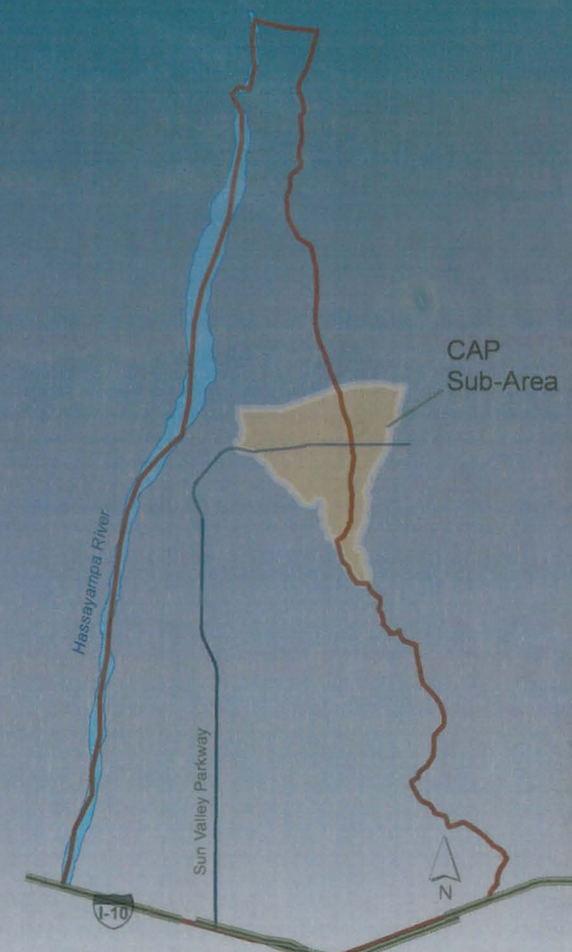
Sun Valley
Area Drainage Master Plan



Step 2
Proposed Alternatives
Analysis Report

Volume 2 PART 2 OF 3
CAP SUB-AREA

Flood Control District of Maricopa County

September 2006

SUN VALLEY AREA DRAINAGE MASTER PLAN

STEP 2 PROPOSED ALTERNATIVES REPORT
CAP SUB-AREA
VOLUME 2

Flood Control District of Maricopa County

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ENCLOSED DATA CD INCLUDES:

- Digital Copy of Report in PDF Format
- GIS Shapefile Coverages of Project Elements
- 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 Central Arizona Project (CAP) 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 CAP 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 (this volume),

3) Wagner Wash (Volume 3),

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 5). 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).*

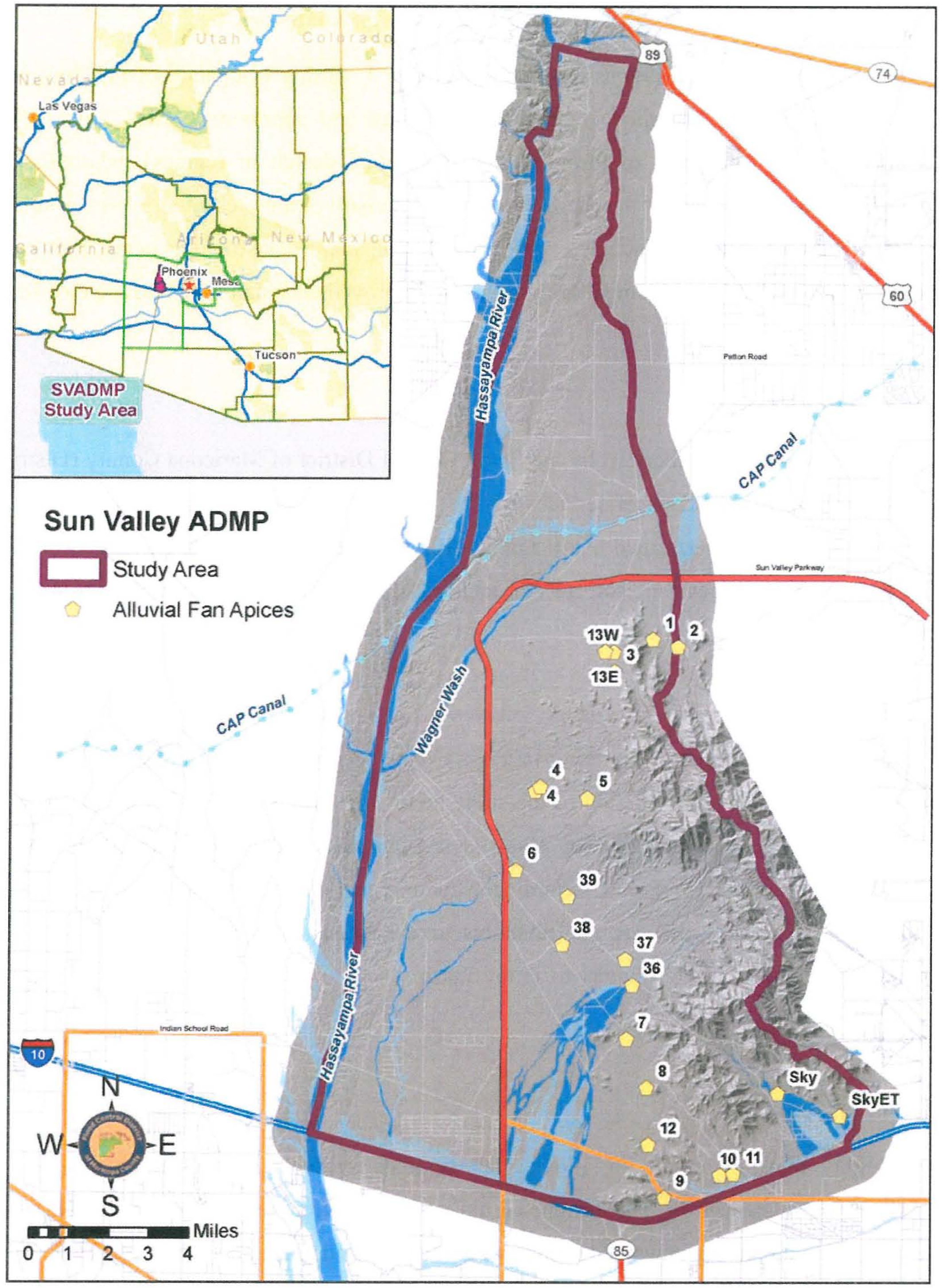

Figure 3 Location of Study Area

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 4 shows a flowchart illustrating the SVADMP alternatives development process.

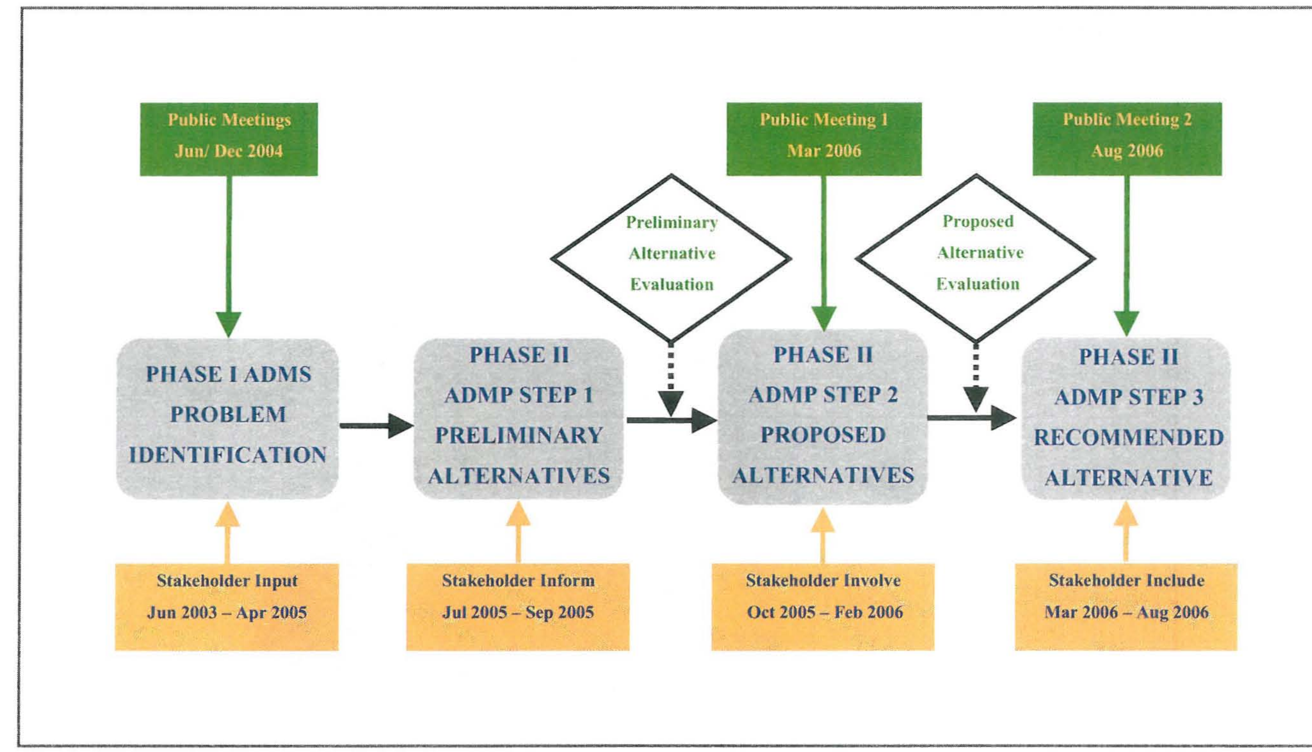

Figure 4 Alternatives development process

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.

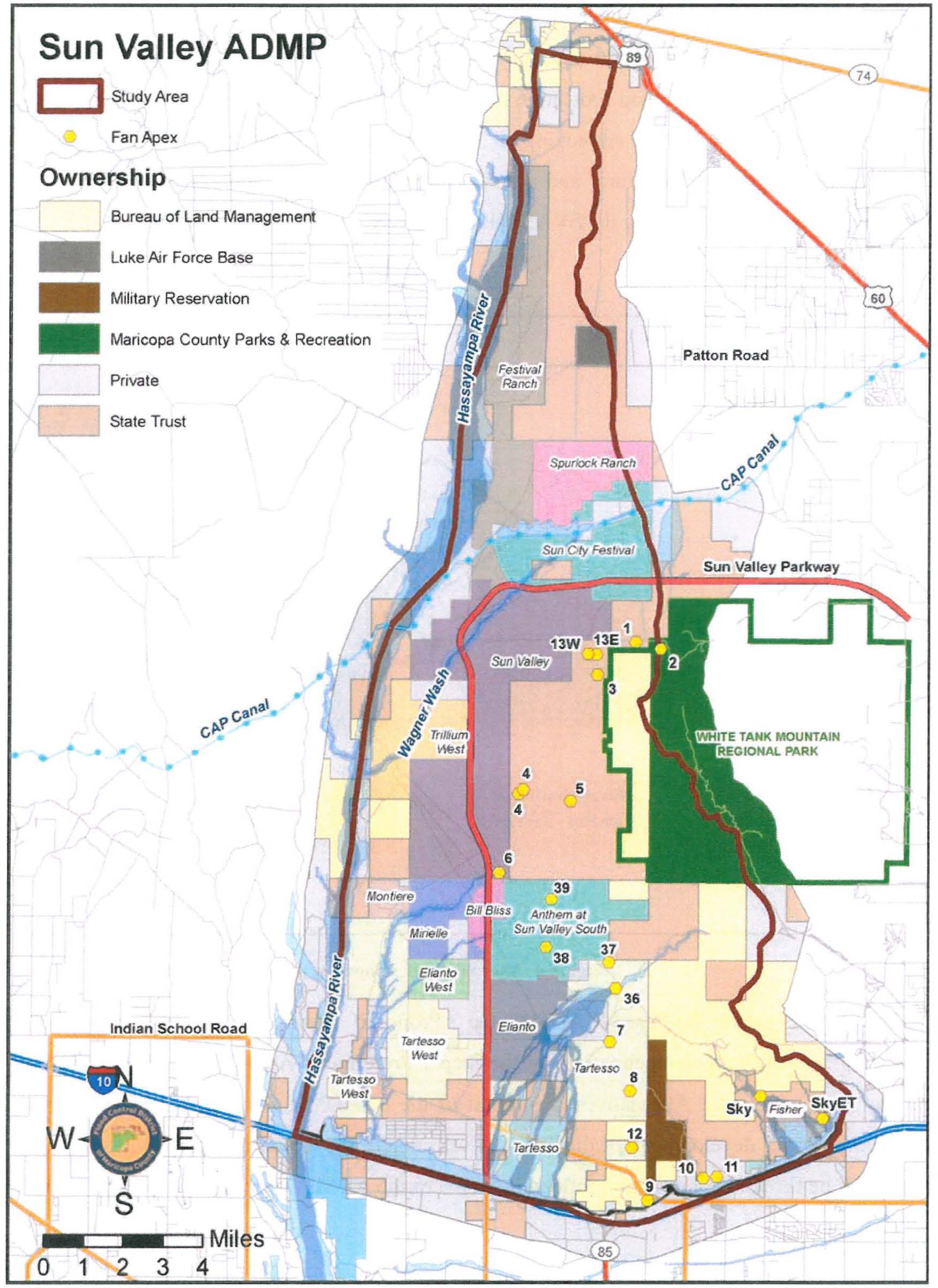

Figure 5 Future developments in the ADMP study area

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).

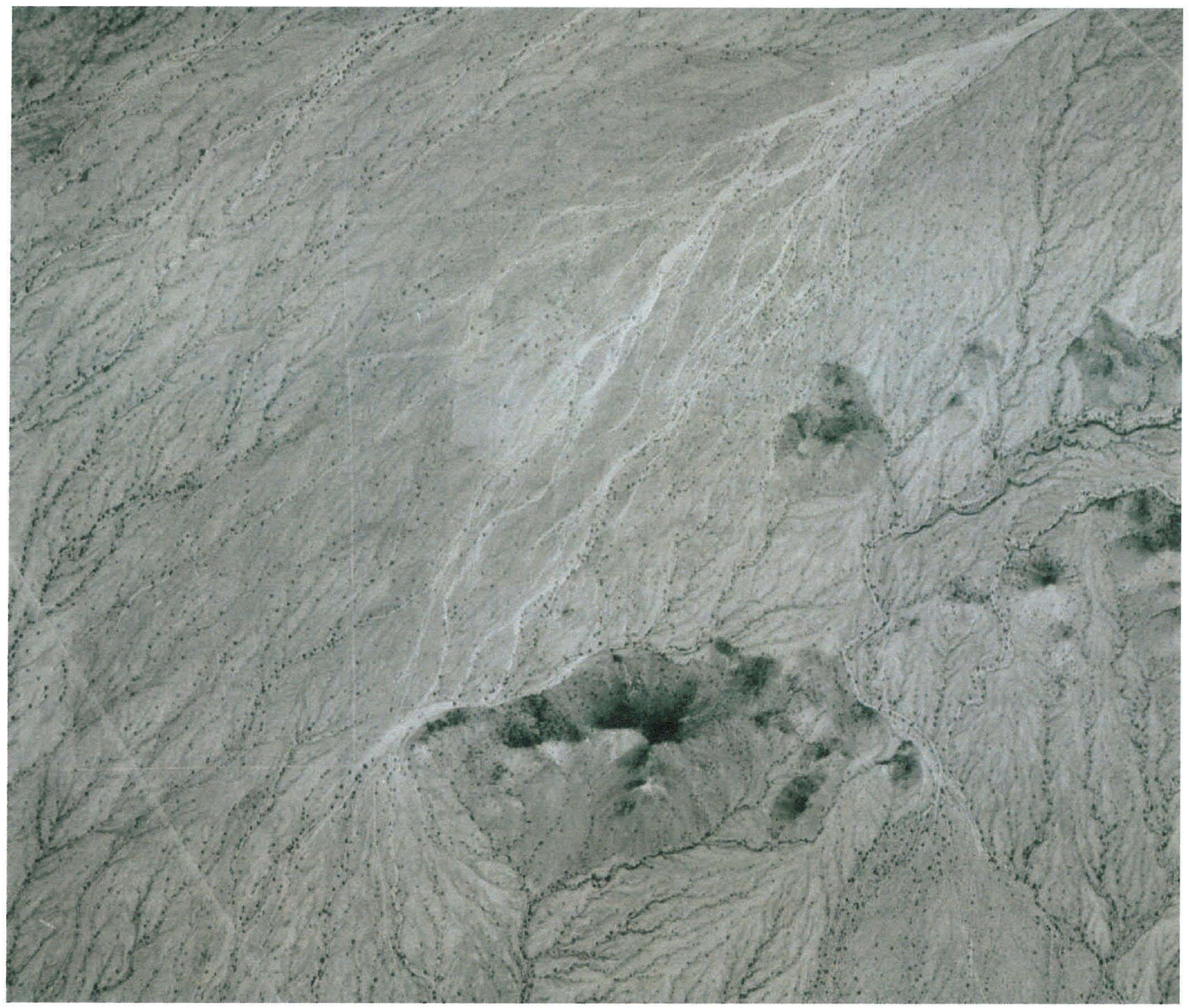

Figure 6 Aerial view of active portion Fan 36 in the FRS 1 Sub-area dated 1954

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 (see 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.

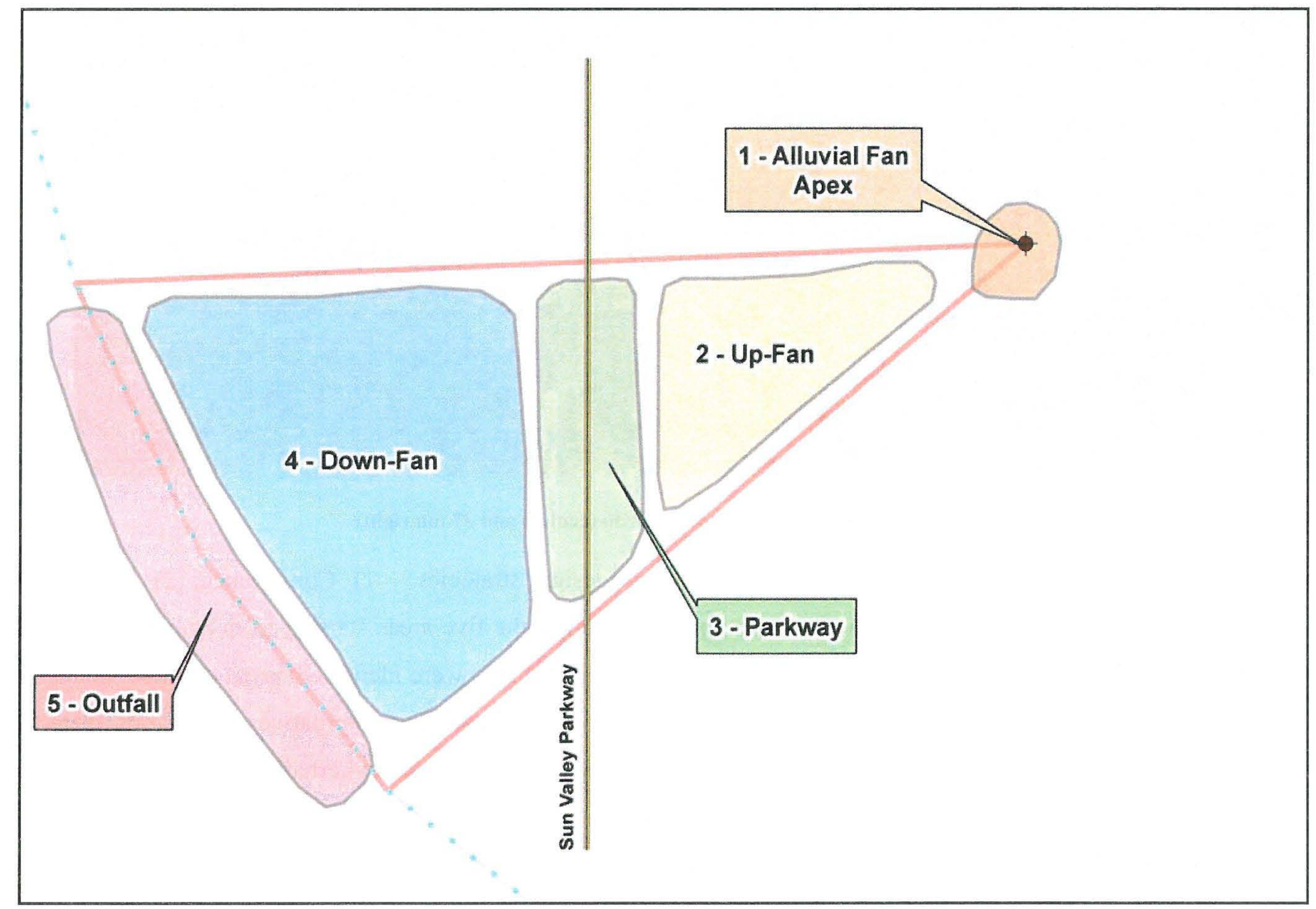

Figure 7 Fan Area Classification

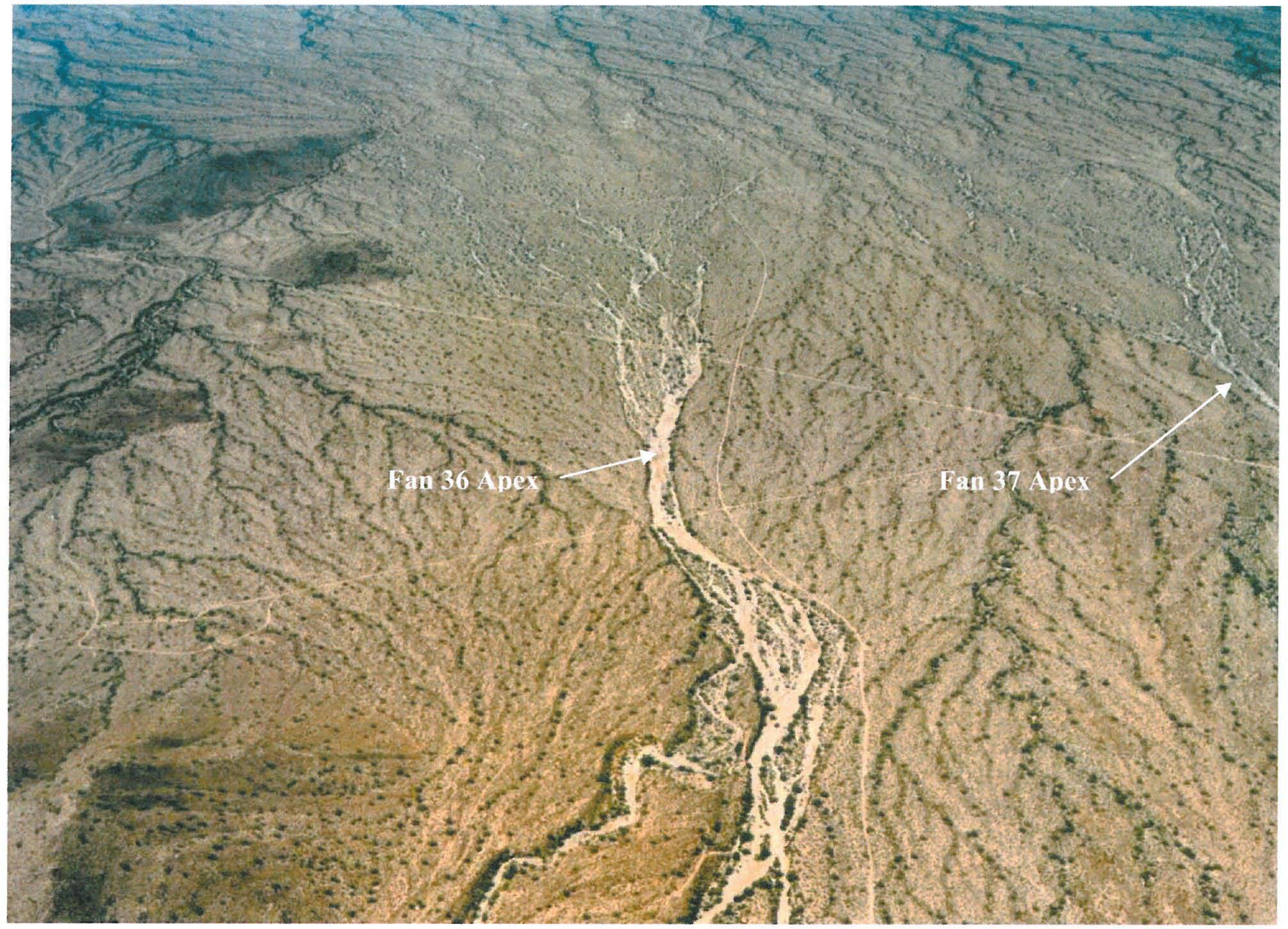

Figure 8 View downstream of Fan 36 (center) and 37 (on right)

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 CAP 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 3-7 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 CAP 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. One is located within the CAP sub-area. 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 (this volume),
3) Wagner Wash (Volume 3),
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 CAP 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 3-7).

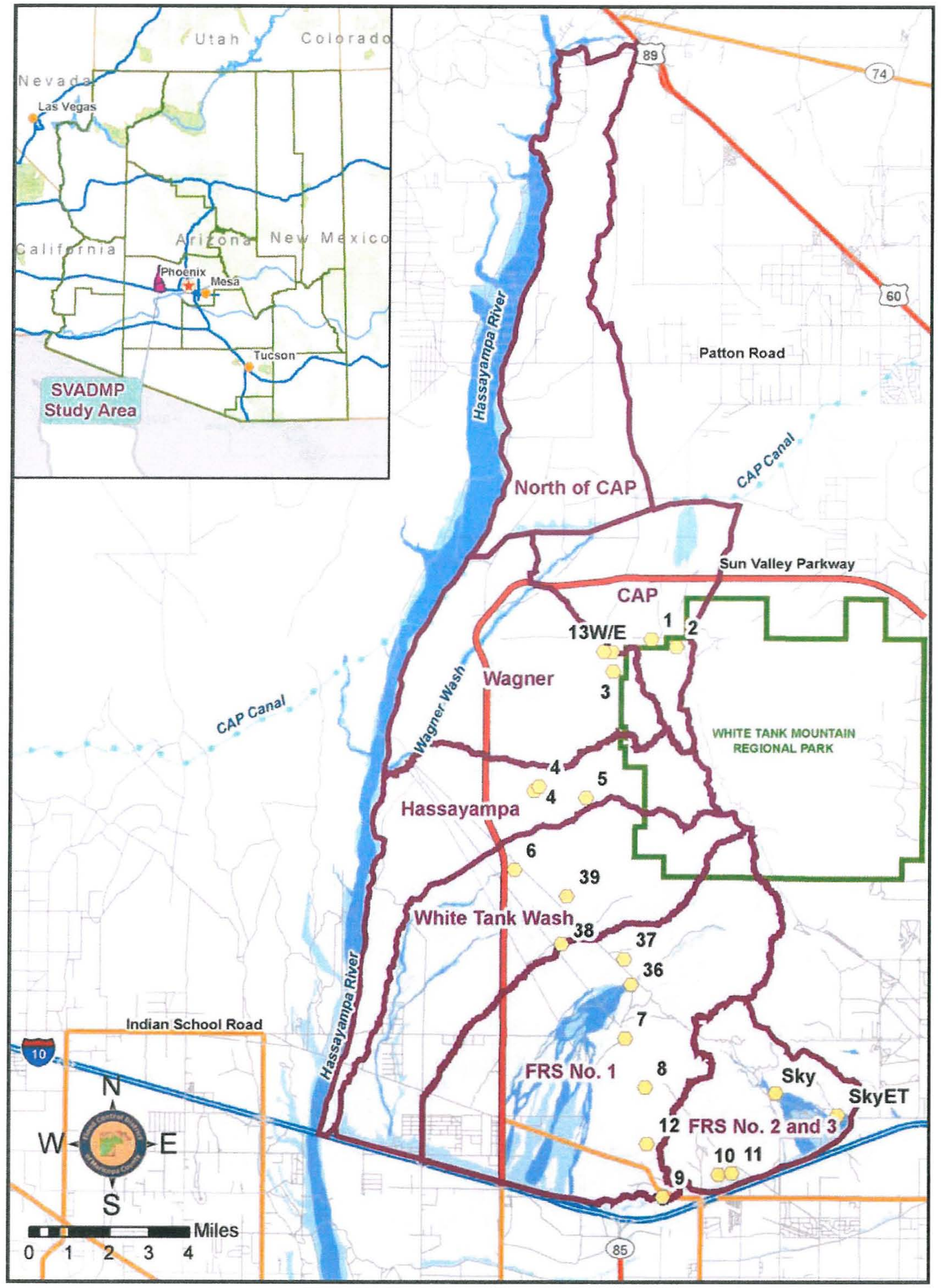

Figure 9 ADMP Sub-Areas

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 2-7 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.

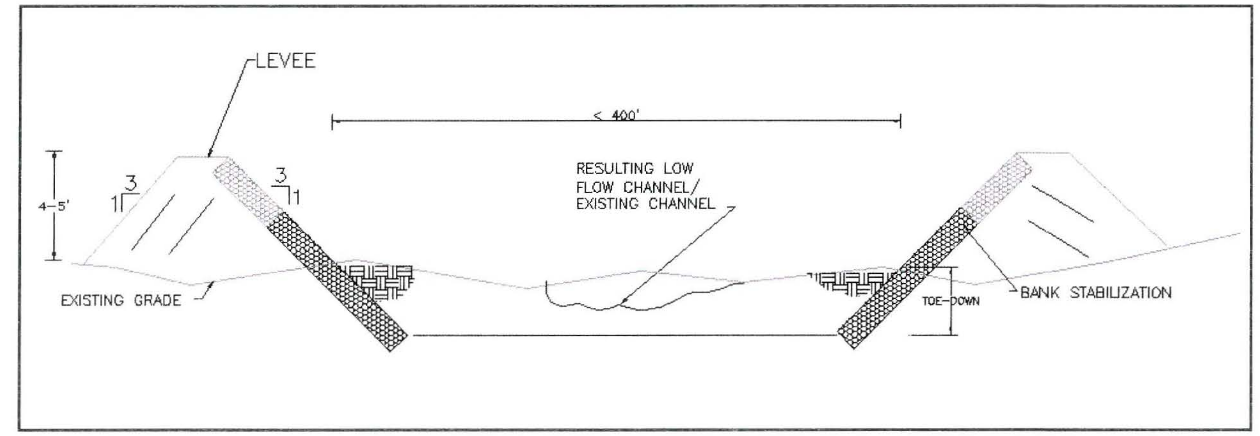

Figure 10 Concept Cross Section for Earthen Leveed Corridor (Alternatives A, B1, B2, B4, B5) (Not to scale)

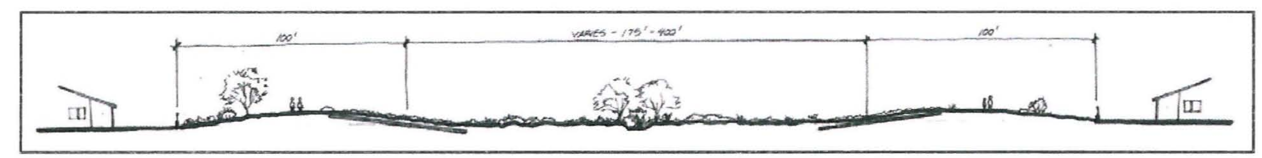

Figure 11 Concept Cross Section for Earthen Leveed Corridor with Landscape Compatibility Enhancements (Alternatives A, B1, B2, B4, B5) (Not to scale)

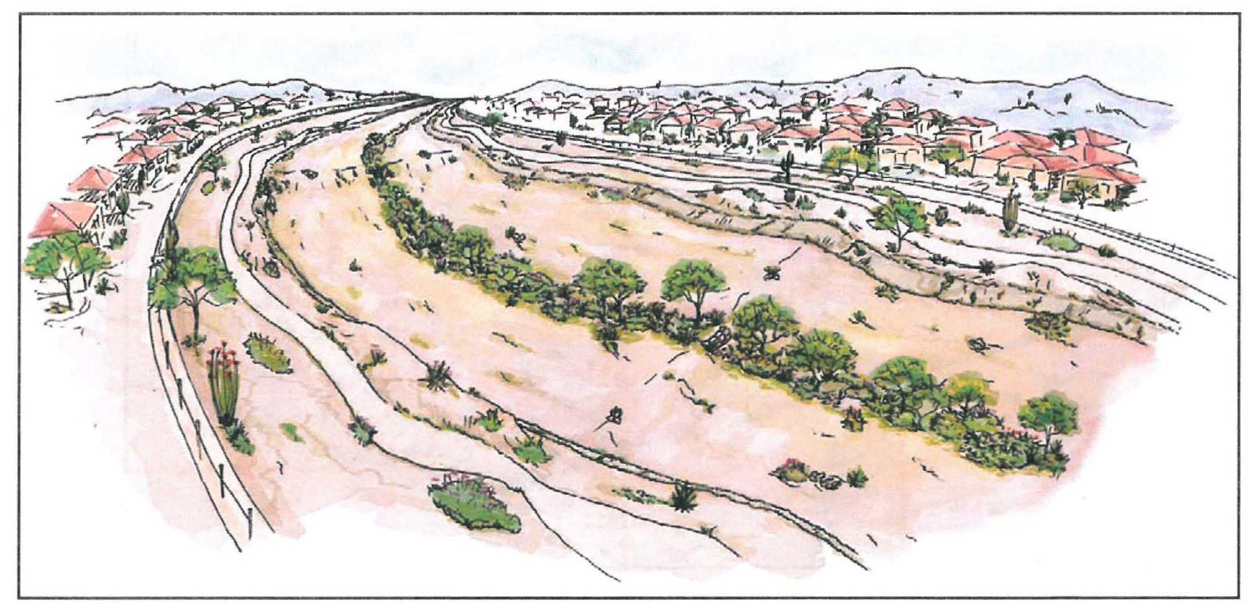

Figure 12 Oblique View of Earthen Leveed Corridor with Landscape Compatibility Enhancements (Not to scale)

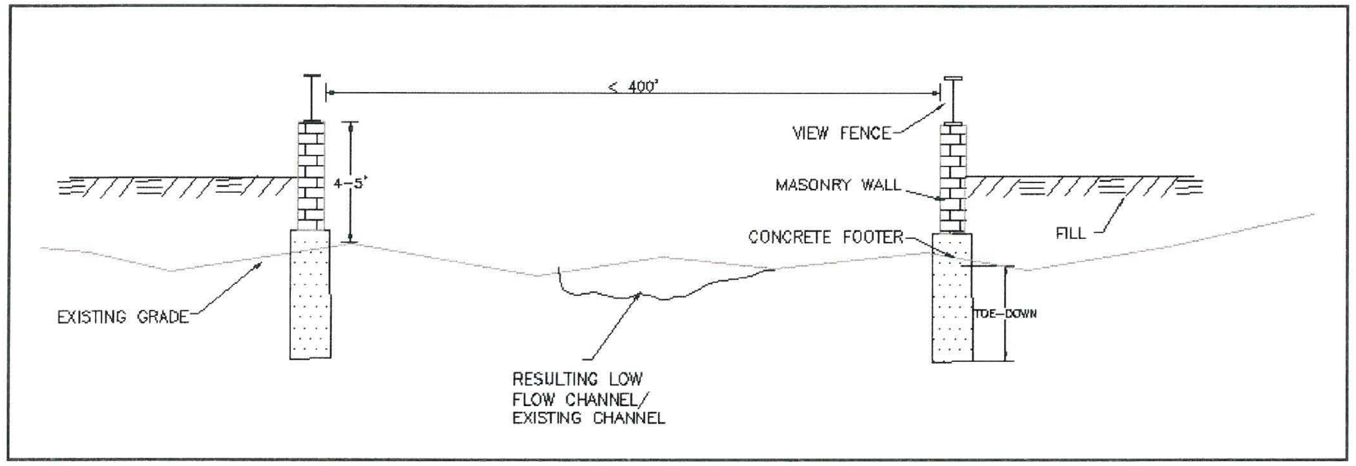

Figure 13 Concept Cross Section for Leveed Corridor with Walls (Alternatives A, B1, B2, B4, B5) (Not to scale)

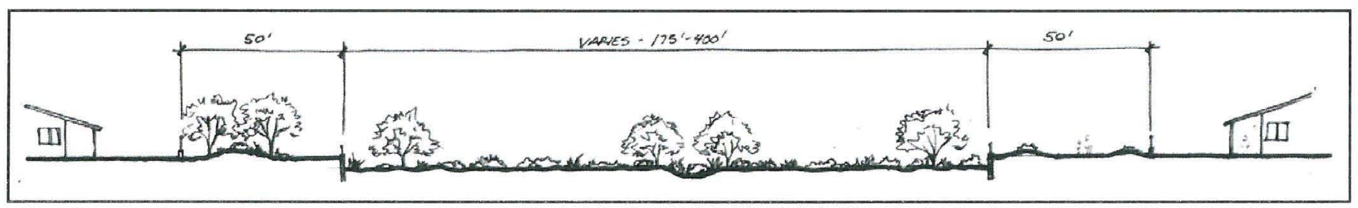

Figure 14 Concept Cross Section for Leveed Corridor with Walls & Landscape Compatibility Enhancements (Alternatives A, B1, B2, B4, B5) (Not to scale)

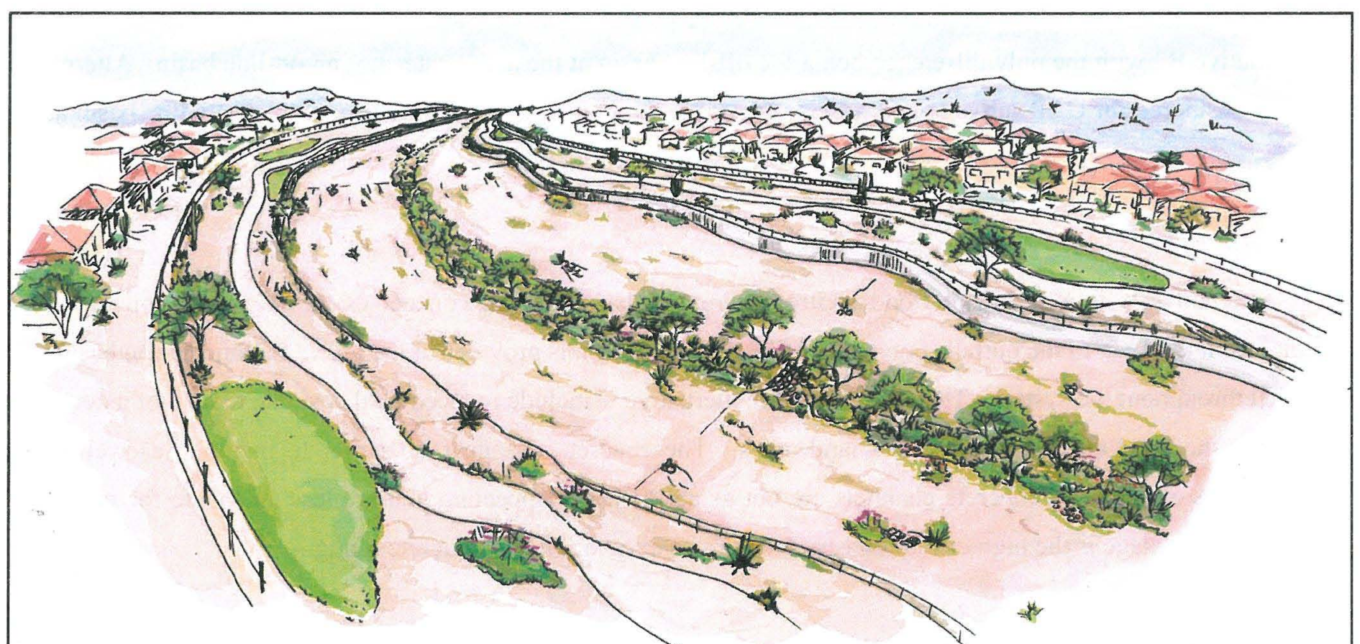

Figure 15 Oblique View of Walled Corridor with Landscape Compatibility Enhancements (Not to scale)

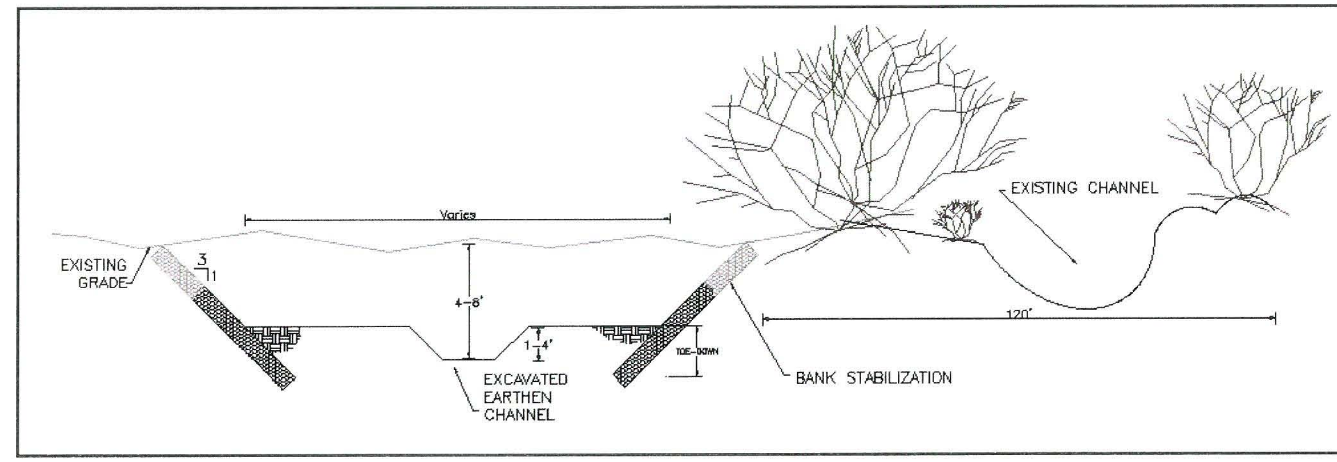

Figure 16 Concept Cross Section for Earthen Companion Channel (Alternative B3) (Not to scale)

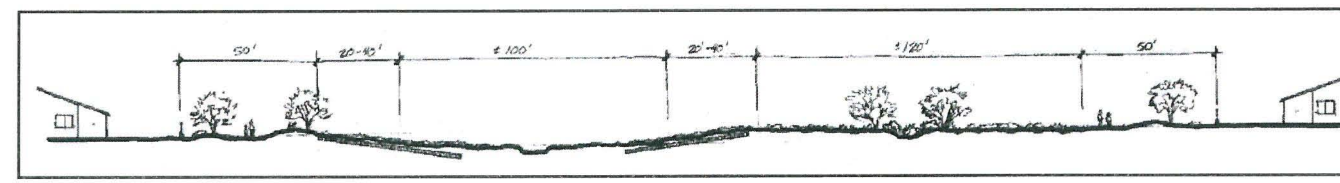

Figure 17 Concept Cross Section for Earthen Companion Channel with Landscape Compatibility Enhancements (Alt B3) (Not to scale)

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.

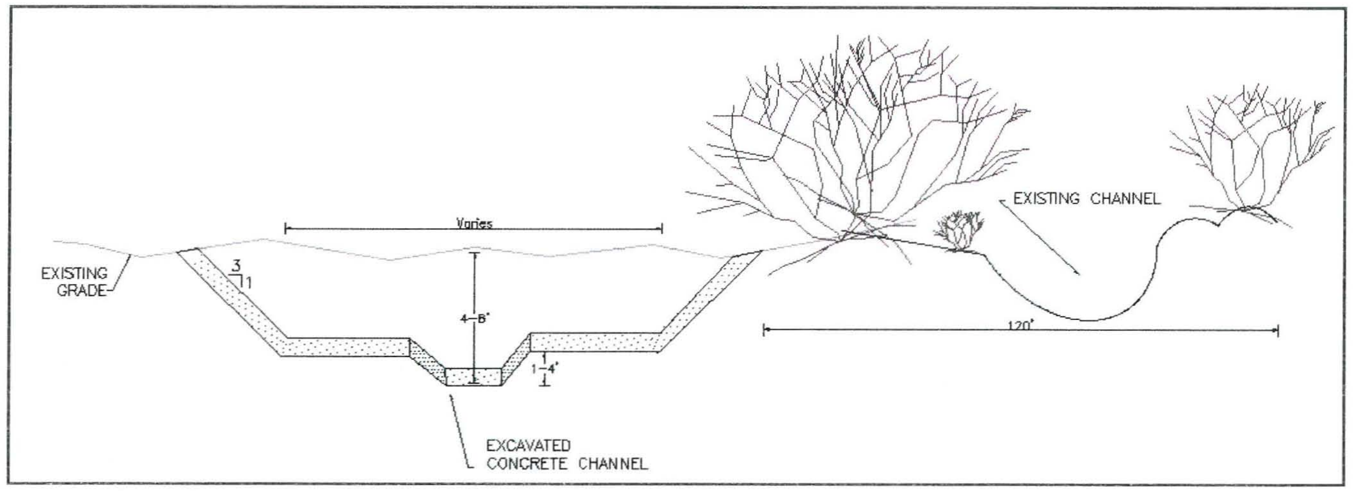

Figure 19 Concept Cross Section for Concrete Companion Channel (Alternative C) (Not to scale)

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 = 0.5 mm	D65 = 0.15 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 is favorable from a 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 provide 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.

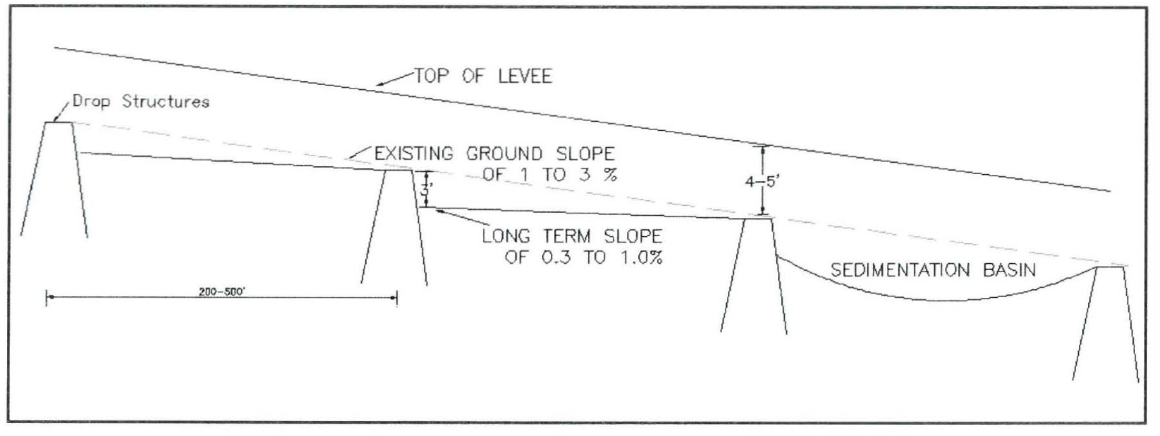

Figure 20 Concept Profile View of Leveed Channel Corridor (Alternatives A, B1, B2, B4, B5) (Not to scale)

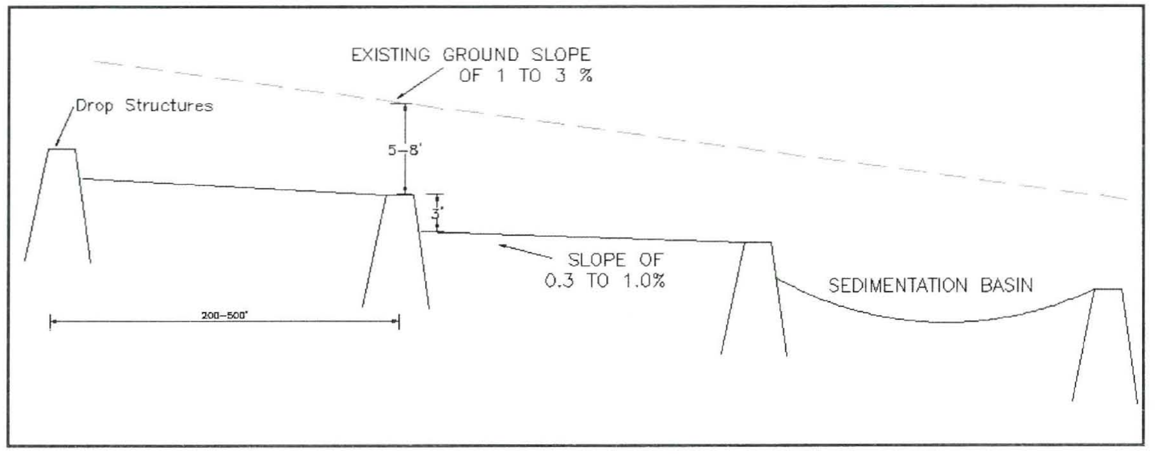

Figure 21 Concept Profile View of Excavated Channel (Alternatives B3 and C) (Not to scale)

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.

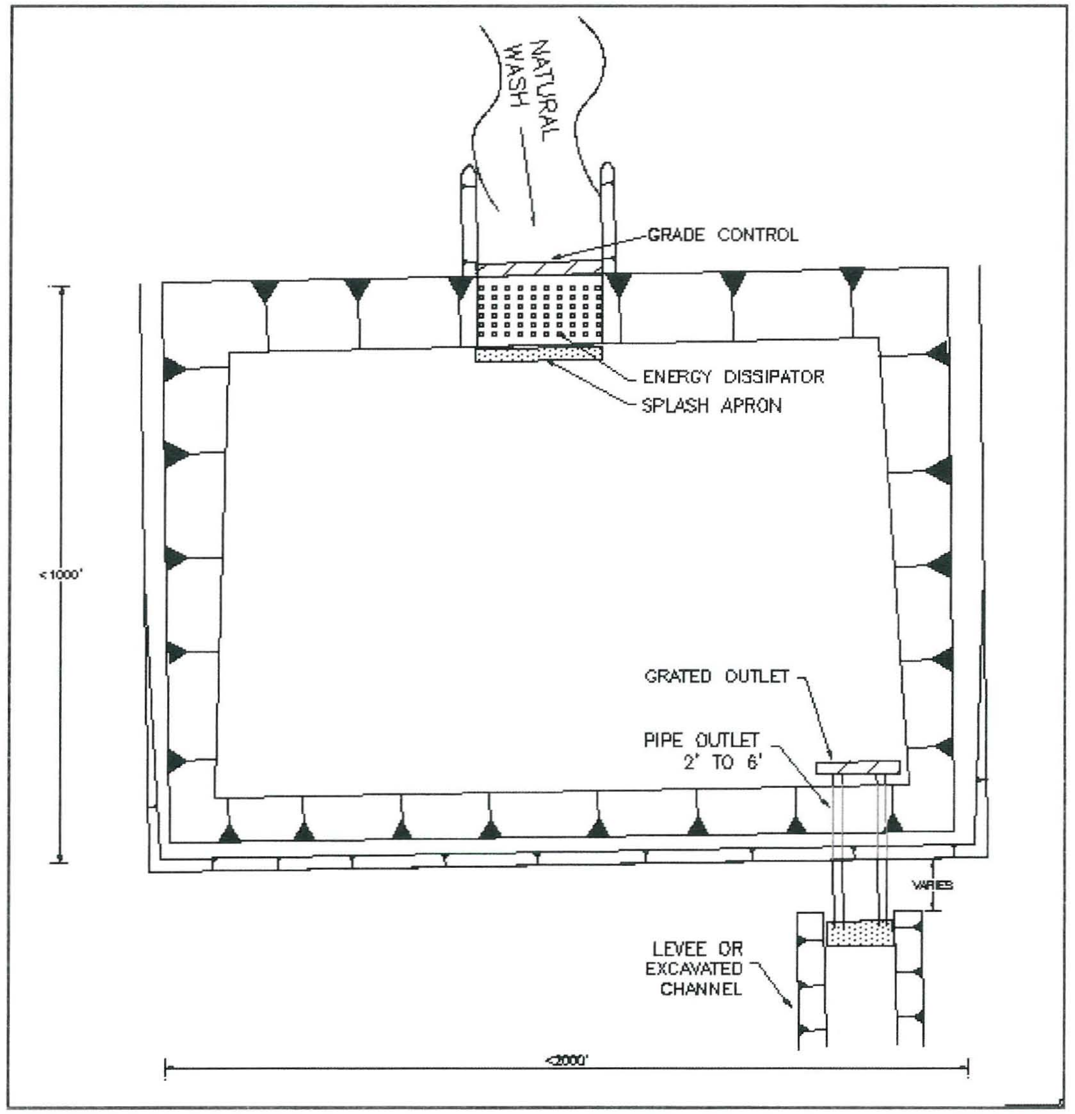

Figure 22 Concept Plan View of On-line Basins for B Alternatives (Not to scale)

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.

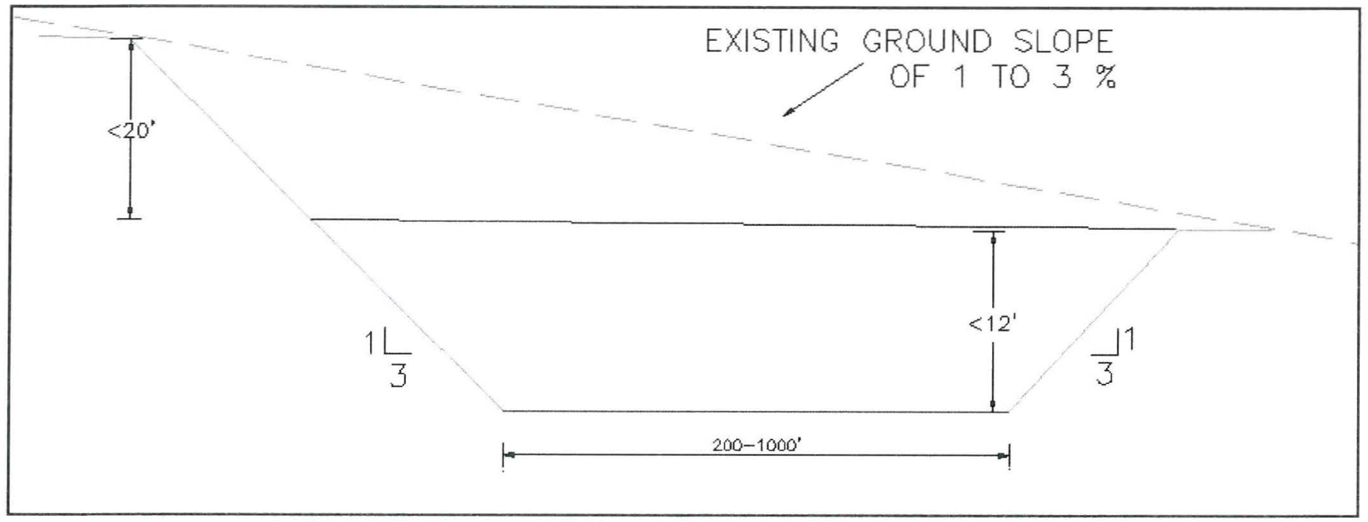

Figure 24 Concept Profile View of On-line Basins (Not to scale)

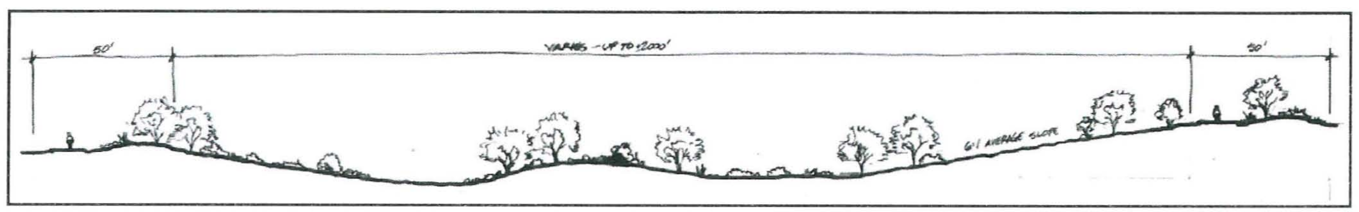

Figure 25 Concept Profile View of On-line Basins with Landscape Compatibility Enhancements (Not to scale)

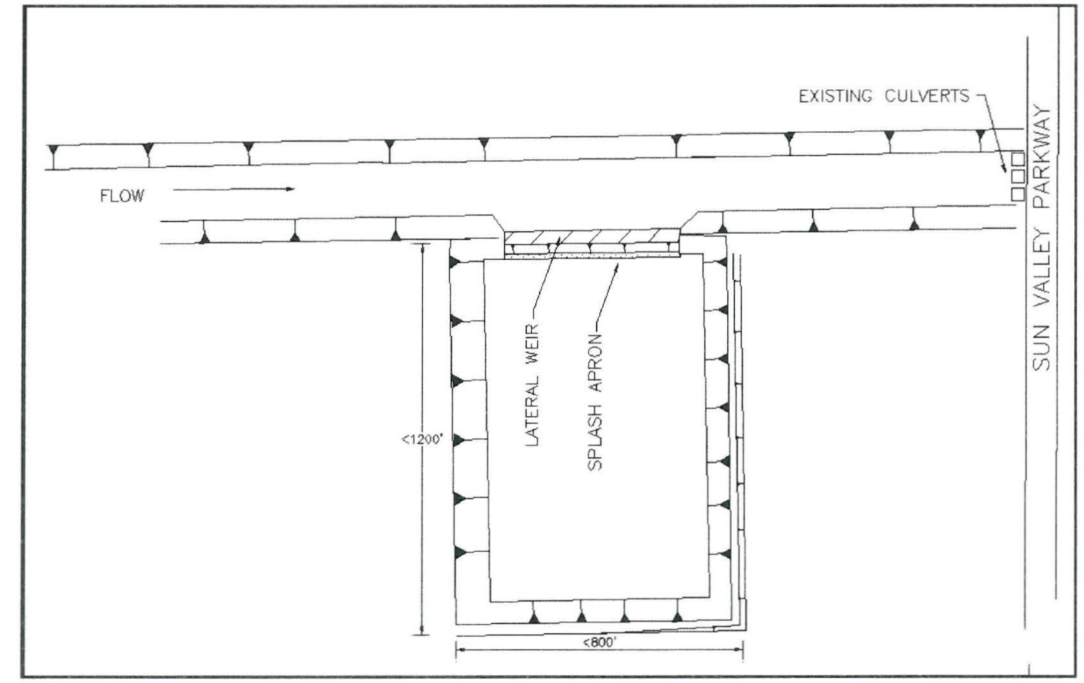

Figure 26 Concept Plan View of Off-line Basins (Not to scale)

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.

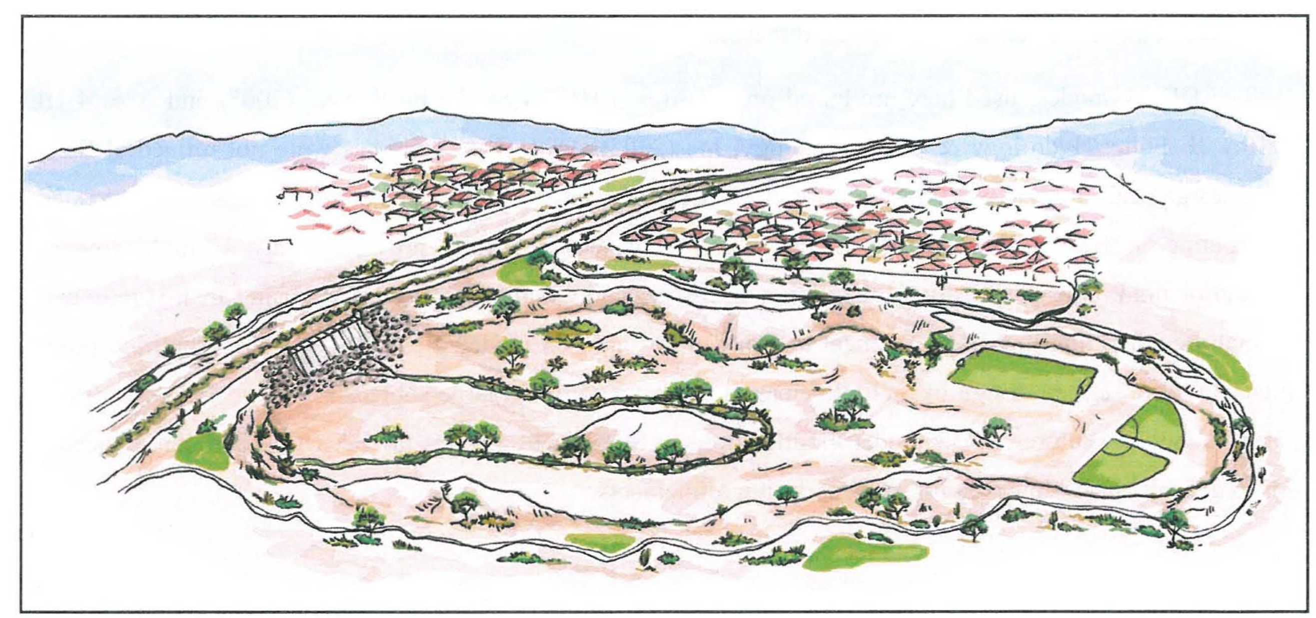

Figure 27 Concept Plan View of Off-line Basins with Landscape Compatibility Enhancements (Not to scale)

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.

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

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_c = 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	5	2.5	Very Soft	5	2.0
(sand)	10	4.0		10	2.5
10	5	4.5	Average	5	3.5
(gravel)	10	5.5		10	4.0
100	5	9.5	Very Stiff	5	5.5
(cobbles)	10	10.5		10	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
- 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

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

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).

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

Where:

S_L = Stable slope (ft/ft)

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

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 was 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 CAP SUB-AREA SPECIFIC DESIGN CONSIDERATIONS

The CAP sub-area is located on the northern end of the White Tank Mountains. Two primary alluvial fans, designated Fan 1 and Fan 2, drain from the White Tank Mountain Regional Park onto the piedmont in this sub-area. The sub-area is bisected by the Sun Valley Parkway which runs east to west across the CAP sub-area. Existing drainage facilities along the Sun Valley Parkway consist of culverts beneath the roadway in the Fan 2 portion of the piedmont and an earthen channel along the south side of the road in the Fan 1 portion of the sub-area. All of the design concepts for the CAP sub-area alternatives incorporate the existing facilities without modification. Therefore, design flow rates for channels or leveed conveyance corridors approaching the Parkway are limited by off-line detention facilities to match the existing capacity of the Sun Valley Parkway channel or roadway culvert crossings.

The existing culvert capacity at Sun Valley Parkway for the Fan 2 corridor was adequate to handle the entire peak discharge for all of the alternatives examined.

The capacity used for the Sun Valley Parkway channel on Fan 1 was 1000 cfs for the upper reach from Station 964+00 to 890+00 and 2000 cfs for the lower reach from Station 890+00 to 850+00 for the purposes of the alternatives evaluation. The capacities are computed using normal-depth hydraulics for the design cross sections assuming a Manning's n-value of 0.03 and 1 foot freeboard. It should be noted that these values are much less than the design discharges reported by Collar, Williams, and White in the original design reports which assumed only 0.5 foot of channel freeboard. The design reports give a design discharge of about 3,800 cfs for the lower reach and about from about 1,700 cfs to 2,100 cfs for the upper reach.

Diversion channels for Alternative A are assumed to be partially excavated with a downstream levee for the purposes of the cost estimation. Active alluvial fan areas are derived from the unstable delineations performed for the ADMS by Ayres (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
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" RGRCP	LF	$ 82.00	sq. Yd	$ -		$ 1.20
42" & 48" RGRCP	LF	$ 160.00	sq. Yd	$ -		$ 2.40
54" & 60" RGRCP	LF	$ 183.00	sq. Yd	$ -		$ 2.75
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 CAP SUB-AREA DESIGN SUMMARY

The design summary of all the alternatives for the CAP sub-area is presented in the following sections. The Cost Summaries for the CAP sub-area are presented in Table 10 & Table 11.

Table 10 Base Cost Summary

		Costs (in $1000)					Cost Percentages			
Alt.	Land Area (acres)	Land Cost	Constr. Cost	Lndscp Cost	Maint. Cost	Total Cost	Land Cost %	Constr. Cost %	Lndscp Cost %	Maint. Cost %
A	434	$ 43,349	$ 15,830	$ 3,373	$ 7,511	$ 70,063	62%	23%	5%	11%
B1	289	$ 28,877	$ 17,752	$ 4,316	$ 8,564	$ 59,509	49%	30%	7%	14%
B2	318	$ 31,774	$ 15,891	$ 3,426	$ 7,866	$ 58,958	54%	27%	6%	13%
B3	249	$ 24,904	$ 87,310	$ 6,677	$ 7,272	$ 126,163	20%	69%	5%	6%
B5	314	$ 31,517	$ 16,102	$ 3,313	$ 7,754	$ 58,687	54%	27%	6%	13%
C	236	$ 19,841	$ 77,511	$ 4,470	$ 8,301	$ 110,123	18%	70%	4%	8%

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	481	$ 48,110	$ 24,865	$ 6,198	$ 13,992	$ 93,165	52%	27%	7%	15%	33%
B1	347	$ 34,700	$ 28,406	$ 8,065	$ 16,819	$ 87,990	39%	32%	9%	19%	48%
B2	369	$ 36,740	$ 25,878	$ 6,754	$ 15,421	$ 84,793	43%	31%	8%	18%	44%
B3	334	$ 33,380	$ 106,311	$ 8,816	$ 9,284	$ 157,791	21%	67%	6%	6%	25%
B5	364	$ 36,310	$ 26,072	$ 6,568	$ 15,240	$ 84,190	43%	31%	8%	18%	43%
C	308	$ 26,990	$ 101,950	$ 6,025	$ 12,695	$ 147,660	18%	69%	4%	9%	34%

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

Sizing alternatives - The large on-line basin (B1) alternative is approximately the same cost as the small on-line basin (B2). In addition, the off-line basin (B5) is a similar cost to the small on-line basin. The reasons for this result are: 1) the downstream reach peak discharges are driven by the on-fan runoff, 2) land cost is the largest portion of the total cost for the leveed corridor alternatives, and 3) smaller apex basins lead to larger off-line basins at the Sun Valley Parkway.

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.

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 25 to 50 percent. The increased costs are greatest for the B1 alternative and least for the B3 alternative for the CAP 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 CAP 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 CAP Sub-Area

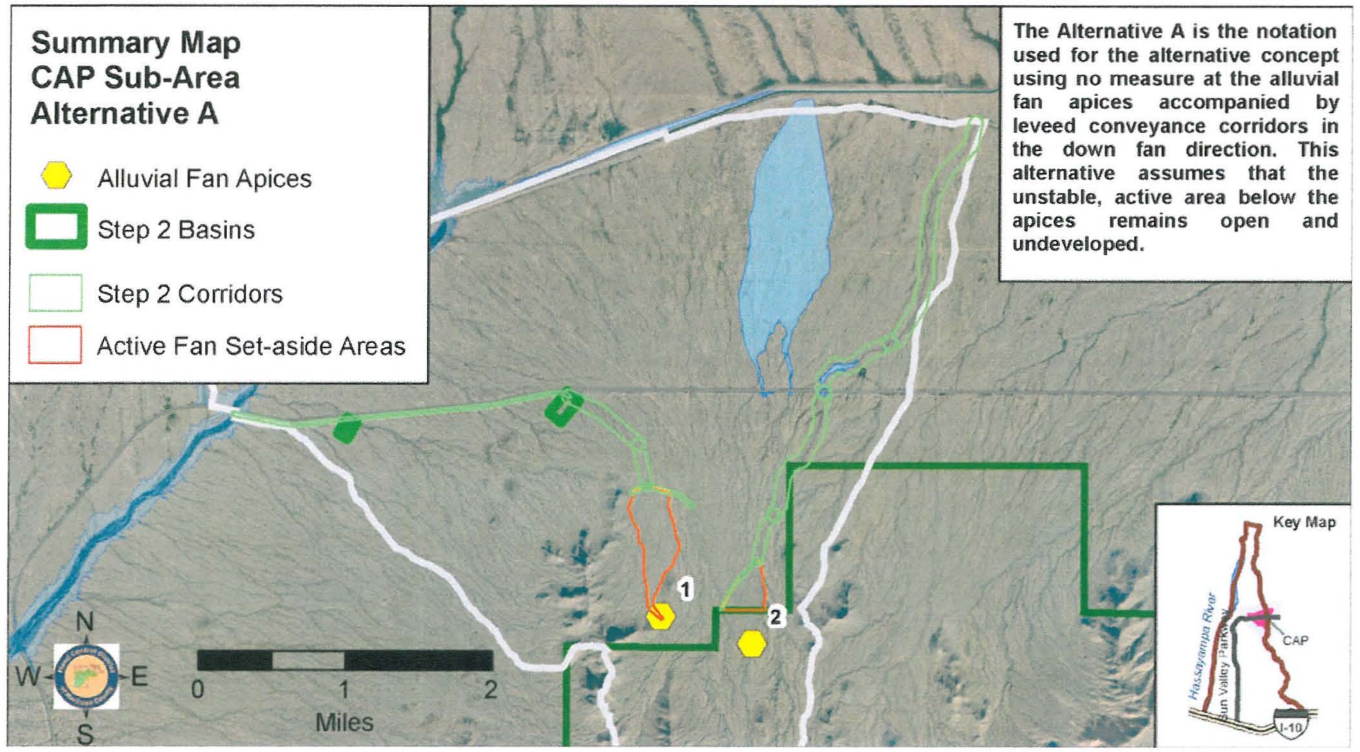

Figure 28 Summary Map of Alternative A for the CAP Sub-area

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 alluvial fan area downstream of the apex. Flood flows and sediment are controlled downstream of the region of uncertainty. The flows will be captured in the up-fan area by partially excavated collector channels. Once collected, the flows are routed downstream in leveed corridors until the flows reach the outfall along the CAP canal for Fan 2 and an existing flood control channel along Sun Valley Parkway for Fan 1. The Sun Valley Parkway channel discharges into Wagner Wash. Two off-line detention basins are provided to restrict peak flows delivered to the Sun Valley Parkway channel. No improvements to the existing Sun Valley Parkway channel were included.

10.2.2 *Key Features*

- $91.7 million is the estimated total cost with landscape compatibility enhancements
- Two off-line basins with a total volume of 84 acre feet along Sun Valley Parkway
- No on-line basins
- 5.2 miles of corridors, of which 0.8 miles are excavated collector channels and 2.3 miles are existing concrete channels along Sun Valley Parkway
- 481 acres needed for right of way. This includes the right of way in the active fan areas.

10.2.3 *Advantages*

- Reduced environmental impacts
- Provide additional open space area near Regional Park boundary
- Maximizes use of existing facilities
- Achieves context sensitivity of new facilities

10.2.4 *Disadvantages*

- The cost of land
- Leaves existing Sun Valley Parkway channel in current, not aesthetically pleasing, state

10.2.5 *Opportunities*

- Enhancement of existing Sun Valley Parkway channel to increase capacity which would eliminate need for off-line basins
- Enhancement to existing Sun Valley Parkway channel to improve visual context sensitivity
- Enhancement of multiple use opportunities in/along the existing Sun Valley Parkway channel
- Opportunity to connect Park and regional trail along the CAP

10.3 ALTERNATIVE B1 - Summary Sheet for CAP Sub-Area

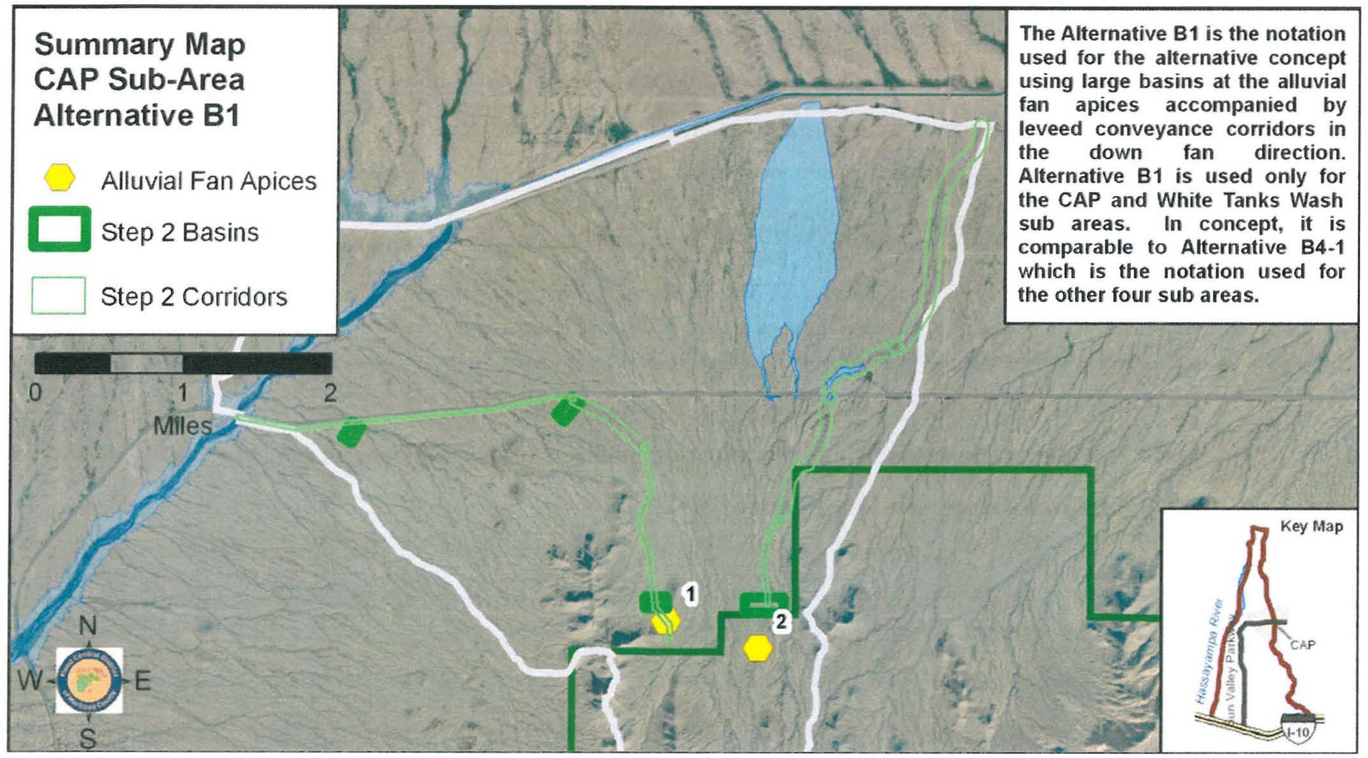

Figure 29 Summary Map of Alternative B1 for the CAP Sub-area

10.3.1 Description for Alternative B1

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 flow of water and sediment near the apex. Outflows from the basins along with downstream tributary inflows are controlled within leveed corridors. Alternative B1 is based on using a relatively larger on-line detention basin at the apex accompanied by leveed channel sections in the down fan direction.

Outflows from the on-line detention basin at Fan 1 are controlled in a single leveed corridor downstream to an existing earthen channel along the Sun Valley Parkway. Two off-line detention basins are provided to restrict peak flows delivered to the Sun Valley Parkway channel. No improvements to the existing Sun Valley Parkway channel were included. The Sun Valley Parkway channel discharges to Wagner Wash. No structural measures are proposed to Wagner Wash.

The on-line detention basin at Fan 2 is located entirely outside the White Tank Regional Park. Since the alluvial fan apex is located within the Park, additional structures will be required to ensure control of the active alluvial fan areas and deliver flood water and sediment to the on-line detention basin. Outflows from the on-line detention basin at Fan 2 are controlled within leveed corridors that direct flow to an existing culvert crossing at Sun Valley Parkway. The existing culvert has sufficient capacity to pass the 100-year peak discharge without need for an additional detention basin. Downstream of Sun Valley Parkway the leveed corridor continues north to an existing tributary of Trilby Wash parallel to the CAP Canal. No structural measures are proposed to this tributary wash.

10.3.2 Key Features

- $86.2 million is the estimated total cost with landscape compatibility enhancements
- Two on-line basins with a total volume of 290 acre feet
- Two off-line basins with a total volume of 62 acre feet
- 5.9 miles of corridors
- 347 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
- Nearly balanced cut & fill requirements when considered as a sub-area project
- Achieves context sensitivity of new facilities
- Large detention basin provides more area for potential wildlife habitat

10.3.4 Disadvantages

- Large costly structures

10.3.5 Opportunities

- Enhancement of existing Sun Valley Parkway channel to increase capacity which would eliminate need for off-line basins
- Enhancement to existing Sun Valley Parkway channel to improve visual context sensitivity
- Enhancement of multiple use opportunities in/along the existing Sun Valley Parkway channel
- Basins near Park boundary could serve as staging areas to Park
- Large detention basin provides more area for potential multi-use opportunities
- Opportunity to connect Park and regional trail along the CAP

10.4 ALTERNATIVE B2 - Summary Sheet for CAP Sub-Area

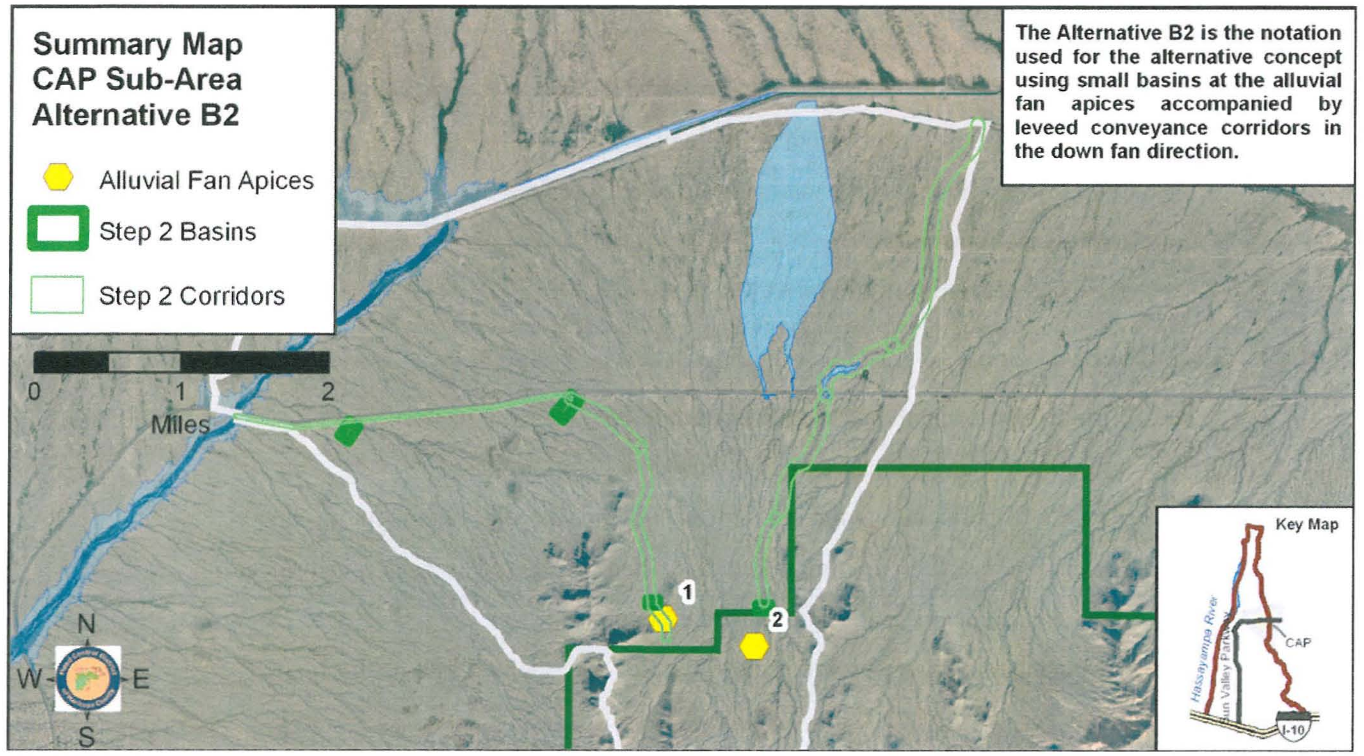

Figure 30 Summary Map of Alternative B2 for the CAP Sub-area

10.4.1 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 the flow of water and sediment near the apex. Outflows from the basins along with downstream tributary inflows are controlled within leveed corridors. Alternative B2 is based on using a relatively smaller on-line detention basin at the apex accompanied by leveed channel sections in the down fan direction.

Outflows from the on-line detention basin at Fan 1 are controlled in a single leveed corridor downstream to an existing earthen channel along the Sun Valley Parkway. Two off-line detention basins are provided to restrict peak flows delivered to the Sun Valley Parkway channel. No improvements to the existing Sun Valley Parkway channel were included. The Sun Valley Parkway channel discharges to Wagner Wash. No structural measures are proposed to Wagner Wash.

The on-line detention basin at Fan 2 is located entirely outside the White Tank Regional Park. Since the alluvial fan apex is located within the Park, additional structures will be required to ensure control of the active alluvial fan areas and deliver flood water and sediment to the on-line detention basin. Outflows from the on-line detention basin at Fan 2 are controlled within leveed corridors that direct flow to an existing culvert crossing at Sun Valley Parkway. The existing culvert has sufficient capacity to pass the 100-year peak discharge without need for an additional detention basin. Downstream of Sun Valley Parkway the leveed corridor continues north to an existing tributary of Trilby Wash parallel to the CAP Canal. No structural measures are proposed to this tributary wash.

10.4.2 Key Features

- $83.3 million is the estimated total cost with landscape compatibility enhancements
- Two on-line basins with a total excavation volume of 33 acre feet
- Two off-line basins with a total excavation volume of 66 acre feet
- 5.9 miles of corridors
- 369 acres needed for right of way

10.4.3 Advantages

- Eliminate flow path uncertainty at the apex
- Effectively manages active alluvial fan sedimentation issues
- Provides trunk system which minimizes the impacts of development phasing
- Achieves context sensitivity of new facilities

10.4.4 Disadvantages

- Large costly structures

10.4.5 Opportunities

- Enhancement of existing Sun Valley Parkway channel to increase capacity which would eliminate need for off-line basins
- Enhancement to existing Sun Valley Parkway channel to improve visual context sensitivity
- Enhancement of multiple use opportunities in/along the existing Sun Valley Parkway channel
- Basins near Park boundary could serve as staging areas to Park
- Opportunity to connect Park and regional trail along the CAP

10.5 ALTERNATIVE B3 - Summary Sheet for CAP Sub-Area

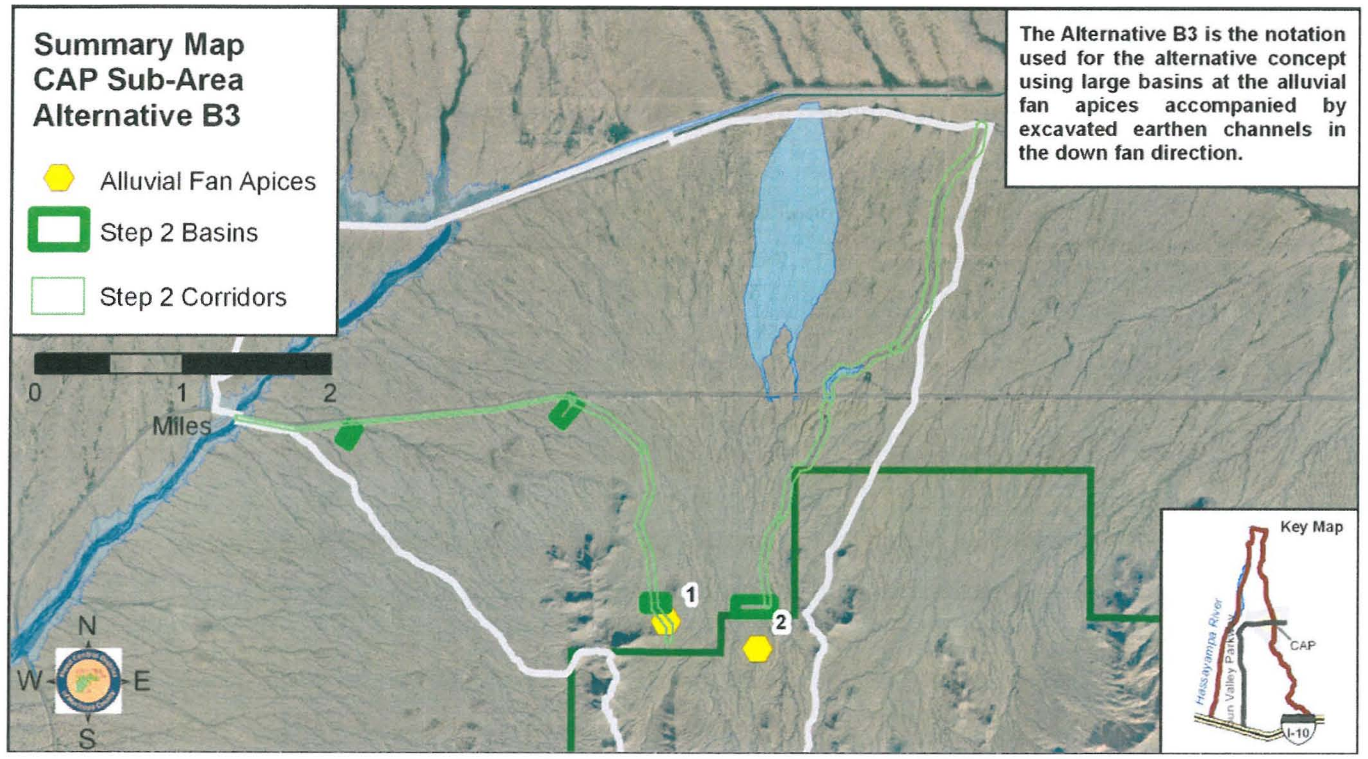

Figure 31 Summary Map of Alternative B3 for the CAP Sub-area

10.5.1 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 the flow of water and sediment near the apex. Outflows from the basins along with downstream tributary inflows are controlled within leveed corridors. Alternative B3 is based on using a relatively larger on-line detention basin at the apex accompanied by smaller excavated channel sections in the down fan direction. The excavated earthen channels are complemented with a 120-foot wide adjacent riparian preservation corridor.

Outflows from the on-line detention basin at Fan 1 are controlled in a single excavated earthen channel downstream to an existing earthen channel along the Sun Valley Parkway. Two off-line detention basins are provided to restrict peak flows delivered to the Sun Valley Parkway channel. No improvements to the existing Sun Valley Parkway channel were included. The Sun Valley Parkway channel discharges to Wagner Wash. No structural measures are proposed to Wagner Wash.

The on-line detention basin at Fan 2 is located entirely outside the White Tank Regional Park. Since the alluvial fan apex is located within the Park, additional structures will be required to ensure control of the active alluvial fan areas and deliver flood water and sediment to the on-line detention basin. Outflows from the on-line detention basin at Fan 2 are controlled within an excavated earthen channel that direct flow to an existing culvert crossing at Sun Valley Parkway. The existing culvert has sufficient capacity to pass the 100-year peak discharge without need for an additional detention basin. Downstream of Sun Valley Parkway the excavated channel continues north to an existing tributary of Trilby Wash parallel to the CAP Canal. No structural measures are proposed to this tributary wash.

10.5.2 Key Features

- $155.8 million is the estimated total cost with landscape compatibility enhancements
- Two on-line basins with a total excavation volume of 290 acre feet
- Two off-line basins with a total excavation volume of 72 acre feet
- 5.9 miles of corridors
- 334 acres needed for right of way, including the riparian preservation corridor

10.5.3 Advantages

- Eliminate flow path uncertainty at the apex
- Effectively manages active alluvial fan sedimentation issues
- Provides trunk a system which minimizes the impacts of development phasing
- Preserves riparian corridor in undisturbed state
- Achieves context sensitivity of new facilities

10.5.4 Disadvantages

- Large costly structures
- Significant excavation costs
- Requires more significantly more excavation than fill

10.5.5 Opportunities

- Enhancement of existing Sun Valley Parkway channel to increase capacity which would eliminate need for off-line basins
- Enhancement to existing Sun Valley Parkway channel to improve visual context sensitivity
- Enhancement of multiple use opportunities in/along the existing Sun Valley Parkway channel
- Basins near Park boundary could serve as staging areas to Park
- Large detention basin provides more area for potential multi-use opportunities
- Opportunity to connect Park and regional trail along the CAP

10.6 ALTERNATIVE B5 - Summary Sheet for CAP Sub-Area

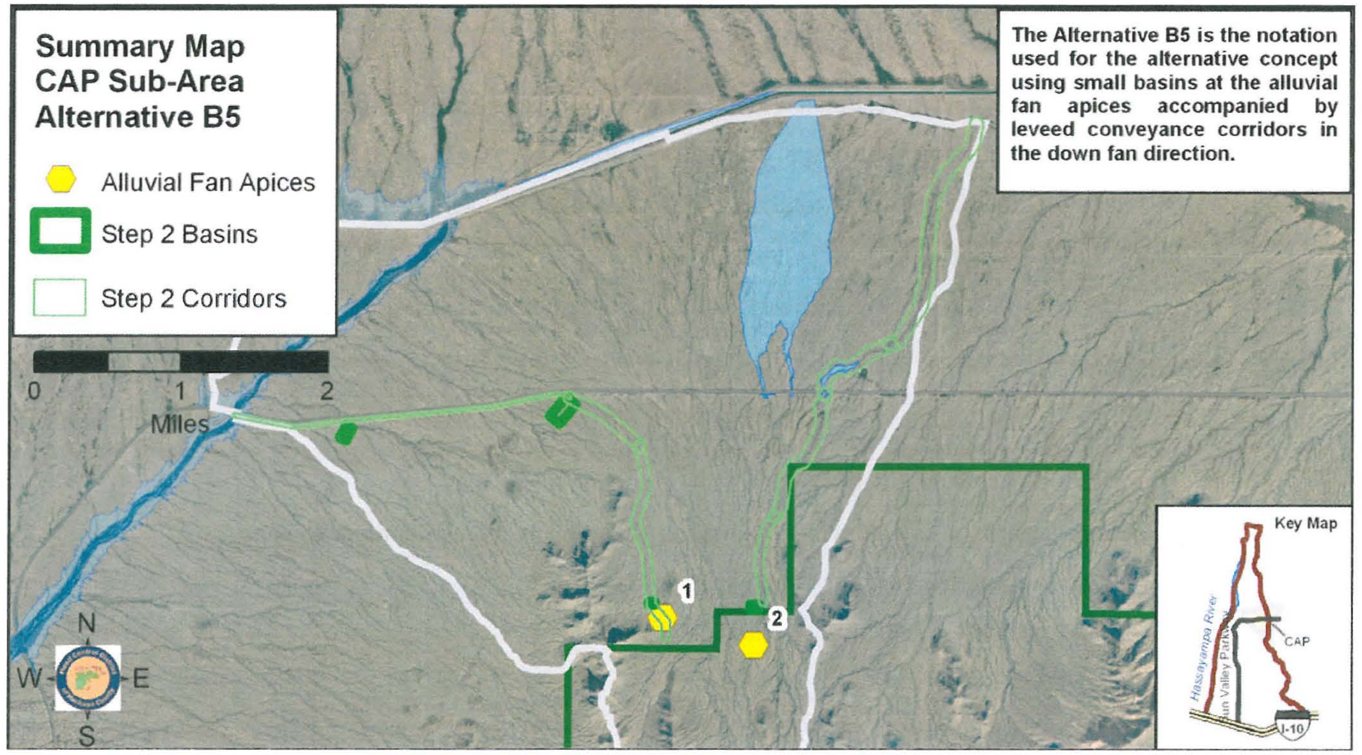

Figure 32 Summary Map of Alternative B5 for the CAP Sub-area

10.6.1 Description for Alternative B5

The purpose of Alternative B is to capture the upstream flow at the apex using detention basins. The presence of the detention basins eliminates the downstream alluvial fan uncertainties by controlling the flow of water and sediment near the apex. Outflows from the basins along with downstream tributary inflows are controlled within leveed corridors. Alternative B5 is based on using a relatively smaller off-line detention basin at the apex accompanied by a small inline sedimentation basin.

Outflows from the on-line detention basin at Fan 1 are controlled in a single leveed corridor downstream to an existing earthen channel along the Sun Valley Parkway. Two off-line detention basins are provided to restrict peak flows delivered to the Sun Valley Parkway channel. No improvements to the existing Sun Valley Parkway channel were included. The Sun Valley Parkway channel discharges to Wagner Wash. No structural measures are proposed to Wagner Wash.

The on-line detention basin at Fan 2 is located entirely outside the White Tank Regional Park. Since the alluvial fan apex is located within the Park, additional structures will be required to ensure control of the active alluvial fan areas and deliver flood water and sediment to the on-line detention basin. Outflows from the on-line detention basin at Fan 2 are controlled within an excavated earthen channel that direct flow to an existing culvert crossing at Sun Valley Parkway. The existing culvert has sufficient capacity to pass the 100-year peak discharge without need for an additional detention basin. Downstream of Sun Valley Parkway the excavated channel continues north to an existing tributary of Trilby Wash parallel to the CAP Canal. No structural measures are proposed to this tributary wash.

10.6.2 Key Features

- $82.8 million is the estimated total cost with landscape compatibility enhancements
- No on-line basins
- Four off-line basins with a total excavation volume of 58 acre feet
- 5.9 miles of corridors
- 364 acres needed for right of way

10.6.3 Advantages

- Eliminate flow path uncertainty at the apex
- Effectively manages active alluvial fan sedimentation issues
- Provides trunk system which minimizes the impacts of development phasing
- Achieves context sensitivity of new facilities

10.6.4 Disadvantages

- Large costly structures
- Potential FEMA approval concerns
- Higher risk of failure than on-line basins

10.6.5 Opportunities

- Enhancement of existing Sun Valley Parkway channel to increase capacity which would eliminate need for off-line basins
- Enhancement to existing Sun Valley Parkway channel to improve visual context sensitivity
- Enhancement of multiple use opportunities in/along the existing Sun Valley Parkway channel
- Opportunity to connect Park and regional trail along the CAP

10.7 ALTERNATIVE C - Summary Sheet for CAP Sub-Area

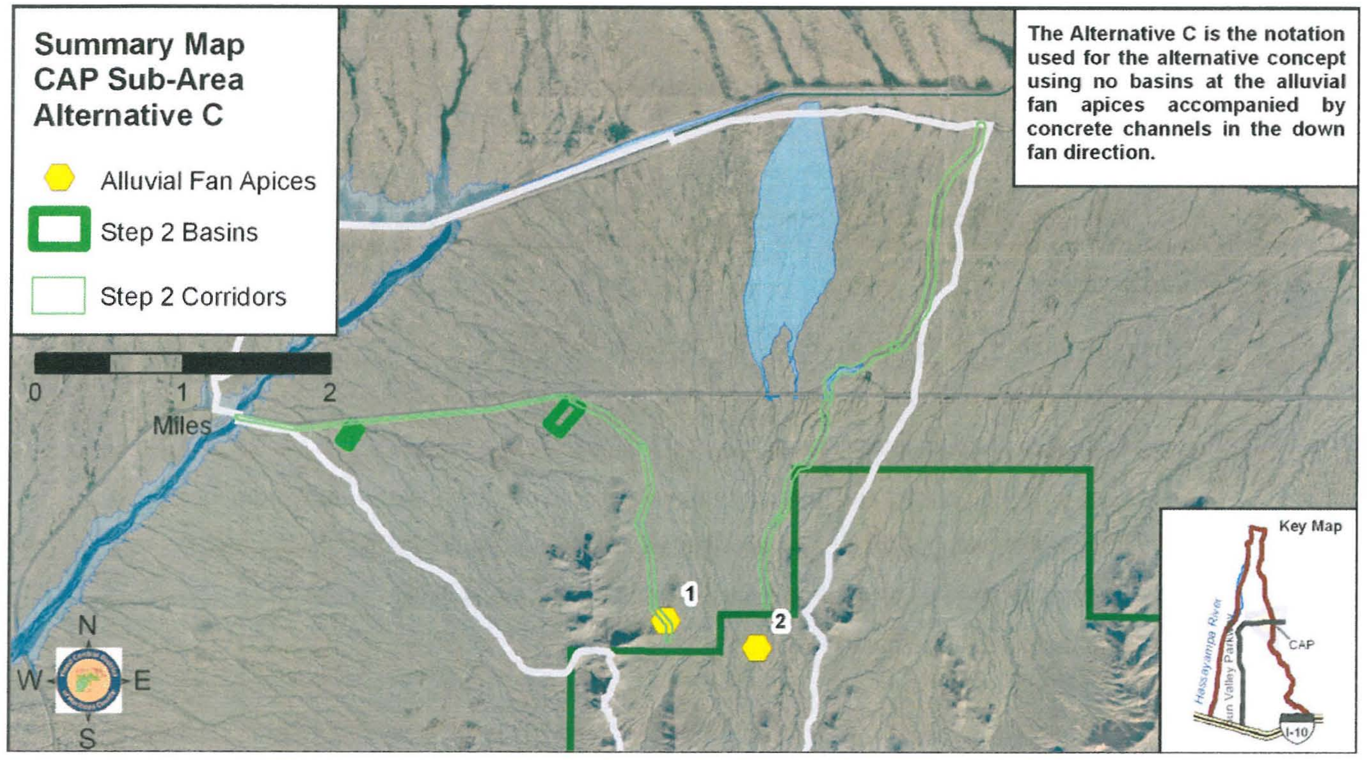

Figure 33 Summary Map of Alternative C for the CAP Sub-area

10.7.1 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.

Flows from Fan 1 are controlled in a single excavated concrete channel downstream to an existing earthen channel along the Sun Valley Parkway. Two off-line detention basins are provided to restrict peak flows delivered to the Sun Valley Parkway channel. No improvements to the existing Sun Valley Parkway channel were included. The Sun Valley Parkway channel discharges to Wagner Wash. No structural measures are proposed to Wagner Wash.

All flood control features for Fan 2 are located entirely outside the White Tank Regional Park. Since the alluvial fan apex is located within the Park, additional structures will be required to ensure control of the active alluvial fan areas and deliver flood water and sediment to the concrete channel. Flows from the Park boundary at Fan 2 are controlled within an excavated concrete channel that direct flow to an existing culvert crossing at Sun Valley Parkway. The existing culvert has sufficient capacity to pass the 100-year peak discharge without need for an additional detention basin. Downstream of Sun Valley Parkway the excavated concrete channel continues north to an existing tributary of Trilby Wash parallel to the CAP Canal. No structural measures are proposed to this tributary wash.

10.7.2 Key Features

- $145.9 million is the estimated total cost with landscape compatibility enhancements
- Two off-line basins at Sun Valley Parkway with a total excavation volume of 100 ac-ft
- 5.9 miles of corridors
- 308 acres needed for right of way, including the riparian preservation corridor

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
- Preserves riparian corridor in undisturbed state

10.7.4 Disadvantages

- Costly structures
- Significant excavation costs
- Requires more significantly more excavation than fill
- Potential aesthetic concerns even with architectural treatments and preservation corridor
- Potential safety concerns to persons caught in channels during flooding

10.7.5 Opportunities

- Enhancement of existing Sun Valley Parkway channel to increase capacity which would eliminate need for off-line basins
- Enhancement to existing Sun Valley Parkway channel to improve visual context sensitivity
- Enhancement of multiple use opportunities in/along the existing Sun Valley Parkway channel
- Opportunity to connect Park and regional trail along the CAP

10.8 ALTERNATIVE D - Summary Sheet for CAP Sub-Area

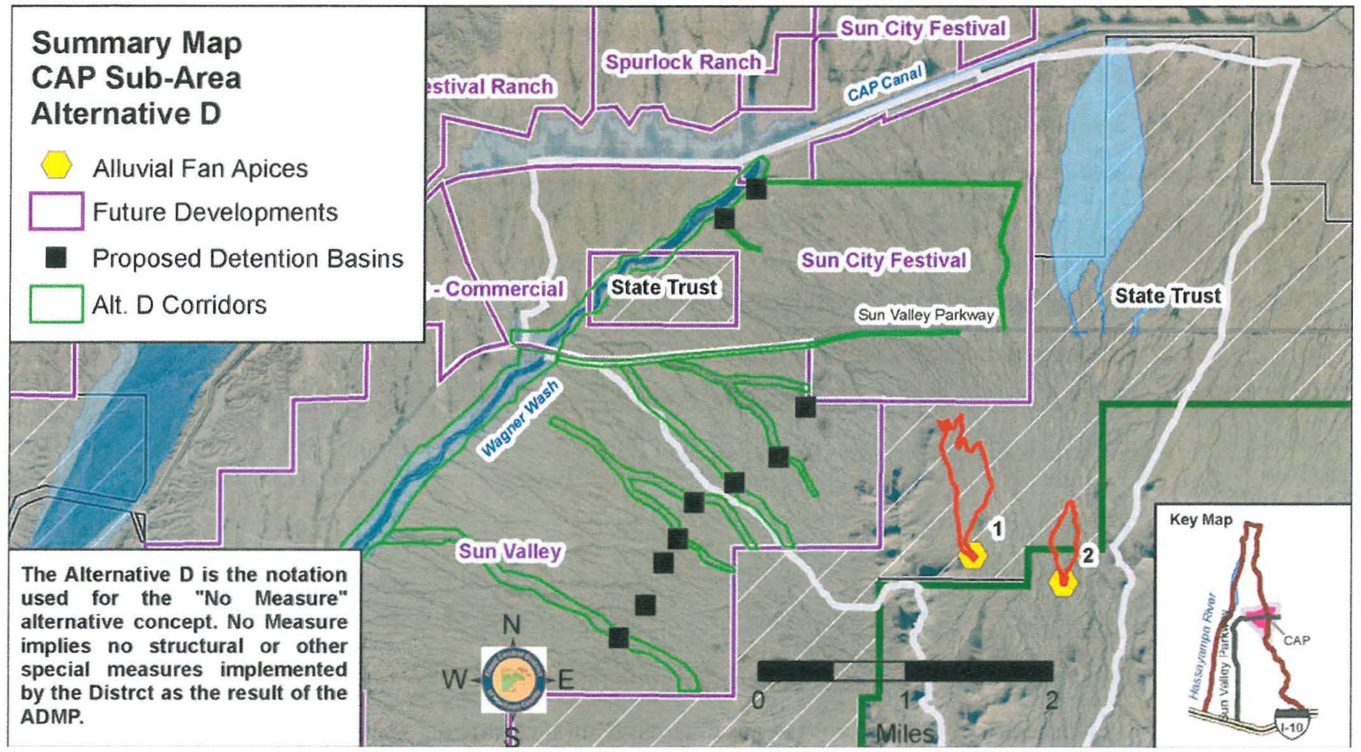

Figure 34 Summary Map of Alternative D for the CAP Sub-area

10.8.1 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 CAP Sub-area, the Sun City Festival development is already under construction north of Sun Valley Parkway. Another portion of the western part of the sub-area lies within the Sun Valley master planned development. Groundbreaking for Sun Valley is expected within two years. Drainage corridors shown on these two master drainage plans are shown on the map above. No modifications to the existing Sun Valley Parkway channel were assumed for Alternative D. The remainder of the area is currently State Trust Land.

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.

10.8.2 Key Features

- Hazards addressed entirely by future development

10.8.3 Advantages

- Requires no direct District expenditures

10.8.4 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

10.8.5 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 CAP 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 CAP 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 CAP 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.

Alternative A - Sedimentation Area at Apex

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.

Alternative B - Big Basin/Small Basin/Off-line/On-line

The main objective Alternatives B1, B2, and B5 is to evaluate the effectiveness of basins at the apices as flood control measures. The B1 alternative represents the big-basin option while the B2 represents a smaller basin. Both are on-line basin options. The B5 Alternative 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.

Leveed Corridors

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.

<u>Alternative D</u>

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.

<u>Outcome</u>

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				

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11.2.2 Sub-area Evaluation

Because the CAP sub-area only had one set of alignments, the strategy evaluation is essentially identical to the sub-area specific evaluation for the CAP 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 B1 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 B1/B2 alternatives were preferred according to the Function evaluation. The reason both alternatives were selected was to reflect the suggestion by the Function evaluation group that the design of the recommended alternative endeavor to balance the volume of material excavated for the detention basins with the volume of fill required for the levees.

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	
CAP Sub-Area	B1/B2			3	1	3	3	10	B1
	B5			3	1	3	3	10	
	B4			N/A	N/A	N/A	N/A	N/A	
	D			3	1	1	2	7	

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

Alternative Measure		Function Criteria	Economic Criteria	Form Criteria	Ranking	
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	
CAP Sub-Area	B1/B2	3	2		5	B1/B2
	B5	3	2		5	
	B4	N/A	N/A		N/A	
	D	1	3		4	

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

Alternative Measure		Preferred Alternative		Preliminary Recommended Alternative
Alternative Measure	Alternative	Form	Function	
CAP Sub-Area	B1/B2	B1	B1/B2	B1/B2
	B5			
	D			

11.2.3 Preliminary Recommended Alternative for CAP Sub-area

The B1/B2 alternatives were selected as the recommended alternative for the CAP sub-area. The reason both alternatives were identified was that the design of the recommended alternative should try to balance the volume of material excavated for the detention basins with the volume of fill required for the levees. It should also be noted that the recommended alternative for the CAP sub-area includes use of the existing Sun Valley Parkway channel. However, the project team did express an interest to explore enhancement of the visual aesthetic, multiple-use potential, and/or channel capacity as part of the Step 3 refinements. Non-structural elements also comprise portions of the recommended alternative; in particular the delineated floodplains of Wagner Wash north of Sun Valley Parkway.

12 Recommendations for Step 3 for the CAP 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 CAP 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. For the CAP sub-area this may include the addition of one corridor between Fan 1 and Fan 2 where the alluvial fan apex for Fan 2 is located within the White Tank Regional Park.
- 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 CAP sub-area this means Fan 1 and Fan 2 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.
- Enhancement to the existing Sun Valley Parkway channel should be investigated and incorporated into the recommended alternative for Fan 1. This could include landscape aesthetic and/or capacity increases to remove the need for the off-line detention basins proposed along the channel.
- 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 CAP 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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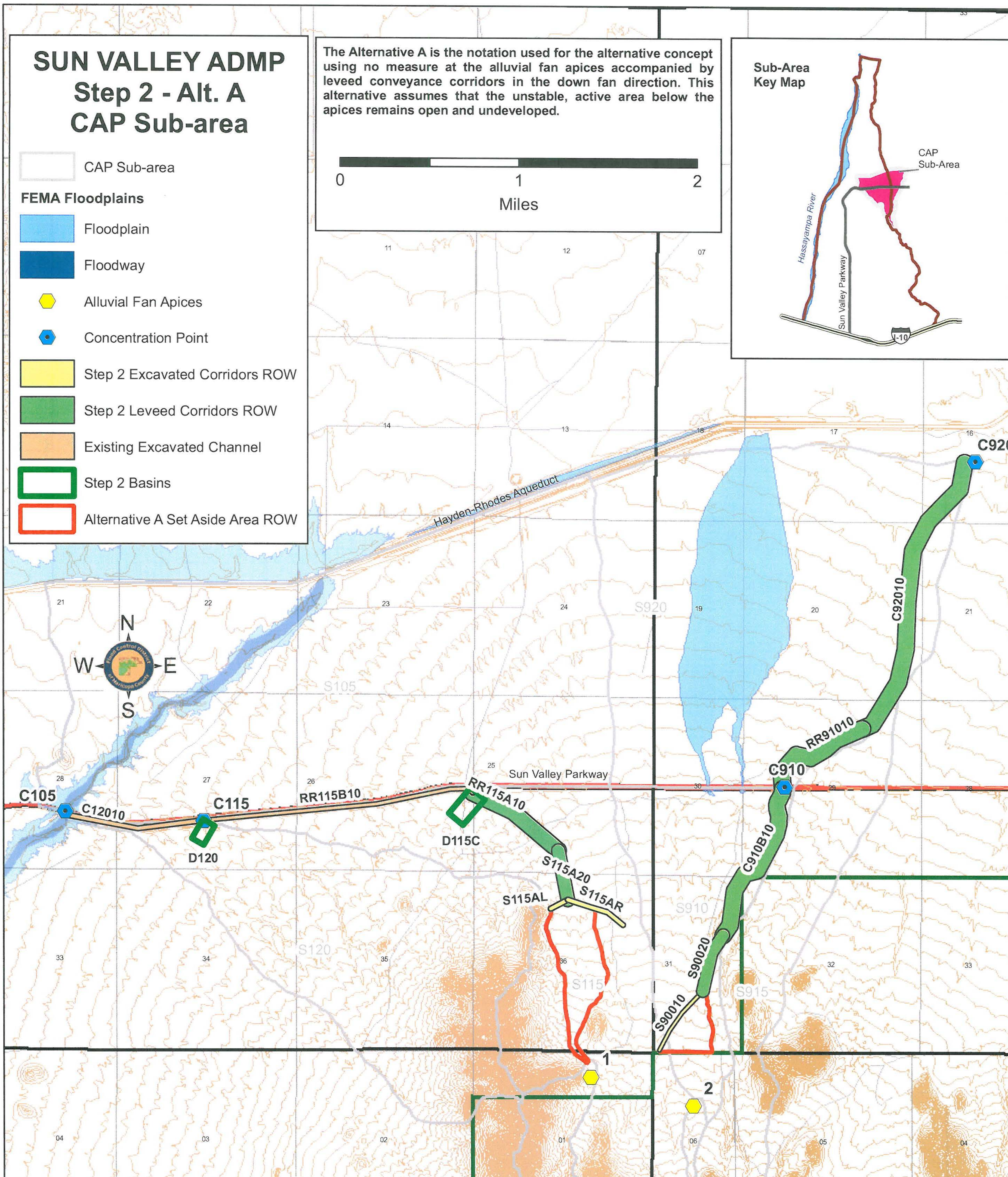
Appendix A

Design Analyses



						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
S115A20	Leveed Chl.	2008	14	0	7	0.3	408	4	$ 1,400	$ 741	$ 116	$ 350	$ 2,607	54%	28%	4%	13%	4%
RR115A10	Leveed Chl.	2103	34	0	15	0.6	476	4	$ 3,370	$ 1,566	$ 241	$ 771	$ 5,947	57%	26%	4%	13%	8%
RR115B10	Existing Chl.	1000	0	0	0	1.5	108	6	$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
D115C	Offline Basin	1000	13	126	0	1000	550	5	$ 1,263	$ 1,156	$ 550	$ 530	$ 3,499	36%	33%	16%	15%	5%
C12010	Existing Chl.	2000	0	0	0	0.8	136	7	$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
D120	Offline Basin	2000	6	51	0	660	400	5	$ 606	$ 519	$ 264	$ 262	$ 1,651	37%	31%	16%	16%	2%
S90010	Excavated Chl.	1253	44	46	5	0.4	140	4	$ 4,420	$ 1,441	$ 227	$ 454	$ 6,542	68%	22%	3%	7%	9%
S90020	Leveed Chl.	1529	15	0	9	0.3	376	4	$ 1,540	$ 803	$ 140	$ 400	$ 2,882	53%	28%	5%	14%	4%
C910B10	Leveed Chl.	2521	56	0	24	0.9	488	4	$ 5,600	$ 2,132	$ 389	$ 1,097	$ 9,218	61%	23%	4%	12%	13%
RR91010	Leveed Chl.	2907	39	0	23	0.6	500	5	$ 3,890	$ 1,742	$ 312	$ 872	$ 6,816	57%	26%	5%	13%	10%
C92010	Leveed Chl.	3898	103	0	59	1.7	506	5	$10,290	$ 4,445	$ 815	$ 2,269	$ 17,819	58%	25%	5%	13%	25%
S115AR	Excavated Chl.	2202	108	32	4	0.3	170	4	$10,820	$ 1,032	$ 243	$ 358	$ 12,453	87%	8%	2%	3%	18%
S115AL	Excavated Chl.	2202	2	6	1	0.1	170	4	$ 150	$ 253	$ 76	$ 149	$ 628	24%	40%	12%	24%	1%
		TOTAL	434	261	147				$43,349	$ 15,830	$ 3,373	$ 7,511	**$ 70,063**	62%	23%	5%	11%	100%
All Channels			415	84	147	5.2			$41,480	$ 14,154	$ 2,559	$ 6,719	$ 64,912	64%	22%	4%	10%	93%
All Online Basins			0	0	0				$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
All Offline Basins			19	177	0				$ 1,869	$ 1,676	$ 814	$ 792	$ 5,150	36%	33%	16%	15%	7%
Channel Cost per mile (in $1000)			$12,483		Basins Cost per ac. ft. (in $1000)				$4.60									

Cost Increase for Landscape Compatibility Enhancement over Base Costs

All Channels % increase			9%	29%	135%				9%	63%	94%	91%	33%
All Online Basins % increase			0%	0%	0%				0%	0%	0%	0%	0%
All Offline Basins % increase			47%	8%	0%				51%	7%	51%	49%	37%
Total % increase			11%	15%	135%				11%	57%	84%	86%	33%

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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
S115A20	Leveed Chl.	2008	14	0	7	0.3	408	4	$ 1,400	$ 741	$ 116	$ 350	$ 2,607	54%	28%	4%	13%	4%
RR115A10	Leveed Chl.	2103	34	0	15	0.6	476	4	$ 3,370	$ 1,566	$ 241	$ 771	$ 5,947	57%	26%	4%	13%	8%
RR115B10	Existing Chl.	1000	0	0	0	1.5	108	6	$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
D115C	Offline Basin	1000	13	126	0	1000	550	5	$ 1,263	$ 1,156	$ 550	$ 530	$ 3,499	36%	33%	16%	15%	5%
C12010	Existing Chl.	2000	0	0	0	0.8	136	7	$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
D120	Offline Basin	2000	6	51	0	660	400	5	$ 606	$ 519	$ 264	$ 262	$ 1,651	37%	31%	16%	16%	2%
S90010	Excavated Chl.	1253	44	46	5	0.4	140	4	$ 4,420	$ 1,441	$ 227	$ 454	$ 6,542	68%	22%	3%	7%	9%
S90020	Leveed Chl.	1529	15	0	9	0.3	376	4	$ 1,540	$ 803	$ 140	$ 400	$ 2,882	53%	28%	5%	14%	4%
C910B10	Leveed Chl.	2521	56	0	24	0.9	488	4	$ 5,600	$ 2,132	$ 389	$ 1,097	$ 9,218	61%	23%	4%	12%	13%
RR91010	Leveed Chl.	2907	39	0	23	0.6	500	5	$ 3,890	$ 1,742	$ 312	$ 872	$ 6,816	57%	26%	5%	13%	10%
C92010	Leveed Chl.	3898	103	0	59	1.7	506	5	$ 10,290	$ 4,445	$ 815	$ 2,269	$ 17,819	58%	25%	5%	13%	25%
S115AR	Excavated Chl.	2202	108	32	4	0.3	170	4	$ 10,820	$ 1,032	$ 243	$ 358	$ 12,453	87%	8%	2%	3%	18%
S115AL	Excavated Chl.	2202	2	6	1	0.1	170	4	$ 150	$ 253	$ 76	$ 149	$ 628	24%	40%	12%	24%	1%
		TOTAL	434	261	147				$ 43,349	$ 15,830	$ 3,373	$ 7,511	**$ 70,063**	62%	23%	5%	11%	100%
All Channels			415	84	147	5.2			$ 41,480	$ 14,154	$ 2,559	$ 6,719	$ 64,912	64%	22%	4%	10%	93%
All Online Basins			0	0	0				$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
All Offline Basins			19	177	0				$ 1,869	$ 1,676	$ 814	$ 792	$ 5,150	36%	33%	16%	15%	7%
Channel Cost per mile (in $1000)			$12,483		Basins Cost per ac. ft. (in $1000)				$4.60									

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
S115A20	Leveed Chl.	2008	16	0	17	0.3	456	4	$ 1,560	$ 1,187	$ 241	$ 658	$ 3,647	43%	33%	7%	18%	4%
RR115A10	Leveed Chl.	2103	37	0	35	0.6	524	4	$ 3,710	$ 2,491	$ 500	$ 1,409	$ 8,109	46%	31%	6%	17%	9%
RR115B10	Existing Chl.	1000	0	0	0	1.5	122	6	$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
D115C	Offline Basin	1000	18	136	0	1230	650	5	$ 1,840	$ 1,237	$ 799	$ 765	$ 4,641	40%	27%	17%	16%	5%
C12010	Existing Chl.	2000	0	0	0	0.8	150	7	$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
D120	Offline Basin	2000	10	55	0	860	500	5	$ 990	$ 553	$ 430	$ 419	$ 2,392	41%	23%	18%	18%	3%
S90010	Excavated Chl.	1253	49	62	13	0.4	188	4	$ 4,910	$ 2,093	$ 372	$ 729	$ 8,104	61%	26%	5%	9%	9%
S90020	Leveed Chl.	1529	17	0	21	0.3	424	4	$ 1,740	$ 1,334	$ 290	$ 770	$ 4,134	42%	32%	7%	19%	4%
C910B10	Leveed Chl.	2521	62	0	57	0.9	536	4	$ 6,150	$ 3,600	$ 809	$ 2,124	$ 12,683	48%	28%	6%	17%	14%
RR91010	Leveed Chl.	2907	43	0	52	0.6	554	5	$ 4,310	$ 2,962	$ 631	$ 1,750	$ 9,652	45%	31%	7%	18%	10%
C92010	Leveed Chl.	3898	114	0	137	1.7	560	5	$ 11,390	$ 7,611	$ 1,648	$ 4,561	$ 25,210	45%	30%	7%	18%	27%
S115AR	Excavated Chl.	2202	112	39	11	0.3	218	4	$ 11,230	$ 1,438	$ 364	$ 587	$ 13,620	82%	11%	3%	4%	15%
S115AL	Excavated Chl.	2202	3	7	3	0.1	218	4	$ 280	$ 358	$ 114	$ 220	$ 972	29%	37%	12%	23%	1%
		TOTAL	481	299	346				$ 48,110	$ 24,865	$ 6,198	$ 13,992	**$ 93,165**	52%	27%	7%	15%	100%
All Channels			453	108	346	5.2			$ 45,280	$ 23,075	$ 4,969	$ 12,808	$ 86,132	53%	27%	6%	15%	92%
All Online Basins			0	0	0				$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
All Offline Basins			28	191	0				$ 2,830	$ 1,790	$ 1,229	$ 1,184	$ 7,033	40%	25%	17%	17%	8%
Channel Cost per mile (in $1000)			$16,564		Basins Cost per ac. ft. (in $1000)				$6.44									
All Channels % increase			9%	29%	135%				9%	63%	94%	91%	33%					
All Online Basins % increase			0%	0%	0%				0%	0%	0%	0%	0%					
All Offline Basins % increase			47%	8%	0%				51%	7%	51%	49%	37%					
Total % increase			11%	15%	135%				11%	57%	84%	86%	33%					

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	61	100.2	17.36	11.4	10.23	59	51	36	20	0.054	0.185	0.39	0.513	29	101	213	280
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	100.3	9.31	8	10.23	60	51	36	20	0.055	0.186	0.39	0.513	30	101	213	280
C105U	COMBINE	2863			4.5	14.6	554	228	121	64	0.353	0.58	0.923	1.129	275	451	719	879
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	617	100.6	6.56	4.3	0.43	76	19	6	3	1.638	1.64	1.64	1.64	38	38	38	38
S115A	BASIN	1540			4.3	1.4	213	53	18	8	1.415	1.416	1.416	1.416	105	105	105	105
C115A	COMBINE	1886			4.3	1.83	271	68	23	10	1.381	1.383	1.383	1.383	135	135	135	135
15I15A	ROUTE	1827	101	28.34	4.5	1.83	271	68	23	10	1.381	1.383	1.383	1.383	135	135	135	135
S115B	BASIN	789			4.1	0.42	57	14	5	2	1.269	1.269	1.269	1.269	29	29	29	29
C115B	COMBINE	1954			4.4	2.25	308	77	26	11	1.275	1.277	1.277	1.277	153	153	153	153
15I15B	ROUTE	1918	103.7	36.88	4.5	2.25	308	77	26	11	1.275	1.277	1.277	1.277	153	153	153	153
S115C	BASIN	668			4.1	0.43	58	14	5	2	1.246	1.246	1.246	1.246	29	29	29	29
C115C	COMBINE	2000			4.5	2.68	343	86	29	12	1.19	1.192	1.192	1.192	170	170	170	170
D115C	DIVERT	1000			4.3	2.68	264	66	22	10	0.915	0.917	0.917	0.917	131	131	131	131
115120	ROUTE	1001	102.9	13.51	4.5	2.68	263	66	22	10	0.915	0.917	0.917	0.917	131	131	131	131
S120	BASIN	1838			4.3	2	256	64	21	9	1.189	1.189	1.189	1.189	127	127	127	127
C120	COMBINE	2304			4.5	4.68	477	120	40	17	0.948	0.951	0.951	0.951	237	237	237	237
D120	DIVERT	1960			4.5	4.68	459	115	38	17	0.911	0.914	0.914	0.914	228	228	228	228
C105D	COMBINE	3823			4.5	19.28	799	269	125	64	0.385	0.519	0.726	0.851	396	534	746	875
S900	BASIN	936			4.5	1.03	170	43	14	6	1.529	1.535	1.535	1.535	84	85	85	85
90091A	ROUTE	902	100.8	22.03	4.6	1.03	170	43	14	6	1.527	1.535	1.535	1.535	84	85	85	85
90091B	ROUTE	778	100.6	29.39	5	1.03	170	43	14	6	1.525	1.535	1.535	1.535	84	85	85	85
S910	BASIN	1585			4.1	0.98	138	35	12	5	1.307	1.307	1.307	1.307	69	69	69	69
C910	COMBINE	1226			4.1	2.02	282	71	24	10	1.297	1.302	1.302	1.302	140	140	140	140
910915	ROUTE	1096	100.8	25.95	4.3	2.02	281	71	24	10	1.294	1.302	1.302	1.302	139	140	140	140
S915	BASIN	1400			4.5	1.13	189	47	16	7	1.562	1.562	1.562	1.562	94	94	94	94
C915	COMBINE	2032			4.4	3.14	433	109	36	16	1.28	1.288	1.288	1.288	215	216	216	216
915920	ROUTE	1729	101.1	96.57	4.9	3.14	426	109	36	16	1.26	1.288	1.288	1.288	211	216	216	216
S920	BASIN	2660			4.5	3.29	424	106	35	15	1.197	1.197	1.197	1.197	210	210	210	210
C920	COMBINE	3175			4.8	6.43	758	194	65	28	1.095	1.123	1.123	1.123	376	385	385	385

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	71	100.2	20.2	19.1	10.23	68	58	41	23	0.062	0.212	0.445	0.579	34	116	243	316
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	100.3	10.27	15.9	10.23	70	59	41	23	0.063	0.213	0.445	0.58	35	116	243	316
C105U	COMBINE	3466			12.5	14.6	593	239	126	66	0.378	0.609	0.961	1.164	294	474	748	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	491	100.5	5.7	12.3	0.43	62	16	5	2	1.35	1.422	1.422	1.422	31	33	33	33
S115A	BASIN	1536			12.3	1.4	193	50	17	7	1.286	1.321	1.322	1.322	96	98	98	98
C115A	COMBINE	2008			12.3	1.83	253	65	22	9	1.289	1.332	1.333	1.333	126	130	130	130
15115A	ROUTE	1931	101	29.35	12.4	1.83	253	65	22	9	1.289	1.332	1.333	1.333	126	130	130	130
S115B	BASIN	619			12	0.42	47	12	4	2	1.046	1.046	1.046	1.046	23	23	23	23
C115B	COMBINE	2103			12.4	2.25	298	77	26	11	1.233	1.268	1.269	1.269	148	152	152	152
15115B	ROUTE	2060	103.8	38.76	12.5	2.25	298	77	26	11	1.233	1.268	1.269	1.269	148	152	152	152
S115C	BASIN	534			12.1	0.43	47	12	4	2	1.028	1.028	1.028	1.028	24	24	24	24
C115C	COMBINE	2185			12.5	2.68	343	88	29	13	1.191	1.22	1.221	1.221	170	174	174	174
D115C	DIVERT	1000			12.2	2.68	254	66	22	9	0.881	0.91	0.911	0.911	126	130	130	130
115120	ROUTE	1002	102.9	13.52	12.5	2.68	254	66	22	9	0.881	0.91	0.911	0.911	126	130	130	130
S120	BASIN	2032			12.3	2	247	62	21	9	1.146	1.158	1.158	1.158	122	124	124	124
C120	COMBINE	2854			12.4	4.68	495	127	42	18	0.984	1.006	1.006	1.006	246	251	251	251
D120	DIVERT	2000			12.2	4.68	453	116	39	17	0.899	0.921	0.922	0.922	224	230	230	230
C105D	COMBINE	5244			12.5	19.28	989	333	154	78	0.477	0.643	0.893	1.04	490	661	918	1070
S900	BASIN	853			12.5	1.03	150	39	13	6	1.345	1.416	1.417	1.417	74	78	78	78
90091A	ROUTE	816	100.7	20.69	12.6	1.03	150	39	13	6	1.344	1.416	1.417	1.417	74	78	78	78
90091B	ROUTE	679	100.6	26.87	13	1.03	150	39	13	6	1.343	1.415	1.417	1.417	74	78	78	78
S910	BASIN	1512			12.1	0.98	122	30	10	4	1.151	1.151	1.151	1.151	60	60	60	60
C910	COMBINE	1501			12.1	2.02	268	69	23	10	1.233	1.271	1.272	1.272	133	137	137	137
910915	ROUTE	1296	100.9	28.57	12.3	2.02	267	69	23	10	1.23	1.271	1.272	1.272	132	137	137	137
S915	BASIN	1305			12.4	1.13	165	42	14	6	1.366	1.378	1.378	1.378	82	83	83	83
C915	COMBINE	2441			12.3	3.14	427	109	36	16	1.262	1.293	1.294	1.294	212	217	217	217
915920	ROUTE	1957	101.2	104.05	12.8	3.14	420	109	36	16	1.242	1.293	1.294	1.294	208	217	217	217
S920	BASIN	3157			12.5	3.29	428	107	36	15	1.209	1.209	1.209	1.209	212	212	212	212
C920	COMBINE	3898			12.7	6.43	828	214	71	31	1.196	1.234	1.235	1.235	410	424	424	424

