee Length (ft)	1853	1853
Right Levee Lining Width (ft)	0	0
Right Levee Lining Thickness (ft)	0	0
Right Levee Lining Area (sq. Yd)	0	0
Right Levee Lining Volume (cu. Yd)	0	0
Total Lining Area (sq. Yd)	0	0
Total Lining Volume (cu. Yd)	0	0

Drop Structures		
Structure Type	Concrete	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	27	ft
LC Enhancement Ratio	1.1	
Structure Thickness	0.5	ft
Drop Height	3	ft
Scour Depth	9.3	ft
Structure Height	12.3	ft
Number of Structures	15	
Volume per structure	6	cu. Yd
Unit Cost	$ 155.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 930	
Area per structure	2	sq. Yd
Total Area	23	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	2	
Total Volume per Basin	226	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 904	
Other Cost	$ -	
Total cost per basin	$ 904	
Area per basin	371	sq. Yd
Total Area	742	sq. Yd

Structure Cost

Structure Type	Structure Type	Excavation/Construction Quantity	Units	Unit Cost	Cost Subtotal	Landscape Quantity	Units	Unit Cost	Landscape Cost	Maintenance Quantity	Units	Unit Cost	Maintenance Cost
Levee	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining -LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Excavated Channel	Excavated	43,572	cu. Yd	$ 10.00	$ 435,720	5,559	sq. Yd	$ 9.00	$ 50,031	5,559	sq. Yd	$ 8.33	$ 46,325
Exc. Chl - LC Enhancement	Excavated	38,365	cu. Yd	$ 10.00	$ 383,650	4,941	sq. Yd	$ 9.00	$ 44,469	4,941	sq. Yd	$ 8.33	$ 41,175
Channel Lining	Concrete	858	cu. Yd	$ 155.00	$ 132,990	5,147	sq. Yd	$ -	$ -	5,147	sq. Yd	$ 41.67	$ 214,458
Channel Lining - LC Enhancement	Concrete	824	cu. Yd	$ 155.00	$ 127,720	4,942	sq. Yd	$ -	$ -	4,942	sq. Yd	$ 41.67	$ 205,917
Toe Protection	Riprap	721	cu. Yd	$ 75.00	$ 54,075	309	sq. Yd	$ -	$ -	309	sq. Yd	$ 25.00	$ 7,725
Drop Structures	Concrete	15	EA	$ 930.00	$ 13,950	23	sq. Yd	$ -	$ -	23	sq. Yd	$ 41.67	$ 958
Drop Str. - LC Enhancement	Concrete	15	EA	$ 93.00	$ 1,395	2	sq. Yd	$ -	$ -	2	sq. Yd	$ 41.67	$ 96
Sedimentation Basins		2	EA	$ 904.00	$ 1,808	742	sq. Yd	$ -	$ -	742	sq. Yd	$ 8.33	$ 6,183
Other					$ -				$ -				$ -

Base Landscape Cost	$ 50,031	
LC Enhancement Cost	$ 44,469	
Total Landscape Cost	$ 94,500	

Base Maintenance Cost	$ 275,650
LC Enhancement Cost	$ 247,188
Total Maintenance Cost	$ 522,838

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 638,543	$ 512,765	$ 1,151,308
Contingency Cost (25% of Construction Cost)	$ 159,636	$ 128,191	$ 287,827
Engineering Design Cost (5% of Construction Cost)	$ 31,927	$ 25,638	$ 57,565
Total Construction Cost	$ 830,106	$ 666,595	$ 1,496,700

Land Cost

Channel Length	1853 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	134	5.7	$100,000	$ 570,000
LC Enhancement Buffer	50	2.1	$100,000	$ 210,000
Channel	27	1.1	$100,000	$ 110,000
Channel LC Enhancement	24	1	$100,000	$ 100,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	235	9.9		$ 990,000

Right of Way

Preservation Corridor Width	120	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	50	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	6.8	$100,000	$ 680,000
LC Enhancement Cost	acre	3.1	$100,000	$ 310,000
Total Land Cost	acre	9.9	$100,000	$ 990,000

Total Cost

Base Total Cost	$ 1,835,787
Total Landscape Enhancement Cost	$ 1,268,251
Total Cost Including LC Enh.	$ 3,104,038

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Sub-area: Wagner Wash, Alternative: C
Open Channel Structure ID: RR12510

Open Channel

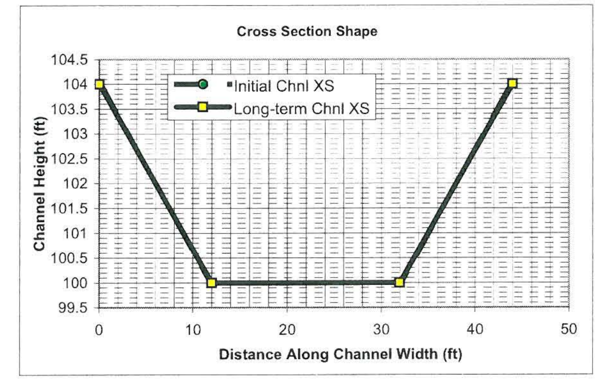
Structure ID	RR13010		HEC1 ID	13035I

Longitundal Geometry

Length	1235.4	ft
U/S Elev	1728.2	ft
D/S Elev	1697.0	ft
Initial Channel Slope	0.0252	ft/ft
Long-term Channel Slope	0.0035	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	1



Initial Channel XS Geometry

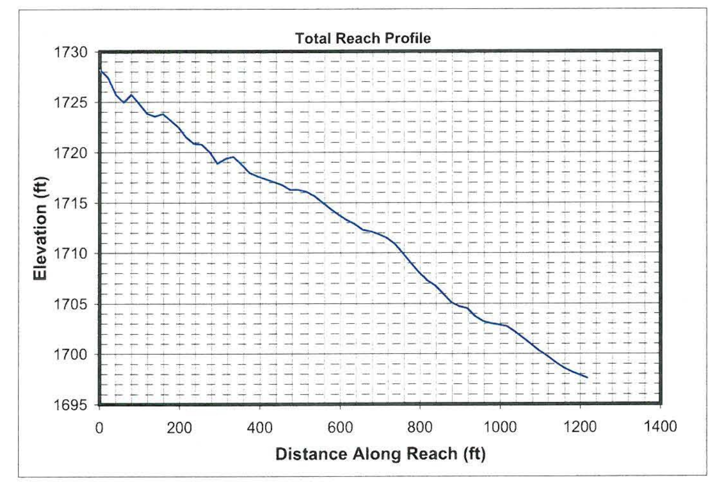
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	0	3	20	4	3	0	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	12	12	32	32	32	44
Y	104	100	100	100	100	100	100	104

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	0	3	20	4	3	0	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	12	12	32	32	32	44
Y	104	100	100	100	100	100	100	104



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.02	0.02	0.02	0.02	0.02	0.02

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	S130									TOTAL
HEC1 Peak-Flow	524									524
Weighting Factor	1.00									
Flow into Channel	524									524

Reach Sediment Inflow Characteristics

U/S Contributing ID										TOTAL
HEC1 Flow Volume (ac. ft)										0
Sediment Conc. (ppm)										
Sediment Volume (ac. ft)										0.00
Weighting Factor	1									
Weighted Sed. Vol. (ac. ft)										0.00

Hydrology

Drainage Area	0.31	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	524	cfs	
Long-term Max. Chnl Capacity	1128	cfs	
Q2 Channel	52	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	44	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
52	24.5	15.9	0.6	100.0	100.7	3.3	0.7	24.3	0.7	0.16	0.72
131	27.7	28.9	1.0	100.0	101.2	4.5	1.2	27.3	1.1	0.27	0.78
393	34.4	60.9	1.8	100.0	102.3	6.5	2.3	33.6	1.8	0.50	0.85
524	36.8	74.4	2.0	100.0	102.7	7.0	2.7	36.0	2.1	0.58	0.86

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
52	24.5	15.9	0.6	100.0	100.7	3.3	0.7	24.3	0.7	0.16	0.72
131	27.7	28.9	1.0	100.0	101.2	4.5	1.2	27.3	1.1	0.27	0.78
393	34.4	60.9	1.8	100.0	102.3	6.5	2.3	33.6	1.8	0.50	0.85
524	36.8	74.4	2.0	100.0	102.7	7.0	2.7	36.0	2.1	0.58	0.86

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
52										0
131										0
393										0
524										0

Allowable Velocity

Channel Lining: Concrete

Discharge (cfs)	Fortier & Scobey (as modified in Chow) Permissive Velocity (ft/s): Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	BUREC Erosive?	Neill (gravel/cobble) Non-cohesive Erosive?	All'ble Vel (ft/s)	Cohesive Erosive?	All'ble Vel (ft/s)	USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
52	1.74	1.2643	1.2011	Erosive	Erosive	Erosive	0.3	Erosive	2.8	Stable	Stable
131	1.74	1.4127	1.3421	Erosive	Erosive	Erosive	0.3	Erosive	3.9	Stable	Stable
393	1.74	1.5785	1.4996	Erosive	Erosive	Erosive	0.4	Erosive	5.8	Stable	Stable
524	1.74	1.6196	1.5386	Erosive	Erosive	Erosive	0.4	Erosive	6.5	Stable	Stable

USCOE Allowable Velocity (ft/s)	20
FHWA Allowable Velocity (ft/s)	50

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	52	131	393	524	52	131	393	524	52	131	393	524
Bray - Equation #1	19	31	55	65	1.0	1.3	1.9	2.1	2.8	3.1	3.6	3.8
Bray - Equation #2	25	41	73	85	1.1	1.5	2.1	2.3	1.9	2.1	2.5	2.6
Hey	5	9	17	20	2.9	4.1	6.2	7.0				
Ackers & Charlton/Lacey	19	28	44	50					1.5	1.8	2.2	2.3
Parker	50	79	136	157	0.7	1.0	1.7	1.9				
Chang	25	45	88	105	0.3	0.3	0.2	0.2				
Kellerhals	13	21	36	41	1.3	1.9	3.0	3.3	3.0	3.3	3.7	3.8
AMAFCA/Schumm	24	27	34	36								
Moody & Odem	8	8	8	8	0.8	0.8	0.8	0.8				
BUREC	9.2	13.0	19.7	21.9	2	3	5	6	3.6	4.5	6.0	6.4
Average	20	30	51	59	1.3	1.8	2.7	2.9	2.6	3.0	3.6	3.8
Values As Designed	24	27	34	36	0.7	1.2	2.3	2.7	3.3	4.5	6.5	7.0
Difference with Design	-5	3	17	23	0.6	0.6	0.4	0.3	-0.7	-1.5	-2.9	-3.3

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
52	238	463	1013	3949	823	400	194	197	3910	334	1396	1174
131	914	1287	2329	17251	1220	1403	500	699	9847	1149	4665	3751
393	4406	4177	7029	96435	2014	7714	1464	2822	29643	4982	18187	16261
524	6609	5654	9419	150020	2312	11824	1929	4012	39543	7282	25669	24025

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
52	1686	3276	7169	27957	5825	2833	1375	1397	27687	2365	9883	8314
131	2587	3645	6595	48855	3456	3974	1417	1979	27887	3255	13211	10624
393	4159	3943	6635	91037	1902	7282	1382	2664	27984	4703	17169	15351
524	4679	4003	6669	106216	1637	8372	1366	2841	27997	5156	18174	17010

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
52	238	338	405	204	184	145	194	197	168	95	235	218
131	914	985	1105	891	325	449	500	699	470	110	886	667
393	4406	3310	3052	4980	611	1679	1464	2822	1483	119	3928	2532
524	6609	4510	4038	7746	718	2368	1929	4012	1991	124	5719	3615

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
52	1686	2392	2864	1444	1304	1030	1375	1397	1188	671	1666	1547
131	2587	2791	3129	2523	922	1271	1417	1979	1331	312	2510	1888
393	4159	3125	2881	4701	577	1585	1382	2664	1400	112	3708	2390
524	4679	3193	2859	5485	508	1676	1366	2841	1410	87	4049	2559

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
52	0.0010	0.0005	238	0.73	0.052	0.0004	31	0.036	0.0003	0.0159	0.0004	0.0006	0.0093	0.0006	0.0015	0.0035	0.0035
131	0.0005	0.0003	302	0.92	0.055	0.0003	32	0.036	0.0002	0.0159	0.0002	0.0003	0.0093	0.0004	0.0008	0.0034	0.0034
393	0.0003	0.0002	394	1.20	0.057	0.0002	33	0.036	0.0001	0.0159	0.0001	0.0002	0.0093	0.0002	0.0003	0.0034	0.0033
524	0.0002	0.0002	420	1.28	0.058	0.0002	33	0.036	0.0001	0.0159	0.0001	0.0002	0.0093	0.0002	0.0003	0.0034	0.0033

Drop Structures

Design Slope	0.0035	ft/ft
Total Drop Needed	26.9	ft
Height of Drop Structure	3	ft
No . of Drop Structures	9	
Distance between structs.	137	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.03	sq. mi
Total Sediment Yield Volume	0.06	ac ft

Sedimentation Basins

Length	137 ft	Depth	3 ft
Width	44 ft	Side slope	3 ft/ft
Total Volume per Basin		0.31	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
52	1.1	0.1	0.1	24.6	0.7	0.7	3.3	0.0035	0.1	0.0	1.0	1.7
131	1.1	0.3	0.3	24.6	1.2	1.1	4.5	0.0035	0.2	0.0	1.0	2.1
393	1.1	0.7	0.6	24.6	2.3	1.8	6.5	0.0035	0.5	0.0	1.0	3.2
524	1.1	0.9	0.7	24.6	2.7	2.1	7.0	0.0035	0.5	0.0	1.0	3.6

Toe Protection Needed	4.0	ft

HEC1 Results For Open Channel

Peak Flow	532	cfs
Stage at Peak Flow	101.5	ft
Flow Volume	24.0	ac. ft

Freeboard

Max. Flow Depth	2.7	ft
Channel Depth as designed	4.0	ft
Available Freeboard	1.3	ft
Required Freeboard	1	ft

Sediment Volume

Inflowing Sediment Volume	0.06	ac. ft
Outflowing Sediment Volume	0.02	ac. ft
Deposited(+)/Eroded(-) Volume	0.04	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	1235	1235
Side Slope (?H:1V)	3	6
Channel Width (ft)	44	68
Channel XS Area (sq. ft)	128	176
Channel Perimeter (ft)	45	68

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	32873	49806
Excavated Area (sq. Yd)	6038	9331

Bank And Channel Lining	Base	LC Enhanced
Lining Type	Concrete	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	1235	1235
Lining Width (ft)	25	49
Lining Thickness (ft)	0.5	0.5
Lining Area (sq. Yd)	3431	6724
Lining Volume (cu. Yd)	572	1121

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	1235	ft
Thickness	1.5	ft
Protection Depth	4	ft
Tie-in Length/Depth	3.0	ft
Total Depth	7.0	ft
Area needed	206	sq. Yd
Volume	480	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	None	None
Left Levee Length (ft)	0	0
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	N/A	6
Left Levee Height (ft)	0	1
Left Levee Surface Area (sq. Yd)	0	0
Left Levee Volume (cu. Yd)	0	0
Right Levee Length (ft)	0	0
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	N/A	6
Right Levee Height (ft)	0	1
Right Levee Surface Area (sq. Yd)	0	0
Right Levee Volume (cu. Yd)	0	0
Total Levee Surface Area (sq. Yd)	0	0
Total Levee Volume (cu. Yd)	0	0

Levee Lining	Base	LC Enhanced
Lining Type	None	None
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	1235	1235
Left Levee Lining Width (ft)	0	0
Left Levee Lining Thickness (ft)	0	0
Left Levee Lining Area (sq. Yd)	0	0
Left Levee Lining Volume (cu. Yd)	0	0
Right Levee Length (ft)	1235	1235
Right Levee Lining Width (ft)	0	0
Right Levee Lining Thickness (ft)	0	0
Right Levee Lining Area (sq. Yd)	0	0
Right Levee Lining Volume (cu. Yd)	0	0
Total Lining Area (sq. Yd)	0	0
Total Lining Volume (cu. Yd)	0	0

Drop Structures		
Structure Type	Concrete	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	44	ft
LC Enhancement Ratio	1.1	
Structure Thickness	0.5	ft
Drop Height	3	ft
Scour Depth	10.9	ft
Structure Height	13.9	ft
Number of Structures	9	
Volume per structure	11	cu. Yd
Unit Cost	$ 155.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 1,705	
Area per structure	2	sq. Yd
Total Area	22	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	500	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 2,000	
Other Cost	$ -	
Total cost per basin	$ 2,000	
Area per basin	671	sq. Yd
Total Area	671	sq. Yd

Structure Cost

Structure Type	Structure Type	Excavation/Construction Quantity	Units	Unit Cost	Cost Subtotal	Landscape Quantity	Units	Unit Cost	Landscape Cost	Maintenance Quantity	Units	Unit Cost	Maintenance Cost
Levee	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining -LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Excavated Channel	Excavated	32,873	cu. Yd	$ 10.00	$ 328,730	6,038	sq. Yd	$ 9.00	$ 54,342	6,038	sq. Yd	$ 8.33	$ 50,317
Exc. Chl - LC Enhancement	Excavated	16,933	cu. Yd	$ 10.00	$ 169,330	3,293	sq. Yd	$ 9.00	$ 29,637	3,293	sq. Yd	$ 8.33	$ 27,442
Channel Lining	Concrete	572	cu. Yd	$ 155.00	$ 88,660	3,431	sq. Yd	$ -	$ -	3,431	sq. Yd	$ 41.67	$ 142,958
Channel Lining - LC Enhancement	Concrete	549	cu. Yd	$ 155.00	$ 85,095	3,293	sq. Yd	$ -	$ -	3,293	sq. Yd	$ 41.67	$ 137,208
Toe Protection	Riprap	480	cu. Yd	$ 75.00	$ 36,000	206	sq. Yd	$ -	$ -	206	sq. Yd	$ 25.00	$ 5,150
Drop Structures	Concrete	9	EA	$ 1,705.00	$ 15,345	22	sq. Yd	$ -	$ -	22	sq. Yd	$ 41.67	$ 917
Drop Str. - LC Enhancement	Concrete	9	EA	$ 170.50	$ 1,535	2	sq. Yd	$ -	$ -	2	sq. Yd	$ 41.67	$ 92
Sedimentation Basins		1	EA	$ 2,000.00	$ 2,000	671	sq. Yd	$ -	$ -	671	sq. Yd	$ 8.33	$ 5,592
Other					$ -				$ -				$ -

Base Landscape Cost	$ 54,342	Base Maintenance Cost	$ 204,933
LC Enhancement Cost	$ 29,637	LC Enhancement Cost	$ 164,742
Total Landscape Cost	$ 83,979	Total Maintenance Cost	$ 369,675

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 470,735	$ 255,960	$ 726,695
Contingency Cost (25% of Construction Cost)	$ 117,684	$ 63,990	$ 181,674
Engineering Design Cost (5% of Construction Cost)	$ 23,537	$ 12,798	$ 36,335
Total Construction Cost	$ 611,956	$ 332,747	$ 944,703

