

ADOBE
DAM/DESERT
HILLS

AREA DRAINAGE MASTER PLAN

Part 9

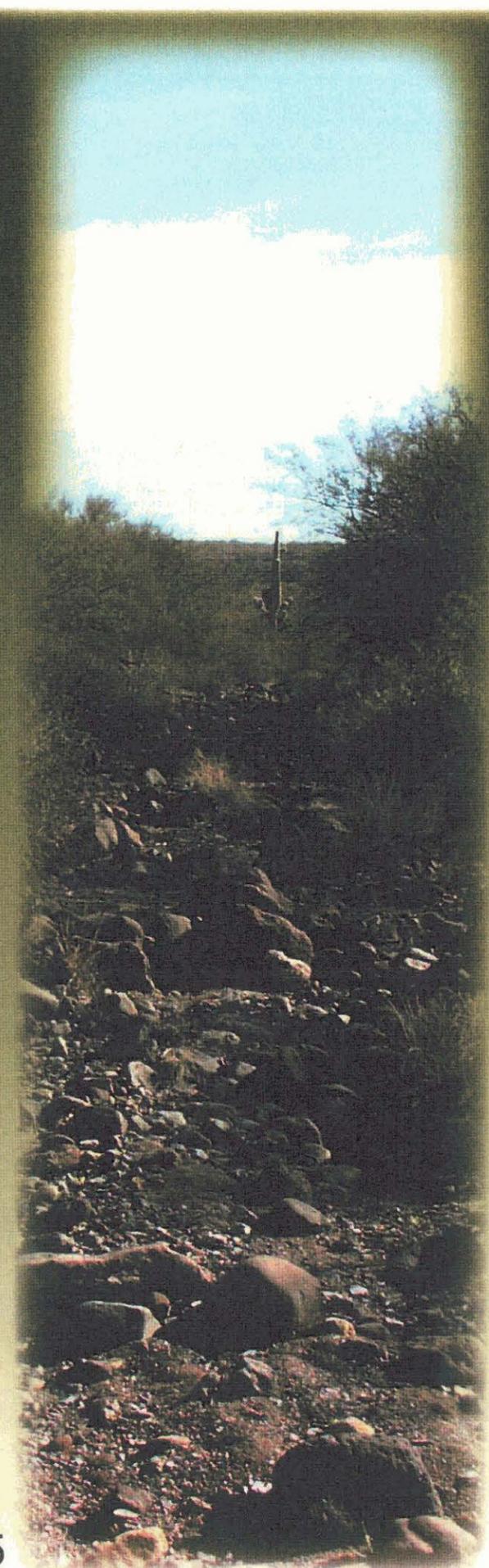
Recommended Alternative Report

Volume 1



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December 2005



ADOBE DAM/DESERT HILLS AREA DRAINAGE MASTER PLAN
RECOMMENDED ALTERNATIVE REPORT
PART 9, VOLUME 1



December 2005



RECOMMENDED ALTERNATIVE REPORT
PART 9, VOLUME 1

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ENCLOSED DATA CD INCLUDES:

- Digital data including a pdf format copy of the report is located in Part 9, Volume 2

SECTION 1: INTRODUCTION

The purposes of the Recommended Alternative Report for the Adobe Dam/Desert Hills Area Drainage Master Plan (ADMP) are to document the analysis of structural and nonstructural components of the Recommended Alternative (Task 4.6) and to present the strategy developed for implementation of the Recommended Alternative as addressed by the Implementation Plan (Task 4.11). Several work tasks comprise the feasibility level analysis of the Recommended Alternative. These include the identification and evaluation of the following items relative to the Recommended Alternative components: utilities, rights-of-way, advantages and disadvantages, environmental impacts, hydrologic effects, area benefited, and regulatory recommendations. The Implementation Plan identifies key opportunities and constraints for implementation of the Recommended Alternative. The Implementation Plan addresses timing, funding, proposed public projects, summary of public feedback, permitting, and regulatory issues.

The Recommended Alternative Report is presented in two volumes. Part 9, Volume 1 contains general project information and a brief summary of the project scope with emphasis on the Recommended Alternative analysis work tasks and deliverables. Part 9, Volume 1 also includes the Implementation Plan developed to provide a strategy for implementation of the Recommended Alternative. Part 9, Volume 2 contains the technical documentation for the Recommended Alternatives analysis and conceptual design. Part 10, Volume 1 contains the Executive Summary (Task 4.6.11) of the ADMP Recommended Alternative and is provided under separate cover.

The ADMP was performed by JE Fuller/Hydrology & Geomorphology, Inc. (JEF), with subconsultants C.L. Williams Consulting, Inc. (CLW), Logan Simpson Design (LSD), Stantec Consulting, Inc. (Stantec), and RBF Consulting (RBF), on behalf of the Flood Control District of Maricopa County (District) under Contract No. FCD2002C001.

SECTION 2: PROJECT AREA DESCRIPTION

The project area for the ADMP is shown in Figure 2.1. The ADMP study area is generally bounded by the Tonto National Forest to the north, Adobe Dam to the south, approximately the 40th Street alignment (north of Carefree Highway) and the 7th Street alignment (south of Carefree Highway) to the east, and the watershed boundary between Skunk Creek and New River to the west. The total project area is approximately 100 square miles. The ADMP study area consists of the Skunk Creek watershed upstream of Adobe Dam plus the Desert Hills Wash and Apache Wash drainage areas, both tributaries to Cave Creek, upstream of the City of Phoenix jurisdictional boundary. The Cave Creek tributaries were included because of their geographic connectivity to the Desert Hills community and the Skunk Creek watershed area.

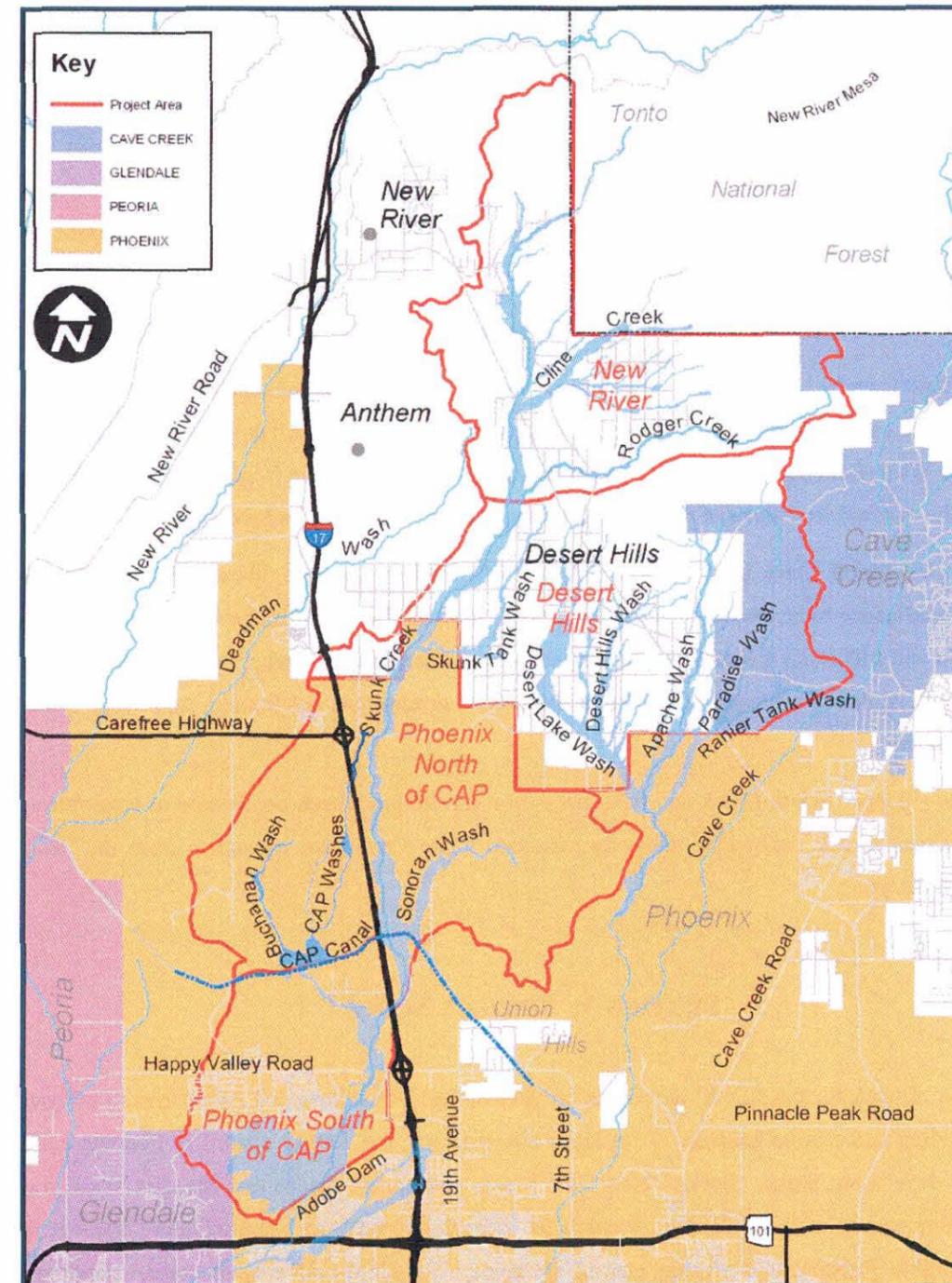


Figure 2.1 Adobe Dam/Desert Hills ADMP Study Area



The study area was further subdivided into four subareas initially: Phoenix South of the Central Arizona Project aqueduct (CAP), Phoenix North of CAP, Desert Hills, and New River (see Figure 2.1). The Phoenix South of the CAP and Phoenix North of the CAP subareas were subsequently combined during Phase II into one subarea named Phoenix/CAP Canal. These subareas were identified based on their jurisdictional boundaries and similar watershed characteristics for the purposes of public and stakeholder coordination and technical analyses, respectively. The study area includes four jurisdictions: unincorporated Maricopa County, City of Phoenix, Town of Cave Creek, and City of Glendale.

The major watercourses within each of the three subareas of the ADMP project area are described below:

Phoenix/CAP Canal – Lower Skunk Creek from Adobe Dam to the CAP aqueduct and lower Buchanan Wash from the Skunk Creek confluence to the CAP aqueduct, Skunk Creek from the CAP aqueduct to the Joy Ranch Road crossing, Sonoran Wash from the CAP aqueduct to headwaters, upper Buchanan Wash from the CAP aqueduct to headwaters, and the east and west forks of the CAP Wash from the CAP aqueduct to headwaters;

Desert Hills – Skunk Creek from Joy Ranch Road to the Rodger Creek confluence, Skunk Tank Wash from the Skunk Creek confluence to headwaters, Desert Lake Wash from the Desert Hills Wash confluence to headwaters, Desert Hills Wash and tributaries from the 16th Street alignment to headwaters, upper Apache Wash from Carefree Highway to headwaters, Paradise Wash from Carefree Highway to headwaters, and Ranieri Tank Wash from Carefree Highway to headwaters;

New River – Upper Skunk Creek and tributaries from the Rodger Creek confluence to headwaters, Rodger Creek from the Skunk Creek confluence to headwaters, and Cline Creek and tributaries from the Skunk Creek confluence to headwaters.

SECTION 3: PROJECT SCOPE

The scope of work for the ADMP is focused on developing a Recommended Alternative to mitigate known and potential flooding and erosion hazards. To achieve this outcome, the ADMP quantifies flooding and drainage conditions in the developing Skunk Creek, Desert Hills Wash, and upper Apache and Paradise Wash watersheds; characterizes erosion hazards within delineated floodplains; identifies current and potential future drainage problems; and generates feasible flooding and erosion control solutions. Flooding and erosion control solutions include structural, nonstructural, and no action measures or a combination of these.

The project includes hydrologic, hydraulic, sedimentation and geomorphic evaluations; identification of drainage problems; development of structural and nonstructural alternative solutions; environmental and visual resources overviews, including landscape aesthetics considerations; preparation of concept design plans documenting the structural alternative measures; public and stakeholder coordination; and formulation of an implementation plan for the Recommended Alternative.

3.1 Project Objectives

Arizona Revised Statutes Title 48, Chapter 21 requires the Board of Directors to identify flood control problems and prepare plans which, when implemented, will eliminate or minimize flooding problems. Successful implementation of the recently completed Skunk Creek Watercourse Master Plan (WCMP) and the Cave Creek/Apache Wash WCMP is largely dependent upon prudent and ongoing management of the watersheds that supply runoff to the WCMP corridors. The ADMP project incorporates existing drainage facilities and current floodplain management and drainage policies into the planning process, and develops regional solutions for the entire Adobe Dam/Desert Hills watershed. The ADMP links management of the watershed to implementation of the WCMPs by making recommendations that support the corridor management tools adopted for the Skunk Creek WCMP and Cave Creek/Apache Wash WCMP corridors.

The major objectives of the ADMP include the following:

- Quantify selected drainage, flooding, and erosion hazards within the project area.
- Alleviate potential flood and erosion damage within the watershed by mitigating the expected increase in runoff due to development and preserving the ability of the primary wash corridors to convey stormwater.
- Couple watershed management with recently adopted Watercourse Master Plan corridor management tools developed for the Skunk Creek and Cave Creek/Apache Wash corridors.
- Develop a plan that area floodplain managers, municipalities, and developers will use as a basis for drainage and watershed regulation, improvements, and design.
- Identify cost-effective, sustainable flood and erosion control solutions for the project area that may be implemented together or individually, based on scheduling, funding, and cost sharing.



Adobe Dam/ Desert Hills ADMP
Alternatives Development Process Description

3.2 Project Approach

The approach used for the development of alternatives for the Adobe Dam/Desert Hills ADMP is presented graphically in Figure 3.1. The work plan consists of four major components as follows: **Problem Identification**, **Measures (Solutions)**, **Preliminary Alternatives**, and **Recommended Alternative**. A brief summary of the specific work tasks comprising these components follows.

ADOBE DAM/DESERT HILLS ADMP ALTERNATIVES DEVELOPMENT PROCESS

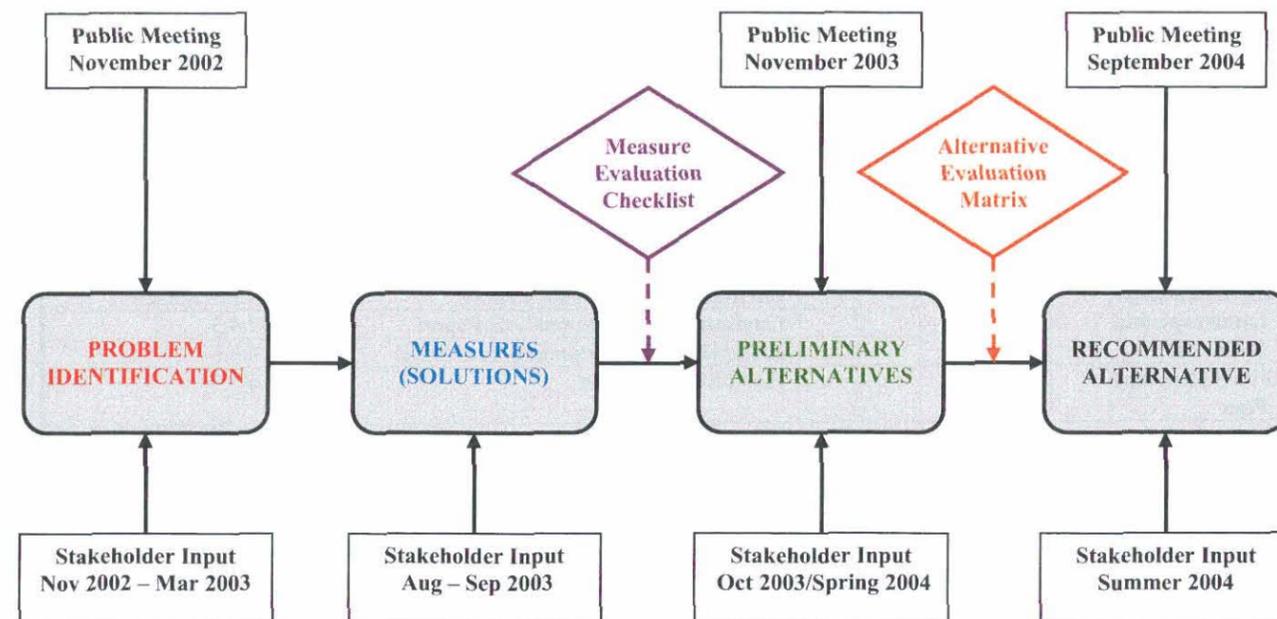


Figure 3.1 Adobe Dam/Desert Hills ADMP Alternatives Development Process Flowchart

Problem ID => Measures (Solutions) => Preliminary Alternatives => Recommended Alternative

Problem Identification

1. Data Collection
2. Complete hydrologic, hydraulic, sedimentation, and geomorphic evaluations. Characterize existing and future conditions.
3. Identify Problem Sites - Categorize by geographic region.
4. Stakeholder Meetings – Inform stakeholders about the ADMP. Solicit input regarding flooding, drainage and erosion problems.
5. Public Meeting – Inform public about the ADMP. Solicit input regarding flooding, drainage and erosion problems.

Measures (Solutions)

6. Brainstorm Measures by Site – Create menu of measures. Describe strengths, weaknesses, opportunities, constraints for each measure.
7. Develop Measure Evaluation Checklist – Qualitative sort and selection of candidate measures at each site.
8. Evaluate Measures Using Checklist – Refine menu of measures.
9. Stakeholder Meetings – Input on acceptability/completeness of menu of measures and measures evaluation.

Preliminary Alternatives

10. Alternative Formulation – Combine measures into regional watershed-wide alternatives.
11. Develop Phase I Alternative Evaluation Criteria Matrix – Quantitative sort and selection of candidate alternatives.
12. Evaluate Alternatives Using Criteria Matrix – Decision aid to select preliminary alternatives.
13. Stakeholder Meetings – Input on acceptability/completeness of preliminary alternatives and alternatives evaluation.
14. Public Meeting – Input on acceptability/completeness of preliminary alternatives and alternatives evaluation. Present floodplain delineation studies.
15. Select Preliminary Alternatives for advancement to Phase II evaluation.

Recommended Alternative

16. Phase II Evaluation of Preliminary Alternatives– Determine engineering feasibility and approximate costs. Prepare conceptual design. Consider implementation methods.
17. Develop Phase II Alternative Evaluation Criteria Matrix – Decision aid to select recommended alternatives.
18. Stakeholder Meetings – Input on acceptability/completeness of recommended alternatives and alternatives evaluation.
19. Public Meeting – Input on acceptability/completeness of recommended alternatives and alternatives evaluation.
20. Select Recommended Alternative.
21. Perform Recommended Alternative Analysis.
22. Prepare Recommended Alternative Implementation Plan.



3.3 Project Phasing

The ADMP project was completed in two Phases described as follows:

Phase I consists largely of data collection, existing conditions analyses, formulation of flood protection alternatives, and preliminary analyses of those alternatives. During Phase I, the project team identified drainage problems by evaluating the impacts in the watershed due to development, reviewed the existing and future conditions hydrologic models, revising as necessary, performed hydraulic analyses, evaluated existing floodplain delineations and delineated additional floodplains, conducted sedimentation and geomorphic evaluations, conducted survey work, produced interim development guidelines, and developed preliminary feasible alternatives to be recommended for consideration in Phase II of the project.

Phase II was authorized by the District on June 2, 2003 after feasible, implementable alternatives were identified as a result of the Phase I effort. During Phase II, the project team performed environmental and visual resources assessments, conducted detailed analysis of the proposed alternatives (structural and nonstructural), and formulated and refined the Recommended Alternative. Development guidelines and erosion hazard non-encroachment areas were refined and procedures for implementation of structural and nonstructural plan features were evaluated and recommended.

Site visits, project team meetings, and public and stakeholder information, education, and coordination were integral to both Phases I and II of the ADMP project.

3.4 Project Deliverables

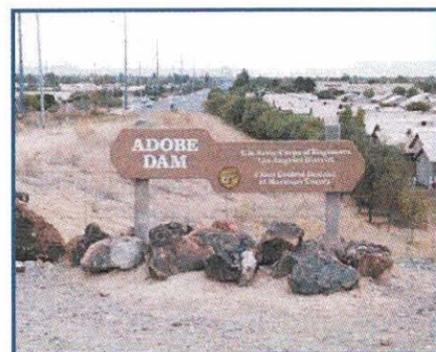


Figure 3.2 Looking south along 35th Avenue from Adobe Dam crest (10-15-02)

Table 3.1 lists the ADMP project deliverables. Note that the deliverables are organized by Part, Volume, and Section as appropriate to the associated work task in the project scope of work. Figure 3.3 presents each of the deliverables listed in Table 3.1 and graphically categorizes the reports by project Phase and Part.

Table 3.1 Adobe Dam/Desert Hills ADMP Deliverables Outline

Part	Volume (Binder)	Section (Tab)	Title	SOW Task Number
1 Data Collection	1	1	Data Collection Report	2.1.7, 2.1.8, 4.1
		2	Stakeholder Involvement Plan	2.8.1, 4.8
		3	Public Involvement Plan	2.9.1, 4.9
2 Survey		4	Project Survey Report	2.3.4
3 Hydrology	1		Desert Hills Area Hydrology TDN	2.5.4, 2.5.9, 2.6.5
	2		Desert Hills Area Hydrology TDN (Appendices: FLO-2D Modeling Documentation)	
	3		Biscuit Flat Area Hydrology TDN	2.5.5, 2.5.9
	4		Lower Skunk Creek Hydrology TDN	2.5.6, 2.5.9
4 FEMA Floodplain Delineation Studies	1		FDS Upper Skunk Creek & Tributaries TDN	2.4.6, 2.4.7, 2.4.8
	2			
	3		Cline Creek Area Approximate FDS TDN	
	4			
	5		Approximate Zone A FDS of Biscuit Flat Area TDN	2.4.2 CO4
	6			
	7		FDS of Portions of Cline Creek Tributary C6, Skunk Creek Tributary 10A & 10B, Upper Skunk Tank Wash, East Fork Desert Lake Wash, and West Fork Apache Wash (Includes 5 Floodway Residences)	
	8			
5 Sedimentation & Geomorphology	1		Sedimentation Engineering and Geomorphology Evaluation	2.7.5
6 Environmental Landscape and Multi-Use	1	1	Environmental Overview Report	4.3.1, 4.3.4
		2	Landscape Character Analysis Report	4.4.3
		3	Multiple-Use Opportunities Assessment	4.5.6
7 Flood Response Plan	1		Flood Response Plan	4.7.3
8 Phase I Alternatives Formulation and Preliminary Analysis	1	11x17 format	Phase I Alternatives Formulation & Preliminary Analysis (Potential Alternatives Submittal)	2.2.8
	2	1	Floodway Structure Risk Assessment	2.5.8, 2.6.4
		2	Floodproofing Evaluation	2.2.4
		3	Interim Development Guidelines	2.2.4, 2.2.5
	4	Roadway Drainage Crossings Hydraulics	2.6.3	
8 Phase II Alternatives Formulation	3	11x17 format	Phase II Alternatives Formulation	4.2.7, 4.2.8
	4	binder	Phase II Alternatives Formulation Appendices, Development Guidelines	4.2.9, 4.2.6
9 Adobe Dam/Desert Hills ADMP Report	1	11x17 format	Recommended Alternative Report Implementation Plan	4.6.8, 4.6.9, 4.6.10, 4.11
	2	binder	Recommended Alternative Report Appendices	4.6.12, 4.8
10 Executive Summary	1	11x17 format	Executive Summary	4.6.11



ADOBE DAM/DESERT HILLS AREA DRAINAGE MASTER PLAN DELIVERABLES SUMMARY

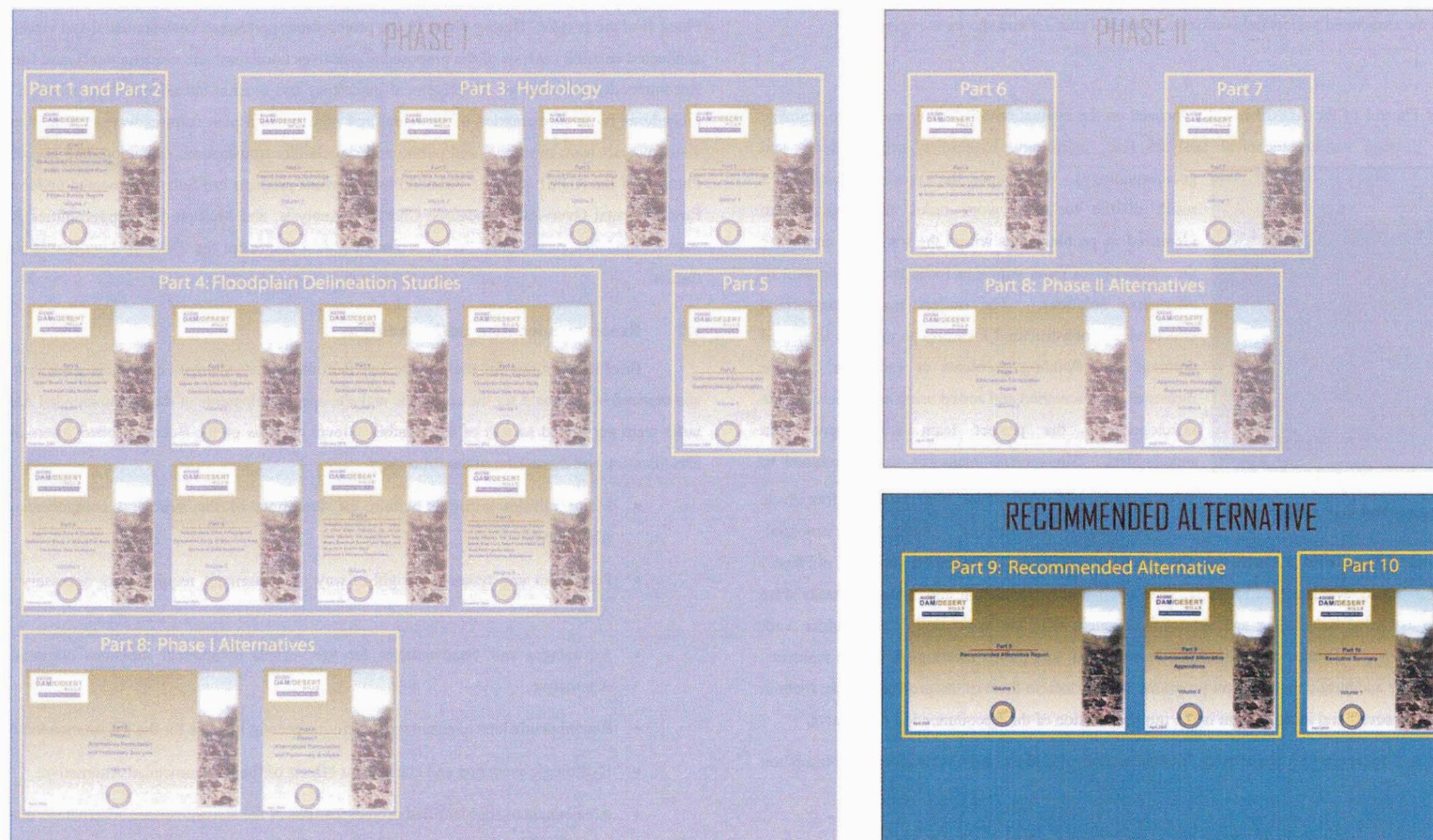


Figure 3.3 Adobe Dam/Desert Hills ADMP Recommended Alternative Deliverables Summary

SECTION 4: PROJECT TASK DESCRIPTIONS

This section briefly summarizes the work tasks of the ADMP project. For more detailed information about any of these tasks, refer to the associated project deliverable as listed in [Table 3.1](#) and shown in [Figure 3.3](#).

4.1 Phase I Tasks

The work plan for Phase I of the ADMP initially focused on the evaluation of existing and future drainage and flooding conditions through various technical analyses (i.e., hydrology, hydraulics, sedimentation, and geomorphology).

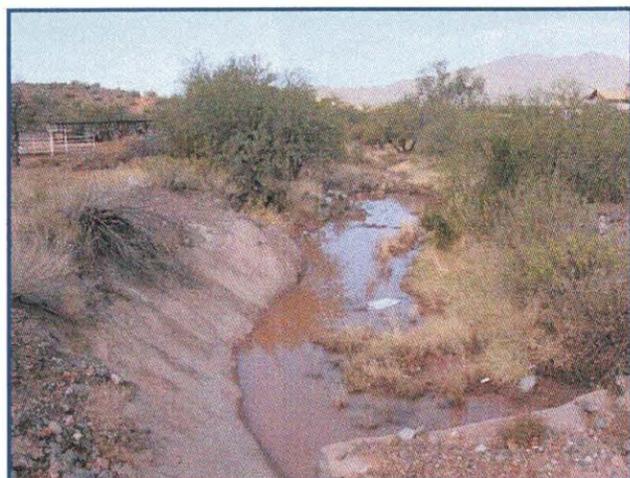


Figure 4.1 Rodger Creek downstream of New River Road (9-20-04)

Based upon the knowledge gained as a result of the technical work tasks, the project team identified 16 problem sites within the watershed and along the watercourses upon which to focus the development of alternative solutions. The project team brainstormed structural and nonstructural measures to mitigate identified drainage and flooding problems at each site. These measures were screened and sorted using evaluation criteria developed by the project team with input from stakeholders. Site-specific measures were combined to

formulate area-wide alternatives. The result was four Phase I Preliminary Alternatives; including Structural,

Nonstructural, No Action, and Combination Alternatives. The resultant Combination Alternative generated in Phase I of the ADMP advanced for further evaluation at Phase II. The alternatives formulation and evaluation tasks were performed in parallel with extensive stakeholder and public involvement programs consisting of stakeholder work group meetings, individual agency meetings, public information materials, and public meetings with area residents. The purposes of the stakeholder and public involvement programs were to inform them of the project, involve them in the alternatives development process, and include them in the implementation of the Recommended Alternative.

Part 8, Volumes 1 & 2 document the Preliminary Alternatives developed in Phase I Alternatives Formulation and Preliminary Analysis.

4.2 Phase II Tasks

Based on the Phase I work tasks briefly described in [Section 4.1](#) and fully documented under separate cover as listed in [Table 3.1](#), the Phase I Combination Alternative was recommended for further evaluation and refinement in Phase II of the project. During Phase II, the project team performed environmental and visual resources assessments, conducted detailed analysis of the proposed alternatives (structural and nonstructural), and formulated and refined the Recommended Alternative. Development guidelines and erosion hazard non-encroachment areas were refined and procedures for implementation of structural and nonstructural plan features were evaluated and recommended. Site visits, project team meetings, and public and stakeholder information, education, and coordination were integral to Phase II of the ADMP project. Related Phase II work products are fully documented under separate cover as Part 6 Environmental Overview, Landscape Character Analysis, and Multiple-Use Opportunities Assessment Reports and Part 7 Flood Response Plan. Part 8, Volumes 3 & 4 document the Phase II Alternatives Formulation process and results.

4.3 Recommended Alternative Analysis

Brief descriptions for each of the key Recommended Alternative analysis work tasks follow. Findings are summarized in [Section 5](#) for the area-wide and site-specific elements of the Recommended Alternative. Several work tasks were performed as part of the feasibility level analysis of the Recommended Alternative. These include the identification and discussion of the following:

- Major utilities corridors within the footprints of the structural components of the Recommended Alternative;
- Permanent and temporary right-of-way and easement requirements necessary for the Recommended Alternative;
- Advantages and disadvantages for the various component measures comprising the Recommended Alternative;
- Recommendations to minimize the environmental impacts for the Recommended Alternative;
- Hydrologic modeling and consequent effects of the Recommended Alternative;
- Area benefited for identified project features of the Recommended Alternative; and
- Recommendations for regulatory methods to circumvent localized flooding.



The Implementation Plan identifies key opportunities and constraints for implementation of the Recommended Alternative. The Plan addresses timing, funding, proposed public projects, summary of public feedback, permitting, and regulatory issues.

4.3.1 Utilities and Right-of-Way Requirements

The Data Collection Report, presented in Part 1, Volume 1, Section 1 of the project deliverables, describes the database catalogue of the materials collected and reviewed by the project team during the course of the ADMP. The types of data collected include aerial photographs, topographic mapping, utility location maps, as-built plans for existing structures, existing hydrologic/hydraulic reports and models affecting the project area, Federal Emergency Management Agency (FEMA) floodplain delineation studies, FEMA Flood Hazard Boundary Maps, Letters of Map Amendment (LOMA) or Revision (LOMR), engineering reports, drainage reports, site plans, future drainage improvement plans, land use plans, and development plans, among others.

The data collection work product is presented in two database formats; tabular and spatial. The first is a Microsoft Access tabular database cataloguing the materials collected for the project. The tabular database is searchable by field or keyword, (e.g., author, title, data type, year, etc.) using standard features of the Access software. The second product is a spatial ArcView Geographic Information System (GIS) database with multiple layers documenting hydrologic data, soils data, floodplain/floodway delineations, erosion hazard zone delineations, roadway crossing structure inventory, utility locations, land ownership, land use, and Assessor parcel information, among others.

The GIS database serves as the digital Existing Facilities Exhibit for the ADMP. The team used the GIS database to display key drainage features, to evaluate existing conditions, and to identify areas impacted as a result of implementation of the alternatives. The project team collected and reviewed these data from the District and multiple other sources, including stakeholder agencies and the public. Where data were lacking or unavailable, the team conducted site visits and field surveys to supplement existing data and/or to collect new information.

During Phase II, the project team updated and refined the Existing Facilities Exhibit to reflect new information, as appropriate. Database updates focused on the following features:

- Major existing utilities impacted by the proposed structural alternatives;
- Right-of-way (ROW) information and identification of ROW and easement requirements for the proposed alternatives; and
- Land ownership for the properties potentially impacted by the proposed alternatives.

Utilities – JEF contacted major utility providers in the study area and requested alignment and size data for utility facilities. Hardcopy maps and/or digital data showing utility alignments were collected. Those data were incorporated into the GIS database, as appropriate. Where major utilities were located within or in the immediate vicinity of the footprints of structural components of the Recommended Alternative, the utility alignments were shown on the concept design plan sheets. Where applicable, utility relocation and/or realignment costs were included as a separate line item in the alternative cost estimates.

Right-of-Way – The District provided available GIS ROW information to JEF. The remaining ROW information was collected by JEF from the Maricopa County Assessor’s website. The combined ROW data is shown on the conceptual design plan sheets. Areas of additional ROW or easements requirements and areas of ROW abandonment were identified and these are most likely at sites where roadway improvements and/or bridge construction is appurtenant to the proposed flood control solution. ROW acquisition and abandonment costs were included as a separate line item in the alternative costs estimates, where applicable.

Refer to detailed discussion of the utilities corridors and ROW needs in the site-specific descriptions included in [Section 5](#) of this report.

4.3.2 Alternatives Advantages and Disadvantages

The Phase II work tasks were performed to evaluate the engineering feasibility of the Combination Alternative recommended at the conclusion of Phase I of the project. The Combination Alternative comprised structural and nonstructural measures identified for 16 sites within the project area, plus the watershed-wide alternatives (See Part 8, Volumes 1 & 2 for details). During Phase II, conceptual design plans of project features were prepared considering sound engineering design along with the environmental compatibility and landscape aesthetics of the major project components. A key element of the Phase II evaluation was identification of the advantages and disadvantages for each of the Phase II alternatives with respect to cost, logistics, environmental issues, ROW issues, project objectives, etc. The project team developed evaluation criteria incorporating these specific considerations to sort the Phase II alternatives and select the components comprising the Recommended Alternative (See Part 8, Volumes 3 & 4). [Figure 4.2](#) presents a key map showing the subareas and the sites of the structural components of the Recommended Alternative. Refer to [Section 5](#) of this report for documentation of the resultant Recommended Alternative including the rationale for selection of the preferred measure for each site. In Phase II the site numbers were refined. [Table 4.1](#) shows the new site numbers with relation to the old numbers. Note that some sites were dropped for various reasons and the numbers were dropped as well.

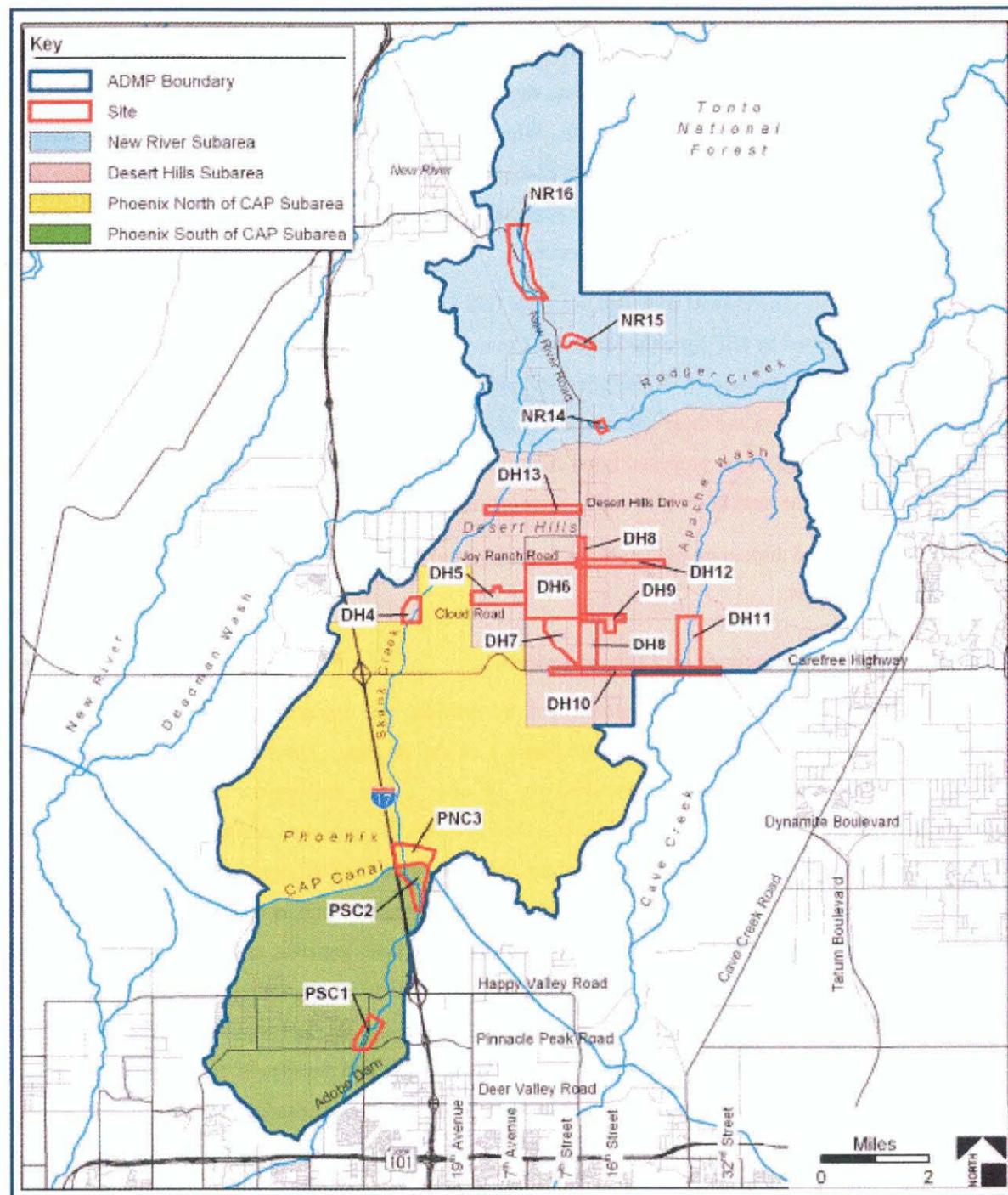


Figure 4.2 Subarea and Structural Alternative Site Map

Table 4.1 Adobe Dam/ Desert Hills Area Drainage Master Plan Number Changes

Problem Site Identification	Phase I Site Numbers	Phase II Site Number
City of Phoenix		
Skunk Creek/ Pinnacle Peak Rd & 35th Ave	PSC1	Site Number 1
Skunk Creek downstream of the CAP	PSC2 and PNC3	Site Number 2
Desert Hills		
Cloud and 27 th Avenue	DH4	Site Number 3
Skunk Tank Wash (Joy Ranch Road to 19 th Avenue)	DH5	Site Number 4
Desert Lake (ASLD parcel), Desert Lake Wash downstream of Cloud Rd, and East fork Desert Lake Wash/ 7th St	DH6, DH7, and DH8	Site Number 5
Carefree Highway Crossings	DH10	Site Number 6
Apache Wash/ 24th St	DH11	Site Number 7
Skunk Creek/ Desert Hills Drive	DH13	Site Number 8
Desert Hills Wash/ Cloud Rd & 12th St	DH9 and DH12	Site Number 12
New River		
Roger Creek/ New River Rd	NR14	Site Number 9
Cline Creek/ Circle Mountain Rd	NR15	Site Number 10
Skunk Creek/ New River Rd Bridge	NR16	Site Number 11

4.3.3 Environmental Impacts

The Environmental Overview Report is provided in Part 6, Volume 1, Section 1. The purpose of the environmental overview was to collect and provide data to assist the project team in evaluating the environmental issues and impacts associated with each Phase II alternative measure. The environmental overview determined the potential impacts of each of the proposed Phase II alternatives on the identified ecological resources, hazardous materials, and cultural resources. The environmental considerations were compared across the Phase II alternatives to evaluate the relative magnitude of impact.