Channels Hydraulics Summary

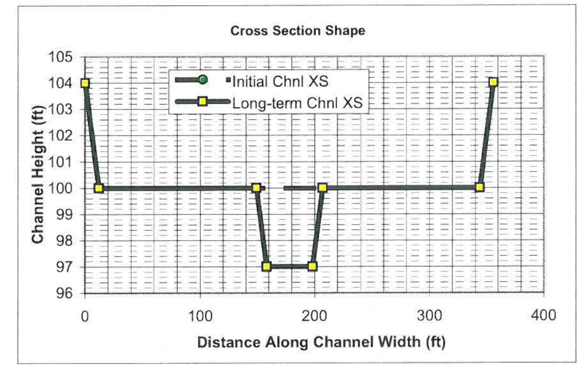
		Design Geometry						Hydraulics										
Structure ID	Type	Initial Slope (ft/ft)	Long-term Slope (ft/ft)	Length (stor-ft; chl-mi)	Width (ft)	Depth (ft)	Chnl Mannings n	Flow Rate (cfs)	Wetted Perimeter (ft)	Wetted XS Area (ft)	Hydraulic Radius (ft)	Hydraulic Depth (ft)	Flow Depth (ft)	Freeboard (ft)	Top Width (ft)	Velocity (ft/s)	Froude Number	Shear Stress (lb/sq. ft)
S115A20	Leveed	0.0192	0.0070	0.30	3	4.0	0.045	2008	339.5	395.3	1.2	1.2	1.2	2.8	339	5.1	0.83	0.51
RR115A10	Leveed	0.0191	0.0070	0.60	3	4.0	0.045	2103	406.9	437.9	1.1	1.1	1.1	2.9	407	4.8	0.82	0.47
RR115B10	Existing	0.0118	0.0015	1.50	3	5.5	0.030	1000	89.1	138.2	1.6	1.6	3.0	2.5	88	7.2	1.02	0.28
C12010	Existing	0.0100	0.0015	0.80	3	6.5	0.030	2000	115.4	244.2	2.1	2.1	3.8	2.7	114	8.2	0.99	0.36
S90010	Excavated	0.0170	0.0070	0.40	3	4.0	0.045	1253	65.3	208.5	3.2	3.3	4.0	0.0	64	6.0	0.59	1.75
S90020	Leveed	0.0178	0.0060	0.30	3	4.0	0.045	1529	306.9	330.1	1.1	1.1	1.1	2.9	307	4.6	0.79	0.41
C910B10	Leveed	0.0158	0.0060	0.90	3	4.0	0.045	2521	420.0	522.9	1.2	1.2	1.3	2.7	420	4.8	0.76	0.47
RR91010	Leveed	0.0131	0.0050	0.60	3	5.0	0.045	2907	421.2	602.9	1.4	1.4	1.4	3.6	421	4.8	0.71	0.45
C92010	Leveed	0.0103	0.0040	1.70	3	5.0	0.045	3898	429.7	780.5	1.8	1.8	1.8	3.2	429	5.0	0.65	0.46
S115AR	Excavated	0.0131	0.0080	0.30	3	4.0	0.045	2202	95.2	326.8	3.4	3.5	4.0	0.0	94	6.7	0.64	1.99
S115AL	Excavated	0.0129	0.0080	0.10	3	4.0	0.045	2202	95.2	326.8	3.4	3.5	4.0	0.0	94	6.7	0.64	1.99

Basins Hydraulics Summary

			Design Geometry				Hydraulics					
Structure ID	Type	Adjacent Topo. Slope (ft/ft)	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)
D115C	Offline Basin	0.0200	1000	550	5.0	45.0	44.0	44.0	1185	0	3.0	2.0
D120	Offline Basin	0.0200	660	400	5.0	21.1	21.0	21.0	854	0	1.5	3.5

Open Channel

Structure ID	S115A20	HEC1 ID	11015I



Longitundal Geometry

Length	1489.3	ft
U/S Elev	1720.7	ft
D/S Elev	1692.1	ft
Initial Channel Slope	0.0192	ft/ft
Long-term Channel Slope	0.0070	ft/ft

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

NSTPS	1

Initial Channel XS Geometry

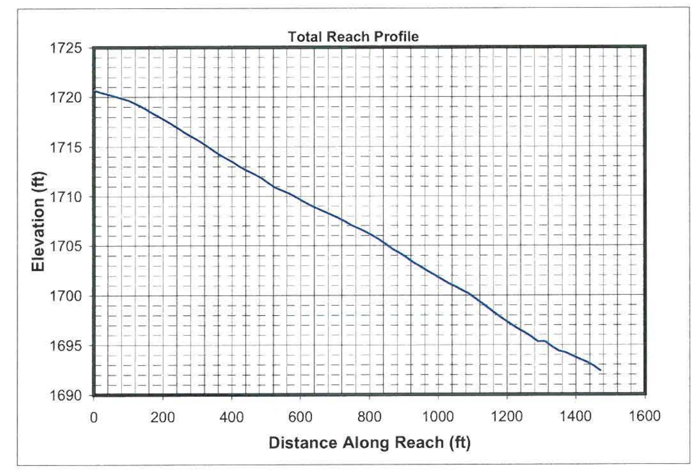
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	0	3	332	4	3	0	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	12	12	344	344	344	356
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	137	3	40	7	3	137	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	149	158	198	207	344	356
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	C115A									TOTAL
HEC1 Peak-Flow	2008									2008
Weighting Factor	1.00									
Flow into Channel	2008									2008

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	1.83	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	2008	cfs	
Long-term Max. Chnl Capacity	11072	cfs	
Q2 Channel	201	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	356	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
201	333.9	98.7	0.3	100.0	100.3	2.0	0.3	333.8	0.3	0.13	0.66
502	335.2	171.2	0.5	100.0	100.5	2.9	0.5	335.1	0.5	0.22	0.72
1506	338.3	332.2	1.0	100.0	101.0	4.5	1.0	338.0	1.0	0.43	0.81
2008	339.5	395.3	1.2	100.0	101.2	5.1	1.2	339.1	1.2	0.51	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
201	48.9	61.9	1.3	97.0	98.4	3.2	1.4	48.4	1.3	0.61	0.51
502	55.1	112.5	2.0	97.0	99.4	4.5	2.4	54.3	2.1	1.04	0.55
1506	338.7	449.9	1.3	97.0	100.9	3.3	3.9	337.4	1.3	1.71	0.51
2008	340.3	535.7	1.6	97.0	101.2	3.7	4.2	339.0	1.6	1.82	0.53

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
	11015I_S115AR	11015I_S115AL								
201	1346	1346								2693
502	4471	4471								8943
1506	19506	19506								39011
2008	28953	28953								57905

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)		
201	1.74	1.0198	0.9688	Erosive	Erosive	Erosive	0.2	Stable	6.1	Stable	Stable
502	1.74	1.1883	1.1289	Erosive	Erosive	Erosive	0.3	Stable	8.6	Stable	Stable
1506	1.74	1.3901	1.3206	Erosive	Erosive	Erosive	0.3	Stable	10.3	Stable	Stable
2008	1.74	1.4428	1.3706	Erosive	Erosive	Erosive	0.3	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)	**201**	**502**	**1506**	**2008**	**201**	**502**	**1506**	**2008**	**201**	**502**	**1506**	**2008**
Bray - Equation #1	39	63	113	131	1.6	2.1	3.0	3.3	3.3	3.8	4.4	4.6
Bray - Equation #2	51	83	148	172	1.7	2.3	3.3	3.7	2.3	2.6	3.0	3.1
Hey	12	20	36	43	4.8	6.8	10.4	11.6				
Ackers & Charlton/Lacey	33	49	78	88					1.9	2.3	2.7	2.8
Parker	97	154	267	308	1.3	1.8	2.9	3.3				
Chang	74	129	250	297	0.0	-0.2	-0.8	-1.0				
Kellerhals	26	40	70	81	2.3	3.3	5.1	5.7	3.5	3.8	4.2	4.4
AMAFCA/Schumm	48	54	338	339								
Moody & Odem	15	15	15	15	1.0	1.0	1.0	1.0				
BUREC	18.2	25.7	38.8	43.2	5	7	10	12	3.6	4.5	5.9	6.3
Average	41	63	135	152	2.2	3.0	4.4	4.9	2.9	3.4	4.1	4.3
Values As Designed	48	54	337	339	1.4	2.4	3.9	4.2	3.2	4.5	3.3	3.7
Difference with Design	-7	9	-202	-187	0.8	0.6	0.5	0.7	-0.3	-1.1	0.7	0.5

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
201	2158	1376	3051	4165	5594	746	641	355	9401	678	2325	2772
502	8930	4378	8777	19730	8216	3045	2015	1746	24512	2311	9574	8476
1506	48574	15651	25900	126917	12386	14256	6454	8729	74886	10941	44884	35416
2008	75656	21583	34013	206487	13711	21216	8600	12924	100073	16555	66054	52443

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
201	3988	2543	5636	7695	10335	1378	1185	655	17369	1252	4296	5121
502	6600	3235	6486	14581	6072	2251	1489	1291	18116	1708	7076	6264
1506	11966	3856	6380	31266	3051	3512	1590	2150	18448	2695	11057	8725
2008	13978	3988	6284	38151	2533	3920	1589	2388	18490	3059	12204	9689

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
201	1514	677	1056	3039	1117	344	238	343	2135	329	1742	1139
502	5819	1961	2763	13299	1702	1206	641	1244	5451	1223	6196	3773
1506	11939	4901	8035	24019	8008	2690	1826	2698	16056	2562	13648	8762
2008	18584	6986	11107	39045	8979	4066	2523	4148	21597	3930	20759	12884

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
201	2797	1251	1951	5616	2064	635	440	633	3945	607	3218	2105
502	4301	1449	2042	9829	1258	891	474	919	4028	904	4579	2789
1506	2941	1207	1979	5917	1973	663	450	665	3955	631	3362	2158
2008	3434	1291	2052	7214	1659	751	466	766	3990	726	3835	2380

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)
201	0.0025	0.0041	140	0.43	0.047	0.0009	30	0.036	0.0006	0.0159	0.0009	0.0020	0.0060	0.0003	0.0027	0.0192	0.0069
502	0.0013	0.0024	184	0.56	0.050	0.0005	31	0.036	0.0004	0.0159	0.0005	0.0011	0.0060	0.0002	0.0013	0.0192	0.0066
1506	0.0006	0.0012	256	0.78	0.053	0.0003	32	0.036	0.0002	0.0159	0.0003	0.0006	0.0060	0.0001	0.0006	0.0192	0.0065
2008	0.0005	0.0010	278	0.85	0.054	0.0002	32	0.036	0.0002	0.0159	0.0002	0.0005	0.0060	0.0001	0.0005	0.0192	0.0064

Drop Structures

Design Slope	0.0070	ft/ft
Total Drop Needed	18.2	ft
Height of Drop Structure	3	ft
No . of Drop Structures	7	
Distance between structs.	213	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	1.22	ac ft

Sedimentation Basins

Length	213 ft	Depth	3 ft
Width	356 ft	Side slope	3 ft/ft
Total Volume per Basin		4.87	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)
201	1.1	-0.4	0.1	24.6	1.4	1.3	3.2	0.0070	0.2	0.0	3.0	4.2
502	1.1	-0.6	0.3	24.6	2.4	2.1	4.5	0.0070	0.3	0.0	3.0	4.4
1506	1.1	-1.1	0.2	24.6	3.9	1.3	3.3	0.0070	0.4	0.0	3.0	4.6
2008	1.1	-1.1	0.2	24.6	4.2	1.6	3.7	0.0070	0.5	0.0	3.0	4.6

Toe Protection Needed	5.0	ft

HEC1 Results For Open Channel

Peak Flow	617	cfs
Stage at Peak Flow	100.6	ft
Flow Volume	38.0	ac. ft

Freeboard

Max. Flow Depth	1.2	ft
Channel Depth as designed	4.0	ft
Available Freeboard	2.8	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	1.22	ac. ft
Outflowing Sediment Volume	0.04	ac. ft
Deposited(+)/Eroded(-) Volume	1.18	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	1489	1489
Side Slope (?H:1V)	3	3
Channel Width (ft)	356	356
Channel XS Area (sq. ft)	1523	1523
Channel Perimeter (ft)	358	358

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	1489	ft
Thickness	1.5	ft
Protection Depth	5	ft
Tie-in Length/Depth	3.0	ft
Total Depth	8.0	ft
Area needed	496	sq. Yd
Volume	1324	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	1489	1489
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)	6452	13401
Left Levee Volume (cu. Yd)	5735	13787
Right Levee Length (ft)	1489	1489
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)	6452	13401
Right Levee Volume (cu. Yd)	5735	13787
Total Levee Surface Area (sq. Yd)	12904	26802
Total Levee Volume (cu. Yd)	11470	27574

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	1489	1489
Left Levee Lining Width (ft)	13	30
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	2151	4963
Left Levee Lining Volume (cu. Yd)	1075	2482
Right Levee Length (ft)	1489	1489
Right Levee Lining Width (ft)	13	30
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	2151	4963
Right Levee Lining Volume (cu. Yd)	1075	2482
Total Lining Area (sq. Yd)	4302	9927
Total Lining Volume (cu. Yd)	2150	4964

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	356	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	7	
Volume per structure	376	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 28,200	
Area per structure	119	sq. Yd
Total Area	831	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	7857	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 31,428	
Other Cost	$ -	
Total cost per basin	$ 31,428	
Area per basin	8,415	sq. Yd
Total Area	8,415	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	11,470	cu. Yd	$ 7.00	$ 80,290	12,904	sq. Yd	$ 9.00	$ 116,136	12,904	sq. Yd	$ 11.67	$ 150,547
Levee - LC Enhancement	Fill	16,104	cu. Yd	$ 7.00	$ 112,728	13,898	sq. Yd	$ 9.00	$ 125,082	16,104	sq. Yd	$ 11.67	$ 187,880
Levee Lining	Riprap	2,150	cu. Yd	$ 75.00	$ 161,250	4,302	sq. Yd	$ -	$ -	4,302	sq. Yd	$ 20.83	$ 89,616
Levee Lining -LC Enhancement	Riprap	2,814	cu. Yd	$ 75.00	$ 211,050	5,625	sq. Yd	$ -	$ -	5,625	sq. Yd	$ 20.83	$ 117,190
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	1,324	cu. Yd	$ 75.00	$ 99,300	496	sq. Yd	$ -	$ -	496	sq. Yd	$ 25.00	$ 12,400
Drop Structures	Riprap	7	EA	$ 28,200.00	$ 197,400	831	sq. Yd	$ -	$ -	831	sq. Yd	$ 33.33	$ 27,700
Drop Str. - LC Enhancement	Riprap	7	EA	$ 2,820.00	$ 19,740	83	sq. Yd	$ -	$ -	83	sq. Yd	$ 33.33	$ 2,770
Sedimentation Basins		1	EA	$ 31,428.00	$ 31,428	8,415	sq. Yd	$ -	$ -	8,415	sq. Yd	$ 8.33	$ 70,125
Other					$ -				$ -				$ -

Base Landscape Cost	$ 116,136	
LC Enhancement Cost	$ 125,082	
Total Landscape Cost	$ 241,218	

Base Maintenance Cost	$ 350,387
LC Enhancement Cost	$ 307,840
Total Maintenance Cost	$ 658,227

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 569,668	$ 343,518	$ 913,186
Contingency Cost (25% of Construction Cost)	$ 142,417	$ 85,880	$ 228,297
Engineering Design Cost (5% of Construction Cost)	$ 28,483	$ 17,176	$ 45,659
Total Construction Cost	$ 740,568	$ 446,573	$ 1,187,142

Land Cost

Channel Length	1489 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	356	12.2	$100,000	$ 1,220,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	52	1.8	$100,000	$ 180,000
Levee LC Enhancement	48	1.6	$100,000	$ 160,000
Other	0	0	$100,000	$ -
Total	456	15.6		$ 1,560,000

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	14	$100,000	$ 1,400,000
LC Enhancement Cost	acre	1.6	$100,000	$ 160,000
Total Land Cost	acre	15.6	$100,000	$ 1,560,000

Total Cost

Base Total Cost	$ 2,607,092
Total Landscape Enhancement Cost	$ 1,039,495
Total Cost Including LC Enh.	$ 3,646,587

Open Channel

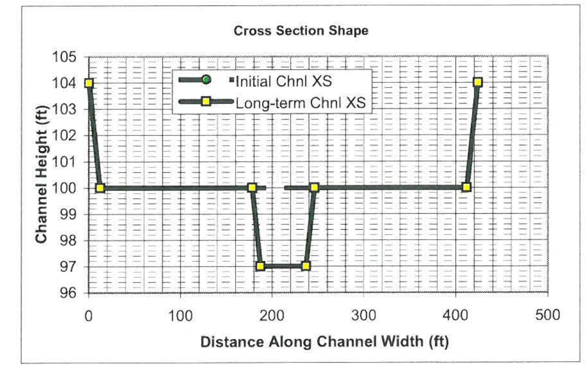
Structure ID	RR115A10	HEC1 ID	15I15A

Longitundal Geometry

Length	3083.7	ft
U/S Elev	1692.1	ft
D/S Elev	1633.3	ft
Initial Channel Slope	0.0191	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

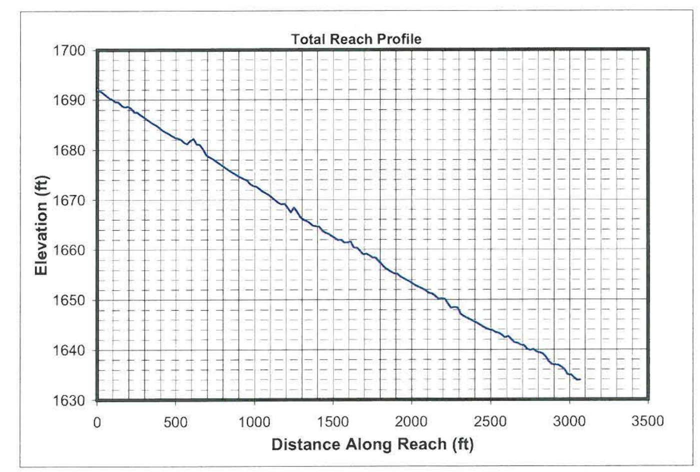
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	0	3	400	4	3	0	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	12	12	412	412	412	424
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	166	3	50	7	3	166	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	178	187	237	246	412	424
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

										TOTAL
Contributing HEC1 ID	C115B									TOTAL
HEC1 Peak-Flow	2103									2103
Weighting Factor	1.00									
Flow into Channel	2103									2103

Reach Sediment Inflow Characteristics

U/S Contributing ID	11015I_S115A20									TOTAL
HEC1 Flow Volume (ac. ft)	38.00									38
Sediment Conc. (ppm)	2789									
Sediment Volume (ac. ft)	0.04									0.04
Weighting Factor	1									
Weighted Sed. Vol. (ac. ft)	0.04									0.04

Hydrology

Drainage Area	1.83	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	2103	cfs	
Long-term Max. Chnl Capacity	13330	cfs	
Q2 Channel	210	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	424	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
210	401.7	109.5	0.3	100.0	100.3	1.9	0.3	401.6	0.3	0.12	0.65
526	403.0	189.9	0.5	100.0	100.5	2.8	0.5	402.8	0.5	0.21	0.71
1577	405.8	368.0	0.9	100.0	100.9	4.3	0.9	405.5	0.9	0.40	0.79
2103	406.9	437.9	1.1	100.0	101.1	4.8	1.1	406.5	1.1	0.47	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
210	58.0	68.2	1.2	97.0	98.3	3.1	1.3	57.6	1.2	0.55	0.50
526	63.7	122.7	1.9	97.0	99.2	4.3	2.2	63.0	1.9	0.95	0.54
1577	406.0	497.3	1.2	97.0	100.8	3.2	3.8	404.8	1.2	1.66	0.50
2103	407.5	591.9	1.5	97.0	101.0	3.6	4.0	406.2	1.5	1.76	0.52

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
	11015I_S115A20									
210	1139									1139
526	3773									3773
1577	8762									8762
2103	12884									12884

Allowable Velocity

Channel Lining	Natural - Sandy Loam (noncolloidal)

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)		
210	1.74	0.9947	0.9449	Erosive	Erosive	Erosive	0.2	Stable	5.7	Stable	Stable
526	1.74	1.1636	1.1055	Erosive	Erosive	Erosive	0.2	Stable	8.2	Stable	Stable
1577	1.74	1.3656	1.2973	Erosive	Erosive	Erosive	0.3	Stable	10.0	Stable	Stable
2103	1.74	1.4184	1.3474	Erosive	Erosive	Erosive	0.3	Stable	10.6	Stable	Stable

USCOE Allowable Velocity (ft/s)	2
FHWA Allowable Velocity (ft/s)	2.5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	**210**	**526**	**1577**	**2103**	**210**	**526**	**1577**	**2103**	**210**	**526**	**1577**	**2103**
Bray - Equation #1	40	65	115	134	1.6	2.1	3.1	3.4	3.3	3.8	4.4	4.6
Bray - Equation #2	52	85	152	176	1.7	2.3	3.4	3.7	2.3	2.6	3.0	3.2
Hey	12	20	37	44	4.9	7.0	10.6	11.8				
Ackers & Charlton/Lacey	34	50	79	90					2.0	2.3	2.7	2.9
Parker	100	158	273	315	1.3	1.9	2.9	3.3				
Chang	76	133	257	305	0.0	-0.2	-0.8	-1.0				
Kellerhals	26	41	71	83	2.3	3.3	5.2	5.8	3.5	3.8	4.3	4.4
AMAFCA/Schumm	58	63	405	407								
Moody & Odem	15	15	15	15	1.0	1.0	1.0	1.0				
BUREC	18.5	26.1	39.5	43.9	5	7	11	12	3.6	4.5	6.0	6.4
Average	43	66	144	161	2.2	3.1	4.5	5.0	2.9	3.4	4.1	4.3
Values As Designed	58	63	405	406	1.3	2.2	3.8	4.0	3.1	4.3	3.2	3.6
Difference with Design	-14	3	-260	-245	1.0	0.9	0.7	0.9	-0.2	-0.9	0.9	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
210	2076	1363	2993	3915	6297	699	625	320	9636	677	2202	2800
526	8562	4407	8944	18548	9329	2952	2043	1663	25304	2271	9297	8484
1577	46805	15997	27231	119533	14127	14010	6697	8602	77534	10695	44416	35059
2103	72932	22110	35576	194577	15649	20867	8948	12799	103650	16174	65597	51716

Discharge (cfs)	Sediment Concentrations (ppm by weight)											
	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
210	3662	2404	5281	6906	11109	1233	1103	564	16999	1195	3885	4940
526	6042	3110	6312	13089	6583	2083	1441	1173	17856	1602	6560	5987
1577	11009	3763	6405	28116	3323	3296	1575	2023	18238	2516	10448	8247
2103	12866	3901	6276	34326	2761	3681	1579	2258	18285	2853	11572	9123

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
210	1485	691	1093	2912	1262	340	245	335	2224	324	1718	1148
526	5793	2031	2937	12972	1901	1216	671	1254	5698	1218	6245	3812
1577	11622	4960	8290	22878	9098	2646	1873	2626	16728	2511	13389	8784
2103	18103	7102	11436	37218	10215	4020	2605	4071	22531	3850	20462	12874

Discharge (cfs)	Sediment Concentrations (ppm by weight)											
	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
210	2619	1219	1928	5138	2227	599	432	591	3924	571	3030	2025
526	4088	1433	2072	9154	1342	858	473	885	4021	859	4407	2690
1577	2734	1167	1950	5381	2140	622	440	618	3935	591	3149	2066
2103	3194	1253	2017	6566	1802	709	460	718	3975	679	3610	2271

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)
210	0.0028	0.0044	134	0.41	0.047	0.0009	30	0.036	0.0007	0.0159	0.0009	0.0022	0.0059	0.0003	0.0030	0.0190	0.0069
526	0.0014	0.0026	177	0.54	0.049	0.0006	30	0.036	0.0004	0.0159	0.0005	0.0012	0.0059	0.0002	0.0015	0.0190	0.0066
1577	0.0006	0.0013	245	0.75	0.052	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0006	0.0059	0.0001	0.0007	0.0191	0.0064
2103	0.0005	0.0011	267	0.81	0.053	0.0003	32	0.036	0.0002	0.0159	0.0002	0.0005	0.0059	0.0001	0.0005	0.0191	0.0064

Drop Structures

Design Slope	0.0070	ft/ft
Total Drop Needed	37.2	ft
Height of Drop Structure	3	ft
No . of Drop Structures	13	
Distance between structs.	237	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	1.60	sq. mi
Total Sediment Yield Volume	3.05	ac ft

Sedimentation Basins

Length	237 ft	Depth	3 ft
Width	424 ft	Side slope	3 ft/ft
Total Volume per Basin		6.52	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 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)
210	1.1	-0.4	0.1	24.6	1.3	1.2	3.1	0.0070	0.1	0.0	3.0	4.2
526	1.1	-0.6	0.3	24.6	2.2	1.9	4.3	0.0070	0.2	0.0	3.0	4.4
1577	1.1	-1.1	0.1	24.6	3.8	1.2	3.2	0.0070	0.4	0.0	3.0	4.5
2103	1.1	-1.1	0.2	24.6	4.0	1.5	3.6	0.0070	0.4	0.0	3.0	4.6

Toe Protection Needed	5.0	ft

HEC1 Results For Open Channel

Peak Flow	1931	cfs
Stage at Peak Flow	101.0	ft
Flow Volume	135.0	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	3.09	ac. ft
Outflowing Sediment Volume	0.14	ac. ft
Deposited(+)/Eroded(-) Volume	2.95	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	3084	3084
Side Slope (?H:1V)	3	3
Channel Width (ft)	424	424
Channel XS Area (sq. ft)	1825	1825
Channel Perimeter (ft)	426	426

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	3084	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	2741	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	3084	3084
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)	13364	27756
Left Levee Volume (cu. Yd)	11879	28556
Right Levee Length (ft)	3084	3084
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)	13364	27756
Right Levee Volume (cu. Yd)	11879	28556
Total Levee Surface Area (sq. Yd)	26728	55512
Total Levee Volume (cu. Yd)	23758	57112

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	3084	3084
Left Levee Lining Width (ft)	13	30
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	4455	10280
Left Levee Lining Volume (cu. Yd)	2227	5140
Right Levee Length (ft)	3084	3084
Right Levee Lining Width (ft)	13	30
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	4455	10280
Right Levee Lining Volume (cu. Yd)	2227	5140
Total Lining Area (sq. Yd)	8909	20560
Total Lining Volume (cu. Yd)	4454	10280

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	424	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	6.0	ft
Structure Height	9.0	ft
Number of Structures	13	
Volume per structure	425	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 31,875	
Area per structure	141	sq. Yd
Total Area	1,837	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	2	
Total Volume per Basin	10519	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 42,076	
Other Cost	$ -	
Total cost per basin	$ 42,076	
Area per basin	11,175	sq. Yd
Total Area	22,350	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	23,758	cu. Yd	$ 7.00	$ 166,306	26,728	sq. Yd	$ 9.00	$ 240,552	26,728	sq. Yd	$ 11.67	$ 311,827
Levee - LC Enhancement	Fill	33,354	cu. Yd	$ 7.00	$ 233,478	28,784	sq. Yd	$ 9.00	$ 259,056	33,354	sq. Yd	$ 11.67	$ 389,130
Levee Lining	Riprap	4,454	cu. Yd	$ 75.00	$ 334,050	8,909	sq. Yd	$ -	$ -	8,909	sq. Yd	$ 20.83	$ 185,611
Levee Lining -LC Enhancement	Riprap	5,826	cu. Yd	$ 75.00	$ 436,950	11,651	sq. Yd	$ -	$ -	11,651	sq. Yd	$ 20.83	$ 242,722
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	2,741	cu. Yd	$ 75.00	$ 205,575	1,028	sq. Yd	$ -	$ -	1,028	sq. Yd	$ 25.00	$ 25,700
Drop Structures	Riprap	13	EA	$ 31,875.00	$ 414,375	1,837	sq. Yd	$ -	$ -	1,837	sq. Yd	$ 33.33	$ 61,233
Drop Str. - LC Enhancement	Riprap	13	EA	$ 3,187.50	$ 41,438	184	sq. Yd	$ -	$ -	184	sq. Yd	$ 33.33	$ 6,123
Sedimentation Basins		2	EA	$ 42,076.00	$ 84,152	22,350	sq. Yd	$ -	$ -	22,350	sq. Yd	$ 8.33	$ 186,250
Other					$ -				$ -				$ -

Base Landscape Cost	$ 240,552	
LC Enhancement Cost	$ 259,056	
Total Landscape Cost	$ 499,608	

Base Maintenance Cost	$ 770,621
LC Enhancement Cost	$ 637,976
Total Maintenance Cost	$ 1,408,597

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,204,458	$ 711,866	$ 1,916,324
Contingency Cost (25% of Construction Cost)	$ 301,115	$ 177,966	$ 479,081
Engineering Design Cost (5% of Construction Cost)	$ 60,223	$ 35,593	$ 95,816
Total Construction Cost	$ 1,565,795	$ 925,425	$ 2,491,221

Land Cost

Channel Length	3084 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	424	30	$100,000	$ 3,000,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	52	3.7	$100,000	$ 370,000
Levee LC Enhancement	48	3.4	$100,000	$ 340,000
Other	0	0	$100,000	$ -
Total	524	37.1		$ 3,710,000

Right of Way

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

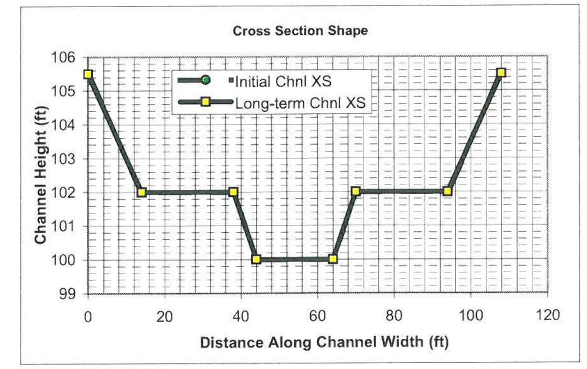
Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	33.7	$100,000	$ 3,370,000
LC Enhancement Cost	acre	3.4	$100,000	$ 340,000
Total Land Cost	acre	37.1	$100,000	$ 3,710,000

Total Cost

Base Total Cost	$ 5,946,969
Total Landscape Enhancement Cost	$ 2,162,457
Total Cost Including LC Enh.	$ 8,109,425

Open Channel

Structure ID	RR115B10	HEC1 ID	15I15B



Longitundal Geometry

Length	8073.3	ft
U/S Elev	1633.3	ft
D/S Elev	1537.8	ft
Initial Channel Slope	0.0118	ft/ft
Long-term Channel Slope	0.0015	ft/ft

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

NSTPS	7

Initial Channel XS Geometry

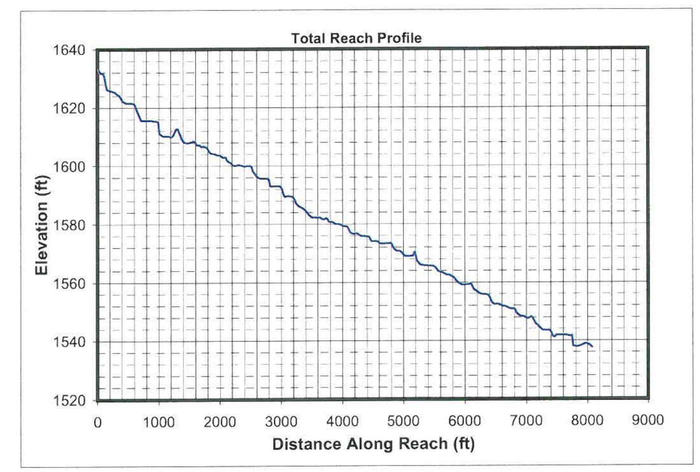
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
4	3.5	24	3	20	5.5	3	24	3.5	4

PT. ID	1	2	3	4	5	6	7	8
X	0	14	38	44	64	70	94	108
Y	105.5	102	102	100	100	102	102	105.5

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
4	3.5	24	3	20	5.5	3	24	3.5	4

PT. ID	1	2	3	4	5	6	7	8
X	0	14	38	44	64	70	94	108
Y	105.5	102	102	100	100	102	102	105.5



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	0.03	0.03	0.03	0.03	0.03	0.03

HEC1 Results Used to Determine Design Peak Flows

										TOTAL
Contributing HEC1 ID	D115C									
HEC1 Peak-Flow	1000									1000
Weighting Factor	1.00									
Flow into Channel	1000									1000

Reach Sediment Inflow Characteristics

U/S Contributing ID	15I15A_RR115A10									TOTAL
HEC1 Flow Volume (ac. ft)	135.00									135
Sediment Conc. (ppm)	2690									
Sediment Volume (ac. ft)	0.14									0.14
Weighting Factor	1									
Weighted Sed. Vol. (ac. ft)	0.14									0.14

Hydrology

Drainage Area	0.42	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	1000	cfs	
Long-term Max. Chnl Capacity	1683	cfs	
Q2 Channel	100	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	108	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
100	25.9	21.2	0.8	100.0	100.9	4.7	0.9	25.6	0.8	0.09	0.92
250	29.9	38.9	1.3	100.0	101.6	6.4	1.6	29.4	1.3	0.15	0.99
750	86.9	115.1	1.3	100.0	102.8	6.5	2.8	86.1	1.3	0.26	0.99
1000	89.1	138.2	1.6	100.0	103.0	7.2	3.0	88.2	1.6	0.28	1.02

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	30.6	42.1	1.4	100.0	101.7	2.4	1.7	30.1	1.4	0.16	0.35
250	86.5	110.4	1.3	100.0	102.7	2.3	2.7	85.6	1.3	0.25	0.35
750	96.7	223.3	2.3	100.0	104.0	3.4	4.0	95.6	2.3	0.37	0.39
1000	100.6	269.6	2.7	100.0	104.4	3.7	4.4	99.4	2.7	0.41	0.40

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
	15I15A_RR115A 10									
100	1148									1148
250	3812									3812
750	8784									8784
1000	12874									12874

Allowable Velocity

Channel Lining	Natural - Sandy Loam (noncolloidal)

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	1.3370	1.2702	Erosive	Erosive	Erosive	0.3	Erosive	3.1	Erosive	Stable
250	1.74	1.4812	1.4072	Erosive	Erosive	Erosive	0.3	Erosive	3.9	Erosive	Stable
750	1.74	1.4851	1.4108	Erosive	Erosive	Erosive	0.3	Erosive	5.3	Erosive	Stable
1000	1.74	1.5339	1.4572	Erosive	Erosive	Erosive	0.4	Erosive	5.7	Erosive	Stable

USCOE Allowable Velocity (ft/s)	2
FHWA Allowable Velocity (ft/s)	2.5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	**100**	**250**	**750**	**1000**	**100**	**250**	**750**	**1000**	**100**	**250**	**750**	**1000**
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	28	49	97	116	0.5	0.6	0.7	0.6				
Kellerhals	18	28	49	57	1.7	2.5	3.8	4.3	3.2	3.5	4.0	4.1
AMAFCA/Schumm	30	86	96	100								
Moody & Odem	9	9	9	9	0.8	0.8	0.8	0.8				
BUREC	16.1	22.7	34.2	38.1	4	6	9	10	2.3	2.9	3.8	4.0
Average	26	45	74	84	1.8	2.5	3.7	4.1	2.5	2.8	3.4	3.5
Values As Designed	30	86	96	99	1.7	2.7	4.0	4.4	2.4	2.3	3.4	3.7
Difference with Design	-4	-40	-22	-15	0.1	-0.2	-0.2	-0.3	0.1	0.6	0.0	-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
100	2261	1265	1788	3899	626	905	618	787	2379	469	2144	1558
250	8549	3406	4339	16752	965	2888	1498	2515	6012	1009	7069	5000
750	26365	9940	13124	51240	2843	8815	4538	7681	18041	2946	21608	15195
1000	40579	13639	17787	82145	3198	12821	5969	11044	24104	3170	31411	22352

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
100	8388	4692	6635	14463	2323	3358	2291	2921	8827	1741	7956	5781
250	12687	5055	6438	24860	1432	4286	2223	3732	8922	1497	10491	7420
750	13042	4917	6492	25347	1406	4361	2245	3800	8924	1457	10689	7516
1000	15055	5060	6599	30476	1186	4757	2215	4097	8942	1176	11653	8292

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	117	105	99	115	208	26	35	58	70	6	117	87
250	276	242	223	263	541	60	81	132	162	15	271	206
750	1416	1083	1150	1576	1085	330	363	763	696	72	1539	916
1000	2161	1550	1560	2500	1282	488	507	1152	965	95	2359	1329

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
100	433	389	367	427	771	98	128	215	260	21	435	322
250	409	360	331	390	803	89	120	196	240	22	402	306
750	701	536	569	780	537	163	180	377	344	35	761	453
1000	802	575	579	928	475	181	188	427	358	35	875	493

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	0.0006	0.0008	183	0.56	0.050	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0005	0.0075	0.0005	0.0018	0.0117	0.0050
250	0.0003	0.0005	231	0.70	0.052	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0003	0.0075	0.0003	0.0009	0.0116	0.0049
750	0.0003	0.0005	233	0.71	0.052	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0003	0.0075	0.0002	0.0004	0.0117	0.0049
1000	0.0003	0.0004	252	0.77	0.053	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0002	0.0075	0.0002	0.0003	0.0117	0.0049

Drop Structures

Design Slope	0.0015	ft/ft
Total Drop Needed	83.4	ft
Height of Drop Structure	3	ft
No . of Drop Structures	28	
Distance between structs.	288	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	0.43	sq. mi
Total Sediment Yield Volume	0.82	ac ft

Sedimentation Basins

Length	288 ft	Depth	3 ft
Width	108 ft	Side slope	3 ft/ft
Total Volume per Basin		1.91	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				Max. Depth	Hyd. Depth	Avg Vel	Se	Bend Scour	LongTerm Scour	Thalweg channel	Total
	COT/PC	General	Antidune	Bend								
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	1.7	1.4	2.4	0.0015	0.2	0.0	1.0	1.6
250	1.1	-0.4	0.1	24.6	2.7	1.3	2.3	0.0015	0.3	0.0	1.0	1.8
750	1.1	-0.4	0.2	24.6	4.0	2.3	3.4	0.0015	0.5	0.0	1.0	2.1
1000	1.1	-0.3	0.2	24.6	4.4	2.7	3.7	0.0015	0.6	0.0	1.0	2.2

Toe Protection Needed	3.0	ft

HEC1 Results For Open Channel

Peak Flow	2060	cfs
Stage at Peak Flow	103.8	ft
Flow Volume	153.0	ac. ft

Freeboard

Max. Flow Depth	3.0	ft
Channel Depth as designed	5.5	ft
Available Freeboard	2.5	ft
Required Freeboard	1.2	ft

Sediment Volume

Inflowing Sediment Volume	0.95	ac. ft
Outflowing Sediment Volume	0.03	ac. ft
Deposited(+)/Eroded(-) Volume	0.92	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Existing	Existing
Channel Length (ft)	8073	8073
Side Slope (?H:1V)	3	3
Channel Width (ft)	108	108
Channel XS Area (sq. ft)	381	381
Channel Perimeter (ft)	110	110

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	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	0	ft
Thickness	0.0	ft
Protection Depth	0	ft
Tie-in Length/Depth	0.0	ft
Total Depth	0.0	ft
Area needed	0	sq. Yd
Volume	0	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)	8073	8073
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)	8073	8073
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	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	0	ft
LC Enhancement Ratio	1.1	
Structure Thickness	0	ft
Drop Height	0	ft
Scour Depth		ft
Structure Height		ft
Number of Structures	0	
Volume per structure	0	cu. Yd
Unit Cost	$ -	cu. Yd
Other Cost	$ -	
Cost per structure	$ -	
Area per structure	0	sq. Yd
Total Area	0	sq. Yd

Sedimentation Basins		
Include Sed. Basins	No	
(Yes/No)		
Number of basins	0	
Total Volume per Basin	3081	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	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	Existing	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Existing	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	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Drop Structures	None	0	EA	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Drop Str. - LC Enhancement	None	0	EA	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Sedimentation Basins		2	EA	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ 8.33	$ -
Other					$ -				$ -				$ -

Base Landscape Cost	$ -	Base Maintenance Cost	$ -
LC Enhancement Cost	$ -	LC Enhancement Cost	$ -
Total Landscape Cost	$ -	Total Maintenance Cost	$ -

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ -	$ -	$ -
Contingency Cost (25% of Construction Cost)	$ -	$ -	$ -
Engineering Design Cost (5% of Construction Cost)	$ -	$ -	$ -
Total Construction Cost	$ -	$ -	$ -

Land Cost

Channel Length	0 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	14	0	$0	$ -
LC Enhancement Buffer	0	0	$0	$ -
Channel	108	0	$0	$ -
Channel LC Enhancement	0	0	$0	$ -
Levee	0	0	$0	$ -
Levee LC Enhancement	0	0	$0	$ -
Other	0	0	$0	$ -
Total	122	0		$ -

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	0	$0	$ -
LC Enhancement Cost	acre	0	$0	$ -
Total Land Cost	acre	0	$0	$ -

Total Cost

Base Total Cost	$ -
Total Landscape Enhancement Cost	$ -
Total Cost Including LC Enh.	$ -

Offline Basin

HEC1 ID	D115C

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

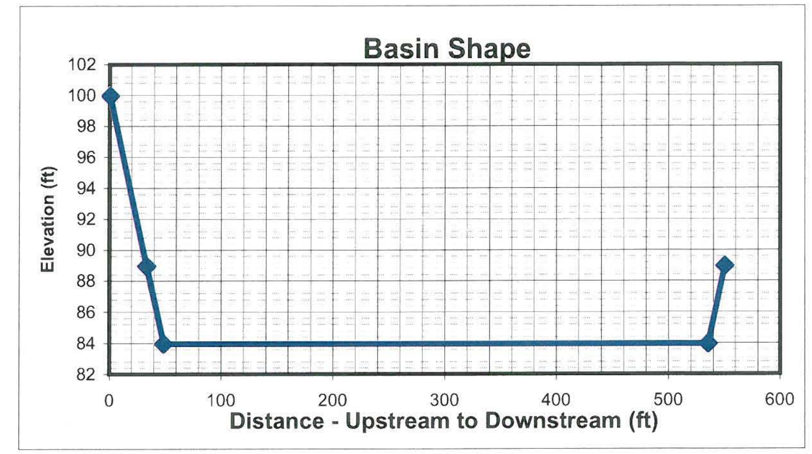
Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.0	sq. mi
Total Sediment Yield Volume	0.0	ac ft

Required Minimum Sediment Volume

Sediment Volume	0.0	ac. ft

Geometry	Base	LC Enhanced
Topography slope (ft/ft)	0.02	0.02
Basin Length (ft)	1000	1130
Basin Width (ft)	550	550
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	5	5
Freeboard (ft)	1	1
Effective Basin Width (ft)	517	484
Top Area (acres)	12.6	14.3
U/S-D/S Height Difference (ft)	11.0	11.0
Excess Area on Upstream (acres)	0.8	1.7

			Base	LC Enhanced
Bottom Length (ft)	970	Allocated Storage Volume (ac. ft)	45.0	45
Bottom Width (ft)	487	Total Available Volume (ac. ft) (incl. Freeboard)	56.8	57.4
		Total Excavation Volume (ac. ft)	126.3	135.9



HEC1 Results

	6-hr Event	24-hr Event	Maximum
Peak flow before diversion (cfs)	2000	2185	2185
Peak flow after diversion (cfs)	1000	1000	1000
Diverted Peak Flow (cfs)	1000	1185	1185
Total Diverted Flow Volume (ac. ft)	39.0	44	44.0
Peak Stage	3	ft	

Volume Check

Total Volume needed	44.0	ac. ft
Total Volume Provided	45.0	ac. ft
Volume OK?	Yes	

Stage Check

Depth Needed	4.0
Depth Provided	5
Depth OK?	Yes

Stage-Storage-Discharge

Stage (ft)												
Inflow (cfs)	0	200	400	600	800	1000	1100	1200	1500	2000	2500	3000
Outflow (cfs)	0	0	0	0	0	0	100	200	500	1000	1500	2000

capacity based on FlowMaster results with 1 ft freeboarc

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

Sub-area: CAP, Alternative: A
Offline Basin Structure ID: D115C

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
Landscape Enhancement	249500	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	1000	ft
Base Total ROW Width	550	ft
LC Enh. Total ROW Length	1230	ft
LC Enh. Total ROW Length	650	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	203764	219252
Excavated Area (sq. Yd)	61111	88833

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	51	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	562	sq. Yd
Material Volume	281	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	333	ft
Unit Cost	160	per ft
Cost per outlet	$53,280	
Other Cost	$ -	
Total Cost	$53,280	
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		203,764	cu. Yd	$ 4.00	$ 815,056	61,111	sq. Yd	$ 9.00	$ 549,999	61,111	sq. Yd	$ 8.33	$ 509,258
Basin - LC Enhanced		15,488	cu. Yd	$ 4.00	$ 61,952	27,722	sq. Yd	$ 9.00	$ 249,498	27,722	sq. Yd	$ 8.33	$ 231,017
Inlet	Riprap	281	sq. Yd	$ 75.00	$ 21,075	562	sq. Yd	$ -	$ -	562	sq. Yd	$ 33.33	$ 18,733
Inlet - LC Enhanced (20%Total)					$ 4,215				$ -				$ 3,747
Outlet	Pipe	1	EA	$ 53,280	$ 53,280	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhanced (5%Total)					$ 2,664				$ -				$ 111
Other					$ -				$ -				$ -

Base Landscape Cost	$ 549,999	
LC Enh. Landscape Cost	$ 249,498	
Total Landscape Cost	$ 799,497	

Base Maintenance Cost	$ 530,208
LC Enh. Maintenance Cost	$ 234,874
Total Maintenance Cost	$ 765,083

Construction Cost Component	Base	LC Enhanced	Total
Construction Cost	$ 889,411	$ 61,952	$ 951,363
Contingency Cost (25% of Construction Cost)	$ 222,353	$ 15,488	$ 237,841
Engineering Design Cost (5% of Construction Cost)	$ 44,471	$ 3,098	$ 47,568
Total Construction Cost	$ 1,156,234	$ 80,538	$ 1,236,772

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	5.7	$100,000	$ 572,773
Basin	12.6	$100,000	$ 1,260,000
Other		$100,000	$ -
Total	18.4	$100,000	$ 1,840,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	12.6	$100,000	$ 1,262,626
LC Enhancement Cost	acre	5.8	$100,000	$ 577,374
Total Land Cost	acre	18.4	$100,000	$ 1,840,000

Total Cost

Base Total Cost	$ 3,499,068
Total LC Enhancement Cost	$ 1,142,284
Total Cost Including LC Enh.	$ 4,641,351

Open Channel

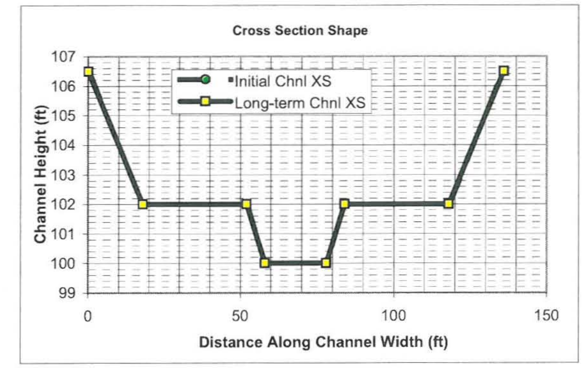
Structure ID	C12010	HEC1 ID	115120

Longitundal Geometry

Length	4136.0	ft
U/S Elev	1537.8	ft
D/S Elev	1496.4	ft
Initial Channel Slope	0.0100	ft/ft
Long-term Channel Slope	0.0015	ft/ft

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

NSTPS	3



Initial Channel XS Geometry

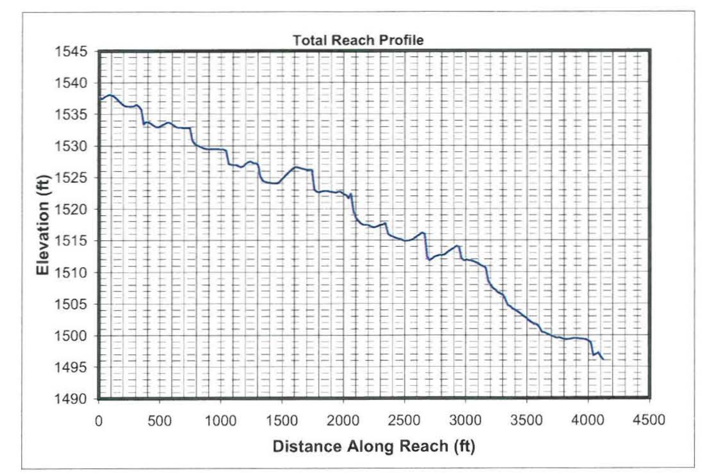
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
4	4.5	34	3	20	6.5	3	34	4.5	4

PT. ID	1	2	3	4	5	6	7	8
X	0	18	52	58	78	84	118	136
Y	106.5	102	102	100	100	102	102	106.5

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
4	4.5	34	3	20	6.5	3	34	4.5	4

PT. ID	1	2	3	4	5	6	7	8
X	0	18	52	58	78	84	118	136
Y	106.5	102	102	100	100	102	102	106.5



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	0.03	0.03	0.03	0.03	0.03	0.03

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	D120									TOTAL
HEC1 Peak-Flow	2000									2000
Weighting Factor	1.00									
Flow into Channel	2000									2000

Reach Sediment Inflow Characteristics

U/S Contributing ID	15I15B_RR115B 10									TOTAL
HEC1 Flow Volume (ac. ft)	153.00									153
Sediment Conc. (ppm)	493									
Sediment Volume (ac. ft)	0.03									0.03
Weighting Factor	1	1								
Weighted Sed. Vol. (ac. ft)	0.03									0.03

Hydrology

Drainage Area	2.68	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	2000	cfs	
Long-term Max. Chnl Capacity	2934	cfs	
Q2 Channel	200	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	136	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
200	29.2	35.4	1.2	100.0	101.5	5.7	1.5	28.7	1.2	0.14	0.90
500	104.7	102.2	1.0	100.0	102.5	4.9	2.5	103.9	1.0	0.23	0.87
1500	112.5	203.4	1.8	100.0	103.4	7.4	3.4	111.5	1.8	0.32	0.96
2000	115.4	244.2	2.1	100.0	103.8	8.2	3.8	114.3	2.1	0.36	0.99

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
200	104.9	104.3	1.0	100.0	102.5	1.9	2.5	104.1	1.0	0.24	0.34
500	111.1	185.0	1.7	100.0	103.3	2.7	3.3	110.1	1.7	0.31	0.37
1500	124.5	374.3	3.0	100.0	104.9	4.0	4.9	123.1	3.0	0.46	0.41
2000	129.6	452.0	3.5	100.0	105.5	4.4	5.5	128.1	3.5	0.52	0.42

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
	15I15B_RR115B 10									
200	87									87
500	206									206
1500	916									916
2000	1329									1329

Allowable Velocity

Channel Lining: Natural - Sandy Loam (noncolloidal)

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)		
200	1.74	1.4599	1.3869	Erosive	Erosive	Erosive	0.3	Erosive	3.6	Erosive	Stable
500	1.74	1.3904	1.3208	Erosive	Erosive	Erosive	0.3	Erosive	4.5	Erosive	Stable
1500	1.74	1.5809	1.5019	Erosive	Erosive	Erosive	0.4	Erosive	6.1	Erosive	Stable
2000	1.74	1.6295	1.5480	Erosive	Erosive	Erosive	0.4	Erosive	6.6	Erosive	Stable

USCOE Allowable Velocity (ft/s)	2
FHWA Allowable Velocity (ft/s)	2.5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	200	500	1500	2000	200	500	1500	2000	200	500	1500	2000
Bray - Equation #1	39	63	112	131	1.6	2.1	3.0	3.3	3.3	3.8	4.4	4.6
Bray - Equation #2	51	83	148	172	1.7	2.3	3.3	3.7	2.3	2.6	3.0	3.1
Hey	12	20	36	43	4.8	6.8	10.4	11.6				
Ackers & Charlton/Lacey	33	49	78	88					1.9	2.3	2.7	2.8
Parker	97	154	266	307	1.2	1.8	2.9	3.2				
Chang	43	76	150	179	0.6	0.6	0.6	0.6				
Kellerhals	25	40	70	80	2.3	3.3	5.1	5.7	3.5	3.8	4.2	4.4
AMAFCA/Schumm	104	110	123	128								
Moody & Odem	18	18	18	18	1.1	1.1	1.1	1.1				
BUREC	20.9	29.4	44.4	49.4	6	8	12	13	2.7	3.4	4.5	4.8
Average	44	64	104	119	2.4	3.2	4.8	5.3	2.7	3.2	3.8	4.0
Values As Designed	104	110	123	128	2.5	3.3	4.9	5.5	1.9	2.7	4.0	4.4
Difference with Design	-60	-46	-19	-9	-0.2	0.0	-0.1	-0.2	0.8	0.5	-0.2	-0.5

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
200	4873	2260	2869	8850	815	1673	1001	1583	3724	706	4376	2975
500	10110	5162	7388	17106	2554	3754	2554	3532	9251	2005	9611	6639
1500	53132	17696	22027	105413	4007	15715	7387	14648	28115	3073	41692	28446
2000	81696	24206	29697	168828	4503	22877	9697	20982	37548	3311	60416	42160

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
200	9040	4192	5322	16416	1511	3104	1857	2937	6907	1310	8117	5519
500	7502	3830	5482	12693	1895	2786	1895	2621	6864	1488	7131	4926
1500	13141	4377	5448	26072	991	3887	1827	3623	6954	760	10312	7036
2000	15155	4490	5509	31318	835	4244	1799	3892	6965	614	11207	7821

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
200	176	150	122	157	485	28	44	71	83	14	155	135
500	704	596	621	717	920	167	206	369	403	41	736	498
1500	3612	2447	2372	4290	1742	791	783	1894	1482	140	3936	2135
2000	5509	3455	3252	6805	2036	1154	1071	2810	2023	166	5967	3113

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
200	327	279	227	291	900	52	81	131	153	25	287	250
500	522	442	461	532	683	124	153	274	299	30	546	370
1500	893	605	587	1061	431	196	194	469	366	35	974	528
2000	1022	641	603	1262	378	214	199	521	375	31	1107	578

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)
200	0.0004	0.0005	205	0.63	0.051	0.0002	31	0.036	0.0002	0.0159	0.0002	0.0003	0.0060	0.0003	0.0013	0.0098	0.0041
500	0.0005	0.0007	184	0.56	0.050	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0004	0.0060	0.0002	0.0007	0.0099	0.0041
1500	0.0002	0.0004	250	0.76	0.053	0.0002	31	0.036	0.0001	0.0159	0.0001	0.0002	0.0060	0.0001	0.0003	0.0099	0.0041
2000	0.0002	0.0003	271	0.83	0.053	0.0001	32	0.036	0.0001	0.0159	0.0001	0.0002	0.0060	0.0001	0.0002	0.0099	0.0040

Drop Structures

Design Slope	0.0015	ft/ft
Total Drop Needed	35.2	ft
Height of Drop Structure	3	ft
No . of Drop Structures	12	
Distance between structs.	345	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	2.00	sq. mi
Total Sediment Yield Volume	3.81	ac ft

Sedimentation Basins

Length	345 ft	Depth	3 ft
Width	136 ft	Side slope	3 ft/ft
Total Volume per Basin		2.94	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		5	

Scour and Toe Protection (Not applicable for concrete channel)

Discharge Q (cfs)	Pima County General Scour Equations 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	Bend Scour Zbs (ft)	LongTerm Scour Zls (ft)	Thalweg channel Zlft (ft)	Total Zt (ft)
200	1.1	-0.5	0.1	24.6	2.5	1.0	1.9	0.0015	0.3	0.0	1.0	1.7
500	1.1	-0.4	0.1	24.6	3.3	1.7	2.7	0.0015	0.4	0.0	1.0	1.9
1500	1.1	-0.3	0.2	24.6	4.9	3.0	4.0	0.0015	0.7	0.0	1.0	2.4
2000	1.1	-0.2	0.3	24.6	5.5	3.5	4.4	0.0015	0.8	0.0	1.0	2.5

Toe Protection Needed	3.0	ft

HEC1 Results For Open Channel

Peak Flow	1002	cfs
Stage at Peak Flow	102.9	ft
Flow Volume	131.0	ac. ft

Freeboard

Max. Flow Depth	3.8	ft
Channel Depth as designed	6.5	ft
Available Freeboard	2.7	ft
Required Freeboard	1.5	ft

Sediment Volume

Inflowing Sediment Volume	3.84	ac. ft
Outflowing Sediment Volume	0.03	ac. ft
Deposited(+)/Eroded(-) Volume	3.81	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Existing	Existing
Channel Length (ft)	4136	4136
Side Slope (?H:1V)	3	3
Channel Width (ft)	136	136
Channel XS Area (sq. ft)	583	583
Channel Perimeter (ft)	138	138

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	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	0	ft
Thickness	0.0	ft
Protection Depth	0	ft
Tie-in Length/Depth	0.0	ft
Total Depth	0.0	ft
Area needed	0	sq. Yd
Volume	0	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)	4136	4136
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)	4136	4136
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	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	0	ft
LC Enhancement Ratio	1.1	
Structure Thickness	0	ft
Drop Height	0	ft
Scour Depth		ft
Structure Height		ft
Number of Structures	0	
Volume per structure	0	cu. Yd
Unit Cost	$ -	cu. Yd
Other Cost	$ -	
Cost per structure	$ -	
Area per structure	0	sq. Yd
Total Area	0	sq. Yd

Sedimentation Basins		
Include Sed. Basins	No	
(Yes/No)		
Number of basins	0	
Total Volume per Basin	4743	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	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	Existing	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Existing	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	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Drop Structures	None	0	EA	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Drop Str. - LC Enhancement	None	0	EA	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Sedimentation Basins		5	EA	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ 8.33	$ -
Other					$ -				$ -				$ -

Base Landscape Cost	$ -
LC Enhancement Cost	$ -
Total Landscape Cost	$ -

Base Maintenance Cost	$ -
LC Enhancement Cost	$ -
Total Maintenance Cost	$ -

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ -	$ -	$ -
Contingency Cost (25% of Construction Cost)	$ -	$ -	$ -
Engineering Design Cost (5% of Construction Cost)	$ -	$ -	$ -
Total Construction Cost	$ -	$ -	$ -

Land Cost

Channel Length	0 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	14	0	$0	$ -
LC Enhancement Buffer	0	0	$0	$ -
Channel	136	0	$0	$ -
Channel LC Enhancement	0	0	$0	$ -
Levee	0	0	$0	$ -
Levee LC Enhancement	0	0	$0	$ -
Other	0	0	$0	$ -
Total	150	0		$ -

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	0	$0	$ -
LC Enhancement Cost	acre	0	$0	$ -
Total Land Cost	acre	0	$0	$ -

Total Cost

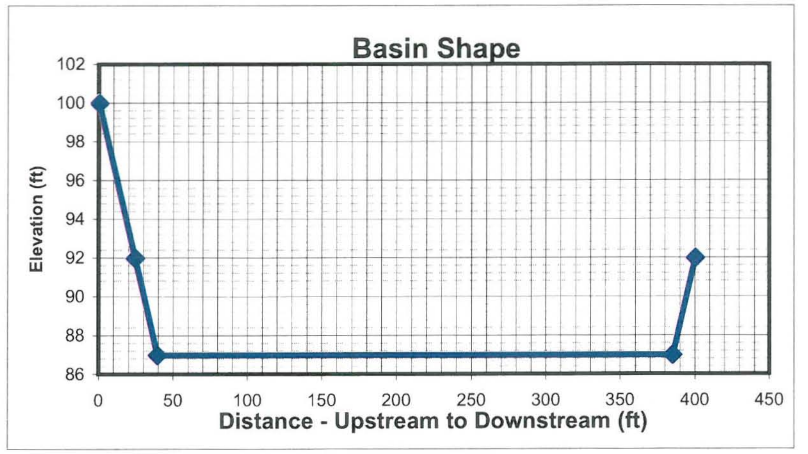
Base Total Cost	$ -
Total Landscape Enhancement Cost	$ -
Total Cost Including LC Enh.	$ -

Offline Basin

HEC1 ID	D120

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)	0.02	0.02
Basin Length (ft)	660	760
Basin Width (ft)	400	400
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	5	5
Freeboard (ft)	1	1
Effective Basin Width (ft)	376	352
Top Area (acres)	6.1	7.0
U/S-D/S Height Difference (ft)	8.0	8.0
Excess Area on Upstream (acres)	0.4	0.8

			Base	LC Enhanced
Bottom Length (ft)	630	Allocated Storage Volume (ac. ft)	21.1	21
Bottom Width (ft)	346	Total Available Volume (ac. ft) (incl. Freeboard)	26.7	27
		Total Excavation Volume (ac. ft)	51.0	55

HEC1 Results

	6-hr Event	24-hr Event	Maximum
Peak flow before diversion (cfs)	2304	2854	2854
Peak flow after diversion (cfs)	1960	2000	2000
Diverted Peak Flow (cfs)	344	854	854
Total Diverted Flow Volume (ac. ft)	9.0	21	21.0
Peak Stage	1.5	ft	

Volume Check

Total Volume needed	21.0	ac. ft
Total Volume Provided	21.1	ac. ft
Volume OK?	Yes	

Stage Check

Depth Needed	2.5
Depth Provided	5
Depth OK?	Yes

Stage-Storage-Discharge

Stage (ft)												
Inflow (cfs)	0	200	400	600	800	1000	1200	1500	2000	2500	3000	4000
Outflow (cfs)	0	0	0	0	0	0	0	0	0	500	1000	2000

capacity based on FlowMaster results with 1 ft freeboarc

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
Landscape Enhancement	166000	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	660	ft
Base Total ROW Width	400	ft
LC Enh. Total ROW Length	860	ft
LC Enh. Total ROW Length	500	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	82280	88733
Excavated Area (sq. Yd)	29333	47778

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	41	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	457	sq. Yd
Material Volume	229	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	333	ft
Unit Cost	160	per ft
Cost per outlet	$53,280	
Other Cost	$ -	
Total Cost	$53,280	
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		82,280	cu. Yd	$ 4.00	$ 329,120	29,333	sq. Yd	$ 9.00	$ 263,997	29,333	sq. Yd	$ 8.33	$ 244,442
Basin - LC Enhanced		6,453	cu. Yd	$ 4.00	$ 25,812	18,445	sq. Yd	$ 9.00	$ 166,005	18,445	sq. Yd	$ 8.33	$ 153,708
Inlet	Riprap	229	sq. Yd	$ 75.00	$ 17,175	457	sq. Yd	$ -	$ -	457	sq. Yd	$ 33.33	$ 15,233
Inlet - LC Enhanced (20%Total)					$ 3,435				$ -				$ 3,047
Outlet	Pipe	1	EA	$ 53,280	$ 53,280	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhanced (5%Total)					$ 2,664				$ -				$ 111
Other					$ -				$ -				$ -

Base Landscape Cost	$ 263,997	Base Maintenance Cost	$ 261,892
LC Enh. Landscape Cost	$ 166,005	LC Enh. Maintenance Cost	$ 156,866
Total Landscape Cost	$ 430,002	Total Maintenance Cost	$ 418,758

Construction Cost Component	Base	LC Enhanced	Total
Construction Cost	$ 399,575	$ 25,812	$ 425,387
Contingency Cost (25% of Construction Cost)	$ 99,894	$ 6,453	$ 106,347
Engineering Design Cost (5% of Construction Cost)	$ 19,979	$ 1,291	$ 21,269
Total Construction Cost	$ 519,448	$ 33,556	$ 553,003

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	$ 381,084
Basin	6.1	$100,000	$ 610,000
Other		$100,000	$ -
Total	9.9	$100,000	$ 990,000

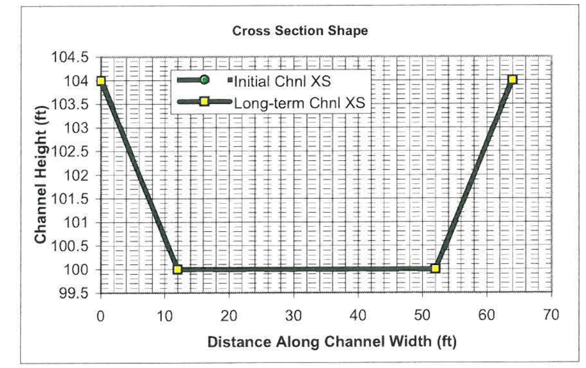
	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	6.1	$100,000	$ 606,061
LC Enhancement Cost	acre	3.8	$100,000	$ 383,939
Total Land Cost	acre	9.9	$100,000	$ 990,000

Total Cost

Base Total Cost	$ 1,651,397
Total LC Enhancement Cost	$ 740,366
Total Cost Including LC Enh.	$ 2,391,763

Open Channel

Structure ID	S90010	HEC1 ID	90091A



Longitundal Geometry

Length	2202.7	ft
U/S Elev	1816.2	ft
D/S Elev	1778.7	ft
Initial Channel Slope	0.0170	ft/ft
Long-term Channel Slope	0.0070	ft/ft

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

NSTPS	5

Initial Channel XS Geometry

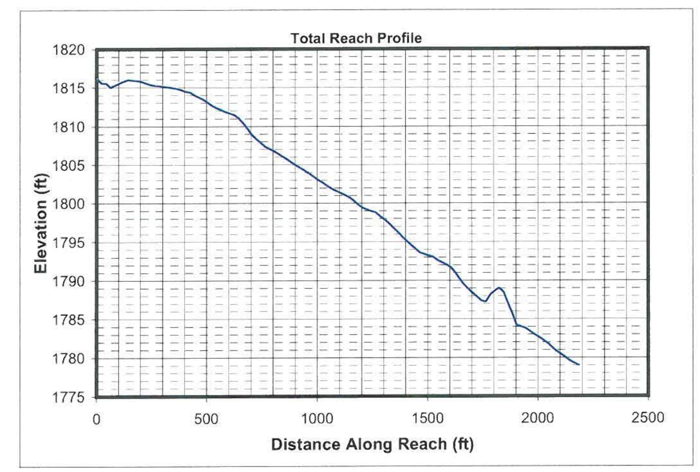
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	0	3	40	4	3	0	4	3

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	S910	S900								TOTAL
HEC1 Peak-Flow	1585	936								2521
Weighting Factor	0.20	1.00								
Flow into Channel	317	936								1253

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	1.241	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	1253	cfs	
Long-term Max. Chnl Capacity	1247	cfs	
Q2 Channel	125	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			

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

Sub-area: CAP, Alternative: A
Open Channel Structure ID: S90010

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
125	46.7	45.8	1.0	100.0	101.1	2.7	1.1	46.4	1.0	0.46	0.48
313	51.5	82.5	1.6	100.0	101.8	3.8	1.8	50.9	1.6	0.79	0.53
940	61.6	171.4	2.8	100.0	103.4	5.5	3.4	60.5	2.8	1.49	0.57
1253	65.3	208.5	3.2	100.0	104.0	6.0	4.0	64.0	3.3	1.75	0.59

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
125	46.7	45.8	1.0	100.0	101.1	2.7	1.1	46.4	1.0	0.46	0.48
313	51.5	82.5	1.6	100.0	101.8	3.8	1.8	50.9	1.6	0.79	0.53
940	61.6	171.4	2.8	100.0	103.4	5.5	3.4	60.5	2.8	1.49	0.57
1253	65.3	208.5	3.2	100.0	104.0	6.0	4.0	64.0	3.3	1.75	0.59

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
125										0
313										0
940										0
1253										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
125	1.74	1.3917	1.3222	Erosive	Erosive	Erosive	0.3	Stable	5.1	Stable	Stable
313	1.74	1.5445	1.4673	Erosive	Erosive	Erosive	0.4	Stable	7.2	Stable	Stable
940	1.74	1.7168	1.6309	Erosive	Erosive	Erosive	0.4	Stable	10.9	Stable	Stable
1253	1.74	1.7529	1.6653	Erosive	Erosive	Erosive	0.5	Stable	12.1	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)	**125**	**313**	**940**	**1253**	**125**	**313**	**940**	**1253**	**125**	**313**	**940**	**1253**
Bray - Equation #1	30	49	88	102	1.3	1.8	2.6	2.9	3.1	3.5	4.1	4.3
Bray - Equation #2	40	65	115	134	1.5	2.0	2.8	3.1	2.1	2.4	2.8	2.9
Hey	9	15	28	33	4.0	5.7	8.7	9.7				
Ackers & Charlton/Lacey	27	40	64	72					1.8	2.1	2.5	2.6
Parker	77	122	211	243	1.0	1.5	2.4	2.7				
Chang	55	97	188	224	0.1	-0.1	-0.5	-0.7				
Kellerhals	20	32	55	64	1.9	2.7	4.2	4.7	3.3	3.6	4.0	4.2
AMAFCA/Schumm	46	51	61	64								
Moody & Odem	13	13	13	13	1.0	1.0	1.0	1.0				
BUREC	15.3	21.5	32.5	36.2	4	6	9	10	3.2	4.0	5.2	5.6
Average	33	51	86	99	1.9	2.5	3.7	4.1	2.7	3.1	3.8	3.9
Values As Designed	46	51	60	64	1.1	1.8	3.4	4.0	2.7	3.8	5.5	6.0
Difference with Design	-13	0	25	35	0.8	0.7	0.3	0.1	0.0	-0.7	-1.7	-2.1

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
125	750	444	949	5326	1587	292	136	166	5151	375	1892	1552
313	2920	1301	2510	23671	2315	1141	390	651	13007	1311	6669	5081
940	14366	4387	7027	135610	3729	6844	1208	2823	39204	5750	27226	22561
1253	21685	5984	9397	212496	4249	10645	1606	4069	52305	8427	38823	33608

Discharge (cfs)	Sediment Concentrations (ppm by weight): Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
125	2220	1314	2810	15771	4700	863	403	490	15253	1110	5602	4594
313	3458	1541	2973	28034	2742	1351	462	772	15405	1553	7899	6017
940	5671	1732	2774	53537	1472	2702	477	1115	15477	2270	10748	8907
1253	6421	1772	2782	62918	1258	3152	476	1205	15487	2495	11495	9951

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
125	750	380	640	1406	897	173	136	166	1305	167	873	627
313	2920	1144	1727	6247	1371	638	390	651	3372	623	3259	2031
940	14366	3932	4919	35787	2282	2756	1208	2823	10274	1569	14141	8551
1253	21685	5384	6487	56077	2615	4014	1606	4069	13728	1735	20466	12533

Discharge (cfs)	Sediment Concentrations (ppm by weight): Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
125	2220	1124	1896	4162	2655	512	403	490	3863	495	2586	1855
313	3458	1355	2046	7398	1623	756	462	772	3994	737	3860	2405
940	5671	1552	1942	14128	901	1088	477	1115	4056	619	5582	3376
1253	6421	1594	1921	16604	774	1188	476	1205	4065	514	6060	3711

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson n	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)
125	0.0008	0.0012	240	0.73	0.052	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0006	0.0070	0.0004	0.0011	0.0069	0.0037
313	0.0004	0.0007	307	0.94	0.055	0.0002	32	0.036	0.0001	0.0159	0.0002	0.0004	0.0070	0.0003	0.0005	0.0069	0.0036
940	0.0002	0.0004	405	1.23	0.058	0.0001	33	0.036	0.0001	0.0159	0.0001	0.0002	0.0070	0.0002	0.0002	0.0068	0.0035
1253	0.0002	0.0004	434	1.32	0.058	0.0001	33	0.036	0.0001	0.0159	0.0001	0.0002	0.0070	0.0001	0.0002	0.0068	0.0035

Drop Structures

Design Slope	0.0070	ft/ft
Total Drop Needed	22.1	ft
Height of Drop Structure	3	ft
No . of Drop Structures	8	
Distance between structs.	275	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	1.24	sq. mi
Total Sediment Yield Volume	2.36	ac ft

Sedimentation Basins

Length	275 ft	Depth	3 ft
Width	64 ft	Side slope	3 ft/ft
Total Volume per Basin		1.01	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		8	

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)
125	1.1	-0.3	0.1	24.6	1.1	1.0	2.7	0.0070	0.1	0.0	2.0	2.8
313	1.1	-0.5	0.2	24.6	1.8	1.6	3.8	0.0070	0.2	0.0	2.0	3.0
940	1.1	-0.7	0.4	24.6	3.4	2.8	5.5	0.0070	0.4	0.0	2.0	3.4
1253	1.1	-0.8	0.5	24.6	4.0	3.3	6.0	0.0070	0.5	0.0	2.0	3.6

Toe Protection Needed	4.0	ft

HEC1 Results For Open Channel

Peak Flow	902	cfs
Stage at Peak Flow	100.8	ft
Flow Volume	85.0	ac. ft

Freeboard

Max. Flow Depth	4.0	ft
Channel Depth as designed	4.0	ft
Available Freeboard	0.0	ft
Required Freeboard	1.1	ft

Sediment Volume

Inflowing Sediment Volume	2.36	ac. ft
Outflowing Sediment Volume	0.12	ac. ft
Deposited(+)/Eroded(-) Volume	2.24	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	2203	2203
Side Slope (?H:1V)	3	6
Channel Width (ft)	64	88
Channel XS Area (sq. ft)	208	256
Channel Perimeter (ft)	65	88

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	74572	100089
Excavated Area (sq. Yd)	15666	21540

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	2203	ft
Thickness	1.5	ft
Protection Depth	4	ft
Tie-in Length/Depth	3.0	ft
Total Depth	7.0	ft
Area needed	367	sq. Yd
Volume	857	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	2203	2203
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)	9546	19827
Left Levee Volume (cu. Yd)	8486	20398
Right Levee Length (ft)	0	0
Right Levee Top Width (ft)	0	0
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	0	0
Right Levee Surface Area (sq. Yd)	0	0
Right Levee Volume (cu. Yd)	0	0
Total Levee Surface Area (sq. Yd)	9546	19827
Total Levee Volume (cu. Yd)	8486	20398

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	2203	2203
Left Levee Lining Width (ft)	13	30
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	3182	7343
Left Levee Lining Volume (cu. Yd)	1591	3672
Right Levee Length (ft)	0	2203
Right Levee Lining Width (ft)	0	0
Right Levee Lining Thickness (ft)	0	1.5
Right Levee Lining Area (sq. Yd)	0	0
Right Levee Lining Volume (cu. Yd)	0	0
Total Lining Area (sq. Yd)	3182	7343
Total Lining Volume (cu. Yd)	1591	3672

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	12.9	ft
Structure Height	15.9	ft
Number of Structures	8	
Volume per structure	113	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 8,475	
Area per structure	21	sq. Yd
Total Area	171	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	8	
Total Volume per Basin	1629	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 6,516	
Other Cost	$ -	
Total cost per basin	$ 6,516	
Area per basin	1,958	sq. Yd
Total Area	15,664	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	8,486	cu. Yd	$ 7.00	$ 59,402	9,546	sq. Yd	$ 9.00	$ 85,914	9,546	sq. Yd	$ 11.67	$ 111,370
Levee - LC Enhancement	Fill	11,912	cu. Yd	$ 7.00	$ 83,384	10,281	sq. Yd	$ 9.00	$ 92,529	11,912	sq. Yd	$ 11.67	$ 138,973
Levee Lining	Riprap	1,591	cu. Yd	$ 75.00	$ 119,325	3,182	sq. Yd	$ -	$ -	3,182	sq. Yd	$ 20.83	$ 66,294
Levee Lining -LC Enhancement	Riprap	2,081	cu. Yd	$ 75.00	$ 156,075	4,161	sq. Yd	$ -	$ -	4,161	sq. Yd	$ 20.83	$ 86,692
Excavated Channel	Excavated	74,572	cu. Yd	$ 10.00	$ 745,720	15,666	sq. Yd	$ 9.00	$ 140,994	15,666	sq. Yd	$ 8.33	$ 130,550
Exc. Chl - LC Enhancement	Excavated	25,517	cu. Yd	$ 10.00	$ 255,170	5,874	sq. Yd	$ 9.00	$ 52,866	5,874	sq. Yd	$ 8.33	$ 48,950
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	857	cu. Yd	$ 75.00	$ 64,275	367	sq. Yd	$ -	$ -	367	sq. Yd	$ 25.00	$ 9,175
Drop Structures	Riprap	8	EA	$ 8,475.00	$ 67,800	171	sq. Yd	$ -	$ -	171	sq. Yd	$ 33.33	$ 5,700
Drop Str. - LC Enhancement	Riprap	8	EA	$ 847.50	$ 6,780	17	sq. Yd	$ -	$ -	17	sq. Yd	$ 33.33	$ 570
Sedimentation Basins		8	EA	$ 6,516.00	$ 52,128	15,664	sq. Yd	$ -	$ -	15,664	sq. Yd	$ 8.33	$ 130,533
Other					$ -				$ -				$ -

Base Landscape Cost	$ 226,908	Base Maintenance Cost	$ 453,622
LC Enhancement Cost	$ 145,395	LC Enhancement Cost	$ 275,185
Total Landscape Cost	$ 372,303	Total Maintenance Cost	$ 728,808

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,108,650	$ 501,409	$ 1,610,059
Contingency Cost (25% of Construction Cost)	$ 277,163	$ 125,352	$ 402,515
Engineering Design Cost (5% of Construction Cost)	$ 55,433	$ 25,070	$ 80,503
Total Construction Cost	$ 1,441,245	$ 651,832	$ 2,093,077

Land Cost

Channel Length	2203 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	50	2.5	$100,000	$ 250,000
Channel	64	3.2	$100,000	$ 320,000
Channel LC Enhancement	24	1.2	$100,000	$ 120,000
Levee	26	1.3	$100,000	$ 130,000
Levee LC Enhancement	24	1.2	$100,000	$ 120,000
Active fan set aside area for Fan 2	0	39.7	$100,000	$ 3,970,000
Total	188	49.1		$ 4,910,000

Right of Way

Preservation Corridor Width	0	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	44.2	$100,000	$ 4,420,000
LC Enhancement Cost	acre	4.9	$100,000	$ 490,000
Total Land Cost	acre	49.1	$100,000	$ 4,910,000

Total Cost

Base Total Cost	$ 6,541,775
Total Landscape Enhancement Cost	$ 1,562,412
Total Cost Including LC Enh.	$ 8,104,187

Open Channel

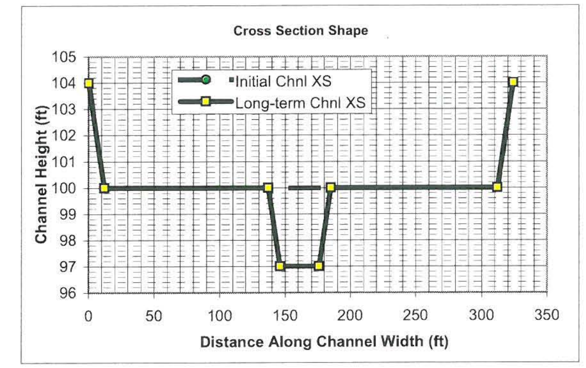
Structure ID	S90020	HEC1 ID	90091A

Longitundal Geometry

Length	1791.7	ft
U/S Elev	1778.7	ft
D/S Elev	1746.9	ft
Initial Channel Slope	0.0178	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

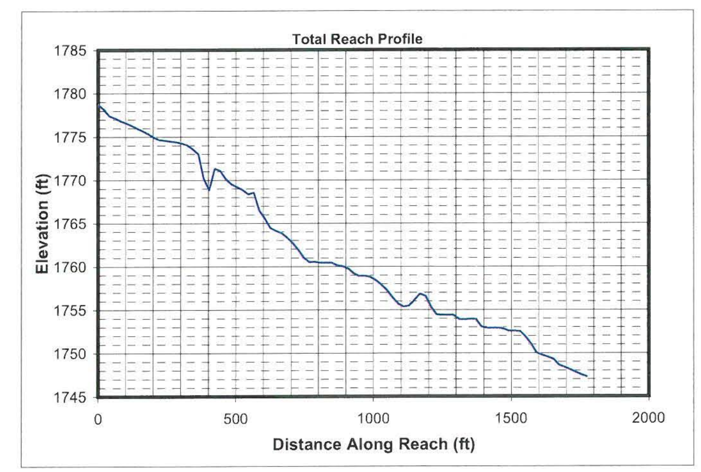
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	0	3	300	4	3	0	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	12	12	312	312	312	324
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	125	3	30	7	3	127	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	137	146	176	185	312	324
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

											TOTAL
Contributing HEC1 ID	S910	S900									
HEC1 Peak-Flow	1585	936									2521
Weighting Factor	0.37	1.00									
Flow into Channel	593	936									1529

Reach Sediment Inflow Characteristics

U/S Contributing ID	S90010									TOTAL
HEC1 Flow Volume (ac. ft)										0
Sediment Conc. (ppm)	0									
Sediment Volume (ac. ft)	1.96									1.96
Weighting Factor	1									
Weighted Sed. Vol. (ac. ft)	1.96									1.96

Hydrology

Drainage Area	1.398	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	1529	cfs	
Long-term Max. Chnl Capacity	9090	cfs	
Q2 Channel	153	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	324	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
153	301.7	82.4	0.3	100.0	100.3	1.9	0.3	301.6	0.3	0.10	0.63
382	303.0	143.0	0.5	100.0	100.5	2.7	0.5	302.8	0.5	0.18	0.69
1147	305.8	277.4	0.9	100.0	100.9	4.1	0.9	305.5	0.9	0.34	0.76
1529	306.9	330.1	1.1	100.0	101.1	4.6	1.1	306.5	1.1	0.41	0.79

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
153	39.3	50.4	1.3	97.0	98.5	3.0	1.5	38.8	1.3	0.55	0.47
382	45.7	92.9	2.0	97.0	99.5	4.1	2.5	44.9	2.1	0.93	0.50
1147	306.6	384.5	1.3	97.0	100.9	3.0	3.9	305.3	1.3	1.45	0.47
1529	308.1	457.8	1.5	97.0	101.1	3.3	4.1	306.7	1.5	1.54	0.48

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
	90091A_S90010									
153	627									627
382	2031									2031
1147	8551									8551
1529	12533									12533

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)		
153	1.74	0.9954	0.9456	Erosive	Erosive	Erosive	0.2	Stable	5.8	Stable	Stable
382	1.74	1.1641	1.1059	Erosive	Erosive	Erosive	0.2	Stable	8.2	Stable	Stable
1147	1.74	1.3657	1.2974	Erosive	Erosive	Erosive	0.3	Stable	9.4	Stable	Stable
1529	1.74	1.4183	1.3474	Erosive	Erosive	Erosive	0.3	Stable	10.0	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)	**153**	**382**	**1147**	**1529**	**153**	**382**	**1147**	**1529**	**153**	**382**	**1147**	**1529**
Bray - Equation #1	34	55	97	113	1.4	1.9	2.8	3.1	3.2	3.6	4.2	4.4
Bray - Equation #2	44	72	128	149	1.6	2.1	3.0	3.3	2.2	2.5	2.9	3.0
Hey	10	17	31	37	4.4	6.2	9.4	10.5				
Ackers & Charlton/Lacey	30	44	69	78					1.9	2.2	2.6	2.7
Parker	85	134	233	269	1.1	1.6	2.6	2.9				
Chang	59	104	202	240	0.1	-0.1	-0.5	-0.7				
Kellerhals	22	35	61	70	2.0	2.9	4.6	5.1	3.4	3.7	4.1	4.2
AMAFCA/Schumm	39	45	306	307								
Moody & Odem	14	14	14	14	1.0	1.0	1.0	1.0				
BUREC	16.9	23.9	36.0	40.1	5	6	10	11	3.1	3.9	5.2	5.6
Average	35	54	118	132	2.0	2.8	4.1	4.5	2.8	3.2	3.8	4.0
Values As Designed	39	45	305	307	1.5	2.5	3.9	4.1	3.0	4.1	3.0	3.3
Difference with Design	-3	9	-188	-175	0.5	0.3	0.2	0.4	-0.3	-0.9	0.8	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
153	1342	888	1913	2471	4481	427	394	197	6216	437	1409	1834
382	5531	2922	5904	11698	6690	1866	1338	1072	16441	1467	6067	5545
1147	30191	10722	18420	75271	10201	8933	4462	5669	50527	6920	29385	22791
1529	47018	14848	23972	122455	11317	13308	5977	8465	67571	10471	43519	33538

Discharge (cfs)	Sediment Concentrations (ppm by weight) Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
153	3255	2155	4642	5995	10872	1035	955	479	15084	1061	3419	4450
382	5368	2836	5730	11354	6493	1811	1298	1040	15958	1424	5888	5382
1147	9767	3469	5959	24352	3300	2890	1444	1834	16347	2239	9507	7373
1529	11409	3603	5817	29713	2746	3229	1450	2054	16396	2541	10560	8138

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
153	900	423	656	1730	816	194	144	209	1276	194	1055	691
382	3399	1240	1786	7410	1279	685	399	768	3275	712	3775	2248
1147	6675	2988	4949	12568	6282	1440	1086	1544	9543	1424	7812	5119
1529	10389	4305	6758	20428	7083	2207	1530	2417	12890	2183	12018	7474

Discharge (cfs)	Sediment Concentrations (ppm by weight) Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
153	2185	1027	1592	4198	1980	472	350	507	3095	470	2560	1676
382	3299	1204	1734	7192	1241	665	387	745	3179	691	3664	2182
1147	2160	967	1601	4066	2032	466	351	500	3087	461	2528	1656
1529	2521	1045	1640	4957	1719	536	371	587	3128	530	2916	1813

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson n	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)
153	0.0029	0.0044	130	0.40	0.047	0.0009	30	0.035	0.0007	0.0159	0.0009	0.0022	0.0065	0.0004	0.0031	0.0177	0.0067
382	0.0015	0.0026	170	0.52	0.049	0.0006	30	0.036	0.0004	0.0159	0.0005	0.0012	0.0065	0.0003	0.0015	0.0177	0.0064
1147	0.0006	0.0013	236	0.72	0.052	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0006	0.0065	0.0002	0.0007	0.0177	0.0063
1529	0.0005	0.0011	257	0.78	0.053	0.0003	32	0.036	0.0002	0.0159	0.0002	0.0005	0.0065	0.0001	0.0005	0.0177	0.0062

Drop Structures

Design Slope	0.0060	ft/ft
Total Drop Needed	21.1	ft
Height of Drop Structure	3	ft
No . of Drop Structures	8	
Distance between structs.	224	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	224 ft	Depth	3 ft
Width	324 ft	Side slope	3 ft/ft
Total Volume per Basin		4.67	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)
153	1.1	-0.4	0.1	24.6	1.5	1.3	3.0	0.0060	0.2	0.0	2.0	2.9
382	1.1	-0.7	0.2	24.6	2.5	2.1	4.1	0.0060	0.3	0.0	2.0	3.1
1147	1.1	-1.2	0.1	24.6	3.9	1.3	3.0	0.0060	0.4	0.0	2.0	3.2
1529	1.1	-1.2	0.2	24.6	4.1	1.5	3.3	0.0060	0.4	0.0	2.0	3.3

Toe Protection Needed	4.0	ft

HEC1 Results For Open Channel

Peak Flow	902	cfs
Stage at Peak Flow	100.8	ft
Flow Volume	85.0	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	2.26	ac. ft
Outflowing Sediment Volume	0.07	ac. ft
Deposited(+)/Eroded(-) Volume	2.19	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	1792	1792
Side Slope (?H:1V)	3	3
Channel Width (ft)	324	324
Channel XS Area (sq. ft)	1365	1365
Channel Perimeter (ft)	326	326

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	1792	ft
Thickness	1.5	ft
Protection Depth	4	ft
Tie-in Length/Depth	3.0	ft
Total Depth	7.0	ft
Area needed	597	sq. Yd
Volume	1394	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	1792	1792
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)	7765	16128
Left Levee Volume (cu. Yd)	6903	16593
Right Levee Length (ft)	1792	1792
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)	7765	16128
Right Levee Volume (cu. Yd)	6903	16593
Total Levee Surface Area (sq. Yd)	15530	32256
Total Levee Volume (cu. Yd)	13806	33186

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	1792	1792
Left Levee Lining Width (ft)	13	30
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	2588	5973
Left Levee Lining Volume (cu. Yd)	1294	2987
Right Levee Length (ft)	1792	1792
Right Levee Lining Width (ft)	13	30
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	2588	5973
Right Levee Lining Volume (cu. Yd)	1294	2987
Total Lining Area (sq. Yd)	5177	11947
Total Lining Volume (cu. Yd)	2588	5974

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	324	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	8	
Volume per structure	320	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 24,000	
Area per structure	108	sq. Yd
Total Area	864	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	7534	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 30,136	
Other Cost	$ -	
Total cost per basin	$ 30,136	
Area per basin	8,063	sq. Yd
Total Area	8,063	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	13,806	cu. Yd	$ 7.00	$ 96,642	15,530	sq. Yd	$ 9.00	$ 139,770	15,530	sq. Yd	$ 11.67	$ 181,183
Levee - LC Enhancement	Fill	19,380	cu. Yd	$ 7.00	$ 135,660	16,726	sq. Yd	$ 9.00	$ 150,534	19,380	sq. Yd	$ 11.67	$ 226,100
Levee Lining	Riprap	2,588	cu. Yd	$ 75.00	$ 194,100	5,177	sq. Yd	$ -	$ -	5,177	sq. Yd	$ 20.83	$ 107,852
Levee Lining -LC Enhancement	Riprap	3,386	cu. Yd	$ 75.00	$ 253,950	6,770	sq. Yd	$ -	$ -	6,770	sq. Yd	$ 20.83	$ 141,037
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	1,394	cu. Yd	$ 75.00	$ 104,550	597	sq. Yd	$ -	$ -	597	sq. Yd	$ 25.00	$ 14,925
Drop Structures	Riprap	8	EA	$ 24,000.00	$ 192,000	864	sq. Yd	$ -	$ -	864	sq. Yd	$ 33.33	$ 28,800
Drop Str. - LC Enhancement	Riprap	8	EA	$ 2,400.00	$ 19,200	86	sq. Yd	$ -	$ -	86	sq. Yd	$ 33.33	$ 2,880
Sedimentation Basins		1	EA	$ 30,136.00	$ 30,136	8,063	sq. Yd	$ -	$ -	8,063	sq. Yd	$ 8.33	$ 67,192
Other					$ -				$ -				$ -

Base Landscape Cost	$ 139,770	Base Maintenance Cost	$ 399,952
LC Enhancement Cost	$ 150,534	LC Enhancement Cost	$ 370,017
Total Landscape Cost	$ 290,304	Total Maintenance Cost	$ 769,969

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 617,428	$ 408,810	$ 1,026,238
Contingency Cost (25% of Construction Cost)	$ 154,357	$ 102,203	$ 256,560
Engineering Design Cost (5% of Construction Cost)	$ 30,871	$ 20,441	$ 51,312
Total Construction Cost	$ 802,656	$ 531,453	$ 1,334,109

Land Cost

Channel Length	1792 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	324	13.3	$100,000	$ 1,330,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	52	2.1	$100,000	$ 210,000
Levee LC Enhancement	48	2	$100,000	$ 200,000
Other	0	0	$100,000	$ -
Total	424	17.4		$ 1,740,000

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	15.4	$100,000	$ 1,540,000
LC Enhancement Cost	acre	2	$100,000	$ 200,000
Total Land Cost	acre	17.4	$100,000	$ 1,740,000

Total Cost

Base Total Cost	$ 2,882,378
Total Landscape Enhancement Cost	$ 1,252,004
Total Cost Including LC Enh.	$ 4,134,382

Open Channel

Structure ID	C910B10	HEC1 ID	90091B

Longitundal Geometry

Length	4991.8	ft
U/S Elev	1746.9	ft
D/S Elev	1667.9	ft
Initial Channel Slope	0.0158	ft/ft
Long-term Channel Slope	0.0060	ft/ft

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

NSTPS	4

Initial Channel XS Geometry

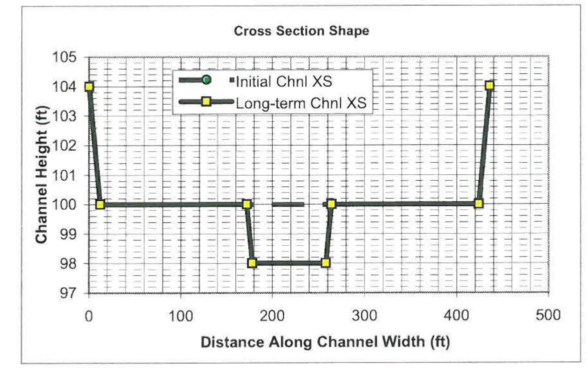
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	0	3	412	4	3	0	4	3

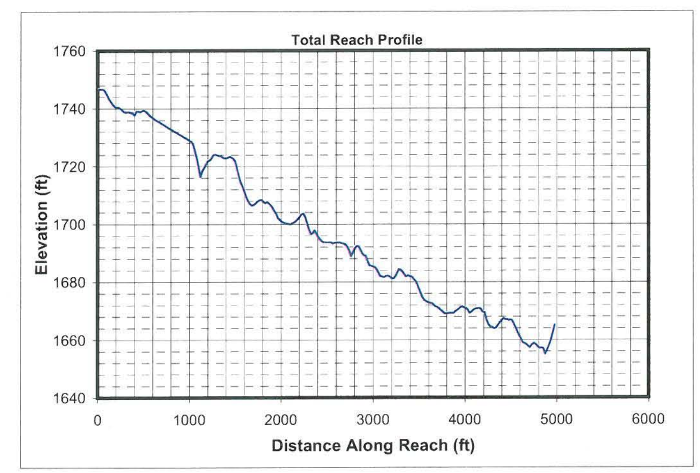
PT. ID	1	2	3	4	5	6	7	8
X	0	12	12	12	424	424	424	436
Y	104	100	100	100	100	100	100	104

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	160	3	80	6	3	160	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	172	178	258	264	424	436
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	S910	S900								TOTAL
HEC1 Peak-Flow	1585	936								2521
Weighting Factor	1.00	1.00								
Flow into Channel	1585	936								2521

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	2.02	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	2521	cfs	
Long-term Max. Chnl Capacity	12601	cfs	
Q2 Channel	252	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	436	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
252	414.0	130.7	0.3	100.0	100.3	1.9	0.3	413.9	0.3	0.12	0.61
630	415.5	226.5	0.5	100.0	100.5	2.8	0.5	415.3	0.5	0.21	0.66
1891	418.7	439.4	1.0	100.0	101.1	4.3	1.1	418.4	1.1	0.40	0.74
2521	420.0	522.9	1.2	100.0	101.3	4.8	1.3	419.5	1.2	0.47	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
252	87.1	93.6	1.1	98.0	99.1	2.7	1.1	86.7	1.1	0.42	0.46
630	92.2	166.1	1.8	98.0	99.9	3.8	1.9	91.6	1.8	0.72	0.50
1891	419.0	588.1	1.4	98.0	101.0	3.2	3.0	418.0	1.4	1.12	0.48
2521	420.7	700.0	1.7	98.0	101.3	3.6	3.3	419.6	1.7	1.22	0.49

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
252										0
630										0
1891										0
2521										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)		
252	1.74	1.0399	0.9879	Erosive	Erosive	Erosive	0.2	Stable	4.9	Stable	Stable
630	1.74	1.2086	1.1481	Erosive	Erosive	Erosive	0.3	Stable	7.0	Stable	Stable
1891	1.74	1.4106	1.3401	Erosive	Erosive	Erosive	0.3	Stable	8.4	Stable	Stable
2521	1.74	1.4633	1.3902	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)	**252**	**630**	**1891**	**2521**	**252**	**630**	**1891**	**2521**	**252**	**630**	**1891**	**2521**
Bray - Equation #1	44	71	127	148	1.7	2.3	3.3	3.6	3.4	3.9	4.5	4.7
Bray - Equation #2	58	93	167	194	1.8	2.5	3.6	3.9	2.4	2.7	3.1	3.3
Hey	13	22	41	48	5.3	7.5	11.3	12.6				
Ackers & Charlton/Lacey	37	54	86	97					2.0	2.3	2.8	3.0
Parker	109	172	299	345	1.4	2.0	3.2	3.6				
Chang	81	141	273	325	0.0	-0.2	-0.8	-1.0				
Kellerhals	29	45	78	90	2.5	3.6	5.6	6.2	3.5	3.9	4.3	4.5
AMAFCA/Schumm	87	92	419	420								
Moody & Odem	16	16	16	16	1.1	1.1	1.1	1.1				
BUREC	20.4	28.8	43.5	48.4	5	8	12	13	3.6	4.5	5.9	6.3
Average	49	74	155	173	2.4	3.3	4.9	5.4	3.0	3.5	4.1	4.4
Values As Designed	87	92	418	420	1.1	1.9	3.0	3.3	2.7	3.8	3.2	3.6
Difference with Design	-37	-18	-263	-247	1.3	1.4	1.8	2.1	0.3	-0.3	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
252	2087	1344	2817	3835	6293	641	583	324	8657	636	2233	2677
630	8638	4408	8590	18172	9359	2766	1954	1706	22856	2199	9498	8195
1891	47030	16088	26471	116996	14230	13156	6447	8849	70186	10556	45719	34157
2521	73263	22267	34515	190405	15775	19596	8626	13182	93852	16026	67673	50471

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
252	3072	1978	4145	5643	9261	943	859	477	12741	936	3286	3940
630	5085	2595	5056	10697	5509	1629	1150	1004	13454	1294	5591	4824
1891	9228	3157	5194	22957	2792	2581	1265	1736	13772	2071	8971	6702
2521	10782	3277	5079	28021	2322	2884	1269	1940	13812	2358	9959	7427

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
252	1276	651	1075	2309	1601	275	223	288	2065	277	1495	1049
630	5086	2004	2892	10545	2401	1048	656	1167	5371	1058	5748	3452
1891	12227	5280	8284	23609	9277	2614	1868	2844	15875	2575	14207	8969
2521	19035	7553	11420	38396	10424	3974	2601	4400	21396	3957	21729	13171

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
252	1877	959	1582	3398	2356	405	328	424	3039	407	2199	1543
630	2994	1180	1703	6207	1413	617	386	687	3162	623	3383	2032
1891	2399	1036	1625	4633	1820	513	366	558	3115	505	2788	1760
2521	2801	1112	1681	5651	1534	585	383	647	3149	582	3198	1938

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson n	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)
252	0.0025	0.0038	132	0.40	0.047	0.0008	30	0.035	0.0006	0.0159	0.0008	0.0019	0.0055	0.0003	0.0026	0.0158	0.0059
630	0.0013	0.0022	173	0.53	0.049	0.0005	30	0.036	0.0003	0.0159	0.0005	0.0011	0.0055	0.0002	0.0013	0.0158	0.0057
1891	0.0006	0.0012	240	0.73	0.052	0.0003	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0055	0.0001	0.0006	0.0158	0.0055
2521	0.0005	0.0010	261	0.80	0.053	0.0002	32	0.036	0.0002	0.0159	0.0002	0.0004	0.0055	0.0001	0.0005	0.0158	0.0055

Drop Structures

Design Slope	0.0060	ft/ft
Total Drop Needed	49.1	ft
Height of Drop Structure	5	ft
No . of Drop Structures	10	
Distance between structs.	499	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	0.62	sq. mi
Total Sediment Yield Volume	1.17	ac ft

Sedimentation Basins

Length	499 ft	Depth	3 ft
Width	436 ft	Side slope	3 ft/ft
Total Volume per Basin		14.42	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)
252	1.1	-0.4	0.1	24.6	1.1	1.1	2.7	0.0060	0.1	0.0	2.0	2.8
630	1.1	-0.5	0.2	24.6	1.9	1.8	3.8	0.0060	0.2	0.0	2.0	3.0
1891	1.1	-0.9	0.1	24.6	3.0	1.4	3.2	0.0060	0.3	0.0	2.0	3.1
2521	1.1	-0.9	0.2	24.6	3.3	1.7	3.6	0.0060	0.4	0.0	2.0	3.2

Toe Protection Needed	4.0	ft

HEC1 Results For Open Channel

Peak Flow	778	cfs
Stage at Peak Flow	100.6	ft
Flow Volume	85.0	ac. ft

Freeboard

Max. Flow Depth	1.3	ft
Channel Depth as designed	4.0	ft
Available Freeboard	2.7	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	1.17	ac. ft
Outflowing Sediment Volume	0.07	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)	4992	4992
Side Slope (?H:1V)	3	3
Channel Width (ft)	436	436
Channel XS Area (sq. ft)	1868	1868
Channel Perimeter (ft)	438	438

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	4992	ft
Thickness	1.5	ft
Protection Depth	4	ft
Tie-in Length/Depth	3.0	ft
Total Depth	7.0	ft
Area needed	1664	sq. Yd
Volume	3883	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	4992	4992
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)	21632	44928
Left Levee Volume (cu. Yd)	19228	46222
Right Levee Length (ft)	4992	4992
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)	21632	44928
Right Levee Volume (cu. Yd)	19228	46222
Total Levee Surface Area (sq. Yd)	43264	89856
Total Levee Volume (cu. Yd)	38456	92444

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	4992	4992
Left Levee Lining Width (ft)	13	30
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	7211	16640
Left Levee Lining Volume (cu. Yd)	3605	8320
Right Levee Length (ft)	4992	4992
Right Levee Lining Width (ft)	13	30
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	7211	16640
Right Levee Lining Volume (cu. Yd)	3605	8320
Total Lining Area (sq. Yd)	14421	33280
Total Lining Volume (cu. Yd)	7210	16640

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	436	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	5	ft
Scour Depth	7.3	ft
Structure Height	12.3	ft
Number of Structures	10	
Volume per structure	594	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 44,550	
Area per structure	145	sq. Yd
Total Area	1,453	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	23264	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 93,056	
Other Cost	$ -	
Total cost per basin	$ 93,056	
Area per basin	24,182	sq. Yd
Total Area	24,182	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	38,456	cu. Yd	$ 7.00	$ 269,192	43,264	sq. Yd	$ 9.00	$ 389,376	43,264	sq. Yd	$ 11.67	$ 504,747
Levee - LC Enhancement	Fill	53,988	cu. Yd	$ 7.00	$ 377,916	46,592	sq. Yd	$ 9.00	$ 419,328	53,988	sq. Yd	$ 11.67	$ 629,860
Levee Lining	Riprap	7,210	cu. Yd	$ 75.00	$ 540,750	14,421	sq. Yd	$ -	$ -	14,421	sq. Yd	$ 20.83	$ 300,444
Levee Lining -LC Enhancement	Riprap	9,430	cu. Yd	$ 75.00	$ 707,250	18,859	sq. Yd	$ -	$ -	18,859	sq. Yd	$ 20.83	$ 392,889
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	3,883	cu. Yd	$ 75.00	$ 291,225	1,664	sq. Yd	$ -	$ -	1,664	sq. Yd	$ 25.00	$ 41,600
Drop Structures	Riprap	10	EA	$ 44,550.00	$ 445,500	1,453	sq. Yd	$ -	$ -	1,453	sq. Yd	$ 33.33	$ 48,433
Drop Str. - LC Enhancement	Riprap	10	EA	$ 4,455.00	$ 44,550	145	sq. Yd	$ -	$ -	145	sq. Yd	$ 33.33	$ 4,843
Sedimentation Basins		1	EA	$ 93,056.00	$ 93,056	24,182	sq. Yd	$ -	$ -	24,182	sq. Yd	$ 8.33	$ 201,517
Other					$ -				$ -				$ -

Base Landscape Cost	$ 389,376	
LC Enhancement Cost	$ 419,328	
Total Landscape Cost	$ 808,704	

Base Maintenance Cost	$ 1,096,741
LC Enhancement Cost	$ 1,027,592
Total Maintenance Cost	$ 2,124,333

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,639,723	$ 1,129,716	$ 2,769,439
Contingency Cost (25% of Construction Cost)	$ 409,931	$ 282,429	$ 692,360
Engineering Design Cost (5% of Construction Cost)	$ 81,986	$ 56,486	$ 138,472
Total Construction Cost	$ 2,131,640	$ 1,468,631	$ 3,600,271

Land Cost

Channel Length	4992 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	436	50	$100,000	$ 5,000,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	52	6	$100,000	$ 600,000
Levee LC Enhancement	48	5.5	$100,000	$ 550,000
Other	0	0	$100,000	$ -
Total	536	61.5		$ 6,150,000

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	56	$100,000	$ 5,600,000
LC Enhancement Cost	acre	5.5	$100,000	$ 550,000
Total Land Cost	acre	61.5	$100,000	$ 6,150,000

Total Cost

Base Total Cost	$ 9,217,757
Total Landscape Enhancement Cost	$ 3,465,551
Total Cost Including LC Enh.	$ 12,683,308

Open Channel

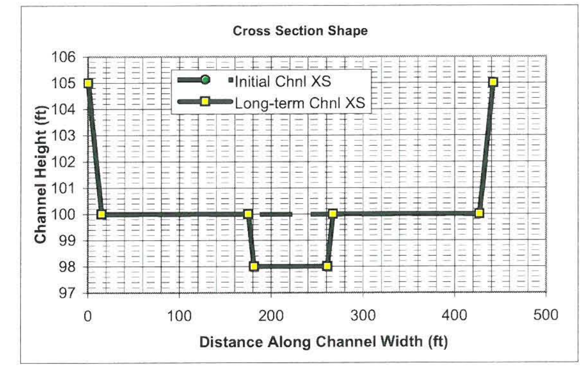
Structure ID	RR91010	HEC1 ID	910915

Longitundal Geometry

Length	3390.4	ft
U/S Elev	1668.1	ft
D/S Elev	1623.5	ft
Initial Channel Slope	0.0131	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

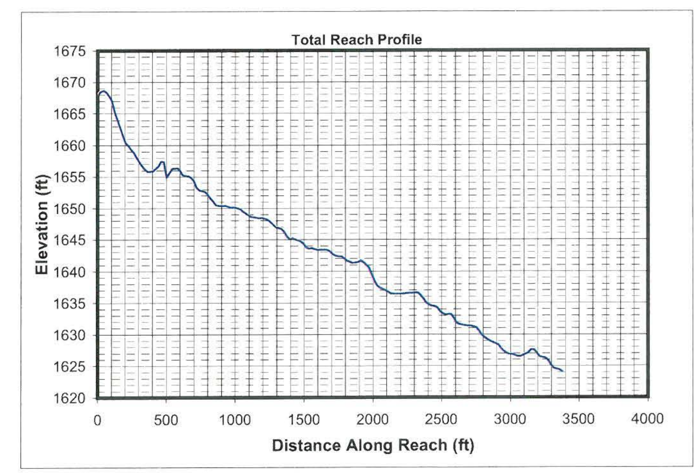
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	5	0	3	412	5	3	0	5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	15	15	15	427	427	427	442
Y	105	100	100	100	100	100	100	105

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	5	160	3	80	7	3	160	5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	15	175	181	261	267	427	442
Y	105	100	100	98	98	100	100	105



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	C915	S920								TOTAL
HEC1 Peak-Flow	2441	3157								5598
Weighting Factor	1.00	0.15								
Flow into Channel	2441	466								2907

Reach Sediment Inflow Characteristics

U/S Contributing ID	90091B_C910B1 0									TOTAL
HEC1 Flow Volume (ac. ft)	85.00									85
Sediment Conc. (ppm)	2032									
Sediment Volume (ac. ft)	0.07									0.07
Weighting Factor	1									
Weighted Sed. Vol. (ac. ft)	0.07									0.07

Hydrology

Drainage Area	2.506	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	2907	cfs	
Long-term Max. Chnl Capacity	16197	cfs	
Q2 Channel	291	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	442	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			

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Sub-area: CAP, Alternative: A
Open Channel Structure ID: RR91010

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
291	414.3	150.5	0.4	100.0	100.4	1.9	0.4	414.2	0.4	0.11	0.56
727	416.0	261.0	0.6	100.0	100.6	2.8	0.6	415.8	0.6	0.20	0.62
2180	419.7	506.6	1.2	100.0	101.2	4.3	1.2	419.3	1.2	0.38	0.69
2907	421.2	602.9	1.4	100.0	101.4	4.8	1.4	420.7	1.4	0.45	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
291	88.2	108.3	1.2	98.0	99.3	2.7	1.3	87.7	1.2	0.40	0.43
727	415.4	348.7	0.8	98.0	100.4	2.1	2.4	414.6	0.8	0.76	0.40
2180	420.3	677.4	1.6	98.0	101.2	3.2	3.2	419.3	1.6	1.00	0.45
2907	422.3	806.6	1.9	98.0	101.5	3.6	3.5	421.1	1.9	1.10	0.46

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
	90091B_C910B1 0									
291	1049									1049
727	3452									3452
2180	8969									8969
2907	13171									13171

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)		
291	1.74	1.0833	1.0292	Erosive	Erosive	Erosive	0.2	Stable	4.9	Stable	Stable
727	1.74	1.2519	1.1893	Erosive	Erosive	Erosive	0.3	Stable	6.3	Stable	Stable
2180	1.74	1.4538	1.3811	Erosive	Erosive	Erosive	0.3	Stable	8.1	Stable	Stable
2907	1.74	1.5064	1.4311	Erosive	Erosive	Erosive	0.4	Stable	8.8	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)	**291**	**727**	**2180**	**2907**	**291**	**727**	**2180**	**2907**	**291**	**727**	**2180**	**2907**
Bray - Equation #1	47	77	137	159	1.8	2.4	3.4	3.8	3.5	4.0	4.6	4.8
Bray - Equation #2	62	101	180	209	1.9	2.6	3.8	4.1	2.4	2.7	3.2	3.3
Hey	14	24	45	52	5.6	7.9	12.0	13.3				
Ackers & Charlton/Lacey	39	57	91	103					2.1	2.4	2.9	3.0
Parker	117	185	321	370	1.5	2.1	3.4	3.8				
Chang	83	145	281	334	0.1	-0.1	-0.7	-1.0				
Kellerhals	31	49	84	97	2.6	3.8	5.9	6.6	3.6	3.9	4.4	4.5
AMAFCA/Schumm	88	415	420	422								
Moody & Odem	17	17	17	17	1.1	1.1	1.1	1.1				
BUREC	22.3	31.4	47.4	52.8	6	8	13	14	3.4	4.3	5.7	6.1
Average	52	110	162	182	2.6	3.5	5.2	5.7	3.0	3.5	4.2	4.4
Values As Designed	88	415	419	421	1.3	2.4	3.2	3.5	2.7	2.1	3.2	3.6
Difference with Design	-36	-304	-257	-239	1.3	1.1	2.0	2.2	0.3	1.4	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
291	2011	1272	2544	3594	6080	560	520	316	7477	578	2164	2465
727	8317	4225	7917	17025	9089	2476	1789	1676	19866	2045	9278	7609
2180	45248	15556	24796	109524	13879	11847	5970	8750	61168	9986	45083	31983
2907	70481	21568	32261	178194	15400	17654	8003	13052	81820	15215	66895	47322

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
291	2567	1623	3246	4587	7759	714	664	403	9542	737	2761	3146
727	4246	2157	4041	8691	4640	1264	913	856	10142	1044	4737	3885
2180	7700	2647	4219	18637	2362	2016	1016	1489	10409	1699	7671	5442
2907	8995	2753	4117	22742	1965	2253	1021	1666	10442	1942	8537	6039

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
291	1226	624	972	2160	1563	244	202	287	1797	258	1447	980
727	2174	1156	1893	3460	5494	371	367	430	4178	481	2437	2040
2180	11816	5136	7669	22216	9033	2350	1716	2849	13860	2422	13887	8451
2907	18387	7357	10549	36116	10165	3582	2400	4407	18702	3730	21287	12426

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
291	1565	797	1240	2756	1995	311	258	366	2293	329	1847	1251
727	1110	590	967	1766	2805	190	187	220	2133	245	1244	1041
2180	2011	874	1305	3780	1537	400	292	485	2358	412	2363	1438
2907	2347	939	1346	4609	1297	457	306	562	2387	476	2717	1586

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)
291	0.0023	0.0033	129	0.39	0.047	0.0007	30	0.035	0.0005	0.0159	0.0007	0.0017	0.0053	0.0003	0.0024	0.0131	0.0051
727	0.0011	0.0019	169	0.52	0.049	0.0004	30	0.036	0.0003	0.0159	0.0004	0.0009	0.0053	0.0002	0.0012	0.0132	0.0049
2180	0.0005	0.0010	235	0.71	0.052	0.0002	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0053	0.0001	0.0005	0.0131	0.0047
2907	0.0004	0.0008	255	0.78	0.053	0.0002	32	0.036	0.0001	0.0159	0.0002	0.0004	0.0053	0.0001	0.0004	0.0131	0.0047

Drop Structures

Design Slope	0.0050	ft/ft
Total Drop Needed	27.6	ft
Height of Drop Structure	3	ft
No . of Drop Structures	10	
Distance between structs.	339	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	0.49	sq. mi
Total Sediment Yield Volume	0.92	ac ft

Sedimentation Basins

Length	339 ft	Depth	3 ft
Width	442 ft	Side slope	3 ft/ft
Total Volume per Basin		9.84	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)
291	1.1	-0.4	0.1	24.6	1.3	1.2	2.7	0.0050	0.1	0.0	2.0	2.8
727	1.1	-0.9	0.1	24.6	2.4	0.8	2.1	0.0050	0.2	0.0	2.0	3.0
2180	1.1	-0.9	0.1	24.6	3.2	1.6	3.2	0.0050	0.3	0.0	2.0	3.1
2907	1.1	-1.0	0.2	24.6	3.5	1.9	3.6	0.0050	0.4	0.0	2.0	3.2

Toe Protection Needed	4.0	ft

HEC1 Results For Open Channel

Peak Flow	1296	cfs
Stage at Peak Flow	100.9	ft
Flow Volume	140.0	ac. ft

Freeboard

Max. Flow Depth	1.4	ft
Channel Depth as designed	5.0	ft
Available Freeboard	3.6	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	0.99	ac. ft
Outflowing Sediment Volume	0.08	ac. ft
Deposited(+)/Eroded(-) Volume	0.90	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	3390	3390
Side Slope (?H:1V)	3	3
Channel Width (ft)	442	442
Channel XS Area (sq. ft)	2307	2307
Channel Perimeter (ft)	444	444

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	3390	ft
Thickness	1.5	ft
Protection Depth	4	ft
Tie-in Length/Depth	3.0	ft
Total Depth	7.0	ft
Area needed	1130	sq. Yd
Volume	2637	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	3390	3390
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	5	6
Left Levee Surface Area (sq. Yd)	17327	35030
Left Levee Volume (cu. Yd)	18206	42187
Right Levee Length (ft)	3390	3390
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	5	6
Right Levee Surface Area (sq. Yd)	17327	35030
Right Levee Volume (cu. Yd)	18206	42187
Total Levee Surface Area (sq. Yd)	34654	70060
Total Levee Volume (cu. Yd)	36412	84374

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	3390	3390
Left Levee Lining Width (ft)	16	36
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	6027	13560
Left Levee Lining Volume (cu. Yd)	3013	6780
Right Levee Length (ft)	3390	3390
Right Levee Lining Width (ft)	16	36
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	6027	13560
Right Levee Lining Volume (cu. Yd)	3013	6780
Total Lining Area (sq. Yd)	12053	27120
Total Lining Volume (cu. Yd)	6026	13560

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	442	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	7.1	ft
Structure Height	10.1	ft
Number of Structures	10	
Volume per structure	496	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 37,200	
Area per structure	147	sq. Yd
Total Area	1,473	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	15875	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 63,500	
Other Cost	$ -	
Total cost per basin	$ 63,500	
Area per basin	16,651	sq. Yd
Total Area	16,651	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	36,412	cu. Yd	$ 7.00	$ 254,884	34,654	sq. Yd	$ 9.00	$ 311,886	34,654	sq. Yd	$ 11.67	$ 404,297
Levee - LC Enhancement	Fill	47,962	cu. Yd	$ 7.00	$ 335,734	35,406	sq. Yd	$ 9.00	$ 318,654	47,962	sq. Yd	$ 11.67	$ 559,557
Levee Lining	Riprap	6,026	cu. Yd	$ 75.00	$ 451,950	12,053	sq. Yd	$ -	$ -	12,053	sq. Yd	$ 20.83	$ 251,111
Levee Lining -LC Enhancement	Riprap	7,534	cu. Yd	$ 75.00	$ 565,050	15,067	sq. Yd	$ -	$ -	15,067	sq. Yd	$ 20.83	$ 313,889
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	2,637	cu. Yd	$ 75.00	$ 197,775	1,130	sq. Yd	$ -	$ -	1,130	sq. Yd	$ 25.00	$ 28,250
Drop Structures	Riprap	10	EA	$ 37,200.00	$ 372,000	1,473	sq. Yd	$ -	$ -	1,473	sq. Yd	$ 33.33	$ 49,100
Drop Str. - LC Enhancement	Riprap	10	EA	$ 3,720.00	$ 37,200	147	sq. Yd	$ -	$ -	147	sq. Yd	$ 33.33	$ 4,910
Sedimentation Basins		1	EA	$ 63,500.00	$ 63,500	16,651	sq. Yd	$ -	$ -	16,651	sq. Yd	$ 8.33	$ 138,758
Other					$ -				$ -				$ -

Base Landscape Cost	$ 311,886	
LC Enhancement Cost	$ 318,654	
Total Landscape Cost	$ 630,540	

Base Maintenance Cost	$ 871,516
LC Enhancement Cost	$ 878,356
Total Maintenance Cost	$ 1,749,872

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,340,109	$ 937,984	$ 2,278,093
Contingency Cost (25% of Construction Cost)	$ 335,027	$ 234,496	$ 569,523
Engineering Design Cost (5% of Construction Cost)	$ 67,005	$ 46,899	$ 113,905
Total Construction Cost	$ 1,742,142	$ 1,219,379	$ 2,961,521

Land Cost

Channel Length	3390 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	442	34.4	$100,000	$ 3,440,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	58	4.5	$100,000	$ 450,000
Levee LC Enhancement	54	4.2	$100,000	$ 420,000
Other	0	0	$100,000	$ -
Total	554	43.1		$ 4,310,000

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	38.9	$100,000	$ 3,890,000
LC Enhancement Cost	acre	4.2	$100,000	$ 420,000
Total Land Cost	acre	43.1	$100,000	$ 4,310,000

Total Cost

Base Total Cost	$ 6,815,544
Total Landscape Enhancement Cost	$ 2,836,389
Total Cost Including LC Enh.	$ 9,651,933

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HYDROLOGY & GEOMORPHOLOGY, INC.