Land Cost

Channel Length	1235 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	134	3.8	$100,000	$ 380,000
LC Enhancement Buffer	50	1.4	$100,000	$ 140,000
Channel	44	1.2	$100,000	$ 120,000
Channel LC Enhancement	24	0.7	$100,000	$ 70,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	252	7.1		$ 710,000

Right of Way

Preservation Corridor Width	120	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	50	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	5	$100,000	$ 500,000
LC Enhancement Cost	acre	2.1	$100,000	$ 210,000
Total Land Cost	acre	7.1	$100,000	$ 710,000

Total Cost

Base Total Cost	$ 1,371,231
Total Landscape Enhancement Cost	$ 737,126
Total Cost Including LC Enh.	$ 2,108,357

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC

Sub-area: Wagner Wash, Alternative: C
Open Channel Structure ID: RR13010

Open Channel

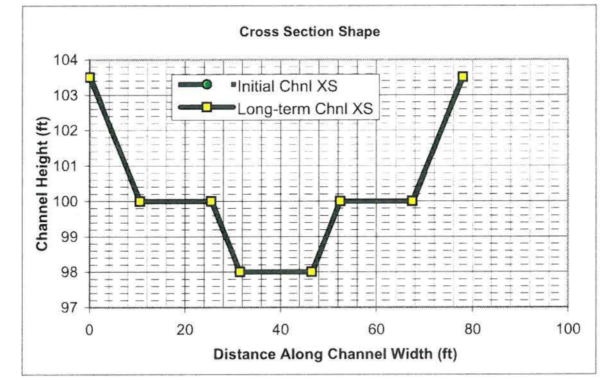
Structure ID	C135L10	HEC1 ID	351135

Longitundal Geometry

Length	12096.9	ft
U/S Elev	1697.0	ft
D/S Elev	1496.9	ft
Initial Channel Slope	0.0165	ft/ft
Long-term Channel Slope	0.0030	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	5



Initial Channel XS Geometry

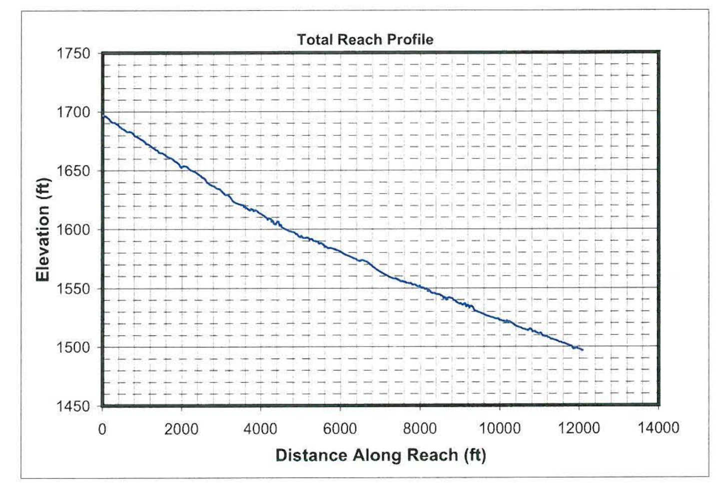
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	3.5	15	3	15	5.5	3	15	3.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	10.5	25.5	31.5	46.5	52.5	67.5	78
Y	103.5	100	100	98	98	100	100	103.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	3.5	15	3	15	5.5	3	15	3.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	10.5	25.5	31.5	46.5	52.5	67.5	78
Y	103.5	100	100	98	98	100	100	103.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.02	0.02	0.02	0.02	0.02	0.02

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	C135L									TOTAL
HEC1 Peak-Flow	1380									1380
Weighting Factor	1.00									
Flow into Channel	1380									1380

Reach Sediment Inflow Characteristics

U/S Contributing ID	12535I_RR12510	13035I_RR13010								TOTAL
HEC1 Flow Volume (ac. ft)	7.00	24.00								31
Sediment Conc. (ppm)	2292	2559								
Sediment Volume (ac. ft)	0.01	0.02								0.03
Weighting Factor	1	1								
Weighted Sed. Vol. (ac. ft)	0.01	0.02								0.03

Hydrology

Drainage Area	1.18	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	1380	cfs	
Long-term Max. Chnl Capacity	2611	cfs	
Q2 Channel	138	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	78	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

Sub-area: Wagner Wash, Alternative: C
Open Channel Structure ID: C135L10

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
138	24.6	29.8	1.2	98.0	99.5	4.6	1.5	24.1	1.2	0.28	0.73
345	61.1	74.3	1.2	98.0	100.5	4.6	2.5	60.3	1.2	0.48	0.74
1035	68.7	150.4	2.2	98.0	101.7	6.9	3.7	67.5	2.2	0.70	0.81
1380	71.5	181.7	2.5	98.0	102.2	7.6	4.2	70.2	2.6	0.79	0.83

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
138	24.6	29.8	1.2	98.0	99.5	4.6	1.5	24.1	1.2	0.28	0.73
345	61.1	74.3	1.2	98.0	100.5	4.6	2.5	60.3	1.2	0.48	0.74
1035	68.7	150.4	2.2	98.0	101.7	6.9	3.7	67.5	2.2	0.70	0.81
1380	71.5	181.7	2.5	98.0	102.2	7.6	4.2	70.2	2.6	0.79	0.83

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
	12535I_RR12510	13035I_RR13010								
138	102	218								320
345	295	667								961
1035	1062	2532								3595
1380	1495	3615								5110

Allowable Velocity

Channel Lining: Concrete

Discharge (cfs)	Fortier & Scobey (as modified in Chow) Permissive Velocity (ft/s) Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	BUREC Erosive?	Neill (gravel/cobble) Non-cohesive Erosive?	All'ble Vel (ft/s)	Cohesive Erosive?	All'ble Vel (ft/s)	USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
138	1.74	1.4603	1.3873	Erosive	Erosive	Erosive	0.3	Erosive	4.1	Stable	Stable
345	1.74	1.4596	1.3867	Erosive	Erosive	Erosive	0.3	Erosive	5.4	Stable	Stable
1035	1.74	1.6427	1.5606	Erosive	Erosive	Erosive	0.4	Erosive	7.2	Stable	Stable
1380	1.74	1.6888	1.6043	Erosive	Erosive	Erosive	0.4	Erosive	7.8	Stable	Stable

USCOE Allowable Velocity (ft/s)	20
FHWA Allowable Velocity (ft/s)	50

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	138	345	1035	1380	138	345	1035	1380	138	345	1035	1380
Bray - Equation #1	32	52	92	107	1.4	1.9	2.7	3.0	3.1	3.6	4.2	4.3
Bray - Equation #2	42	68	121	141	1.5	2.0	2.9	3.2	2.2	2.5	2.9	3.0
Hey	9	16	30	35	4.2	5.9	9.0	10.1				
Ackers & Charlton/Lacey	29	42	66	75					1.8	2.1	2.6	2.7
Parker	81	128	221	255	1.1	1.6	2.5	2.8				
Chang	44	77	151	180	0.3	0.3	0.1	0.0				
Kellerhals	21	33	58	67	2.0	2.8	4.4	4.9	3.3	3.7	4.1	4.2
AMAFCA/Schumm	24	60	68	70								
Moody & Odem	13	13	13	13	1.0	1.0	1.0	1.0				
BUREC	13.7	19.3	29.1	32.5	4	5	8	9	4.3	5.4	7.2	7.7
Average	31	51	85	98	1.9	2.6	3.8	4.2	3.0	3.5	4.2	4.4
Values As Designed	24	60	67	70	1.5	2.5	3.7	4.2	4.6	4.6	6.9	7.6
Difference with Design	7	-9	18	27	0.4	0.0	0.0	0.0	-1.7	-1.2	-2.7	-3.2

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
138	847	1129	1841	10651	926	1017	436	658	5490	863	3614	2497
345	2144	2744	4630	26673	2310	2564	1102	1660	13726	2167	9118	6258
1035	10955	9274	13937	159489	3600	13273	3228	6919	41403	7376	37463	27902
1380	16686	12641	18754	252890	4061	20690	4245	9903	55242	7982	53518	41510

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
138	2277	3035	4949	28634	2489	2734	1173	1768	14761	2319	9716	6714
345	2305	2950	4979	28683	2484	2757	1185	1785	14761	2330	9805	6730
1035	3927	3324	4996	57169	1290	4758	1157	2480	14841	2644	13429	10001
1380	4486	3398	5042	67987	1092	5562	1141	2662	14851	2146	14388	11160

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
138	847	895	966	822	287	392	436	658	392	80	821	600
345	2144	2178	2434	2059	717	988	1102	1660	980	200	2073	1503
1035	10955	7604	6726	12313	1274	3803	3228	6919	3107	190	9630	5977
1380	16686	10427	8934	19524	1472	5405	4245	9903	4172	192	14180	8649

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
138	2277	2406	2598	2211	773	1053	1173	1768	1054	214	2207	1612
345	2305	2342	2617	2214	771	1062	1185	1785	1054	215	2229	1616
1035	3927	2726	2411	4414	457	1363	1157	2480	1114	68	3452	2143
1380	4486	2803	2402	5249	396	1453	1141	2662	1122	51	3812	2325

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
138	0.0005	0.0003	263	0.80	0.053	0.0002	32	0.036	0.0002	0.0159	0.0002	0.0003	0.0067	0.0004	0.0011	0.0029	0.0026
345	0.0005	0.0003	264	0.80	0.053	0.0002	32	0.036	0.0002	0.0159	0.0002	0.0003	0.0067	0.0003	0.0006	0.0029	0.0026
1035	0.0002	0.0002	354	1.08	0.056	0.0001	32	0.036	0.0001	0.0159	0.0001	0.0001	0.0067	0.0002	0.0003	0.0029	0.0025
1380	0.0002	0.0001	382	1.16	0.057	0.0001	33	0.036	0.0001	0.0159	0.0001	0.0001	0.0067	0.0001	0.0002	0.0029	0.0025

Drop Structures

Design Slope	0.0030	ft/ft
Total Drop Needed	163.9	ft
Height of Drop Structure	3	ft
No . of Drop Structures	55	
Distance between structs.	220	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.81	sq. mi
Total Sediment Yield Volume	1.55	ac ft

Sedimentation Basins

Length	220 ft	Depth	3 ft
Width	78 ft	Side slope	3 ft/ft
Total Volume per Basin		1.00	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		6	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge Q (cfs)	COT/PC Sinuosity	General Zgs (ft)	Antidune Za (ft)	Bend Angle (deg)	Max. Depth Ymax (ft)	Hyd. Depth Yh (ft)	Avg Vel Vm (ft/s)	Se	Scour Zbs (ft)	Scour Zls (ft)	channel Zlft (ft)	Total Zt (ft)
138	1.1	0.3	0.3	24.6	1.5	1.2	4.6	0.0030	0.3	0.0	1.0	2.3
345	1.1	0.6	0.3	24.6	2.5	1.2	4.6	0.0030	0.5	0.0	1.0	2.9
1035	1.1	1.2	0.6	24.6	3.7	2.2	6.9	0.0030	0.8	0.0	1.0	4.3
1380	1.1	1.5	0.8	24.6	4.2	2.6	7.6	0.0030	0.9	0.0	1.0	4.9

Toe Protection Needed	5.0	ft

HEC1 Results For Open Channel

Peak Flow	479	cfs
Stage at Peak Flow	99.9	ft
Flow Volume	27.0	ac. ft

Freeboard

Max. Flow Depth	4.2	ft
Channel Depth as designed	5.5	ft
Available Freeboard	1.3	ft
Required Freeboard	1.3	ft

Sediment Volume

Inflowing Sediment Volume	1.58	ac. ft
Outflowing Sediment Volume	0.02	ac. ft
Deposited(+)/Eroded(-) Volume	1.55	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	12097	12097
Side Slope (?H:1V)	3	6
Channel Width (ft)	78	111
Channel XS Area (sq. ft)	278.2	368.95
Channel Perimeter (ft)	80	112

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	2987994	4240070
Excavated Area (sq. Yd)	104841	149196

Bank And Channel Lining	Base	LC Enhanced
Lining Type	Concrete	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	12097	12097
Lining Width (ft)	22	43
Lining Thickness (ft)	0.5	0.5
Lining Area (sq. Yd)	29570	57797
Lining Volume (cu. Yd)	4928	9633

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	12097	ft
Thickness	1.5	ft
Protection Depth	5	ft
Tie-in Length/Depth	3.0	ft
Total Depth	8.0	ft
Area needed	2016	sq. Yd
Volume	5376	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	None	None
Left Levee Length (ft)	0	0
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	N/A	6
Left Levee Height (ft)	0	1
Left Levee Surface Area (sq. Yd)	0	0
Left Levee Volume (cu. Yd)	0	0
Right Levee Length (ft)	0	0
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	N/A	6
Right Levee Height (ft)	0	1
Right Levee Surface Area (sq. Yd)	0	0
Right Levee Volume (cu. Yd)	0	0
Total Levee Surface Area (sq. Yd)	0	0
Total Levee Volume (cu. Yd)	0	0

Levee Lining	Base	LC Enhanced
Lining Type	None	None
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	12097	12097
Left Levee Lining Width (ft)	0	0
Left Levee Lining Thickness (ft)	0	0
Left Levee Lining Area (sq. Yd)	0	0
Left Levee Lining Volume (cu. Yd)	0	0
Right Levee Length (ft)	12097	12097
Right Levee Lining Width (ft)	0	0
Right Levee Lining Thickness (ft)	0	0
Right Levee Lining Area (sq. Yd)	0	0
Right Levee Lining Volume (cu. Yd)	0	0
Total Lining Area (sq. Yd)	0	0
Total Lining Volume (cu. Yd)	0	0

Drop Structures		
Structure Type	Concrete	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	78	ft
LC Enhancement Ratio	1.1	
Structure Thickness	0.5	ft
Drop Height	3	ft
Scour Depth	12.9	ft
Structure Height	15.9	ft
Number of Structures	55	
Volume per structure	23	cu. Yd
Unit Cost	$ 155.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 3,565	
Area per structure	4	sq. Yd
Total Area	238	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	6	
Total Volume per Basin	1613	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 6,452	
Other Cost	$ -	
Total cost per basin	$ 6,452	
Area per basin	1,906	sq. Yd
Total Area	11,436	sq. Yd

Structure Type	Structure Type	Excavation/Construction Quantity	Units	Unit Cost	Cost Subtotal	Landscape Quantity	Units	Unit Cost	Landscape Cost	Maintenance Quantity	Units	Unit Cost	Maintenance Cost
Levee	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining -LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Excavated Channel	Excavated	2,987,994	cu. Yd	$ 10.00	$ 29,879,940	104,841	sq. Yd	$ 9.00	$ 943,569	104,841	sq. Yd	$ 8.33	$ 873,675
Exc. Chl - LC Enhancement	Excavated	1,252,076	cu. Yd	$ 10.00	$ 12,520,760	44,355	sq. Yd	$ 9.00	$ 399,195	44,355	sq. Yd	$ 8.33	$ 369,625
Channel Lining	Concrete	4,928	cu. Yd	$ 155.00	$ 763,840	29,570	sq. Yd	$ -	$ -	29,570	sq. Yd	$ 41.67	$ 1,232,083
Channel Lining - LC Enhancement	Concrete	4,705	cu. Yd	$ 155.00	$ 729,275	28,227	sq. Yd	$ -	$ -	28,227	sq. Yd	$ 41.67	$ 1,176,125
Toe Protection	Riprap	5,376	cu. Yd	$ 75.00	$ 403,200	2,016	sq. Yd	$ -	$ -	2,016	sq. Yd	$ 25.00	$ 50,400
Drop Structures	Concrete	55	EA	$ 3,565.00	$ 196,075	238	sq. Yd	$ -	$ -	238	sq. Yd	$ 41.67	$ 9,917
Drop Str. - LC Enhancement	Concrete	55	EA	$ 356.50	$ 19,608	24	sq. Yd	$ -	$ -	24	sq. Yd	$ 41.67	$ 992
Sedimentation Basins		6	EA	$ 6,452.00	$ 38,712	11,436	sq. Yd	$ -	$ -	11,436	sq. Yd	$ 8.33	$ 95,300
Other					$ -				$ -				$ -

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 31,281,767	$ 13,269,643	$ 44,551,410
Contingency Cost (25% of Construction Cost)	$ 7,820,442	$ 3,317,411	$ 11,137,852
Engineering Design Cost (5% of Construction Cost)	$ 1,564,088	$ 663,482	$ 2,227,570
Total Construction Cost	$ 40,666,297	$ 17,250,535	$ 57,916,832

Base Landscape Cost	$ 943,569
LC Enhancement Cost	$ 399,195
Total Landscape Cost	$ 1,342,764

Base Maintenance Cost	$ 2,261,375
LC Enhancement Cost	$ 1,546,742
Total Maintenance Cost	$ 3,808,117

Land Cost

Channel Length	12097 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	134	37.2	$100,000	$ 3,720,000
LC Enhancement Buffer	50	13.9	$100,000	$ 1,390,000
Channel	78	21.7	$100,000	$ 2,170,000
Channel LC Enhancement	33	9.2	$100,000	$ 920,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	295	82		$ 8,200,000

Right of Way

Preservation Corridor Width	120	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	50	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	58.9	$100,000	$ 5,890,000
LC Enhancement Cost	acre	23.1	$100,000	$ 2,310,000
Total Land Cost	acre	82	$100,000	$ 8,200,000

Total Cost

Base Total Cost	$ 49,761,241
Total Landscape Enhancement Cost	$ 21,506,472
Total Cost Including LC Enh.	$ 71,267,713

Open Channel

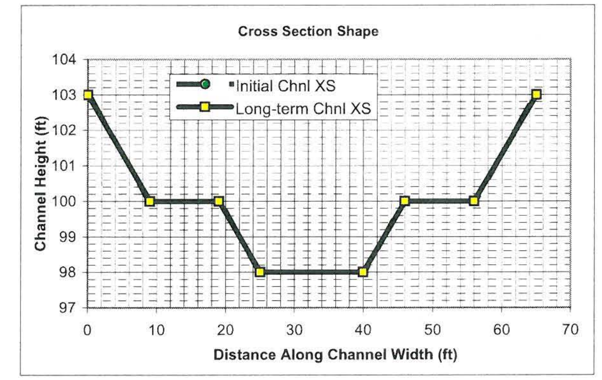
Structure ID	RR15020		HEC1 ID	150165

Longitundal Geometry

Length	4081.6	ft
U/S Elev	1760.1	ft
D/S Elev	1675.9	ft
Initial Channel Slope	0.0206	ft/ft
Long-term Channel Slope	0.0030	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	2



Initial Channel XS Geometry

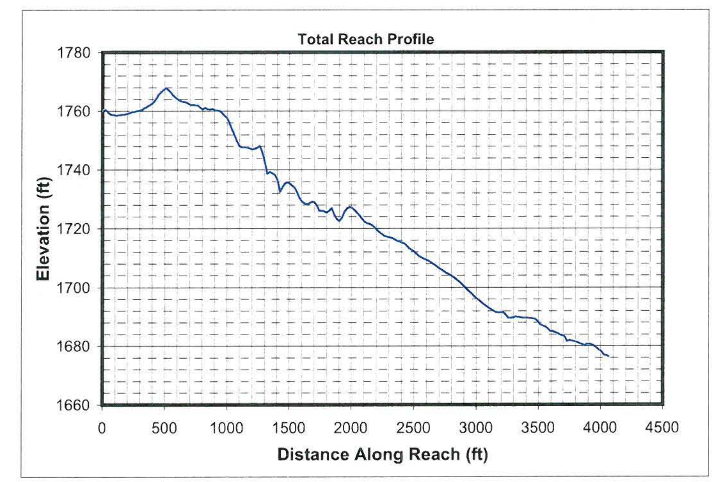
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	3	10	3	15	5	3	10	3	3