LSD assessed for each specific site the potential effects of the Recommended Alternative in terms of ecological resources, cultural resources, hazardous materials assessment, and social environment, as applicable. LSD



ADOBE DAM/DESERT HILLS AREA DRAINAGE MASTER PLAN

developed recommendations to minimize the environmental impacts for the Recommended Alternative at the Skunk Creek crossing at the CAP aqueduct (Site 2) and Skunk Creek crossing at New River Road (Site 11). See [Section 5](#) for these recommendations.

4.3.4 Hydrologic Impacts

JEF updated the hydrologic models to incorporate the effects of the Recommended Alternative. A site-specific discussion of hydrologic impacts is included in [Section 5](#). Digital data is provided on the CD included in the Recommended Alternative Appendices (Part 9, Volume 2).

4.3.5 Area Benefited

JEF assessed the area benefited for each structural feature of the Recommended Alternative. The assessment included a count of the number of parcels positively and negatively impacted by the implementation of each feature. This assessment was done by looking at pre- and post- Recommended Alternative in terms of structural and non-structural components. The structural was performed by superimposing the Recommended Alternative onto aerial photography and actually counting the impacted structures or parcels. The FPAP component was done the same way, but required more common sense judgments based on whether the parcel was impacted or not. These data are summarized in the cost estimates provided in [Appendix B](#) herein.

4.3.6 Planning/Regulatory Coordination

Nonstructural measures were evaluated as part of the Phase I alternatives development process. The nonstructural measures considered planning issues resulting from policies and/or regulations pertinent to the ADMP project and assessed opportunities and obstacles created by adopted codes, ordinances, and development conditions. As a result, the nonstructural measures included the preparation of development guidelines for structures and roads in the study area and an evaluation of floodproofing options for floodway residents. These two nonstructural components are briefly discussed below.

[Phase I Interim Development Guidelines](#) –The general objectives of the Interim Development Guidelines include the following:

- Enhance public safety by guiding development in the watershed to protect current and future residents from the effects of flooding.
- Reduce adverse drainage impacts due to development in the watershed by guiding activities of new residents so that current runoff to Skunk Creek is maintained at current conditions and downstream

neighbors are not negatively impacted.

- Guide future development in a manner consistent with the Recommended Alternative plan of the Adobe ADMP.

The intended purpose of the interim development guidelines is to provide guidance to residents and regulators alike regarding what can and cannot be constructed, ways to alleviate the impacts of construction on the watershed, and how to protect structures and adjacent properties from flooding and erosion. Meetings were held with several groups to better understand the issues prior to and during the process of formulating the Interim Development Guidelines. Input was solicited from the following county, municipal, and private participants during group and/or individual meetings: Maricopa County Supervisor Andy Kunasek; District floodplain managers, planners, and inspectors; City of Phoenix Councilwomen Peggy Neely; North Gateway and Desert View village planning committees. In addition, a Development Guidelines Work Group comprising regulators, planners, hydrologists, land development engineers, and project area residents representing the New River/Desert Hills Community Association was convened to discuss flooding and drainage issues as input to the interim development guidelines formulation.

A careful analysis of area development trends and regulatory options was conducted to identify specific issues that were not addressed by the existing Arizona Revised Statutes (ARS) Title 11 Drainage Ordinances and ARS Title 48 Floodplain Regulations (see [Figure 4.3](#)). Title 48 authorities apply to the 100-year flood areas regulated by the National Flood Insurance Program (NFIP) and Arizona Department of Water Resources. Title 11 authorities regulate drainage concerns in areas outside the regulatory 100-year floodplain. In practice, Title 11 authorities sometimes overlap into the Title 48 area. It became apparent that single-family development on individual lots within unincorporated areas was the one category with insufficient standards to address the cumulative impacts of this type of development.

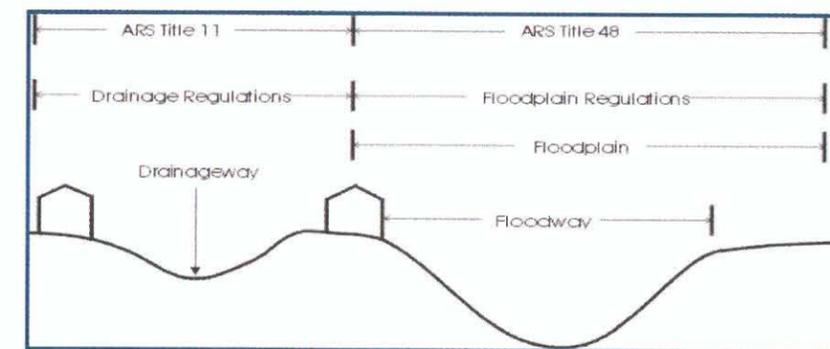


Figure 4.3 Statute Applicability

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This analysis documented the existing practices and procedures and carefully integrated a unique toolkit and implementation strategy to address individual single-family lot development. By maximizing resources, both technical and personnel, a significant percentage of reviews may be simplified. An option is also available for individuals to obtain approval for variations to the regulations if a higher degree of drainage analysis is provided in order to justify the proposed change(s). By providing this degree of flexibility within clearly documented and easily applied Development Guidelines, both the public and regulatory staff will benefit.

A number of tools or criteria were evaluated for application to single-lot development in the ADMP study area. The tools were evaluated based on their hydrologic efficacy, long-term viability, and their potential for implementation. Seven types of tools or criteria relating to single-family, individual lot development were examined:

- Drainageways
- (Erosion Hazard) Setbacks
- Finished Floor Elevations
- Disturbance Envelopes
- Culverts, Driveways, & Roads
- Walls, Fences, & Berms
- Retention

Each criterion is discussed in detail in the *Interim Rules of Development for Individual Single-Family Lots* in Part 8, Volume 2, Section 3. Recommendations are made for selection of specific measures or requirements for each tool or criteria for the ADMP.

Phase II Development Guidelines – The Interim Rules of Development were further refined in Phase II of the ADMP and are presented as the *Development Guidelines for Individual Single-Family Lots* in Part 8, Volume 4, Section 2 and [Appendix C](#) of this report. Due to the uncertainty of implementation protocols brought about by the recent transition of regulatory authority for Title 11 Drainage Ordinance to the Maricopa County Planning & Development Department, final implementation strategies for the Development Guidelines are pending and will be determined in the future.



Figure 4.4 Block wall under construction across drainageway in Desert Hills area

4.3.7 Stakeholder Involvement

The stakeholder involvement program for this project was designed and completed with the goal of maximizing implementation opportunities for the Recommended Alternative of the ADMP. To achieve this objective, the 3 I's method was applied to **I**nform, **I**nvolve, and **I**nclude stakeholders. This approach has been used successfully in other similar projects. Simply put, the 3 I's method of Stakeholder Involvement is to utilize a 3-Phase approach as described below and as shown in the Stakeholder Flowchart (Figure 4.5).

Phase 1 Inform – Inform the stakeholders of the project at the early stages to obtain any useful knowledge they may have from a data collection standpoint as well as to receive any initial input they may have regarding scope of work or process. This was accomplished through facilitated workgroups of stakeholders with similar mandates, jurisdictions, and interests (i.e. transportation system agencies, unincorporated area, etc.). Several individual meetings were also held for those stakeholders with a unique interest (e.g., Sonoran Parkway, City of Phoenix Transfer Station, etc.). Stakeholders and their anticipated preliminary concerns/ interests were identified and compiled into a spreadsheet which was used as the baseline database for the rest of the stakeholder involvement program. The Stakeholder database is documented in Part 1, Volume 1, Section 2.

Phase 2 Involve –Involve the stakeholders throughout the course of the ADMP so that they stay informed and interested in the project. This also allowed for them to see the reasons why, or why not, their input would be included in the development of alternatives. This was accomplished through the use of workgroups as well as individual meetings. An added benefit of maintaining contact through the course of the project is that new staff members from the agencies were educated prior to being shown the end product. Their involvement was documented in the evaluation matrices developed for all of the alternatives at each site (see Section 5 of this report).

Phase 3 Include – Include the stakeholders in the process of selection of the Recommended Alternative. This effort included information exchange and discussion of:

- Costs of capital improvements
- Costs of maintenance
- Conceptual cost sharing agreements for capital improvements
- Conceptual agreements on maintenance responsibilities
- Construction timelines coordinated with other agencies' projects and budgets.

This was accomplished using a combination of workgroups and individual meetings because of the iterative nature of these negotiations. Stakeholders' input was documented in the conceptual design plans and cost estimates contained in Section 5 of this report.

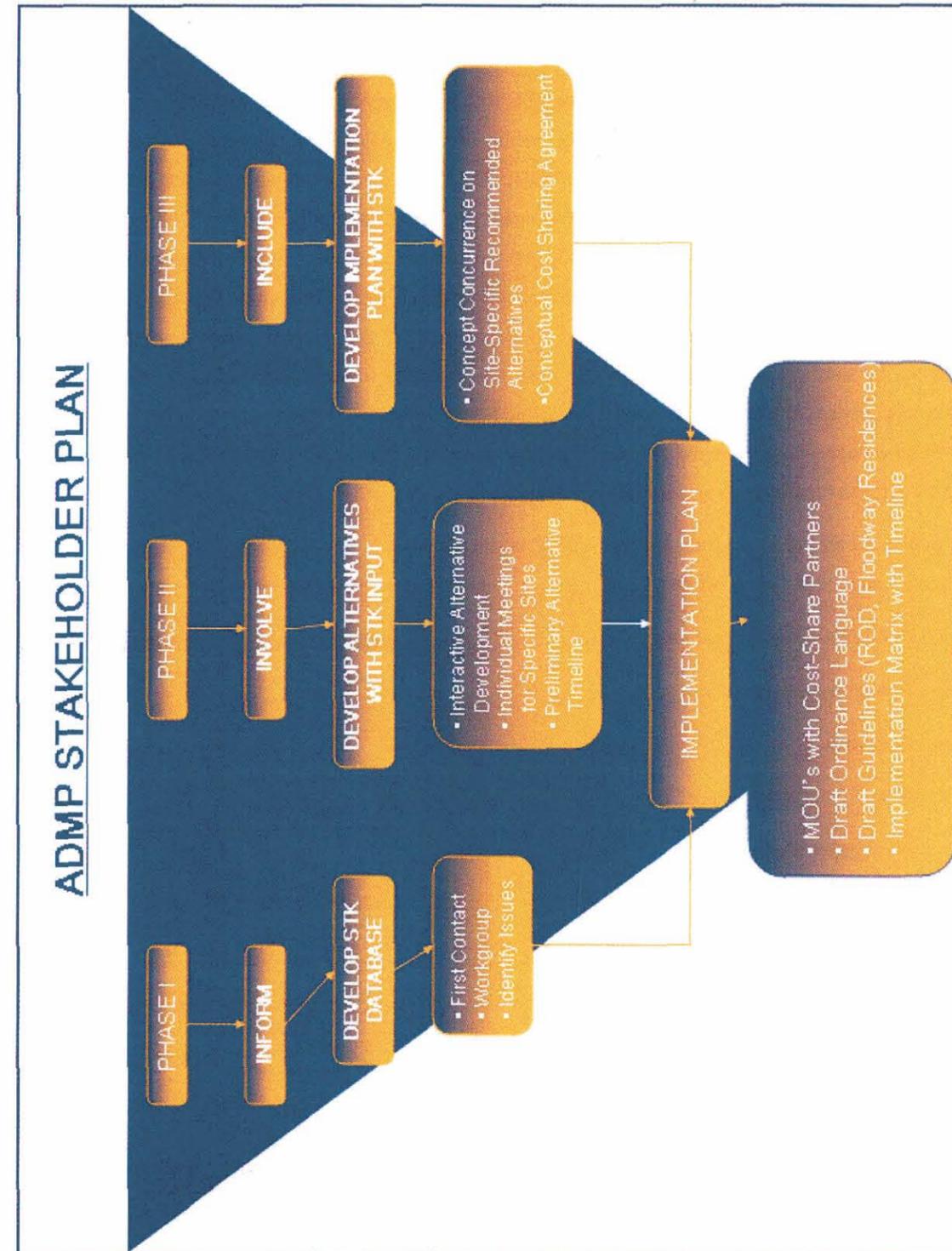


Figure 4.5 ADMP Stakeholder Plan

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4.3.8 Public Involvement

The District began a public involvement process for the ADMP in September 2002. The Public Involvement Plan created a blueprint for the public involvement process that would give the public multiple opportunities to ask questions and provide feedback to the District. The public involvement efforts centered on three sets of public meetings, with each set comprising three separate meetings. The three sets of meetings were scheduled in relation to project development stages: one set in the Phase I information gathering stage in November 2002, one set during the Phase II alternatives development in November 2003, and the last set to present the Recommended Alternative in September 2004. In each set, the public meetings occurred within a two-week timeframe. Because the project area is so large and to reduce the travel burden on potential attendees, each of the three meetings was held in a different location – one in the southern portion of the project area, one centrally located, and one in the north. During the public involvement process, the District decided it would be best to have two separate meetings designed specifically for residents who owned property in the floodway. These meetings were each scheduled in November 2003 and September 2004 prior to the final two sets of public meetings.

The public involvement program for the ADMP is documented in Part 1, Volume 1, Section 3. The work products presented therein are listed below:

- Public Involvement Summary Report
- Public Involvement Plan
- Postcards
- Fliers/ Doorhangers (see Figure 4.7)
- Newspaper Notices
- Notification Letters
- Handouts (see Figure 4.6)
- Sign-in Sheets
- Meeting Summaries
- Public Meeting Presentations
- Exhibit Boards

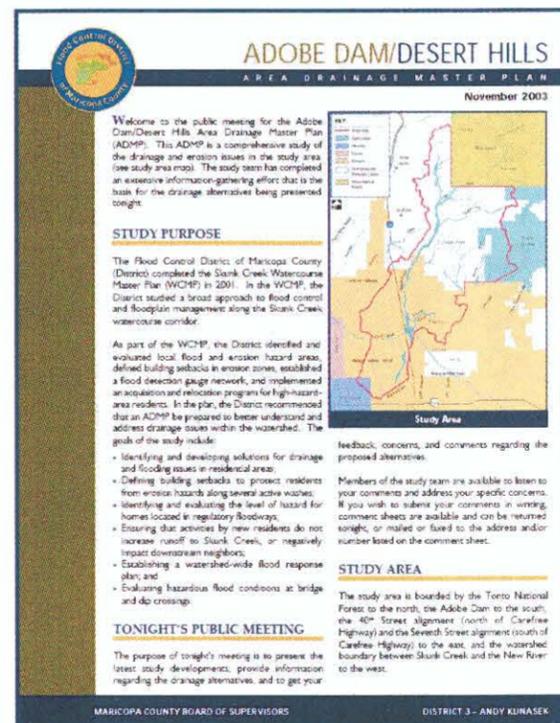


Figure 4.6 November 2003 Public Meeting Handout

The District maintained a project web site for the ADMP to provide residents the opportunity to access project-specific public information materials digitally and to provide a means for residents to submit inquires or requests for information directly to the District's Project Manager. The web site URL is as follows:

<http://www.fcd.maricopa.gov/Neighborhood/ProjectDetails.asp?wPROJECT=42>

The District also met with the staff of the local newspaper in the project area in conjunction with the public meetings. A project fact sheet was prepared to provide concise information about the project to members in the community, press, and the public.

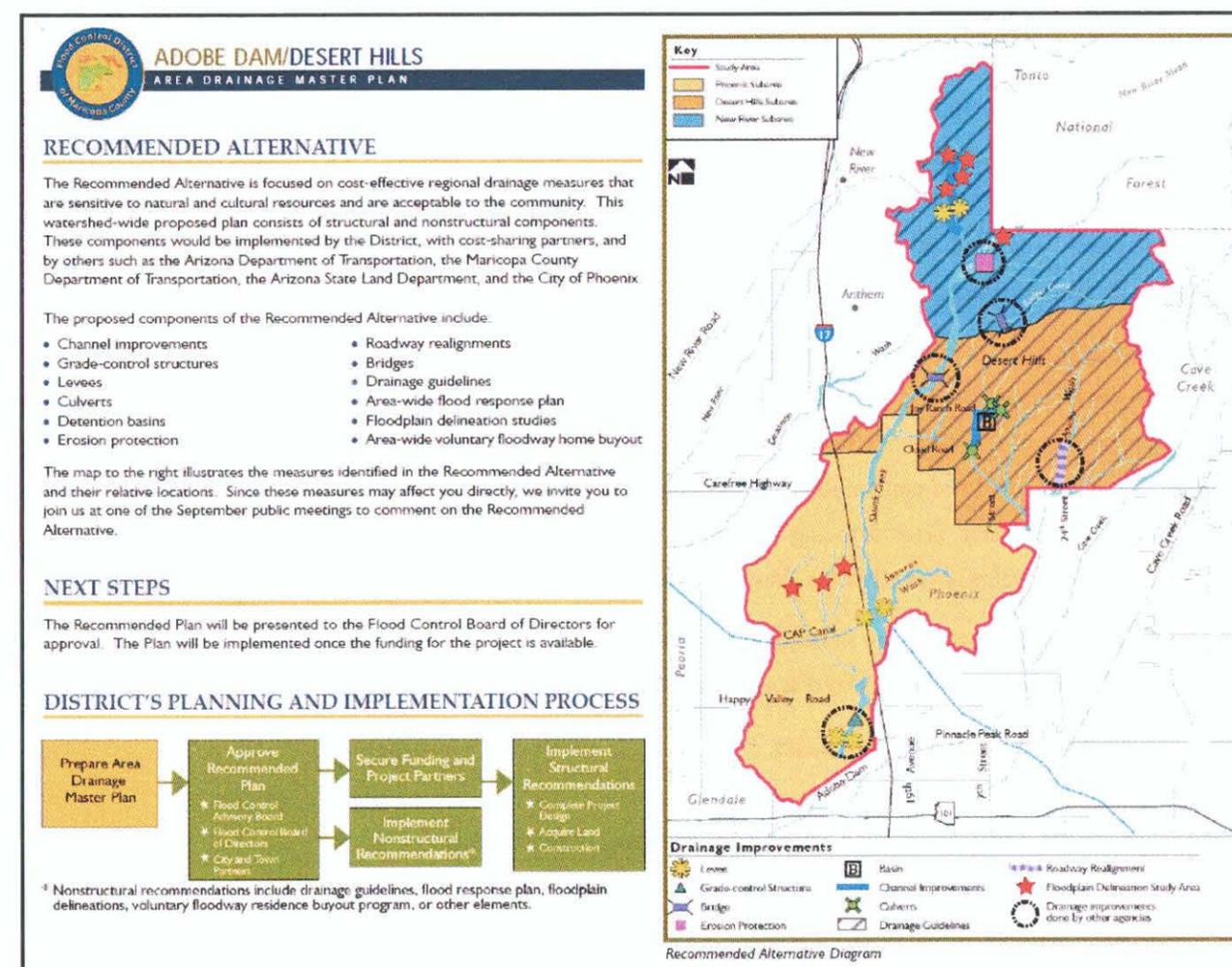


Figure 4.7 September 2004 Public Meeting Notice



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Table 5.1 Adobe Dam/ Desert Hills Area Drainage Master Plan Recommended Alternative

Problem Site Identification	Phase II Site Number	Recommended Alternative
City of Phoenix		
Skunk Creek/ Pinnacle Peak Rd & 35th Ave	Site Number 1	Channelization/ grade control, Upper Buchanan Wash Floodplain Delineation Study (FDS), and the Flood Response Plan (FRP)
Skunk Creek downstream of the CAP	Site Number 2	Levees followed by Floodplain Re-Delineation (FDS) and the Flood Response Plan (FRP)
Desert Hills		
Cloud and 27 th Avenue	Site Number 3	Flood Response Plan (FRP) and No Action
Skunk Tank Wash (Joy Ranch Road to 19 th Avenue	Site Number 4	Floodprone Property Acquisition Program (FPAP), Flood Response Plan (FRP), Development Guidelines, and Joy Ranch Road Interceptor upstream detention basin (Part of Site 5)
Desert Lake (ASLD parcel), Desert Lake Wash downstream of Cloud Rd, and East fork Desert Lake Wash/ 7th St	Site Number 5	Basin on ASLD parcel/ channelization, 100-yr Channel/ Culverts @ 7th St followed by Floodplain Re-Delineation (FDS), Flood Response Plan (FRP), Floodprone Property Acquisition Program (FPAP) south of Cloud Road, and Development Guidelines
Carefree Highway Crossings	Site Number 6	Flood Response Plan (FRP) and No Action
Apache Wash/ 24th St	Site Number 7	Flood Response Plan (FRP) and Realignment of the roadway
Skunk Creek/ Desert Hills Drive	Site Number 8	Flood Response Plan (FRP) and constructed bridge with bypass access on side streets
Desert Hills Wash/ Cloud Rd & 12th St	Site Number 12	Flood Response Plan (FRP), Floodprone Property Acquisition Program (FPAP), and Development Guidelines
New River		
Roger Creek/ New River Rd	Site Number 9	Flood Response Plan (FRP), Floodprone Property Acquisition Program (FPAP), and constructed bridge
Cline Creek/ Circle Mountain Rd	Site Number 10	Flood Response Plan (FRP), Constructed terraced wall w/ naturalized treatment, and Floodplain Delineation Study (FDS)
Skunk Creek/ New River Rd Bridge	Site Number 11	Levees/ Channel improvements followed by Floodplain Re-Delineation (FDS) and Flood Response Plan (FRP)

Development Guidelines - One of the area wide non-structural components of the ADMP is the Development Guidelines. The Development Guidelines will establish rules for single-family development on individual lots within the unincorporated portion of the study area. The purposes of these guidelines are to avoid future problems resulting from the effects of development on local drainage and to maintain runoff to area watercourses at current levels. The guidelines address the following elements of single-lot development:

- Drainageways
- Erosion hazard setbacks
- Finished floor elevations
- Disturbance envelopes
- Culverts, driveways, and roads
- Walls, fences and berms
- Retention basins

The Development Guidelines are discussed and provided within this report in [Appendix C](#).

Floodplain Delineation Studies (FDS) – Another area wide non-structural component of the ADMP addressing future conditions, is the FDS. The FDS provide information used to update existing FEMA Flood Insurance Rate Maps (FIRMs). The purpose of the FDS is to provide the best available information to local and regional planners and floodplain administrators to further promote sound land use practices and floodplain development. In this manner, future development within mapped floodways is prevented and construction within floodplains is regulated to enhance public safety in floodprone areas. [Figure 5.2](#) shows the areas within the ADMP study area that are associated with FDS. Part 4, Volumes 1, 2, 3, 4, 5, 6, 7, and 8 contain the details of the FDS.

Even though Site Numbers 3, 4, 6, and 12 do not have structural elements associated with them in terms of the Recommended Alternative, they, along with the entire study area is addressed with the area wide components of the ADMP.

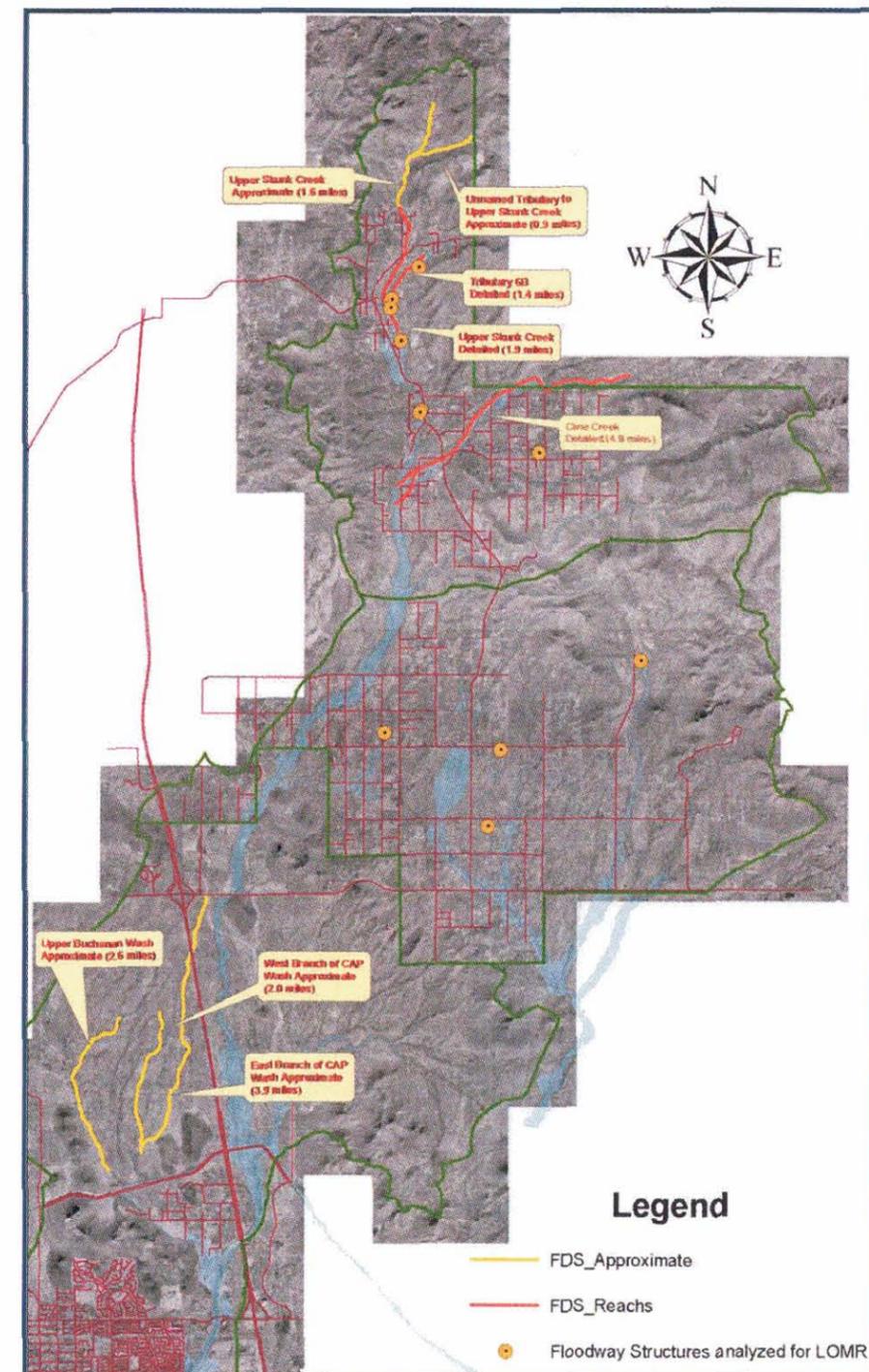


Figure 5.2 Floodplain and Floodway Delineation Watercourse Reach Locations



5.2 Problem Description, Recommended Alternative, and Environmental Summary

Site Numbers 2 and 11 are the only sites where ecological resources, hazardous materials concerns, cultural resources, landscape theme, aesthetic design, and multi-use opportunities were specifically analyzed. Even though a general look at environmental concerns was performed at each site, only those sites where the FCDMC is involved in implementation of the recommended alternative has design guidelines been provided. This decision was made by the project team and the FCDMC at the October 14, 2004 monthly progress meeting.

Site Number 1

Problem Description – In June of 1993 Wood/ Patel contracted with Phoenix to perform an analysis of alternatives for design options of a bridge over Skunk Creek at Pinnacle Peak Road. This report, *Phase I, Design Option Report Pinnacle Peak Road Bridge Over Skunk Creek, BR-922765*, performed by Wood/ Patel Associates in June, 1993, looked at several options for bridges. From this report, the recommended alternative was Option C-1 which provided a 100-year crossing at Pinnacle Peak Road and allowed for future extension of the 35th Avenue, which would be a bridge constructed by the City, to the north. In addition, its channel geometry provided a sediment transport rate comparable to the existing channelization to the north.

Even though this alternative was recommended, what was actually built in 1995 was a four-span concrete box-girder bridge, a roller-compacted concrete drop structure (Figure 5.3) located approximately 350 feet upstream of

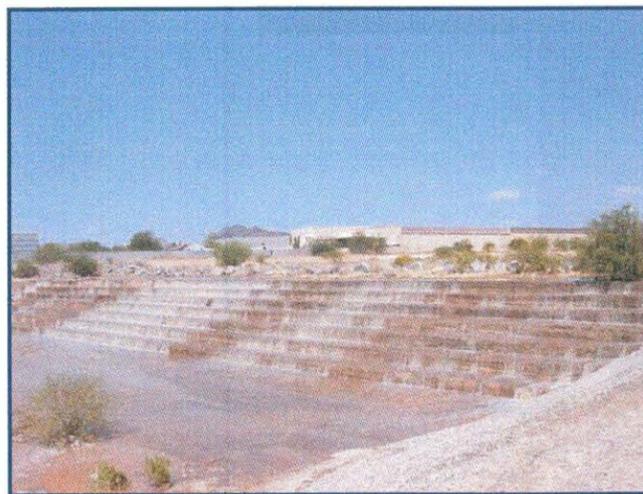


Figure 5.3 Skunk Creek Drop Structure (9-20-04)

the bridge, and an excavated channel with soil-cement bank protection between the drop structure and the bridge. The excavated channel has a bottom width of 250 feet and continues, unlined, downstream of the bridge to the Adobe Dam reservoir area. After conversations with Phoenix and Wood/ Patel, it appears that the reason for downgrading the construction from the recommended alternative was because of budgetary reasons. It was felt that it was better to build something that protected most of the time and improve it later when funds or cost sharing partners became available.

In 2002 Tetra Tech, Inc. completed the *Letter of Map Revision Request for Skunk Creek, City of Phoenix*

Contract No. SA-930222, Technical Data Notebook. This report identified a breakout from Skunk Creek downstream of the landfills and upstream of the drop structure across Pinnacle Peak Road. Also in 2002, Coe & Van Loo Consultants performed the *Split Flow Analysis Over Pinnacle Peak Road, CVL #98-0013*. This report analyzed this breakout from Skunk Creek further and looked at the breakout effects further downstream through the park and back into the Adobe Dam reservoir impoundment area. This split flow analysis assumed that the entire 15,500 cfs breakout crossed Pinnacle Peak Road and entered the park site. Because of this breakout, the ADMP looked at this site and what could be done to eliminate future breakouts and deliver the flows to the Adobe Dam reservoir area.

Recommended Alternative – While researching this site, JEF found that considerable analysis has already been performed. The *Phase I, Design Option Report Pinnacle Peak Road Bridge Over Skunk Creek, BR-922765*, performed by Wood/Patel Associates in June, 1993 looked at several options at this particular location. After reviewing this report, JEF agreed with Wood/Patel that Option C-1 is the best alternative for this site. The methodology that Wood/Patel used follows generally accepted design methodology and makes the most economic sense.

This structural option consists of a 320-foot span Pinnacle Peak Road bridge crossing, a concrete stepped drop structure immediately downstream of the southern boundary of the Skunk Creek Landfill, a levee between the drop structure and landfill, and an incised channel downstream of the drop structure. The cross-sectional geometry of the channel is a trapezoid with 2:1 side slopes. The City of Phoenix plans to build a bridge at the 35th Avenue crossing.

The drop structure is a stepped concrete structure with eight 2-foot high steps to dissipate energy. The levees will be keyed into the existing levee system for the landfill. All channel embankment lining consists of soil cement. The freeboard allowance for the 100-year flow condition is 1.5 feet.

Comparisons of the 100-year water surface elevations of this option with those of the revised CVL model shows that the water surface does not increase at any cross sections.

Based on the fact that this alternative has been recommended previously in other reports as well as further analysis by JEF and the ADMP team, this alternative has become part of the recommended alternative.

The non-structural elements for Site Number 1 consist of the Upper Buchanan Wash FDS and the FRP. Some of the advantages of the Recommended Alternative for Site Number 1 are:

- Protects Pinnacle Peak Road and 35th Avenue alignments from flooding
- Provides an opportunity for aesthetic improvements near the 35th Avenue alignment

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- Provides an opportunity to improve degraded habitat in Skunk Creek downstream of the landfill area
- Opportunities for trail linkage to Adobe Dam Recreation Area, Thunderbird Park, Paseo Highlands Park, and CAP Canal regional trail

Environmental – LSD provided an environmental summary for Site Number 1. There is an opportunity for improvement of the moderate habitat located around this site. Numerous hazardous materials concerns are located within the area of Site Number 1. However, only illegal dumping is present at the site itself. The opportunity for improvement of the visual character exists especially next to the landfill and Skunk Creek (Figure 5.4). Currently this area is in bad visual shape. Multiuse opportunities exist in the form of a proposed trail system along Skunk Creek. The trail system could create links to nearby Adobe Dam Recreation Area, Thunderbird Park, and Paseo Highland Park.



Figure 5.4 Illegal Dumping in Skunk Creek.

Site Number 2

Problem Description – In 1990, Coe & Van Loo used HEC-2 to estimate the 100-year floodplain limits for Skunk Creek upstream of the Central Arizona Project Canal (CAP) and to estimate the amount of discharge that breaks away from Skunk Creek in the effective Flood Insurance Study. Their findings were as follows:

- Approximately 3,000 cfs breaks out to the west across I-17.
- Approximately 5,000 cfs breaks out to the south into the CAP Canal on the west side of the Skunk Creek Overchute.
- Approximately 1,000 cfs breaks out to the south into the CAP Canal on the east side of the Skunk Creek Overchute.
- Approximately 1,000 cfs breaks out to the south into the CAP Canal on the west side of the Sonoran Wash Overchute.

- Approximately 200 cfs breaks out south into the CAP Canal on the east side of the Sonoran Wash Overchute.
- Approximately 16,600 cfs continues down the Skunk Creek channel corridor.

In 1997 Montgomery –Watson accepted the Coe & Van Loo study for the *Skunk Creek Floodplain Delineation Study*.

In 2001 Tetra Tech, Inc. performed the Skunk Creek Watercourse Master plan (WCMP) and identified flooding across I-17 upstream of the CAP. This flooding is summarized in the *Skunk Creek Watercourse Master Plan, Attachment 7, Two Dimensional Hydraulic Model of the Confluence of Skunk Creek & Sonoran Wash at the CAP Canal, FCD 99-23*. This attachment was added to the Watercourse Master Plan because of the complex problem of a very broad floodplain in the confluence area in combination with the structures associated with the CAP. The FCDMC was interested in better defining the following:

- The 100-year water surface elevations, limits of flooding, and flow patterns upstream and downstream of the CAP.
- The location and magnitude of flow that would break out of the Skunk Creek/Sonoran Wash corridors during the 100-year flood event.
- The associated hydraulic parameters associated with the 100-year event such as depths, velocities, etc...
- The location and type of hydraulic controls.
- The modifications needed to contain the 100-year event within the Skunk Creek/Sonoran Wash corridors.
- The ability of the CAP overchute structures to accommodate the 100-year event.
- The impact of the two dimensional analysis results on the starting water surface elevations specified in the existing FIS studies on Skunk Creek and the initial FIS study for Sonoran Wash.
- The recurrence interval of the initial breakout flow across I-17.

The following is summary of the results found in this initial two dimensional modeling:

- The 100-year starting water surface elevation for Skunk Creek was estimated at 1533.7 by two dimensional modeling which compares to a starting water surface elevation of 1532.5 that was used for both the effective FEMA study and the Tramonto Conditional Letter of Map Revision (CLOMR).



- The 100-year starting water surface elevation for Sonoran Wash was established as 1532.1.
- The breakout flow across I-17 is 6,400 cfs, has an average depth of 2.5 feet, and a total volume of 76,800 acre feet.
- The overchute structures are capable of passing the combined 100-year event from Skunk Creek and Sonoran Wash assuming that flow is directed to them by raising the upstream embankment so that the design flow is actually 100-year instead of 50-year. However, the extent of local scour upstream and downstream of the structures was not evaluated. These results assumed that ponding behind the proposed levee improvements upstream of the CAP are allowed to occur.
- The earliest breakout flow was noted to be 14.20 hours at I-17. This corresponds to a total discharge of approximately 17,600 cfs on the Skunk Creek Hydrograph which also corresponds to approximately a 26-year recurrence interval on the discharge frequency curve.

Table 5.2

WCMP Comparison of Breakout Flows for Site Number 2

Location	100-Year Breakout Discharge (cfs)	Coe & Van Loo 100-Year Breakout Discharge (cfs)
West of the Skunk Creek Overchute	1,100	5,000
Across I-17	6,400	3,000
East of the Skunk Creek Overchute	500	1,000
West of the Sonoran Wash Overchute	2,500	1,000
East of the Sonoran Wash Overchute	1,200	200
Flow to the Southeast along the CAP.	100	Not Reported
Overchutes		
Skunk Creek	18,500	*16,600
Sonoran Wash	6,100	*16,600
Total	36,400	26,800
Reported total in Report	36,400	35,000
*It was unclear if these are for both overchutes together or individually. It was assumed that they are combined since they are different size hydraulic structures.		

- Table 5.2 shows the comparison of this study with the Coe & Van Loo study with respect to breakout locations and magnitude.
- Table 5.3 is a summarization of levees that were modeled in this report to contain the flows.

Table 5.3

WCMP Levee Design for Site Number 2

Location Description	Length of Levee (feet)	Estimated Height (feet)	Quantity of Fill (20' Average Width) (cu yd)
From Skunk Creek Overchute, 1800' west	1,800	5	8,000
From the end of previous levee, 500' north	500	4	2,000
East side of Skunk Creek Overchute	500	5	2,300
West side of Sonoran Wash Overchute	200	4	1,000
East side of Sonoran Wash Overchute	300	4.5	1,500
East side of study area, upstream of the CAP	300	7	1,600
East side of Study area upstream of the CAP	300	4	900

One of the outcomes of the WCMP was the recommendation that the two dimensional modeling be extended to include Buchanan Wash to the west and extend downstream to Happy Valley Road. In 2002, The FCDMC contracted with Tetra Tech, Inc. to perform this modeling. As a result of this, the *Floodplain Delineation Study for Skunk Creek Between the Central Arizona Project and Happy Valley Road, Two-Dimensional Hydraulic Model*, was performed. This study expanded on the previous studies and includes the following analyses for both the 100-year and Standard Project Flood (SPF) events:

- An expanded two dimensional analysis of existing conditions. The Skunk Creek study limits are from Happy Valley Road (downstream limit) to the CAP. Buchanan Wash, from the CAP to its confluence with Skunk Creek, is also included in the study area.
- A floodplain analysis for the area west of I-17.



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- Two pre-development condition models; one without the CAP and another without I-17 or the CAP.
- An analysis of widening the CAP overchutes as a possible remedial alternative.
- An analysis of extending the existing levee system to contain breakout flows.

The results from this study are as follows:

- The existing condition model confirmed breakouts north of the CAP over I-17 in both the 100-year and SPF flood events. The 100-year breakout conveys over the canal and ponds on the north side of the CAP and in the medians.

Table 5.4

2D Report Levee Cost Estimates for Site Number 2 (Soil Alluvium Toe-Down)

Location	Height (feet)			Length (Feet)	Avg. End Area (sq ft)		Volume (cu yd)		Construction Cost		
	High	Low	Avg.		Levee	Toe-Down	Levee	Toe-Down	Levee	Toe-Down	Total
East bank from existing levee to CAP	6	2	3.3	4,600	78	135	13,289	23,000	\$0.83M	\$1.44M	\$2.27M
East bank from CAP to end	12	3	6.6	1,200	251	135	11,156	6,100	\$0.70M	\$0.38M	\$1.07M
West bank from existing levee to CAP	6	1	3.1	3,000	85	135	9,444	15,000	\$0.59M	\$0.94M	\$1.53M
West bank from CAP to end	7	1	3.8	2,000	89	135	6,593	10,000	\$0.41M	\$0.63M	\$1.04M
Total									\$2.53M	\$3.38M	\$5.91M

*Construction cost = \$62.50 per cubic yard, per FCDMC.

- The existing condition model showed that significant ponding occurs north of the CAP on Buchanan Wash. This ponding causes significant attenuation in the model that is not accounted for in the

effective FIS hydrologic model. The land in the ponding area is presently owned by the State of Arizona.

- The predevelopment models show that the flows were fairly well contained only after I-17 was built. The addition of the CAP only helped to contain the flows within the system.
- Widening the overchutes does not help to alleviate the flooding problems within the system. Flow still breaks out over I-17 north of the CAP.
- Extending the levees upstream from the current location to the CAP, and north of the canal, on both the east and west sides effectively confines the flows in the channel corridor during the 100-year event. During the SPF event, there is some backwater leaving the channel through the opening between the Corp of Engineers (Corp) levees and the City of Phoenix landfill levees. The costs of these levees are summarized in [Tables 5.4](#) and [5.5](#).

Table 5.5

2D Report Levee Cost Estimates for Site Number 2 (Concrete Toe-Down)

Location	*Construction Cost		
	Levee	Toe-Down	Total
East bank from existing levee to CAP	\$830,600	\$480,700	\$1,311,300
East bank from CAP to end	\$697,300	\$125,400	\$822,700
West bank from existing levee to CAP	\$590,300	\$313,500	\$903,800
West bank from CAP to end	\$412,100	\$209,000	\$621,100
Total	\$2,530,300	\$1,128,600	\$3,659,000

*Construction cost = \$62.50 per cubic yard for Cement Soil Alluvium (levee), per FCDMC. \$94 per cubic yard for concrete (toe-down), per CalTrans Construction Cost Index.

The ADMP was tasked with formulating alternatives that would solve the flooding across I-17 as well as the flooding that would occur upstream of the Corps of Engineers levees. The Corps of Engineers levees are upstream of the crossing of Skunk Creek and I-17. These levees, however, do not extend to the CAP. The aforementioned

modeling shows that the 100-year flow backs up in the levee area and “end runs” the levees to both the east and west. New development currently exists to the east and established businesses and residences exist to the west between I-17 and the back side of the Corps of Engineer’s levees.