Sub-area: CAP, Alternative: A
Open Channel Structure ID: RR91010

Open Channel

Structure ID	C92010	HEC1 ID	915920

Longitundal Geometry

Length	8861.8	ft
U/S Elev	1623.5	ft
D/S Elev	1532.6	ft
Initial Channel Slope	0.0103	ft/ft
Long-term Channel Slope	0.0040	ft/ft

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

NSTPS	7

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	5	0	3	418	5	3	0	5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	15	15	15	433	433	433	448
Y	105	100	100	100	100	100	100	105

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	5	150	3	100	8	3	150	5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	15	165	174	274	283	433	448
Y	105	100	100	97	97	100	100	105

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	C920									TOTAL
HEC1 Peak-Flow	3898									3898
Weighting Factor	1.00									
Flow into Channel	3898									3898

Reach Sediment Inflow Characteristics

U/S Contributing ID	910915_RR9101 0									TOTAL
HEC1 Flow Volume (ac. ft)	140.00									140
Sediment Conc. (ppm)	1586									
Sediment Volume (ac. ft)	0.08									0.08
Weighting Factor	1									
Weighted Sed. Vol. (ac. ft)	0.08									0.08

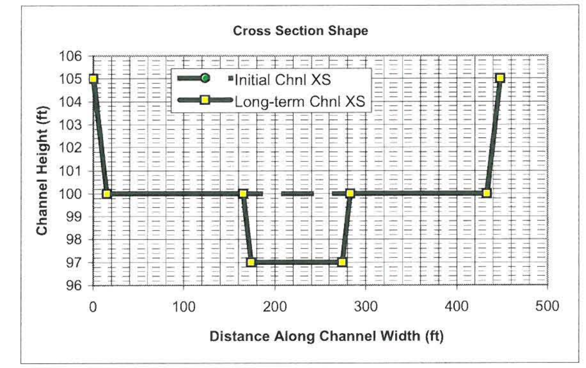
Hydrology

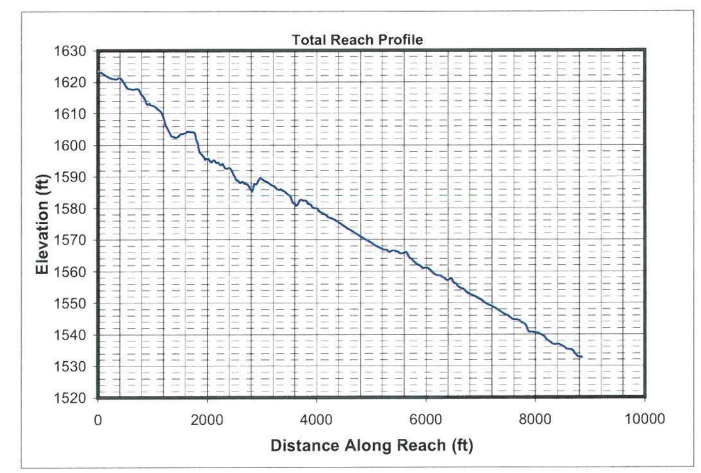
Drainage Area	6.43	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	3898	cfs	
Long-term Max. Chnl Capacity	16320	cfs	
Q2 Channel	390	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	448	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
390	420.9	194.5	0.5	100.0	100.5	2.0	0.5	420.8	0.5	0.12	0.52
975	423.1	337.6	0.8	100.0	100.8	2.9	0.8	422.8	0.8	0.20	0.57
2924	427.8	655.6	1.5	100.0	101.6	4.5	1.6	427.3	1.5	0.39	0.63
3898	429.7	780.5	1.8	100.0	101.8	5.0	1.8	429.1	1.8	0.46	0.65

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
390	109.1	150.3	1.4	97.0	98.4	2.6	1.4	108.6	1.4	0.36	0.39
975	115.7	266.7	2.3	97.0	99.5	3.7	2.5	114.9	2.3	0.62	0.42
2924	427.1	869.3	2.0	97.0	101.3	3.4	4.3	425.7	2.0	1.07	0.41
3898	429.6	1035.4	2.4	97.0	101.7	3.8	4.7	428.0	2.4	1.17	0.43

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
	910915_RR9101 0									
390	980									980
975	2040									2040
2924	8451									8451
3898	12426									12426

Allowable Velocity

Channel Lining	Natural - Sandy Loam (noncolloidal)										
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)		
390	1.74	1.1575	1.0997	Erosive	Erosive	Erosive	0.2	Stable	4.7	Stable	Stable
975	1.74	1.3260	1.2597	Erosive	Erosive	Erosive	0.3	Stable	6.8	Stable	Stable
2924	1.74	1.5275	1.4511	Erosive	Erosive	Erosive	0.4	Stable	8.7	Stable	Stable
3898	1.74	1.5799	1.5009	Erosive	Erosive	Erosive	0.4	Stable	9.4	Stable	Stable

USCOE Allowable Velocity (ft/s)	2
FHWA Allowable Velocity (ft/s)	2.5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	**390**	**975**	**2924**	**3898**	**390**	**975**	**2924**	**3898**	**390**	**975**	**2924**	**3898**
Bray - Equation #1	55	89	160	186	1.9	2.6	3.8	4.2	3.6	4.1	4.8	5.0
Bray - Equation #2	72	117	210	244	2.1	2.9	4.1	4.6	2.5	2.8	3.3	3.5
Hey	17	29	52	61	6.2	8.8	13.4	14.9				
Ackers & Charlton/Lacey	44	65	103	116					2.2	2.5	3.0	3.2
Parker	136	214	371	429	1.6	2.4	3.8	4.3				
Chang	92	161	313	372	0.1	-0.1	-0.7	-1.0				
Kellerhals	36	56	97	112	3.0	4.3	6.6	7.4	3.7	4.1	4.5	4.7
AMAFCA/Schumm	109	115	426	429								
Moody & Odem	25	25	25	25	1.3	1.3	1.3	1.3				
BUREC	25.9	36.6	55.2	61.5	7	10	15	16	3.4	4.3	5.6	6.1
Average	61	91	181	204	2.9	4.0	5.9	6.5	3.1	3.6	4.3	4.5
Values As Designed	109	115	426	428	1.4	2.5	4.3	4.7	2.6	3.7	3.4	3.8
Difference with Design	-48	-24	-244	-225	1.5	1.5	1.6	1.8	0.5	-0.1	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
390	2229	1359	2548	3891	6144	557	520	375	6879	587	2444	2503
975	9204	4530	7950	18417	9198	2471	1792	1931	18340	2145	10420	7854
2924	50022	16729	24987	118313	14073	11832	5993	9949	56550	10727	50727	33627
3898	77896	23210	32507	192387	15625	17630	8037	14814	75656	16417	75357	49958

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
390	2121	1294	2425	3704	5848	530	494	356	6547	559	2326	2382
975	3504	1724	3027	7012	3502	941	682	735	6982	817	3967	2990
2924	6348	2123	3171	15014	1786	1502	761	1263	7176	1361	6437	4267
3898	7414	2209	3094	18311	1487	1678	765	1410	7201	1563	7172	4755

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
390	1261	651	936	2119	1786	224	195	305	1691	257	1495	993
975	5026	2064	2697	9670	2717	897	611	1261	4470	990	5905	3301
2924	13523	5709	7931	25041	9240	2447	1777	3415	13286	2674	16040	9189
3898	21036	8168	10922	40678	10402	3726	2483	5247	17931	3733	24568	13536

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
390	1200	620	891	2017	1700	213	186	291	1610	244	1422	945
975	1914	786	1027	3681	1034	342	232	480	1702	377	2248	1257
2924	1716	724	1006	3178	1173	311	225	433	1686	339	2035	1166
3898	2002	777	1040	3872	990	355	236	499	1707	355	2338	1288

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)
390	0.0018	0.0026	128	0.39	0.047	0.0005	30	0.035	0.0004	0.0159	0.0006	0.0014	0.0048	0.0003	0.0019	0.0102	0.0042
975	0.0009	0.0015	168	0.51	0.049	0.0003	30	0.036	0.0002	0.0159	0.0003	0.0008	0.0048	0.0002	0.0010	0.0103	0.0040
2924	0.0004	0.0008	234	0.71	0.052	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0004	0.0048	0.0001	0.0004	0.0103	0.0039
3898	0.0003	0.0007	254	0.77	0.053	0.0002	31	0.036	0.0001	0.0159	0.0001	0.0003	0.0048	0.0001	0.0003	0.0103	0.0039

Drop Structures

Design Slope	0.0040	ft/ft
Total Drop Needed	55.5	ft
Height of Drop Structure	3	ft
No . of Drop Structures	19	
Distance between structs.	466	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	2.81	sq. mi
Total Sediment Yield Volume	5.33	ac ft

Sedimentation Basins

Length	466 ft	Depth	3 ft
Width	448 ft	Side slope	3 ft/ft
Total Volume per Basin		13.83	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)
390	1.1	-0.5	0.1	24.6	1.4	1.4	2.6	0.0040	0.1	0.0	3.0	4.2
975	1.1	-0.7	0.2	24.6	2.5	2.3	3.7	0.0040	0.3	0.0	3.0	4.4
2924	1.1	-1.2	0.2	24.6	4.3	2.0	3.4	0.0040	0.5	0.0	3.0	4.6
3898	1.1	-1.3	0.2	24.6	4.7	2.4	3.8	0.0040	0.5	0.0	3.0	4.7

Toe Protection Needed	5.0	ft

HEC1 Results For Open Channel

Peak Flow	1957	cfs
Stage at Peak Flow	101.2	ft
Flow Volume	217.0	ac. ft

Freeboard

Max. Flow Depth	1.8	ft
Channel Depth as designed	5.0	ft
Available Freeboard	3.2	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	5.41	ac. ft
Outflowing Sediment Volume	0.11	ac. ft
Deposited(+)/Eroded(-) Volume	5.31	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	8862	8862
Side Slope (?H:1V)	3	3
Channel Width (ft)	448	448
Channel XS Area (sq. ft)	2492	2492
Channel Perimeter (ft)	451	451

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	8862	ft
Thickness	1.5	ft
Protection Depth	5	ft
Tie-in Length/Depth	3.0	ft
Total Depth	8.0	ft
Area needed	2954	sq. Yd
Volume	7877	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	8862	8862
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	5	6
Left Levee Surface Area (sq. Yd)	45295	91574
Left Levee Volume (cu. Yd)	47592	110283
Right Levee Length (ft)	8862	8862
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	5	6
Right Levee Surface Area (sq. Yd)	45295	91574
Right Levee Volume (cu. Yd)	47592	110283
Total Levee Surface Area (sq. Yd)	90590	183148
Total Levee Volume (cu. Yd)	95184	220566

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	8862	8862
Left Levee Lining Width (ft)	16	36
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	15755	35448
Left Levee Lining Volume (cu. Yd)	7877	17724
Right Levee Length (ft)	8862	8862
Right Levee Lining Width (ft)	16	36
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	15755	35448
Right Levee Lining Volume (cu. Yd)	7877	17724
Total Lining Area (sq. Yd)	31509	70896
Total Lining Volume (cu. Yd)	15754	35448

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	448	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	8.3	ft
Structure Height	11.3	ft
Number of Structures	19	
Volume per structure	563	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 42,225	
Area per structure	149	sq. Yd
Total Area	2,837	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	2	
Total Volume per Basin	22312	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 89,248	
Other Cost	$ -	
Total cost per basin	$ 89,248	
Area per basin	23,217	sq. Yd
Total Area	46,434	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	95,184	cu. Yd	$ 7.00	$ 666,288	90,590	sq. Yd	$ 9.00	$ 815,310	90,590	sq. Yd	$ 11.67	$ 1,056,883
Levee - LC Enhancement	Fill	125,382	cu. Yd	$ 7.00	$ 877,674	92,558	sq. Yd	$ 9.00	$ 833,022	125,382	sq. Yd	$ 11.67	$ 1,462,790
Levee Lining	Riprap	15,754	cu. Yd	$ 75.00	$ 1,181,550	31,509	sq. Yd	$ -	$ -	31,509	sq. Yd	$ 20.83	$ 656,444
Levee Lining -LC Enhancement	Riprap	19,694	cu. Yd	$ 75.00	$ 1,477,050	39,387	sq. Yd	$ -	$ -	39,387	sq. Yd	$ 20.83	$ 820,556
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	7,877	cu. Yd	$ 75.00	$ 590,775	2,954	sq. Yd	$ -	$ -	2,954	sq. Yd	$ 25.00	$ 73,850
Drop Structures	Riprap	19	EA	$ 42,225.00	$ 802,275	2,837	sq. Yd	$ -	$ -	2,837	sq. Yd	$ 33.33	$ 94,567
Drop Str. - LC Enhancement	Riprap	19	EA	$ 4,222.50	$ 80,228	284	sq. Yd	$ -	$ -	284	sq. Yd	$ 33.33	$ 9,457
Sedimentation Basins		2	EA	$ 89,248.00	$ 178,496	46,434	sq. Yd	$ -	$ -	46,434	sq. Yd	$ 8.33	$ 386,950
Other					$ -				$ -				$ -

Base Landscape Cost	$ 815,310	
LC Enhancement Cost	$ 833,022	
Total Landscape Cost	$ 1,648,332	
Base Maintenance Cost		$ 2,268,694
LC Enhancement Cost		$ 2,292,802
Total Maintenance Cost		$ 4,561,497

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 3,419,384	$ 2,434,952	$ 5,854,336
Contingency Cost (25% of Construction Cost)	$ 854,846	$ 608,738	$ 1,463,584
Engineering Design Cost (5% of Construction Cost)	$ 170,969	$ 121,748	$ 292,717
Total Construction Cost	$ 4,445,199	$ 3,165,437	$ 7,610,636

Land Cost

Channel Length	8862 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	448	91.1	$100,000	$ 9,110,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	58	11.8	$100,000	$ 1,180,000
Levee LC Enhancement	54	11	$100,000	$ 1,100,000
Other	0	0	$100,000	$ -
Total	560	113.9		$ 11,390,000

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	102.9	$100,000	$ 10,290,000
LC Enhancement Cost	acre	11	$100,000	$ 1,100,000
Total Land Cost	acre	113.9	$100,000	$ 11,390,000

Total Cost

Base Total Cost	$ 17,819,204
Total Landscape Enhancement Cost	$ 7,391,261
Total Cost Including LC Enh.	$ 25,210,465

Open Channel

Structure ID	S115AR		HEC1 ID	S115AR

Longitundal Geometry

Length	1829.7	ft
U/S Elev	1744.7	ft
D/S Elev	1720.7	ft
Initial Channel Slope	0.0131	ft/ft
Long-term Channel Slope	0.0080	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	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	S110	S115A								TOTAL
HEC1 Peak-Flow	662	1540								2202
Weighting Factor	1.00	1.00								
Flow into Channel	662	1540								2202

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

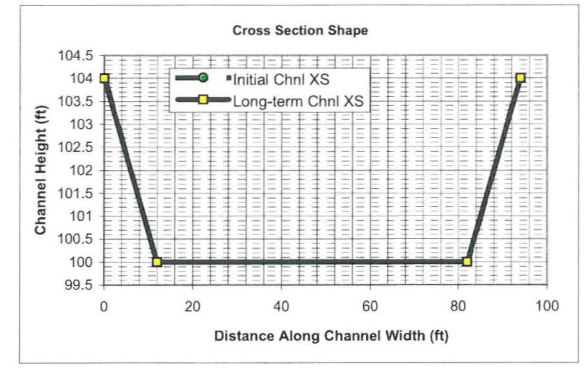
Hydrology

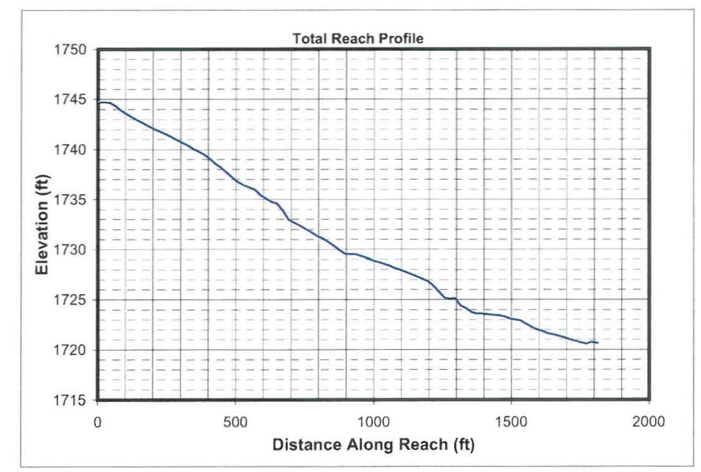
Drainage Area	1.83	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	2202	cfs	
Long-term Max. Chnl Capacity	2214	cfs	
Q2 Channel	220	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
220	76.5	75.2	1.0	100.0	101.0	2.9	1.0	76.2	1.0	0.51	0.52
551	81.2	133.5	1.6	100.0	101.8	4.1	1.8	80.6	1.7	0.88	0.56
1652	91.3	270.5	3.0	100.0	103.4	6.1	3.4	90.3	3.0	1.68	0.62
2202	95.2	326.8	3.4	100.0	104.0	6.7	4.0	93.9	3.5	1.99	0.64

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
220	76.5	75.2	1.0	100.0	101.0	2.9	1.0	76.2	1.0	0.51	0.52
551	81.2	133.5	1.6	100.0	101.8	4.1	1.8	80.6	1.7	0.88	0.56
1652	91.3	270.5	3.0	100.0	103.4	6.1	3.4	90.3	3.0	1.68	0.62
2202	95.2	326.8	3.4	100.0	104.0	6.7	4.0	93.9	3.5	1.99	0.64

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
220										0
551										0
1652										0
2202										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)		
220	1.74	1.3915	1.3219	Erosive	Erosive	Erosive	0.3	Stable	5.4	Stable	Stable
551	1.74	1.5508	1.4733	Erosive	Erosive	Erosive	0.4	Stable	7.7	Stable	Stable
1652	1.74	1.7339	1.6472	Erosive	Erosive	Erosive	0.5	Stable	11.7	Stable	Stable
2202	1.74	1.7784	1.6894	Erosive	Erosive	Erosive	0.5	Stable	13.0	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)	**220**	**551**	**1652**	**2202**	**220**	**551**	**1652**	**2202**	**220**	**551**	**1652**	**2202**
Bray - Equation #1	41	66	118	137	1.6	2.2	3.1	3.5	3.4	3.8	4.5	4.6
Bray - Equation #2	54	87	155	181	1.8	2.4	3.4	3.8	2.3	2.6	3.1	3.2
Hey	12	21	38	45	5.0	7.1	10.8	12.0				
Ackers & Charlton/Lacey	35	51	81	91					2.0	2.3	2.8	2.9
Parker	102	161	279	322	1.3	1.9	3.0	3.4				
Chang	82	142	275	327	-0.1	-0.3	-1.0	-1.2				
Kellerhals	27	42	73	84	2.4	3.4	5.3	5.9	3.5	3.8	4.3	4.4
AMAFCA/Schumm	76	81	90	94								
Moody & Odem	15	15	15	15	1.0	1.0	1.0	1.0				
BUREC	18.4	25.9	39.1	43.6	5	7	10	12	3.8	4.8	6.3	6.8
Average	46	69	116	134	2.2	3.1	4.5	5.0	3.0	3.5	4.2	4.4
Values As Designed	76	81	90	94	1.0	1.8	3.4	4.0	2.9	4.1	6.1	6.7
Difference with Design	-30	-11	26	40	1.2	1.3	1.1	1.0	0.1	-0.6	-1.9	-2.3

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
220	1655	872	1671	6781	2227	535	297	362	6093	605	2933	2185
551	6588	2559	4343	30920	3204	2025	824	1405	15441	2210	10546	7279
1652	33610	8657	12343	184773	4986	11135	2500	6080	46611	8270	44241	33019
2202	51186	11806	16648	292944	5622	17442	3308	8762	62198	8922	63487	49302

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
220	2788	1469	2815	11425	3753	902	500	610	10266	1019	4941	3681
551	4440	1725	2927	20838	2159	1365	555	947	10406	1489	7107	4905
1652	7550	1945	2773	41508	1120	2502	562	1366	10471	1858	9938	7417
2202	8624	1989	2805	49356	947	2939	557	1476	10479	1503	10697	8307

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
220	1655	802	1333	3230	1616	402	297	362	2838	371	1905	1346
551	6588	2388	3625	14727	2390	1469	824	1405	7287	1404	7079	4471
1652	33610	8162	10040	88005	3794	6458	2500	6080	22124	3004	30784	19506
2202	51186	11153	13408	139526	4294	9462	3308	8762	29545	3269	44567	28953

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
220	2788	1351	2247	5442	2722	677	500	610	4782	625	3210	2268
551	4440	1610	2443	9925	1611	990	555	947	4911	946	4771	3013
1652	7550	1834	2255	19770	852	1451	562	1366	4970	675	6915	4382
2202	8624	1879	2259	23508	723	1594	557	1476	4978	551	7509	4878

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson n	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)
220	0.0008	0.0012	211	0.64	0.051	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0006	0.0058	0.0003	0.0009	0.0080	0.0037
551	0.0004	0.0007	273	0.83	0.054	0.0002	32	0.036	0.0001	0.0159	0.0002	0.0004	0.0058	0.0002	0.0005	0.0079	0.0036
1652	0.0002	0.0004	367	1.12	0.057	0.0001	33	0.036	0.0001	0.0159	0.0001	0.0002	0.0058	0.0001	0.0002	0.0079	0.0035
2202	0.0002	0.0003	395	1.20	0.057	0.0001	33	0.036	0.0001	0.0159	0.0001	0.0002	0.0058	0.0001	0.0002	0.0079	0.0035

Drop Structures

Design Slope	0.0080	ft/ft
Total Drop Needed	9.4	ft
Height of Drop Structure	3	ft
No . of Drop Structures	4	
Distance between structs.	457	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	1.22	ac ft

Sedimentation Basins

Length	457 ft	Depth	3 ft
Width	94 ft	Side slope	3 ft/ft
Total Volume per Basin		2.63	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)
220	1.1	-0.3	0.1	24.6	1.0	1.0	2.9	0.0080	0.1	0.0	2.0	2.8
551	1.1	-0.5	0.2	24.6	1.8	1.7	4.1	0.0080	0.2	0.0	2.0	3.0
1652	1.1	-0.7	0.5	24.6	3.4	3.0	6.1	0.0080	0.4	0.0	2.0	3.5
2202	1.1	-0.7	0.6	24.6	4.0	3.5	6.7	0.0080	0.5	0.0	2.0	3.7

Toe Protection Needed	4.0	ft

HEC1 Results For Open Channel

Peak Flow	3466	cfs
Stage at Peak Flow	0.0	ft
Flow Volume	906.0	ac. ft

Freeboard

Max. Flow Depth	4.0	ft
Channel Depth as designed	4.0	ft
Available Freeboard	0.0	ft
Required Freeboard	1.2	ft

Sediment Volume

Inflowing Sediment Volume	1.22	ac. ft
Outflowing Sediment Volume	1.67	ac. ft
Deposited(+)/Eroded(-) Volume	-0.45	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	1830	1830
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)	52063	62933
Excavated Area (sq. Yd)	19113	23993

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	1830	1830
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)	1830	1830
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)	7930	16470
Right Levee Volume (cu. Yd)	7049	16944
Total Levee Surface Area (sq. Yd)	7930	16470
Total Levee Volume (cu. Yd)	7049	16944

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	1830	1830
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)	1830	1830
Right Levee Lining Width (ft)	13	30
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	2643	6100
Right Levee Lining Volume (cu. Yd)	1322	3050
Total Lining Area (sq. Yd)	2643	6100
Total Lining Volume (cu. Yd)	1322	3050

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	1830	ft
Thickness	1.5	ft
Protection Depth	4	ft
Tie-in Length/Depth	3.0	ft
Total Depth	7.0	ft
Area needed	305	sq. Yd
Volume	712	cu. Yd

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	14.3	ft
Structure Height	17.3	ft
Number of Structures	4	
Volume per structure	180	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 13,500	
Area per structure	31	sq. Yd
Total Area	125	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	4243	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 16,972	
Other Cost	$ -	
Total cost per basin	$ 16,972	
Area per basin	4,778	sq. Yd
Total Area	4,778	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	7,049	cu. Yd	$ 7.00	$ 49,343	7,930	sq. Yd	$ 9.00	$ 71,370	7,930	sq. Yd	$ 11.67	$ 92,517
Levee - LC Enhancement	Fill	9,895	cu. Yd	$ 7.00	$ 69,265	8,540	sq. Yd	$ 9.00	$ 76,860	9,895	sq. Yd	$ 11.67	$ 115,442
Levee Lining	Riprap	1,322	cu. Yd	$ 75.00	$ 99,150	2,643	sq. Yd	$ -	$ -	2,643	sq. Yd	$ 20.83	$ 55,069
Levee Lining -LC Enhancement	Riprap	1,728	cu. Yd	$ 75.00	$ 129,600	3,457	sq. Yd	$ -	$ -	3,457	sq. Yd	$ 20.83	$ 72,014
Excavated Channel	Excavated	52,063	cu. Yd	$ 10.00	$ 520,630	19,113	sq. Yd	$ 9.00	$ 172,017	19,113	sq. Yd	$ 8.33	$ 159,275
Exc. Chl - LC Enhancement	Excavated	10,870	cu. Yd	$ 10.00	$ 108,700	4,880	sq. Yd	$ 9.00	$ 43,920	4,880	sq. Yd	$ 8.33	$ 40,667
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	712	cu. Yd	$ 75.00	$ 53,400	305	sq. Yd	$ -	$ -	305	sq. Yd	$ 25.00	$ 7,625
Drop Structures	Riprap	4	EA	$ 13,500.00	$ 54,000	125	sq. Yd	$ -	$ -	125	sq. Yd	$ 33.33	$ 4,167
Drop Str. - LC Enhancement	Riprap	4	EA	$ 1,350.00	$ 5,400	13	sq. Yd	$ -	$ -	13	sq. Yd	$ 33.33	$ 417
Sedimentation Basins		1	EA	$ 16,972.00	$ 16,972	4,778	sq. Yd	$ -	$ -	4,778	sq. Yd	$ 8.33	$ 39,817
Other					$ -				$ -				$ -

Base Landscape Cost	$ 243,387	Base Maintenance Cost	$ 358,469
LC Enhancement Cost	$ 120,780	LC Enhancement Cost	$ 228,539
Total Landscape Cost	$ 364,167	Total Maintenance Cost	$ 587,008

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 793,495	$ 312,965	$ 1,106,460
Contingency Cost (25% of Construction Cost)	$ 198,374	$ 78,241	$ 276,615
Engineering Design Cost (5% of Construction Cost)	$ 39,675	$ 15,648	$ 55,323
Total Construction Cost	$ 1,031,544	$ 406,855	$ 1,438,398

Land Cost

Channel Length	1830 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	50	2.1	$100,000	$ 210,000
Channel	94	3.9	$100,000	$ 390,000
Channel LC Enhancement	24	1	$100,000	$ 100,000
Levee	26	1.1	$100,000	$ 110,000
Levee LC Enhancement	24	1	$100,000	$ 100,000
Active fan set aside area for Fan 1	0	103.2	$100,000	$ 10,320,000
Total	218	112.3		$ 11,230,000

Right of Way

Preservation Corridor Width	0	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	108.2	$100,000	$ 10,820,000
LC Enhancement Cost	acre	4.1	$100,000	$ 410,000
Total Land Cost	acre	112.3	$100,000	$ 11,230,000

Total Cost

Base Total Cost	$ 12,453,400
Total Landscape Enhancement Cost	$ 1,166,173
Total Cost Including LC Enh.	$ 13,619,573

JE FULLER
HYDROLOGY & GEOMORPHOLOGY, INC.

Sub-area: CAP, Alternative: A
Open Channel Structure ID: S115AR

Open Channel

Structure ID	S115AL	HEC1 ID	S115AL

Longitundal Geometry

Length	570.7	ft
U/S Elev	1728.1	ft
D/S Elev	1720.7	ft
Initial Channel Slope	0.0129	ft/ft
Long-term Channel Slope	0.0080	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	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	S110	S115A								TOTAL
HEC1 Peak-Flow	662	1540								2202
Weighting Factor	1.00	1.00								
Flow into Channel	662	1540								2202

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

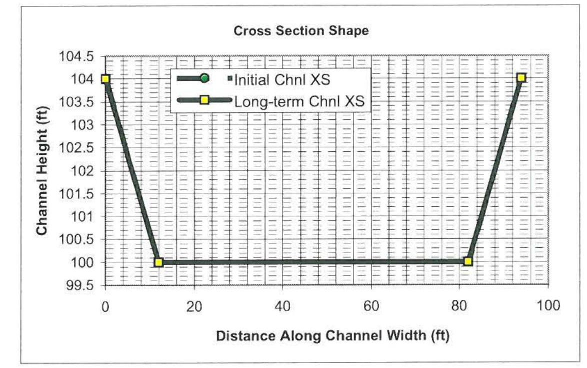
Hydrology

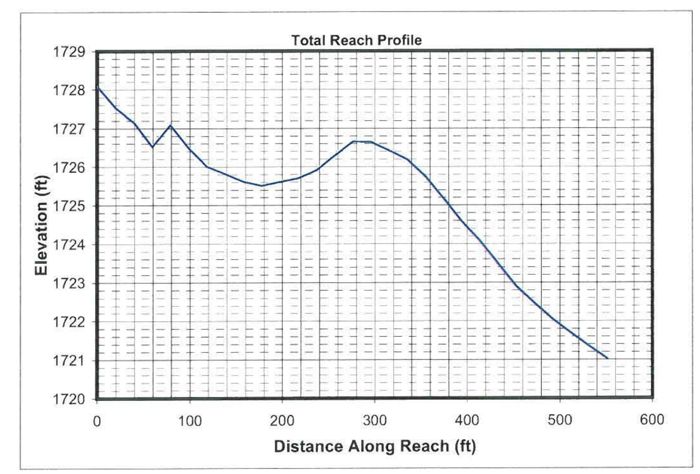
Drainage Area	1.83	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	2202	cfs	
Long-term Max. Chnl Capacity	2214	cfs	
Q2 Channel	220	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
220	76.5	75.2	1.0	100.0	101.0	2.9	1.0	76.2	1.0	0.51	0.52
551	81.2	133.5	1.6	100.0	101.8	4.1	1.8	80.6	1.7	0.88	0.56
1652	91.3	270.5	3.0	100.0	103.4	6.1	3.4	90.3	3.0	1.68	0.62
2202	95.2	326.8	3.4	100.0	104.0	6.7	4.0	93.9	3.5	1.99	0.64

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
220	76.5	75.2	1.0	100.0	101.0	2.9	1.0	76.2	1.0	0.51	0.52
551	81.2	133.5	1.6	100.0	101.8	4.1	1.8	80.6	1.7	0.88	0.56
1652	91.3	270.5	3.0	100.0	103.4	6.1	3.4	90.3	3.0	1.68	0.62
2202	95.2	326.8	3.4	100.0	104.0	6.7	4.0	93.9	3.5	1.99	0.64

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
220										0
551										0
1652										0
2202										0

Allowable Velocity

Channel Lining	Natural - Fine Gravel										
	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)					
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
Discharge (cfs)	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)	USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
220	1.74	1.3915	1.3219	Erosive	Erosive	Erosive	0.3	Stable	5.4	Stable	Stable
551	1.74	1.5508	1.4733	Erosive	Erosive	Erosive	0.4	Stable	7.7	Stable	Stable
1652	1.74	1.7339	1.6472	Erosive	Erosive	Erosive	0.5	Stable	11.7	Stable	Stable
2202	1.74	1.7784	1.6894	Erosive	Erosive	Erosive	0.5	Stable	13.0	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)	**220**	**551**	**1652**	**2202**	**220**	**551**	**1652**	**2202**	**220**	**551**	**1652**	**2202**
Bray - Equation #1	41	66	118	137	1.6	2.2	3.1	3.5	3.4	3.8	4.5	4.6
Bray - Equation #2	54	87	155	181	1.8	2.4	3.4	3.8	2.3	2.6	3.1	3.2
Hey	12	21	38	45	5.0	7.1	10.8	12.0				
Ackers & Charlton/Lacey	35	51	81	91					2.0	2.3	2.8	2.9
Parker	102	161	279	322	1.3	1.9	3.0	3.4				
Chang	82	142	275	327	-0.1	-0.3	-1.0	-1.2				
Kellerhals	27	42	73	84	2.4	3.4	5.3	5.9	3.5	3.8	4.3	4.4
AMAFCA/Schumm	76	81	90	94								
Moody & Odem	15	15	15	15	1.0	1.0	1.0	1.0				
BUREC	18.4	25.9	39.1	43.6	5	7	10	12	3.8	4.8	6.3	6.8
Average	46	69	116	134	2.2	3.1	4.5	5.0	3.0	3.5	4.2	4.4
Values As Designed	76	81	90	94	1.0	1.8	3.4	4.0	2.9	4.1	6.1	6.7
Difference with Design	-30	-11	26	40	1.2	1.3	1.1	1.0	0.1	-0.6	-1.9	-2.3

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
220	1655	870	1659	6626	2206	530	297	362	5951	597	2895	2150
551	6588	2554	4318	30214	3176	2004	824	1405	15085	2184	10421	7161
1652	33610	8641	12263	180555	4944	10940	2500	6080	45543	8034	43766	32443
2202	51186	11785	16534	286256	5576	17135	3308	8762	60774	8669	62823	48437

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
220	2788	1465	2795	11164	3717	893	500	610	10027	1006	4878	3622
551	4440	1721	2910	20362	2140	1350	555	947	10167	1472	7023	4826
1652	7550	1941	2755	40561	1111	2458	562	1366	10231	1805	9832	7288
2202	8624	1986	2786	48229	939	2887	557	1476	10239	1461	10585	8161

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
220	1655	802	1333	3230	1616	402	297	362	2838	371	1905	1346
551	6588	2388	3625	14727	2390	1469	824	1405	7287	1404	7079	4471
1652	33610	8162	10040	88005	3794	6458	2500	6080	22124	3004	30784	19506
2202	51186	11153	13408	139526	4294	9462	3308	8762	29545	3269	44567	28953

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
220	2788	1351	2247	5442	2722	677	500	610	4782	625	3210	2268
551	4440	1610	2443	9925	1611	990	555	947	4911	946	4771	3013
1652	7550	1834	2255	19770	852	1451	562	1366	4970	675	6915	4382
2202	8624	1879	2259	23508	723	1594	557	1476	4978	551	7509	4878

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)
220	0.0008	0.0012	210	0.64	0.051	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0006	0.0058	0.0003	0.0009	0.0080	0.0037
551	0.0004	0.0007	271	0.83	0.053	0.0002	32	0.036	0.0001	0.0159	0.0002	0.0004	0.0058	0.0002	0.0005	0.0079	0.0036
1652	0.0002	0.0004	364	1.11	0.056	0.0001	33	0.036	0.0001	0.0159	0.0001	0.0002	0.0058	0.0001	0.0002	0.0079	0.0035
2202	0.0002	0.0003	392	1.19	0.057	0.0001	33	0.036	0.0001	0.0159	0.0001	0.0002	0.0058	0.0001	0.0002	0.0079	0.0035

Drop Structures

Design Slope	0.0080	ft/ft
Total Drop Needed	2.8	ft
Height of Drop Structure	3	ft
No . of Drop Structures	1	
Distance between structs.	571	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	1.22	ac ft

Sedimentation Basins

Length	571 ft	Depth	3 ft
Width	94 ft	Side slope	3 ft/ft
Total Volume per Basin		3.29	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)
220	1.1	-0.3	0.1	24.6	1.0	1.0	2.9	0.0080	0.1	0.0	2.0	2.8
551	1.1	-0.5	0.2	24.6	1.8	1.7	4.1	0.0080	0.2	0.0	2.0	3.0
1652	1.1	-0.7	0.5	24.6	3.4	3.0	6.1	0.0080	0.4	0.0	2.0	3.5
2202	1.1	-0.7	0.6	24.6	4.0	3.5	6.7	0.0080	0.5	0.0	2.0	3.7

Toe Protection Needed	4.0	ft

HEC1 Results For Open Channel

Peak Flow	3466	cfs
Stage at Peak Flow	0.0	ft
Flow Volume	906.0	ac. ft

Freeboard

Max. Flow Depth	4.0	ft
Channel Depth as designed	4.0	ft
Available Freeboard	0.0	ft
Required Freeboard	1.2	ft

Sediment Volume

Inflowing Sediment Volume	1.22	ac. ft
Outflowing Sediment Volume	1.67	ac. ft
Deposited(+)/Eroded(-) Volume	-0.45	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	571	571
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)	9727	11455
Excavated Area (sq. Yd)	5964	7486

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	571	571
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)	2474	5139
Left Levee Volume (cu. Yd)	2199	5287
Right Levee Length (ft)	571	571
Right Levee Top Width (ft)	0	0
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	0	0
Right Levee Surface Area (sq. Yd)	0	0
Right Levee Volume (cu. Yd)	0	0
Total Levee Surface Area (sq. Yd)	2474	5139
Total Levee Volume (cu. Yd)	2199	5287

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	571	571
Left Levee Lining Width (ft)	13	30
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	825	1903
Left Levee Lining Volume (cu. Yd)	412	952
Right Levee Length (ft)	571	571
Right Levee Lining Width (ft)	0	0
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	0	0
Right Levee Lining Volume (cu. Yd)	0	0
Total Lining Area (sq. Yd)	825	1903
Total Lining Volume (cu. Yd)	412	952

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	571	ft
Thickness	1.5	ft
Protection Depth	4	ft
Tie-in Length/Depth	3.0	ft
Total Depth	7.0	ft
Area needed	95	sq. Yd
Volume	222	cu. Yd

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	14.3	ft
Structure Height	17.3	ft
Number of Structures	1	
Volume per structure	180	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 13,500	
Area per structure	31	sq. Yd
Total Area	31	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	5308	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 21,232	
Other Cost	$ -	
Total cost per basin	$ 21,232	
Area per basin	5,960	sq. Yd
Total Area	5,960	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	2,199	cu. Yd	$ 7.00	$ 15,393	2,474	sq. Yd	$ 9.00	$ 22,266	2,474	sq. Yd	$ 11.67	$ 28,863
Levee - LC Enhancement	Fill	3,088	cu. Yd	$ 7.00	$ 21,616	2,665	sq. Yd	$ 9.00	$ 23,985	3,088	sq. Yd	$ 11.67	$ 36,027
Levee Lining	Riprap	412	cu. Yd	$ 75.00	$ 30,900	825	sq. Yd	$ -	$ -	825	sq. Yd	$ 20.83	$ 17,183
Levee Lining -LC Enhancement	Riprap	540	cu. Yd	$ 75.00	$ 40,500	1,079	sq. Yd	$ -	$ -	1,079	sq. Yd	$ 20.83	$ 22,470
Excavated Channel	Excavated	9,727	cu. Yd	$ 10.00	$ 97,270	5,964	sq. Yd	$ 9.00	$ 53,676	5,964	sq. Yd	$ 8.33	$ 49,700
Exc. Chl - LC Enhancement	Excavated	1,728	cu. Yd	$ 10.00	$ 17,280	1,522	sq. Yd	$ 9.00	$ 13,698	1,522	sq. Yd	$ 8.33	$ 12,683
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	222	cu. Yd	$ 75.00	$ 16,650	95	sq. Yd	$ -	$ -	95	sq. Yd	$ 25.00	$ 2,375
Drop Structures	Riprap	1	EA	$ 13,500.00	$ 13,500	31	sq. Yd	$ -	$ -	31	sq. Yd	$ 33.33	$ 1,033
Drop Str. - LC Enhancement	Riprap	1	EA	$ 1,350.00	$ 1,350	3	sq. Yd	$ -	$ -	3	sq. Yd	$ 33.33	$ 103
Sedimentation Basins		1	EA	$ 21,232.00	$ 21,232	5,960	sq. Yd	$ -	$ -	5,960	sq. Yd	$ 8.33	$ 49,667
Other					$ -				$ -				$ -

Base Landscape Cost	$ 75,942
LC Enhancement Cost	$ 37,683
Total Landscape Cost	$ 113,625

Base Maintenance Cost	$ 148,821
LC Enhancement Cost	$ 71,283
Total Maintenance Cost	$ 220,104

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 194,945	$ 80,746	$ 275,691
Contingency Cost (25% of Construction Cost)	$ 48,736	$ 20,187	$ 68,923
Engineering Design Cost (5% of Construction Cost)	$ 9,747	$ 4,037	$ 13,785
Total Construction Cost	$ 253,429	$ 104,970	$ 358,398

Land Cost

Channel Length	571 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	50	0.7	$100,000	$ 70,000
Channel	94	1.2	$100,000	$ 120,000
Channel LC Enhancement	24	0.3	$100,000	$ 30,000
Levee	26	0.3	$100,000	$ 30,000
Levee LC Enhancement	24	0.3	$100,000	$ 30,000
Other	0	0	$100,000	$ -
Total	218	2.8		$ 280,000

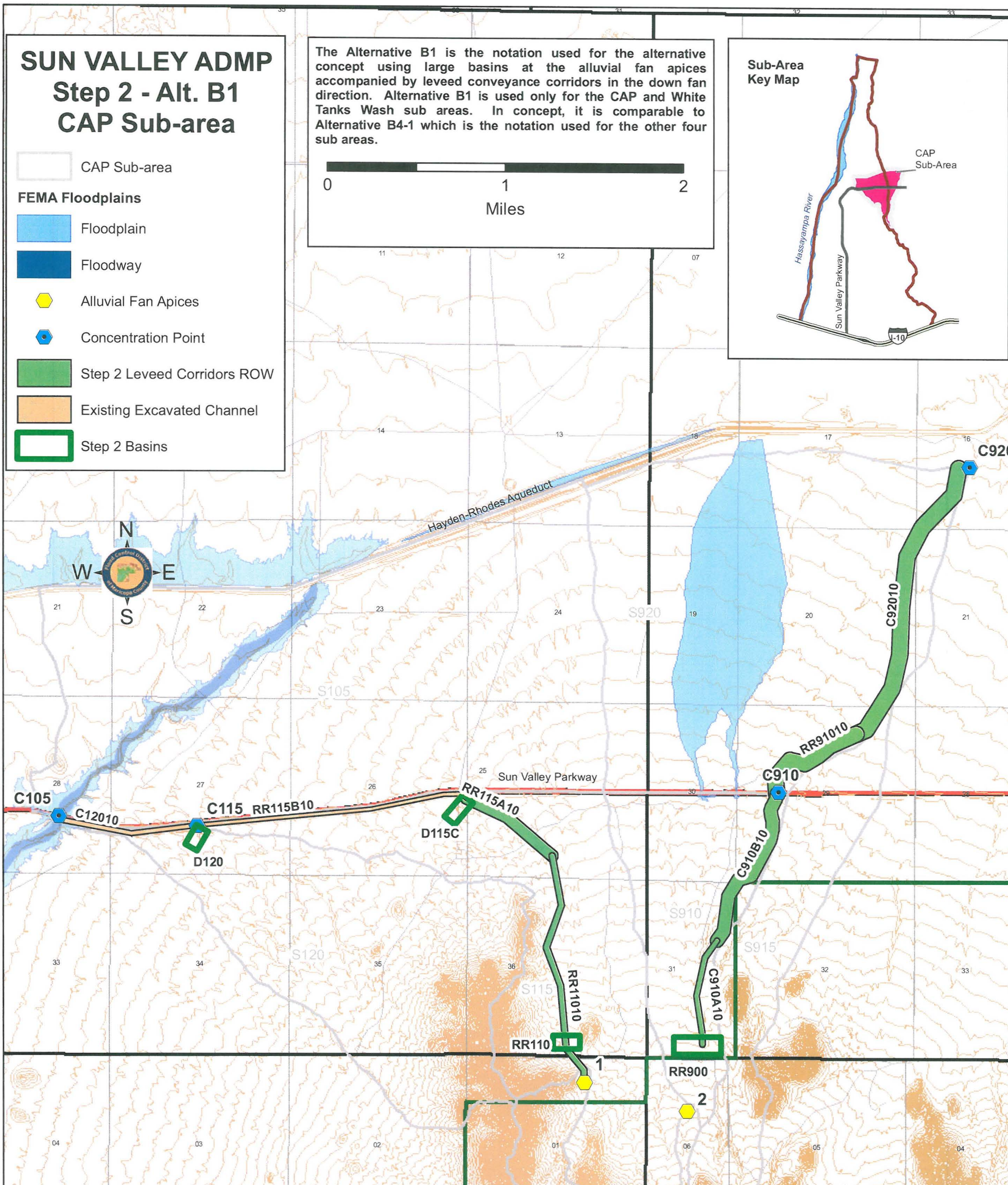
Right of Way

Preservation Corridor Width	0	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	1.5	$100,000	$ 150,000
LC Enhancement Cost	acre	1.3	$100,000	$ 130,000
Total Land Cost	acre	2.8	$100,000	$ 280,000

Total Cost

Base Total Cost	$ 628,192
Total Landscape Enhancement Cost	$ 343,936
Total Cost Including LC Enh.	$ 972,128



						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
RR110	Online Basin	74	7	79	0	800	400	6	$ 730	$ 744	$ 320	$ 319	$ 2,113	35%	35%	15%	15%	4%
RR11010	Leveed Chl.	782	30	0	41	1.4	182	5	$ 3,010	$ 2,804	$ 605	$ 1,431	$ 7,850	38%	36%	8%	18%	13%
RR115A10	Leveed Chl.	1664	25	0	18	0.6	350	5	$ 2,480	$ 1,466	$ 259	$ 734	$ 4,939	50%	30%	5%	15%	8%
RR115B10	Existing Chl.	1000	0	0	0	1.5	108	6	$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
D115C	Offline Basin	1000	8	66	0	850	400	5	$ 781	$ 644	$ 340	$ 332	$ 2,097	37%	31%	16%	16%	4%
C12010	Existing Chl.	2000	0	0	0	0.8	136	7	$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
D120	Offline Basin	2000	6	51	0	660	400	5	$ 606	$ 519	$ 264	$ 262	$ 1,651	37%	31%	16%	16%	3%
RR900	Online Basin	74	17	211	0	1400	525	6	$ 1,690	$ 1,857	$ 735	$ 707	$ 4,989	34%	37%	15%	14%	8%
C910A10	Leveed Chl.	667	14	0	21	0.7	166	5	$ 1,380	$ 1,379	$ 304	$ 727	$ 3,790	36%	36%	8%	19%	6%
C910B10	Leveed Chl.	1498	45	0	24	0.9	394	4	$ 4,520	$ 2,086	$ 389	$ 1,004	$ 7,999	57%	26%	5%	13%	13%
RR91010	Leveed Chl.	2902	38	0	19	0.6	482	5	$ 3,750	$ 1,643	$ 285	$ 799	$ 6,476	58%	25%	4%	12%	11%
C92010	Leveed Chl.	3962	99	0	59	1.7	488	5	$ 9,930	$ 4,609	$ 815	$ 2,249	$ 17,604	56%	26%	5%	13%	30%
		TOTAL	289	407	182				$28,877	$ 17,752	$ 4,316	$ 8,564	**$ 59,509**	49%	30%	7%	14%	100%
All Channels			251	0	182	5.9			$25,070	$ 13,987	$ 2,657	$ 6,944	$ 48,658	52%	29%	5%	14%	82%
All Online Basins			24	290	0				$ 2,420	$ 2,601	$ 1,055	$ 1,025	$ 7,102	34%	37%	15%	14%	12%
All Offline Basins			14	117	0				$ 1,387	$ 1,164	$ 604	$ 594	$ 3,749	37%	31%	16%	16%	6%
Channel Cost per mile (in $1000)			$8,247		Basins Cost per ac. ft. (in $1000)				$4.08									

Cost Increase for Landscape Compatibility Enhancement over Base Costs

All Channels % increase	15%	0%	134%					15%	74%	106%	106%	50%
All Online Basins % increase	54%	11%	0%					54%	10%	54%	53%	38%
All Offline Basins % increase	57%	8%	0%					61%	7%	61%	58%	44%
Total % increase	20%	10%	134%					20%	60%	87%	96%	48%

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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
RR110	Online Basin	74	7	79	0	800	400	6	$ 730	$ 744	$ 320	$ 319	$ 2,113	35%	35%	15%	15%	4%
RR11010	Leveed Chl.	782	30	0	41	1.4	182	5	$ 3,010	$ 2,804	$ 605	$ 1,431	$ 7,850	38%	36%	8%	18%	13%
RR115A10	Leveed Chl.	1664	25	0	18	0.6	350	5	$ 2,480	$ 1,466	$ 259	$ 734	$ 4,939	50%	30%	5%	15%	8%
RR115B10	Existing Chl.	1000	0	0	0	1.5	108	6	$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
D115C	Offline Basin	1000	8	66	0	850	400	5	$ 781	$ 644	$ 340	$ 332	$ 2,097	37%	31%	16%	16%	4%
C12010	Existing Chl.	2000	0	0	0	0.8	136	7	$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
D120	Offline Basin	2000	6	51	0	660	400	5	$ 606	$ 519	$ 264	$ 262	$ 1,651	37%	31%	16%	16%	3%
RR900	Online Basin	74	17	211	0	1400	525	6	$ 1,690	$ 1,857	$ 735	$ 707	$ 4,989	34%	37%	15%	14%	8%
C910A10	Leveed Chl.	667	14	0	21	0.7	166	5	$ 1,380	$ 1,379	$ 304	$ 727	$ 3,790	36%	36%	8%	19%	6%
C910B10	Leveed Chl.	1498	45	0	24	0.9	394	4	$ 4,520	$ 2,086	$ 389	$ 1,004	$ 7,999	57%	26%	5%	13%	13%
RR91010	Leveed Chl.	2902	38	0	19	0.6	482	5	$ 3,750	$ 1,643	$ 285	$ 799	$ 6,476	58%	25%	4%	12%	11%
C92010	Leveed Chl.	3962	99	0	59	1.7	488	5	$ 9,930	$ 4,609	$ 815	$ 2,249	$ 17,604	56%	26%	5%	13%	30%
		TOTAL	289	407	182				$ 28,877	$ 17,752	$ 4,316	$ 8,564	**$ 59,509**	49%	30%	7%	14%	100%
All Channels			251	0	182	5.9			$ 25,070	$ 13,987	$ 2,657	$ 6,944	$ 48,658	52%	29%	5%	14%	82%
All Online Basins			24	290	0				$ 2,420	$ 2,601	$ 1,055	$ 1,025	$ 7,102	34%	37%	15%	14%	12%
All Offline Basins			14	117	0				$ 1,387	$ 1,164	$ 604	$ 594	$ 3,749	37%	31%	16%	16%	6%
Channel Cost per mile (in $1000)			$8,247		Basins Cost per ac. ft. (in $1000)				$4.08									

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
RR110	Online Basin	74	12	88	0	1070	500	6	$ 1,220	$ 824	$ 535	$ 522	$ 3,101	39%	27%	17%	17%	4%
RR11010	Leveed Chl.	782	39	0	97	1.4	233	5	$ 3,850	$ 5,154	$ 1,253	$ 3,115	$ 13,371	29%	39%	9%	23%	15%
RR115A10	Leveed Chl.	1664	28	0	41	0.6	401	5	$ 2,840	$ 2,490	$ 537	$ 1,457	$ 7,324	39%	34%	7%	20%	8%
RR115B10	Existing Chl.	1000	0	0	0	1.5	122	6	$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
D115C	Offline Basin	1000	12	71	0	1080	500	5	$ 1,240	$ 689	$ 540	$ 521	$ 2,990	41%	23%	18%	17%	3%
C12010	Existing Chl.	2000	0	0	0	0.8	150	7	$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
D120	Offline Basin	2000	10	55	0	860	500	5	$ 990	$ 553	$ 430	$ 419	$ 2,392	41%	23%	18%	18%	3%
RR900	Online Basin	74	25	233	0	1750	625	6	$ 2,510	$ 2,049	$ 1,094	$ 1,044	$ 6,697	37%	31%	16%	16%	8%
C910A10	Leveed Chl.	667	18	0	49	0.7	217	5	$ 1,800	$ 2,552	$ 630	$ 1,573	$ 6,555	27%	39%	10%	24%	7%
C910B10	Leveed Chl.	1498	51	0	57	0.9	442	4	$ 5,070	$ 3,551	$ 809	$ 2,034	$ 11,463	44%	31%	7%	18%	13%
RR91010	Leveed Chl.	2902	42	0	45	0.6	533	5	$ 4,150	$ 2,772	$ 590	$ 1,594	$ 9,105	46%	30%	6%	18%	10%
C92010	Leveed Chl.	3962	110	0	137	1.7	542	5	$ 11,030	$ 7,773	$ 1,648	$ 4,542	$ 24,993	44%	31%	7%	18%	28%
		TOTAL	347	447	426				$ 34,700	$ 28,406	$ 8,065	$ 16,819	**$ 87,990**	39%	32%	9%	19%	100%
All Channels			288	0	426	5.9			$ 28,740	$ 24,292	$ 5,466	$ 14,314	$ 72,811	39%	33%	8%	20%	83%
All Online Basins			37	321	0				$ 3,730	$ 2,873	$ 1,629	$ 1,566	$ 9,797	38%	29%	17%	16%	11%
All Offline Basins			22	126	0				$ 2,230	$ 1,242	$ 970	$ 939	$ 5,381	41%	23%	18%	17%	6%
Channel Cost per mile (in $1000)			$12,341		Basins Cost per ac. ft. (in $1000)				$5.81									
All Channels % increase			15%	0%	134%				15%	74%	106%	106%	50%					
All Online Basins % increase			54%	11%	0%				54%	10%	54%	53%	38%					
All Offline Basins % increase			57%	8%	0%				61%	7%	61%	58%	44%					
Total % increase			20%	10%	134%				20%	60%	87%	96%	48%					

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	61	100.2	17.36	11.4	10.23	59	51	36	20	0.054	0.185	0.39	0.513	29	101	213	280
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	100.3	9.31	8	10.23	60	51	36	20	0.055	0.186	0.39	0.513	30	101	213	280
C105U	COMBINE	2863			4.5	14.6	554	228	121	64	0.353	0.58	0.923	1.129	275	451	719	879
S110	BASIN	662			4.2	0.43	76	19	6	3	1.639	1.64	1.64	1.64	38	38	38	38
RR110	STORAGE	74	4.8	29.28	5	0.43	59	19	6	3	1.274	1.64	1.64	1.64	29	38	38	38
11015I	ROUTE	74	100.3	5.01	5.6	0.43	58	19	6	3	1.244	1.64	1.64	1.64	29	38	38	38
S115A	BASIN	1540			4.3	1.4	213	53	18	8	1.415	1.416	1.416	1.416	105	105	105	105
C115A	COMBINE	1442			4.3	1.83	249	68	23	10	1.266	1.383	1.383	1.383	123	135	135	135
15I15A	ROUTE	1406	101.1	20.67	4.5	1.83	247	68	23	10	1.259	1.383	1.383	1.383	123	135	135	135
S115B	BASIN	789			4.1	0.42	57	14	5	2	1.269	1.269	1.269	1.269	29	29	29	29
C115B	COMBINE	1565			4.4	2.25	284	77	26	11	1.175	1.277	1.277	1.277	141	153	153	153
15I15B	ROUTE	1536	103.4	31.57	4.5	2.25	283	77	26	11	1.169	1.277	1.277	1.277	140	153	153	153
S115C	BASIN	668			4.1	0.43	58	14	5	2	1.246	1.246	1.246	1.246	29	29	29	29
C115C	COMBINE	1640			4.5	2.68	316	86	29	12	1.096	1.192	1.192	1.192	157	170	170	170
D115C	DIVERT	1000			4.3	2.68	271	75	25	11	0.943	1.039	1.039	1.039	135	148	148	148
115120	ROUTE	1001	102.9	13.51	4.5	2.68	271	75	25	11	0.94	1.039	1.039	1.039	134	148	148	148
S120	BASIN	1838			4.3	2	256	64	21	9	1.189	1.189	1.189	1.189	127	127	127	127
C120	COMBINE	2294			4.5	4.68	479	127	42	18	0.952	1.009	1.009	1.009	238	252	252	252
D120	DIVERT	1950			4.5	4.68	461	122	41	18	0.915	0.972	0.973	0.973	228	243	243	243
C105D	COMBINE	3793			4.5	19.28	795	273	127	64	0.383	0.527	0.733	0.858	394	541	754	882
S900	BASIN	936			4.5	1.03	170	43	14	6	1.529	1.535	1.535	1.535	84	85	85	85
RR900	STORAGE	74	4.8	69.22	6.1	1.03	69	42	14	6	0.622	1.502	1.535	1.535	34	83	85	85
90091A	ROUTE	74	100.4	2.5	6.4	1.03	69	42	14	6	0.622	1.501	1.535	1.535	34	83	85	85
90091B	ROUTE	74	100.2	5.76	7.6	1.03	68	42	14	6	0.614	1.499	1.535	1.535	34	83	85	85
S910	BASIN	1585			4.1	0.98	138	35	12	5	1.307	1.307	1.307	1.307	69	69	69	69
C910	COMBINE	1223			4.1	2.02	170	70	24	10	0.782	1.284	1.302	1.302	84	138	140	140
910915	ROUTE	1106	100.8	25.66	4.3	2.02	166	70	24	10	0.764	1.282	1.302	1.302	82	138	140	140
S915	BASIN	1400			4.5	1.13	189	47	16	7	1.562	1.562	1.562	1.562	94	94	94	94
C915	COMBINE	2024			4.4	3.14	323	108	36	16	0.954	1.276	1.288	1.288	160	214	216	216
915920	ROUTE	1728	101.2	94.85	4.9	3.14	312	108	36	16	0.922	1.272	1.288	1.288	155	213	216	216
S920	BASIN	2660			4.5	3.29	424	106	35	15	1.197	1.197	1.197	1.197	210	210	210	210
C920	COMBINE	3209			4.8	6.43	657	193	65	28	0.949	1.115	1.123	1.123	326	383	385	385

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	71	100.2	20.2	19.1	10.23	68	58	41	23	0.062	0.212	0.445	0.579	34	116	243	316
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	100.3	10.27	15.9	10.23	70	59	41	23	0.063	0.213	0.445	0.58	35	116	243	316
C105U	COMBINE	3466			12.5	14.6	593	239	126	66	0.378	0.609	0.961	1.164	294	474	748	906
S110	BASIN	532			12.1	0.43	62	16	5	2	1.35	1.422	1.422	1.422	31	33	33	33
RR110	STORAGE	67	3.9	23.69	13	0.43	52	16	5	2	1.115	1.418	1.422	1.422	26	33	33	33
11015I	ROUTE	66	100.3	4.69	13.5	0.43	50	16	5	2	1.091	1.418	1.422	1.422	25	33	33	33
S115A	BASIN	1536			12.3	1.4	193	50	17	7	1.286	1.321	1.322	1.322	96	98	98	98
C115A	COMBINE	1533			12.3	1.83	235	65	22	9	1.194	1.33	1.333	1.333	116	130	130	130
15I15A	ROUTE	1488	101.1	21.41	12.4	1.83	233	65	22	9	1.186	1.33	1.333	1.333	116	130	130	130
S115B	BASIN	619			12	0.42	47	12	4	2	1.046	1.046	1.046	1.046	23	23	23	23
C115B	COMBINE	1664			12.3	2.25	277	77	26	11	1.145	1.266	1.269	1.269	137	152	152	152
15I15B	ROUTE	1636	103.5	33.04	12.5	2.25	275	77	26	11	1.139	1.266	1.269	1.269	137	152	152	152
S115C	BASIN	534			12.1	0.43	47	12	4	2	1.028	1.028	1.028	1.028	24	24	24	24
C115C	COMBINE	1822			12.5	2.68	318	88	29	13	1.105	1.219	1.221	1.221	158	174	174	174
D115C	DIVERT	1000			12.3	2.68	263	74	25	11	0.912	1.026	1.028	1.028	130	146	147	147
115120	ROUTE	1002	102.9	13.52	12.5	2.68	262	74	25	11	0.91	1.026	1.028	1.028	130	146	147	147
S120	BASIN	2032			12.3	2	247	62	21	9	1.146	1.158	1.158	1.158	122	124	124	124
C120	COMBINE	2853			12.4	4.68	501	135	45	19	0.996	1.071	1.072	1.072	249	267	268	268
D120	DIVERT	2000			12.2	4.68	459	124	41	18	0.911	0.986	0.988	0.988	227	246	247	247
C105D	COMBINE	5244			12.5	19.28	995	341	157	79	0.48	0.657	0.907	1.055	493	676	933	1084
S900	BASIN	853			12.5	1.03	150	39	13	6	1.345	1.416	1.417	1.417	74	78	78	78
RR900	STORAGE	70	4.2	61.68	14	1.03	65	38	13	6	0.581	1.367	1.417	1.417	32	75	78	78
90091A	ROUTE	70	100.3	2.41	14.4	1.03	65	38	13	6	0.581	1.367	1.417	1.417	32	75	78	78
90091B	ROUTE	69	100.1	5.37	15.5	1.03	64	38	13	6	0.573	1.367	1.417	1.417	32	75	78	78
S910	BASIN	1512			12.1	0.98	122	30	10	4	1.151	1.151	1.151	1.151	60	60	60	60
C910	COMBINE	1498			12.1	2.02	165	68	23	10	0.76	1.245	1.272	1.272	82	134	137	137
910915	ROUTE	1291	100.9	28.26	12.3	2.02	161	67	23	10	0.743	1.244	1.272	1.272	80	134	137	137
S915	BASIN	1305			12.4	1.13	165	42	14	6	1.366	1.378	1.378	1.378	82	83	83	83
C915	COMBINE	2436			12.3	3.14	320	108	36	16	0.946	1.273	1.294	1.294	159	214	217	217
915920	ROUTE	1968	101.3	102.72	12.8	3.14	309	107	36	16	0.914	1.271	1.294	1.294	153	213	217	217
S920	BASIN	3157			12.5	3.29	428	107	36	15	1.209	1.209	1.209	1.209	212	212	212	212
C920	COMBINE	3962			12.7	6.43	719	212	71	31	1.039	1.223	1.235	1.235	357	420	424	424

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)
RR11010	Leveed	0.0240	0.0090	1.40	3	4.5	0.045	782	108.1	132.8	1.2	1.2	1.3	3.2	108	5.9	0.93	0.72
RR115A10	Leveed	0.0191	0.0070	0.60	3	4.5	0.045	1664	275.6	325.6	1.2	1.2	1.2	3.3	275	5.1	0.83	0.52
RR115B10	Existing	0.0118	0.0015	1.50	3	5.5	0.030	1000	89.1	138.2	1.6	1.6	3.0	2.5	88	7.2	1.02	0.28
C12010	Existing	0.0100	0.0015	0.80	3	6.5	0.030	2000	115.4	244.2	2.1	2.1	3.8	2.7	114	8.2	0.99	0.36
C910A10	Leveed	0.0198	0.0080	0.70	3	4.5	0.045	667	92.6	120.2	1.3	1.3	1.4	3.1	92	5.5	0.86	0.68
C910B10	Leveed	0.0158	0.0060	0.90	3	4.0	0.045	1498	324.8	345.2	1.1	1.1	1.1	2.9	324	4.3	0.74	0.40
RR91010	Leveed	0.0131	0.0050	0.60	3	4.5	0.045	2902	409.3	595.4	1.5	1.5	1.5	3.0	409	4.9	0.71	0.46
C92010	Leveed	0.0103	0.0040	1.70	3	5.0	0.045	3962	412.1	775.0	1.9	1.9	1.9	3.1	411	5.1	0.66	0.48

Basins Hydraulics Summary

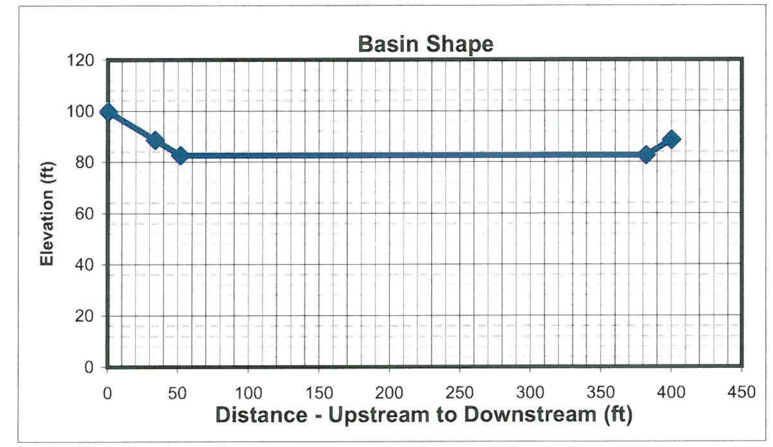
			Design Geometry				Hydraulics					
Structure ID	Type	Adjacent Topo. Slope (ft/ft)	Length (stor ft; chl-mi)	Width (ft)	Depth (ft)	Storage Volume Provided	Peak Storage (ac. Ft)	Total Vol. Entering Basin (ac.	Peak Inflow into Basin (cfs)	Peak Outflow (cfs)	Peak Stage (ft)	Freeboard (ft)
RR110	Online Basin	0.0280	800	400	6.0	30.9	29.3	38.0	662	74	4.8	1.2
D115C	Offline Basin	0.0200	850	400	5.0	27.4	27.0	27.0	822	0	2.7	2.3
D120	Offline Basin	0.0200	660	400	5.0	21.1	21.0	21.0	853	0	1.5	3.5
RR900	Online Basin	0.0276	1400	525	6.0	73.0	69.2	85.0	936	74	4.8	1.2

Online Basin

HEC1 ID	RR110

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	0.4	sq. mi
Total Sediment Yield Volume	0.8	ac ft

Required Minimum Sediment Volume

Sediment Volume	0.8	ac. ft

Geometry	Base	LC Enhanced
Topography slope (ft/ft)	0.028	0.028
Basin Length (ft)	800	970
Basin Width (ft)	400	400
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	6	6
Freeboard (ft)	1	1
Effective Basin Width (ft)	366	333
Top Area (acres)	7.3	8.9
U/S-D/S Height Difference (ft)	11.2	11.2
Excess Area on Upstream (acres)	0.7	1.5

			Base	LC Enhanced
Bottom Length (ft)	764	Allocated Storage Volume (ac. ft)	30.9	31
Bottom Width (ft)	330	Total Available Volume (ac. ft) (incl. Freeboard)	37.5	38.3
		Total Excavation Volume (ac. ft)	78.7	88.2

HEC1 Results

	6-hr Event	24-hr Event	Maximum
Total Flow Volume entering Basin (ac. ft)	38.0	33	38.0
Peak Inflow (cfs)	662	532	662.0
Peak Outflow (cfs)	74	67	74.0
Stage at Peak Outflow (ft)	4.8	3.9	4.8
Volume at Peak Outflow (ac. ft)	29.3	23.69	29.3

Volume Check

Total Volume needed	30.1	ac. ft
Total Volume Provided	30.9	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)	3.00	ft
Invert Elevation	0.00	ft
Number of pipes	1	

Stage-Storage-Discharge

Elevation	0	0.5	1	1.5	2	2.5	3	4	5	6
Volume	0.00	2.91	5.86	8.85	11.88	14.94	18.05	24.37	30.86	37.50
Outflow	0.0	24.1	34.0	41.7	48.1	53.8	59.0	68.1	76.1	83.4

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
LC Enhancement Buffer	215000	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	1070	ft
LC Enh. Total ROW Length	500	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	126969	142296
Excavated Area (sq. Yd)	35556	59444

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	54	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	604	sq. Yd
Material Volume	302	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	261	ft
Unit Cost	160	per ft
Cost per outlet	$41,760	
Other Cost	$ -	
Total Cost	$41,760	
Outlet Area	133	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
Basin		126,969	cu. Yd	$ 4.00	$ 507,876	35,556	sq. Yd	$ 9.00	$ 320,004	35,556	sq. Yd	$ 8.33	$ 296,300
Basin - LC Enhancement		15,327	cu. Yd	$ 4.00	$ 61,308	23,888	sq. Yd	$ 9.00	$ 214,992	23,888	sq. Yd	$ 8.33	$ 199,067
Inlet	Riprap	302	sq. Yd	$ 75.00	$ 22,650	604	sq. Yd	$ -	$ -	604	sq. Yd	$ 33.33	$ 20,133
Inlet - LC Enhancement (20%Inlet)					$ 4,530				$ -				$ 4,027
Outlet	Pipe	1	EA	$ 41,760	$ 41,760	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhancement (5% Outlet)					$ 2,088				$ -				$ 111
Other					$ -				$ -				$ -

Base Landscape Cost	$ 320,004	Base Maintenance Cost	$ 318,650
LC Enh. Landscape Cost	$ 214,992	LC Enh. Maintenance Cost	$ 203,204
Total Landscape Cost	$ 534,996	Total Maintenance Cost	$ 521,854

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 572,286	$ 61,308	$ 633,594
Contingency Cost (25% of Construction Cost)	$ 143,072	$ 15,327	$ 158,399
Engineering Design Cost (5% of Construction Cost)	$ 28,614	$ 3,065	$ 31,680
Total Construction Cost	$ 743,972	$ 79,700	$ 823,672

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	7.3	$100,000	$ 730,000
Other		$100,000	$ -
Total	12.2	$100,000	$ 1,220,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	7.3	$100,000	$ 730,000
LC Enhancement Cost	acre	4.9	$100,000	$ 490,000
Total Land Cost	acre	12.2	$100,000	$ 1,220,000

Total Cost

Base Total Cost	$ 2,112,626
Total LC Enhancement Cost	$ 987,897
Total Cost Including LC Enh.	$ 3,100,522

Open Channel

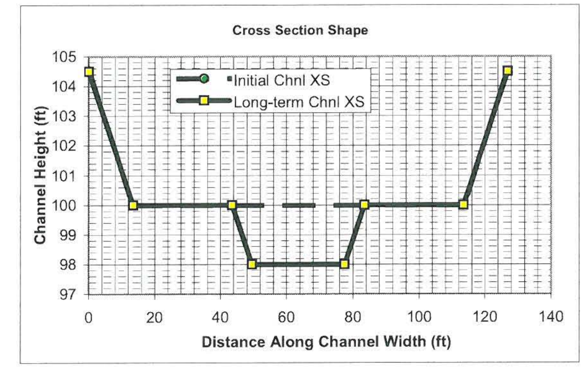
Structure ID	RR11010	HEC1 ID	11015I

Longitundal Geometry

Length	7199.5	ft
U/S Elev	1865.3	ft
D/S Elev	1692.1	ft
Initial Channel Slope	0.0240	ft/ft
Long-term Channel Slope	0.0090	ft/ft

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

NSTPS	6



Initial Channel XS Geometry

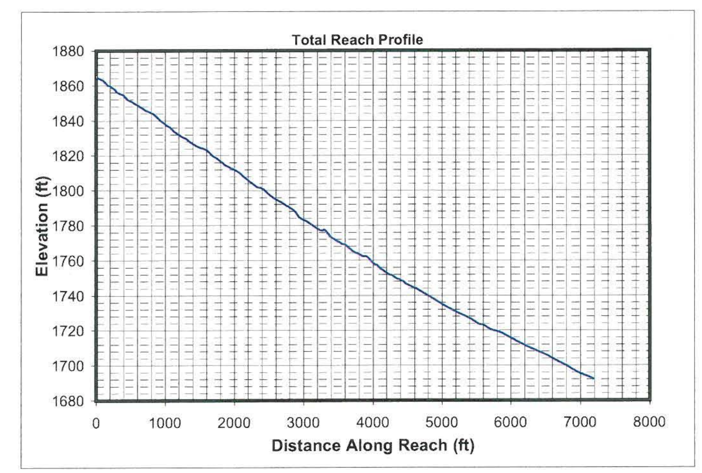
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	100	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	113.5	113.5	113.5	127
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	30	3	28	6.5	3	30	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	43.5	49.5	77.5	83.5	113.5	127
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	RR110	S115A								TOTAL
HEC1 Peak-Flow	74	1540								1614
Weighting Factor	1.00	0.46								
Flow into Channel	74	708								782

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	1.073	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	782	cfs	
Long-term Max. Chnl Capacity	4942	cfs	
Q2 Channel	78	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	127	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
78	102.0	32.6	0.3	100.0	100.3	2.4	0.3	101.9	0.3	0.18	0.75
196	103.5	56.8	0.5	100.0	100.6	3.4	0.6	103.4	0.5	0.31	0.82
587	106.8	111.2	1.0	100.0	101.1	5.3	1.1	106.5	1.0	0.60	0.91
782	108.1	132.8	1.2	100.0	101.3	5.9	1.3	107.7	1.2	0.72	0.93

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
78	33.8	28.1	0.8	98.0	98.9	2.8	0.9	33.5	0.8	0.51	0.53
196	37.9	51.0	1.3	98.0	99.6	3.8	1.6	37.4	1.4	0.88	0.58
587	105.6	148.7	1.4	98.0	100.8	3.9	2.8	104.7	1.4	1.57	0.58
782	107.4	177.8	1.7	98.0	101.1	4.4	3.1	106.4	1.7	1.72	0.60

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
78										0
196										0
587										0
782										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)		
78	1.74	1.0440	0.9918	Erosive	Erosive	Erosive	0.2	Stable	5.2	Stable	Stable
196	1.74	1.2108	1.1503	Erosive	Erosive	Erosive	0.3	Stable	7.4	Stable	Stable
587	1.74	1.4089	1.3384	Erosive	Erosive	Erosive	0.3	Stable	9.9	Stable	Stable
782	1.74	1.4601	1.3871	Erosive	Erosive	Erosive	0.3	Stable	10.7	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)			
	78	196	587	782	78	196	587	782	78	196	587	782
Bray - Equation #1	24	38	68	80	1.1	1.5	2.2	2.4	2.9	3.3	3.9	4.0
Bray - Equation #2	31	50	90	105	1.3	1.7	2.4	2.7	2.0	2.3	2.7	2.8
Hey	7	11	21	25	3.4	4.8	7.3	8.1				
Ackers & Charlton/Lacey	22	33	52	59					1.7	1.9	2.3	2.4
Parker	61	96	166	192	0.8	1.2	2.0	2.2				
Chang	45	79	153	182	0.0	-0.1	-0.4	-0.6				
Kellerhals	16	25	44	50	1.6	2.2	3.5	3.9	3.2	3.5	3.9	4.0
AMAFCA/Schumm	34	37	105	107								
Moody & Odem	13	13	13	13	1.0	1.0	1.0	1.0				
BUREC	12.2	17.2	26.0	28.9	3	5	7	8	3.1	3.9	5.1	5.5
Average	26	40	74	84	1.6	2.1	3.1	3.4	2.6	3.0	3.6	3.7
Values As Designed	33	37	105	106	0.9	1.6	2.8	3.1	2.8	3.8	3.9	4.4
Difference with Design	-7	3	-31	-22	0.6	0.6	0.3	0.4	-0.2	-0.9	-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
78	1310	760	1697	2787	2124	506	378	241	5285	397	1414	1536
196	5384	2281	4634	13109	3060	1900	1068	1026	13531	1359	5400	4796
587	28898	7829	12790	83073	4595	8649	3246	4701	41021	6351	23808	20451
782	44786	10711	17126	134393	5098	13751	4291	6856	54766	9550	34557	30535

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
78	6216	3606	8053	13222	10076	2400	1794	1144	25074	1881	6708	7289
196	10217	4329	8794	24877	5807	3606	2026	1946	25678	2579	10247	9101
587	18280	4952	8090	52549	2907	5471	2053	2974	25948	4018	15060	12937
782	21247	5081	8125	63759	2419	6524	2036	3253	25982	4531	16395	14487

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
78	611	307	539	1199	689	156	118	130	1199	142	701	526
196	2354	908	1468	5266	1058	563	329	501	3081	518	2559	1691
587	7392	2676	4457	16583	3037	1748	1000	1562	9256	1609	7957	5207
782	11426	3751	5746	26743	3409	2600	1353	2341	12400	2450	11864	7644

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
78	2898	1455	2555	5687	3270	742	559	616	5690	673	3326	2497
196	4468	1723	2787	9993	2007	1068	625	951	5847	982	4855	3210
587	4676	1693	2820	10490	1921	1106	633	988	5855	1018	5033	3294
782	5421	1779	2726	12688	1617	1233	642	1111	5883	1162	5629	3626

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)
78	0.0021	0.0038	163	0.50	0.049	0.0008	30	0.036	0.0006	0.0159	0.0008	0.0018	0.0082	0.0005	0.0025	0.0240	0.0086
196	0.0011	0.0022	214	0.65	0.051	0.0005	31	0.036	0.0003	0.0159	0.0005	0.0010	0.0082	0.0003	0.0013	0.0240	0.0084
587	0.0005	0.0012	295	0.90	0.054	0.0003	32	0.036	0.0002	0.0159	0.0002	0.0005	0.0082	0.0002	0.0006	0.0240	0.0082
782	0.0004	0.0010	320	0.98	0.055	0.0002	32	0.036	0.0002	0.0159	0.0002	0.0004	0.0082	0.0002	0.0004	0.0239	0.0082

Drop Structures

Design Slope	0.0090	ft/ft
Total Drop Needed	108.3	ft
Height of Drop Structure	3	ft
No . of Drop Structures	37	
Distance between structs.	195	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	1.22	ac ft

Sedimentation Basins

Length	195 ft	Depth	3 ft
Width	127 ft	Side slope	3 ft/ft
Total Volume per Basin		1.51	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)
78	1.1	-0.3	0.1	24.6	0.9	0.8	2.8	0.0090	0.1	0.0	2.0	2.8
196	1.1	-0.4	0.2	24.6	1.6	1.4	3.8	0.0090	0.2	0.0	2.0	3.0
587	1.1	-0.7	0.2	24.6	2.8	1.4	3.9	0.0090	0.3	0.0	2.0	3.1
782	1.1	-0.8	0.3	24.6	3.1	1.7	4.4	0.0090	0.4	0.0	2.0	3.2

Toe Protection Needed	4.0	ft

HEC1 Results For Open Channel

Peak Flow	74	cfs
Stage at Peak Flow	100.3	ft
Flow Volume	38.0	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	1.22	ac. ft
Outflowing Sediment Volume	0.05	ac. ft
Deposited(+)/Eroded(-) Volume	1.17	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	7199	7199
Side Slope (?H:1V)	3	3
Channel Width (ft)	127	127
Channel XS Area (sq. ft)	578.8	578.8
Channel Perimeter (ft)	129	129

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	7199	ft
Thickness	1.5	ft
Protection Depth	4	ft
Tie-in Length/Depth	3.0	ft
Total Depth	7.0	ft
Area needed	2400	sq. Yd
Volume	5599	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	7199	7199
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)	33595	69590
Left Levee Volume (cu. Yd)	33062	77856
Right Levee Length (ft)	7199	7199
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)	33595	69590
Right Levee Volume (cu. Yd)	33062	77856
Total Levee Surface Area (sq. Yd)	67190	139180
Total Levee Volume (cu. Yd)	66124	155712

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	7199	7199
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	11198	26396
Left Levee Lining Volume (cu. Yd)	5599	13198
Right Levee Length (ft)	7199	7199
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	11198	26396
Right Levee Lining Volume (cu. Yd)	5599	13198
Total Lining Area (sq. Yd)	22397	52793
Total Lining Volume (cu. Yd)	11198	26396

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	127	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	7.4	ft
Structure Height	10.4	ft
Number of Structures	37	
Volume per structure	146	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 10,950	
Area per structure	42	sq. Yd
Total Area	1,566	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	3	
Total Volume per Basin	2436	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 9,744	
Other Cost	$ -	
Total cost per basin	$ 9,744	
Area per basin	2,746	sq. Yd
Total Area	8,238	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	66,124	cu. Yd	$ 7.00	$ 462,868	67,190	sq. Yd	$ 9.00	$ 604,710	67,190	sq. Yd	$ 11.67	$ 783,883
Levee - LC Enhancement	Fill	89,588	cu. Yd	$ 7.00	$ 627,116	71,990	sq. Yd	$ 9.00	$ 647,910	89,588	sq. Yd	$ 11.67	$ 1,045,193
Levee Lining	Riprap	11,198	cu. Yd	$ 75.00	$ 839,850	22,397	sq. Yd	$ -	$ -	22,397	sq. Yd	$ 20.83	$ 466,602
Levee Lining -LC Enhancement	Riprap	15,198	cu. Yd	$ 75.00	$ 1,139,850	30,396	sq. Yd	$ -	$ -	30,396	sq. Yd	$ 20.83	$ 633,245
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	5,599	cu. Yd	$ 75.00	$ 419,925	2,400	sq. Yd	$ -	$ -	2,400	sq. Yd	$ 25.00	$ 60,000
Drop Structures	Riprap	37	EA	$ 10,950.00	$ 405,150	1,566	sq. Yd	$ -	$ -	1,566	sq. Yd	$ 33.33	$ 52,200
Drop Str. - LC Enhancement	Riprap	37	EA	$ 1,095.00	$ 40,515	157	sq. Yd	$ -	$ -	157	sq. Yd	$ 33.33	$ 5,220
Sedimentation Basins		3	EA	$ 9,744.00	$ 29,232	8,238	sq. Yd	$ -	$ -	8,238	sq. Yd	$ 8.33	$ 68,650
Other					$ -				$ -				$ -

Base Landscape Cost	$ 604,710	
LC Enhancement Cost	$ 647,910	
Total Landscape Cost	$ 1,252,620	
Base Maintenance Cost		$ 1,431,335
LC Enhancement Cost		$ 1,683,659
Total Maintenance Cost		$ 3,114,994

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 2,157,025	$ 1,807,481	$ 3,964,506
Contingency Cost (25% of Construction Cost)	$ 539,256	$ 451,870	$ 991,127
Engineering Design Cost (5% of Construction Cost)	$ 107,851	$ 90,374	$ 198,225
Total Construction Cost	$ 2,804,133	$ 2,349,725	$ 5,153,858

Land Cost

Channel Length	7199 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	127	21	$100,000	$ 2,100,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	9.1	$100,000	$ 910,000
Levee LC Enhancement	51	8.4	$100,000	$ 840,000
Other	0	0	$100,000	$ -
Total	233	38.5		$ 3,850,000

Right of Way

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

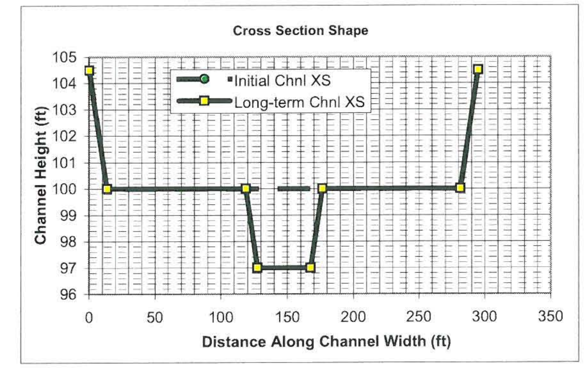
Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	30.1	$100,000	$ 3,010,000
LC Enhancement Cost	acre	8.4	$100,000	$ 840,000
Total Land Cost	acre	38.5	$100,000	$ 3,850,000

Total Cost

Base Total Cost	$ 7,850,178
Total Landscape Enhancement Cost	$ 5,521,294
Total Cost Including LC Enh.	$ 13,371,472

Open Channel

Structure ID	RR115A10	HEC1 ID	15I15A



Longitundal Geometry

Length	3083.7	ft
U/S Elev	1692.1	ft
D/S Elev	1633.3	ft
Initial Channel Slope	0.0191	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

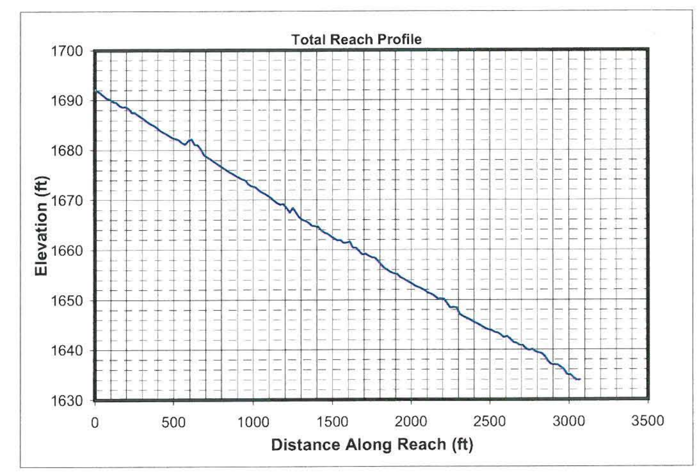
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	268	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	281.5	281.5	281.5	295
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	40	7.5	3	105	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	118.5	127.5	167.5	176.5	281.5	295
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	C115B									TOTAL
HEC1 Peak-Flow	1664									1664
Weighting Factor	1.00									
Flow into Channel	1664									1664

Reach Sediment Inflow Characteristics

U/S Contributing ID	11015I_RR11010									TOTAL
HEC1 Flow Volume (ac. ft)	38.00									38
Sediment Conc. (ppm)	3626									
Sediment Volume (ac. ft)	0.05									0.05
Weighting Factor	1									
Weighted Sed. Vol. (ac. ft)	0.05									0.05

Hydrology

Drainage Area	2.25	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	1664	cfs	
Long-term Max. Chnl Capacity	11072	cfs	
Q2 Channel	166	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	295	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
166	269.9	81.1	0.3	100.0	100.3	2.1	0.3	269.8	0.3	0.13	0.66
416	271.3	140.8	0.5	100.0	100.5	3.0	0.5	271.1	0.5	0.23	0.72
1248	274.4	273.5	1.0	100.0	101.0	4.6	1.0	274.1	1.0	0.44	0.81
1664	275.6	325.6	1.2	100.0	101.2	5.1	1.2	275.2	1.2	0.52	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
166	47.9	54.9	1.1	97.0	98.3	3.0	1.3	47.5	1.2	0.55	0.50
416	53.5	99.4	1.9	97.0	99.1	4.2	2.1	52.8	1.9	0.94	0.54
1248	274.2	369.3	1.3	97.0	100.8	3.4	3.8	272.9	1.4	1.67	0.51
1664	275.8	440.0	1.6	97.0	101.1	3.8	4.1	274.5	1.6	1.78	0.53

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
	11015I_RR11010									
166	526									526
416	1691									1691
1248	5207									5207
1664	7644									7644

Allowable Velocity

Channel Lining	Natural - Sandy Loam (noncolloidal)

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)		
166	1.74	1.0250	0.9737	Erosive	Erosive	Erosive	0.2	Stable	5.7	Stable	Stable
416	1.74	1.1933	1.1337	Erosive	Erosive	Erosive	0.3	Stable	8.1	Stable	Stable
1248	1.74	1.3948	1.3251	Erosive	Erosive	Erosive	0.3	Stable	10.2	Stable	Stable
1664	1.74	1.4473	1.3749	Erosive	Erosive	Erosive	0.3	Stable	10.8	Stable	Stable

USCOE Allowable Velocity (ft/s)	2
FHWA Allowable Velocity (ft/s)	2.5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	**166**	**416**	**1248**	**1664**	**166**	**416**	**1248**	**1664**	**166**	**416**	**1248**	**1664**
Bray - Equation #1	35	57	102	119	1.5	2.0	2.9	3.1	3.2	3.7	4.3	4.5
Bray - Equation #2	46	75	134	156	1.6	2.2	3.1	3.4	2.2	2.5	2.9	3.1
Hey	10	18	33	38	4.5	6.4	9.7	10.8				
Ackers & Charlton/Lacey	31	45	72	81					1.9	2.2	2.6	2.8
Parker	89	140	243	280	1.2	1.7	2.7	3.0				
Chang	66	115	223	265	0.0	-0.2	-0.7	-0.9				
Kellerhals	23	37	64	73	2.1	3.0	4.7	5.3	3.4	3.7	4.2	4.3
AMAFCA/Schumm	48	53	273	275								
Moody & Odem	17	17	17	17	1.1	1.1	1.1	1.1				
BUREC	17.0	23.9	36.1	40.3	5	6	10	11	3.4	4.3	5.6	6.0
Average	38	58	120	134	2.1	2.8	4.1	4.6	2.8	3.3	3.9	4.1
Values As Designed	48	53	273	274	1.3	2.1	3.8	4.1	3.0	4.2	3.4	3.8
Difference with Design	-9	5	-153	-140	0.8	0.7	0.3	0.5	-0.2	-0.9	0.6	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
166	1796	1140	2525	3473	4556	620	531	297	7721	560	1939	2287
416	7428	3617	7231	16442	6690	2522	1660	1454	20118	1914	7956	7003
1248	40337	12908	21272	105602	10093	11781	5305	7236	61443	9068	37198	29295
1664	62794	17795	27950	171706	11179	17526	7067	10706	82107	13718	54710	43387

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
166	4005	2541	5631	7744	10159	1383	1184	663	17215	1248	4323	5100
416	6624	3226	6449	14663	5966	2249	1481	1297	17942	1707	7096	6245
1248	11991	3837	6324	31393	3000	3502	1577	2151	18266	2696	11058	8709
1664	14000	3967	6232	38283	2492	3908	1576	2387	18306	3059	12198	9673

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
166	1145	539	860	2237	1024	263	192	258	1757	251	1328	896
416	4426	1585	2337	9852	1561	937	527	965	4504	935	4809	2949
1248	10011	4088	6672	20241	6541	2252	1517	2262	13317	2148	11429	7316
1664	15573	5820	9226	32877	7337	3399	2092	3471	17908	3293	17362	10760

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
166	2553	1202	1918	4988	2284	586	427	576	3916	560	2960	1997
416	3947	1414	2085	8786	1392	836	470	861	4017	834	4289	2630
1248	2976	1215	1983	6017	1944	669	451	672	3959	638	3398	2175
1664	3472	1298	2057	7330	1636	758	467	774	3993	734	3871	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)
166	0.0025	0.0040	141	0.43	0.047	0.0009	30	0.036	0.0006	0.0159	0.0008	0.0020	0.0063	0.0004	0.0027	0.0190	0.0069
416	0.0013	0.0023	185	0.56	0.050	0.0005	31	0.036	0.0004	0.0159	0.0005	0.0011	0.0063	0.0002	0.0013	0.0191	0.0067
1248	0.0006	0.0012	257	0.78	0.053	0.0003	32	0.036	0.0002	0.0159	0.0003	0.0006	0.0063	0.0001	0.0006	0.0191	0.0065
1664	0.0005	0.0010	279	0.85	0.054	0.0002	32	0.036	0.0002	0.0159	0.0002	0.0005	0.0063	0.0001	0.0005	0.0191	0.0065

Drop Structures

Design Slope	0.0070	ft/ft
Total Drop Needed	37.2	ft
Height of Drop Structure	3	ft
No . of Drop Structures	13	
Distance between structs.	237	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	1.18	sq. mi
Total Sediment Yield Volume	2.25	ac ft

Sedimentation Basins

Length	237 ft	Depth	3 ft
Width	295 ft	Side slope	3 ft/ft
Total Volume per Basin		4.50	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)
166	1.1	-0.4	0.1	24.6	1.3	1.2	3.0	0.0070	0.1	0.0	3.0	4.2
416	1.1	-0.6	0.2	24.6	2.1	1.9	4.2	0.0070	0.2	0.0	3.0	4.4
1248	1.1	-1.1	0.2	24.6	3.8	1.4	3.4	0.0070	0.4	0.0	3.0	4.5
1664	1.1	-1.1	0.2	24.6	4.1	1.6	3.8	0.0070	0.5	0.0	3.0	4.6

Toe Protection Needed	5.0	ft

HEC1 Results For Open Channel

Peak Flow	1488	cfs
Stage at Peak Flow	101.1	ft
Flow Volume	135.0	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	2.30	ac. ft
Outflowing Sediment Volume	0.13	ac. ft
Deposited(+)/Eroded(-) Volume	2.17	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	3084	3084
Side Slope (?H:1V)	3	3
Channel Width (ft)	295	295
Channel XS Area (sq. ft)	1413.8	1413.8
Channel Perimeter (ft)	297	297

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	3084	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	2741	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	3084	3084
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)	14392	29812
Left Levee Volume (cu. Yd)	14164	33353
Right Levee Length (ft)	3084	3084
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)	14392	29812
Right Levee Volume (cu. Yd)	14164	33353
Total Levee Surface Area (sq. Yd)	28784	59624
Total Levee Volume (cu. Yd)	28328	66706

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	3084	3084
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	4797	11308
Left Levee Lining Volume (cu. Yd)	2399	5654
Right Levee Length (ft)	3084	3084
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	4797	11308
Right Levee Lining Volume (cu. Yd)	2399	5654
Total Lining Area (sq. Yd)	9595	22616
Total Lining Volume (cu. Yd)	4798	11308

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	295	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	13	
Volume per structure	314	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 23,550	
Area per structure	98	sq. Yd
Total Area	1,278	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	2	
Total Volume per Basin	7260	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 29,040	
Other Cost	$ -	
Total cost per basin	$ 29,040	
Area per basin	7,775	sq. Yd
Total Area	15,550	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	28,328	cu. Yd	$ 7.00	$ 198,296	28,784	sq. Yd	$ 9.00	$ 259,056	28,784	sq. Yd	$ 11.67	$ 335,813
Levee - LC Enhancement	Fill	38,378	cu. Yd	$ 7.00	$ 268,646	30,840	sq. Yd	$ 9.00	$ 277,560	38,378	sq. Yd	$ 11.67	$ 447,743
Levee Lining	Riprap	4,798	cu. Yd	$ 75.00	$ 359,850	9,595	sq. Yd	$ -	$ -	9,595	sq. Yd	$ 20.83	$ 199,889
Levee Lining -LC Enhancement	Riprap	6,510	cu. Yd	$ 75.00	$ 488,250	13,021	sq. Yd	$ -	$ -	13,021	sq. Yd	$ 20.83	$ 271,278
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	2,741	cu. Yd	$ 75.00	$ 205,575	1,028	sq. Yd	$ -	$ -	1,028	sq. Yd	$ 25.00	$ 25,700
Drop Structures	Riprap	13	EA	$ 23,550.00	$ 306,150	1,278	sq. Yd	$ -	$ -	1,278	sq. Yd	$ 33.33	$ 42,600
Drop Str. - LC Enhancement	Riprap	13	EA	$ 2,355.00	$ 30,615	128	sq. Yd	$ -	$ -	128	sq. Yd	$ 33.33	$ 4,260
Sedimentation Basins		2	EA	$ 29,040.00	$ 58,080	15,550	sq. Yd	$ -	$ -	15,550	sq. Yd	$ 8.33	$ 129,583
Other					$				$ -				$ -

Base Landscape Cost	$ 259,056
LC Enhancement Cost	$ 277,560
Total Landscape Cost	$ 536,616

Base Maintenance Cost	$ 733,586
LC Enhancement Cost	$ 723,281
Total Maintenance Cost	$ 1,456,867

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,127,951	$ 787,511	$ 1,915,462
Contingency Cost (25% of Construction Cost)	$ 281,988	$ 196,878	$ 478,866
Engineering Design Cost (5% of Construction Cost)	$ 56,398	$ 39,376	$ 95,773
Total Construction Cost	$ 1,466,336	$ 1,023,764	$ 2,490,101

Land Cost

Channel Length	3084 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	295	20.9	$100,000	$ 2,090,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	3.9	$100,000	$ 390,000
Levee LC Enhancement	51	3.6	$100,000	$ 360,000
Other	0	0	$100,000	$ -
Total	401	28.4		$ 2,840,000

Right of Way

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

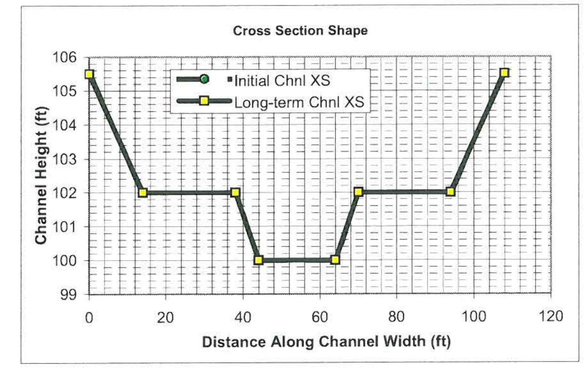
Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	24.8	$100,000	$ 2,480,000
LC Enhancement Cost	acre	3.6	$100,000	$ 360,000
Total Land Cost	acre	28.4	$100,000	$ 2,840,000

Total Cost

Base Total Cost	$ 4,938,978
Total Landscape Enhancement Cost	$ 2,384,605
Total Cost Including LC Enh.	$ 7,323,583

Open Channel

Structure ID	RR115B10		HEC1 ID	15I15B



Longitundal Geometry

Length	8073.3	ft
U/S Elev	1633.3	ft
D/S Elev	1537.8	ft
Initial Channel Slope	0.0118	ft/ft
Long-term Channel Slope	0.0015	ft/ft

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

NSTPS	7

Initial Channel XS Geometry

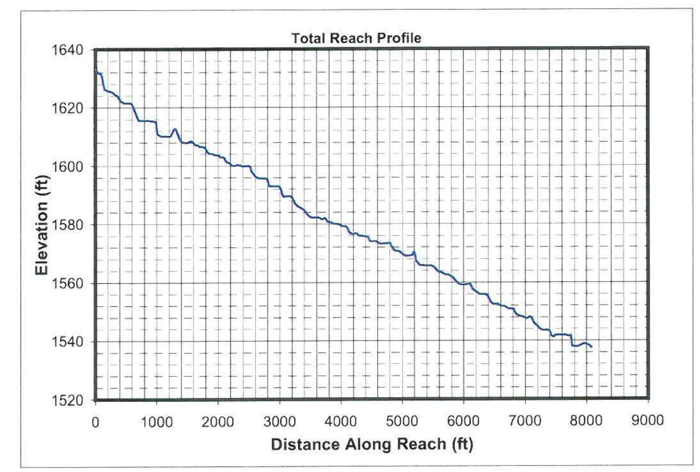
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
4	3.5	24	3	20	5.5	3	24	3.5	4

PT. ID	1	2	3	4	5	6	7	8
X	0	14	38	44	64	70	94	108
Y	105.5	102	102	100	100	102	102	105.5

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
4	3.5	24	3	20	5.5	3	24	3.5	4

PT. ID	1	2	3	4	5	6	7	8
X	0	14	38	44	64	70	94	108
Y	105.5	102	102	100	100	102	102	105.5



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	0.03	0.03	0.03	0.03	0.03	0.03

HEC1 Results Used to Determine Design Peak Flows

										TOTAL
Contributing HEC1 ID	D115C									
HEC1 Peak-Flow	1000									1000
Weighting Factor	1.00									
Flow into Channel	1000									1000

Reach Sediment Inflow Characteristics

U/S Contributing ID	15I15A_RR115A10									TOTAL
HEC1 Flow Volume (ac. ft)	135.00									135
Sediment Conc. (ppm)	2630									
Sediment Volume (ac. ft)	0.13									0.13
Weighting Factor	1									
Weighted Sed. Vol. (ac. ft)	0.13									0.13

Hydrology

Drainage Area	0.42	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	1000	cfs	
Long-term Max. Chnl Capacity	1683	cfs	
Q2 Channel	100	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	108	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	25.9	21.2	0.8	100.0	100.9	4.7	0.9	25.6	0.8	0.09	0.92
250	29.9	38.9	1.3	100.0	101.6	6.4	1.6	29.4	1.3	0.15	0.99
750	86.9	115.1	1.3	100.0	102.8	6.5	2.8	86.1	1.3	0.26	0.99
1000	89.1	138.2	1.6	100.0	103.0	7.2	3.0	88.2	1.6	0.28	1.02

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	30.6	42.1	1.4	100.0	101.7	2.4	1.7	30.1	1.4	0.16	0.35
250	86.5	110.4	1.3	100.0	102.7	2.3	2.7	85.6	1.3	0.25	0.35
750	96.7	223.3	2.3	100.0	104.0	3.4	4.0	95.6	2.3	0.37	0.39
1000	100.6	269.6	2.7	100.0	104.4	3.7	4.4	99.4	2.7	0.41	0.40

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
	15I15A_RR115A 10									
100	896									896
250	2949									2949
750	7316									7316
1000	10760									10760

Allowable Velocity

Channel Lining	Natural - Sandy Loam (noncolloidal)

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	1.3370	1.2702	Erosive	Erosive	Erosive	0.3	Erosive	3.1	Erosive	Stable
250	1.74	1.4812	1.4072	Erosive	Erosive	Erosive	0.3	Erosive	3.9	Erosive	Stable
750	1.74	1.4851	1.4108	Erosive	Erosive	Erosive	0.3	Erosive	5.3	Erosive	Stable
1000	1.74	1.5339	1.4572	Erosive	Erosive	Erosive	0.4	Erosive	5.7	Erosive	Stable

USCOE Allowable Velocity (ft/s)	2
FHWA Allowable Velocity (ft/s)	2.5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	100	250	750	1000	100	250	750	1000	100	250	750	1000
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	28	49	97	116	0.5	0.6	0.7	0.6				
Kellerhals	18	28	49	57	1.7	2.5	3.8	4.3	3.2	3.5	4.0	4.1
AMAFCA/Schumm	30	86	96	100								
Moody & Odem	9	9	9	9	0.8	0.8	0.8	0.8				
BUREC	16.1	22.7	34.2	38.1	4	6	9	10	2.3	2.9	3.8	4.0
Average	26	45	74	84	1.8	2.5	3.7	4.1	2.5	2.8	3.4	3.5
Values As Designed	30	86	96	99	1.7	2.7	4.0	4.4	2.4	2.3	3.4	3.7
Difference with Design	-4	-40	-22	-15	0.1	-0.2	-0.2	-0.3	0.1	0.6	0.0	-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
100	2261	1265	1788	3899	626	905	618	787	2379	469	2144	1558
250	8549	3406	4339	16752	965	2888	1498	2515	6012	1009	7069	5000
750	26365	9940	13124	51240	2843	8815	4538	7681	18041	2946	21608	15195
1000	40579	13639	17787	82145	3198	12821	5969	11044	24104	3170	31411	22352

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
100	8388	4692	6635	14463	2323	3358	2291	2921	8827	1741	7956	5781
250	12687	5055	6438	24860	1432	4286	2223	3732	8922	1497	10491	7420
750	13042	4917	6492	25347	1406	4361	2245	3800	8924	1457	10689	7516
1000	15055	5060	6599	30476	1186	4757	2215	4097	8942	1176	11653	8292

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	117	105	99	115	208	26	35	58	70	6	117	87
250	276	242	223	263	541	60	81	132	162	15	271	206
750	1416	1083	1150	1576	1085	330	363	763	696	72	1539	916
1000	2161	1550	1560	2500	1282	488	507	1152	965	95	2359	1329

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
100	433	389	367	427	771	98	128	215	260	21	435	322
250	409	360	331	390	803	89	120	196	240	22	402	306
750	701	536	569	780	537	163	180	377	344	35	761	453
1000	802	575	579	928	475	181	188	427	358	35	875	493

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	0.0006	0.0008	183	0.56	0.050	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0005	0.0075	0.0005	0.0018	0.0117	0.0050
250	0.0003	0.0005	231	0.70	0.052	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0003	0.0075	0.0003	0.0009	0.0116	0.0049
750	0.0003	0.0005	233	0.71	0.052	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0003	0.0075	0.0002	0.0004	0.0117	0.0049
1000	0.0003	0.0004	252	0.77	0.053	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0002	0.0075	0.0002	0.0003	0.0117	0.0049

Drop Structures

Design Slope	0.0015	ft/ft
Total Drop Needed	83.4	ft
Height of Drop Structure	3	ft
No . of Drop Structures	28	
Distance between structs.	288	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	0.00	sq. mi
Total Sediment Yield Volume	0.00	ac ft

Sedimentation Basins

Length	288 ft	Depth	3 ft
Width	108 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)

	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	-0.3	0.1	24.6	1.7	1.4	2.4	0.0015	0.2	0.0	1.0	1.6
250	1.1	-0.4	0.1	24.6	2.7	1.3	2.3	0.0015	0.3	0.0	1.0	1.8
750	1.1	-0.4	0.2	24.6	4.0	2.3	3.4	0.0015	0.5	0.0	1.0	2.1
1000	1.1	-0.3	0.2	24.6	4.4	2.7	3.7	0.0015	0.6	0.0	1.0	2.2

Toe Protection Needed	3.0	ft

HEC1 Results For Open Channel

Peak Flow	1636	cfs
Stage at Peak Flow	103.5	ft
Flow Volume	153.0	ac. ft

Freeboard

Max. Flow Depth	3.0	ft
Channel Depth as designed	5.5	ft
Available Freeboard	2.5	ft
Required Freeboard	1.2	ft

Sediment Volume

Inflowing Sediment Volume	0.13	ac. ft
Outflowing Sediment Volume	0.03	ac. ft
Deposited(+)/Eroded(-) Volume	0.11	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Existing	Existing
Channel Length (ft)	8073	8073
Side Slope (?H:1V)	3	3
Channel Width (ft)	108	108
Channel XS Area (sq. ft)	381	381
Channel Perimeter (ft)	110	110

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	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	0	ft
Thickness	0.0	ft
Protection Depth	0	ft
Tie-in Length/Depth	0.0	ft
Total Depth	0.0	ft
Area needed	0	sq. Yd
Volume	0	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)	8073	8073
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)	8073	8073
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	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	0	ft
LC Enhancement Ratio	1.1	
Structure Thickness	0	ft
Drop Height	0	ft
Scour Depth		ft
Structure Height		ft
Number of Structures	0	
Volume per structure	0	cu. Yd
Unit Cost	$ -	cu. Yd
Other Cost	$ -	
Cost per structure	$ -	
Area per structure	0	sq. Yd
Total Area	0	sq. Yd

Sedimentation Basins		
Include Sed. Basins (Yes/No)	No	
Number of basins	0	
Total Volume per Basin	3081	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 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	Existing	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Existing	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	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Drop Structures	None	0	EA	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Drop Str. - LC Enhancement	None	0	EA	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Sedimentation Basins		1	EA	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ 8.33	$ -
Other					$ -				$ -				$ -

Base Landscape Cost	$ -
LC Enhancement Cost	$ -
Total Landscape Cost	$ -

Base Maintenance Cost	$ -
LC Enhancement Cost	$ -
Total Maintenance Cost	$ -

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ -	$ -	$ -
Contingency Cost (25% of Construction Cost)	$ -	$ -	$ -
Engineering Design Cost (5% of Construction Cost)	$ -	$ -	$ -
Total Construction Cost	$ -	$ -	$ -

Land Cost

Channel Length	0 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	14	0	$0	$ -
LC Enhancement Buffer	0	0	$0	$ -
Channel	108	0	$0	$ -
Channel LC Enhancement	0	0	$0	$ -
Levee	0	0	$0	$ -
Levee LC Enhancement	0	0	$0	$ -
Other	0	0	$0	$ -
Total	122	0		$ -

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	0	$0	$ -
LC Enhancement Cost	acre	0	$0	$ -
Total Land Cost	acre	0	$0	$ -

Total Cost

Base Total Cost	$ -
Total Landscape Enhancement Cost	$ -
Total Cost Including LC Enh.	$ -

Offline Basin

HEC1 ID	D115C

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

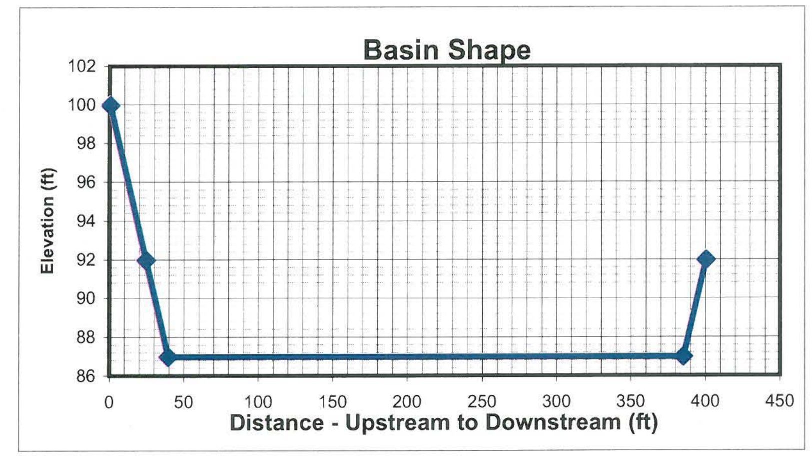
Sediment Volume	0.0	ac. ft

Geometry	Base	LC Enhanced
Topography slope (ft/ft)	0.02	0.02
Basin Length (ft)	850	980
Basin Width (ft)	400	400
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	5	5
Freeboard (ft)	1	1
Effective Basin Width (ft)	376	352
Top Area (acres)	7.8	9.0
U/S-D/S Height Difference (ft)	8.0	8.0
Excess Area on Upstream (acres)	0.5	1.1

			Base	LC Enhanced
Bottom Length (ft)	820	Allocated Storage Volume (ac. ft)	27.4	27.4
Bottom Width (ft)	346	Total Available Volume (ac. ft) (incl. Freeboard)	34.6	35.1
		Total Excavation Volume (ac. ft)	65.9	71.2

Stage-Storage-Discharge

Stage (ft)													
Inflow (cfs)	0	200	400	600	800	1000	1100	1200	1500	2000	2500	3000	
Outflow (cfs)	0	0	0	0	0	0	100	200	500	1000	1500	2000	capacity based on FlowMaster results with 1 ft freeboarc



HEC1 Results

	6-hr Event	24-hr Event	Maximum
Peak flow before diversion (cfs)	1640	1822	1822
Peak flow after diversion (cfs)	1000	1000	1000
Diverted Peak Flow (cfs)	640	822	822
Total Diverted Flow Volume (ac. ft)	22.0	27	27.0
Peak Stage	2.7	ft	

Volume Check

Total Volume needed	27.0	ac. ft
Total Volume Provided	27.4	ac. ft
Volume OK?	Yes	

Stage Check

Depth Needed	3.7
Depth Provided	5
Depth OK?	Yes

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
Landscape Enhancement	200000	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	850	ft
Base Total ROW Width	400	ft
LC Enh. Total ROW Length	1080	ft
LC Enh. Total ROW Length	500	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	106319	114869
Excavated Area (sq. Yd)	37778	60000

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	41	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	457	sq. Yd
Material Volume	229	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	333	ft
Unit Cost	160	per ft
Cost per outlet	$53,280	
Other Cost	$ -	
Total Cost	$53,280	
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		106,319	cu. Yd	$ 4.00	$ 425,276	37,778	sq. Yd	$ 9.00	$ 340,002	37,778	sq. Yd	$ 8.33	$ 314,817
Basin - LC Enhanced		8,550	cu. Yd	$ 4.00	$ 34,200	22,222	sq. Yd	$ 9.00	$ 199,998	22,222	sq. Yd	$ 8.33	$ 185,183
Inlet	Riprap	229	sq. Yd	$ 75.00	$ 17,175	457	sq. Yd	$ -	$ -	457	sq. Yd	$ 33.33	$ 15,233
Inlet - LC Enhanced (20%Total)					$ 3,435				$ -				$ 3,047
Outlet	Pipe	1	EA	$ 53,280	$ 53,280	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhanced (5%Total)					$ 2,664				$ -				$ 111
Other					$ -				$ -				$ -

Base Landscape Cost	$ 340,002	Base Maintenance Cost	$ 332,267
LC Enh. Landscape Cost	$ 199,998	LC Enh. Maintenance Cost	$ 188,341
Total Landscape Cost	$ 540,000	Total Maintenance Cost	$ 520,608

Construction Cost Component	Base	LC Enhanced	Total
Construction Cost	$ 495,731	$ 34,200	$ 529,931
Contingency Cost (25% of Construction Cost)	$ 123,933	$ 8,550	$ 132,483
Engineering Design Cost (5% of Construction Cost)	$ 24,787	$ 1,710	$ 26,497
Total Construction Cost	$ 644,450	$ 44,460	$ 688,910

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	4.6	$100,000	$ 459,137
Basin	7.8	$100,000	$ 780,000
Other		$100,000	$ -
Total	12.4	$100,000	$ 1,240,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	7.8	$100,000	$ 780,533
LC Enhancement Cost	acre	4.6	$100,000	$ 459,467
Total Land Cost	acre	12.4	$100,000	$ 1,240,000

Total Cost

Base Total Cost	$ 2,097,252
Total LC Enhancement Cost	$ 892,266
Total Cost Including LC Enh.	$ 2,989,518

Open Channel

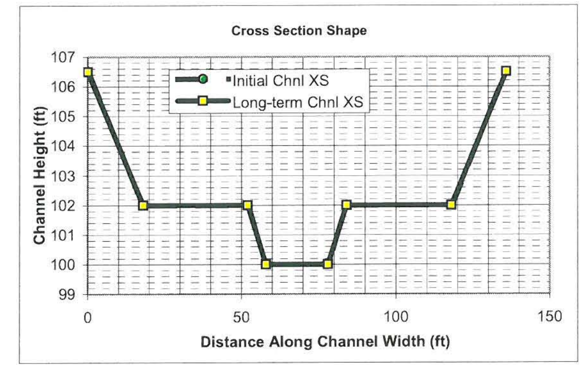
Structure ID	C12010	HEC1 ID	115120

Longitundal Geometry

Length	4136.0	ft
U/S Elev	1537.8	ft
D/S Elev	1496.4	ft
Initial Channel Slope	0.0100	ft/ft
Long-term Channel Slope	0.0015	ft/ft

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

NSTPS	3



Initial Channel XS Geometry

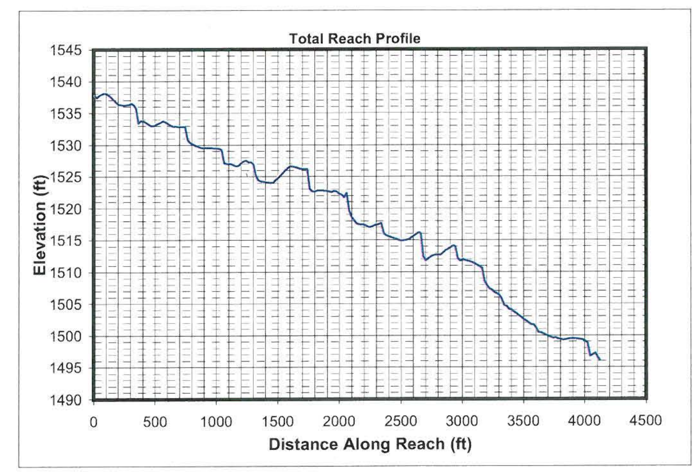
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
4	4.5	34	3	20	6.5	3	34	4.5	4

PT. ID	1	2	3	4	5	6	7	8
X	0	18	52	58	78	84	118	136
Y	106.5	102	102	100	100	102	102	106.5

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
4	4.5	34	3	20	6.5	3	34	4.5	4

PT. ID	1	2	3	4	5	6	7	8
X	0	18	52	58	78	84	118	136
Y	106.5	102	102	100	100	102	102	106.5



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	0.03	0.03	0.03	0.03	0.03	0.03

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	D120									TOTAL
HEC1 Peak-Flow	2000									2000
Weighting Factor	1.00									
Flow into Channel	2000									2000

Reach Sediment Inflow Characteristics

U/S Contributing ID	15I15B_RR115B10									TOTAL
HEC1 Flow Volume (ac. ft)	153.00									153
Sediment Conc. (ppm)	493									
Sediment Volume (ac. ft)	0.03									0.03
Weighting Factor	1	1								
Weighted Sed. Vol. (ac. ft)	0.03									0.03

Hydrology

Drainage Area	4.68	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	2000	cfs	
Long-term Max. Chnl Capacity	2934	cfs	
Q2 Channel	200	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	136	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
200	29.2	35.4	1.2	100.0	101.5	5.7	1.5	28.7	1.2	0.14	0.90
500	104.7	102.2	1.0	100.0	102.5	4.9	2.5	103.9	1.0	0.23	0.87
1500	112.5	203.4	1.8	100.0	103.4	7.4	3.4	111.5	1.8	0.32	0.96
2000	115.4	244.2	2.1	100.0	103.8	8.2	3.8	114.3	2.1	0.36	0.99

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
200	104.9	104.3	1.0	100.0	102.5	1.9	2.5	104.1	1.0	0.24	0.34
500	111.1	185.0	1.7	100.0	103.3	2.7	3.3	110.1	1.7	0.31	0.37
1500	124.5	374.3	3.0	100.0	104.9	4.0	4.9	123.1	3.0	0.46	0.41
2000	129.6	452.0	3.5	100.0	105.5	4.4	5.5	128.1	3.5	0.52	0.42

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
	15I15B_RR115B 10									
200	87									87
500	206									206
1500	916									916
2000	1329									1329

Allowable Velocity

Channel Lining	Natural - Sandy Loam (noncolloidal)

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)		
200	1.74	1.4599	1.3869	Erosive	Erosive	Erosive	0.3	Erosive	3.6	Erosive	Stable
500	1.74	1.3904	1.3208	Erosive	Erosive	Erosive	0.3	Erosive	4.5	Erosive	Stable
1500	1.74	1.5809	1.5019	Erosive	Erosive	Erosive	0.4	Erosive	6.1	Erosive	Stable
2000	1.74	1.6295	1.5480	Erosive	Erosive	Erosive	0.4	Erosive	6.6	Erosive	Stable

USCOE Allowable Velocity (ft/s)	2
FHWA Allowable Velocity (ft/s)	2.5

Regime Width

Discharge (cfs)	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
	200	500	1500	2000	200	500	1500	2000	200	500	1500	2000
Bray - Equation #1	39	63	112	131	1.6	2.1	3.0	3.3	3.3	3.8	4.4	4.6
Bray - Equation #2	51	83	148	172	1.7	2.3	3.3	3.7	2.3	2.6	3.0	3.1
Hey	12	20	36	43	4.8	6.8	10.4	11.6				
Ackers & Charlton/Lacey	33	49	78	88					1.9	2.3	2.7	2.8
Parker	97	154	266	307	1.2	1.8	2.9	3.2				
Chang	43	76	150	179	0.6	0.6	0.6	0.6				
Kellerhals	25	40	70	80	2.3	3.3	5.1	5.7	3.5	3.8	4.2	4.4
AMAFCA/Schumm	104	110	123	128								
Moody & Odem	22	22	22	22	1.2	1.2	1.2	1.2				
BUREC	20.9	29.4	44.4	49.4	6	8	12	13	2.7	3.4	4.5	4.8
Average	45	65	105	120	2.4	3.3	4.8	5.3	2.7	3.2	3.8	4.0
Values As Designed	104	110	123	128	2.5	3.3	4.9	5.5	1.9	2.7	4.0	4.4
Difference with Design	-59	-46	-18	-8	-0.1	0.0	-0.1	-0.2	0.8	0.5	-0.2	-0.5

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
200	4873	2260	2869	8850	815	1673	1001	1583	3724	706	4376	2975
500	10110	5162	7388	17106	2554	3754	2554	3532	9251	2005	9611	6639
1500	53132	17696	22027	105413	4007	15715	7387	14648	28115	3073	41692	28446
2000	81696	24206	29697	168828	4503	22877	9697	20982	37548	3311	60416	42160

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
200	9040	4192	5322	16416	1511	3104	1857	2937	6907	1310	8117	5519
500	7502	3830	5482	12693	1895	2786	1895	2621	6864	1488	7131	4926
1500	13141	4377	5448	26072	991	3887	1827	3623	6954	760	10312	7036
2000	15155	4490	5509	31318	835	4244	1799	3892	6965	614	11207	7821

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
200	176	150	122	157	485	28	44	71	83	14	155	135
500	704	596	621	717	920	167	206	369	403	41	736	498
1500	3612	2447	2372	4290	1742	791	783	1894	1482	140	3936	2135
2000	5509	3455	3252	6805	2036	1154	1071	2810	2023	166	5967	3113

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
200	327	279	227	291	900	52	81	131	153	25	287	250
500	522	442	461	532	683	124	153	274	299	30	546	370
1500	893	605	587	1061	431	196	194	469	366	35	974	528
2000	1022	641	603	1262	378	214	199	521	375	31	1107	578

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson n	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)
200	0.0004	0.0005	205	0.63	0.051	0.0002	31	0.036	0.0002	0.0159	0.0002	0.0003	0.0060	0.0003	0.0013	0.0098	0.0041
500	0.0005	0.0007	184	0.56	0.050	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0004	0.0060	0.0002	0.0007	0.0099	0.0041
1500	0.0002	0.0004	250	0.76	0.053	0.0002	31	0.036	0.0001	0.0159	0.0001	0.0002	0.0060	0.0001	0.0003	0.0099	0.0041
2000	0.0002	0.0003	271	0.83	0.053	0.0001	32	0.036	0.0001	0.0159	0.0001	0.0002	0.0060	0.0001	0.0002	0.0099	0.0040

Drop Structures

Design Slope	0.0015	ft/ft
Total Drop Needed	35.2	ft
Height of Drop Structure	3	ft
No . of Drop Structures	12	
Distance between structs.	345	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	0.00	sq. mi
Total Sediment Yield Volume	0.00	ac ft

Sedimentation Basins

Length	345 ft	Depth	3 ft
Width	136 ft	Side slope	3 ft/ft
Total Volume per Basin		2.94	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)
200	1.1	-0.5	0.1	24.6	2.5	1.0	1.9	0.0015	0.3	0.0	1.0	1.7
500	1.1	-0.4	0.1	24.6	3.3	1.7	2.7	0.0015	0.4	0.0	1.0	1.9
1500	1.1	-0.3	0.2	24.6	4.9	3.0	4.0	0.0015	0.7	0.0	1.0	2.4
2000	1.1	-0.2	0.3	24.6	5.5	3.5	4.4	0.0015	0.8	0.0	1.0	2.5

Toe Protection Needed	3.0	ft

HEC1 Results For Open Channel

Peak Flow	1002	cfs
Stage at Peak Flow	102.9	ft
Flow Volume	148.0	ac. ft

Freeboard

Max. Flow Depth	3.8	ft
Channel Depth as designed	6.5	ft
Available Freeboard	2.7	ft
Required Freeboard	1.5	ft

Sediment Volume

Inflowing Sediment Volume	0.03	ac. ft
Outflowing Sediment Volume	0.03	ac. ft
Deposited(+)/Eroded(-) Volume	0.00	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Existing	Existing
Channel Length (ft)	4136	4136
Side Slope (?H:1V)	3	3
Channel Width (ft)	136	136
Channel XS Area (sq. ft)	583	583
Channel Perimeter (ft)	138	138

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	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	0	ft
Thickness	0.0	ft
Protection Depth	0	ft
Tie-in Length/Depth	0.0	ft
Total Depth	0.0	ft
Area needed	0	sq. Yd
Volume	0	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)	4136	4136
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)	4136	4136
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	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	0	ft
LC Enhancement Ratio	1.1	
Structure Thickness	0	ft
Drop Height	0	ft
Scour Depth		ft
Structure Height		ft
Number of Structures	0	
Volume per structure	0	cu. Yd
Unit Cost	$ -	cu. Yd
Other Cost	$ -	
Cost per structure	$ -	
Area per structure	0	sq. Yd
Total Area	0	sq. Yd

Sedimentation Basins		
Include Sed. Basins	No	
(Yes/No)		
Number of basins	0	
Total Volume per Basin	4743	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	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	Existing	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Existing	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	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Drop Structures	None	0	EA	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Drop Str. - LC Enhancement	None	0	EA	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Sedimentation Basins		1	EA	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ 8.33	$ -
Other					$ -				$ -				$ -

Base Landscape Cost	$ -	Base Maintenance Cost	$ -
LC Enhancement Cost	$ -	LC Enhancement Cost	$ -
Total Landscape Cost	$ -	Total Maintenance Cost	$ -

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ -	$ -	$ -
Contingency Cost (25% of Construction Cost)	$ -	$ -	$ -
Engineering Design Cost (5% of Construction Cost)	$ -	$ -	$ -
Total Construction Cost	$ -	$ -	$ -

Land Cost

Channel Length	0 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	14	0	$0	$ -
LC Enhancement Buffer	0	0	$0	$ -
Channel	136	0	$0	$ -
Channel LC Enhancement	0	0	$0	$ -
Levee	0	0	$0	$ -
Levee LC Enhancement	0	0	$0	$ -
Other	0	0	$0	$ -
Total	150	0		$ -

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	0	$0	$ -
LC Enhancement Cost	acre	0	$0	$ -
Total Land Cost	acre	0	$0	$ -

Total Cost

Base Total Cost	$ -
Total Landscape Enhancement Cost	$ -
Total Cost Including LC Enh.	$ -

Offline Basin

HEC1 ID	D120

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

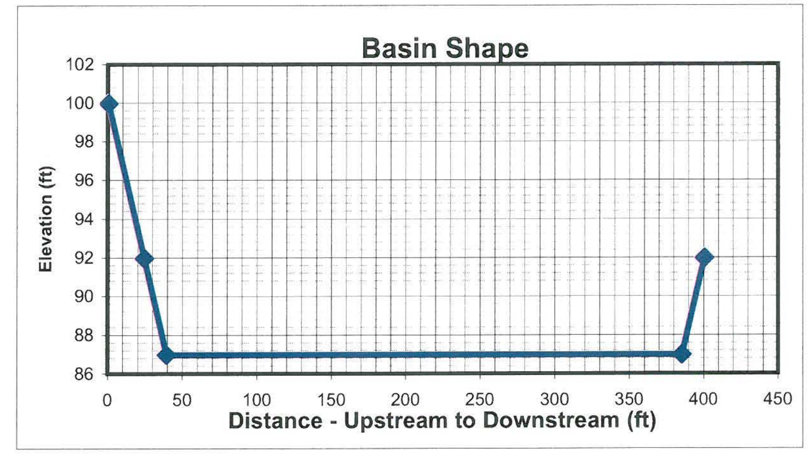
Sediment Volume	0.0	ac. ft

Geometry	Base	LC Enhanced
Topography slope (ft/ft)	0.02	0.02
Basin Length (ft)	660	760
Basin Width (ft)	400	400
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	5	5
Freeboard (ft)	1	1
Effective Basin Width (ft)	376	352
Top Area (acres)	6.1	7.0
U/S-D/S Height Difference (ft)	8.0	8.0
Excess Area on Upstream (acres)	0.4	0.8

			Base	LC Enhanced
Bottom Length (ft)	630	Allocated Storage Volume (ac. ft)	21.1	21
Bottom Width (ft)	346	Total Available Volume (ac. ft) (incl. Freeboard)	26.7	27
		Total Excavation Volume (ac. ft)	51.0	55

Stage-Storage-Discharge

Stage (ft)													
Inflow (cfs)	0	200	400	600	800	1000	1200	1500	2000	2500	3000	4000	
Outflow (cfs)	0	0	0	0	0	0	0	0	0	500	1000	2000	capacity based on FlowMaster results with 1 ft freeboarc



HEC1 Results

	6-hr Event	24-hr Event	Maximum
Peak flow before diversion (cfs)	2294	2853	2853
Peak flow after diversion (cfs)	1950	2000	2000
Diverted Peak Flow (cfs)	344	853	853
Total Diverted Flow Volume (ac. ft)	9.0	21	21.0
Peak Stage	1.5	ft	

Volume Check			***Stage Check***	
Total Volume needed	21.0	ac. ft	Depth Needed	2.5
Total Volume Provided	21.1	ac. ft	Depth Provided	5
Volume OK?	Yes		Depth OK?	Yes

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
Landscape Enhancement	166000	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	660	ft
Base Total ROW Width	400	ft
LC Enh. Total ROW Length	860	ft
LC Enh. Total ROW Length	500	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	82280	88733
Excavated Area (sq. Yd)	29333	47778

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	41	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	457	sq. Yd
Material Volume	229	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	333	ft
Unit Cost	160	per ft
Cost per outlet	$53,280	
Other Cost	$ -	
Total Cost	$53,280	
Outlet Area	133	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
Basin		82,280	cu. Yd	$ 4.00	$ 329,120	29,333	sq. Yd	$ 9.00	$ 263,997	29,333	sq. Yd	$ 8.33	$ 244,442
Basin - LC Enhanced		6,453	cu. Yd	$ 4.00	$ 25,812	18,445	sq. Yd	$ 9.00	$ 166,005	18,445	sq. Yd	$ 8.33	$ 153,708
Inlet	Riprap	229	sq. Yd	$ 75.00	$ 17,175	457	sq. Yd	$ -	$ -	457	sq. Yd	$ 33.33	$ 15,233
Inlet - LC Enhanced (20%Total)					$ 3,435				$ -				$ 3,047
Outlet	Pipe	1	EA	$ 53,280	$ 53,280	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhanced (5%Total)					$ 2,664				$ -				$ 111
Other					$ -				$ -				$ -

Base Landscape Cost	$ 263,997	Base Maintenance Cost	$ 261,892
LC Enh. Landscape Cost	$ 166,005	LC Enh. Maintenance Cost	$ 156,866
Total Landscape Cost	$ 430,002	Total Maintenance Cost	$ 418,758

Construction Cost Component	Base	LC Enhanced	Total
Construction Cost	$ 399,575	$ 25,812	$ 425,387
Contingency Cost (25% of Construction Cost)	$ 99,894	$ 6,453	$ 106,347
Engineering Design Cost (5% of Construction Cost)	$ 19,979	$ 1,291	$ 21,269
Total Construction Cost	$ 519,448	$ 33,556	$ 553,003

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	$ 381,084
Basin	6.1	$100,000	$ 610,000
Other		$100,000	$ -
Total	9.9	$100,000	$ 990,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	6.1	$100,000	$ 606,061
LC Enhancement Cost	acre	3.8	$100,000	$ 383,939
Total Land Cost	acre	9.9	$100,000	$ 990,000

Total Cost

Base Total Cost	$ 1,651,397
Total LC Enhancement Cost	$ 740,366
Total Cost Including LC Enh.	$ 2,391,763

Online Basin

HEC1 ID	RR900

HEC1 Results Used to Determine Sediment Volume From Upstream

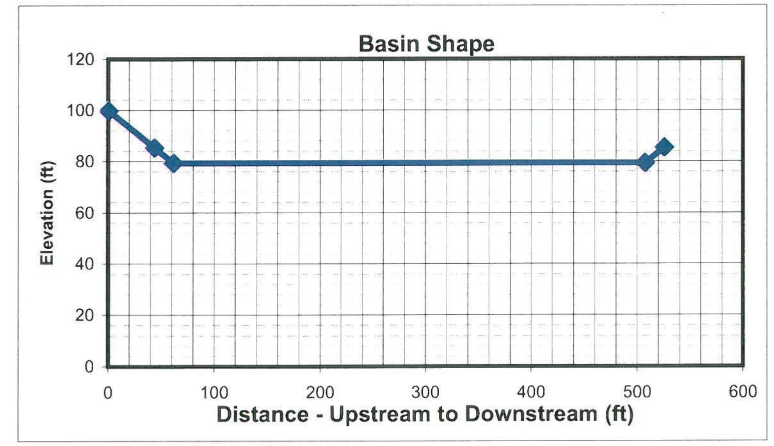
Contributing HEC1 ID							Total Volume (ac. ft)
Inflow Volume (ac. ft)							0
Volume Fraction							
Weighted Volume							0
Sediment Conc. (ppm)							
Sediment Volume (ac. ft)							0.00
Weighting Factor							
Weighted Sed. Vol. (ac. ft)							0.00

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	1.0	sq. mi
Total Sediment Yield Volume	2.0	ac ft

Required Minimum Sediment Volume

Sediment Volume	2.0	ac. ft



Geometry	Base	LC Enhanced
Topography slope (ft/ft)	0.027586207	0.027586207
Basin Length (ft)	1400	1650
Basin Width (ft)	525	525
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	6	6
Freeboard (ft)	1	1
Effective Basin Width (ft)	482	438
Top Area (acres)	16.9	19.9
U/S-D/S Height Difference (ft)	14.5	14.5
Excess Area on Upstream (acres)	1.5	3.3

			Base	LC Enhanced
Bottom Length (ft)	1364	Allocated Storage Volume (ac. ft)	73.0	73.1
Bottom Width (ft)	446	Total Available Volume (ac. ft) (incl. Freeboard)	88.3	89.4
		Total Excavation Volume (ac. ft)	210.6	233.5

HEC1 Results

	6-hr Event	24-hr Event	Maximum
Total Flow Volume entering Basin (ac. ft)	85.0	78	85.0
Peak Inflow (cfs)	936	853	936.0
Peak Outflow (cfs)	74	70	74.0
Stage at Peak Outflow (ft)	4.8	4.2	4.8
Volume at Peak Outflow (ac. ft)	69.2	61.68	69.2

Volume Check

Total Volume needed	71.2	ac. ft
Total Volume Provided	73.0	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)	3.00	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	7.01	14.09	21.23	28.43	43.03	57.87	72.98	88.34	103.96
Outflow	0.0	24.1	34.0	41.7	48.1	59.0	68.1	76.1	83.4	90.0

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
LC Enhancement Buffer	358750	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	1400	ft
Base Total ROW Width	525	ft
LC Enh. Total ROW Length	1750	ft
LC Enh. Total ROW Length	625	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	339768	376713
Excavated Area (sq. Yd)	81667	121528