PT. ID	1	2	3	4	5	6	7	8
X	0	9	19	25	40	46	56	65
Y	103	100	100	98	98	100	100	103

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	3	10	3	15	5	3	10	3	3

PT. ID	1	2	3	4	5	6	7	8
X	0	9	19	25	40	46	56	65
Y	103	100	100	98	98	100	100	103



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.02	0.02	0.02	0.02	0.02	0.02

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	S150	S155								TOTAL
HEC1 Peak-Flow	836	1781								2617
Weighting Factor	1.00	0.06								
Flow into Channel	836	109								945

Reach Sediment Inflow Characteristics

U/S Contributing ID										TOTAL
HEC1 Flow Volume (ac. ft)										0
Sediment Conc. (ppm)										
Sediment Volume (ac. ft)										0.00
Weighting Factor										
Weighted Sed. Vol. (ac. ft)										0.00

Hydrology

Drainage Area	0.77	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	945	cfs	
Long-term Max. Chnl Capacity	1842	cfs	
Q2 Channel	95	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	65	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
95	22.8	23.0	1.0	98.0	99.2	4.1	1.2	22.4	1.0	0.23	0.71
236	49.3	54.3	1.1	98.0	100.3	4.4	2.3	48.5	1.1	0.42	0.73
709	56.1	110.6	2.0	98.0	101.3	6.4	3.3	55.1	2.0	0.63	0.80
945	58.8	133.8	2.3	98.0	101.8	7.1	3.8	57.5	2.3	0.70	0.82

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
95	22.8	23.0	1.0	98.0	99.2	4.1	1.2	22.4	1.0	0.23	0.71
236	49.3	54.3	1.1	98.0	100.3	4.4	2.3	48.5	1.1	0.42	0.73
709	56.1	110.6	2.0	98.0	101.3	6.4	3.3	55.1	2.0	0.63	0.80
945	58.8	133.8	2.3	98.0	101.8	7.1	3.8	57.5	2.3	0.70	0.82

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
95										0
236										0
709										0
945										0

Allowable Velocity

Channel Lining	Concrete

Discharge (cfs)	Fortier & Scobey (as modified in Chow) Permissive Velocity (ft/s) Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	BUREC Erosive?	Neill (gravel/cobble) Non-cohesive Erosive?	All'ble Vel (ft/s)	Cohesive Erosive?	All'ble Vel (ft/s)	USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
95	1.74	1.4039	1.3337	Erosive	Erosive	Erosive	0.3	Erosive	3.6	Stable	Stable
236	1.74	1.4299	1.3584	Erosive	Erosive	Erosive	0.3	Erosive	5.0	Stable	Stable
709	1.74	1.6104	1.5299	Erosive	Erosive	Erosive	0.4	Erosive	6.7	Stable	Stable
945	1.74	1.6557	1.5729	Erosive	Erosive	Erosive	0.4	Erosive	7.2	Stable	Stable

USCOE Allowable Velocity (ft/s)	20
FHWA Allowable Velocity (ft/s)	50

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	**95**	**236**	**709**	**945**	**95**	**236**	**709**	**945**	**95**	**236**	**709**	**945**
Bray - Equation #1	26	42	76	88	1.2	1.6	2.4	2.6	3.0	3.4	4.0	4.1
Bray - Equation #2	34	56	99	116	1.3	1.8	2.6	2.9	2.1	2.3	2.7	2.8
Hey	7	13	24	28	3.6	5.1	7.8	8.7				
Ackers & Charlton/Lacey	24	36	57	64					1.7	2.0	2.4	2.5
Parker	67	106	183	211	0.9	1.3	2.1	2.4				
Chang	34	61	120	143	0.3	0.3	0.2	0.1				
Kellerhals	17	28	48	55	1.7	2.4	3.8	4.2	3.2	3.5	3.9	4.0
AMAFCA/Schumm	22	49	55	58								
Moody & Odem	11	11	11	11	0.9	0.9	0.9	0.9				
BUREC	11.9	16.7	25.3	28.2	3	4	7	8	3.9	5.0	6.5	7.0
Average	26	42	70	80	1.7	2.3	3.3	3.7	2.8	3.2	3.9	4.1
Values As Designed	22	49	55	58	1.2	2.3	3.3	3.8	4.1	4.4	6.4	7.1
Difference with Design	3	-7	15	23	0.4	0.0	0.0	-0.1	-1.3	-1.1	-2.5	-3.0

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
95	494	767	1409	8213	877	716	298	400	5232	619	2622	1968
236	1340	1890	3487	22692	1996	1907	751	1064	13095	1647	6927	5163
709	6792	6395	10347	134359	3128	10446	2219	4479	39471	7499	28200	23030
945	10323	8719	13971	212403	3537	16262	2925	6420	52660	9688	40182	34281

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
95	1938	3012	5532	32242	3444	2811	1169	1569	20540	2429	10295	7726
236	2105	2969	5476	35635	3135	2994	1179	1671	20564	2586	10878	8108
709	3555	3348	5416	70331	1638	5468	1162	2344	20661	3925	14761	12055
945	4053	3423	5485	83388	1389	6384	1148	2520	20674	3803	15775	13458

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
95	494	582	636	456	227	248	298	400	260	78	485	378
236	1340	1448	1626	1259	531	647	751	1064	660	165	1308	982
709	6792	5088	4633	7453	964	2482	2219	4479	2115	159	6109	3863
945	10323	6988	6113	11783	1120	3521	2925	6420	2843	161	9003	5564

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
95	1938	2286	2498	1789	890	975	1169	1569	1020	306	1903	1486
236	2105	2273	2553	1977	833	1016	1179	1671	1037	260	2054	1542
709	3555	2664	2425	3902	505	1299	1162	2344	1107	83	3198	2022
945	4053	2743	2400	4626	440	1382	1148	2520	1116	63	3535	2184

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
95	0.0006	0.0003	269	0.82	0.053	0.0003	32	0.036	0.0002	0.0159	0.0002	0.0003	0.0077	0.0005	0.0013	0.0029	0.0029
236	0.0005	0.0003	281	0.86	0.054	0.0003	32	0.036	0.0002	0.0159	0.0002	0.0003	0.0077	0.0003	0.0007	0.0029	0.0028
709	0.0003	0.0002	375	1.14	0.057	0.0002	33	0.036	0.0001	0.0159	0.0001	0.0002	0.0077	0.0002	0.0003	0.0029	0.0027
945	0.0002	0.0002	403	1.23	0.058	0.0001	33	0.036	0.0001	0.0159	0.0001	0.0001	0.0077	0.0002	0.0002	0.0029	0.0027

Drop Structures

Design Slope	0.0030	ft/ft
Total Drop Needed	71.9	ft
Height of Drop Structure	3	ft
No . of Drop Structures	24	
Distance between structs.	170	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.89	sq. mi
Total Sediment Yield Volume	1.68	ac ft

Sedimentation Basins

Length	170 ft	Depth	3 ft
Width	65 ft	Side slope	3 ft/ft
Total Volume per Basin		0.62	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		9	

Scour and Toe Protection (Not applicable for concrete channel)

		Pima County General Scour Equations							Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
95	1.1	0.2	0.2	24.6	1.2	1.0	4.1	0.0030	0.2	0.0	1.0	2.1
236	1.1	0.5	0.3	24.6	2.3	1.1	4.4	0.0030	0.4	0.0	1.0	2.6
709	1.1	1.0	0.6	24.6	3.3	2.0	6.4	0.0030	0.7	0.0	1.0	3.9
945	1.1	1.3	0.7	24.6	3.8	2.3	7.1	0.0030	0.8	0.0	1.0	4.4

Toe Protection Needed	5.0	ft

HEC1 Results For Open Channel

Peak Flow	825	cfs
Stage at Peak Flow	100.3	ft
Flow Volume	62.0	ac. ft

Freeboard

Max. Flow Depth	3.8	ft
Channel Depth as designed	5.0	ft
Available Freeboard	1.2	ft
Required Freeboard	1.1	ft

Sediment Volume

Inflowing Sediment Volume	1.68	ac. ft
Outflowing Sediment Volume	0.05	ac. ft
Deposited(+)/Eroded(-) Volume	1.63	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	4082	4082
Side Slope (?H:1V)	3	6
Channel Width (ft)	65	95
Channel XS Area (sq. ft)	210	285
Channel Perimeter (ft)	67	96

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	385251	559745
Excavated Area (sq. Yd)	29481	43088

Bank And Channel Lining	Base	LC Enhanced
Lining Type	Concrete	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	4082	4082
Lining Width (ft)	19	36
Lining Thickness (ft)	0.5	0.5
Lining Area (sq. Yd)	8618	16328
Lining Volume (cu. Yd)	1436	2721

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	4082	ft
Thickness	1.5	ft
Protection Depth	5	ft
Tie-in Length/Depth	3.0	ft
Total Depth	8.0	ft
Area needed	680	sq. Yd
Volume	1814	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	None	None
Left Levee Length (ft)	0	0
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	N/A	6
Left Levee Height (ft)	0	1
Left Levee Surface Area (sq. Yd)	0	0
Left Levee Volume (cu. Yd)	0	0
Right Levee Length (ft)	0	0
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	N/A	6
Right Levee Height (ft)	0	1
Right Levee Surface Area (sq. Yd)	0	0
Right Levee Volume (cu. Yd)	0	0
Total Levee Surface Area (sq. Yd)	0	0
Total Levee Volume (cu. Yd)	0	0

Levee Lining	Base	LC Enhanced
Lining Type	None	None
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	4082	4082
Left Levee Lining Width (ft)	0	0
Left Levee Lining Thickness (ft)	0	0
Left Levee Lining Area (sq. Yd)	0	0
Left Levee Lining Volume (cu. Yd)	0	0
Right Levee Length (ft)	4082	4082
Right Levee Lining Width (ft)	0	0
Right Levee Lining Thickness (ft)	0	0
Right Levee Lining Area (sq. Yd)	0	0
Right Levee Lining Volume (cu. Yd)	0	0
Total Lining Area (sq. Yd)	0	0
Total Lining Volume (cu. Yd)	0	0

Drop Structures		
Structure Type	Concrete	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	65	ft
LC Enhancement Ratio	1.1	
Structure Thickness	0.5	ft
Drop Height	3	ft
Scour Depth	11.6	ft
Structure Height	14.6	ft
Number of Structures	24	
Volume per structure	18	cu. Yd
Unit Cost	$ 155.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 2,790	
Area per structure	4	sq. Yd
Total Area	87	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	9	
Total Volume per Basin	1000	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 4,000	
Other Cost	$ -	
Total cost per basin	$ 4,000	
Area per basin	1,228	sq. Yd
Total Area	11,052	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining -LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Excavated Channel	Excavated	385,251	cu. Yd	$ 10.00	$ 3,852,510	29,481	sq. Yd	$ 9.00	$ 265,329	29,481	sq. Yd	$ 8.33	$ 245,675
Exc. Chl - LC Enhancement	Excavated	174,494	cu. Yd	$ 10.00	$ 1,744,940	13,607	sq. Yd	$ 9.00	$ 122,463	13,607	sq. Yd	$ 8.33	$ 113,392
Channel Lining	Concrete	1,436	cu. Yd	$ 155.00	$ 222,580	8,618	sq. Yd	$ -	$ -	8,618	sq. Yd	$ 41.67	$ 359,083
Channel Lining - LC Enhancement	Concrete	1,285	cu. Yd	$ 155.00	$ 199,175	7,710	sq. Yd	$ -	$ -	7,710	sq. Yd	$ 41.67	$ 321,250
Toe Protection	Riprap	1,814	cu. Yd	$ 75.00	$ 136,050	680	sq. Yd	$ -	$ -	680	sq. Yd	$ 25.00	$ 17,000
Drop Structures	Concrete	24	EA	$ 2,790.00	$ 66,960	87	sq. Yd	$ -	$ -	87	sq. Yd	$ 41.67	$ 3,625
Drop Str. - LC Enhancement	Concrete	24	EA	$ 279.00	$ 6,696	9	sq. Yd	$ -	$ -	9	sq. Yd	$ 41.67	$ 363
Sedimentation Basins		9	EA	$ 4,000.00	$ 36,000	11,052	sq. Yd	$ -	$ -	11,052	sq. Yd	$ 8.33	$ 92,100
Other					$ -				$ -				$ -

Base Landscape Cost	$ 265,329	Base Maintenance Cost	$ 717,483
LC Enhancement Cost	$ 122,463	LC Enhancement Cost	$ 435,004
Total Landscape Cost	$ 387,792	Total Maintenance Cost	$ 1,152,488

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 4,314,100	$ 1,950,811	$ 6,264,911
Contingency Cost (25% of Construction Cost)	$ 1,078,525	$ 487,703	$ 1,566,228
Engineering Design Cost (5% of Construction Cost)	$ 215,705	$ 97,541	$ 313,246
Total Construction Cost	$ 5,608,330	$ 2,536,054	$ 8,144,384

Land Cost

Channel Length	4082 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	134	12.6	$100,000	$ 1,260,000
LC Enhancement Buffer	50	4.7	$100,000	$ 470,000
Channel	65	6.1	$100,000	$ 610,000
Channel LC Enhancement	30	2.8	$100,000	$ 280,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	279	26.2		$ 2,620,000

Right of Way

Preservation Corridor Width	120	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	50	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	18.7	$100,000	$ 1,870,000
LC Enhancement Cost	acre	7.5	$100,000	$ 750,000
Total Land Cost	acre	26.2	$100,000	$ 2,620,000

Total Cost

Base Total Cost	$ 8,461,142
Total Landscape Enhancement Cost	$ 3,843,521
Total Cost Including LC Enh.	$ 12,304,664

Open Channel

Structure ID	C17510A	HEC1 ID	165175

Longitundal Geometry

Length	7076.2	ft
U/S Elev	1674.9	ft
D/S Elev	1546.4	ft
Initial Channel Slope	0.0182	ft/ft
Long-term Channel Slope	0.0030	ft/ft

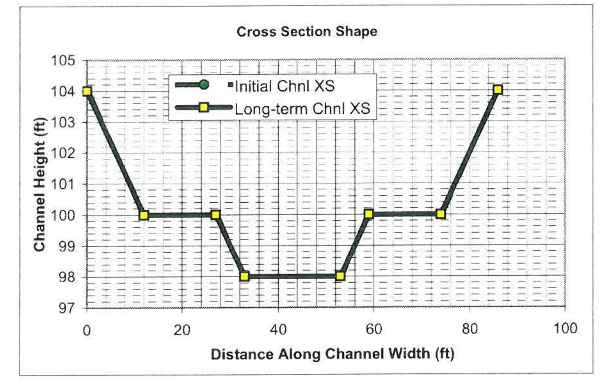
Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	6

Initial Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	15	3	20	6	3	15	4	3

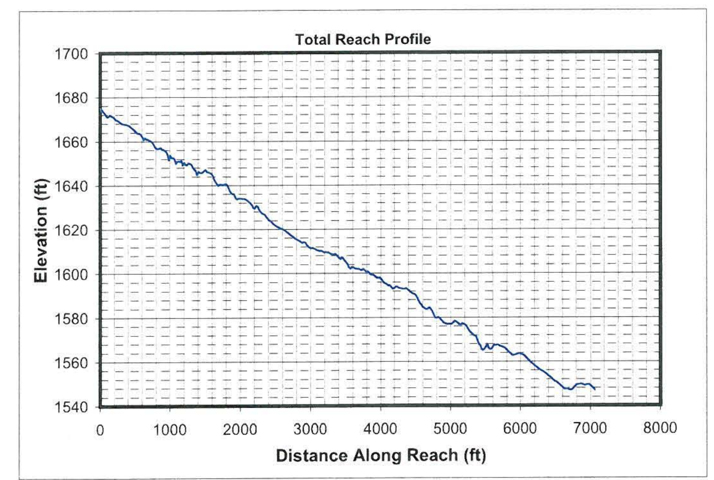
PT. ID	1	2	3	4	5	6	7	8
X	0	12	27	33	53	59	74	86
Y	104	100	100	98	98	100	100	104



Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	15	3	20	6	3	15	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	27	33	53	59	74	86
Y	104	100	100	98	98	100	100	104



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.02	0.02	0.02	0.02	0.02	0.02

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	S165	S170								TOTAL
HEC1 Peak-Flow	1008	1802								2810
Weighting Factor	1.00	0.41								
Flow into Channel	1008	740								1748

Reach Sediment Inflow Characteristics

U/S Contributing ID										TOTAL
HEC1 Flow Volume (ac. ft)										0
Sediment Conc. (ppm)										
Sediment Volume (ac. ft)										0.00
Weighting Factor										
Weighted Sed. Vol. (ac. ft)										0.00

Hydrology

Drainage Area	1.221	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	1748	cfs	
Long-term Max. Chnl Capacity	3552	cfs	
Q2 Channel	175	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	86	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
175	29.5	36.9	1.3	98.0	99.5	4.7	1.5	29.0	1.3	0.28	0.74
437	66.3	88.4	1.3	98.0	100.6	4.9	2.6	65.4	1.4	0.48	0.75
1311	74.5	179.1	2.4	98.0	101.9	7.3	3.9	73.3	2.4	0.73	0.83
1748	77.7	216.4	2.8	98.0	102.4	8.1	4.4	76.3	2.8	0.82	0.85

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
175	29.5	36.9	1.3	98.0	99.5	4.7	1.5	29.0	1.3	0.28	0.74
437	66.3	88.4	1.3	98.0	100.6	4.9	2.6	65.4	1.4	0.48	0.75
1311	74.5	179.1	2.4	98.0	101.9	7.3	3.9	73.3	2.4	0.73	0.83
1748	77.7	216.4	2.8	98.0	102.4	8.1	4.4	76.3	2.8	0.82	0.85

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
175										0
437										0
1311										0
1748										0

Allowable Velocity

Channel Lining	Concrete

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
175	1.74	1.4695	1.3960	Erosive	Erosive	Erosive	0.3	Erosive	4.1	Stable	Stable
437	1.74	1.4882	1.4138	Erosive	Erosive	Erosive	0.3	Erosive	5.5	Stable	Stable
1311	1.74	1.6710	1.5875	Erosive	Erosive	Erosive	0.4	Erosive	7.4	Stable	Stable
1748	1.74	1.7170	1.6312	Erosive	Erosive	Erosive	0.4	Erosive	8.1	Stable	Stable