Recommended Alternative – For Site Number 2 the structural components of the Recommended Alternative consist of extending the Corp levees (Figure 5.5) north until they tie into the CAP (4,600 feet from the east bank to the CAP and 3,000 feet from the west bank to the CAP). Additionally, a levee north of the CAP along I-17 is recommended (approximately 2,000 feet of levee) to stop overtopping of the I-17. Refer to Table 5.3 for approximate lengths of levee extensions.

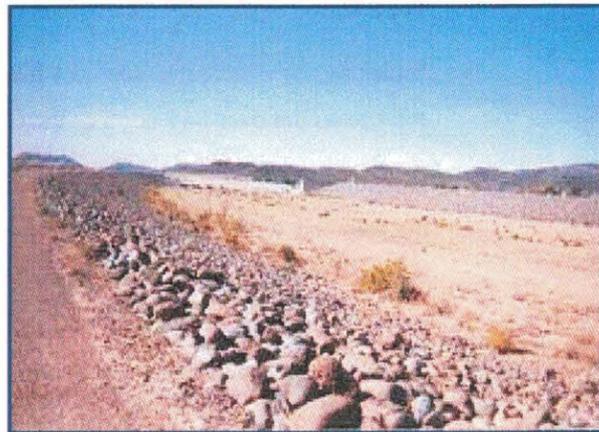


Figure 5.5 The Corp of Engineers Levees in Skunk Creek

The non-structural components of the Recommended Alternative at Site Number 2 consist of the FRP. It is also recommended that redelineation of the floodplain/floodway occur once the structural components have been implemented so that an accurate depiction of the flood hazard is known between Skunk Creek and I-17.

Some of the benefits of the Recommended Alternative are:

- Protection of residential and commercial areas immediately downstream of the CAP Canal from flooding
- Protection of I-17 from flooding
- Prevention of potentially damaging flows along the upstream side of the CAP Canal embankment
- Opportunities for trail linkage CAP Canal regional trail

Some of the disadvantages of the Recommended Alternative include:

- Impact to natural landscape with construction of levees, particularly north and south of the CAP Canal
- Affects to high-quality habitat along Sonoran Wash
- Requires acquisition of one business north of the CAP Canal

Environmental – The Recommended Alternative at this site consists of a pair of levees both north and south of the CAP Canal that will assist in constraining flows and help funnel water across existing flood overchutes at the canal. The levees will tie into existing levees along Skunk Creek south of the CAP Canal. The following text is a brief description of ecological resources, hazardous materials concerns, and cultural resources at the site, along with a list of recommendations and mitigation measures to remind future planners, designers, and contractors of the possible permits, surveys, and other environmental clearances that may be required in an effort to minimize environmental harm of levee construction.

Ecological Resources – The habitat of the proposed project area can be described as high- and medium-quality xeroriparian vegetation along Skunk Creek and Sonoran Wash with occasional saguaros in disturbed upland areas. The CAP Canal in the area is a special ecological feature because of the availability of year-round fresh water and the accessibility of perch sites on perimeter fence lines with little adjacent cover for predators. Combined with the CAP Canal, the washes form an important movement corridor for local wildlife (especially small mammals and birds). The thick xeroriparian vegetation combined with upland saguaros represents habitat components for the cactus ferruginous pygmy-owl (CFPO). Eroded banks in Sonoran Wash and other nearby rocky areas could be home to Sonoran desert tortoises (SDT). Levees north of the CAP Canal are proposed far enough east and west to encompass both drainages while being located in upland areas of low quality where only an occasional saguaro might be removed. Levees south of the CAP Canal are proposed to form a much tighter corridor nearer the washes but will avoid the channels themselves as they also cross low-quality upland habitat while tying into existing levees to the south. Impacts to wildlife may not necessarily result from the location of the levees themselves but from any ground disturbing activities done in the washes during construction and from construction –noise impacts to wildlife while the levees are being built.

- Construction of the levees should avoid the high-quality xeroriparian habitat present along Skunk Creek and Sonoran Wash. A dense patch of paloverdes growing along the existing levees of Skunk Creek at the southern end of the proposed project and ecologically sensitive cliff habitat in Sonoran Wash south of the CAP Canal should also be avoided.
- The permanent exclusion of grazing from the project area would aid in revegetation efforts, and native species could be replanted along the levee base, sides, and top to create a more lushly vegetated corridor.
- Revegetation efforts along the levee should include an appropriate diversity and density of native plants, including the appropriate xeroriparian plants, to help mitigate impacts to Skunk Creek and Sonoran Wash and maintain their usefulness as important wildlife movement corridors in the area.



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- Presence/absence surveys for CFPOs may be necessary for up to 2 years at sites located within Survey Zone 3 and outside the Phoenix Urban Exclusion Area if the United States Fish and Wildlife Service (USFWS) determine that ground-disturbing activities may affect the CFPO or its habitat.
- If SDT are encountered during construction, the contractor should follow the guidelines for handling and relocating tortoises as provided in the Arizona Game and Fish Department's (AGFD) *Guidelines for Handling Sonoran Desert Tortoises Encountered on Development Projects*.
- AGFD should be contacted to obtain updated and current information on special status species during the design and environmental clearance stages.
- If protected native plants are impacted by construction activities, a permit should be obtained from the Arizona Department of Agriculture (ADA) prior to clearing and grubbing. The permit may include salvaging provisions.
- Surveys of invasive species may be necessary. All disturbed soils that will not be landscaped or otherwise permanently stabilized by construction should be seeded using species native to the project vicinity.
- A Clean Water Act Section 404/401 permit will be required on projects which impact delineated "waters of the U.S.", as defined by the US Army Corps of Engineers (Corp).
- Because more than 1 acre of ground will be disturbed during project activities, and Arizona Pollutant Discharge Elimination System permit will be required from Arizona Department of Environmental Quality (ADEQ).

Hazardous Materials Concerns – No known hazardous materials concerns were discovered during a records check of the site; however, evidence of many instances of illegal dumping was seen scattered about during a site visit.

- During levee construction, efforts should be made to remove trash from the area.
- A Phase I Environmental Site Assessment for hazardous materials should be conducted prior to any property acquisition during the design phase. If suspected hazardous materials are encountered during construction, work should cease at that location and the appropriate authority should be contacted to arrange for proper assessment, treatment, or disposal of those materials.

Cultural Resources – Most of the proposed project area has already been surveyed for cultural resources. A historic dirt road (the "road from Phoenix to Prescott") was recorded in the project area in a survey dating back to 1895.

- The road's exact alignment should be researched and compared to the limits of disturbance for the levee construction, along with the eligibility of the road segment for inclusion in the National Register of Historic Places.
- For those areas not previously surveyed for cultural resources, a Class III (pedestrian) archeological survey should be conducted prior to ground-disturbing activities. All county, state, and federal archeological compliance guidelines should be followed during the design and implementation of future activities. New sites should be recorded and evaluated for possible inclusion in the National Register of Historic Places. While avoidance of known sites is preferred, unavoidable impacts might be mitigated by testing and data recovery of those sites.
- If previously unidentified cultural resources, including human remains, are encountered during activity related to the construction of the project, work should stop immediately at that location and all reasonable steps to secure the preservation of those resources should be taken. The appropriate authority (ies) should be contacted immediately to make arrangements for the proper treatment of those resources.

Landscape Theme – The levees will range from 6 to 9 feet in height and include a 10-foot operations and maintenance road. The overall landscape theme for the CAP Canal Levees is a natural Sonora Desert landscape that protects, enhances, and complements the existing setting. Multi-use trails should be integrated as part of the operations and maintenance road along the top of the proposed levees. The top of the levees offer excellent views to Union Hills, Middle Mountain, Pyramid Peak, Deems Hills, Bradshaw, New River, and North Mountains, and CAP Canal. Viewing opportunities along the operations and maintenance road/multi-use path should be integrated into the overall project aesthetic and combined with path rest nodes, trailheads, and /or destination points where possible. In addition viewing opportunities should also take into consideration the adjacent residential land use/private property owners.

Aesthetic Design – Aesthetic Concept: to incorporate the levee into a more natural appearing feature by using landscape berms that mimic on a smaller scale the distant mountain forms and incorporating plant material associated with Sonoran Desert scrub. [Figures 5.6, 5.7 and 5.8](#) illustrate the aesthetic concept for the CAP Canal levees.

Landscape Berm and Levee Criteria:

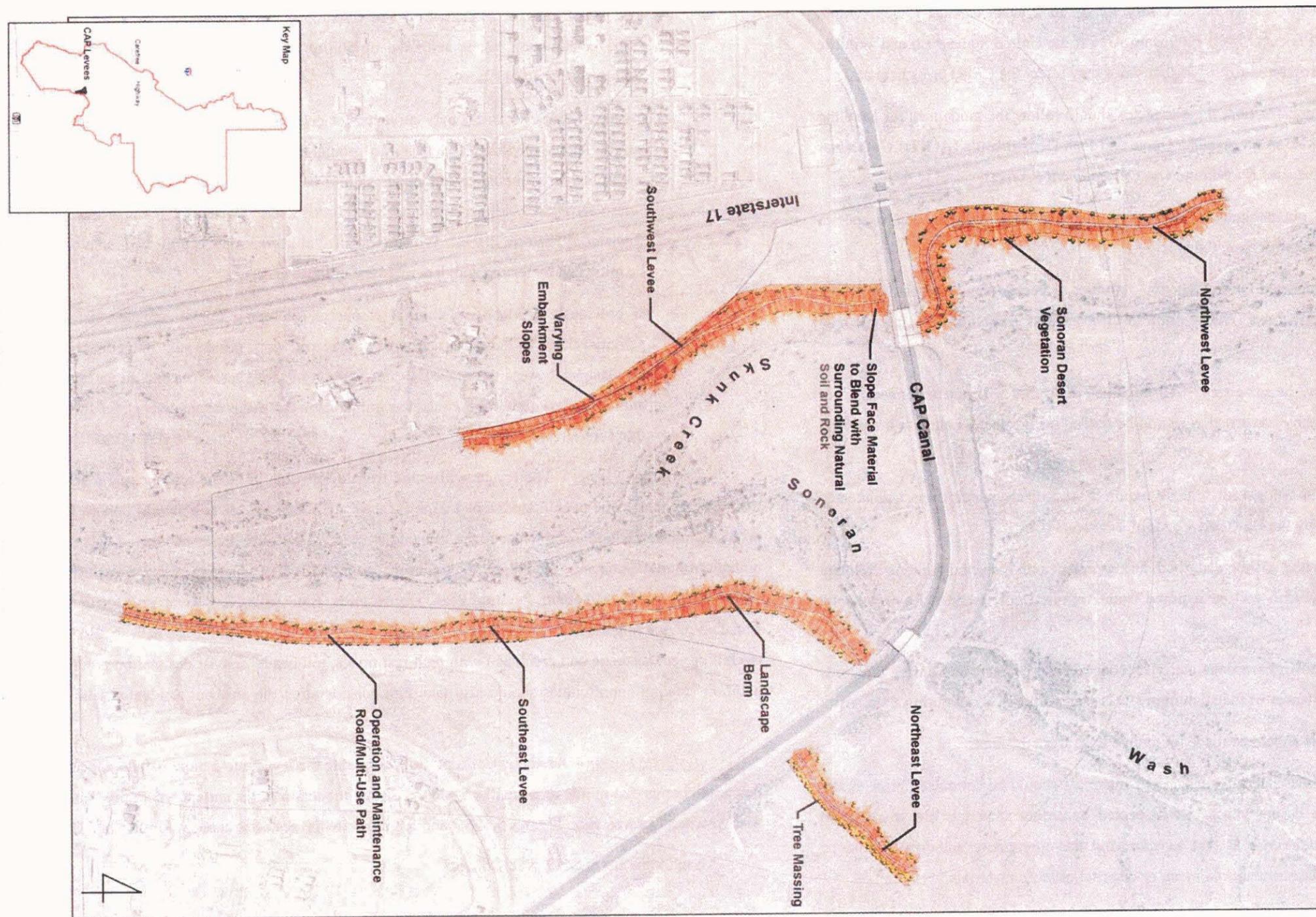
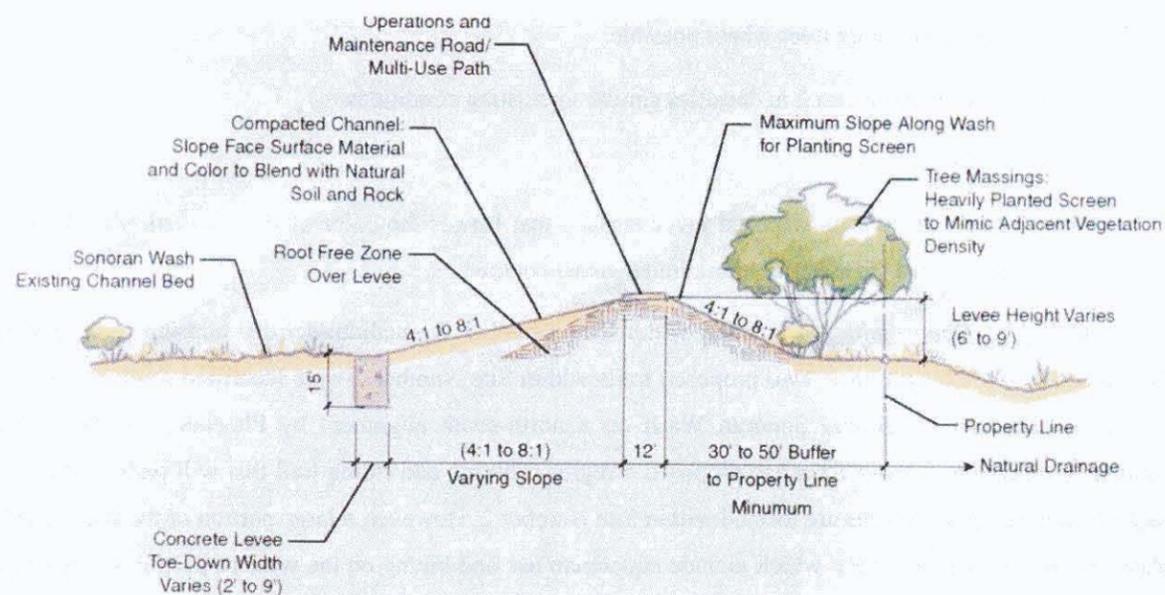


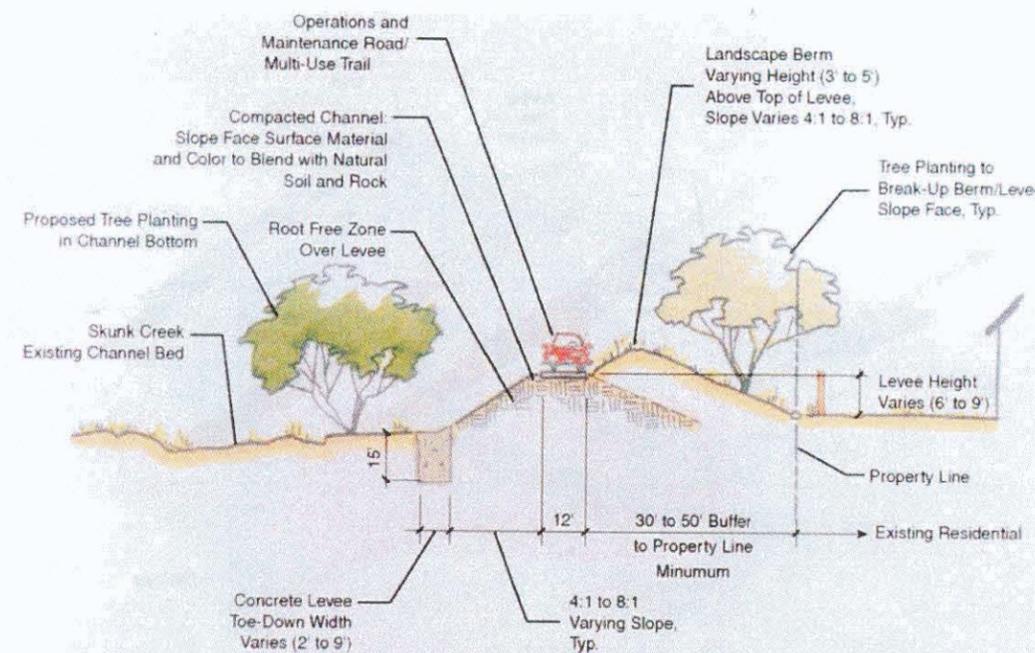
Figure 5.6 Recommended Alternative – CAP Canal Levee Aesthetic Treatments



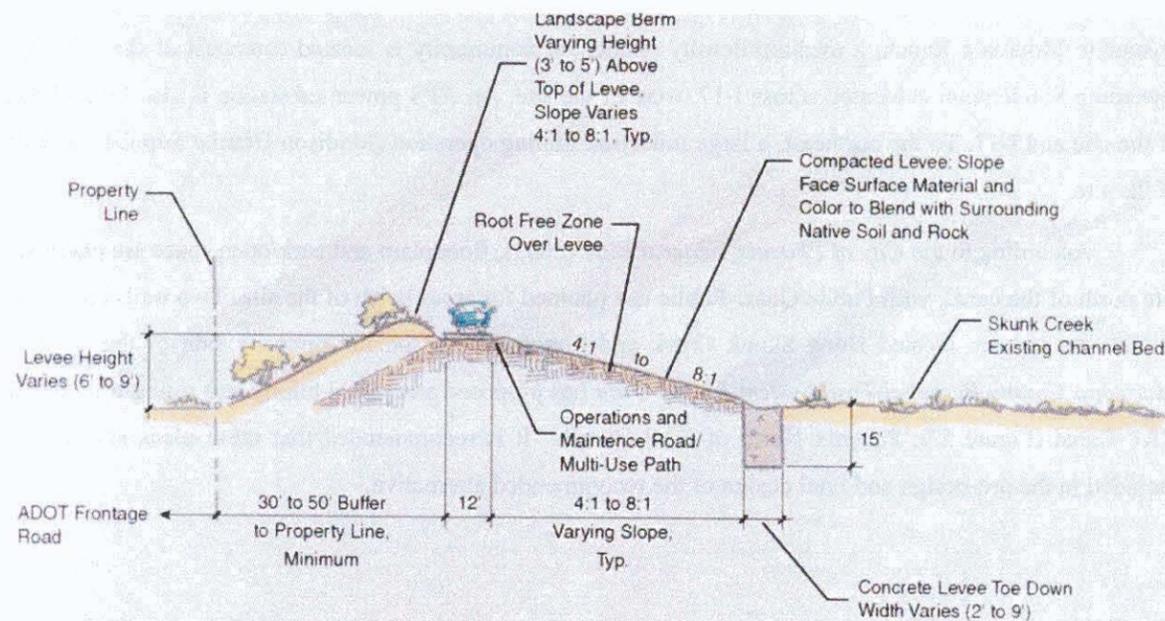
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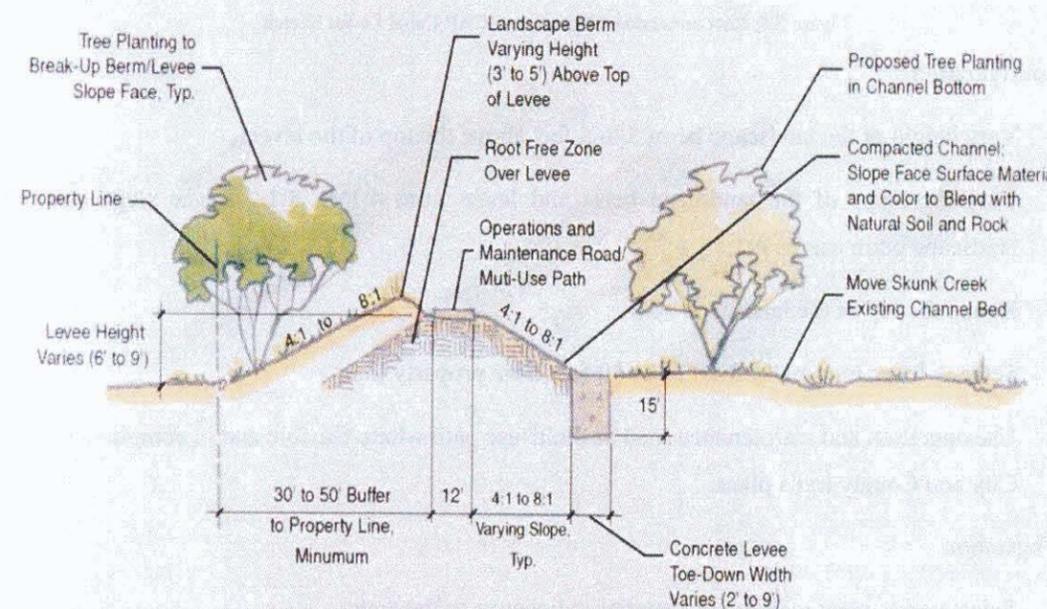
Northeast Levee



Southeast Levee



Northwest Levee



Southwest Levee

Figure 5.7 Recommended Alternative – CAP Canal Levee Aesthetic Treatments

Figure 5.7 Continued

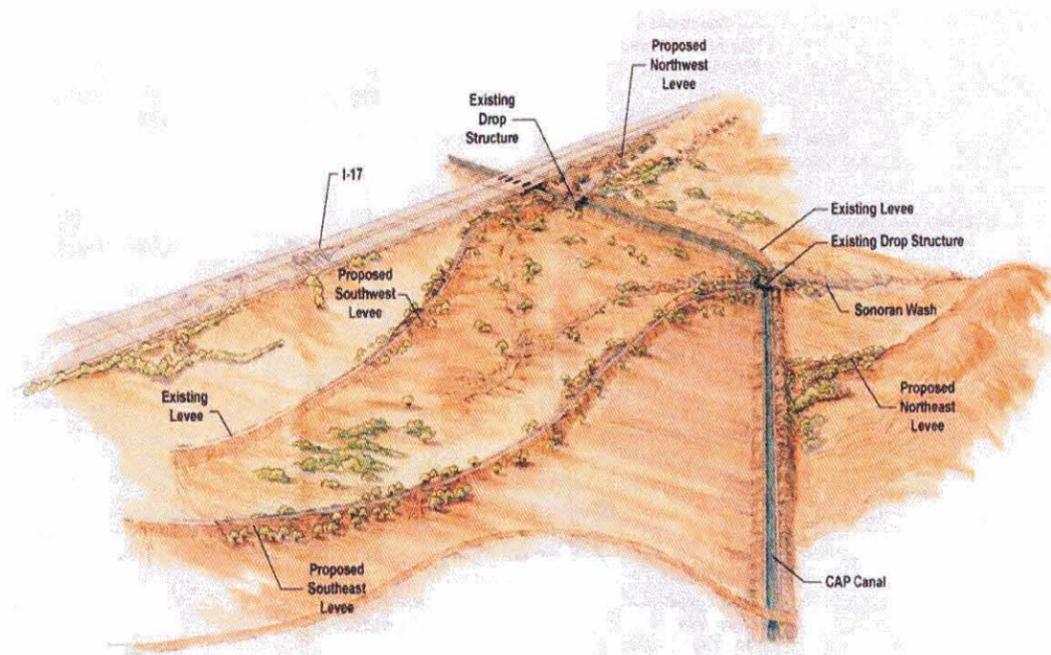


Figure 5.8 Recommended Alternative – CAP Canal Levee Sketch

1. Configuration

- Vary height of the landscape berm 3 to 5 feet above the top of the levee.
- Vary the slope of the landscape berm and levee from 4:1 to 8:1. Levee slope covered by the landscape berm can be 4:1.
- Round the top of the landscape berm.
- Setback levee minimally from 30 to 50 feet from property line.
- Use operation and maintenance road as multi-use path where feasible and in compliance with adopted City and County trails plans.

2. Vegetation

- Select native plant material or material indigenous to the area.
- Place trees, shrubs, ground covers, and rocks in an irregular pattern along the sides and top of the landscape berm to break-up the linear form of the landscape berm.

- Preserve mature trees where possible.
- Place plant material in densities similar to existing conditions

3. Materials

- Use materials for exposed levee surface that blends the color of the material with the surrounding native surface material to minimize visual contrast.

Multi-Use Opportunities - Located within Site Number 2, medium-density housing and open space are planned south of the CAP Canal. Two proposed trails within Site Number 2 were identified south of the CAP Canal, located along Skunk Creek and Sonoran Wash on a north-south alignment by Phoenix. The *Maricopa County Regional Trail System Master Plan* has proposed a regional hiking and riding trail that will parallel the CAP Canal. No developed recreational sites are located within Site Number 2. However, a large portion of the site is used for open space and recreational activities, which include equestrian use and hiking on the western portion of the site, users fly remote-controlled model airplanes and use level portions of the site for landings.

Within the site, two flood control structures cross the CAP Canal, facilitating Skunk Creek’s and Sonoran Wash’s southward drainage. Several low-density residences are located south of the CAP Canal and one to the north. Dynamite Mountain Ranch, a medium-density residential community is located southeast of the site and I-17, and Dynamite Subdivision is located across I-17, west of the site. An APS power substation is also located directly west of the site and I-17. To the northeast, a large industrial mining operation (Madison Granite Supplies) is within 1 mile of the site.

According to the *City of Phoenix General Plan (2001)*, floodplain and park/open space are planned within the site north of the canal, with Public/Quasi-Public use planned for areas north of the site. Two trails are proposed south of the site and are located along Skunk Creek and Sonoran Wash on the opposite side of the CAP Canal. The *Maricopa County Regional Trail System Master Plan* has proposed a regional hiking and riding trail that parallel the CAP Canal (*Figure 5.9: Phoenix North of CAP Canal*). It is recommended that these plans and trail systems be included in the pre-design and final design of the recommended alternative.

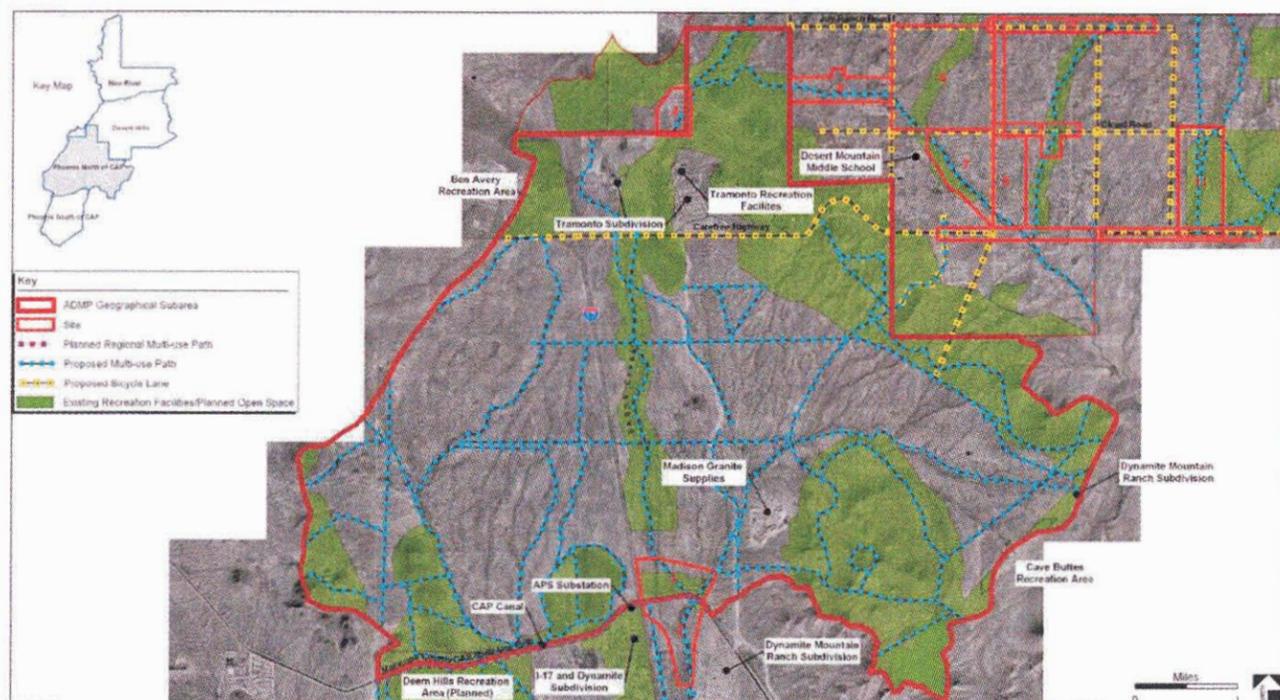


Figure 5.9 Phoenix North of the CAP, Multi-Use

The primary land uses within and surrounding the site are vacant/undeveloped (water/flood control) and open space. One residence is located in the western portion of the site, along the I-17 frontage road. Large, medium-density residential communities are located southwest (I-17 and Dynamite Subdivision) and southeast (Dynamite Mountain Ranch) of the site. Madison Granite Supplies has a large mining operation located approximately 1 mile northeast of the site. Most of area the surrounding the site is used for undesignated open space and recreational activities, including equestrian use and hiking.

Site Number 3

Problem Description – During the process of identifying problem areas within the ADMP study area, the ADMP team noticed that where Cloud Road bends north and transitions into 27th avenue, the existing alignment is located within the 100-year floodway of Skunk Creek. The ADMP team identified this site because of two major reasons. One, the high hazard potential of the roadway “washing out” would create a major public safety hazard and two; access north could be completely cut off due to the fact that the only other access to this area, at Skunk Creek and Desert Hills Drive, is a low water crossing.

Recommended Alternative - As the team moved into the recommended alternative phase of the project, the structural component of this site was dropped. Access to the north became the driving factor by the team. Site Number 8, a new bridge structure spanning the floodplain of Skunk Creek at Desert Hills Drive, also provides access to this same area. Since the bridge would be located on a major arterial road it became much more desirable to the team than Site Number 3. Significant property acquisition would also be necessary for the structural measure at this site. It is recommended that the existing roadway not be removed due to the secondary access that it does supply to the area north. The fact that Site Number 3 is not included in the recommended alternative as a structural measure means that the possibility exists for roadway “washouts”.

The element that is included in the recommended alternative is the FRP. The existence of the FRP will supply adequate protocol for emergency services and will alert those in the area when it is unsafe to follow this particular route.

Site Number 4

Problem Description – Site Number 4 (the area between 7th Avenue and 15th Avenue and between Joy Ranch Road and Cloud Road) was identified by the ADMP team during the process of problem identification. The hydrology in this area showed that there is a flow breakout that occurs from Desert Lake Wash that was not accounted for in the Skunk Tank Wash Hydrology. JEF performed a FLO-2D analysis that encompassed the area between 12th Street and 15th Avenue east and west and between Saddle Mountain Road and the Carefree Highway north and south. This FLO-2D analysis showed where this flow breakout occurred and defined how much of the flow went in each direction. Refer to Part 3, Volume 2 for the results of the FLO-2D analysis. Flow for Site Number 4 floods existing structures and inundates the roadway system. More specifically, the flow that crosses Joy Ranch Road from the north and flows across the State Land Parcel currently intersects 7th Avenue between Joy Ranch Road and Cloud Road. It then continues west into Skunk Tank Wash, flooding several structures along the way. At the Skunk Tank Wash Confluence, the flow combines with the Skunk Tank Wash flows coming from the north. The combined flow then continues west until it outfalls into Skunk Creek.

The main issues with this site are to lower the peak discharge to a level that would protect the residences in danger and to manage the flow in such a way that it can be conveyed through the system so that it does not inundate the roadway system or spread into inhabited properties.

Recommended Alternative - As the team moved into the recommended alternative phase of the project, the structural measures for this site were dropped. It was decided that the cost of these measures were too expensive. Also, public acceptance of the large basins and channels was low enough that justification of the structural measures was not warranted. It was recommended that the residences located within the floodway be included in the FPAP.

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The FRP is also recommended for this site. Adequate notification and response times can help to protect the local residents during flooding times. Development Guidelines are recommended to help to reduce the future effects of development within the area.

In the discussion for Site Number 5 mention is made to a Joy Ranch Road Interceptor Channel. This could also be used to minimize the effects of flooding for Site Number 4. However, since Site Number 4 is not included in the recommended alternative for structural measures, flooding will continue to occur during major storm events.

Site Number 5

Problem Description – Site Number 5 was identified by the ADMP team during the process of problem identification. Overland flow coming from the north either uses 7th Street from Saddle Mountain Road to Cloud Road as a flow corridor or it crosses 7th street around Desert Hills Drive and flows south through a developed area until it intersects Joy Ranch Road where it crosses and continues across the ASLD parcel to Cloud Road. Flooding of structures and the roadway system do occur north of Joy Ranch Road, but becomes a substantial concern once it reaches Cloud Road. The flow that comes down the right-of-way of 7th Street turns in a southwesterly direction and sheet flows across a developed area before it enters Desert Lake Wash again west of 3rd Street. The flow coming down Desert Lake Wash continues south of Cloud Road inundating several floodway residences, combining with the flow from 7th street, and continuing southeast back to 7th Street and eventually past the Carefree Highway toward Cave Creek.

The main issues with this site are to confine the flows from the north in such a manner as to convey them through the area without flooding the roads or any of the existing structures. Removal of structures from the floodway is also an important aspect of this site.

Recommended Alternative – Design flows for this site came from a HEC-1 model performed by JEF that was built as described in Part 9, Volume 2. Site Number 5 began as several individual sites that were somewhat tied into the same system. The recommended alternative at Site Number 5 is detailed as flow coming from the north is intercepted in a channel that parallels 7th Street from Irvine Street to Joy Ranch Road. One Culvert would need to be constructed for access within this stretch of channel. Once the flow gets to Joy Ranch Road, it is necessary to convey the flow from the northeast corner of the intersection to the southwest corner of the intersection. This would be done in a culvert that would outlet onto the ASLD parcel.

Once the flow crosses the intersection of 7th Street and Joy Ranch Road, it continues parallel to Joy Ranch Road for approximately 1,300 feet. This Channel has three functions; 1) to convey flow to the channel which flows south to below Cloud Road; 2) to intercept flow crossing Joy Ranch Road from the north out of the developed area; 3)

to function as an inlet weir section to the offline detention basin located in the northeastern corner of the ASLD parcel. The ultimate channel design will be a function of the amount of flow spilled to the basin which JEF estimates at 250 cfs.

The detention basin is designed with a required volume of 40 acre-feet to make it function correctly. For the graphical context of this report, JEF designed the basin at 5 feet deep. This basin will require a control/spillway structure to allow all but 250cfs of inflow hydrograph into the basin.

After the peak has been reduced by the detention basin, a channel will be constructed that will flow south to Cloud Road (Figure 5.10) where it will be conveyed under the Roadway by a culvert. Flow will then continue down to Leisure Lane where it will flow under the roadway in another culvert.

South of Leisure Lane, the flow will be conveyed in a channel until approximately 250 feet south of 3rd Street. The flow will also cross Galvin Street and 3rd Street in culverts. The channel from Restin Road to 7th Street is to be a regrade of the existing wash to a section the intent of which is to provide a bank-full capacity for something less than the 100-year flow (approximately 1,100 cfs), with the full 100-year flow being conveyed in a floodway (encroached section) that surcharges the channel by one foot.

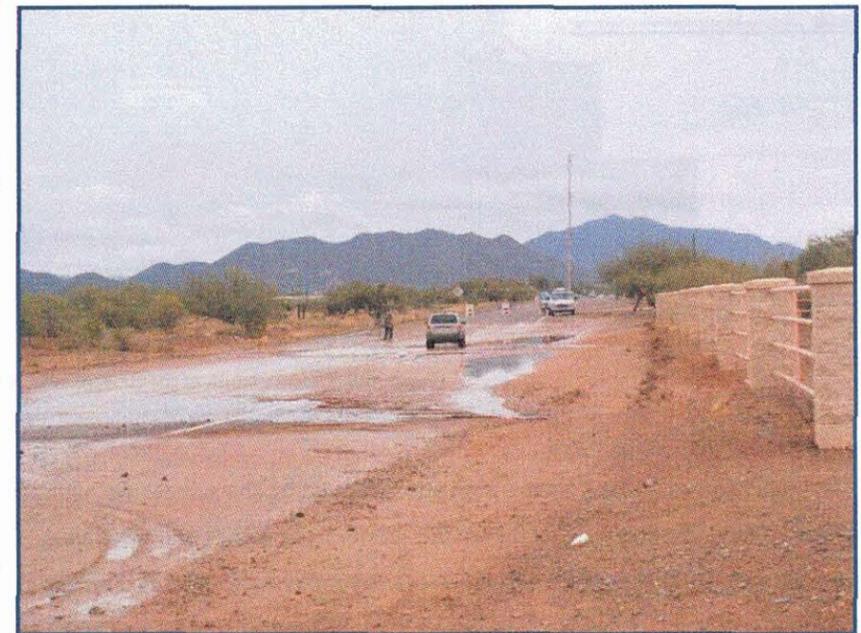


Figure 5.10 Desert Lake Wash Flooding at Cloud Road (10-10-03)

The channels for Site Number 5 were designed using normal depth calculations and using the FlowMaster program distributed by Haestad Methods. The roadway crossings were designed using the HY8 computer program as distributed by the University of Florida, McTrans Center for Microcomputers in Transportation. FlowMaster output, HY8 printouts, and basin design calculations can also be found in Part 9, Volume 2.



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The non-structural components of the Recommended Alternative include; 1) The FPAP for floodway residents along Desert Lake Wash, 2) The FRP for the entire region, and 3) New Development Guidelines to better control future development within the area.

Some of the benefits of the Recommended Alternative include:

- Removes Desert Lake Wash floodway residents downstream of Cloud Road from flooding hazard through the FPAP
- Protects 7th Street and Cloud Road from Desert Lake Wash flooding
- Opportunity to create long wildlife corridor along Desert Lake Wash to link to trails and open space at Desert Mountain Middle School and ASLD parcel
- Opportunity to improve aesthetic quality of wash corridor

Some of the disadvantages of the Recommended Alternative include:

- Current Street flooding at 7th Avenue, Joy Ranch Road, and Maddock Road will continue.

Environmental – LSD provided an environmental summary for Site Number 5. Drainage structures added in residential areas could be made wildlife-friendly and could help restore smaller wash connectivity. This site is located in survey zone 3 for CFPO. A few storage tanks at convenience stores and farms are present within the area. Drainage structures constructed in this area would need to be visually compatible with nearby residences. Any trails constructed need to tie to open space at the Desert Mountain Middle School. The visual character in this area is mostly “rural ranch residential” with numerous equine facilities. Little consistency exists in the area with regard to material, style, or color. Any drainage structures constructed would need to be visually compatible with nearby residences. Also, any improvements constructed around the ASLD parcel would be very visible in regards to development plans associated with the ASLD parcel.

Site Number 6

Problem Description – While analyzing the alternatives in the Desert Hills area, it was observed that many of the roadway crossings associated with the Carefree Highway were undersized when analyzed with the 100-year recurrence interval storm. Therefore Site Number 6 was identified by the ADMP team as an area of concern. The probable impassable crossings along the Carefree Highway are at Desert Lake Wash, Desert Hills Wash, Apache Wash, the West Branch of Paradise Wash and Paradise Wash itself.

In addition to impassable crossings in the 100-year event, it was also identified in the FLO-2D analysis, referred to earlier for Site Numbers 4 and 5, that flow running along the south side of the Carefree Highway between 3rd Avenue and the crossing of Desert Lake Wash is confined into a channel that does not contain the 100-year event. The channel and driveway access crossings are under-sized.

The main issues with this site are to confine the flows in the existing washes by upgrading the roadway crossings and upgrade the channel between 3rd Avenue and the Desert Lake Wash Crossing so that it is confined within the channel.

Recommended Alternative – The structural alternative analyzed during the ADMP reduced the flooding associated with roadway crossings and allowed for 100-year flows to pass under the Carefree Highway. However, the Maricopa County Department of Transportation (MCDOT) had recently upgraded Carefree Highway and the cost of upgrading at this point was not a very viable option for them. The Carefree Highway is also considered a scenic roadway, so a higher standard of design would also make structural alternatives very expensive. Because of these reasons, the ADMP team did not see structural alternatives as a viable solution for the recommended alternative. The non-structural FRP is recommended to help aid the residents and emergency responders in the event of flooding. It is necessary to state that because structural alternatives have not been recommended as an alternative, flooding around these structures is probable. Possible “washouts” could occur and access to many residents and business would be lost if this occurred.

Site Number 7

Problem Description - The Cave Creek Watercourse Master Plan identified this site as a problem area. Site 7 became a problem when the decision was made to locate 24th Street north of the Carefree Highway in the bottom of Apache Wash. The roadway and Apache Wash coexist for nearly 700 feet at one location and about 250 feet at another.

In the 100-year event of 7,210 cfs 24th Street is impassable. 24th Street is a primary artery for the area north. This situation will only increase in severity as the area north continues to develop.

Recommended Alternative – Design flows for this site came from Part 3, Volume 1 of the ADMP report. The design 100-year peak flow of 7,210 cfs comes from the north and flows directly south encompassing 24th Street for most of its length from Cloud Road to the Carefree Highway.

Although somewhat challenging, realigning 24th Street up out of Apache Wash was determined by the ADMP team to be the structural component of the Recommended Alternative. For this alternative, 24th Street would be realigned to the west side of Apache Wash, generally along the existing natural ridge. At the Carefree Highway, the

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intersection would also need to be shifted west of Apache Wash so that there is no need for crossing of the wash at all. At Cloud Road, the current intersection could be left alone since the roadway can be swung back into its original location at this point. The road can be built in the floodplain fringe and elevated to preserve land. In fact, a breakout area just north of the Carefree Highway could be eliminated and kept within the Apache Wash corridor. No new culvert would be required to cross Apache Wash. A relief culvert may be required at the Carefree Highway depending on how the breakout flow is actually handled.