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	65	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	720	sq. Yd
Material Volume	360	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	266	ft
Unit Cost	160	per ft
Cost per outlet	$42,560	
Other Cost	$ -	
Total Cost	$42,560	
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		339,768	cu. Yd	$ 4.00	$ 1,359,072	81,667	sq. Yd	$ 9.00	$ 735,003	81,667	sq. Yd	$ 8.33	$ 680,558
Basin - LC Enhancement		36,945	cu. Yd	$ 4.00	$ 147,780	39,861	sq. Yd	$ 9.00	$ 358,749	39,861	sq. Yd	$ 8.33	$ 332,175
Inlet	Riprap	360	sq. Yd	$ 75.00	$ 27,000	720	sq. Yd	$ -	$ -	720	sq. Yd	$ 33.33	$ 24,000
Inlet - LC Enhancement (20%Inlet)					$ 5,400				$ -				$ 4,800
Outlet	Pipe	1	EA	$ 42,560	$ 42,560	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhancement (5% Outlet)					$ 2,128				$ -				$ 111
Other					$ -				$ -				$ -

Base Landscape Cost	$ 735,003
LC Enh. Landscape Cost	$ 358,749
Total Landscape Cost	$ 1,093,752

Base Maintenance Cost	$ 706,775
LC Enh. Maintenance Cost	$ 337,086
Total Maintenance Cost	$ 1,043,861

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,428,632	$ 147,780	$ 1,576,412
Contingency Cost (25% of Construction Cost)	$ 357,158	$ 36,945	$ 394,103
Engineering Design Cost (5% of Construction Cost)	$ 71,432	$ 7,389	$ 78,821
Total Construction Cost	$ 1,857,222	$ 192,114	$ 2,049,336

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	8.2	$100,000	$ 820,000
Basin	16.9	$100,000	$ 1,690,000
Other		$100,000	$ -
Total	25.1	$100,000	$ 2,510,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	16.9	$100,000	$ 1,690,000
LC Enhancement Cost	acre	8.2	$100,000	$ 820,000
Total Land Cost	acre	25.1	$100,000	$ 2,510,000

Total Cost

Base Total Cost	$ 4,989,000
Total LC Enhancement Cost	$ 1,707,949
Total Cost Including LC Enh.	$ 6,696,948

Open Channel

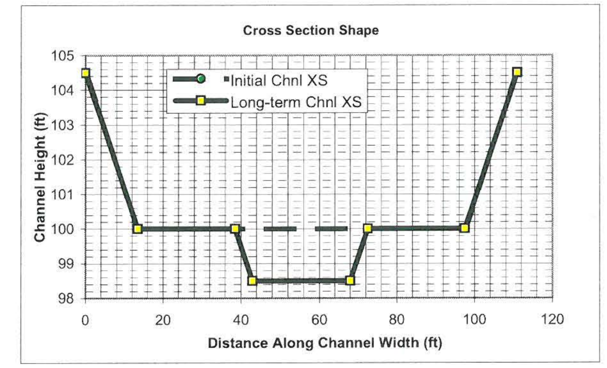
Structure ID	C910A10	HEC1 ID	90091A

Longitundal Geometry

Length	3620.4	ft
U/S Elev	1818.8	ft
D/S Elev	1746.9	ft
Initial Channel Slope	0.0198	ft/ft
Long-term Channel Slope	0.0080	ft/ft

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

NSTPS	4



Initial Channel XS Geometry

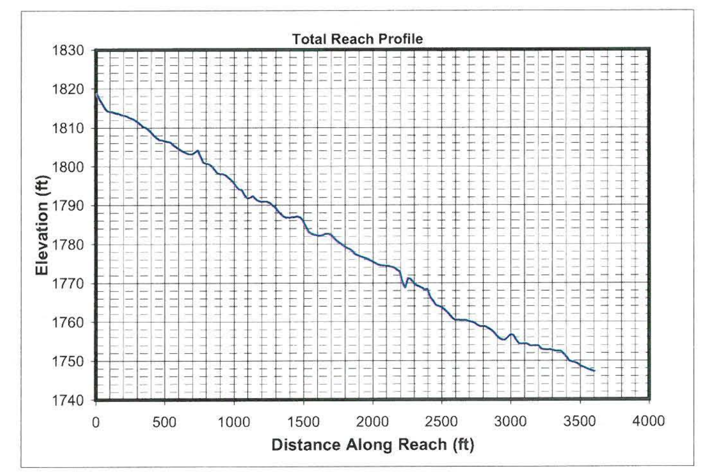
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	84	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	97.5	97.5	97.5	111
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	25	3	25	6	3	25	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	38.5	43	68	72.5	97.5	111
Y	104.5	100	100	98.5	98.5	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	S910	RR900								TOTAL
HEC1 Peak-Flow	1585	74								1659
Weighting Factor	0.37	1.00								
Flow into Channel	593	74								667

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	1.398	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	667	cfs	
Long-term Max. Chnl Capacity	3769	cfs	
Q2 Channel	67	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	111	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			

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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
67	86.2	29.3	0.3	100.0	100.3	2.3	0.3	86.1	0.3	0.17	0.69
167	87.8	51.2	0.6	100.0	100.6	3.3	0.6	87.6	0.6	0.30	0.75
500	91.3	100.5	1.1	100.0	101.1	5.0	1.1	90.9	1.1	0.57	0.83
667	92.6	120.2	1.3	100.0	101.4	5.5	1.4	92.2	1.3	0.68	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
67	30.8	25.5	0.8	98.5	99.4	2.6	0.9	30.5	0.8	0.46	0.50
167	86.2	66.7	0.8	98.5	100.3	2.5	1.8	85.6	0.8	0.88	0.50
500	90.9	131.8	1.5	98.5	101.0	3.8	2.5	90.0	1.5	1.25	0.55
667	92.7	157.9	1.7	98.5	101.3	4.2	2.8	91.8	1.7	1.39	0.57

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
67										0
167										0
500										0
667										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
67	1.74	1.0637	1.0105	Erosive	Erosive	Erosive	0.2	Stable	4.9	Stable	Stable
167	1.74	1.2298	1.1683	Erosive	Erosive	Erosive	0.3	Stable	6.8	Stable	Stable
500	1.74	1.4265	1.3552	Erosive	Erosive	Erosive	0.3	Stable	8.9	Stable	Stable
667	1.74	1.4772	1.4034	Erosive	Erosive	Erosive	0.3	Stable	9.7	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)	67	167	500	667	67	167	500	667	67	167	500	667
Bray - Equation #1	22	35	63	73	1.1	1.5	2.1	2.3	2.8	3.2	3.8	3.9
Bray - Equation #2	29	46	83	96	1.2	1.6	2.3	2.5	2.0	2.2	2.6	2.7
Hey	6	10	20	23	3.2	4.5	6.8	7.6				
Ackers & Charlton/Lacey	21	31	49	55					1.6	1.9	2.3	2.4
Parker	56	89	154	177	0.8	1.2	1.8	2.1				
Chang	39	69	134	160	0.1	0.0	-0.3	-0.4				
Kellerhals	15	23	40	46	1.5	2.1	3.3	3.7	3.1	3.4	3.8	3.9
AMAFCA/Schumm	31	86	90	92								
Moody & Odem	14	14	14	14	1.0	1.0	1.0	1.0				
BUREC	11.8	16.6	25.0	27.9	3	4	7	7	2.8	3.6	4.7	5.1
Average	24	42	67	77	1.5	2.0	3.0	3.3	2.5	2.9	3.4	3.6
Values As Designed	31	86	90	92	0.9	1.8	2.5	2.8	2.6	2.5	3.8	4.2
Difference with Design	-6	-44	-23	-15	0.6	0.3	0.5	0.5	-0.1	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
67	861	514	1147	1744	1639	307	244	154	3342	255	941	1013
167	3530	1575	3137	8183	2391	1183	715	688	8615	884	3682	3144
500	18855	5484	8790	51580	3635	5401	2218	3240	26194	4168	16564	13284
667	29163	7521	11653	83277	4046	7998	2940	4743	34984	6278	24146	19704

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
67	4787	2856	6380	9701	9118	1709	1357	859	18590	1417	5231	5637
167	7853	3504	6978	18206	5320	2633	1592	1531	19167	1967	8191	6995
500	13984	4067	6519	38253	2696	4005	1645	2403	19426	3091	12285	9852
667	16221	4183	6482	46321	2250	4449	1636	2638	19459	3492	13430	10960

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
67	426	222	396	804	577	104	83	91	847	98	493	376
167	1005	511	968	1855	1537	244	201	209	2101	234	1159	911
500	5329	2022	3255	11581	2473	1222	735	1159	6592	1151	5869	3763
667	8220	2838	4347	18634	2786	1819	998	1742	8839	1753	8772	5522

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
67	2369	1236	2204	4469	3207	577	461	503	4710	547	2740	2093
167	2237	1136	2153	4126	3420	542	447	466	4674	521	2580	2027
500	3952	1500	2414	8589	1834	906	545	860	4889	854	4353	2790
667	4572	1579	2418	10364	1549	1012	555	969	4916	975	4879	3072

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson n	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)
67	0.0021	0.0036	153	0.47	0.048	0.0008	30	0.036	0.0005	0.0159	0.0007	0.0017	0.0086	0.0006	0.0026	0.0198	0.0077
167	0.0011	0.0021	200	0.61	0.051	0.0005	31	0.036	0.0003	0.0159	0.0004	0.0010	0.0086	0.0004	0.0013	0.0198	0.0074
500	0.0005	0.0011	275	0.84	0.054	0.0003	32	0.036	0.0002	0.0159	0.0002	0.0005	0.0086	0.0002	0.0006	0.0198	0.0073
667	0.0004	0.0009	299	0.91	0.054	0.0002	32	0.036	0.0001	0.0159	0.0002	0.0004	0.0086	0.0002	0.0005	0.0197	0.0072

Drop Structures

Design Slope	0.0080	ft/ft
Total Drop Needed	42.9	ft
Height of Drop Structure	3	ft
No . of Drop Structures	15	
Distance between structs.	241	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	0.37	sq. mi
Total Sediment Yield Volume	0.70	ac ft

Sedimentation Basins

Length	241 ft	Depth	3 ft
Width	111 ft	Side slope	3 ft/ft
Total Volume per Basin		1.63	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)
67	1.1	-0.3	0.1	24.6	0.9	0.8	2.6	0.0080	0.1	0.0	3.0	4.1
167	1.1	-0.6	0.1	24.6	1.8	0.8	2.5	0.0080	0.2	0.0	3.0	4.2
500	1.1	-0.7	0.2	24.6	2.5	1.5	3.8	0.0080	0.3	0.0	3.0	4.4
667	1.1	-0.7	0.2	24.6	2.8	1.7	4.2	0.0080	0.3	0.0	3.0	4.5

Toe Protection Needed	5.0	ft

HEC1 Results For Open Channel

Peak Flow	74	cfs
Stage at Peak Flow	100.4	ft
Flow Volume	85.0	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	0.70	ac. ft
Outflowing Sediment Volume	0.10	ac. ft
Deposited(+)/Eroded(-) Volume	0.60	ac. ft

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Sub-area: CAP, Alternative: B1
Open Channel Structure ID: C910A10

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	3620	3620
Side Slope (?H:1V)	3	3
Channel Width (ft)	111	111
Channel XS Area (sq. ft)	483	483
Channel Perimeter (ft)	113	113

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	3620	ft
Thickness	1.5	ft
Protection Depth	5	ft
Tie-in Length/Depth	3.0	ft
Total Depth	8.0	ft
Area needed	1207	sq. Yd
Volume	3218	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	3620	3620
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)	16893	34993
Left Levee Volume (cu. Yd)	16625	39150
Right Levee Length (ft)	3620	3620
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)	16893	34993
Right Levee Volume (cu. Yd)	16625	39150
Total Levee Surface Area (sq. Yd)	33786	69986
Total Levee Volume (cu. Yd)	33250	78300

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	3620	3620
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	5631	13273
Left Levee Lining Volume (cu. Yd)	2816	6637
Right Levee Length (ft)	3620	3620
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	5631	13273
Right Levee Lining Volume (cu. Yd)	2816	6637
Total Lining Area (sq. Yd)	11262	26547
Total Lining Volume (cu. Yd)	5632	13274

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	111	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	7.3	ft
Structure Height	10.3	ft
Number of Structures	15	
Volume per structure	127	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 9,525	
Area per structure	37	sq. Yd
Total Area	555	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	2	
Total Volume per Basin	2630	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 10,520	
Other Cost	$ -	
Total cost per basin	$ 10,520	
Area per basin	2,977	sq. Yd
Total Area	5,954	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	33,250	cu. Yd	$ 7.00	$ 232,750	33,786	sq. Yd	$ 9.00	$ 304,074	33,786	sq. Yd	$ 11.67	$ 394,170
Levee - LC Enhancement	Fill	45,050	cu. Yd	$ 7.00	$ 315,350	36,200	sq. Yd	$ 9.00	$ 325,800	45,050	sq. Yd	$ 11.67	$ 525,583
Levee Lining	Riprap	5,632	cu. Yd	$ 75.00	$ 422,400	11,262	sq. Yd	$ -	$ -	11,262	sq. Yd	$ 20.83	$ 234,630
Levee Lining -LC Enhancement	Riprap	7,642	cu. Yd	$ 75.00	$ 573,150	15,284	sq. Yd	$ -	$ -	15,284	sq. Yd	$ 20.83	$ 318,426
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	3,218	cu. Yd	$ 75.00	$ 241,350	1,207	sq. Yd	$ -	$ -	1,207	sq. Yd	$ 25.00	$ 30,175
Drop Structures	Riprap	15	EA	$ 9,525.00	$ 142,875	555	sq. Yd	$ -	$ -	555	sq. Yd	$ 33.33	$ 18,500
Drop Str. - LC Enhancement	Riprap	15	EA	$ 952.50	$ 14,288	56	sq. Yd	$ -	$ -	56	sq. Yd	$ 33.33	$ 1,850
Sedimentation Basins		2	EA	$ 10,520.00	$ 21,040	5,954	sq. Yd	$ -	$ -	5,954	sq. Yd	$ 8.33	$ 49,617
Other					$				$ -				$ -

Base Landscape Cost	$ 304,074	Base Maintenance Cost	$ 727,091
LC Enhancement Cost	$ 325,800	LC Enhancement Cost	$ 845,859
Total Landscape Cost	$ 629,874	Total Maintenance Cost	$ 1,572,951

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,060,415	$ 902,788	$ 1,963,203
Contingency Cost (25% of Construction Cost)	$ 265,104	$ 225,697	$ 490,801
Engineering Design Cost (5% of Construction Cost)	$ 53,021	$ 45,139	$ 98,160
Total Construction Cost	$ 1,378,540	$ 1,173,624	$ 2,552,163

Land Cost

Channel Length	3620 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	111	9.2	$100,000	$ 920,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	4.6	$100,000	$ 460,000
Levee LC Enhancement	51	4.2	$100,000	$ 420,000
Other	0	0	$100,000	$ -
Total	217	18		$ 1,800,000

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	13.8	$100,000	$ 1,380,000
LC Enhancement Cost	acre	4.2	$100,000	$ 420,000
Total Land Cost	acre	18	$100,000	$ 1,800,000

Total Cost

Base Total Cost	$ 3,789,705
Total Landscape Enhancement Cost	$ 2,765,283
Total Cost Including LC Enh.	$ 6,554,988

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

Sub-area: CAP, Alternative: B1
Open Channel Structure ID: C910A10

Open Channel

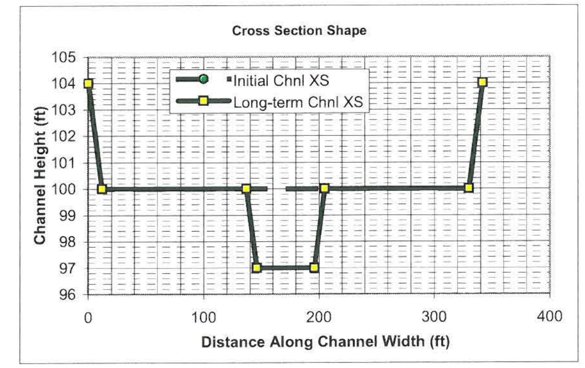
Structure ID	C910B10	HEC1 ID	90091B

Longitundal Geometry

Length	4991.8	ft
U/S Elev	1746.9	ft
D/S Elev	1667.9	ft
Initial Channel Slope	0.0158	ft/ft
Long-term Channel Slope	0.0060	ft/ft

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

NSTPS	4



Initial Channel XS Geometry

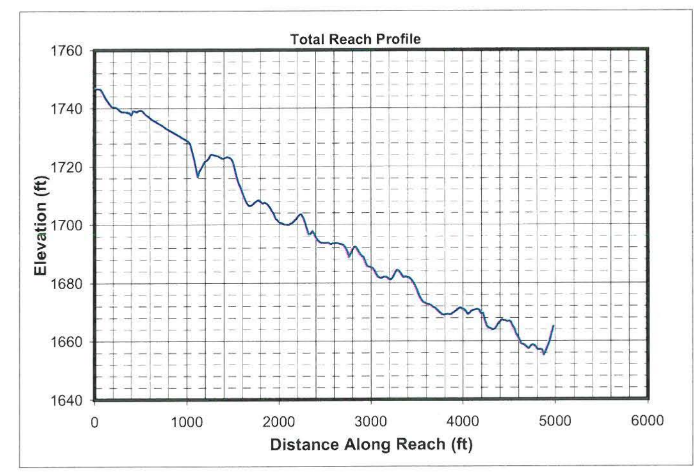
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	0	3	318	4	3	0	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	12	12	330	330	330	342
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	125	3	50	7	3	125	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	137	146	196	205	330	342
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	C910									TOTAL
HEC1 Peak-Flow	1498									1498
Weighting Factor	1.00									
Flow into Channel	1498									1498

Reach Sediment Inflow Characteristics

U/S Contributing ID	90091A_C910A1 0									TOTAL
HEC1 Flow Volume (ac. ft)	85.00									85
Sediment Conc. (ppm)	3072									
Sediment Volume (ac. ft)	0.10									0.10
Weighting Factor	1									
Weighted Sed. Vol. (ac. ft)	0.10									0.10

Hydrology

Drainage Area	2.02	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	1498	cfs	
Long-term Max. Chnl Capacity	10229	cfs	
Q2 Channel	150	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	342	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
150	319.7	86.2	0.3	100.0	100.3	1.7	0.3	319.6	0.3	0.10	0.59
375	321.0	149.6	0.5	100.0	100.5	2.5	0.5	320.8	0.5	0.18	0.65
1124	323.7	290.1	0.9	100.0	100.9	3.9	0.9	323.4	0.9	0.34	0.72
1498	324.8	345.2	1.1	100.0	101.1	4.3	1.1	324.4	1.1	0.40	0.74

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
150	56.9	57.8	1.0	97.0	98.1	2.6	1.1	56.5	1.0	0.41	0.45
375	61.8	103.5	1.7	97.0	98.9	3.6	1.9	61.2	1.7	0.70	0.49
1124	323.1	387.8	1.2	97.0	100.7	2.9	3.7	322.0	1.2	1.37	0.47
1498	324.6	461.8	1.4	97.0	100.9	3.2	3.9	323.3	1.4	1.46	0.48

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
	90091A_C910A10									
150	376									376
375	911									911
1124	3763									3763
1498	5522									5522

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)		
150	1.74	0.9914	0.9419	Erosive	Erosive	Erosive	0.2	Stable	4.8	Stable	Stable
375	1.74	1.1603	1.1023	Erosive	Erosive	Erosive	0.2	Stable	6.8	Stable	Stable
1124	1.74	1.3619	1.2938	Erosive	Erosive	Erosive	0.3	Stable	9.1	Stable	Stable
1498	1.74	1.4146	1.3439	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)	**150**	**375**	**1124**	**1498**	**150**	**375**	**1124**	**1498**	**150**	**375**	**1124**	**1498**
Bray - Equation #1	33	54	96	112	1.4	1.9	2.8	3.0	3.2	3.6	4.2	4.4
Bray - Equation #2	44	71	127	147	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	43	69	78					1.8	2.2	2.6	2.7
Parker	84	133	230	266	1.1	1.6	2.6	2.9				
Chang	59	103	200	238	0.1	-0.1	-0.5	-0.6				
Kellerhals	22	35	60	70	2.0	2.9	4.5	5.1	3.4	3.7	4.1	4.2
AMAFCA/Schumm	57	61	322	324								
Moody & Odem	16	16	16	16	1.1	1.1	1.1	1.1				
BUREC	16.8	23.7	35.8	39.8	4	6	10	11	3.1	3.9	5.2	5.6
Average	37	56	119	133	2.0	2.8	4.0	4.5	2.7	3.2	3.8	4.0
Values As Designed	57	61	322	323	1.1	1.9	3.7	3.9	2.6	3.6	2.9	3.2
Difference with Design	-19	-6	-203	-191	0.9	0.9	0.4	0.6	0.1	-0.4	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
150	1074	719	1513	1897	4289	302	296	142	5000	352	1097	1516
375	4429	2448	4994	8982	6496	1437	1096	847	13436	1178	4919	4569
1124	24192	9191	16178	57823	10006	7041	3794	4699	41559	5573	24507	18597
1498	37680	12777	20926	94084	11121	10507	5108	7069	55620	8443	36503	27258

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
150	2661	1779	3747	4698	10622	747	732	352	12384	872	2717	3755
375	4388	2425	4948	8898	6435	1424	1086	839	13311	1167	4873	4527
1124	7989	3035	5342	19094	3304	2325	1253	1552	13723	1840	8093	6141
1498	9332	3164	5183	23301	2754	2602	1265	1751	13775	2091	9040	6751

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
150	718	375	616	1286	1003	154	128	160	1219	157	840	605
375	2820	1156	1687	5771	1534	589	383	653	3180	592	3222	1962
1124	6288	2872	4833	11696	6423	1359	1046	1447	9311	1346	7367	4908
1498	9787	4148	6569	19016	7249	2090	1482	2277	12591	2063	11365	7149

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
150	1779	928	1525	3185	2483	382	317	396	3019	389	2081	1498
375	2794	1145	1671	5717	1519	584	379	647	3151	586	3192	1944
1124	2076	948	1596	3862	2121	449	345	478	3075	444	2433	1621
1498	2424	1027	1627	4710	1795	518	367	564	3118	511	2815	1771

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)
150	0.0031	0.0045	122	0.37	0.046	0.0009	29	0.035	0.0007	0.0159	0.0009	0.0023	0.0066	0.0004	0.0032	0.0158	0.0063
375	0.0015	0.0026	160	0.49	0.049	0.0006	30	0.036	0.0004	0.0159	0.0005	0.0013	0.0066	0.0003	0.0016	0.0158	0.0060
1124	0.0007	0.0014	222	0.68	0.052	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0006	0.0066	0.0002	0.0007	0.0158	0.0058
1498	0.0006	0.0011	241	0.74	0.052	0.0003	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0066	0.0001	0.0006	0.0158	0.0058

Drop Structures

Design Slope	0.0060	ft/ft
Total Drop Needed	49.1	ft
Height of Drop Structure	3	ft
No . of Drop Structures	17	
Distance between structs.	294	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	0.62	sq. mi
Total Sediment Yield Volume	1.17	ac ft

Sedimentation Basins

Length	294 ft	Depth	3 ft
Width	342 ft	Side slope	3 ft/ft
Total Volume per Basin		6.53	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)
150	1.1	-0.4	0.1	24.6	1.1	1.0	2.6	0.0060	0.1	0.0	3.0	4.1
375	1.1	-0.5	0.2	24.6	1.9	1.7	3.6	0.0060	0.2	0.0	3.0	4.3
1124	1.1	-1.1	0.1	24.6	3.7	1.2	2.9	0.0060	0.4	0.0	3.0	4.5
1498	1.1	-1.1	0.1	24.6	3.9	1.4	3.2	0.0060	0.4	0.0	3.0	4.5

Toe Protection Needed	5.0	ft

HEC1 Results For Open Channel

Peak Flow	74	cfs
Stage at Peak Flow	100.2	ft
Flow Volume	85.0	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	1.27	ac. ft
Outflowing Sediment Volume	0.06	ac. ft
Deposited(+)/Eroded(-) Volume	1.20	ac. ft

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HYDROLOGY & GEOMORPHOLOGY, INC

Sub-area: CAP, Alternative: B1
Open Channel Structure ID: C910B10

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	4992	4992
Side Slope (?H:1V)	3	3
Channel Width (ft)	342	342
Channel XS Area (sq. ft)	1497	1497
Channel Perimeter (ft)	344	344

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	4992	ft
Thickness	1.5	ft
Protection Depth	5	ft
Tie-in Length/Depth	3.0	ft
Total Depth	8.0	ft
Area needed	1664	sq. Yd
Volume	4437	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	4992	4992
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)	21632	44928
Left Levee Volume (cu. Yd)	19228	46222
Right Levee Length (ft)	4992	4992
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)	21632	44928
Right Levee Volume (cu. Yd)	19228	46222
Total Levee Surface Area (sq. Yd)	43264	89856
Total Levee Volume (cu. Yd)	38456	92444

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	4992	4992
Left Levee Lining Width (ft)	13	30
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	7211	16640
Left Levee Lining Volume (cu. Yd)	3605	8320
Right Levee Length (ft)	4992	4992
Right Levee Lining Width (ft)	13	30
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	7211	16640
Right Levee Lining Volume (cu. Yd)	3605	8320
Total Lining Area (sq. Yd)	14421	33280
Total Lining Volume (cu. Yd)	7210	16640

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	342	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	17	
Volume per structure	329	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 24,675	
Area per structure	114	sq. Yd
Total Area	1,938	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	10535	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 42,140	
Other Cost	$ -	
Total cost per basin	$ 42,140	
Area per basin	11,158	sq. Yd
Total Area	11,158	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	38,456	cu. Yd	$ 7.00	$ 269,192	43,264	sq. Yd	$ 9.00	$ 389,376	43,264	sq. Yd	$ 11.67	$ 504,747
Levee - LC Enhancement	Fill	53,988	cu. Yd	$ 7.00	$ 377,916	46,592	sq. Yd	$ 9.00	$ 419,328	53,988	sq. Yd	$ 11.67	$ 629,860
Levee Lining	Riprap	7,210	cu. Yd	$ 75.00	$ 540,750	14,421	sq. Yd	$ -	$ -	14,421	sq. Yd	$ 20.83	$ 300,444
Levee Lining -LC Enhancement	Riprap	9,430	cu. Yd	$ 75.00	$ 707,250	18,859	sq. Yd	$ -	$ -	18,859	sq. Yd	$ 20.83	$ 392,889
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	4,437	cu. Yd	$ 75.00	$ 332,775	1,664	sq. Yd	$ -	$ -	1,664	sq. Yd	$ 25.00	$ 41,600
Drop Structures	Riprap	17	EA	$ 24,675.00	$ 419,475	1,938	sq. Yd	$ -	$ -	1,938	sq. Yd	$ 33.33	$ 64,600
Drop Str. - LC Enhancement	Riprap	17	EA	$ 2,467.50	$ 41,948	194	sq. Yd	$ -	$ -	194	sq. Yd	$ 33.33	$ 6,460
Sedimentation Basins		1	EA	$ 42,140.00	$ 42,140	11,158	sq. Yd	$ -	$ -	11,158	sq. Yd	$ 8.33	$ 92,983
Other					$ -				$ -				$ -

Base Landscape Cost	$ 389,376	
LC Enhancement Cost	$ 419,328	
Total Landscape Cost	$ 808,704	

Base Maintenance Cost	$ 1,004,374
LC Enhancement Cost	$ 1,029,209
Total Maintenance Cost	$ 2,033,583

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,604,332	$ 1,127,114	$ 2,731,446
Contingency Cost (25% of Construction Cost)	$ 401,083	$ 281,778	$ 682,861
Engineering Design Cost (5% of Construction Cost)	$ 80,217	$ 56,356	$ 136,572
Total Construction Cost	$ 2,085,632	$ 1,465,248	$ 3,550,879

Land Cost

Channel Length	4992 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	342	39.2	$100,000	$ 3,920,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	52	6	$100,000	$ 600,000
Levee LC Enhancement	48	5.5	$100,000	$ 550,000
Other	0	0	$100,000	$ -
Total	442	50.7		$ 5,070,000

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	45.2	$100,000	$ 4,520,000
LC Enhancement Cost	acre	5.5	$100,000	$ 550,000
Total Land Cost	acre	50.7	$100,000	$ 5,070,000

Total Cost

Base Total Cost	$ 7,999,382
Total Landscape Enhancement Cost	$ 3,463,784
Total Cost Including LC Enh.	$ 11,463,166

Open Channel

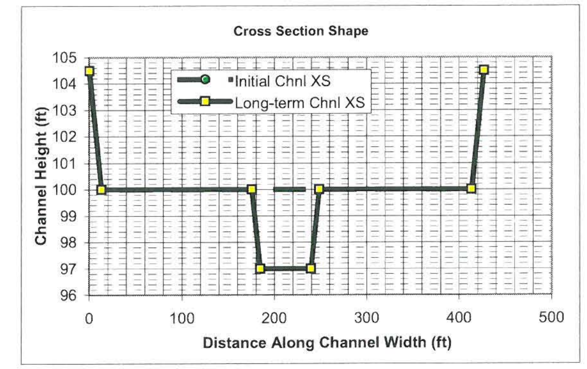
Structure ID	RR91010	HEC1 ID	910915

Longitundal Geometry

Length	3390.4	ft
U/S Elev	1668.1	ft
D/S Elev	1623.5	ft
Initial Channel Slope	0.0131	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

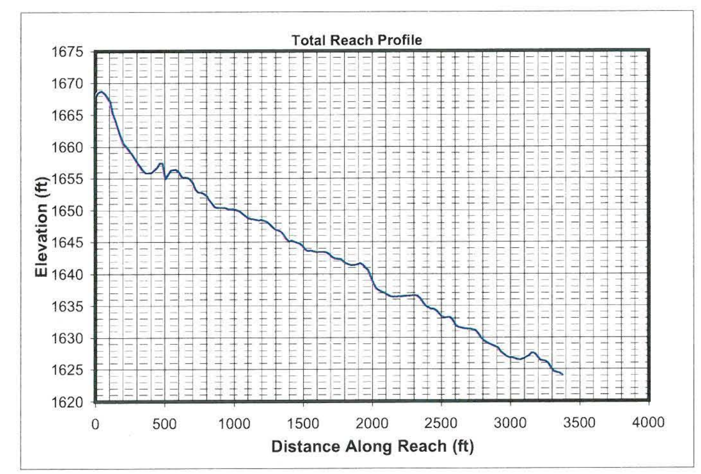
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	400	4.5	3	0	4.5	3

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	162	3	55	7.5	3	165	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	175.5	184.5	239.5	248.5	413.5	427
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	C915	S920								TOTAL
HEC1 Peak-Flow	2436	3157								5593
Weighting Factor	1.00	0.15								
Flow into Channel	2436	466								2902

Reach Sediment Inflow Characteristics

U/S Contributing ID	90091B_C910B10									TOTAL
HEC1 Flow Volume (ac. ft)	85.00									85
Sediment Conc. (ppm)	1944									
Sediment Volume (ac. ft)	0.06									0.06
Weighting Factor	1									
Weighted Sed. Vol. (ac. ft)	0.06									0.06

Hydrology

Drainage Area	2.506	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	2902	cfs	
Long-term Max. Chnl Capacity	13638	cfs	
Q2 Channel	290	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	427	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
290	402.3	148.6	0.4	100.0	100.4	2.0	0.4	402.2	0.4	0.12	0.57
726	404.1	257.8	0.6	100.0	100.6	2.8	0.6	403.8	0.6	0.20	0.62
2177	407.8	500.3	1.2	100.0	101.2	4.4	1.2	407.4	1.2	0.39	0.69
2902	409.3	595.4	1.5	100.0	101.5	4.9	1.5	408.8	1.5	0.46	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
290	65.1	95.8	1.5	97.0	98.6	3.0	1.6	64.6	1.5	0.50	0.44
726	72.3	173.2	2.4	97.0	99.7	4.2	2.7	71.4	2.4	0.85	0.47
2177	408.5	669.0	1.6	97.0	101.2	3.3	4.2	407.1	1.6	1.30	0.45
2902	410.4	796.6	1.9	97.0	101.5	3.6	4.5	409.0	1.9	1.40	0.46

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
	90091B_C910B1 0									
290	605									605
726	1962									1962
2177	4908									4908
2902	7149									7149

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)		
290	1.74	1.0884	1.0340	Erosive	Erosive	Erosive	0.2	Stable	5.7	Stable	Stable
726	1.74	1.2570	1.1942	Erosive	Erosive	Erosive	0.3	Stable	8.0	Stable	Stable
2177	1.74	1.4588	1.3858	Erosive	Erosive	Erosive	0.3	Stable	9.3	Stable	Stable
2902	1.74	1.5114	1.4358	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)	**290**	**726**	**2177**	**2902**	**290**	**726**	**2177**	**2902**	**290**	**726**	**2177**	**2902**
Bray - Equation #1	47	77	137	159	1.8	2.4	3.4	3.8	3.5	4.0	4.6	4.8
Bray - Equation #2	62	101	180	209	1.9	2.6	3.8	4.1	2.4	2.7	3.2	3.3
Hey	14	24	45	52	5.6	7.9	12.0	13.3				
Ackers & Charlton/Lacey	39	57	91	102					2.1	2.4	2.9	3.0
Parker	117	185	321	370	1.5	2.1	3.4	3.8				
Chang	83	144	281	334	0.1	-0.1	-0.7	-1.0				
Kellerhals	31	48	84	97	2.6	3.8	5.9	6.6	3.6	3.9	4.4	4.5
AMAFCA/Schumm	65	72	408	409								
Moody & Odem	17	17	17	17	1.1	1.1	1.1	1.1				
BUREC	22.3	31.4	47.4	52.8	6	8	13	14	3.4	4.3	5.7	6.1
Average	50	76	161	180	2.6	3.5	5.2	5.7	3.0	3.5	4.2	4.4
Values As Designed	65	71	407	409	1.6	2.7	4.2	4.5	3.0	4.2	3.3	3.6
Difference with Design	-15	4	-246	-229	0.9	0.8	1.0	1.2	0.0	-0.7	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
290	2038	1283	2567	3658	5982	572	527	324	7485	582	2202	2475
726	8426	4245	7926	17324	8927	2504	1795	1702	19853	2065	9391	7651
2177	45840	15589	24685	111422	13617	11953	5965	8832	61084	10095	45476	32233
2902	71395	21603	32146	181262	15107	17807	7990	13161	81700	15382	67433	47726

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
290	2606	1641	3281	4676	7647	731	674	415	9569	744	2815	3164
726	4309	2171	4053	8859	4565	1281	918	870	10152	1056	4802	3912
2177	7814	2657	4208	18993	2321	2037	1017	1505	10412	1721	7752	5494
2902	9127	2762	4110	23173	1931	2277	1021	1683	10445	1966	8621	6101

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
290	1437	677	1007	2666	1312	288	219	346	1831	299	1699	1071
726	5571	2018	2743	11788	2005	1043	615	1297	4722	950	6256	3546
2177	11957	5097	7665	22610	8872	2375	1719	2884	13854	2451	14042	8502
2902	18613	7303	10560	36753	9980	3617	2402	4455	18688	3776	21507	12514

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
290	1837	865	1287	3408	1678	368	280	442	2340	382	2172	1369
726	2849	1032	1403	6028	1025	533	314	663	2414	486	3199	1813
2177	2038	869	1306	3854	1512	405	293	492	2362	418	2394	1449
2902	2380	934	1350	4699	1276	462	307	570	2389	483	2750	1600

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)
290	0.0022	0.0033	130	0.40	0.047	0.0007	30	0.035	0.0005	0.0159	0.0007	0.0017	0.0053	0.0003	0.0023	0.0131	0.0051
726	0.0011	0.0019	170	0.52	0.049	0.0004	30	0.036	0.0003	0.0159	0.0004	0.0009	0.0053	0.0002	0.0012	0.0131	0.0049
2177	0.0005	0.0010	236	0.72	0.052	0.0002	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0053	0.0001	0.0005	0.0131	0.0047
2902	0.0004	0.0008	257	0.78	0.053	0.0002	32	0.036	0.0001	0.0159	0.0002	0.0004	0.0053	0.0001	0.0004	0.0131	0.0047

Drop Structures

Design Slope	0.0050	ft/ft
Total Drop Needed	27.6	ft
Height of Drop Structure	3	ft
No . of Drop Structures	10	
Distance between structs.	339	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	0.49	sq. mi
Total Sediment Yield Volume	0.92	ac ft

Sedimentation Basins

Length	339 ft	Depth	3 ft
Width	427 ft	Side slope	3 ft/ft
Total Volume per Basin		9.50	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)
290	1.1	-0.5	0.1	24.6	1.6	1.5	3.0	0.0050	0.2	0.0	3.0	4.2
726	1.1	-0.7	0.2	24.6	2.7	2.4	4.2	0.0050	0.3	0.0	3.0	4.5
2177	1.1	-1.2	0.1	24.6	4.2	1.6	3.3	0.0050	0.5	0.0	3.0	4.6
2902	1.1	-1.2	0.2	24.6	4.5	1.9	3.6	0.0050	0.5	0.0	3.0	4.7

Toe Protection Needed	5.0	ft

HEC1 Results For Open Channel

Peak Flow	1291	cfs
Stage at Peak Flow	100.9	ft
Flow Volume	140.0	ac. ft

Freeboard

Max. Flow Depth	1.5	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.0	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	0.99	ac. ft
Outflowing Sediment Volume	0.10	ac. ft
Deposited(+)/Eroded(-) Volume	0.89	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	3390	3390
Side Slope (?H:1V)	3	3
Channel Width (ft)	427	427
Channel XS Area (sq. ft)	2052.8	2052.8
Channel Perimeter (ft)	429	429

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)	3390	3390
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)	15820	32770
Left Levee Volume (cu. Yd)	15569	36662
Right Levee Length (ft)	3390	3390
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)	15820	32770
Right Levee Volume (cu. Yd)	15569	36662
Total Levee Surface Area (sq. Yd)	31640	65540
Total Levee Volume (cu. Yd)	31138	73324

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	3390	3390
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	5273	12430
Left Levee Lining Volume (cu. Yd)	2637	6215
Right Levee Length (ft)	3390	3390
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	5273	12430
Right Levee Lining Volume (cu. Yd)	2637	6215
Total Lining Area (sq. Yd)	10547	24860
Total Lining Volume (cu. Yd)	5274	12430

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	3390	ft
Thickness	1.5	ft
Protection Depth	5	ft
Tie-in Length/Depth	3.0	ft
Total Depth	8.0	ft
Area needed	1130	sq. Yd
Volume	3013	cu. Yd

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	427	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	7.2	ft
Structure Height	10.2	ft
Number of Structures	10	
Volume per structure	484	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 36,300	
Area per structure	142	sq. Yd
Total Area	1,423	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	15327	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 61,308	
Other Cost	$ -	
Total cost per basin	$ 61,308	
Area per basin	16,086	sq. Yd
Total Area	16,086	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	31,138	cu. Yd	$ 7.00	$ 217,966	31,640	sq. Yd	$ 9.00	$ 284,760	31,640	sq. Yd	$ 11.67	$ 369,133
Levee - LC Enhancement	Fill	42,186	cu. Yd	$ 7.00	$ 295,302	33,900	sq. Yd	$ 9.00	$ 305,100	42,186	sq. Yd	$ 11.67	$ 492,170
Levee Lining	Riprap	5,274	cu. Yd	$ 75.00	$ 395,550	10,547	sq. Yd	$ -	$ -	10,547	sq. Yd	$ 20.83	$ 219,722
Levee Lining -LC Enhancement	Riprap	7,156	cu. Yd	$ 75.00	$ 536,700	14,313	sq. Yd	$ -	$ -	14,313	sq. Yd	$ 20.83	$ 298,194
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	3,013	cu. Yd	$ 75.00	$ 225,975	1,130	sq. Yd	$ -	$ -	1,130	sq. Yd	$ 25.00	$ 28,250
Drop Structures	Riprap	10	EA	$ 36,300.00	$ 363,000	1,423	sq. Yd	$ -	$ -	1,423	sq. Yd	$ 33.33	$ 47,433
Drop Str. - LC Enhancement	Riprap	10	EA	$ 3,630.00	$ 36,300	142	sq. Yd	$ -	$ -	142	sq. Yd	$ 33.33	$ 4,743
Sedimentation Basins		1	EA	$ 61,308.00	$ 61,308	16,086	sq. Yd	$ -	$ -	16,086	sq. Yd	$ 8.33	$ 134,050
Other					$ -				$ -				$ -

Base Landscape Cost	$ 284,760	Base Maintenance Cost	$ 798,589
LC Enhancement Cost	$ 305,100	LC Enhancement Cost	$ 795,108
Total Landscape Cost	$ 589,860	Total Maintenance Cost	$ 1,593,697

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,263,799	$ 868,302	$ 2,132,101
Contingency Cost (25% of Construction Cost)	$ 315,950	$ 217,076	$ 533,025
Engineering Design Cost (5% of Construction Cost)	$ 63,190	$ 43,415	$ 106,605
Total Construction Cost	$ 1,642,939	$ 1,128,793	$ 2,771,731

Land Cost

Channel Length	3390 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	427	33.2	$100,000	$ 3,320,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	4.3	$100,000	$ 430,000
Levee LC Enhancement	51	4	$100,000	$ 400,000
Other	0	0	$100,000	$ -
Total	533	41.5		$ 4,150,000

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	37.5	$100,000	$ 3,750,000
LC Enhancement Cost	acre	4	$100,000	$ 400,000
Total Land Cost	acre	41.5	$100,000	$ 4,150,000

Total Cost

Base Total Cost	$ 6,476,288
Total Landscape Enhancement Cost	$ 2,629,000
Total Cost Including LC Enh.	$ 9,105,288

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Open Channel

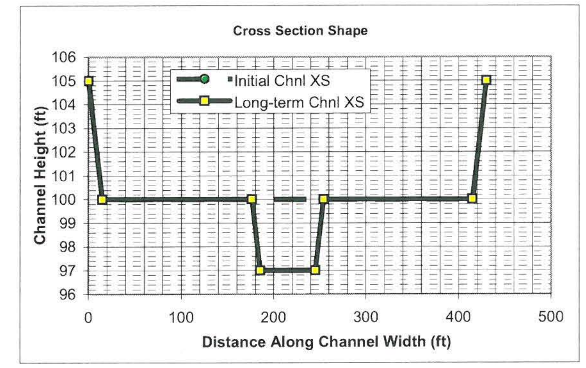
Structure ID	C92010	HEC1 ID	915920

Longitundal Geometry

Length	8861.8	ft
U/S Elev	1623.5	ft
D/S Elev	1532.6	ft
Initial Channel Slope	0.0103	ft/ft
Long-term Channel Slope	0.0040	ft/ft

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

NSTPS	7



Initial Channel XS Geometry

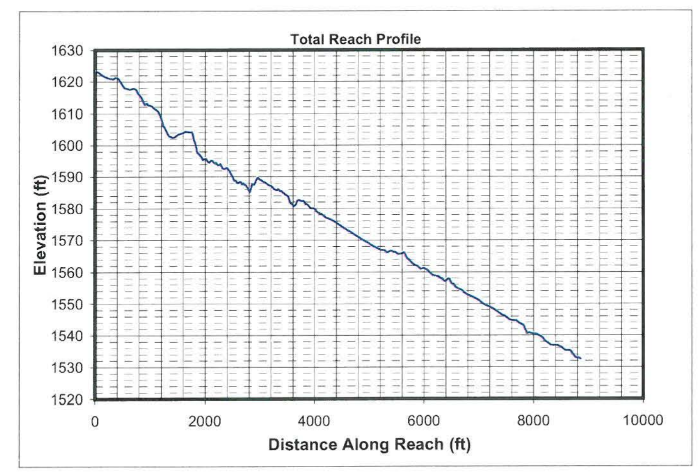
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	5	0	3	400	5	3	0	5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	15	15	15	415	415	415	430
Y	105	100	100	100	100	100	100	105

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	5	161	3	60	8	3	161	5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	15	176	185	245	254	415	430
Y	105	100	100	97	97	100	100	105



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	C920									TOTAL
HEC1 Peak-Flow	3962									3962
Weighting Factor	1.00									
Flow into Channel	3962									3962

Reach Sediment Inflow Characteristics

U/S Contributing ID	910915_RR9101 0									TOTAL
HEC1 Flow Volume (ac. ft)	140.00									140
Sediment Conc. (ppm)	1813									
Sediment Volume (ac. ft)	0.10									0.10
Weighting Factor	1	1								
Weighted Sed. Vol. (ac. ft)	0.10									0.10

Hydrology

Drainage Area	6.43	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	3962	cfs	
Long-term Max. Chnl Capacity	14481	cfs	
Q2 Channel	396	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	430	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
396	403.0	193.1	0.5	100.0	100.5	2.1	0.5	402.9	0.5	0.12	0.52
991	405.3	335.1	0.8	100.0	100.8	3.0	0.8	405.0	0.8	0.21	0.57
2972	410.2	651.0	1.6	100.0	101.6	4.6	1.6	409.6	1.6	0.40	0.64
3962	412.1	775.0	1.9	100.0	101.9	5.1	1.9	411.5	1.9	0.48	0.66

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
396	72.4	128.8	1.8	97.0	99.0	3.1	2.0	71.7	1.8	0.49	0.40
991	404.7	444.4	1.1	97.0	100.6	2.2	3.6	403.5	1.1	0.90	0.37
2972	411.2	864.6	2.1	97.0	101.6	3.4	4.6	409.7	2.1	1.15	0.42
3962	413.8	1029.9	2.5	97.0	102.0	3.8	5.0	412.2	2.5	1.25	0.43

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
	910915_RR9101 0									
396	1071									1071
991	3546									3546
2972	8502									8502
3962	12514									12514

Allowable Velocity

Channel Lining	Natural - Sandy Loam (noncolloidal)

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)		
396	1.74	1.1686	1.1102	Erosive	Erosive	Erosive	0.2	Stable	5.8	Stable	Stable
991	1.74	1.3370	1.2702	Erosive	Erosive	Erosive	0.3	Stable	7.2	Stable	Stable
2972	1.74	1.5383	1.4614	Erosive	Erosive	Erosive	0.4	Stable	9.1	Stable	Stable
3962	1.74	1.5907	1.5112	Erosive	Erosive	Erosive	0.4	Stable	9.8	Stable	Stable

USCOE Allowable Velocity (ft/s)	2
FHWA Allowable Velocity (ft/s)	2.5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	**396**	**991**	**2972**	**3962**	**396**	**991**	**2972**	**3962**	**396**	**991**	**2972**	**3962**
Bray - Equation #1	56	90	161	187	1.9	2.6	3.8	4.2	3.7	4.2	4.8	5.0
Bray - Equation #2	73	119	212	246	2.1	2.9	4.2	4.6	2.5	2.9	3.3	3.5
Hey	17	29	53	62	6.3	8.9	13.5	15.0				
Ackers & Charlton/Lacey	44	65	104	117					2.2	2.5	3.0	3.2
Parker	137	216	374	432	1.7	2.4	3.8	4.3				
Chang	93	162	316	375	0.1	-0.1	-0.7	-1.0				
Kellerhals	36	57	98	113	3.0	4.3	6.7	7.5	3.7	4.1	4.5	4.7
AMAFCA/Schumm	72	404	410	413								
Moody & Odem	25	25	25	25	1.3	1.3	1.3	1.3				
BUREC	26.1	36.8	55.6	61.9	7	10	15	17	3.4	4.3	5.7	6.1
Average	58	120	181	203	2.9	4.0	5.9	6.6	3.1	3.6	4.3	4.5
Values As Designed	72	404	410	412	2.0	3.6	4.6	5.0	3.1	2.2	3.4	3.8
Difference with Design	-14	-283	-229	-209	1.0	0.4	1.3	1.5	0.0	1.4	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
396	2341	1414	2650	4124	6051	595	546	404	7037	610	2586	2578
991	9659	4669	8131	19513	9026	2585	1841	2034	18687	2239	10910	8118
2972	52489	17148	25247	125278	13777	12306	6101	10352	57524	11216	52745	34926
3962	81738	23770	32914	203671	15292	18329	8173	15386	76943	17167	78248	51966

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
396	2192	1324	2482	3862	5666	557	511	378	6589	571	2421	2414
991	3618	1749	3046	7309	3381	968	689	762	6999	839	4087	3041
2972	6553	2141	3152	15641	1720	1536	762	1292	7182	1400	6585	4361
3962	7654	2226	3082	19072	1432	1716	765	1441	7205	1608	7327	4866

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
396	1610	750	1056	2911	1425	294	227	407	1779	323	1924	1155
991	2610	1347	2057	4129	5553	420	405	577	4100	545	2997	2249
2972	14155	5869	8107	26441	9093	2554	1824	3571	13540	2796	16749	9518
3962	22022	8386	11176	42942	10230	3880	2542	5471	18261	3636	25611	14014

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
396	1508	703	989	2725	1334	275	212	381	1666	303	1802	1082
991	978	505	771	1547	2080	157	152	216	1536	204	1122	842
2972	1767	733	1012	3301	1135	319	228	446	1690	349	2091	1188
3962	2062	785	1047	4021	958	363	238	512	1710	341	2398	1312

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)
396	0.0018	0.0025	131	0.40	0.047	0.0005	30	0.035	0.0004	0.0159	0.0005	0.0013	0.0047	0.0002	0.0019	0.0102	0.0041
991	0.0009	0.0015	172	0.52	0.049	0.0003	30	0.036	0.0002	0.0159	0.0003	0.0007	0.0047	0.0002	0.0009	0.0103	0.0040
2972	0.0004	0.0008	238	0.72	0.052	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0004	0.0047	0.0001	0.0004	0.0103	0.0039
3962	0.0003	0.0006	259	0.79	0.053	0.0002	32	0.036	0.0001	0.0159	0.0001	0.0003	0.0047	0.0001	0.0003	0.0103	0.0038

Drop Structures

Design Slope	0.0040	ft/ft
Total Drop Needed	55.5	ft
Height of Drop Structure	3	ft
No . of Drop Structures	19	
Distance between structs.	466	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	3.93	sq. mi
Total Sediment Yield Volume	7.47	ac ft

Sedimentation Basins

Length	466 ft	Depth	3 ft
Width	430 ft	Side slope	3 ft/ft
Total Volume per Basin		13.26	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)
396	1.1	-0.6	0.1	24.6	2.0	1.8	3.1	0.0040	0.2	1.0	3.0	5.6
991	1.1	-1.2	0.1	24.6	3.6	1.1	2.2	0.0040	0.4	1.0	3.0	5.7
2972	1.1	-1.3	0.2	24.6	4.6	2.1	3.4	0.0040	0.5	1.0	3.0	6.0
3962	1.1	-1.4	0.2	24.6	5.0	2.5	3.8	0.0040	0.6	1.0	3.0	6.1

Toe Protection Needed	7.0	ft

Freeboard

Max. Flow Depth	1.9	ft
Channel Depth as designed	5.0	ft
Available Freeboard	3.1	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	7.56	ac. ft
Outflowing Sediment Volume	0.11	ac. ft
Deposited(+)/Eroded(-) Volume	7.46	ac. ft

HEC1 Results For Open Channel

Peak Flow	1968	cfs
Stage at Peak Flow	101.3	ft
Flow Volume	217.0	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	8862	8862
Side Slope (?H:1V)	3	3
Channel Width (ft)	430	430
Channel XS Area (sq. ft)	2282	2282
Channel Perimeter (ft)	433	433

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	8862	ft
Thickness	1.5	ft
Protection Depth	7	ft
Tie-in Length/Depth	3.0	ft
Total Depth	10.0	ft
Area needed	2954	sq. Yd
Volume	9847	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	8862	8862
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	5	6
Left Levee Surface Area (sq. Yd)	45295	91574
Left Levee Volume (cu. Yd)	47592	110283
Right Levee Length (ft)	8862	8862
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	5	6
Right Levee Surface Area (sq. Yd)	45295	91574
Right Levee Volume (cu. Yd)	47592	110283
Total Levee Surface Area (sq. Yd)	90590	183148
Total Levee Volume (cu. Yd)	95184	220566

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	8862	8862
Left Levee Lining Width (ft)	16	36
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	15755	35448
Left Levee Lining Volume (cu. Yd)	7877	17724
Right Levee Length (ft)	8862	8862
Right Levee Lining Width (ft)	16	36
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	15755	35448
Right Levee Lining Volume (cu. Yd)	7877	17724
Total Lining Area (sq. Yd)	31509	70896
Total Lining Volume (cu. Yd)	15754	35448

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	430	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	19	
Volume per structure	553	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 41,475	
Area per structure	143	sq. Yd
Total Area	2,723	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	2	
Total Volume per Basin	21393	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 85,572	
Other Cost	$ -	
Total cost per basin	$ 85,572	
Area per basin	22,284	sq. Yd
Total Area	44,568	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	95,184	cu. Yd	$ 7.00	$ 666,288	90,590	sq. Yd	$ 9.00	$ 815,310	90,590	sq. Yd	$ 11.67	$ 1,056,883
Levee - LC Enhancement	Fill	125,382	cu. Yd	$ 7.00	$ 877,674	92,558	sq. Yd	$ 9.00	$ 833,022	125,382	sq. Yd	$ 11.67	$ 1,462,790
Levee Lining	Riprap	15,754	cu. Yd	$ 75.00	$ 1,181,550	31,509	sq. Yd	$ -	$ -	31,509	sq. Yd	$ 20.83	$ 656,444
Levee Lining -LC Enhancement	Riprap	19,694	cu. Yd	$ 75.00	$ 1,477,050	39,387	sq. Yd	$ -	$ -	39,387	sq. Yd	$ 20.83	$ 820,556
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	9,847	cu. Yd	$ 75.00	$ 738,525	2,954	sq. Yd	$ -	$ -	2,954	sq. Yd	$ 25.00	$ 73,850
Drop Structures	Riprap	19	EA	$ 41,475.00	$ 788,025	2,723	sq. Yd	$ -	$ -	2,723	sq. Yd	$ 33.33	$ 90,767
Drop Str. - LC Enhancement	Riprap	19	EA	$ 4,147.50	$ 78,803	272	sq. Yd	$ -	$ -	272	sq. Yd	$ 33.33	$ 9,077
Sedimentation Basins		2	EA	$ 85,572.00	$ 171,144	44,568	sq. Yd	$ -	$ -	44,568	sq. Yd	$ 8.33	$ 371,400
Other					$ -				$ -				$ -

Base Landscape Cost	$ 815,310	
LC Enhancement Cost	$ 833,022	
Total Landscape Cost	$ 1,648,332	

Base Maintenance Cost	$ 2,249,344
LC Enhancement Cost	$ 2,292,422
Total Maintenance Cost	$ 4,541,767

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 3,545,532	$ 2,433,527	$ 5,979,059
Contingency Cost (25% of Construction Cost)	$ 886,383	$ 608,382	$ 1,494,765
Engineering Design Cost (5% of Construction Cost)	$ 177,277	$ 121,676	$ 298,953
Total Construction Cost	$ 4,609,192	$ 3,163,584	$ 7,772,776

Land Cost

Channel Length	8862 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	430	87.5	$100,000	$ 8,750,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	58	11.8	$100,000	$ 1,180,000
Levee LC Enhancement	54	11	$100,000	$ 1,100,000
Other	0	0	$100,000	$ -
Total	542	110.3		$ 11,030,000

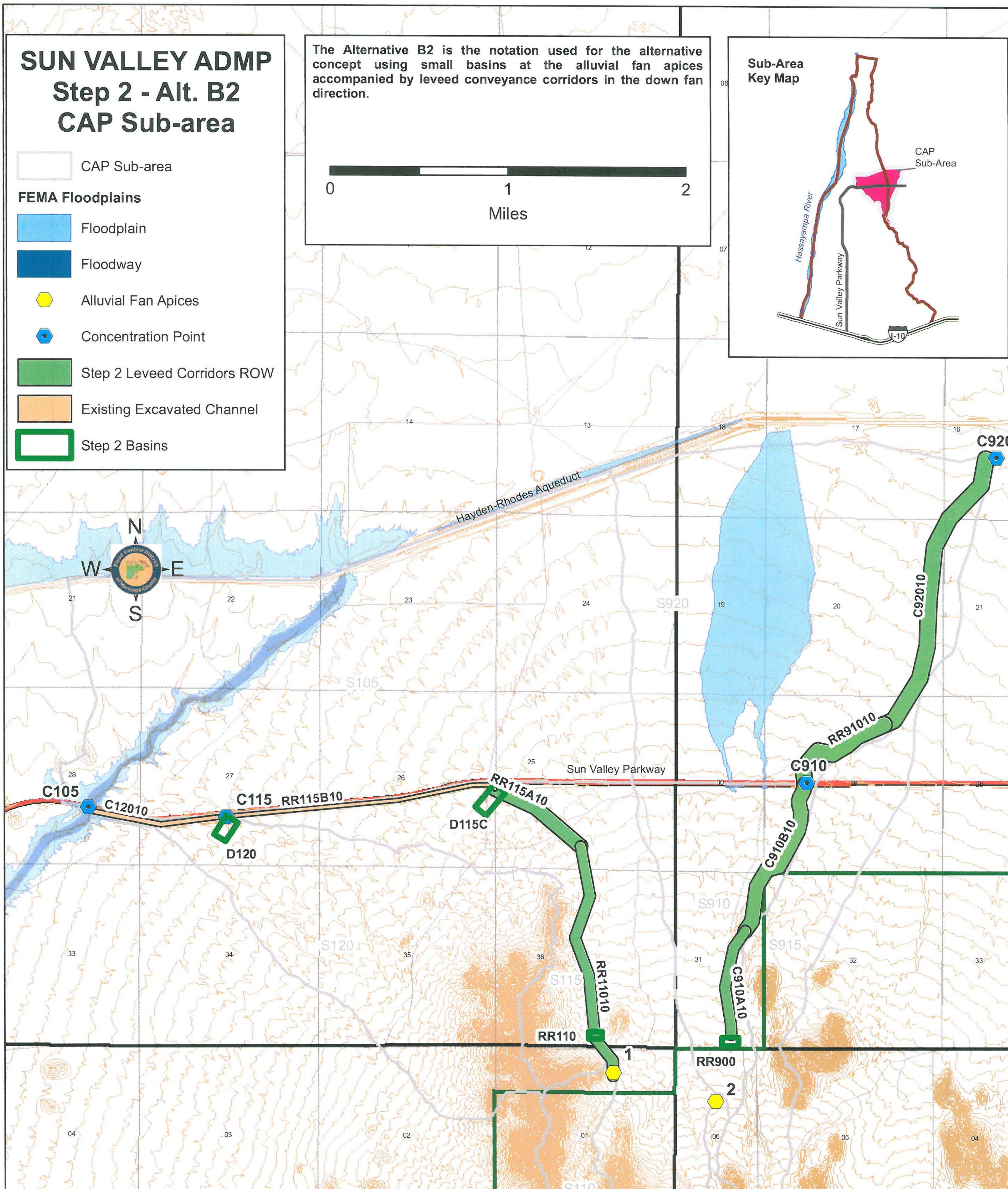
Right of Way

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	99.3	$100,000	$ 9,930,000
LC Enhancement Cost	acre	11	$100,000	$ 1,100,000
Total Land Cost	acre	110.3	$100,000	$ 11,030,000

Total Cost

Base Total Cost	$ 17,603,846
Total Landscape Enhancement Cost	$ 7,389,029
Total Cost Including LC Enh.	$ 24,992,875



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
RR110	Online Basin	600	2	12	0	400	220	4	$ 200	$ 162	$ 88	$ 95	$ 545	37%	30%	16%	17%	1%
RR11010	Leveed Chl.	1308	54	0	34	1.4	326	4	$ 5,390	$ 3,238	$ 562	$ 1,434	$ 10,623	51%	30%	5%	13%	18%
RR115A10	Leveed Chl.	1664	30	0	15	0.6	428	4	$ 3,030	$ 1,473	$ 241	$ 743	$ 5,487	55%	27%	4%	14%	9%
RR115B10	Existing Chl.	1000	0	0	0	1.5	108	6	$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
D115C	Offline Basin	1000	9	75	0	900	420	5	$ 868	$ 722	$ 378	$ 368	$ 2,336	37%	31%	16%	16%	4%
C12010	Existing Chl.	2000	0	0	0	0.8	136	7	$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
D120	Offline Basin	2000	6	51	0	660	400	5	$ 606	$ 519	$ 264	$ 262	$ 1,651	37%	31%	16%	16%	3%
RR900	Online Basin	829	3	21	0	490	250	5	$ 280	$ 246	$ 122	$ 130	$ 778	36%	32%	16%	17%	1%
C910A10	Leveed Chl.	1422	27	0	17	0.7	328	4	$ 2,720	$ 1,513	$ 282	$ 721	$ 5,236	52%	29%	5%	14%	9%
C910B10	Leveed Chl.	1501	50	0	24	0.9	436	4	$ 5,000	$ 1,989	$ 389	$ 1,067	$ 8,445	59%	24%	5%	13%	14%
RR91010	Leveed Chl.	2906	38	0	19	0.6	482	5	$ 3,750	$ 1,607	$ 285	$ 799	$ 6,441	58%	25%	4%	12%	11%
C92010	Leveed Chl.	3974	99	0	59	1.7	488	5	$ 9,930	$ 4,421	$ 815	$ 2,249	$ 17,415	57%	25%	5%	13%	30%
		TOTAL	318	159	168				$31,774	$ 15,891	$ 3,426	$ 7,866	**$ 58,958**	54%	27%	6%	13%	100%
All Channels			298	0	168	5.9			$29,820	$ 14,242	$ 2,574	$ 7,012	$ 53,648	56%	27%	5%	13%	91%
All Online Basins			5	33	0				$ 480	$ 408	$ 211	$ 224	$ 1,323	36%	31%	16%	17%	2%
All Offline Basins			15	126	0				$ 1,474	$ 1,242	$ 642	$ 630	$ 3,987	37%	31%	16%	16%	7%

Channel Cost per mile (in $1000)	$9,093	Basins Cost per ac. ft. (in $1000)	$5.36

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	12%	0%	138%				12%	69%	106%	100%	43%
All Online Basins % increase	100%	15%	0%				108%	8%	108%	96%	75%
All Offline Basins % increase	60%	8%	0%				59%	7%	59%	56%	42%
Total % increase	16%	9%	138%				16%	63%	97%	96%	44%

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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
RR110	Online Basin	600	2	12	0	400	220	4	$ 200	$ 162	$ 88	$ 95	$ 545	37%	30%	16%	17%	1%
RR11010	Leveed Chl.	1308	54	0	34	1.4	326	4	$ 5,390	$ 3,238	$ 562	$ 1,434	$ 10,623	51%	30%	5%	13%	18%
RR115A10	Leveed Chl.	1664	30	0	15	0.6	428	4	$ 3,030	$ 1,473	$ 241	$ 743	$ 5,487	55%	27%	4%	14%	9%
RR115B10	Existing Chl.	1000	0	0	0	1.5	108	6	$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
D115C	Offline Basin	1000	9	75	0	900	420	5	$ 868	$ 722	$ 378	$ 368	$ 2,336	37%	31%	16%	16%	4%
C12010	Existing Chl.	2000	0	0	0	0.8	136	7	$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
D120	Offline Basin	2000	6	51	0	660	400	5	$ 606	$ 519	$ 264	$ 262	$ 1,651	37%	31%	16%	16%	3%
RR900	Online Basin	829	3	21	0	490	250	5	$ 280	$ 246	$ 122	$ 130	$ 778	36%	32%	16%	17%	1%
C910A10	Leveed Chl.	1422	27	0	17	0.7	328	4	$ 2,720	$ 1,513	$ 282	$ 721	$ 5,236	52%	29%	5%	14%	9%
C910B10	Leveed Chl.	1501	50	0	24	0.9	436	4	$ 5,000	$ 1,989	$ 389	$ 1,067	$ 8,445	59%	24%	5%	13%	14%
RR91010	Leveed Chl.	2906	38	0	19	0.6	482	5	$ 3,750	$ 1,607	$ 285	$ 799	$ 6,441	58%	25%	4%	12%	11%
C92010	Leveed Chl.	3974	99	0	59	1.7	488	5	$ 9,930	$ 4,421	$ 815	$ 2,249	$ 17,415	57%	25%	5%	13%	30%
		TOTAL	318	159	168				$ 31,774	$ 15,891	$ 3,426	$ 7,866	**$ 58,958**	54%	27%	6%	13%	100%
All Channels			298	0	168	5.9			$ 29,820	$ 14,242	$ 2,574	$ 7,012	$ 53,648	56%	27%	5%	13%	91%
All Online Basins			5	33	0				$ 480	$ 408	$ 211	$ 224	$ 1,323	36%	31%	16%	17%	2%
All Offline Basins			15	126	0				$ 1,474	$ 1,242	$ 642	$ 630	$ 3,987	37%	31%	16%	16%	7%
Channel Cost per mile (in $1000)			$9,093		Basins Cost per ac. ft. (in $1000)				$5.36									

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
RR110	Online Basin	600	4	14	0	590	320	4	$ 430	$ 174	$ 189	$ 191	$ 983	44%	18%	19%	19%	1%
RR11010	Leveed Chl.	1308	62	0	83	1.4	374	4	$ 6,180	$ 5,377	$ 1,166	$ 2,920	$ 15,643	40%	34%	7%	19%	18%
RR115A10	Leveed Chl.	1664	34	0	35	0.6	476	4	$ 3,370	$ 2,391	$ 500	$ 1,380	$ 7,640	44%	31%	7%	18%	9%
RR115B10	Existing Chl.	1000	0	0	0	1.5	122	6	$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
D115C	Offline Basin	1000	14	81	0	1130	520	5	$ 1,350	$ 770	$ 588	$ 565	$ 3,273	41%	24%	18%	17%	4%
C12010	Existing Chl.	2000	0	0	0	0.8	150	7	$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
D120	Offline Basin	2000	10	55	0	860	500	5	$ 990	$ 553	$ 430	$ 419	$ 2,392	41%	23%	18%	18%	3%
RR900	Online Basin	829	6	24	0	710	350	5	$ 570	$ 268	$ 248	$ 249	$ 1,335	43%	20%	19%	19%	2%
C910A10	Leveed Chl.	1422	31	0	42	0.7	376	4	$ 3,120	$ 2,580	$ 586	$ 1,468	$ 7,754	40%	33%	8%	19%	9%
C910B10	Leveed Chl.	1501	56	0	57	0.9	484	4	$ 5,550	$ 3,445	$ 809	$ 2,094	$ 11,898	47%	29%	7%	18%	14%
RR91010	Leveed Chl.	2906	42	0	45	0.6	533	5	$ 4,150	$ 2,736	$ 590	$ 1,594	$ 9,070	46%	30%	7%	18%	11%
C92010	Leveed Chl.	3974	110	0	137	1.7	542	5	$ 11,030	$ 7,585	$ 1,648	$ 4,542	$ 24,805	44%	31%	7%	18%	29%
		TOTAL	369	174	399				$ 36,740	$ 25,878	$ 6,754	$ 15,421	**$ 84,793**	43%	31%	8%	18%	100%
All Channels			335	0	399	5.9			$ 33,400	$ 24,114	$ 5,299	$ 13,997	$ 76,810	43%	31%	7%	18%	91%
All Online Basins			10	38	0				$ 1,000	$ 441	$ 437	$ 440	$ 2,318	43%	19%	19%	19%	3%
All Offline Basins			24	136	0				$ 2,340	$ 1,323	$ 1,018	$ 984	$ 5,665	41%	23%	18%	17%	7%
Channel Cost per mile (in $1000)			$13,019		Basins Cost per ac. ft. (in $1000)				$8.36									
All Channels % increase			12%	0%	138%				12%	69%	106%	100%	43%					
All Online Basins % increase			100%	15%	0%				108%	8%	108%	96%	75%					
All Offline Basins % increase			60%	8%	0%				59%	7%	59%	56%	42%					
Total % increase			16%	9%	138%				16%	63%	97%	96%	44%					

JE FULLER
HYDROLOGY & GEOMORPHOLOGY, INC.

Sub-area: CAP, Alternative: B2
Cost Summary

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	61	100.2	17.36	11.4	10.23	59	51	36	20	0.054	0.185	0.39	0.513	29	101	213	280
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	100.3	9.31	8	10.23	60	51	36	20	0.055	0.186	0.39	0.513	30	101	213	280
C105U	COMBINE	2863			4.5	14.6	554	228	121	64	0.353	0.58	0.923	1.129	275	451	719	879
S110	BASIN	662			4.2	0.43	76	19	6	3	1.639	1.64	1.64	1.64	38	38	38	38
RR110	STORAGE	600	2.5	4.22	4.3	0.43	76	19	6	3	1.639	1.64	1.64	1.64	38	38	38	38
11015I	ROUTE	504	100.6	23.44	4.7	0.43	76	19	6	3	1.636	1.64	1.64	1.64	38	38	38	38
S115A	BASIN	1540			4.3	1.4	213	53	18	8	1.415	1.416	1.416	1.416	105	105	105	105
C115A	COMBINE	1466			4.4	1.83	271	68	23	10	1.379	1.383	1.383	1.383	134	135	135	135
15I15A	ROUTE	1452	100.9	23.44	4.5	1.83	271	68	23	10	1.378	1.383	1.383	1.383	134	135	135	135
S115B	BASIN	789			4.1	0.42	57	14	5	2	1.269	1.269	1.269	1.269	29	29	29	29
C115B	COMBINE	1559			4.4	2.25	308	77	26	11	1.273	1.277	1.277	1.277	153	153	153	153
15I15B	ROUTE	1538	103.4	31.6	4.5	2.25	308	77	26	11	1.273	1.277	1.277	1.277	153	153	153	153
S115C	BASIN	668			4.1	0.43	58	14	5	2	1.246	1.246	1.246	1.246	29	29	29	29
C115C	COMBINE	1639			4.5	2.68	342	86	29	12	1.189	1.192	1.192	1.192	170	170	170	170
D115C	DIVERT	1000			4.3	2.68	290	73	24	10	1.008	1.012	1.012	1.012	144	144	144	144
115120	ROUTE	1002	102.9	13.52	4.5	2.68	290	73	24	10	1.008	1.012	1.012	1.012	144	144	144	144
S120	BASIN	1838			4.3	2	256	64	21	9	1.189	1.189	1.189	1.189	127	127	127	127
C120	COMBINE	2277			4.5	4.68	500	126	42	18	0.994	0.998	0.998	0.998	248	249	249	249
D120	DIVERT	1935			4.5	4.68	483	121	40	17	0.958	0.963	0.963	0.963	239	240	240	240
C105D	COMBINE	3745			4.5	19.28	813	273	127	64	0.392	0.526	0.733	0.858	403	541	754	882
S900	BASIN	936			4.5	1.03	170	43	14	6	1.529	1.535	1.535	1.535	84	85	85	85
RR900	STORAGE	829	3.1	6.89	4.5	1.03	170	43	14	6	1.529	1.535	1.535	1.535	84	85	85	85
90091A	ROUTE	819	100.8	16.9	4.7	1.03	170	43	14	6	1.528	1.535	1.535	1.535	84	85	85	85
90091B	ROUTE	768	100.7	27.59	5	1.03	170	43	14	6	1.525	1.535	1.535	1.535	84	85	85	85
S910	BASIN	1585			4.1	0.98	138	35	12	5	1.307	1.307	1.307	1.307	69	69	69	69
C910	COMBINE	1226			4.1	2.02	282	71	24	10	1.297	1.302	1.302	1.302	140	140	140	140
910915	ROUTE	1111	100.8	25.73	4.3	2.02	281	71	24	10	1.295	1.302	1.302	1.302	139	140	140	140
S915	BASIN	1400			4.5	1.13	189	47	16	7	1.562	1.562	1.562	1.562	94	94	94	94
C915	COMBINE	2029			4.4	3.14	433	109	36	16	1.281	1.288	1.288	1.288	215	216	216	216
915920	ROUTE	1740	101.2	95.24	4.9	3.14	426	109	36	16	1.261	1.288	1.288	1.288	211	216	216	216
S920	BASIN	2660			4.5	3.29	424	106	35	15	1.197	1.197	1.197	1.197	210	210	210	210
C920	COMBINE	3225			4.8	6.43	759	194	65	28	1.097	1.123	1.123	1.123	376	385	385	385

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	71	100.2	20.2	19.1	10.23	68	58	41	23	0.062	0.212	0.445	0.579	34	116	243	316
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	100.3	10.27	15.9	10.23	70	59	41	23	0.063	0.213	0.445	0.58	35	116	243	316
C105U	COMBINE	3466			12.5	14.6	593	239	126	66	0.378	0.609	0.961	1.164	294	474	748	906
S110	BASIN	532			12.1	0.43	62	16	5	2	1.35	1.422	1.422	1.422	31	33	33	33
RR110	STORAGE	503	1.9	3.1	12.2	0.43	62	16	5	2	1.35	1.422	1.422	1.422	31	33	33	33
11015I	ROUTE	392	100.5	20.1	12.7	0.43	62	16	5	2	1.35	1.421	1.422	1.422	31	33	33	33
S115A	BASIN	1536			12.3	1.4	193	50	17	7	1.286	1.321	1.322	1.322	96	98	98	98
C115A	COMBINE	1551			12.3	1.83	253	65	22	9	1.288	1.332	1.333	1.333	126	130	130	130
15I15A	ROUTE	1496	100.9	23.87	12.5	1.83	253	65	22	9	1.288	1.332	1.333	1.333	125	130	130	130
S115B	BASIN	619			12	0.42	47	12	4	2	1.046	1.046	1.046	1.046	23	23	23	23
C115B	COMBINE	1664			12.4	2.25	298	77	26	11	1.232	1.268	1.269	1.269	148	152	152	152
15I15B	ROUTE	1635	103.5	33.03	12.5	2.25	298	77	26	11	1.232	1.268	1.269	1.269	148	152	152	152
S115C	BASIN	534			12.1	0.43	47	12	4	2	1.028	1.028	1.028	1.028	24	24	24	24
C115C	COMBINE	1766			12.5	2.68	343	88	29	13	1.19	1.22	1.221	1.221	170	174	174	174
D115C	DIVERT	1000			12.3	2.68	282	73	24	10	0.979	1.009	1.009	1.009	140	144	144	144
115120	ROUTE	1000	102.9	13.5	12.5	2.68	282	73	24	10	0.978	1.009	1.009	1.009	140	144	144	144
S120	BASIN	2032			12.3	2	247	62	21	9	1.146	1.158	1.158	1.158	122	124	124	124
C120	COMBINE	2842			12.4	4.68	523	134	45	19	1.039	1.062	1.063	1.063	259	265	265	265
D120	DIVERT	2000			12.2	4.68	481	123	41	18	0.955	0.978	0.979	0.979	238	244	244	244
C105D	COMBINE	5244			12.5	19.28	1016	340	157	79	0.49	0.656	0.906	1.054	504	675	932	1083
S900	BASIN	853			12.5	1.03	150	39	13	6	1.345	1.416	1.417	1.417	74	78	78	78
RR900	STORAGE	769	2.7	5.93	12.5	1.03	150	39	13	6	1.345	1.416	1.417	1.417	74	78	78	78
90091A	ROUTE	752	100.8	16.01	12.7	1.03	150	39	13	6	1.344	1.416	1.417	1.417	74	78	78	78
90091B	ROUTE	684	100.6	25.8	13	1.03	150	39	13	6	1.343	1.415	1.417	1.417	74	78	78	78
S910	BASIN	1512			12.1	0.98	122	30	10	4	1.151	1.151	1.151	1.151	60	60	60	60
C910	COMBINE	1501			12.1	2.02	268	69	23	10	1.234	1.271	1.272	1.272	133	137	137	137
910915	ROUTE	1295	100.9	28.32	12.3	2.02	267	69	23	10	1.231	1.271	1.272	1.272	132	137	137	137
S915	BASIN	1305			12.4	1.13	165	42	14	6	1.366	1.378	1.378	1.378	82	83	83	83
C915	COMBINE	2440			12.3	3.14	427	109	36	16	1.262	1.294	1.294	1.294	212	217	217	217
915920	ROUTE	1975	101.3	102.95	12.8	3.14	420	109	36	16	1.243	1.293	1.294	1.294	208	217	217	217
S920	BASIN	3157			12.5	3.29	428	107	36	15	1.209	1.209	1.209	1.209	212	212	212	212
C920	COMBINE	3974			12.7	6.43	829	214	71	31	1.198	1.234	1.235	1.235	411	424	424	424

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)
RR11010	Leveed	0.0240	0.0080	1.40	3	4.0	0.045	1308	256.4	255.4	1.0	1.0	1.0	3.0	256	5.1	0.90	0.50
RR115A10	Leveed	0.0191	0.0070	0.60	3	4.0	0.045	1664	358.4	361.6	1.0	1.0	1.0	3.0	358	4.6	0.81	0.44
RR115B10	Existing	0.0118	0.0015	1.50	3	5.5	0.030	1000	89.1	138.2	1.6	1.6	3.0	2.5	88	7.2	1.02	0.28
C12010	Existing	0.0100	0.0015	0.80	3	6.5	0.030	2000	115.4	244.2	2.1	2.1	3.8	2.7	114	8.2	0.99	0.36
C910A10	Leveed	0.0198	0.0070	0.70	3	4.0	0.045	1422	259.1	285.6	1.1	1.1	1.1	2.9	259	5.0	0.84	0.49
C910B10	Leveed	0.0158	0.0060	0.90	3	4.0	0.045	1501	366.3	362.7	1.0	1.0	1.0	3.0	366	4.1	0.73	0.37
RR91010	Leveed	0.0131	0.0050	0.60	3	4.5	0.045	2906	409.3	595.9	1.5	1.5	1.5	3.0	409	4.9	0.71	0.46
C92010	Leveed	0.0103	0.0040	1.70	3	5.0	0.045	3974	412.1	776.5	1.9	1.9	1.9	3.1	411	5.1	0.66	0.48

Basins Hydraulics Summary

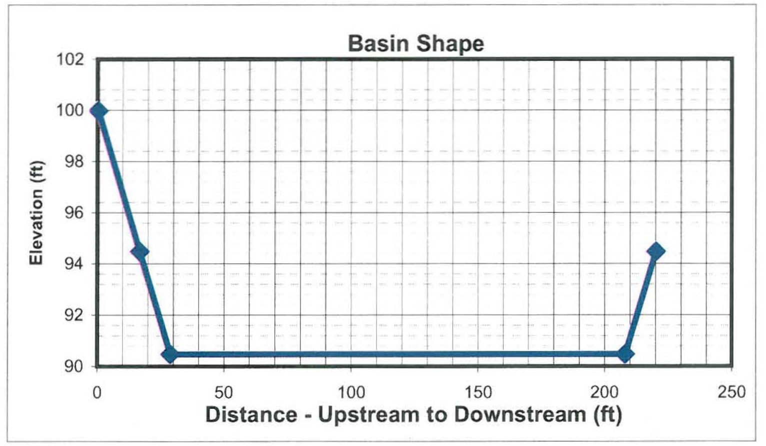
			Design Geometry				Hydraulics					
Structure ID	Type	Adjacent Topo. Slope (ft/ft)	Length (stor ft; chl-mi)	Width (ft)	Depth (ft)	Storage Volume Provided	Peak Storage (ac. Ft)	Total Vol. Entering Basin (ac.	Peak Inflow into Basin (cfs)	Peak Outflow (cfs)	Peak Stage (ft)	Freeboard (ft)
RR110	Online Basin	0.0250	400	220	4.0	5.0	4.2	38.0	662	600	2.5	1.5
D115C	Offline Basin	0.0200	900	420	5.0	30.5	30.0	30.0	766	0	2.9	2.1
D120	Offline Basin	0.0200	660	400	5.0	21.1	21.0	21.0	842	0	1.5	3.5
RR900	Online Basin	0.0276	490	250	5.0	9.1	6.9	85.0	936	829	3.1	1.9

Online Basin

HEC1 ID	RR110

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	0.4	sq. mi
Total Sediment Yield Volume	0.8	ac ft

Required Minimum Sediment Volume

Sediment Volume	0.8	ac. ft

Geometry	Base	LC Enhanced
Topography slope (ft/ft)	0.025	0.025
Basin Length (ft)	400	490
Basin Width (ft)	220	220
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	4	4
Freeboard (ft)	1	1
Effective Basin Width (ft)	204	187
Top Area (acres)	2.0	2.5
U/S-D/S Height Difference (ft)	5.5	5.5
Excess Area on Upstream (acres)	0.2	0.4

			Base	LC Enhanced
Bottom Length (ft)	376	Allocated Storage Volume (ac. ft)	5.0	5
Bottom Width (ft)	180	Total Available Volume (ac. ft) (incl. Freeboard)	6.8	7
		Total Excavation Volume (ac. ft)	12.4	13.8

HEC1 Results

	6-hr Event	24-hr Event	Maximum
Total Flow Volume entering Basin (ac. ft)	38.0	33	38.0
Peak Inflow (cfs)	662	532	662.0
Peak Outflow (cfs)	600	503	600.0
Stage at Peak Outflow (ft)	2.5	1.9	2.5
Volume at Peak Outflow (ac. ft)	4.2	3.1	4.2

Volume Check

Total Volume needed	5.0	ac. ft
Total Volume Provided	5.0	ac. ft
Volume OK?	Yes	

Stage Check

Depth Needed	3.5	ft
Depth Provided	4	ft
Depth OK?	Yes	

Basin Outlet

Outlet Coeff	0.60	(0.6 for Orifice, 3.0 for Weir)
D (Orifice) or W (Weir)	5.00	ft
Invert Elevation	0.00	ft
Number of pipes	4	

Stage-Storage-Discharge

Elevation	0	2	3	3.5	4	4.5	5	5.5	6	7
Volume	0.00	3.26	5.01	5.92	6.85	7.79	8.76	9.75	10.76	12.85
Outflow	0.0	534.8	655.0	707.5	756.3	802.2	845.6	886.9	926.3	1000.5

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
LC Enhancement Buffer	100800	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	220	ft
LC Enh. Total ROW Length	590	ft
LC Enh. Total ROW Length	320	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	20005	22264
Excavated Area (sq. Yd)	9778	20978

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	30	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	334	sq. Yd
Material Volume	167	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		20,005	cu. Yd	$ 4.00	$ 80,020	9,778	sq. Yd	$ 9.00	$ 88,002	9,778	sq. Yd	$ 8.33	$ 81,483
Basin - LC Enhancement		2,259	cu. Yd	$ 4.00	$ 9,036	11,200	sq. Yd	$ 9.00	$ 100,800	11,200	sq. Yd	$ 8.33	$ 93,333
Inlet	Riprap	167	sq. Yd	$ 75.00	$ 12,525	334	sq. Yd	$ -	$ -	334	sq. Yd	$ 33.33	$ 11,133
Inlet - LC Enhancement (20%Inlet)					$ 2,505				$ -				$ 2,227
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			$ 88,002	Base Maintenance Cost			$ 94,833
						LC Enh. Landscape Cost			$ 100,800	LC Enh. Maintenance Cost			$ 95,671
						Total Landscape Cost			$ 188,802	Total Maintenance Cost			$ 190,504

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 124,545	$ 9,036	$ 133,581
Contingency Cost (25% of Construction Cost)	$ 31,136	$ 2,259	$ 33,395
Engineering Design Cost (5% of Construction Cost)	$ 6,227	$ 452	$ 6,679
Total Construction Cost	$ 161,909	$ 11,747	$ 173,655

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	2.3	$100,000	$ 230,000
Basin	2.0	$100,000	$ 200,000
Other		$100,000	$ -
Total	4.3	$100,000	$ 430,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	2.0	$100,000	$ 200,000
LC Enhancement Cost	acre	2.3	$100,000	$ 230,000
Total Land Cost	acre	4.3	$100,000	$ 430,000

Total Cost

Base Total Cost	$ 544,744
Total LC Enhancement Cost	$ 438,218
Total Cost Including LC Enh.	$ 982,961

Open Channel

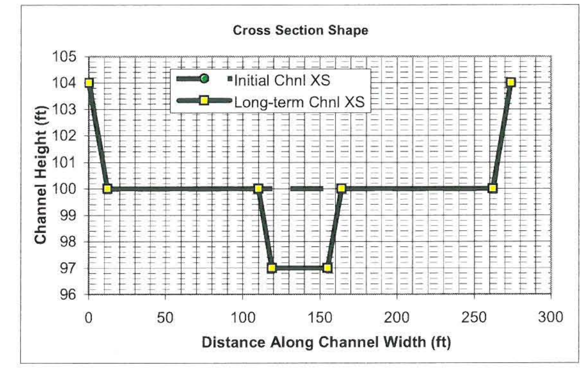
Structure ID	RR11010	HEC1 ID	11015I

Longitundal Geometry

Length	7199.5	ft
U/S Elev	1865.3	ft
D/S Elev	1692.1	ft
Initial Channel Slope	0.0240	ft/ft
Long-term Channel Slope	0.0080	ft/ft

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

NSTPS	6



Initial Channel XS Geometry

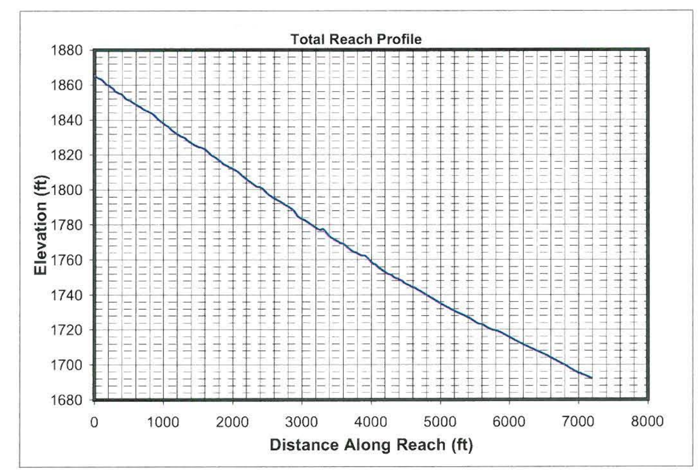
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	0	3	250	4	3	0	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	12	12	262	262	262	274
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	98	3	36	7	3	98	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	110	119	155	164	262	274
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	RR110	S115A								TOTAL
HEC1 Peak-Flow	600	1540								2140
Weighting Factor	1.00	0.46								
Flow into Channel	600	708								1308

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	1.073	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	1308	cfs	
Long-term Max. Chnl Capacity	9239	cfs	
Q2 Channel	131	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	274	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
131	251.6	63.7	0.3	100.0	100.3	2.1	0.3	251.5	0.3	0.13	0.72
327	252.8	110.6	0.4	100.0	100.4	3.0	0.4	252.6	0.4	0.22	0.79
981	255.4	214.5	0.8	100.0	100.8	4.6	0.8	255.1	0.8	0.42	0.88
1308	256.4	255.4	1.0	100.0	101.0	5.1	1.0	256.1	1.0	0.50	0.90

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
131	43.0	43.7	1.0	97.0	98.1	3.0	1.1	42.7	1.0	0.55	0.52
327	48.0	79.1	1.6	97.0	98.9	4.1	1.9	47.4	1.7	0.95	0.56
981	255.1	298.4	1.2	97.0	100.6	3.3	3.6	253.9	1.2	1.82	0.53
1308	256.5	355.4	1.4	97.0	100.9	3.7	3.9	255.2	1.4	1.93	0.55

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
131										0
327										0
981										0
1308										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
131	1.74	0.9720	0.9234	Erosive	Erosive	Erosive	0.2	Stable	5.6	Stable	Stable
327	1.74	1.1407	1.0837	Erosive	Erosive	Erosive	0.2	Stable	8.0	Stable	Stable
981	1.74	1.3421	1.2750	Erosive	Erosive	Erosive	0.3	Stable	10.4	Stable	Stable
1308	1.74	1.3946	1.3249	Erosive	Erosive	Erosive	0.3	Stable	11.0	Stable	Stable

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

Regime Width

Discharge (cfs)	Channel Width (ft): 131	327	981	1308	Flow Depth (ft): 131	327	981	1308	Velocity (ft/s): 131	327	981	1308
Bray - Equation #1	31	50	90	104	1.3	1.8	2.6	2.9	3.1	3.6	4.1	4.3
Bray - Equation #2	41	66	118	137	1.5	2.0	2.9	3.2	2.1	2.4	2.8	3.0
Hey	9	15	29	34	4.1	5.8	8.8	9.9				
Ackers & Charlton/Lacey	28	41	65	73					1.8	2.1	2.5	2.7
Parker	79	124	215	248	1.0	1.5	2.4	2.7				
Chang	59	104	201	239	0.0	-0.2	-0.6	-0.8				
Kellerhals	21	33	56	65	1.9	2.8	4.3	4.8	3.3	3.6	4.1	4.2
AMAFCA/Schumm	43	47	254	256								
Moody & Odem	13	13	13	13	1.0	1.0	1.0	1.0				
BUREC	15.1	21.3	32.2	35.9	4	6	9	10	3.4	4.2	5.6	6.0
Average	34	51	107	121	1.9	2.6	3.8	4.2	2.8	3.2	3.8	4.0
Values As Designed	43	47	254	255	1.1	1.9	3.6	3.9	3.0	4.1	3.3	3.7
Difference with Design	-9	4	-147	-135	0.7	0.7	0.1	0.3	-0.2	-0.9	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
131	1773	1145	2701	3551	4440	681	567	295	8670	600	1892	2392
327	7305	3569	7509	16809	6484	2707	1725	1408	22465	1971	7667	7238
981	39865	12643	21701	108091	9731	12625	5469	6943	68451	9119	35441	30007
1308	62064	17392	28607	175800	10767	18780	7271	10247	91444	13728	51958	44369

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
131	5029	3247	7660	10073	12593	1931	1610	836	24591	1701	5365	6785
327	8288	4049	8520	19071	7356	3071	1957	1597	25488	2236	8699	8212
981	15076	4781	8207	40879	3680	4775	2068	2626	25887	3449	13403	11348
1308	17604	4933	8114	49864	3054	5327	2062	2906	25937	3894	14737	12585

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
131	1007	479	791	1997	928	244	177	221	1690	226	1159	811
327	3895	1406	2139	8804	1412	870	485	831	4329	836	4190	2654
981	8633	3571	6116	17627	6054	2056	1390	1906	12793	1895	9800	6531
1308	13430	5090	8454	28638	6791	3105	1919	2935	17202	2899	14891	9578

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
131	2857	1359	2244	5665	2633	693	502	628	4795	641	3287	2300
327	4419	1595	2427	9988	1602	987	550	943	4912	948	4753	3011
981	3265	1350	2313	6666	2290	778	526	721	4838	717	3706	2470
1308	3809	1444	2398	8123	1926	881	544	833	4879	822	4224	2717

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson n	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)
131	0.0028	0.0048	145	0.44	0.048	0.0010	30	0.036	0.0007	0.0159	0.0010	0.0023	0.0069	0.0004	0.0030	0.0240	0.0084
327	0.0014	0.0028	191	0.58	0.050	0.0006	31	0.036	0.0004	0.0159	0.0006	0.0013	0.0069	0.0003	0.0015	0.0240	0.0081
981	0.0006	0.0014	265	0.81	0.053	0.0003	32	0.036	0.0002	0.0159	0.0003	0.0007	0.0069	0.0002	0.0007	0.0240	0.0079
1308	0.0005	0.0012	288	0.88	0.054	0.0003	32	0.036	0.0002	0.0159	0.0003	0.0005	0.0069	0.0001	0.0005	0.0240	0.0079

Drop Structures

Design Slope	0.0080	ft/ft
Total Drop Needed	115.5	ft
Height of Drop Structure	3	ft
No . of Drop Structures	39	
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	0.64	sq. mi
Total Sediment Yield Volume	1.22	ac ft

Sedimentation Basins

Length	185 ft	Depth	3 ft
Width	274 ft	Side slope	3 ft/ft
Total Volume per Basin		3.21	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)
131	1.1	-0.3	0.1	24.6	1.1	1.0	3.0	0.0080	0.1	0.0	3.0	4.1
327	1.1	-0.5	0.2	24.6	1.9	1.7	4.1	0.0080	0.2	0.0	3.0	4.3
981	1.1	-1.1	0.1	24.6	3.6	1.2	3.3	0.0080	0.4	0.0	3.0	4.5
1308	1.1	-1.1	0.2	24.6	3.9	1.4	3.7	0.0080	0.4	0.0	3.0	4.6

Toe Protection Needed	5.0	ft

HEC1 Results For Open Channel

Peak Flow	504	cfs
Stage at Peak Flow	100.6	ft
Flow Volume	38.0	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	1.22	ac. ft
Outflowing Sediment Volume	0.04	ac. ft
Deposited(+)/Eroded(-) Volume	1.18	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	7199	7199
Side Slope (?H:1V)	3	3
Channel Width (ft)	274	274
Channel XS Area (sq. ft)	1183	1183
Channel Perimeter (ft)	276	276

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	7199	ft
Thickness	1.5	ft
Protection Depth	5	ft
Tie-in Length/Depth	3.0	ft
Total Depth	8.0	ft
Area needed	2400	sq. Yd
Volume	6399	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	7199	7199
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)	31196	64791
Left Levee Volume (cu. Yd)	27729	66657
Right Levee Length (ft)	7199	7199
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)	31196	64791
Right Levee Volume (cu. Yd)	27729	66657
Total Levee Surface Area (sq. Yd)	62392	129582
Total Levee Volume (cu. Yd)	55458	133314

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	7199	7199
Left Levee Lining Width (ft)	13	30
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	10399	23997
Left Levee Lining Volume (cu. Yd)	5199	11998
Right Levee Length (ft)	7199	7199
Right Levee Lining Width (ft)	13	30
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	10399	23997
Right Levee Lining Volume (cu. Yd)	5199	11998
Total Lining Area (sq. Yd)	20797	47993
Total Lining Volume (cu. Yd)	10398	23996

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	274	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	6.0	ft
Structure Height	9.0	ft
Number of Structures	39	
Volume per structure	274	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 20,550	
Area per structure	91	sq. Yd
Total Area	3,562	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	2	
Total Volume per Basin	5179	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 20,716	
Other Cost	$ -	
Total cost per basin	$ 20,716	
Area per basin	5,620	sq. Yd
Total Area	11,240	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	55,458	cu. Yd	$ 7.00	$ 388,206	62,392	sq. Yd	$ 9.00	$ 561,528	62,392	sq. Yd	$ 11.67	$ 727,907
Levee - LC Enhancement	Fill	77,856	cu. Yd	$ 7.00	$ 544,992	67,190	sq. Yd	$ 9.00	$ 604,710	77,856	sq. Yd	$ 11.67	$ 908,320
Levee Lining	Riprap	10,398	cu. Yd	$ 75.00	$ 779,850	20,797	sq. Yd	$ -	$ -	20,797	sq. Yd	$ 20.83	$ 433,273
Levee Lining -LC Enhancement	Riprap	13,598	cu. Yd	$ 75.00	$ 1,019,850	27,196	sq. Yd	$ -	$ -	27,196	sq. Yd	$ 20.83	$ 566,588
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	6,399	cu. Yd	$ 75.00	$ 479,925	2,400	sq. Yd	$ -	$ -	2,400	sq. Yd	$ 25.00	$ 60,000
Drop Structures	Riprap	39	EA	$ 20,550.00	$ 801,450	3,562	sq. Yd	$ -	$ -	3,562	sq. Yd	$ 33.33	$ 118,733
Drop Str. - LC Enhancement	Riprap	39	EA	$ 2,055.00	$ 80,145	356	sq. Yd	$ -	$ -	356	sq. Yd	$ 33.33	$ 11,873
Sedimentation Basins		2	EA	$ 20,716.00	$ 41,432	11,240	sq. Yd	$ -	$ -	11,240	sq. Yd	$ 8.33	$ 93,667
Other					$ -				$ -				$ -

Base Landscape Cost	$ 561,528	Base Maintenance Cost	$ 1,433,580
LC Enhancement Cost	$ 604,710	LC Enhancement Cost	$ 1,486,781
Total Landscape Cost	$ 1,166,238	Total Maintenance Cost	$ 2,920,361

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 2,490,863	$ 1,644,987	$ 4,135,850
Contingency Cost (25% of Construction Cost)	$ 622,716	$ 411,247	$ 1,033,963
Engineering Design Cost (5% of Construction Cost)	$ 124,543	$ 82,249	$ 206,793
Total Construction Cost	$ 3,238,122	$ 2,138,483	$ 5,376,605

Land Cost

Channel Length	7199 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	274	45.3	$100,000	$ 4,530,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	52	8.6	$100,000	$ 860,000
Levee LC Enhancement	48	7.9	$100,000	$ 790,000
Other	0	0	$100,000	$ -
Total	374	61.8		$ 6,180,000

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	53.9	$100,000	$ 5,390,000
LC Enhancement Cost	acre	7.9	$100,000	$ 790,000
Total Land Cost	acre	61.8	$100,000	$ 6,180,000

Total Cost

Base Total Cost	$ 10,623,230
Total Landscape Enhancement Cost	$ 5,019,974
Total Cost Including LC Enh.	$ 15,643,204

Open Channel

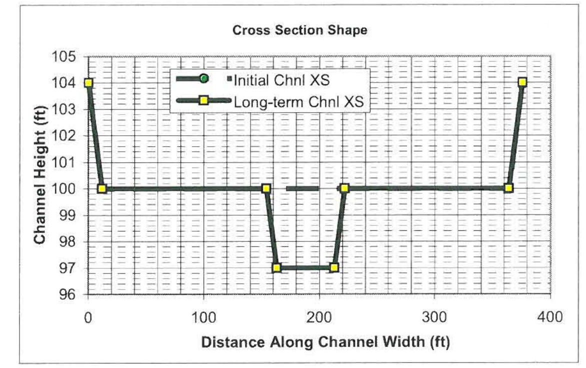
Structure ID	RR115A10	HEC1 ID	15I15A

Longitundal Geometry

Length	3083.7	ft
U/S Elev	1692.1	ft
D/S Elev	1633.3	ft
Initial Channel Slope	0.0191	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

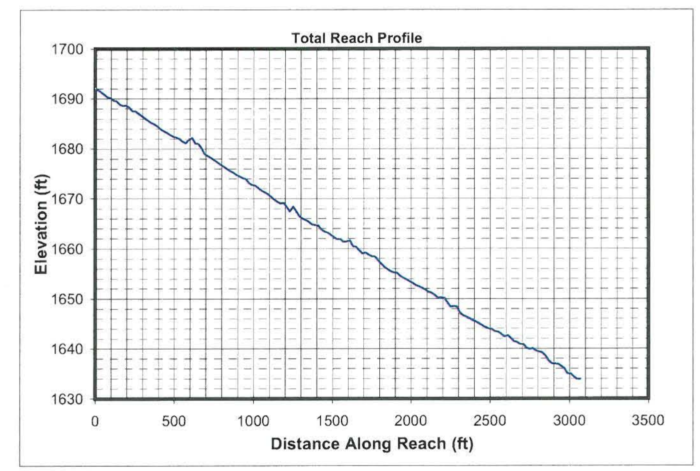
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	0	3	352	4	3	0	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	12	12	364	364	364	376
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	142	3	50	7	3	142	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	154	163	213	222	364	376
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	C115B									TOTAL
HEC1 Peak-Flow	1664									1664
Weighting Factor	1.00									
Flow into Channel	1664									1664

Reach Sediment Inflow Characteristics

U/S Contributing ID	11015I_RR11010									TOTAL
HEC1 Flow Volume (ac. ft)	38.00									38
Sediment Conc. (ppm)	3011									
Sediment Volume (ac. ft)	0.04									0.04
Weighting Factor	1									
Weighted Sed. Vol. (ac. ft)	0.04									0.04

Hydrology

Drainage Area	2.25	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	1664	cfs	
Long-term Max. Chnl Capacity	11994	cfs	
Q2 Channel	166	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	376	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
166	353.6	90.4	0.3	100.0	100.3	1.8	0.3	353.5	0.3	0.11	0.64
416	354.8	156.9	0.4	100.0	100.4	2.7	0.4	354.7	0.4	0.19	0.70
1248	357.4	303.9	0.9	100.0	100.9	4.1	0.9	357.1	0.9	0.37	0.78
1664	358.4	361.6	1.0	100.0	101.0	4.6	1.0	358.1	1.0	0.44	0.81

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
166	57.0	58.8	1.0	97.0	98.1	2.8	1.1	56.6	1.0	0.48	0.49
416	62.0	105.4	1.7	97.0	98.9	3.9	1.9	61.4	1.7	0.83	0.53
1248	357.1	410.5	1.1	97.0	100.7	3.0	3.7	356.0	1.2	1.60	0.50
1664	358.5	488.6	1.4	97.0	100.9	3.4	3.9	357.3	1.4	1.69	0.51

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
	11015I_RR11010									
166	811									811
416	2654									2654
1248	6531									6531
1664	9578									9578

Allowable Velocity

Channel Lining	Natural - Sandy Loam (noncolloidal)									
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)		
166	1.74	0.9750	0.9262	Erosive	Erosive	Erosive	0.2	Stable	5.2	Stable	Stable
416	1.74	1.1439	1.0867	Erosive	Erosive	Erosive	0.2	Stable	7.5	Stable	Stable
1248	1.74	1.3457	1.2784	Erosive	Erosive	Erosive	0.3	Stable	9.7	Stable	Stable
1664	1.74	1.3985	1.3286	Erosive	Erosive	Erosive	0.3	Stable	10.3	Stable	Stable

USCOE Allowable Velocity (ft/s)	2
FHWA Allowable Velocity (ft/s)	2.5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	**166**	**416**	**1248**	**1664**	**166**	**416**	**1248**	**1664**	**166**	**416**	**1248**	**1664**
Bray - Equation #1	35	57	102	119	1.5	2.0	2.9	3.1	3.2	3.7	4.3	4.5
Bray - Equation #2	46	75	134	156	1.6	2.2	3.1	3.4	2.2	2.5	2.9	3.1
Hey	10	18	33	38	4.5	6.4	9.7	10.8				
Ackers & Charlton/Lacey	31	45	72	81					1.9	2.2	2.6	2.8
Parker	89	140	243	280	1.2	1.7	2.7	3.0				
Chang	66	115	223	265	0.0	-0.2	-0.7	-0.9				
Kellerhals	23	37	64	73	2.1	3.0	4.7	5.3	3.4	3.7	4.2	4.3
AMAFCA/Schumm	57	61	356	358								
Moody & Odem	17	17	17	17	1.1	1.1	1.1	1.1				
BUREC	17.0	23.9	36.1	40.3	5	6	10	11	3.4	4.3	5.6	6.0
Average	39	59	128	143	2.1	2.8	4.1	4.6	2.8	3.3	3.9	4.1
Values As Designed	57	61	356	357	1.1	1.9	3.7	3.9	2.8	3.9	3.0	3.4
Difference with Design	-18	-2	-228	-215	1.0	0.9	0.5	0.7	0.0	-0.7	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
166	1549	1037	2272	2875	5275	509	469	226	7552	523	1618	2173
416	6388	3403	6992	13619	7869	2220	1586	1229	19949	1727	6973	6541
1248	34939	12476	21769	87748	11977	10633	5288	6516	61276	8077	33760	26769
1664	54427	17269	28336	142817	13281	15841	7080	9729	81939	12203	49979	39355

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
166	3454	2312	5066	6410	11762	1135	1045	503	16838	1165	3608	4845
416	5697	3034	6235	12146	7018	1980	1415	1096	17791	1540	6219	5834
1248	10387	3709	6471	26085	3560	3161	1572	1937	18216	2401	10036	7958
1664	12135	3850	6318	31842	2961	3532	1579	2169	18269	2721	11143	8774

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
166	1045	517	855	1980	1134	241	185	233	1741	231	1216	853
416	4101	1552	2330	8880	1713	885	524	907	4489	869	4528	2798
1248	8675	3814	6488	16811	7665	1988	1452	1954	13175	1888	10041	6723
1664	13509	5479	8926	27344	8622	3032	2031	3050	17767	2891	15397	9822

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
166	2330	1153	1905	4415	2529	537	412	519	3882	515	2710	1901
416	3657	1384	2078	7919	1528	789	467	809	4004	775	4038	2495
1248	2579	1134	1929	4998	2279	591	432	581	3917	561	2985	1999
1664	3012	1222	1990	6096	1922	676	453	680	3961	645	3433	2190

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson n	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)
166	0.0031	0.0047	130	0.40	0.047	0.0010	30	0.035	0.0007	0.0159	0.0010	0.0024	0.0063	0.0004	0.0032	0.0190	0.0070
416	0.0015	0.0027	171	0.52	0.049	0.0006	30	0.036	0.0004	0.0159	0.0006	0.0013	0.0063	0.0002	0.0016	0.0190	0.0067
1248	0.0007	0.0014	237	0.72	0.052	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0007	0.0063	0.0001	0.0007	0.0191	0.0066
1664	0.0005	0.0012	258	0.79	0.053	0.0003	32	0.036	0.0002	0.0159	0.0003	0.0005	0.0063	0.0001	0.0006	0.0191	0.0065

Drop Structures

Design Slope	0.0070	ft/ft
Total Drop Needed	37.2	ft
Height of Drop Structure	3	ft
No . of Drop Structures	13	
Distance between structs.	237	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	1.18	sq. mi
Total Sediment Yield Volume	2.25	ac ft

Sedimentation Basins

Length	237 ft	Depth	3 ft
Width	376 ft	Side slope	3 ft/ft
Total Volume per Basin		5.77	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)
166	1.1	-0.3	0.1	24.6	1.1	1.0	2.8	0.0070	0.1	0.0	3.0	4.1
416	1.1	-0.5	0.2	24.6	1.9	1.7	3.9	0.0070	0.2	0.0	3.0	4.3
1248	1.1	-1.1	0.1	24.6	3.7	1.2	3.0	0.0070	0.4	0.0	3.0	4.5
1664	1.1	-1.1	0.2	24.6	3.9	1.4	3.4	0.0070	0.4	0.0	3.0	4.6

Toe Protection Needed	5.0	ft

HEC1 Results For Open Channel

Peak Flow	1496	cfs
Stage at Peak Flow	100.9	ft
Flow Volume	135.0	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	2.29	ac. ft
Outflowing Sediment Volume	0.13	ac. ft
Deposited(+)/Eroded(-) Volume	2.17	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	3084	3084
Side Slope (?H:1V)	3	3
Channel Width (ft)	376	376
Channel XS Area (sq. ft)	1633	1633
Channel Perimeter (ft)	378	378

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	3084	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	2741	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	3084	3084
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)	13364	27756
Left Levee Volume (cu. Yd)	11879	28556
Right Levee Length (ft)	3084	3084
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)	13364	27756
Right Levee Volume (cu. Yd)	11879	28556
Total Levee Surface Area (sq. Yd)	26728	55512
Total Levee Volume (cu. Yd)	23758	57112

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	3084	3084
Left Levee Lining Width (ft)	13	30
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	4455	10280
Left Levee Lining Volume (cu. Yd)	2227	5140
Right Levee Length (ft)	3084	3084
Right Levee Lining Width (ft)	13	30
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	4455	10280
Right Levee Lining Volume (cu. Yd)	2227	5140
Total Lining Area (sq. Yd)	8909	20560
Total Lining Volume (cu. Yd)	4454	10280

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	376	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	13	
Volume per structure	362	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 27,150	
Area per structure	125	sq. Yd
Total Area	1,629	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	2	
Total Volume per Basin	9309	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 37,236	
Other Cost	$ -	
Total cost per basin	$ 37,236	
Area per basin	9,910	sq. Yd
Total Area	19,820	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	23,758	cu. Yd	$ 7.00	$ 166,306	26,728	sq. Yd	$ 9.00	$ 240,552	26,728	sq. Yd	$ 11.67	$ 311,827
Levee - LC Enhancement	Fill	33,354	cu. Yd	$ 7.00	$ 233,478	28,784	sq. Yd	$ 9.00	$ 259,056	33,354	sq. Yd	$ 11.67	$ 389,130
Levee Lining	Riprap	4,454	cu. Yd	$ 75.00	$ 334,050	8,909	sq. Yd	$ -	$ -	8,909	sq. Yd	$ 20.83	$ 185,611
Levee Lining -LC Enhancement	Riprap	5,826	cu. Yd	$ 75.00	$ 436,950	11,651	sq. Yd	$ -	$ -	11,651	sq. Yd	$ 20.83	$ 242,722
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	2,741	cu. Yd	$ 75.00	$ 205,575	1,028	sq. Yd	$ -	$ -	1,028	sq. Yd	$ 25.00	$ 25,700
Drop Structures	Riprap	13	EA	$ 27,150.00	$ 352,950	1,629	sq. Yd	$ -	$ -	1,629	sq. Yd	$ 33.33	$ 54,300
Drop Str. - LC Enhancement	Riprap	13	EA	$ 2,715.00	$ 35,295	163	sq. Yd	$ -	$ -	163	sq. Yd	$ 33.33	$ 5,430
Sedimentation Basins		2	EA	$ 37,236.00	$ 74,472	19,820	sq. Yd	$ -	$ -	19,820	sq. Yd	$ 8.33	$ 165,167
Other					$ -				$ -				$ -

Base Landscape Cost	$ 240,552	Base Maintenance Cost	$ 742,604
LC Enhancement Cost	$ 259,056	LC Enhancement Cost	$ 637,282
Total Landscape Cost	$ 499,608	Total Maintenance Cost	$ 1,379,887

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,133,353	$ 705,723	$ 1,839,076
Contingency Cost (25% of Construction Cost)	$ 283,338	$ 176,431	$ 459,769
Engineering Design Cost (5% of Construction Cost)	$ 56,668	$ 35,286	$ 91,954
Total Construction Cost	$ 1,473,359	$ 917,440	$ 2,390,799

Land Cost

Channel Length	3084 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	376	26.6	$100,000	$ 2,660,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	52	3.7	$100,000	$ 370,000
Levee LC Enhancement	48	3.4	$100,000	$ 340,000
Other	0	0	$100,000	$ -
Total	476	33.7		$ 3,370,000

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	30.3	$100,000	$ 3,030,000
LC Enhancement Cost	acre	3.4	$100,000	$ 340,000
Total Land Cost	acre	33.7	$100,000	$ 3,370,000

Total Cost

Base Total Cost	$ 5,486,515
Total Landscape Enhancement Cost	$ 2,153,778
Total Cost Including LC Enh.	$ 7,640,293

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

Sub-area: CAP, Alternative: B2
Open Channel Structure ID: RR115A10

Open Channel

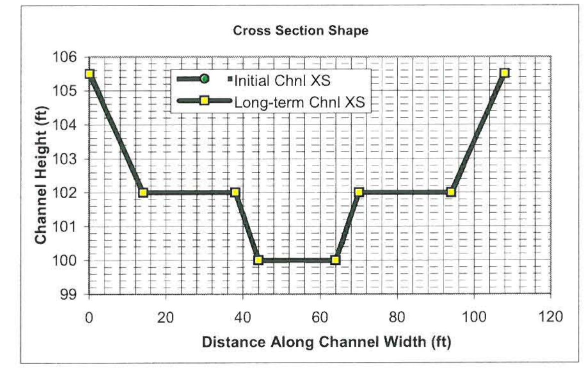
Structure ID	RR115B10		HEC1 ID	15I15B

Longitundal Geometry

Length	8073.3	ft
U/S Elev	1633.3	ft
D/S Elev	1537.8	ft
Initial Channel Slope	0.0118	ft/ft
Long-term Channel Slope	0.0015	ft/ft

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

NSTPS	7



Initial Channel XS Geometry

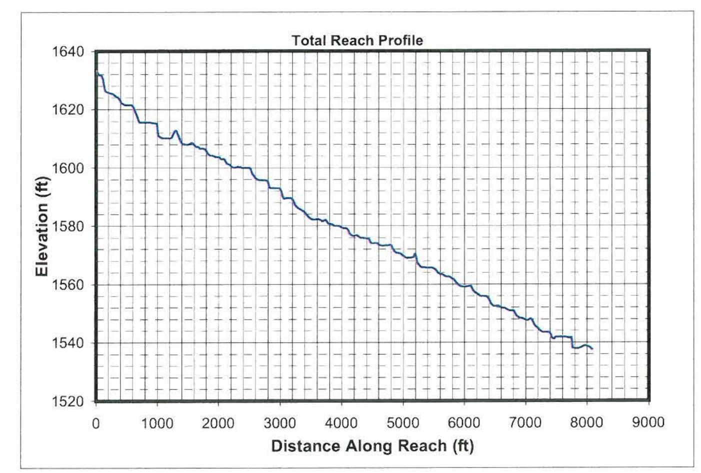
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
4	3.5	24	3	20	5.5	3	24	3.5	4

PT. ID	1	2	3	4	5	6	7	8
X	0	14	38	44	64	70	94	108
Y	105.5	102	102	100	100	102	102	105.5

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
4	3.5	24	3	20	5.5	3	24	3.5	4

PT. ID	1	2	3	4	5	6	7	8
X	0	14	38	44	64	70	94	108
Y	105.5	102	102	100	100	102	102	105.5



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	0.03	0.03	0.03	0.03	0.03	0.03

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	D115C									TOTAL
HEC1 Peak-Flow	1000									1000
Weighting Factor	1.00									
Flow into Channel	1000									1000

Reach Sediment Inflow Characteristics

U/S Contributing ID	15I15A_RR115A 10									TOTAL
HEC1 Flow Volume (ac. ft)	135.00									135
Sediment Conc. (ppm)	2495									
Sediment Volume (ac. ft)	0.13									0.13
Weighting Factor	1									
Weighted Sed. Vol. (ac. ft)	0.13									0.13

Hydrology

Drainage Area	0.42	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	1000	cfs	
Long-term Max. Chnl Capacity	1683	cfs	
Q2 Channel	100	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	108	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	25.9	21.2	0.8	100.0	100.9	4.7	0.9	25.6	0.8	0.09	0.92
250	29.9	38.9	1.3	100.0	101.6	6.4	1.6	29.4	1.3	0.15	0.99
750	86.9	115.1	1.3	100.0	102.8	6.5	2.8	86.1	1.3	0.26	0.99
1000	89.1	138.2	1.6	100.0	103.0	7.2	3.0	88.2	1.6	0.28	1.02

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	30.6	42.1	1.4	100.0	101.7	2.4	1.7	30.1	1.4	0.16	0.35
250	86.5	110.4	1.3	100.0	102.7	2.3	2.7	85.6	1.3	0.25	0.35
750	96.7	223.3	2.3	100.0	104.0	3.4	4.0	95.6	2.3	0.37	0.39
1000	100.6	269.6	2.7	100.0	104.4	3.7	4.4	99.4	2.7	0.41	0.40

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
	15I15A_RR115A 10									
100	853									853
250	2798									2798
750	6723									6723
1000	9822									9822

Allowable Velocity

Channel Lining	Natural - Sandy Loam (noncolloidal)

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	1.3370	1.2702	Erosive	Erosive	Erosive	0.3	Erosive	3.1	Erosive	Stable
250	1.74	1.4812	1.4072	Erosive	Erosive	Erosive	0.3	Erosive	3.9	Erosive	Stable
750	1.74	1.4851	1.4108	Erosive	Erosive	Erosive	0.3	Erosive	5.3	Erosive	Stable
1000	1.74	1.5339	1.4572	Erosive	Erosive	Erosive	0.4	Erosive	5.7	Erosive	Stable

USCOE Allowable Velocity (ft/s)	2
FHWA Allowable Velocity (ft/s)	2.5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	**100**	**250**	**750**	**1000**	**100**	**250**	**750**	**1000**	**100**	**250**	**750**	**1000**
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	28	49	97	116	0.5	0.6	0.7	0.6				
Kellerhals	18	28	49	57	1.7	2.5	3.8	4.3	3.2	3.5	4.0	4.1
AMAFCA/Schumm	30	86	96	100								
Moody & Odem	9	9	9	9	0.8	0.8	0.8	0.8				
BUREC	16.1	22.7	34.2	38.1	4	6	9	10	2.3	2.9	3.8	4.0
Average	26	45	74	84	1.8	2.5	3.7	4.1	2.5	2.8	3.4	3.5
Values As Designed	30	86	96	99	1.7	2.7	4.0	4.4	2.4	2.3	3.4	3.7
Difference with Design	-4	-40	-22	-15	0.1	-0.2	-0.2	-0.3	0.1	0.6	0.0	-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
100	2261	1265	1788	3899	626	905	618	787	2379	469	2144	1558
250	8549	3406	4339	16752	965	2888	1498	2515	6012	1009	7069	5000
750	26365	9940	13124	51240	2843	8815	4538	7681	18041	2946	21608	15195
1000	40579	13639	17787	82145	3198	12821	5969	11044	24104	3170	31411	22352

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
100	8388	4692	6635	14463	2323	3358	2291	2921	8827	1741	7956	5781
250	12687	5055	6438	24860	1432	4286	2223	3732	8922	1497	10491	7420
750	13042	4917	6492	25347	1406	4361	2245	3800	8924	1457	10689	7516
1000	15055	5060	6599	30476	1186	4757	2215	4097	8942	1176	11653	8292

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	117	105	99	115	208	26	35	58	70	6	117	87
250	276	242	223	263	541	60	81	132	162	15	271	206
750	1416	1083	1150	1576	1085	330	363	763	696	72	1539	916
1000	2161	1550	1560	2500	1282	488	507	1152	965	95	2359	1329

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
100	433	389	367	427	771	98	128	215	260	21	435	322
250	409	360	331	390	803	89	120	196	240	22	402	306
750	701	536	569	780	537	163	180	377	344	35	761	453
1000	802	575	579	928	475	181	188	427	358	35	875	493

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	0.0006	0.0008	183	0.56	0.050	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0005	0.0075	0.0005	0.0018	0.0117	0.0050
250	0.0003	0.0005	231	0.70	0.052	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0003	0.0075	0.0003	0.0009	0.0116	0.0049
750	0.0003	0.0005	233	0.71	0.052	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0003	0.0075	0.0002	0.0004	0.0117	0.0049
1000	0.0003	0.0004	252	0.77	0.053	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0002	0.0075	0.0002	0.0003	0.0117	0.0049

Drop Structures

Design Slope	0.0015	ft/ft
Total Drop Needed	83.4	ft
Height of Drop Structure	3	ft
No . of Drop Structures	28	
Distance between structs.	288	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	0.00	sq. mi
Total Sediment Yield Volume	0.00	ac ft

Sedimentation Basins

Length	288 ft	Depth	3 ft
Width	108 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)

	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	-0.3	0.1	24.6	1.7	1.4	2.4	0.0015	0.2	0.0	1.0	1.6
250	1.1	-0.4	0.1	24.6	2.7	1.3	2.3	0.0015	0.3	0.0	1.0	1.8
750	1.1	-0.4	0.2	24.6	4.0	2.3	3.4	0.0015	0.5	0.0	1.0	2.1
1000	1.1	-0.3	0.2	24.6	4.4	2.7	3.7	0.0015	0.6	0.0	1.0	2.2

Toe Protection Needed	3.0	ft

HEC1 Results For Open Channel

Peak Flow	1635	cfs
Stage at Peak Flow	103.5	ft
Flow Volume	153.0	ac. ft

Freeboard

Max. Flow Depth	3.0	ft
Channel Depth as designed	5.5	ft
Available Freeboard	2.5	ft
Required Freeboard	1.2	ft

Sediment Volume

Inflowing Sediment Volume	0.13	ac. ft
Outflowing Sediment Volume	0.03	ac. ft
Deposited(+)/Eroded(-) Volume	0.10	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Existing	Existing
Channel Length (ft)	8073	8073
Side Slope (?H:1V)	3	3
Channel Width (ft)	108	108
Channel XS Area (sq. ft)	381	381
Channel Perimeter (ft)	110	110

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	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	0	ft
Thickness	0.0	ft
Protection Depth	0	ft
Tie-in Length/Depth	0.0	ft
Total Depth	0.0	ft
Area needed	0	sq. Yd
Volume	0	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)	8073	8073
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)	8073	8073
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	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	0	ft
LC Enhancement Ratio	1.1	
Structure Thickness	0	ft
Drop Height	0	ft
Scour Depth		ft
Structure Height		ft
Number of Structures	0	
Volume per structure	0	cu. Yd
Unit Cost	$ -	cu. Yd
Other Cost	$ -	
Cost per structure	$ -	
Area per structure	0	sq. Yd
Total Area	0	sq. Yd

Sedimentation Basins		
Include Sed. Basins	No	
(Yes/No)		
Number of basins	0	
Total Volume per Basin	3081	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 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	Existing	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Existing	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	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Drop Structures	None	0	EA	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Drop Str. - LC Enhancement	None	0	EA	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Sedimentation Basins		1	EA	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ 8.33	$ -
Other					$ -				$ -				$ -

Base Landscape Cost	$ -
LC Enhancement Cost	$ -
Total Landscape Cost	$ -

Base Maintenance Cost	$ -
LC Enhancement Cost	$ -
Total Maintenance Cost	$ -

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ -	$ -	$ -
Contingency Cost (25% of Construction Cost)	$ -	$ -	$ -
Engineering Design Cost (5% of Construction Cost)	$ -	$ -	$ -
Total Construction Cost	$ -	$ -	$ -

Land Cost

Channel Length	0 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	14	0	$0	$ -
LC Enhancement Buffer	0	0	$0	$ -
Channel	108	0	$0	$ -
Channel LC Enhancement	0	0	$0	$ -
Levee	0	0	$0	$ -
Levee LC Enhancement	0	0	$0	$ -
Other	0	0	$0	$ -
Total	122	0		$ -

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	0	$0	$ -
LC Enhancement Cost	acre	0	$0	$ -
Total Land Cost	acre	0	$0	$ -

Total Cost

Base Total Cost	$ -
Total Landscape Enhancement Cost	$ -
Total Cost Including LC Enh.	$ -

Offline Basin

HEC1 ID	D115C

HEC1 Results Used to Determine Sediment Volume From Upstream

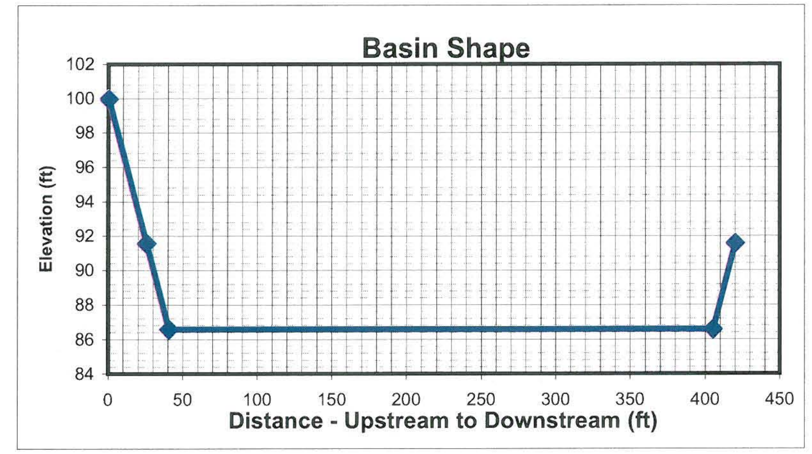
Contributing HEC1 ID								Total Volume (ac. ft)
Inflow Volume (ac. ft)								0
Volume Fraction								
Weighted Volume								0
Sediment Conc. (ppm)								
Sediment Volume (ac. ft)								0.00
Weighting Factor								
Weighted Sed. Vol. (ac. ft)								0.00

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)	0.02	0.02
Basin Length (ft)	900	1030
Basin Width (ft)	420	420
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	5	5
Freeboard (ft)	1	1
Effective Basin Width (ft)	394.8	369.6
Top Area (acres)	8.7	9.9
U/S-D/S Height Difference (ft)	8.4	8.4
Excess Area on Upstream (acres)	0.5	1.2

			Base	LC Enhanced
Bottom Length (ft)	870	Allocated Storage Volume (ac. ft)	30.5	30.5
Bottom Width (ft)	364.8	Total Available Volume (ac. ft) (incl. Freeboard)	38.6	39
		Total Excavation Volume (ac. ft)	75.1	80.8

HEC1 Results

	6-hr Event	24-hr Event	Maximum
Peak flow before diversion (cfs)	1639	1766	1766
Peak flow after diversion (cfs)	1000	1000	1000
Diverted Peak Flow (cfs)	639	766	766
Total Diverted Flow Volume (ac. ft)	26.0	30	30.0
Peak Stage	2.9	ft	

Volume Check

Total Volume needed	30.0	ac. ft
Total Volume Provided	30.5	ac. ft
Volume OK?	Yes	

Stage Check

Depth Needed	3.9
Depth Provided	5
Depth OK?	Yes

Stage-Storage-Discharge

Stage (ft)												
Inflow (cfs)	0	200	400	600	800	1000	1100	1200	1500	2000	2500	3000
Outflow (cfs)	0	0	0	0	0	0	100	200	500	1000	1500	2000

capacity based on FlowMaster results with 1 ft freeboarc

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
Landscape Enhancement	209600	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	900	ft
Base Total ROW Width	420	ft
LC Enh. Total ROW Length	1130	ft
LC Enh. Total ROW Length	520	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	121161	130357
Excavated Area (sq. Yd)	42000	65289

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	42	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	471	sq. Yd
Material Volume	236	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	333	ft
Unit Cost	160	per ft
Cost per outlet	$53,280	
Other Cost	$ -	
Total Cost	$53,280	
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		121,161	cu. Yd	$ 4.00	$ 484,644	42,000	sq. Yd	$ 9.00	$ 378,000	42,000	sq. Yd	$ 8.33	$ 350,000
Basin - LC Enhanced		9,196	cu. Yd	$ 4.00	$ 36,784	23,289	sq. Yd	$ 9.00	$ 209,601	23,289	sq. Yd	$ 8.33	$ 194,075
Inlet	Riprap	236	sq. Yd	$ 75.00	$ 17,700	471	sq. Yd	$ -	$ -	471	sq. Yd	$ 33.33	$ 15,700
Inlet - LC Enhanced (20%Total)					$ 3,540				$ -				$ 3,140
Outlet	Pipe	1	EA	$ 53,280	$ 53,280	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhanced (5%Total)					$ 2,664				$ -				$ 111
Other					$ -				$ -				$ -