USCOE Allowable Velocity (ft/s)	20
FHWA Allowable Velocity (ft/s)	50

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	175	437	1311	1748	175	437	1311	1748	175	437	1311	1748
Bray - Equation #1	36	59	105	122	1.5	2.0	2.9	3.2	3.3	3.7	4.3	4.5
Bray - Equation #2	47	77	137	160	1.6	2.2	3.2	3.5	2.2	2.5	3.0	3.1
Hey	11	18	34	39	4.6	6.5	9.9	11.0				
Ackers & Charlton/Lacey	31	46	73	83					1.9	2.2	2.7	2.8
Parker	91	144	249	287	1.2	1.7	2.7	3.1				
Chang	51	89	175	208	0.3	0.3	0.0	-0.1				
Kellerhals	24	38	65	75	2.1	3.1	4.8	5.4	3.4	3.7	4.2	4.3
AMAFCA/Schumm	29	66	73	76								
Moody & Odem	13	13	13	13	1.0	1.0	1.0	1.0				
BUREC	15.0	21.1	31.8	35.5	4	6	9	9	4.6	5.8	7.6	8.2
Average	35	57	96	110	2.0	2.8	4.1	4.6	3.1	3.6	4.4	4.6
Values As Designed	29	65	73	76	1.5	2.6	3.9	4.4	4.7	4.9	7.3	8.1
Difference with Design	6	-8	22	34	0.5	0.2	0.2	0.2	-1.7	-1.3	-3.0	-3.5

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
175	1111	1467	2417	16097	1195	1407	556	854	8009	1211	5021	3577
437	2961	3613	6034	43310	2786	3688	1399	2232	20038	3179	13079	9302
1311	15115	12082	18495	258738	4322	20658	4065	9182	60359	9832	52808	42332
1748	23023	16438	25132	410168	4871	32165	5341	13116	80522	10609	75149	63321

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
175	2357	3114	5131	34165	2536	2987	1180	1812	16999	2570	10656	7592
437	2514	3067	5122	36769	2366	3131	1188	1895	17011	2699	11103	7897
1311	4277	3419	5234	73220	1223	5846	1150	2599	17081	2782	14944	11980
1748	4886	3489	5334	87055	1034	6827	1134	2784	17090	2252	15950	13439

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
175	1111	1152	1234	1081	355	505	556	854	499	95	1072	774
437	2961	2852	3055	2907	841	1304	1399	2232	1257	211	2832	1987
1311	15115	9842	8504	17369	1477	5021	4065	9182	3954	203	13007	7976
1748	23023	13471	11374	27535	1702	7143	5341	13116	5303	204	19107	11574

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
175	2357	2445	2620	2293	753	1072	1180	1812	1059	202	2275	1643
437	2514	2421	2593	2468	714	1107	1188	1895	1068	179	2405	1687
1311	4277	2785	2406	4915	418	1421	1150	2599	1119	57	3681	2257
1748	4886	2859	2414	5844	361	1516	1134	2784	1126	43	4055	2457

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
175	0.0005	0.0003	281	0.86	0.054	0.0002	32	0.036	0.0002	0.0159	0.0002	0.0003	0.0062	0.0004	0.0010	0.0029	0.0025
437	0.0004	0.0003	290	0.88	0.054	0.0002	32	0.036	0.0001	0.0159	0.0002	0.0003	0.0062	0.0002	0.0005	0.0030	0.0024
1311	0.0002	0.0001	389	1.19	0.057	0.0001	33	0.036	0.0001	0.0159	0.0001	0.0001	0.0062	0.0001	0.0002	0.0029	0.0024
1748	0.0002	0.0001	419	1.28	0.058	0.0001	33	0.036	0.0001	0.0159	0.0001	0.0001	0.0062	0.0001	0.0002	0.0029	0.0024

Drop Structures

Design Slope	0.0030	ft/ft
Total Drop Needed	107.3	ft
Height of Drop Structure	3	ft
No . of Drop Structures	36	
Distance between structs.	197	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.60	sq. mi
Total Sediment Yield Volume	1.14	ac ft

Sedimentation Basins

Length	197 ft	Depth	3 ft
Width	86 ft	Side slope	3 ft/ft
Total Volume per Basin		1.00	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		4	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
175	1.1	0.4	0.3	24.6	1.5	1.3	4.7	0.0030	0.3	0.0	1.0	2.3
437	1.1	0.6	0.3	24.6	2.6	1.4	4.9	0.0030	0.5	0.0	1.0	3.0
1311	1.1	1.3	0.7	24.6	3.9	2.4	7.3	0.0030	0.8	0.0	1.0	4.6
1748	1.1	1.6	0.9	24.6	4.4	2.8	8.1	0.0030	0.9	0.0	1.0	5.2

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	1237	cfs
Stage at Peak Flow	100.0	ft
Flow Volume	100.0	ac. ft

Freeboard

Max. Flow Depth	4.4	ft
Channel Depth as designed	6.0	ft
Available Freeboard	1.6	ft
Required Freeboard	1.3	ft

Sediment Volume

Inflowing Sediment Volume	1.14	ac. ft
Outflowing Sediment Volume	0.09	ac. ft
Deposited(+)/Eroded(-) Volume	1.05	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	7076	7076
Side Slope (?H:1V)	3	6
Channel Width (ft)	86	122
Channel XS Area (sq. ft)	348	456
Channel Perimeter (ft)	88	123

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	1300271	1834697
Excavated Area (sq. Yd)	67615	95919

Bank And Channel Lining	Base	LC Enhanced
Lining Type	Concrete	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	7076	7076
Lining Width (ft)	25	49
Lining Thickness (ft)	0.5	0.5
Lining Area (sq. Yd)	19656	38525
Lining Volume (cu. Yd)	3276	6421

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	7076	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	1179	sq. Yd
Volume	3538	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	None	None
Left Levee Length (ft)	0	0
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	N/A	6
Left Levee Height (ft)	0	1
Left Levee Surface Area (sq. Yd)	0	0
Left Levee Volume (cu. Yd)	0	0
Right Levee Length (ft)	0	0
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	N/A	6
Right Levee Height (ft)	0	1
Right Levee Surface Area (sq. Yd)	0	0
Right Levee Volume (cu. Yd)	0	0
Total Levee Surface Area (sq. Yd)	0	0
Total Levee Volume (cu. Yd)	0	0

Levee Lining	Base	LC Enhanced
Lining Type	None	None
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	7076	7076
Left Levee Lining Width (ft)	0	0
Left Levee Lining Thickness (ft)	0	0
Left Levee Lining Area (sq. Yd)	0	0
Left Levee Lining Volume (cu. Yd)	0	0
Right Levee Length (ft)	7076	7076
Right Levee Lining Width (ft)	0	0
Right Levee Lining Thickness (ft)	0	0
Right Levee Lining Area (sq. Yd)	0	0
Right Levee Lining Volume (cu. Yd)	0	0
Total Lining Area (sq. Yd)	0	0
Total Lining Volume (cu. Yd)	0	0

Drop Structures		
Structure Type	Concrete	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	86	ft
LC Enhancement Ratio	1.1	
Structure Thickness	0.5	ft
Drop Height	3	ft
Scour Depth	14.1	ft
Structure Height	17.1	ft
Number of Structures	36	
Volume per structure	27	cu. Yd
Unit Cost	$ 155.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 4,185	
Area per structure	5	sq. Yd
Total Area	172	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	4	
Total Volume per Basin	1613	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 6,452	
Other Cost	$ -	
Total cost per basin	$ 6,452	
Area per basin	1,878	sq. Yd
Total Area	7,512	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining -LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Excavated Channel	Excavated	1,300,271	cu. Yd	$ 10.00	$ 13,002,710	67,615	sq. Yd	$ 9.00	$ 608,535	67,615	sq. Yd	$ 8.33	$ 563,458
Exc. Chl - LC Enhancement	Excavated	534,426	cu. Yd	$ 10.00	$ 5,344,260	28,304	sq. Yd	$ 9.00	$ 254,736	28,304	sq. Yd	$ 8.33	$ 235,867
Channel Lining	Concrete	3,276	cu. Yd	$ 155.00	$ 507,780	19,656	sq. Yd	$ -	$ -	19,656	sq. Yd	$ 41.67	$ 819,000
Channel Lining - LC Enhancement	Concrete	3,145	cu. Yd	$ 155.00	$ 487,475	18,869	sq. Yd	$ -	$ -	18,869	sq. Yd	$ 41.67	$ 786,208
Toe Protection	Riprap	3,538	cu. Yd	$ 75.00	$ 265,350	1,179	sq. Yd	$ -	$ -	1,179	sq. Yd	$ 25.00	$ 29,475
Drop Structures	Concrete	36	EA	$ 4,185.00	$ 150,660	172	sq. Yd	$ -	$ -	172	sq. Yd	$ 41.67	$ 7,167
Drop Str. - LC Enhancement	Concrete	36	EA	$ 418.50	$ 15,066	17	sq. Yd	$ -	$ -	17	sq. Yd	$ 41.67	$ 717
Sedimentation Basins		4	EA	$ 6,452.00	$ 25,808	7,512	sq. Yd	$ -	$ -	7,512	sq. Yd	$ 8.33	$ 62,600
Other					$ -				$ -				$ -

Base Landscape Cost	$ 608,535
LC Enhancement Cost	$ 254,736
Total Landscape Cost	$ 863,271

Base Maintenance Cost	$ 1,481,700
LC Enhancement Cost	$ 1,022,792
Total Maintenance Cost	$ 2,504,492

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 13,952,308	$ 5,846,801	$ 19,799,109
Contingency Cost (25% of Construction Cost)	$ 3,488,077	$ 1,461,700	$ 4,949,777
Engineering Design Cost (5% of Construction Cost)	$ 697,615	$ 292,340	$ 989,955
Total Construction Cost	$ 18,138,000	$ 7,600,841	$ 25,738,842

Land Cost

Channel Length	7076 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	134	21.8	$100,000	$ 2,180,000
LC Enhancement Buffer	50	8.1	$100,000	$ 810,000
Channel	86	14	$100,000	$ 1,400,000
Channel LC Enhancement	36	5.8	$100,000	$ 580,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	306	49.7		$ 4,970,000

Right of Way

Preservation Corridor Width	120	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	50	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	35.8	$100,000	$ 3,580,000
LC Enhancement Cost	acre	13.9	$100,000	$ 1,390,000
Total Land Cost	acre	49.7	$100,000	$ 4,970,000

Total Cost

Base Total Cost	$ 23,808,235
Total Landscape Enhancement Cost	$ 10,268,369
Total Cost Including LC Enh.	$ 34,076,604

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

Sub-area: Wagner Wash, Alternative: C
Open Channel Structure ID: CI7510A

Open Channel

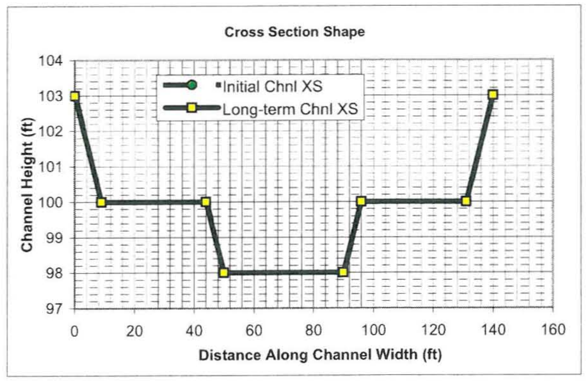
Structure ID	C17510B	HEC1 ID	165175

Longitundal Geometry

Length	6169.2	ft
U/S Elev	1546.4	ft
D/S Elev	1462.9	ft
Initial Channel Slope	0.0135	ft/ft
Long-term Channel Slope	0.0030	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	6



Initial Channel XS Geometry

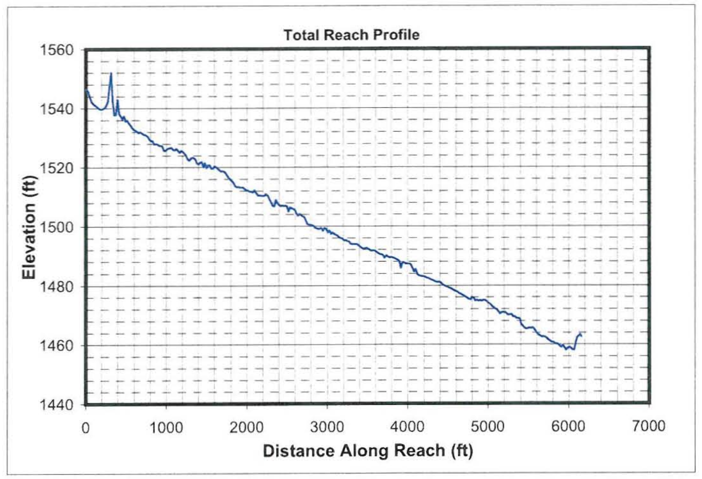
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	3	35	3	40	5	3	35	3	3

PT. ID	1	2	3	4	5	6	7	8
X	0	9	44	50	90	96	131	140
Y	103	100	100	98	98	100	100	103

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	3	35	3	40	5	3	35	3	3

PT. ID	1	2	3	4	5	6	7	8
X	0	9	44	50	90	96	131	140
Y	103	100	100	98	98	100	100	103



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.02	0.02	0.02	0.02	0.02	0.02

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	C175								TOTAL
HEC1 Peak-Flow	2452								2452
Weighting Factor	1.00								
Flow into Channel	2452								2452

Reach Sediment Inflow Characteristics

U/S Contributing ID	165175_C17510A								TOTAL
HEC1 Flow Volume (ac. ft)	100.00								100
Sediment Conc. (ppm)	2457								
Sediment Volume (ac. ft)	0.09								0.09
Weighting Factor	1								
Weighted Sed. Vol. (ac. ft)	0.09								0.09

Hydrology

Drainage Area	1.885	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	2452	cfs	
Long-term Max. Chnl Capacity	4496	cfs	
Q2 Channel	245	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	140	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

Sub-area: Wagner Wash, Alternative: C
Open Channel Structure ID: C17510B

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
245	47.9	54.9	1.1	98.0	99.3	4.5	1.3	47.5	1.2	0.23	0.73
613	125.1	139.6	1.1	98.0	100.4	4.4	2.4	124.3	1.1	0.45	0.73
1839	131.8	275.6	2.1	98.0	101.5	6.7	3.5	130.7	2.1	0.65	0.81
2452	134.5	330.2	2.5	98.0	101.9	7.4	3.9	133.2	2.5	0.72	0.83

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
245	47.9	54.9	1.1	98.0	99.3	4.5	1.3	47.5	1.2	0.23	0.73
613	125.1	139.6	1.1	98.0	100.4	4.4	2.4	124.3	1.1	0.45	0.73
1839	131.8	275.6	2.1	98.0	101.5	6.7	3.5	130.7	2.1	0.65	0.81
2452	134.5	330.2	2.5	98.0	101.9	7.4	3.9	133.2	2.5	0.72	0.83

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
	165175_C17510 A									
245	774									774
613	1987									1987
1839	7976									7976
2452	11574									11574

Allowable Velocity

Channel Lining	Concrete

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
245	1.74	1.4399	1.3679	Erosive	Erosive	Erosive	0.3	Erosive	3.7	Stable	Stable
613	1.74	1.4312	1.3596	Erosive	Erosive	Erosive	0.3	Erosive	5.1	Stable	Stable
1839	1.74	1.6255	1.5442	Erosive	Erosive	Erosive	0.4	Erosive	6.8	Stable	Stable
2452	1.74	1.6754	1.5916	Erosive	Erosive	Erosive	0.4	Erosive	7.4	Stable	Stable

USCOE Allowable Velocity (ft/s)	20
FHWA Allowable Velocity (ft/s)	50

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	**245**	**613**	**1839**	**2452**	**245**	**613**	**1839**	**2452**	**245**	**613**	**1839**	**2452**
Bray - Equation #1	43	70	125	145	1.7	2.3	3.3	3.6	3.4	3.9	4.5	4.7
Bray - Equation #2	57	92	164	191	1.8	2.5	3.6	3.9	2.3	2.7	3.1	3.2
Hey	13	22	41	48	5.2	7.4	11.2	12.5				
Ackers & Charlton/Lacey	36	53	85	95					2.0	2.3	2.8	2.9
Parker	108	170	295	340	1.4	2.0	3.1	3.5				
Chang	62	110	215	256	0.3	0.2	-0.1	-0.2				
Kellerhals	28	45	77	89	2.5	3.5	5.5	6.2	3.5	3.9	4.3	4.5
AMAFCA/Schumm	48	124	131	133								
Moody & Odem	16	16	16	16	1.0	1.0	1.0	1.0				
BUREC	17.0	23.9	36.1	40.3	5	6	10	11	5.0	6.3	8.3	8.9
Average	43	73	118	135	2.3	3.2	4.7	5.2	3.3	3.8	4.6	4.9
Values As Designed	48	124	131	133	1.3	2.4	3.5	3.9	4.5	4.4	6.7	7.4
Difference with Design	-5	-52	-12	2	1.0	0.8	1.2	1.3	-1.2	-0.6	-2.1	-2.6

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
245	1453	1973	3089	13075	1559	1545	788	1142	7198	1223	5385	3494
613	3559	4683	7771	31682	4010	3808	1977	2813	17985	2997	13274	8596
1839	18879	16172	22696	197896	6062	16956	5834	12127	54418	9284	57101	37948
2452	29119	22145	30807	318449	6753	28277	7678	17496	72636	9910	82524	56890

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
245	2199	2986	4674	19783	2359	2338	1193	1727	10892	1850	8148	5286
613	2154	2834	4703	19175	2427	2305	1196	1702	10885	1814	8034	5203
1839	3809	3262	4579	39924	1223	3421	1177	2446	10978	1873	11520	7656
2452	4406	3351	4661	48183	1022	4279	1162	2647	10990	1499	12486	8608

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
245	1453	1600	1714	1363	534	688	788	1142	690	161	1411	1049
613	3559	3795	4268	3302	1364	1706	1977	2813	1716	425	3461	2580
1839	18879	13536	12094	20626	2372	6683	5834	12127	5505	375	16718	10432
2452	29119	18648	16023	33190	2711	9553	7678	17496	7400	367	24875	15187

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
245	2199	2420	2593	2062	809	1041	1193	1727	1043	243	2135	1588
613	2154	2297	2583	1998	825	1032	1196	1702	1038	257	2095	1562
1839	3809	2731	2440	4161	478	1348	1177	2446	1111	76	3373	2104
2452	4406	2822	2424	5022	410	1445	1162	2647	1120	56	3764	2298

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
245	0.0005	0.0003	232	0.71	0.052	0.0002	31	0.036	0.0002	0.0159	0.0002	0.0003	0.0056	0.0003	0.0011	0.0030	0.0023
613	0.0005	0.0003	229	0.70	0.052	0.0003	31	0.036	0.0002	0.0159	0.0002	0.0003	0.0056	0.0002	0.0006	0.0030	0.0023
1839	0.0002	0.0002	313	0.95	0.055	0.0001	32	0.036	0.0001	0.0159	0.0001	0.0002	0.0056	0.0001	0.0003	0.0030	0.0022
2452	0.0002	0.0001	340	1.03	0.056	0.0001	32	0.036	0.0001	0.0159	0.0001	0.0001	0.0056	0.0001	0.0002	0.0030	0.0022