The non-structural components of the Recommended Alternative consist of the FRP and the Development Guidelines. New Development Guidelines would help to control how future development would occur upstream of the site so that existing flows may be maintained at the current level.

This alternative removes the roadway out of the flood hazard and becomes an all weather access. No Apache Wash crossings are needed. The opportunity of stopping breakout flow from Apache Wash is possible if that is considered desirable. All of the adjacent land is ASLD trust land. Because of this, the possibility exists for cost share either with the State Land Department or with a potential buyer of this property.

Environmental – LSD provided an environmental summary for Site Number 7. It is important that the connectivity to the Carefree Highway be done in such a manner that improvements are made to the multiuse path along the corridor. Drainage structures added in residential areas could be made wildlife-friendly and could help restore smaller wash connectivity. The avoidance of stock tanks and paloverde-mixed cacti association at this site is also important. This site is located in survey zone 3 for CFPO. Habitat restoration is a real possibility for Apache Wash. The Carefree Highway corridor is designated as a scenic corridor. The visual character in this area is mostly “rural ranch residential” with numerous equine facilities. Little consistency exists in the area with regard to material, style, or color. Any drainage structures constructed would need to be visually compatible with nearby residences.

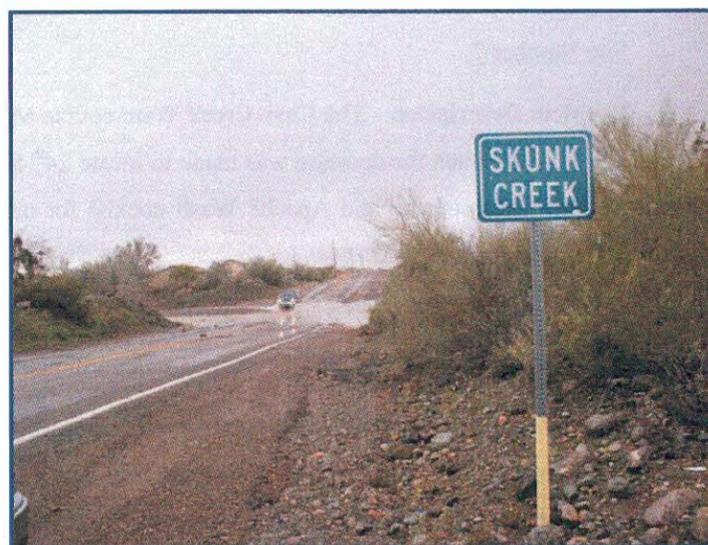


Figure 5.11 Skunk Creek Crossing at Desert Hills Drive (1-1-02)

Site Number 8

Problem Description – Included in the

sites recommended for upgrade in the Skunk Creek Watercourse Master Plan was Site Number 8. Site Number 8 is the confluence of Desert Hills Drive and Skunk Creek (Figure 5.11).

At this location, the flow coming down Skunk Creek intersects Desert Hills Drive, which is a low water crossing. All flow, including minor nuisance flow, crosses over the roadway surface creating a frequently closed situation. This crossing is continually barricaded during storm events.

From the discussion in Part 8, Volume 4, Section 1, Section 3.2.3, this location is one of two access points to the area west of Skunk Creek. Currently, if the roadway at Cloud Road and 27th Avenue (Site Number 3 that was not included in the Recommended Alternative) were washed out and Site Number 8 was inundated with active flow, access to the west side of Skunk Creek would be cut off and residents would be stranded. Additionally, this would not allow for emergency services to cross Skunk Creek. The new Daisy Mountain fire station is located just east of Skunk Creek on Desert Hills Drive and 11th Avenue.

Recommended Alternative – Only one full structural component makes sense at this site for the Recommended Alternative and that is to bridge the crossing. The flows in this location are too large to warrant box culverts and would not allow for wildlife to cross under the roadway. The actual bridge looked at for this alternative is one that would span the floodplain. This is necessary so that the current flows are not disturbed in any way. Increasing water surface elevations at this location would mean increased flooding to current structures.

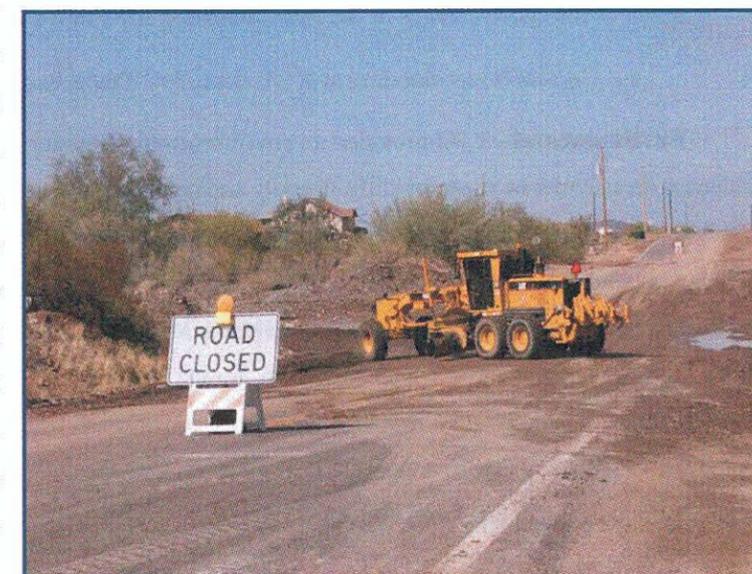


Figure 5.12 Skunk Creek Crossing Maintenance at Desert Hills Drive (9-19-04)

One additional problem had to be solved for Site Number 8 because of the placement of the bridge itself. In order for the bridge to be able to span the floodplain, it cuts off access from Desert Hills Drive onto 15th Avenue, which is located just east of Skunk Creek in the floodway. For the full structural alternative, 15th Avenue access would be accomplished by upgrading Tanya Road to a paved section from its intersection with 15th Avenue east to 11th Avenue. 11th Avenue would also be upgraded to a paved section from Tanya Road north to the intersection of Desert Hills Drive.

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The non-structural components of the Recommended Alternative consist of the FRP and new Development Guidelines. New Development Guidelines will help to control future development within the area so that current flows are maintained.

Environmental – LSD provided an environmental summary for Site Number 8. Drainage structures added in residential areas could be made wildlife-friendly and could help restore smaller wash connectivity. This site is located in survey zone 3 for CFPO. Drainage structures constructed in this area would need to be visually compatible with nearby residences. The visual character in this area is mostly “rural ranch residential” with numerous equine facilities. Little consistency exists in the area with regard to material, style, or color.

Site Number 9

Problem Description – While looking at the issue of access throughout the Desert Hills/New River area for the Flood Response Plan, the Skunk Creek WCMP identified this location as a problem area for access north into New River. The ADMP team analyzed the issues associated with the area and agreed that the culvert crossing at Rodger Creek and the New River Road was in imminent danger of failure. If this were to occur, the only access into the New River area is from the I-17 exit to the west. Emergency services would be greatly hampered because of the distance that would have to be taken to get north into the area.



Figure 5.13 Rodger Creek Crossing Erosion Damage at New River Road (9-19-04)

Flow in Rodger Creek coming from the northeast out of the area between Pyramid Peak and Apache Peak to the north crosses the New River Road in two 8 foot diameter culverts. The headwalls of these culverts are hand placed rock and are very old and damaged. The 100-year peak discharge overtops the roadway making it impassable. Once flow exits these structures, serious erosion problems along the southern bank is evident (Figure 5.13) and needs to be replaced or modified so that it functions more efficiently. The flow in Rodger Creek also inundates a floodway residence downstream of the crossing before it eventually enters Skunk Creek.

Recommended Alternative – The full structural component of the Recommended Alternative for Site Number 9, like Site Number 8, is a 400 foot long span bridge over Rodger Creek that would span the floodplain. The roadway profile would need to be raised to accommodate the flow from Rodger Creek, but containment of the flow would be the driving force for the expense needed to achieve a bridge. A bridge would provide a 100-year all weather access, reduce the floodplain elevation and limits upstream of the culverts, and would potentially reduce scour of the left bank downstream due to existing culvert outflows. The cost is high, but MCDOT is a potential partner. A bridge would also improve moderate habitat in the area to high and would provide a corridor for the Maricopa County trail system. This alternative does not remove the residence located within the floodway from the current hazard.

The non-structural components of the Recommended Alternative for this site include; 1) The FRP; 2) The FPAP for the residence downstream of the proposed bridge; and 3) New Development Guidelines to control future development within the area so that current flows are maintained.

Some of the benefits of the Recommended Alternative include:

- Protects New River Road from Rodger Creek flooding and maintains access between New River and Desert Hills
- Opportunity to link to regional trail proposed for New River Road
- Opportunity to build bridge compatible with proposed regional trail from Lake Pleasant to Cave Creek
- Bridge crossing more wildlife-friendly than existing culvert at Rodger Creek

Environmental – LSD provided an environmental summary for Site Number 9. Lots of undisturbed Arizona Upland vegetation (upland tree and cacti) exist within the area of the site. This site is located in survey zone 3 for CFPO as well as the Sonoran Desert Tortoise (SDT). Scattered illegal dumping is present throughout the area. The Lake Pleasant to Cave Creek regional trail alignment is proposed along the right-of-way of this site. Drainage structures constructed in this area would need to be visually compatible with nearby residences. Many prominent views to the surrounding landforms are present around the site. The visual character in this area is mostly “rural ranch residential” with numerous equine facilities. This area is even more rustic with rolling terrain and undisturbed uplands. Little consistency exists in the area with regard to material, style, or color.

Site Number 10

Problem Description – Site Number 10 evolved from discussions and field visits of the ADMP team. It was observed that flow in the Cline Creek tributary to Skunk Creek coming southwest out of the Tonto National Forest

made a large sweeping bend (Figure 5.14) at the base of Circle Mountain Road before it continued under the New River Road Bridge. Circle Mountain Road is elevated approximately 10 feet above the bottom of the wash bottom. The sideslope embankment of the roadway is currently unprotected from erosion in any way.

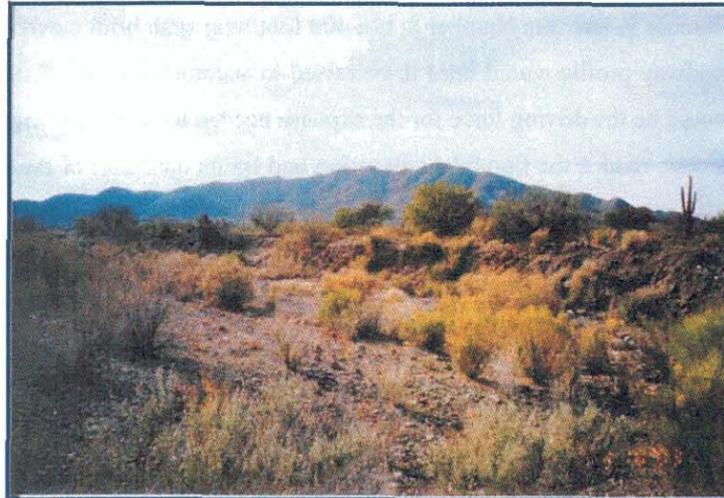


Figure 5.14 Cline Creek at Circle Mountain Road (1-10-03)

The reason that this particular location is critical is due to the fact that this is the sole access into the Cline Creek Area. If the roadway embankment were to fail due to erosion, access would be cut off for approximately four square miles of developed land. Emergency access would only be available through the air.

Recommended Alternative – Site Number 10 is highly visible to the surrounding area, so aesthetics is an important factor in the solution chosen for this site. The full structural component of the Recommended Alternative for this site consists of terraced walls that would be supplemented with a more naturalized treatment such as native plants and grasses. This alternative is much more visually pleasing as opposed to the more hard engineered solutions looked at in the Phase I. This treatment would actually incorporate terraced gabion baskets that would be placed into the embankment. Dumped rock riprap would be placed below the gabions to protect the toe of the slope to the scour depth. Backfill would then be placed over the gabion baskets and riprap. The embankment would then be planted with natural vegetation of a type that would hold the slope in higher recurrence interval storms such as the 2-year event. Maintenance of the site would be necessary if a larger (100-year) event occurred that removed the top layer of the treatment. The integrity of the roadway embankment would not be compromised in anything less than a 100-year event.

The non-structural components of the Recommended Alternative for this site consist of the FRP, FPAP, new Development Guidelines, and Cline Creek FDS.

Some of the advantages of the Recommended Alternative include:

- Removes Cline Creek floodway residents from flooding hazard through the FPAP

- Protects Circle Mountain Road from Cline Creek flooding and maintains access to residential area

Opportunity for more improved aesthetic design of terraced bank protecting Circle Mountain Road at Cline Creek

Environmental – LSD provided an environmental summary for Site Number 10. Lots of undisturbed Arizona Upland vegetation (upland tree and cacti) exist within the area of the site. This site is located in survey zone 3 for CFPO as well as the SDT. Scattered illegal dumping is present throughout the area. Links need to be maintained to open space in the Pyramid Peak area. Drainage structures constructed in this area would need to be visually compatible with nearby residences. Many prominent views to the surrounding landforms are present around the site. The visual character in this area is mostly “rural ranch residential” with numerous equine facilities. This area is even more rustic with rolling terrain and undisturbed uplands. Little consistency exists in the area with regard to material, style, or color.

Site Number 11

Problem Description – During the course of the WCMP, the WCMP team identified Site Number 11 as a considerable problem area. The problems include; 1) Residences in the floodway. 2) Flow breakouts occurring in many locations. 3) A bridge that has a very severe skew with regards to the flow of Skunk Creek.

Flows come down from the north in Skunk Creek. When they get to Wolf Trap Road, they begin to break out to the west and southwest. The flow continues to breakout from this location until approximately 600 feet north of the New River Road Bridge. The flow that breaks out continues west/southwest until it reaches the New River Road. At this point the flow inundates the roadway, crosses to the south, floods several residences, then turns southeast until it intersects back into Skunk Creek.

This occurs because of the following reasons; 1) The channels in the area are braided with low banks that tend to allow flow to jump between flowpaths from flow event to flow event. 2) Flows, as they approach the bridge, are backed up due to the skew of the bridge combined with steeper slopes approaching the bridge flattening out causing the stream to drop its sediment and aggrade through the bridge section increasing the water surface elevations and therefore pushing water out of the system.

Breakout that reaches New River Road just west of the bridge occurs in less than the 10-year recurrence interval and occurs at a rate of between 700 and 1,000 cfs. The velocities impacting the road at this location are on the magnitude of 5 to 8 feet per second. Approximately 20 homes are impacted by this breakout in one form or another.

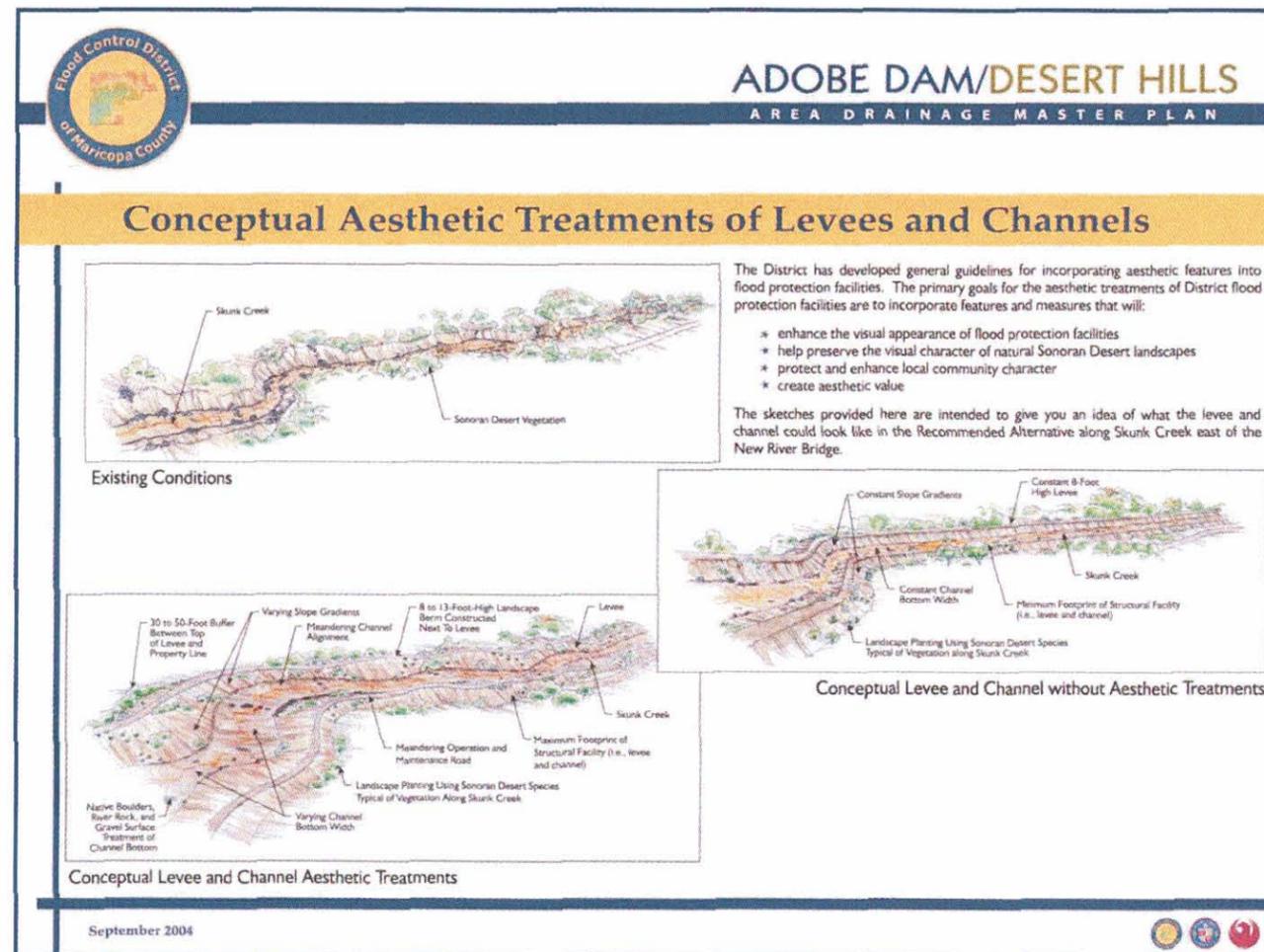


Figure 5.15 Site Number 11 Levee Concepts (9-04)

Alternatives – Modeling of this area has taken on many forms. The FCDMC commenced FLO-2D modeling of this area prior to the beginning of this project which continues to the current date. Refer to *Recommended Alternative Report Appendices, Part 9, Volume 2, Appendix B* for full printouts of FLO-2D modeling performed by the FCDMC. The current FIS study, performed by Montgomery Watson in 1997, is the current regulated floodplain/floodway for Skunk Creek. Part 4, Volumes 1 and 2 of the ADMP are a mix of detailed and approximate zone A delineations of Skunk Creek to just below the confluence of tributary 6B and Skunk Creek to the County boundaries in the north. This study also included a portion of tributary 6B and tributary 28.8339. Part 4, Volumes 7 and 8 of the ADMP, are floodplain delineations that include portions of Cline Creek Tributary C6, Skunk Creek

Tributary 10A, Upper Skunk Tank Wash, East Fork Desert Lake Wash and West Fork Apache Wash. Of these the Skunk Creek Tributary 10A enters Skunk Creek just south of Wolf Trap Road. All of these studies provided backup to the analysis of Site Number 11.

The full structural component of the Recommended Alternative for Site Number 11 is to construct levees upstream and downstream of the New River Road Bridge (Figure 5.15). These levees would stretch approximately 6,200 lineal feet and would be constructed along both banks confining the flows within Skunk Creek upstream and downstream of the bridge. This alternative would remove all of the homes from the floodway and keep New River Road an all weather access during 100-year recurrence intervals. The downside to this alternative is that it will carry a high price tag, flows that naturally flow into Skunk Creek currently would be difficult to bring into the system, and the levees could create a negative visual impact to the surrounding area. This alternative has some challenges associated with it. The acquisition of right-of-way for the levee system may be difficult, the permitting required for construction could be expensive and difficult, visual design of the levees will be expensive and challenging, and the habitat value around the bridge is moderate to high and would be impacted. JEF also performed an analysis using the FlowMaster computer program to determine the range of channel bottom widths that would be acceptable based on depth and velocity. The results of this analysis are that at 24 foot bottom width and 3 to 1 sideslopes the channel velocity is 16.74 feet per second. At a channel bottom width of 40 feet, the resulting velocity is 16.21 feet per second. Even though the depths reduce, the velocity remains somewhat constant creating the need for grade control structures, energy dissipaters, and possible erosion protection to reduce erosion within the final design.

The non-structural components of the Recommended Alternative for Site Number 11 consist of the FRP, the FPAP, new Development Guidelines, and Upper Skunk Creek and Tributary 6A FDS. Redelineation of the construction area is recommended once construction is complete. This new FDS will provide the actual limits of the flood hazard.

Some benefits of the Recommended Alternative include:

- Removes Skunk Creek and Tributary 6A floodway residents from flooding hazard through the FPAP
- Protects New River Road from Skunk Creek flooding
- Opportunity to link to regional trail proposed for New River Road

Some disadvantages of the Recommended Alternative include:

- Levees impact high-quality habitat along Skunk Creek
- Levee impacts the landscape's scenic integrity and substantially alters existing character of setting



ADOBE DAM/DESERT HILLS AREA DRAINAGE MASTER PLAN

Environmental – The Recommended Alternative at this site consists of a pair of levees that will assist in constraining flows along Skunk Creek and help funnel water underneath the bridge at New River Road. No levees currently exist along Skunk Creek in the vicinity of the bridge. The following text is a brief description of ecological resources, hazardous materials concerns, and cultural resources at the site, along with a list of recommendations and mitigation measures to remind future planners, designers, and contractors of the possible permits, surveys, and other environmental clearances that may be required in an effort to minimize environmental harm of levee construction.

Ecological Resources – The habitat of the proposed project area can be described as high- and medium-quality xeroriparian vegetation along Skunk Creek, which is largely undisturbed and unfragmented in the area (only occasional structures built next to the wash). Upland vegetation is lush, and saguaros and other cacti are numerous. Skunk Creek here is generally wide and rocky and is an excellent wildlife corridor through the steep and not-easily-accessible uplands of the greater New River area and the Tonto National Forest to the east. The thick xeroriparian vegetation combined with upland saguaros represents habitat components for the CFPO. The abundance of rocky hillsides and eroded cliff banks in Skunk Creek could be home to SDTs. Levees along Skunk Creek will undoubtedly require the removal of previously undisturbed upland and xeroriparian vegetation along their entire lengths. Impacts to wildlife and native plants will arise not only from the placement of the levees alongside the wash but also from construction activities staged in the wash channel itself. Because of the proximity of the levees to Skunk Creek, noise impacts to wildlife while the levees are being built are likely.

- Construction of the levees should avoid the high-quality xeroriparian habitat present along Skunk Creek. Ecologically sensitive cliff habitat in Skunk Creek should also be avoided.
- Revegetation efforts along the levee should include an appropriate diversity and density of native plants, including the appropriate xeroriparian plants, to help mitigate impacts to Skunk Creek and maintain its usefulness as an important wildlife movement corridor in the area.
- Presence/absence surveys for CFPOs may be necessary for up to 2 years at sites located within Survey Zone 3 and outside the Phoenix Urban Exclusion Area if the USFWS determine that ground-disturbing activities may affect the CFPO or its habitat.
- If SDT are encountered during construction, the contractor should follow the guidelines for handling and relocating tortoises as provided in the AGFD's *Guidelines for Handling Sonoran Desert Tortoises Encountered on Development Projects*.
- AGFD should be contacted to obtain updated and current information on special status species during the design and environmental clearance stages.

- If protected native plants are impacted by construction activities, a permit should be obtained from the Arizona Department of Agriculture (ADA) prior to clearing and grubbing. The permit may include salvaging provisions.
- Surveys of invasive species may be necessary. All disturbed soils that will not be landscaped or otherwise permanently stabilized by construction should be seeded using species native to the project vicinity.
- A Clean Water Act Section 404/401 permit will be required on projects which impact delineated "waters of the U.S.," as defined by the Corp.
- Because more than 1 acre of ground will be disturbed during project activities, and Arizona Pollutant Discharge Elimination System permit will be required from ADEQ.

Hazardous Materials Concerns – No known hazardous materials concerns were discovered during a records check of the site; however, evidence of many instances of illegal dumping was seen scattered about during a site visit.

- During levee construction, efforts should be made to remove trash from the area.
- A Phase I Environmental Site Assessment for hazardous materials should be conducted prior to any property acquisition during the design phase. If suspected hazardous materials are encountered during construction, work should cease at that location and the appropriate authority should be contacted to arrange for proper assessment, treatment, or disposal of those materials.

Cultural Resources – Very little of the proposed project area has been surveyed for cultural resources (only a parcel along a portion of New River Road). An unnamed historic dirt road cuts across the site in its northern half.

- The road's exact alignment should be researched and compared to the limits of disturbance for the levee construction, along with the eligibility of the road segment for inclusion in the National Register of Historic Places.
- For those areas not previously surveyed for cultural resources, a Class III (pedestrian) archeological survey should be conducted prior to ground-disturbing activities. All county, state, and federal archeological compliance guidelines should be followed during the design and implementation of future activities. New sites should be recorded and evaluated for possible inclusion in the National Register of Historic Places. While avoidance of known sites is preferred, unavoidable impacts might be mitigated by testing and data recovery of those sites.



ADOBE DAM/DESERT HILLS AREA DRAINAGE MASTER PLAN

- If previously unidentified cultural resources, including human remains, are encountered during activity related to the construction of the project, work should stop immediately at that location and all reasonable steps to secure the preservation of those resources should be taken. The appropriate authority (ies) should be contacted immediately to make arrangements for the proper treatment of those resources.

Landscape Theme – The levees will range from 6 to 9 feet in height and include a 10-foot operations and maintenance road. Similar to the CAP Canal levees, multi-use paths should be integrated as part of the operations and maintenance road along the top of the proposed levees. The paths should be integrated into the overall project aesthetic. In addition, channel improvements in Skunk Creek will be constructed in the vicinity of the New River Road Bridge to keep all streamflow in the channel passing through the bridge opening. The overall landscape theme for the New River Levees is a natural Sonoran Desert landscape that protects, enhances, and complements the existing setting.

Aesthetic Design – Aesthetic Concept: to incorporate the levee into a more natural appearing feature by using landscape berms that mimic the existing rolling terrain, to vary the width of Skunk Creek and maintain the natural curvilinear characteristics of the channel, and to incorporate plant material associated with a natural Sonoran Desert wash (Skunk Creek). [Figures 5.16](#) and [5.17](#) illustrate the aesthetic concept for the New River Bridge Levees.

Landscape Berm and Levee Criteria:

1. Configuration

- Vary height of the landscape berm 3 to 5 feet above the top of the levee.
- Vary the slope of the landscape berm and levee from 4:1 to 8:1. Levee slope covered by the landscape berm can be 4:1.
- Round the top of the landscape berm.
- Setback levee minimally from 30 to 50 feet from property line.
- Use operation and maintenance road as multi-use path where feasible and in compliance with adopted city and county trails plans.

2. Vegetation

- Select native plant material or material indigenous to the area.

- Place trees, shrubs, ground covers, and rocks in an irregular pattern along the sides and top of the landscape berm to break-up the linear form of the landscape berm.
- Preserve mature trees where possible.
- Place plant material in densities similar to existing conditions.

3. Materials

- Use materials for exposed levee surface that blends the color of the material with the surrounding native surface material to minimize visual contrast.

4. Channel Criteria

- Construct irregular channel bottom slope. Accentuate the changes in grade by the placement of rocks, similar to a natural wash bottom.
- Create an overall channel form that is more organic and not geometric, vary channel width bottom.
- Meander channel alignment in an irregular pattern to mimic natural form of Skunk Creek.
- Scatter bottom surface of channel with cobbles and rocks, similar to adjacent areas of Skunk Creek.
- Blend bottom surface material with the surrounding native surface material to minimize visual contrast.

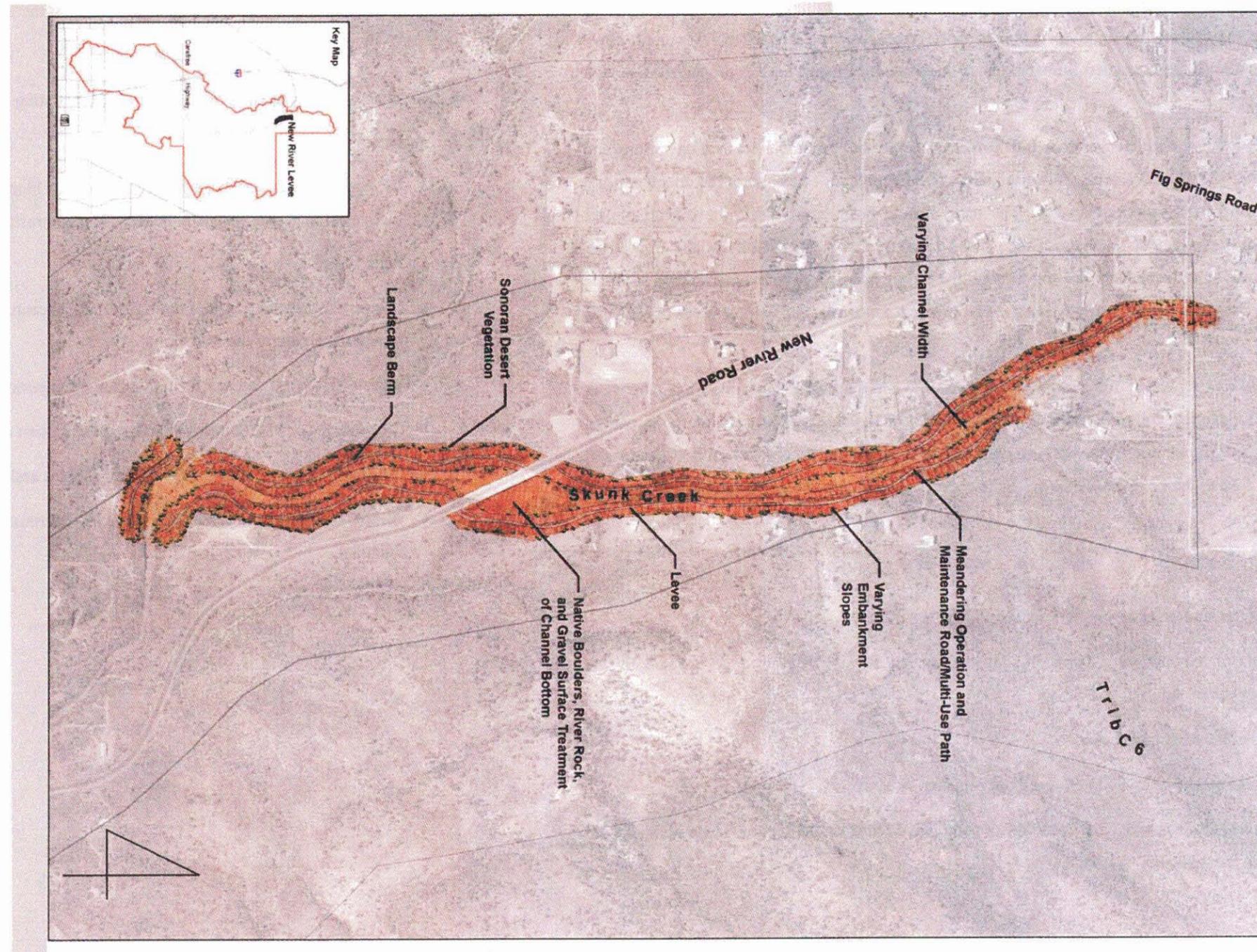


Figure 5.16 Recommended Alternative – New River Road Bridge Levees Aesthetic Treatments

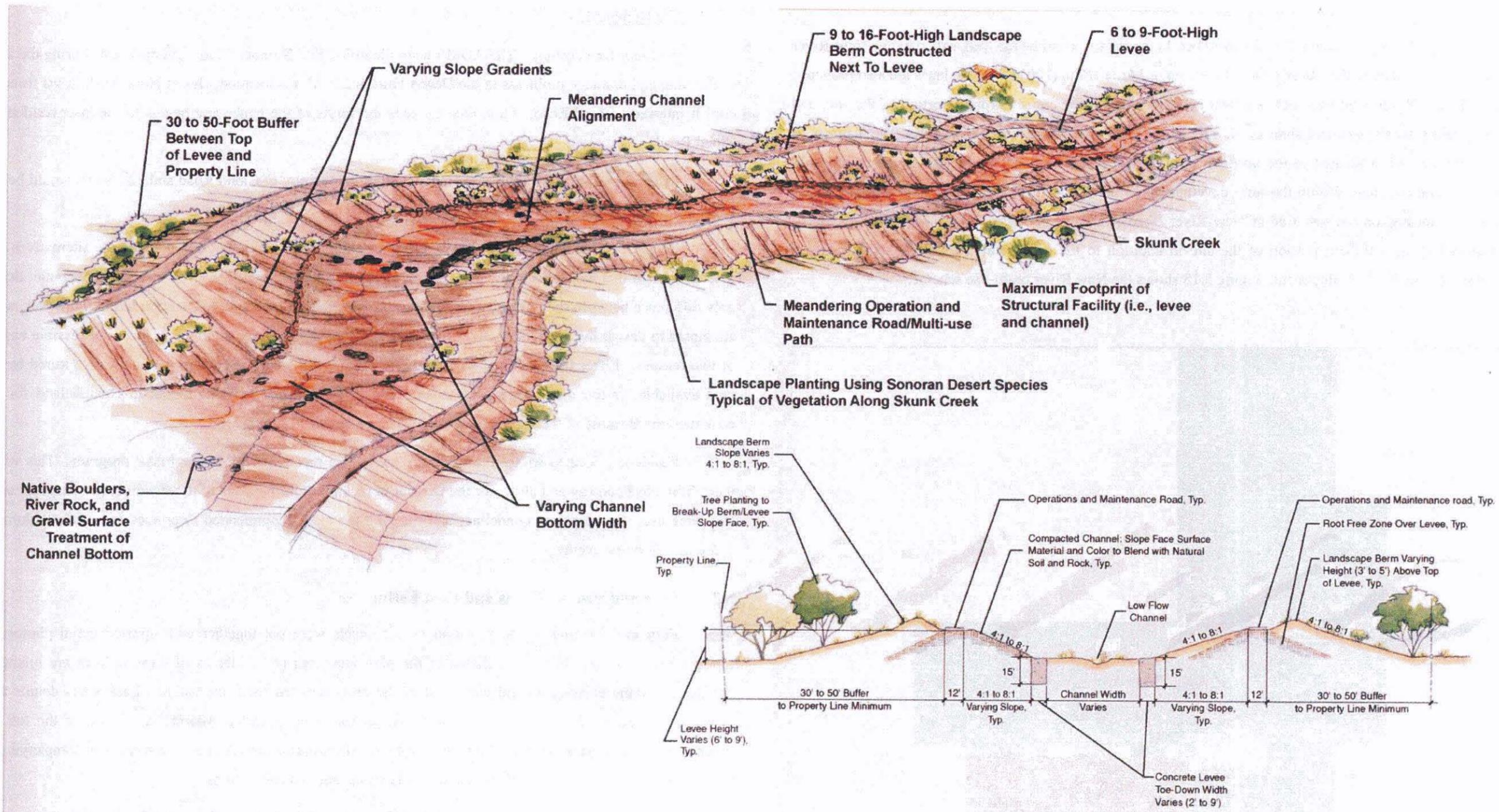


Figure 5.5 Recommended Alternative – New River Road Bridge Levees Aesthetic Treatments Section and Sketch

Figure 5.17 Recommended Alternative – New River Road Bridge Levees Aesthetic Treatments

Multi-Use Opportunities - Within the Site Number 11 boundary, a proposed trail will parallel New River Road through the site, according to the *Skunk Creek Watercourse Master Plan (2001)*. Bicycle lanes are also proposed along New River Road. Rural residential development is designated for the entire northern portion of the site, and flood control use planned for the southern areas of the site, which follow the Skunk Creek floodplain. The majority of rural residential development is located in the northern portion of the site, with additional low-density residential development on the southern edge. Within the rural development, a newspaper publishing company, a tavern, and a real-estate agency are located on the east side of New River Road. Undesignated open space (vacant/undeveloped) occupies the majority of the southern portion of the site in addition to the ephemeral drainage areas that extend throughout the site, on a north-south alignment. [Figure 5.18](#) shows the New River multi-use scheme.

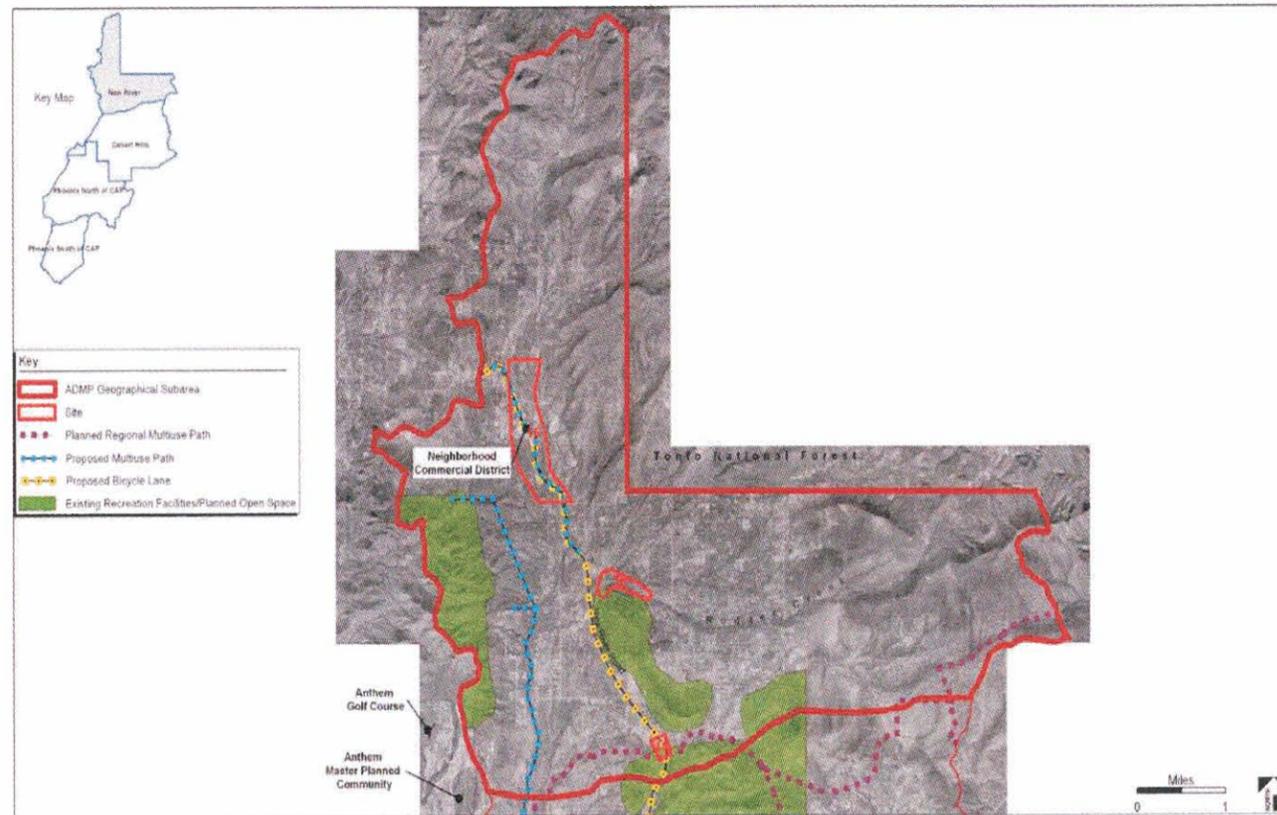


Figure 5.18 New River , Multi-Use

Site Number 12

Problem Description – The ADMP team identified Site Number 12 as a problem area during the assessment of flooding and drainage problems in the Desert Hills area. At this location, Desert Hills Wash flows from the north until it intersects Cloud Road. Flow then exceeds the limits of the banks and begins to inundate residences below Cloud Road.

Reduction of the peak discharge somewhere in the vicinity of Cloud Road and 12th Street would be necessary to remove the downstream residents from the floodway.

Recommended Alternative - Three structural alternatives were analyzed. Each of the alternatives included a detention basin that would scalp the peak down, attempting to reduce it to a level acceptable for outlet design. The only difference between the three alternatives was the location and size of the detention basin. However, when CLW attempted to design the three alternatives, it was discovered that all three alternatives were not feasible based on one of two reasons. Either the basin could not be made large enough so that enough volume was captured based on the land available, or too many residences would need to be acquired in order to obtain enough land for the basin construction. Because of these reasons, this site was not analyzed further.

Residences located within the floodway have been recommended to the FPAP program. This will remove them from the floodway and allow for the District to reclaim those portions of the floodway for purposes suitable for floodway use. Development Guidelines and the FRP are also recommended to protect the residents during current and future flooding events.

5.3 Plan and Profile Sheets and Cost Estimates

Plan and Profiles – The plan and profile sheets were put together with updated aerial photography and topography. Existing utilities are shown in the plan view, but actual depths of these utilities are unknown. The profiles show the existing ground compared to the proposed structural alternative. Each sheet details the design flows, plan view of the full structural component of the Recommended Alternative, profile of the full structural component of the Recommended Alternative, and typical cross sections either on the sheet or accompanying the main sheet. Refer to [Appendix A](#) for all plan and profile sheets and typical sections.