Base Landscape Cost	$ 378,000	Base Maintenance Cost	$ 367,917
LC Enh. Landscape Cost	$ 209,601	LC Enh. Maintenance Cost	$ 197,326
Total Landscape Cost	$ 587,601	Total Maintenance Cost	$ 565,243

Construction Cost Component	**Base**	**LC Enhanced**	**Total**
Construction Cost	$ 555,624	$ 36,784	$ 592,408
Contingency Cost (25% of Construction Cost)	$ 138,906	$ 9,196	$ 148,102
Engineering Design Cost (5% of Construction Cost)	$ 27,781	$ 1,839	$ 29,620
Total Construction Cost	$ 722,311	$ 47,819	$ 770,130

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	$ 481,175
Basin	8.7	$100,000	$ 870,000
Other		$100,000	$ -
Total	13.5	$100,000	$ 1,350,000

	Units	**Quantity**	**Unit Cost**	**Cost Subtotal**
Base Land Cost	acre	8.7	$100,000	$ 867,769
LC Enhancement Cost	acre	4.8	$100,000	$ 482,231
Total Land Cost	acre	13.5	$100,000	$ 1,350,000

Total Cost

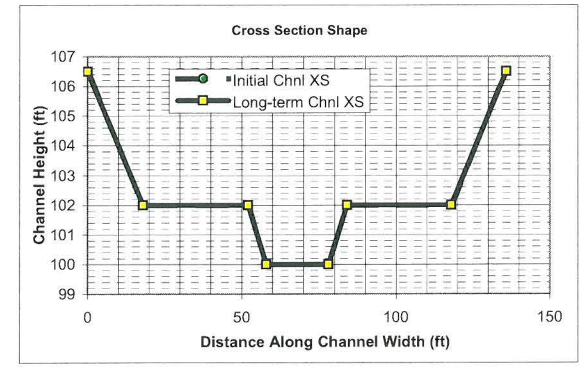
Base Total Cost	$ 2,335,996
Total LC Enhancement Cost	$ 936,977
Total Cost Including LC Enh.	$ 3,272,974

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

Sub-area: CAP, Alternative: B2
Offline Basin Structure ID: D115C

Open Channel

Structure ID	C12010	HEC1 ID	115120



Longitundal Geometry

Length	4136.0	ft
U/S Elev	1537.8	ft
D/S Elev	1496.4	ft
Initial Channel Slope	0.0100	ft/ft
Long-term Channel Slope	0.0015	ft/ft

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

NSTPS	3

Initial Channel XS Geometry

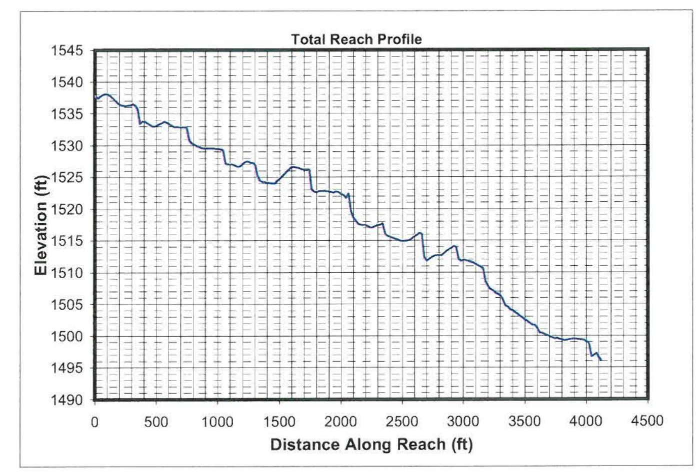
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
4	4.5	34	3	20	6.5	3	34	4.5	4

PT. ID	1	2	3	4	5	6	7	8
X	0	18	52	58	78	84	118	136
Y	106.5	102	102	100	100	102	102	106.5

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
4	4.5	34	3	20	6.5	3	34	4.5	4

PT. ID	1	2	3	4	5	6	7	8
X	0	18	52	58	78	84	118	136
Y	106.5	102	102	100	100	102	102	106.5



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	0.03	0.03	0.03	0.03	0.03	0.03

HEC1 Results Used to Determine Design Peak Flows

										TOTAL
Contributing HEC1 ID	D120									
HEC1 Peak-Flow	2000									2000
Weighting Factor	1.00									
Flow into Channel	2000									2000

Reach Sediment Inflow Characteristics

U/S Contributing ID	15I15B_RR115B 10									TOTAL
HEC1 Flow Volume (ac. ft)	153.00									153
Sediment Conc. (ppm)	493									
Sediment Volume (ac. ft)	0.03									0.03
Weighting Factor	1									
Weighted Sed. Vol. (ac. ft)	0.03									0.03

Hydrology

Drainage Area	2.68	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	2000	cfs	
Long-term Max. Chnl Capacity	2934	cfs	
Q2 Channel	200	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	136	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
200	29.2	35.4	1.2	100.0	101.5	5.7	1.5	28.7	1.2	0.14	0.90
500	104.7	102.2	1.0	100.0	102.5	4.9	2.5	103.9	1.0	0.23	0.87
1500	112.5	203.4	1.8	100.0	103.4	7.4	3.4	111.5	1.8	0.32	0.96
2000	115.4	244.2	2.1	100.0	103.8	8.2	3.8	114.3	2.1	0.36	0.99

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
200	104.9	104.3	1.0	100.0	102.5	1.9	2.5	104.1	1.0	0.24	0.34
500	111.1	185.0	1.7	100.0	103.3	2.7	3.3	110.1	1.7	0.31	0.37
1500	124.5	374.3	3.0	100.0	104.9	4.0	4.9	123.1	3.0	0.46	0.41
2000	129.6	452.0	3.5	100.0	105.5	4.4	5.5	128.1	3.5	0.52	0.42

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
	15I15B_RR115B 10									
200	87									87
500	206									206
1500	916									916
2000	1329									1329

Allowable Velocity

Channel Lining	Natural - Sandy Loam (noncolloidal)

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)		
200	1.74	1.4599	1.3869	Erosive	Erosive	Erosive	0.3	Erosive	3.6	Erosive	Stable
500	1.74	1.3904	1.3208	Erosive	Erosive	Erosive	0.3	Erosive	4.5	Erosive	Stable
1500	1.74	1.5809	1.5019	Erosive	Erosive	Erosive	0.4	Erosive	6.1	Erosive	Stable
2000	1.74	1.6295	1.5480	Erosive	Erosive	Erosive	0.4	Erosive	6.6	Erosive	Stable

USCOE Allowable Velocity (ft/s)	2
FHWA Allowable Velocity (ft/s)	2.5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	**200**	**500**	**1500**	**2000**	**200**	**500**	**1500**	**2000**	**200**	**500**	**1500**	**2000**
Bray - Equation #1	39	63	112	131	1.6	2.1	3.0	3.3	3.3	3.8	4.4	4.6
Bray - Equation #2	51	83	148	172	1.7	2.3	3.3	3.7	2.3	2.6	3.0	3.1
Hey	12	20	36	43	4.8	6.8	10.4	11.6				
Ackers & Charlton/Lacey	33	49	78	88					1.9	2.3	2.7	2.8
Parker	97	154	266	307	1.2	1.8	2.9	3.2				
Chang	43	76	150	179	0.6	0.6	0.6	0.6				
Kellerhals	25	40	70	80	2.3	3.3	5.1	5.7	3.5	3.8	4.2	4.4
AMAFCA/Schumm	104	110	123	128								
Moody & Odem	18	18	18	18	1.1	1.1	1.1	1.1				
BUREC	20.9	29.4	44.4	49.4	6	8	12	13	2.7	3.4	4.5	4.8
Average	44	64	104	119	2.4	3.2	4.8	5.3	2.7	3.2	3.8	4.0
Values As Designed	104	110	123	128	2.5	3.3	4.9	5.5	1.9	2.7	4.0	4.4
Difference with Design	-60	-46	-19	-9	-0.2	0.0	-0.1	-0.2	0.8	0.5	-0.2	-0.5

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
200	4873	2260	2869	8850	815	1673	1001	1583	3724	706	4376	2975
500	10110	5162	7388	17106	2554	3754	2554	3532	9251	2005	9611	6639
1500	53132	17696	22027	105413	4007	15715	7387	14648	28115	3073	41692	28446
2000	81696	24206	29697	168828	4503	22877	9697	20982	37548	3311	60416	42160

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
200	9040	4192	5322	16416	1511	3104	1857	2937	6907	1310	8117	5519
500	7502	3830	5482	12693	1895	2786	1895	2621	6864	1488	7131	4926
1500	13141	4377	5448	26072	991	3887	1827	3623	6954	760	10312	7036
2000	15155	4490	5509	31318	835	4244	1799	3892	6965	614	11207	7821

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
200	176	150	122	157	485	28	44	71	83	14	155	135
500	704	596	621	717	920	167	206	369	403	41	736	498
1500	3612	2447	2372	4290	1742	791	783	1894	1482	140	3936	2135
2000	5509	3455	3252	6805	2036	1154	1071	2810	2023	166	5967	3113

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
200	327	279	227	291	900	52	81	131	153	25	287	250
500	522	442	461	532	683	124	153	274	299	30	546	370
1500	893	605	587	1061	431	196	194	469	366	35	974	528
2000	1022	641	603	1262	378	214	199	521	375	31	1107	578

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)
200	0.0004	0.0005	205	0.63	0.051	0.0002	31	0.036	0.0002	0.0159	0.0002	0.0003	0.0060	0.0003	0.0013	0.0098	0.0041
500	0.0005	0.0007	184	0.56	0.050	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0004	0.0060	0.0002	0.0007	0.0099	0.0041
1500	0.0002	0.0004	250	0.76	0.053	0.0002	31	0.036	0.0001	0.0159	0.0001	0.0002	0.0060	0.0001	0.0003	0.0099	0.0041
2000	0.0002	0.0003	271	0.83	0.053	0.0001	32	0.036	0.0001	0.0159	0.0001	0.0002	0.0060	0.0001	0.0002	0.0099	0.0040

Drop Structures

Design Slope	0.0015	ft/ft
Total Drop Needed	35.2	ft
Height of Drop Structure	3	ft
No . of Drop Structures	12	
Distance between structs.	345	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	0.00	sq. mi
Total Sediment Yield Volume	0.00	ac ft

Sedimentation Basins

Length	345 ft	Depth	3 ft
Width	136 ft	Side slope	3 ft/ft
Total Volume per Basin		2.94	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)
200	1.1	-0.5	0.1	24.6	2.5	1.0	1.9	0.0015	0.3	0.0	1.0	1.7
500	1.1	-0.4	0.1	24.6	3.3	1.7	2.7	0.0015	0.4	0.0	1.0	1.9
1500	1.1	-0.3	0.2	24.6	4.9	3.0	4.0	0.0015	0.7	0.0	1.0	2.4
2000	1.1	-0.2	0.3	24.6	5.5	3.5	4.4	0.0015	0.8	0.0	1.0	2.5

Toe Protection Needed	3.0	ft

HEC1 Results For Open Channel

Peak Flow	1002	cfs
Stage at Peak Flow	102.9	ft
Flow Volume	144.0	ac. ft

Freeboard

Max. Flow Depth	3.8	ft
Channel Depth as designed	6.5	ft
Available Freeboard	2.7	ft
Required Freeboard	1.5	ft

Sediment Volume

Inflowing Sediment Volume	0.03	ac. ft
Outflowing Sediment Volume	0.03	ac. ft
Deposited(+)/Eroded(-) Volume	0.00	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Existing	Existing
Channel Length (ft)	4136	4136
Side Slope (?H:1V)	3	3
Channel Width (ft)	136	136
Channel XS Area (sq. ft)	583	583
Channel Perimeter (ft)	138	138

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	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	0	ft
Thickness	0.0	ft
Protection Depth	0	ft
Tie-in Length/Depth	0.0	ft
Total Depth	0.0	ft
Area needed	0	sq. Yd
Volume	0	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)	4136	4136
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)	4136	4136
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	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	0	ft
LC Enhancement Ratio	1.1	
Structure Thickness	0	ft
Drop Height	0	ft
Scour Depth		ft
Structure Height		ft
Number of Structures	0	
Volume per structure	0	cu. Yd
Unit Cost	$ -	cu. Yd
Other Cost	$ -	
Cost per structure	$ -	
Area per structure	0	sq. Yd
Total Area	0	sq. Yd

Sedimentation Basins		
Include Sed. Basins	No	
(Yes/No)		
Number of basins	0	
Total Volume per Basin	4743	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	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	Existing	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Existing	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	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Drop Structures	None	0	EA	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Drop Str. - LC Enhancement	None	0	EA	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Sedimentation Basins		1	EA	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ 8.33	$ -
Other					$ -				$ -				$ -

Base Landscape Cost	$ -
LC Enhancement Cost	$ -
Total Landscape Cost	$ -

Base Maintenance Cost	$ -
LC Enhancement Cost	$ -
Total Maintenance Cost	$ -

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ -	$ -	$ -
Contingency Cost (25% of Construction Cost)	$ -	$ -	$ -
Engineering Design Cost (5% of Construction Cost)	$ -	$ -	$ -
Total Construction Cost	$ -	$ -	$ -

Land Cost

Channel Length	0 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	14	0	$0	$ -
LC Enhancement Buffer	0	0	$0	$ -
Channel	136	0	$0	$ -
Channel LC Enhancement	0	0	$0	$ -
Levee	0	0	$0	$ -
Levee LC Enhancement	0	0	$0	$ -
Other	0	0	$0	$ -
Total	150	0		$ -

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	0	$0	$ -
LC Enhancement Cost	acre	0	$0	$ -
Total Land Cost	acre	0	$0	$ -

Total Cost

Base Total Cost	$ -
Total Landscape Enhancement Cost	$ -
Total Cost Including LC Enh.	$ -

Offline Basin

HEC1 ID	D120

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

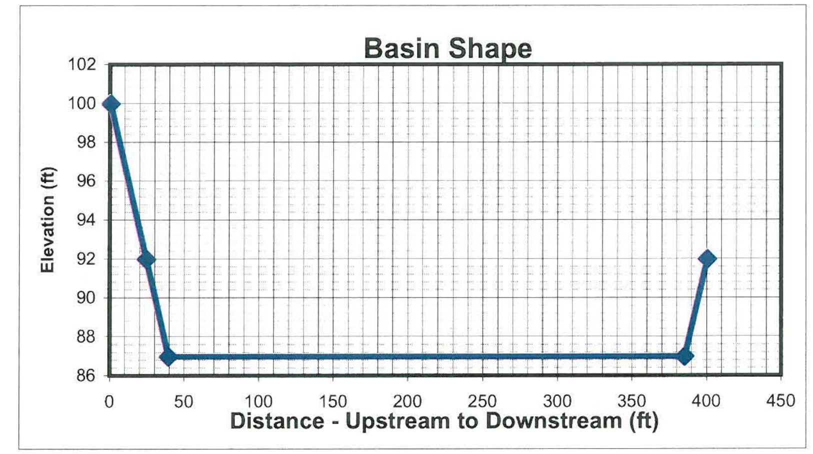
Required Minimum Sediment Volume

Sediment Volume	0.0	ac. ft

Geometry

	Base	LC Enhanced
Topography slope (ft/ft)	0.02	0.02
Basin Length (ft)	660	760
Basin Width (ft)	400	400
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	5	5
Freeboard (ft)	1	1
Effective Basin Width (ft)	376	352
Top Area (acres)	6.1	7.0
U/S-D/S Height Difference (ft)	8.0	8.0
Excess Area on Upstream (acres)	0.4	0.8

			Base	LC Enhanced
Bottom Length (ft)	630	Allocated Storage Volume (ac. ft)	21.1	21
Bottom Width (ft)	346	Total Available Volume (ac. ft) (incl. Freeboard)	26.7	27
		Total Excavation Volume (ac. ft)	51.0	55



HEC1 Results

	6-hr Event	24-hr Event	Maximum
Peak flow before diversion (cfs)	2277	2842	2842
Peak flow after diversion (cfs)	1935	2000	2000
Diverted Peak Flow (cfs)	342	842	842
Total Diverted Flow Volume (ac. ft)	9.0	21	21.0
Peak Stage	1.5	ft	

Volume Check

Total Volume needed	21.0	ac. ft
Total Volume Provided	21.1	ac. ft
Volume OK?	Yes	

Stage Check

Depth Needed	2.5
Depth Provided	5
Depth OK?	Yes

Stage-Storage-Discharge

Stage (ft)												
Inflow (cfs)	0	200	400	600	800	1000	1200	1500	2000	2500	3000	4000
Outflow (cfs)	0	0	0	0	0	0	0	0	0	500	1000	2000

capacity based on FlowMaster results with 1 ft freeboarc

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
Landscape Enhancement	166000	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	660	ft
Base Total ROW Width	400	ft
LC Enh. Total ROW Length	860	ft
LC Enh. Total ROW Length	500	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	82280	88733
Excavated Area (sq. Yd)	29333	47778

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	41	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	457	sq. Yd
Material Volume	229	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	333	ft
Unit Cost	160	per ft
Cost per outlet	$53,280	
Other Cost	$ -	
Total Cost	$53,280	
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		82,280	cu. Yd	$ 4.00	$ 329,120	29,333	sq. Yd	$ 9.00	$ 263,997	29,333	sq. Yd	$ 8.33	$ 244,442
Basin - LC Enhanced		6,453	cu. Yd	$ 4.00	$ 25,812	18,445	sq. Yd	$ 9.00	$ 166,005	18,445	sq. Yd	$ 8.33	$ 153,708
Inlet	Riprap	229	sq. Yd	$ 75.00	$ 17,175	457	sq. Yd	$ -	$ -	457	sq. Yd	$ 33.33	$ 15,233
Inlet - LC Enhanced (20%Total)					$ 3,435				$ -				$ 3,047
Outlet	Pipe	1	EA	$ 53,280	$ 53,280	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhanced (5%Total)					$ 2,664				$ -				$ 111
Other					$ -				$ -				$ -

Base Landscape Cost	$ 263,997
LC Enh. Landscape Cost	$ 166,005
Total Landscape Cost	$ 430,002

Base Maintenance Cost	$ 261,892
LC Enh. Maintenance Cost	$ 156,866
Total Maintenance Cost	$ 418,758

Construction Cost Component	Base	LC Enhanced	Total
Construction Cost	$ 399,575	$ 25,812	$ 425,387
Contingency Cost (25% of Construction Cost)	$ 99,894	$ 6,453	$ 106,347
Engineering Design Cost (5% of Construction Cost)	$ 19,979	$ 1,291	$ 21,269
Total Construction Cost	$ 519,448	$ 33,556	$ 553,003

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	$ 381,084
Basin	6.1	$100,000	$ 610,000
Other		$100,000	$ -
Total	9.9	$100,000	$ 990,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	6.1	$100,000	$ 606,061
LC Enhancement Cost	acre	3.8	$100,000	$ 383,939
Total Land Cost	acre	9.9	$100,000	$ 990,000

Total Cost

Base Total Cost	$ 1,651,397
Total LC Enhancement Cost	$ 740,366
Total Cost Including LC Enh.	$ 2,391,763

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

Sub-area: CAP, Alternative: B2
Offline Basin Structure ID: D120

Online Basin

HEC1 ID	RR900

HEC1 Results Used to Determine Sediment Volume From Upstream

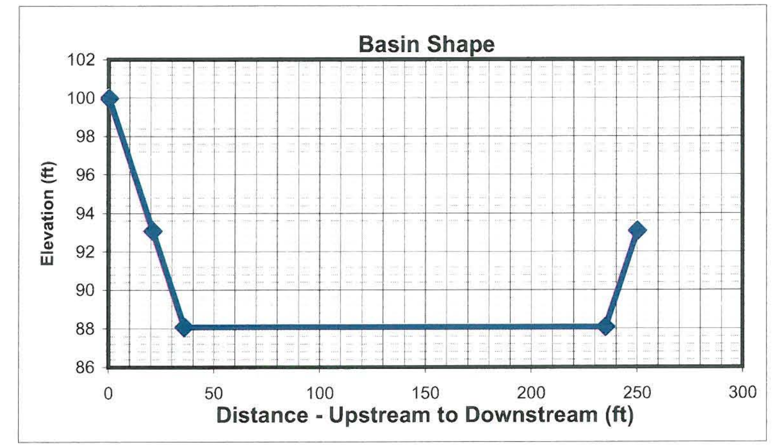
Contributing HEC1 ID							Total Volume (ac. ft)
Inflow Volume (ac. ft)							0
Volume Fraction							
Weighted Volume							0
Sediment Conc. (ppm)							
Sediment Volume (ac. ft)							0.00
Weighting Factor							
Weighted Sed. Vol. (ac. ft)							0.00

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	1.0	sq. mi
Total Sediment Yield Volume	2.0	ac ft

Required Minimum Sediment Volume

Sediment Volume	2.0	ac. ft



Geometry	Base	LC Enhanced
Topography slope (ft/ft)	0.027586207	0.027586207
Basin Length (ft)	490	610
Basin Width (ft)	250	250
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	5	5
Freeboard (ft)	1	1
Effective Basin Width (ft)	229	209
Top Area (acres)	2.8	3.5
U/S-D/S Height Difference (ft)	6.9	6.9
Excess Area on Upstream (acres)	0.2	0.6

			Base	LC Enhanced
Bottom Length (ft)	460	Allocated Storage Volume (ac. ft)	9.1	9.1
Bottom Width (ft)	199	Total Available Volume (ac. ft) (incl. Freeboard)	11.7	12
		Total Excavation Volume (ac. ft)	21.4	24

HEC1 Results

	6-hr Event	24-hr Event	Maximum
Total Flow Volume entering Basin (ac. ft)	85.0	78	85.0
Peak Inflow (cfs)	936	853	936.0
Peak Outflow (cfs)	829	769	829.0
Stage at Peak Outflow (ft)	3.1	2.7	3.1
Volume at Peak Outflow (ac. ft)	6.9	5.93	6.9

Volume Check

Total Volume needed	8.9	ac. ft
Total Volume Provided	9.1	ac. ft

Volume OK?	Yes

Stage Check

Depth Needed	4.1	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)	5.00	ft
Invert Elevation	0.00	ft
Number of pipes	5	

Stage-Storage-Discharge

Elevation	0	0.5	1	1.5	2	3	4	5	6	7
Volume	0.00	1.06	2.15	3.26	4.39	6.72	9.15	11.68	14.30	17.03
Outflow	0.0	334.3	472.7	578.9	668.5	818.8	945.4	1057.0	1157.9	1250.7

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
LC Enhancement Buffer	126000	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	490	ft
Base Total ROW Width	250	ft
LC Enh. Total ROW Length	710	ft
LC Enh. Total ROW Length	350	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	34525	38720
Excavated Area (sq. Yd)	13611	27611

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	38	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	418	sq. Yd
Material Volume	209	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	221	ft
Unit Cost	160	per ft
Cost per outlet	$35,360	
Other Cost	$ -	
Total Cost	$35,360	
Outlet Area	133	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
Basin		34,525	cu. Yd	$ 4.00	$ 138,100	13,611	sq. Yd	$ 9.00	$ 122,499	13,611	sq. Yd	$ 8.33	$ 113,425
Basin - LC Enhancement		4,195	cu. Yd	$ 4.00	$ 16,780	14,000	sq. Yd	$ 9.00	$ 126,000	14,000	sq. Yd	$ 8.33	$ 116,667
Inlet	Riprap	209	sq. Yd	$ 75.00	$ 15,675	418	sq. Yd	$ -	$ -	418	sq. Yd	$ 33.33	$ 13,933
Inlet - LC Enhancement (20%Inlet)					$ 3,135				$ -				$ 2,787
Outlet	Pipe	1	EA	$ 35,360	$ 35,360	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhancement (5% Outlet)					$ 1,768				$ -				$ 111
Other					$ -				$ -				$ -

Base Landscape Cost	$ 122,499	Base Maintenance Cost	$ 129,575
LC Enh. Landscape Cost	$ 126,000	LC Enh. Maintenance Cost	$ 119,564
Total Landscape Cost	$ 248,499	Total Maintenance Cost	$ 249,139

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 189,135	$ 16,780	$ 205,915
Contingency Cost (25% of Construction Cost)	$ 47,284	$ 4,195	$ 51,479
Engineering Design Cost (5% of Construction Cost)	$ 9,457	$ 839	$ 10,296
Total Construction Cost	$ 245,876	$ 21,814	$ 267,690

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	2.9	$100,000	$ 290,000
Basin	2.8	$100,000	$ 280,000
Other		$100,000	$ -
Total	5.7	$100,000	$ 570,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	2.8	$100,000	$ 280,000
LC Enhancement Cost	acre	2.9	$100,000	$ 290,000
Total Land Cost	acre	5.7	$100,000	$ 570,000

Total Cost

Base Total Cost	$ 777,950
Total LC Enhancement Cost	$ 557,378
Total Cost Including LC Enh.	$ 1,335,328

Open Channel

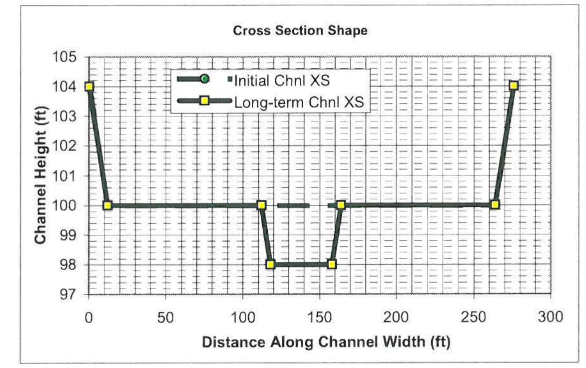
Structure ID	C910A10		HEC1 ID	90091A

Longitundal Geometry

Length	3620.4	ft
U/S Elev	1818.8	ft
D/S Elev	1746.9	ft
Initial Channel Slope	0.0198	ft/ft
Long-term Channel Slope	0.0070	ft/ft

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

NSTPS	5



Initial Channel XS Geometry

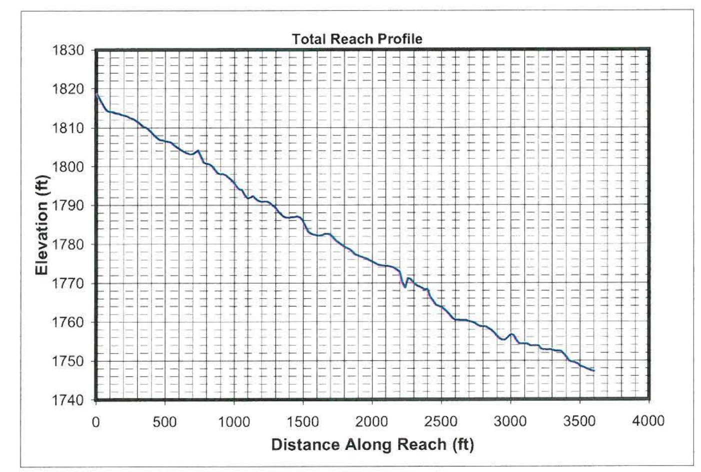
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	0	3	252	4	3	0	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	12	12	264	264	264	276
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	100	3	40	6	3	100	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	112	118	158	164	264	276
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	S910	RR900								TOTAL
HEC1 Peak-Flow	1585	829								2414
Weighting Factor	0.37	1.00								
Flow into Channel	593	829								1422

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	1.398	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	1422	cfs	
Long-term Max. Chnl Capacity	8187	cfs	
Q2 Channel	142	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	276	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
142	253.8	71.2	0.3	100.0	100.3	2.0	0.3	253.7	0.3	0.12	0.66
356	255.1	123.6	0.5	100.0	100.5	2.9	0.5	254.9	0.5	0.21	0.73
1067	258.0	239.9	0.9	100.0	100.9	4.4	0.9	257.6	0.9	0.41	0.81
1422	259.1	285.6	1.1	100.0	101.1	5.0	1.1	258.7	1.1	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
142	47.2	49.6	1.1	98.0	99.1	2.9	1.1	46.9	1.1	0.50	0.49
356	52.4	89.7	1.7	98.0	100.0	4.0	2.0	51.7	1.7	0.85	0.53
1067	258.5	328.3	1.3	98.0	100.9	3.2	2.9	257.6	1.3	1.28	0.51
1422	260.1	391.1	1.5	98.0	101.2	3.6	3.2	259.0	1.5	1.38	0.52

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
142										0
356										0
1067										0
1422										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
142	1.74	1.0036	0.9534	Erosive	Erosive	Erosive	0.2	Stable	5.4	Stable	Stable
356	1.74	1.1722	1.1136	Erosive	Erosive	Erosive	0.2	Stable	7.6	Stable	Stable
1067	1.74	1.3734	1.3048	Erosive	Erosive	Erosive	0.3	Stable	8.8	Stable	Stable
1422	1.74	1.4260	1.3547	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) 142	356	1067	1422	Flow Depth (ft) 142	356	1067	1422	Velocity (ft/s) 142	356	1067	1422
Bray - Equation #1	32	53	94	109	1.4	1.9	2.7	3.0	3.2	3.6	4.2	4.4
Bray - Equation #2	43	69	123	143	1.5	2.1	3.0	3.3	2.2	2.5	2.9	3.0
Hey	10	16	30	35	4.2	6.0	9.1	10.2				
Ackers & Charlton/Lacey	29	42	67	76					1.8	2.1	2.6	2.7
Parker	82	130	224	259	1.1	1.6	2.5	2.8				
Chang	60	105	203	241	0.0	-0.1	-0.6	-0.7				
Kellerhals	21	34	59	68	2.0	2.8	4.4	5.0	3.3	3.7	4.1	4.2
AMAFCA/Schumm	47	52	258	259								
Moody & Odem	14	14	14	14	1.0	1.0	1.0	1.0				
BUREC	16.0	22.6	34.1	37.9	4	6	9	10	3.3	4.1	5.4	5.8
Average	35	54	111	124	1.9	2.7	3.9	4.3	2.8	3.2	3.8	4.0
Values As Designed	47	52	258	259	1.1	2.0	2.9	3.2	2.9	4.0	3.2	3.6
Difference with Design	-12	2	-147	-135	0.8	0.7	1.0	1.1	-0.1	-0.8	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
142	1539	994	2216	2965	4191	537	466	248	6982	495	1648	2026
356	6341	3163	6417	14027	6173	2201	1471	1235	18227	1668	6819	6158
1067	34586	11362	19104	90143	9327	10350	4749	6237	55714	7853	32089	25592
1422	53815	15667	25047	146565	10334	15394	6329	9240	74457	11863	47232	37813

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
142	4016	2593	5783	7735	10934	1401	1216	647	18217	1292	4301	5285
356	6617	3301	6696	14639	6442	2297	1535	1289	19022	1741	7116	6427
1067	12031	3953	6646	31358	3245	3600	1652	2170	19381	2732	11163	8903
1422	14040	4088	6535	38239	2696	4016	1651	2411	19426	3095	12323	9865

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
142	906	445	730	1730	952	209	159	202	1490	200	1054	734
356	3515	1324	1990	7657	1453	758	447	777	3838	747	3880	2399
1067	8116	3453	5641	16140	5933	1840	1278	1835	11338	1749	9321	6059
1422	12622	4927	7785	26215	6665	2786	1772	2831	15262	2679	14200	8886

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
142	2364	1160	1906	4513	2483	545	415	528	3889	523	2750	1916
356	3669	1382	2077	7991	1516	791	466	811	4005	779	4049	2503
1067	2823	1201	1962	5615	2064	640	445	638	3944	608	3242	2108
1422	3293	1286	2031	6840	1739	727	462	739	3982	699	3705	2318

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)
142	0.0027	0.0043	139	0.42	0.047	0.0009	30	0.036	0.0007	0.0159	0.0009	0.0021	0.0067	0.0004	0.0029	0.0198	0.0073
356	0.0014	0.0025	183	0.56	0.050	0.0006	31	0.036	0.0004	0.0159	0.0005	0.0012	0.0067	0.0003	0.0014	0.0198	0.0070
1067	0.0006	0.0013	253	0.77	0.053	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0006	0.0067	0.0002	0.0006	0.0198	0.0068
1422	0.0005	0.0011	275	0.84	0.054	0.0003	32	0.036	0.0002	0.0159	0.0002	0.0005	0.0067	0.0001	0.0005	0.0198	0.0068

Drop Structures

Design Slope	0.0070	ft/ft
Total Drop Needed	46.5	ft
Height of Drop Structure	3	ft
No . of Drop Structures	16	
Distance between structs.	226	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	0.37	sq. mi
Total Sediment Yield Volume	0.70	ac ft

Sedimentation Basins

Length	226 ft	Depth	3 ft
Width	276 ft	Side slope	3 ft/ft
Total Volume per Basin		4.00	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)
142	1.1	-0.4	0.1	24.6	1.1	1.1	2.9	0.0070	0.1	0.0	2.0	2.8
356	1.1	-0.5	0.2	24.6	2.0	1.7	4.0	0.0070	0.2	0.0	2.0	3.0
1067	1.1	-0.9	0.1	24.6	2.9	1.3	3.2	0.0070	0.3	0.0	2.0	3.1
1422	1.1	-0.9	0.2	24.6	3.2	1.5	3.6	0.0070	0.4	0.0	2.0	3.2

Toe Protection Needed	4.0	ft

HEC1 Results For Open Channel

Peak Flow	819	cfs
Stage at Peak Flow	100.8	ft
Flow Volume	85.0	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	0.70	ac. ft
Outflowing Sediment Volume	0.08	ac. ft
Deposited(+)/Eroded(-) Volume	0.62	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	3620	3620
Side Slope (?H:1V)	3	3
Channel Width (ft)	276	276
Channel XS Area (sq. ft)	1148	1148
Channel Perimeter (ft)	278	278

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	3620	ft
Thickness	1.5	ft
Protection Depth	4	ft
Tie-in Length/Depth	3.0	ft
Total Depth	7.0	ft
Area needed	1207	sq. Yd
Volume	2816	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	3620	3620
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)	15687	32580
Left Levee Volume (cu. Yd)	13944	33519
Right Levee Length (ft)	3620	3620
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)	15687	32580
Right Levee Volume (cu. Yd)	13944	33519
Total Levee Surface Area (sq. Yd)	31374	65160
Total Levee Volume (cu. Yd)	27888	67038

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	3620	3620
Left Levee Lining Width (ft)	13	30
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	5229	12067
Left Levee Lining Volume (cu. Yd)	2614	6033
Right Levee Length (ft)	3620	3620
Right Levee Lining Width (ft)	13	30
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	5229	12067
Right Levee Lining Volume (cu. Yd)	2614	6033
Total Lining Area (sq. Yd)	10458	24133
Total Lining Volume (cu. Yd)	5228	12066

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	276	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	6.2	ft
Structure Height	9.2	ft
Number of Structures	16	
Volume per structure	283	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 21,225	
Area per structure	92	sq. Yd
Total Area	1,472	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	6453	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 25,812	
Other Cost	$ -	
Total cost per basin	$ 25,812	
Area per basin	6,939	sq. Yd
Total Area	6,939	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	27,888	cu. Yd	$ 7.00	$ 195,216	31,374	sq. Yd	$ 9.00	$ 282,366	31,374	sq. Yd	$ 11.67	$ 366,030
Levee - LC Enhancement	Fill	39,150	cu. Yd	$ 7.00	$ 274,050	33,786	sq. Yd	$ 9.00	$ 304,074	39,150	sq. Yd	$ 11.67	$ 456,750
Levee Lining	Riprap	5,228	cu. Yd	$ 75.00	$ 392,100	10,458	sq. Yd	$ -	$ -	10,458	sq. Yd	$ 20.83	$ 217,870
Levee Lining -LC Enhancement	Riprap	6,838	cu. Yd	$ 75.00	$ 512,850	13,676	sq. Yd	$ -	$ -	13,676	sq. Yd	$ 20.83	$ 284,907
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	2,816	cu. Yd	$ 75.00	$ 211,200	1,207	sq. Yd	$ -	$ -	1,207	sq. Yd	$ 25.00	$ 30,175
Drop Structures	Riprap	16	EA	$ 21,225.00	$ 339,600	1,472	sq. Yd	$ -	$ -	1,472	sq. Yd	$ 33.33	$ 49,067
Drop Str. - LC Enhancement	Riprap	16	EA	$ 2,122.50	$ 33,960	147	sq. Yd	$ -	$ -	147	sq. Yd	$ 33.33	$ 4,907
Sedimentation Basins		1	EA	$ 25,812.00	$ 25,812	6,939	sq. Yd	$ -	$ -	6,939	sq. Yd	$ 8.33	$ 57,825
Other					$ -				$ -				$ -

Base Landscape Cost	$ 282,366	Base Maintenance Cost	$ 720,967
LC Enhancement Cost	$ 304,074	LC Enhancement Cost	$ 746,564
Total Landscape Cost	$ 586,440	Total Maintenance Cost	$ 1,467,531

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,163,928	$ 820,860	$ 1,984,788
Contingency Cost (25% of Construction Cost)	$ 290,982	$ 205,215	$ 496,197
Engineering Design Cost (5% of Construction Cost)	$ 58,196	$ 41,043	$ 99,239
Total Construction Cost	$ 1,513,106	$ 1,067,118	$ 2,580,224

Land Cost

Channel Length	3620 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	276	22.9	$100,000	$ 2,290,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	52	4.3	$100,000	$ 430,000
Levee LC Enhancement	48	4	$100,000	$ 400,000
Other	0	0	$100,000	$ -
Total	376	31.2		$ 3,120,000

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	27.2	$100,000	$ 2,720,000
LC Enhancement Cost	acre	4	$100,000	$ 400,000
Total Land Cost	acre	31.2	$100,000	$ 3,120,000

Total Cost

Base Total Cost	$ 5,236,439
Total Landscape Enhancement Cost	$ 2,517,756
Total Cost Including LC Enh.	$ 7,754,196

Open Channel

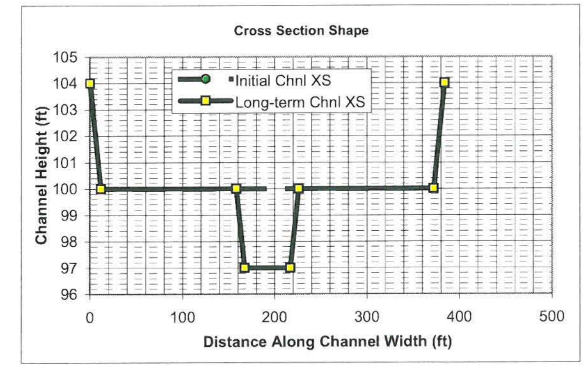
Structure ID	C910B10	HEC1 ID	90091B

Longitundal Geometry

Length	4991.8	ft
U/S Elev	1746.9	ft
D/S Elev	1667.9	ft
Initial Channel Slope	0.0158	ft/ft
Long-term Channel Slope	0.0060	ft/ft

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

NSTPS	4



Initial Channel XS Geometry

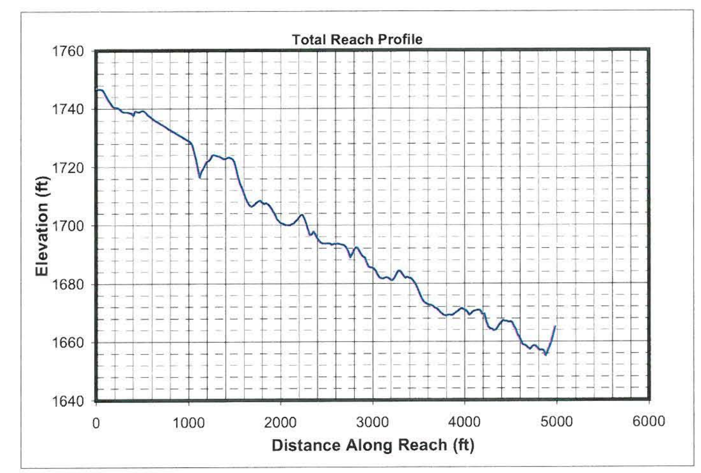
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	0	3	360	4	3	0	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	12	12	372	372	372	384
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	146	3	50	7	3	146	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	158	167	217	226	372	384
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	C910									TOTAL
HEC1 Peak-Flow	1501									1501
Weighting Factor	1.00									
Flow into Channel	1501									1501

Reach Sediment Inflow Characteristics

U/S Contributing ID	90091A_C910A10									TOTAL
HEC1 Flow Volume (ac. ft)	85.00									85
Sediment Conc. (ppm)	2503									
Sediment Volume (ac. ft)	0.08									0.08
Weighting Factor	1									
Weighted Sed. Vol. (ac. ft)	0.08									0.08

Hydrology

Drainage Area	2.02	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	1501	cfs	
Long-term Max. Chnl Capacity	11310	cfs	
Q2 Channel	150	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	384	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
150	361.6	90.7	0.3	100.0	100.3	1.7	0.3	361.5	0.3	0.09	0.58
375	362.8	157.3	0.4	100.0	100.4	2.4	0.4	362.6	0.4	0.16	0.64
1126	365.3	304.8	0.8	100.0	100.8	3.7	0.8	365.0	0.8	0.31	0.71
1501	366.3	362.7	1.0	100.0	101.0	4.1	1.0	366.0	1.0	0.37	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
150	56.9	57.8	1.0	97.0	98.1	2.6	1.1	56.5	1.0	0.41	0.45
375	61.8	103.6	1.7	97.0	98.9	3.6	1.9	61.2	1.7	0.70	0.49
1126	365.0	407.7	1.1	97.0	100.6	2.8	3.6	363.8	1.1	1.36	0.46
1501	366.4	485.2	1.3	97.0	100.9	3.1	3.9	365.1	1.3	1.44	0.47

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
	90091A_C910A1 0									
150	734									734
375	2399									2399
1126	6059									6059
1501	8886									8886

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)		
150	1.74	0.9690	0.9206	Erosive	Erosive	Erosive	0.2	Stable	4.8	Stable	Stable
375	1.74	1.1380	1.0811	Erosive	Erosive	Erosive	0.2	Stable	6.8	Stable	Stable
1126	1.74	1.3399	1.2729	Erosive	Erosive	Erosive	0.3	Stable	8.9	Stable	Stable
1501	1.74	1.3926	1.3230	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)	**150**	**375**	**1126**	**1501**	**150**	**375**	**1126**	**1501**	**150**	**375**	**1126**	**1501**
Bray - Equation #1	33	54	97	112	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	43	69	78					1.8	2.2	2.6	2.7
Parker	84	133	231	266	1.1	1.6	2.6	2.9				
Chang	59	103	200	238	0.1	-0.1	-0.5	-0.6				
Kellerhals	22	35	60	70	2.0	2.9	4.5	5.1	3.4	3.7	4.1	4.2
AMAFCA/Schumm	57	61	364	366								
Moody & Odem	16	16	16	16	1.1	1.1	1.1	1.1				
BUREC	16.8	23.7	35.8	39.9	4	6	10	11	3.1	3.9	5.2	5.6
Average	37	56	123	137	2.0	2.8	4.0	4.5	2.7	3.2	3.8	4.0
Values As Designed	57	61	364	365	1.1	1.9	3.6	3.9	2.6	3.6	2.8	3.1
Difference with Design	-19	-6	-241	-228	0.9	0.9	0.4	0.6	0.1	-0.4	1.0	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
150	1007	682	1368	1746	4568	265	270	121	4929	343	998	1482
375	4155	2375	4976	8273	6979	1349	1064	776	13382	1129	4613	4461
1126	22718	9037	16455	53309	10811	6725	3777	4461	41562	5297	23396	17959
1501	35394	12592	21216	86772	12025	10050	5103	6747	55652	8020	34963	26230

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
150	2490	1685	3382	4316	11291	654	666	299	12184	848	2468	3662
375	4108	2348	4920	8179	6900	1334	1052	767	13231	1116	4561	4411
1126	7487	2978	5423	17568	3563	2216	1245	1470	13697	1746	7710	5918
1501	8748	3112	5244	21447	2972	2484	1261	1668	13755	1982	8642	6483

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
150	720	376	617	1290	1004	155	128	161	1222	158	843	607
375	2828	1159	1691	5790	1535	591	383	655	3187	593	3231	1968
1126	5904	2771	4818	10775	6897	1275	1016	1344	9261	1273	6920	4750
1501	9193	4023	6514	17527	7796	1977	1452	2135	12548	1949	10728	6894

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
150	1780	928	1526	3189	2481	382	317	397	3019	390	2083	1499
375	2796	1145	1672	5725	1518	584	379	647	3151	587	3195	1945
1126	1946	913	1588	3551	2273	420	335	443	3052	420	2281	1566
1501	2272	994	1610	4332	1927	489	359	528	3101	482	2652	1704

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)
150	0.0034	0.0048	117	0.36	0.046	0.0010	29	0.035	0.0007	0.0159	0.0010	0.0025	0.0066	0.0004	0.0035	0.0158	0.0063
375	0.0017	0.0028	154	0.47	0.048	0.0006	30	0.036	0.0004	0.0159	0.0006	0.0014	0.0066	0.0003	0.0018	0.0158	0.0060
1126	0.0007	0.0015	214	0.65	0.051	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0007	0.0066	0.0002	0.0008	0.0158	0.0058
1501	0.0006	0.0012	233	0.71	0.052	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0006	0.0066	0.0001	0.0006	0.0158	0.0058

Drop Structures

Design Slope	0.0060	ft/ft
Total Drop Needed	49.1	ft
Height of Drop Structure	5	ft
No . of Drop Structures	10	
Distance between structs.	499	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	0.62	sq. mi
Total Sediment Yield Volume	1.17	ac ft

Sedimentation Basins

Length	499 ft	Depth	3 ft
Width	384 ft	Side slope	3 ft/ft
Total Volume per Basin		12.66	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)
150	1.1	-0.4	0.1	24.6	1.1	1.0	2.6	0.0060	0.1	0.0	2.0	2.8
375	1.1	-0.5	0.2	24.6	1.9	1.7	3.6	0.0060	0.2	0.0	2.0	3.0
1126	1.1	-1.1	0.1	24.6	3.6	1.1	2.8	0.0060	0.4	0.0	2.0	3.2
1501	1.1	-1.2	0.1	24.6	3.9	1.3	3.1	0.0060	0.4	0.0	2.0	3.2

Toe Protection Needed	4.0	ft

HEC1 Results For Open Channel

Peak Flow	768	cfs
Stage at Peak Flow	100.7	ft
Flow Volume	85.0	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	1.25	ac. ft
Outflowing Sediment Volume	0.06	ac. ft
Deposited(+)/Eroded(-) Volume	1.19	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	4992	4992
Side Slope (?H:1V)	3	3
Channel Width (ft)	384	384
Channel XS Area (sq. ft)	1665	1665
Channel Perimeter (ft)	386	386

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	4992	ft
Thickness	1.5	ft
Protection Depth	4	ft
Tie-in Length/Depth	3.0	ft
Total Depth	7.0	ft
Area needed	1664	sq. Yd
Volume	3883	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	4992	4992
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)	21632	44928
Left Levee Volume (cu. Yd)	19228	46222
Right Levee Length (ft)	4992	4992
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)	21632	44928
Right Levee Volume (cu. Yd)	19228	46222
Total Levee Surface Area (sq. Yd)	43264	89856
Total Levee Volume (cu. Yd)	38456	92444

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	4992	4992
Left Levee Lining Width (ft)	13	30
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	7211	16640
Left Levee Lining Volume (cu. Yd)	3605	8320
Right Levee Length (ft)	4992	4992
Right Levee Lining Width (ft)	13	30
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	7211	16640
Right Levee Lining Volume (cu. Yd)	3605	8320
Total Lining Area (sq. Yd)	14421	33280
Total Lining Volume (cu. Yd)	7210	16640

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	384	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	5	ft
Scour Depth	5.9	ft
Structure Height	10.9	ft
Number of Structures	10	
Volume per structure	463	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 34,725	
Area per structure	128	sq. Yd
Total Area	1,280	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	20425	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 81,700	
Other Cost	$ -	
Total cost per basin	$ 81,700	
Area per basin	21,298	sq. Yd
Total Area	21,298	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	38,456	cu. Yd	$ 7.00	$ 269,192	43,264	sq. Yd	$ 9.00	$ 389,376	43,264	sq. Yd	$ 11.67	$ 504,747
Levee - LC Enhancement	Fill	53,988	cu. Yd	$ 7.00	$ 377,916	46,592	sq. Yd	$ 9.00	$ 419,328	53,988	sq. Yd	$ 11.67	$ 629,860
Levee Lining	Riprap	7,210	cu. Yd	$ 75.00	$ 540,750	14,421	sq. Yd	$ -	$ -	14,421	sq. Yd	$ 20.83	$ 300,444
Levee Lining -LC Enhancement	Riprap	9,430	cu. Yd	$ 75.00	$ 707,250	18,859	sq. Yd	$ -	$ -	18,859	sq. Yd	$ 20.83	$ 392,889
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	3,883	cu. Yd	$ 75.00	$ 291,225	1,664	sq. Yd	$ -	$ -	1,664	sq. Yd	$ 25.00	$ 41,600
Drop Structures	Riprap	10	EA	$ 34,725.00	$ 347,250	1,280	sq. Yd	$ -	$ -	1,280	sq. Yd	$ 33.33	$ 42,667
Drop Str. - LC Enhancement	Riprap	10	EA	$ 3,472.50	$ 34,725	128	sq. Yd	$ -	$ -	128	sq. Yd	$ 33.33	$ 4,267
Sedimentation Basins		1	EA	$ 81,700.00	$ 81,700	21,298	sq. Yd	$ -	$ -	21,298	sq. Yd	$ 8.33	$ 177,483
Other					$ -				$ -				$ -

Base Landscape Cost	$ 389,376	Base Maintenance Cost	$ 1,066,941
LC Enhancement Cost	$ 419,328	LC Enhancement Cost	$ 1,027,016
Total Landscape Cost	$ 808,704	Total Maintenance Cost	$ 2,093,957

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,530,117	$ 1,119,891	$ 2,650,008
Contingency Cost (25% of Construction Cost)	$ 382,529	$ 279,973	$ 662,502
Engineering Design Cost (5% of Construction Cost)	$ 76,506	$ 55,995	$ 132,500
Total Construction Cost	$ 1,989,152	$ 1,455,858	$ 3,445,010

Land Cost

Channel Length	4992 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	384	44	$100,000	$ 4,400,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	52	6	$100,000	$ 600,000
Levee LC Enhancement	48	5.5	$100,000	$ 550,000
Other	0	0	$100,000	$ -
Total	484	55.5		$ 5,550,000

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	50	$100,000	$ 5,000,000
LC Enhancement Cost	acre	5.5	$100,000	$ 550,000
Total Land Cost	acre	55.5	$100,000	$ 5,550,000

Total Cost

Base Total Cost	$ 8,445,469
Total Landscape Enhancement Cost	$ 3,452,202
Total Cost Including LC Enh.	$ 11,897,671

JE FULLER
HYDROLOGY & GEOMORPHOLOGY, INC.

Sub-area: CAP, Alternative: B2
Open Channel Structure ID: C910B10

Open Channel

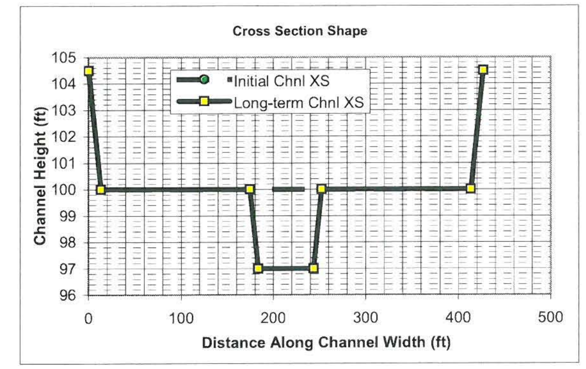
Structure ID	RR91010	HEC1 ID	910915

Longitundal Geometry

Length	3390.4	ft
U/S Elev	1668.1	ft
D/S Elev	1623.5	ft
Initial Channel Slope	0.0131	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

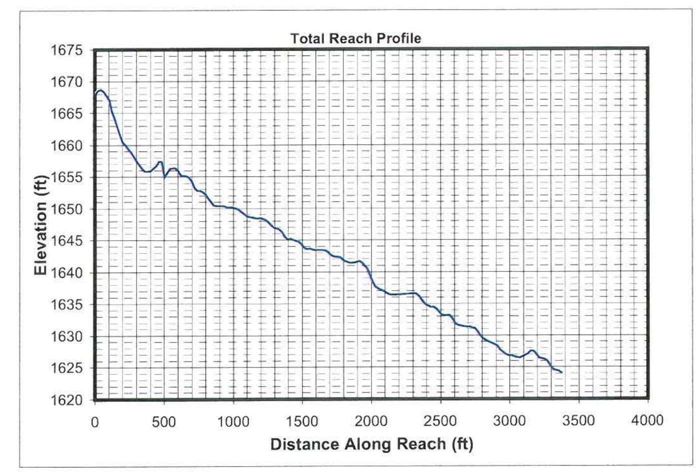
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	400	4.5	3	0	4.5	3

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	161	3	60	7.5	3	161	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	174.5	183.5	243.5	252.5	413.5	427
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	C915	S920							TOTAL
HEC1 Peak-Flow	2440	3157							5597
Weighting Factor	1.00	0.15							
Flow into Channel	2440	466							2906

Reach Sediment Inflow Characteristics

U/S Contributing ID	90091B_C910B1 0								TOTAL
HEC1 Flow Volume (ac. ft)	85.00								85
Sediment Conc. (ppm)	1945								
Sediment Volume (ac. ft)	0.06								0.06
Weighting Factor	1								
Weighted Sed. Vol. (ac. ft)	0.06								0.06

Hydrology

Drainage Area	2.506	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	2906	cfs	
Long-term Max. Chnl Capacity	13805	cfs	
Q2 Channel	291	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	427	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
291	402.3	148.7	0.4	100.0	100.4	2.0	0.4	402.2	0.4	0.12	0.57
727	404.1	258.0	0.6	100.0	100.6	2.8	0.6	403.9	0.6	0.20	0.62
2180	407.8	500.7	1.2	100.0	101.2	4.4	1.2	407.4	1.2	0.39	0.69
2906	409.3	595.9	1.5	100.0	101.5	4.9	1.5	408.8	1.5	0.46	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
291	69.6	98.5	1.4	97.0	98.5	3.0	1.5	69.2	1.4	0.48	0.44
727	76.5	177.3	2.3	97.0	99.6	4.1	2.6	75.7	2.3	0.82	0.47
2180	408.2	669.4	1.6	97.0	101.1	3.3	4.1	406.9	1.6	1.29	0.45
2906	410.2	797.1	1.9	97.0	101.5	3.6	4.5	408.8	2.0	1.39	0.46

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
	90091B_C910B10									
291	607									607
727	1968									1968
2180	4750									4750
2906	6894									6894

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)		
291	1.74	1.0887	1.0342	Erosive	Erosive	Erosive	0.2	Stable	5.5	Stable	Stable
727	1.74	1.2573	1.1944	Erosive	Erosive	Erosive	0.3	Stable	7.8	Stable	Stable
2180	1.74	1.4590	1.3861	Erosive	Erosive	Erosive	0.3	Stable	9.3	Stable	Stable
2906	1.74	1.5116	1.4360	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)	291	727	2180	2906	291	727	2180	2906	291	727	2180	2906
Bray - Equation #1	47	77	137	159	1.8	2.4	3.4	3.8	3.5	4.0	4.6	4.8
Bray - Equation #2	62	101	180	209	1.9	2.6	3.8	4.1	2.4	2.7	3.2	3.3
Hey	14	24	45	52	5.6	7.9	12.0	13.3				
Ackers & Charlton/Lacey	39	57	91	103					2.1	2.4	2.9	3.0
Parker	117	185	321	370	1.5	2.1	3.4	3.8				
Chang	83	145	281	334	0.1	-0.1	-0.7	-1.0				
Kellerhals	31	49	84	97	2.6	3.8	5.9	6.6	3.6	3.9	4.4	4.5
AMAFCA/Schumm	69	76	407	409								
Moody & Odem	17	17	17	17	1.1	1.1	1.1	1.1				
BUREC	22.3	31.4	47.4	52.8	6	8	13	14	3.4	4.3	5.7	6.1
Average	50	76	161	180	2.6	3.5	5.2	5.7	3.0	3.5	4.2	4.4
Values As Designed	69	76	407	409	1.5	2.6	4.1	4.5	3.0	4.1	3.3	3.6
Difference with Design	-19	0	-246	-228	1.0	0.9	1.0	1.3	0.0	-0.6	0.9	0.7

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)											
291	2043	1286	2571	3667	5985	573	529	325	7496	583	2207	2479
727	8444	4252	7938	17364	8932	2509	1797	1706	19882	2069	9410	7664
2180	45937	15614	24716	111682	13624	11976	5973	8849	61169	10116	45562	32293
2906	71547	21637	32187	181685	15115	17841	8001	13186	81814	15413	67559	47817

Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
	Sediment Concentrations (ppm by weight)											
291	2608	1642	3283	4681	7641	732	675	415	9570	744	2817	3164
727	4312	2171	4054	8867	4561	1282	918	871	10153	1056	4806	3914
2180	7819	2658	4207	19011	2319	2039	1017	1506	10412	1722	7756	5497
2906	9134	2762	4109	23195	1930	2278	1021	1683	10445	1968	8625	6105

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)											
291	1390	667	1006	2549	1365	278	216	333	1826	289	1644	1051
727	5422	2004	2729	11351	2078	1022	614	1270	4721	993	6121	3484
2180	11989	5110	7678	22672	8874	2381	1723	2892	13875	2457	14077	8521
2906	18651	7317	10574	36850	9983	3624	2405	4464	18715	3785	21554	12538

Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
	Sediment Concentrations (ppm by weight)											
291	1774	851	1284	3254	1743	355	275	425	2331	370	2099	1342
727	2769	1023	1393	5797	1061	522	314	648	2411	507	3126	1779
2180	2041	870	1307	3859	1511	405	293	492	2362	418	2396	1450
2906	2381	934	1350	4705	1274	463	307	570	2389	483	2752	1601

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)
291	0.0022	0.0033	130	0.40	0.047	0.0007	30	0.035	0.0005	0.0159	0.0007	0.0017	0.0053	0.0003	0.0023	0.0131	0.0051
727	0.0011	0.0019	171	0.52	0.049	0.0004	30	0.036	0.0003	0.0159	0.0004	0.0009	0.0053	0.0002	0.0012	0.0131	0.0049
2180	0.0005	0.0010	237	0.72	0.052	0.0002	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0053	0.0001	0.0005	0.0131	0.0047
2906	0.0004	0.0008	258	0.79	0.053	0.0002	32	0.036	0.0001	0.0159	0.0002	0.0004	0.0053	0.0001	0.0004	0.0131	0.0047

Drop Structures

Design Slope	0.0050	ft/ft
Total Drop Needed	27.6	ft
Height of Drop Structure	3	ft
No . of Drop Structures	10	
Distance between structs.	339	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	0.49	sq. mi
Total Sediment Yield Volume	0.92	ac ft

Sedimentation Basins

Length	339 ft	Depth	3 ft
Width	427 ft	Side slope	3 ft/ft
Total Volume per Basin		9.50	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			Max. Depth	Hyd. Depth	Avg Vel	Se	Bend Scour	LongTerm Scour	Thalweg channel	Total
		General	Antidune	Bend								
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
291	1.1	-0.5	0.1	24.6	1.5	1.4	3.0	0.0050	0.2	0.0	2.0	2.9
727	1.1	-0.7	0.2	24.6	2.6	2.3	4.1	0.0050	0.3	0.0	2.0	3.1
2180	1.1	-1.2	0.1	24.6	4.1	1.6	3.3	0.0050	0.5	0.0	2.0	3.3
2906	1.1	-1.2	0.2	24.6	4.5	2.0	3.6	0.0050	0.5	0.0	2.0	3.4

Toe Protection Needed	4.0	ft

HEC1 Results For Open Channel

Peak Flow	1295	cfs
Stage at Peak Flow	100.9	ft
Flow Volume	140.0	ac. ft

Freeboard

Max. Flow Depth	1.5	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.0	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	0.99	ac. ft
Outflowing Sediment Volume	0.09	ac. ft
Deposited(+)/Eroded(-) Volume	0.89	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	3390	3390
Side Slope (?H:1V)	3	3
Channel Width (ft)	427	427
Channel XS Area (sq. ft)	2067.8	2067.8
Channel Perimeter (ft)	429	429

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	3390	ft
Thickness	1.5	ft
Protection Depth	4	ft
Tie-in Length/Depth	3.0	ft
Total Depth	7.0	ft
Area needed	1130	sq. Yd
Volume	2637	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	3390	3390
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)	15820	32770
Left Levee Volume (cu. Yd)	15569	36662
Right Levee Length (ft)	3390	3390
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)	15820	32770
Right Levee Volume (cu. Yd)	15569	36662
Total Levee Surface Area (sq. Yd)	31640	65540
Total Levee Volume (cu. Yd)	31138	73324

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	3390	3390
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	5273	12430
Left Levee Lining Volume (cu. Yd)	2637	6215
Right Levee Length (ft)	3390	3390
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	5273	12430
Right Levee Lining Volume (cu. Yd)	2637	6215
Total Lining Area (sq. Yd)	10547	24860
Total Lining Volume (cu. Yd)	5274	12430

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	427	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	7.2	ft
Structure Height	10.2	ft
Number of Structures	10	
Volume per structure	485	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 36,375	
Area per structure	142	sq. Yd
Total Area	1,423	sq. Yd

Sedimentation Basins		
Include Sed. Basins (Yes/No)	Yes	
Number of basins	1	
Total Volume per Basin	15327	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 61,308	
Other Cost	$ -	
Total cost per basin	$ 61,308	
Area per basin	16,086	sq. Yd
Total Area	16,086	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	31,138	cu. Yd	$ 7.00	$ 217,966	31,640	sq. Yd	$ 9.00	$ 284,760	31,640	sq. Yd	$ 11.67	$ 369,133
Levee - LC Enhancement	Fill	42,186	cu. Yd	$ 7.00	$ 295,302	33,900	sq. Yd	$ 9.00	$ 305,100	42,186	sq. Yd	$ 11.67	$ 492,170
Levee Lining	Riprap	5,274	cu. Yd	$ 75.00	$ 395,550	10,547	sq. Yd	$ -	$ -	10,547	sq. Yd	$ 20.83	$ 219,722
Levee Lining -LC Enhancement	Riprap	7,156	cu. Yd	$ 75.00	$ 536,700	14,313	sq. Yd	$ -	$ -	14,313	sq. Yd	$ 20.83	$ 298,194
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	2,637	cu. Yd	$ 75.00	$ 197,775	1,130	sq. Yd	$ -	$ -	1,130	sq. Yd	$ 25.00	$ 28,250
Drop Structures	Riprap	10	EA	$ 36,375.00	$ 363,750	1,423	sq. Yd	$ -	$ -	1,423	sq. Yd	$ 33.33	$ 47,433
Drop Str. - LC Enhancement	Riprap	10	EA	$ 3,637.50	$ 36,375	142	sq. Yd	$ -	$ -	142	sq. Yd	$ 33.33	$ 4,743
Sedimentation Basins		1	EA	$ 61,308.00	$ 61,308	16,086	sq. Yd	$ -	$ -	16,086	sq. Yd	$ 8.33	$ 134,050
Other					$ -				$ -				$ -

Base Landscape Cost	$ 284,760
LC Enhancement Cost	$ 305,100
Total Landscape Cost	$ 589,860

Base Maintenance Cost	$ 798,589
LC Enhancement Cost	$ 795,108
Total Maintenance Cost	$ 1,593,697

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,236,349	$ 868,377	$ 2,104,726
Contingency Cost (25% of Construction Cost)	$ 309,087	$ 217,094	$ 526,182
Engineering Design Cost (5% of Construction Cost)	$ 61,817	$ 43,419	$ 105,236
Total Construction Cost	$ 1,607,254	$ 1,128,890	$ 2,736,144

Land Cost

Channel Length	3390 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	427	33.2	$100,000	$ 3,320,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	4.3	$100,000	$ 430,000
Levee LC Enhancement	51	4	$100,000	$ 400,000
Other	0	0	$100,000	$ -
Total	533	41.5		$ 4,150,000

Right of Way

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

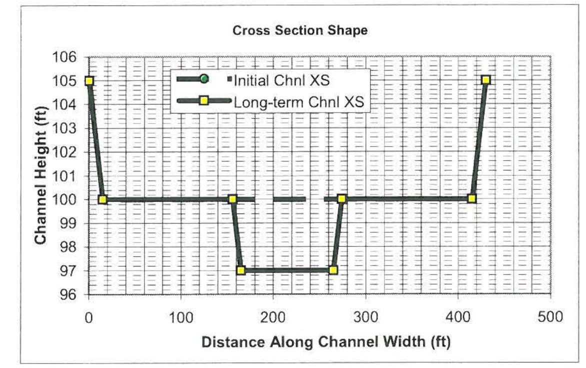
Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	37.5	$100,000	$ 3,750,000
LC Enhancement Cost	acre	4	$100,000	$ 400,000
Total Land Cost	acre	41.5	$100,000	$ 4,150,000

Total Cost

Base Total Cost	$ 6,440,603
Total Landscape Enhancement Cost	$ 2,629,098
Total Cost Including LC Enh.	$ 9,069,700

Open Channel

Structure ID	C92010		HEC1 ID	915920



Longitundal Geometry

Length	8861.8	ft
U/S Elev	1623.5	ft
D/S Elev	1532.6	ft
Initial Channel Slope	0.0103	ft/ft
Long-term Channel Slope	0.0040	ft/ft

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

NSTPS	7

Initial Channel XS Geometry

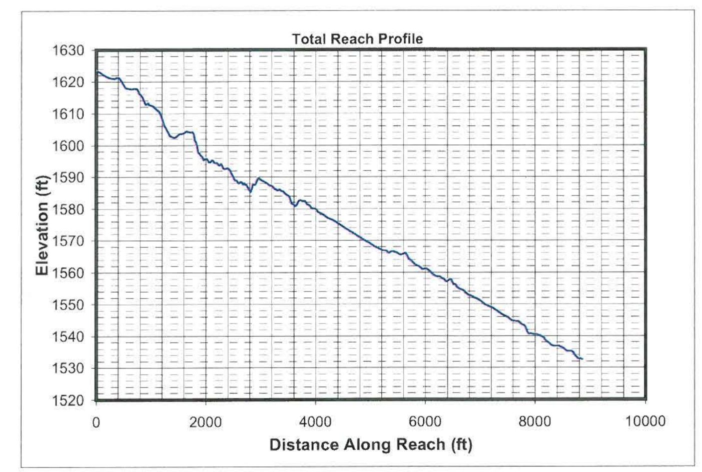
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	5	0	3	400	5	3	0	5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	15	15	15	415	415	415	430
Y	105	100	100	100	100	100	100	105

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	5	141	3	100	8	3	141	5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	15	156	165	265	274	415	430
Y	105	100	100	97	97	100	100	105



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	C920									TOTAL
HEC1 Peak-Flow	3974									3974
Weighting Factor	1.00									
Flow into Channel	3974									3974

Reach Sediment Inflow Characteristics

U/S Contributing ID	910915_RR9101 0									TOTAL
HEC1 Flow Volume (ac. ft)	140.00									140
Sediment Conc. (ppm)	1779									
Sediment Volume (ac. ft)	0.09									0.09
Weighting Factor	1									
Weighted Sed. Vol. (ac. ft)	0.09									0.09

Hydrology

Drainage Area	6.43	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	3974	cfs	
Long-term Max. Chnl Capacity	15773	cfs	
Q2 Channel	397	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	430	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: CAP, Alternative: B2
Open Channel Structure ID: C92010

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
397	403.0	193.4	0.5	100.0	100.5	2.1	0.5	402.9	0.5	0.12	0.52
994	405.3	335.7	0.8	100.0	100.8	3.0	0.8	405.0	0.8	0.21	0.57
2981	410.2	652.2	1.6	100.0	101.6	4.6	1.6	409.7	1.6	0.40	0.64
3974	412.1	776.5	1.9	100.0	101.9	5.1	1.9	411.5	1.9	0.48	0.66

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
397	109.2	152.1	1.4	97.0	98.5	2.6	1.5	108.7	1.4	0.36	0.39
994	115.9	270.0	2.3	97.0	99.5	3.7	2.5	115.1	2.3	0.63	0.42
2981	409.4	864.7	2.1	97.0	101.3	3.4	4.3	408.0	2.1	1.08	0.42
3974	411.9	1030.0	2.5	97.0	101.7	3.9	4.7	410.4	2.5	1.18	0.43

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
	910915_RR91010									
397	1051									1051
994	3484									3484
2981	8521									8521
3974	12538									12538

Allowable Velocity

Channel Lining	Natural - Sandy Loam (noncolloidal)										
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)		
397	1.74	1.1692	1.1107	Erosive	Erosive	Erosive	0.2	Stable	4.8	Stable	Stable
994	1.74	1.3376	1.2707	Erosive	Erosive	Erosive	0.3	Stable	6.8	Stable	Stable
2981	1.74	1.5388	1.4619	Erosive	Erosive	Erosive	0.4	Stable	8.8	Stable	Stable
3974	1.74	1.5912	1.5117	Erosive	Erosive	Erosive	0.4	Stable	9.5	Stable	Stable

USCOE Allowable Velocity (ft/s)	2
FHWA Allowable Velocity (ft/s)	2.5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	**397**	**994**	**2981**	**3974**	**397**	**994**	**2981**	**3974**	**397**	**994**	**2981**	**3974**
Bray - Equation #1	56	90	161	188	2.0	2.6	3.8	4.2	3.7	4.2	4.8	5.0
Bray - Equation #2	73	119	212	247	2.1	2.9	4.2	4.6	2.5	2.9	3.3	3.5
Hey	17	29	53	62	6.3	8.9	13.5	15.0				
Ackers & Charlton/Lacey	44	65	104	117					2.2	2.5	3.0	3.2
Parker	137	217	375	433	1.7	2.4	3.8	4.3				
Chang	93	163	316	376	0.1	-0.1	-0.7	-1.0				
Kellerhals	36	57	98	113	3.0	4.3	6.7	7.5	3.7	4.1	4.5	4.7
AMAFCA/Schumm	109	115	408	411								
Moody & Odem	25	25	25	25	1.3	1.3	1.3	1.3				
BUREC	26.1	36.8	55.6	62.0	7	10	15	17	3.4	4.3	5.7	6.1
Average	62	92	181	203	2.9	4.0	5.9	6.6	3.1	3.6	4.3	4.5
Values As Designed	109	115	408	410	1.5	2.5	4.3	4.7	2.6	3.7	3.4	3.9
Difference with Design	-47	-23	-227	-207	1.5	1.5	1.6	1.8	0.5	-0.1	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
397	2352	1420	2662	4145	6059	598	548	407	7060	613	2599	2588
994	9704	4686	8159	19613	9037	2596	1847	2044	18745	2249	10960	8149
2981	52734	17207	25317	125920	13792	12357	6120	10396	57700	11267	52966	35070
3974	82120	23852	33008	204714	15308	18405	8198	15449	77179	17244	78570	52186

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
397	2196	1326	2485	3870	5657	559	512	380	6591	572	2426	2416
994	3624	1750	3047	7324	3375	969	690	763	7000	840	4093	3043
2981	6564	2142	3151	15674	1717	1538	762	1294	7182	1402	6593	4365
3974	7666	2227	3082	19111	1429	1718	765	1442	7205	1610	7335	4872

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
397	1299	668	961	2188	1803	231	200	315	1727	264	1540	1018
994	5174	2112	2755	9982	2741	922	624	1297	4561	995	6072	3385
2981	14256	5916	8139	26658	9081	2571	1832	3596	13585	2815	16866	9574
3974	22181	8450	11222	43293	10215	3905	2552	5507	18321	3626	25784	14096

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
397	1212	624	897	2043	1683	216	187	294	1612	247	1438	950
994	1932	789	1029	3727	1023	344	233	484	1703	372	2267	1264
2981	1775	736	1013	3318	1130	320	228	448	1691	350	2099	1192
3974	2071	789	1048	4042	954	365	238	514	1710	339	2407	1316

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderso n	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)
397	0.0018	0.0025	131	0.40	0.047	0.0005	30	0.035	0.0004	0.0159	0.0005	0.0013	0.0047	0.0002	0.0019	0.0102	0.0041
994	0.0009	0.0015	172	0.52	0.049	0.0003	30	0.036	0.0002	0.0159	0.0003	0.0007	0.0047	0.0002	0.0009	0.0103	0.0040
2981	0.0004	0.0008	238	0.72	0.052	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0004	0.0047	0.0001	0.0004	0.0103	0.0039
3974	0.0003	0.0006	259	0.79	0.053	0.0002	32	0.036	0.0001	0.0159	0.0001	0.0003	0.0047	0.0001	0.0003	0.0103	0.0038

Drop Structures

Design Slope	0.0040	ft/ft
Total Drop Needed	55.5	ft
Height of Drop Structure	3	ft
No . of Drop Structures	19	
Distance between structs.	466	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	2.81	sq. mi
Total Sediment Yield Volume	5.33	ac ft

Sedimentation Basins

Length	466 ft	Depth	3 ft
Width	430 ft	Side slope	3 ft/ft
Total Volume per Basin		13.26	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)
397	1.1	-0.5	0.1	24.6	1.5	1.4	2.6	0.0040	0.2	0.0	3.0	4.2
994	1.1	-0.7	0.2	24.6	2.5	2.3	3.7	0.0040	0.3	0.0	3.0	4.4
2981	1.1	-1.2	0.2	24.6	4.3	2.1	3.4	0.0040	0.5	0.0	3.0	4.6
3974	1.1	-1.3	0.2	24.6	4.7	2.5	3.9	0.0040	0.5	0.0	3.0	4.7

Toe Protection Needed	5.0	ft

HEC1 Results For Open Channel

Peak Flow	1975	cfs
Stage at Peak Flow	101.3	ft
Flow Volume	217.0	ac. ft

Freeboard

Max. Flow Depth	1.9	ft
Channel Depth as designed	5.0	ft
Available Freeboard	3.1	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	5.42	ac. ft
Outflowing Sediment Volume	0.11	ac. ft
Deposited(+)/Eroded(-) Volume	5.32	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	8862	8862
Side Slope (?H:1V)	3	3
Channel Width (ft)	430	430
Channel XS Area (sq. ft)	2402	2402
Channel Perimeter (ft)	433	433

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	8862	ft
Thickness	1.5	ft
Protection Depth	5	ft
Tie-in Length/Depth	3.0	ft
Total Depth	8.0	ft
Area needed	2954	sq. Yd
Volume	7877	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	8862	8862
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	5	6
Left Levee Surface Area (sq. Yd)	45295	91574
Left Levee Volume (cu. Yd)	47592	110283
Right Levee Length (ft)	8862	8862
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	5	6
Right Levee Surface Area (sq. Yd)	45295	91574
Right Levee Volume (cu. Yd)	47592	110283
Total Levee Surface Area (sq. Yd)	90590	183148
Total Levee Volume (cu. Yd)	95184	220566

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	8862	8862
Left Levee Lining Width (ft)	16	36
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	15755	35448
Left Levee Lining Volume (cu. Yd)	7877	17724
Right Levee Length (ft)	8862	8862
Right Levee Lining Width (ft)	16	36
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	15755	35448
Right Levee Lining Volume (cu. Yd)	7877	17724
Total Lining Area (sq. Yd)	31509	70896
Total Lining Volume (cu. Yd)	15754	35448

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	430	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	19	
Volume per structure	555	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 41,625	
Area per structure	143	sq. Yd
Total Area	2,723	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	2	
Total Volume per Basin	21393	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 85,572	
Other Cost	$ -	
Total cost per basin	$ 85,572	
Area per basin	22,284	sq. Yd
Total Area	44,568	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	95,184	cu. Yd	$ 7.00	$ 666,288	90,590	sq. Yd	$ 9.00	$ 815,310	90,590	sq. Yd	$ 11.67	$ 1,056,883
Levee - LC Enhancement	Fill	125,382	cu. Yd	$ 7.00	$ 877,674	92,558	sq. Yd	$ 9.00	$ 833,022	125,382	sq. Yd	$ 11.67	$ 1,462,790
Levee Lining	Riprap	15,754	cu. Yd	$ 75.00	$ 1,181,550	31,509	sq. Yd	$ -	$ -	31,509	sq. Yd	$ 20.83	$ 656,444
Levee Lining -LC Enhancement	Riprap	19,694	cu. Yd	$ 75.00	$ 1,477,050	39,387	sq. Yd	$ -	$ -	39,387	sq. Yd	$ 20.83	$ 820,556
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	7,877	cu. Yd	$ 75.00	$ 590,775	2,954	sq. Yd	$ -	$ -	2,954	sq. Yd	$ 25.00	$ 73,850
Drop Structures	Riprap	19	EA	$ 41,625.00	$ 790,875	2,723	sq. Yd	$ -	$ -	2,723	sq. Yd	$ 33.33	$ 90,767
Drop Str. - LC Enhancement	Riprap	19	EA	$ 4,162.50	$ 79,088	272	sq. Yd	$ -	$ -	272	sq. Yd	$ 33.33	$ 9,077
Sedimentation Basins		2	EA	$ 85,572.00	$ 171,144	44,568	sq. Yd	$ -	$ -	44,568	sq. Yd	$ 8.33	$ 371,400
Other					$ -				$ -				$ -

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 3,400,632	$ 2,433,812	$ 5,834,444
Contingency Cost (25% of Construction Cost)	$ 850,158	$ 608,453	$ 1,458,611
Engineering Design Cost (5% of Construction Cost)	$ 170,032	$ 121,691	$ 291,722
Total Construction Cost	$ 4,420,822	$ 3,163,955	$ 7,584,777

Base Landscape Cost	$ 815,310	Base Maintenance Cost	$ 2,249,344
LC Enhancement Cost	$ 833,022	LC Enhancement Cost	$ 2,292,422
Total Landscape Cost	$ 1,648,332	Total Maintenance Cost	$ 4,541,767

Land Cost

Channel Length	8862 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	430	87.5	$100,000	$ 8,750,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	58	11.8	$100,000	$ 1,180,000
Levee LC Enhancement	54	11	$100,000	$ 1,100,000
Other	0	0	$100,000	$ -
Total	542	110.3		$ 11,030,000

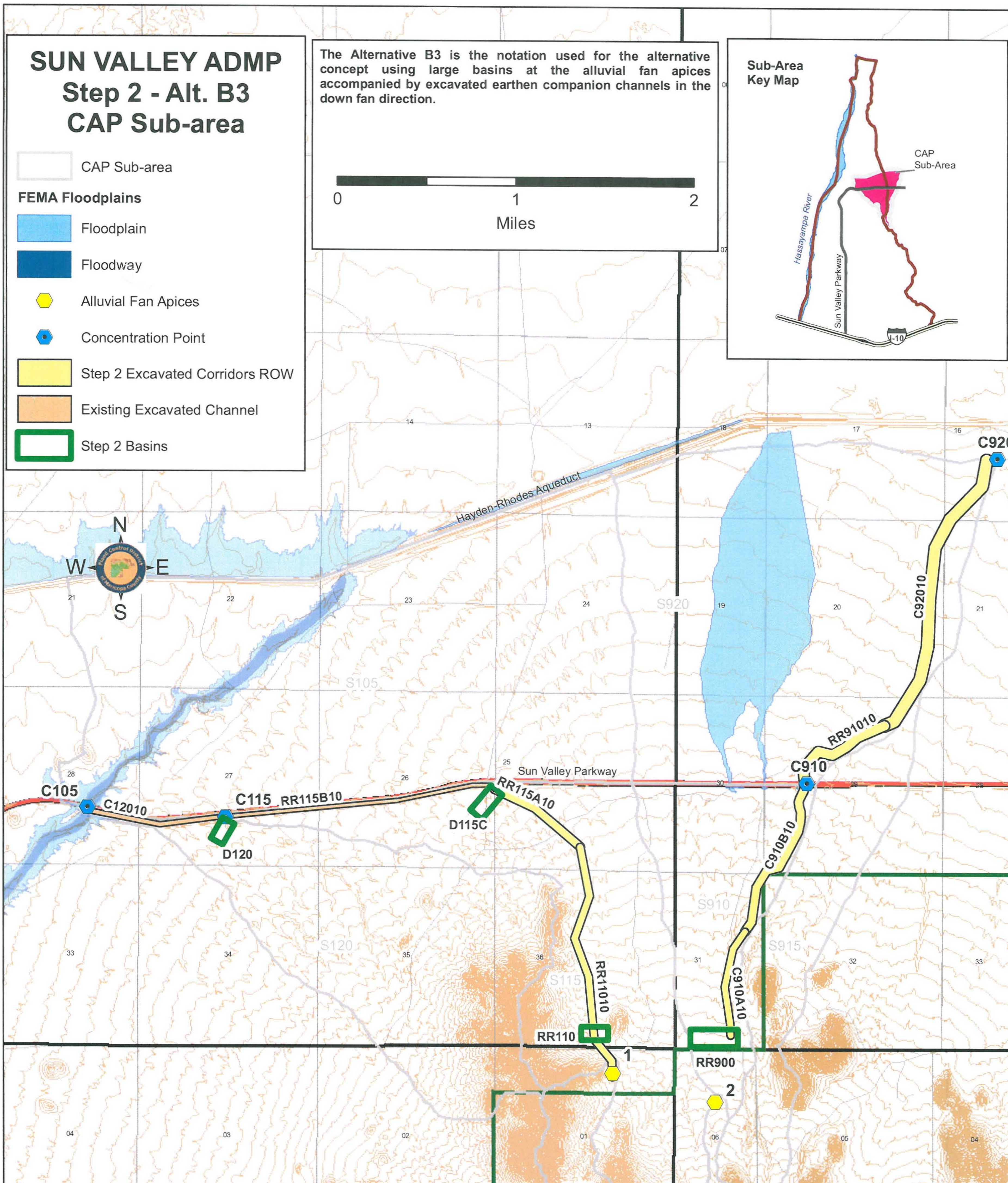
Right of Way

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	99.3	$100,000	$ 9,930,000
LC Enhancement Cost	acre	11	$100,000	$ 1,100,000
Total Land Cost	acre	110.3	$100,000	$ 11,030,000

Total Cost

Base Total Cost	$ 17,415,476
Total Landscape Enhancement Cost	$ 7,389,399
Total Cost Including LC Enh.	$ 24,804,875



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
RR110	Online Basin	74	7	79	0	800	400	6	$ 730	$ 744	$ 320	$ 319	$ 2,113	35%	35%	15%	15%	2%
RR11010	Excavated Chl.	782	39	1020	0	1.4	152	5	$ 3,900	$ 22,174	$ 734	$ 824	$ 27,632	14%	80%	3%	3%	22%
RR115A10	Excavated Chl.	1691	18	200	0	0.6	176	6	$ 1,840	$ 4,622	$ 389	$ 557	$ 7,408	25%	62%	5%	8%	6%
RR115B10	Existing Chl.	1000	0	0	0	1.5	108	6	$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
D115C	Offline Basin	1000	10	88	0	950	450	5	$ 981	$ 832	$ 428	$ 414	$ 2,655	37%	31%	16%	16%	2%
C12010	Existing Chl.	2000	0	0	0	0.8	136	7	$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
D120	Offline Basin	2000	6	54	0	700	400	5	$ 643	$ 545	$ 280	$ 277	$ 1,745	37%	31%	16%	16%	1%
RR900	Online Basin	74	17	211	0	1400	525	6	$ 1,690	$ 1,857	$ 735	$ 707	$ 4,989	34%	37%	15%	14%	4%
C910A10	Excavated Chl.	667	19	190	0	0.7	139	4	$ 1,850	$ 4,314	$ 322	$ 367	$ 6,853	27%	63%	5%	5%	5%
C910B10	Excavated Chl.	1498	31	431	0	0.9	185	5	$ 3,090	$ 9,496	$ 674	$ 722	$ 13,982	22%	68%	5%	5%	11%
RR91010	Excavated Chl.	2881	25	275	0	0.6	242	7	$ 2,530	$ 6,248	$ 651	$ 698	$ 10,127	25%	62%	6%	7%	8%
C92010	Excavated Chl.	5262	77	1667	0	1.7	292	9	$ 7,650	$ 36,478	$ 2,145	$ 2,387	$ 48,660	16%	75%	4%	5%	39%
		TOTAL	249	4215	0				$24,904	$ 87,310	$ 6,677	$ 7,272	**$ 126,163**	20%	69%	5%	6%	100%
All Channels			209	3783	0	5.9			$20,860	$ 83,332	$ 4,914	$ 5,555	$ 114,662	18%	73%	4%	5%	91%
All Online Basins			24	290	0				$ 2,420	$ 2,601	$ 1,055	$ 1,025	$ 7,102	34%	37%	15%	14%	6%
All Offline Basins			16	142	0				$ 1,624	$ 1,377	$ 707	$ 691	$ 4,400	37%	31%	16%	16%	3%
Channel Cost per mile (in $1000)			$19,434		Basins Cost per ac. ft. (in $1000)				$4.08									

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	30%	23%	0%				30%	22%	24%	20%	24%
All Online Basins % increase	54%	11%	0%				54%	10%	54%	53%	38%
All Offline Basins % increase	56%	8%	0%				56%	7%	57%	55%	41%
Total % increase	34%	22%	0%				34%	22%	32%	28%	25%

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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
RR110	Online Basin	74	7	79	0	800	400	6	$ 730	$ 744	$ 320	$ 319	$ 2,113	35%	35%	15%	15%	2%
RR11010	Excavated Chl.	782	39	1020	0	1.4	152	5	$ 3,900	$ 22,174	$ 734	$ 824	$ 27,632	14%	80%	3%	3%	22%
RR115A10	Excavated Chl.	1691	18	200	0	0.6	176	6	$ 1,840	$ 4,622	$ 389	$ 557	$ 7,408	25%	62%	5%	8%	6%
RR115B10	Existing Chl.	1000	0	0	0	1.5	108	6	$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
D115C	Offline Basin	1000	10	88	0	950	450	5	$ 981	$ 832	$ 428	$ 414	$ 2,655	37%	31%	16%	16%	2%
C12010	Existing Chl.	2000	0	0	0	0.8	136	7	$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
D120	Offline Basin	2000	6	54	0	700	400	5	$ 643	$ 545	$ 280	$ 277	$ 1,745	37%	31%	16%	16%	1%
RR900	Online Basin	74	17	211	0	1400	525	6	$ 1,690	$ 1,857	$ 735	$ 707	$ 4,989	34%	37%	15%	14%	4%
C910A10	Excavated Chl.	667	19	190	0	0.7	139	4	$ 1,850	$ 4,314	$ 322	$ 367	$ 6,853	27%	63%	5%	5%	5%
C910B10	Excavated Chl.	1498	31	431	0	0.9	185	5	$ 3,090	$ 9,496	$ 674	$ 722	$ 13,982	22%	68%	5%	5%	11%
RR91010	Excavated Chl.	2881	25	275	0	0.6	242	7	$ 2,530	$ 6,248	$ 651	$ 698	$ 10,127	25%	62%	6%	7%	8%
C92010	Excavated Chl.	5262	77	1667	0	1.7	292	9	$ 7,650	$ 36,478	$ 2,145	$ 2,387	$ 48,660	16%	75%	4%	5%	39%
		TOTAL	249	4215	0				$ 24,904	$ 87,310	$ 6,677	$ 7,272	**$ 126,163**	20%	69%	5%	6%	100%
All Channels			209	3783	0	5.9			$ 20,860	$ 83,332	$ 4,914	$ 5,555	$ 114,662	18%	73%	4%	5%	91%
All Online Basins			24	290	0				$ 2,420	$ 2,601	$ 1,055	$ 1,025	$ 7,102	34%	37%	15%	14%	6%
All Offline Basins			16	142	0				$ 1,624	$ 1,377	$ 707	$ 691	$ 4,400	37%	31%	16%	16%	3%
Channel Cost per mile (in $1000)			$19,434		Basins Cost per ac. ft. (in $1000)				$4.08									

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
RR110	Online Basin	74	12	88	0	1070	500	6	$ 1,220	$ 824	$ 535	$ 522	$ 3,101	39%	27%	17%	17%	2%
RR11010	Excavated Chl.	782	52	1287	0	1.4	313	5	$ 5,180	$ 27,821	$ 929	$ 1,008	$ 34,938	15%	80%	3%	3%	22%
RR115A10	Excavated Chl.	1691	24	255	0	0.6	346	6	$ 2,440	$ 5,804	$ 500	$ 662	$ 9,405	26%	62%	5%	7%	6%
RR115B10	Existing Chl.	1000	0	0	0	1.5	122	6	$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
D115C	Offline Basin	1000	15	95	0	1190	550	5	$ 1,500	$ 893	$ 654	$ 628	$ 3,675	41%	24%	18%	17%	2%
C12010	Existing Chl.	2000	0	0	0	0.8	150	7	$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
D120	Offline Basin	2000	10	59	0	910	500	5	$ 1,040	$ 583	$ 455	$ 442	$ 2,520	41%	23%	18%	18%	2%
RR900	Online Basin	74	25	233	0	1750	625	6	$ 2,510	$ 2,049	$ 1,094	$ 1,044	$ 6,697	37%	31%	16%	16%	4%
C910A10	Excavated Chl.	667	25	241	0	0.7	297	4	$ 2,470	$ 5,383	$ 409	$ 449	$ 8,711	28%	62%	5%	5%	6%
C910B10	Excavated Chl.	1498	40	524	0	0.9	349	5	$ 4,000	$ 11,463	$ 824	$ 862	$ 17,149	23%	67%	5%	5%	11%
RR91010	Excavated Chl.	2881	33	331	0	0.6	418	7	$ 3,250	$ 7,459	$ 793	$ 832	$ 12,335	26%	60%	6%	7%	8%
C92010	Excavated Chl.	5262	98	2023	0	1.7	480	9	$ 9,770	$ 44,032	$ 2,623	$ 2,836	$ 59,261	16%	74%	4%	5%	38%
		TOTAL	334	5136	0				$ 33,380	$ 106,311	$ 8,816	$ 9,284	**$ 157,791**	21%	67%	6%	6%	100%
All Channels			272	4661	0	5.9			$ 27,110	$ 101,962	$ 6,077	$ 6,649	$ 141,798	19%	72%	4%	5%	90%
All Online Basins			37	321	0				$ 3,730	$ 2,873	$ 1,629	$ 1,566	$ 9,797	38%	29%	17%	16%	6%
All Offline Basins			25	154	0				$ 2,540	$ 1,476	$ 1,110	$ 1,070	$ 6,195	41%	24%	18%	17%	4%
Channel Cost per mile (in $1000)			$24,034		Basins Cost per ac. ft. (in $1000)				$5.76									
All Channels % increase			30%	23%	0%				30%	22%	24%	20%	24%					
All Online Basins % increase			54%	11%	0%				54%	10%	54%	53%	38%					
All Offline Basins % increase			56%	8%	0%				56%	7%	57%	55%	41%					
Total % increase			34%	22%	0%				34%	22%	32%	28%	25%					

JE FULLER
HYDROLOGY & GEOMORPHOLOGY, INC.

Sub-area: CAP, Alternative: B3
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	61	100.2	17.36	11.4	10.23	59	51	36	20	0.054	0.185	0.39	0.513	29	101	213	280
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	100.3	9.31	8	10.23	60	51	36	20	0.055	0.186	0.39	0.513	30	101	213	280
C105U	COMBINE	2863			4.5	14.6	554	228	121	64	0.353	0.58	0.923	1.129	275	451	719	879
S110	BASIN	662			4.2	0.43	76	19	6	3	1.639	1.64	1.64	1.64	38	38	38	38
RR110	STORAGE	74	4.8	29.28	5	0.43	59	19	6	3	1.274	1.64	1.64	1.64	29	38	38	38
11015I	ROUTE	74	98.7	3.17	5.5	0.43	58	19	6	3	1.263	1.64	1.64	1.64	29	38	38	38
S115A	BASIN	1540			4.3	1.4	213	53	18	8	1.415	1.416	1.416	1.416	105	105	105	105
C115A	COMBINE	1443			4.3	1.83	252	68	23	10	1.28	1.383	1.383	1.383	125	135	135	135
15I15A	ROUTE	1408	100.5	12.26	4.4	1.83	251	68	23	10	1.277	1.383	1.383	1.383	124	135	135	135
S115B	BASIN	789			4.1	0.42	57	14	5	2	1.269	1.269	1.269	1.269	29	29	29	29
C115B	COMBINE	1567			4.4	2.25	288	77	26	11	1.192	1.277	1.277	1.277	143	153	153	153
15I15B	ROUTE	1542	103.4	31.66	4.5	2.25	287	77	26	11	1.185	1.277	1.277	1.277	142	153	153	153
S115C	BASIN	668			4.1	0.43	58	14	5	2	1.246	1.246	1.246	1.246	29	29	29	29
C115C	COMBINE	1695			4.5	2.68	320	86	29	12	1.112	1.192	1.192	1.192	159	170	170	170
D115C	DIVERT	1000			4.2	2.68	265	72	24	10	0.922	1.002	1.002	1.002	132	143	143	143
115120	ROUTE	1002	102.9	13.52	4.5	2.68	265	72	24	10	0.919	1.002	1.002	1.002	131	143	143	143
S120	BASIN	1838			4.3	2	256	64	21	9	1.189	1.189	1.189	1.189	127	127	127	127
C120	COMBINE	2398			4.4	4.68	475	125	42	18	0.943	0.992	0.992	0.992	235	248	248	248
D120	DIVERT	1996			4.5	4.68	453	119	40	17	0.899	0.948	0.948	0.948	225	237	237	237
C105D	COMBINE	3971			4.5	19.28	794	272	126	64	0.383	0.524	0.731	0.856	394	539	752	880
S900	BASIN	936			4.5	1.03	170	43	14	6	1.529	1.535	1.535	1.535	84	85	85	85
RR900	STORAGE	74	4.8	69.22	6.1	1.03	69	42	14	6	0.622	1.502	1.535	1.535	34	83	85	85
90091A	ROUTE	74	100.7	1.69	6.3	1.03	69	42	14	6	0.622	1.5	1.535	1.535	34	83	85	85
90091B	ROUTE	74	98.7	2.76	6.6	1.03	69	42	14	6	0.621	1.498	1.535	1.535	34	83	85	85
S910	BASIN	1585			4.1	0.98	138	35	12	5	1.307	1.307	1.307	1.307	69	69	69	69
C910	COMBINE	1223			4.1	2.02	176	70	24	10	0.812	1.285	1.302	1.302	87	138	140	140
910915	ROUTE	1157	99.9	13.01	4.2	2.02	174	70	24	10	0.802	1.283	1.302	1.302	86	138	140	140
S915	BASIN	1400			4.5	1.13	189	47	16	7	1.562	1.562	1.562	1.562	94	94	94	94
C915	COMBINE	1989			4.3	3.14	332	108	36	16	0.982	1.276	1.288	1.288	165	214	216	216
915920	ROUTE	1897	99.6	55.09	4.5	3.14	325	108	36	16	0.96	1.274	1.288	1.288	161	214	216	216
S920	BASIN	2660			4.5	3.29	424	106	35	15	1.197	1.197	1.197	1.197	210	210	210	210
C920	COMBINE	4053			4.5	6.43	672	193	65	28	0.972	1.117	1.123	1.123	333	383	385	385

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	71	100.2	20.2	19.1	10.23	68	58	41	23	0.062	0.212	0.445	0.579	34	116	243	316
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	100.3	10.27	15.9	10.23	70	59	41	23	0.063	0.213	0.445	0.58	35	116	243	316
C105U	COMBINE	3466			12.5	14.6	593	239	126	66	0.378	0.609	0.961	1.164	294	474	748	906
S110	BASIN	532			12.1	0.43	62	16	5	2	1.35	1.422	1.422	1.422	31	33	33	33
RR110	STORAGE	67	3.9	23.6	13	0.43	52	16	5	2	1.115	1.418	1.422	1.422	26	33	33	33
11015I	ROUTE	66	98.7	2.93	13.4	0.43	51	16	5	2	1.105	1.418	1.422	1.422	25	33	33	33
S115A	BASIN	1536			12.3	1.4	193	50	17	7	1.286	1.321	1.322	1.322	96	98	98	98
C115A	COMBINE	1534			12.3	1.83	237	65	22	9	1.206	1.33	1.333	1.333	118	130	130	130
15I15A	ROUTE	1491	100.6	12.85	12.4	1.83	236	65	22	9	1.203	1.33	1.333	1.333	117	130	130	130
S115B	BASIN	619			12	0.42	47	12	4	2	1.046	1.046	1.046	1.046	23	23	23	23
C115B	COMBINE	1691			12.3	2.25	281	77	26	11	1.161	1.266	1.269	1.269	139	152	152	152
15I15B	ROUTE	1676	103.5	33.59	12.5	2.25	279	77	26	11	1.156	1.266	1.269	1.269	139	152	152	152
S115C	BASIN	534			12.1	0.43	47	12	4	2	1.028	1.028	1.028	1.028	24	24	24	24
C115C	COMBINE	1937			12.4	2.68	323	88	29	13	1.12	1.219	1.221	1.221	160	174	174	174
D115C	DIVERT	1000			12.2	2.68	254	71	24	10	0.883	0.981	0.983	0.983	126	140	140	140
115120	ROUTE	1000	102.9	13.5	12.5	2.68	253	71	24	10	0.88	0.981	0.983	0.983	126	140	140	140
S120	BASIN	2032			12.3	2	247	62	21	9	1.146	1.158	1.158	1.158	122	124	124	124
C120	COMBINE	2880			12.4	4.68	493	132	44	19	0.979	1.045	1.047	1.047	244	261	261	261
D120	DIVERT	2000			12.1	4.68	448	120	40	17	0.889	0.955	0.957	0.957	222	238	239	239
C105D	COMBINE	5244			12.5	19.28	983	337	156	78	0.474	0.65	0.9	1.047	488	668	925	1077
S900	BASIN	853			12.5	1.03	150	39	13	6	1.345	1.416	1.417	1.417	74	78	78	78
RR900	STORAGE	70	4.2	61.68	14	1.03	65	38	13	6	0.581	1.367	1.417	1.417	32	75	78	78
90091A	ROUTE	70	100.7	1.63	14.2	1.03	65	38	13	6	0.581	1.367	1.417	1.417	32	75	78	78
90091B	ROUTE	70	98.6	2.67	14.5	1.03	65	38	13	6	0.58	1.367	1.417	1.417	32	75	78	78
S910	BASIN	1512			12.1	0.98	122	30	10	4	1.151	1.151	1.151	1.151	60	60	60	60
C910	COMBINE	1498			12.1	2.02	171	68	23	10	0.789	1.245	1.272	1.272	85	134	137	137
910915	ROUTE	1363	100.1	15.25	12.2	2.02	169	68	23	10	0.78	1.244	1.272	1.272	84	134	137	137
S915	BASIN	1305			12.4	1.13	165	42	14	6	1.366	1.378	1.378	1.378	82	83	83	83
C915	COMBINE	2415			12.3	3.14	329	108	36	16	0.973	1.274	1.294	1.294	163	214	217	217
915920	ROUTE	2164	99.9	61.34	12.5	3.14	322	108	36	16	0.952	1.273	1.294	1.294	160	213	217	217
S920	BASIN	3157			12.5	3.29	428	107	36	15	1.209	1.209	1.209	1.209	212	212	212	212
C920	COMBINE	5262			12.5	6.43	736	212	71	31	1.063	1.224	1.235	1.235	365	420	424	424

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)
RR11010	Excavated	0.0240	0.0080	1.40	3	4.5	0.045	782	95.6	175.9	1.8	1.9	3.3	1.2	95	4.4	0.57	1.62
RR115A10	Excavated	0.0191	0.0070	0.60	3	6.0	0.045	1691	120.2	318.7	2.7	2.7	4.8	1.2	119	5.3	0.57	2.09
RR115B10	Existing	0.0118	0.0015	1.50	3	5.5	0.030	1000	89.1	138.2	1.6	1.6	3.0	2.5	88	7.2	1.02	0.28
C12010	Existing	0.0100	0.0015	0.80	3	6.5	0.030	2000	115.4	244.2	2.1	2.1	3.8	2.7	114	8.2	0.99	0.36
C910A10	Excavated	0.0198	0.0070	0.70	3	4.0	0.045	667	85.3	158.9	1.9	1.9	3.2	0.8	84	4.2	0.54	1.40
C910B10	Excavated	0.0158	0.0060	0.90	3	5.0	0.045	1498	129.9	320.1	2.5	2.5	3.9	1.1	129	4.7	0.52	1.47
RR91010	Excavated	0.0131	0.0050	0.60	3	7.0	0.045	2881	183.4	574.6	3.1	3.2	5.3	1.7	182	5.0	0.50	1.65
C92010	Excavated	0.0103	0.0040	1.70	3	9.0	0.045	5262	232.0	969.0	4.2	4.2	7.0	2.0	230	5.4	0.47	1.75

Basins Hydraulics Summary

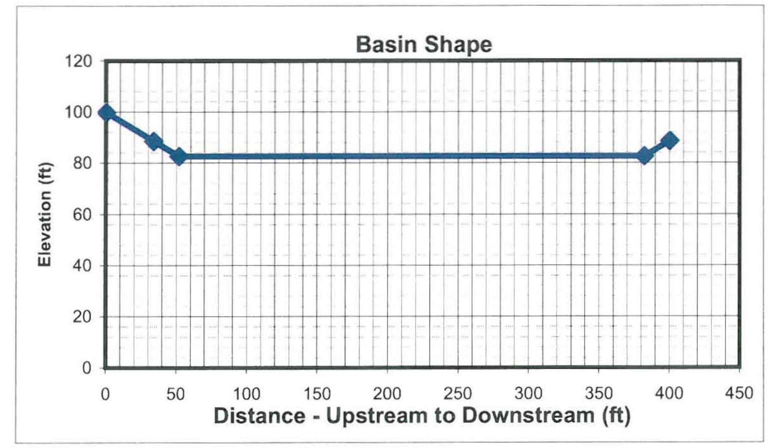
			Design Geometry				Hydraulics					
Structure ID	Type	Adjacent Topo. Slope (ft/ft)	Length (stor ft; chl-mi)	Width (ft)	Depth (ft)	Storage Volume Provided	Peak Storage (ac. Ft)	Total Vol. Entering Basin (ac.	Peak Inflow into Basin (cfs)	Peak Outflow (cfs)	Peak Stage (ft)	Freeboard (ft)
RR110	Online Basin	0.0280	800	400	6.0	30.9	29.3	38.0	662	74	4.8	1.2
D115C	Offline Basin	0.0200	950	450	5.0	34.7	34.0	34.0	937	0	2.7	2.3
D120	Offline Basin	0.0200	700	400	5.0	22.4	22.0	22.0	880	0	1.7	3.3
RR900	Online Basin	0.0276	1400	525	6.0	73.0	69.2	85.0	936	74	4.8	1.2

Online Basin

HEC1 ID	RR110

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	0.4	sq. mi
Total Sediment Yield Volume	0.8	ac ft

Required Minimum Sediment Volume

Sediment Volume	0.8	ac. ft

Geometry	Base	LC Enhanced
Topography slope (ft/ft)	0.028	0.028
Basin Length (ft)	800	970
Basin Width (ft)	400	400
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	6	6
Freeboard (ft)	1	1
Effective Basin Width (ft)	366	333
Top Area (acres)	7.3	8.9
U/S-D/S Height Difference (ft)	11.2	11.2
Excess Area on Upstream (acres)	0.7	1.5

			Base	LC Enhanced
Bottom Length (ft)	764	Allocated Storage Volume (ac. ft)	30.9	31
Bottom Width (ft)	330	Total Available Volume (ac. ft) (incl. Freeboard)	37.5	38.3
		Total Excavation Volume (ac. ft)	78.7	88.2

HEC1 Results

	6-hr Event	24-hr Event	Maximum
Total Flow Volume entering Basin (ac. ft)	38.0	33	38.0
Peak Inflow (cfs)	662	532	662.0
Peak Outflow (cfs)	74	67	74.0
Stage at Peak Outflow (ft)	4.8	3.9	4.8
Volume at Peak Outflow (ac. ft)	29.3	23.6	29.3

Volume Check

Total Volume needed	30.1	ac. ft
Total Volume Provided	30.9	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)	3.00	ft
Invert Elevation	0.00	ft
Number of pipes	1	

Stage-Storage-Discharge

Elevation	0	0.5	1	1.5	2	2.5	3	3.5	4	5
Volume	0.00	2.91	5.86	8.85	11.88	14.94	18.05	21.19	24.37	30.86
Outflow	0.0	24.1	34.0	41.7	48.1	53.8	59.0	63.7	68.1	76.1

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
LC Enhancement Buffer	215000	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	1070	ft
LC Enh. Total ROW Length	500	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	126969	142296
Excavated Area (sq. Yd)	35556	59444

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	54	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	604	sq. Yd
Material Volume	302	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	261	ft
Unit Cost	160	per ft
Cost per outlet	$41,760	
Other Cost	$ -	
Total Cost	$41,760	
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		126,969	cu. Yd	$ 4.00	$ 507,876	35,556	sq. Yd	$ 9.00	$ 320,004	35,556	sq. Yd	$ 8.33	$ 296,300
Basin - LC Enhancement		15,327	cu. Yd	$ 4.00	$ 61,308	23,888	sq. Yd	$ 9.00	$ 214,992	23,888	sq. Yd	$ 8.33	$ 199,067
Inlet	Riprap	302	sq. Yd	$ 75.00	$ 22,650	604	sq. Yd	$ -	$ -	604	sq. Yd	$ 33.33	$ 20,133
Inlet - LC Enhancement (20%Inlet)					$ 4,530				$ -				$ 4,027
Outlet	Pipe	1	EA	$ 41,760	$ 41,760	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhancement (5% Outlet)					$ 2,088				$ -				$ 111
Other					$ -				$ -				$ -

Base Landscape Cost	$ 320,004
LC Enh. Landscape Cost	$ 214,992
Total Landscape Cost	$ 534,996

Base Maintenance Cost	$ 318,650
LC Enh. Maintenance Cost	$ 203,204
Total Maintenance Cost	$ 521,854

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 572,286	$ 61,308	$ 633,594
Contingency Cost (25% of Construction Cost)	$ 143,072	$ 15,327	$ 158,399
Engineering Design Cost (5% of Construction Cost)	$ 28,614	$ 3,065	$ 31,680
Total Construction Cost	$ 743,972	$ 79,700	$ 823,672

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	7.3	$100,000	$ 730,000
Other		$100,000	$ -
Total	12.2	$100,000	$ 1,220,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	7.3	$100,000	$ 730,000
LC Enhancement Cost	acre	4.9	$100,000	$ 490,000
Total Land Cost	acre	12.2	$100,000	$ 1,220,000

Total Cost

Base Total Cost	$ 2,112,626
Total LC Enhancement Cost	$ 987,897
Total Cost Including LC Enh.	$ 3,100,522

Open Channel

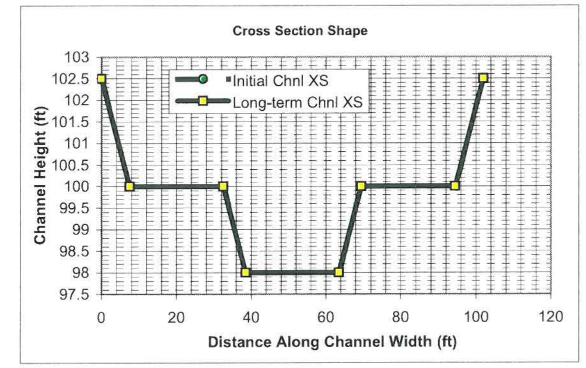
Structure ID	RR11010	HEC1 ID	11015I

Longitundal Geometry

Length	7199.5	ft
U/S Elev	1865.3	ft
D/S Elev	1692.1	ft
Initial Channel Slope	0.0240	ft/ft
Long-term Channel Slope	0.0080	ft/ft

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

NSTPS	6



Initial Channel XS Geometry

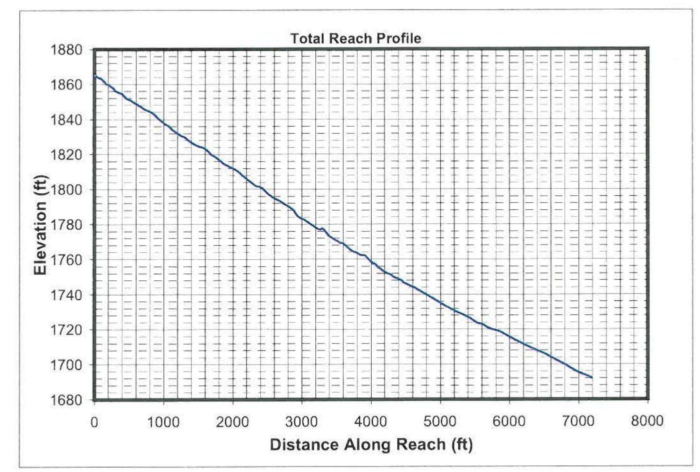
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	2.5	25	3	25	4.5	3	25	2.5	3

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	RR110	S115A								TOTAL
HEC1 Peak-Flow	74	1540								1614
Weighting Factor	1.00	0.46								
Flow into Channel	74	708								782

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	1.073	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	782	cfs	
Long-term Max. Chnl Capacity	1789	cfs	
Q2 Channel	78	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			

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
78	31.4	28.3	0.9	98.0	99.0	2.8	1.0	31.1	0.9	0.50	0.51
196	35.8	51.7	1.4	98.0	99.7	3.8	1.7	35.3	1.5	0.86	0.55
587	93.6	146.8	1.6	98.0	100.9	4.0	2.9	92.7	1.6	1.47	0.56
782	95.6	175.9	1.8	98.0	101.3	4.4	3.3	94.5	1.9	1.62	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
78	31.4	28.3	0.9	98.0	99.0	2.8	1.0	31.1	0.9	0.50	0.51
196	35.8	51.7	1.4	98.0	99.7	3.8	1.7	35.3	1.5	0.86	0.55
587	93.6	146.8	1.6	98.0	100.9	4.0	2.9	92.7	1.6	1.47	0.56
782	95.6	175.9	1.8	98.0	101.3	4.4	3.3	94.5	1.9	1.62	0.57

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
78										0
196										0
587										0
782										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)		
78	1.74	1.3667	1.2984	Erosive	Erosive	Erosive	0.3	Stable	5.2	Stable	Stable
196	1.74	1.5132	1.4375	Erosive	Erosive	Erosive	0.4	Stable	7.4	Stable	Stable
587	1.74	1.5372	1.4604	Erosive	Erosive	Erosive	0.4	Stable	9.8	Stable	Stable
782	1.74	1.5869	1.5075	Erosive	Erosive	Erosive	0.4	Stable	10.6	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)	78	196	587	782	78	196	587	782	78	196	587	782
Bray - Equation #1	24	38	68	80	1.1	1.5	2.2	2.4	2.9	3.3	3.9	4.0
Bray - Equation #2	31	50	90	105	1.3	1.7	2.4	2.7	2.0	2.3	2.7	2.8
Hey	7	11	21	25	3.4	4.8	7.3	8.1				
Ackers & Charlton/Lacey	22	33	52	59					1.7	1.9	2.3	2.4
Parker	61	96	166	192	0.8	1.2	2.0	2.2				
Chang	43	76	148	176	0.1	-0.1	-0.4	-0.5				
Kellerhals	16	25	44	50	1.6	2.2	3.5	3.9	3.2	3.5	3.9	4.0
AMAFCA/Schumm	31	35	93	95								
Moody & Odem	13	13	13	13	1.0	1.0	1.0	1.0				
BUREC	12.5	17.6	26.6	29.6	3	5	7	8	3.0	3.7	4.9	5.3
Average	26	40	72	82	1.6	2.1	3.1	3.5	2.5	2.9	3.5	3.7
Values As Designed	31	35	93	95	1.0	1.7	2.9	3.3	2.8	3.8	4.0	4.4
Difference with Design	-5	4	-20	-12	0.6	0.4	0.2	0.2	-0.2	-0.8	-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
78	539	327	768	5404	1239	257	101	117	5417	304	1573	1459
196	2055	940	1959	23439	1835	1139	284	448	13631	1026	5354	4737
587	6694	2810	5823	77269	5026	3799	869	1441	40922	3259	16954	14988
782	10320	3907	7599	124242	5592	6147	1175	2153	54623	4826	24699	22298

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
78	2556	1551	3642	25639	5877	1218	478	553	25699	1440	7464	6920
196	3900	1783	3717	44480	3482	2162	539	850	25868	1947	10160	8990
587	4234	1778	3684	48878	3180	2403	549	911	25886	2061	10725	9481
782	4896	1854	3605	58944	2653	2916	557	1021	25915	2289	11718	10579

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
78	539	271	467	1040	623	131	101	117	1001	123	623	458
196	2055	803	1263	4511	970	473	284	448	2576	448	2269	1464
587	6694	2414	3885	14870	2673	1510	869	1441	7751	1438	7270	4620
782	10320	3380	5014	23910	3009	2243	1175	2153	10386	2190	10827	6782

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
78	2556	1285	2216	4934	2956	624	478	553	4749	584	2957	2172
196	3900	1524	2396	8560	1840	897	539	850	4889	850	4306	2777
587	4234	1527	2458	9407	1691	955	549	911	4903	910	4599	2922
782	4896	1604	2379	11344	1428	1064	557	1021	4927	1039	5137	3218

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)
78	0.0009	0.0013	274	0.83	0.054	0.0003	32	0.036	0.0002	0.0159	0.0003	0.0007	0.0082	0.0005	0.0021	0.0079	0.0043
196	0.0005	0.0008	346	1.06	0.056	0.0002	32	0.036	0.0001	0.0159	0.0002	0.0004	0.0082	0.0003	0.0011	0.0078	0.0042
587	0.0004	0.0008	361	1.10	0.056	0.0002	33	0.036	0.0001	0.0159	0.0002	0.0004	0.0082	0.0002	0.0005	0.0079	0.0042
782	0.0004	0.0007	391	1.19	0.057	0.0002	33	0.036	0.0001	0.0159	0.0001	0.0003	0.0082	0.0002	0.0004	0.0079	0.0041

Drop Structures

Design Slope	0.0080	ft/ft
Total Drop Needed	115.2	ft
Height of Drop Structure	3	ft
No . of Drop Structures	39	
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	0.64	sq. mi
Total Sediment Yield Volume	1.22	ac ft

Sedimentation Basins

Length	185 ft	Depth	3 ft
Width	102 ft	Side slope	3 ft/ft
Total Volume per Basin		1.13	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)
78	1.1	-0.3	0.1	24.6	1.0	0.9	2.8	0.0080	0.1	0.0	2.0	2.8
196	1.1	-0.5	0.2	24.6	1.7	1.5	3.8	0.0080	0.2	0.0	2.0	3.0
587	1.1	-0.8	0.2	24.6	2.9	1.6	4.0	0.0080	0.3	0.0	2.0	3.2
782	1.1	-0.8	0.3	24.6	3.3	1.9	4.4	0.0080	0.4	0.0	2.0	3.3

Toe Protection Needed	4.0	ft

HEC1 Results For Open Channel

Peak Flow	74	cfs
Stage at Peak Flow	98.7	ft
Flow Volume	38.0	ac. ft

Freeboard

Max. Flow Depth	3.3	ft
Channel Depth as designed	4.5	ft
Available Freeboard	1.2	ft
Required Freeboard	1	ft

Sediment Volume

Inflowing Sediment Volume	1.22	ac. ft
Outflowing Sediment Volume	0.05	ac. ft
Deposited(+)/Eroded(-) Volume	1.18	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	7199	7199
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)	1645794	2076596
Excavated Area (sq. Yd)	81589	103186

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	7199	ft
Thickness	1.5	ft
Protection Depth	4	ft
Tie-in Length/Depth	3.0	ft
Total Depth	7.0	ft
Area needed	1200	sq. Yd
Volume	2800	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)	7199	7199
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)	7199	7199
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	7.9	ft
Structure Height	10.9	ft
Number of Structures	39	
Volume per structure	123	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 9,225	
Area per structure	34	sq. Yd
Total Area	1,326	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	4	
Total Volume per Basin	1823	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 7,292	
Other Cost	$ -	
Total cost per basin	$ 7,292	
Area per basin	2,092	sq. Yd
Total Area	8,368	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	1,645,794	cu. Yd	$ 10.00	$ 16,457,940	81,589	sq. Yd	$ 9.00	$ 734,301	81,589	sq. Yd	$ 8.33	$ 679,908
Exc. Chl - LC Enhancement	Excavated	430,802	cu. Yd	$ 10.00	$ 4,308,020	21,597	sq. Yd	$ 9.00	$ 194,373	21,597	sq. Yd	$ 8.33	$ 179,975
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	2,800	cu. Yd	$ 75.00	$ 210,000	1,200	sq. Yd	$ -	$ -	1,200	sq. Yd	$ 25.00	$ 30,000
Drop Structures	Riprap	39	EA	$ 9,225.00	$ 359,775	1,326	sq. Yd	$ -	$ -	1,326	sq. Yd	$ 33.33	$ 44,200
Drop Str. - LC Enhancement	Riprap	39	EA	$ 922.50	$ 35,978	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 33.33	$ 4,420
Sedimentation Basins		4	EA	$ 7,292.00	$ 29,168	8,368	sq. Yd	$ -	$ -	8,368	sq. Yd	$ 8.33	$ 69,733
Other					$ -				$ -				$ -

Base Landscape Cost	$ 734,301	Base Maintenance Cost	$ 823,842
LC Enhancement Cost	$ 194,373	LC Enhancement Cost	$ 184,395
Total Landscape Cost	$ 928,674	Total Maintenance Cost	$ 1,008,237

Construction Cost Component	**Base**	**LC Enhancement**	**Total**
Construction Cost	$ 17,056,883	$ 4,343,998	$ 21,400,881
Contingency Cost (25% of Construction Cost)	$ 4,264,221	$ 1,085,999	$ 5,350,220
Engineering Design Cost (5% of Construction Cost)	$ 852,844	$ 217,200	$ 1,070,044
Total Construction Cost	$ 22,173,948	$ 5,647,197	$ 27,821,145

Land Cost

Channel Length	7199 ft

Land Cost Component	**Width (ft)**	**Area (acre)**	**Unit Cost**	**Cost**
Misc. Right of Way	134	22.1	$100,000	$ 2,210,000
LC Enhancement Buffer	50	8.3	$100,000	$ 830,000
Channel	102	16.9	$100,000	$ 1,690,000
Channel LC Enhancement	27	4.5	$100,000	$ 450,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	313	51.8		$ 5,180,000

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	39	$100,000	$ 3,900,000
LC Enhancement Cost	acre	12.8	$100,000	$ 1,280,000
Total Land Cost	acre	51.8	$100,000	$ 5,180,000

Total Cost

Base Total Cost	$ 27,632,091
Total Landscape Enhancement Cost	$ 7,305,965
Total Cost Including LC Enh.	$ 34,938,055

Open Channel

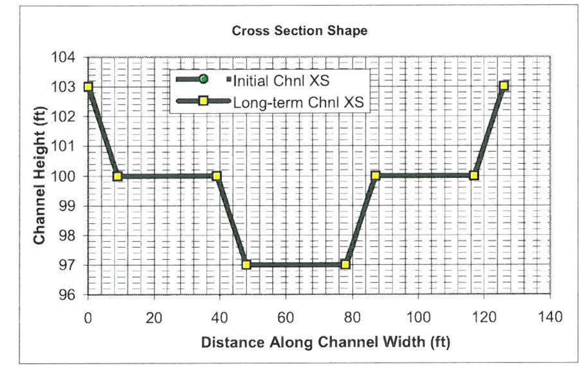
Structure ID	RR115A10	HEC1 ID	15I15A

Longitundal Geometry

Length	3083.7	ft
U/S Elev	1692.1	ft
D/S Elev	1633.3	ft
Initial Channel Slope	0.0191	ft/ft
Long-term Channel Slope	0.0070	ft/ft

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

NSTPS	2



Initial Channel XS Geometry

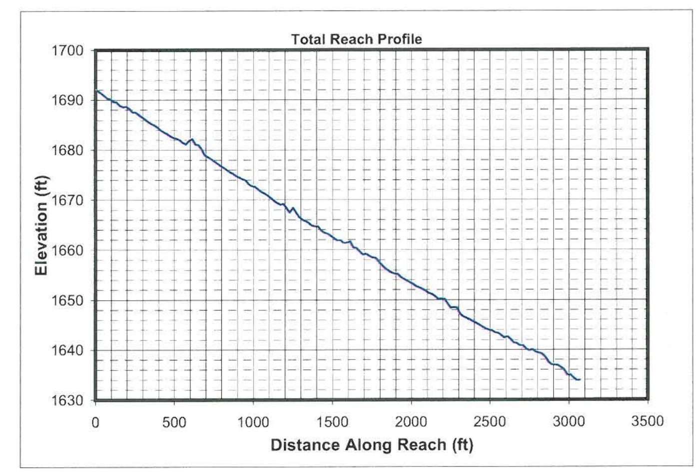
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	3	30	3	30	6	3	30	3	3

PT. ID	1	2	3	4	5	6	7	8
X	0	9	39	48	78	87	117	126
Y	103	100	100	97	97	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	30	6	3	30	3	3

PT. ID	1	2	3	4	5	6	7	8
X	0	9	39	48	78	87	117	126
Y	103	100	100	97	97	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	C115B									TOTAL
HEC1 Peak-Flow	1691									1691
Weighting Factor	1.00									
Flow into Channel	1691									1691

Reach Sediment Inflow Characteristics

U/S Contributing ID	11015I_RR11010									TOTAL
HEC1 Flow Volume (ac. ft)	38.00									38
Sediment Conc. (ppm)	3218									
Sediment Volume (ac. ft)	0.05									0.05
Weighting Factor	1									
Weighted Sed. Vol. (ac. ft)	0.05									0.05

Hydrology

Drainage Area	2.25	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	1691	cfs	
Long-term Max. Chnl Capacity	3078	cfs	
Q2 Channel	169	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	126	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
169	39.4	51.2	1.3	97.0	98.5	3.3	1.5	38.9	1.3	0.65	0.51
423	45.9	94.4	2.1	97.0	99.5	4.5	2.5	45.1	2.1	1.10	0.55
1268	117.4	265.6	2.3	97.0	101.3	4.8	4.3	116.0	2.3	1.89	0.56
1691	120.2	318.7	2.7	97.0	101.8	5.3	4.8	118.7	2.7	2.09	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
169	39.4	51.2	1.3	97.0	98.5	3.3	1.5	38.9	1.3	0.65	0.51
423	45.9	94.4	2.1	97.0	99.5	4.5	2.5	45.1	2.1	1.10	0.55
1268	117.4	265.6	2.3	97.0	101.3	4.8	4.3	116.0	2.3	1.89	0.56
1691	120.2	318.7	2.7	97.0	101.8	5.3	4.8	118.7	2.7	2.09	0.57

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
	11015I_RR11010									
169	458									458
423	1464									1464
1268	4620									4620
1691	6782									6782

Allowable Velocity

Channel Lining	Natural - Coarse Gravel (noncolloidal)

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)		
169	1.74	1.4802	1.4062	Erosive	Erosive	Erosive	0.3	Stable	6.3	Stable	Stable
423	1.74	1.6232	1.5421	Erosive	Erosive	Erosive	0.4	Stable	8.9	Stable	Stable
1268	1.74	1.6510	1.5684	Erosive	Erosive	Erosive	0.4	Stable	11.8	Stable	Stable
1691	1.74	1.7000	1.6150	Erosive	Erosive	Erosive	0.4	Stable	12.8	Stable	Stable

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

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	**169**	**423**	**1268**	**1691**	**169**	**423**	**1268**	**1691**	**169**	**423**	**1268**	**1691**
Bray - Equation #1	36	58	103	120	1.5	2.0	2.9	3.2	3.2	3.7	4.3	4.5
Bray - Equation #2	47	76	135	157	1.6	2.2	3.1	3.5	2.2	2.5	3.0	3.1
Hey	11	18	33	39	4.5	6.4	9.7	10.9				
Ackers & Charlton/Lacey	31	46	72	82					1.9	2.2	2.6	2.8
Parker	89	141	245	283	1.2	1.7	2.7	3.0				
Chang	66	116	225	268	0.0	-0.2	-0.7	-0.9				
Kellerhals	23	37	64	74	2.1	3.1	4.7	5.3	3.4	3.7	4.2	4.3
AMAFCA/Schumm	39	45	116	119								
Moody & Odem	17	17	17	17	1.1	1.1	1.1	1.1				
BUREC	17.1	24.1	36.4	40.5	5	6	10	11	3.4	4.3	5.6	6.1
Average	38	58	105	120	2.1	2.8	4.2	4.6	2.8	3.3	3.9	4.1
Values As Designed	39	45	116	119	1.5	2.5	4.3	4.8	3.3	4.5	4.8	5.3
Difference with Design	-1	13	-11	1	0.6	0.3	-0.2	-0.2	-0.5	-1.2	-0.8	-1.2

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
169	1301	670	1428	11909	1681	557	201	295	8338	655	3421	2769
423	4905	1879	3378	50956	2513	2475	537	1048	20950	2225	11278	9286
1268	16179	5643	10093	170444	6786	8337	1636	3372	62889	7145	35873	29854
1691	24896	7799	13339	273441	7561	13340	2190	4961	83924	10601	51916	44906

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
169	2854	1469	3134	26129	3687	1222	441	647	18293	1436	7505	6074
423	4305	1649	2964	44718	2206	2172	471	920	18385	1952	9897	8149
1268	4733	1651	2952	49860	1985	2439	479	986	18397	2090	10494	8733
1691	5462	1711	2927	59992	1659	2927	481	1088	18413	2326	11390	9852

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
169	1301	573	891	2642	916	295	201	295	1801	283	1494	972
423	4905	1644	2315	11306	1422	1016	537	1048	4592	1036	5222	3186
1268	16179	4958	6866	37816	3860	3266	1636	3372	13807	2792	16809	10124
1691	24896	6888	8945	60668	4339	4827	2190	4961	18471	3014	24806	14910