Drop Structures

Design Slope	0.0030	ft/ft
Total Drop Needed	65.1	ft
Height of Drop Structure	3	ft
No . of Drop Structures	22	
Distance between structs.	280	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	1.80	sq. mi
Total Sediment Yield Volume	3.42	ac ft

Sedimentation Basins

Length	280 ft	Depth	3 ft
Width	140 ft	Side slope	3 ft/ft
Total Volume per Basin		2.45	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		5	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
245	1.1	0.3	0.3	24.6	1.3	1.2	4.5	0.0030	0.2	0.0	1.0	2.1
613	1.1	0.5	0.3	24.6	2.4	1.1	4.4	0.0030	0.4	0.0	1.0	2.7
1839	1.1	1.1	0.6	24.6	3.5	2.1	6.7	0.0030	0.7	0.0	1.0	4.1
2452	1.1	1.4	0.8	24.6	3.9	2.5	7.4	0.0030	0.8	0.0	1.0	4.6

Toe Protection Needed	5.0	ft

HEC1 Results For Open Channel

Peak Flow	1237	cfs
Stage at Peak Flow	100.0	ft
Flow Volume	100.0	ac. ft

Freeboard

Max. Flow Depth	3.9	ft
Channel Depth as designed	5.0	ft
Available Freeboard	1.1	ft
Required Freeboard	1.2	ft

Sediment Volume

Inflowing Sediment Volume	3.51	ac. ft
Outflowing Sediment Volume	0.09	ac. ft
Deposited(+)/Eroded(-) Volume	3.43	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	6169	6169
Side Slope (?H:1V)	3	6
Channel Width (ft)	140	170
Channel XS Area (sq. ft)	485	560
Channel Perimeter (ft)	142	171

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	1151330	1391434
Excavated Area (sq. Yd)	95962	116526

Bank And Channel Lining	Base	LC Enhanced
Lining Type	Concrete	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	6169	6169
Lining Width (ft)	19	36
Lining Thickness (ft)	0.5	0.5
Lining Area (sq. Yd)	13023	24676
Lining Volume (cu. Yd)	2171	4113

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	6169	ft
Thickness	1.5	ft
Protection Depth	5	ft
Tie-in Length/Depth	3.0	ft
Total Depth	8.0	ft
Area needed	1028	sq. Yd
Volume	2742	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	None	None
Left Levee Length (ft)	0	0
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	N/A	6
Left Levee Height (ft)	0	1
Left Levee Surface Area (sq. Yd)	0	0
Left Levee Volume (cu. Yd)	0	0
Right Levee Length (ft)	0	0
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	N/A	6
Right Levee Height (ft)	0	1
Right Levee Surface Area (sq. Yd)	0	0
Right Levee Volume (cu. Yd)	0	0
Total Levee Surface Area (sq. Yd)	0	0
Total Levee Volume (cu. Yd)	0	0

Levee Lining	Base	LC Enhanced
Lining Type	None	None
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	6169	6169
Left Levee Lining Width (ft)	0	0
Left Levee Lining Thickness (ft)	0	0
Left Levee Lining Area (sq. Yd)	0	0
Left Levee Lining Volume (cu. Yd)	0	0
Right Levee Length (ft)	6169	6169
Right Levee Lining Width (ft)	0	0
Right Levee Lining Thickness (ft)	0	0
Right Levee Lining Area (sq. Yd)	0	0
Right Levee Lining Volume (cu. Yd)	0	0
Total Lining Area (sq. Yd)	0	0
Total Lining Volume (cu. Yd)	0	0

Drop Structures		
Structure Type	Concrete	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	140	ft
LC Enhancement Ratio	1.1	
Structure Thickness	0.5	ft
Drop Height	3	ft
Scour Depth	12.4	ft
Structure Height	15.4	ft
Number of Structures	22	
Volume per structure	40	cu. Yd
Unit Cost	$ 155.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 6,200	
Area per structure	8	sq. Yd
Total Area	171	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	5	
Total Volume per Basin	3953	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 15,812	
Other Cost	$ -	
Total cost per basin	$ 15,812	
Area per basin	4,362	sq. Yd
Total Area	21,810	sq. Yd

Structure Cost

Structure Type	Structure Type	Excavation/Construction Quantity	Units	Unit Cost	Cost Subtotal	Landscape Quantity	Units	Unit Cost	Landscape Cost	Maintenance Quantity	Units	Unit Cost	Maintenance Cost
Levee	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining -LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Excavated Channel	Excavated	1,151,330	cu. Yd	$ 10.00	$ 11,513,300	95,962	sq. Yd	$ 9.00	$ 863,658	95,962	sq. Yd	$ 8.33	$ 799,683
Exc. Chl - LC Enhancement	Excavated	240,104	cu. Yd	$ 10.00	$ 2,401,040	20,564	sq. Yd	$ 9.00	$ 185,076	20,564	sq. Yd	$ 8.33	$ 171,367
Channel Lining	Concrete	2,171	cu. Yd	$ 155.00	$ 336,505	13,023	sq. Yd	$ -	$ -	13,023	sq. Yd	$ 41.67	$ 542,625
Channel Lining - LC Enhancement	Concrete	1,942	cu. Yd	$ 155.00	$ 301,010	11,653	sq. Yd	$ -	$ -	11,653	sq. Yd	$ 41.67	$ 485,542
Toe Protection	Riprap	2,742	cu. Yd	$ 75.00	$ 205,650	1,028	sq. Yd	$ -	$ -	1,028	sq. Yd	$ 25.00	$ 25,700
Drop Structures	Concrete	22	EA	$ 6,200.00	$ 136,400	171	sq. Yd	$ -	$ -	171	sq. Yd	$ 41.67	$ 7,125
Drop Str. - LC Enhancement	Concrete	22	EA	$ 620.00	$ 13,640	17	sq. Yd	$ -	$ -	17	sq. Yd	$ 41.67	$ 713
Sedimentation Basins		5	EA	$ 15,812.00	$ 79,060	21,810	sq. Yd	$ -	$ -	21,810	sq. Yd	$ 8.33	$ 181,750
Other					$ -				$ -				$ -

Base Landscape Cost	$ 863,658
LC Enhancement Cost	$ 185,076
Total Landscape Cost	$ 1,048,734

Base Maintenance Cost	$ 1,556,883
LC Enhancement Cost	$ 657,621
Total Maintenance Cost	$ 2,214,504

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 12,270,915	$ 2,715,690	$ 14,986,605
Contingency Cost (25% of Construction Cost)	$ 3,067,729	$ 678,923	$ 3,746,651
Engineering Design Cost (5% of Construction Cost)	$ 613,546	$ 135,785	$ 749,330
Total Construction Cost	$ 15,952,190	$ 3,530,397	$ 19,482,587

Land Cost

Channel Length	6169 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	134	19	$100,000	$ 1,900,000
LC Enhancement Buffer	50	7.1	$100,000	$ 710,000
Channel	140	19.8	$100,000	$ 1,980,000
Channel LC Enhancement	30	4.2	$100,000	$ 420,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	354	50.1		$ 5,010,000

Right of Way

Preservation Corridor Width	120	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	50	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	38.8	$100,000	$ 3,880,000
LC Enhancement Cost	acre	11.3	$100,000	$ 1,130,000
Total Land Cost	acre	50.1	$100,000	$ 5,010,000

Total Cost

Base Total Cost	$ 22,252,731
Total Landscape Enhancement Cost	$ 5,503,094
Total Cost Including LC Enh.	$ 27,755,825

Offline Basin

HEC1 ID	D175

HEC1 Results Used to Determine Sediment Volume From Upstream

Contributing HEC1 ID							Total Volume (ac. ft)
Inflow Volume (ac. ft)							0
Volume Fraction							
Weighted Volume							0
Sediment Conc. (ppm)							
Sediment Volume (ac. ft)							0.00
Weighting Factor							
Weighted Sed. Vol. (ac. ft)							0.00

Sediment Yield

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.0	sq. mi
Total Sediment Yield Volume	0.0	ac ft

Required Minimum Sediment Volume

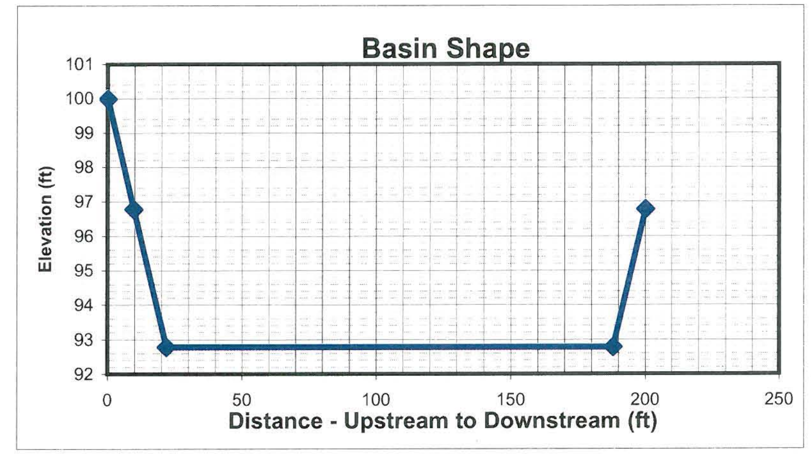
Sediment Volume	0.0	ac. ft

Geometry	Base	LC Enhanced
Topography slope (ft/ft)	0.016	0.016
Basin Length (ft)	280	340
Basin Width (ft)	200	200
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	4	4
Freeboard (ft)	1	1
Effective Basin Width (ft)	190.4	180.8
Top Area (acres)	1.3	1.6
U/S-D/S Height Difference (ft)	3.2	3.2
Excess Area on Upstream (acres)	0.1	0.2

			Base	LC Enhanced
Bottom Length (ft)	256	Allocated Storage Volume (ac. ft)	3.2	3.2
Bottom Width (ft)	166.4	Total Available Volume (ac. ft) (incl. Freeboard)	4.4	4.6
		Total Excavation Volume (ac. ft)	6.5	7.1

Stage-Storage-Discharge

Stage (ft)	0												
Inflow (cfs)	0	600	800	1000	1200	1400	1600	1800	2000	2236	4000	5000	
Outflow (cfs)	0	0	0	0	0	0	0	0	0	0	1764	2764	Combined capacity of culverts at Sta. 630+89 and 632+08 = 856 + 1380 cfs



HEC1 Results

	6-hr Event	24-hr Event	Maximum
Peak flow before diversion (cfs)	2054	2452	2452
Peak flow after diversion (cfs)	2054	2236	2236
Diverted Peak Flow (cfs)	0	216	216
Total Diverted Flow Volume (ac. ft)	0.0	3	3.0
Peak Stage	0	ft	

Volume Check

Total Volume needed	3.0	ac. ft
Total Volume Provided	3.2	ac. ft
Volume OK?	Yes	

Stage Check

Depth Needed	1.0
Depth Provided	4
Depth OK?	Yes

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
Landscape Enhancement	76000	sq. ft
Other		sq. ft

Additional ROW Length	0	ft
Additional ROW Width	0	ft
Landscaping Buffer Length	100	ft
Landscaping Buffer Width	100	ft

Base Total ROW Length	280	ft
Base Total ROW Width	200	ft
LC Enh. Total ROW Length	440	ft
LC Enh. Total ROW Length	300	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	10487	11455
Excavated Area (sq. Yd)	6222	14667

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	23	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	253	sq. Yd
Material Volume	127	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	364	ft
Unit Cost	160	per ft
Cost per outlet	$58,240	
Other Cost	$ -	
Total Cost	$58,240	
Outlet Area	133	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Basin		10,487	cu. Yd	$ 4.00	$ 41,948	6,222	sq. Yd	$ 9.00	$ 55,998	6,222	sq. Yd	$ 8.33	$ 51,850
Basin - LC Enhanced		968	cu. Yd	$ 4.00	$ 3,872	8,445	sq. Yd	$ 9.00	$ 76,005	8,445	sq. Yd	$ 8.33	$ 70,375
Inlet	Riprap	127	sq. Yd	$ 75.00	$ 9,525	253	sq. Yd	$ -	$ -	253	sq. Yd	$ 33.33	$ 8,433
Inlet - LC Enhanced (20%Total)					$ 1,905				$ -				$ 1,687
Outlet	Pipe	1	EA	$ 58,240	$ 58,240	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhanced (5%Total)					$ 2,912				$ -				$ 111
Other					$ -				$ -				$ -

Base Landscape Cost	$ 55,998
LC Enh. Landscape Cost	$ 76,005
Total Landscape Cost	$ 132,003

Base Maintenance Cost	$ 62,500
LC Enh. Maintenance Cost	$ 72,173
Total Maintenance Cost	$ 134,673

Construction Cost Component	Base	LC Enhanced	Total
Construction Cost	$ 109,713	$ 3,872	$ 113,585
Contingency Cost (25% of Construction Cost)	$ 27,428	$ 968	$ 28,396
Engineering Design Cost (5% of Construction Cost)	$ 5,486	$ 194	$ 5,679
Total Construction Cost	$ 142,627	$ 5,034	$ 147,661

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	1.7	$100,000	$ 174,472
Basin	1.3	$100,000	$ 130,000
Other		$100,000	$ -
Total	3.0	$100,000	$ 300,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	1.3	$100,000	$ 128,558
LC Enhancement Cost	acre	1.7	$100,000	$ 171,442
Total Land Cost	acre	3	$100,000	$ 300,000

Total Cost

Base Total Cost	$ 389,683
Total LC Enhancement Cost	$ 324,653
Total Cost Including LC Enh.	$ 714,336

Open Channel

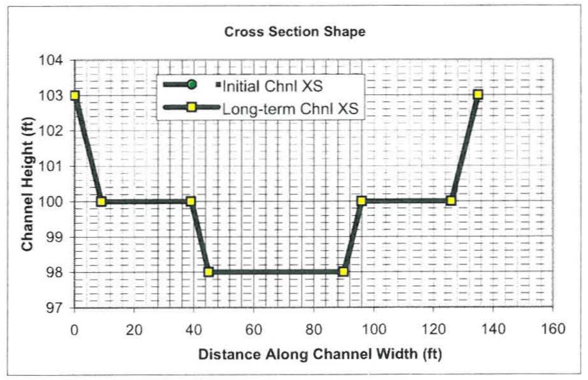
Structure ID	RR17510		HEC1 ID	175R

Longitundal Geometry

Length	3035.2	ft
U/S Elev	1462.9	ft
D/S Elev	1413.1	ft
Initial Channel Slope	0.0164	ft/ft
Long-term Channel Slope	0.0030	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	1



Initial Channel XS Geometry

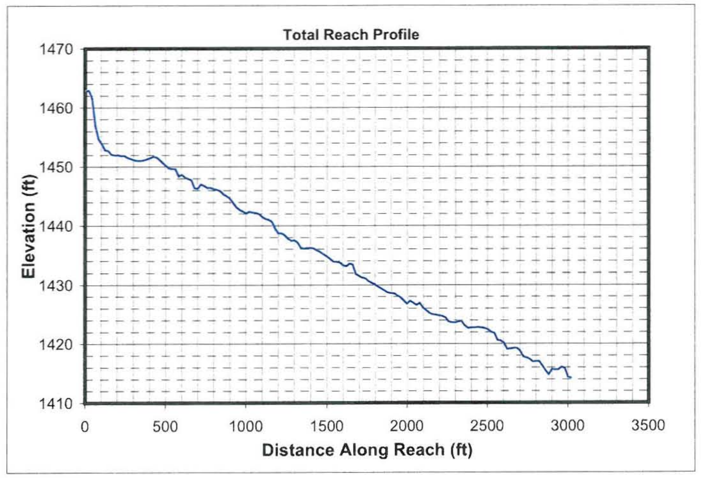
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	3	30	3	45	5	3	30	3	3

PT. ID	1	2	3	4	5	6	7	8
X	0	9	39	45	90	96	126	135
Y	103	100	100	98	98	100	100	103

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	3	30	3	45	5	3	30	3	3

PT. ID	1	2	3	4	5	6	7	8
X	0	9	39	45	90	96	126	135
Y	103	100	100	98	98	100	100	103



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.02	0.02	0.02	0.02	0.02	0.02

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	D175	S190								TOTAL
HEC1 Peak-Flow	2236	2590								4826
Weighting Factor	1.00	0.05								
Flow into Channel	2236	119								2355

Reach Sediment Inflow Characteristics

U/S Contributing ID	165175_C17510B									TOTAL
HEC1 Flow Volume (ac. ft)	100.00									100
Sediment Conc. (ppm)	2298									
Sediment Volume (ac. ft)	0.09									0.09
Weighting Factor	1									
Weighted Sed. Vol. (ac. ft)	0.09									0.09

Hydrology

Drainage Area	1.885	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	2355	cfs	
Long-term Max. Chnl Capacity	4527	cfs	
Q2 Channel	236	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	135	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
236	52.2	55.5	1.1	98.0	99.1	4.2	1.1	51.9	1.1	0.21	0.72
589	57.4	99.8	1.7	98.0	100.0	5.9	2.0	56.8	1.8	0.37	0.78
1766	126.1	264.3	2.1	98.0	101.3	6.7	3.3	125.0	2.1	0.63	0.81
2355	128.8	316.7	2.5	98.0	101.8	7.4	3.8	127.5	2.5	0.70	0.83

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
236	52.2	55.5	1.1	98.0	99.1	4.2	1.1	51.9	1.1	0.21	0.72
589	57.4	99.8	1.7	98.0	100.0	5.9	2.0	56.8	1.8	0.37	0.78
1766	126.1	264.3	2.1	98.0	101.3	6.7	3.3	125.0	2.1	0.63	0.81
2355	128.8	316.7	2.5	98.0	101.8	7.4	3.8	127.5	2.5	0.70	0.83

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
	165175_C17510 B									
236	1049									1049
589	2580									2580
1766	10432									10432
2355	15187									15187

Allowable Velocity

Channel Lining	Concrete

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
236	1.74	1.4160	1.3452	Erosive	Erosive	Erosive	0.3	Erosive	3.5	Stable	Stable
589	1.74	1.5694	1.4909	Erosive	Erosive	Erosive	0.4	Erosive	5.0	Stable	Stable
1766	1.74	1.6262	1.5449	Erosive	Erosive	Erosive	0.4	Erosive	6.7	Stable	Stable
2355	1.74	1.6759	1.5921	Erosive	Erosive	Erosive	0.4	Erosive	7.3	Stable	Stable

USCOE Allowable Velocity (ft/s)	20
FHWA Allowable Velocity (ft/s)	50

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	236	589	1766	2355	236	589	1766	2355	236	589	1766	2355
Bray - Equation #1	42	69	122	142	1.6	2.2	3.2	3.5	3.4	3.9	4.5	4.7
Bray - Equation #2	56	90	161	187	1.8	2.4	3.5	3.9	2.3	2.7	3.1	3.2
Hey	13	22	40	47	5.1	7.3	11.0	12.3				
Ackers & Charlton/Lacey	36	52	83	94					2.0	2.3	2.8	2.9
Parker	105	167	289	333	1.3	2.0	3.1	3.5				
Chang	61	107	210	250	0.3	0.2	-0.1	-0.2				
Kellerhals	28	44	76	87	2.4	3.5	5.4	6.1	3.5	3.9	4.3	4.4
AMAFCA/Schumm	52	57	125	128								
Moody & Odem	16	16	16	16	1.0	1.0	1.0	1.0				
BUREC	16.7	23.6	35.6	39.7	4	6	10	11	5.0	6.2	8.2	8.8
Average	42	65	116	132	2.3	3.1	4.6	5.1	3.2	3.8	4.6	4.8
Values As Designed	52	57	125	128	1.1	2.0	3.3	3.8	4.2	5.9	6.7	7.4
Difference with Design	-9	8	-9	5	1.1	1.2	1.2	1.3	-1.0	-2.1	-2.1	-2.6