Cost Estimates – Cost estimates were performed by JEF. Many of the cost estimates provide a range of costs based on the land needed to construct the alternative. The lower range cost was based on the amount of land needed if only the footprint of the alternative was purchased. This is obviously going to be a cost that is too low based on the fact that it would be very difficult if not impossible to purchase just the land needed for right-of-way. Because of this, an upper range was established based on the purchase of every parcel that the alternative comes in contact. The actual

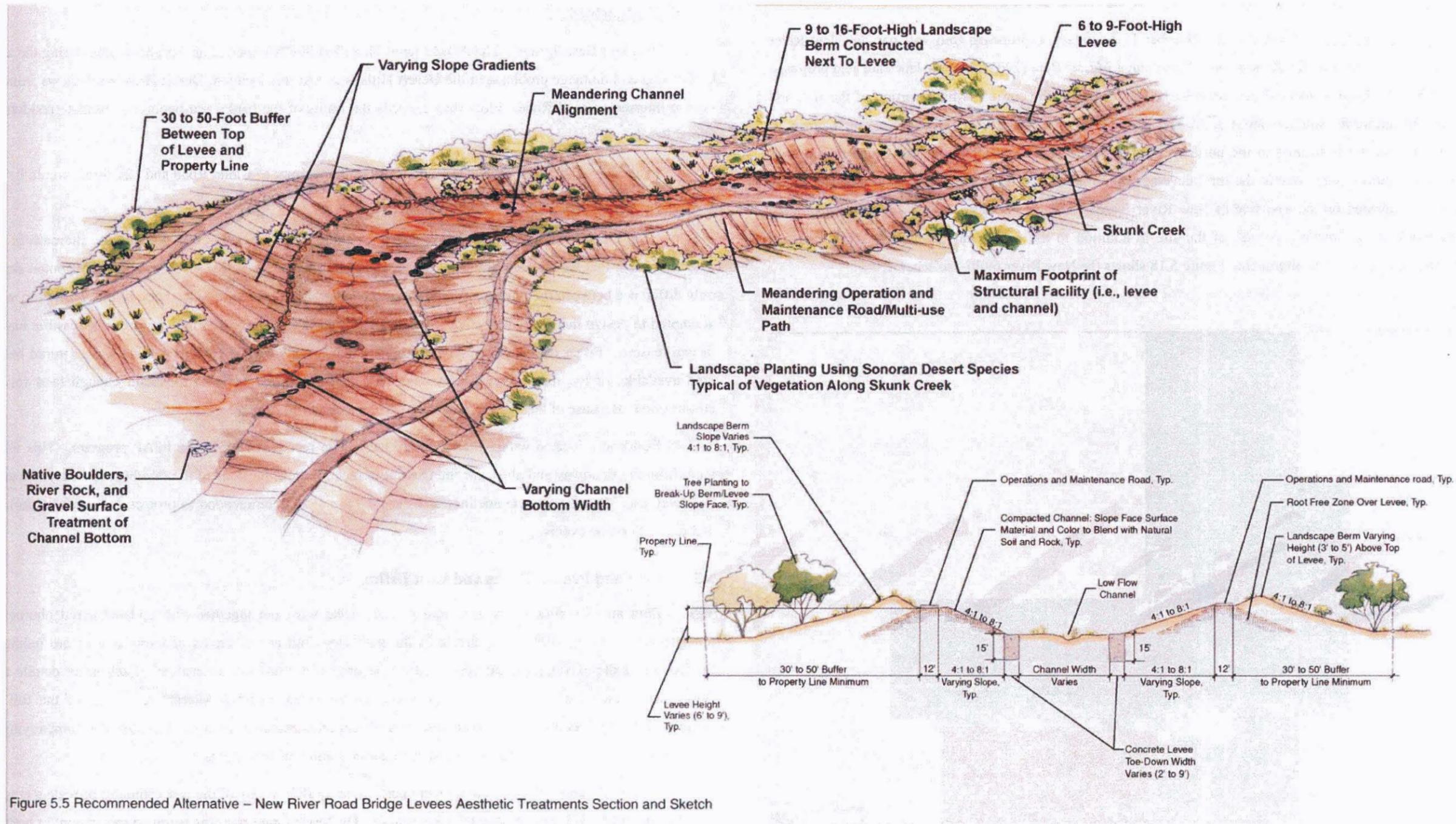


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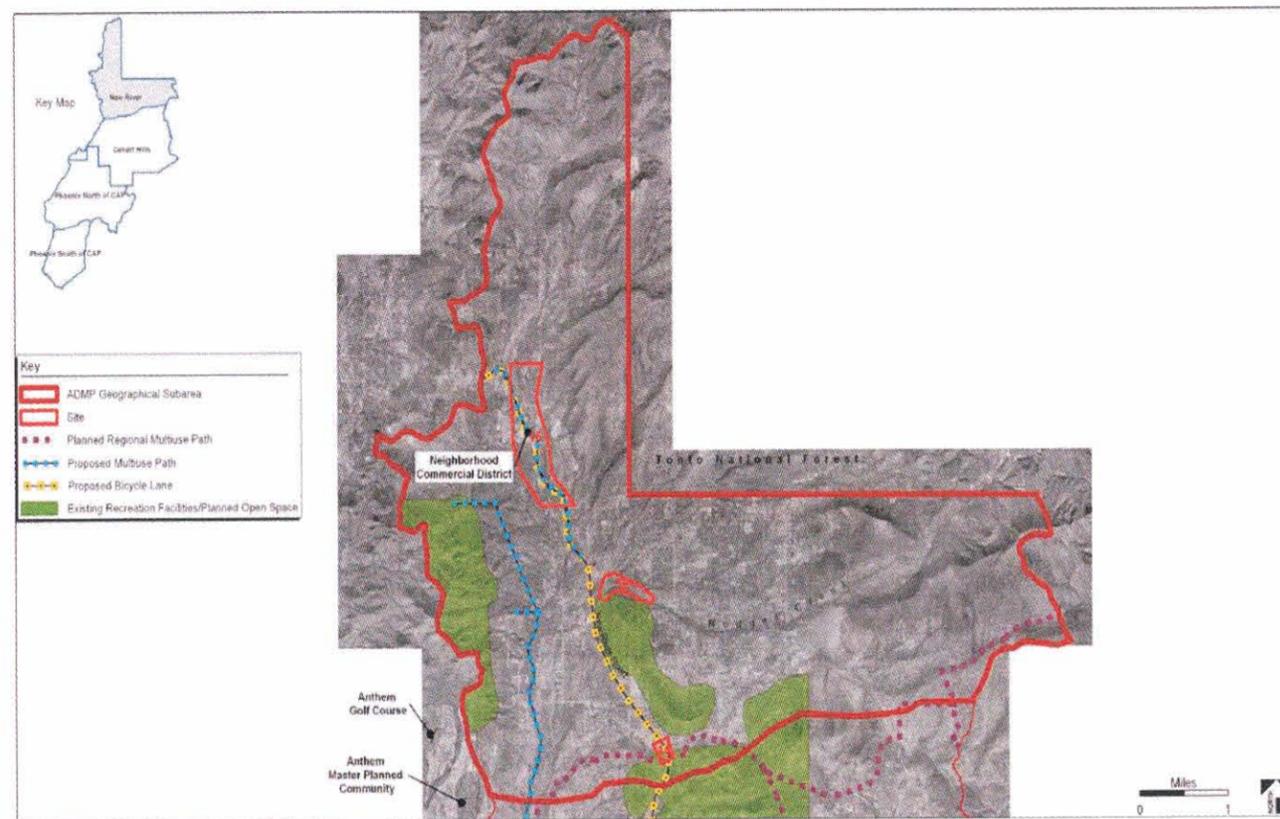


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Reduction of the peak discharge somewhere in the vicinity of Cloud Road and 12th Street would be necessary to remove the downstream residents from the floodway.

Recommended Alternative - Three structural alternatives were analyzed. Each of the alternatives included a detention basin that would scalp the peak down, attempting to reduce it to a level acceptable for outlet design. The only difference between the three alternatives was the location and size of the detention basin. However, when CLW attempted to design the three alternatives, it was discovered that all three alternatives were not feasible based on one of two reasons. Either the basin could not be made large enough so that enough volume was captured based on the land available, or too many residences would need to be acquired in order to obtain enough land for the basin construction. Because of these reasons, this site was not analyzed further.

Residences located within the floodway have been recommended to the FPAP program. This will remove them from the floodway and allow for the District to reclaim those portions of the floodway for purposes suitable for floodway use. Development Guidelines and the FRP are also recommended to protect the residents during current and future flooding events.

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cost is going to fall somewhere between these two. At the time of the analysis (July, 2004), the land costs are assumed to equal \$1.50 per square foot of raw ground or \$65,340.26 per acre as provided by the FCDMC. Due to the fact that this is a conceptual level design, details regarding, operation and maintenance roads, erosion protection, side slopes, sight design, changes between bridge decking and the water surface elevation, local drainage relief etc. were thought about and taken into consideration. However, it is very difficult to quantify some of these design related issues. Therefore, a 25 percent contingency was added to account for these types of pre-design issues. Refer to [Appendix B](#) for all cost estimates.

Included in the cost estimates is a summary of impacted structures. This analysis was accomplished by looking at the actual aerial photographs with the superimposed flood hazard overlain so that estimates could be made for both pre- and post-Recommended Alternative.

SECTION 6: IMPLEMENTATION PLAN

6.1 Implementation Summary

The results of the Stakeholder Involvement and Implementation Strategy are summarized in the following Implementation Summary ([Table 6.1](#)). The Summary details the Recommended Alternative by location, capital improvement costs, potential cost sharing partner, participation interest, mechanism for participation and preliminary timeline. The Implementation Summary was developed iteratively and in cooperation with the affected stakeholders. It does not represent a binding legal agreement on any partners, but does provide a solid summary of implementation strategies to date and a roadmap for the District's implementation efforts given the ADMP's adoption by the Board of Directors. Many of the Recommended Alternatives are connected with other agency programs. The result is that often their schedule or funding will drive the construction timeline. Recognition of this fact by the District and planning for this in future follow through efforts will allow for cost effective and efficient construction completion. If the coordination is not continued after ADMP completion, it is possible that other agencies will move ahead with their projects and not include Recommended Alternatives drainage improvements.

The Recommended Alternatives for this project is comprised of structural and non-structural solutions at various locations. These locations are distributed throughout the project area and include construction and non-construction activities that will ultimately be funded in one of three ways:

- 1) Solely funded by the District.
- 2) Funded solely or in partnership among private and/or public agencies including the District.

- 3) Funded solely or in partnership among private and/or public agencies **not** including the District.

The Recommended Alternatives was developed after extensive technical review of the drainage, infrastructure and land use conditions in the project area. Significant effort was also put forth by the project team to involve the general public, as well as public and private sector stakeholders, in development of the Recommended Alternatives. Included within the ADMP deliverables is documentation of the public and stakeholder activities and responses. The stakeholder effort was designed and carried out so as to maximize development of a Recommended Alternatives that could be implemented as efficiently and cost-effectively as possible. The purpose of this section is to summarize the key opportunities and constraints for implementation of the Recommended Alternatives.

6.2 Recommended Alternative Opportunities and Constraints

The Recommended Alternatives is organized into the 4 regions of the project with specific sites in each region. The Regions (in capital letters) and sites within each Region are as follows:

Phoenix Incorporated Area

- Site 1 - 35th Avenue and Pinnacle Peak Road/Skunk Creek
- Site 2 - CAP/I-17/ Skunk Creek

Desert Hills Area

- Site 5 - 7th St., Joy Ranch Rd., Cloud Rd. /Desert Lake Wash
- Site 7 - 24th St./Apache Wash
- Site 8 - Desert Hills Dr. Bridge/Skunk Creek

New River Area

- Site 9 - New River Rd. Bridge/Rodger Creek
- Site 10 - Circle Mountain Rd. Erosion Protection /Cline Creek
- Site 11 - New River Rd. Levee System/Skunk Creek



Table 6.1 Implementation Summary

SITE(S)	TOTAL COST	PARTNER(S)	INTEREST/BENEFIT	PARTICIPATION	MECHANISM	TIMELINE
PHOENIX NORTH & SOUTH						
35th Ave, Pinnacle Peak Rd/ Skunk Creek	\$8.0M	FCDMC	Public Safety	1) ADMP	Planning Budget	Completed 6/05
				2) Partial Design & Construction	CIP Budget	Available 2008
		COP	Public Safety	1) Partial Design & Construction	CIP Budget	Available 2008
				2) Maintenance	Operations Budget	Upon completion
CAP, I-17/ Skunk Creek	\$6.1M	FCDMC	Residential Flooding/Public Safety	1) WCMP & ADMP	Planning Budget	Completed 6/05
				2) Partial Design & Construction	CIP Budget	Available 2008
				3) Partial Levee Maintenance	Operations Budget	Upon completion
		ADOT	I-17 traffic protection	1) Westside Levees Upstream of CAP	TIP when widening occurs	Completed 2008
				2) ROW for 1) as it becomes available	TIP when widening occurs	Completed 2008
				3) Partial Levee Routine Maintenance	Operations Budget	Upon completion
		CAP	Canal Protection from Overtopping	1) ROW for levees at Canal	Issuance when Design completed	Issued 2007
				2) Maintenance of levees at the Canal	Operations Budget	Upon completion
		COP	Residential Flooding/Public&Facilities Protection	1) Partial Design & Construction	CIP Budget	Available 2008
				2) Partial Levee Maintenance	Operations Budget	Upon completion
DESERT HILLS AREA						
7th St, Joy Ranch Rd, Cloud Road/ Desert Lake Wash	\$4.6M	FCDMC	Residential Flooding/Public Safety	1) WCMP & ADMP	Planning Budget	Completed 6/05
				2) Partial Design & Construction	CIP Budget	Available 2008
		MCDOT	Traffic Safety	1) Roadside Channels and Culvert Crossings	TIP when widening or as ASLD Development occurs	Completed 2009
24th Street/ Apache Wash	\$1.83M	FCDMC	Public Safety	1) WCMP & ADMP	Planning Budget	Completed 6/05
				MCDOT	Traffic Safety	1) ROW abandonment
		ASLD	Parcel Disposition Drainage Requirement	1) Disposition acquisition requirement	Developer Funded upon Disposition	When ASLD Disposition occurs
Desert Hills Road Bridge/ Skunk Creek	\$11.2M	FCDMC	Public Safety	1) WCMP & ADMP	Planning Budget	Completed 6/05
		MCDOT	Accessibility	1) Bridge and Appurtenant Facilities	TIP when widening occurs	To Be Determined by Need
NEW RIVER AREA						
New River Road Bridge/ Rodger Creek	\$2.65M	FCDMC	Resident/Public Safety	1) WCMP & ADMP	Planning Budget	Completed 6/05
		MCDOT	Traffic Safety/Accessibility	1) Design & Construction	TIP Budget	After 2010 as Needed
Circle Mtn Road Erosion Protection/ Cline Creek	\$1M	FCDMC	Resident/Public Safety	1) WCMP & ADMP	CIP Budget	Completed 6/05
		MCDOT	Traffic Safety	1) Design & Construction	TIP Budget	After 2010 as Needed
New River Rd Levee System/ Skunk Creek	\$7.4M	FCDMC	Resident/Public Safety	1) WCMP & ADMP	Planning Budget	Completed 6/05
				2) Partial Design & Construction	CIP Budget	2010
		MCDOT	Traffic Safety	3) Partial Levee Maintenance	Operations Budget	Upon completion
				1) Partial Design & Construction	TIP Budget	After 2010 as Needed
ADMP WIDE						
Recurrence Interval Map	\$13K+	FCDMC	Resident/Public Safety	1) WCMP & ADMP	Planning Budget	Completed 6/05
		MCDOT	Traffic Safety	1) Upgrade of Culvert Crossings	Operations Budget	As Major Maintenance occurs
Flood Response Plan	\$45K +	FCDMC	Resident/Public Safety	1) WCMP & ADMP	Planning Budget	Completed 6/05
		MCDOT	Traffic Safety	1) Incorporate into Database and Procedures	Operations Budget	As Funds are Available
Floodplain Delineation Studies	\$218K	FCDMC	Resident/Public Safety	1) ADMP & CIP	Planning & CIP Budget	Completed 6/05
Floodprone Property Acquisition Program	\$13.1M	FCDMC	Resident/Public Safety	1) ADMP & CIP	Planning & CIP Budget	As Funds are Available
Development Guidelines	\$50K	FCDMC	Resident/Public Safety	1) ADMP	Planning Budget	As policies are Developed



ADMP Area – Wide

- Flood Response Plan
- Development Guidelines
- Floodplain Delineation Studies
- Floodprone Properties Acquisition Program (FPAP) for Floodway Residences

Section 6.2.4 contains narrative of opportunities and constraints for each site that only contains non-structural elements within the Recommended Alternatives. A narrative of opportunities and constraints for each of those sites containing structural elements within the Recommended Alternatives follows.

6.2.1 Phoenix Incorporated Area

Site 1 - 35th Avenue and Pinnacle Peak Road/Skunk Creek – This site will most likely be the first to be constructed of all the sites recommended in the Recommended Alternatives. It lies entirely in the City of Phoenix (City) and is currently being designed by the City for construction to begin in 2008. The City could pay for roadway and bridge improvements while the District may program funding for the new grade control structure and levee system. The site is in a developed area next to the landfill and no unusual permitting or regulatory requirements are anticipated. There was no negative feedback from the public regarding this component of the Recommended Alternatives. The City will be the lead agency for implementation of this alternative and will be responsible for pursuing an Intergovernmental Agreement (IGA) with the District. As of the time of this report, the City had not been able to pass a bond for monies to fund this project. However, the City indicated to the team that funding of this project will continue to be presented to the public for eventual movement into their CIP.

Site 2 - CAP/I-17/ Skunk Creek – This site has the most number of partners involved in the solution. The site lies entirely in the City and construction activities would be required in portions of ADOT ROW as well as on property owned by the CAP. This site may need to be constructed as early as 2008, which is the timeframe that ADOT is scheduled to conduct widening of Interstate 17 (I-17) in this area. However, passage of the renewal of the Maricopa County one-half cent sales tax may result in an acceleration of the ADOT project. Preliminary discussions are that ADOT may participate in development of the westside levees north of the CAP; the CAP may participate in the levee system on the north side of their canal, the City may participate in the levees on the downstream side of the CAP and the District could also participate in the levee system. The District could be the lead agency for implementation of this Alternative and therefore would be responsible for pursuing an IGA with the City, ADOT and

the CAP. The area upstream of the CAP is relatively undisturbed and has medium quality habitat. As a result, issues may arise during the 404-permit acquisition process in this part of the system. The current Recommended Alternatives is designed to minimize those concerns. There was no negative feedback from the public regarding this component of the Recommended Alternatives.

6.2.2 Desert Hills Area

Site 5 – 7th Street, /Joy Ranch Road, /Cloud Road, /Desert Lake Wash - This is a complex drainage system that may be constructed in two phases. The first phase could be completed when MCDOT completes widening improvements to 7th Street south of Joy Ranch Road. It is anticipated that this could occur in the 2008/2009 timeframe. Preliminary discussions are that MCDOT may pay for necessary drainage structures needed for the widening and the District may consider participating in the detention basin(s) to some degree since the attenuation of the flood flows will mitigate flooding to residences downstream of Cloud Road. MCDOT will be the lead agency for implementation of this Alternative and will be responsible for pursuing an IGA with the District. This phase occurs primarily within or near the road prism and no unusual permitting or regulatory requirements are anticipated. There was no negative feedback from the public regarding this component of the Recommended Alternatives.

The second phase of this system will most likely be triggered upon development of the ASLD parcel between Joy Ranch Road and Cloud Road. It is anticipated that this could occur as soon as the 2009/2010 timeframe. Preliminary discussions are that the parcel developer will be required to make improvements consistent with the intent of the ADMP. MCDOT will provide any needed culvert crossing of Cloud Road. The Recommended Alternative includes nonstructural measures to mitigate the identified flooding hazard for the area downstream of Cloud Road along Desert Lake Wash. The District will offer to floodway residents in this area voluntary participation in the Floodprone Property Acquisition Program (FPAP). The District will be the lead agency for implementation of this Alternative. The District may also be responsible for pursuing a Memorandum of Understanding (MOU) with ASLD, an IGA with the MCDOT elements in this area. The undeveloped ASLD parcel is relatively undisturbed floodplain with low quality habitat. There will likely be Clean Water Act (CWA) 404 permit issues that will need to be addressed by the developer before permitting will be released by the U.S. Army Corps of Engineers (USACOE). There was some negative feedback from the public regarding this component of the Recommended Alternative; specifically many were opposed to disposition of the ASLD parcel for development. There was general agreement that if it was to be developed, the Recommended Alternatives was a reasonable solution that should then be accomplished as outlined above.

Site 7 – 24th Street /Apache Wash – The existing 24th Street alignment, identified as an area of interest in the ADMP, is a MCDOT-maintained paved collector roadway between Carefree Highway and Cloud Road. The road is a



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section line alignment that unfortunately was built essentially in Apache Wash. The roadway lies entirely in the unincorporated area and is bordered by ASLD land on both sides.

The Recommended Alternatives for this site is abandonment and demolition of the existing roadway followed by restoration of the Apache Wash corridor. A new alignment will be constructed to the west prior to the abandonment of the existing roadway. There will be 404 permit issues associated with the demolition and restoration, but they are expected to be relatively minor since the mitigation is the outcome of the project. The ASLD and MCDOT were generally supportive of the Recommended Alternatives since implementation will occur at the disposition stage of the ASLD lands surrounding the project. It is anticipated that the cost of the abandonment and new roadway will be part of the development costs of those parcels. While ASLD will be the lead on implementation, it is recommended that the District should keep in close contact with ASLD and MCDOT to insure that this Recommended Alternative is not forgotten when the disposition occurs. It is anticipated that disposition could occur in 5-7 years. The public was generally supportive of the Recommended Alternatives.

Site 8 – Desert Hills Road Bridge/Skunk Creek – The problem area of Desert Hills Drive identified in the ADMP is the dip crossing at Skunk Creek. It is a MCDOT-maintained unpaved collector road. MCDOT records indicate numerous barricading instances at this location due to flooding. The Recommended Alternatives is to build a bridge and restore local access roads to surrounding parcels. MCDOT is to be the lead and only funding agency on this effort. This bridge is currently not budgeted in the MCDOT 5-year Capital Improvement Program. However, in meetings with MCDOT, they showed strong support for this project. There will be 404 issues associated with the Recommended Alternative but they are expected to be minimal since the Recommended Alternative will provide for an improved wildlife corridor under the bridge. There was a mixed response from the public regarding this part of the Recommended Alternative. Those in support agreed with the need for dry crossings while those against were concerned that a bridge would lead to opening the roadway through to Anthem and I-17.

6.2.3 New River Area

Site 9 – New River Road Bridge/Rodger Creek – The problem area of New River Road identified in this portion of the Recommended Alternative is a MCDOT-maintained paved arterial roadway at the existing culvert crossing of Rodger Creek. The 2-barrel corrugated metal arch culvert was constructed by MCDOT maintenance staff about twenty-five years ago and only passes the 5-year flow event or less. The Recommended Alternative at this site is a new bridge crossing at Roger Creek. MCDOT is to be the lead and only funding agency on this effort. This bridge is currently not budgeted in the MCDOT 5-year CIP so it could be constructed after 2010. There will be 404 issues associated with the Recommended Alternative but they are expected to be minimal since the Recommended

Alternative will provide for an improved wildlife corridor under the bridge. There was generally a positive response from the public regarding this part of the Recommended Alternative.

Site 10 – Circle Mountain Road Erosion Protection /Cline Creek – The problem area of Circle Mountain Rd. identified in the Recommended Alternative is a MCDOT-paved collector roadway at the east corner of the intersection with New River Rd. at Cline Creek. The problem identified is that the toe of slope formed by the slope cut created by the construction of Circle Mountain Rd. is subject to erosion and Circle Mountain Rd. is the only primary access to the populated area (approximately 3.5 square miles) east of New River Rd. The Recommended Alternative is to provide armored bioengineered bank protection for the north portion of reverse curve. MCDOT is to be the lead and only funding agency on this effort. This erosion protection is currently not budgeted in the MCDOT 5-year CIP so it is expected that it could be constructed after 2010. There will be 404 issues associated with the Recommended Alternative but they are expected to be minimal since the majority of the work will be completed on the disturbed cut slope. The public was supportive of this Recommended Alternative.

Site 11 – New River Road Levee System/Skunk Creek – The problem area identified in the Recommended Alternative is upstream and downstream of the New River Road bridge across Skunk Creek. The area upstream contains multiple homes in the floodway and floodplain as does the downstream area to the west of the bridge. The MCDOT-maintained paved arterial roadway is also overtopped in frequent events just west of the bridge. The identified Recommended Alternative is to construct levees along Skunk Creek to protect the homes and to prevent overtopping of the roadway along with channel improvements to mainstream Skunk Creek downstream of the New River Road bridge to increase conveyance through the bridge opening. The District will be the lead agency for implementation of this alternative and will be responsible for pursuing an IGA for cost sharing with MCDOT. The project is not in either agency's current 5-yr Capital Improvement Project budget so construction could occur after 2010. The area upstream of the roadway is relatively undisturbed and has medium quality habitat. As a result, issues may arise during the 404 permit acquisition in this part of the system. The current Recommended Alternative is designed to minimize those concerns utilizing a bioengineered approach to levee design and construction. There was both positive and negative feedback from the public regarding this component of the Recommended Alternative. Those generally in favor were supportive of the flood protection and bioengineered component while those generally in opposition were concerned about takings and aesthetics issues.

6.2.4 ADMP Area – Wide

Flood Response Plan – The drainage and transportation system within the ADMP was developed over time and involves multiple jurisdictions. As a result, flooding does and will occur at locations not included in the Recommended Alternative discussed above. The Recommended Alternative for these areas is to prepare and



ADOBE DAM/DESERT HILLS AREA DRAINAGE MASTER PLAN

distribute a Flood Response Plan (FRP) for coordinated use by the various agencies having jurisdiction within the ADMP (ADOT, COP, MCDOT, MCSO, the District, etc.). The District will be the lead agency for distribution and maintenance of the FRP while the Maricopa County Department of Emergency Management (MCDEM) will be the lead agency for operation and administration of the FRP. Implementation of the FRP is underway by the Flood Warning Branch of the District. The District has to coordinate with COP CENS Program Manager and MCSO Communications Dispatch Center to initialize the flood warning information dissemination component of the FRP. In addition, the District will need to implement the public information component of the FRP before issuing flood warning messages to the public. The FRP is recommended specifically for Sites 3, 4, 6, and 12. These sites do not include structural elements within the Recommended Alternative so inclusion to the FRP is critical for these sites.

Development Guidelines – Until recently, in addition to the regulatory authorities granted under Arizona Revised Statutes (ARS) Title 48, the District administered the Maricopa County Drainage Ordinance under the authorities granted counties in ARS Title 11. The Drainage Ordinance provides that if technical rules of development are developed on a watershed specific basis they may be adopted by the Board of Supervisors as part of an ADMP. *Development Guidelines for Individual Single-Family Lot Development* are included in this ADMP for the unincorporated portions of the study area. Due to the uncertainty of implementation protocols brought about from the recent transition of regulatory authority for the Drainage Ordinance to Maricopa County Planning & Development Department, final implementation strategies for the Development Guidelines are pending and will be determined in the near future. The Development Guidelines are an important component of the ADMP for Site Numbers 3 and 12. The regulation of future development upstream and within the boundaries of these two sites determine whether the flooding problems that currently exist get worse or remain the same. The Development Guidelines are included in Part 8, Volume 4, Section 2 and [Appendix C](#) of this report.

Floodplain Delineation Studies – As part of the non-structural component of the Recommended Alternative Floodplain Delineation Studies (FDS) were conducted and included in the ADMP. These FDS were conducted in both unincorporated Maricopa County and City of Phoenix jurisdictions. A total of 16.9 watercourse miles of new or redelineated FDS have been submitted to the Federal Emergency Management Agency (FEMA) for their review and approval. The FDS were submitted at different times within the ADMP process and all have been approved by FEMA. The results of the FDS will be used by the District regulatory staff in managing floodplains in the ADMP area.

In addition twelve locations/residences were determined to possibly have erroneous or incorrect floodplains mapped. Of the twelve investigated 8 were determined to be incorrect or erroneous. Letters of Map Revision

(LOMR) have been prepared and submitted to FEMA for approval. The LOMR information has been approved by FEMA and adopted by District regulatory staff.

In addition to the FDS and LOMR activities approximately seventy five miles of Erosion Hazard Zones (HZ) were identified as part of the ADMP. These EHZ will be regulated as “Best Available Information” by District regulatory staff.

Floodprone Properties Acquisition Program – The District has a Board of Directors which adopted Floodprone Properties Acquisition Program (FPAP) that is available county-wide for residents living in a FEMA adopted Floodplain. Funding for the FPAP is evaluated on an annual basis and is subject to funding availability. While the FPAP is a countywide program directed at residents living within the floodplain, the large amount of information generated as part of the ADMP was presented to those residences living in the floodway at 2 public meetings. As of April, 2005 twelve residents in the ADMP area had applied for the FPAP. Evaluation and possible approval will be determined on an individual basis per FPAP Policies. Site Numbers 4 and 12 are of particular concern in regards to the FPAP. Since no structural measures within the Recommended Alternative were included for these two sites, the FPAP is the only way for the floodway residents within these areas to be removed from the flooding hazard.



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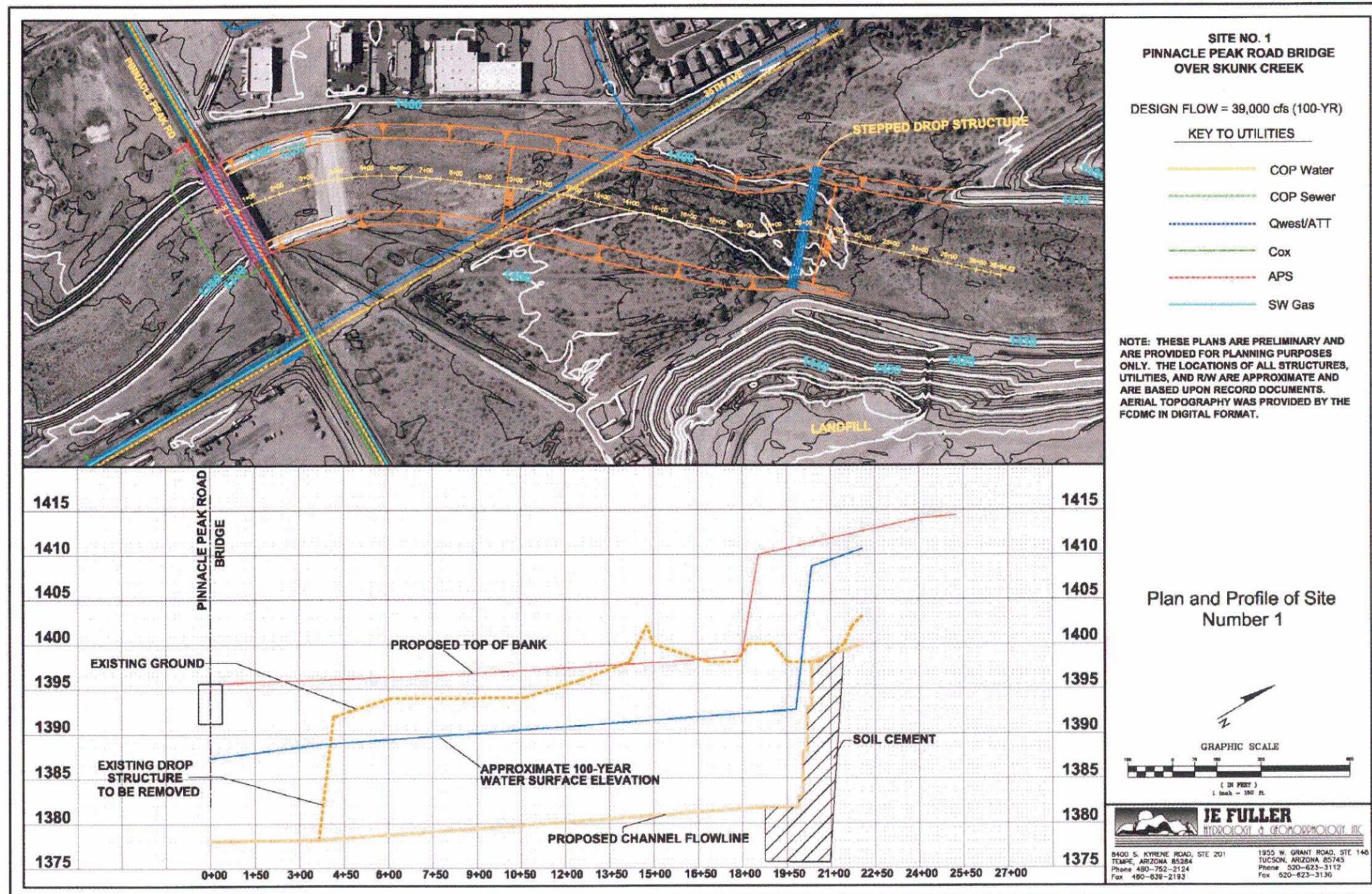
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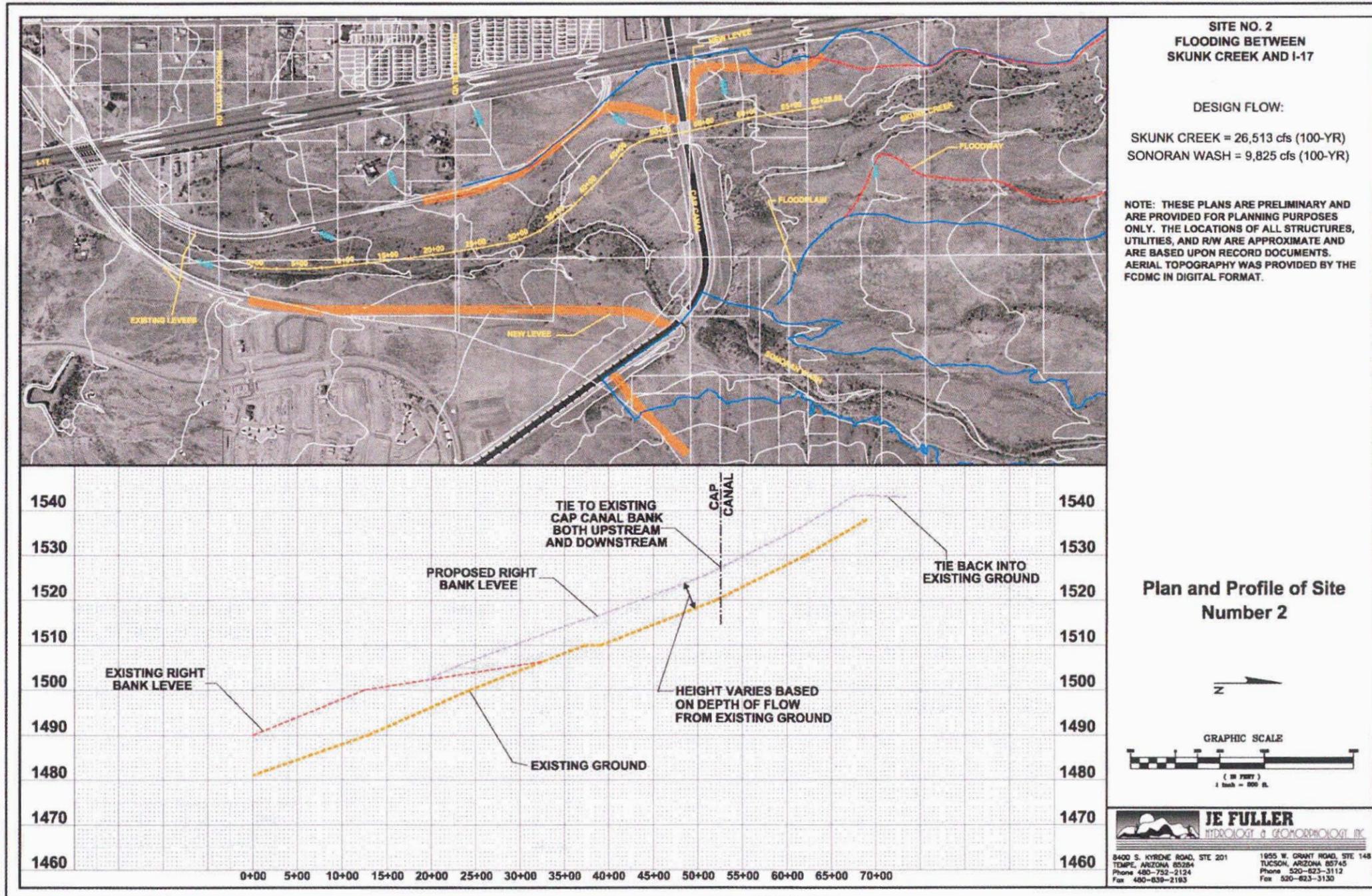
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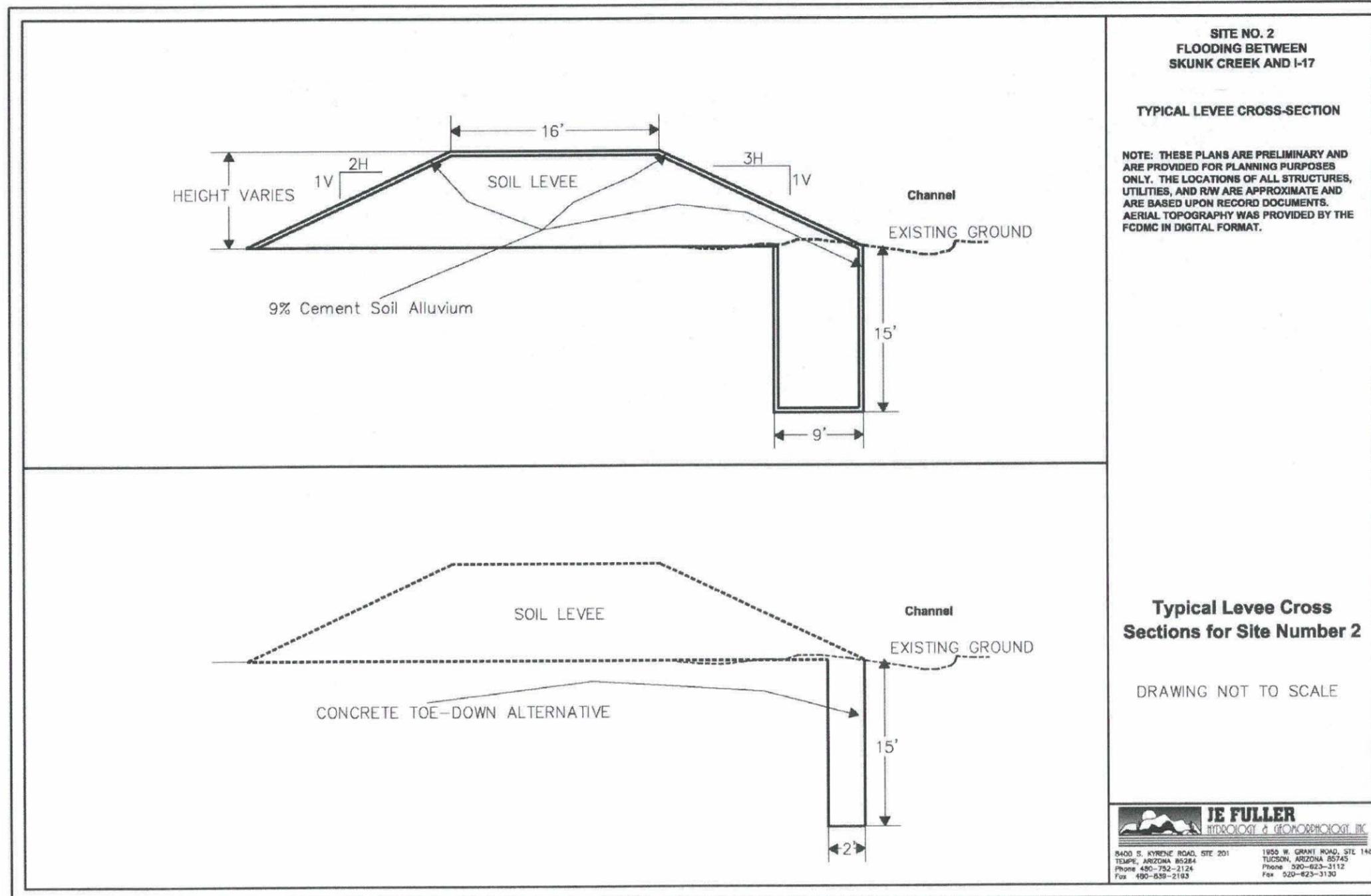