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
169	2854	1257	1955	5797	2009	646	441	647	3951	620	3277	2132
423	4305	1442	2032	9922	1248	892	471	920	4029	909	4582	2796
1268	4733	1450	2009	11062	1129	955	479	986	4039	817	4917	2962
1691	5462	1511	1962	13310	952	1059	481	1088	4053	661	5442	3271

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)
169	0.0006	0.0009	293	0.89	0.054	0.0002	32	0.036	0.0001	0.0159	0.0002	0.0005	0.0063	0.0004	0.0014	0.0069	0.0035
423	0.0003	0.0006	369	1.12	0.057	0.0001	33	0.036	0.0001	0.0159	0.0001	0.0003	0.0063	0.0002	0.0007	0.0068	0.0034
1268	0.0003	0.0005	387	1.18	0.057	0.0001	33	0.036	0.0001	0.0159	0.0001	0.0003	0.0063	0.0001	0.0003	0.0069	0.0034
1691	0.0002	0.0005	419	1.28	0.058	0.0001	33	0.036	0.0001	0.0159	0.0001	0.0002	0.0063	0.0001	0.0002	0.0069	0.0034

Drop Structures

Design Slope	0.0070	ft/ft
Total Drop Needed	37.3	ft
Height of Drop Structure	3	ft
No . of Drop Structures	13	
Distance between structs.	237	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	1.60	sq. mi
Total Sediment Yield Volume	3.05	ac ft

Sedimentation Basins

Length	237 ft	Depth	3 ft
Width	126 ft	Side slope	3 ft/ft
Total Volume per Basin		1.84	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)
169	1.1	-0.4	0.1	24.6	1.5	1.3	3.3	0.0070	0.2	0.0	1.0	1.6
423	1.1	-0.6	0.3	24.6	2.5	2.1	4.5	0.0070	0.3	0.0	1.0	1.9
1268	1.1	-1.0	0.3	24.6	4.3	2.3	4.8	0.0070	0.5	0.0	1.0	2.2
1691	1.1	-1.1	0.4	24.6	4.8	2.7	5.3	0.0070	0.6	0.0	1.0	2.3

Toe Protection Needed	3.0	ft

HEC1 Results For Open Channel

Peak Flow	1491	cfs
Stage at Peak Flow	100.6	ft
Flow Volume	135.0	ac. ft

Freeboard

Max. Flow Depth	4.8	ft
Channel Depth as designed	6.0	ft
Available Freeboard	1.2	ft
Required Freeboard	1.3	ft

Sediment Volume

Inflowing Sediment Volume	3.09	ac. ft
Outflowing Sediment Volume	0.17	ac. ft
Deposited(+)/Eroded(-) Volume	2.93	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	3084	3084
Side Slope (?H:1V)	3	6
Channel Width (ft)	126	162
Channel XS Area (sq. ft)	468	576
Channel Perimeter (ft)	128	163

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	321985	411043
Excavated Area (sq. Yd)	43176	55512

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	3084	ft
Thickness	1.5	ft
Protection Depth	3	ft
Tie-in Length/Depth	3.0	ft
Total Depth	6.0	ft
Area needed	514	sq. Yd
Volume	1028	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)	3084	3084
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)	3084	3084
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	126	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	13	
Volume per structure	192	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 14,400	
Area per structure	42	sq. Yd
Total Area	546	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	6	
Total Volume per Basin	2969	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 11,876	
Other Cost	$ -	
Total cost per basin	$ 11,876	
Area per basin	3,321	sq. Yd
Total Area	19,926	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	321,985	cu. Yd	$ 10.00	$ 3,219,850	43,176	sq. Yd	$ 9.00	$ 388,584	43,176	sq. Yd	$ 8.33	$ 359,800
Exc. Chl - LC Enhancement	Excavated	89,058	cu. Yd	$ 10.00	$ 890,580	12,336	sq. Yd	$ 9.00	$ 111,024	12,336	sq. Yd	$ 8.33	$ 102,800
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	1,028	cu. Yd	$ 75.00	$ 77,100	514	sq. Yd	$ -	$ -	514	sq. Yd	$ 25.00	$ 12,850
Drop Structures	Riprap	13	EA	$ 14,400.00	$ 187,200	546	sq. Yd	$ -	$ -	546	sq. Yd	$ 33.33	$ 18,200
Drop Str. - LC Enhancement	Riprap	13	EA	$ 1,440.00	$ 18,720	55	sq. Yd	$ -	$ -	55	sq. Yd	$ 33.33	$ 1,820
Sedimentation Basins		6	EA	$ 11,876.00	$ 71,256	19,926	sq. Yd	$ -	$ -	19,926	sq. Yd	$ 8.33	$ 166,050
Other					$ -				$ -				$ -

Base Landscape Cost	$ 388,584	
LC Enhancement Cost	$ 111,024	
Total Landscape Cost	$ 499,608	

Base Maintenance Cost	$ 556,900
LC Enhancement Cost	$ 104,620
Total Maintenance Cost	$ 661,520

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 3,555,406	$ 909,300	$ 4,464,706
Contingency Cost (25% of Construction Cost)	$ 888,852	$ 227,325	$ 1,116,177
Engineering Design Cost (5% of Construction Cost)	$ 177,770	$ 45,465	$ 223,235
Total Construction Cost	$ 4,622,028	$ 1,182,090	$ 5,804,118

Land Cost

Channel Length	3084 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	134	9.5	$100,000	$ 950,000
LC Enhancement Buffer	50	3.5	$100,000	$ 350,000
Channel	126	8.9	$100,000	$ 890,000
Channel LC Enhancement	36	2.5	$100,000	$ 250,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	346	24.4		$ 2,440,000

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	18.4	$100,000	$ 1,840,000
LC Enhancement Cost	acre	6	$100,000	$ 600,000
Total Land Cost	acre	24.4	$100,000	$ 2,440,000

Total Cost

Base Total Cost	$ 7,407,512
Total Landscape Enhancement Cost	$ 1,997,734
Total Cost Including LC Enh.	$ 9,405,246

JE FULLER
HYDROLOGY & GEOMORPHOLOGY, INC

Sub-area: CAP, Alternative: B3
Open Channel Structure ID: RR115A10

Open Channel

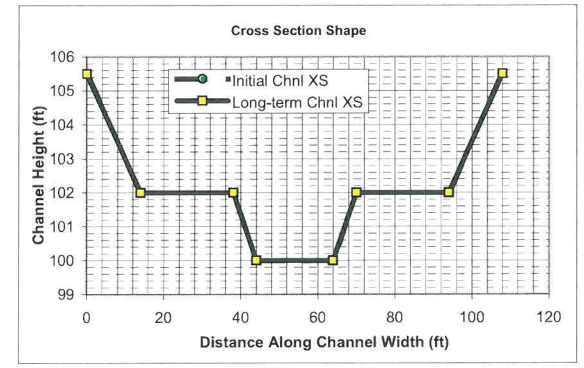
Structure ID	RR115B10	HEC1 ID	15I15B

Longitundal Geometry

Length	8073.3	ft
U/S Elev	1633.3	ft
D/S Elev	1537.8	ft
Initial Channel Slope	0.0118	ft/ft
Long-term Channel Slope	0.0015	ft/ft

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

NSTPS	7



Initial Channel XS Geometry

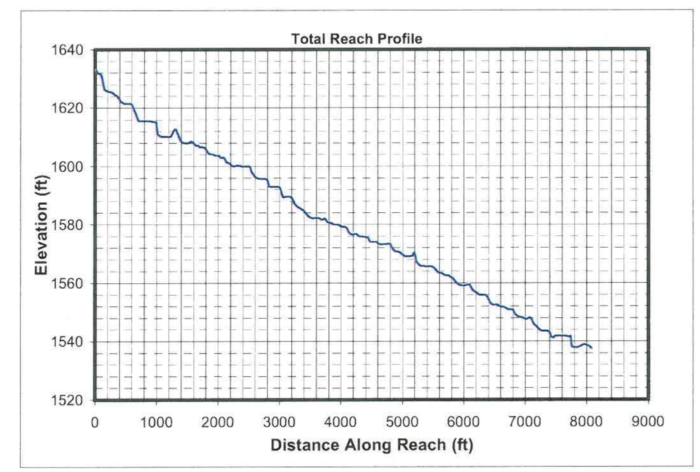
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
4	3.5	24	3	20	5.5	3	24	3.5	4

PT. ID	1	2	3	4	5	6	7	8
X	0	14	38	44	64	70	94	108
Y	105.5	102	102	100	100	102	102	105.5

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
4	3.5	24	3	20	5.5	3	24	3.5	4

PT. ID	1	2	3	4	5	6	7	8
X	0	14	38	44	64	70	94	108
Y	105.5	102	102	100	100	102	102	105.5



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	0.03	0.03	0.03	0.03	0.03	0.03

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	D115C									TOTAL
HEC1 Peak-Flow	1000									1000
Weighting Factor	1.00									
Flow into Channel	1000									1000

Reach Sediment Inflow Characteristics

U/S Contributing ID	15I15A_RR115A10									TOTAL
HEC1 Flow Volume (ac. ft)	135.00									135
Sediment Conc. (ppm)	3271									
Sediment Volume (ac. ft)	0.17									0.17
Weighting Factor	1									
Weighted Sed. Vol. (ac. ft)	0.17									0.17

Hydrology

Drainage Area	0.42	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	1000	cfs	
Long-term Max. Chnl Capacity	1683	cfs	
Q2 Channel	100	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	108	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	25.9	21.2	0.8	100.0	100.9	4.7	0.9	25.6	0.8	0.09	0.92
250	29.9	38.9	1.3	100.0	101.6	6.4	1.6	29.4	1.3	0.15	0.99
750	86.9	115.1	1.3	100.0	102.8	6.5	2.8	86.1	1.3	0.26	0.99
1000	89.1	138.2	1.6	100.0	103.0	7.2	3.0	88.2	1.6	0.28	1.02

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	30.6	42.1	1.4	100.0	101.7	2.4	1.7	30.1	1.4	0.16	0.35
250	86.5	110.4	1.3	100.0	102.7	2.3	2.7	85.6	1.3	0.25	0.35
750	96.7	223.3	2.3	100.0	104.0	3.4	4.0	95.6	2.3	0.37	0.39
1000	100.6	269.6	2.7	100.0	104.4	3.7	4.4	99.4	2.7	0.41	0.40

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
	15I15A_RR115A 10									
100	972									972
250	3186									3186
750	10124									10124
1000	14910									14910

Allowable Velocity

Channel Lining: Natural - Sandy Loam (noncolloidal)

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
100	1.74	1.3370	1.2702	Erosive	Erosive	Erosive	0.3	Erosive	3.1	Erosive	Stable
250	1.74	1.4812	1.4072	Erosive	Erosive	Erosive	0.3	Erosive	3.9	Erosive	Stable
750	1.74	1.4851	1.4108	Erosive	Erosive	Erosive	0.3	Erosive	5.3	Erosive	Stable
1000	1.74	1.5339	1.4572	Erosive	Erosive	Erosive	0.4	Erosive	5.7	Erosive	Stable

USCOE Allowable Velocity (ft/s)	2
FHWA Allowable Velocity (ft/s)	2.5

Regime Width

Discharge (cfs)	Channel Width (ft) 100	250	750	1000	Flow Depth (ft) 100	250	750	1000	Velocity (ft/s) 100	250	750	1000
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	28	49	97	116	0.5	0.6	0.7	0.6				
Kellerhals	18	28	49	57	1.7	2.5	3.8	4.3	3.2	3.5	4.0	4.1
AMAFCA/Schumm	30	86	96	100								
Moody & Odem	9	9	9	9	0.8	0.8	0.8	0.8				
BUREC	16.1	22.7	34.2	38.1	4	6	9	10	2.3	2.9	3.8	4.0
Average	26	45	74	84	1.8	2.5	3.7	4.1	2.5	2.8	3.4	3.5
Values As Designed	30	86	96	99	1.7	2.7	4.0	4.4	2.4	2.3	3.4	3.7
Difference with Design	-4	-40	-22	-15	0.1	-0.2	-0.2	-0.3	0.1	0.6	0.0	-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)											
100	2261	1265	1788	3899	626	905	618	787	2379	469	2144	1558
250	8549	3406	4339	16752	965	2888	1498	2515	6012	1009	7069	5000
750	26365	9940	13124	51240	2843	8815	4538	7681	18041	2946	21608	15195
1000	40579	13639	17787	82145	3198	12821	5969	11044	24104	3170	31411	22352

Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
	Sediment Concentrations (ppm by weight)											
100	8388	4692	6635	14463	2323	3358	2291	2921	8827	1741	7956	5781
250	12687	5055	6438	24860	1432	4286	2223	3732	8922	1497	10491	7420
750	13042	4917	6492	25347	1406	4361	2245	3800	8924	1457	10689	7516
1000	15055	5060	6599	30476	1186	4757	2215	4097	8942	1176	11653	8292

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)											
100	117	105	99	115	208	26	35	58	70	6	117	87
250	276	242	223	263	541	60	81	132	162	15	271	206
750	1416	1083	1150	1576	1085	330	363	763	696	72	1539	916
1000	2161	1550	1560	2500	1282	488	507	1152	965	95	2359	1329

Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
	Sediment Concentrations (ppm by weight)											
100	433	389	367	427	771	98	128	215	260	21	435	322
250	409	360	331	390	803	89	120	196	240	22	402	306
750	701	536	569	780	537	163	180	377	344	35	761	453
1000	802	575	579	928	475	181	188	427	358	35	875	493

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson n	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	0.0006	0.0008	183	0.56	0.050	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0005	0.0075	0.0005	0.0018	0.0117	0.0050
250	0.0003	0.0005	231	0.70	0.052	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0003	0.0075	0.0003	0.0009	0.0116	0.0049
750	0.0003	0.0005	233	0.71	0.052	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0003	0.0075	0.0002	0.0004	0.0117	0.0049
1000	0.0003	0.0004	252	0.77	0.053	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0002	0.0075	0.0002	0.0003	0.0117	0.0049

Drop Structures

Design Slope	0.0015	ft/ft
Total Drop Needed	83.4	ft
Height of Drop Structure	3	ft
No . of Drop Structures	28	
Distance between structs.	288	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	0.00	sq. mi
Total Sediment Yield Volume	0.00	ac ft

Sedimentation Basins

Length	288 ft	Depth	3 ft
Width	108 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	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	1.7	1.4	2.4	0.0015	0.2	0.0	1.0	1.6
250	1.1	-0.4	0.1	24.6	2.7	1.3	2.3	0.0015	0.3	0.0	1.0	1.8
750	1.1	-0.4	0.2	24.6	4.0	2.3	3.4	0.0015	0.5	0.0	1.0	2.1
1000	1.1	-0.3	0.2	24.6	4.4	2.7	3.7	0.0015	0.6	0.0	1.0	2.2

Toe Protection Needed	3.0	ft

HEC1 Results For Open Channel

Peak Flow	1676	cfs
Stage at Peak Flow	103.5	ft
Flow Volume	153.0	ac. ft

Freeboard

Max. Flow Depth	3.0	ft
Channel Depth as designed	5.5	ft
Available Freeboard	2.5	ft
Required Freeboard	1.2	ft

Sediment Volume

Inflowing Sediment Volume	0.17	ac. ft
Outflowing Sediment Volume	0.03	ac. ft
Deposited(+)/Eroded(-) Volume	0.14	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Existing	Existing
Channel Length (ft)	8073	8073
Side Slope (?H:1V)	3	3
Channel Width (ft)	108	108
Channel XS Area (sq. ft)	381	381
Channel Perimeter (ft)	110	110

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	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	0	ft
Thickness	0.0	ft
Protection Depth	0	ft
Tie-in Length/Depth	0.0	ft
Total Depth	0.0	ft
Area needed	0	sq. Yd
Volume	0	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)	8073	8073
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)	8073	8073
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	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	0	ft
LC Enhancement Ratio	1.1	
Structure Thickness	0	ft
Drop Height	0	ft
Scour Depth		ft
Structure Height		ft
Number of Structures	0	
Volume per structure	0	cu. Yd
Unit Cost	$ -	cu. Yd
Other Cost	$ -	
Cost per structure	$ -	
Area per structure	0	sq. Yd
Total Area	0	sq. Yd

Sedimentation Basins		
Include Sed. Basins	No	
(Yes/No)		
Number of basins	0	
Total Volume per Basin	3081	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: Structure Type	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	Existing	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Existing	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	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Drop Structures	None	0	EA	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Drop Str. - LC Enhancement	None	0	EA	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Sedimentation Basins		1	EA	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ 8.33	$ -
Other					$ -				$ -				$ -

Base Landscape Cost	$ -	Base Maintenance Cost	$ -
LC Enhancement Cost	$ -	LC Enhancement Cost	$ -
Total Landscape Cost	$ -	Total Maintenance Cost	$ -

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ -	$ -	$ -
Contingency Cost (25% of Construction Cost)	$ -	$ -	$ -
Engineering Design Cost (5% of Construction Cost)	$ -	$ -	$ -
Total Construction Cost	$ -	$ -	$ -

Land Cost

Channel Length	0 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	14	0	$0	$ -
LC Enhancement Buffer	0	0	$0	$ -
Channel	108	0	$0	$ -
Channel LC Enhancement	0	0	$0	$ -
Levee	0	0	$0	$ -
Levee LC Enhancement	0	0	$0	$ -
Other	0	0	$0	$ -
Total	122	0		$ -

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	0	$0	$ -
LC Enhancement Cost	acre	0	$0	$ -
Total Land Cost	acre	0	$0	$ -

Total Cost

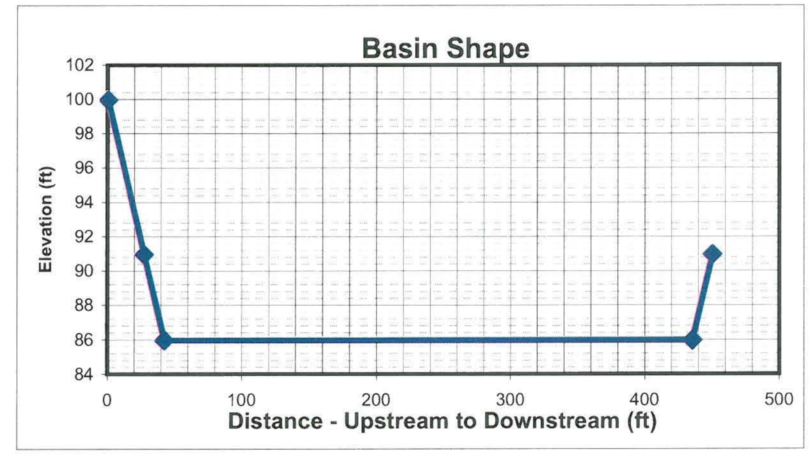
Base Total Cost	$ -
Total Landscape Enhancement Cost	$ -
Total Cost Including LC Enh.	$ -

Offline Basin

HEC1 ID	D115C

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)	0.02	0.02
Basin Length (ft)	950	1090
Basin Width (ft)	450	450
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	5	5
Freeboard (ft)	1	1
Effective Basin Width (ft)	423	396
Top Area (acres)	9.8	11.3
U/S-D/S Height Difference (ft)	9.0	9.0
Excess Area on Upstream (acres)	0.6	1.4

			Base	LC Enhanced
Bottom Length (ft)	920	Allocated Storage Volume (ac. ft)	34.7	34.9
Bottom Width (ft)	393	Total Available Volume (ac. ft) (incl. Freeboard)	43.8	44.6
		Total Excavation Volume (ac. ft)	88.0	95.3

HEC1 Results

	6-hr Event	24-hr Event	Maximum
Peak flow before diversion (cfs)	1695	1937	1937
Peak flow after diversion (cfs)	1000	1000	1000
Diverted Peak Flow (cfs)	695	937	937
Total Diverted Flow Volume (ac. ft)	27.0	34	34.0
Peak Stage	2.7	ft	

Volume Check

Total Volume needed	34.0	ac. ft
Total Volume Provided	34.7	ac. ft
Volume OK?	Yes	

Stage Check

Depth Needed	3.7
Depth Provided	5
Depth OK?	Yes

Stage-Storage-Discharge

Stage (ft)													
Inflow (cfs)	0	200	400	600	800	1000	1100	1200	1500	2000	2500	3000	
Outflow (cfs)	0	0	0	0	0	0	100	200	500	1000	1500	2000	capacity based on FlowMaster results with 1 ft freeboarc

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
Landscape Enhancement	227000	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	950	ft
Base Total ROW Width	450	ft
LC Enh. Total ROW Length	1190	ft
LC Enh. Total ROW Length	550	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	141973	153751
Excavated Area (sq. Yd)	47500	72722

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	44	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	492	sq. Yd
Material Volume	246	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	333	ft
Unit Cost	160	per ft
Cost per outlet	$53,280	
Other Cost	$ -	
Total Cost	$53,280	
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		141,973	cu. Yd	$ 4.00	$ 567,892	47,500	sq. Yd	$ 9.00	$ 427,500	47,500	sq. Yd	$ 8.33	$ 395,833
Basin - LC Enhanced		11,778	cu. Yd	$ 4.00	$ 47,112	25,222	sq. Yd	$ 9.00	$ 226,998	25,222	sq. Yd	$ 8.33	$ 210,183
Inlet	Riprap	246	sq. Yd	$ 75.00	$ 18,450	492	sq. Yd	$ -	$ -	492	sq. Yd	$ 33.33	$ 16,400
Inlet - LC Enhanced (20%Total)					$ 3,690				$ -				$ 3,280
Outlet	Pipe	1	EA	$ 53,280	$ 53,280	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhanced (5%Total)					$ 2,664				$ -				$ 111
Other					$ -				$ -				$ -

Base Landscape Cost	$ 427,500	Base Maintenance Cost	$ 414,450
LC Enh. Landscape Cost	$ 226,998	LC Enh. Maintenance Cost	$ 213,574
Total Landscape Cost	$ 654,498	Total Maintenance Cost	$ 628,024

Construction Cost Component	Base	LC Enhanced	Total
Construction Cost	$ 639,622	$ 47,112	$ 686,734
Contingency Cost (25% of Construction Cost)	$ 159,906	$ 11,778	$ 171,684
Engineering Design Cost (5% of Construction Cost)	$ 31,981	$ 2,356	$ 34,337
Total Construction Cost	$ 831,509	$ 61,246	$ 892,754

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	5.2	$100,000	$ 521,120
Basin	9.8	$100,000	$ 980,000
Other		$100,000	$ -
Total	15.0	$100,000	$ 1,500,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	9.8	$100,000	$ 981,405
LC Enhancement Cost	acre	5.2	$100,000	$ 518,595
Total Land Cost	acre	15	$100,000	$ 1,500,000

Total Cost

Base Total Cost	$ 2,654,864
Total LC Enhancement Cost	$ 1,020,413
Total Cost Including LC Enh.	$ 3,675,276

Open Channel

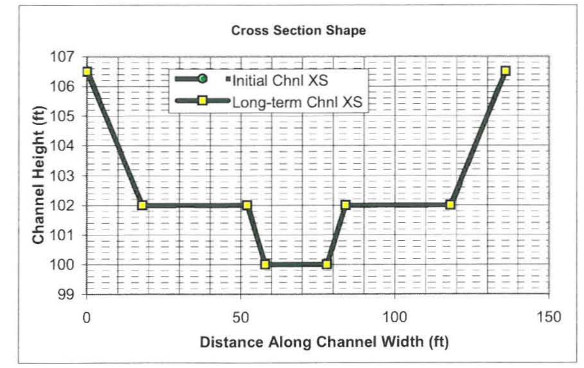
Structure ID	C12010		HEC1 ID	115120

Longitundal Geometry

Length	4136.0	ft
U/S Elev	1537.8	ft
D/S Elev	1496.4	ft
Initial Channel Slope	0.0100	ft/ft
Long-term Channel Slope	0.0015	ft/ft

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

NSTPS	3



Initial Channel XS Geometry

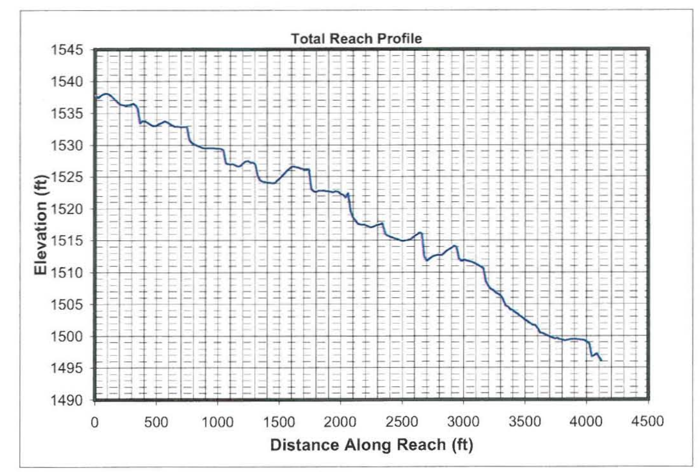
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
4	4.5	34	3	20	6.5	3	34	4.5	4

PT. ID	1	2	3	4	5	6	7	8
X	0	18	52	58	78	84	118	136
Y	106.5	102	102	100	100	102	102	106.5

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
4	4.5	34	3	20	6.5	3	34	4.5	4

PT. ID	1	2	3	4	5	6	7	8
X	0	18	52	58	78	84	118	136
Y	106.5	102	102	100	100	102	102	106.5



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	0.03	0.03	0.03	0.03	0.03	0.03

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	D120									TOTAL
HEC1 Peak-Flow	2000									2000
Weighting Factor	1.00									
Flow into Channel	2000									2000

Reach Sediment Inflow Characteristics

U/S Contributing ID	15I15B_RR115B10									TOTAL
HEC1 Flow Volume (ac. ft)	153.00									153
Sediment Conc. (ppm)	493									
Sediment Volume (ac. ft)	0.03									0.03
Weighting Factor	1	1								
Weighted Sed. Vol. (ac. ft)	0.03									0.03

Hydrology

Drainage Area	1.83	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	2000	cfs	
Long-term Max. Chnl Capacity	2934	cfs	
Q2 Channel	200	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	136	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
200	29.2	35.4	1.2	100.0	101.5	5.7	1.5	28.7	1.2	0.14	0.90
500	104.7	102.2	1.0	100.0	102.5	4.9	2.5	103.9	1.0	0.23	0.87
1500	112.5	203.4	1.8	100.0	103.4	7.4	3.4	111.5	1.8	0.32	0.96
2000	115.4	244.2	2.1	100.0	103.8	8.2	3.8	114.3	2.1	0.36	0.99

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
200	104.9	104.3	1.0	100.0	102.5	1.9	2.5	104.1	1.0	0.24	0.34
500	111.1	185.0	1.7	100.0	103.3	2.7	3.3	110.1	1.7	0.31	0.37
1500	124.5	374.3	3.0	100.0	104.9	4.0	4.9	123.1	3.0	0.46	0.41
2000	129.6	452.0	3.5	100.0	105.5	4.4	5.5	128.1	3.5	0.52	0.42

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
	15I15B_RR115B 10									
200	87									87
500	206									206
1500	916									916
2000	1329									1329

Allowable Velocity

Channel Lining	Natural - Sandy Loam (noncolloidal)

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)		
200	1.74	1.4599	1.3869	Erosive	Erosive	Erosive	0.3	Erosive	3.6	Erosive	Stable
500	1.74	1.3904	1.3208	Erosive	Erosive	Erosive	0.3	Erosive	4.5	Erosive	Stable
1500	1.74	1.5809	1.5019	Erosive	Erosive	Erosive	0.4	Erosive	6.1	Erosive	Stable
2000	1.74	1.6295	1.5480	Erosive	Erosive	Erosive	0.4	Erosive	6.6	Erosive	Stable

USCOE Allowable Velocity (ft/s)	2
FHWA Allowable Velocity (ft/s)	2.5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	200	500	1500	2000	200	500	1500	2000	200	500	1500	2000
Bray - Equation #1	39	63	112	131	1.6	2.1	3.0	3.3	3.3	3.8	4.4	4.6
Bray - Equation #2	51	83	148	172	1.7	2.3	3.3	3.7	2.3	2.6	3.0	3.1
Hey	12	20	36	43	4.8	6.8	10.4	11.6				
Ackers & Charlton/Lacey	33	49	78	88					1.9	2.3	2.7	2.8
Parker	97	154	266	307	1.2	1.8	2.9	3.2				
Chang	43	76	150	179	0.6	0.6	0.6	0.6				
Kellerhals	25	40	70	80	2.3	3.3	5.1	5.7	3.5	3.8	4.2	4.4
AMAFCA/Schumm	104	110	123	128								
Moody & Odem	15	15	15	15	1.0	1.0	1.0	1.0				
BUREC	20.9	29.4	44.4	49.4	6	8	12	13	2.7	3.4	4.5	4.8
Average	44	64	104	119	2.4	3.2	4.8	5.3	2.7	3.2	3.8	4.0
Values As Designed	104	110	123	128	2.5	3.3	4.9	5.5	1.9	2.7	4.0	4.4
Difference with Design	-60	-46	-19	-9	-0.2	0.0	-0.1	-0.2	0.8	0.5	-0.2	-0.5

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
200	4873	2260	2869	8850	815	1673	1001	1583	3724	706	4376	2975
500	10110	5162	7388	17106	2554	3754	2554	3532	9251	2005	9611	6639
1500	53132	17696	22027	105413	4007	15715	7387	14648	28115	3073	41692	28446
2000	81696	24206	29697	168828	4503	22877	9697	20982	37548	3311	60416	42160

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
200	9040	4192	5322	16416	1511	3104	1857	2937	6907	1310	8117	5519
500	7502	3830	5482	12693	1895	2786	1895	2621	6864	1488	7131	4926
1500	13141	4377	5448	26072	991	3887	1827	3623	6954	760	10312	7036
2000	15155	4490	5509	31318	835	4244	1799	3892	6965	614	11207	7821

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
200	176	150	122	157	485	28	44	71	83	14	155	135
500	704	596	621	717	920	167	206	369	403	41	736	498
1500	3612	2447	2372	4290	1742	791	783	1894	1482	140	3936	2135
2000	5509	3455	3252	6805	2036	1154	1071	2810	2023	166	5967	3113

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
200	327	279	227	291	900	52	81	131	153	25	287	250
500	522	442	461	532	683	124	153	274	299	30	546	370
1500	893	605	587	1061	431	196	194	469	366	35	974	528
2000	1022	641	603	1262	378	214	199	521	375	31	1107	578

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)
200	0.0004	0.0005	205	0.63	0.051	0.0002	31	0.036	0.0002	0.0159	0.0002	0.0003	0.0060	0.0003	0.0013	0.0098	0.0041
500	0.0005	0.0007	184	0.56	0.050	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0004	0.0060	0.0002	0.0007	0.0099	0.0041
1500	0.0002	0.0004	250	0.76	0.053	0.0002	31	0.036	0.0001	0.0159	0.0001	0.0002	0.0060	0.0001	0.0003	0.0099	0.0041
2000	0.0002	0.0003	271	0.83	0.053	0.0001	32	0.036	0.0001	0.0159	0.0001	0.0002	0.0060	0.0001	0.0002	0.0099	0.0040

Drop Structures

Design Slope	0.0015	ft/ft
Total Drop Needed	35.2	ft
Height of Drop Structure	3	ft
No . of Drop Structures	12	
Distance between structs.	345	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	0.00	sq. mi
Total Sediment Yield Volume	0.00	ac ft

Sedimentation Basins

Length	345 ft	Depth	3 ft
Width	136 ft	Side slope	3 ft/ft
Total Volume per Basin		2.94	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)
200	1.1	-0.5	0.1	24.6	2.5	1.0	1.9	0.0015	0.3	0.0	1.0	1.7
500	1.1	-0.4	0.1	24.6	3.3	1.7	2.7	0.0015	0.4	0.0	1.0	1.9
1500	1.1	-0.3	0.2	24.6	4.9	3.0	4.0	0.0015	0.7	0.0	1.0	2.4
2000	1.1	-0.2	0.3	24.6	5.5	3.5	4.4	0.0015	0.8	0.0	1.0	2.5

Toe Protection Needed	3.0	ft

HEC1 Results For Open Channel

Peak Flow	1002	cfs
Stage at Peak Flow	102.9	ft
Flow Volume	143.0	ac. ft

Freeboard

Max. Flow Depth	3.8	ft
Channel Depth as designed	6.5	ft
Available Freeboard	2.7	ft
Required Freeboard	1.5	ft

Sediment Volume

Inflowing Sediment Volume	0.03	ac. ft
Outflowing Sediment Volume	0.03	ac. ft
Deposited(+)/Eroded(-) Volume	0.00	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Existing	Existing
Channel Length (ft)	4136	4136
Side Slope (?H:1V)	3	3
Channel Width (ft)	136	136
Channel XS Area (sq. ft)	583	583
Channel Perimeter (ft)	138	138

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	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	0	ft
Thickness	0.0	ft
Protection Depth	0	ft
Tie-in Length/Depth	0.0	ft
Total Depth	0.0	ft
Area needed	0	sq. Yd
Volume	0	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)	4136	4136
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)	4136	4136
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	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	0	ft
LC Enhancement Ratio	1.1	
Structure Thickness	0	ft
Drop Height	0	ft
Scour Depth		ft
Structure Height		ft
Number of Structures	0	
Volume per structure	0	cu. Yd
Unit Cost	$ -	cu. Yd
Other Cost	$ -	
Cost per structure	$ -	
Area per structure	0	sq. Yd
Total Area	0	sq. Yd

Sedimentation Basins		
Include Sed. Basins	No	
(Yes/No)		
Number of basins	0	
Total Volume per Basin	4743	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	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	Existing	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Existing	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	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Drop Structures	None	0	EA	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Drop Str. - LC Enhancement	None	0	EA	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Sedimentation Basins		1	EA	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ 8.33	$ -
Other					$ -				$ -				$ -

Base Landscape Cost	$ -
LC Enhancement Cost	$ -
Total Landscape Cost	$ -

Base Maintenance Cost	$ -
LC Enhancement Cost	$ -
Total Maintenance Cost	$ -

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ -	$ -	$ -
Contingency Cost (25% of Construction Cost)	$ -	$ -	$ -
Engineering Design Cost (5% of Construction Cost)	$ -	$ -	$ -
Total Construction Cost	$ -	$ -	$ -

Land Cost

Channel Length	0 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	14	0	$0	$ -
LC Enhancement Buffer	0	0	$0	$ -
Channel	136	0	$0	$ -
Channel LC Enhancement	0	0	$0	$ -
Levee	0	0	$0	$ -
Levee LC Enhancement	0	0	$0	$ -
Other	0	0	$0	$ -
Total	150	0		$ -

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	0	$0	$ -
LC Enhancement Cost	acre	0	$0	$ -
Total Land Cost	acre	0	$0	$ -

Total Cost

Base Total Cost	$ -
Total Landscape Enhancement Cost	$ -
Total Cost Including LC Enh.	$ -

JE FULLER
HYDROLOGY & GEOMORPHOLOGY, INC.

Sub-area: CAP, Alternative: B3
Open Channel Structure ID: C12010

Offline Basin

HEC1 ID	D120

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

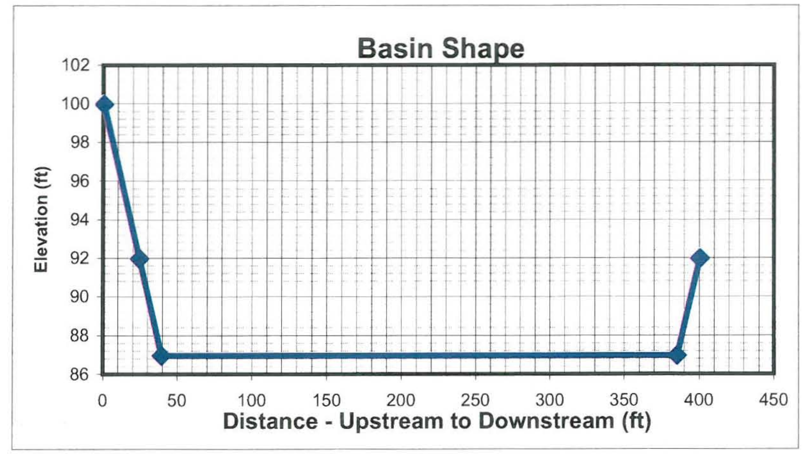
Sediment Volume	0.0	ac. ft

Geometry	Base	LC Enhanced
Topography slope (ft/ft)	0.02	0.02
Basin Length (ft)	700	810
Basin Width (ft)	400	400
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	5	5
Freeboard (ft)	1	1
Effective Basin Width (ft)	376	352
Top Area (acres)	6.4	7.4
U/S-D/S Height Difference (ft)	8.0	8.0
Excess Area on Upstream (acres)	0.4	0.9

			Base	LC Enhanced
Bottom Length (ft)	670	Allocated Storage Volume (ac. ft)	22.4	22.5
Bottom Width (ft)	346	Total Available Volume (ac. ft) (incl. Freeboard)	28.4	28.9
		Total Excavation Volume (ac. ft)	54.1	58.6

Stage-Storage-Discharge

Stage (ft)													
Inflow (cfs)	0	200	400	600	800	1000	1200	1500	2000	2500	3000	4000	
Outflow (cfs)	0	0	0	0	0	0	0	0	0	500	1000	2000	capacity based on FlowMaster results with 1 ft freeboarc



HEC1 Results

	6-hr Event	24-hr Event	Maximum
Peak flow before diversion (cfs)	2398	2880	2880
Peak flow after diversion (cfs)	1996	2000	2000
Diverted Peak Flow (cfs)	402	880	880
Total Diverted Flow Volume (ac. ft)	11.0	22	22.0
Peak Stage	1.7	ft	

Volume Check			*Stage Check*	
Total Volume needed	22.0	ac. ft	Depth Needed	2.7
Total Volume Provided	22.4	ac. ft	Depth Provided	5
Volume OK?	Yes		Depth OK?	Yes

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
Landscape Enhancement	175000	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	700	ft
Base Total ROW Width	400	ft
LC Enh. Total ROW Length	910	ft
LC Enh. Total ROW Length	500	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	87281	94541
Excavated Area (sq. Yd)	31111	50556

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	41	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	457	sq. Yd
Material Volume	229	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	333	ft
Unit Cost	160	per ft
Cost per outlet	$53,280	
Other Cost	$ -	
Total Cost	$53,280	
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		87,281	cu. Yd	$ 4.00	$ 349,124	31,111	sq. Yd	$ 9.00	$ 279,999	31,111	sq. Yd	$ 8.33	$ 259,258
Basin - LC Enhanced		7,260	cu. Yd	$ 4.00	$ 29,040	19,445	sq. Yd	$ 9.00	$ 175,005	19,445	sq. Yd	$ 8.33	$ 162,042
Inlet	Riprap	229	sq. Yd	$ 75.00	$ 17,175	457	sq. Yd	$ -	$ -	457	sq. Yd	$ 33.33	$ 15,233
Inlet - LC Enhanced (20%Total)					$ 3,435				$ -				$ 3,047
Outlet	Pipe	1	EA	$ 53,280	$ 53,280	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhanced (5%Total)					$ 2,664				$ -				$ 111
Other					$ -				$ -				$ -

Base Landscape Cost	$ 279,999	Base Maintenance Cost	$ 276,708
LC Enh. Landscape Cost	$ 175,005	LC Enh. Maintenance Cost	$ 165,199
Total Landscape Cost	$ 455,004	Total Maintenance Cost	$ 441,908

Construction Cost Component	Base	LC Enhanced	Total
Construction Cost	$ 419,579	$ 29,040	$ 448,619
Contingency Cost (25% of Construction Cost)	$ 104,895	$ 7,260	$ 112,155
Engineering Design Cost (5% of Construction Cost)	$ 20,979	$ 1,452	$ 22,431
Total Construction Cost	$ 545,453	$ 37,752	$ 583,205

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	4.0	$100,000	$ 401,745
Basin	6.4	$100,000	$ 640,000
Other		$100,000	$ -
Total	10.4	$100,000	$ 1,040,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	6.4	$100,000	$ 642,792
LC Enhancement Cost	acre	4.0	$100,000	$ 397,208
Total Land Cost	acre	10.4	$100,000	$ 1,040,000

Total Cost

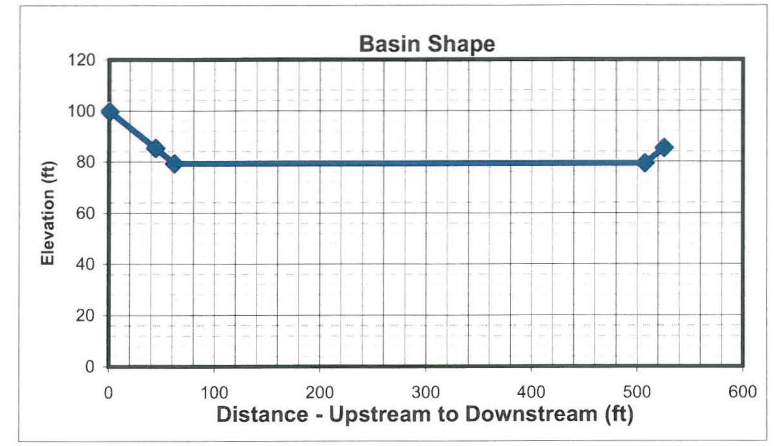
Base Total Cost	$ 1,744,952
Total LC Enhancement Cost	$ 775,165
Total Cost Including LC Enh.	$ 2,520,116

Online Basin

HEC1 ID	RR900

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	1.0	sq. mi
Total Sediment Yield Volume	2.0	ac ft

Required Minimum Sediment Volume

Sediment Volume	2.0	ac. ft

Geometry	Base	LC Enhanced
Topography slope (ft/ft)	0.027586207	0.027586207
Basin Length (ft)	1400	1650
Basin Width (ft)	525	525
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	6	6
Freeboard (ft)	1	1
Effective Basin Width (ft)	482	438
Top Area (acres)	16.9	19.9
U/S-D/S Height Difference (ft)	14.5	14.5
Excess Area on Upstream (acres)	1.5	3.3

			Base	LC Enhanced
Bottom Length (ft)	1364	Allocated Storage Volume (ac. ft)	73.0	73.1
Bottom Width (ft)	446	Total Available Volume (ac. ft) (incl. Freeboard)	88.3	89.4
		Total Excavation Volume (ac. ft)	210.6	233.5

HEC1 Results

	6-hr Event	24-hr Event	Maximum
Total Flow Volume entering Basin (ac. ft)	85.0	78	85.0
Peak Inflow (cfs)	936	853	936.0
Peak Outflow (cfs)	74	70	74.0
Stage at Peak Outflow (ft)	4.8	4.2	4.8
Volume at Peak Outflow (ac. ft)	69.2	61.68	69.2

Volume Check

Total Volume needed	71.2	ac. ft
Total Volume Provided	73.0	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)	3.00	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	7.01	14.09	21.23	28.43	43.03	57.87	72.98	88.34	103.96
Outflow	0.0	24.1	34.0	41.7	48.1	59.0	68.1	76.1	83.4	90.0

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
LC Enhancement Buffer	358750	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	1400	ft
Base Total ROW Width	525	ft
LC Enh. Total ROW Length	1750	ft
LC Enh. Total ROW Length	625	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	339768	376713
Excavated Area (sq. Yd)	81667	121528

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	65	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	720	sq. Yd
Material Volume	360	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	266	ft
Unit Cost	160	per ft
Cost per outlet	$42,560	
Other Cost	$ -	
Total Cost	$42,560	
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		339,768	cu. Yd	$ 4.00	$ 1,359,072	81,667	sq. Yd	$ 9.00	$ 735,003	81,667	sq. Yd	$ 8.33	$ 680,558
Basin - LC Enhancement		36,945	cu. Yd	$ 4.00	$ 147,780	39,861	sq. Yd	$ 9.00	$ 358,749	39,861	sq. Yd	$ 8.33	$ 332,175
Inlet	Riprap	360	sq. Yd	$ 75.00	$ 27,000	720	sq. Yd	$ -	$ -	720	sq. Yd	$ 33.33	$ 24,000
Inlet - LC Enhancement (20%Inlet)					$ 5,400				$ -				$ 4,800
Outlet	Pipe	1	EA	$ 42,560	$ 42,560	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhancement (5% Outlet)					$ 2,128				$ -				$ 111
Other					$ -				$ -				$ -

Base Landscape Cost	$ 735,003	Base Maintenance Cost	$ 706,775
LC Enh. Landscape Cost	$ 358,749	LC Enh. Maintenance Cost	$ 337,086
Total Landscape Cost	$ 1,093,752	Total Maintenance Cost	$ 1,043,861

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,428,632	$ 147,780	$ 1,576,412
Contingency Cost (25% of Construction Cost)	$ 357,158	$ 36,945	$ 394,103
Engineering Design Cost (5% of Construction Cost)	$ 71,432	$ 7,389	$ 78,821
Total Construction Cost	$ 1,857,222	$ 192,114	$ 2,049,336

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	8.2	$100,000	$ 820,000
Basin	16.9	$100,000	$ 1,690,000
Other		$100,000	$ -
Total	25.1	$100,000	$ 2,510,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	16.9	$100,000	$ 1,690,000
LC Enhancement Cost	acre	8.2	$100,000	$ 820,000
Total Land Cost	acre	25.1	$100,000	$ 2,510,000

Total Cost

Base Total Cost	$ 4,989,000
Total LC Enhancement Cost	$ 1,707,949
Total Cost Including LC Enh.	$ 6,696,948

Open Channel

Structure ID	C910A10	HEC1 ID	90091A

Longitundal Geometry

Length	3620.4	ft
U/S Elev	1818.8	ft
D/S Elev	1746.9	ft
Initial Channel Slope	0.0198	ft/ft
Long-term Channel Slope	0.0070	ft/ft

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

NSTPS	4

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	20	3	25	4	3	20	2	3

PT. ID	1	2	3	4	5	6	7	8
X	0	6	26	32	57	63	83	89
Y	104	102	102	100	100	102	102	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	2	20	3	25	4	3	20	2	3

PT. ID	1	2	3	4	5	6	7	8
X	0	6	26	32	57	63	83	89
Y	104	102	102	100	100	102	102	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	S910	RR900								TOTAL
HEC1 Peak-Flow	1585	74								1659
Weighting Factor	0.37	1.00								
Flow into Channel	593	74								667

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

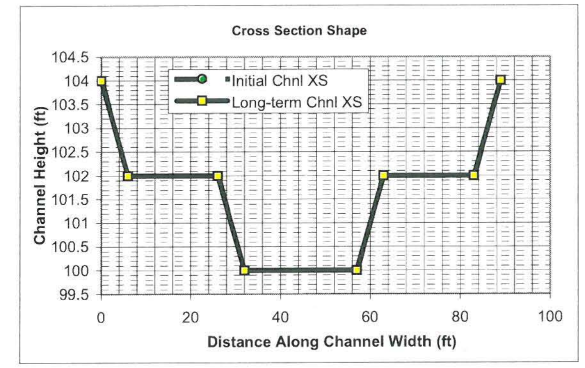
Hydrology

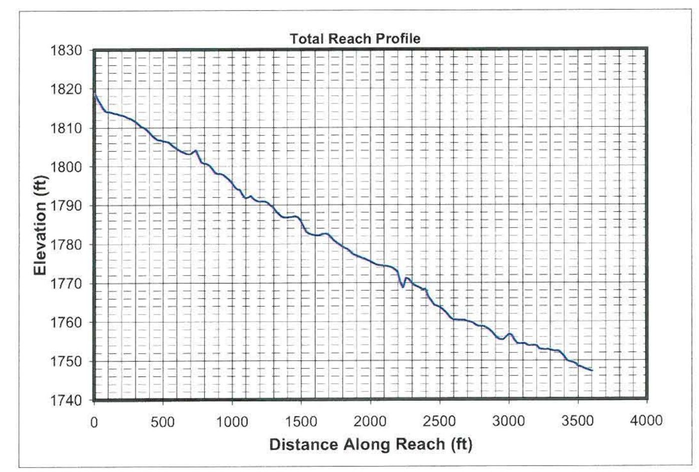
Drainage Area	1.398	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	667	cfs	
Long-term Max. Chnl Capacity	1171	cfs	
Q2 Channel	67	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	89	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
67	31.0	26.6	0.9	100.0	101.0	2.5	1.0	30.7	0.9	0.42	0.47
167	35.3	48.6	1.4	100.0	101.6	3.4	1.6	34.8	1.4	0.71	0.51
500	83.2	132.5	1.6	100.0	102.9	3.8	2.9	82.3	1.6	1.26	0.52
667	85.3	158.9	1.9	100.0	103.2	4.2	3.2	84.2	1.9	1.40	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
67	31.0	26.6	0.9	100.0	101.0	2.5	1.0	30.7	0.9	0.42	0.47
167	35.3	48.6	1.4	100.0	101.6	3.4	1.6	34.8	1.4	0.71	0.51
500	83.2	132.5	1.6	100.0	102.9	3.8	2.9	82.3	1.6	1.26	0.52
667	85.3	158.9	1.9	100.0	103.2	4.2	3.2	84.2	1.9	1.40	0.54

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
67										0
167										0
500										0
667										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)		
67	1.74	1.3514	1.2839	Erosive	Erosive	Erosive	0.3	Stable	4.7	Stable	Stable
167	1.74	1.4989	1.4239	Erosive	Erosive	Erosive	0.4	Stable	6.7	Stable	Stable
500	1.74	1.5422	1.4651	Erosive	Erosive	Erosive	0.4	Stable	9.1	Stable	Stable
667	1.74	1.5913	1.5117	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)	**67**	**167**	**500**	**667**	**67**	**167**	**500**	**667**	**67**	**167**	**500**	**667**
Bray - Equation #1	22	35	63	73	1.1	1.5	2.1	2.3	2.8	3.2	3.8	3.9
Bray - Equation #2	29	46	83	96	1.2	1.6	2.3	2.5	2.0	2.2	2.6	2.7
Hey	6	10	20	23	3.2	4.5	6.8	7.6				
Ackers & Charlton/Lacey	21	31	49	55					1.6	1.9	2.3	2.4
Parker	56	89	154	177	0.8	1.2	1.8	2.1				
Chang	38	66	129	153	0.1	0.0	-0.2	-0.3				
Kellerhals	15	23	40	46	1.5	2.1	3.3	3.7	3.1	3.4	3.8	3.9
AMAFCA/Schumm	31	35	82	84								
Moody & Odem	14	14	14	14	1.0	1.0	1.0	1.0				
BUREC	12.1	17.0	25.6	28.6	3	5	7	8	2.7	3.4	4.5	4.8
Average	24	37	66	75	1.5	2.1	3.0	3.3	2.4	2.8	3.4	3.5
Values As Designed	31	35	82	84	1.0	1.6	2.9	3.2	2.5	3.4	3.8	4.2
Difference with Design	-6	2	-16	-9	0.5	0.4	0.1	0.1	-0.1	-0.6	-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
67	352	228	529	3051	1065	147	67	75	3441	200	1020	925
167	1347	672	1449	13277	1584	592	200	305	8689	683	3591	2945
500	4632	2054	4244	47041	4055	2233	622	1034	26112	2261	11854	9649
667	7128	2864	5504	75479	4526	3625	847	1553	34868	3353	17357	14282

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
67	1960	1268	2945	16972	5926	819	374	418	19142	1115	5672	5146
167	2997	1496	3224	29540	3525	1317	446	678	19332	1519	7991	6551
500	3435	1524	3148	34887	3008	1656	461	767	19366	1677	8792	7156
667	3965	1593	3061	41983	2518	2016	471	864	19394	1865	9654	7944

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
67	352	188	324	641	541	81	67	75	684	80	409	313
167	1347	574	886	2791	851	303	200	305	1782	292	1538	988
500	4632	1769	2754	9888	2206	1013	622	1034	5384	988	5176	3224
667	7128	2485	3747	15866	2493	1508	847	1553	7222	1504	7738	4736

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
67	1960	1045	1800	3568	3010	448	374	418	3806	447	2275	1741
167	2997	1277	1972	6209	1894	674	446	678	3965	650	3423	2199
500	3435	1312	2042	7333	1636	752	461	767	3993	733	3839	2391
667	3965	1382	2084	8825	1387	839	471	864	4017	837	4304	2634

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)
67	0.0010	0.0014	243	0.74	0.052	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0007	0.0086	0.0006	0.0022	0.0069	0.0042
167	0.0005	0.0009	307	0.94	0.055	0.0002	32	0.036	0.0001	0.0159	0.0002	0.0004	0.0086	0.0004	0.0011	0.0069	0.0041
500	0.0004	0.0008	330	1.01	0.055	0.0002	32	0.036	0.0001	0.0159	0.0002	0.0004	0.0086	0.0002	0.0005	0.0069	0.0040
667	0.0004	0.0006	358	1.09	0.056	0.0002	33	0.036	0.0001	0.0159	0.0001	0.0003	0.0086	0.0002	0.0004	0.0069	0.0040

Drop Structures

Design Slope	0.0070	ft/ft
Total Drop Needed	46.3	ft
Height of Drop Structure	3	ft
No . of Drop Structures	16	
Distance between structs.	226	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	0.37	sq. mi
Total Sediment Yield Volume	0.70	ac ft

Sedimentation Basins

Length	226 ft	Depth	3 ft
Width	89 ft	Side slope	3 ft/ft
Total Volume per Basin		1.20	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)
67	1.1	-0.3	0.1	24.6	1.0	0.9	2.5	0.0070	0.1	0.0	2.0	2.8
167	1.1	-0.5	0.2	24.6	1.6	1.4	3.4	0.0070	0.2	0.0	2.0	2.9
500	1.1	-0.8	0.2	24.6	2.9	1.6	3.8	0.0070	0.3	0.0	2.0	3.1
667	1.1	-0.8	0.2	24.6	3.2	1.9	4.2	0.0070	0.4	0.0	2.0	3.2

Toe Protection Needed	4.0	ft

HEC1 Results For Open Channel

Peak Flow	74	cfs
Stage at Peak Flow	100.7	ft
Flow Volume	85.0	ac. ft

Freeboard

Max. Flow Depth	3.2	ft
Channel Depth as designed	4.0	ft
Available Freeboard	0.8	ft
Required Freeboard	1	ft

Sediment Volume

Inflowing Sediment Volume	0.70	ac. ft
Outflowing Sediment Volume	0.08	ac. ft
Deposited(+)/Eroded(-) Volume	0.61	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	3620	3620
Side Slope (?H:1V)	3	6
Channel Width (ft)	89	113
Channel XS Area (sq. ft)	228	276
Channel Perimeter (ft)	90	113

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	307023	388008
Excavated Area (sq. Yd)	35798	45451

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	3620	ft
Thickness	1.5	ft
Protection Depth	4	ft
Tie-in Length/Depth	3.0	ft
Total Depth	7.0	ft
Area needed	603	sq. Yd
Volume	1408	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)	3620	3620
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)	3620	3620
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	89	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	7.7	ft
Structure Height	10.7	ft
Number of Structures	16	
Volume per structure	106	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 7,950	
Area per structure	30	sq. Yd
Total Area	475	sq. Yd

Sedimentation Basins		
Include Sed. Basins (Yes/No)	Yes	
Number of basins	2	
Total Volume per Basin	1936	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 7,744	
Other Cost	$ -	
Total cost per basin	$ 7,744	
Area per basin	2,238	sq. Yd
Total Area	4,476	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	307,023	cu. Yd	$ 10.00	$ 3,070,230	35,798	sq. Yd	$ 9.00	$ 322,182	35,798	sq. Yd	$ 8.33	$ 298,317
Exc. Chl - LC Enhancement	Excavated	80,985	cu. Yd	$ 10.00	$ 809,850	9,653	sq. Yd	$ 9.00	$ 86,877	9,653	sq. Yd	$ 8.33	$ 80,442
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	1,408	cu. Yd	$ 75.00	$ 105,600	603	sq. Yd	$ -	$ -	603	sq. Yd	$ 25.00	$ 15,075
Drop Structures	Riprap	16	EA	$ 7,950.00	$ 127,200	475	sq. Yd	$ -	$ -	475	sq. Yd	$ 33.33	$ 15,833
Drop Str. - LC Enhancement	Riprap	16	EA	$ 795.00	$ 12,720	48	sq. Yd	$ -	$ -	48	sq. Yd	$ 33.33	$ 1,583
Sedimentation Basins		2	EA	$ 7,744.00	$ 15,488	4,476	sq. Yd	$ -	$ -	4,476	sq. Yd	$ 8.33	$ 37,300
Other					$ -				$ -				$ -

Base Landscape Cost	$ 322,182	Base Maintenance Cost	$ 366,525
LC Enhancement Cost	$ 86,877	LC Enhancement Cost	$ 82,025
Total Landscape Cost	$ 409,059	Total Maintenance Cost	$ 448,550

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 3,318,518	$ 822,570	$ 4,141,088
Contingency Cost (25% of Construction Cost)	$ 829,630	$ 205,643	$ 1,035,272
Engineering Design Cost (5% of Construction Cost)	$ 165,926	$ 41,129	$ 207,054
Total Construction Cost	$ 4,314,073	$ 1,069,341	$ 5,383,414

Land Cost

Channel Length	3620 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	134	11.1	$100,000	$ 1,110,000
LC Enhancement Buffer	50	4.2	$100,000	$ 420,000
Channel	89	7.4	$100,000	$ 740,000
Channel LC Enhancement	24	2	$100,000	$ 200,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	297	24.7		$ 2,470,000

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	18.5	$100,000	$ 1,850,000
LC Enhancement Cost	acre	6.2	$100,000	$ 620,000
Total Land Cost	acre	24.7	$100,000	$ 2,470,000

Total Cost

Base Total Cost	$ 6,852,780
Total Landscape Enhancement Cost	$ 1,858,243
Total Cost Including LC Enh.	$ 8,711,023

Open Channel

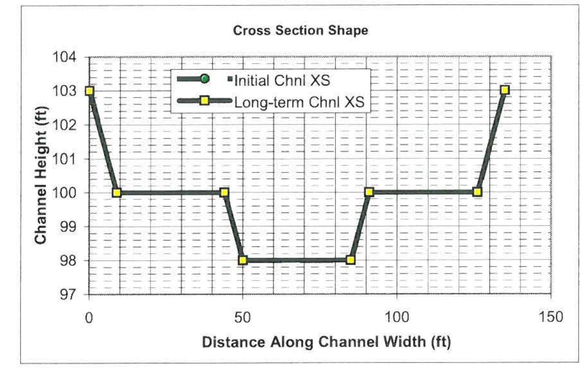
Structure ID	C910B10	HEC1 ID	90091B

Longitundal Geometry

Length	4991.8	ft
U/S Elev	1746.9	ft
D/S Elev	1667.9	ft
Initial Channel Slope	0.0158	ft/ft
Long-term Channel Slope	0.0060	ft/ft

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

NSTPS	4



Initial Channel XS Geometry

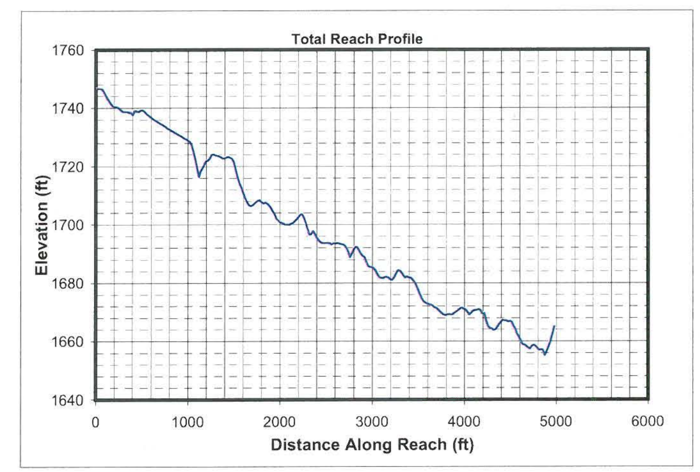
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	3	35	3	35	5	3	35	3	3

PT. ID	1	2	3	4	5	6	7	8
X	0	9	44	50	85	91	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	35	3	35	5	3	35	3	3

PT. ID	1	2	3	4	5	6	7	8
X	0	9	44	50	85	91	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	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	C910									TOTAL
HEC1 Peak-Flow	1498									1498
Weighting Factor	1.00									
Flow into Channel	1498									1498

Reach Sediment Inflow Characteristics

U/S Contributing ID	90091A_C910A10									TOTAL
HEC1 Flow Volume (ac. ft)	85.00									85
Sediment Conc. (ppm)	2634									
Sediment Volume (ac. ft)	0.08									0.08
Weighting Factor	1									
Weighted Sed. Vol. (ac. ft)	0.08									0.08

Hydrology

Drainage Area	2.02	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	1498	cfs	
Long-term Max. Chnl Capacity	2650	cfs	
Q2 Channel	150	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			

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
150	43.4	51.9	1.2	98.0	99.3	2.9	1.3	43.0	1.2	0.50	0.46
375	120.5	135.2	1.1	98.0	100.4	2.8	2.4	119.7	1.1	0.92	0.46
1124	127.3	267.2	2.1	98.0	101.5	4.2	3.5	126.1	2.1	1.32	0.51
1498	129.9	320.1	2.5	98.0	101.9	4.7	3.9	128.6	2.5	1.47	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
150	43.4	51.9	1.2	98.0	99.3	2.9	1.3	43.0	1.2	0.50	0.46
375	120.5	135.2	1.1	98.0	100.4	2.8	2.4	119.7	1.1	0.92	0.46
1124	127.3	267.2	2.1	98.0	101.5	4.2	3.5	126.1	2.1	1.32	0.51
1498	129.9	320.1	2.5	98.0	101.9	4.7	3.9	128.6	2.5	1.47	0.52

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
	90091A_C910A1 0									
150	313									313
375	988									988
1124	3224									3224
1498	4736									4736

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)		
150	1.74	1.4534	1.3807	Erosive	Erosive	Erosive	0.3	Stable	5.5	Stable	Stable
375	1.74	1.4330	1.3614	Erosive	Erosive	Erosive	0.3	Stable	7.3	Stable	Stable
1124	1.74	1.6269	1.5455	Erosive	Erosive	Erosive	0.4	Stable	9.8	Stable	Stable
1498	1.74	1.6766	1.5928	Erosive	Erosive	Erosive	0.4	Stable	10.6	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)	**150**	**375**	**1124**	**1498**	**150**	**375**	**1124**	**1498**	**150**	**375**	**1124**	**1498**
Bray - Equation #1	33	54	96	112	1.4	1.9	2.8	3.0	3.2	3.6	4.2	4.4
Bray - Equation #2	44	71	127	147	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	43	69	78					1.8	2.2	2.6	2.7
Parker	84	133	230	266	1.1	1.6	2.6	2.9				
Chang	59	103	200	238	0.1	-0.1	-0.5	-0.6				
Kellerhals	22	35	60	70	2.0	2.9	4.5	5.1	3.4	3.7	4.1	4.2
AMAFCA/Schumm	43	120	126	129								
Moody & Odem	16	16	16	16	1.1	1.1	1.1	1.1				
BUREC	16.8	23.7	35.8	39.8	4	6	10	11	3.1	3.9	5.2	5.6
Average	36	61	99	113	2.0	2.8	4.0	4.5	2.7	3.2	3.8	4.0
Values As Designed	43	120	126	129	1.3	2.4	3.5	3.9	2.9	2.8	4.2	4.7
Difference with Design	-7	-58	-27	-16	0.7	0.3	0.5	0.5	-0.1	0.4	-0.4	-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
150	828	476	990	6650	1584	320	138	191	5525	429	2251	1762
375	1964	1112	2453	15426	4245	752	337	448	13790	1028	5379	4267
1124	10402	4165	7611	96204	6384	4503	1193	2331	41825	4752	24723	18554
1498	16039	5789	9919	154725	7107	7286	1613	3470	55844	7080	36151	27729

Discharge (cfs)	Sediment Concentrations (ppm by weight)											
	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
150	2051	1178	2451	16469	3924	793	341	473	13685	1062	5576	4364
375	1945	1102	2430	15282	4206	745	334	443	13661	1018	5329	4227
1124	3435	1375	2513	31768	2108	1487	394	770	13811	1569	8164	6127
1498	3972	1434	2456	38320	1760	1805	399	859	13831	1753	8953	6868

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
150	828	403	640	1556	859	179	138	191	1241	179	972	653
375	1964	939	1598	3610	2282	424	337	448	3083	425	2304	1583
1124	10402	3645	5334	22513	3646	2077	1193	2331	9636	2149	11455	6762
1498	16039	5098	6876	36208	4103	3085	1613	3470	12914	2407	17077	9899

Discharge (cfs)	Sediment Concentrations (ppm by weight)											
	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
150	2051	998	1585	3854	2126	444	341	473	3074	443	2408	1618
375	1945	931	1583	3576	2261	420	334	443	3054	421	2283	1568
1124	3435	1204	1761	7434	1204	686	394	770	3182	710	3783	2233
1498	3972	1262	1703	8967	1016	764	399	859	3198	596	4229	2452

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)
150	0.0007	0.0010	256	0.78	0.053	0.0002	32	0.036	0.0002	0.0159	0.0002	0.0005	0.0066	0.0004	0.0016	0.0059	0.0033
375	0.0007	0.0011	248	0.76	0.053	0.0003	31	0.036	0.0002	0.0159	0.0002	0.0006	0.0066	0.0003	0.0008	0.0060	0.0033
1124	0.0003	0.0006	339	1.03	0.056	0.0001	32	0.036	0.0001	0.0159	0.0001	0.0003	0.0066	0.0002	0.0004	0.0059	0.0032
1498	0.0003	0.0005	367	1.12	0.057	0.0001	33	0.036	0.0001	0.0159	0.0001	0.0002	0.0066	0.0001	0.0003	0.0059	0.0032

Drop Structures

Design Slope	0.0060	ft/ft
Total Drop Needed	48.9	ft
Height of Drop Structure	5	ft
No . of Drop Structures	10	
Distance between structs.	499	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	0.62	sq. mi
Total Sediment Yield Volume	1.17	ac ft

Sedimentation Basins

Length	499 ft	Depth	3 ft
Width	135 ft	Side slope	3 ft/ft
Total Volume per Basin		4.26	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)
150	1.1	-0.4	0.1	24.6	1.3	1.2	2.9	0.0060	0.1	0.0	2.0	2.9
375	1.1	-0.8	0.1	24.6	2.4	1.1	2.8	0.0060	0.3	0.0	2.0	3.0
1124	1.1	-0.9	0.2	24.6	3.5	2.1	4.2	0.0060	0.4	0.0	2.0	3.3
1498	1.1	-1.0	0.3	24.6	3.9	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	74	cfs
Stage at Peak Flow	98.7	ft
Flow Volume	85.0	ac. ft

Freeboard

Max. Flow Depth	3.9	ft
Channel Depth as designed	5.0	ft
Available Freeboard	1.1	ft
Required Freeboard	1.1	ft

Sediment Volume

Inflowing Sediment Volume	1.25	ac. ft
Outflowing Sediment Volume	0.08	ac. ft
Deposited(+)/Eroded(-) Volume	1.17	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	4992	4992
Side Slope (?H:1V)	3	6
Channel Width (ft)	135	165
Channel XS Area (sq. ft)	460	535
Channel Perimeter (ft)	137	166

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	695590	845133
Excavated Area (sq. Yd)	74880	91520

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)	4992	4992
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)	4992	4992
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

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	4992	ft
Thickness	1.5	ft
Protection Depth	4	ft
Tie-in Length/Depth	3.0	ft
Total Depth	7.0	ft
Area needed	832	sq. Yd
Volume	1941	cu. Yd

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	135	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	5	ft
Scour Depth	10.6	ft
Structure Height	15.6	ft
Number of Structures	10	
Volume per structure	234	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 17,550	
Area per structure	45	sq. Yd
Total Area	450	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	6873	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 27,492	
Other Cost	$ -	
Total cost per basin	$ 27,492	
Area per basin	7,488	sq. Yd
Total Area	7,488	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	695,590	cu. Yd	$ 10.00	$ 6,955,900	74,880	sq. Yd	$ 9.00	$ 673,920	74,880	sq. Yd	$ 8.33	$ 624,000
Exc. Chl - LC Enhancement	Excavated	149,543	cu. Yd	$ 10.00	$ 1,495,430	16,640	sq. Yd	$ 9.00	$ 149,760	16,640	sq. Yd	$ 8.33	$ 138,667
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	1,941	cu. Yd	$ 75.00	$ 145,575	832	sq. Yd	$ -	$ -	832	sq. Yd	$ 25.00	$ 20,800
Drop Structures	Riprap	10	EA	$ 17,550.00	$ 175,500	450	sq. Yd	$ -	$ -	450	sq. Yd	$ 33.33	$ 15,000
Drop Str. - LC Enhancement	Riprap	10	EA	$ 1,755.00	$ 17,550	45	sq. Yd	$ -	$ -	45	sq. Yd	$ 33.33	$ 1,500
Sedimentation Basins		1	EA	$ 27,492.00	$ 27,492	7,488	sq. Yd	$ -	$ -	7,488	sq. Yd	$ 8.33	$ 62,400
Other					$ -				$ -				$ -

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 7,304,467	$ 1,512,980	$ 8,817,447
Contingency Cost (25% of Construction Cost)	$ 1,826,117	$ 378,245	$ 2,204,362
Engineering Design Cost (5% of Construction Cost)	$ 365,223	$ 75,649	$ 440,872
Total Construction Cost	$ 9,495,807	$ 1,966,874	$ 11,462,681

Base Landscape Cost	$ 673,920
LC Enhancement Cost	$ 149,760
Total Landscape Cost	$ 823,680

Base Maintenance Cost	$ 722,200
LC Enhancement Cost	$ 140,167
Total Maintenance Cost	$ 862,367

Land Cost

Channel Length	4992 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	134	15.4	$100,000	$ 1,540,000
LC Enhancement Buffer	50	5.7	$100,000	$ 570,000
Channel	135	15.5	$100,000	$ 1,550,000
Channel LC Enhancement	30	3.4	$100,000	$ 340,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	349	40		$ 4,000,000

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	30.9	$100,000	$ 3,090,000
LC Enhancement Cost	acre	9.1	$100,000	$ 910,000
Total Land Cost	acre	40	$100,000	$ 4,000,000

Total Cost

Base Total Cost	$ 13,981,927
Total Landscape Enhancement Cost	$ 3,166,801
Total Cost Including LC Enh.	$ 17,148,728

Open Channel

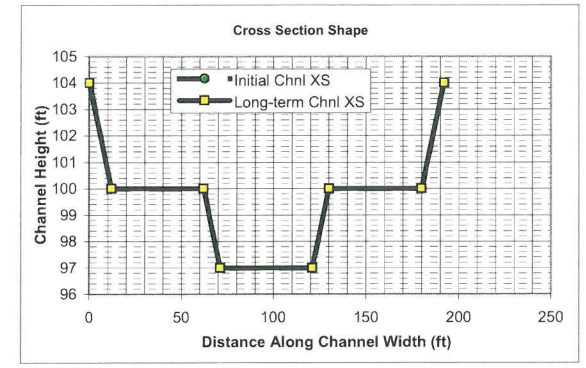
Structure ID	RR91010	HEC1 ID	910915

Longitundal Geometry

Length	3390.4	ft
U/S Elev	1668.1	ft
D/S Elev	1623.5	ft
Initial Channel Slope	0.0131	ft/ft
Long-term Channel Slope	0.0050	ft/ft

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

NSTPS	2



Initial Channel XS Geometry

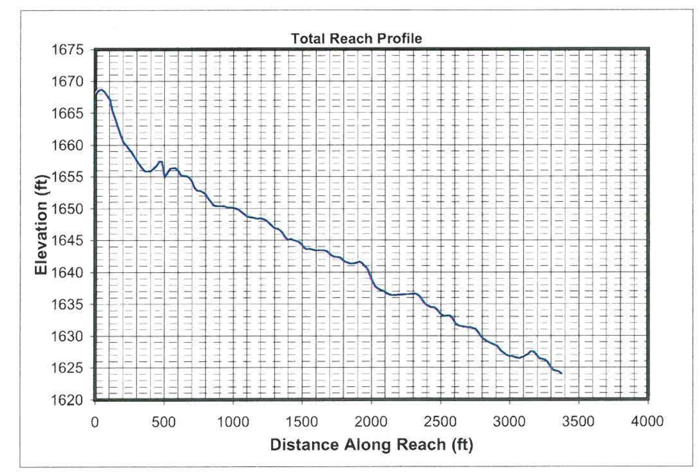
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	50	3	50	7	3	50	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	62	71	121	130	180	192
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	50	3	50	7	3	50	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	62	71	121	130	180	192
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	C915	S920								TOTAL
HEC1 Peak-Flow	2415	3157								5572
Weighting Factor	1.00	0.15								
Flow into Channel	2415	466								2881

Reach Sediment Inflow Characteristics

U/S Contributing ID	90091B_C910B1 0									TOTAL
HEC1 Flow Volume (ac. ft)	85.00									85
Sediment Conc. (ppm)	2452									
Sediment Volume (ac. ft)	0.08									0.08
Weighting Factor	1									
Weighted Sed. Vol. (ac. ft)	0.08									0.08

Hydrology

Drainage Area	2.506	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	2881	cfs	
Long-term Max. Chnl Capacity	5823	cfs	
Q2 Channel	288	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	192	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: CAP, Alternative: B3
Open Channel Structure ID: RR91010

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
288	60.7	92.7	1.5	97.0	98.7	3.1	1.7	60.1	1.5	0.53	0.44
720	68.2	168.4	2.5	97.0	99.9	4.3	2.9	67.2	2.5	0.90	0.48
2161	180.0	480.0	2.7	97.0	101.7	4.5	4.7	178.5	2.7	1.48	0.48
2881	183.4	574.6	3.1	97.0	102.3	5.0	5.3	181.6	3.2	1.65	0.50

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
288	60.7	92.7	1.5	97.0	98.7	3.1	1.7	60.1	1.5	0.53	0.44
720	68.2	168.4	2.5	97.0	99.9	4.3	2.9	67.2	2.5	0.90	0.48
2161	180.0	480.0	2.7	97.0	101.7	4.5	4.7	178.5	2.7	1.48	0.48
2881	183.4	574.6	3.1	97.0	102.3	5.0	5.3	181.6	3.2	1.65	0.50

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
	90091B_C910B1 0									
288	653									653
720	1583									1583
2161	6762									6762
2881	9899									9899

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)		
288	1.74	1.5291	1.4527	Erosive	Erosive	Erosive	0.4	Stable	5.8	Stable	Stable
720	1.74	1.6785	1.5946	Erosive	Erosive	Erosive	0.4	Stable	8.3	Stable	Stable
2161	1.74	1.7005	1.6154	Erosive	Erosive	Erosive	0.4	Stable	10.8	Stable	Stable
2881	1.74	1.7415	1.6544	Erosive	Erosive	Erosive	0.5	Stable	11.7	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)	**288**	**720**	**2161**	**2881**	**288**	**720**	**2161**	**2881**	**288**	**720**	**2161**	**2881**
Bray - Equation #1	47	76	136	158	1.8	2.4	3.4	3.8	3.5	4.0	4.6	4.8
Bray - Equation #2	62	100	179	208	1.9	2.6	3.8	4.1	2.4	2.7	3.2	3.3
Hey	14	24	44	52	5.5	7.9	11.9	13.3				
Ackers & Charlton/Lacey	39	57	91	102					2.1	2.4	2.9	3.0
Parker	117	184	319	369	1.5	2.1	3.4	3.8				
Chang	82	144	280	332	0.1	-0.1	-0.7	-1.0				
Kellerhals	31	48	84	97	2.6	3.8	5.9	6.6	3.6	3.9	4.4	4.5
AMAFCA/Schumm	60	67	179	182								
Moody & Odem	17	17	17	17	1.1	1.1	1.1	1.1				
BUREC	22.2	31.3	47.3	52.7	6	8	13	14	3.4	4.3	5.7	6.1
Average	49	75	138	157	2.6	3.5	5.2	5.7	3.0	3.5	4.2	4.4
Values As Designed	60	67	178	182	1.7	2.9	4.7	5.3	3.1	4.3	4.5	5.0
Difference with Design	-11	8	-41	-25	0.9	0.6	0.4	0.4	-0.1	-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
288	1475	800	1557	11745	2292	530	220	356	8031	745	4022	2889
720	5681	2306	3934	51506	3366	2260	612	1315	20235	2613	13808	9785
2161	18400	6928	11723	168498	9290	7463	1867	4186	60748	8295	43596	30999
2881	28411	9623	15327	271397	10324	12065	2519	6203	81104	12393	63734	46645

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
288	1900	1031	2005	15124	2951	682	283	458	10342	960	5180	3720
720	2926	1188	2026	26531	1734	1164	315	678	10423	1346	7113	5040
2161	3159	1190	2013	28931	1595	1281	321	719	10430	1424	7485	5323
2881	3659	1239	1974	34949	1329	1554	324	799	10444	1596	8207	6007

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
288	1475	682	1002	2769	1255	295	220	356	1824	306	1742	1084
720	5681	2018	2741	12145	1925	1057	612	1315	4693	905	6346	3585
2161	18400	6085	8199	39732	5341	3359	1867	4186	14117	2455	20220	11269
2881	28411	8502	10595	63996	5997	4988	2519	6203	18913	2642	30136	16628

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
288	1900	879	1290	3566	1615	380	283	458	2349	394	2244	1396
720	2926	1039	1412	6256	992	544	315	678	2417	466	3269	1847
2161	3159	1045	1408	6822	917	577	321	719	2424	421	3472	1935
2881	3659	1095	1364	8241	772	642	324	799	2436	340	3881	2141

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson n	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)
288	0.0005	0.0008	263	0.80	0.053	0.0002	32	0.036	0.0001	0.0159	0.0002	0.0004	0.0053	0.0003	0.0013	0.0049	0.0027
720	0.0003	0.0005	335	1.02	0.056	0.0001	32	0.036	0.0001	0.0159	0.0001	0.0002	0.0053	0.0002	0.0006	0.0049	0.0027
2161	0.0003	0.0005	348	1.06	0.056	0.0001	32	0.036	0.0001	0.0159	0.0001	0.0002	0.0053	0.0001	0.0003	0.0049	0.0026
2881	0.0002	0.0004	377	1.15	0.057	0.0001	33	0.036	0.0001	0.0159	0.0001	0.0002	0.0053	0.0001	0.0002	0.0049	0.0026

Drop Structures

Design Slope	0.0050	ft/ft
Total Drop Needed	27.5	ft
Height of Drop Structure	3	ft
No . of Drop Structures	10	
Distance between structs.	339	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	0.49	sq. mi
Total Sediment Yield Volume	0.92	ac ft

Sedimentation Basins

Length	339 ft	Depth	3 ft
Width	192 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)
288	1.1	-0.5	0.1	24.6	1.7	1.5	3.1	0.0050	0.2	0.0	3.0	4.2
720	1.1	-0.7	0.3	24.6	2.9	2.5	4.3	0.0050	0.3	0.0	3.0	4.5
2161	1.1	-1.2	0.3	24.6	4.7	2.7	4.5	0.0050	0.5	0.0	3.0	4.8
2881	1.1	-1.2	0.3	24.6	5.3	3.2	5.0	0.0050	0.6	0.0	3.0	4.9

Toe Protection Needed	5.0	ft

HEC1 Results For Open Channel

Peak Flow	1363	cfs
Stage at Peak Flow	100.1	ft
Flow Volume	140.0	ac. ft

Freeboard

Max. Flow Depth	5.3	ft
Channel Depth as designed	7.0	ft
Available Freeboard	1.7	ft
Required Freeboard	1.4	ft

Sediment Volume

Inflowing Sediment Volume	1.00	ac. ft
Outflowing Sediment Volume	0.11	ac. ft
Deposited(+)/Eroded(-) Volume	0.89	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	3390	3390
Side Slope (?H:1V)	3	6
Channel Width (ft)	192	234
Channel XS Area (sq. ft)	897	1044
Channel Perimeter (ft)	194	235

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	443596	534453
Excavated Area (sq. Yd)	72320	88140

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	3390	ft
Thickness	1.5	ft
Protection Depth	5	ft
Tie-in Length/Depth	3.0	ft
Total Depth	8.0	ft
Area needed	565	sq. Yd
Volume	1507	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)	3390	3390
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)	3390	3390
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	192	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	307	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 23,025	
Area per structure	64	sq. Yd
Total Area	640	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	7,233	sq. Yd
Total Area	7,233	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	443,596	cu. Yd	$ 10.00	$ 4,435,960	72,320	sq. Yd	$ 9.00	$ 650,880	72,320	sq. Yd	$ 8.33	$ 602,667
Exc. Chl - LC Enhancement	Excavated	90,857	cu. Yd	$ 10.00	$ 908,570	15,820	sq. Yd	$ 9.00	$ 142,380	15,820	sq. Yd	$ 8.33	$ 131,833
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	1,507	cu. Yd	$ 75.00	$ 113,025	565	sq. Yd	$ -	$ -	565	sq. Yd	$ 25.00	$ 14,125
Drop Structures	Riprap	10	EA	$ 23,025.00	$ 230,250	640	sq. Yd	$ -	$ -	640	sq. Yd	$ 33.33	$ 21,333
Drop Str. - LC Enhancement	Riprap	10	EA	$ 2,302.50	$ 23,025	64	sq. Yd	$ -	$ -	64	sq. Yd	$ 33.33	$ 2,133
Sedimentation Basins		1	EA	$ 26,844.00	$ 26,844	7,233	sq. Yd	$ -	$ -	7,233	sq. Yd	$ 8.33	$ 60,275
Other					$				$ -				$ -

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 4,806,079	$ 931,595	$ 5,737,674
Contingency Cost (25% of Construction Cost)	$ 1,201,520	$ 232,899	$ 1,434,419
Engineering Design Cost (5% of Construction Cost)	$ 240,304	$ 46,580	$ 286,884
Total Construction Cost	$ 6,247,903	$ 1,211,074	$ 7,458,976

Base Landscape Cost	$ 650,880
LC Enhancement Cost	$ 142,380
Total Landscape Cost	$ 793,260

Base Maintenance Cost	$ 698,400
LC Enhancement Cost	$ 133,967
Total Maintenance Cost	$ 832,367

Land Cost

Channel Length	3390 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	134	10.4	$100,000	$ 1,040,000
LC Enhancement Buffer	50	3.9	$100,000	$ 390,000
Channel	192	14.9	$100,000	$ 1,490,000
Channel LC Enhancement	42	3.3	$100,000	$ 330,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	418	32.5		$ 3,250,000

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	25.3	$100,000	$ 2,530,000
LC Enhancement Cost	acre	7.2	$100,000	$ 720,000
Total Land Cost	acre	32.5	$100,000	$ 3,250,000

Total Cost

Base Total Cost	$ 10,127,183
Total Landscape Enhancement Cost	$ 2,207,420
Total Cost Including LC Enh.	$ 12,334,603

Open Channel

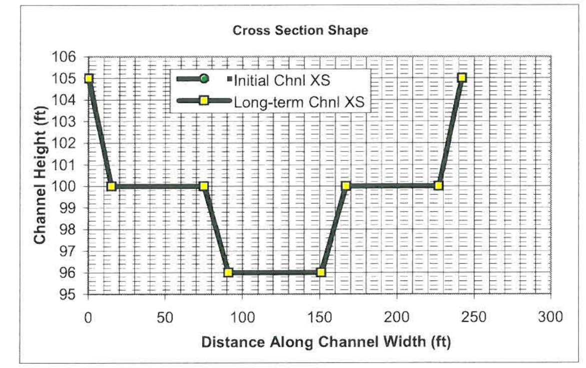
Structure ID	C92010		HEC1 ID	915920

Longitundal Geometry

Length	8861.8	ft
U/S Elev	1623.5	ft
D/S Elev	1532.6	ft
Initial Channel Slope	0.0103	ft/ft
Long-term Channel Slope	0.0040	ft/ft

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

NSTPS	5



Initial Channel XS Geometry

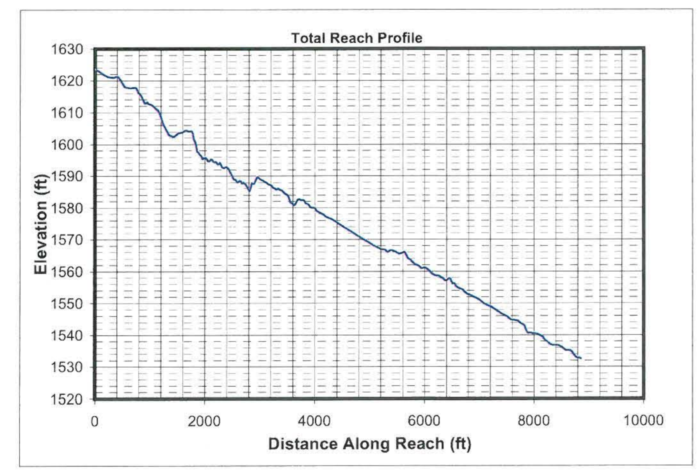
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	5	60	4	60	9	4	60	5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	15	75	91	151	167	227	242
Y	105	100	100	96	96	100	100	105

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	5	60	4	60	9	4	60	5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	15	75	91	151	167	227	242
Y	105	100	100	96	96	100	100	105



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	C920									TOTAL
HEC1 Peak-Flow	5262									5262
Weighting Factor	1.00									
Flow into Channel	5262									5262

Reach Sediment Inflow Characteristics

U/S Contributing ID	910915_RR9101 0									TOTAL
HEC1 Flow Volume (ac. ft)	140.00									140
Sediment Conc. (ppm)	2141									
Sediment Volume (ac. ft)	0.11									0.11
Weighting Factor	1									
Weighted Sed. Vol. (ac. ft)	0.11									0.11

Hydrology

Drainage Area	6.43	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	5262	cfs	
Long-term Max. Chnl Capacity	9820	cfs	
Q2 Channel	526	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	242	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
526	78.9	158.1	2.0	96.0	98.3	3.3	2.3	78.3	2.0	0.57	0.41
1316	91.8	291.1	3.2	96.0	99.9	4.5	3.9	90.9	3.2	0.96	0.44
3947	227.6	809.1	3.6	96.0	102.3	4.9	6.3	225.8	3.6	1.57	0.45
5262	232.0	969.0	4.2	96.0	103.0	5.4	7.0	230.1	4.2	1.75	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
526	78.9	158.1	2.0	96.0	98.3	3.3	2.3	78.3	2.0	0.57	0.41
1316	91.8	291.1	3.2	96.0	99.9	4.5	3.9	90.9	3.2	0.96	0.44
3947	227.6	809.1	3.6	96.0	102.3	4.9	6.3	225.8	3.6	1.57	0.45
5262	232.0	969.0	4.2	96.0	103.0	5.4	7.0	230.1	4.2	1.75	0.47

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
	910915_RR9101 0									
526	1084									1084
1316	3585									3585
3947	11269									11269
5262	16628									16628

Allowable Velocity

Channel Lining	Natural - Sandy Loam (noncolloidal)			

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)		
526	1.74	1.6121	1.5315	Erosive	Erosive	Erosive	0.4	Stable	6.4	Erosive	Erosive
1316	1.74	1.7464	1.6591	Erosive	Erosive	Erosive	0.5	Stable	8.9	Erosive	Erosive
3947	1.74	1.7897	1.7002	Erosive	Erosive	Erosive	0.5	Stable	11.6	Erosive	Erosive
5262	1.74	1.8524	1.7598	Erosive	Erosive	Erosive	0.5	Stable	12.6	Erosive	Erosive

USCOE Allowable Velocity (ft/s)	2
FHWA Allowable Velocity (ft/s)	2.5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	**526**	**1316**	**3947**	**5262**	**526**	**1316**	**3947**	**5262**	**526**	**1316**	**3947**	**5262**
Bray - Equation #1	65	105	187	218	2.1	2.9	4.2	4.6	3.8	4.3	5.0	5.2
Bray - Equation #2	85	138	246	286	2.3	3.2	4.6	5.0	2.6	3.0	3.5	3.6
Hey	20	34	62	72	7.0	9.9	15.0	16.7				
Ackers & Charlton/Lacey	50	74	117	132					2.3	2.7	3.2	3.3
Parker	158	249	432	498	1.9	2.7	4.3	4.8				
Chang	110	193	375	445	0.1	-0.2	-1.0	-1.3				
Kellerhals	41	65	113	131	3.3	4.8	7.5	8.4	3.8	4.2	4.7	4.8
AMAFCA/Schumm	78	91	226	230								
Moody & Odem	25	25	25	25	1.3	1.3	1.3	1.3				
BUREC	29.0	40.9	61.8	68.8	8	11	17	18	3.7	4.6	6.1	6.5
Average	66	101	184	211	3.2	4.4	6.5	7.2	3.2	3.8	4.5	4.7
Values As Designed	78	91	226	230	2.3	3.9	6.3	7.0	3.3	4.5	4.9	5.4
Difference with Design	-12	10	-42	-19	0.9	0.6	0.2	0.2	-0.1	-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
526	2388	1223	2202	18331	3035	773	316	604	10229	1174	6497	4252
1316	9036	3494	5501	78360	4563	3226	869	2152	25763	4091	21976	14457
3947	30212	10615	16282	268341	12055	11137	2648	6986	77375	13352	70806	47255
5262	46603	14713	21363	431901	13402	17943	3561	10285	103296	17511	103397	71270

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
526	1684	862	1552	12925	2140	545	223	426	7212	828	4580	2998
1316	2548	985	1551	22099	1287	910	245	607	7266	1154	6198	4077
3947	2840	998	1531	25226	1133	1047	249	657	7274	1255	6656	4442
5262	3286	1037	1506	30451	945	1265	251	725	7283	1235	7290	5025

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
526	2388	1050	1420	4436	1686	433	316	604	2389	475	2839	1640
1316	9036	3070	3884	18964	2640	1520	869	2152	6134	880	10146	5390
3947	30212	9375	11410	64941	7026	4944	2648	6986	18475	2269	33132	17402
5262	46603	13063	14786	104525	7887	7328	3561	10285	24744	2441	49297	25865

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
526	1684	740	1001	3128	1189	305	223	426	1684	335	2001	1156
1316	2548	866	1095	5348	745	429	245	607	1730	248	2861	1520
3947	2840	881	1073	6105	661	465	249	657	1737	213	3115	1636
5262	3286	921	1043	7370	556	517	251	725	1745	172	3476	1824

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson n	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)
526	0.0004	0.0006	268	0.82	0.053	0.0001	32	0.036	0.0001	0.0159	0.0001	0.0003	0.0043	0.0002	0.0010	0.0040	0.0022
1316	0.0002	0.0004	336	1.03	0.056	0.0001	32	0.036	0.0001	0.0159	0.0001	0.0002	0.0043	0.0001	0.0005	0.0040	0.0021
3947	0.0002	0.0003	356	1.09	0.056	0.0001	32	0.036	0.0001	0.0159	0.0001	0.0002	0.0043	0.0001	0.0002	0.0040	0.0021
5262	0.0002	0.0003	386	1.18	0.057	0.0001	33	0.036	0.0000	0.0159	0.0001	0.0001	0.0043	0.0001	0.0002	0.0040	0.0021

Drop Structures

Design Slope	0.0040	ft/ft
Total Drop Needed	55.8	ft
Height of Drop Structure	3	ft
No . of Drop Structures	19	
Distance between structs.	466	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	2.81	sq. mi
Total Sediment Yield Volume	5.33	ac ft

Sedimentation Basins

Length	466 ft	Depth	3 ft
Width	242 ft	Side slope	3 ft/ft
Total Volume per Basin		7.34	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)
526	1.1	-0.7	0.2	24.6	2.3	2.0	3.3	0.0040	0.2	0.0	4.0	5.6
1316	1.1	-1.0	0.3	24.6	3.9	3.2	4.5	0.0040	0.4	0.0	4.0	6.0
3947	1.1	-1.5	0.3	24.6	6.3	3.6	4.9	0.0040	0.7	0.0	4.0	6.4
5262	1.1	-1.5	0.4	24.6	7.0	4.2	5.4	0.0040	0.8	0.0	4.0	6.6

Toe Protection Needed	7.0	ft

HEC1 Results For Open Channel

Peak Flow	2164	cfs
Stage at Peak Flow	99.9	ft
Flow Volume	217.0	ac. ft

Freeboard

Max. Flow Depth	7.0	ft
Channel Depth as designed	9.0	ft
Available Freeboard	2.0	ft
Required Freeboard	1.9	ft

Sediment Volume

Inflowing Sediment Volume	5.44	ac. ft
Outflowing Sediment Volume	0.15	ac. ft
Deposited(+)/Eroded(-) Volume	5.29	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	8862	8862
Side Slope (?H:1V)	3	6
Channel Width (ft)	242	296
Channel XS Area (sq. ft)	1439	1682
Channel Perimeter (ft)	245	298

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	2689618	3264147
Excavated Area (sq. Yd)	238289	291461

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	8862	ft
Thickness	1.5	ft
Protection Depth	7	ft
Tie-in Length/Depth	3.0	ft
Total Depth	10.0	ft
Area needed	1477	sq. Yd
Volume	4923	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)	8862	8862
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)	8862	8862
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	242	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	14.1	ft
Structure Height	17.1	ft
Number of Structures	19	
Volume per structure	458	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 34,350	
Area per structure	81	sq. Yd
Total Area	1,533	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	3	
Total Volume per Basin	11842	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 47,368	
Other Cost	$ -	
Total cost per basin	$ 47,368	
Area per basin	12,541	sq. Yd
Total Area	37,623	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	2,689,618	cu. Yd	$ 10.00	$ 26,896,180	238,289	sq. Yd	$ 9.00	$ 2,144,601	238,289	sq. Yd	$ 8.33	$ 1,985,742
Exc. Chl - LC Enhancement	Excavated	574,529	cu. Yd	$ 10.00	$ 5,745,290	53,172	sq. Yd	$ 9.00	$ 478,548	53,172	sq. Yd	$ 8.33	$ 443,100
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	4,923	cu. Yd	$ 75.00	$ 369,225	1,477	sq. Yd	$ -	$ -	1,477	sq. Yd	$ 25.00	$ 36,925
Drop Structures	Riprap	19	EA	$ 34,350.00	$ 652,650	1,533	sq. Yd	$ -	$ -	1,533	sq. Yd	$ 33.33	$ 51,100
Drop Str. - LC Enhancement	Riprap	19	EA	$ 3,435.00	$ 65,265	153	sq. Yd	$ -	$ -	153	sq. Yd	$ 33.33	$ 5,110
Sedimentation Basins		3	EA	$ 47,368.00	$ 142,104	37,623	sq. Yd	$ -	$ -	37,623	sq. Yd	$ 8.33	$ 313,525
Other					$ -				$ -				$ -

Base Landscape Cost	$ 2,144,601	Base Maintenance Cost	$ 2,387,292
LC Enhancement Cost	$ 478,548	LC Enhancement Cost	$ 448,210
Total Landscape Cost	$ 2,623,149	Total Maintenance Cost	$ 2,835,502

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 28,060,159	$ 5,810,555	$ 33,870,714
Contingency Cost (25% of Construction Cost)	$ 7,015,040	$ 1,452,639	$ 8,467,679
Engineering Design Cost (5% of Construction Cost)	$ 1,403,008	$ 290,528	$ 1,693,536
Total Construction Cost	$ 36,478,207	$ 7,553,722	$ 44,031,928

Land Cost

Channel Length	8862 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	134	27.3	$100,000	$ 2,730,000
LC Enhancement Buffer	50	10.2	$100,000	$ 1,020,000
Channel	242	49.2	$100,000	$ 4,920,000
Channel LC Enhancement	54	11	$100,000	$ 1,100,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	480	97.7		$ 9,770,000

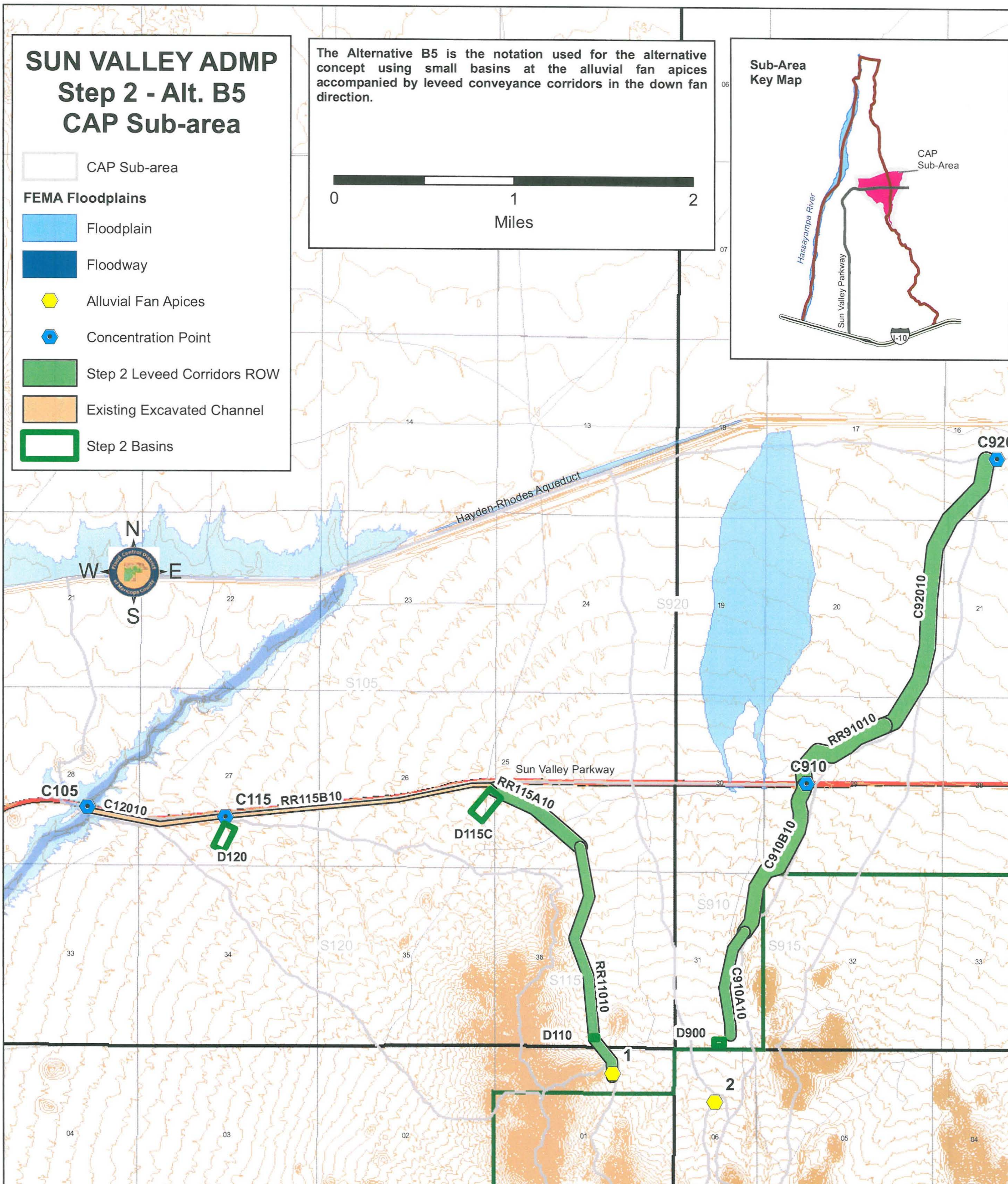
Right of Way

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	76.5	$100,000	$ 7,650,000
LC Enhancement Cost	acre	21.2	$100,000	$ 2,120,000
Total Land Cost	acre	97.7	$100,000	$ 9,770,000

Total Cost

Base Total Cost	$ 48,660,099
Total Landscape Enhancement Cost	$ 10,600,480
Total Cost Including LC Enh.	$ 59,260,579



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
D110	Offline Basin	600	0	2	0	200	100	4	$ 46	$ 69	$ 20	$ 28	$ 164	28%	42%	12%	17%	0%
RR11010	Leveed Chl.	1308	54	0	34	1.4	326	4	$ 5,390	$ 3,550	$ 562	$ 1,434	$ 10,935	49%	32%	5%	13%	19%
RR115A10	Leveed Chl.	1681	30	0	15	0.6	428	4	$ 3,030	$ 1,476	$ 241	$ 743	$ 5,489	55%	27%	4%	14%	9%
RR115B10	Existing Chl.	1000	0	0	0	1.5	108	6	$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
D115C	Offline Basin	1000	9	80	0	900	440	5	$ 909	$ 768	$ 396	$ 385	$ 2,458	37%	31%	16%	16%	4%
C12010	Existing Chl.	2000	0	0	0	0.8	136	7	$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
D120	Offline Basin	2000	6	49	0	740	360	5	$ 612	$ 501	$ 266	$ 263	$ 1,642	37%	31%	16%	16%	3%
D900	Offline Basin	831	1	8	0	300	190	4	$ 131	$ 118	$ 57	$ 66	$ 371	35%	32%	15%	18%	1%
C910A10	Leveed Chl.	1424	27	0	17	0.7	328	4	$ 2,720	$ 1,513	$ 282	$ 721	$ 5,236	52%	29%	5%	14%	9%
C910B10	Leveed Chl.	1501	50	0	24	0.9	436	4	$ 5,000	$ 2,043	$ 389	$ 1,067	$ 8,499	59%	24%	5%	13%	14%
RR91010	Leveed Chl.	2906	38	0	19	0.6	482	5	$ 3,750	$ 1,644	$ 285	$ 799	$ 6,477	58%	25%	4%	12%	11%
C92010	Leveed Chl.	3976	99	0	59	1.7	488	5	$ 9,930	$ 4,419	$ 815	$ 2,249	$ 17,414	57%	25%	5%	13%	30%
		TOTAL	314	139	168				$31,517	$ 16,102	$ 3,313	$ 7,754	**$ 58,687**	54%	27%	6%	13%	100%
All Channels			298	0	168	5.9			$29,820	$ 14,645	$ 2,574	$ 7,012	$ 54,051	55%	27%	5%	13%	92%
All Online Basins			0	0	0				$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
All Offline Basins			16	139	0				$ 1,697	$ 1,457	$ 739	$ 742	$ 4,636	37%	31%	16%	16%	8%
Channel Cost per mile (in $1000)			$9,161		Basins Cost per ac. ft. (in $1000)				$5.32									

Cost Increase for Landscape Compatibility Enhancement over Base Costs

All Channels % increase			12%	0%	138%				12%	67%	106%	100%	43%
All Online Basins % increase			0%	0%	0%				0%	0%	0%	0%	0%
All Offline Basins % increase			81%	9%	0%				71%	7%	72%	67%	50%
Total % increase			16%	9%	138%				15%	62%	98%	97%	43%

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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)	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
D110	Offline Basin	600	0	2	0	200	100	4	$ 46	$ 69	$ 20	$ 28	$ 164	28%	42%	12%	17%	0%
RR11010	Leveed Chl.	1308	54	0	34	1.4	326	4	$ 5,390	$ 3,550	$ 562	$ 1,434	$ 10,935	49%	32%	5%	13%	19%
RR115A10	Leveed Chl.	1681	30	0	15	0.6	428	4	$ 3,030	$ 1,476	$ 241	$ 743	$ 5,489	55%	27%	4%	14%	9%
RR115B10	Existing Chl.	1000	0	0	0	1.5	108	6	$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
D115C	Offline Basin	1000	9	80	0	900	440	5	$ 909	$ 768	$ 396	$ 385	$ 2,458	37%	31%	16%	16%	4%
C12010	Existing Chl.	2000	0	0	0	0.8	136	7	$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
D120	Offline Basin	2000	6	49	0	740	360	5	$ 612	$ 501	$ 266	$ 263	$ 1,642	37%	31%	16%	16%	3%
D900	Offline Basin	831	1	8	0	300	190	4	$ 131	$ 118	$ 57	$ 66	$ 371	35%	32%	15%	18%	1%
C910A10	Leveed Chl.	1424	27	0	17	0.7	328	4	$ 2,720	$ 1,513	$ 282	$ 721	$ 5,236	52%	29%	5%	14%	9%
C910B10	Leveed Chl.	1501	50	0	24	0.9	436	4	$ 5,000	$ 2,043	$ 389	$ 1,067	$ 8,499	59%	24%	5%	13%	14%
RR91010	Leveed Chl.	2906	38	0	19	0.6	482	5	$ 3,750	$ 1,644	$ 285	$ 799	$ 6,477	58%	25%	4%	12%	11%
C92010	Leveed Chl.	3976	99	0	59	1.7	488	5	$ 9,930	$ 4,419	$ 815	$ 2,249	$ 17,414	57%	25%	5%	13%	30%
		TOTAL	314	139	168				$ 31,517	$ 16,102	$ 3,313	$ 7,754	**$ 58,687**	54%	27%	6%	13%	100%
All Channels			298	0	168	5.9			$ 29,820	$ 14,645	$ 2,574	$ 7,012	$ 54,051	55%	27%	5%	13%	92%
All Online Basins			0	0	0				$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
All Offline Basins			16	139	0				$ 1,697	$ 1,457	$ 739	$ 742	$ 4,636	37%	31%	16%	16%	8%
Channel Cost per mile (in $1000)			$9,161		Basins Cost per ac. ft. (in $1000)				$5.32									

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)	LCE Design Geometry: ROW Width (ft)	LCE Design Geometry: Depth (ft)	LCE Costs (in $1000): Land Cost	LCE Costs (in $1000): Constr. Cost	LCE Costs (in $1000): Lndscp Cost	LCE Costs (in $1000): 50 Yr Maint. Cost	LCE Costs (in $1000): Total Cost	LCE Cost Percentages: Land Cost %	LCE Cost Percentages: Constr. Cost %	LCE Cost Percentages: Lndscp Cost %	LCE Cost Percentages: 50 Yr Maint. Cost %	LCE Cost Percentages: % of Total Cost
D110	Offline Basin	600	2	2	0	390	200	4	$ 180	$ 72	$ 78	$ 84	$ 414	44%	17%	19%	20%	0%
RR11010	Leveed Chl.	1308	62	0	83	1.4	374	4	$ 6,180	$ 5,689	$ 1,166	$ 2,920	$ 15,955	39%	36%	7%	18%	19%
RR115A10	Leveed Chl.	1681	34	0	35	0.6	476	4	$ 3,370	$ 2,394	$ 500	$ 1,380	$ 7,643	44%	31%	7%	18%	9%
RR115B10	Existing Chl.	1000	0	0	0	1.5	122	6	$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
D115C	Offline Basin	1000	14	87	0	1130	540	5	$ 1,400	$ 822	$ 610	$ 587	$ 3,419	41%	24%	18%	17%	4%
C12010	Existing Chl.	2000	0	0	0	0.8	150	7	$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
D120	Offline Basin	2000	10	53	0	960	460	5	$ 1,010	$ 535	$ 442	$ 428	$ 2,415	42%	22%	18%	18%	3%
D900	Offline Basin	831	3	9	0	480	290	4	$ 320	$ 126	$ 139	$ 144	$ 730	44%	17%	19%	20%	1%
C910A10	Leveed Chl.	1424	31	0	42	0.7	376	4	$ 3,120	$ 2,580	$ 586	$ 1,468	$ 7,754	40%	33%	8%	19%	9%
C910B10	Leveed Chl.	1501	56	0	57	0.9	484	4	$ 5,550	$ 3,499	$ 809	$ 2,094	$ 11,952	46%	29%	7%	18%	14%
RR91010	Leveed Chl.	2906	42	0	45	0.6	533	5	$ 4,150	$ 2,773	$ 590	$ 1,594	$ 9,106	46%	30%	6%	18%	11%
C92010	Leveed Chl.	3976	110	0	137	1.7	542	5	$ 11,030	$ 7,583	$ 1,648	$ 4,542	$ 24,803	44%	31%	7%	18%	29%
		TOTAL	364	151	399				$ 36,310	$ 26,072	$ 6,568	$ 15,240	**$ 84,190**	43%	31%	8%	18%	100%
All Channels			335	0	399	5.9			$ 33,400	$ 24,517	$ 5,299	$ 13,997	$ 77,213	43%	32%	7%	18%	92%
All Online Basins			0	0	0				$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
All Offline Basins			29	151	0				$ 2,910	$ 1,555	$ 1,269	$ 1,243	$ 6,977	42%	22%	18%	18%	8%
Channel Cost per mile (in $1000)			$13,087		Basins Cost per ac. ft. (in $1000)				$8.40									
All Channels % increase			12%	0%	138%				12%	67%	106%	100%	43%					
All Online Basins % increase			0%	0%	0%				0%	0%	0%	0%	0%					
All Offline Basins % increase			81%	9%	0%				71%	7%	72%	67%	50%					
Total % increase			16%	9%	138%				15%	62%	98%	97%	43%					

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	61	100.2	17.36	11.4	10.23	59	51	36	20	0.054	0.185	0.39	0.513	29	101	213	280
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	100.3	9.31	8	10.23	60	51	36	20	0.055	0.186	0.39	0.513	30	101	213	280
C105U	COMBINE	2863			4.5	14.6	554	228	121	64	0.353	0.58	0.923	1.129	275	451	719	879
S110	BASIN	662			4.2	0.43	76	19	6	3	1.639	1.64	1.64	1.64	38	38	38	38
D110	DIVERT	600			4.1	0.43	74	19	6	3	1.603	1.604	1.604	1.604	37	37	37	37
11015I	ROUTE	499	100.6	23.29	4.6	0.43	74	19	6	3	1.6	1.604	1.604	1.604	37	37	37	37
S115A	BASIN	1540			4.3	1.4	213	53	18	8	1.415	1.416	1.416	1.416	105	105	105	105
C115A	COMBINE	1529			4.5	1.83	271	68	23	10	1.377	1.381	1.381	1.381	134	135	135	135
15I15A	ROUTE	1510	101	24.01	4.5	1.83	270	68	23	10	1.376	1.381	1.381	1.381	134	135	135	135
S115B	BASIN	789			4.1	0.42	57	14	5	2	1.269	1.269	1.269	1.269	29	29	29	29
C115B	COMBINE	1586			4.5	2.25	308	77	26	11	1.273	1.276	1.276	1.276	153	153	153	153
15I15B	ROUTE	1571	103.4	32.09	4.6	2.25	308	77	26	11	1.272	1.276	1.276	1.276	153	153	153	153
S115C	BASIN	668			4.1	0.43	58	14	5	2	1.246	1.246	1.246	1.246	29	29	29	29
C115C	COMBINE	1659			4.5	2.68	342	86	29	12	1.189	1.192	1.192	1.192	170	170	170	170
D115C	DIVERT	1000			4.3	2.68	286	72	24	10	0.994	0.997	0.997	0.997	142	142	142	142
115120	ROUTE	1002	102.9	13.52	4.5	2.68	286	72	24	10	0.994	0.997	0.997	0.997	142	142	142	142
S120	BASIN	1838			4.3	2	256	64	21	9	1.189	1.189	1.189	1.189	127	127	127	127
C120	COMBINE	2278			4.5	4.68	497	125	42	18	0.988	0.992	0.992	0.992	247	248	248	248
D120	DIVERT	1936			4.5	4.68	479	120	40	17	0.952	0.956	0.956	0.956	238	239	239	239
C105D	COMBINE	3747			4.5	19.28	812	273	127	64	0.392	0.526	0.733	0.858	403	541	753	882
S900	BASIN	936			4.5	1.03	170	43	14	6	1.529	1.535	1.535	1.535	84	85	85	85
D900	DIVERT	797			4.5	1.03	165	41	14	6	1.48	1.485	1.485	1.485	82	82	82	82
90091A	ROUTE	791	100.8	16.53	4.6	1.03	165	41	14	6	1.478	1.485	1.485	1.485	82	82	82	82
90091B	ROUTE	737	100.6	26.95	5	1.03	164	41	14	6	1.476	1.485	1.485	1.485	81	82	82	82
S910	BASIN	1585			4.1	0.98	138	35	12	5	1.307	1.307	1.307	1.307	69	69	69	69
C910	COMBINE	1227			4.1	2.02	280	70	23	10	1.289	1.294	1.294	1.294	139	139	139	139
910915	ROUTE	1111	100.8	25.73	4.3	2.02	279	70	23	10	1.287	1.294	1.294	1.294	138	139	139	139
S915	BASIN	1400			4.5	1.13	189	47	16	7	1.562	1.562	1.562	1.562	94	94	94	94
C915	COMBINE	2030			4.4	3.14	433	109	36	16	1.281	1.288	1.288	1.288	215	216	216	216
915920	ROUTE	1746	101.2	95.44	4.9	3.14	427	109	36	16	1.262	1.288	1.288	1.288	212	216	216	216
S920	BASIN	2660			4.5	3.29	424	106	35	15	1.197	1.197	1.197	1.197	210	210	210	210
C920	COMBINE	3228			4.8	6.43	760	194	65	28	1.097	1.123	1.123	1.123	377	385	385	385

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	71	100.2	20.2	19.1	10.23	68	58	41	23	0.062	0.212	0.445	0.579	34	116	243	316
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	100.3	10.27	15.9	10.23	70	59	41	23	0.063	0.213	0.445	0.58	35	116	243	316
C105U	COMBINE	3466			12.5	14.6	593	239	126	66	0.378	0.609	0.961	1.164	294	474	748	906
S110	BASIN	532			12.1	0.43	62	16	5	2	1.35	1.422	1.422	1.422	31	33	33	33
D110	DIVERT	532			12.1	0.43	62	16	5	2	1.35	1.422	1.422	1.422	31	33	33	33
110151	ROUTE	404	100.5	20.46	12.6	0.43	62	16	5	2	1.35	1.421	1.422	1.422	31	33	33	33
S115A	BASIN	1536			12.3	1.4	193	50	17	7	1.286	1.321	1.322	1.322	96	98	98	98
C115A	COMBINE	1569			12.3	1.83	253	65	22	9	1.288	1.332	1.333	1.333	126	130	130	130
15I15A	ROUTE	1540	101	24.3	12.5	1.83	253	65	22	9	1.288	1.332	1.333	1.333	126	130	130	130
S115B	BASIN	619			12	0.42	47	12	4	2	1.046	1.046	1.046	1.046	23	23	23	23
C115B	COMBINE	1681			12.4	2.25	298	77	26	11	1.232	1.268	1.269	1.269	148	152	152	152
15I15B	ROUTE	1656	103.5	33.32	12.5	2.25	298	77	26	11	1.232	1.268	1.269	1.269	148	152	152	152
S115C	BASIN	534			12.1	0.43	47	12	4	2	1.028	1.028	1.028	1.028	24	24	24	24
C115C	COMBINE	1783			12.5	2.68	343	88	29	13	1.19	1.22	1.221	1.221	170	174	174	174
D115C	DIVERT	1000			12.3	2.68	277	72	24	10	0.964	0.993	0.994	0.994	138	142	142	142
115120	ROUTE	1000	102.9	13.5	12.5	2.68	277	72	24	10	0.963	0.993	0.994	0.994	138	142	142	142
S120	BASIN	2032			12.3	2	247	62	21	9	1.146	1.158	1.158	1.158	122	124	124	124
C120	COMBINE	2842			12.4	4.68	519	133	44	19	1.03	1.053	1.054	1.054	257	263	263	263
D120	DIVERT	2000			12.2	4.68	477	122	41	18	0.947	0.97	0.97	0.97	236	242	242	242
C105D	COMBINE	5244			12.5	19.28	1013	339	156	79	0.488	0.654	0.905	1.052	502	673	930	1081
S900	BASIN	853			12.5	1.03	150	39	13	6	1.345	1.416	1.417	1.417	74	78	78	78
D900	DIVERT	831			12.5	1.03	149	39	13	6	1.34	1.411	1.413	1.413	74	78	78	78
90091A	ROUTE	809	100.8	16.76	12.6	1.03	149	39	13	6	1.34	1.411	1.413	1.413	74	78	78	78
90091B	ROUTE	700	100.6	26.2	13	1.03	149	39	13	6	1.339	1.411	1.413	1.413	74	78	78	78
S910	BASIN	1512			12.1	0.98	122	30	10	4	1.151	1.151	1.151	1.151	60	60	60	60
C910	COMBINE	1501			12.1	2.02	267	69	23	10	1.232	1.269	1.27	1.27	133	137	137	137
910915	ROUTE	1295	100.9	28.32	12.3	2.02	267	69	23	10	1.229	1.269	1.27	1.27	132	137	137	137
S915	BASIN	1305			12.4	1.13	165	42	14	6	1.366	1.378	1.378	1.378	82	83	83	83
C915	COMBINE	2440			12.3	3.14	427	109	36	16	1.262	1.293	1.294	1.294	212	217	217	217
915920	ROUTE	1977	101.3	103.02	12.8	3.14	421	109	36	16	1.244	1.293	1.294	1.294	209	217	217	217
S920	BASIN	3157			12.5	3.29	428	107	36	15	1.209	1.209	1.209	1.209	212	212	212	212
C920	COMBINE	3976			12.7	6.43	829	214	71	31	1.198	1.234	1.235	1.235	411	424	424	424

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)
RR11010	Leveed	0.0240	0.0080	1.40	3	4.0	0.045	1308	256.4	255.4	1.0	1.0	1.0	3.0	256	5.1	0.90	0.50
RR115A10	Leveed	0.0191	0.0070	0.60	3	4.0	0.045	1681	358.5	363.9	1.0	1.0	1.0	3.0	358	4.6	0.81	0.45
RR115B10	Existing	0.0118	0.0015	1.50	3	5.5	0.030	1000	89.1	138.2	1.6	1.6	3.0	2.5	88	7.2	1.02	0.28
C12010	Existing	0.0100	0.0015	0.80	3	6.5	0.030	2000	115.4	244.2	2.1	2.1	3.8	2.7	114	8.2	0.99	0.36
C910A10	Leveed	0.0198	0.0070	0.70	3	4.0	0.045	1424	259.1	285.9	1.1	1.1	1.1	2.9	259	5.0	0.84	0.49
C910B10	Leveed	0.0158	0.0060	0.90	3	4.0	0.045	1501	366.3	362.7	1.0	1.0	1.0	3.0	366	4.1	0.73	0.37
RR91010	Leveed	0.0131	0.0050	0.60	3	4.5	0.045	2906	409.3	595.9	1.5	1.5	1.5	3.0	409	4.9	0.71	0.46
C92010	Leveed	0.0103	0.0040	1.70	3	5.0	0.045	3976	412.1	776.7	1.9	1.9	1.9	3.1	411	5.1	0.66	0.48

Basins Hydraulics Summary

			Design Geometry				Hydraulics					
Structure ID	Type	Adjacent Topo. Slope (ft/ft)	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)
D110	Offline Basin	0.0250	200	100	4.0	1.0	1.0	1.0	62	0	2.0	2.0
D115C	Offline Basin	0.0200	900	440	5.0	32.0	32.0	32.0	783	0	3.0	2.0
D120	Offline Basin	0.0200	740	360	5.0	21.2	21.0	21.0	842	0	1.4	3.6
D900	Offline Basin	0.0280	300	190	4.0	3.1	3.0	3.0	139	0	2.2	1.8

Offline Basin

HEC1 ID	D110

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

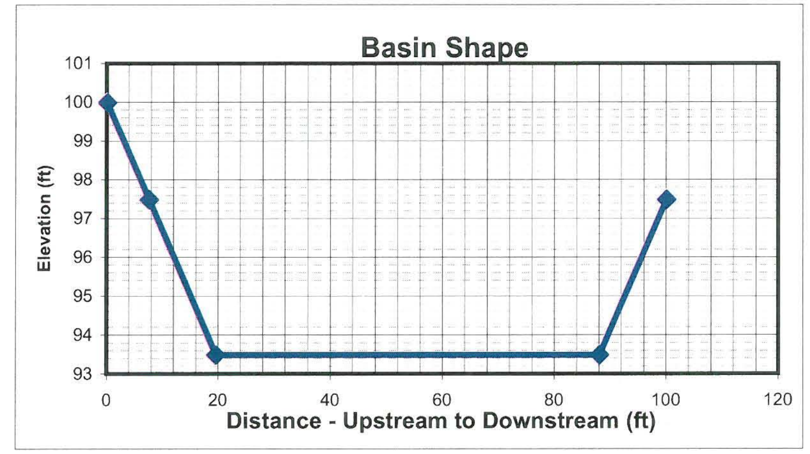
Sediment Volume	0.0	ac. ft

Geometry	Base	LC Enhanced
Topography slope (ft/ft)	0.025	0.025
Basin Length (ft)	200	290
Basin Width (ft)	100	100
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	4	4
Freeboard (ft)	1	1
Effective Basin Width (ft)	92.5	85
Top Area (acres)	0.5	0.7
U/S-D/S Height Difference (ft)	2.5	2.5
Excess Area on Upstream (acres)	0.0	0.1

			Base	LC Enhanced
Bottom Length (ft)	176	Allocated Storage Volume (ac. ft)	1.0	1
Bottom Width (ft)	68.5	Total Available Volume (ac. ft) (incl. Freeboard)	1.4	1.5
		Total Excavation Volume (ac. ft)	2.0	2.3

Stage-Storage-Discharge

Stage (ft)												
Inflow (cfs)	0	200	400	600	800	1000	1100	1200	1250	1500	2000	2500
Outflow (cfs)	0	0	0	0	200	400	500	600	650	900	1200	1900



HEC1 Results

	6-hr Event	24-hr Event	Maximum
Peak flow before diversion (cfs)	662	532	662
Peak flow after diversion (cfs)	600	532	600
Diverted Peak Flow (cfs)	62	0	62
Total Diverted Flow Volume (ac. ft)	1.0	0	1.0
Peak Stage	2	ft	

Volume Check

Total Volume needed	1.0	ac. ft
Total Volume Provided	1.0	ac. ft
Volume OK?	Yes	

Stage Check

Depth Needed	3.0
Depth Provided	4
Depth OK?	Yes

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
Landscape Enhancement	58000	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	200	ft
Base Total ROW Width	100	ft
LC Enh. Total ROW Length	390	ft
LC Enh. Total ROW Length	200	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	3227	3711
Excavated Area (sq. Yd)	2222	8667

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	21	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	228	sq. Yd
Material Volume	114	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 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
Basin		3,227	cu. Yd	$ 4.00	$ 12,908	2,222	sq. Yd	$ 9.00	$ 19,998	2,222	sq. Yd	$ 8.33	$ 18,517
Basin - LC Enhanced		484	cu. Yd	$ 4.00	$ 1,936	6,445	sq. Yd	$ 9.00	$ 58,005	6,445	sq. Yd	$ 8.33	$ 53,708
Inlet	Riprap	114	sq. Yd	$ 75.00	$ 8,550	228	sq. Yd	$ -	$ -	228	sq. Yd	$ 33.33	$ 7,600
Inlet - LC Enhanced (20%Total)					$ 1,710				$ -				$ 1,520
Outlet	Pipe	1	EA	$ 32,000	$ 32,000	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhanced (5%Total)					$ 1,600				$ -				$ 111
Other					$ -				$ -				$ -

Base Landscape Cost	$ 19,998
LC Enh. Landscape Cost	$ 58,005
Total Landscape Cost	$ 78,003

Base Maintenance Cost	$ 28,333
LC Enh. Maintenance Cost	$ 55,339
Total Maintenance Cost	$ 83,673

Construction Cost Component	Base	LC Enhanced	Total
Construction Cost	$ 53,458	$ 1,936	$ 55,394
Contingency Cost (25% of Construction Cost)	$ 13,365	$ 484	$ 13,849
Engineering Design Cost (5% of Construction Cost)	$ 2,673	$ 97	$ 2,770
Total Construction Cost	$ 69,495	$ 2,517	$ 72,012

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	1.3	$100,000	$ 133,150
Basin	0.5	$100,000	$ 50,000
Other		$100,000	$ -
Total	1.8	$100,000	$ 180,000

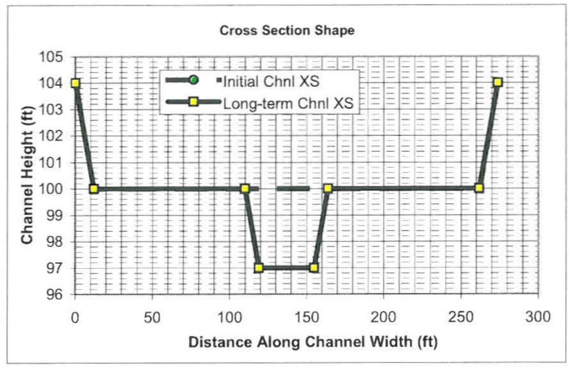
	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	0.5	$100,000	$ 45,914
LC Enhancement Cost	acre	1.3	$100,000	$ 134,086
Total Land Cost	acre	1.8	$100,000	$ 180,000

Total Cost

Base Total Cost	$ 163,740
Total LC Enhancement Cost	$ 249,947
Total Cost Including LC Enh.	$ 413,688

Open Channel

Structure ID	RR11010		HEC1 ID	11015I



Longitundal Geometry

Length	7199.5	ft
U/S Elev	1865.3	ft
D/S Elev	1692.1	ft
Initial Channel Slope	0.0240	ft/ft
Long-term Channel Slope	0.0080	ft/ft

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

NSTPS	6

Initial Channel XS Geometry

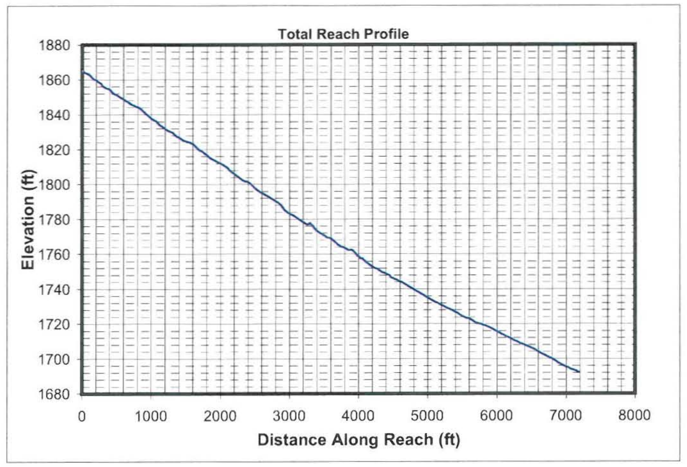
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	0	3	250	4	3	0	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	12	12	262	262	262	274
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	98	3	36	7	3	98	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	110	119	155	164	262	274
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	D110	S115A								TOTAL
HEC1 Peak-Flow	600	1540								2140
Weighting Factor	1.00	0.46								
Flow into Channel	600	708								1308