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
236	1305	1915	3230	15291	1820	1599	757	1043	9217	1328	5726	3930
589	5090	5250	7762	68098	2646	5515	1879	3512	23187	4820	18954	13337
1766	18169	15911	23728	253730	6450	21447	5602	11659	69650	13177	62731	45660
2355	28011	21766	32086	408037	7180	33897	7373	16817	92944	14030	90297	68403

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
236	2056	3017	5088	24089	2867	2520	1192	1644	14521	2092	9020	6191
589	3207	3308	4891	42912	1667	3475	1184	2213	14611	3037	11944	8405
1766	3816	3342	4984	53296	1355	4505	1177	2449	14630	2768	13177	9591
2355	4413	3429	5055	64281	1131	5340	1161	2649	14642	2210	14225	10776

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
236	1305	1505	1620	1197	545	640	757	1043	653	180	1274	974
589	5090	4259	3936	5331	900	1971	1879	3512	1740	170	4676	3042
1766	18169	13033	11612	19865	2273	6425	5602	11659	5288	358	16082	10033
2355	28011	17948	15389	31946	2599	9182	7373	16817	7108	351	23917	14604

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
236	2056	2371	2552	1886	858	1009	1192	1644	1029	283	2007	1535
589	3207	2684	2480	3360	567	1242	1184	2213	1097	107	2947	1917
1766	3816	2737	2439	4173	477	1350	1177	2449	1111	75	3378	2107
2355	4413	2827	2424	5033	409	1447	1161	2649	1120	55	3768	2301

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
236	0.0006	0.0003	246	0.75	0.053	0.0003	31	0.036	0.0002	0.0159	0.0002	0.0003	0.0056	0.0003	0.0011	0.0030	0.0023
589	0.0003	0.0002	314	0.96	0.055	0.0002	32	0.036	0.0001	0.0159	0.0001	0.0002	0.0056	0.0002	0.0006	0.0030	0.0022
1766	0.0002	0.0002	345	1.05	0.056	0.0001	32	0.036	0.0001	0.0159	0.0001	0.0002	0.0056	0.0001	0.0003	0.0030	0.0022
2355	0.0002	0.0001	374	1.14	0.057	0.0001	33	0.036	0.0001	0.0159	0.0001	0.0001	0.0056	0.0001	0.0002	0.0030	0.0022

Drop Structures

Design Slope	0.0030	ft/ft
Total Drop Needed	40.6	ft
Height of Drop Structure	3	ft
No . of Drop Structures	14	
Distance between structs.	217	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.19	sq. mi
Total Sediment Yield Volume	0.36	ac ft

Sedimentation Basins

Length	217 ft	Depth	3 ft
Width	135 ft	Side slope	3 ft/ft
Total Volume per Basin		1.81	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
236	1.1	0.2	0.2	24.6	1.1	1.1	4.2	0.0030	0.2	0.0	1.0	2.1
589	1.1	0.6	0.5	24.6	2.0	1.8	5.9	0.0030	0.4	0.0	1.0	2.9
1766	1.1	1.1	0.6	24.6	3.3	2.1	6.7	0.0030	0.7	0.0	1.0	4.0
2355	1.1	1.3	0.8	24.6	3.8	2.5	7.4	0.0030	0.8	0.0	1.0	4.5

Toe Protection Needed	5.0	ft

HEC1 Results For Open Channel

Peak Flow	2236	cfs
Stage at Peak Flow	100.5	ft
Flow Volume	199.0	ac. ft

Freeboard

Max. Flow Depth	3.8	ft
Channel Depth as designed	5.0	ft
Available Freeboard	1.2	ft
Required Freeboard	1.2	ft

Sediment Volume

Inflowing Sediment Volume	0.44	ac. ft
Outflowing Sediment Volume	0.17	ac. ft
Deposited(+)/Eroded(-) Volume	0.27	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	3035	3035
Side Slope (?H:1V)	3	6
Channel Width (ft)	135	165
Channel XS Area (sq. ft)	480	555
Channel Perimeter (ft)	137	166

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	362361	439326
Excavated Area (sq. Yd)	45525	55642

Bank And Channel Lining	Base	LC Enhanced
Lining Type	Concrete	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	3035	3035
Lining Width (ft)	19	36
Lining Thickness (ft)	0.5	0.5
Lining Area (sq. Yd)	6407	12140
Lining Volume (cu. Yd)	1068	2023

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	3035	ft
Thickness	1.5	ft
Protection Depth	5	ft
Tie-in Length/Depth	3.0	ft
Total Depth	8.0	ft
Area needed	506	sq. Yd
Volume	1349	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	None	None
Left Levee Length (ft)	0	0
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	N/A	6
Left Levee Height (ft)	0	1
Left Levee Surface Area (sq. Yd)	0	0
Left Levee Volume (cu. Yd)	0	0
Right Levee Length (ft)	0	0
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	N/A	6
Right Levee Height (ft)	0	1
Right Levee Surface Area (sq. Yd)	0	0
Right Levee Volume (cu. Yd)	0	0
Total Levee Surface Area (sq. Yd)	0	0
Total Levee Volume (cu. Yd)	0	0

Levee Lining	Base	LC Enhanced
Lining Type	None	None
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	3035	3035
Left Levee Lining Width (ft)	0	0
Left Levee Lining Thickness (ft)	0	0
Left Levee Lining Area (sq. Yd)	0	0
Left Levee Lining Volume (cu. Yd)	0	0
Right Levee Length (ft)	3035	3035
Right Levee Lining Width (ft)	0	0
Right Levee Lining Thickness (ft)	0	0
Right Levee Lining Area (sq. Yd)	0	0
Right Levee Lining Volume (cu. Yd)	0	0
Total Lining Area (sq. Yd)	0	0
Total Lining Volume (cu. Yd)	0	0

Drop Structures		
Structure Type	Concrete	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	135	ft
LC Enhancement Ratio	1.1	
Structure Thickness	0.5	ft
Drop Height	3	ft
Scour Depth	12.4	ft
Structure Height	15.4	ft
Number of Structures	14	
Volume per structure	39	cu. Yd
Unit Cost	$ 155.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 6,045	
Area per structure	8	sq. Yd
Total Area	105	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	2920	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 11,680	
Other Cost	$ -	
Total cost per basin	$ 11,680	
Area per basin	3,252	sq. Yd
Total Area	3,252	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining -LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Excavated Channel	Excavated	362,361	cu. Yd	$ 10.00	$ 3,623,610	45,525	sq. Yd	$ 9.00	$ 409,725	45,525	sq. Yd	$ 8.33	$ 379,375
Exc. Chl - LC Enhancement	Excavated	76,965	cu. Yd	$ 10.00	$ 769,650	10,117	sq. Yd	$ 9.00	$ 91,053	10,117	sq. Yd	$ 8.33	$ 84,308
Channel Lining	Concrete	1,068	cu. Yd	$ 155.00	$ 165,540	6,407	sq. Yd	$ -	$ -	6,407	sq. Yd	$ 41.67	$ 266,958
Channel Lining - LC Enhancement	Concrete	955	cu. Yd	$ 155.00	$ 148,025	5,733	sq. Yd	$ -	$ -	5,733	sq. Yd	$ 41.67	$ 238,875
Toe Protection	Riprap	1,349	cu. Yd	$ 75.00	$ 101,175	506	sq. Yd	$ -	$ -	506	sq. Yd	$ 25.00	$ 12,650
Drop Structures	Concrete	14	EA	$ 6,045.00	$ 84,630	105	sq. Yd	$ -	$ -	105	sq. Yd	$ 41.67	$ 4,375
Drop Str. - LC Enhancement	Concrete	14	EA	$ 604.50	$ 8,463	11	sq. Yd	$ -	$ -	11	sq. Yd	$ 41.67	$ 438
Sedimentation Basins		1	EA	$ 11,680.00	$ 11,680	3,252	sq. Yd	$ -	$ -	3,252	sq. Yd	$ 8.33	$ 27,100
Other					$ -				$ -				$ -

Base Landscape Cost	$ 409,725
LC Enhancement Cost	$ 91,053
Total Landscape Cost	$ 500,778

Base Maintenance Cost	$ 690,458
LC Enhancement Cost	$ 323,621
Total Maintenance Cost	$ 1,014,079

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 3,986,635	$ 926,138	$ 4,912,773
Contingency Cost (25% of Construction Cost)	$ 996,659	$ 231,535	$ 1,228,193
Engineering Design Cost (5% of Construction Cost)	$ 199,332	$ 46,307	$ 245,639
Total Construction Cost	$ 5,182,626	$ 1,203,979	$ 6,386,605

Land Cost

Channel Length	3035 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	134	9.3	$100,000	$ 930,000
LC Enhancement Buffer	50	3.5	$100,000	$ 350,000
Channel	135	9.4	$100,000	$ 940,000
Channel LC Enhancement	30	2.1	$100,000	$ 210,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	349	24.3		$ 2,430,000

Right of Way

Preservation Corridor Width	120	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	50	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	18.7	$100,000	$ 1,870,000
LC Enhancement Cost	acre	5.6	$100,000	$ 560,000
Total Land Cost	acre	24.3	$100,000	$ 2,430,000

Total Cost

Base Total Cost	$ 8,152,809
Total Landscape Enhancement Cost	$ 2,178,653
Total Cost Including LC Enh.	$ 10,331,462

Open Channel

Structure ID	S18010		HEC1 ID	180R

Longitundal Geometry

Length	5165.4	ft
U/S Elev	1531.6	ft
D/S Elev	1456.3	ft
Initial Channel Slope	0.0146	ft/ft
Long-term Channel Slope	0.0030	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	2

Initial Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	3.5	10	3	10	5.5	3	10	3.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	10.5	20.5	26.5	36.5	42.5	52.5	63
Y	103.5	100	100	98	98	100	100	103.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	3.5	10	3	10	5.5	3	10	3.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	10.5	20.5	26.5	36.5	42.5	52.5	63
Y	103.5	100	100	98	98	100	100	103.5

Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.02	0.02	0.02	0.02	0.02	0.02

HEC1 Results Used to Determine Design Peak Flows

										TOTAL
Contributing HEC1 ID	S180									
HEC1 Peak-Flow	1039									1039
Weighting Factor	1.00									
Flow into Channel	1039									1039

Reach Sediment Inflow Characteristics

U/S Contributing ID										TOTAL
HEC1 Flow Volume (ac. ft)										0
Sediment Conc. (ppm)										
Sediment Volume (ac. ft)										0.00
Weighting Factor										
Weighted Sed. Vol. (ac. ft)										0.00

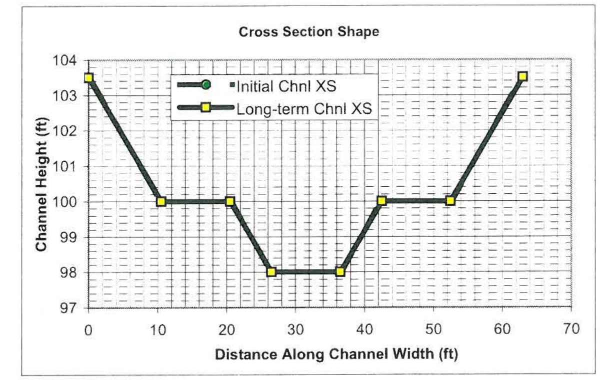
Hydrology

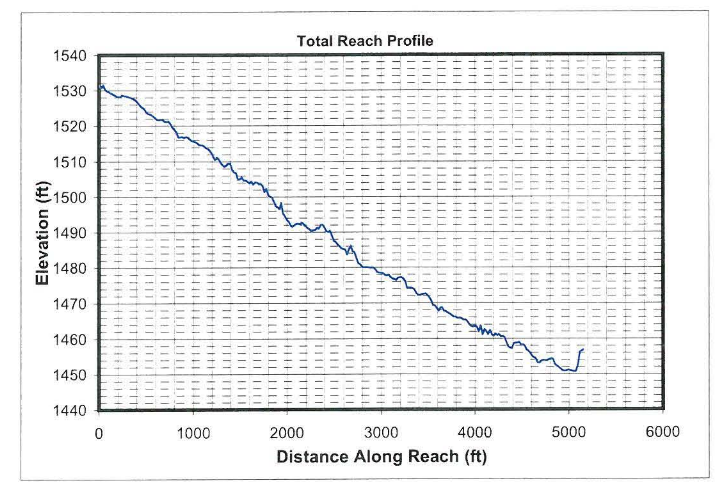
Drainage Area	0.986	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	1039	cfs	
Long-term Max. Chnl Capacity	1963	cfs	
Q2 Channel	104	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	63	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			





JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

Sub-area: Wagner Wash, Alternative: C
Open Channel Structure ID: S18010

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
104	19.9	23.1	1.2	98.0	99.6	4.5	1.6	19.4	1.2	0.29	0.73
260	46.1	56.0	1.2	98.0	100.5	4.6	2.5	45.3	1.2	0.48	0.74
779	53.8	115.0	2.1	98.0	101.8	6.8	3.8	52.5	2.2	0.70	0.81
1039	56.6	139.6	2.5	98.0	102.2	7.4	4.2	55.3	2.5	0.79	0.83

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
104	19.9	23.1	1.2	98.0	99.6	4.5	1.6	19.4	1.2	0.29	0.73
260	46.1	56.0	1.2	98.0	100.5	4.6	2.5	45.3	1.2	0.48	0.74
779	53.8	115.0	2.1	98.0	101.8	6.8	3.8	52.5	2.2	0.70	0.81
1039	56.6	139.6	2.5	98.0	102.2	7.4	4.2	55.3	2.5	0.79	0.83

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
104										0
260										0
779										0
1039										0

Allowable Velocity

Channel Lining	Concrete

Discharge (cfs)	Fortier & Scobey (as modified in Chow) Permissive Velocity (ft/s) Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	BUREC Erosive?	Neill (gravel/cobble) Non-cohesive Erosive?	All'ble Vel (ft/s)	Cohesive Erosive?	All'ble Vel (ft/s)	USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
104	1.74	1.4487	1.3763	Erosive	Erosive	Erosive	0.3	Erosive	4.2	Stable	Stable
260	1.74	1.4606	1.3876	Erosive	Erosive	Erosive	0.3	Erosive	5.4	Stable	Stable
779	1.74	1.6370	1.5552	Erosive	Erosive	Erosive	0.4	Erosive	7.2	Stable	Stable
1039	1.74	1.6811	1.5970	Erosive	Erosive	Erosive	0.4	Erosive	7.8	Stable	Stable

USCOE Allowable Velocity (ft/s)	20
FHWA Allowable Velocity (ft/s)	50

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	**104**	**260**	**779**	**1039**	**104**	**260**	**779**	**1039**	**104**	**260**	**779**	**1039**
Bray - Equation #1	28	45	80	93	1.2	1.7	2.4	2.7	3.0	3.4	4.0	4.2
Bray - Equation #2	36	58	104	122	1.4	1.9	2.7	2.9	2.1	2.4	2.8	2.9
Hey	8	13	25	30	3.8	5.3	8.1	9.0				
Ackers & Charlton/Lacey	25	37	59	67					1.7	2.0	2.4	2.6
Parker	70	111	192	221	1.0	1.4	2.2	2.5				
Chang	37	65	127	152	0.3	0.3	0.2	0.1				
Kellerhals	18	29	50	58	1.7	2.5	3.9	4.4	3.2	3.6	4.0	4.1
AMAFCA/Schumm	19	45	53	55								
Moody & Odem	12	12	12	12	0.9	0.9	0.9	0.9				
BUREC	12.3	17.4	26.2	29.2	3	5	7	8	4.0	5.1	6.7	7.2
Average	27	43	73	84	1.7	2.3	3.4	3.8	2.8	3.3	4.0	4.2
Values As Designed	19	45	53	55	1.6	2.5	3.8	4.2	4.5	4.6	6.8	7.4
Difference with Design	7	-2	20	29	0.1	-0.2	-0.3	-0.4	-1.7	-1.4	-2.8	-3.3

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
104	609	819	1321	6327	677	681	325	479	3412	560	2393	1600
260	1603	2022	3307	16626	1615	1766	824	1243	8536	1453	6204	4109
779	8019	6812	9826	96907	2591	8409	2415	5120	25770	4437	25422	17793
1039	12144	9282	13276	152481	2947	13022	3180	7310	34388	4857	36302	26290

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
104	2174	2924	4718	22591	2417	2432	1162	1709	12183	2001	8546	5714
260	2289	2889	4723	23746	2307	2523	1177	1775	12192	2076	8861	5869
779	3818	3243	4678	46137	1233	4004	1150	2438	12269	2112	12104	8471
1039	4336	3314	4741	54447	1052	4650	1135	2610	12279	1734	12962	9387

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
104	609	658	716	590	224	288	325	479	293	65	593	440
260	1603	1632	1824	1552	540	740	824	1243	738	150	1552	1127
779	8019	5660	5045	9043	979	2820	2415	5120	2337	149	7097	4426
1039	12144	7755	6691	14230	1139	3996	3180	7310	3138	152	10409	6377

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
104	2174	2350	2557	2108	799	1027	1162	1709	1047	231	2119	1571
260	2289	2331	2605	2216	771	1056	1177	1775	1054	214	2217	1610
779	3818	2695	2402	4306	466	1342	1150	2438	1113	71	3379	2107
1039	4336	2769	2389	5081	407	1427	1135	2610	1120	54	3717	2277

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
104	0.0005	0.0003	242	0.74	0.052	0.0002	31	0.036	0.0002	0.0159	0.0002	0.0003	0.0074	0.0005	0.0012	0.0029	0.0028
260	0.0005	0.0003	248	0.75	0.053	0.0002	31	0.036	0.0002	0.0159	0.0002	0.0003	0.0074	0.0003	0.0006	0.0029	0.0027
779	0.0002	0.0002	329	1.00	0.055	0.0001	32	0.036	0.0001	0.0159	0.0001	0.0001	0.0074	0.0002	0.0003	0.0029	0.0027
1039	0.0002	0.0001	353	1.08	0.056	0.0001	32	0.036	0.0001	0.0159	0.0001	0.0001	0.0074	0.0002	0.0002	0.0029	0.0027

Drop Structures

Design Slope	0.0030	ft/ft
Total Drop Needed	59.8	ft
Height of Drop Structure	3	ft
No . of Drop Structures	20	
Distance between structs.	258	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	1.44	sq. mi
Total Sediment Yield Volume	2.74	ac ft

Sedimentation Basins

Length	258 ft	Depth	3 ft
Width	63 ft	Side slope	3 ft/ft
Total Volume per Basin		0.93	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		10	

Scour and Toe Protection (Not applicable for concrete channel)