APPENDIX A

Plan and Profile Sheets with Typical Cross Sections

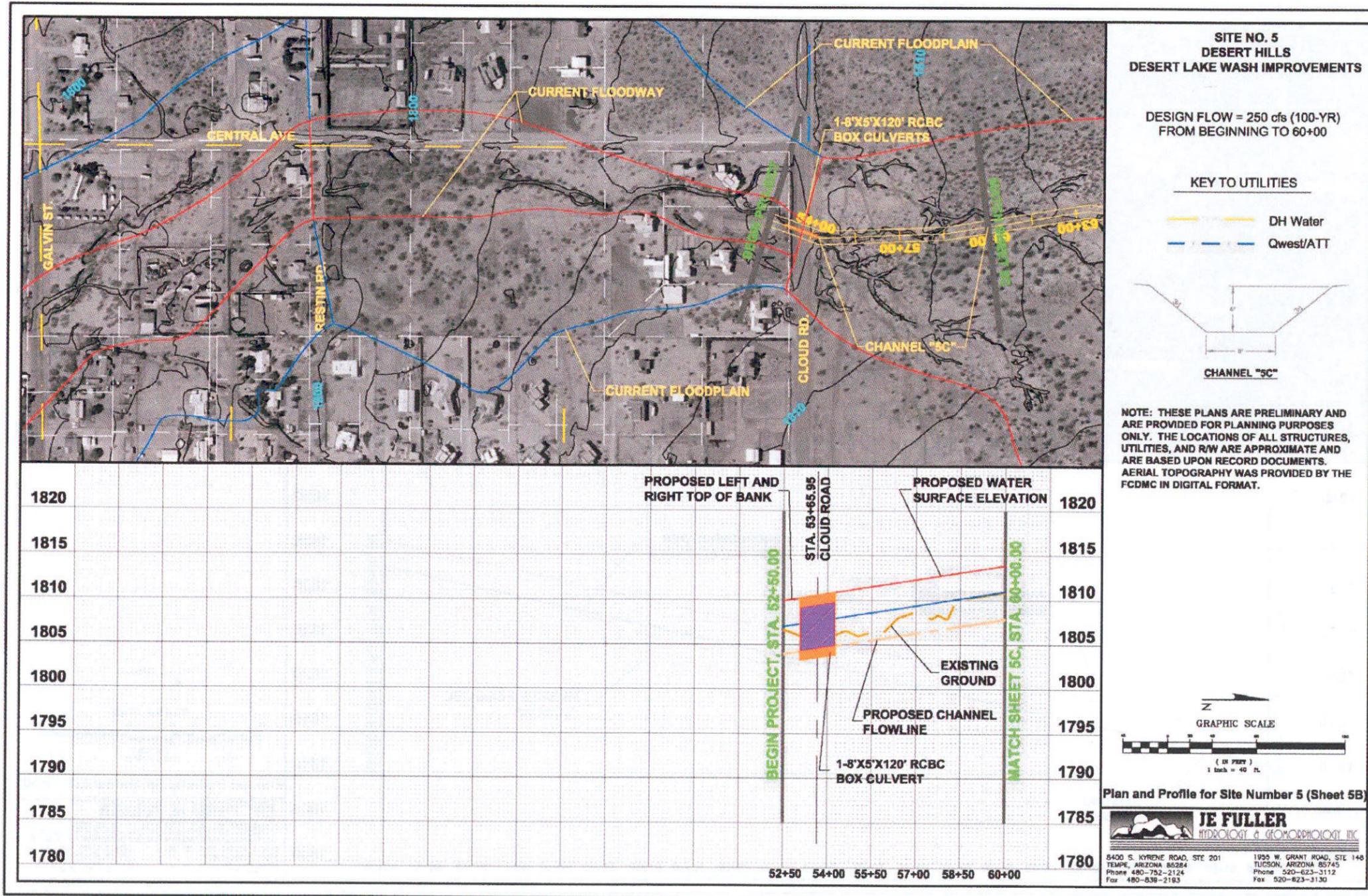


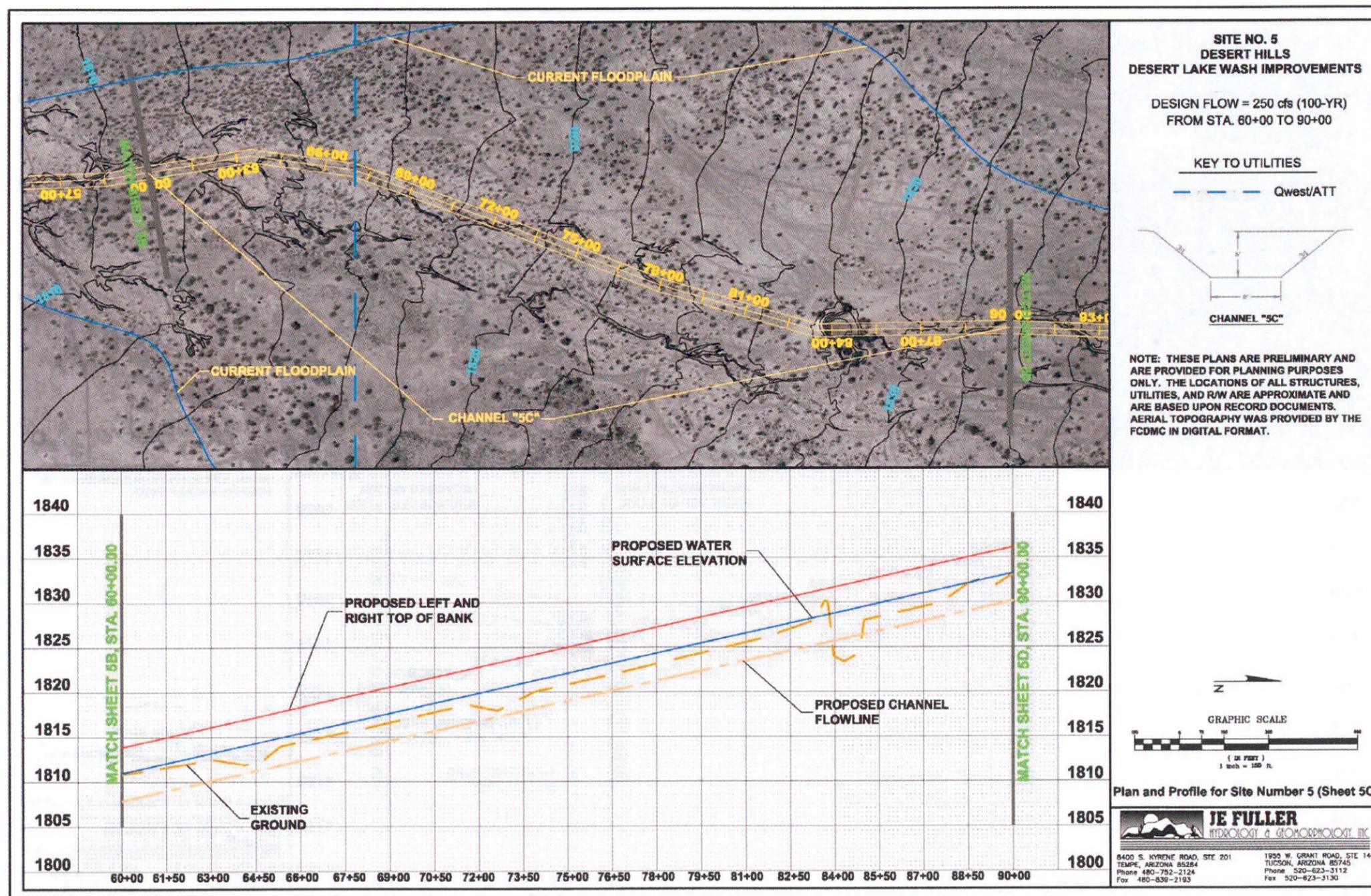


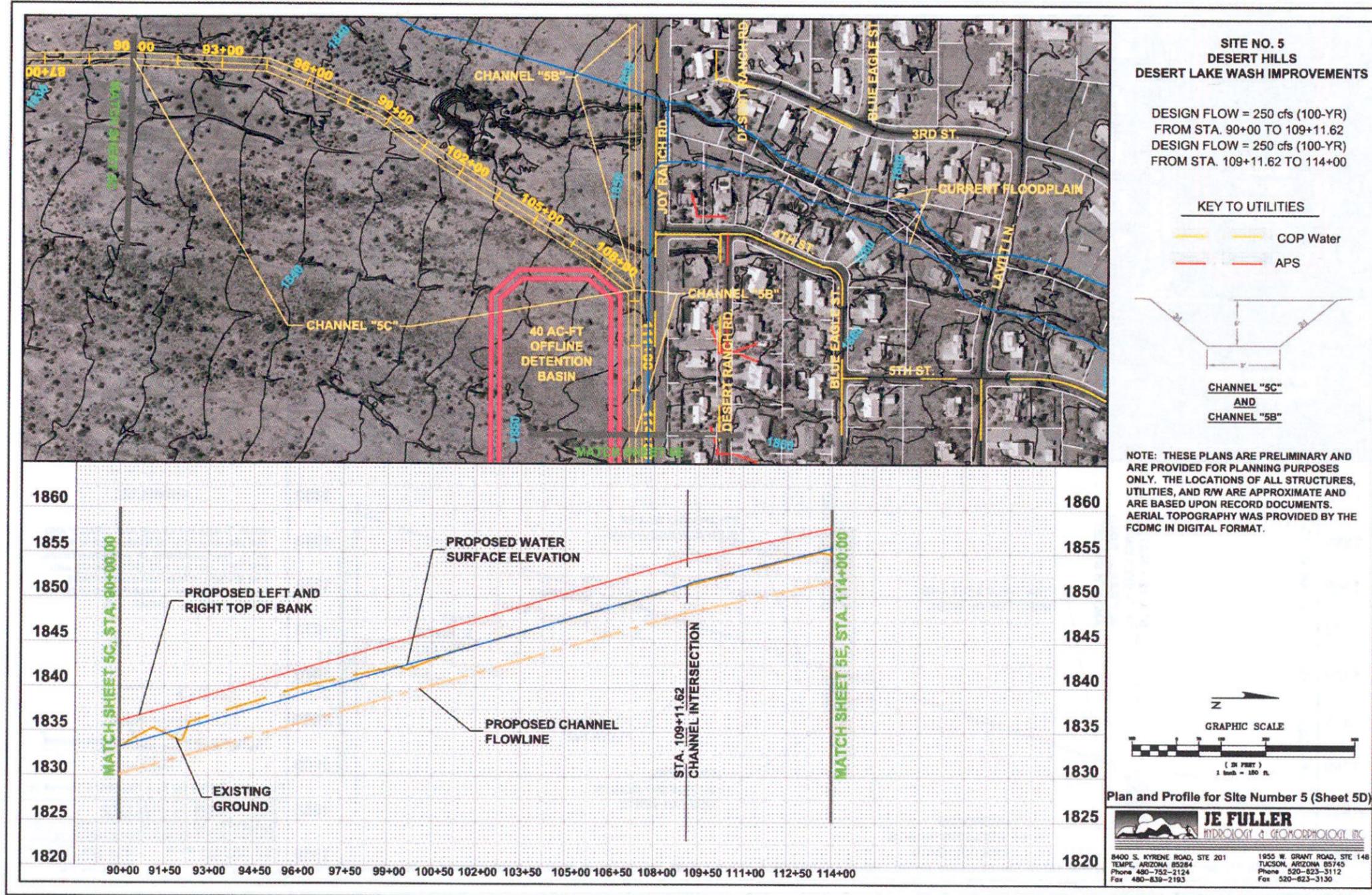


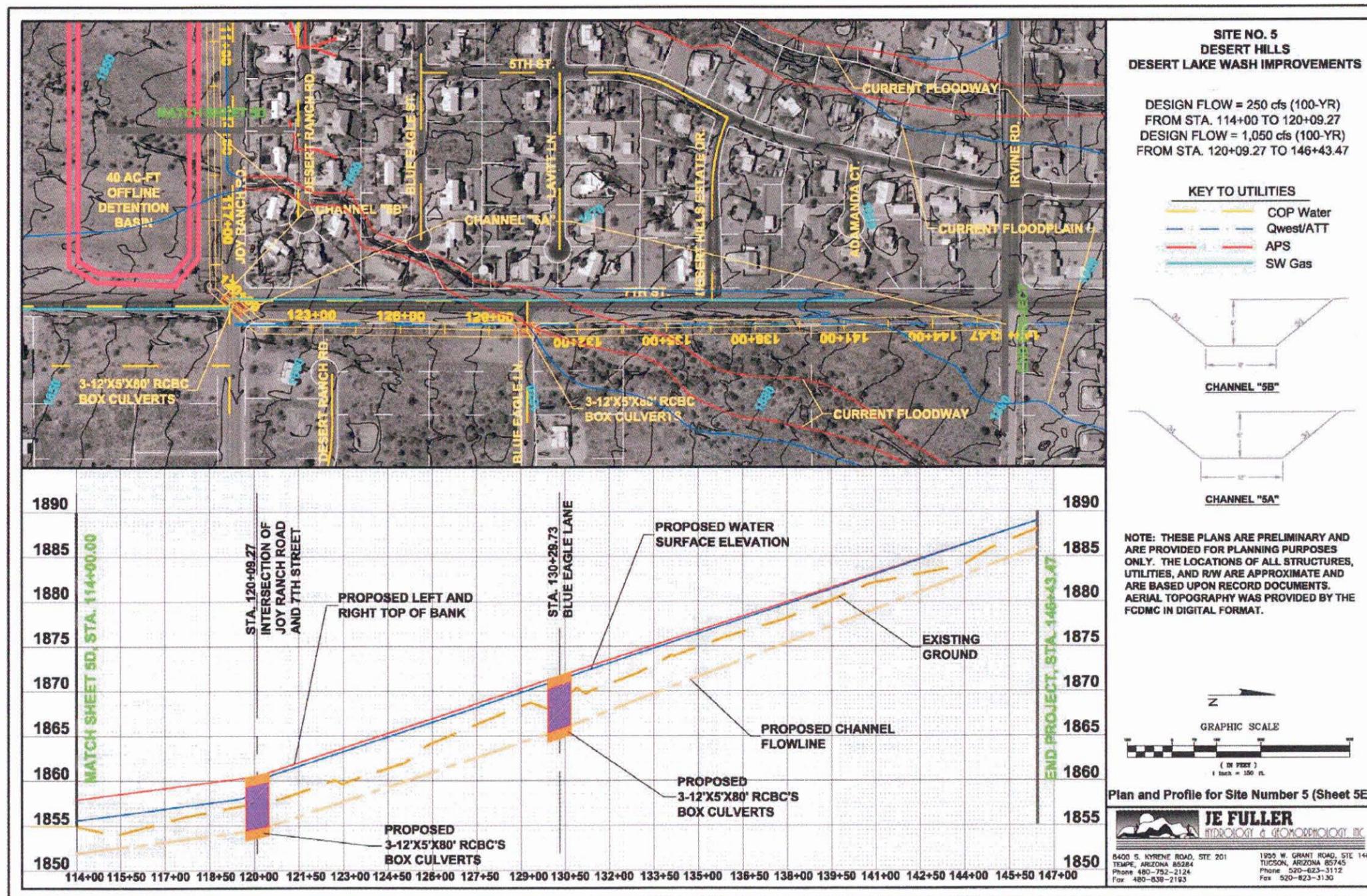


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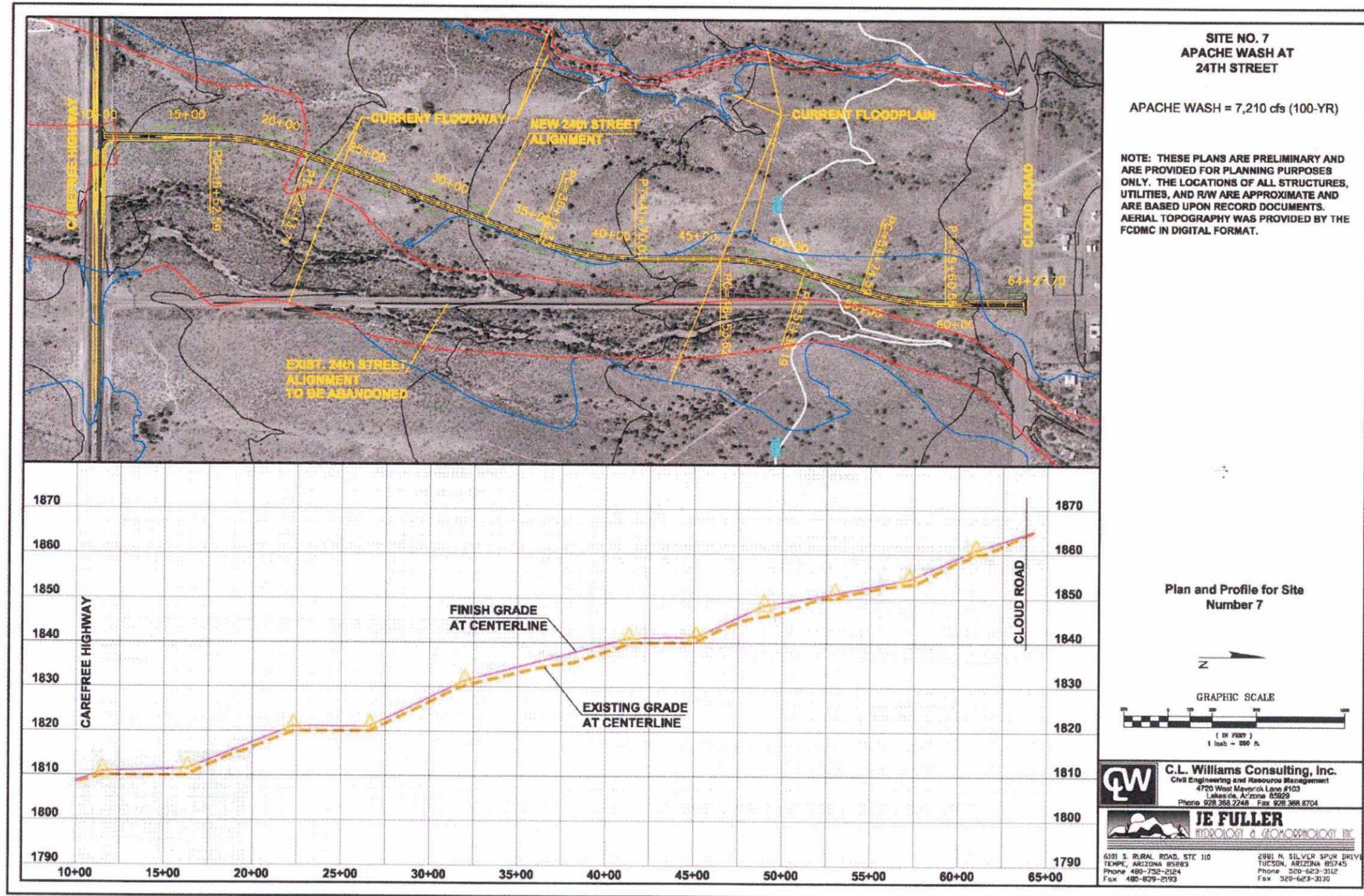


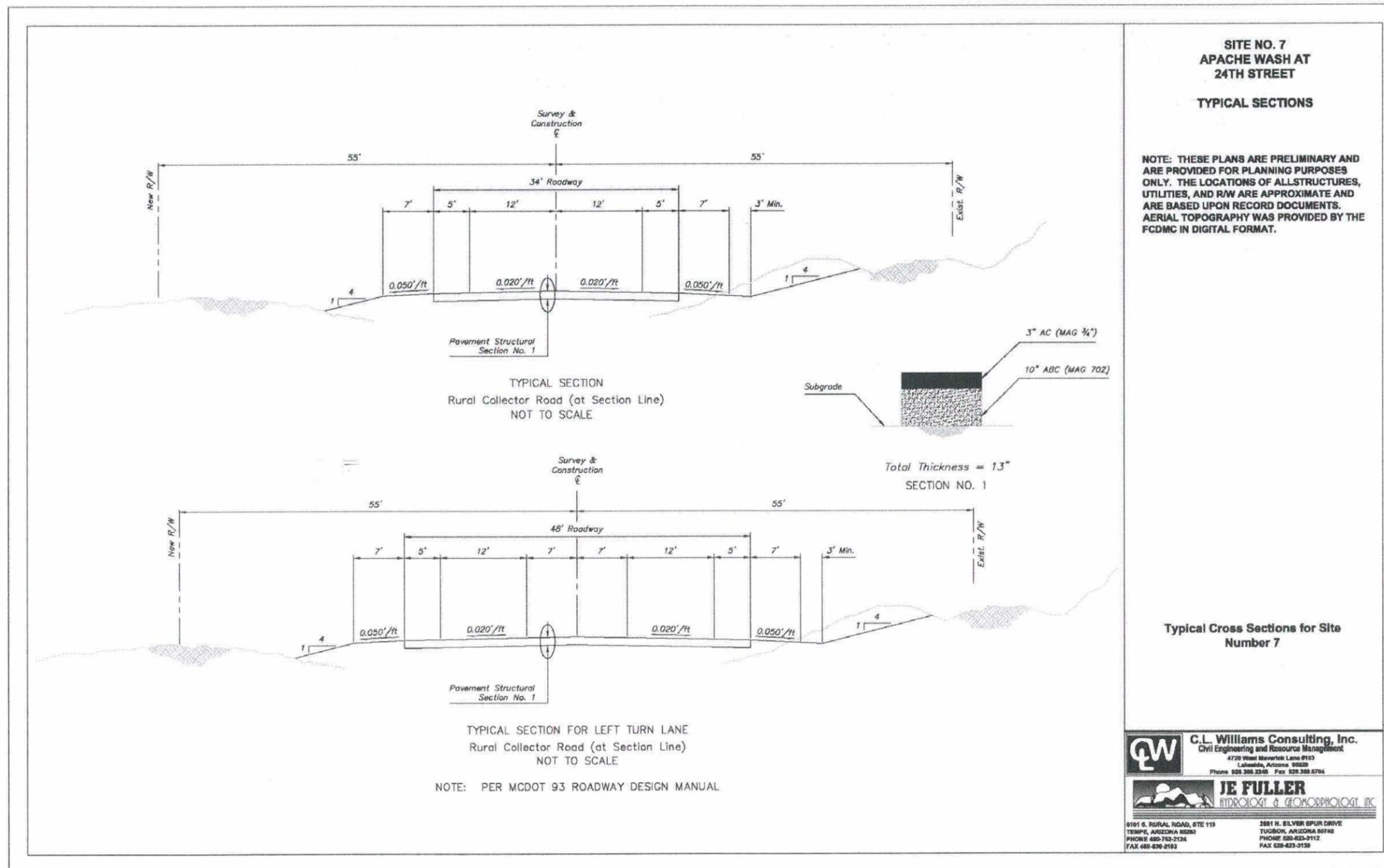






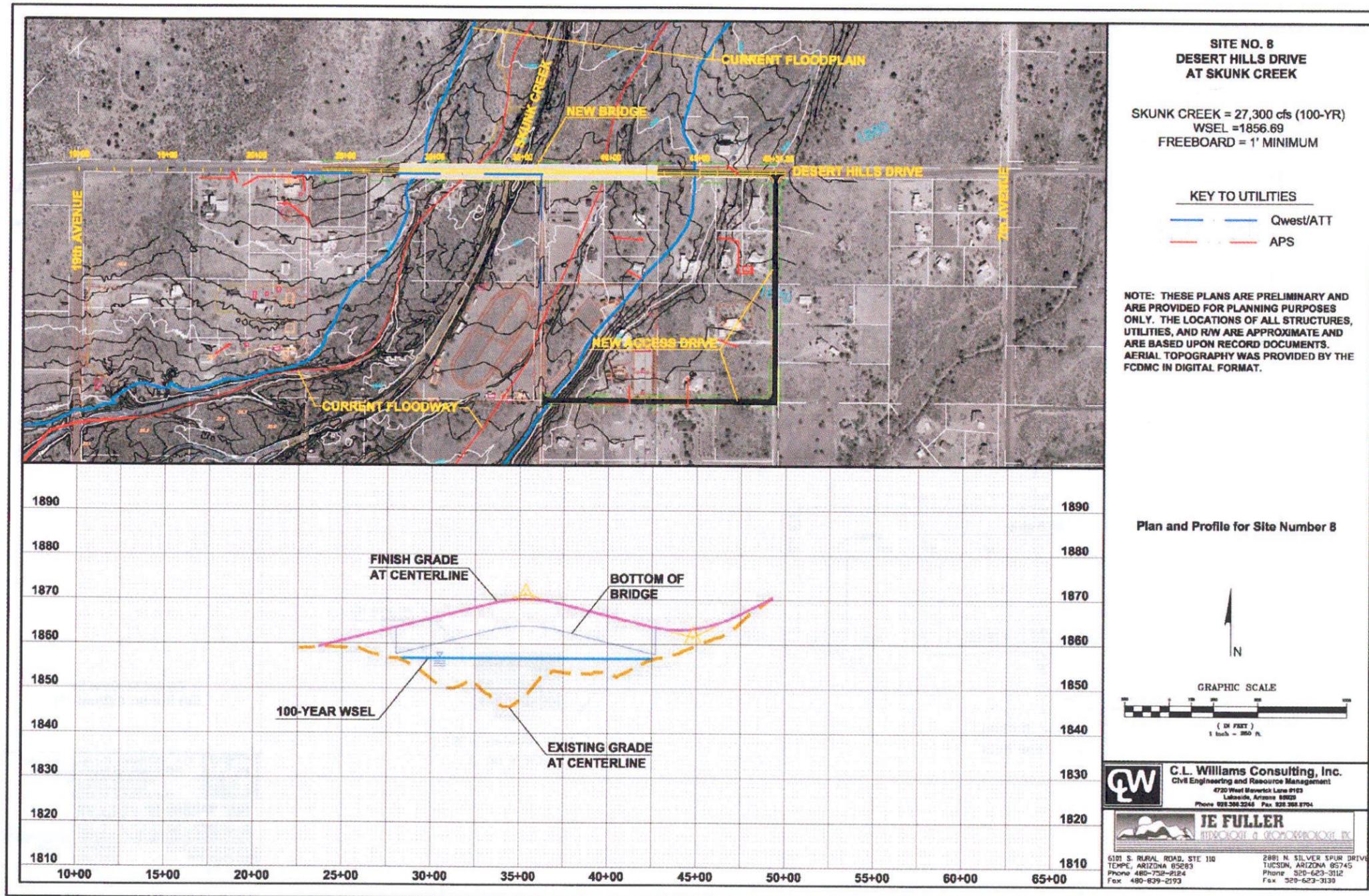
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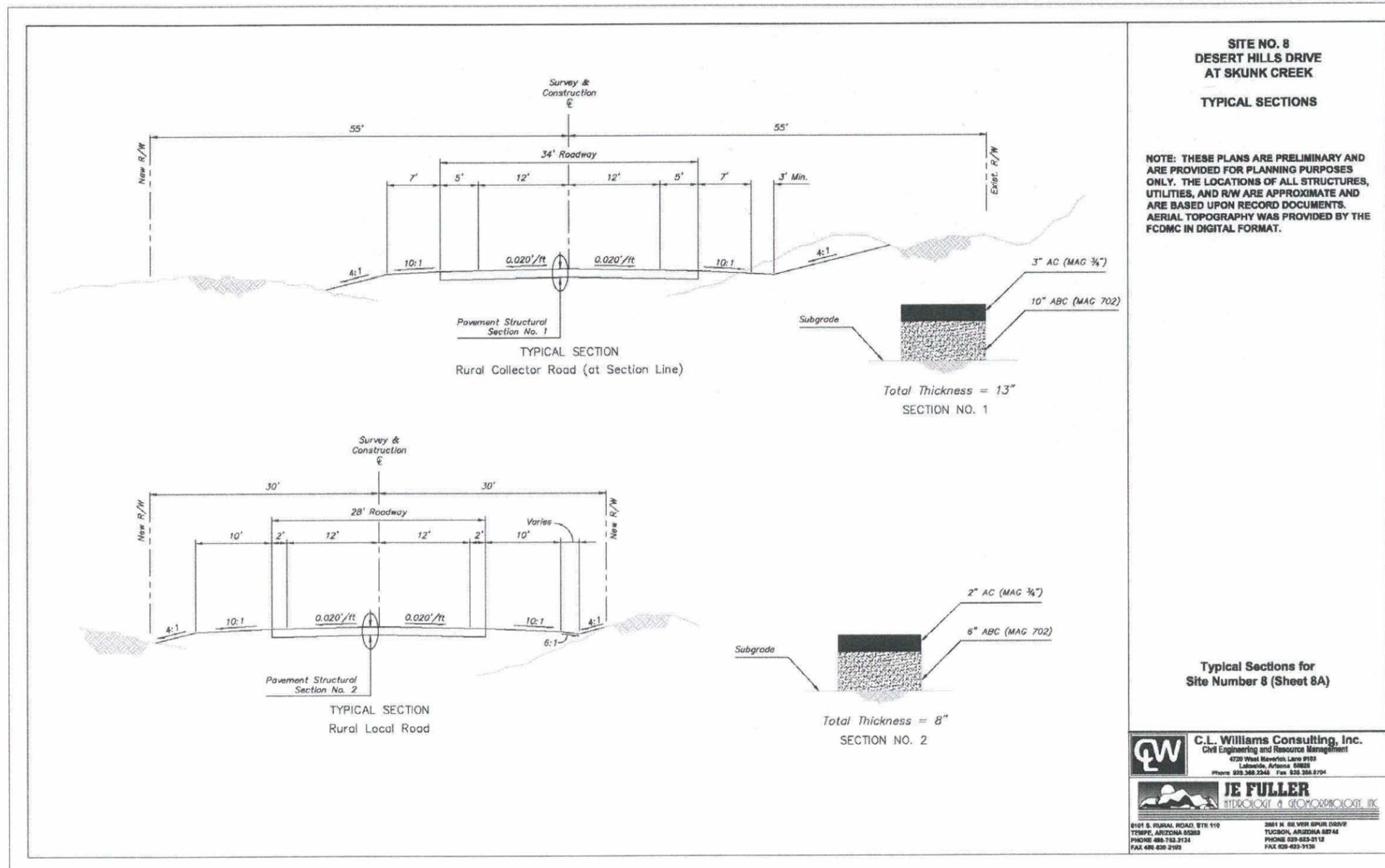


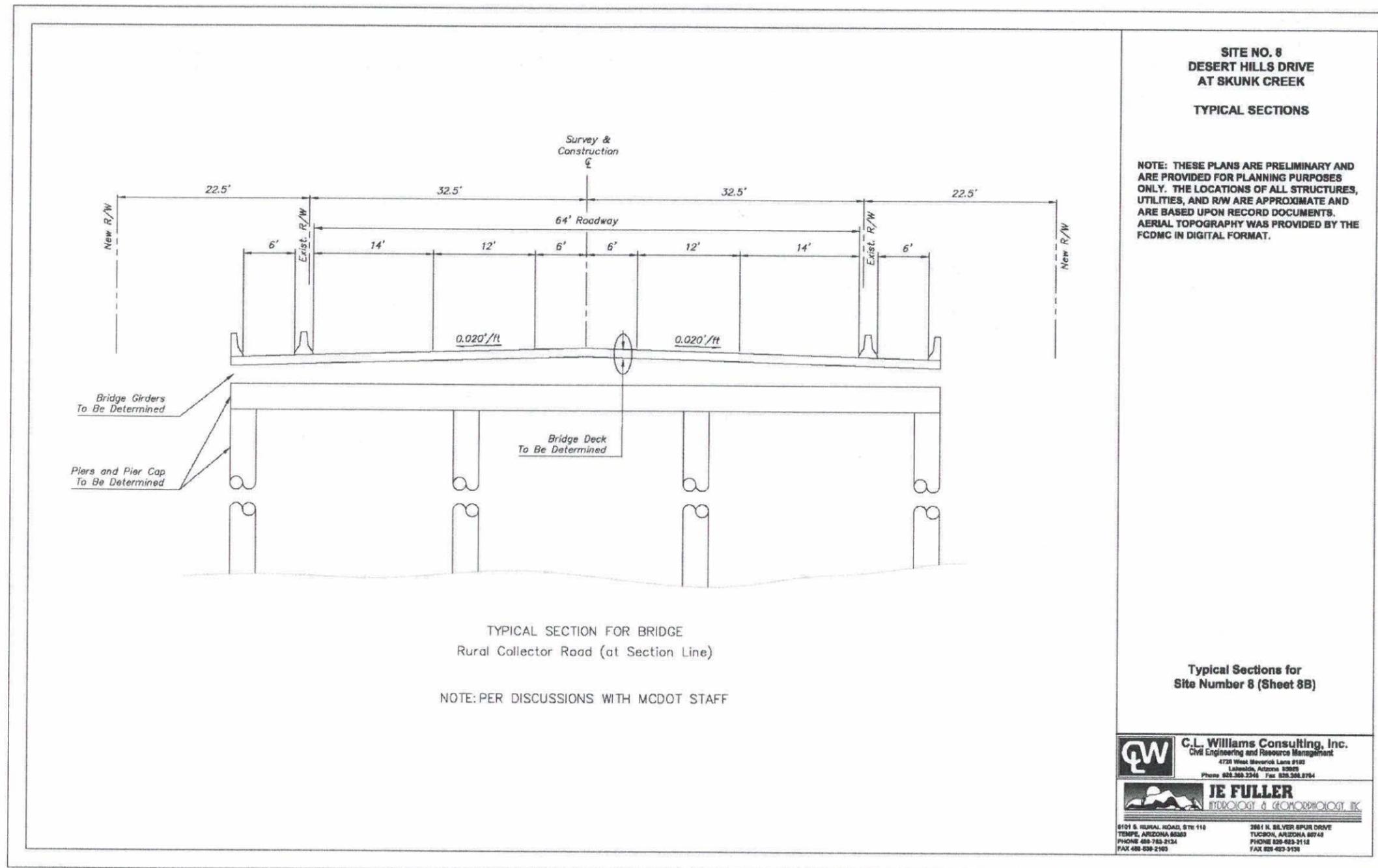


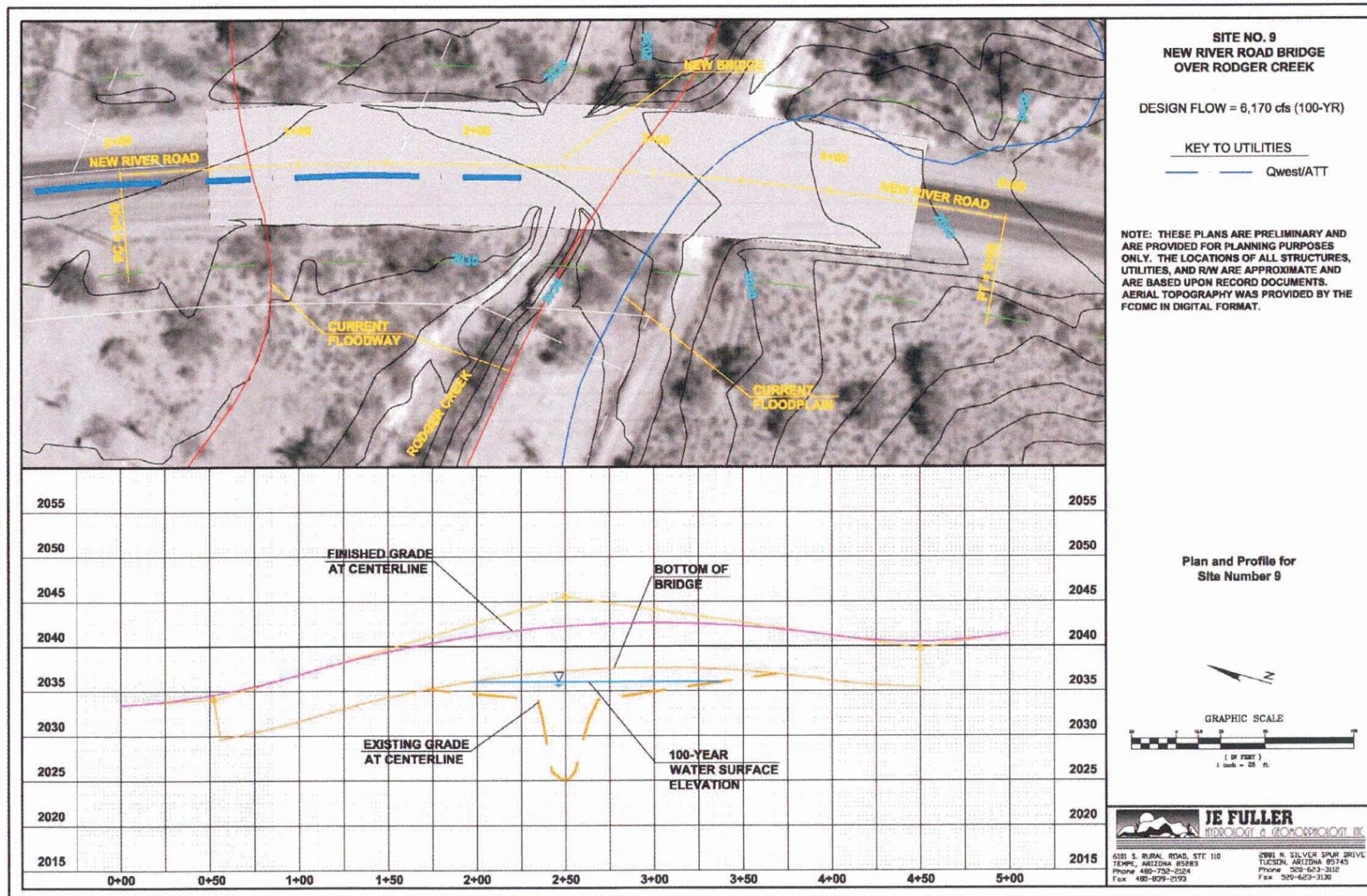


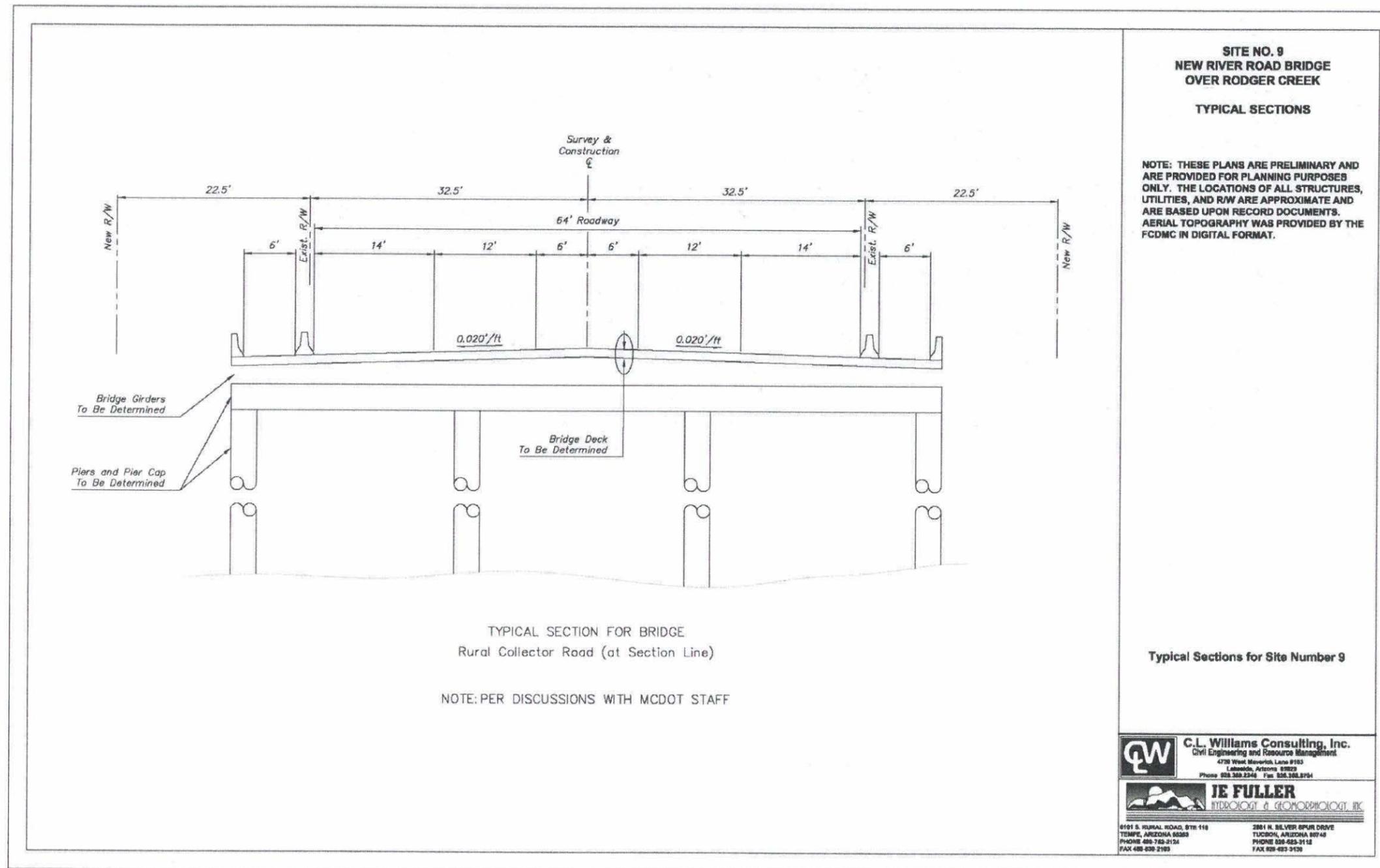
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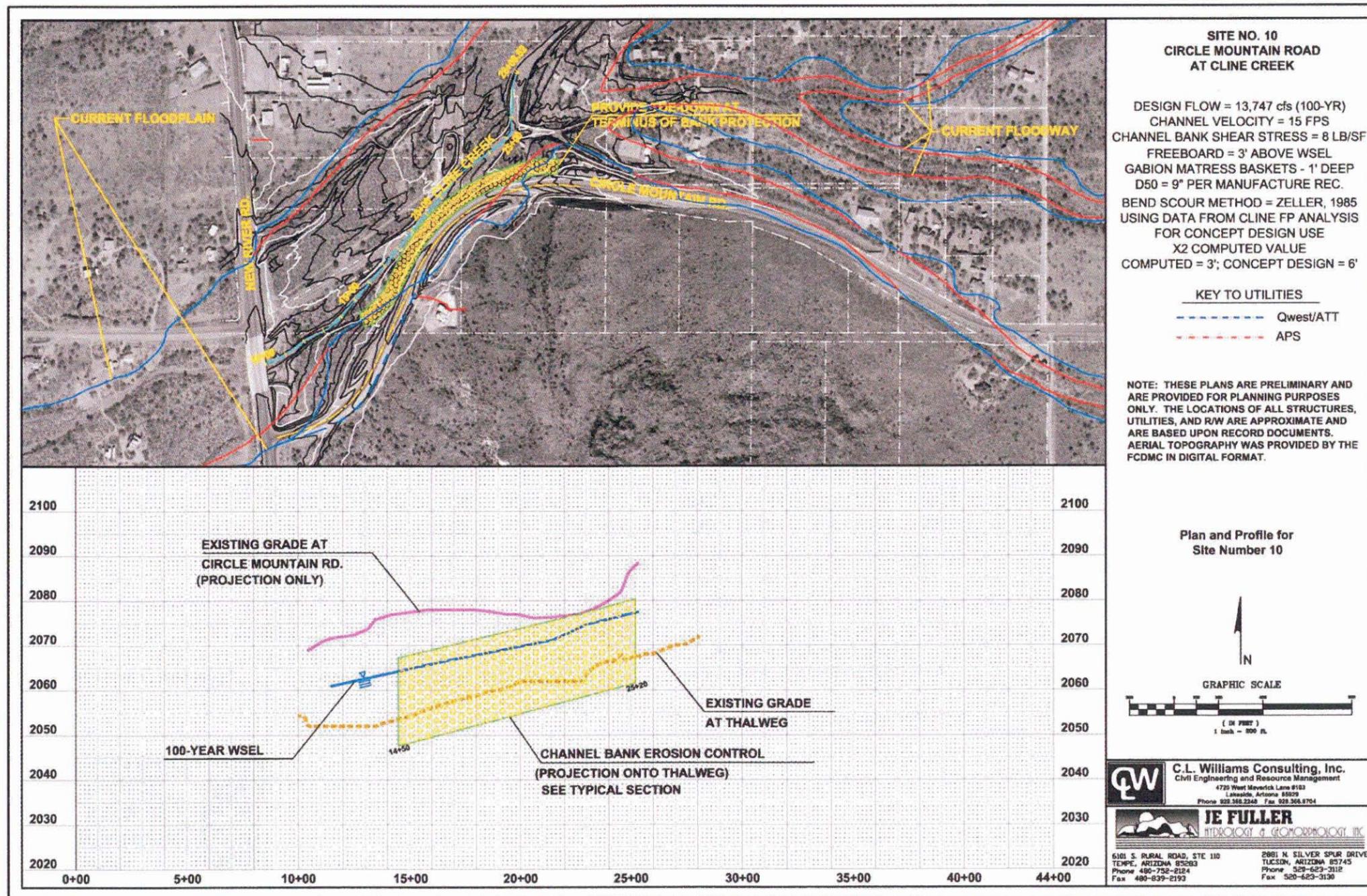