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	1.073	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	1308	cfs	
Long-term Max. Chnl Capacity	9239	cfs	
Q2 Channel	131	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	274	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
131	251.6	63.7	0.3	100.0	100.3	2.1	0.3	251.5	0.3	0.13	0.72
327	252.8	110.6	0.4	100.0	100.4	3.0	0.4	252.6	0.4	0.22	0.79
981	255.4	214.5	0.8	100.0	100.8	4.6	0.8	255.1	0.8	0.42	0.88
1308	256.4	255.4	1.0	100.0	101.0	5.1	1.0	256.1	1.0	0.50	0.90

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
131	43.0	43.7	1.0	97.0	98.1	3.0	1.1	42.7	1.0	0.55	0.52
327	48.0	79.1	1.6	97.0	98.9	4.1	1.9	47.4	1.7	0.95	0.56
981	255.1	298.4	1.2	97.0	100.6	3.3	3.6	253.9	1.2	1.82	0.53
1308	256.5	355.4	1.4	97.0	100.9	3.7	3.9	255.2	1.4	1.93	0.55

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
131										0
327										0
981										0
1308										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
131	1.74	0.9720	0.9234	Erosive	Erosive	Erosive	0.2	Stable	5.6	Stable	Stable
327	1.74	1.1407	1.0837	Erosive	Erosive	Erosive	0.2	Stable	8.0	Stable	Stable
981	1.74	1.3421	1.2750	Erosive	Erosive	Erosive	0.3	Stable	10.4	Stable	Stable
1308	1.74	1.3946	1.3249	Erosive	Erosive	Erosive	0.3	Stable	11.0	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)	**131**	**327**	**981**	**1308**	**131**	**327**	**981**	**1308**	**131**	**327**	**981**	**1308**
Bray - Equation #1	31	50	90	104	1.3	1.8	2.6	2.9	3.1	3.6	4.1	4.3
Bray - Equation #2	41	66	118	137	1.5	2.0	2.9	3.2	2.1	2.4	2.8	3.0
Hey	9	15	29	34	4.1	5.8	8.8	9.9				
Ackers & Charlton/Lacey	28	41	65	73					1.8	2.1	2.5	2.7
Parker	79	124	215	248	1.0	1.5	2.4	2.7				
Chang	59	104	201	239	0.0	-0.2	-0.6	-0.8				
Kellerhals	21	33	56	65	1.9	2.8	4.3	4.8	3.3	3.6	4.1	4.2
AMAFCA/Schumm	43	47	254	256								
Moody & Odem	13	13	13	13	1.0	1.0	1.0	1.0				
BUREC	15.1	21.3	32.2	35.9	4	6	9	10	3.4	4.2	5.6	6.0
Average	34	51	107	121	1.9	2.6	3.8	4.2	2.8	3.2	3.8	4.0
Values As Designed	43	47	254	255	1.1	1.9	3.6	3.9	3.0	4.1	3.3	3.7
Difference with Design	-9	4	-147	-135	0.7	0.7	0.1	0.3	-0.2	-0.9	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
131	1773	1145	2701	3551	4440	681	567	295	8670	600	1892	2392
327	7305	3569	7509	16809	6484	2707	1725	1408	22465	1971	7667	7238
981	39865	12643	21701	108091	9731	12625	5469	6943	68451	9119	35441	30007
1308	62064	17392	28607	175800	10767	18780	7271	10247	91444	13728	51958	44369

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
131	5029	3247	7660	10073	12593	1931	1610	836	24591	1701	5365	6785
327	8288	4049	8520	19071	7356	3071	1957	1597	25488	2236	8699	8212
981	15076	4781	8207	40879	3680	4775	2068	2626	25887	3449	13403	11348
1308	17604	4933	8114	49864	3054	5327	2062	2906	25937	3894	14737	12585

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
131	1007	479	791	1997	928	244	177	221	1690	226	1159	811
327	3895	1406	2139	8804	1412	870	485	831	4329	836	4190	2654
981	8633	3571	6116	17627	6054	2056	1390	1906	12793	1895	9800	6531
1308	13430	5090	8454	28638	6791	3105	1919	2935	17202	2899	14891	9578

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
131	2857	1359	2244	5665	2633	693	502	628	4795	641	3287	2300
327	4419	1595	2427	9988	1602	987	550	943	4912	948	4753	3011
981	3265	1350	2313	6666	2290	778	526	721	4838	717	3706	2470
1308	3809	1444	2398	8123	1926	881	544	833	4879	822	4224	2717

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson n	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)
131	0.0028	0.0048	145	0.44	0.048	0.0010	30	0.036	0.0007	0.0159	0.0010	0.0023	0.0069	0.0004	0.0030	0.0240	0.0084
327	0.0014	0.0028	191	0.58	0.050	0.0006	31	0.036	0.0004	0.0159	0.0006	0.0013	0.0069	0.0003	0.0015	0.0240	0.0081
981	0.0006	0.0014	265	0.81	0.053	0.0003	32	0.036	0.0002	0.0159	0.0003	0.0007	0.0069	0.0002	0.0007	0.0240	0.0079
1308	0.0005	0.0012	288	0.88	0.054	0.0003	32	0.036	0.0002	0.0159	0.0003	0.0005	0.0069	0.0001	0.0005	0.0240	0.0079

Drop Structures

Design Slope	0.0080	ft/ft
Total Drop Needed	115.5	ft
Height of Drop Structure	3	ft
No . of Drop Structures	39	
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	0.64	sq. mi
Total Sediment Yield Volume	1.22	ac ft

Sedimentation Basins

Length	185 ft	Depth	3 ft
Width	274 ft	Side slope	3 ft/ft
Total Volume per Basin		3.21	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)
131	1.1	-0.3	0.1	24.6	1.1	1.0	3.0	0.0080	0.1	0.0	6.0	8.0
327	1.1	-0.5	0.2	24.6	1.9	1.7	4.1	0.0080	0.2	0.0	6.0	8.2
981	1.1	-1.1	0.1	24.6	3.6	1.2	3.3	0.0080	0.4	0.0	6.0	8.4
1308	1.1	-1.1	0.2	24.6	3.9	1.4	3.7	0.0080	0.4	0.0	6.0	8.5

Toe Protection Needed	9.0	ft

HEC1 Results For Open Channel

Peak Flow	499	cfs
Stage at Peak Flow	100.6	ft
Flow Volume	37.0	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	1.22	ac. ft
Outflowing Sediment Volume	0.04	ac. ft
Deposited(+)/Eroded(-) Volume	1.18	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	7199	7199
Side Slope (?H:1V)	3	3
Channel Width (ft)	274	274
Channel XS Area (sq. ft)	1183	1183
Channel Perimeter (ft)	276	276

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	7199	ft
Thickness	1.5	ft
Protection Depth	9	ft
Tie-in Length/Depth	3.0	ft
Total Depth	12.0	ft
Area needed	2400	sq. Yd
Volume	9599	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	7199	7199
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)	31196	64791
Left Levee Volume (cu. Yd)	27729	66657
Right Levee Length (ft)	7199	7199
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)	31196	64791
Right Levee Volume (cu. Yd)	27729	66657
Total Levee Surface Area (sq. Yd)	62392	129582
Total Levee Volume (cu. Yd)	55458	133314

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	7199	7199
Left Levee Lining Width (ft)	13	30
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	10399	23997
Left Levee Lining Volume (cu. Yd)	5199	11998
Right Levee Length (ft)	7199	7199
Right Levee Lining Width (ft)	13	30
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	10399	23997
Right Levee Lining Volume (cu. Yd)	5199	11998
Total Lining Area (sq. Yd)	20797	47993
Total Lining Volume (cu. Yd)	10398	23996

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	274	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	6.0	ft
Structure Height	9.0	ft
Number of Structures	39	
Volume per structure	274	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 20,550	
Area per structure	91	sq. Yd
Total Area	3,562	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	2	
Total Volume per Basin	5179	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 20,716	
Other Cost	$ -	
Total cost per basin	$ 20,716	
Area per basin	5,620	sq. Yd
Total Area	11,240	sq. Yd

Structure Type	Structure Type	Excavation/Construction				Landscape				Maintenance			
		Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	55,458	cu. Yd	$ 7.00	$ 388,206	62,392	sq. Yd	$ 9.00	$ 561,528	62,392	sq. Yd	$ 11.67	$ 727,907
Levee - LC Enhancement	Fill	77,856	cu. Yd	$ 7.00	$ 544,992	67,190	sq. Yd	$ 9.00	$ 604,710	77,856	sq. Yd	$ 11.67	$ 908,320
Levee Lining	Riprap	10,398	cu. Yd	$ 75.00	$ 779,850	20,797	sq. Yd	$ -	$ -	20,797	sq. Yd	$ 20.83	$ 433,273
Levee Lining -LC Enhancement	Riprap	13,598	cu. Yd	$ 75.00	$ 1,019,850	27,196	sq. Yd	$ -	$ -	27,196	sq. Yd	$ 20.83	$ 566,588
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	9,599	cu. Yd	$ 75.00	$ 719,925	2,400	sq. Yd	$ -	$ -	2,400	sq. Yd	$ 25.00	$ 60,000
Drop Structures	Riprap	39	EA	$ 20,550.00	$ 801,450	3,562	sq. Yd	$ -	$ -	3,562	sq. Yd	$ 33.33	$ 118,733
Drop Str. - LC Enhancement	Riprap	39	EA	$ 2,055.00	$ 80,145	356	sq. Yd	$ -	$ -	356	sq. Yd	$ 33.33	$ 11,873
Sedimentation Basins		2	EA	$ 20,716.00	$ 41,432	11,240	sq. Yd	$ -	$ -	11,240	sq. Yd	$ 8.33	$ 93,667
Other					$ -				$ -				$ -

Base Landscape Cost	$ 561,528	Base Maintenance Cost	$ 1,433,580
LC Enhancement Cost	$ 604,710	LC Enhancement Cost	$ 1,486,781
Total Landscape Cost	$ 1,166,238	Total Maintenance Cost	$ 2,920,361

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 2,730,863	$ 1,644,987	$ 4,375,850
Contingency Cost (25% of Construction Cost)	$ 682,716	$ 411,247	$ 1,093,963
Engineering Design Cost (5% of Construction Cost)	$ 136,543	$ 82,249	$ 218,793
Total Construction Cost	$ 3,550,122	$ 2,138,483	$ 5,688,605

Land Cost

Channel Length	7199 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	274	45.3	$100,000	$ 4,530,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	52	8.6	$100,000	$ 860,000
Levee LC Enhancement	48	7.9	$100,000	$ 790,000
Other	0	0	$100,000	$ -
Total	374	61.8		$ 6,180,000

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	53.9	$100,000	$ 5,390,000
LC Enhancement Cost	acre	7.9	$100,000	$ 790,000
Total Land Cost	acre	61.8	$100,000	$ 6,180,000

Total Cost

Base Total Cost	$ 10,935,230
Total Landscape Enhancement Cost	$ 5,019,974
Total Cost Including LC Enh.	$ 15,955,204

Open Channel

Structure ID	RR115A10		HEC1 ID	15I15A

Longitundal Geometry

Length	3083.7	ft
U/S Elev	1692.1	ft
D/S Elev	1633.3	ft
Initial Channel Slope	0.0191	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	0	3	352	4	3	0	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	12	12	364	364	364	376
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	142	3	50	7	3	142	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	154	163	213	222	364	376
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

										TOTAL
Contributing HEC1 ID	C115B									
HEC1 Peak-Flow	1681									1681
Weighting Factor	1.00									
Flow into Channel	1681									1681

Reach Sediment Inflow Characteristics

U/S Contributing ID	11015I_RR11010									TOTAL
HEC1 Flow Volume (ac. ft)	37.00									37
Sediment Conc. (ppm)	3011									
Sediment Volume (ac. ft)	0.04									0.04
Weighting Factor	1									
Weighted Sed. Vol. (ac. ft)	0.04									0.04

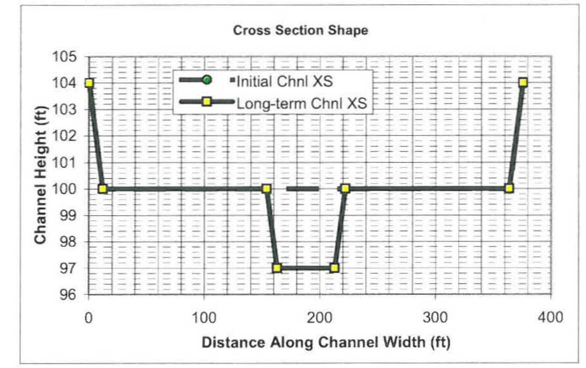
Hydrology

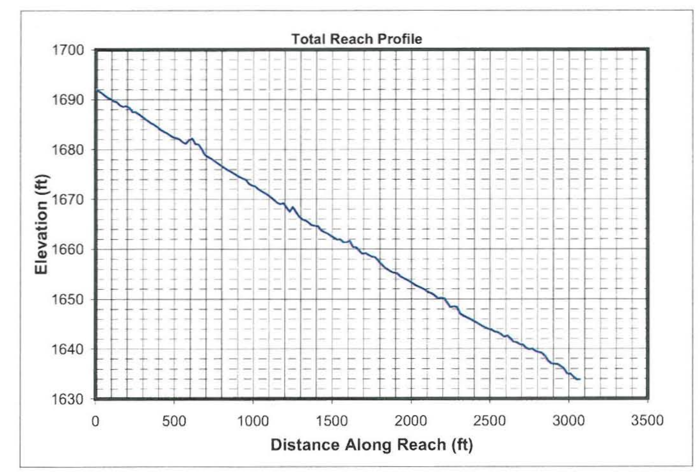
Drainage Area	1.83	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	1681	cfs	
Long-term Max. Chnl Capacity	11994	cfs	
Q2 Channel	168	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	376	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
168	353.6	91.0	0.3	100.0	100.3	1.8	0.3	353.5	0.3	0.11	0.64
420	354.8	157.8	0.4	100.0	100.4	2.7	0.4	354.7	0.4	0.20	0.70
1261	357.5	305.8	0.9	100.0	100.9	4.1	0.9	357.2	0.9	0.38	0.79
1681	358.5	363.9	1.0	100.0	101.0	4.6	1.0	358.1	1.0	0.45	0.81

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
168	57.0	59.2	1.0	97.0	98.1	2.8	1.1	56.7	1.0	0.48	0.49
420	62.0	106.1	1.7	97.0	98.9	4.0	1.9	61.4	1.7	0.83	0.53
1261	357.2	413.1	1.2	97.0	100.7	3.1	3.7	356.0	1.2	1.60	0.50
1681	358.6	491.7	1.4	97.0	100.9	3.4	3.9	357.3	1.4	1.70	0.51

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
	11015I_RR11010									
168	811									811
420	2654									2654
1261	6531									6531
1681	9578									9578

Allowable Velocity

Channel Lining	Natural - Sandy Loam (noncolloidal)										
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)		
168	1.74	0.9768	0.9280	Erosive	Erosive	Erosive	0.2	Stable	5.3	Stable	Stable
420	1.74	1.1458	1.0885	Erosive	Erosive	Erosive	0.2	Stable	7.5	Stable	Stable
1261	1.74	1.3476	1.2802	Erosive	Erosive	Erosive	0.3	Stable	9.7	Stable	Stable
1681	1.74	1.4003	1.3303	Erosive	Erosive	Erosive	0.3	Stable	10.3	Stable	Stable

USCOE Allowable Velocity (ft/s)	2
FHWA Allowable Velocity (ft/s)	2.5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	**168**	**420**	**1261**	**1681**	**168**	**420**	**1261**	**1681**	**168**	**420**	**1261**	**1681**
Bray - Equation #1	35	57	102	119	1.5	2.0	2.9	3.2	3.2	3.7	4.3	4.5
Bray - Equation #2	46	75	135	157	1.6	2.2	3.1	3.5	2.2	2.5	3.0	3.1
Hey	10	18	33	39	4.5	6.4	9.7	10.8				
Ackers & Charlton/Lacey	31	46	72	81					1.9	2.2	2.6	2.8
Parker	89	141	244	282	1.2	1.7	2.7	3.0				
Chang	66	116	225	267	0.0	-0.2	-0.7	-0.9				
Kellerhals	23	37	64	74	2.1	3.0	4.7	5.3	3.4	3.7	4.2	4.3
AMAFCA/Schumm	57	62	356	358								
Moody & Odem	15	15	15	15	1.0	1.0	1.0	1.0				
BUREC	17.0	24.0	36.3	40.4	5	6	10	11	3.4	4.3	5.6	6.1
Average	39	59	128	143	2.1	2.8	4.2	4.6	2.8	3.3	3.9	4.1
Values As Designed	57	61	356	357	1.1	1.9	3.7	3.9	2.8	4.0	3.1	3.4
Difference with Design	-18	-2	-228	-214	1.0	0.9	0.5	0.7	0.0	-0.7	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
168	1574	1052	2305	2925	5301	518	476	230	7637	529	1646	2199
420	6491	3446	7072	13856	7901	2254	1606	1250	20160	1751	7081	6624
1261	35489	12620	21968	89271	12021	10783	5343	6610	61909	8195	34235	27131
1681	55283	17466	28605	145295	13329	16064	7152	9866	82784	12382	50670	39900

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
168	3473	2321	5086	6455	11699	1144	1051	509	16854	1168	3634	4854
420	5731	3042	6243	12232	6975	1990	1418	1104	17798	1546	6252	5848
1261	10443	3714	6465	26270	3537	3173	1572	1945	18218	2411	10074	7984
1681	12201	3855	6313	32067	2942	3545	1579	2177	18271	2733	11183	8806

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
168	1061	524	864	2014	1140	245	187	236	1760	234	1234	863
420	4163	1570	2357	9027	1721	897	530	920	4536	881	4592	2836
1261	8810	3863	6554	17102	7698	2018	1469	1985	13316	1916	10195	6812
1681	13722	5549	9028	27818	8657	3077	2055	3097	17954	2935	15628	9956

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
168	2341	1156	1906	4444	2515	540	413	522	3884	517	2724	1906
420	3675	1386	2081	7970	1519	792	468	812	4005	778	4054	2504
1261	2592	1137	1929	5033	2265	594	432	584	3918	564	3000	2004
1681	3028	1225	1993	6139	1911	679	454	684	3963	648	3449	2197

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)
168	0.0030	0.0047	130	0.40	0.047	0.0010	30	0.035	0.0007	0.0159	0.0010	0.0024	0.0063	0.0004	0.0032	0.0190	0.0070
420	0.0015	0.0027	171	0.52	0.049	0.0006	30	0.036	0.0004	0.0159	0.0006	0.0013	0.0063	0.0002	0.0016	0.0190	0.0067
1261	0.0007	0.0014	238	0.72	0.052	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0007	0.0063	0.0001	0.0007	0.0191	0.0065
1681	0.0005	0.0012	259	0.79	0.053	0.0003	32	0.036	0.0002	0.0159	0.0003	0.0005	0.0063	0.0001	0.0006	0.0191	0.0065

Drop Structures

Design Slope	0.0070	ft/ft
Total Drop Needed	37.2	ft
Height of Drop Structure	3	ft
No . of Drop Structures	13	
Distance between structs.	237	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	1.60	sq. mi
Total Sediment Yield Volume	3.05	ac ft

Sedimentation Basins

Length	237 ft	Depth	3 ft
Width	376 ft	Side slope	3 ft/ft
Total Volume per Basin		5.77	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	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)
168	1.1	-0.3	0.1	24.6	1.1	1.0	2.8	0.0070	0.1	0.0	3.0	4.1
420	1.1	-0.5	0.2	24.6	1.9	1.7	4.0	0.0070	0.2	0.0	3.0	4.3
1261	1.1	-1.1	0.1	24.6	3.7	1.2	3.1	0.0070	0.4	0.0	3.0	4.5
1681	1.1	-1.1	0.2	24.6	3.9	1.4	3.4	0.0070	0.4	0.0	3.0	4.6

Toe Protection Needed	5.0	ft

HEC1 Results For Open Channel

Peak Flow	1540	cfs
Stage at Peak Flow	101.0	ft
Flow Volume	135.0	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	3.09	ac. ft
Outflowing Sediment Volume	0.13	ac. ft
Deposited(+)/Eroded(-) Volume	2.96	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	3084	3084
Side Slope (?H:1V)	3	3
Channel Width (ft)	376	376
Channel XS Area (sq. ft)	1633	1633
Channel Perimeter (ft)	378	378

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	3084	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	2741	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	3084	3084
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)	13364	27756
Left Levee Volume (cu. Yd)	11879	28556
Right Levee Length (ft)	3084	3084
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)	13364	27756
Right Levee Volume (cu. Yd)	11879	28556
Total Levee Surface Area (sq. Yd)	26728	55512
Total Levee Volume (cu. Yd)	23758	57112

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	3084	3084
Left Levee Lining Width (ft)	13	30
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	4455	10280
Left Levee Lining Volume (cu. Yd)	2227	5140
Right Levee Length (ft)	3084	3084
Right Levee Lining Width (ft)	13	30
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	4455	10280
Right Levee Lining Volume (cu. Yd)	2227	5140
Total Lining Area (sq. Yd)	8909	20560
Total Lining Volume (cu. Yd)	4454	10280

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	376	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	13	
Volume per structure	364	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 27,300	
Area per structure	125	sq. Yd
Total Area	1,629	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	2	
Total Volume per Basin	9309	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 37,236	
Other Cost	$ -	
Total cost per basin	$ 37,236	
Area per basin	9,910	sq. Yd
Total Area	19,820	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	23,758	cu. Yd	$ 7.00	$ 166,306	26,728	sq. Yd	$ 9.00	$ 240,552	26,728	sq. Yd	$ 11.67	$ 311,827
Levee - LC Enhancement	Fill	33,354	cu. Yd	$ 7.00	$ 233,478	28,784	sq. Yd	$ 9.00	$ 259,056	33,354	sq. Yd	$ 11.67	$ 389,130
Levee Lining	Riprap	4,454	cu. Yd	$ 75.00	$ 334,050	8,909	sq. Yd	$ -	$ -	8,909	sq. Yd	$ 20.83	$ 185,611
Levee Lining -LC Enhancement	Riprap	5,826	cu. Yd	$ 75.00	$ 436,950	11,651	sq. Yd	$ -	$ -	11,651	sq. Yd	$ 20.83	$ 242,722
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	2,741	cu. Yd	$ 75.00	$ 205,575	1,028	sq. Yd	$ -	$ -	1,028	sq. Yd	$ 25.00	$ 25,700
Drop Structures	Riprap	13	EA	$ 27,300.00	$ 354,900	1,629	sq. Yd	$ -	$ -	1,629	sq. Yd	$ 33.33	$ 54,300
Drop Str. - LC Enhancement	Riprap	13	EA	$ 2,730.00	$ 35,490	163	sq. Yd	$ -	$ -	163	sq. Yd	$ 33.33	$ 5,430
Sedimentation Basins		2	EA	$ 37,236.00	$ 74,472	19,820	sq. Yd	$ -	$ -	19,820	sq. Yd	$ 8.33	$ 165,167
Other					$ -				$ -				$ -

Base Landscape Cost	$ 240,552	Base Maintenance Cost	$ 742,604
LC Enhancement Cost	$ 259,056	LC Enhancement Cost	$ 637,282
Total Landscape Cost	$ 499,608	Total Maintenance Cost	$ 1,379,887

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,135,303	$ 705,918	$ 1,841,221
Contingency Cost (25% of Construction Cost)	$ 283,826	$ 176,480	$ 460,305
Engineering Design Cost (5% of Construction Cost)	$ 56,765	$ 35,296	$ 92,061
Total Construction Cost	$ 1,475,894	$ 917,693	$ 2,393,587

Land Cost

Channel Length	3084 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	376	26.6	$100,000	$ 2,660,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	52	3.7	$100,000	$ 370,000
Levee LC Enhancement	48	3.4	$100,000	$ 340,000
Other	0	0	$100,000	$ -
Total	476	33.7		$ 3,370,000

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	30.3	$100,000	$ 3,030,000
LC Enhancement Cost	acre	3.4	$100,000	$ 340,000
Total Land Cost	acre	33.7	$100,000	$ 3,370,000

Total Cost

Base Total Cost	$ 5,489,050
Total Landscape Enhancement Cost	$ 2,154,032
Total Cost Including LC Enh.	$ 7,643,082

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Sub-area: CAP, Alternative: B5
Open Channel Structure ID: RR115A10

Open Channel

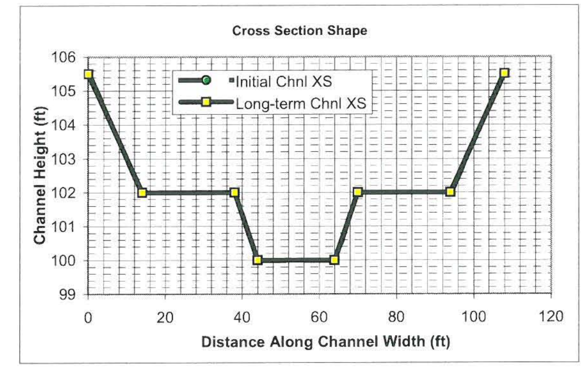
Structure ID	RR115B10	HEC1 ID	15I15B

Longitundal Geometry

Length	8073.3	ft
U/S Elev	1633.3	ft
D/S Elev	1537.8	ft
Initial Channel Slope	0.0118	ft/ft
Long-term Channel Slope	0.0015	ft/ft

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

NSTPS	7



Initial Channel XS Geometry

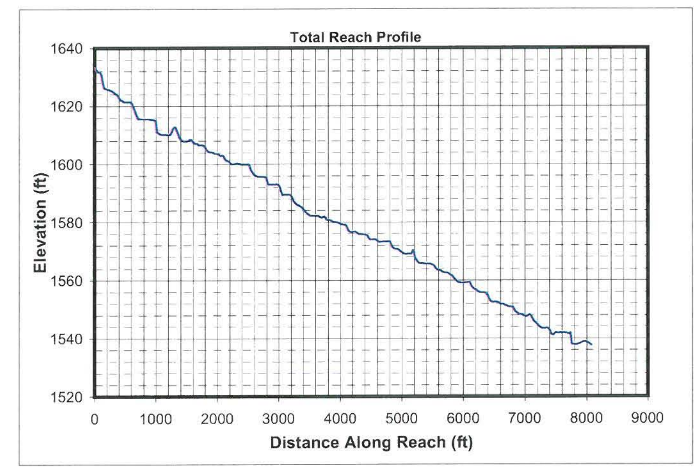
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
4	3.5	24	3	20	5.5	3	24	3.5	4

PT. ID	1	2	3	4	5	6	7	8
X	0	14	38	44	64	70	94	108
Y	105.5	102	102	100	100	102	102	105.5

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
4	3.5	24	3	20	5.5	3	24	3.5	4

PT. ID	1	2	3	4	5	6	7	8
X	0	14	38	44	64	70	94	108
Y	105.5	102	102	100	100	102	102	105.5



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	0.03	0.03	0.03	0.03	0.03	0.03

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	D115C									TOTAL
HEC1 Peak-Flow	1000									1000
Weighting Factor	1.00									
Flow into Channel	1000									1000

Reach Sediment Inflow Characteristics

U/S Contributing ID	15I15A_RR115A10									TOTAL
HEC1 Flow Volume (ac. ft)	135.00									135
Sediment Conc. (ppm)	2504									
Sediment Volume (ac. ft)	0.13									0.13
Weighting Factor	1									
Weighted Sed. Vol. (ac. ft)	0.13									0.13

Hydrology

Drainage Area	0.42	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	1000	cfs	
Long-term Max. Chnl Capacity	1683	cfs	
Q2 Channel	100	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	108	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			

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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	25.9	21.2	0.8	100.0	100.9	4.7	0.9	25.6	0.8	0.09	0.92
250	29.9	38.9	1.3	100.0	101.6	6.4	1.6	29.4	1.3	0.15	0.99
750	86.9	115.1	1.3	100.0	102.8	6.5	2.8	86.1	1.3	0.26	0.99
1000	89.1	138.2	1.6	100.0	103.0	7.2	3.0	88.2	1.6	0.28	1.02

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	30.6	42.1	1.4	100.0	101.7	2.4	1.7	30.1	1.4	0.16	0.35
250	86.5	110.4	1.3	100.0	102.7	2.3	2.7	85.6	1.3	0.25	0.35
750	96.7	223.3	2.3	100.0	104.0	3.4	4.0	95.6	2.3	0.37	0.39
1000	100.6	269.6	2.7	100.0	104.4	3.7	4.4	99.4	2.7	0.41	0.40

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
	15I15A_RR115A 10									
100	863									863
250	2836									2836
750	6812									6812
1000	9956									9956

Allowable Velocity

Channel Lining	Natural - Sandy Loam (noncolloidal)

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	1.3370	1.2702	Erosive	Erosive	Erosive	0.3	Erosive	3.1	Erosive	Stable
250	1.74	1.4812	1.4072	Erosive	Erosive	Erosive	0.3	Erosive	3.9	Erosive	Stable
750	1.74	1.4851	1.4108	Erosive	Erosive	Erosive	0.3	Erosive	5.3	Erosive	Stable
1000	1.74	1.5339	1.4572	Erosive	Erosive	Erosive	0.4	Erosive	5.7	Erosive	Stable

USCOE Allowable Velocity (ft/s)	2
FHWA Allowable Velocity (ft/s)	2.5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	**100**	**250**	**750**	**1000**	**100**	**250**	**750**	**1000**	**100**	**250**	**750**	**1000**
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	28	49	97	116	0.5	0.6	0.7	0.6				
Kellerhals	18	28	49	57	1.7	2.5	3.8	4.3	3.2	3.5	4.0	4.1
AMAFCA/Schumm	30	86	96	100								
Moody & Odem	9	9	9	9	0.8	0.8	0.8	0.8				
BUREC	16.1	22.7	34.2	38.1	4	6	9	10	2.3	2.9	3.8	4.0
Average	26	45	74	84	1.8	2.5	3.7	4.1	2.5	2.8	3.4	3.5
Values As Designed	30	86	96	99	1.7	2.7	4.0	4.4	2.4	2.3	3.4	3.7
Difference with Design	-4	-40	-22	-15	0.1	-0.2	-0.2	-0.3	0.1	0.6	0.0	-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
100	2261	1265	1788	3899	626	905	618	787	2379	469	2144	1558
250	8549	3406	4339	16752	965	2888	1498	2515	6012	1009	7069	5000
750	26365	9940	13124	51240	2843	8815	4538	7681	18041	2946	21608	15195
1000	40579	13639	17787	82145	3198	12821	5969	11044	24104	3170	31411	22352

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
100	8388	4692	6635	14463	2323	3358	2291	2921	8827	1741	7956	5781
250	12687	5055	6438	24860	1432	4286	2223	3732	8922	1497	10491	7420
750	13042	4917	6492	25347	1406	4361	2245	3800	8924	1457	10689	7516
1000	15055	5060	6599	30476	1186	4757	2215	4097	8942	1176	11653	8292

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	117	105	99	115	208	26	35	58	70	6	117	87
250	276	242	223	263	541	60	81	132	162	15	271	206
750	1416	1083	1150	1576	1085	330	363	763	696	72	1539	916
1000	2161	1550	1560	2500	1282	488	507	1152	965	95	2359	1329

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
100	433	389	367	427	771	98	128	215	260	21	435	322
250	409	360	331	390	803	89	120	196	240	22	402	306
750	701	536	569	780	537	163	180	377	344	35	761	453
1000	802	575	579	928	475	181	188	427	358	35	875	493

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	0.0006	0.0008	183	0.56	0.050	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0005	0.0075	0.0005	0.0018	0.0117	0.0050
250	0.0003	0.0005	231	0.70	0.052	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0003	0.0075	0.0003	0.0009	0.0116	0.0049
750	0.0003	0.0005	233	0.71	0.052	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0003	0.0075	0.0002	0.0004	0.0117	0.0049
1000	0.0003	0.0004	252	0.77	0.053	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0002	0.0075	0.0002	0.0003	0.0117	0.0049

Drop Structures

Design Slope	0.0015	ft/ft
Total Drop Needed	83.4	ft
Height of Drop Structure	3	ft
No . of Drop Structures	28	
Distance between structs.	288	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	0.00	sq. mi
Total Sediment Yield Volume	0.00	ac ft

Sedimentation Basins

Length	288 ft	Depth	3 ft
Width	108 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)

	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	-0.3	0.1	24.6	1.7	1.4	2.4	0.0015	0.2	0.0	1.0	1.6
250	1.1	-0.4	0.1	24.6	2.7	1.3	2.3	0.0015	0.3	0.0	1.0	1.8
750	1.1	-0.4	0.2	24.6	4.0	2.3	3.4	0.0015	0.5	0.0	1.0	2.1
1000	1.1	-0.3	0.2	24.6	4.4	2.7	3.7	0.0015	0.6	0.0	1.0	2.2

Toe Protection Needed	3.0	ft

HEC1 Results For Open Channel

Peak Flow	1656	cfs
Stage at Peak Flow	103.5	ft
Flow Volume	153.0	ac. ft

Freeboard

Max. Flow Depth	3.0	ft
Channel Depth as designed	5.5	ft
Available Freeboard	2.5	ft
Required Freeboard	1.2	ft

Sediment Volume

Inflowing Sediment Volume	0.13	ac. ft
Outflowing Sediment Volume	0.03	ac. ft
Deposited(+)/Eroded(-) Volume	0.10	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Existing	Existing
Channel Length (ft)	8073	8073
Side Slope (?H:1V)	3	3
Channel Width (ft)	108	108
Channel XS Area (sq. ft)	381	381
Channel Perimeter (ft)	110	110

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	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	0	ft
Thickness	0.0	ft
Protection Depth	0	ft
Tie-in Length/Depth	0.0	ft
Total Depth	0.0	ft
Area needed	0	sq. Yd
Volume	0	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)	8073	8073
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)	8073	8073
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	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	0	ft
LC Enhancement Ratio	1.1	
Structure Thickness	0	ft
Drop Height	0	ft
Scour Depth		ft
Structure Height		ft
Number of Structures	0	
Volume per structure	0	cu. Yd
Unit Cost	$ -	cu. Yd
Other Cost	$ -	
Cost per structure	$ -	
Area per structure	0	sq. Yd
Total Area	0	sq. Yd

Sedimentation Basins		
Include Sed. Basins	No	
(Yes/No)		
Number of basins	0	
Total Volume per Basin	3081	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	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	Existing	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Existing	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	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Drop Structures	None	0	EA	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Drop Str. - LC Enhancement	None	0	EA	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Sedimentation Basins		1	EA	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ 8.33	$ -
Other					$ -				$ -				$ -

Base Landscape Cost	$ -	
LC Enhancement Cost	$ -	
Total Landscape Cost	$ -	

Base Maintenance Cost	$ -
LC Enhancement Cost	$ -
Total Maintenance Cost	$ -

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ -	$ -	$ -
Contingency Cost (25% of Construction Cost)	$ -	$ -	$ -
Engineering Design Cost (5% of Construction Cost)	$ -	$ -	$ -
Total Construction Cost	$ -	$ -	$ -

Land Cost

Channel Length	0 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	14	0	$0	$ -
LC Enhancement Buffer	0	0	$0	$ -
Channel	108	0	$0	$ -
Channel LC Enhancement	0	0	$0	$ -
Levee	0	0	$0	$ -
Levee LC Enhancement	0	0	$0	$ -
Other	0	0	$0	$ -
Total	122	0		$ -

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	0	$0	$ -
LC Enhancement Cost	acre	0	$0	$ -
Total Land Cost	acre	0	$0	$ -

Total Cost

Base Total Cost	$ -
Total Landscape Enhancement Cost	$ -
Total Cost Including LC Enh.	$ -

Offline Basin

HEC1 ID	D115C

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

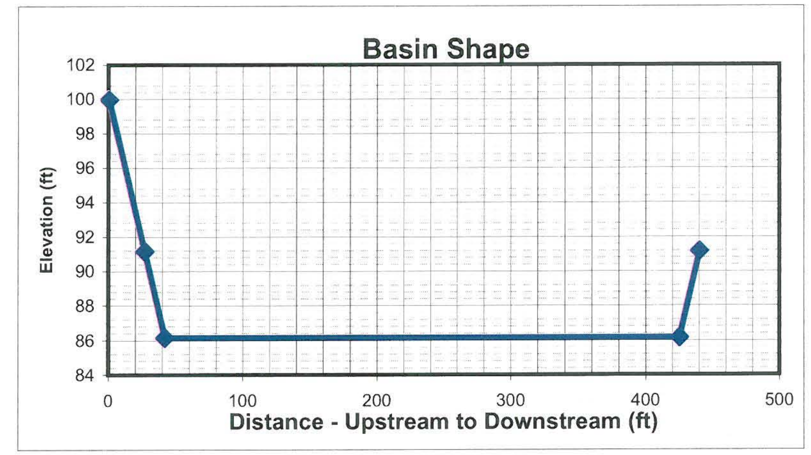
Sediment Volume	0.0	ac. ft

Geometry	Base	LC Enhanced
Topography slope (ft/ft)	0.02	0.02
Basin Length (ft)	900	1030
Basin Width (ft)	440	440
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	5	5
Freeboard (ft)	1	1
Effective Basin Width (ft)	413.6	387.2
Top Area (acres)	9.1	10.4
U/S-D/S Height Difference (ft)	8.8	8.8
Excess Area on Upstream (acres)	0.6	1.3

			Base	LC Enhanced
Bottom Length (ft)	870	Allocated Storage Volume (ac. ft)	32.0	32.1
Bottom Width (ft)	383.6	Total Available Volume (ac. ft) (incl. Freeboard)	40.5	41
		Total Excavation Volume (ac. ft)	80.5	86.9

Stage-Storage-Discharge

Stage (ft)													
Inflow (cfs)	0	200	400	600	800	1000	1100	1200	1500	2000	2500	3000	
Outflow (cfs)	0	0	0	0	0	0	100	200	500	1000	1500	2000	capacity based on FlowMaster results with 1 ft freeboarc



HEC1 Results

	6-hr Event	24-hr Event	Maximum
Peak flow before diversion (cfs)	1659	1783	1783
Peak flow after diversion (cfs)	1000	1000	1000
Diverted Peak Flow (cfs)	659	783	783
Total Diverted Flow Volume (ac. ft)	28.0	32	32.0
Peak Stage	3	ft	

Volume Check

Total Volume needed	32.0	ac. ft
Total Volume Provided	32.0	ac. ft
Volume OK?	Yes	

Stage Check

Depth Needed	4.0
Depth Provided	5
Depth OK?	Yes

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Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
Landscape Enhancement	214200	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	900	ft
Base Total ROW Width	440	ft
LC Enh. Total ROW Length	1130	ft
LC Enh. Total ROW Length	540	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	129873	140199
Excavated Area (sq. Yd)	44000	67800

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	44	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	485	sq. Yd
Material Volume	243	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	333	ft
Unit Cost	160	per ft
Cost per outlet	$53,280	
Other Cost	$ -	
Total Cost	$53,280	
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		129,873	cu. Yd	$ 4.00	$ 519,492	44,000	sq. Yd	$ 9.00	$ 396,000	44,000	sq. Yd	$ 8.33	$ 366,667
Basin - LC Enhanced		10,326	cu. Yd	$ 4.00	$ 41,304	23,800	sq. Yd	$ 9.00	$ 214,200	23,800	sq. Yd	$ 8.33	$ 198,333
Inlet	Riprap	243	sq. Yd	$ 75.00	$ 18,225	485	sq. Yd	$ -	$ -	485	sq. Yd	$ 33.33	$ 16,167
Inlet - LC Enhanced (20%Total)					$ 3,645				$ -				$ 3,233
Outlet	Pipe	1	EA	$ 53,280	$ 53,280	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhanced (5%Total)					$ 2,664				$ -				$ 111
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 396,000	Base Maintenance Cost			$ 385,050
						LC Enh. Landscape Cost			$ 214,200	LC Enh. Maintenance Cost			$ 201,678
						Total Landscape Cost			$ 610,200	Total Maintenance Cost			$ 586,728

Construction Cost Component	Base	LC Enhanced	Total
Construction Cost	$ 590,997	$ 41,304	$ 632,301
Contingency Cost (25% of Construction Cost)	$ 147,749	$ 10,326	$ 158,075
Engineering Design Cost (5% of Construction Cost)	$ 29,550	$ 2,065	$ 31,615
Total Construction Cost	$ 768,296	$ 53,695	$ 821,991

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	$ 491,736
Basin	9.1	$100,000	$ 910,000
Other		$100,000	$ -
Total	14.0	$100,000	$ 1,400,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	9.1	$100,000	$ 909,091
LC Enhancement Cost	acre	4.9	$100,000	$ 490,909
Total Land Cost	acre	14	$100,000	$ 1,400,000

Total Cost

Base Total Cost	$ 2,458,437
Total LC Enhancement Cost	$ 960,482
Total Cost Including LC Enh.	$ 3,418,919

Open Channel

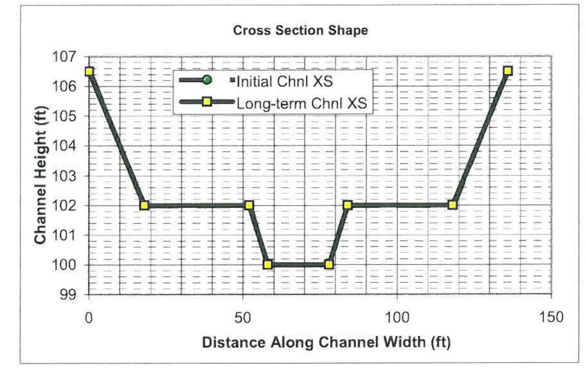
Structure ID	C12010	HEC1 ID	115120

Longitundal Geometry

Length	4136.0	ft
U/S Elev	1537.8	ft
D/S Elev	1496.4	ft
Initial Channel Slope	0.0100	ft/ft
Long-term Channel Slope	0.0015	ft/ft

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

NSTPS	3



Initial Channel XS Geometry

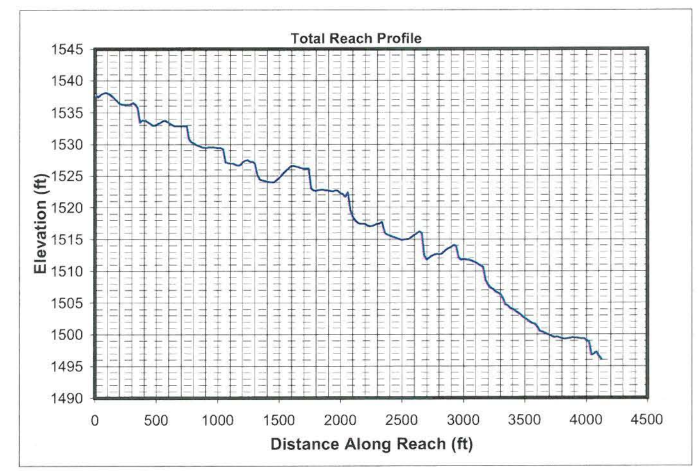
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
4	4.5	34	3	20	6.5	3	34	4.5	4

PT. ID	1	2	3	4	5	6	7	8
X	0	18	52	58	78	84	118	136
Y	106.5	102	102	100	100	102	102	106.5

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
4	4.5	34	3	20	6.5	3	34	4.5	4

PT. ID	1	2	3	4	5	6	7	8
X	0	18	52	58	78	84	118	136
Y	106.5	102	102	100	100	102	102	106.5



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	0.03	0.03	0.03	0.03	0.03	0.03

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	D120									TOTAL
HEC1 Peak-Flow	2000									2000
Weighting Factor	1.00									
Flow into Channel	2000									2000

Reach Sediment Inflow Characteristics

U/S Contributing ID	15I15B_RR115B10									TOTAL
HEC1 Flow Volume (ac. ft)	153.00									153
Sediment Conc. (ppm)	493									
Sediment Volume (ac. ft)	0.03									0.03
Weighting Factor	1	1								
Weighted Sed. Vol. (ac. ft)	0.03									0.03

Hydrology

Drainage Area	2.68	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	2000	cfs	
Long-term Max. Chnl Capacity	2934	cfs	
Q2 Channel	200	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	136	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			

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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
200	29.2	35.4	1.2	100.0	101.5	5.7	1.5	28.7	1.2	0.14	0.90
500	104.7	102.2	1.0	100.0	102.5	4.9	2.5	103.9	1.0	0.23	0.87
1500	112.5	203.4	1.8	100.0	103.4	7.4	3.4	111.5	1.8	0.32	0.96
2000	115.4	244.2	2.1	100.0	103.8	8.2	3.8	114.3	2.1	0.36	0.99

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
200	104.9	104.3	1.0	100.0	102.5	1.9	2.5	104.1	1.0	0.24	0.34
500	111.1	185.0	1.7	100.0	103.3	2.7	3.3	110.1	1.7	0.31	0.37
1500	124.5	374.3	3.0	100.0	104.9	4.0	4.9	123.1	3.0	0.46	0.41
2000	129.6	452.0	3.5	100.0	105.5	4.4	5.5	128.1	3.5	0.52	0.42

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
	15I15B_RR115B 10									
200	87									87
500	206									206
1500	916									916
2000	1329									1329

Allowable Velocity

Channel Lining	Natural - Sandy Loam (noncolloidal)										
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)		
200	1.74	1.4599	1.3869	Erosive	Erosive	Erosive	0.3	Erosive	3.6	Erosive	Stable
500	1.74	1.3904	1.3208	Erosive	Erosive	Erosive	0.3	Erosive	4.5	Erosive	Stable
1500	1.74	1.5809	1.5019	Erosive	Erosive	Erosive	0.4	Erosive	6.1	Erosive	Stable
2000	1.74	1.6295	1.5480	Erosive	Erosive	Erosive	0.4	Erosive	6.6	Erosive	Stable

USCOE Allowable Velocity (ft/s)	2
FHWA Allowable Velocity (ft/s)	2.5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	200	500	1500	2000	200	500	1500	2000	200	500	1500	2000
Bray - Equation #1	39	63	112	131	1.6	2.1	3.0	3.3	3.3	3.8	4.4	4.6
Bray - Equation #2	51	83	148	172	1.7	2.3	3.3	3.7	2.3	2.6	3.0	3.1
Hey	12	20	36	43	4.8	6.8	10.4	11.6				
Ackers & Charlton/Lacey	33	49	78	88					1.9	2.3	2.7	2.8
Parker	97	154	266	307	1.2	1.8	2.9	3.2				
Chang	43	76	150	179	0.6	0.6	0.6	0.6				
Kellerhals	25	40	70	80	2.3	3.3	5.1	5.7	3.5	3.8	4.2	4.4
AMAFCA/Schumm	104	110	123	128								
Moody & Odem	18	18	18	18	1.1	1.1	1.1	1.1				
BUREC	20.9	29.4	44.4	49.4	6	8	12	13	2.7	3.4	4.5	4.8
Average	44	64	104	119	2.4	3.2	4.8	5.3	2.7	3.2	3.8	4.0
Values As Designed	104	110	123	128	2.5	3.3	4.9	5.5	1.9	2.7	4.0	4.4
Difference with Design	-60	-46	-19	-9	-0.2	0.0	-0.1	-0.2	0.8	0.5	-0.2	-0.5

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
200	4873	2260	2869	8850	815	1673	1001	1583	3724	706	4376	2975
500	10110	5162	7388	17106	2554	3754	2554	3532	9251	2005	9611	6639
1500	53132	17696	22027	105413	4007	15715	7387	14648	28115	3073	41692	28446
2000	81696	24206	29697	168828	4503	22877	9697	20982	37548	3311	60416	42160

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
200	9040	4192	5322	16416	1511	3104	1857	2937	6907	1310	8117	5519
500	7502	3830	5482	12693	1895	2786	1895	2621	6864	1488	7131	4926
1500	13141	4377	5448	26072	991	3887	1827	3623	6954	760	10312	7036
2000	15155	4490	5509	31318	835	4244	1799	3892	6965	614	11207	7821

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
200	176	150	122	157	485	28	44	71	83	14	155	135
500	704	596	621	717	920	167	206	369	403	41	736	498
1500	3612	2447	2372	4290	1742	791	783	1894	1482	140	3936	2135
2000	5509	3455	3252	6805	2036	1154	1071	2810	2023	166	5967	3113

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
200	327	279	227	291	900	52	81	131	153	25	287	250
500	522	442	461	532	683	124	153	274	299	30	546	370
1500	893	605	587	1061	431	196	194	469	366	35	974	528
2000	1022	641	603	1262	378	214	199	521	375	31	1107	578

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson n	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)
200	0.0004	0.0005	205	0.63	0.051	0.0002	31	0.036	0.0002	0.0159	0.0002	0.0003	0.0060	0.0003	0.0013	0.0098	0.0041
500	0.0005	0.0007	184	0.56	0.050	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0004	0.0060	0.0002	0.0007	0.0099	0.0041
1500	0.0002	0.0004	250	0.76	0.053	0.0002	31	0.036	0.0001	0.0159	0.0001	0.0002	0.0060	0.0001	0.0003	0.0099	0.0041
2000	0.0002	0.0003	271	0.83	0.053	0.0001	32	0.036	0.0001	0.0159	0.0001	0.0002	0.0060	0.0001	0.0002	0.0099	0.0040

Drop Structures

Design Slope	0.0015	ft/ft
Total Drop Needed	35.2	ft
Height of Drop Structure	3	ft
No . of Drop Structures	12	
Distance between structs.	345	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	0.00	sq. mi
Total Sediment Yield Volume	0.00	ac ft

Sedimentation Basins

Length	345 ft	Depth	3 ft
Width	136 ft	Side slope	3 ft/ft
Total Volume per Basin		2.94	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)
200	1.1	-0.5	0.1	24.6	2.5	1.0	1.9	0.0015	0.3	0.0	1.0	1.7
500	1.1	-0.4	0.1	24.6	3.3	1.7	2.7	0.0015	0.4	0.0	1.0	1.9
1500	1.1	-0.3	0.2	24.6	4.9	3.0	4.0	0.0015	0.7	0.0	1.0	2.4
2000	1.1	-0.2	0.3	24.6	5.5	3.5	4.4	0.0015	0.8	0.0	1.0	2.5

Toe Protection Needed	3.0	ft

HEC1 Results For Open Channel

Peak Flow	1002	cfs
Stage at Peak Flow	102.9	ft
Flow Volume	142.0	ac. ft

Freeboard

Max. Flow Depth	3.8	ft
Channel Depth as designed	6.5	ft
Available Freeboard	2.7	ft
Required Freeboard	1.5	ft

Sediment Volume

Inflowing Sediment Volume	0.03	ac. ft
Outflowing Sediment Volume	0.03	ac. ft
Deposited(+)/Eroded(-) Volume	0.00	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Existing	Existing
Channel Length (ft)	4136	4136
Side Slope (?H:1V)	3	3
Channel Width (ft)	136	136
Channel XS Area (sq. ft)	583	583
Channel Perimeter (ft)	138	138

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)	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)	4136	4136
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)	4136	4136
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

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	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	0	ft
Thickness	0.0	ft
Protection Depth	0	ft
Tie-in Length/Depth	0.0	ft
Total Depth	0.0	ft
Area needed	0	sq. Yd
Volume	0	cu. Yd

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

Sedimentation Basins		
Include Sed. Basins	No	
(Yes/No)		
Number of basins	0	
Total Volume per Basin	4743	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	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	Existing	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Existing	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	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Drop Structures	None	0	EA	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Drop Str. - LC Enhancement	None	0	EA	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Sedimentation Basins		1	EA	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ 8.33	$ -
Other					$ -				$ -				$ -

Base Landscape Cost	$ -	Base Maintenance Cost	$ -
LC Enhancement Cost	$ -	LC Enhancement Cost	$ -
Total Landscape Cost	$ -	Total Maintenance Cost	$ -

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ -	$ -	$ -
Contingency Cost (25% of Construction Cost)	$ -	$ -	$ -
Engineering Design Cost (5% of Construction Cost)	$ -	$ -	$ -
Total Construction Cost	$ -	$ -	$ -

Land Cost	
Channel Length	0 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	14	0	$0	$ -
LC Enhancement Buffer	0	0	$0	$ -
Channel	136	0	$0	$ -
Channel LC Enhancement	0	0	$0	$ -
Levee	0	0	$0	$ -
Levee LC Enhancement	0	0	$0	$ -
Other	0	0	$0	$ -
Total	150	0		$ -

Right of Way		
Preservation Corridor Width	0	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	0	$0	$ -
LC Enhancement Cost	acre	0	$0	$ -
Total Land Cost	acre	0	$0	$ -

Total Cost	
Base Total Cost	$ -
Total Landscape Enhancement Cost	$ -
Total Cost Including LC Enh.	$ -

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Offline Basin

HEC1 ID	D120

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

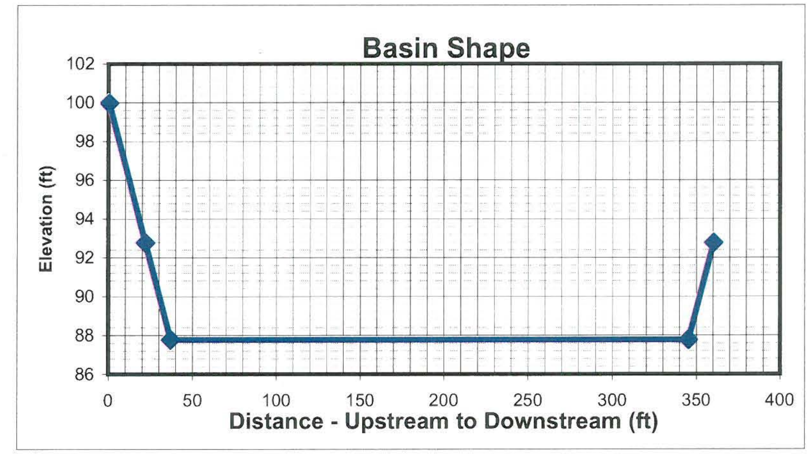
Sediment Volume	0.0	ac. ft

Geometry	Base	LC Enhanced
Topography slope (ft/ft)	0.02	0.02
Basin Length (ft)	740	860
Basin Width (ft)	360	360
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	5	5
Freeboard (ft)	1	1
Effective Basin Width (ft)	338.4	316.8
Top Area (acres)	6.1	7.1
U/S-D/S Height Difference (ft)	7.2	7.2
Excess Area on Upstream (acres)	0.4	0.9

			Base	LC Enhanced
Bottom Length (ft)	710	Allocated Storage Volume (ac. ft)	21.2	21.3
Bottom Width (ft)	308.4	Total Available Volume (ac. ft) (incl. Freeboard)	26.9	27.4
		Total Excavation Volume (ac. ft)	49.0	53

Stage-Storage-Discharge

Stage (ft)													
Inflow (cfs)	0	200	400	600	800	1000	1200	1500	2000	2500	3000	4000	
Outflow (cfs)	0	0	0	0	0	0	0	0	0	500	1000	2000	capacity based on FlowMaster results with 1 ft freeboarc



HEC1 Results

	6-hr Event	24-hr Event	Maximum
Peak flow before diversion (cfs)	2278	2842	2842
Peak flow after diversion (cfs)	1936	2000	2000
Diverted Peak Flow (cfs)	342	842	842
Total Diverted Flow Volume (ac. ft)	9.0	21	21.0
Peak Stage	1.4	ft	

Volume Check

Total Volume needed	21.0	ac. ft
Total Volume Provided	21.2	ac. ft
Volume OK?	Yes	

Stage Check

Depth Needed	2.4
Depth Provided	5
Depth OK?	Yes

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
Landscape Enhancement	175200	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	740	ft
Base Total ROW Width	360	ft
LC Enh. Total ROW Length	960	ft
LC Enh. Total ROW Length	460	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	79053	85507
Excavated Area (sq. Yd)	29600	49067

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	39	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	429	sq. Yd
Material Volume	215	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	333	ft
Unit Cost	160	per ft
Cost per outlet	$53,280	
Other Cost	$ -	
Total Cost	$53,280	
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		79,053	cu. Yd	$ 4.00	$ 316,212	29,600	sq. Yd	$ 9.00	$ 266,400	29,600	sq. Yd	$ 8.33	$ 246,667
Basin - LC Enhanced		6,454	cu. Yd	$ 4.00	$ 25,816	19,467	sq. Yd	$ 9.00	$ 175,203	19,467	sq. Yd	$ 8.33	$ 162,225
Inlet	Riprap	215	sq. Yd	$ 75.00	$ 16,125	429	sq. Yd	$ -	$ -	429	sq. Yd	$ 33.33	$ 14,300
Inlet - LC Enhanced (20%Total)					$ 3,225				$ -				$ 2,860
Outlet	Pipe	1	EA	$ 53,280	$ 53,280	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhanced (5%Total)					$ 2,664				$ -				$ 111
Other					$ -				$ -				$ -

Base Landscape Cost	$ 266,400	Base Maintenance Cost	$ 263,183
LC Enh. Landscape Cost	$ 175,203	LC Enh. Maintenance Cost	$ 165,196
Total Landscape Cost	$ 441,603	Total Maintenance Cost	$ 428,379

Construction Cost Component	Base	LC Enhanced	Total
Construction Cost	$ 385,617	$ 25,816	$ 411,433
Contingency Cost (25% of Construction Cost)	$ 96,404	$ 6,454	$ 102,858
Engineering Design Cost (5% of Construction Cost)	$ 19,281	$ 1,291	$ 20,572
Total Construction Cost	$ 501,302	$ 33,561	$ 534,863

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	4.0	$100,000	$ 402,204
Basin	6.1	$100,000	$ 610,000
Other		$100,000	$ -
Total	10.1	$100,000	$ 1,010,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	6.1	$100,000	$ 611,570
LC Enhancement Cost	acre	4.0	$100,000	$ 398,430
Total Land Cost	acre	10.1	$100,000	$ 1,010,000

Total Cost

Base Total Cost	$ 1,642,456
Total LC Enhancement Cost	$ 772,389
Total Cost Including LC Enh.	$ 2,414,845

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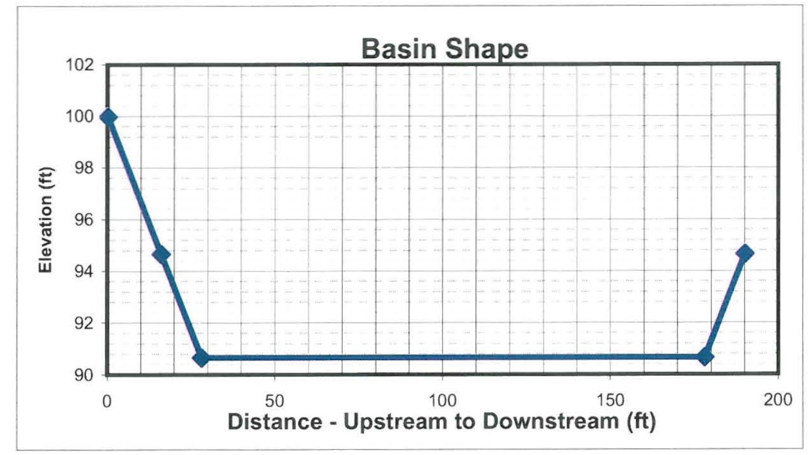
Sub-area: CAP, Alternative: B5
Offline Basin Structure ID: D120

Offline Basin

HEC1 ID	D900

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)	0.028	0.028
Basin Length (ft)	300	380
Basin Width (ft)	190	190
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	4	4
Freeboard (ft)	1	1
Effective Basin Width (ft)	174.04	158.08
Top Area (acres)	1.3	1.7
U/S-D/S Height Difference (ft)	5.3	5.3
Excess Area on Upstream (acres)	0.1	0.3

			Base	LC Enhanced
Bottom Length (ft)	276	Allocated Storage Volume (ac. ft)	3.1	3.1
Bottom Width (ft)	150.04	Total Available Volume (ac. ft) (incl. Freeboard)	4.3	4.4
		Total Excavation Volume (ac. ft)	7.8	8.8

HEC1 Results

	6-hr Event	24-hr Event	Maximum
Peak flow before diversion (cfs)	936	853	936
Peak flow after diversion (cfs)	797	831	831
Diverted Peak Flow (cfs)	139	22	139
Total Diverted Flow Volume (ac. ft)	3.0	0	3.0
Peak Stage	2.2	ft	

Volume Check

Total Volume needed	3.0	ac. ft
Total Volume Provided	3.1	ac. ft
Volume OK?	Yes	

Stage Check

Depth Needed	3.2
Depth Provided	4
Depth OK?	Yes

Stage-Storage-Discharge

Stage (ft)												
Inflow (cfs)	0	200	400	600	800	840	1000	1200	1400	1500	2000	2500
Outflow (cfs)	0	0	0	0	0	0	160	360	560	660	1160	1660

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
Landscape Enhancement	82200	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	190	ft
LC Enh. Total ROW Length	480	ft
LC Enh. Total ROW Length	290	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	12584	14197
Excavated Area (sq. Yd)	6333	15467

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	29	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	327	sq. Yd
Material Volume	164	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	174	ft
Unit Cost	160	per ft
Cost per outlet	$27,840	
Other Cost	$ -	
Total Cost	$27,840	
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		12,584	cu. Yd	$ 4.00	$ 50,336	6,333	sq. Yd	$ 9.00	$ 56,997	6,333	sq. Yd	$ 8.33	$ 52,775
Basin - LC Enhanced		1,613	cu. Yd	$ 4.00	$ 6,452	9,134	sq. Yd	$ 9.00	$ 82,206	9,134	sq. Yd	$ 8.33	$ 76,117
Inlet	Riprap	164	sq. Yd	$ 75.00	$ 12,300	327	sq. Yd	$ -	$ -	327	sq. Yd	$ 33.33	$ 10,900
Inlet - LC Enhanced (20%Total)					$ 2,460				$ -				$ 2,180
Outlet	Pipe	1	EA	$ 27,840	$ 27,840	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhanced (5%Total)					$ 1,392				$ -				$ 111
Other					$ -				$ -				$ -

Base Landscape Cost	$ 56,997	Base Maintenance Cost	$ 65,892
LC Enh. Landscape Cost	$ 82,206	LC Enh. Maintenance Cost	$ 78,408
Total Landscape Cost	$ 139,203	Total Maintenance Cost	$ 144,299

Construction Cost Component	Base	LC Enhanced	Total
Construction Cost	$ 90,476	$ 6,452	$ 96,928
Contingency Cost (25% of Construction Cost)	$ 22,619	$ 1,613	$ 24,232
Engineering Design Cost (5% of Construction Cost)	$ 4,524	$ 323	$ 4,846
Total Construction Cost	$ 117,619	$ 8,388	$ 126,006

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	1.9	$100,000	$ 188,705
Basin	1.3	$100,000	$ 130,000
Other		$100,000	$ -
Total	3.2	$100,000	$ 320,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	1.3	$100,000	$ 130,854
LC Enhancement Cost	acre	1.9	$100,000	$ 189,146
Total Land Cost	acre	3.2	$100,000	$ 320,000

Total Cost

Base Total Cost	$ 371,361
Total LC Enhancement Cost	$ 358,147
Total Cost Including LC Enh.	$ 729,509

Open Channel

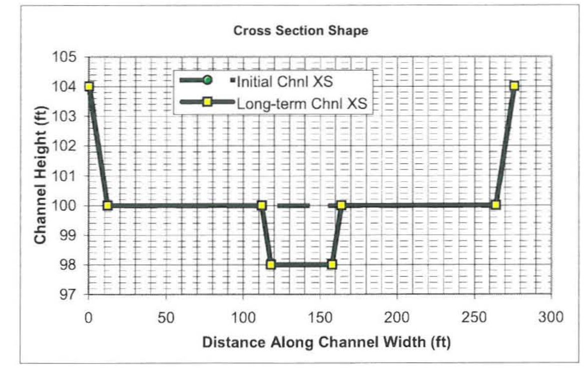
Structure ID	C910A10	HEC1 ID	90091A

Longitundal Geometry

Length	3620.4	ft
U/S Elev	1818.8	ft
D/S Elev	1746.9	ft
Initial Channel Slope	0.0198	ft/ft
Long-term Channel Slope	0.0070	ft/ft

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

NSTPS	5



Initial Channel XS Geometry

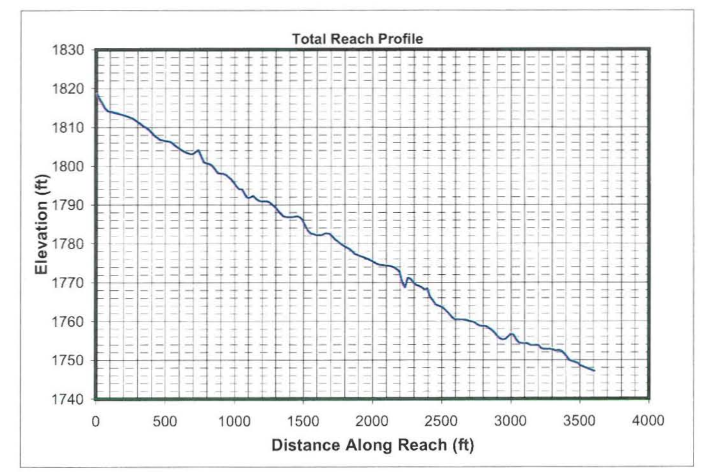
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	0	3	252	4	3	0	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	12	12	264	264	264	276
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	100	3	40	6	3	100	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	112	118	158	164	264	276
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	S910	D900								TOTAL
HEC1 Peak-Flow	1585	831								2416
Weighting Factor	0.37	1.00								
Flow into Channel	593	831								1424

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	1.398	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	1424	cfs	
Long-term Max. Chnl Capacity	8187	cfs	
Q2 Channel	142	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	276	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			

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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
142	253.8	71.3	0.3	100.0	100.3	2.0	0.3	253.7	0.3	0.12	0.66
356	255.1	123.7	0.5	100.0	100.5	2.9	0.5	254.9	0.5	0.21	0.73
1068	258.0	240.1	0.9	100.0	100.9	4.4	0.9	257.7	0.9	0.41	0.81
1424	259.1	285.9	1.1	100.0	101.1	5.0	1.1	258.7	1.1	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
142	47.2	49.7	1.1	98.0	99.1	2.9	1.1	46.9	1.1	0.50	0.49
356	52.4	89.7	1.7	98.0	100.0	4.0	2.0	51.7	1.7	0.85	0.53
1068	258.5	328.6	1.3	98.0	100.9	3.3	2.9	257.6	1.3	1.28	0.51
1424	260.1	391.4	1.5	98.0	101.2	3.6	3.2	259.0	1.5	1.39	0.52

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
142										0
356										0
1068										0
1424										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)		
142	1.74	1.0039	0.9537	Erosive	Erosive	Erosive	0.2	Stable	5.4	Stable	Stable
356	1.74	1.1725	1.1139	Erosive	Erosive	Erosive	0.2	Stable	7.6	Stable	Stable
1068	1.74	1.3737	1.3050	Erosive	Erosive	Erosive	0.3	Stable	8.8	Stable	Stable
1424	1.74	1.4262	1.3549	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)	**142**	**356**	**1068**	**1424**	**142**	**356**	**1068**	**1424**	**142**	**356**	**1068**	**1424**
Bray - Equation #1	32	53	94	109	1.4	1.9	2.7	3.0	3.2	3.6	4.2	4.4
Bray - Equation #2	43	69	123	144	1.5	2.1	3.0	3.3	2.2	2.5	2.9	3.0
Hey	10	16	30	35	4.2	6.0	9.1	10.2				
Ackers & Charlton/Lacey	29	42	67	76					1.8	2.1	2.6	2.7
Parker	82	130	225	259	1.1	1.6	2.5	2.8				
Chang	60	105	203	242	0.0	-0.1	-0.6	-0.7				
Kellerhals	21	34	59	68	2.0	2.9	4.4	5.0	3.3	3.7	4.1	4.2
AMAFCA/Schumm	47	52	258	259								
Moody & Odem	14	14	14	14	1.0	1.0	1.0	1.0				
BUREC	16.0	22.6	34.1	38.0	4	6	9	10	3.3	4.1	5.4	5.8
Average	35	54	111	124	1.9	2.7	3.9	4.3	2.8	3.2	3.8	4.0
Values As Designed	47	52	258	259	1.1	2.0	2.9	3.2	2.9	4.0	3.3	3.6
Difference with Design	-12	2	-147	-135	0.8	0.7	1.0	1.2	-0.1	-0.8	0.6	0.4

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)											
142	1542	996	2221	2972	4193	538	467	249	6993	496	1652	2029
356	6355	3169	6427	14061	6177	2206	1473	1238	18254	1671	6833	6169
1068	34660	11380	19129	90357	9332	10370	4756	6249	55793	7869	32150	25640
1424	53931	15692	25081	146913	10339	15424	6338	9257	74563	11887	47321	37886

Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
	Sediment Concentrations (ppm by weight)											
142	4018	2594	5785	7742	10925	1402	1216	648	18219	1292	4305	5286
356	6623	3302	6698	14654	6437	2299	1536	1290	19023	1742	7121	6429
1068	12040	3953	6645	31388	3242	3602	1652	2171	19381	2733	11168	8907
1424	14051	4088	6534	38276	2694	4018	1651	2412	19426	3097	12329	9871

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)											
142	908	445	731	1734	952	209	159	203	1493	201	1056	736
356	3523	1326	1993	7674	1453	759	447	779	3843	748	3887	2403
1068	8134	3459	5650	16178	5936	1844	1280	1839	11355	1752	9340	6070
1424	12649	4936	7798	26277	6668	2792	1774	2837	15284	2685	14229	8903

Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
	Sediment Concentrations (ppm by weight)											
142	2366	1160	1906	4517	2481	545	415	529	3889	523	2752	1917
356	3671	1382	2077	7998	1515	791	466	812	4005	780	4051	2504
1068	2826	1202	1963	5620	2062	641	445	639	3944	609	3245	2109
1424	3296	1286	2032	6846	1737	727	462	739	3982	700	3707	2319

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderso n	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)
142	0.0027	0.0043	139	0.42	0.047	0.0009	30	0.036	0.0007	0.0159	0.0009	0.0021	0.0067	0.0004	0.0029	0.0198	0.0073
356	0.0014	0.0025	183	0.56	0.050	0.0006	31	0.036	0.0004	0.0159	0.0005	0.0012	0.0067	0.0003	0.0014	0.0198	0.0070
1068	0.0006	0.0013	253	0.77	0.053	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0006	0.0067	0.0002	0.0006	0.0198	0.0068
1424	0.0005	0.0011	276	0.84	0.054	0.0003	32	0.036	0.0002	0.0159	0.0002	0.0005	0.0067	0.0001	0.0005	0.0198	0.0068

Drop Structures

Design Slope	0.0070	ft/ft
Total Drop Needed	46.5	ft
Height of Drop Structure	3	ft
No . of Drop Structures	16	
Distance between structs.	226	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	0.37	sq. mi
Total Sediment Yield Volume	0.70	ac ft

Sedimentation Basins

Length	226 ft	Depth	3 ft
Width	276 ft	Side slope	3 ft/ft
Total Volume per Basin		4.00	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)
142	1.1	-0.4	0.1	24.6	1.1	1.1	2.9	0.0070	0.1	0.0	2.0	2.8
356	1.1	-0.5	0.2	24.6	2.0	1.7	4.0	0.0070	0.2	0.0	2.0	3.0
1068	1.1	-0.9	0.1	24.6	2.9	1.3	3.3	0.0070	0.3	0.0	2.0	3.1
1424	1.1	-0.9	0.2	24.6	3.2	1.5	3.6	0.0070	0.4	0.0	2.0	3.2

Toe Protection Needed	4.0	ft

HEC1 Results For Open Channel

Peak Flow	809	cfs
Stage at Peak Flow	100.8	ft
Flow Volume	82.0	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	0.70	ac. ft
Outflowing Sediment Volume	0.08	ac. ft
Deposited(+)/Eroded(-) Volume	0.63	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	3620	3620
Side Slope (?H:1V)	3	3
Channel Width (ft)	276	276
Channel XS Area (sq. ft)	1148	1148
Channel Perimeter (ft)	278	278

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	3620	ft
Thickness	1.5	ft
Protection Depth	4	ft
Tie-in Length/Depth	3.0	ft
Total Depth	7.0	ft
Area needed	1207	sq. Yd
Volume	2816	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	3620	3620
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)	15687	32580
Left Levee Volume (cu. Yd)	13944	33519
Right Levee Length (ft)	3620	3620
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)	15687	32580
Right Levee Volume (cu. Yd)	13944	33519
Total Levee Surface Area (sq. Yd)	31374	65160
Total Levee Volume (cu. Yd)	27888	67038

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	3620	3620
Left Levee Lining Width (ft)	13	30
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	5229	12067
Left Levee Lining Volume (cu. Yd)	2614	6033
Right Levee Length (ft)	3620	3620
Right Levee Lining Width (ft)	13	30
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	5229	12067
Right Levee Lining Volume (cu. Yd)	2614	6033
Total Lining Area (sq. Yd)	10458	24133
Total Lining Volume (cu. Yd)	5228	12066

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	276	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	6.2	ft
Structure Height	9.2	ft
Number of Structures	16	
Volume per structure	283	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 21,225	
Area per structure	92	sq. Yd
Total Area	1,472	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	6453	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 25,812	
Other Cost	$ -	
Total cost per basin	$ 25,812	
Area per basin	6,939	sq. Yd
Total Area	6,939	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	27,888	cu. Yd	$ 7.00	$ 195,216	31,374	sq. Yd	$ 9.00	$ 282,366	31,374	sq. Yd	$ 11.67	$ 366,030
Levee - LC Enhancement	Fill	39,150	cu. Yd	$ 7.00	$ 274,050	33,786	sq. Yd	$ 9.00	$ 304,074	39,150	sq. Yd	$ 11.67	$ 456,750
Levee Lining	Riprap	5,228	cu. Yd	$ 75.00	$ 392,100	10,458	sq. Yd	$ -	$ -	10,458	sq. Yd	$ 20.83	$ 217,870
Levee Lining -LC Enhancement	Riprap	6,838	cu. Yd	$ 75.00	$ 512,850	13,676	sq. Yd	$ -	$ -	13,676	sq. Yd	$ 20.83	$ 284,907
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	2,816	cu. Yd	$ 75.00	$ 211,200	1,207	sq. Yd	$ -	$ -	1,207	sq. Yd	$ 25.00	$ 30,175
Drop Structures	Riprap	16	EA	$ 21,225.00	$ 339,600	1,472	sq. Yd	$ -	$ -	1,472	sq. Yd	$ 33.33	$ 49,067
Drop Str. - LC Enhancement	Riprap	16	EA	$ 2,122.50	$ 33,960	147	sq. Yd	$ -	$ -	147	sq. Yd	$ 33.33	$ 4,907
Sedimentation Basins		1	EA	$ 25,812.00	$ 25,812	6,939	sq. Yd	$ -	$ -	6,939	sq. Yd	$ 8.33	$ 57,825
Other					$ -				$ -				$ -

Base Landscape Cost	$ 282,366	Base Maintenance Cost	$ 720,967
LC Enhancement Cost	$ 304,074	LC Enhancement Cost	$ 746,564
Total Landscape Cost	$ 586,440	Total Maintenance Cost	$ 1,467,531

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,163,928	$ 820,860	$ 1,984,788
Contingency Cost (25% of Construction Cost)	$ 290,982	$ 205,215	$ 496,197
Engineering Design Cost (5% of Construction Cost)	$ 58,196	$ 41,043	$ 99,239
Total Construction Cost	$ 1,513,106	$ 1,067,118	$ 2,580,224

Land Cost

Channel Length	3620 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	276	22.9	$100,000	$ 2,290,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	52	4.3	$100,000	$ 430,000
Levee LC Enhancement	48	4	$100,000	$ 400,000
Other	0	0	$100,000	$ -
Total	376	31.2		$ 3,120,000

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	27.2	$100,000	$ 2,720,000
LC Enhancement Cost	acre	4	$100,000	$ 400,000
Total Land Cost	acre	31.2	$100,000	$ 3,120,000

Total Cost

Base Total Cost	$ 5,236,439
Total Landscape Enhancement Cost	$ 2,517,756
Total Cost Including LC Enh.	$ 7,754,196

Open Channel

Structure ID	C910B10		HEC1 ID	90091B

Longitundal Geometry

Length	4991.8	ft
U/S Elev	1746.9	ft
D/S Elev	1667.9	ft
Initial Channel Slope	0.0158	ft/ft
Long-term Channel Slope	0.0060	ft/ft

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

NSTPS	4

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	360	4	3	0	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	12	12	372	372	372	384
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	146	3	50	7	3	146	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	158	167	217	226	372	384
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	C910									TOTAL
HEC1 Peak-Flow	1501									1501
Weighting Factor	1.00									
Flow into Channel	1501									1501

Reach Sediment Inflow Characteristics

U/S Contributing ID	90091A_C910A10									TOTAL
HEC1 Flow Volume (ac. ft)	82.00									82
Sediment Conc. (ppm)	2504									
Sediment Volume (ac. ft)	0.08									0.08
Weighting Factor	1									
Weighted Sed. Vol. (ac. ft)	0.08									0.08

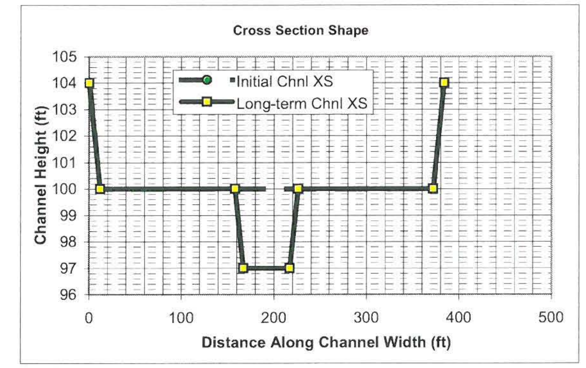
Hydrology

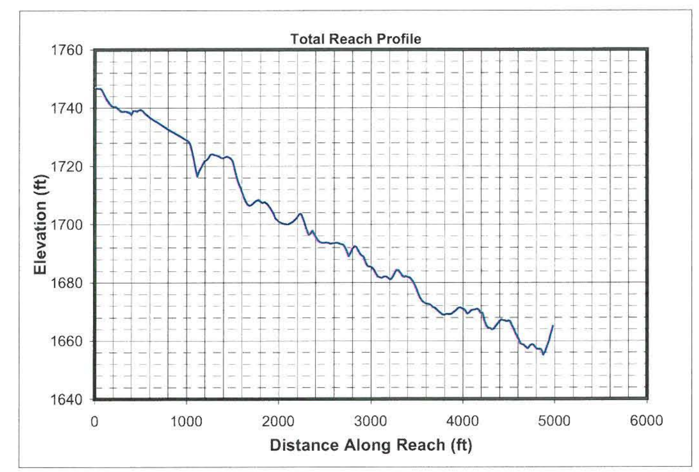
Drainage Area	2.02	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	1501	cfs	
Long-term Max. Chnl Capacity	11310	cfs	
Q2 Channel	150	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	384	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
150	361.6	90.7	0.3	100.0	100.3	1.7	0.3	361.5	0.3	0.09	0.58
375	362.8	157.3	0.4	100.0	100.4	2.4	0.4	362.6	0.4	0.16	0.64
1126	365.3	304.8	0.8	100.0	100.8	3.7	0.8	365.0	0.8	0.31	0.71
1501	366.3	362.7	1.0	100.0	101.0	4.1	1.0	366.0	1.0	0.37	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
150	56.9	57.8	1.0	97.0	98.1	2.6	1.1	56.5	1.0	0.41	0.45
375	61.8	103.6	1.7	97.0	98.9	3.6	1.9	61.2	1.7	0.70	0.49
1126	365.0	407.7	1.1	97.0	100.6	2.8	3.6	363.8	1.1	1.36	0.46
1501	366.4	485.2	1.3	97.0	100.9	3.1	3.9	365.1	1.3	1.44	0.47

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
	90091A_C910A1 0									
150	736									736
375	2403									2403
1126	6070									6070
1501	8903									8903

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)		
150	1.74	0.9690	0.9206	Erosive	Erosive	Erosive	0.2	Stable	4.8	Stable	Stable
375	1.74	1.1380	1.0811	Erosive	Erosive	Erosive	0.2	Stable	6.8	Stable	Stable
1126	1.74	1.3399	1.2729	Erosive	Erosive	Erosive	0.3	Stable	8.9	Stable	Stable
1501	1.74	1.3926	1.3230	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)	**150**	**375**	**1126**	**1501**	**150**	**375**	**1126**	**1501**	**150**	**375**	**1126**	**1501**
Bray - Equation #1	33	54	97	112	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	43	69	78					1.8	2.2	2.6	2.7
Parker	84	133	231	266	1.1	1.6	2.6	2.9				
Chang	59	103	200	238	0.1	-0.1	-0.5	-0.6				
Kellerhals	22	35	60	70	2.0	2.9	4.5	5.1	3.4	3.7	4.1	4.2
AMAFCA/Schumm	57	61	364	366								
Moody & Odem	16	16	16	16	1.1	1.1	1.1	1.1				
BUREC	16.8	23.7	35.8	39.9	4	6	10	11	3.1	3.9	5.2	5.6
Average	37	56	123	137	2.0	2.8	4.0	4.5	2.7	3.2	3.8	4.0
Values As Designed	57	61	364	365	1.1	1.9	3.6	3.9	2.6	3.6	2.8	3.1
Difference with Design	-19	-6	-241	-228	0.9	0.9	0.4	0.6	0.1	-0.4	1.0	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
150	1007	682	1368	1746	4568	265	270	121	4929	343	998	1482
375	4155	2375	4976	8273	6979	1349	1064	776	13382	1129	4613	4461
1126	22718	9037	16455	53309	10811	6725	3777	4461	41562	5297	23396	17959
1501	35394	12592	21216	86772	12025	10050	5103	6747	55652	8020	34963	26230

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
150	2490	1685	3382	4316	11291	654	666	299	12184	848	2468	3662
375	4108	2348	4920	8179	6900	1334	1052	767	13231	1116	4561	4411
1126	7487	2978	5423	17568	3563	2216	1245	1470	13697	1746	7710	5918
1501	8748	3112	5244	21447	2972	2484	1261	1668	13755	1982	8642	6483

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
150	720	376	617	1290	1004	155	128	161	1222	158	843	607
375	2828	1159	1691	5790	1535	591	383	655	3187	593	3231	1968
1126	5904	2771	4818	10775	6897	1275	1016	1344	9261	1273	6920	4750
1501	9193	4023	6514	17527	7796	1977	1452	2135	12548	1949	10728	6894

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
150	1780	928	1526	3189	2481	382	317	397	3019	390	2083	1499
375	2796	1145	1672	5725	1518	584	379	647	3151	587	3195	1945
1126	1946	913	1588	3551	2273	420	335	443	3052	420	2281	1566
1501	2272	994	1610	4332	1927	489	359	528	3101	482	2652	1704

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderso n	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)
150	0.0034	0.0048	117	0.36	0.046	0.0010	29	0.035	0.0007	0.0159	0.0010	0.0025	0.0066	0.0004	0.0035	0.0158	0.0063
375	0.0017	0.0028	154	0.47	0.048	0.0006	30	0.036	0.0004	0.0159	0.0006	0.0014	0.0066	0.0003	0.0018	0.0158	0.0060
1126	0.0007	0.0015	214	0.65	0.051	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0007	0.0066	0.0002	0.0008	0.0158	0.0058
1501	0.0006	0.0012	233	0.71	0.052	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0006	0.0066	0.0001	0.0006	0.0158	0.0058

Drop Structures

Design Slope	0.0060	ft/ft
Total Drop Needed	49.1	ft
Height of Drop Structure	5	ft
No . of Drop Structures	10	
Distance between structs.	499	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	0.62	sq. mi
Total Sediment Yield Volume	1.17	ac ft

Sedimentation Basins

Length	499 ft	Depth	3 ft
Width	384 ft	Side slope	3 ft/ft
Total Volume per Basin		12.66	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)
150	1.1	-0.4	0.1	24.6	1.1	1.0	2.6	0.0060	0.1	0.0	3.0	4.1
375	1.1	-0.5	0.2	24.6	1.9	1.7	3.6	0.0060	0.2	0.0	3.0	4.3
1126	1.1	-1.1	0.1	24.6	3.6	1.1	2.8	0.0060	0.4	0.0	3.0	4.5
1501	1.1	-1.2	0.1	24.6	3.9	1.3	3.1	0.0060	0.4	0.0	3.0	4.5

Toe Protection Needed	5.0	ft

HEC1 Results For Open Channel

Peak Flow	737	cfs
Stage at Peak Flow	100.6	ft
Flow Volume	82.0	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	1.25	ac. ft
Outflowing Sediment Volume	0.06	ac. ft
Deposited(+)/Eroded(-) Volume	1.19	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	4992	4992
Side Slope (?H:1V)	3	3
Channel Width (ft)	384	384
Channel XS Area (sq. ft)	1665	1665
Channel Perimeter (ft)	386	386

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	4992	ft
Thickness	1.5	ft
Protection Depth	5	ft
Tie-in Length/Depth	3.0	ft
Total Depth	8.0	ft
Area needed	1664	sq. Yd
Volume	4437	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	4992	4992
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)	21632	44928
Left Levee Volume (cu. Yd)	19228	46222
Right Levee Length (ft)	4992	4992
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)	21632	44928
Right Levee Volume (cu. Yd)	19228	46222
Total Levee Surface Area (sq. Yd)	43264	89856
Total Levee Volume (cu. Yd)	38456	92444

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	4992	4992
Left Levee Lining Width (ft)	13	30
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	7211	16640
Left Levee Lining Volume (cu. Yd)	3605	8320
Right Levee Length (ft)	4992	4992
Right Levee Lining Width (ft)	13	30
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	7211	16640
Right Levee Lining Volume (cu. Yd)	3605	8320
Total Lining Area (sq. Yd)	14421	33280
Total Lining Volume (cu. Yd)	7210	16640

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	384	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	5	ft
Scour Depth	5.9	ft
Structure Height	10.9	ft
Number of Structures	10	
Volume per structure	463	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 34,725	
Area per structure	128	sq. Yd
Total Area	1,280	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	20425	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 81,700	
Other Cost	$ -	
Total cost per basin	$ 81,700	
Area per basin	21,298	sq. Yd
Total Area	21,298	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	38,456	cu. Yd	$ 7.00	$ 269,192	43,264	sq. Yd	$ 9.00	$ 389,376	43,264	sq. Yd	$ 11.67	$ 504,747
Levee - LC Enhancement	Fill	53,988	cu. Yd	$ 7.00	$ 377,916	46,592	sq. Yd	$ 9.00	$ 419,328	53,988	sq. Yd	$ 11.67	$ 629,860
Levee Lining	Riprap	7,210	cu. Yd	$ 75.00	$ 540,750	14,421	sq. Yd	$ -	$ -	14,421	sq. Yd	$ 20.83	$ 300,444
Levee Lining -LC Enhancement	Riprap	9,430	cu. Yd	$ 75.00	$ 707,250	18,859	sq. Yd	$ -	$ -	18,859	sq. Yd	$ 20.83	$ 392,889
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	4,437	cu. Yd	$ 75.00	$ 332,775	1,664	sq. Yd	$ -	$ -	1,664	sq. Yd	$ 25.00	$ 41,600
Drop Structures	Riprap	10	EA	$ 34,725.00	$ 347,250	1,280	sq. Yd	$ -	$ -	1,280	sq. Yd	$ 33.33	$ 42,667
Drop Str. - LC Enhancement	Riprap	10	EA	$ 3,472.50	$ 34,725	128	sq. Yd	$ -	$ -	128	sq. Yd	$ 33.33	$ 4,267
Sedimentation Basins		1	EA	$ 81,700.00	$ 81,700	21,298	sq. Yd	$ -	$ -	21,298	sq. Yd	$ 8.33	$ 177,483
Other					$ -				$ -				$ -

Base Landscape Cost	$ 389,376	Base Maintenance Cost	$ 1,066,941
LC Enhancement Cost	$ 419,328	LC Enhancement Cost	$ 1,027,016
Total Landscape Cost	$ 808,704	Total Maintenance Cost	$ 2,093,957

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,571,667	$ 1,119,891	$ 2,691,558
Contingency Cost (25% of Construction Cost)	$ 392,917	$ 279,973	$ 672,890
Engineering Design Cost (5% of Construction Cost)	$ 78,583	$ 55,995	$ 134,578
Total Construction Cost	$ 2,043,167	$ 1,455,858	$ 3,499,025

Land Cost

Channel Length	4992 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	384	44	$100,000	$ 4,400,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	52	6	$100,000	$ 600,000
Levee LC Enhancement	48	5.5	$100,000	$ 550,000
Other	0	0	$100,000	$ -
Total	484	55.5		$ 5,550,000

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	50	$100,000	$ 5,000,000
LC Enhancement Cost	acre	5.5	$100,000	$ 550,000
Total Land Cost	acre	55.5	$100,000	$ 5,550,000

Total Cost

Base Total Cost	$ 8,499,484
Total Landscape Enhancement Cost	$ 3,452,202
Total Cost Including LC Enh.	$ 11,951,686

Open Channel

Structure ID	RR91010

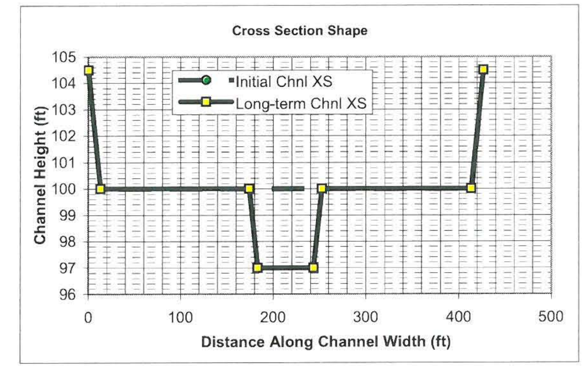
HEC1 ID	910915

Longitundal Geometry

Length	3390.4	ft
U/S Elev	1668.1	ft
D/S Elev	1623.5	ft
Initial Channel Slope	0.0131	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

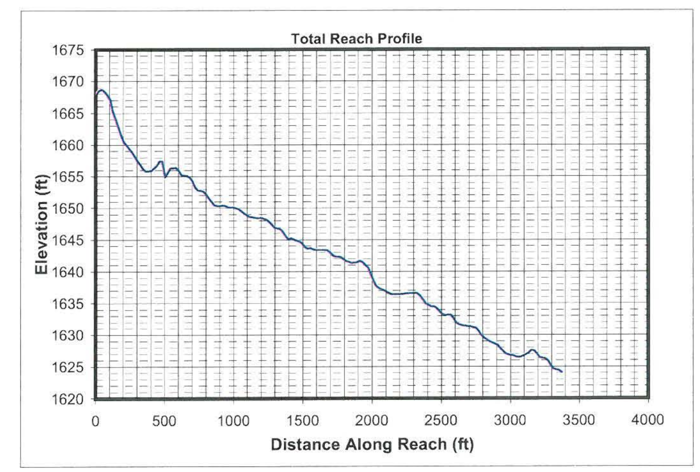
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	400	4.5	3	0	4.5	3

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	161	3	60	7.5	3	161	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	174.5	183.5	243.5	252.5	413.5	427
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	C915	S920								TOTAL
HEC1 Peak-Flow	2440	3157								5597
Weighting Factor	1.00	0.15								
Flow into Channel	2440	466								2906

Reach Sediment Inflow Characteristics

U/S Contributing ID	90091B_C910B10									TOTAL
HEC1 Flow Volume (ac. ft)	82.00									82
Sediment Conc. (ppm)	1945									
Sediment Volume (ac. ft)	0.06									0.06
Weighting Factor	1									
Weighted Sed. Vol. (ac. ft)	0.06									0.06

Hydrology

Drainage Area	2.506	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	2906	cfs	
Long-term Max. Chnl Capacity	13805	cfs	
Q2 Channel	291	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	427	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
291	402.3	148.7	0.4	100.0	100.4	2.0	0.4	402.2	0.4	0.12	0.57
727	404.1	258.0	0.6	100.0	100.6	2.8	0.6	403.9	0.6	0.20	0.62
2180	407.8	500.7	1.2	100.0	101.2	4.4	1.2	407.4	1.2	0.39	0.69
2906	409.3	595.9	1.5	100.0	101.5	4.9	1.5	408.8	1.5	0.46	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
291	69.6	98.5	1.4	97.0	98.5	3.0	1.5	69.2	1.4	0.48	0.44
727	76.5	177.3	2.3	97.0	99.6	4.1	2.6	75.7	2.3	0.82	0.47
2180	408.2	669.4	1.6	97.0	101.1	3.3	4.1	406.9	1.6	1.29	0.45
2906	410.2	797.1	1.9	97.0	101.5	3.6	4.5	408.8	2.0	1.39	0.46

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
	90091B_C910B1 0									
291	607									607
727	1968									1968
2180	4750									4750
2906	6894									6894

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)		
291	1.74	1.0887	1.0342	Erosive	Erosive	Erosive	0.2	Stable	5.5	Stable	Stable
727	1.74	1.2573	1.1944	Erosive	Erosive	Erosive	0.3	Stable	7.8	Stable	Stable
2180	1.74	1.4590	1.3861	Erosive	Erosive	Erosive	0.3	Stable	9.3	Stable	Stable
2906	1.74	1.5116	1.4360	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)	**291**	**727**	**2180**	**2906**	**291**	**727**	**2180**	**2906**	**291**	**727**	**2180**	**2906**
Bray - Equation #1	47	77	137	159	1.8	2.4	3.4	3.8	3.5	4.0	4.6	4.8
Bray - Equation #2	62	101	180	209	1.9	2.6	3.8	4.1	2.4	2.7	3.2	3.3
Hey	14	24	45	52	5.6	7.9	12.0	13.3				
Ackers & Charlton/Lacey	39	57	91	103					2.1	2.4	2.9	3.0
Parker	117	185	321	370	1.5	2.1	3.4	3.8				
Chang	83	145	281	334	0.1	-0.1	-0.7	-1.0				
Kellerhals	31	49	84	97	2.6	3.8	5.9	6.6	3.6	3.9	4.4	4.5
AMAFCA/Schumm	69	76	407	409								
Moody & Odem	17	17	17	17	1.1	1.1	1.1	1.1				
BUREC	22.3	31.4	47.4	52.8	6	8	13	14	3.4	4.3	5.7	6.1
Average	50	76	161	180	2.6	3.5	5.2	5.7	3.0	3.5	4.2	4.4
Values As Designed	69	76	407	409	1.5	2.6	4.1	4.5	3.0	4.1	3.3	3.6
Difference with Design	-19	0	-246	-228	1.0	0.9	1.0	1.3	0.0	-0.6	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
291	2043	1286	2571	3667	5985	573	529	325	7496	583	2207	2479
727	8444	4252	7938	17364	8932	2509	1797	1706	19882	2069	9410	7664
2180	45937	15614	24716	111682	13624	11976	5973	8849	61169	10116	45562	32293
2906	71547	21637	32187	181685	15115	17841	8001	13186	81814	15413	67559	47817

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
291	2608	1642	3283	4681	7641	732	675	415	9570	744	2817	3164
727	4312	2171	4054	8867	4561	1282	918	871	10153	1056	4806	3914
2180	7819	2658	4207	19011	2319	2039	1017	1506	10412	1722	7756	5497
2906	9134	2762	4109	23195	1930	2278	1021	1683	10445	1968	8625	6105

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
291	1390	667	1006	2549	1365	278	216	333	1826	289	1644	1051
727	5422	2004	2729	11351	2078	1022	614	1270	4721	993	6121	3484
2180	11989	5110	7678	22672	8874	2381	1723	2892	13875	2457	14077	8521
2906	18651	7317	10574	36850	9983	3624	2405	4464	18715	3785	21554	12538

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
291	1774	851	1284	3254	1743	355	275	425	2331	370	2099	1342
727	2769	1023	1393	5797	1061	522	314	648	2411	507	3126	1779
2180	2041	870	1307	3859	1511	405	293	492	2362	418	2396	1450
2906	2381	934	1350	4705	1274	463	307	570	2389	483	2752	1601

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)
291	0.0022	0.0033	130	0.40	0.047	0.0007	30	0.035	0.0005	0.0159	0.0007	0.0017	0.0053	0.0003	0.0023	0.0131	0.0051
727	0.0011	0.0019	171	0.52	0.049	0.0004	30	0.036	0.0003	0.0159	0.0004	0.0009	0.0053	0.0002	0.0012	0.0131	0.0049
2180	0.0005	0.0010	237	0.72	0.052	0.0002	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0053	0.0001	0.0005	0.0131	0.0047
2906	0.0004	0.0008	258	0.79	0.053	0.0002	32	0.036	0.0001	0.0159	0.0002	0.0004	0.0053	0.0001	0.0004	0.0131	0.0047

Drop Structures

Design Slope	0.0050	ft/ft
Total Drop Needed	27.6	ft
Height of Drop Structure	3	ft
No . of Drop Structures	10	
Distance between structs.	339	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	0.49	sq. mi
Total Sediment Yield Volume	0.92	ac ft

Sedimentation Basins

Length	339 ft	Depth	3 ft
Width	427 ft	Side slope	3 ft/ft
Total Volume per Basin		9.50	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)
291	1.1	-0.5	0.1	24.6	1.5	1.4	3.0	0.0050	0.2	0.0	3.0	4.2
727	1.1	-0.7	0.2	24.6	2.6	2.3	4.1	0.0050	0.3	0.0	3.0	4.4
2180	1.1	-1.2	0.1	24.6	4.1	1.6	3.3	0.0050	0.5	0.0	3.0	4.6
2906	1.1	-1.2	0.2	24.6	4.5	2.0	3.6	0.0050	0.5	0.0	3.0	4.7

Toe Protection Needed	5.0	ft

HEC1 Results For Open Channel

Peak Flow	1295	cfs
Stage at Peak Flow	100.9	ft
Flow Volume	139.0	ac. ft

Freeboard

Max. Flow Depth	1.5	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.0	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	0.98	ac. ft
Outflowing Sediment Volume	0.09	ac. ft
Deposited(+)/Eroded(-) Volume	0.89	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	3390	3390
Side Slope (?H:1V)	3	3
Channel Width (ft)	427	427
Channel XS Area (sq. ft)	2067.8	2067.8
Channel Perimeter (ft)	429	429

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	3390	ft
Thickness	1.5	ft
Protection Depth	5	ft
Tie-in Length/Depth	3.0	ft
Total Depth	8.0	ft
Area needed	1130	sq. Yd
Volume	3013	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	3390	3390
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)	15820	32770
Left Levee Volume (cu. Yd)	15569	36662
Right Levee Length (ft)	3390	3390
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)	15820	32770
Right Levee Volume (cu. Yd)	15569	36662
Total Levee Surface Area (sq. Yd)	31640	65540
Total Levee Volume (cu. Yd)	31138	73324

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	3390	3390
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	5273	12430
Left Levee Lining Volume (cu. Yd)	2637	6215
Right Levee Length (ft)	3390	3390
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	5273	12430
Right Levee Lining Volume (cu. Yd)	2637	6215
Total Lining Area (sq. Yd)	10547	24860
Total Lining Volume (cu. Yd)	5274	12430

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	427	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	7.2	ft
Structure Height	10.2	ft
Number of Structures	10	
Volume per structure	485	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 36,375	
Area per structure	142	sq. Yd
Total Area	1,423	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	15327	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 61,308	
Other Cost	$ -	
Total cost per basin	$ 61,308	
Area per basin	16,086	sq. Yd
Total Area	16,086	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	31,138	cu. Yd	$ 7.00	$ 217,966	31,640	sq. Yd	$ 9.00	$ 284,760	31,640	sq. Yd	$ 11.67	$ 369,133
Levee - LC Enhancement	Fill	42,186	cu. Yd	$ 7.00	$ 295,302	33,900	sq. Yd	$ 9.00	$ 305,100	42,186	sq. Yd	$ 11.67	$ 492,170
Levee Lining	Riprap	5,274	cu. Yd	$ 75.00	$ 395,550	10,547	sq. Yd	$ -	$ -	10,547	sq. Yd	$ 20.83	$ 219,722
Levee Lining -LC Enhancement	Riprap	7,156	cu. Yd	$ 75.00	$ 536,700	14,313	sq. Yd	$ -	$ -	14,313	sq. Yd	$ 20.83	$ 298,194
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	3,013	cu. Yd	$ 75.00	$ 225,975	1,130	sq. Yd	$ -	$ -	1,130	sq. Yd	$ 25.00	$ 28,250
Drop Structures	Riprap	10	EA	$ 36,375.00	$ 363,750	1,423	sq. Yd	$ -	$ -	1,423	sq. Yd	$ 33.33	$ 47,433
Drop Str. - LC Enhancement	Riprap	10	EA	$ 3,637.50	$ 36,375	142	sq. Yd	$ -	$ -	142	sq. Yd	$ 33.33	$ 4,743
Sedimentation Basins		1	EA	$ 61,308.00	$ 61,308	16,086	sq. Yd	$ -	$ -	16,086	sq. Yd	$ 8.33	$ 134,050
Other					$ -				$ -				$ -

Base Landscape Cost	$ 284,760	Base Maintenance Cost	$ 798,589
LC Enhancement Cost	$ 305,100	LC Enhancement Cost	$ 795,108
Total Landscape Cost	$ 589,860	Total Maintenance Cost	$ 1,593,697

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,264,549	$ 868,377	$ 2,132,926
Contingency Cost (25% of Construction Cost)	$ 316,137	$ 217,094	$ 533,232
Engineering Design Cost (5% of Construction Cost)	$ 63,227	$ 43,419	$ 106,646
Total Construction Cost	$ 1,643,914	$ 1,128,890	$ 2,772,804

Land Cost

Channel Length	3390 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	427	33.2	$100,000	$ 3,320,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	4.3	$100,000	$ 430,000
Levee LC Enhancement	51	4	$100,000	$ 400,000
Other	0	0	$100,000	$ -
Total	533	41.5		$ 4,150,000

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	37.5	$100,000	$ 3,750,000
LC Enhancement Cost	acre	4	$100,000	$ 400,000
Total Land Cost	acre	41.5	$100,000	$ 4,150,000

Total Cost

Base Total Cost	$ 6,477,263
Total Landscape Enhancement Cost	$ 2,629,098
Total Cost Including LC Enh.	$ 9,106,360

Open Channel

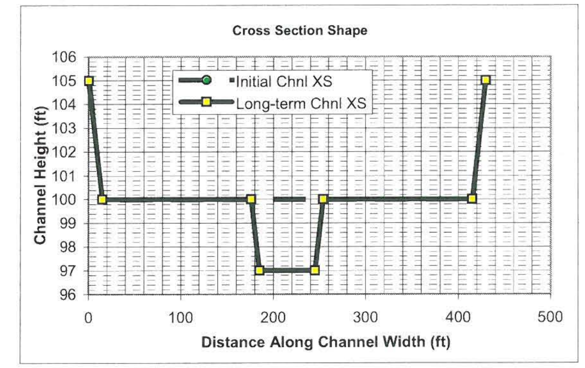
Structure ID	C92010	HEC1 ID	915920

Longitundal Geometry

Length	8861.8	ft
U/S Elev	1623.5	ft
D/S Elev	1532.6	ft
Initial Channel Slope	0.0103	ft/ft
Long-term Channel Slope	0.0040	ft/ft

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

NSTPS	7



Initial Channel XS Geometry

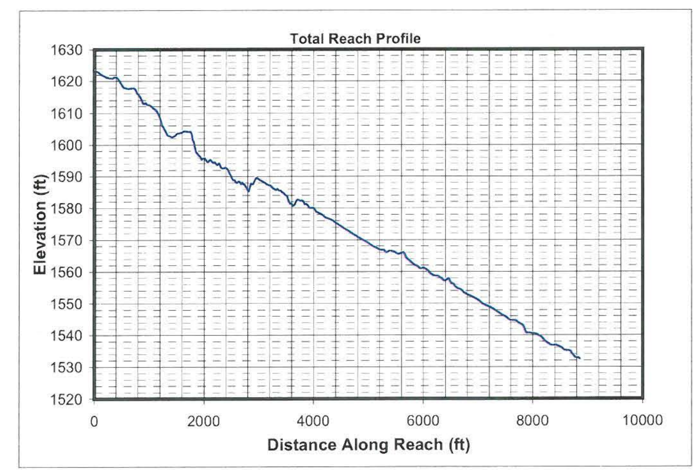
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	5	0	3	400	5	3	0	5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	15	15	15	415	415	415	430
Y	105	100	100	100	100	100	100	105

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	5	161	3	60	8	3	161	5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	15	176	185	245	254	415	430
Y	105	100	100	97	97	100	100	105



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	C920									
HEC1 Peak-Flow	3976									3976
Weighting Factor	1.00									
Flow into Channel	3976									3976

Reach Sediment Inflow Characteristics

U/S Contributing ID	910915_RR9101 0									TOTAL
HEC1 Flow Volume (ac. ft)	139.00									139
Sediment Conc. (ppm)	1779									
Sediment Volume (ac. ft)	0.09									0.09
Weighting Factor	1									
Weighted Sed. Vol. (ac. ft)	0.09									0.09

Hydrology

Drainage Area	6.43	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	3976	cfs	
Long-term Max. Chnl Capacity	14481	cfs	
Q2 Channel	398	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	430	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
398	403.0	193.5	0.5	100.0	100.5	2.1	0.5	402.9	0.5	0.12	0.52
994	405.3	335.8	0.8	100.0	100.8	3.0	0.8	405.0	0.8	0.21	0.57
2982	410.2	652.4	1.6	100.0	101.6	4.6	1.6	409.7	1.6	0.40	0.64
3976	412.1	776.7	1.9	100.0	101.9	5.1	1.9	411.5	1.9	0.48	0.66

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
398	72.4	129.1	1.8	97.0	99.0	3.1	2.0	71.8	1.8	0.49	0.40
994	404.7	445.3	1.1	97.0	100.6	2.2	3.6	403.6	1.1	0.90	0.37
2982	411.3	866.5	2.1	97.0	101.6	3.4	4.6	409.8	2.1	1.16	0.42
3976	413.8	1032.3	2.5	97.0	102.0	3.9	5.0	412.2	2.5	1.26	0.43

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
	910915_RR9101 0									
398	1051									1051
994	3484									3484
2982	8521									8521
3976	12538									12538

Allowable Velocity

Channel Lining	Natural - Sandy Loam (noncolloidal)

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)		
398	1.74	1.1692	1.1108	Erosive	Erosive	Erosive	0.2	Stable	5.8	Stable	Stable
994	1.74	1.3377	1.2708	Erosive	Erosive	Erosive	0.3	Stable	7.2	Stable	Stable
2982	1.74	1.5389	1.4620	Erosive	Erosive	Erosive	0.4	Stable	9.1	Stable	Stable
3976	1.74	1.5913	1.5118	Erosive	Erosive	Erosive	0.4	Stable	9.8	Stable	Stable

USCOE Allowable Velocity (ft/s)	2
FHWA Allowable Velocity (ft/s)	2.5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	**398**	**994**	**2982**	**3976**	**398**	**994**	**2982**	**3976**	**398**	**994**	**2982**	**3976**
Bray - Equation #1	56	90	161	188	2.0	2.6	3.8	4.2	3.7	4.2	4.8	5.0
Bray - Equation #2	73	119	212	247	2.1	2.9	4.2	4.6	2.5	2.9	3.3	3.5
Hey	17	29	53	62	6.3	8.9	13.5	15.0				
Ackers & Charlton/Lacey	44	65	104	117					2.2	2.5	3.0	3.2
Parker	137	217	375	433	1.7	2.4	3.8	4.3				
Chang	93	163	316	376	0.1	-0.1	-0.7	-1.0				
Kellerhals	36	57	98	113	3.0	4.3	6.7	7.5	3.7	4.1	4.5	4.7
AMAFCA/Schumm	72	404	410	413								
Moody & Odem	25	25	25	25	1.3	1.3	1.3	1.3				
BUREC	26.1	36.9	55.6	62.0	7	10	15	17	3.4	4.3	5.7	6.1
Average	58	121	181	204	2.9	4.0	5.9	6.6	3.1	3.6	4.3	4.5
Values As Designed	72	404	410	412	2.0	3.6	4.6	5.0	3.1	2.2	3.4	3.9
Difference with Design	-14	-283	-229	-209	1.0	0.4	1.3	1.5	0.0	1.3	0.8	0.6

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
398	2354	1421	2664	4149	6061	599	549	407	7064	613	2601	2589
994	9712	4689	8163	19630	9039	2598	1848	2045	18755	2250	10968	8154
2982	52774	17217	25328	126027	13795	12366	6123	10403	57730	11275	53002	35095
3976	82184	23865	33024	204888	15311	18418	8202	15460	77218	17257	78624	52223

Discharge (cfs)	Sediment Concentrations (ppm by weight)											
	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
398	2196	1326	2485	3871	5655	559	512	380	6592	572	2427	2416
994	3625	1750	3047	7327	3374	970	690	763	7000	840	4094	3044
2982	6566	2142	3151	15679	1716	1538	762	1294	7182	1403	6594	4366
3976	7669	2227	3081	19118	1429	1719	765	1443	7205	1610	7336	4873

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
398	1619	754	1060	2927	1427	295	228	409	1785	325	1934	1160
994	2624	1354	2067	4154	5562	423	408	581	4116	548	3014	2259
2982	14232	5895	8139	26599	9107	2567	1832	3590	13590	2811	16838	9564
3976	22128	8419	11217	43195	10245	3898	2550	5496	18327	3641	25739	14078

Discharge (cfs)	Sediment Concentrations (ppm by weight)											
	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
398	1510	703	989	2731	1332	276	213	381	1666	303	1805	1083
994	979	505	772	1550	2076	158	152	217	1536	204	1125	843
2982	1771	733	1013	3309	1133	319	228	447	1691	350	2095	1190
3976	2065	786	1047	4030	956	364	238	513	1710	340	2402	1314

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)
398	0.0018	0.0025	131	0.40	0.047	0.0005	30	0.035	0.0004	0.0159	0.0005	0.0013	0.0047	0.0002	0.0019	0.0102	0.0041
994	0.0009	0.0015	172	0.52	0.049	0.0003	30	0.036	0.0002	0.0159	0.0003	0.0007	0.0047	0.0002	0.0009	0.0103	0.0040
2982	0.0004	0.0008	238	0.73	0.052	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0004	0.0047	0.0001	0.0004	0.0103	0.0039
3976	0.0003	0.0006	259	0.79	0.053	0.0002	32	0.036	0.0001	0.0159	0.0001	0.0003	0.0047	0.0001	0.0003	0.0103	0.0038

Drop Structures

Design Slope	0.0040	ft/ft
Total Drop Needed	55.5	ft
Height of Drop Structure	3	ft
No . of Drop Structures	19	
Distance between structs.	466	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	2.81	sq. mi
Total Sediment Yield Volume	5.33	ac ft

Sedimentation Basins

Length	466 ft	Depth	3 ft
Width	430 ft	Side slope	3 ft/ft
Total Volume per Basin		13.26	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	
	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)
398	1.1	-0.6	0.1	24.6	2.0	1.8	3.1	0.0040	0.2	0.0	3.0	4.3
994	1.1	-1.2	0.1	24.6	3.6	1.1	2.2	0.0040	0.4	0.0	3.0	4.4
2982	1.1	-1.3	0.2	24.6	4.6	2.1	3.4	0.0040	0.5	0.0	3.0	4.7
3976	1.1	-1.4	0.2	24.6	5.0	2.5	3.9	0.0040	0.6	0.0	3.0	4.8

Toe Protection Needed	5.0	ft

HEC1 Results For Open Channel

Peak Flow	1977	cfs
Stage at Peak Flow	101.3	ft
Flow Volume	217.0	ac. ft

Freeboard

Max. Flow Depth	1.9	ft
Channel Depth as designed	5.0	ft
Available Freeboard	3.1	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	5.42	ac. ft
Outflowing Sediment Volume	0.11	ac. ft
Deposited(+)/Eroded(-) Volume	5.32	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	8862	8862
Side Slope (?H:1V)	3	3
Channel Width (ft)	430	430
Channel XS Area (sq. ft)	2282	2282
Channel Perimeter (ft)	433	433

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	8862	ft
Thickness	1.5	ft
Protection Depth	5	ft
Tie-in Length/Depth	3.0	ft
Total Depth	8.0	ft
Area needed	2954	sq. Yd
Volume	7877	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	8862	8862
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	5	6
Left Levee Surface Area (sq. Yd)	45295	91574
Left Levee Volume (cu. Yd)	47592	110283
Right Levee Length (ft)	8862	8862
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	5	6
Right Levee Surface Area (sq. Yd)	45295	91574
Right Levee Volume (cu. Yd)	47592	110283
Total Levee Surface Area (sq. Yd)	90590	183148
Total Levee Volume (cu. Yd)	95184	220566

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	8862	8862
Left Levee Lining Width (ft)	16	36
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	15755	35448
Left Levee Lining Volume (cu. Yd)	7877	17724
Right Levee Length (ft)	8862	8862
Right Levee Lining Width (ft)	16	36
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	15755	35448
Right Levee Lining Volume (cu. Yd)	7877	17724
Total Lining Area (sq. Yd)	31509	70896
Total Lining Volume (cu. Yd)	15754	35448

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	430	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	19	
Volume per structure	554	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 41,550	
Area per structure	143	sq. Yd
Total Area	2,723	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	2	
Total Volume per Basin	21393	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 85,572	
Other Cost	$ -	
Total cost per basin	$ 85,572	
Area per basin	22,284	sq. Yd
Total Area	44,568	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	95,184	cu. Yd	$ 7.00	$ 666,288	90,590	sq. Yd	$ 9.00	$ 815,310	90,590	sq. Yd	$ 11.67	$ 1,056,883
Levee - LC Enhancement	Fill	125,382	cu. Yd	$ 7.00	$ 877,674	92,558	sq. Yd	$ 9.00	$ 833,022	125,382	sq. Yd	$ 11.67	$ 1,462,790
Levee Lining	Riprap	15,754	cu. Yd	$ 75.00	$ 1,181,550	31,509	sq. Yd	$ -	$ -	31,509	sq. Yd	$ 20.83	$ 656,444
Levee Lining -LC Enhancement	Riprap	19,694	cu. Yd	$ 75.00	$ 1,477,050	39,387	sq. Yd	$ -	$ -	39,387	sq. Yd	$ 20.83	$ 820,556
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	7,877	cu. Yd	$ 75.00	$ 590,775	2,954	sq. Yd	$ -	$ -	2,954	sq. Yd	$ 25.00	$ 73,850
Drop Structures	Riprap	19	EA	$ 41,550.00	$ 789,450	2,723	sq. Yd	$ -	$ -	2,723	sq. Yd	$ 33.33	$ 90,767
Drop Str. - LC Enhancement	Riprap	19	EA	$ 4,155.00	$ 78,945	272	sq. Yd	$ -	$ -	272	sq. Yd	$ 33.33	$ 9,077
Sedimentation Basins		2	EA	$ 85,572.00	$ 171,144	44,568	sq. Yd	$ -	$ -	44,568	sq. Yd	$ 8.33	$ 371,400
Other					$ -				$ -				$ -

Base Landscape Cost	$ 815,310	
LC Enhancement Cost	$ 833,022	
Total Landscape Cost	$ 1,648,332	
Base Maintenance Cost	$ 2,249,344	
LC Enhancement Cost	$ 2,292,422	
Total Maintenance Cost	$ 4,541,767	

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 3,399,207	$ 2,433,669	$ 5,832,876
Contingency Cost (25% of Construction Cost)	$ 849,802	$ 608,417	$ 1,458,219
Engineering Design Cost (5% of Construction Cost)	$ 169,960	$ 121,683	$ 291,644
Total Construction Cost	$ 4,418,969	$ 3,163,770	$ 7,582,739

Land Cost

Channel Length	8862 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	430	87.5	$100,000	$ 8,750,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	58	11.8	$100,000	$ 1,180,000
Levee LC Enhancement	54	11	$100,000	$ 1,100,000
Other	0	0	$100,000	$ -
Total	542	110.3		$ 11,030,000

Right of Way

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

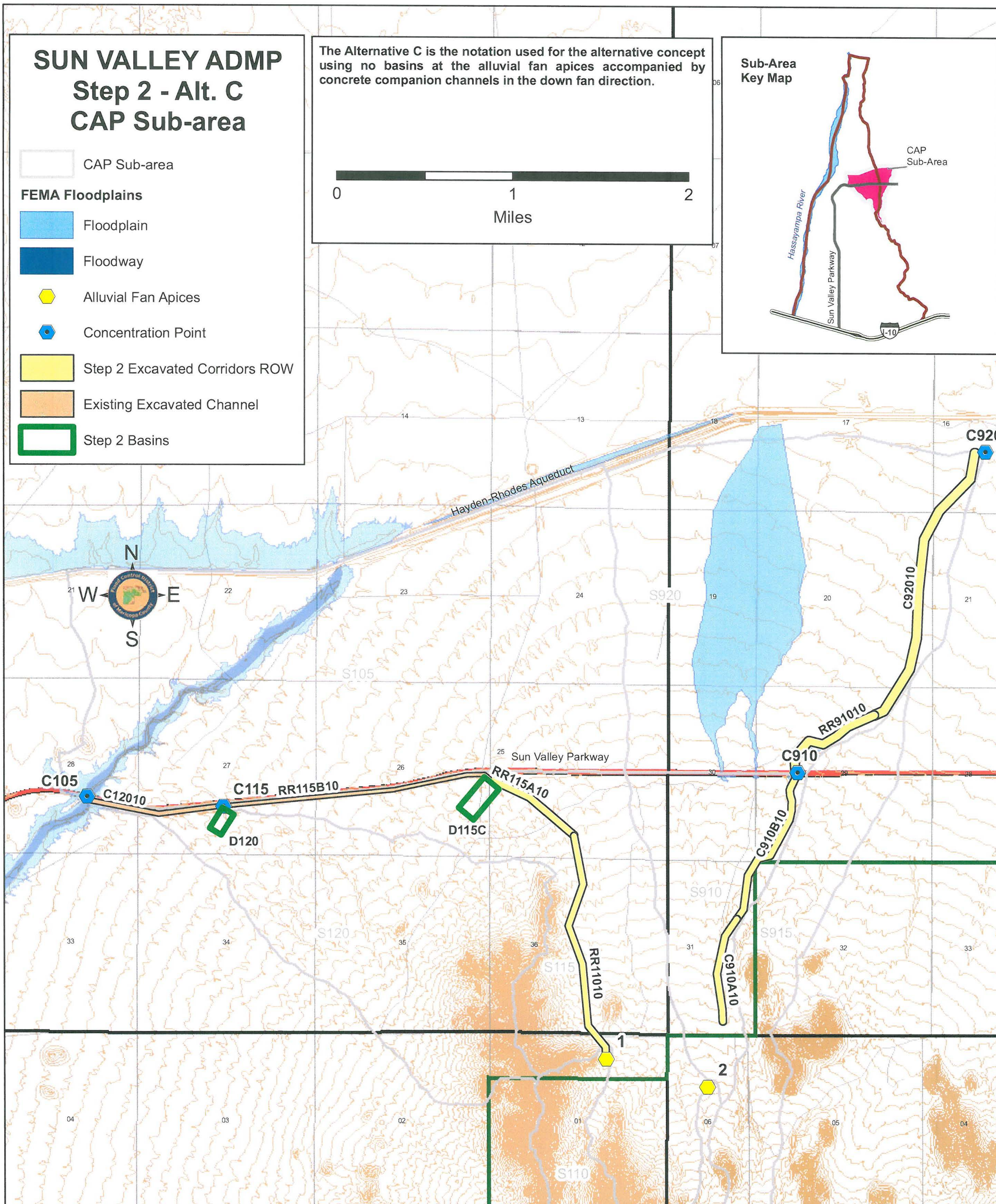
Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	99.3	$100,000	$ 9,930,000
LC Enhancement Cost	acre	11	$100,000	$ 1,100,000
Total Land Cost	acre	110.3	$100,000	$ 11,030,000

Total Cost

Base Total Cost	$ 17,413,624
Total Landscape Enhancement Cost	$ 7,389,214
Total Cost Including LC Enh.	$ 24,802,837

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

Sub-area: CAP, Alternative: B5
Open Channel Structure ID: C92010



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
RR11010	Excavated Chl.	1370	35	1004	0	1.4	127	5	$ 3,480	$ 22,146	$ 554	$ 1,256	$ 27,436	13%	81%	2%	5%	25%
RR115A10	Excavated Chl.	2291	17	206	0	0.6	151	6	$ 1,670	$ 4,903	$ 311	$ 746	$ 7,630	22%	64%	4%	10%	7%
RR115B10	Existing Chl.	1000	23	0	0	1.5	108	6	$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
D115C	Offline Basin	1000	16	160	0	1200	570	5	$ 1,570	$ 1,443	$ 684	$ 655	$ 4,352	36%	33%	16%	15%	4%
C12010	Existing Chl.	2000	14	0	0	0.8	136	7	$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
D120	Offline Basin	2000	7	56	0	720	400	5	$ 661	$ 559	$ 288	$ 284	$ 1,792	37%	31%	16%	16%	2%
C910A10	Excavated Chl.	1529	18	239	0	0.7	135	5	$ 1,820	$ 5,551	$ 308	$ 663	$ 8,342	22%	67%	4%	8%	8%
C910B10	Excavated Chl.	1703	26	366	0	0.9	140	5	$ 2,570	$ 8,360	$ 449	$ 943	$ 12,322	21%	68%	4%	8%	11%
RR91010	Excavated Chl.	3107	21	227	0	0.6	190	5	$ 2,130	$ 5,306	$ 475	$ 829	$ 8,740	24%	61%	5%	9%	8%
C92010	Excavated Chl.	5660	59	1299	0	1.7	208	8	$ 5,940	$ 29,242	$ 1,400	$ 2,925	$ 39,508	15%	74%	4%	7%	36%
		TOTAL	236	3557	0				$19,841	$ 77,511	$ 4,470	$ 8,301	**$ 110,123**	18%	70%	4%	8%	100%
All Channels			176	3341	0	5.9			$17,610	$ 75,509	$ 3,498	$ 7,362	$ 103,979	17%	73%	3%	7%	94%
All Online Basins			0	0	0				$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
All Offline Basins			23	216	0				$ 2,231	$ 2,002	$ 972	$ 939	$ 6,144	36%	33%	16%	15%	6%
Channel Cost per mile (in $1000)			$17,624			Basins Cost per ac. ft. (in $1000)			$4.50									

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	35%	31%	0%				35%	32%	31%	54%	34%
All Online Basins % increase	0%	0%	0%				0%	0%	0%	0%	0%
All Offline Basins % increase	43%	7%	0%				48%	7%	48%	47%	34%
Total % increase	31%	30%	0%				36%	32%	35%	53%	34%

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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
RR11010	Excavated Chl.	1370	35	1004	0	1.4	127	5	$ 3,480	$ 22,146	$ 554	$ 1,256	$ 27,436	13%	81%	2%	5%	25%
RR115A10	Excavated Chl.	2291	17	206	0	0.6	151	6	$ 1,670	$ 4,903	$ 311	$ 746	$ 7,630	22%	64%	4%	10%	7%
RR115B10	Existing Chl.	1000	23	0	0	1.5	108	6	$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
D115C	Offline Basin	1000	16	160	0	1200	570	5	$ 1,570	$ 1,443	$ 684	$ 655	$ 4,352	36%	33%	16%	15%	4%
C12010	Existing Chl.	2000	14	0	0	0.8	136	7	$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
D120	Offline Basin	2000	7	56	0	720	400	5	$ 661	$ 559	$ 288	$ 284	$ 1,792	37%	31%	16%	16%	2%
C910A10	Excavated Chl.	1529	18	239	0	0.7	135	5	$ 1,820	$ 5,551	$ 308	$ 663	$ 8,342	22%	67%	4%	8%	8%
C910B10	Excavated Chl.	1703	26	366	0	0.9	140	5	$ 2,570	$ 8,360	$ 449	$ 943	$ 12,322	21%	68%	4%	8%	11%
RR91010	Excavated Chl.	3107	21	227	0	0.6	190	5	$ 2,130	$ 5,306	$ 475	$ 829	$ 8,740	24%	61%	5%	9%	8%
C92010	Excavated Chl.	5660	59	1299	0	1.7	208	8	$ 5,940	$ 29,242	$ 1,400	$ 2,925	$ 39,508	15%	74%	4%	7%	36%
	TOTAL		236	3557	0				$ 19,841	$ 77,511	$ 4,470	$ 8,301	**$ 110,123**	18%	70%	4%	8%	100%
All Channels			176	3341	0	5.9			$ 17,610	$ 75,509	$ 3,498	$ 7,362	$ 103,979	17%	73%	3%	7%	94%
All Online Basins			0	0	0				$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
All Offline Basins			23	216	0				$ 2,231	$ 2,002	$ 972	$ 939	$ 6,144	36%	33%	16%	15%	6%
Channel Cost per mile (in $1000)			$17,624		Basins Cost per ac. ft. (in $1000)				$4.50									