		Pima County General Scour Equations							Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
104	1.1	0.3	0.3	24.6	1.6	1.2	4.5	0.0030	0.3	0.0	1.0	2.3
260	1.1	0.6	0.3	24.6	2.5	1.2	4.6	0.0030	0.5	0.0	1.0	2.9
779	1.1	1.2	0.6	24.6	3.8	2.2	6.8	0.0030	0.8	0.0	1.0	4.3
1039	1.1	1.5	0.8	24.6	4.2	2.5	7.4	0.0030	0.9	0.0	1.0	4.8

Toe Protection Needed	5.0	ft

HEC1 Results For Open Channel

Peak Flow	954	cfs
Stage at Peak Flow	100.9	ft
Flow Volume	90.0	ac. ft

Freeboard

Max. Flow Depth	4.2	ft
Channel Depth as designed	5.5	ft
Available Freeboard	1.3	ft
Required Freeboard	1.3	ft

Sediment Volume

Inflowing Sediment Volume	2.74	ac. ft
Outflowing Sediment Volume	0.08	ac. ft
Deposited(+)/Eroded(-) Volume	2.66	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	5165	5165
Side Slope (?H:1V)	3	6
Channel Width (ft)	63	96
Channel XS Area (sq. ft)	215.8	306.55
Channel Perimeter (ft)	65	97

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	401738	607908
Excavated Area (sq. Yd)	36155	55093

Bank And Channel Lining	Base	LC Enhanced
Lining Type	Concrete	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	5165	5165
Lining Width (ft)	22	43
Lining Thickness (ft)	0.5	0.5
Lining Area (sq. Yd)	12626	24677
Lining Volume (cu. Yd)	2104	4113

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	5165	ft
Thickness	1.5	ft
Protection Depth	5	ft
Tie-in Length/Depth	3.0	ft
Total Depth	8.0	ft
Area needed	861	sq. Yd
Volume	2296	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	None	None
Left Levee Length (ft)	0	0
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	N/A	6
Left Levee Height (ft)	0	1
Left Levee Surface Area (sq. Yd)	0	0
Left Levee Volume (cu. Yd)	0	0
Right Levee Length (ft)	0	0
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	N/A	6
Right Levee Height (ft)	0	1
Right Levee Surface Area (sq. Yd)	0	0
Right Levee Volume (cu. Yd)	0	0
Total Levee Surface Area (sq. Yd)	0	0
Total Levee Volume (cu. Yd)	0	0

Levee Lining	Base	LC Enhanced
Lining Type	None	None
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	5165	5165
Left Levee Lining Width (ft)	0	0
Left Levee Lining Thickness (ft)	0	0
Left Levee Lining Area (sq. Yd)	0	0
Left Levee Lining Volume (cu. Yd)	0	0
Right Levee Length (ft)	5165	5165
Right Levee Lining Width (ft)	0	0
Right Levee Lining Thickness (ft)	0	0
Right Levee Lining Area (sq. Yd)	0	0
Right Levee Lining Volume (cu. Yd)	0	0
Total Lining Area (sq. Yd)	0	0
Total Lining Volume (cu. Yd)	0	0

Drop Structures		
Structure Type	Concrete	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	63	ft
LC Enhancement Ratio	1.1	
Structure Thickness	0.5	ft
Drop Height	3	ft
Scour Depth	12.6	ft
Structure Height	15.6	ft
Number of Structures	20	
Volume per structure	18	cu. Yd
Unit Cost	$ 155.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 2,790	
Area per structure	4	sq. Yd
Total Area	70	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	10	
Total Volume per Basin	1500	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 6,000	
Other Cost	$ -	
Total cost per basin	$ 6,000	
Area per basin	1,808	sq. Yd
Total Area	18,080	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining -LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Excavated Channel	Excavated	401,738	cu. Yd	$ 10.00	$ 4,017,380	36,155	sq. Yd	$ 9.00	$ 325,395	36,155	sq. Yd	$ 8.33	$ 301,292
Exc. Chl - LC Enhancement	Excavated	206,170	cu. Yd	$ 10.00	$ 2,061,700	18,938	sq. Yd	$ 9.00	$ 170,442	18,938	sq. Yd	$ 8.33	$ 157,817
Channel Lining	Concrete	2,104	cu. Yd	$ 155.00	$ 326,120	12,626	sq. Yd	$ -	$ -	12,626	sq. Yd	$ 41.67	$ 526,083
Channel Lining - LC Enhancement	Concrete	2,009	cu. Yd	$ 155.00	$ 311,395	12,051	sq. Yd	$ -	$ -	12,051	sq. Yd	$ 41.67	$ 502,125
Toe Protection	Riprap	2,296	cu. Yd	$ 75.00	$ 172,200	861	sq. Yd	$ -	$ -	861	sq. Yd	$ 25.00	$ 21,525
Drop Structures	Concrete	20	EA	$ 2,790.00	$ 55,800	70	sq. Yd	$ -	$ -	70	sq. Yd	$ 41.67	$ 2,917
Drop Str. - LC Enhancement	Concrete	20	EA	$ 279.00	$ 5,580	7	sq. Yd	$ -	$ -	7	sq. Yd	$ 41.67	$ 292
Sedimentation Basins		10	EA	$ 6,000.00	$ 60,000	18,080	sq. Yd	$ -	$ -	18,080	sq. Yd	$ 8.33	$ 150,667
Other					$ -				$ -				$ -

Base Landscape Cost	$ 325,395	
LC Enhancement Cost	$ 170,442	
Total Landscape Cost	$ 495,837	

Base Maintenance Cost	$ 1,002,483
LC Enhancement Cost	$ 660,233
Total Maintenance Cost	$ 1,662,717

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 4,631,500	$ 2,378,675	$ 7,010,175
Contingency Cost (25% of Construction Cost)	$ 1,157,875	$ 594,669	$ 1,752,544
Engineering Design Cost (5% of Construction Cost)	$ 231,575	$ 118,934	$ 350,509
Total Construction Cost	$ 6,020,950	$ 3,092,278	$ 9,113,228

Land Cost

Channel Length	5165 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	134	15.9	$100,000	$ 1,590,000
LC Enhancement Buffer	50	5.9	$100,000	$ 590,000
Channel	63	7.5	$100,000	$ 750,000
Channel LC Enhancement	33	3.9	$100,000	$ 390,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	280	33.2		$ 3,320,000

Right of Way

Preservation Corridor Width	120	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	50	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	23.4	$100,000	$ 2,340,000
LC Enhancement Cost	acre	9.8	$100,000	$ 980,000
Total Land Cost	acre	33.2	$100,000	$ 3,320,000

Total Cost

Base Total Cost	$ 9,688,828
Total Landscape Enhancement Cost	$ 4,902,953
Total Cost Including LC Enh.	$ 14,591,781

Open Channel

Structure ID	RR18010	HEC1 ID	180R

Longitundal Geometry

Length	2824.7	ft
U/S Elev	1456.3	ft
D/S Elev	1413.1	ft
Initial Channel Slope	0.0153	ft/ft
Long-term Channel Slope	0.0030	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	1

Initial Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	3.5	10	3	10	5.5	3	10	3.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	10.5	20.5	26.5	36.5	42.5	52.5	63
Y	103.5	100	100	98	98	100	100	103.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	3.5	10	3	10	5.5	3	10	3.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	10.5	20.5	26.5	36.5	42.5	52.5	63
Y	103.5	100	100	98	98	100	100	103.5

Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.02	0.02	0.02	0.02	0.02	0.02

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	S180	S190								TOTAL
HEC1 Peak-Flow	1039	2590								3629
Weighting Factor	1.00	0.03								
Flow into Channel	1039	85								1124

Reach Sediment Inflow Characteristics

U/S Contributing ID	180R_S18010									TOTAL
HEC1 Flow Volume (ac. ft)	90.00									90
Sediment Conc. (ppm)	2277									
Sediment Volume (ac. ft)	0.08									0.08
Weighting Factor	1									
Weighted Sed. Vol. (ac. ft)	0.08									0.08

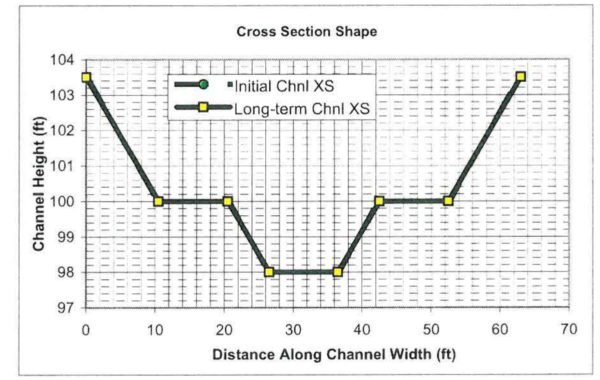
Hydrology

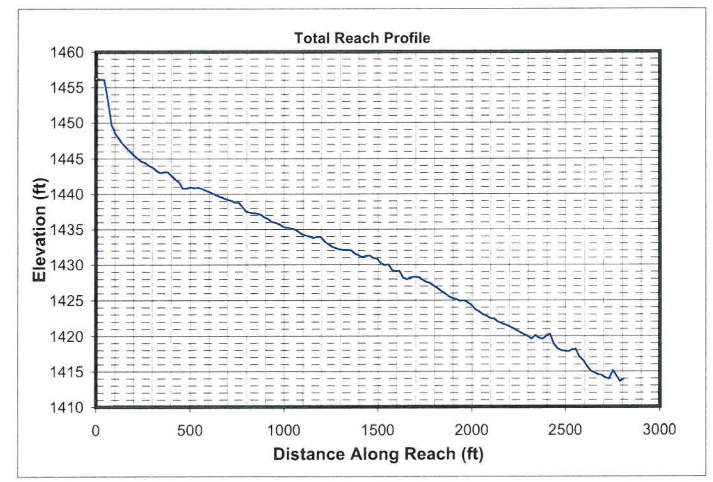
Drainage Area	0.986	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	1124	cfs	
Long-term Max. Chnl Capacity	1963	cfs	
Q2 Channel	112	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	63	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			





Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
112	20.3	24.4	1.2	98.0	99.6	4.6	1.6	19.8	1.2	0.31	0.73
281	46.5	58.9	1.3	98.0	100.6	4.8	2.6	45.7	1.3	0.49	0.74
843	54.5	121.2	2.2	98.0	101.9	7.0	3.9	53.2	2.3	0.73	0.81
1124	57.5	147.2	2.6	98.0	102.3	7.6	4.3	56.1	2.6	0.81	0.83

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
112	20.3	24.4	1.2	98.0	99.6	4.6	1.6	19.8	1.2	0.31	0.73
281	46.5	58.9	1.3	98.0	100.6	4.8	2.6	45.7	1.3	0.49	0.74
843	54.5	121.2	2.2	98.0	101.9	7.0	3.9	53.2	2.3	0.73	0.81
1124	57.5	147.2	2.6	98.0	102.3	7.6	4.3	56.1	2.6	0.81	0.83

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
	180R_S18010									
112	440									440
281	1127									1127
843	4426									4426
1124	6377									6377

Allowable Velocity

Channel Lining	Concrete										
Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
112	1.74	1.4596	1.3866	Erosive	Erosive	Erosive	0.3	Erosive	4.3	Stable	Stable
281	1.74	1.4736	1.4000	Erosive	Erosive	Erosive	0.3	Erosive	5.5	Stable	Stable
843	1.74	1.6492	1.5667	Erosive	Erosive	Erosive	0.4	Erosive	7.3	Stable	Stable
1124	1.74	1.6930	1.6083	Erosive	Erosive	Erosive	0.4	Erosive	7.9	Stable	Stable

USCOE Allowable Velocity (ft/s)	20
FHWA Allowable Velocity (ft/s)	50

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	112	281	843	1124	112	281	843	1124	112	281	843	1124
Bray - Equation #1	29	46	83	96	1.3	1.7	2.5	2.8	3.1	3.5	4.1	4.2
Bray - Equation #2	38	61	109	127	1.4	1.9	2.7	3.0	2.1	2.4	2.8	2.9
Hey	8	14	26	31	3.9	5.5	8.3	9.3				
Ackers & Charlton/Lacey	26	38	61	69					1.8	2.1	2.5	2.6
Parker	73	115	199	230	1.0	1.4	2.3	2.6				
Chang	38	68	133	159	0.3	0.3	0.2	0.1				
Kellerhals	19	30	52	60	1.8	2.6	4.0	4.5	3.3	3.6	4.0	4.1
AMAFCA/Schumm	20	46	53	56								
Moody & Odem	12	12	12	12	0.9	0.9	0.9	0.9				
BUREC	12.7	17.9	27.0	30.0	3	5	7	8	4.1	5.2	6.8	7.3
Average	28	45	76	87	1.8	2.4	3.5	3.9	2.9	3.3	4.0	4.2
Values As Designed	20	46	53	56	1.6	2.6	3.9	4.3	4.6	4.8	7.0	7.6
Difference with Design	8	-1	22	31	0.1	-0.2	-0.4	-0.4	-1.7	-1.4	-2.9	-3.4

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
112	679	897	1448	7649	725	777	352	529	3966	650	2741	1856
281	1801	2225	3624	20274	1716	2026	892	1381	9923	1696	7135	4790
843	8985	7454	10920	117761	2753	10010	2604	5646	29932	5007	28964	20912
1124	13588	10144	14689	185094	3133	15476	3425	8048	39939	5481	41266	30935

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
112	2242	2962	4778	25247	2393	2565	1162	1747	13091	2146	9046	6125
281	2378	2937	4785	26768	2265	2674	1177	1823	13101	2239	9420	6324
843	3954	3281	4806	51826	1212	4405	1146	2485	13173	2204	12747	9203
1124	4485	3348	4848	61094	1034	5108	1131	2656	13183	1809	13621	10211

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
112	679	719	781	665	236	316	352	529	319	65	660	484
281	1801	1789	1976	1763	564	815	892	1381	803	149	1737	1243
843	8985	6171	5444	10240	1021	3102	2604	5646	2533	149	7884	4889
1124	13588	8444	7238	16095	1187	4394	3425	8048	3400	153	11545	7047

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
112	2242	2372	2577	2195	777	1042	1162	1747	1053	216	2178	1596
281	2378	2362	2608	2328	745	1076	1177	1823	1061	197	2293	1641
843	3954	2716	2396	4507	449	1365	1146	2485	1115	66	3470	2152
1124	4485	2787	2389	5312	392	1450	1131	2656	1122	50	3811	2326

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
112	0.0005	0.0003	252	0.77	0.053	0.0002	31	0.036	0.0002	0.0159	0.0002	0.0003	0.0072	0.0004	0.0011	0.0029	0.0027
281	0.0004	0.0003	259	0.79	0.053	0.0002	32	0.036	0.0001	0.0159	0.0002	0.0003	0.0072	0.0003	0.0006	0.0029	0.0027
843	0.0002	0.0002	343	1.05	0.056	0.0001	32	0.036	0.0001	0.0159	0.0001	0.0001	0.0072	0.0002	0.0002	0.0029	0.0026
1124	0.0002	0.0001	368	1.12	0.057	0.0001	33	0.036	0.0001	0.0159	0.0001	0.0001	0.0072	0.0002	0.0002	0.0029	0.0026

Drop Structures

Design Slope	0.0030	ft/ft
Total Drop Needed	34.7	ft
Height of Drop Structure	3	ft
No . of Drop Structures	12	
Distance between structs.	235	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.13	sq. mi
Total Sediment Yield Volume	0.25	ac ft

Sedimentation Basins

Length	235 ft	Depth	3 ft
Width	63 ft	Side slope	3 ft/ft
Total Volume per Basin		0.84	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
112	1.1	0.4	0.3	24.6	1.6	1.2	4.6	0.0030	0.3	0.0	1.0	2.4
281	1.1	0.6	0.3	24.6	2.6	1.3	4.8	0.0030	0.5	0.0	1.0	2.9
843	1.1	1.3	0.7	24.6	3.9	2.3	7.0	0.0030	0.8	0.0	1.0	4.4
1124	1.1	1.5	0.8	24.6	4.3	2.6	7.6	0.0030	0.9	0.0	1.0	5.0

Toe Protection Needed	5.0	ft

Freeboard

Max. Flow Depth	4.3	ft
Channel Depth as designed	5.5	ft
Available Freeboard	1.2	ft
Required Freeboard	1.3	ft

Sediment Volume

Inflowing Sediment Volume	0.33	ac. ft
Outflowing Sediment Volume	0.08	ac. ft
Deposited(+)/Eroded(-) Volume	0.25	ac. ft

HEC1 Results For Open Channel

Peak Flow	954	cfs
Stage at Peak Flow	100.9	ft
Flow Volume	90.0	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	2825	2825
Side Slope (?H:1V)	3	6
Channel Width (ft)	63	96
Channel XS Area (sq. ft)	215.8	306.55
Channel Perimeter (ft)	65	97

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	136958	206366
Excavated Area (sq. Yd)	19775	30133

Bank And Channel Lining	Base	LC Enhanced
Lining Type	Concrete	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	2825	2825
Lining Width (ft)	22	43
Lining Thickness (ft)	0.5	0.5
Lining Area (sq. Yd)	6906	13497
Lining Volume (cu. Yd)	1151	2250

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	2825	ft
Thickness	1.5	ft
Protection Depth	5	ft
Tie-in Length/Depth	3.0	ft
Total Depth	8.0	ft
Area needed	471	sq. Yd
Volume	1256	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	None	None
Left Levee Length (ft)	0	0
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	N/A	6
Left Levee Height (ft)	0	1
Left Levee Surface Area (sq. Yd)	0	0
Left Levee Volume (cu. Yd)	0	0
Right Levee Length (ft)	0	0
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	N/A	6
Right Levee Height (ft)	0	1
Right Levee Surface Area (sq. Yd)	0	0
Right Levee Volume (cu. Yd)	0	0
Total Levee Surface Area (sq. Yd)	0	0
Total Levee Volume (cu. Yd)	0	0

Levee Lining	Base	LC Enhanced
Lining Type	None	None
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	2825	2825
Left Levee Lining Width (ft)	0	0
Left Levee Lining Thickness (ft)	0	0
Left Levee Lining Area (sq. Yd)	0	0
Left Levee Lining Volume (cu. Yd)	0	0
Right Levee Length (ft)	2825	2825
Right Levee Lining Width (ft)	0	0
Right Levee Lining Thickness (ft)	0	0
Right Levee Lining Area (sq. Yd)	0	0
Right Levee Lining Volume (cu. Yd)	0	0
Total Lining Area (sq. Yd)	0	0
Total Lining Volume (cu. Yd)	0	0