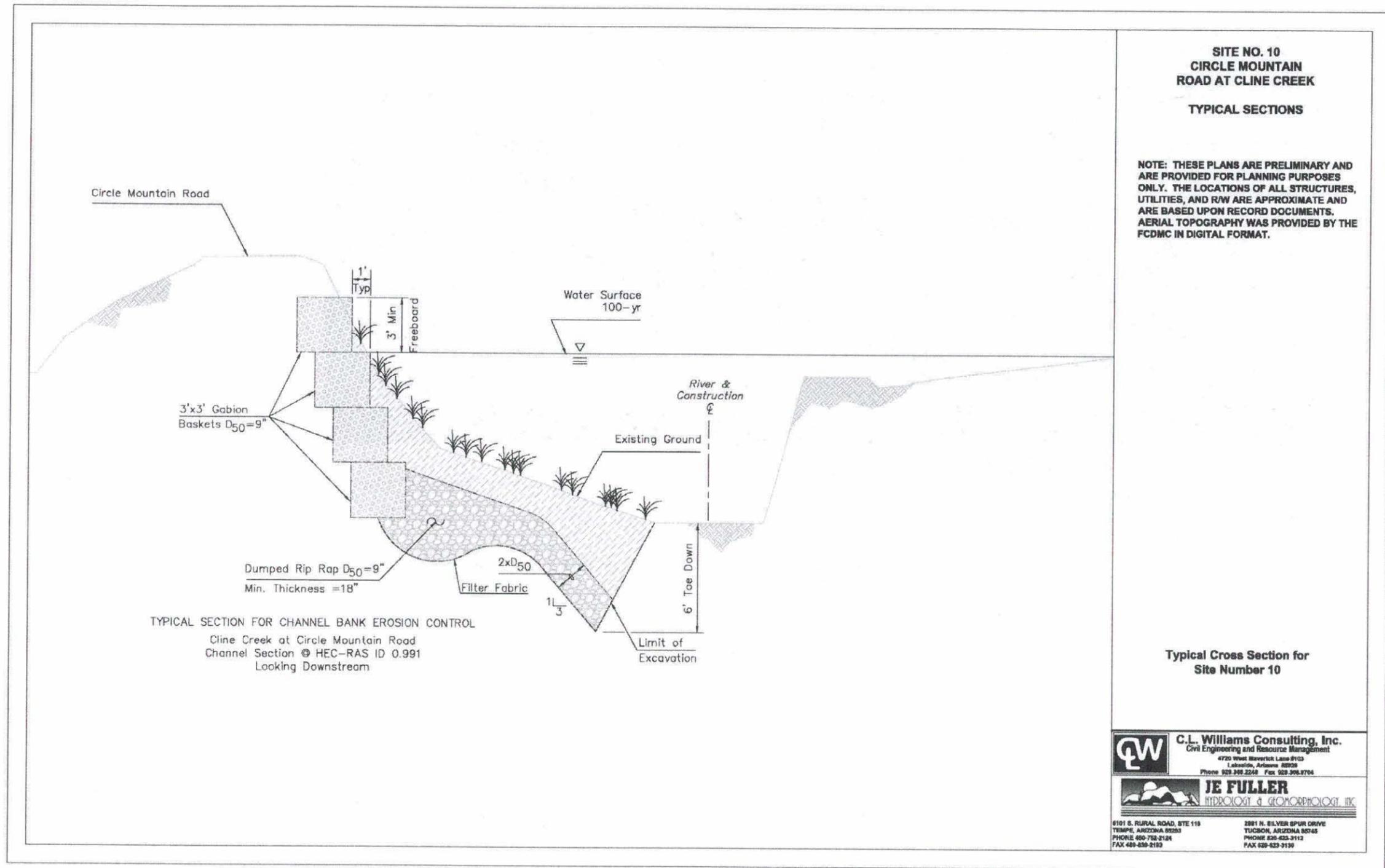












**SITE NO. 10
CIRCLE MOUNTAIN
ROAD AT CLINE CREEK**
TYPICAL SECTIONS

NOTE: THESE PLANS ARE PRELIMINARY AND ARE PROVIDED FOR PLANNING PURPOSES ONLY. THE LOCATIONS OF ALL STRUCTURES, UTILITIES, AND R/W ARE APPROXIMATE AND ARE BASED UPON RECORD DOCUMENTS. AERIAL TOPOGRAPHY WAS PROVIDED BY THE FCDMC IN DIGITAL FORMAT.

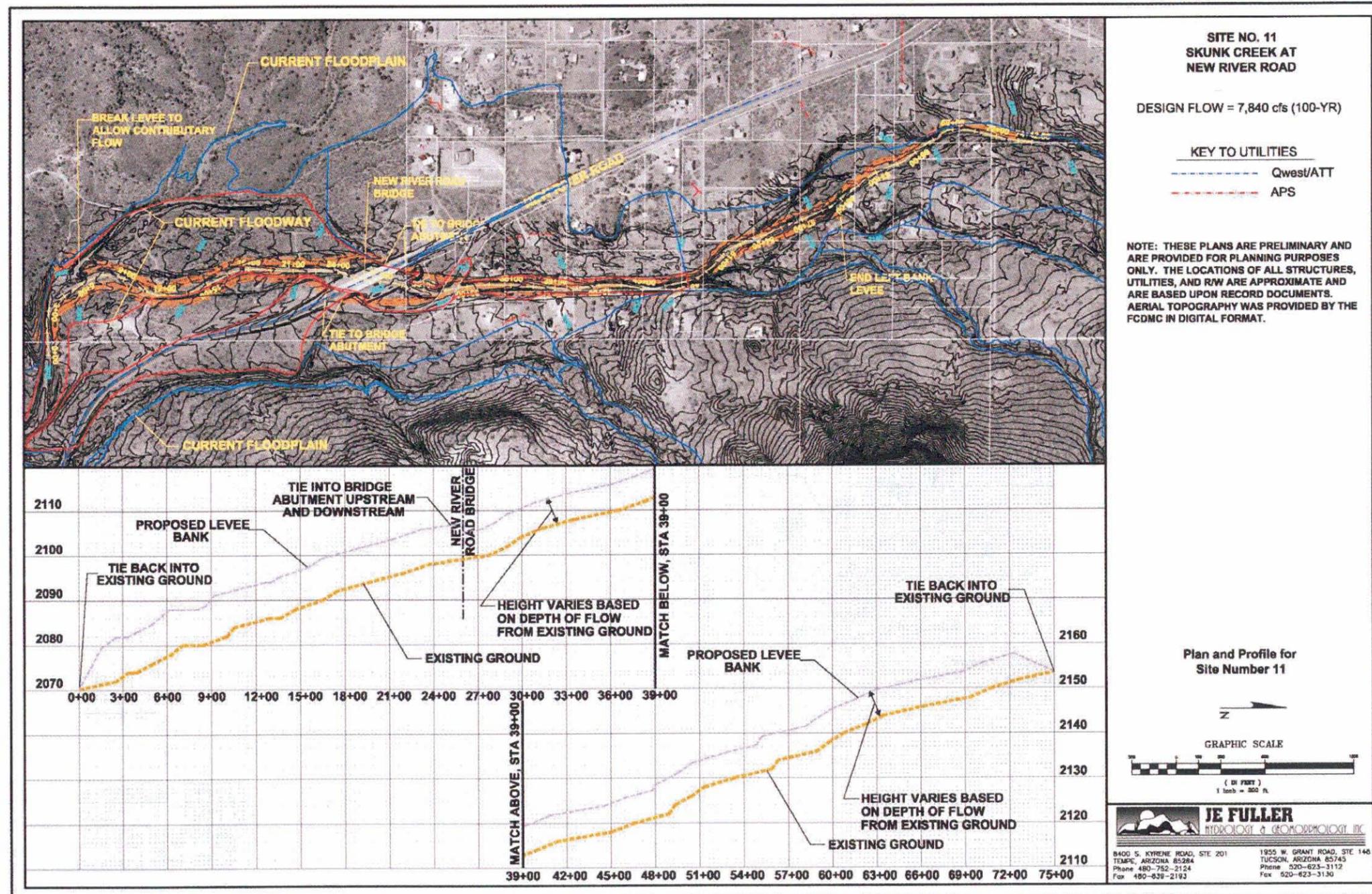
TYPICAL SECTION FOR CHANNEL BANK EROSION CONTROL
Cline Creek at Circle Mountain Road
Channel Section @ HEC-RAS ID 0.991
Looking Downstream

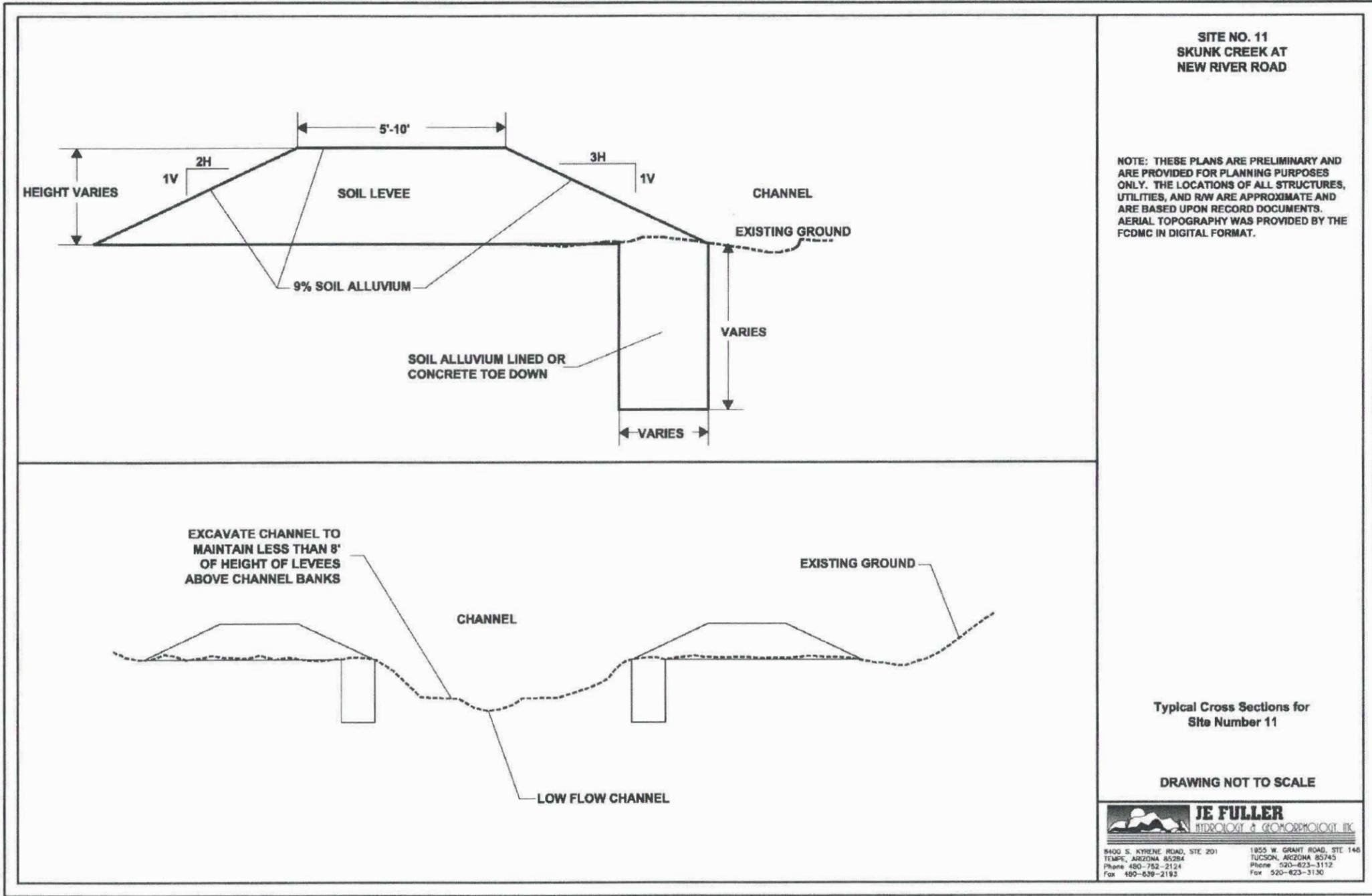
Typical Cross Section for
Site Number 10

	C.L. Williams Consulting, Inc. Civil Engineering and Resource Management 4720 West Maricopa Lane #110 Lubbock, Arizona 86908 Phone 809.249.2248 Fax 809.398.9704
6101 S. RURAL ROAD, STE 118 TEMPE, ARIZONA 85283 PHONE 480.788.9184 FAX 480.439.2193	2881 N. SILVER SPUR DRIVE TUCSON, ARIZONA 85745 PHONE 520.623.3112 FAX 520.623.9199



ADOBE DAM/DESERT HILLS AREA DRAINAGE MASTER PLAN







APPENDIX B

Cost Estimates



ADOBE DAM/DESERT HILLS AREA DRAINAGE MASTER PLAN

Cost Estimates for Site Number 1				
Item	Unit	Quantity	Unit Cost	Total
Subgrade Prep.	Sq. Yd.	43413.00	\$3.50	\$151,945.50
Pavement (surface)	Tons	3662.97	\$40.00	\$146,518.88
Pavement (base)	Tons	14651.89	\$38.00	\$556,771.73
Tack Coat	Tons	36.47	\$380.00	\$13,857.43
Vert. Curb & Gutter	Lin. Ft.	11000.00	\$9.00	\$99,000.00
Single Curb	Lin. Ft.		\$11.00	\$0.00
Sidewalk	Sq. Ft.	55000.00	\$2.00	\$110,000.00
Ribbon Curb	Lin. Ft.		\$8.00	\$0.00
Landscaping	Sq. Ft.	105000.00	\$2.50	\$262,500.00
Deco Pavement	Sq. Ft.	1000.00	\$6.00	\$6,000.00
Street Lights	Lin. Ft.	11000.00	\$8.00	\$88,000.00
Storm Drain	Lin. Ft.	5280.00	\$200.00	\$1,056,000.00
Catch Basins	Each	20.00	\$2,500.00	\$50,000.00
Bridge	Sq. Ft.	37600.00	\$66.00	\$2,481,600.00
Channelization	C.Y.	385000.00	\$3.00	\$1,155,000.00
Soil Cement Bank Protection	C.Y.	71000.00	\$50.00	\$3,550,000.00
Remove RCC Drop Structure	L.S.	1.00	\$200,000.00	\$200,000.00
New RCC Drop Structure	C.Y.	6000.00	\$75.00	\$450,000.00
Adjustments	Each	40.00	\$300.00	\$12,000.00
Remove V.C.&G.	Lin. Ft.		\$1.00	\$0.00
Remove Concrete D/W,S/W,etc.	Sq. Ft.		\$1.50	\$0.00
Remove Structures	L.S.			\$0.00
Misc. Removal and Other Work	L.S.	1.00	\$15,000.00	\$15,000.00
Waterline Relocation	Each			\$0.00
Traffic Signals (Per Intersection)	Each	1.00	\$50,000.00	\$50,000.00
Contingent (20%)	L.S.			\$2,090,838.71
TOTAL				\$12,545,032.24

Cost Estimates for Site Number 1				
Item	Unit	Quantity	Unit Cost	Total
Design Cost				
Consultant				\$752,701.93
DCM Staff				\$1,003,602.58
Construction Adm.				\$1,756,304.51
TOTAL Design/Const.				\$3,512,609.03
Right-of-Way				\$250,000.00
GRAND TOTAL				\$16,307,641.26
<p>Note: Costs provided by the City of Phoenix. This job has already been sent out for design bid.</p> <p>No edits were made to the cost estimates at this time.</p>				



ADOBE DAM/DESERT HILLS AREA DRAINAGE MASTER PLAN

Cost Estimates for Site Number 2

COSTS WITH CONCRETE TOE-DOWN

Item	Construction				Land				Contingency	Engineering	Total
	Units	Unit Cost	Quantity	Construction Cost	Units	Unit Cost	Quantity	Land Cost			
Dike Embankment	Cu. Yd.	\$ 7	112217	\$ 785,519	SF	\$ 1.50	832373	\$ 1,248,560	\$ 196,380	\$ 117,828	\$ 2,348,286
Soil-Cement Bank Protection	Cu. Yd.	\$ 71	10688	\$ 758,848	SF	\$ 1.50	0	\$ -	\$ 189,712	\$ 113,827	\$ 1,062,387
Clearing and Grubbing	LS	\$ 4,000	1	\$ 4,000	SF	\$ 1.50	0	\$ -	\$ 1,000	\$ 600	\$ 5,600
Concrete Toe-Down (for Soil Cement Lining)	Cu. Yd.	\$ 155	12332	\$ 1,911,460	SF	\$ 1.50	0	\$ -	\$ 477,865	\$ 286,719	\$ 2,676,044
			Totals	\$ 3,459,827				\$ 1,248,560	\$ 864,957	\$ 518,974	\$ 6,092,317

Note: Land costs are assumed to equal \$1.50 per square foot raw ground and is only the footprint of the structural alternative. This is equal to \$65,340.26 per acre. (July, 2004)

COST WITH CEMENT SOIL ALLUVIUM TOE-DOWN

Item	Construction				Land				Contingency	Engineering	Total
	Units	Unit Cost	Quantity	Construction Cost	Units	Unit Cost	Quantity	Land Cost			
Dike Embankment	Cu. Yd.	\$ 7	112217	\$ 785,519	SF	\$ 1.50	832373	\$ 1,248,560	\$ 196,380	\$ 117,828	\$ 2,348,286
Soil-Cement Bank Protection	Cu. Yd.	\$ 71	66180	\$ 4,698,780	SF	\$ 1.50	0	\$ -	\$ 1,174,695	\$ 704,817	\$ 6,578,292
Clearing and Grubbing	LS	\$ 4,000	1	\$ 4,000	SF	\$ 1.50	0	\$ -	\$ 1,000	\$ 600	\$ 5,600
			Totals	\$ 5,488,299				\$ 1,248,560	\$ 1,372,075	\$ 823,245	\$ 8,932,178

Note: Land costs are assumed to equal \$1.50 per square foot raw ground and is only the footprint of the structural alternative. This is equal to \$65,340.26 per acre. (July, 2004)

LAND COSTS ASSUMING FULL TAKE ON AFFECTED PROPERTIES

Number of Parcels	Land				Number of Dev. Parcels	Unit Cost	Developed Costs	Total
	Units	Unit Cost	Quantity	Land Cost				
12 - Undeveloped Parcels	SF	\$ 1.50	12938481	\$ 19,407,722	0	\$ -	\$ -	\$ 19,407,722
1 - Developed Parcel	SF	\$ 1.50	0	\$ -	1	\$ 185,000	\$ 185,000	\$ 185,000
			Totals	\$ 19,407,722			\$ 185,000	\$ 19,592,722

SUMMARY

	Minimum Costs	Maximum Costs
Range of Costs	\$ 6,092,317	\$ 27,276,341
Number of Parcels negatively impacted	13	
Number of Parcels positively impacted	25	

Note: All parcel and structure data based on 2002 parcel and aerial data.

Note: A 25% contingency is added for erosion protection, side slope changes, local drainage relief, etc. and any other unknown that will be determined in pre-design/



ADOBE DAM/DESERT HILLS AREA DRAINAGE MASTER PLAN

Cost Estimates for Site Number 5

Item	Description	Construction				Land				Contingency	Engineering	Total	
		Units	Unit Cost	Quantity	Construction Cost	Units	Unit Cost	Quantity	Land Cost				
CH5A	3200' of 48' Channel	LF	\$135	3200	\$ 432,000	SF	\$1.50	160000	\$ 240,000	\$ 108,000	\$ 64,800	\$ 844,800	
CLV5A	3 barrels of 12'x5' RCBC with inlet and outlet headwalls.	LF	\$600	240	\$ 144,000	SF	\$1.50	11520	\$ 17,280	\$ 36,000	\$ 21,600	\$ 218,880	
CLV5B	3 barrels of 12'x5' RCBC with inlet and outlet headwalls.	LF	\$600	240	\$ 144,000	SF	\$1.50	11520	\$ 17,280	\$ 36,000	\$ 21,600	\$ 218,880	
CH5B	2400' of 44" Channel	LF	\$75	2400	\$ 180,000	SF	\$1.50	2000	\$ 3,000	\$ 45,000	\$ 27,000	\$ 255,000	
BASIN 5A	40 Ac-Ft Offline Detention Basin	LS	\$363,000	1	\$ 363,000	SF	\$1.50	348482	\$ 522,723	\$ 90,750	\$ 54,450	\$1,030,923	
CH5C	8,300' of 44' Channel	LF	\$75	8300	\$ 622,500	SF	\$1.50	365200	\$ 547,800	\$ 155,625	\$ 93,375	\$1,419,300	
CLV5C	1- 8'x5' RCBC with inlet and outlet headwalls.	LF	\$480	120	\$ 57,600	SF	\$1.50	3840	\$ 5,760	\$ 14,400	\$ 8,640	\$ 86,400	
CLV5D	N/A	LF	\$480	0	\$ -	SF	\$1.50	0	\$ -	\$ -	\$ -	\$ -	
CH5D	N/A	LF	\$135	0	\$ -	SF	\$1.50	0	\$ -	\$ -	\$ -	\$ -	
CLV5E	N/A	LF	\$600	0	\$ -	SF	\$1.50	0	\$ -	\$ -	\$ -	\$ -	
CLV5F	N/A	LF	\$600	0	\$ -	SF	\$1.50	0	\$ -	\$ -	\$ -	\$ -	
				Totals	\$ 1,943,100					\$ 1,353,843	\$ 485,775	\$ 291,465	\$4,074,183

Note: Land costs are assumed to equal \$1.50 per square foot raw ground and is only the footprint of the structural alternative. This is equal to \$65,340.26 per acre. (July, 2004)

LAND COSTS ASSUMING FULL TAKE ON AFFECTED PROPERTIES

Number of Parcels	Land				Number of Dev. Parcels	Developed		
	Units	Unit Cost	Quantity	Land Cost		Unit Cost	Costs	Total
16 - Undeveloped Parcels	SF	\$ 1.50	381150	\$ 571,725	0	\$ -	\$ -	\$ 571,725
1 - Developed Parcels	SF	\$ 1.50	21780	\$ 32,670	1	\$ 185,000	\$ 185,000	\$ 217,670
Totals				\$ 604,395			\$ 185,000	\$ 789,395

SUMMARY

	Minimum Costs	Maximum Costs
Range of Costs	\$ 4,074,183	\$ 4,583,258

Number of Parcels negatively impacted	29
Number of Parcels positively impacted	47 (Approximately)

Note: All parcel and structure data based on 2002 parcel and aerial data.

Note: A 25% contingency is added for erosion protection, side slope changes, local drainage relief, etc. and any other unknown that will be determined in pre-design/



Cost Estimates for Site Number 7							
Description	Construction				Contingency	Engineering	Total
	Units	Unit Cost	Quantity	Construction Cost			
Roadway Excavation	Cu.Yd.	\$10	3,000	\$ 30,000	\$ 7,500	\$ 4,500	\$ 42,000
Pavement	Sq. Yd.	\$25	22,000	\$ 550,000	\$ 137,500	\$ 82,500	\$ 770,000
Misc. Roadway Items	LS	\$250,000	1	\$ 250,000	\$ 62,500	\$ 37,500	\$ 350,000
Right-of-Way Acquisition	Acre	\$50,000	13.6	\$ 680,000	\$ 170,000	\$ 102,000	\$ 952,000
Improvements (Carefree Highway)	LS	\$65,000	1	\$ 65,000	\$ 16,250	\$ 9,750	\$ 91,000
Demolition	Sq. Yd.	\$5	22,100	\$ 110,500	\$ 27,625	\$ 16,575	\$ 154,700
Rehabilitation	Acre	\$2,845	8.8	\$ 25,036	\$ 6,259	\$ 3,755	\$ 35,050
Environmental Assessment	LS	\$100,000	1	\$ 100,000	\$ 25,000	\$ 15,000	\$ 140,000
Right-of-Way Abandonment	LS	\$20,000	1	\$ 20,000	\$ 5,000	\$ 3,000	\$ 28,000
Totals				\$ 1,830,536	\$ 457,634	\$ 274,580	\$ 2,562,750
SUMMARY							
				Minimum Costs		Maximum Costs	
Range of Costs				\$ 2,562,750		\$ 2,562,750	
Number of Parcels negatively impacted		2					
Number of Parcels positively impacted		50 (Approximately)					
<p>Note: All parcel and structure data based on 2002 parcel and aerial data. Note: A 25% contingency is added for erosion protection, side slope changes, local drainage relief, etc. and any other unknown that will be determined in pre-design/</p>							



Cost Estimates for Site Number 8							
COST ESTIMATE							
Description	Construction				Contingency	Engineering	Total
	Units	Unit Cost	Quantity	Construction Cost			
Roadway Excavation	Cu.Yd.	\$10	1,800	\$ 18,000	\$ 4,500	\$ 2,700	\$ 25,200
Pavement	Sq. Yd.	\$25	12,550	\$ 313,750	\$ 78,438	\$ 47,063	\$ 439,250
Misc. Roadway Items	LS	\$250,000	1	\$ 250,000	\$ 62,500	\$ 37,500	\$ 350,000
Right-of-Way Acquisition	Acre	\$50,000	6.2	\$ 310,000	\$ 77,500	\$ 46,500	\$ 434,000
Bridge	Sq. Ft.	\$85	121,200	\$ 10,302,000	\$ 2,575,500	\$ 1,545,300	\$ 14,422,800
Guardrail	LF	\$15	200	\$ 3,000	\$ 750	\$ 450	\$ 4,200
Guardrail Terminals	Each	\$2,500	4.0	\$ 10,000	\$ 2,500	\$ 1,500	\$ 14,000
Totals				\$ 11,206,750	\$ 2,801,688	\$ 1,681,013	\$ 15,689,450
SUMMARY							
				Minimum Costs		Maximum Costs	
Range of Costs				\$ 15,689,450		\$ 15,689,450	
Number of Parcels negatively impacted		12					
Number of Parcels positively impacted		65 (Approximately)					
<p>Note: All parcel and structure data based on 2002 parcel and aerial data.</p> <p>Note: A 25% contingency is added for erosion protection, side slope changes, local drainage relief, etc. and any other unknown that will be determined in pre-design/</p>							



ADOBE DAM/DESERT HILLS AREA DRAINAGE MASTER PLAN

Cost Estimates for Site Number 9

COST ESTIMATE

Description	Construction				Land				Contingency	Engineering	Total
	Units	Unit Cost	Quantity	Construction Cost	Units	Unit Cost	Quantity	Land Cost			
Roadway Excavation	Cu.Yd.	\$10	500	\$ 5,000	SF	\$1.50	0	\$ -	\$ 1,250	\$ 750	\$ 7,000
Pavement	Sq. Yd.	\$25	1450	\$ 36,250	SF	\$1.50	0	\$ -	\$ 9,063	\$ 5,438	\$ 50,750
Misc. Roadway Items	LS	\$250,000	1	\$ 250,000	SF	\$1.50	0	\$ -	\$ 62,500	\$ 37,500	\$ 350,000
Right-of-Way Acquisition	Acre	\$50,000	1	\$ 50,000	SF	\$1.50	43560	\$ 65,340	\$ 12,500	\$ 7,500	\$ 135,340
Bridge	Sq. Ft.	\$85	34000	\$ 2,890,000	SF	\$1.50	0	\$ -	\$ 722,500	\$ 433,500	\$ 4,046,000
Guardrail	LF	\$15	1200	\$ 18,000	SF	\$1.50	0	\$ -	\$ 4,500	\$ 2,700	\$ 25,200
Guardrail Terminals	Each	\$2,500	4	\$ 10,000	SF	\$1.50	0	\$ -	\$ 2,500	\$ 1,500	\$ 14,000
Totals				\$ 3,259,250				\$ 65,340	\$ 814,813	\$ 488,888	\$ 4,628,290

Note: Land costs are assumed to equal \$1.50 per square foot raw ground and is only the footprint of the structural alternative. This is equal to \$65,340.26 per acre. (July, 2004)

LAND COSTS ASSUMING FULL TAKE ON AFFECTED PROPERTIES

Number of Parcels	Land				Number of Dev. Parcels	Developed		
	Units	Unit Cost	Quantity	Land Cost		Unit Cost	Costs	Total
1 - Undeveloped Parcels	SF	\$ 1.50	95947	\$ 143,921	0	\$ -	\$ -	\$ 143,921
1 - Developed Parcel	SF	\$ 1.50	206257	\$ 309,386	1	\$ 185,000	\$ 185,000	\$ 494,386
Totals				\$ 453,306			\$ 185,000	\$ 638,306

SUMMARY

	Minimum Costs	Maximum Costs
Range of Costs	\$ 4,628,290	\$ 5,201,256

Number of Parcels negatively impacted	2
Number of Parcels positively impacted	5 (5 Directly, All of the Cline Creek and New River area)

Note: All parcel and structure data based on 2002 parcel and aerial data.

Note: A 25% contingency is added for erosion protection, side slope changes, local drainage relief, etc. and any other unknown that will be determined in pre-design/



ADOBE DAM/DESERT HILLS AREA DRAINAGE MASTER PLAN

Cost Estimates for Site Number 10

COST ESTIMATE

Description	Construction				Land				Contingency	Engineering	Total	
	Units	Unit Cost	Quantity	Construction Cost	Units	Unit Cost	Quantity	Land Cost				
Excavation	Cu.Yd.	\$10	25400	\$ 254,000	SF	\$1.50	83468.55	\$ 125,203	\$ 63,500	\$ 38,100	\$ 480,803	
Gabions	Cu.Yd.	\$85	1560	\$ 132,600	SF	\$1.50	0	\$ -	\$ 33,150	\$ 19,890	\$ 185,640	
Dumped Rip Rap	Cu.Yd.	\$65	8000	\$ 520,000	SF	\$1.50	0	\$ -	\$ 130,000	\$ 78,000	\$ 728,000	
Landscaping	Sq. Yd.	\$6	9200	\$ 55,200	SF	\$1.50	0	\$ -	\$ 13,800	\$ 8,280	\$ 77,280	
Misc. Erosion Items	LS	\$100,000	1	\$ 100,000	SF	\$1.50	0	\$ -	\$ 25,000	\$ 15,000	\$ 140,000	
Totals				\$ 1,061,800					\$ 125,203	\$ 265,450	\$ 159,270	\$ 1,611,723

Note: Land costs are assumed to equal \$1.50 per square foot raw ground and is only the footprint of the structural alternative. This is equal to \$65,340.26 per acre. (July, 2004)

LAND COSTS ASSUMING FULL TAKE ON AFFECTED PROPERTIES

Number of Parcels	Land				Number of Dev. Parcels	Developed			
	Units	Unit Cost	Quantity	Land Cost		Unit Cost	Costs	Total	
2 - Undeveloped Parcels	SF	\$ 1.50	776281	\$ 1,164,422	0	\$ -	\$ -	\$ 1,164,422	
0 - Developed Parcel	SF	\$ 1.50	0	\$ -	0	\$ -	\$ -	\$ -	
Totals				\$ 1,164,422				\$ -	\$ 1,164,422

SUMMARY

	Minimum Costs	Maximum Costs
Range of Costs	\$ 1,611,723	\$ 2,650,942

Number of Parcels negatively impacted	2
Number of Parcels positively impacted	4 Square Miles (All of the Cline Creek Area)

Note: All parcel and structure data based on 2002 parcel and aerial data.

Note: A 25% contingency is added for erosion protection, side slope changes, local drainage relief, etc. and any other unknown that will be determined in pre-design/



ADOBE DAM/DESERT HILLS AREA DRAINAGE MASTER PLAN

Cost Estimates for Site Number 11

COSTS WITH CONCRETE TOE-DOWN

Item	Construction				Land				Contingency	Engineering	Total
	Units	Unit Cost	Quantity	Construction Cost	Units	Unit Cost	Quantity	Land Cost			
Dike Embankment	Cu. Yd.	\$ 7	48000	\$ 336,000	SF	\$ 1.50	283500	\$ 425,250	\$ 84,000	\$ 50,400	\$ 895,650
Channel Excavation	Cu. Yd.	\$ 10	10000	\$ 100,000	SF	\$ 1.50	0	\$ -	\$ 25,000	\$ 15,000	\$ 140,000
Soil-Cement Bank Protection	Cu. Yd.	\$ 71	8100	\$ 575,100	SF	\$ 1.50	0	\$ -	\$ 143,775	\$ 86,265	\$ 805,140
Clearing and Grubbing	LS	\$ 8,000	1	\$ 8,000	SF	\$ 1.50	0	\$ -	\$ 2,000	\$ 1,200	\$ 11,200
Concrete Toe-Down (for Soil Cement Lining)	Cu. Yd.	\$ 155	4050	\$ 627,750	SF	\$ 1.50	0	\$ -	\$ 156,938	\$ 94,163	\$ 878,850
Totals				\$ 1,646,850				\$ 425,250	\$ 411,713	\$ 247,028	\$ 2,730,840

Note: Land costs are assumed to equal \$1.50 per square foot raw ground and is only the footprint of the structural alternative. This is equal to \$65,340.26 per acre. (July, 2004)

COST WITH CEMENT SOIL ALLUVIUM TOE-DOWN

Item	Construction				Land				Contingency	Engineering	Total
	Units	Unit Cost	Quantity	Construction Cost	Units	Unit Cost	Quantity	Land Cost			
Dike Embankment	Cu. Yd.	\$ 7	48000	\$ 336,000	SF	\$ 1.50	283500	\$ 425,250	\$ 84,000	\$ 50,400	\$ 895,650
Channel Excavation	Cu. Yd.	\$ 10	10000	\$ 100,000	SF	\$ 1.50	0	\$ -	\$ 25,000	\$ 15,000	\$ 140,000
Soil-Cement Bank Protection	Cu. Yd.	\$ 71	12600	\$ 894,600	SF	\$ 1.50	0	\$ -	\$ 223,650	\$ 134,190	\$ 1,252,440
Clearing and Grubbing	LS	\$ 8,000	1	\$ 8,000	SF	\$ 1.50	0	\$ -	\$ 2,000	\$ 1,200	\$ 11,200
Totals				\$ 1,338,600				\$ 425,250	\$ 334,650	\$ 200,790	\$ 2,299,290

Note: Land costs are assumed to equal \$1.50 per square foot raw ground and is only the footprint of the structural alternative. This is equal to \$65,340.26 per acre. (July, 2004)

LAND COSTS ASSUMING FULL TAKE ON AFFECTED PROPERTIES

Number of Parcels	Land				Number of Dev. Parcels	Developed		
	Units	Unit Cost	Quantity	Land Cost		Unit Cost	Costs	Total
5 - Undeveloped Parcels	SF	\$ 1.50	307969	\$ 461,954	0	\$ -	\$ -	\$ 461,954
13 - Developed Parcel	SF	\$ 1.50	3041562	\$ 4,562,343	13	\$ 185,000	\$ 2,405,000	\$ 6,967,343
Totals				\$ 5,024,297			\$ 2,405,000	\$ 7,429,297



**Table 3.12 Cont.
Cost Estimates for Site Number 11**

Summary		Minimum Costs		Maximum Costs	
Range of Costs		\$	2,299,290	\$	9,734,887
Number of Parcels negatively impacted	18				
Number of Parcels positively impacted	72 (Approximately)				
8100 Total feet of Levee Used for Calculations					

Note: All parcel and structure data based on 2002 parcel and aerial data.

Note: A 25% contingency is added for erosion protection, side slope changes, local drainage relief, etc. and any other unknown that will be determined in pre-design/



APPENDIX C

Development Guidelines for Individual Single-Family Lot Development



**DEVELOPMENT GUIDELINES FOR
INDIVIDUAL SINGLE-FAMILY LOTS
Part 9, Volume 1, Appendix C**

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SECTION 1: INTRODUCTION

1.1 Applicability

Development guidelines are a work product of an Area Drainage Master Plan (ADMP). This plan is based on an Area Drainage Master Study (ADMS) which develops hydrology for a watershed, identifies potential flood prone areas and drainage problems, and identifies alternatives for solving these problems. There are 48 identified study areas within the jurisdiction of the Flood Control District of Maricopa County (FCDMC). To date, there have been 32 studies completed and the remainder are projected to be completed by 2010. See Figure 1.1.1 for the general boundaries of all 48 study areas.

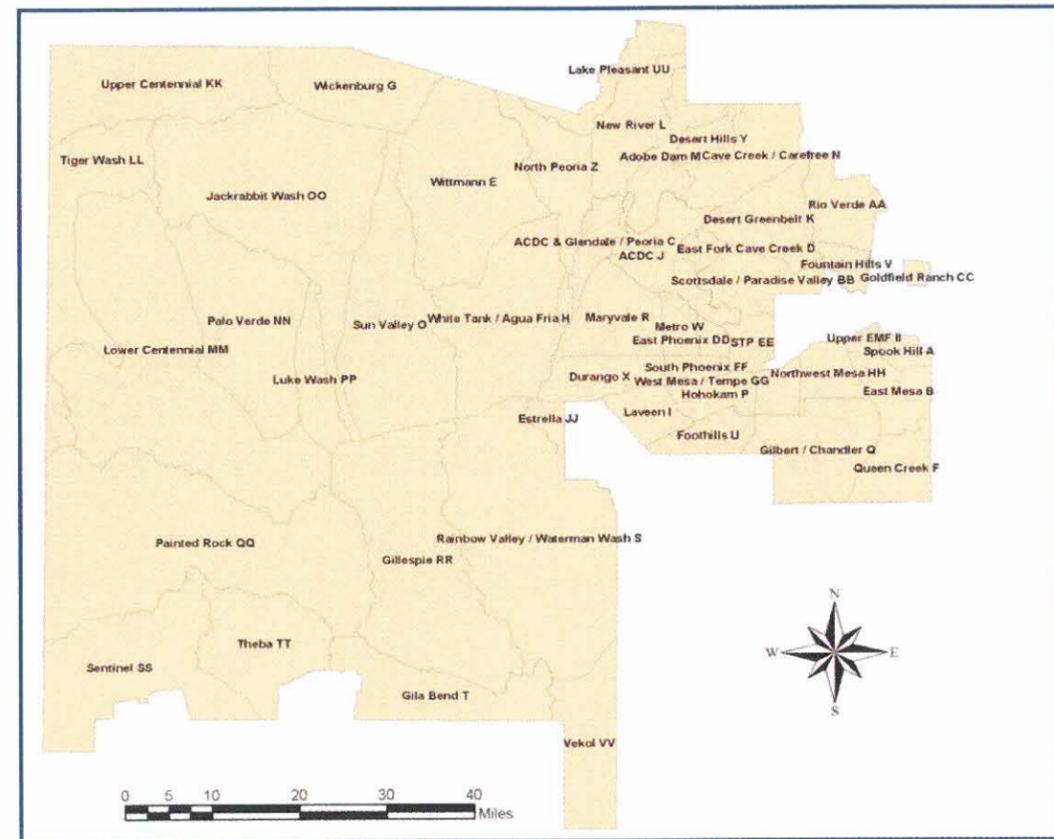


Figure 1.1.1 Maricopa County Drainage Study Areas

The ADMP takes the information from the ADMS and analyzes the alternatives to reach a preferred solution. The solutions proposed are both structural (such as levees, basins, culverts and channels) and non-structural (such as development guidelines, flood warning system, and property acquisition) in nature.