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
RR11010	Excavated Chl.	1370	48	1352	0	1.4	288	5	$ 4,760	$ 29,910	$ 749	$ 2,004	$ 37,422	13%	80%	2%	5%	25%
RR115A10	Excavated Chl.	2291	23	277	0	0.6	321	6	$ 2,270	$ 6,597	$ 423	$ 1,092	$ 10,382	22%	64%	4%	11%	7%
RR115B10	Existing Chl.	1000	23	0	0	1.5	122	6	$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
D115C	Offline Basin	1000	22	172	0	1450	670	5	$ 2,230	$ 1,542	$ 971	$ 925	$ 5,668	39%	27%	17%	16%	4%
C12010	Existing Chl.	2000	14	0	0	0.8	150	7	$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
D120	Offline Basin	2000	11	60	0	930	500	5	$ 1,070	$ 596	$ 465	$ 451	$ 2,582	41%	23%	18%	17%	2%
C910A10	Excavated Chl.	1529	25	321	0	0.7	299	5	$ 2,490	$ 7,512	$ 416	$ 1,049	$ 11,468	22%	66%	4%	9%	8%
C910B10	Excavated Chl.	1703	35	484	0	0.9	304	5	$ 3,480	$ 11,169	$ 599	$ 1,474	$ 16,723	21%	67%	4%	9%	11%
RR91010	Excavated Chl.	3107	28	273	0	0.6	354	5	$ 2,750	$ 6,493	$ 576	$ 1,190	$ 11,010	25%	59%	5%	11%	7%
C92010	Excavated Chl.	5660	79	1675	0	1.7	390	8	$ 7,940	$ 38,131	$ 1,826	$ 4,510	$ 52,406	15%	73%	3%	9%	35%
	TOTAL		308	4614	0				$ 26,990	$ 101,950	$ 6,025	$ 12,695	**$ 147,660**	18%	69%	4%	9%	100%
All Channels			238	4382	0	5.9			$ 23,690	$ 99,812	$ 4,588	$ 11,319	$ 139,410	17%	72%	3%	8%	94%
All Online Basins			0	0	0				$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
All Offline Basins			33	232	0				$ 3,300	$ 2,138	$ 1,436	$ 1,376	$ 8,250	40%	26%	17%	17%	6%
Channel Cost per mile (in $1000)			$23,629		Basins Cost per ac. ft. (in $1000)				$6.19									
All Channels % increase			35%	31%	0%				35%	32%	31%	54%	34%					
All Online Basins % increase			0%	0%	0%				0%	0%	0%	0%	0%					
All Offline Basins % increase			43%	7%	0%				48%	7%	48%	47%	34%					
Total % increase			31%	30%	0%				36%	32%	35%	53%	34%					

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	61	100.2	17.36	11.4	10.23	59	51	36	20	0.054	0.185	0.39	0.513	29	101	213	280
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	100.3	9.31	8	10.23	60	51	36	20	0.055	0.186	0.39	0.513	30	101	213	280
C105U	COMBINE	2863			4.5	14.6	554	228	121	64	0.353	0.58	0.923	1.129	275	451	719	879
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	648	99.9	8.01	4.3	0.43	76	19	6	3	1.638	1.64	1.64	1.64	38	38	38	38
S115A	BASIN	1540			4.3	1.4	213	53	18	8	1.415	1.416	1.416	1.416	105	105	105	105
C115A	COMBINE	1901			4.3	1.83	271	68	23	10	1.381	1.383	1.383	1.383	135	135	135	135
15I15A	ROUTE	1882	99.6	7.78	4.4	1.83	271	68	23	10	1.381	1.383	1.383	1.383	135	135	135	135
S115B	BASIN	789			4.1	0.42	57	14	5	2	1.269	1.269	1.269	1.269	29	29	29	29
C115B	COMBINE	2069			4.3	2.25	308	77	26	11	1.276	1.277	1.277	1.277	153	153	153	153
15I15B	ROUTE	2038	101.8	38.48	4.5	2.25	308	77	26	11	1.275	1.277	1.277	1.277	153	153	153	153
S115C	BASIN	668			4.1	0.43	58	14	5	2	1.246	1.246	1.246	1.246	29	29	29	29
C115C	COMBINE	2168			4.5	2.68	343	86	29	12	1.19	1.192	1.192	1.192	170	170	170	170
D115C	DIVERT	1000			4.2	2.68	244	61	20	9	0.849	0.851	0.851	0.851	121	121	121	121
115120	ROUTE	1000	100.9	13.5	5	2.68	244	61	20	9	0.849	0.851	0.851	0.851	121	121	121	121
S120	BASIN	1838			4.3	2	256	64	21	9	1.189	1.189	1.189	1.189	127	127	127	127
C120	COMBINE	2429			4.4	4.68	461	115	38	17	0.915	0.917	0.917	0.917	228	229	229	229
D120	DIVERT	2000			4.5	4.68	437	110	37	16	0.868	0.87	0.87	0.87	217	217	217	217
C105D	COMBINE	3990			4.5	19.28	787	266	124	63	0.38	0.514	0.72	0.845	390	528	741	869
S900	BASIN	936			4.5	1.03	170	43	14	6	1.529	1.535	1.535	1.535	84	85	85	85
90091A	ROUTE	922	100	5.32	4.5	1.03	170	43	14	6	1.529	1.535	1.535	1.535	84	85	85	85
90091B	ROUTE	902	99.9	8	4.6	1.03	170	43	14	6	1.527	1.535	1.535	1.535	84	85	85	85
S910	BASIN	1585			4.1	0.98	138	35	12	5	1.307	1.307	1.307	1.307	69	69	69	69
C910	COMBINE	1491			4.2	2.02	282	71	24	10	1.299	1.302	1.302	1.302	140	140	140	140
910915	ROUTE	1466	99.8	9.43	4.3	2.02	282	71	24	10	1.298	1.302	1.302	1.302	140	140	140	140
S915	BASIN	1400			4.5	1.13	189	47	16	7	1.562	1.562	1.562	1.562	94	94	94	94
C915	COMBINE	2409			4.4	3.14	434	109	36	16	1.285	1.288	1.288	1.288	215	216	216	216
915920	ROUTE	2363	99.6	36.22	4.5	3.14	434	109	36	16	1.284	1.288	1.288	1.288	215	216	216	216
S920	BASIN	2660			4.5	3.29	424	106	35	15	1.197	1.197	1.197	1.197	210	210	210	210
C920	COMBINE	4470			4.5	6.43	775	194	65	28	1.12	1.123	1.123	1.123	385	385	385	385

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	71	100.2	20.2	19.1	10.23	68	58	41	23	0.062	0.212	0.445	0.579	34	116	243	316
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	100.3	10.27	15.9	10.23	70	59	41	23	0.063	0.213	0.445	0.58	35	116	243	316
C105U	COMBINE	3466			12.5	14.6	593	239	126	66	0.378	0.609	0.961	1.164	294	474	748	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	518	99.7	6.91	12.3	0.43	62	16	5	2	1.35	1.422	1.422	1.422	31	33	33	33
S115A	BASIN	1536			12.3	1.4	193	50	17	7	1.286	1.321	1.322	1.322	96	98	98	98
C115A	COMBINE	2035			12.3	1.83	253	65	22	9	1.289	1.332	1.333	1.333	126	130	130	130
15I15A	ROUTE	2000	99.7	8.1	12.3	1.83	253	65	22	9	1.289	1.332	1.333	1.333	126	130	130	130
S115B	BASIN	619			12	0.42	47	12	4	2	1.046	1.046	1.046	1.046	23	23	23	23
C115B	COMBINE	2291			12.3	2.25	298	77	26	11	1.233	1.268	1.269	1.269	148	152	152	152
15I15B	ROUTE	2262	101.9	41.33	12.4	2.25	298	77	26	11	1.233	1.268	1.269	1.269	148	152	152	152
S115C	BASIN	534			12.1	0.43	47	12	4	2	1.028	1.028	1.028	1.028	24	24	24	24
C115C	COMBINE	2543			12.4	2.68	343	88	29	13	1.191	1.22	1.221	1.221	170	174	174	174
D115C	DIVERT	1000			12.1	2.68	230	60	20	9	0.798	0.827	0.828	0.828	114	118	118	118
115120	ROUTE	1000	100.9	13.5	12.9	2.68	230	60	20	9	0.798	0.827	0.828	0.828	114	118	118	118
S120	BASIN	2032			12.3	2	247	62	21	9	1.146	1.158	1.158	1.158	122	124	124	124
C120	COMBINE	2887			12.3	4.68	472	121	40	17	0.937	0.959	0.959	0.959	234	239	239	239
D120	DIVERT	2000			12.1	4.68	425	109	36	16	0.844	0.866	0.867	0.867	211	216	216	216
C105D	COMBINE	5244			12.5	19.28	962	326	152	77	0.464	0.629	0.88	1.027	477	647	904	1056
S900	BASIN	853			12.5	1.03	150	39	13	6	1.345	1.416	1.417	1.417	74	78	78	78
90091A	ROUTE	838	99.9	4.92	12.5	1.03	150	39	13	6	1.345	1.416	1.417	1.417	74	78	78	78
90091B	ROUTE	825	99.8	7.47	12.5	1.03	150	39	13	6	1.344	1.416	1.417	1.417	74	78	78	78
S910	BASIN	1512			12.1	0.98	122	30	10	4	1.151	1.151	1.151	1.151	60	60	60	60
C910	COMBINE	1703			12.1	2.02	268	69	23	10	1.235	1.271	1.272	1.272	133	137	137	137
910915	ROUTE	1634	100	10.23	12.2	2.02	268	69	23	10	1.234	1.271	1.272	1.272	133	137	137	137
S915	BASIN	1305			12.4	1.13	165	42	14	6	1.366	1.378	1.378	1.378	82	83	83	83
C915	COMBINE	2641			12.3	3.14	428	109	36	16	1.266	1.294	1.294	1.294	212	217	217	217
915920	ROUTE	2597	99.8	38.5	12.4	3.14	428	109	36	16	1.266	1.294	1.294	1.294	212	217	217	217
S920	BASIN	3157			12.5	3.29	428	107	36	15	1.209	1.209	1.209	1.209	212	212	212	212
C920	COMBINE	5660			12.5	6.43	845	214	71	31	1.221	1.235	1.235	1.235	419	424	424	424

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)
RR11010	Excavated	0.0240	0.0030	1.40	3	4.5	0.020	1370	72.1	181.5	2.5	2.6	3.5	1.0	71	7.5	0.83	0.65
RR115A10	Excavated	0.0191	0.0030	0.60	3	6.0	0.020	2291	94.3	275.0	2.9	3.0	4.6	1.4	93	8.3	0.85	0.87
RR115B10	Existing	0.0118	0.0015	1.50	3	5.5	0.030	1000	89.1	138.2	1.6	1.6	3.0	2.5	88	7.2	1.02	0.28
C12010	Existing	0.0100	0.0015	0.80	3	6.5	0.030	2000	115.4	244.2	2.1	2.1	3.8	2.7	114	8.2	0.99	0.36
C910A10	Excavated	0.0198	0.0030	0.70	3	5.0	0.020	1529	79.8	201.9	2.5	2.6	3.9	1.1	79	7.6	0.83	0.73
C910B10	Excavated	0.0158	0.0030	0.90	3	5.0	0.020	1703	84.7	220.6	2.6	2.6	3.9	1.1	83	7.7	0.84	0.73
RR91010	Excavated	0.0131	0.0030	0.60	3	5.0	0.020	3107	135.0	381.1	2.8	2.9	3.9	1.1	134	8.2	0.85	0.74
C92010	Excavated	0.0103	0.0025	1.70	3	8.0	0.020	5660	147.0	597.0	4.1	4.1	5.9	2.1	145	9.5	0.82	0.91

Basins Hydraulics Summary

			Design Geometry				Hydraulics					
Structure ID	Type	Adjacent Topo. Slope (ft/ft)	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)
D115C	Offline Basin	0.0200	1200	570	5.0	56.2	56.0	56.0	1543	0	3.0	2.0
D120	Offline Basin	0.0200	720	400	5.0	23.1	23.0	23.0	887	0	1.8	3.2

Open Channel

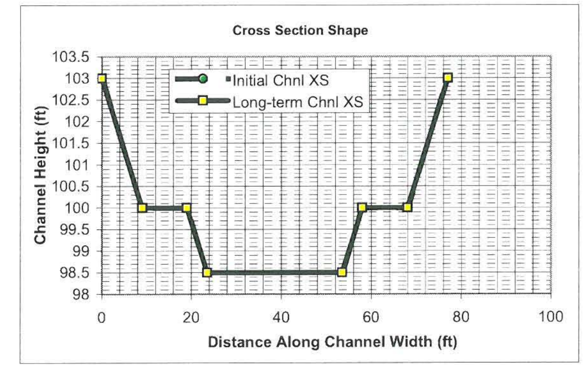
Structure ID	RR11010	HEC1 ID	11015I

Longitundal Geometry

Length	7199.5	ft
U/S Elev	1865.3	ft
D/S Elev	1692.1	ft
Initial Channel Slope	0.0240	ft/ft
Long-term Channel Slope	0.0030	ft/ft

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

NSTPS	3



Initial Channel XS Geometry

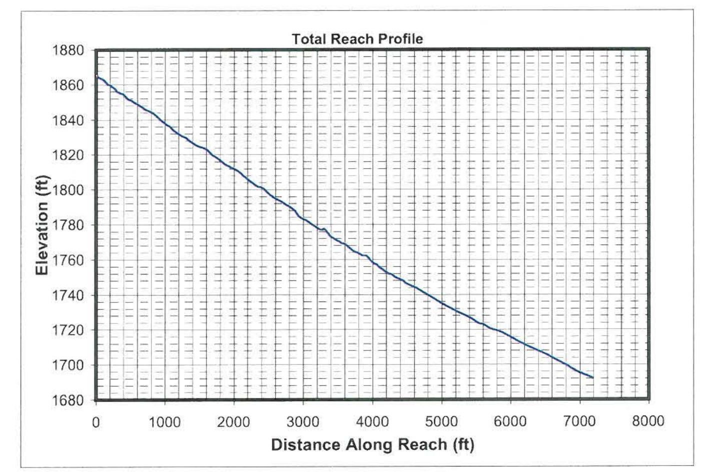
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	3	10	3	30	4.5	3	10	3	3

PT. ID	1	2	3	4	5	6	7	8
X	0	9	19	23.5	53.5	58	68	77
Y	103	100	100	98.5	98.5	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	10	3	30	4.5	3	10	3	3

PT. ID	1	2	3	4	5	6	7	8
X	0	9	19	23.5	53.5	58	68	77
Y	103	100	100	98.5	98.5	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	0.02	0.02	0.02	0.02	0.02	0.02

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	S115A	S110								TOTAL
HEC1 Peak-Flow	1540	662								2202
Weighting Factor	0.46	1.00								
Flow into Channel	708	662								1370

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	1.073	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	1370	cfs	
Long-term Max. Chnl Capacity	2294	cfs	
Q2 Channel	137	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	77	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
137	36.6	34.8	0.9	98.5	99.5	3.9	1.0	36.3	1.0	0.20	0.71
343	61.9	74.3	1.2	98.5	100.4	4.6	1.9	61.2	1.2	0.35	0.74
1028	69.3	150.3	2.2	98.5	101.5	6.8	3.0	68.3	2.2	0.57	0.81
1370	72.1	181.5	2.5	98.5	102.0	7.5	3.5	71.0	2.6	0.65	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
137	36.6	34.8	0.9	98.5	99.5	3.9	1.0	36.3	1.0	0.20	0.71
343	61.9	74.3	1.2	98.5	100.4	4.6	1.9	61.2	1.2	0.35	0.74
1028	69.3	150.3	2.2	98.5	101.5	6.8	3.0	68.3	2.2	0.57	0.81
1370	72.1	181.5	2.5	98.5	102.0	7.5	3.5	71.0	2.6	0.65	0.83

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
137										0
343										0
1028										0
1370										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)		
137	1.74	1.3822	1.3131	Erosive	Erosive	Erosive	0.3	Erosive	3.3	Stable	Stable
343	1.74	1.4549	1.3822	Erosive	Erosive	Erosive	0.3	Erosive	4.6	Stable	Stable
1028	1.74	1.6387	1.5567	Erosive	Erosive	Erosive	0.4	Erosive	6.5	Stable	Stable
1370	1.74	1.6849	1.6007	Erosive	Erosive	Erosive	0.4	Erosive	7.1	Stable	Stable

USCOE Allowable Velocity (ft/s)	20
FHWA Allowable Velocity (ft/s)	50

Regime Width

Discharge (cfs)	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
	137	343	1028	1370	137	343	1028	1370	137	343	1028	1370
Bray - Equation #1	32	52	92	107	1.4	1.9	2.7	2.9	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	29	35	4.2	5.9	9.0	10.0				
Ackers & Charlton/Lacey	28	42	66	75					1.8	2.1	2.5	2.7
Parker	80	127	220	254	1.1	1.6	2.5	2.8				
Chang	43	77	151	180	0.3	0.3	0.1	0.0				
Kellerhals	21	33	58	67	1.9	2.8	4.4	4.9	3.3	3.7	4.1	4.2
AMAFCA/Schumm	36	61	68	71								
Moody & Odem	13	13	13	13	1.0	1.0	1.0	1.0				
BUREC	13.7	19.2	29.1	32.4	4	5	8	9	4.3	5.4	7.2	7.7
Average	32	51	85	97	1.9	2.6	3.8	4.2	3.0	3.5	4.2	4.4
Values As Designed	36	61	68	71	1.0	1.9	3.0	3.5	3.9	4.6	6.8	7.5
Difference with Design	-4	-11	16	26	0.8	0.7	0.7	0.7	-1.0	-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
137	683	1137	2201	13842	1490	1109	436	559	9528	960	4127	3279
343	2116	2917	5337	45556	2870	3284	1100	1643	23882	2823	11826	9396
1028	10825	9731	16254	273001	4419	20039	3223	6860	71889	12779	47385	43309
1370	16500	13231	21987	433206	4971	31263	4239	9824	95895	15987	67277	64944

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
137	1850	3078	5961	37484	4034	3003	1179	1514	25803	2601	11176	8880
343	2292	3160	5781	49347	3109	3557	1192	1779	25870	3058	12810	10178
1028	3909	3514	5869	98573	1595	7235	1164	2477	25957	4614	17109	15638
1370	4468	3583	5954	117313	1346	8466	1148	2660	25969	4329	18219	17587

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
137	683	840	918	612	344	354	436	559	371	130	672	538
343	2116	2205	2418	2013	719	980	1100	1643	971	204	2046	1492
1028	10825	7648	6703	12065	1278	3772	3223	6860	3083	193	9528	5925
1370	16500	10475	8898	19145	1476	5362	4239	9824	4140	194	14039	8572

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
137	1850	2275	2486	1657	933	957	1179	1514	1005	351	1819	1457
343	2292	2389	2620	2181	778	1061	1192	1779	1052	221	2217	1617
1028	3909	2761	2420	4356	461	1362	1164	2477	1113	70	3440	2139
1370	4468	2837	2410	5185	400	1452	1148	2660	1121	53	3802	2321

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson n	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)
137	0.0006	0.0004	281	0.86	0.054	0.0003	32	0.036	0.0002	0.0159	0.0003	0.0004	0.0068	0.0004	0.0011	0.0030	0.0026
343	0.0005	0.0003	316	0.96	0.055	0.0002	32	0.036	0.0002	0.0159	0.0002	0.0003	0.0068	0.0003	0.0006	0.0030	0.0026
1028	0.0002	0.0002	425	1.29	0.058	0.0001	33	0.036	0.0001	0.0159	0.0001	0.0001	0.0068	0.0002	0.0002	0.0029	0.0025
1370	0.0002	0.0001	458	1.39	0.058	0.0001	33	0.036	0.0001	0.0159	0.0001	0.0001	0.0068	0.0001	0.0002	0.0029	0.0025

Drop Structures

Design Slope	0.0030	ft/ft
Total Drop Needed	151.2	ft
Height of Drop Structure	3	ft
No . of Drop Structures	51	
Distance between structs.	141	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	1.22	ac ft

Sedimentation Basins

Length	141 ft	Depth	3 ft
Width	77 ft	Side slope	3 ft/ft
Total Volume per Basin		0.62	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		7	

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)
137	1.1	0.2	0.2	24.6	1.0	1.0	3.9	0.0030	0.2	0.0	1.0	2.0
343	1.1	0.4	0.3	24.6	1.9	1.2	4.6	0.0030	0.4	0.0	1.0	2.5
1028	1.1	1.0	0.6	24.6	3.0	2.2	6.8	0.0030	0.6	0.0	1.0	3.8
1370	1.1	1.2	0.8	24.6	3.5	2.6	7.5	0.0030	0.7	0.0	1.0	4.4

Toe Protection Needed	5.0	ft

HEC1 Results For Open Channel

Peak Flow	648	cfs
Stage at Peak Flow	99.9	ft
Flow Volume	38.0	ac. ft

Freeboard

Max. Flow Depth	3.5	ft
Channel Depth as designed	4.5	ft
Available Freeboard	1.0	ft
Required Freeboard	1.1	ft

Sediment Volume

Inflowing Sediment Volume	1.22	ac. ft
Outflowing Sediment Volume	0.03	ac. ft
Deposited(+)/Eroded(-) Volume	1.19	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	7199	7199
Side Slope (?H:1V)	3	6
Channel Width (ft)	77	104
Channel XS Area (sq. ft)	255.8	316.55
Channel Perimeter (ft)	79	105

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	1620093	2180459
Excavated Area (sq. Yd)	61591	83188

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)	7199	7199
Lining Width (ft)	19	36
Lining Thickness (ft)	0.5	0.5
Lining Area (sq. Yd)	15198	28796
Lining Volume (cu. Yd)	2533	4799

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	7199	ft
Thickness	1.5	ft
Protection Depth	5	ft
Tie-in Length/Depth	3.0	ft
Total Depth	8.0	ft
Area needed	1200	sq. Yd
Volume	3200	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)	7199	7199
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)	7199	7199
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	77	ft
LC Enhancement Ratio	1.1	
Structure Thickness	0.5	ft
Drop Height	3	ft
Scour Depth	12.8	ft
Structure Height	15.8	ft
Number of Structures	51	
Volume per structure	22	cu. Yd
Unit Cost	$ 155.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 3,410	
Area per structure	4	sq. Yd
Total Area	218	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	7	
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	1,208	sq. Yd
Total Area	8,456	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	1,620,093	cu. Yd	$ 10.00	$ 16,200,930	61,591	sq. Yd	$ 9.00	$ 554,319	61,591	sq. Yd	$ 8.33	$ 513,258
Exc. Chl - LC Enhancement	Excavated	560,366	cu. Yd	$ 10.00	$ 5,603,660	21,597	sq. Yd	$ 9.00	$ 194,373	21,597	sq. Yd	$ 8.33	$ 179,975
Channel Lining	Concrete	2,533	cu. Yd	$ 155.00	$ 392,615	15,198	sq. Yd	$ -	$ -	15,198	sq. Yd	$ 41.67	$ 633,250
Channel Lining - LC Enhancement	Concrete	2,266	cu. Yd	$ 155.00	$ 351,230	13,598	sq. Yd	$ -	$ -	13,598	sq. Yd	$ 41.67	$ 566,583
Toe Protection	Riprap	3,200	cu. Yd	$ 75.00	$ 240,000	1,200	sq. Yd	$ -	$ -	1,200	sq. Yd	$ 25.00	$ 30,000
Drop Structures	Concrete	51	EA	$ 3,410.00	$ 173,910	218	sq. Yd	$ -	$ -	218	sq. Yd	$ 41.67	$ 9,083
Drop Str. - LC Enhancement	Concrete	51	EA	$ 341.00	$ 17,391	22	sq. Yd	$ -	$ -	22	sq. Yd	$ 41.67	$ 908
Sedimentation Basins		7	EA	$ 4,000.00	$ 28,000	8,456	sq. Yd	$ -	$ -	8,456	sq. Yd	$ 8.33	$ 70,467
Other					$ -				$ -				$ -

Base Landscape Cost	$ 554,319	Base Maintenance Cost	$ 1,256,058
LC Enhancement Cost	$ 194,373	LC Enhancement Cost	$ 747,467
Total Landscape Cost	$ 748,692	Total Maintenance Cost	$ 2,003,525

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 17,035,455	$ 5,972,281	$ 23,007,736
Contingency Cost (25% of Construction Cost)	$ 4,258,864	$ 1,493,070	$ 5,751,934
Engineering Design Cost (5% of Construction Cost)	$ 851,773	$ 298,614	$ 1,150,387
Total Construction Cost	$ 22,146,092	$ 7,763,965	$ 29,910,057

Land Cost

Channel Length	7199 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	134	22.1	$100,000	$ 2,210,000
LC Enhancement Buffer	50	8.3	$100,000	$ 830,000
Channel	77	12.7	$100,000	$ 1,270,000
Channel LC Enhancement	27	4.5	$100,000	$ 450,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	288	47.6		$ 4,760,000

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	34.8	$100,000	$ 3,480,000
LC Enhancement Cost	acre	12.8	$100,000	$ 1,280,000
Total Land Cost	acre	47.6	$100,000	$ 4,760,000

Total Cost

Base Total Cost	$ 27,436,469
Total Landscape Enhancement Cost	$ 9,985,805
Total Cost Including LC Enh.	$ 37,422,274

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

Open Channel

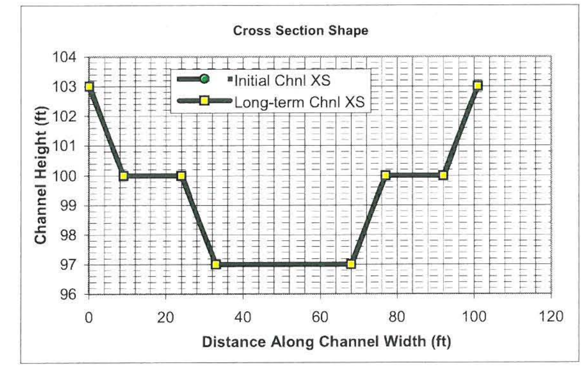
Structure ID	RR115A10		HEC1 ID	15I15A

Longitundal Geometry

Length	3083.7	ft
U/S Elev	1692.1	ft
D/S Elev	1633.3	ft
Initial Channel Slope	0.0191	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

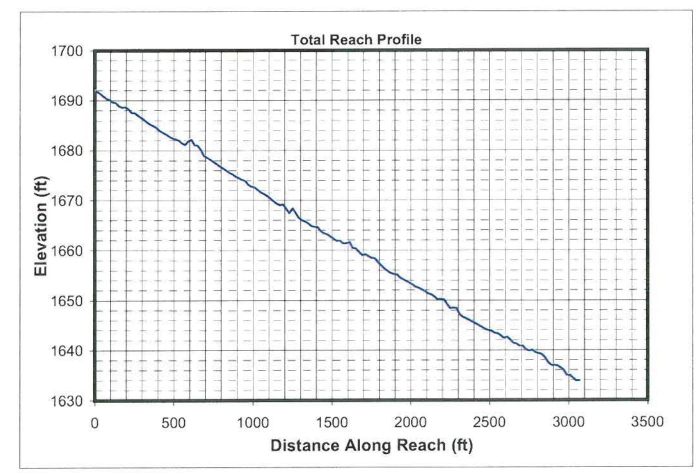
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	3	15	3	35	6	3	15	3	3

PT. ID	1	2	3	4	5	6	7	8
X	0	9	24	33	68	77	92	101
Y	103	100	100	97	97	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	15	3	35	6	3	15	3	3

PT. ID	1	2	3	4	5	6	7	8
X	0	9	24	33	68	77	92	101
Y	103	100	100	97	97	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	C115B									TOTAL
HEC1 Peak-Flow	2291									2291
Weighting Factor	1.00									
Flow into Channel	2291									2291

Reach Sediment Inflow Characteristics

U/S Contributing ID	11015I_RR11010									TOTAL
HEC1 Flow Volume (ac. ft)	38.00									38
Sediment Conc. (ppm)	2321									
Sediment Volume (ac. ft)	0.03									0.03
Weighting Factor	1									
Weighted Sed. Vol. (ac. ft)	0.03									0.03

Hydrology

Drainage Area	2	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	2291	cfs	
Long-term Max. Chnl Capacity	4169	cfs	
Q2 Channel	229	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	101	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
229	43.2	50.6	1.2	97.0	98.3	4.5	1.3	42.8	1.2	0.24	0.73
573	49.0	92.1	1.9	97.0	99.2	6.2	2.2	48.3	1.9	0.41	0.79
1718	91.0	228.2	2.5	97.0	101.1	7.5	4.1	89.7	2.5	0.77	0.83
2291	94.3	275.0	2.9	97.0	101.6	8.3	4.6	92.8	3.0	0.87	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
229	43.2	50.6	1.2	97.0	98.3	4.5	1.3	42.8	1.2	0.24	0.73
573	49.0	92.1	1.9	97.0	99.2	6.2	2.2	48.3	1.9	0.41	0.79
1718	91.0	228.2	2.5	97.0	101.1	7.5	4.1	89.7	2.5	0.77	0.83
2291	94.3	275.0	2.9	97.0	101.6	8.3	4.6	92.8	3.0	0.87	0.85

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
	11015I_RR11010									
229	538									538
573	1492									1492
1718	5925									5925
2291	8572									8572

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)		
229	1.74	1.4469	1.3745	Erosive	Erosive	Erosive	0.3	Erosive	3.8	Stable	Stable
573	1.74	1.5947	1.5150	Erosive	Erosive	Erosive	0.4	Erosive	5.4	Stable	Stable
1718	1.74	1.6834	1.5992	Erosive	Erosive	Erosive	0.4	Erosive	7.7	Stable	Stable
2291	1.74	1.7305	1.6440	Erosive	Erosive	Erosive	0.5	Erosive	8.4	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)	**229**	**573**	**1718**	**2291**	**229**	**573**	**1718**	**2291**	**229**	**573**	**1718**	**2291**
Bray - Equation #1	42	68	121	140	1.6	2.2	3.2	3.5	3.4	3.8	4.5	4.7
Bray - Equation #2	55	89	159	185	1.8	2.4	3.5	3.8	2.3	2.6	3.1	3.2
Hey	13	21	39	46	5.1	7.2	10.9	12.2				
Ackers & Charlton/Lacey	35	52	82	93					2.0	2.3	2.8	2.9
Parker	104	164	285	329	1.3	1.9	3.0	3.4				
Chang	60	105	206	246	0.3	0.2	-0.1	-0.2				
Kellerhals	27	43	75	86	2.4	3.4	5.4	6.0	3.5	3.8	4.3	4.4
AMAFCA/Schumm	43	48	90	93								
Moody & Odem	16	16	16	16	1.0	1.0	1.0	1.0				
BUREC	16.6	23.3	35.2	39.2	4	6	9	10	4.9	6.2	8.1	8.7
Average	41	63	111	127	2.3	3.1	4.6	5.0	3.2	3.8	4.6	4.8
Values As Designed	43	48	90	93	1.3	2.2	4.1	4.6	4.5	6.2	7.5	8.3
Difference with Design	-2	15	21	34	1.0	0.9	0.4	0.4	-1.3	-2.4	-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
229	1382	1933	3276	20983	1738	1836	736	1080	11316	1576	6613	4770
573	5295	5233	8076	91479	2560	7365	1811	3551	28409	5575	21265	16420
1718	20653	16037	24933	383821	5552	30032	5328	12314	85339	13354	73071	60949
2291	31572	21828	34145	611150	6228	46929	6995	17606	113839	14310	103977	91689

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
229	2238	3131	5305	33979	2815	2974	1191	1749	18325	2552	10709	7724
573	3430	3390	5231	59255	1658	4771	1173	2300	18402	3611	13775	10636
1718	4459	3463	5384	82874	1199	6484	1150	2659	18426	2883	15777	13160
2291	5113	3535	5529	98968	1008	7600	1133	2851	18435	2317	16838	14848

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
229	1382	1500	1607	1306	491	648	736	1080	647	144	1340	989
573	5295	4187	3779	5694	814	1976	1811	3551	1703	142	4799	3068
1718	20653	13017	11172	23892	1858	6721	5328	12314	5191	246	17582	10725
2291	31572	17823	15001	38043	2132	9582	6995	17606	6961	246	25869	15621

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
229	2238	2430	2603	2115	795	1049	1191	1749	1047	233	2170	1602
573	3430	2712	2448	3689	527	1280	1173	2300	1103	92	3109	1988
1718	4459	2811	2412	5159	401	1451	1150	2659	1121	53	3796	2316
2291	5113	2886	2429	6161	345	1552	1133	2851	1127	40	4189	2530

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)
229	0.0005	0.0003	278	0.85	0.054	0.0002	32	0.036	0.0002	0.0159	0.0002	0.0003	0.0057	0.0003	0.0009	0.0030	0.0023
573	0.0003	0.0002	353	1.08	0.056	0.0002	32	0.036	0.0001	0.0159	0.0001	0.0002	0.0057	0.0002	0.0005	0.0029	0.0023
1718	0.0002	0.0001	407	1.24	0.058	0.0001	33	0.036	0.0001	0.0159	0.0001	0.0001	0.0057	0.0001	0.0002	0.0029	0.0022
2291	0.0002	0.0001	439	1.34	0.058	0.0001	33	0.036	0.0001	0.0159	0.0001	0.0001	0.0057	0.0001	0.0002	0.0029	0.0022

Drop Structures

Design Slope	0.0030	ft/ft
Total Drop Needed	49.6	ft
Height of Drop Structure	3	ft
No . of Drop Structures	17	
Distance between structs.	181	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	1.60	sq. mi
Total Sediment Yield Volume	3.05	ac ft

Sedimentation Basins

Length	181 ft	Depth	3 ft
Width	101 ft	Side slope	3 ft/ft
Total Volume per Basin		1.09	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)
229	1.1	0.3	0.3	24.6	1.3	1.2	4.5	0.0030	0.2	0.0	1.0	2.2
573	1.1	0.7	0.5	24.6	2.2	1.9	6.2	0.0030	0.4	0.0	1.0	3.1
1718	1.1	1.5	0.8	24.6	4.1	2.5	7.5	0.0030	0.9	0.0	1.0	4.8
2291	1.1	1.8	1.0	24.6	4.6	3.0	8.3	0.0030	1.0	0.0	1.0	5.5

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	2000	cfs
Stage at Peak Flow	99.7	ft
Flow Volume	135.0	ac. ft

Freeboard

Max. Flow Depth	4.6	ft
Channel Depth as designed	6.0	ft
Available Freeboard	1.4	ft
Required Freeboard	1.4	ft

Sediment Volume

Inflowing Sediment Volume	3.08	ac. ft
Outflowing Sediment Volume	0.13	ac. ft
Deposited(+)/Eroded(-) Volume	2.95	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	3084	3084
Side Slope (?H:1V)	3	6
Channel Width (ft)	101	137
Channel XS Area (sq. ft)	408	516
Channel Perimeter (ft)	103	138

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	333009	447430
Excavated Area (sq. Yd)	34609	46945

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)	3084	3084
Lining Width (ft)	19	36
Lining Thickness (ft)	0.5	0.5
Lining Area (sq. Yd)	6511	12336
Lining Volume (cu. Yd)	1085	2056

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	3084	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	514	sq. Yd
Volume	1542	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)	3084	3084
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)	3084	3084
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	101	ft
LC Enhancement Ratio	1.1	
Structure Thickness	0.5	ft
Drop Height	3	ft
Scour Depth	14.7	ft
Structure Height	17.7	ft
Number of Structures	17	
Volume per structure	33	cu. Yd
Unit Cost	$ 155.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 5,115	
Area per structure	6	sq. Yd
Total Area	95	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	10	
Total Volume per Basin	1759	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 7,036	
Other Cost	$ -	
Total cost per basin	$ 7,036	
Area per basin	2,036	sq. Yd
Total Area	20,360	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	333,009	cu. Yd	$ 10.00	$ 3,330,090	34,609	sq. Yd	$ 9.00	$ 311,481	34,609	sq. Yd	$ 8.33	$ 288,408
Exc. Chl - LC Enhancement	Excavated	114,421	cu. Yd	$ 10.00	$ 1,144,210	12,336	sq. Yd	$ 9.00	$ 111,024	12,336	sq. Yd	$ 8.33	$ 102,800
Channel Lining	Concrete	1,085	cu. Yd	$ 155.00	$ 168,175	6,511	sq. Yd	$ -	$ -	6,511	sq. Yd	$ 41.67	$ 271,292
Channel Lining - LC Enhancement	Concrete	971	cu. Yd	$ 155.00	$ 150,505	5,825	sq. Yd	$ -	$ -	5,825	sq. Yd	$ 41.67	$ 242,708
Toe Protection	Riprap	1,542	cu. Yd	$ 75.00	$ 115,650	514	sq. Yd	$ -	$ -	514	sq. Yd	$ 25.00	$ 12,850
Drop Structures	Concrete	17	EA	$ 5,115.00	$ 86,955	95	sq. Yd	$ -	$ -	95	sq. Yd	$ 41.67	$ 3,958
Drop Str. - LC Enhancement	Concrete	17	EA	$ 511.50	$ 8,696	10	sq. Yd	$ -	$ -	10	sq. Yd	$ 41.67	$ 396
Sedimentation Basins		10	EA	$ 7,036.00	$ 70,360	20,360	sq. Yd	$ -	$ -	20,360	sq. Yd	$ 8.33	$ 169,667
Other					$ -				$ -				$ -

Base Landscape Cost	$ 311,481
LC Enhancement Cost	$ 111,024
Total Landscape Cost	$ 422,505

Base Maintenance Cost	$ 746,175
LC Enhancement Cost	$ 345,904
Total Maintenance Cost	$ 1,092,079

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 3,771,230	$ 1,303,411	$ 5,074,641
Contingency Cost (25% of Construction Cost)	$ 942,808	$ 325,853	$ 1,268,660
Engineering Design Cost (5% of Construction Cost)	$ 188,562	$ 65,171	$ 253,732
Total Construction Cost	$ 4,902,599	$ 1,694,434	$ 6,597,033

Land Cost

Channel Length	3084 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	134	9.5	$100,000	$ 950,000
LC Enhancement Buffer	50	3.5	$100,000	$ 350,000
Channel	101	7.2	$100,000	$ 720,000
Channel LC Enhancement	36	2.5	$100,000	$ 250,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	321	22.7		$ 2,270,000

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	16.7	$100,000	$ 1,670,000
LC Enhancement Cost	acre	6	$100,000	$ 600,000
Total Land Cost	acre	22.7	$100,000	$ 2,270,000

Total Cost

Base Total Cost	$ 7,630,255
Total Landscape Enhancement Cost	$ 2,751,362
Total Cost Including LC Enh.	$ 10,381,617

Open Channel

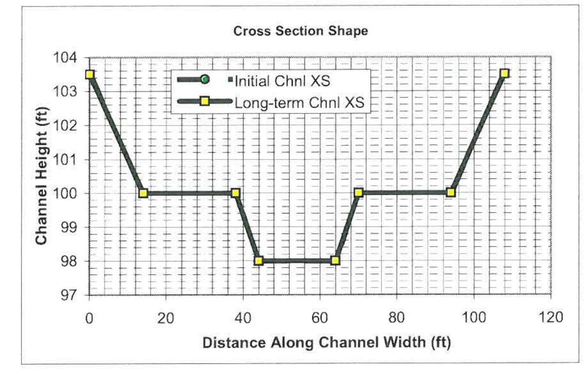
Structure ID	RR115B10		HEC1 ID	15I15B

Longitundal Geometry

Length	8073.3	ft
U/S Elev	1633.3	ft
D/S Elev	1537.8	ft
Initial Channel Slope	0.0118	ft/ft
Long-term Channel Slope	0.0015	ft/ft

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

NSTPS	8



Initial Channel XS Geometry

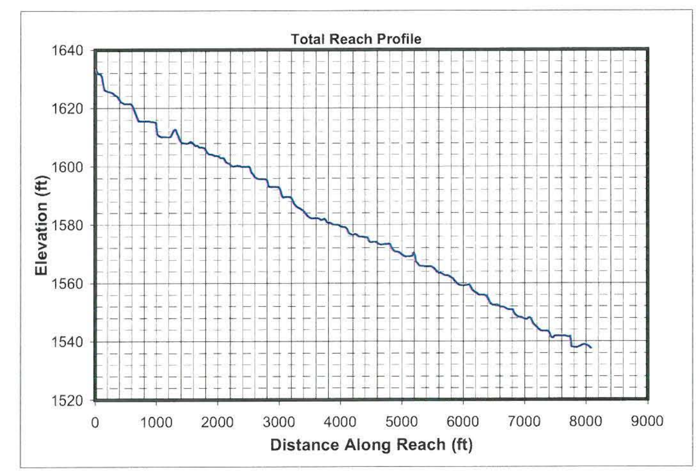
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
4	3.5	24	3	20	5.5	3	24	3.5	4

PT. ID	1	2	3	4	5	6	7	8
X	0	14	38	44	64	70	94	108
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
4	3.5	24	3	20	5.5	3	24	3.5	4

PT. ID	1	2	3	4	5	6	7	8
X	0	14	38	44	64	70	94	108
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	0.03	0.03	0.03	0.03	0.03	0.03

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	D115C									TOTAL
HEC1 Peak-Flow	1000									1000
Weighting Factor	1.00									
Flow into Channel	1000									1000

Reach Sediment Inflow Characteristics

U/S Contributing ID	15I15A_RR115A10									TOTAL
HEC1 Flow Volume (ac. ft)	135.00									135
Sediment Conc. (ppm)	2530									
Sediment Volume (ac. ft)	0.13									0.13
Weighting Factor	1									
Weighted Sed. Vol. (ac. ft)	0.13									0.13

Hydrology

Drainage Area	0.42	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	1000	cfs	
Long-term Max. Chnl Capacity	1683	cfs	
Q2 Channel	100	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	108	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: CAP, Alternative: C
Open Channel Structure ID: RR115B10

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	25.9	21.2	0.8	98.0	98.9	4.7	0.9	25.6	0.8	0.09	0.92
250	29.9	38.9	1.3	98.0	99.6	6.4	1.6	29.4	1.3	0.15	0.99
750	86.9	115.1	1.3	98.0	100.8	6.5	2.8	86.1	1.3	0.26	0.99
1000	89.1	138.2	1.6	98.0	101.0	7.2	3.0	88.2	1.6	0.28	1.02

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	30.6	42.1	1.4	98.0	99.7	2.4	1.7	30.1	1.4	0.16	0.35
250	86.5	110.4	1.3	98.0	100.7	2.3	2.7	85.6	1.3	0.25	0.35
750	96.7	223.3	2.3	98.0	102.0	3.4	4.0	95.6	2.3	0.37	0.39
1000	100.6	269.6	2.7	98.0	102.4	3.7	4.4	99.4	2.7	0.41	0.40

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
	15I15A_RR115A 10									
100	989									989
250	3068									3068
750	10725									10725
1000	15621									15621

Allowable Velocity

Channel Lining	Natural - Sandy Loam (noncolloidal)

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	1.3370	1.2702	Erosive	Erosive	Erosive	0.3	Erosive	3.1	Erosive	Stable
250	1.74	1.4812	1.4072	Erosive	Erosive	Erosive	0.3	Erosive	3.9	Erosive	Stable
750	1.74	1.4851	1.4108	Erosive	Erosive	Erosive	0.3	Erosive	5.3	Erosive	Stable
1000	1.74	1.5339	1.4572	Erosive	Erosive	Erosive	0.4	Erosive	5.7	Erosive	Stable

USCOE Allowable Velocity (ft/s)	2
FHWA Allowable Velocity (ft/s)	2.5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	**100**	**250**	**750**	**1000**	**100**	**250**	**750**	**1000**	**100**	**250**	**750**	**1000**
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	28	49	97	116	0.5	0.6	0.7	0.6				
Kellerhals	18	28	49	57	1.7	2.5	3.8	4.3	3.2	3.5	4.0	4.1
AMAFCA/Schumm	30	86	96	100								
Moody & Odem	9	9	9	9	0.8	0.8	0.8	0.8				
BUREC	16.1	22.7	34.2	38.1	4	6	9	10	2.3	2.9	3.8	4.0
Average	26	45	74	84	1.8	2.5	3.7	4.1	2.5	2.8	3.4	3.5
Values As Designed	30	86	96	99	1.7	2.7	4.0	4.4	2.4	2.3	3.4	3.7
Difference with Design	-4	-40	-22	-15	0.1	-0.2	-0.2	-0.3	0.1	0.6	0.0	-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)											
100	2261	1265	1788	3899	626	905	618	787	2379	469	2144	1558
250	8549	3406	4339	16752	965	2888	1498	2515	6012	1009	7069	5000
750	26365	9940	13124	51240	2843	8815	4538	7681	18041	2946	21608	15195
1000	40579	13639	17787	82145	3198	12821	5969	11044	24104	3170	31411	22352

Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
	Sediment Concentrations (ppm by weight)											
100	8388	4692	6635	14463	2323	3358	2291	2921	8827	1741	7956	5781
250	12687	5055	6438	24860	1432	4286	2223	3732	8922	1497	10491	7420
750	13042	4917	6492	25347	1406	4361	2245	3800	8924	1457	10689	7516
1000	15055	5060	6599	30476	1186	4757	2215	4097	8942	1176	11653	8292

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)											
100	117	105	99	115	208	26	35	58	70	6	117	87
250	276	242	223	263	541	60	81	132	162	15	271	206
750	1416	1083	1150	1576	1085	330	363	763	696	72	1539	916
1000	2161	1550	1560	2500	1282	488	507	1152	965	95	2359	1329

Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
	Sediment Concentrations (ppm by weight)											
100	433	389	367	427	771	98	128	215	260	21	435	322
250	409	360	331	390	803	89	120	196	240	22	402	306
750	701	536	569	780	537	163	180	377	344	35	761	453
1000	802	575	579	928	475	181	188	427	358	35	875	493

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderso n	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	0.0006	0.0008	183	0.56	0.050	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0005	0.0075	0.0005	0.0018	0.0117	0.0050
250	0.0003	0.0005	231	0.70	0.052	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0003	0.0075	0.0003	0.0009	0.0116	0.0049
750	0.0003	0.0005	233	0.71	0.052	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0003	0.0075	0.0002	0.0004	0.0117	0.0049
1000	0.0003	0.0004	252	0.77	0.053	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0002	0.0075	0.0002	0.0003	0.0117	0.0049

Drop Structures

Design Slope	0.0015	ft/ft
Total Drop Needed	83.4	ft
Height of Drop Structure	3	ft
No . of Drop Structures	28	
Distance between structs.	288	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	0.00	sq. mi
Total Sediment Yield Volume	0.00	ac ft

Sedimentation Basins

Length	288 ft	Depth	3 ft
Width	108 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							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)
100	1.1	-0.3	0.1	24.6	1.7	1.4	2.4	0.0015	0.2	0.0	1.0	1.6
250	1.1	-0.4	0.1	24.6	2.7	1.3	2.3	0.0015	0.3	0.0	1.0	1.8
750	1.1	-0.4	0.2	24.6	4.0	2.3	3.4	0.0015	0.5	0.0	1.0	2.1
1000	1.1	-0.3	0.2	24.6	4.4	2.7	3.7	0.0015	0.6	0.0	1.0	2.2

Toe Protection Needed	3.0	ft

HEC1 Results For Open Channel

Peak Flow	2262	cfs
Stage at Peak Flow	101.9	ft
Flow Volume	153.0	ac. ft

Freeboard

Max. Flow Depth	3.0	ft
Channel Depth as designed	5.5	ft
Available Freeboard	2.5	ft
Required Freeboard	1.2	ft

Sediment Volume

Inflowing Sediment Volume	0.13	ac. ft
Outflowing Sediment Volume	0.03	ac. ft
Deposited(+)/Eroded(-) Volume	0.10	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Existing	Existing
Channel Length (ft)	8073	8073
Side Slope (?H:1V)	3	3
Channel Width (ft)	108	108
Channel XS Area (sq. ft)	381	381
Channel Perimeter (ft)	110	110

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	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	0	ft
Thickness	0.0	ft
Protection Depth	0	ft
Tie-in Length/Depth	0.0	ft
Total Depth	0.0	ft
Area needed	0	sq. Yd
Volume	0	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)	8073	8073
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)	8073	8073
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	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	0	ft
LC Enhancement Ratio	1.1	
Structure Thickness	0	ft
Drop Height	0	ft
Scour Depth		ft
Structure Height		ft
Number of Structures	0	
Volume per structure	0	cu. Yd
Unit Cost	$ -	cu. Yd
Other Cost	$ -	
Cost per structure	$ -	
Area per structure	0	sq. Yd
Total Area	0	sq. Yd

Sedimentation Basins		
Include Sed. Basins	No	
(Yes/No)		
Number of basins	0	
Total Volume per Basin	3081	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	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	Existing	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Existing	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	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Drop Structures	None	0	EA	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Drop Str. - LC Enhancement	None	0	EA	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Sedimentation Basins		1	EA	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ 8.33	$ -
Other					$ -				$ -				$ -

Base Landscape Cost	$ -
LC Enhancement Cost	$ -
Total Landscape Cost	$ -

Base Maintenance Cost	$ -
LC Enhancement Cost	$ -
Total Maintenance Cost	$ -

Construction Cost Component	**Base**	**LC Enhancement**	**Total**
Construction Cost	$ -	$ -	$ -
Contingency Cost (25% of Construction Cost)	$ -	$ -	$ -
Engineering Design Cost (5% of Construction Cost)	$ -	$ -	$ -
Total Construction Cost	$ -	$ -	$ -

Land Cost

Channel Length	8073 ft

Land Cost Component	**Width (ft)**	**Area (acre)**	**Unit Cost**	**Cost**
Misc. Right of Way	14	2.6	$0	$ -
LC Enhancement Buffer	0	0	$0	$ -
Channel	108	20	$0	$ -
Channel LC Enhancement	0	0	$0	$ -
Levee	0	0	$0	$ -
Levee LC Enhancement	0	0	$0	$ -
Other	0	0	$0	$ -
Total	122	22.6		$ -

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	**Units**	**Quantity**	**Unit Cost**	**Cost Subtotal**
Base Land Cost	acre	22.6	$0	$ -
LC Enhancement Cost	acre	0	$0	$ -
Total Land Cost	acre	22.6	$0	$ -

Total Cost

Base Total Cost	$ -
Total Landscape Enhancement Cost	$ -
Total Cost Including LC Enh.	$ -

Offline Basin

HEC1 ID	D115C

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

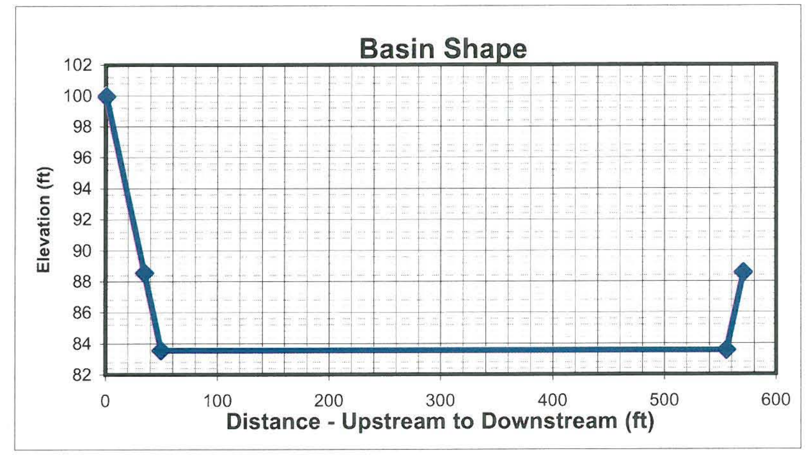
Sediment Volume	0.0	ac. ft

Geometry	Base	LC Enhanced
Topography slope (ft/ft)	0.02	0.02
Basin Length (ft)	1200	1350
Basin Width (ft)	570	570
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	5	5
Freeboard (ft)	1	1
Effective Basin Width (ft)	535.8	501.6
Top Area (acres)	15.7	17.7
U/S-D/S Height Difference (ft)	11.4	11.4
Excess Area on Upstream (acres)	1.0	2.1

			Base	LC Enhanced
Bottom Length (ft)	1170	Allocated Storage Volume (ac. ft)	56.2	56.2
Bottom Width (ft)	505.8	Total Available Volume (ac. ft) (incl. Freeboard)	70.8	71.5
		Total Excavation Volume (ac. ft)	160.4	172.2

Stage-Storage-Discharge

Stage (ft)													
Inflow (cfs)	0	200	400	600	800	1000	1100	1200	1500	2000	2500	3000	
Outflow (cfs)	0	0	0	0	0	0	100	200	500	1000	1500	2000	capacity based on FlowMaster results with 1 ft freeboarc



HEC1 Results

	6-hr Event	24-hr Event	Maximum
Peak flow before diversion (cfs)	2168	2543	2543
Peak flow after diversion (cfs)	1000	1000	1000
Diverted Peak Flow (cfs)	1168	1543	1543
Total Diverted Flow Volume (ac. ft)	49.0	56	56.0
Peak Stage	3	ft	

Volume Check			*Stage Check*	
Total Volume needed	56.0	ac. ft	Depth Needed	4.0
Total Volume Provided	56.2	ac. ft	Depth Provided	5
Volume OK?	Yes		Depth OK?	Yes

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
Landscape Enhancement	287500	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	1200	ft
Base Total ROW Width	570	ft
LC Enh. Total ROW Length	1450	ft
LC Enh. Total ROW Length	670	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	258779	277816
Excavated Area (sq. Yd)	76000	107944

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	52	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	576	sq. Yd
Material Volume	288	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	333	ft
Unit Cost	160	per ft
Cost per outlet	$53,280	
Other Cost	$ -	
Total Cost	$53,280	
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		258,779	cu. Yd	$ 4.00	$ 1,035,116	76,000	sq. Yd	$ 9.00	$ 684,000	76,000	sq. Yd	$ 8.33	$ 633,333
Basin - LC Enhanced		19,037	cu. Yd	$ 4.00	$ 76,148	31,944	sq. Yd	$ 9.00	$ 287,496	31,944	sq. Yd	$ 8.33	$ 266,200
Inlet	Riprap	288	sq. Yd	$ 75.00	$ 21,600	576	sq. Yd	$ -	$ -	576	sq. Yd	$ 33.33	$ 19,200
Inlet - LC Enhanced (20%Total)					$ 4,320				$ -				$ 3,840
Outlet	Pipe	1	EA	$ 53,280	$ 53,280	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhanced (5%Total)					$ 2,664				$ -				$ 111
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 684,000	Base Maintenance Cost			$ 654,750
						LC Enh. Landscape Cost			$ 287,496	LC Enh. Maintenance Cost			$ 270,151
						Total Landscape Cost			$ 971,496	Total Maintenance Cost			$ 924,901

Construction Cost Component	Base	LC Enhanced	Total
Construction Cost	$ 1,109,996	$ 76,148	$ 1,186,144
Contingency Cost (25% of Construction Cost)	$ 277,499	$ 19,037	$ 296,536
Engineering Design Cost (5% of Construction Cost)	$ 55,500	$ 3,807	$ 59,307
Total Construction Cost	$ 1,442,995	$ 98,992	$ 1,541,987

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	6.6	$100,000	$ 660,009
Basin	15.7	$100,000	$ 1,570,000
Other		$100,000	$ -
Total	22.3	$100,000	$ 2,230,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	15.7	$100,000	$ 1,570,248
LC Enhancement Cost	acre	6.6	$100,000	$ 659,752
Total Land Cost	acre	22.3	$100,000	$ 2,230,000

Total Cost

Base Total Cost	$ 4,351,993
Total LC Enhancement Cost	$ 1,316,391
Total Cost Including LC Enh.	$ 5,668,384

Open Channel

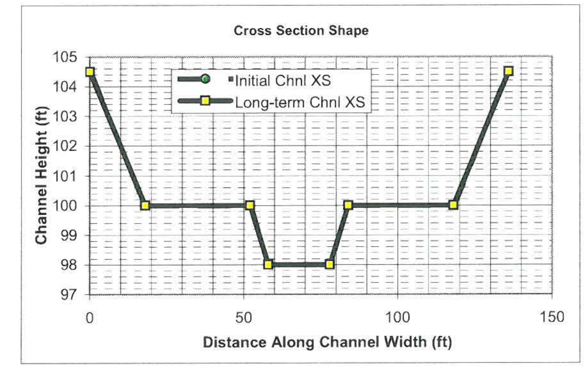
Structure ID	C12010	HEC1 ID	115120

Longitundal Geometry

Length	4136.0	ft
U/S Elev	1537.8	ft
D/S Elev	1496.4	ft
Initial Channel Slope	0.0100	ft/ft
Long-term Channel Slope	0.0015	ft/ft

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

NSTPS	2



Initial Channel XS Geometry

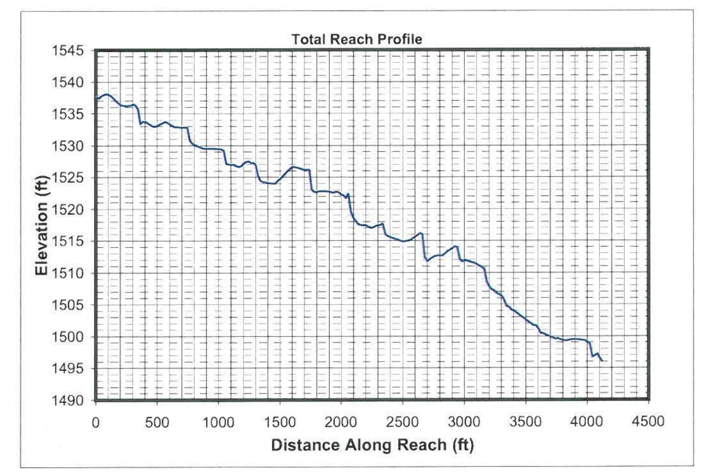
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
4	4.5	34	3	20	6.5	3	34	4.5	4

PT. ID	1	2	3	4	5	6	7	8
X	0	18	52	58	78	84	118	136
Y	104.5	100	100	98	98	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
4	4.5	34	3	20	6.5	3	34	4.5	4

PT. ID	1	2	3	4	5	6	7	8
X	0	18	52	58	78	84	118	136
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	0.03	0.03	0.03	0.03	0.03	0.03

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	D120								TOTAL
HEC1 Peak-Flow	2000								2000
Weighting Factor	1.00								
Flow into Channel	2000								2000

Reach Sediment Inflow Characteristics

U/S Contributing ID	15I15B_RR115B10								TOTAL
HEC1 Flow Volume (ac. ft)	153.00								153
Sediment Conc. (ppm)	493								
Sediment Volume (ac. ft)	0.03								0.03
Weighting Factor	1								
Weighted Sed. Vol. (ac. ft)	0.03								0.03

Hydrology

Drainage Area	2	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	2000	cfs	
Long-term Max. Chnl Capacity	2934	cfs	
Q2 Channel	200	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	136	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
200	29.2	35.4	1.2	98.0	99.5	5.7	1.5	28.7	1.2	0.14	0.90
500	104.7	102.2	1.0	98.0	100.5	4.9	2.5	103.9	1.0	0.23	0.87
1500	112.5	203.4	1.8	98.0	101.4	7.4	3.4	111.5	1.8	0.32	0.96
2000	115.4	244.2	2.1	98.0	101.8	8.2	3.8	114.3	2.1	0.36	0.99

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
200	104.9	104.3	1.0	98.0	100.5	1.9	2.5	104.1	1.0	0.24	0.34
500	111.1	185.0	1.7	98.0	101.3	2.7	3.3	110.1	1.7	0.31	0.37
1500	124.5	374.3	3.0	98.0	102.9	4.0	4.9	123.1	3.0	0.46	0.41
2000	129.6	452.0	3.5	98.0	103.5	4.4	5.5	128.1	3.5	0.52	0.42

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
	15I15B_RR115B 10									
200	87									87
500	206									206
1500	916									916
2000	1329									1329

Allowable Velocity

Channel Lining	Natural - Sandy Loam (noncolloidal)

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)		
200	1.74	1.4599	1.3869	Erosive	Erosive	Erosive	0.3	Erosive	3.6	Erosive	Stable
500	1.74	1.3904	1.3208	Erosive	Erosive	Erosive	0.3	Erosive	4.5	Erosive	Stable
1500	1.74	1.5809	1.5019	Erosive	Erosive	Erosive	0.4	Erosive	6.1	Erosive	Stable
2000	1.74	1.6295	1.5480	Erosive	Erosive	Erosive	0.4	Erosive	6.6	Erosive	Stable

USCOE Allowable Velocity (ft/s)	2
FHWA Allowable Velocity (ft/s)	2.5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	**200**	**500**	**1500**	**2000**	**200**	**500**	**1500**	**2000**	**200**	**500**	**1500**	**2000**
Bray - Equation #1	39	63	112	131	1.6	2.1	3.0	3.3	3.3	3.8	4.4	4.6
Bray - Equation #2	51	83	148	172	1.7	2.3	3.3	3.7	2.3	2.6	3.0	3.1
Hey	12	20	36	43	4.8	6.8	10.4	11.6				
Ackers & Charlton/Lacey	33	49	78	88					1.9	2.3	2.7	2.8
Parker	97	154	266	307	1.2	1.8	2.9	3.2				
Chang	43	76	150	179	0.6	0.6	0.6	0.6				
Kellerhals	25	40	70	80	2.3	3.3	5.1	5.7	3.5	3.8	4.2	4.4
AMAFCA/Schumm	104	110	123	128								
Moody & Odem	16	16	16	16	1.0	1.0	1.0	1.0				
BUREC	20.9	29.4	44.4	49.4	6	8	12	13	2.7	3.4	4.5	4.8
Average	44	64	104	119	2.4	3.2	4.8	5.3	2.7	3.2	3.8	4.0
Values As Designed	104	110	123	128	2.5	3.3	4.9	5.5	1.9	2.7	4.0	4.4
Difference with Design	-60	-46	-19	-9	-0.2	0.0	-0.1	-0.2	0.8	0.5	-0.2	-0.5

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
200	4873	2260	2869	8850	815	1673	1001	1583	3724	706	4376	2975
500	10110	5162	7388	17106	2554	3754	2554	3532	9251	2005	9611	6639
1500	53132	17696	22027	105413	4007	15715	7387	14648	28115	3073	41692	28446
2000	81696	24206	29697	168828	4503	22877	9697	20982	37548	3311	60416	42160

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
200	9040	4192	5322	16416	1511	3104	1857	2937	6907	1310	8117	5519
500	7502	3830	5482	12693	1895	2786	1895	2621	6864	1488	7131	4926
1500	13141	4377	5448	26072	991	3887	1827	3623	6954	760	10312	7036
2000	15155	4490	5509	31318	835	4244	1799	3892	6965	614	11207	7821

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
200	176	150	122	157	485	28	44	71	83	14	155	135
500	704	596	621	717	920	167	206	369	403	41	736	498
1500	3612	2447	2372	4290	1742	791	783	1894	1482	140	3936	2135
2000	5509	3455	3252	6805	2036	1154	1071	2810	2023	166	5967	3113

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
200	327	279	227	291	900	52	81	131	153	25	287	250
500	522	442	461	532	683	124	153	274	299	30	546	370
1500	893	605	587	1061	431	196	194	469	366	35	974	528
2000	1022	641	603	1262	378	214	199	521	375	31	1107	578

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)
200	0.0004	0.0005	205	0.63	0.051	0.0002	31	0.036	0.0002	0.0159	0.0002	0.0003	0.0060	0.0003	0.0013	0.0098	0.0041
500	0.0005	0.0007	184	0.56	0.050	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0004	0.0060	0.0002	0.0007	0.0099	0.0041
1500	0.0002	0.0004	250	0.76	0.053	0.0002	31	0.036	0.0001	0.0159	0.0001	0.0002	0.0060	0.0001	0.0003	0.0099	0.0041
2000	0.0002	0.0003	271	0.83	0.053	0.0001	32	0.036	0.0001	0.0159	0.0001	0.0002	0.0060	0.0001	0.0002	0.0099	0.0040

Drop Structures

Design Slope	0.0015	ft/ft
Total Drop Needed	35.2	ft
Height of Drop Structure	3	ft
No . of Drop Structures	12	
Distance between structs.	345	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	0.00	sq. mi
Total Sediment Yield Volume	0.00	ac ft

Sedimentation Basins

Length	345 ft	Depth	3 ft
Width	136 ft	Side slope	3 ft/ft
Total Volume per Basin		2.94	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)
200	1.1	-0.5	0.1	24.6	2.5	1.0	1.9	0.0015	0.3	0.0	1.0	1.7
500	1.1	-0.4	0.1	24.6	3.3	1.7	2.7	0.0015	0.4	0.0	1.0	1.9
1500	1.1	-0.3	0.2	24.6	4.9	3.0	4.0	0.0015	0.7	0.0	1.0	2.4
2000	1.1	-0.2	0.3	24.6	5.5	3.5	4.4	0.0015	0.8	0.0	1.0	2.5

Toe Protection Needed	3.0	ft

HEC1 Results For Open Channel

Peak Flow	1000	cfs
Stage at Peak Flow	100.9	ft
Flow Volume	121.0	ac. ft

Freeboard

Max. Flow Depth	3.8	ft
Channel Depth as designed	6.5	ft
Available Freeboard	2.7	ft
Required Freeboard	1.5	ft

Sediment Volume

Inflowing Sediment Volume	0.03	ac. ft
Outflowing Sediment Volume	0.03	ac. ft
Deposited(+)/Eroded(-) Volume	0.00	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Existing	Existing
Channel Length (ft)	4136	4136
Side Slope (?H:1V)	3	3
Channel Width (ft)	136	136
Channel XS Area (sq. ft)	583	583
Channel Perimeter (ft)	138	138

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	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	0	ft
Thickness	0.0	ft
Protection Depth	0	ft
Tie-in Length/Depth	0.0	ft
Total Depth	0.0	ft
Area needed	0	sq. Yd
Volume	0	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)	4136	4136
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)	4136	4136
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	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	0	ft
LC Enhancement Ratio	1.1	
Structure Thickness	0	ft
Drop Height	0	ft
Scour Depth		ft
Structure Height		ft
Number of Structures	0	
Volume per structure	0	cu. Yd
Unit Cost	$ -	cu. Yd
Other Cost	$ -	
Cost per structure	$ -	
Area per structure	0	sq. Yd
Total Area	0	sq. Yd

Sedimentation Basins		
Include Sed. Basins	No	
(Yes/No)		
Number of basins	0	
Total Volume per Basin	4743	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	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	Existing	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Existing	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	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Drop Structures	None	0	EA	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Drop Str. - LC Enhancement	None	0	EA	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Sedimentation Basins		1	EA	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ 8.33	$ -
Other					$ -				$ -				$ -

Base Landscape Cost	$ -
LC Enhancement Cost	$ -
Total Landscape Cost	$ -

Base Maintenance Cost	$ -
LC Enhancement Cost	$ -
Total Maintenance Cost	$ -

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ -	$ -	$ -
Contingency Cost (25% of Construction Cost)	$ -	$ -	$ -
Engineering Design Cost (5% of Construction Cost)	$ -	$ -	$ -
Total Construction Cost	$ -	$ -	$ -

Land Cost	
Channel Length	4136 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	14	1.3	$0	$ -
LC Enhancement Buffer	0	0	$0	$ -
Channel	136	12.9	$0	$ -
Channel LC Enhancement	0	0	$0	$ -
Levee	0	0	$0	$ -
Levee LC Enhancement	0	0	$0	$ -
Other	0	0	$0	$ -
Total	150	14.2		$ -

Right of Way		
Preservation Corridor Width	0	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	14.2	$0	$ -
LC Enhancement Cost	acre	0	$0	$ -
Total Land Cost	acre	14.2	$0	$ -

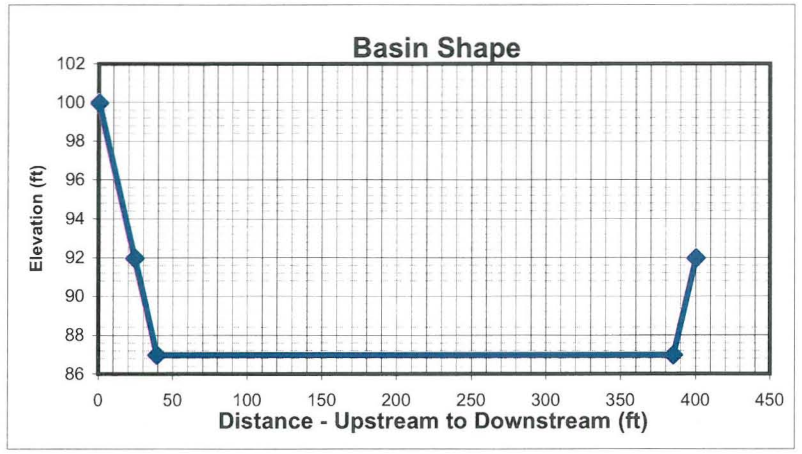
Total Cost	
Base Total Cost	$ -
Total Landscape Enhancement Cost	$ -
Total Cost Including LC Enh.	$ -

Offline Basin

HEC1 ID	D120

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)	0.02	0.02
Basin Length (ft)	720	830
Basin Width (ft)	400	400
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	5	5
Freeboard (ft)	1	1
Effective Basin Width (ft)	376	352
Top Area (acres)	6.6	7.6
U/S-D/S Height Difference (ft)	8.0	8.0
Excess Area on Upstream (acres)	0.4	0.9

			Base	LC Enhanced
Bottom Length (ft)	690	Allocated Storage Volume (ac. ft)	23.1	23.1
Bottom Width (ft)	346	Total Available Volume (ac. ft) (incl. Freeboard)	29.2	29.6
		Total Excavation Volume (ac. ft)	55.7	60.1

HEC1 Results

	6-hr Event	24-hr Event	Maximum
Peak flow before diversion (cfs)	2429	2887	2887
Peak flow after diversion (cfs)	2000	2000	2000
Diverted Peak Flow (cfs)	429	887	887
Total Diverted Flow Volume (ac. ft)	12.0	23	23.0
Peak Stage	1.8	ft	

Volume Check

Total Volume needed	23.0	ac. ft
Total Volume Provided	23.1	ac. ft
Volume OK?	Yes	

Stage Check

Depth Needed	2.8
Depth Provided	5
Depth OK?	Yes

Stage-Storage-Discharge

Stage (ft)													
Inflow (cfs)	0	200	400	600	800	1000	1200	1500	2000	2500	3000	4000	
Outflow (cfs)	0	0	0	0	0	0	0	0	0	500	1000	2000	capacity based on FlowMaster results with 1 ft freeboarc

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

Sub-area: CAP, Alternative: C
Offline Basin Structure ID: D120

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
Landscape Enhancement	177000	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	720	ft
Base Total ROW Width	400	ft
LC Enh. Total ROW Length	930	ft
LC Enh. Total ROW Length	500	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	89863	96961
Excavated Area (sq. Yd)	32000	51667

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	41	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	457	sq. Yd
Material Volume	229	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	333	ft
Unit Cost	160	per ft
Cost per outlet	$53,280	
Other Cost	$ -	
Total Cost	$53,280	
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		89,863	cu. Yd	$ 4.00	$ 359,452	32,000	sq. Yd	$ 9.00	$ 288,000	32,000	sq. Yd	$ 8.33	$ 266,667
Basin - LC Enhanced		7,098	cu. Yd	$ 4.00	$ 28,392	19,667	sq. Yd	$ 9.00	$ 177,003	19,667	sq. Yd	$ 8.33	$ 163,892
Inlet	Riprap	229	sq. Yd	$ 75.00	$ 17,175	457	sq. Yd	$ -	$ -	457	sq. Yd	$ 33.33	$ 15,233
Inlet - LC Enhanced (20%Total)					$ 3,435				$ -				$ 3,047
Outlet	Pipe	1	EA	$ 53,280	$ 53,280	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhanced (5%Total)					$ 2,664				$ -				$ 111
Other					$ -				$ -				$ -

Base Landscape Cost	$ 288,000	Base Maintenance Cost	$ 284,117
LC Enh. Landscape Cost	$ 177,003	LC Enh. Maintenance Cost	$ 167,049
Total Landscape Cost	$ 465,003	Total Maintenance Cost	$ 451,166

Construction Cost Component	Base	LC Enhanced	Total
Construction Cost	$ 429,907	$ 28,392	$ 458,299
Contingency Cost (25% of Construction Cost)	$ 107,477	$ 7,098	$ 114,575
Engineering Design Cost (5% of Construction Cost)	$ 21,495	$ 1,420	$ 22,915
Total Construction Cost	$ 558,879	$ 36,910	$ 595,789

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	4.1	$100,000	$ 406,336
Basin	6.6	$100,000	$ 660,000
Other		$100,000	$ -
Total	10.7	$100,000	$ 1,070,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	6.6	$100,000	$ 661,157
LC Enhancement Cost	acre	4.1	$100,000	$ 408,843
Total Land Cost	acre	10.7	$100,000	$ 1,070,000

Total Cost

Base Total Cost	$ 1,792,153
Total LC Enhancement Cost	$ 789,805
Total Cost Including LC Enh.	$ 2,581,958

Open Channel

Structure ID	C910A10	HEC1 ID	90091A

Longitundal Geometry

Length	3620.4	ft
U/S Elev	1818.8	ft
D/S Elev	1746.9	ft
Initial Channel Slope	0.0198	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	15	3	25	5	3	15	3	3

PT. ID	1	2	3	4	5	6	7	8
X	0	9	24	30	55	61	76	85
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	15	3	25	5	3	15	3	3

PT. ID	1	2	3	4	5	6	7	8
X	0	9	24	30	55	61	76	85
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	S910	S900								TOTAL
HEC1 Peak-Flow	1585	936								2521
Weighting Factor	0.37	1.00								
Flow into Channel	593	936								1529

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

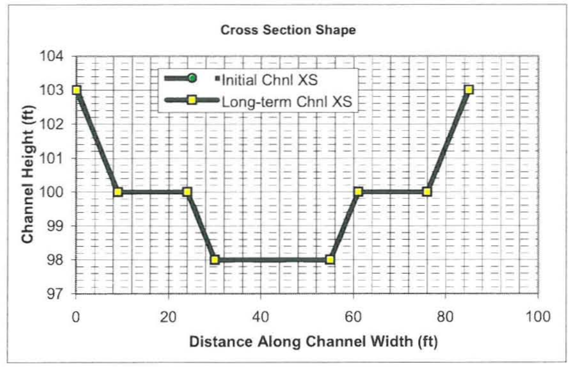
Hydrology

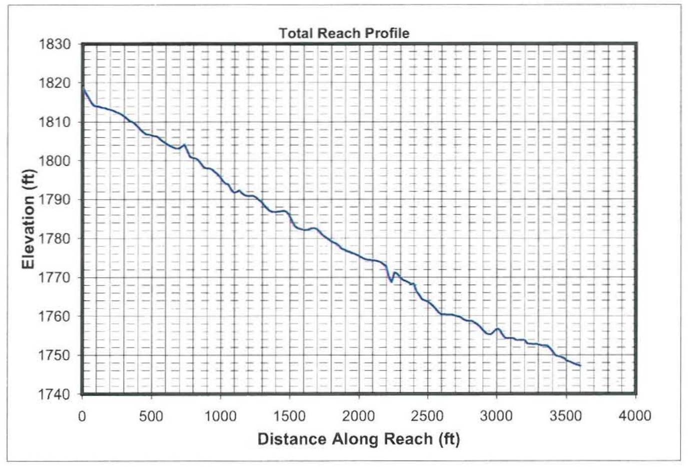
Drainage Area	1.398	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	1529	cfs	
Long-term Max. Chnl Capacity	2648	cfs	
Q2 Channel	153	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	85	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
153	32.8	35.5	1.1	98.0	99.2	4.3	1.2	32.4	1.1	0.23	0.72
382	69.6	83.2	1.2	98.0	100.3	4.6	2.3	68.9	1.2	0.43	0.74
1147	77.0	167.4	2.2	98.0	101.5	6.8	3.5	75.9	2.2	0.65	0.81
1529	79.8	201.9	2.5	98.0	101.9	7.6	3.9	78.5	2.6	0.73	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
153	32.8	35.5	1.1	98.0	99.2	4.3	1.2	32.4	1.1	0.23	0.72
382	69.6	83.2	1.2	98.0	100.3	4.6	2.3	68.9	1.2	0.43	0.74
1147	77.0	167.4	2.2	98.0	101.5	6.8	3.5	75.9	2.2	0.65	0.81
1529	79.8	201.9	2.5	98.0	101.9	7.6	3.9	78.5	2.6	0.73	0.83

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
153										0
382										0
1147										0
1529										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)		
153	1.74	1.4237	1.3525	Erosive	Erosive	Erosive	0.3	Erosive	3.7	Stable	Stable
382	1.74	1.4537	1.3810	Erosive	Erosive	Erosive	0.3	Erosive	5.1	Stable	Stable
1147	1.74	1.6396	1.5576	Erosive	Erosive	Erosive	0.4	Erosive	6.9	Stable	Stable
1529	1.74	1.6865	1.6022	Erosive	Erosive	Erosive	0.4	Erosive	7.5	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)	**153**	**382**	**1147**	**1529**	**153**	**382**	**1147**	**1529**	**153**	**382**	**1147**	**1529**
Bray - Equation #1	34	55	97	113	1.4	1.9	2.8	3.1	3.2	3.6	4.2	4.4
Bray - Equation #2	44	72	128	149	1.6	2.1	3.0	3.3	2.2	2.5	2.9	3.0
Hey	10	17	31	37	4.4	6.2	9.4	10.5				
Ackers & Charlton/Lacey	30	44	69	78					1.9	2.2	2.6	2.7
Parker	85	134	233	269	1.1	1.6	2.6	2.9				
Chang	46	82	161	192	0.3	0.3	0.1	0.0				
Kellerhals	22	35	61	70	2.0	2.9	4.6	5.1	3.4	3.7	4.1	4.2
AMAFCA/Schumm	32	69	76	79								
Moody & Odem	14	14	14	14	1.0	1.0	1.0	1.0				
BUREC	14.2	20.1	30.3	33.7	4	5	8	9	4.4	5.6	7.4	7.9
Average	33	54	90	103	2.0	2.7	3.9	4.4	3.0	3.5	4.3	4.5
Values As Designed	32	69	76	79	1.2	2.3	3.5	3.9	4.3	4.6	6.8	7.6
Difference with Design	1	-15	14	25	0.7	0.4	0.5	0.4	-1.3	-1.1	-2.6	-3.1

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
153	857	1268	2233	13519	1288	1188	488	683	7966	1022	4317	3166
382	2348	3124	5523	37892	2891	3184	1226	1825	19941	2744	11457	8378
1147	12105	10546	16734	229052	4436	17967	3594	7663	60088	11668	46773	38239
1529	18493	14372	22536	364475	4982	28102	4728	10988	80163	12541	66714	57099

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
153	2079	3077	5419	32802	3125	2884	1184	1657	19330	2479	10475	7683
382	2279	3032	5361	36777	2806	3090	1190	1772	19354	2663	11120	8131
1147	3916	3412	5414	74103	1435	5813	1163	2479	19440	3775	15132	12371
1529	4487	3487	5468	88437	1209	6819	1147	2666	19451	3043	16188	13855

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
153	857	974	1051	797	348	417	488	683	426	111	837	635
382	2348	2420	2693	2235	805	1090	1226	1825	1083	230	2272	1657
1147	12105	8471	7477	13509	1422	4213	3594	7663	3441	215	10649	6614
1529	18493	11623	9929	21496	1639	5996	4728	10988	4621	215	15717	9586

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
153	2079	2362	2550	1935	845	1012	1184	1657	1033	270	2030	1541
382	2279	2349	2614	2169	782	1058	1190	1772	1051	223	2205	1608
1147	3916	2740	2419	4370	460	1363	1163	2479	1113	69	3445	2140
1529	4487	2820	2409	5216	398	1455	1147	2666	1121	52	3814	2326

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson n	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)
153	0.0005	0.0003	273	0.83	0.054	0.0003	32	0.036	0.0002	0.0159	0.0002	0.0003	0.0065	0.0004	0.0011	0.0030	0.0025
382	0.0005	0.0003	286	0.87	0.054	0.0002	32	0.036	0.0002	0.0159	0.0002	0.0003	0.0065	0.0003	0.0006	0.0030	0.0025
1147	0.0002	0.0002	386	1.18	0.057	0.0001	33	0.036	0.0001	0.0159	0.0001	0.0001	0.0065	0.0002	0.0002	0.0029	0.0024
1529	0.0002	0.0001	417	1.27	0.058	0.0001	33	0.036	0.0001	0.0159	0.0001	0.0001	0.0065	0.0001	0.0002	0.0029	0.0024

Drop Structures

Design Slope	0.0030	ft/ft
Total Drop Needed	60.8	ft
Height of Drop Structure	3	ft
No . of Drop Structures	21	
Distance between structs.	172	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	0.37	sq. mi
Total Sediment Yield Volume	0.70	ac ft

Sedimentation Basins

Length	172 ft	Depth	3 ft
Width	85 ft	Side slope	3 ft/ft
Total Volume per Basin		0.86	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)
153	1.1	0.3	0.3	24.6	1.2	1.1	4.3	0.0030	0.2	0.0	1.0	2.1
382	1.1	0.5	0.3	24.6	2.3	1.2	4.6	0.0030	0.4	0.0	1.0	2.7
1147	1.1	1.1	0.6	24.6	3.5	2.2	6.8	0.0030	0.7	0.0	1.0	4.1
1529	1.1	1.4	0.8	24.6	3.9	2.6	7.6	0.0030	0.8	0.0	1.0	4.7

Toe Protection Needed	5.0	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	0.70	ac. ft
Outflowing Sediment Volume	0.07	ac. ft
Deposited(+)/Eroded(-) Volume	0.62	ac. ft

HEC1 Results For Open Channel

Peak Flow	922	cfs
Stage at Peak Flow	100.0	ft
Flow Volume	85.0	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	3620	3620
Side Slope (?H:1V)	3	6
Channel Width (ft)	85	115
Channel XS Area (sq. ft)	290	365
Channel Perimeter (ft)	87	116

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	385420	517783
Excavated Area (sq. Yd)	34189	46256

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)	3620	3620
Lining Width (ft)	19	36
Lining Thickness (ft)	0.5	0.5
Lining Area (sq. Yd)	7642	14480
Lining Volume (cu. Yd)	1274	2413

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	3620	ft
Thickness	1.5	ft
Protection Depth	5	ft
Tie-in Length/Depth	3.0	ft
Total Depth	8.0	ft
Area needed	603	sq. Yd
Volume	1609	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)	3620	3620
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)	3620	3620
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	85	ft
LC Enhancement Ratio	1.1	
Structure Thickness	0.5	ft
Drop Height	3	ft
Scour Depth	12.8	ft
Structure Height	15.8	ft
Number of Structures	21	
Volume per structure	25	cu. Yd
Unit Cost	$ 155.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 3,875	
Area per structure	5	sq. Yd
Total Area	99	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	3	
Total Volume per Basin	1387	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 5,548	
Other Cost	$ -	
Total cost per basin	$ 5,548	
Area per basin	1,628	sq. Yd
Total Area	4,884	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	385,420	cu. Yd	$ 10.00	$ 3,854,200	34,189	sq. Yd	$ 9.00	$ 307,701	34,189	sq. Yd	$ 8.33	$ 284,908
Exc. Chl - LC Enhancement	Excavated	132,363	cu. Yd	$ 10.00	$ 1,323,630	12,067	sq. Yd	$ 9.00	$ 108,603	12,067	sq. Yd	$ 8.33	$ 100,558
Channel Lining	Concrete	1,274	cu. Yd	$ 155.00	$ 197,470	7,642	sq. Yd	$ -	$ -	7,642	sq. Yd	$ 41.67	$ 318,417
Channel Lining - LC Enhancement	Concrete	1,139	cu. Yd	$ 155.00	$ 176,545	6,838	sq. Yd	$ -	$ -	6,838	sq. Yd	$ 41.67	$ 284,917
Toe Protection	Riprap	1,609	cu. Yd	$ 75.00	$ 120,675	603	sq. Yd	$ -	$ -	603	sq. Yd	$ 25.00	$ 15,075
Drop Structures	Concrete	21	EA	$ 3,875.00	$ 81,375	99	sq. Yd	$ -	$ -	99	sq. Yd	$ 41.67	$ 4,125
Drop Str. - LC Enhancement	Concrete	21	EA	$ 387.50	$ 8,138	10	sq. Yd	$ -	$ -	10	sq. Yd	$ 41.67	$ 413
Sedimentation Basins		3	EA	$ 5,548.00	$ 16,644	4,884	sq. Yd	$ -	$ -	4,884	sq. Yd	$ 8.33	$ 40,700
Other					$ -				$ -				$ -

Base Landscape Cost	$ 307,701	Base Maintenance Cost	$ 663,225
LC Enhancement Cost	$ 108,603	LC Enhancement Cost	$ 385,888
Total Landscape Cost	$ 416,304	Total Maintenance Cost	$ 1,049,113

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 4,270,364	$ 1,508,313	$ 5,778,677
Contingency Cost (25% of Construction Cost)	$ 1,067,591	$ 377,078	$ 1,444,669
Engineering Design Cost (5% of Construction Cost)	$ 213,518	$ 75,416	$ 288,934
Total Construction Cost	$ 5,551,473	$ 1,960,806	$ 7,512,279

Land Cost

Channel Length	3620 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	134	11.1	$100,000	$ 1,110,000
LC Enhancement Buffer	50	4.2	$100,000	$ 420,000
Channel	85	7.1	$100,000	$ 710,000
Channel LC Enhancement	30	2.5	$100,000	$ 250,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	299	24.9		$ 2,490,000

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	18.2	$100,000	$ 1,820,000
LC Enhancement Cost	acre	6.7	$100,000	$ 670,000
Total Land Cost	acre	24.9	$100,000	$ 2,490,000

Total Cost

Base Total Cost	$ 8,342,399
Total Landscape Enhancement Cost	$ 3,125,297
Total Cost Including LC Enh.	$ 11,467,696

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

Sub-area: CAP, Alternative: C
Open Channel Structure ID: C910A10

Open Channel

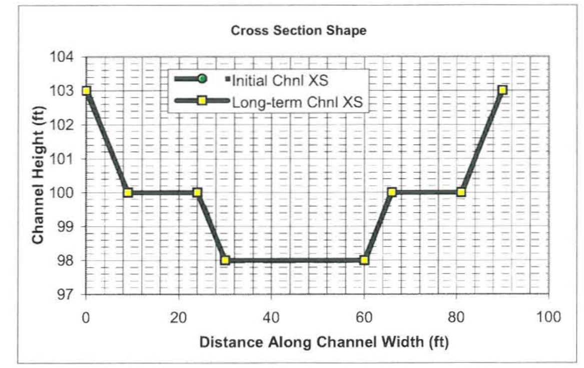
Structure ID	C910B10		HEC1 ID	90091B

Longitundal Geometry

Length	4991.8	ft
U/S Elev	1746.9	ft
D/S Elev	1667.9	ft
Initial Channel Slope	0.0158	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

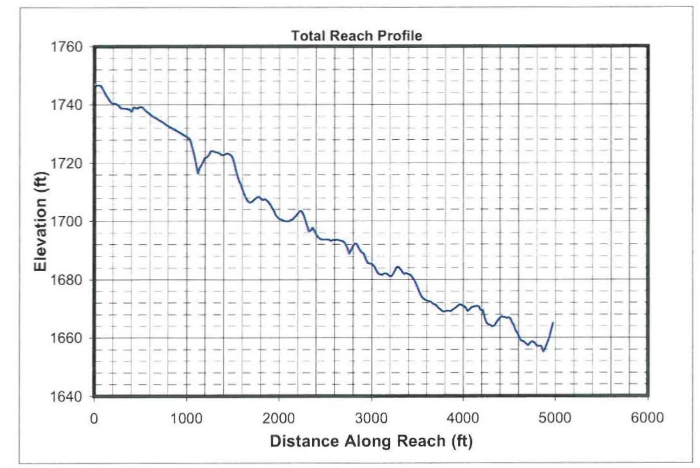
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	3	15	3	30	5	3	15	3	3

PT. ID	1	2	3	4	5	6	7	8
X	0	9	24	30	60	66	81	90
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	15	3	30	5	3	15	3	3

PT. ID	1	2	3	4	5	6	7	8
X	0	9	24	30	60	66	81	90
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	C910									TOTAL
HEC1 Peak-Flow	1703									1703
Weighting Factor	1.00									
Flow into Channel	1703									1703

Reach Sediment Inflow Characteristics

U/S Contributing ID	90091A_C910A1 0									TOTAL
HEC1 Flow Volume (ac. ft)	85.00									85
Sediment Conc. (ppm)	2326									
Sediment Volume (ac. ft)	0.07									0.07
Weighting Factor	1									
Weighted Sed. Vol. (ac. ft)	0.07									0.07

Hydrology

Drainage Area	2.02	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	1703	cfs	
Long-term Max. Chnl Capacity	2928	cfs	
Q2 Channel	170	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	90	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
170	37.5	40.0	1.1	98.0	99.2	4.3	1.2	37.1	1.1	0.22	0.72
426	74.3	91.1	1.2	98.0	100.3	4.7	2.3	73.6	1.2	0.42	0.74
1277	81.8	183.0	2.2	98.0	101.5	7.0	3.5	80.7	2.3	0.65	0.82
1703	84.7	220.6	2.6	98.0	101.9	7.7	3.9	83.5	2.6	0.73	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
170	37.5	40.0	1.1	98.0	99.2	4.3	1.2	37.1	1.1	0.22	0.72
426	74.3	91.1	1.2	98.0	100.3	4.7	2.3	73.6	1.2	0.42	0.74
1277	81.8	183.0	2.2	98.0	101.5	7.0	3.5	80.7	2.3	0.65	0.82
1703	84.7	220.6	2.6	98.0	101.9	7.7	3.9	83.5	2.6	0.73	0.84

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
	90091A_C910A1 0									
170	635									635
426	1657									1657
1277	6614									6614
1703	9586									9586

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)		
170	1.74	1.4182	1.3473	Erosive	Erosive	Erosive	0.3	Erosive	3.6	Stable	Stable
426	1.74	1.4613	1.3882	Erosive	Erosive	Erosive	0.3	Erosive	5.1	Stable	Stable
1277	1.74	1.6479	1.5655	Erosive	Erosive	Erosive	0.4	Erosive	6.9	Stable	Stable
1703	1.74	1.6951	1.6103	Erosive	Erosive	Erosive	0.4	Erosive	7.5	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)	**170**	**426**	**1277**	**1703**	**170**	**426**	**1277**	**1703**	**170**	**426**	**1277**	**1703**
Bray - Equation #1	36	58	103	120	1.5	2.0	2.9	3.2	3.2	3.7	4.3	4.5
Bray - Equation #2	47	76	136	158	1.6	2.2	3.2	3.5	2.2	2.5	3.0	3.1
Hey	11	18	33	39	4.5	6.4	9.8	10.9				
Ackers & Charlton/Lacey	31	46	73	82					1.9	2.2	2.6	2.8
Parker	90	142	246	284	1.2	1.7	2.7	3.0				
Chang	50	88	172	205	0.3	0.3	0.0	-0.1				
Kellerhals	23	37	64	74	2.1	3.1	4.8	5.3	3.4	3.7	4.2	4.3
AMAFCA/Schumm	37	74	81	84								
Moody & Odem	16	16	16	16	1.1	1.1	1.1	1.1				
BUREC	14.8	20.9	31.5	35.1	4	6	8	9	4.6	5.7	7.6	8.1
Average	36	57	95	110	2.0	2.8	4.1	4.5	3.1	3.6	4.3	4.6
Values As Designed	37	74	81	83	1.2	2.3	3.5	3.9	4.3	4.7	7.0	7.7
Difference with Design	-2	-16	15	26	0.8	0.5	0.6	0.6	-1.2	-1.1	-2.6	-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
170	943	1371	2295	10528	1281	1129	544	754	6305	931	4021	2736
426	2680	3414	5627	30982	2753	3096	1368	2069	15799	2588	10967	7395
1277	13849	11536	16969	187787	4240	15902	4001	8664	47671	8073	45441	33103
1703	21175	15727	22836	299083	4763	24886	5261	12421	63609	8691	65061	49410

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
170	2054	2986	4999	22934	2790	2459	1186	1642	13735	2028	8761	5961
426	2335	2975	4904	26997	2399	2698	1192	1803	13767	2255	9557	6444
1277	4023	3351	4929	54546	1232	4619	1162	2517	13847	2345	13199	9615
1703	4613	3426	4975	65156	1038	5421	1146	2706	13857	1893	14174	10764

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
170	943	1083	1169	871	393	462	544	754	473	128	921	704
426	2680	2727	3021	2563	879	1229	1368	2069	1211	244	2586	1871
1277	13849	9515	8325	15537	1543	4755	4001	8664	3838	227	12104	7487
1703	21175	13049	11079	24745	1775	6772	5261	12421	5153	227	17862	10865

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
170	2054	2359	2546	1898	855	1007	1186	1642	1030	279	2007	1533
426	2335	2376	2633	2234	766	1071	1192	1803	1055	212	2254	1630
1277	4023	2764	2418	4513	448	1381	1162	2517	1115	66	3516	2175
1703	4613	2843	2413	5391	387	1475	1146	2706	1123	49	3891	2367

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson n	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)
170	0.0006	0.0003	242	0.74	0.052	0.0003	31	0.036	0.0002	0.0159	0.0002	0.0003	0.0063	0.0004	0.0011	0.0030	0.0025
426	0.0005	0.0003	259	0.79	0.053	0.0002	32	0.036	0.0002	0.0159	0.0002	0.0003	0.0063	0.0002	0.0005	0.0030	0.0024
1277	0.0002	0.0002	350	1.07	0.056	0.0001	32	0.036	0.0001	0.0159	0.0001	0.0001	0.0063	0.0001	0.0002	0.0029	0.0024
1703	0.0002	0.0001	378	1.15	0.057	0.0001	33	0.036	0.0001	0.0159	0.0001	0.0001	0.0063	0.0001	0.0002	0.0029	0.0024

Drop Structures

Design Slope	0.0030	ft/ft
Total Drop Needed	63.9	ft
Height of Drop Structure	5	ft
No . of Drop Structures	13	
Distance between structs.	384	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	0.62	sq. mi
Total Sediment Yield Volume	1.17	ac ft

Sedimentation Basins

Length	384 ft	Depth	3 ft
Width	90 ft	Side slope	3 ft/ft
Total Volume per Basin		2.09	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											
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)
170	1.1	0.3	0.2	24.6	1.2	1.1	4.3	0.0030	0.2	0.0	1.0	2.1
426	1.1	0.5	0.3	24.6	2.3	1.2	4.7	0.0030	0.4	0.0	1.0	2.7
1277	1.1	1.2	0.7	24.6	3.5	2.3	7.0	0.0030	0.7	0.0	1.0	4.2
1703	1.1	1.4	0.8	24.6	3.9	2.6	7.7	0.0030	0.8	0.0	1.0	4.7

Toe Protection Needed	5.0	ft

HEC1 Results For Open Channel

Peak Flow	902	cfs
Stage at Peak Flow	99.9	ft
Flow Volume	85.0	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	1.24	ac. ft
Outflowing Sediment Volume	0.08	ac. ft
Deposited(+)/Eroded(-) Volume	1.17	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	4992	4992
Side Slope (?H:1V)	3	6
Channel Width (ft)	90	120
Channel XS Area (sq. ft)	315	390
Channel Perimeter (ft)	92	121

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	589868	780944
Excavated Area (sq. Yd)	49920	66560

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)	4992	4992
Lining Width (ft)	19	36
Lining Thickness (ft)	0.5	0.5
Lining Area (sq. Yd)	10539	19968
Lining Volume (cu. Yd)	1757	3328

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	4992	ft
Thickness	1.5	ft
Protection Depth	5	ft
Tie-in Length/Depth	3.0	ft
Total Depth	8.0	ft
Area needed	832	sq. Yd
Volume	2219	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)	4992	4992
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)	4992	4992
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	90	ft
LC Enhancement Ratio	1.1	
Structure Thickness	0.5	ft
Drop Height	5	ft
Scour Depth	14.6	ft
Structure Height	19.6	ft
Number of Structures	13	
Volume per structure	33	cu. Yd
Unit Cost	$ 155.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 5,115	
Area per structure	5	sq. Yd
Total Area	65	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	2	
Total Volume per Basin	3372	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 13,488	
Other Cost	$ -	
Total cost per basin	$ 13,488	
Area per basin	3,840	sq. Yd
Total Area	7,680	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	589,868	cu. Yd	$ 10.00	$ 5,898,680	49,920	sq. Yd	$ 9.00	$ 449,280	49,920	sq. Yd	$ 8.33	$ 416,000
Exc. Chl - LC Enhancement	Excavated	191,076	cu. Yd	$ 10.00	$ 1,910,760	16,640	sq. Yd	$ 9.00	$ 149,760	16,640	sq. Yd	$ 8.33	$ 138,667
Channel Lining	Concrete	1,757	cu. Yd	$ 155.00	$ 272,335	10,539	sq. Yd	$ -	$ -	10,539	sq. Yd	$ 41.67	$ 439,125
Channel Lining - LC Enhancement	Concrete	1,571	cu. Yd	$ 155.00	$ 243,505	9,429	sq. Yd	$ -	$ -	9,429	sq. Yd	$ 41.67	$ 392,875
Toe Protection	Riprap	2,219	cu. Yd	$ 75.00	$ 166,425	832	sq. Yd	$ -	$ -	832	sq. Yd	$ 25.00	$ 20,800
Drop Structures	Concrete	13	EA	$ 5,115.00	$ 66,495	65	sq. Yd	$ -	$ -	65	sq. Yd	$ 41.67	$ 2,708
Drop Str. - LC Enhancement	Concrete	13	EA	$ 511.50	$ 6,650	7	sq. Yd	$ -	$ -	7	sq. Yd	$ 41.67	$ 271
Sedimentation Basins		2	EA	$ 13,488.00	$ 26,976	7,680	sq. Yd	$ -	$ -	7,680	sq. Yd	$ 8.33	$ 64,000
Other					$ -				$ -				$ -

Base Landscape Cost	$ 449,280	
LC Enhancement Cost	$ 149,760	
Total Landscape Cost	$ 599,040	

Base Maintenance Cost	$ 942,633
LC Enhancement Cost	$ 531,813
Total Maintenance Cost	$ 1,474,446

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 6,430,911	$ 2,160,915	$ 8,591,826
Contingency Cost (25% of Construction Cost)	$ 1,607,728	$ 540,229	$ 2,147,956
Engineering Design Cost (5% of Construction Cost)	$ 321,546	$ 108,046	$ 429,591
Total Construction Cost	$ 8,360,184	$ 2,809,189	$ 11,169,373

Land Cost

Channel Length	4992 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	134	15.4	$100,000	$ 1,540,000
LC Enhancement Buffer	50	5.7	$100,000	$ 570,000
Channel	90	10.3	$100,000	$ 1,030,000
Channel LC Enhancement	30	3.4	$100,000	$ 340,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	304	34.8		$ 3,480,000

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	25.7	$100,000	$ 2,570,000
LC Enhancement Cost	acre	9.1	$100,000	$ 910,000
Total Land Cost	acre	34.8	$100,000	$ 3,480,000

Total Cost

Base Total Cost	$ 12,322,098
Total Landscape Enhancement Cost	$ 4,400,761
Total Cost Including LC Enh.	$ 16,722,859

JE FULLER
HYDROLOGY & GEOMORPHOLOGY, INC.

Sub-area: CAP, Alternative: C
Open Channel Structure ID: C910B10

Open Channel

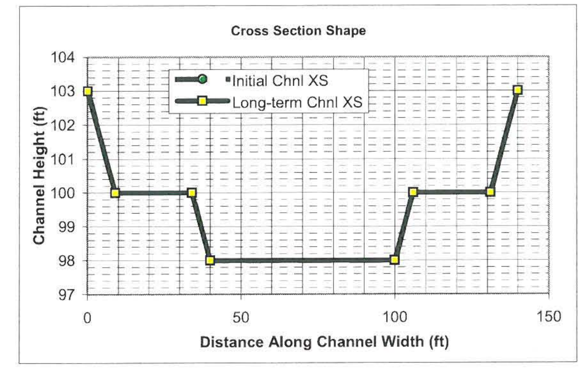
Structure ID	RR91010	HEC1 ID	910915

Longitundal Geometry

Length	3390.4	ft
U/S Elev	1668.1	ft
D/S Elev	1623.5	ft
Initial Channel Slope	0.0131	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

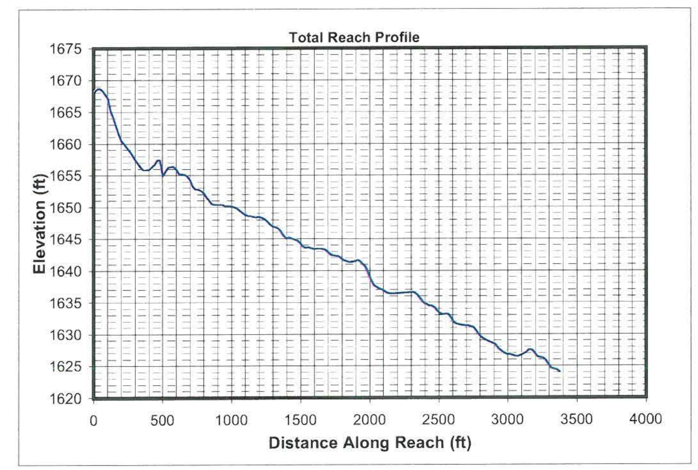
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	3	25	3	60	5	3	25	3	3

PT. ID	1	2	3	4	5	6	7	8
X	0	9	34	40	100	106	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	25	3	60	5	3	25	3	3

PT. ID	1	2	3	4	5	6	7	8
X	0	9	34	40	100	106	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	C915	S920								TOTAL
HEC1 Peak-Flow	2641	3157								5798
Weighting Factor	1.00	0.15								
Flow into Channel	2641	466								3107

Reach Sediment Inflow Characteristics

U/S Contributing ID	90091B_C910B1 0									TOTAL
HEC1 Flow Volume (ac. ft)	85.00									85
Sediment Conc. (ppm)	2367									
Sediment Volume (ac. ft)	0.08									0.08
Weighting Factor	1									
Weighted Sed. Vol. (ac. ft)	0.08									0.08

Hydrology

Drainage Area	2.506	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	3107	cfs	
Long-term Max. Chnl Capacity	5131	cfs	
Q2 Channel	311	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			

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
311	67.2	72.4	1.1	98.0	99.1	4.3	1.1	66.9	1.1	0.21	0.73
777	72.4	129.3	1.8	98.0	100.0	6.0	2.0	71.8	1.8	0.37	0.79
2330	131.9	317.8	2.4	98.0	101.5	7.3	3.5	130.8	2.4	0.65	0.83
3107	135.0	381.1	2.8	98.0	101.9	8.2	3.9	133.7	2.9	0.74	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
311	67.2	72.4	1.1	98.0	99.1	4.3	1.1	66.9	1.1	0.21	0.73
777	72.4	129.3	1.8	98.0	100.0	6.0	2.0	71.8	1.8	0.37	0.79
2330	131.9	317.8	2.4	98.0	101.5	7.3	3.5	130.8	2.4	0.65	0.83
3107	135.0	381.1	2.8	98.0	101.9	8.2	3.9	133.7	2.9	0.74	0.85

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
	90091B_C910B10									
311	704									704
777	1871									1871
2330	7487									7487
3107	10865									10865

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)		
311	1.74	1.4202	1.3492	Erosive	Erosive	Erosive	0.3	Erosive	3.5	Stable	Stable
777	1.74	1.5770	1.4981	Erosive	Erosive	Erosive	0.4	Erosive	5.0	Stable	Stable
2330	1.74	1.6692	1.5857	Erosive	Erosive	Erosive	0.4	Erosive	7.0	Stable	Stable
3107	1.74	1.7185	1.6326	Erosive	Erosive	Erosive	0.4	Erosive	7.7	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)	311	777	2330	3107	311	777	2330	3107	311	777	2330	3107
Bray - Equation #1	49	79	142	165	1.8	2.4	3.5	3.9	3.5	4.0	4.7	4.9
Bray - Equation #2	64	104	186	217	2.0	2.7	3.8	4.2	2.4	2.8	3.2	3.3
Hey	15	25	46	54	5.7	8.1	12.3	13.7				
Ackers & Charlton/Lacey	40	59	93	105					2.1	2.4	2.9	3.1
Parker	121	191	332	383	1.5	2.2	3.5	3.9				
Chang	72	127	248	296	0.3	0.2	-0.2	-0.4				
Kellerhals	32	50	87	100	2.7	3.9	6.0	6.8	3.6	4.0	4.4	4.6
AMAFCA/Schumm	67	72	131	134								
Moody & Odem	17	17	17	17	1.1	1.1	1.1	1.1				
BUREC	18.6	26.2	39.5	44.0	5	7	11	12	5.3	6.7	8.8	9.4
Average	50	75	132	152	2.5	3.4	5.1	5.6	3.4	4.0	4.8	5.1
Values As Designed	67	72	131	134	1.1	2.0	3.5	3.9	4.3	6.0	7.3	8.2
Difference with Design	-17	3	1	18	1.4	1.5	1.6	1.7	-0.9	-2.0	-2.5	-3.1

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
311	1748	2467	3915	14654	2068	1849	1001	1393	8657	1429	6408	4144
777	6903	6804	9349	66153	2991	6330	2485	4713	21823	4524	21630	13973
2330	27224	21040	28878	281314	6440	25345	7318	16489	65630	9009	75954	51331
3107	41918	28709	38977	451751	7183	39935	9611	23685	87584	9621	109339	77119

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
311	2088	2946	4675	17498	2469	2208	1196	1663	10337	1706	7652	4949
777	3297	3250	4465	31597	1428	3023	1187	2251	10424	2161	10331	6674
2330	4334	3350	4598	44788	1025	4035	1165	2625	10449	1434	12093	8172
3107	5005	3428	4654	53943	858	4769	1148	2828	10458	1149	13056	9209

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
311	1748	2000	2147	1606	710	852	1001	1393	864	231	1705	1296
777	6903	5676	5186	7250	1159	2637	2485	4713	2301	214	6307	4075
2330	27224	17769	15242	30829	2625	9010	7318	16489	7027	362	23354	14295
3107	41918	24375	20416	49508	2993	12885	9611	23685	9429	358	34574	20886

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
311	2088	2389	2564	1918	848	1017	1196	1663	1032	276	2036	1548
777	3297	2711	2477	3463	554	1259	1187	2251	1099	102	3012	1947
2330	4334	2829	2427	4908	418	1434	1165	2625	1119	58	3718	2276
3107	5005	2911	2438	5912	357	1539	1148	2828	1126	43	4128	2494

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)
311	0.0005	0.0003	221	0.67	0.052	0.0003	31	0.036	0.0002	0.0159	0.0002	0.0003	0.0051	0.0003	0.0010	0.0030	0.0022
777	0.0003	0.0002	285	0.87	0.054	0.0002	32	0.036	0.0001	0.0159	0.0001	0.0002	0.0051	0.0002	0.0005	0.0030	0.0021
2330	0.0002	0.0001	331	1.01	0.055	0.0001	32	0.036	0.0001	0.0159	0.0001	0.0001	0.0051	0.0001	0.0002	0.0030	0.0021
3107	0.0002	0.0001	358	1.09	0.056	0.0001	33	0.036	0.0001	0.0159	0.0001	0.0001	0.0051	0.0001	0.0002	0.0030	0.0021

Drop Structures

Design Slope	0.0030	ft/ft
Total Drop Needed	34.2	ft
Height of Drop Structure	3	ft
No . of Drop Structures	12	
Distance between structs.	283	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	0.49	sq. mi
Total Sediment Yield Volume	0.92	ac ft

Sedimentation Basins

Length	283 ft	Depth	3 ft
Width	140 ft	Side slope	3 ft/ft
Total Volume per Basin		2.47	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)
311	1.1	0.2	0.3	24.6	1.1	1.1	4.3	0.0030	0.2	0.0	1.0	2.1
777	1.1	0.6	0.5	24.6	2.0	1.8	6.0	0.0030	0.4	0.0	1.0	2.9
2330	1.1	1.2	0.7	24.6	3.5	2.4	7.3	0.0030	0.7	0.0	1.0	4.3
3107	1.1	1.5	0.9	24.6	3.9	2.9	8.2	0.0030	0.8	0.0	1.0	4.9

Toe Protection Needed	5.0	ft

HEC1 Results For Open Channel

Peak Flow	1634	cfs
Stage at Peak Flow	100.0	ft
Flow Volume	140.0	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	1.00	ac. ft
Outflowing Sediment Volume	0.13	ac. ft
Deposited(+)/Eroded(-) Volume	0.87	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	3390	3390
Side Slope (?H:1V)	3	6
Channel Width (ft)	140	170
Channel XS Area (sq. ft)	525	600
Channel Perimeter (ft)	142	171

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	366839	440740
Excavated Area (sq. Yd)	52733	64033

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)	3390	3390
Lining Width (ft)	19	36
Lining Thickness (ft)	0.5	0.5
Lining Area (sq. Yd)	7157	13560
Lining Volume (cu. Yd)	1193	2260

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	3390	ft
Thickness	1.5	ft
Protection Depth	5	ft
Tie-in Length/Depth	3.0	ft
Total Depth	8.0	ft
Area needed	565	sq. Yd
Volume	1507	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)	3390	3390
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)	3390	3390
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	14.2	ft
Structure Height	17.2	ft
Number of Structures	12	
Volume per structure	45	cu. Yd
Unit Cost	$ 155.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 6,975	
Area per structure	8	sq. Yd
Total Area	93	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	2	
Total Volume per Basin	3985	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 15,940	
Other Cost	$ -	
Total cost per basin	$ 15,940	
Area per basin	4,395	sq. Yd
Total Area	8,790	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	366,839	cu. Yd	$ 10.00	$ 3,668,390	52,733	sq. Yd	$ 9.00	$ 474,597	52,733	sq. Yd	$ 8.33	$ 439,442
Exc. Chl - LC Enhancement	Excavated	73,901	cu. Yd	$ 10.00	$ 739,010	11,300	sq. Yd	$ 9.00	$ 101,700	11,300	sq. Yd	$ 8.33	$ 94,167
Channel Lining	Concrete	1,193	cu. Yd	$ 155.00	$ 184,915	7,157	sq. Yd	$ -	$ -	7,157	sq. Yd	$ 41.67	$ 298,208
Channel Lining - LC Enhancement	Concrete	1,067	cu. Yd	$ 155.00	$ 165,385	6,403	sq. Yd	$ -	$ -	6,403	sq. Yd	$ 41.67	$ 266,792
Toe Protection	Riprap	1,507	cu. Yd	$ 75.00	$ 113,025	565	sq. Yd	$ -	$ -	565	sq. Yd	$ 25.00	$ 14,125
Drop Structures	Concrete	12	EA	$ 6,975.00	$ 83,700	93	sq. Yd	$ -	$ -	93	sq. Yd	$ 41.67	$ 3,875
Drop Str. - LC Enhancement	Concrete	12	EA	$ 697.50	$ 8,370	9	sq. Yd	$ -	$ -	9	sq. Yd	$ 41.67	$ 388
Sedimentation Basins		2	EA	$ 15,940.00	$ 31,880	8,790	sq. Yd	$ -	$ -	8,790	sq. Yd	$ 8.33	$ 73,250
Other					$ -				$ -				$ -

Base Landscape Cost	$ 474,597	Base Maintenance Cost	$ 828,900
LC Enhancement Cost	$ 101,700	LC Enhancement Cost	$ 361,346
Total Landscape Cost	$ 576,297	Total Maintenance Cost	$ 1,190,246

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 4,081,910	$ 912,765	$ 4,994,675
Contingency Cost (25% of Construction Cost)	$ 1,020,478	$ 228,191	$ 1,248,669
Engineering Design Cost (5% of Construction Cost)	$ 204,096	$ 45,638	$ 249,734
Total Construction Cost	$ 5,306,483	$ 1,186,595	$ 6,493,078

Land Cost

Channel Length	3390 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	134	10.4	$100,000	$ 1,040,000
LC Enhancement Buffer	50	3.9	$100,000	$ 390,000
Channel	140	10.9	$100,000	$ 1,090,000
Channel LC Enhancement	30	2.3	$100,000	$ 230,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	354	27.5		$ 2,750,000

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	21.3	$100,000	$ 2,130,000
LC Enhancement Cost	acre	6.2	$100,000	$ 620,000
Total Land Cost	acre	27.5	$100,000	$ 2,750,000

Total Cost

Base Total Cost	$ 8,739,980
Total Landscape Enhancement Cost	$ 2,269,640
Total Cost Including LC Enh.	$ 11,009,620

Open Channel

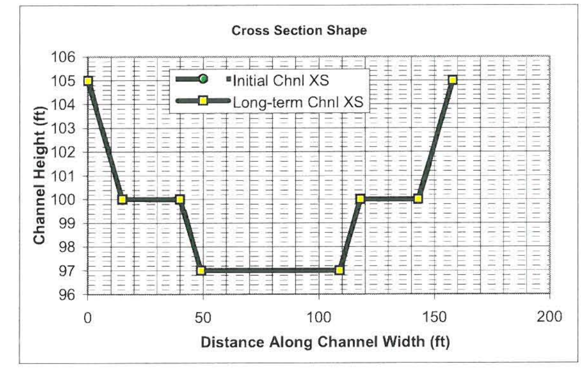
Structure ID	C92010	HEC1 ID	915920

Longitundal Geometry

Length	8861.8	ft
U/S Elev	1623.5	ft
D/S Elev	1532.6	ft
Initial Channel Slope	0.0103	ft/ft
Long-term Channel Slope	0.0025	ft/ft

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

NSTPS	3



Initial Channel XS Geometry

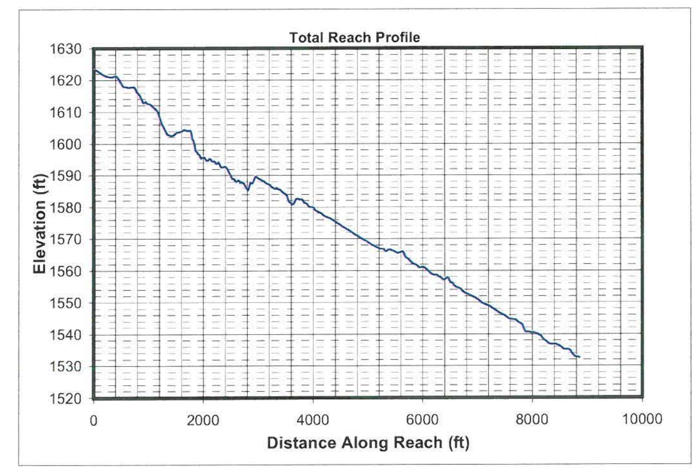
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	5	25	3	60	8	3	25	5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	15	40	49	109	118	143	158
Y	105	100	100	97	97	100	100	105

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	5	25	3	60	8	3	25	5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	15	40	49	109	118	143	158
Y	105	100	100	97	97	100	100	105



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	C920									TOTAL
HEC1 Peak-Flow	5660									5660
Weighting Factor	1.00									
Flow into Channel	5660									5660

Reach Sediment Inflow Characteristics

U/S Contributing ID	910915_RR9101 0									TOTAL
HEC1 Flow Volume (ac. ft)	140.00									140
Sediment Conc. (ppm)	2494									
Sediment Volume (ac. ft)	0.13									0.13
Weighting Factor	1									
Weighted Sed. Vol. (ac. ft)	0.13									0.13

Hydrology

Drainage Area	6.43	sq. miles	(Used in Moody & Odem Regime Eqs.)

Design Peak Flow	5660	cfs	
Long-term Max. Chnl Capacity	11012	cfs	
Q2 Channel	566	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	158	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
566	70.9	112.0	1.6	97.0	98.7	5.1	1.7	70.3	1.6	0.27	0.71
1415	131.0	248.1	1.9	97.0	100.3	5.7	3.3	129.9	1.9	0.52	0.73
4245	142.6	496.2	3.5	97.0	102.2	8.6	5.2	140.9	3.5	0.80	0.80
5660	147.0	597.0	4.1	97.0	102.9	9.5	5.9	145.1	4.1	0.91	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
566	70.9	112.0	1.6	97.0	98.7	5.1	1.7	70.3	1.6	0.27	0.71
1415	131.0	248.1	1.9	97.0	100.3	5.7	3.3	129.9	1.9	0.52	0.73
4245	142.6	496.2	3.5	97.0	102.2	8.6	5.2	140.9	3.5	0.80	0.80
5660	147.0	597.0	4.1	97.0	102.9	9.5	5.9	145.1	4.1	0.91	0.82

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using HEC1 ID)									TOTAL
	910915_RR91010									
566	1296									1296
1415	4075									4075
4245	14295									14295
5660	20886									20886

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)		
566	1.74	1.5390	1.4620	Erosive	Erosive	Erosive	0.4	Erosive	4.2	Stable	Stable
1415	1.74	1.5950	1.5152	Erosive	Erosive	Erosive	0.4	Erosive	6.0	Stable	Stable
4245	1.74	1.7830	1.6939	Erosive	Erosive	Erosive	0.5	Erosive	8.3	Stable	Stable
5660	1.74	1.8432	1.7510	Erosive	Erosive	Erosive	0.5	Erosive	9.1	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)	**566**	**1415**	**4245**	**5660**	**566**	**1415**	**4245**	**5660**	**566**	**1415**	**4245**	**5660**
Bray - Equation #1	67	109	194	226	2.2	3.0	4.3	4.7	3.8	4.4	5.1	5.3
Bray - Equation #2	88	143	256	297	2.4	3.3	4.7	5.2	2.6	3.0	3.5	3.6
Hey	21	35	64	75	7.2	10.2	15.4	17.2				
Ackers & Charlton/Lacey	52	76	120	136					2.3	2.7	3.2	3.4
Parker	163	258	448	517	1.9	2.8	4.4	5.0				
Chang	98	172	337	401	0.3	0.2	-0.4	-0.6				
Kellerhals	43	68	117	135	3.4	5.0	7.7	8.6	3.8	4.2	4.7	4.8
AMAFCA/Schumm	70	130	141	145								
Moody & Odem	25	25	25	25	1.3	1.3	1.3	1.3				
BUREC	24.0	33.9	51.2	57.0	6	9	14	15	5.8	7.2	9.5	10.2
Average	65	105	175	201	3.1	4.3	6.4	7.1	3.7	4.3	5.2	5.5
Values As Designed	70	130	141	145	1.7	3.3	5.2	5.9	5.1	5.7	8.6	9.5
Difference with Design	-5	-25	34	56	1.4	1.0	1.2	1.2	-1.4	-1.4	-3.3	-4.0

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
566	3328	3960	5477	26588	2373	2969	1476	2556	11028	2447	11146	6668
1415	9811	9956	13497	82130	4877	8300	3678	7104	27653	5312	31081	18491
4245	51066	33214	42276	501889	7452	42384	10552	28892	83413	6922	128666	85157
5660	78259	45181	58432	801512	8348	66316	13830	41236	111295	7423	184387	128747

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
566	2181	2595	3590	17428	1555	1946	967	1675	7229	1604	7306	4371
1415	2572	2610	3539	21534	1279	2176	964	1863	7250	1393	8149	4848
4245	4463	2903	3695	43864	651	3704	922	2525	7290	605	11245	7442
5660	5130	2961	3830	52537	547	4347	907	2703	7295	487	12086	8439

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
566	3328	3279	3225	3179	891	1365	1476	2556	1233	182	3173	2171
1415	9811	8327	7789	9821	1906	3685	3678	7104	3149	317	9131	5884
4245	51066	28417	22606	60015	3217	14373	10552	28892	9804	434	41923	24663
5660	78259	38821	30810	95844	3669	20548	13830	41236	13133	591	61654	36218

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
566	2181	2149	2114	2084	584	895	967	1675	809	119	2080	1423
1415	2572	2183	2042	2575	500	966	964	1863	826	83	2394	1543
4245	4463	2484	1976	5245	281	1256	922	2525	857	38	3664	2156
5660	5130	2545	2020	6282	241	1347	907	2703	861	39	4041	2374

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)
566	0.0004	0.0002	238	0.72	0.052	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0002	0.0042	0.0002	0.0007	0.0025	0.0018
1415	0.0003	0.0002	260	0.79	0.053	0.0002	32	0.036	0.0001	0.0159	0.0001	0.0002	0.0042	0.0001	0.0003	0.0025	0.0018
4245	0.0001	0.0001	352	1.07	0.056	0.0001	32	0.036	0.0001	0.0159	0.0001	0.0001	0.0042	0.0001	0.0001	0.0025	0.0017
5660	0.0001	0.0001	381	1.16	0.057	0.0001	33	0.036	0.0000	0.0159	0.0001	0.0001	0.0042	0.0001	0.0001	0.0025	0.0017

Drop Structures

Design Slope	0.0025	ft/ft
Total Drop Needed	69.1	ft
Height of Drop Structure	3	ft
No . of Drop Structures	24	
Distance between structs.	369	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	2.81	sq. mi
Total Sediment Yield Volume	5.33	ac ft

Sedimentation Basins

Length	369 ft	Depth	3 ft
Width	158 ft	Side slope	3 ft/ft
Total Volume per Basin		3.70	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)
566	1.1	0.4	0.3	24.6	1.7	1.6	5.1	0.0025	0.3	0.0	1.0	2.5
1415	1.1	0.9	0.4	24.6	3.3	1.9	5.7	0.0025	0.7	0.0	1.0	3.7
4245	1.1	2.0	1.0	24.6	5.2	3.5	8.6	0.0025	1.1	0.0	1.0	6.0
5660	1.1	2.5	1.2	24.6	5.9	4.1	9.5	0.0025	1.3	0.0	1.0	7.0

Toe Protection Needed	7.0	ft

HEC1 Results For Open Channel

Peak Flow	2597	cfs
Stage at Peak Flow	99.8	ft
Flow Volume	217.0	ac. ft

Freeboard

Max. Flow Depth	5.9	ft
Channel Depth as designed	8.0	ft
Available Freeboard	2.1	ft
Required Freeboard	1.8	ft

Sediment Volume

Inflowing Sediment Volume	5.46	ac. ft
Outflowing Sediment Volume	0.19	ac. ft
Deposited(+)/Eroded(-) Volume	5.27	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	8862	8862
Side Slope (?H:1V)	3	6
Channel Width (ft)	158	206
Channel XS Area (sq. ft)	922	1114
Channel Perimeter (ft)	161	208

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	2094965	2702493
Excavated Area (sq. Yd)	155577	202841

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)	8862	8862
Lining Width (ft)	32	61
Lining Thickness (ft)	0.5	0.5
Lining Area (sq. Yd)	31509	60065
Lining Volume (cu. Yd)	5252	10011

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	8862	ft
Thickness	1.5	ft
Protection Depth	7	ft
Tie-in Length/Depth	3.0	ft
Total Depth	10.0	ft
Area needed	1477	sq. Yd
Volume	4923	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)	8862	8862
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)	8862	8862
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	158	ft
LC Enhancement Ratio	1.1	
Structure Thickness	0.5	ft
Drop Height	3	ft
Scour Depth	19.0	ft
Structure Height	22.0	ft
Number of Structures	24	
Volume per structure	65	cu. Yd
Unit Cost	$ 155.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 10,075	
Area per structure	9	sq. Yd
Total Area	211	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	5	
Total Volume per Basin	5969	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 23,876	
Other Cost	$ -	
Total cost per basin	$ 23,876	
Area per basin	6,482	sq. Yd
Total Area	32,410	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	2,094,965	cu. Yd	$ 10.00	$ 20,949,650	155,577	sq. Yd	$ 9.00	$ 1,400,193	155,577	sq. Yd	$ 8.33	$ 1,296,475
Exc. Chl - LC Enhancement	Excavated	607,528	cu. Yd	$ 10.00	$ 6,075,280	47,264	sq. Yd	$ 9.00	$ 425,376	47,264	sq. Yd	$ 8.33	$ 393,867
Channel Lining	Concrete	5,252	cu. Yd	$ 155.00	$ 814,060	31,509	sq. Yd	$ -	$ -	31,509	sq. Yd	$ 41.67	$ 1,312,875
Channel Lining - LC Enhancement	Concrete	4,759	cu. Yd	$ 155.00	$ 737,645	28,556	sq. Yd	$ -	$ -	28,556	sq. Yd	$ 41.67	$ 1,189,833
Toe Protection	Riprap	4,923	cu. Yd	$ 75.00	$ 369,225	1,477	sq. Yd	$ -	$ -	1,477	sq. Yd	$ 25.00	$ 36,925
Drop Structures	Concrete	24	EA	$ 10,075.00	$ 241,800	211	sq. Yd	$ -	$ -	211	sq. Yd	$ 41.67	$ 8,792
Drop Str. - LC Enhancement	Concrete	24	EA	$ 1,007.50	$ 24,180	21	sq. Yd	$ -	$ -	21	sq. Yd	$ 41.67	$ 879
Sedimentation Basins		5	EA	$ 23,876.00	$ 119,380	32,410	sq. Yd	$ -	$ -	32,410	sq. Yd	$ 8.33	$ 270,083
Other					$ -				$ -				$ -

Base Landscape Cost	$ 1,400,193	
LC Enhancement Cost	$ 425,376	
Total Landscape Cost	$ 1,825,569	

Base Maintenance Cost	$ 2,925,150
LC Enhancement Cost	$ 1,584,579
Total Maintenance Cost	$ 4,509,729

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 22,494,115	$ 6,837,105	$ 29,331,220
Contingency Cost (25% of Construction Cost)	$ 5,623,529	$ 1,709,276	$ 7,332,805
Engineering Design Cost (5% of Construction Cost)	$ 1,124,706	$ 341,855	$ 1,466,561
Total Construction Cost	$ 29,242,350	$ 8,888,237	$ 38,130,586

Land Cost

Channel Length	8862 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	134	27.3	$100,000	$ 2,730,000
LC Enhancement Buffer	50	10.2	$100,000	$ 1,020,000
Channel	158	32.1	$100,000	$ 3,210,000
Channel LC Enhancement	48	9.8	$100,000	$ 980,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	390	79.4		$ 7,940,000

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	59.4	$100,000	$ 5,940,000
LC Enhancement Cost	acre	20	$100,000	$ 2,000,000
Total Land Cost	acre	79.4	$100,000	$ 7,940,000

Total Cost

Base Total Cost	$ 39,507,693
Total Landscape Enhancement Cost	$ 12,898,192
Total Cost Including LC Enh.	$ 52,405,884

JE FULLER
HYDROLOGY & GEOMORPHOLOGY, INC.

Flood Control District of Maricopa County

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C.L. Williams Consulting, Inc.

LOGAN SIMPSON DESIGN INC.

EDAW

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