Drop Structures		
Structure Type	Concrete	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	63	ft
LC Enhancement Ratio	1.1	
Structure Thickness	0.5	ft
Drop Height	3	ft
Scour Depth	13.0	ft
Structure Height	16.0	ft
Number of Structures	12	
Volume per structure	19	cu. Yd
Unit Cost	$ 155.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 2,945	
Area per structure	4	sq. Yd
Total Area	42	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	1355	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 5,420	
Other Cost	$ -	
Total cost per basin	$ 5,420	
Area per basin	1,648	sq. Yd
Total Area	1,648	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining -LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Excavated Channel	Excavated	136,958	cu. Yd	$ 10.00	$ 1,369,580	19,775	sq. Yd	$ 9.00	$ 177,975	19,775	sq. Yd	$ 8.33	$ 164,792
Exc. Chl - LC Enhancement	Excavated	69,408	cu. Yd	$ 10.00	$ 694,080	10,358	sq. Yd	$ 9.00	$ 93,222	10,358	sq. Yd	$ 8.33	$ 86,317
Channel Lining	Concrete	1,151	cu. Yd	$ 155.00	$ 178,405	6,906	sq. Yd	$ -	$ -	6,906	sq. Yd	$ 41.67	$ 287,750
Channel Lining - LC Enhancement	Concrete	1,099	cu. Yd	$ 155.00	$ 170,345	6,591	sq. Yd	$ -	$ -	6,591	sq. Yd	$ 41.67	$ 274,625
Toe Protection	Riprap	1,256	cu. Yd	$ 75.00	$ 94,200	471	sq. Yd	$ -	$ -	471	sq. Yd	$ 25.00	$ 11,775
Drop Structures	Concrete	12	EA	$ 2,945.00	$ 35,340	42	sq. Yd	$ -	$ -	42	sq. Yd	$ 41.67	$ 1,750
Drop Str. - LC Enhancement	Concrete	12	EA	$ 294.50	$ 3,534	4	sq. Yd	$ -	$ -	4	sq. Yd	$ 41.67	$ 175
Sedimentation Basins		1	EA	$ 5,420.00	$ 5,420	1,648	sq. Yd	$ -	$ -	1,648	sq. Yd	$ 8.33	$ 13,733
Other					$ -				$ -				$ -

Base Landscape Cost	$ 177,975
LC Enhancement Cost	$ 93,222
Total Landscape Cost	$ 271,197

Base Maintenance Cost	$ 479,800
LC Enhancement Cost	$ 361,117
Total Maintenance Cost	$ 840,917

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,682,945	$ 867,959	$ 2,550,904
Contingency Cost (25% of Construction Cost)	$ 420,736	$ 216,990	$ 637,726
Engineering Design Cost (5% of Construction Cost)	$ 84,147	$ 43,398	$ 127,545
Total Construction Cost	$ 2,187,829	$ 1,128,347	$ 3,316,175

Land Cost

Channel Length	2825 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	134	8.7	$100,000	$ 870,000
LC Enhancement Buffer	50	3.2	$100,000	$ 320,000
Channel	63	4.1	$100,000	$ 410,000
Channel LC Enhancement	33	2.1	$100,000	$ 210,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	280	18.1		$ 1,810,000

Right of Way

Preservation Corridor Width	120	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	50	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	12.8	$100,000	$ 1,280,000
LC Enhancement Cost	acre	5.3	$100,000	$ 530,000
Total Land Cost	acre	18.1	$100,000	$ 1,810,000

Total Cost

Base Total Cost	$ 4,125,604
Total Landscape Enhancement Cost	$ 2,112,685
Total Cost Including LC Enh.	$ 6,238,289

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

Sub-area: Wagner Wash, Alternative: C
Open Channel Structure ID: RR18010

Open Channel

Structure ID	C180R10	HEC1 ID	RI180R

Longitundal Geometry

Length	3720.6	ft
U/S Elev	1413.1	ft
D/S Elev	1367.6	ft
Initial Channel Slope	0.0122	ft/ft
Long-term Channel Slope	0.0030	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	2

Initial Channel XS Geometry

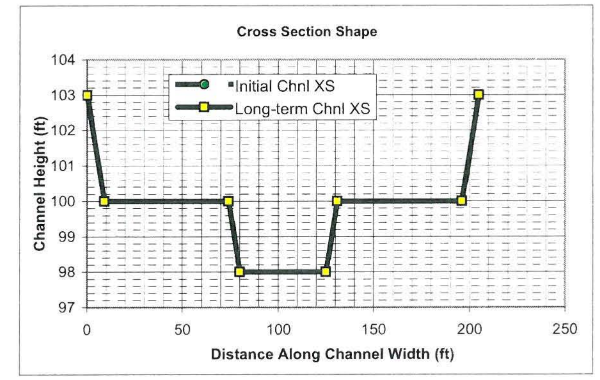
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	3	65	3	45	5	3	65	3	3

PT. ID	1	2	3	4	5	6	7	8
X	0	9	74	80	125	131	196	205
Y	103	100	100	98	98	100	100	103

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	3	65	3	45	5	3	65	3	3

PT. ID	1	2	3	4	5	6	7	8
X	0	9	74	80	125	131	196	205
Y	103	100	100	98	98	100	100	103



Mannings n (includes effects of vegetation etc.)

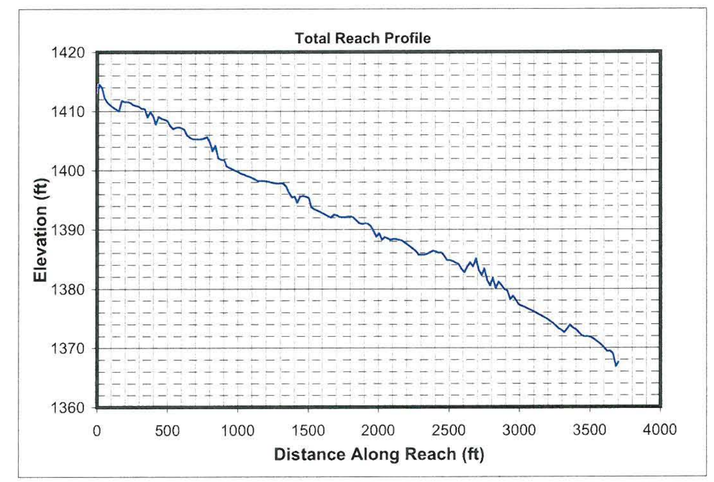
Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.02	0.02	0.02	0.02	0.02	0.02

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	RI180R	S190								TOTAL
HEC1 Peak-Flow	3116	2590								5706
Weighting Factor	1.00	0.12								
Flow into Channel	3116	323								3439

Reach Sediment Inflow Characteristics

U/S Contributing ID	175R_RR17510	180R_RR18010								TOTAL
HEC1 Flow Volume (ac. ft)	199.00	90.00								289
Sediment Conc. (ppm)	2301	2326								
Sediment Volume (ac. ft)	0.17	0.08								0.25
Weighting Factor	1	1								
Weighted Sed. Vol. (ac. ft)	0.17	0.08								0.25



Hydrology

Drainage Area	4.63	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	3439	cfs	
Long-term Max. Chnl Capacity	6290	cfs	
Q2 Channel	344	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	205	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
344	54.1	70.6	1.3	98.0	99.4	4.9	1.4	53.6	1.3	0.27	0.75
860	191.0	202.6	1.1	98.0	100.5	4.2	2.5	190.2	1.1	0.47	0.72
2579	197.4	396.8	2.0	98.0	101.5	6.5	3.5	196.2	2.0	0.66	0.81
3439	199.9	473.9	2.4	98.0	101.9	7.3	3.9	198.6	2.4	0.74	0.83

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
344	54.1	70.6	1.3	98.0	99.4	4.9	1.4	53.6	1.3	0.27	0.75
860	191.0	202.6	1.1	98.0	100.5	4.2	2.5	190.2	1.1	0.47	0.72
2579	197.4	396.8	2.0	98.0	101.5	6.5	3.5	196.2	2.0	0.66	0.81
3439	199.9	473.9	2.4	98.0	101.9	7.3	3.9	198.6	2.4	0.74	0.83

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)								TOTAL
	175R_RR17510	180R_RR18010							
344	974	484							1458
860	3042	1243							4285
2579	10033	4889							14922
3439	14604	7047							21651

Allowable Velocity

Channel Lining	Concrete

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
344	1.74	1.4803	1.4063	Erosive	Erosive	Erosive	0.3	Erosive	4.1	Stable	Stable
860	1.74	1.4149	1.3441	Erosive	Erosive	Erosive	0.3	Erosive	5.2	Stable	Stable
2579	1.74	1.6126	1.5320	Erosive	Erosive	Erosive	0.4	Erosive	6.9	Stable	Stable
3439	1.74	1.6637	1.5805	Erosive	Erosive	Erosive	0.4	Erosive	7.4	Stable	Stable

USCOE Allowable Velocity (ft/s)	20
FHWA Allowable Velocity (ft/s)	50

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	**344**	**860**	**2579**	**3439**	**344**	**860**	**2579**	**3439**	**344**	**860**	**2579**	**3439**
Bray - Equation #1	52	84	149	174	1.9	2.5	3.6	4.0	3.6	4.1	4.7	4.9
Bray - Equation #2	68	110	196	229	2.0	2.8	4.0	4.4	2.5	2.8	3.3	3.4
Hey	16	27	49	57	5.9	8.4	12.8	14.2				
Ackers & Charlton/Lacey	42	61	98	110					2.1	2.5	3.0	3.1
Parker	127	201	349	403	1.6	2.3	3.6	4.1				
Chang	77	135	264	315	0.3	0.2	-0.3	-0.5				
Kellerhals	33	53	91	106	2.8	4.1	6.3	7.1	3.7	4.0	4.5	4.6
AMAFCA/Schumm	54	190	196	199								
Moody & Odem	22	22	22	22	1.2	1.2	1.2	1.2				
BUREC	19.3	27.2	41.0	45.7	5	7	11	12	5.4	6.8	9.0	9.7
Average	51	91	146	166	2.6	3.6	5.3	5.8	3.5	4.0	4.9	5.2
Values As Designed	54	190	196	199	1.4	2.5	3.5	3.9	4.9	4.2	6.5	7.3
Difference with Design	-3	-99	-51	-33	1.2	1.0	1.7	1.9	-1.4	-0.2	-1.6	-2.1

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
344	2296	2812	4094	18325	1788	2203	1108	1741	8669	1714	7568	4756
860	4777	6361	10603	35878	5581	4860	2774	3818	21567	3635	16624	10589
2579	25639	22246	30412	227143	8395	21626	8237	16717	65401	11003	73062	46353
3439	39716	30549	41382	367309	9320	31955	10848	24204	87319	11704	106173	69134

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
344	2477	3033	4416	19769	1929	2377	1195	1878	9352	1849	8164	5131
860	2061	2745	4575	15482	2409	2097	1197	1648	9306	1568	7174	4569
2579	3688	3200	4374	32672	1208	3111	1185	2405	9407	1583	10509	6667
3439	4285	3296	4464	39625	1005	3447	1170	2611	9420	1263	11454	7458

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
344	2296	2328	2425	2227	674	1021	1108	1741	986	175	2200	1562
860	4777	5209	5928	4359	1990	2344	2774	3818	2383	660	4660	3537
2579	25639	18813	17058	27599	3453	9241	8237	16717	7702	569	22871	14354
3439	39716	25990	22544	44630	3936	13233	10848	24204	10362	552	34177	20926

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
344	2477	2512	2616	2402	727	1101	1195	1878	1064	188	2373	1685
860	2061	2248	2558	1881	859	1012	1197	1648	1028	285	2011	1526
2579	3688	2706	2454	3970	497	1329	1185	2405	1108	82	3290	2065
3439	4285	2804	2432	4815	425	1428	1170	2611	1118	60	3687	2258

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields								Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)		Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
344	0.0004	0.0003	235	0.72	0.052	0.0002	31	0.036	0.0001		0.0159	0.0002	0.0003	0.0050	0.0003	0.0012	0.0030	0.0021
860	0.0006	0.0003	212	0.65	0.051	0.0003	31	0.036	0.0002		0.0159	0.0002	0.0003	0.0050	0.0002	0.0006	0.0030	0.0021
2579	0.0003	0.0002	292	0.89	0.054	0.0001	32	0.036	0.0001		0.0159	0.0001	0.0002	0.0050	0.0001	0.0003	0.0030	0.0021
3439	0.0002	0.0002	317	0.97	0.055	0.0001	32	0.036	0.0001		0.0159	0.0001	0.0001	0.0050	0.0001	0.0002	0.0030	0.0020

Drop Structures

Design Slope	0.0030	ft/ft
Total Drop Needed	34.3	ft
Height of Drop Structure	3	ft
No . of Drop Structures	12	
Distance between structs.	310	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.19	sq. mi
Total Sediment Yield Volume	0.35	ac ft

Sedimentation Basins

Length	310 ft	Depth	3 ft
Width	205 ft	Side slope	3 ft/ft
Total Volume per Basin		4.07	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
344	1.1	0.4	0.3	24.6	1.4	1.3	4.9	0.0030	0.3	0.0	1.0	2.3
860	1.1	0.5	0.2	24.6	2.5	1.1	4.2	0.0030	0.5	0.0	1.0	2.8
2579	1.1	1.1	0.6	24.6	3.5	2.0	6.5	0.0030	0.7	0.0	1.0	4.1
3439	1.1	1.4	0.7	24.6	3.9	2.4	7.3	0.0030	0.8	0.0	1.0	4.6

Toe Protection Needed	5.0	ft

HEC1 Results For Open Channel

Peak Flow	3116	cfs
Stage at Peak Flow	100.8	ft
Flow Volume	283.0	ac. ft

Freeboard

Max. Flow Depth	3.9	ft
Channel Depth as designed	5.0	ft
Available Freeboard	1.1	ft
Required Freeboard	1.2	ft

Sediment Volume

Inflowing Sediment Volume	0.61	ac. ft
Outflowing Sediment Volume	0.24	ac. ft
Deposited(+)/Eroded(-) Volume	0.36	ac. ft

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HYDROLOGY & GEOMORPHOLOGY, INC

Sub-area: Wagner Wash, Alternative: C
Open Channel Structure ID: C180R10

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	3721	3721
Side Slope (?H:1V)	3	6
Channel Width (ft)	205	235
Channel XS Area (sq. ft)	690	765
Channel Perimeter (ft)	207	236

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	580200	661527
Excavated Area (sq. Yd)	84756	97159

Bank And Channel Lining	Base	LC Enhanced
Lining Type	Concrete	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	3721	3721
Lining Width (ft)	19	36
Lining Thickness (ft)	0.5	0.5
Lining Area (sq. Yd)	7855	14884
Lining Volume (cu. Yd)	1309	2481

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	3721	ft
Thickness	1.5	ft
Protection Depth	5	ft
Tie-in Length/Depth	3.0	ft
Total Depth	8.0	ft
Area needed	620	sq. Yd
Volume	1654	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	None	None
Left Levee Length (ft)	0	0
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	N/A	6
Left Levee Height (ft)	0	1
Left Levee Surface Area (sq. Yd)	0	0
Left Levee Volume (cu. Yd)	0	0
Right Levee Length (ft)	0	0
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	N/A	6
Right Levee Height (ft)	0	1
Right Levee Surface Area (sq. Yd)	0	0
Right Levee Volume (cu. Yd)	0	0
Total Levee Surface Area (sq. Yd)	0	0
Total Levee Volume (cu. Yd)	0	0

Levee Lining	Base	LC Enhanced
Lining Type	None	None
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	3721	3721
Left Levee Lining Width (ft)	0	0
Left Levee Lining Thickness (ft)	0	0
Left Levee Lining Area (sq. Yd)	0	0
Left Levee Lining Volume (cu. Yd)	0	0
Right Levee Length (ft)	3721	3721
Right Levee Lining Width (ft)	0	0
Right Levee Lining Thickness (ft)	0	0
Right Levee Lining Area (sq. Yd)	0	0
Right Levee Lining Volume (cu. Yd)	0	0
Total Lining Area (sq. Yd)	0	0
Total Lining Volume (cu. Yd)	0	0

Drop Structures		
Structure Type	Concrete	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	205	ft
LC Enhancement Ratio	1.1	
Structure Thickness	0.5	ft
Drop Height	3	ft
Scour Depth	12.0	ft
Structure Height	15.0	ft
Number of Structures	12	
Volume per structure	57	cu. Yd
Unit Cost	$ 155.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 8,835	
Area per structure	11	sq. Yd
Total Area	137	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	6566	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 26,264	
Other Cost	$ -	
Total cost per basin	$ 26,264	
Area per basin	7,062	sq. Yd
Total Area	7,062	sq. Yd

Structure Cost

Structure Type		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining -LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Excavated Channel	Excavated	580,200	cu. Yd	$ 10.00	$ 5,802,000	84,756	sq. Yd	$ 9.00	$ 762,804	84,756	sq. Yd	$ 8.33	$ 706,300
Exc. Chl - LC Enhancement	Excavated	81,327	cu. Yd	$ 10.00	$ 813,270	12,403	sq. Yd	$ 9.00	$ 111,627	12,403	sq. Yd	$ 8.33	$ 103,358
Channel Lining	Concrete	1,309	cu. Yd	$ 155.00	$ 202,895	7,855	sq. Yd	$ -	$ -	7,855	sq. Yd	$ 41.67	$ 327,292
Channel Lining - LC Enhancement	Concrete	1,172	cu. Yd	$ 155.00	$ 181,660	7,029	sq. Yd	$ -	$ -	7,029	sq. Yd	$ 41.67	$ 292,875
Toe Protection	Riprap	1,654	cu. Yd	$ 75.00	$ 124,050	620	sq. Yd	$ -	$ -	620	sq. Yd	$ 25.00	$ 15,500
Drop Structures	Concrete	12	EA	$ 8,835.00	$ 106,020	137	sq. Yd	$ -	$ -	137	sq. Yd	$ 41.67	$ 5,708
Drop Str. - LC Enhancement	Concrete	12	EA	$ 883.50	$ 10,602	14	sq. Yd	$ -	$ -	14	sq. Yd	$ 41.67	$ 571
Sedimentation Basins		1	EA	$ 26,264.00	$ 26,264	7,062	sq. Yd	$ -	$ -	7,062	sq. Yd	$ 8.33	$ 58,850
Other					$ -				$ -				$ -

Base Landscape Cost	$ 762,804	
LC Enhancement Cost	$ 111,627	
Total Landscape Cost	$ 874,431	

Base Maintenance Cost	$ 1,113,650
LC Enhancement Cost	$ 396,804
Total Maintenance Cost	$ 1,510,454

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 6,261,229	$ 1,005,532	$ 7,266,761
Contingency Cost (25% of Construction Cost)	$ 1,565,307	$ 251,383	$ 1,816,690
Engineering Design Cost (5% of Construction Cost)	$ 313,061	$ 50,277	$ 363,338
Total Construction Cost	$ 8,139,598	$ 1,307,192	$ 9,446,789

Land Cost

Channel Length	3721 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	134	11.4	$100,000	$ 1,140,000
LC Enhancement Buffer	50	4.3	$100,000	$ 430,000
Channel	205	17.5	$100,000	$ 1,750,000
Channel LC Enhancement	30	2.6	$100,000	$ 260,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	419	35.8		$ 3,580,000

Right of Way

Preservation Corridor Width	120	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	50	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	28.9	$100,000	$ 2,890,000
LC Enhancement Cost	acre	6.9	$100,000	$ 690,000
Total Land Cost	acre	35.8	$100,000	$ 3,580,000

Total Cost

Base Total Cost	$ 12,906,052
Total Landscape Enhancement Cost	$ 2,505,623
Total Cost Including LC Enh.	$ 15,411,674

Flood Control District of Maricopa County

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Logan Simpson Design Inc.

EDAW

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