The Adobe Dam/Desert Hills study area is located in the north central portion of the Phoenix metropolitan area (see Figure 1.1.2). The southern half of the study area lies predominantly within the incorporated limits of the City of Phoenix. The Town of Cave Creek covers a small area in the northeastern portion of the study area. The majority of the northern portion of the study area is unincorporated Maricopa County.

Counties lack the regulatory authority to manage lot splits. As a result, these types of land division are exempt from subdivision and/or other improvement requirements. Although impacts from lot split development may appear relatively insignificant when viewed on the individual lot basis, frequently the cumulative impact of such external impacts is much more significant. Counties have greater ability to review residential subdivisions, multi-family, industrial and commercial projects to address potential impacts on adjacent properties. Cities have the authority to review and require compliance with development standards for the above projects, as well as individual lots.

In reviewing these issues, it became apparent that development guidelines would have the most positive affect on single-family development on individual lots within the unincorporated areas of Maricopa County. Therefore, the analysis of the types of potential regulations was done with a specific focus on the nature of single-family development on individual lots.

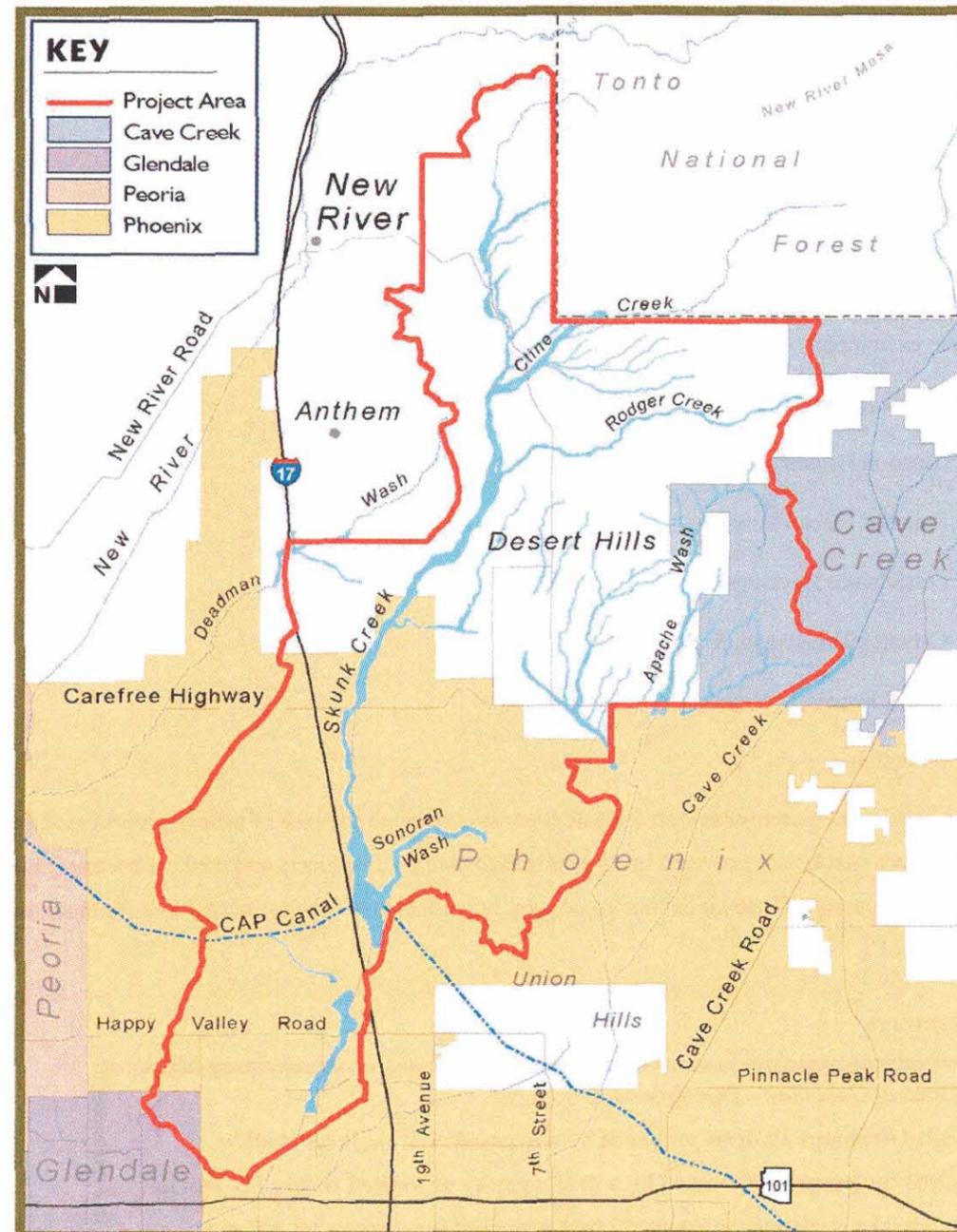


Figure 1.1.2 Adobe Dam/Desert Hills Study Area

1.2 Development Guidelines Objectives

The Adobe Dam/ Desert Hills ADMP identifies flooding and erosion hazards in the New River and Desert Hills areas and recommends measures to mitigate those hazards. Both structural and non-structural measures are component parts of the recommended alternative plan for addressing drainage and flooding problems. The development guidelines are one of the non-structural components of the alternative plan. The general objectives of the development guidelines include the following:

General Objectives

- Enhance public safety by guiding development in the watershed to protect current and future residents from the effects of flooding.
- Reduce adverse drainage impacts due to development in the watershed by guiding activities of new residents so that future runoff to Skunk Creek is maintained at current conditions and downstream neighbors are not negatively impacted.
- Guide future development in a manner consistent with the recommended alternative plan of the Adobe ADMP.

The following specific objectives were established to guide the development of the recommended criteria as presented herein and their means of implementation:

Specific Objectives

- Use existing aerial photography, topographic data, and parcel database resources to the maximum extent possible.
- Use available resources and the work products of the ADMP, including floodplain delineations, geomorphic evaluation, and identification of drainage problems, as input to the review required for each permit application.
- Develop guidelines that have been tested against the actual environmental and development conditions within the study area.
- Provide the consumer with a development guidelines checklist to minimize cost and time investments for all parties.



- Provide a means for flexibility in the review process so that drainage permit applicants may proceed with lot development incorporating drainage features that do not explicitly meet the development guidelines provided they are designed and sealed by a registered professional engineer, and reviewed and approved by the District.
- Develop guidelines consistent and compatible with existing statutes, ordinances, and regulations.
- Limit the guidelines to solely those necessary to address watershed-specific problems not adequately covered by existing Floodplain and/or Drainage Regulations.

The proposed development guidelines for the Adobe Dam/Desert Hills ADMP are consistent with the general and specific objectives set forth above.

1.3 Summary and Conclusions

A careful analysis of area development trends and regulatory options was conducted to identify specific issues that were not addressed by the existing drainage and floodplain regulations. It became apparent that single-family development on individual lots within unincorporated areas was the one category with insufficient standards to address the cumulative impacts of this type of development. See Appendix A for a discussion of the statutory basis of the development guidelines.

This analysis documented the existing practices and procedures and carefully integrated a unique toolkit to address individual single-family lot development in the study area. An option is also available for individuals to obtain approval for variations to the regulations if a higher degree of drainage analysis is provided by a registered professional engineer in order to justify the proposed change(s). By providing this degree of flexibility, both the public and FCDMC staff will benefit from these proposed Development Guidelines.

SECTION 2: DEVELOPMENT GUIDELINES

2.1 Overview

A number of tools or criteria were evaluated for application to single-lot development in the Adobe Dam/ Desert Hills ADMP study area. The tools were evaluated based on their hydrologic efficacy, long-term viability, and their potential for implementation. Seven types of tools, or development guidelines, relating to single-family, individual lot development were examined:

- Drainageways
- (Erosion Hazard) Setbacks
- Finished Floor Elevations
- Disturbance Envelopes
- Culverts, Driveways, & Roads
- Walls, Fences, & Berms
- Retention

Based on this investigation, development guidelines were created for each of the categories listed above. A development guidelines checklist is provided in Appendix B for use by developers and landowners as a guide to construction on their property. These guidelines are shown, in bold, below. The technical basis for these guidelines may be found in Appendix C.

2.2 Drainageways

Development Guideline – Drainageways

A detailed drainage analysis prepared by a licensed civil engineer shall be submitted for properties crossed by a drainageway or located within 150 feet on either side of a drainageway to verify that proposed improvements will not



The primary use of the drainageways will be as a tool to quickly determine which parcels may require more detailed engineering analysis prior to processing a permit for development. Submittals for parcels outside of the drainageway influence area and which comply with all development guidelines and drainage regulations would be limited to a site plan and general drainage information. However, parcels within the influence area, or those seeking to deviate from a development guideline, would require a detailed drainage analysis prepared by a licensed civil engineer.

2.3 Erosion Hazard Setbacks

Development Guideline – Erosion Hazard Setbacks

Properties crossed by a delineated wash with a detailed erosion hazard zone shall comply with the erosion hazard setbacks set forth in the *Riverine Erosion Hazard*

shall be identified for any parcel crossed by or adjacent to “a delineated floodplain and watercourses or contributing watersheds that have flows greater than 50 cfs during a 100-year flood event.” All of the existing FEMA floodplain delineations and those being conducted as part of the ADMP have, or will have, a detailed erosion hazard zone identified for them. Any drainageway that carries more than 50 cfs in the 100-year flood event (i.e., subject to the Floodplain Regulation) will also need to have an erosion hazard setback assessment prior to development. The erosion setback shall be determined using the District’s draft *Riverine Erosion Hazard Delineation and Development Guidelines*. These guidelines describe a three-level approach. Generally, additional information and analysis are required to reduce the required setback distance without erosion protection measures. A minimum setback of 15 ft or 2 times the bank height, whichever is greater, is required per the draft erosion hazard guidelines. Structural measures for erosion hazard mitigation are also presented in the guidelines.

2.4 Disturbance Envelope

Development Guidelines – Disturbance Envelope

- **No more than 50% of the site may be disturbed, and all improvements (including, but not limited to, roof-bearing structures, retention, cleared and grubbed areas such as horse corrals, landscaping with permanent irrigation, and areas with impervious ground cover and/or barriers that preclude infiltration) shall be located within this area.**
- **Boundaries of the disturbed area must be delineated on the property with permanent markers.**
- **Temporary disturbance in excess of the 50% is allowed for utility installation, temporary construction access, and temporary stockpiling of construction related materials. Revegetation of these areas is required and must be completed prior to final certificate of occupancy.**

A disturbance envelope is a contiguous spatial limit on a lot which may be altered from its natural state as part of the development of the lot. The rationale for the disturbance envelope is that the removal of vegetation and other disturbance of the natural ground results in an adverse impact on storm water runoff from the lot. Namely, rainfall is no longer intercepted by the native plants and consequently becomes runoff. In addition, plant roots and other biological activity associated with the plant increase the rate at which rainfall soaks into the soil. The combined result is an increase in both the magnitude and frequency of runoff from the disturbed area. Another consequence of the disturbance of the natural areas is a disruption and elimination of habitat for native desert species.

2.5 Culverts, Driveways, Roads

Development Guidelines – Culverts, Driveways, Roads

- **Dip crossings should be used for driveways and local streets unless it can be demonstrated that culverts are necessary due to the depth and/or velocity of flows.**
- **All culverts and bridged crossings should be designed to minimize the disruption of sediment transport continuity upstream and downstream of the crossing. Crossings that mimic the natural channel’s depth and width within the reach being crossed will be most successful.**
- **Lowering of the local channel bottom elevation is discouraged.**
- **Roadways shall be designed so as not to divert flows.**



Dip crossings are preferred to culvert crossings for access on driveways and local streets. Arterial streets should be designed in accordance with existing County criteria. However in addition to the design levels prescribed in those criteria, all culverts or bridged crossings should be designed to minimize disruption of sediment transport continuity upstream and downstream of the crossing. Crossings that mimic the natural channel’s depth and width within the reach being crossed will be most successful. Lowering of local channel bottom elevations is also discouraged. Roadways shall be designed so as not to divert flows.

2.6 Walls, Fences, Berms

Development Guidelines – Walls, Fences, Berms

- Fences at the perimeter of a parcel shall be limited to open-type fencing (pipe rail, split rail, barbed wire, etc.) for lots crossed by or within 150-feet of a drainageway or within the inundation limits of the 100-year flood along a drainageway or floodplain.
- Chain link and chicken wire are not considered open-type fencing, as it must have openings at least 8-inches in diameter.
- A solid “courtyard” wall is permitted immediately downslope or upslope of the principle dwelling unit, and is defined a wall that surrounds an area immediately adjacent to the principle dwelling unit and is limited in lateral distance to no more than 15 feet if oriented perpendicular to the direction of flow and is not limited in lateral distance if oriented parallel to the direction of flow.
- Closed fences, walls or perimeter berms are not allowed unless it can be demonstrated to the satisfaction of the Drainage Administrator that there is no increase in peak discharge, flow depth or velocity, or flow diversion as a result of the proposed improvement.

Perimeter fences shall be limited to open-type fencing (pipe rail, barb wire, etc.) for lots within drainageway influence areas or within the inundation limits of the 100-year flood along a drainageway or floodplain. Chain link or chicken wire does not constitute open-type fencing. In order to be considered “open-type” fencing, the openings must be a minimum of 8 inches in diameter. For lots not in a drainageway influence area or 100-year floodplain, solid perimeter fences that comply with current Maricopa County development standards are permitted.

“Courtyard” fences are considered acceptable immediately upslope or downslope of the residence. A “courtyard” fence is considered any fence (open-type or otherwise) or wall that surrounds an area immediately adjacent to a residential structure and is limited laterally to no more than 15 feet from the building walls in the direction perpendicular to flow (i.e.

parallel to the topographic contours). The “courtyard” fence or wall may extend as far as desired if it projects from an exterior wall of the residential structure in the upslope or downslope direction parallel to flow (i.e. perpendicular to the topographic contours). See Figure 2.6.1, below.

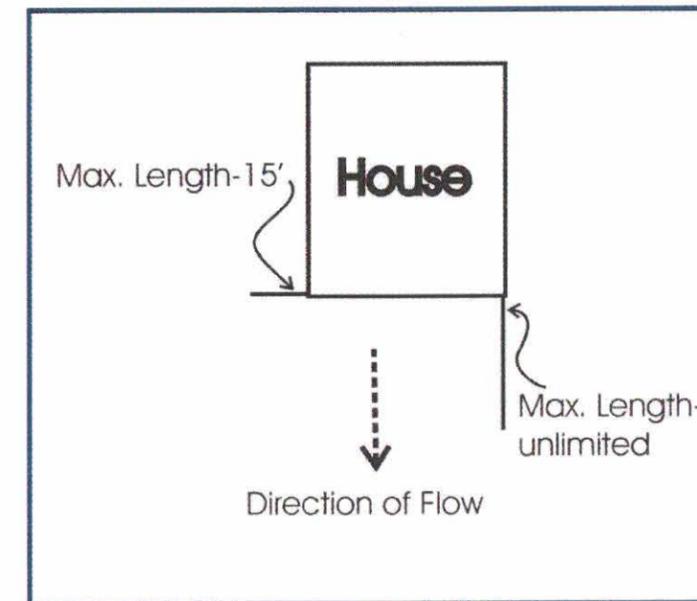


Figure 2.6.1 Courtyard Walls

Closed fences, walls, or perimeter berms are not allowed without a demonstration that no adverse impact on neighboring properties results from the construction of the proposed fence, wall, or berm. That is, it can be demonstrated to the satisfaction of the Drainage Administrator that there is no increase in peak discharge, flow depth, or velocity or flow diversion as the result of the proposed improvement(s).



2.7 Retention

Development Guidelines – Retention

- **On-lot retention shall be provided based on the following formula:**
 - **R-43 Zoning: 1500 ft³/acre**
 - **R-70 Zoning: 1600 ft³/acre**
 - **R-190 Zoning: 2200 ft³/acre**
- **Retention areas shall be located within the 50% disturbable area limit and in such a fashion as to effectively capture runoff from the impervious surfaces of the lot.**
- **Retention may be provided in multiple basins.**
- **Retention areas shall not be placed within a regulatory floodplain or otherwise such that off-site runoff is intercepted. The regulatory floodplain included delineated floodplains and watercourses that have flows greater than 50 cfs during a 100-year flood.**
- **Septic system percolation rates shall determine the suitability of a retention area location.**
- **Retention areas may be landscaped with organic and/or inorganic ground cover.**

Although concern has been raised about the long-term assurance of single-lot retention facilities, retention may be the most effective tool available to mitigate adverse hydrologic impacts from development. Additionally, retention may have possible complementary benefits with respect to requirements of the Clean Water Act.

2.8 Summary and Recommendations

Table 2.9.1 summarizes the recommended tools and measures for the Development Guidelines for the Adobe ADMP.

Table 2.9.1 Summary of Development Guidelines Criteria for Adobe ADMP

Tool	Measure	Source/Basis
Erosion Hazard Setback	<ul style="list-style-type: none"> ▪ Function of discharge ▪ Minimum 15 ft or 2 times bank height (whichever is greater) 	<ul style="list-style-type: none"> ▪ Riverine Erosion Hazard Delineation ▪ Development Guidelines
Minimum Floor Elevation	<ul style="list-style-type: none"> ▪ 1 ft above highest adjacent natural ground ▪ 1 ft above regulatory base flood 	<ul style="list-style-type: none"> ▪ Drainage Regulations ▪ Floodplain Regulations
Disturbance Envelope	50% of lot	Consistent with current zoning regulatory environment
Culverts, driveways, roads	<ul style="list-style-type: none"> ▪ Prefer dips ▪ Maintain sediment transport continuity ▪ Prevent base level lowering ▪ Do not divert flow 	<ul style="list-style-type: none"> ▪ Drainage Design Manual Vol. II ▪ Drainage Regulations
Walls, Fences, Berms	Open-type fencing and courtyard fencing allowed	Floodplain Regulations
Retention	R-43: 1500 ft ³ /acre R-70: 1600 ft ³ /acre R-190: 2200 ft ³ /acre	<ul style="list-style-type: none"> ▪ 100-yr 2-hr ▪ Drainage Design Manual Vol. II

Any variations from these minimum criteria will require engineering analyses that demonstrate to the satisfaction of the Drainage or Floodplain Administrator that no adverse impact to adjacent properties results from the requested variations, and that the proposed improvements will themselves be free of inundation from the 100-year flood event and protected against erosion.

SECTION 3: CONCLUSION

The development guidelines are intended to provide a mechanism to manage the potential cumulative impacts to drainage and flooding caused by single-family development on individual lots within incorporated Maricopa County in the study area. The guidelines are based upon customary regulations that have been successfully implemented in numerous jurisdictions within Maricopa County.



APPENDIX A

A.1 Statutory Basis for Development Guidelines

Governmental entities are limited in their powers to those the State has expressly granted them. The Arizona Revised Statutes describe these powers and duties. The Statutes are divided into Titles (or chapters) that address the various governmental entities in Arizona. Title 11 addresses county authority to regulate. Special Districts, such as the Flood Control District, are addressed in Title 48. Specific applicable citations from the Statutes are given below.

Figure A.1.1 depicts the approximate boundaries or areas of limitation for the respective statutory authorities. Title 48 authorities apply to 100-year flood areas regulated by the National Flood Insurance Program (NFIP) and Arizona Department of Water Resources. Title 11 authorities regulate drainage concerns in areas outside of the regulatory 100-year floodplain. In practice, Title 11 authorities sometimes overlap into the Title 48 area.

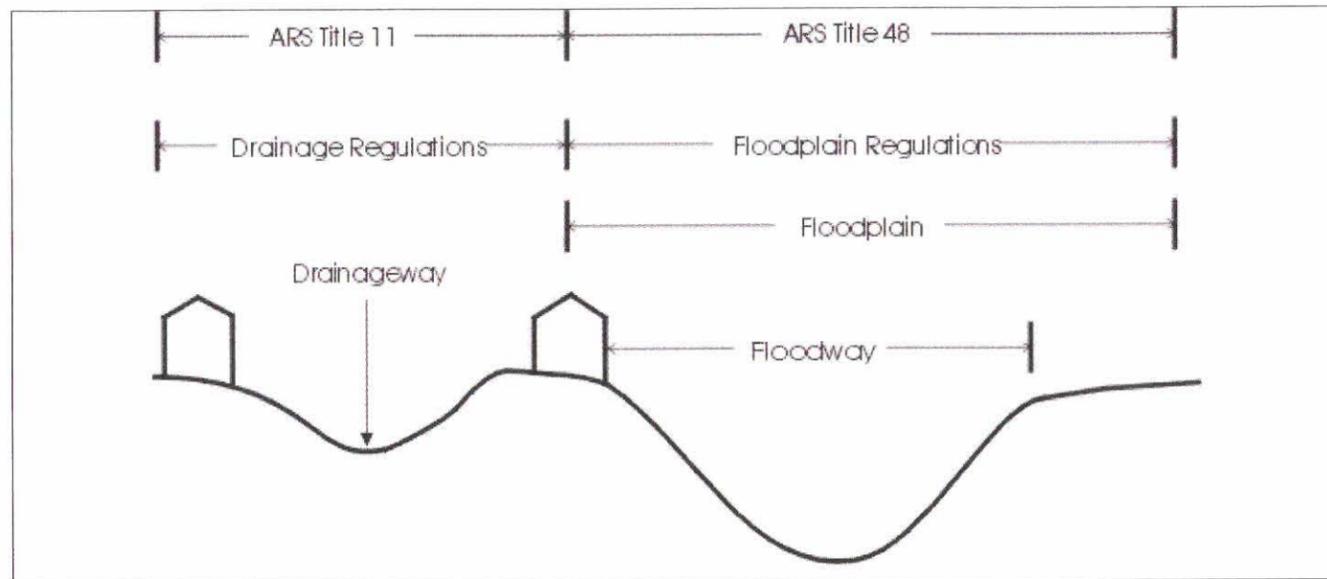


Figure A.1.1 Statute Applicability

Section A.2.1 summarizes State Statutes, while Section A.2.2 summarizes Maricopa County ordinance authorized under Title 11. Section A.2.3 summarizes Flood Control District of Maricopa County ordinance authorized under Title 48. The underlined sections within the statutes highlight language that relates to development guidelines. These statutes and ordinances are provided as references to facilitate a better understanding of the opportunities and limitations associated with development guidelines.

A.2.1 Arizona Revised Statutes

State statutes specifically pertaining to “development guidelines” include the following:

ARS 11-251.36. Subject to the prohibitions, restrictions and limitations as set forth in section 11-830, adopt and enforce standards for excavation, landfill and grading to prevent unnecessary loss from erosion, flooding and landslides.

ARS 48-2664.D. The Board may adopt equitable by-laws, rules and regulations and perform all acts necessary to carry out the purposes of this chapter.

ARS 48-3609.B. Except as provided in section 48-3610, the board shall adopt and enforce regulations governing floodplains and floodplain management in its area of jurisdiction which shall include the following:

1. Regulations for all development of land, construction of residential, commercial or industrial structures or uses of any kind which may divert, retard or obstruct floodwater and threaten public health or safety or the general welfare.

ARS 48-3609.01.A. If a district organized pursuant to this chapter has completed a watercourse master plan which includes one or more watercourses, and if the plan has been adopted by the board or by any other jurisdiction in that river or drainage system, then the board and the governing body of each jurisdiction may adopt and shall enforce uniform rules for the river or drainage system within the jurisdiction using criteria that meet or exceed criteria adopted by the director of water resources pursuant to section 48-3605, subsection A.

A.2.2 Drainage Regulations

The Drainage Regulations for Maricopa County, dated 1994, provides specific guidance for “development guidelines” associated with Area Drainage Master Studies.

Article III. Definitions

3. Area Drainage Master Study – a study to develop stormwater hydrology for a watershed, to define drainage systems, identify potential flood hazard areas, drainage problems and recommend solutions and standards for sound floodplain and stormwater management. The ADMS identifies alternative solutions to a given flooding or drainage problem. An Area Drainage Master Plan (ADMP) identifies the preferred alternative. An ADMP, unique to the subject watershed



provides minimum criteria and standards (for flood control and drainage) for land use and development.

Article XI. Area Drainage Master Study

Section 1101. Adoption

Whenever an Area Drainage Master Study authorized under this regulation has been completed, such plan including uniform rules for development may be submitted to the Board of Supervisors for adoption as an Area Drainage Master Plan. If adopted by the Board of Supervisors, the District shall enforce the Area Drainage Master Plan under this Regulation.

A.2.3 Floodplain Regulations

The Maricopa County Flood Control District Board of Directors has adopted floodplain regulations as required by State Statute. In the current regulations, dated 1993, further basis is found for “development guidelines” in the following sections:

Article III. Definitions

Section 301.

6. Area Drainage Master Study (ADMS): A study to develop hydrology for a watershed, to define watercourses, identify potential flood problem areas, drainage problems and recommend solutions and standards for sound floodplain and stormwater management. The ADMS will identify alternative solutions to a given flooding or drainage problem. An Area Drainage Master Plan (ADMP) identifies the preferred alternative. An ADMP, unique to the subject watershed provides minimum criteria and standards (for flood control and drainage) for land use and development.

Article VIII. Flood Hazard Boundaries

Section 803. Other Flood Hazard Boundaries

Whenever the District determines through a flood hazard study, watercourse master plan or other flood related study authorized by the Board that a flood related hazard exists due to such factors as high-velocity flows, erosion, sediment transport, deposition, unstable soil conditions or land subsidence, the Floodplain Administrator shall designate such hazard areas on the Flood Control Management Maps for Maricopa County and shall establish technical criteria and enforce rules

and regulations for subsequent development that meet or exceed criteria adopted by the Director, State Department of Water Resources and when appropriate such studies may be forwarded to the Federal Emergency Management Agency.

Article XIV. Other Flood Hazard Zones

Section 1402. Flood Hazard Development Standards

1. Standards adopted for development contained in a Watercourse Master Plan, Area Drainage Master Plan or other hydrologically oriented master plan shall be consistent with sound floodplain management practices and this Regulation.
6. The standards, provisions, criteria and requirements for development in flood hazard zones imposed by an authorized master plan shall meet or exceed the requirements of this Regulation.



APPENDIX B

DEVELOPMENT GUIDELINES CHECKLIST

Drainageways

- A detailed drainage analysis prepared by a licensed civil engineer shall be submitted for properties crossed by a drainageway or located within 150 feet on either side of a drainageway to verify that proposed improvements will not negatively alter pre-development drainage conditions.

Erosion Hazard Setbacks

- Properties crossed by a delineated wash with a detailed erosion hazard zone shall comply with the erosion hazard setbacks set forth in the *Riverine Erosion Hazard Delineation and Development Guidelines* (FCDMC, 200X).

Minimum Floor Elevation

- All properties shall meet the District standard per the current Drainage Regulations and Floodplain Regulations.

Disturbance Envelope

- No more than 50% of the site may be disturbed, and all improvements (including, but not limited to, roof-bearing structures, retention, cleared and grubbed areas such as horse corrals, landscaping with permanent irrigation, and areas with impervious ground cover and/or barriers that preclude infiltration) shall be located within this area.
- Boundaries of the disturbed area must be delineated on the property with permanent markers.
- Temporary disturbance in excess of the 50% is allowed for utility installation, temporary construction access, and temporary stockpiling of construction related materials. Revegetation of these areas is required and must be completed prior to final development approval.

Culverts, Driveways and Roads

- Dip crossings should be used for driveways and local streets unless it can be demonstrated that culverts are necessary due to the depth and/or velocity of flows.
- All culverts and bridged crossings should be designed to minimize the disruption of sediment transport continuity upstream and downstream of the crossing. Crossings that mimic the natural channel's depth and width within the reach being crossed will be most successful.
- Lowering of the local channel bottom elevation is discouraged.
- Roadways shall be designed so as not to divert flows.

Walls, Fences, Berms

- Fences at the perimeter of a parcel shall be limited to open-type fencing (pipe rail, split rail, barbed wire, etc.) for lots crossed by or within 150-feet of a drainageway or within the inundation limits of the 100-year flood along a drainageway or floodplain.
- Chain link and chicken wire are not considered open-type fencing, as it must have openings at least 8-inches in diameter.
- A solid "courtyard" wall is permitted immediately downslope or upslope of the principle dwelling unit, and is defined a wall that surrounds an area immediately adjacent to the principle dwelling unit and is limited in lateral distance to no more than 15 feet if oriented perpendicular to the direction of flow and is not limited in lateral distance if oriented parallel to the direction of flow.
- Closed fences, walls or perimeter berms are not allowed unless it can be demonstrated to the satisfaction of the Drainage Administrator that there is no increase in peak discharge, flow depth or velocity, or flow diversion as a result of the proposed improvement.

Retention

- On-lot retention shall be provided based on the following formula:
 $2.75'' \times \text{maximum lot coverage (see zoning ordinance)} \times \text{lot size (in square feet)} = \text{retention volume required.}$
- Retention areas shall be located within the 50% disturbable area limit and in such a fashion as to effectively capture runoff from the impervious surfaces of the lot.
- Retention may be provided in multiple basins.
- Retention areas shall not be placed within a regulatory floodplain or otherwise such that off-site runoff is intercepted. The regulatory floodplain included delineated floodplains and watercourses that have flows greater than 50 cfs during a 100-year flood.
- Septic system percolation rates shall determine the suitability of a retention area location.
- Retention areas may be landscaped with organic and/or inorganic ground cover.



APPENDIX C

TOOLKIT EVALUATION

C.1 Overview

A number of tools or criteria were evaluated for application to single-lot development in the Adobe Dam / Desert Hills ADMP study area. The tools were evaluated based on their hydrologic efficacy, long-term viability, and their potential for implementation. Seven types of tools or criteria relating to single-family, individual lot development were examined:

- Drainageways
- (Erosion Hazard) Setbacks
- Finished Floor Elevations
- Disturbance Envelopes
- Culverts, Driveways, & Roads
- Walls, Fences, & Berms
- Retention

Each criterion and their evaluation is discussed in the following sections. Recommendations are made for selection of specific measures or requirements for each tool or criteria for the ADMP.

C.2 Drainageways

The primary use of the drainageways will be as a routing tool to quickly assess parcels requesting a permit for development. This function is discussed further under the implementation discussion in Section 3. It should be recognized that many of these drainageways may potentially carry 50 cfs or more during the 100-year event. Article IV of the *Floodplain Regulations for Maricopa County* states that “The Regulation is applicable to all lands located within a delineated floodplain and watercourses or contributing watersheds that have flows greater than 50 cfs during a 100-year flood event which are within the area of jurisdiction of the Flood Control District of Maricopa County.” As such, they would be subject to the Floodplain Regulations.

Drainageways were delineated based on examination of available topography and interpretation of 2002 orthographic aerial photographs. Drainageways include all observable washes, swales or other drainage features as

indicated by their physical, biological (vegetation), or topographic characteristics. Drainageways were delineated for all areas outside of the City of Phoenix and the Cave Creek Recreation Area.

The delineated drainageways were used to identify existing parcels crossed by these drainageways. In addition, a second set of parcels were identified that lie within a 150-foot influence area of any delineated drainageway. The parcels crossed by drainageways, or within their influence area, were selected using ArcView GIS 8.2. A map and a summary table of the number and acreage of parcels affected by drainageways and the 150-foot influence area are provided in a memorandum to Afshin Ahouraiyan dated July 7, 2004 describing the development guidelines implementation strategy.

The 150-foot width of the influence area was determined based on a 160-acre drainage area (the limit of State Standard 2-96 for floodplain delineation (Title 48)). A discharge of 500 cfs (2000 cfs/ square mile * 0.25) (also State Standard) with an assumed depth of 1 foot, a width of 250 feet, and a velocity of 2 ft/s, gives 125 feet from center. Therefore, a 150-foot distance was selected as a “conservative” measurement for use in identifying parcels that might be influenced by or potentially have an effect on the drainageways, and therefore require additional drainage and/or floodplain review.

C.3 Erosion Hazard Setbacks

An erosion hazard setback shall be identified for any parcel crossed by or adjacent to “a delineated floodplain and watercourses or contributing watersheds that have flows greater than 50 cfs during a 100-year flood event.” All of the existing FEMA floodplain delineations and those being conducted as part of the ADMP have or will have a detailed erosion hazard zone identified for them. Any drainageway that carries more than 50 cfs in the 100-year flood event (i.e. subject to the Floodplain Regulation) will also need to have an erosion hazard setback assessment prior to development. The erosion setback shall be determined using the District’s draft *Riverine Erosion Hazard Delineation and Development Guidelines*. These guidelines describe a three level approach. Generally, additional information and analysis are required to reduce the required setback distance without erosion protection measures. A minimum setback of 15 ft or 2 times the bank height, whichever is greater, is required per the draft erosion hazard guidelines. Structural measures for erosion hazard mitigation are also presented in the guidelines.

C.4 Minimum Floor Elevation

The District already has minimum criteria for minimum finished floor elevations for all construction. All new buildings shall have a minimum finished floor elevation no less than 1 foot above the natural adjacent grade. Within a (delineated) floodplain the minimum finished floor shall be set 1 foot above the regulatory flood elevation. The Regulatory Flood Elevation is defined within the Floodplain Regulations as “(T)he elevation which is one foot above the base flood elevation for a watercourse. Where a floodway has been delineated, the base flood elevation is the higher of either the natural or encroached water surface elevation of the 100-year flow.” No change to the minimum finished floor elevation criterion is recommended for the Adobe Dam/Desert Hills ADMP rules of development. This existing minimum finished floor elevation criteria should continue to be enforced in the Adobe Dam/Desert Hills ADMP study area.

C.5 Disturbance Envelope

A disturbance envelope is a contiguous spatial limit on a lot which may be altered from its natural state as part of the development of the lot. The rationale for the disturbance envelope is that the removal of vegetation and other disturbance of the natural ground results in an adverse impact on storm water runoff from the lot. Namely, rainfall is no longer intercepted by the native plants and consequently becomes runoff. In addition, plant roots and other biological activity associated with the plant increase the rate at which rainfall soaks into the soil. The combined result is an increase in both the magnitude and frequency of runoff from the disturbed area. Another consequence of the disturbance of the natural areas is a disruption and elimination of habitat for native desert species.

Hydrologic modeling of the effects of single lot development of very low density development on one acre or larger lots shows that any disturbance of the natural ground and removal of vegetation results in an adverse impact to storm water runoff. Total conversion of a 160-acre watershed from natural desert to residential land use with complete removal of vegetation results in nearly a 200% increase in the runoff magnitude generated by a 2-year rainfall event and a 50% increase in the runoff from a 100-year event. The reduction in these adverse impacts is approximately proportional to the amount of disturbed area. The details of the hydrologic analysis were presented in a memorandum to the District dated March 25, 2003. This memorandum and HEC-1 output are provided at the back of this appendix.

A maximum disturbance area of 50% including all improvements was recommended for the ADMP development guidelines. Improvements include landscaping with permanent irrigation, impervious ground cover and/or barriers that

preclude infiltration, retention, cleared and grubbed areas (such as horse corrals), and all roof-bearing structures. While this will not fully mitigate the adverse effects of development, it will reduce those effects appreciably.

Temporary disturbances in excess of the final disturbance envelope will be allowed for utility installation, temporary construction access, stockpiling, etc. Revegetation of the temporarily disturbed areas must be demonstrated before final approval of the development.

Figure C.5.1 shows examples of disturbance envelopes for some existing lots in the Desert Hills area. Table C.5.1 shows the gross lot area, the disturbed area, and the coverage of the lot by roof top or paved surfaces.



Figure C.5.1 Example Lots with Disturbance Envelopes



Table C.5.1 Summary of Example Lots with Disturbance Envelopes

Parcel Id (1)	Disturbed Area (2) (sq.ft)	Impervious Area (3) (sq.ft)	Total Parcel Area (4) (sq.ft)	Percent of Parcel (5) (%)
1	25302		48180	53%
1		4214	48180	9%
2	37220		54450	68%
2		8207	54450	15%
3	30631		49500	62%
3		5239	49500	11%
4	21225		48180	44%
4		4021	48180	8%

The data for these example lots show that three of the four lots exceed the proposed 50% disturbance envelope. The “impervious area” [column (3)] relates to the maximum lot coverage discussed under retention in Section C.9, and is included in the disturbed area [column (2)].

C.6 Culverts, Driveways, Roads

Dip crossings are preferred to culvert crossings for access on driveways and local streets. Arterial streets should be designed in accordance with existing County criteria. However in addition to the design levels prescribed in those criteria, all culverts or bridged crossings should be designed to minimize disruption of sediment transport continuity upstream and downstream of the crossing. Crossings that mimic the natural channel’s depth and width within the reach being crossed will be most successful. Lowering of local channel bottom elevations is also discouraged. Roadways shall be designed so as not to divert flows.

C.7 Walls, Fences, Berms

Perimeter fences shall be limited to open-type fencing (pipe rail, barb wire, etc.) for lots within drainageway influence areas or within the inundation limits of the 100-year flood along a drainageway or floodplain. Chain link or

chicken wire does not constitute open-type fencing. In order to be considered “open-type” fencing, the openings must be a minimum of 8 inches in diameter. For lots not in a drainageway influence area or 100-year floodplain, solid perimeter fences that comply with current Maricopa County development standards are permitted.

“Courtyard” fences are considered acceptable immediately upslope or downslope of the residence. A “courtyard” fence is considered any fence (open-type or otherwise) or wall that surrounds an area immediately adjacent to a residential structure and is limited laterally to no more than 15 feet from the building walls in the direction perpendicular to flow (i.e. parallel to the topographic contours). The “courtyard” fence or wall may extend as far as desired if it projects from an exterior wall of the residential structure in the upslope or downslope direction parallel to flow (i.e. perpendicular to the topographic contours), see Figure C.7.1., below.

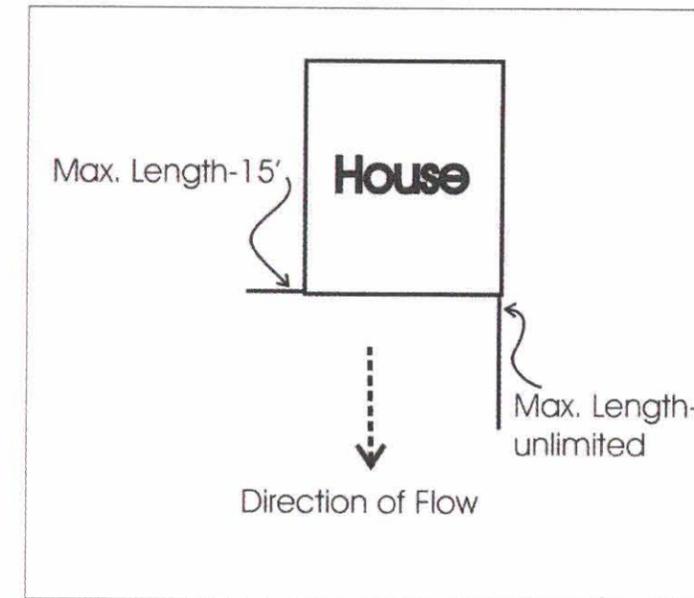


Figure C.7.1 Courtyard Walls

Closed fences, walls, or perimeter berms are not allowed without a demonstration that no adverse impact on neighboring properties results from the construction of the proposed fence, wall, or berm. That is, it can be demonstrated to the satisfaction of the Drainage Administrator that there is no increase in peak discharge, flow depth, or velocity or flow diversion as the result of the proposed improvement(s).



C.8 Retention

Although concern has been raised about the long-term assurance of single-lot retention facilities, retention may be the most effective tool available to mitigate adverse hydrologic impacts from development. Additionally, retention may have possible complementary benefits with respect to requirements of the Clean Water Act.

Some possible criteria for retention volume for single-lot development are listed below:

- Current retention requirement for commercial, industrial, multi-family residential and subdivisions (i.e. 100-yr 2-hr which equals about 2.75” in the Desert Hills area)
- 100-yr 2-hr pre vs. post development
- Retention of runoff from biggest “typical” storms
- Retention related to runoff based on the maximum lot coverage per zoning
- Future development increases in runoff volume from hypothetical basin analyses using HEC-1

An evaluation of these criteria was conducted and is provided in detail below.

100-yr 2-hour Retention Approach

Currently all commercial, industrial, multi-family residential and subdivision developments are required to retain the 100-year 2-hour runoff volume as described in the Drainage Design Manual. In the Desert Hills portion of the ADMP area, the 100-year 2-hour point rainfall is about 2.75 inches. For a single-lot one acre type development this would equate to a requirement for about 5,290 cu. ft. of retention volume.

100-yr 2-hour Pre- vs. Post-Development Approach

Another consideration for a retention requirement might be to require single-lot developers to retain the difference in runoff volume from the pre- to post-development runoff conditions. Some examples are shown below:

- Assume C=0.53 vs. C=0.38 (Table 3.2 – new Manual); $\Delta C = 0.15 * 2.75" = 0.41" = 1,488 \text{ cu.ft./ac}$
- Assume C=0.7 vs. C=0.4 (more conservative); $\Delta C = 0.30 * 2.75 = 0.82" = 2,977 \text{ cu.ft./ac}$

Biggest “Typical” Storm Approach

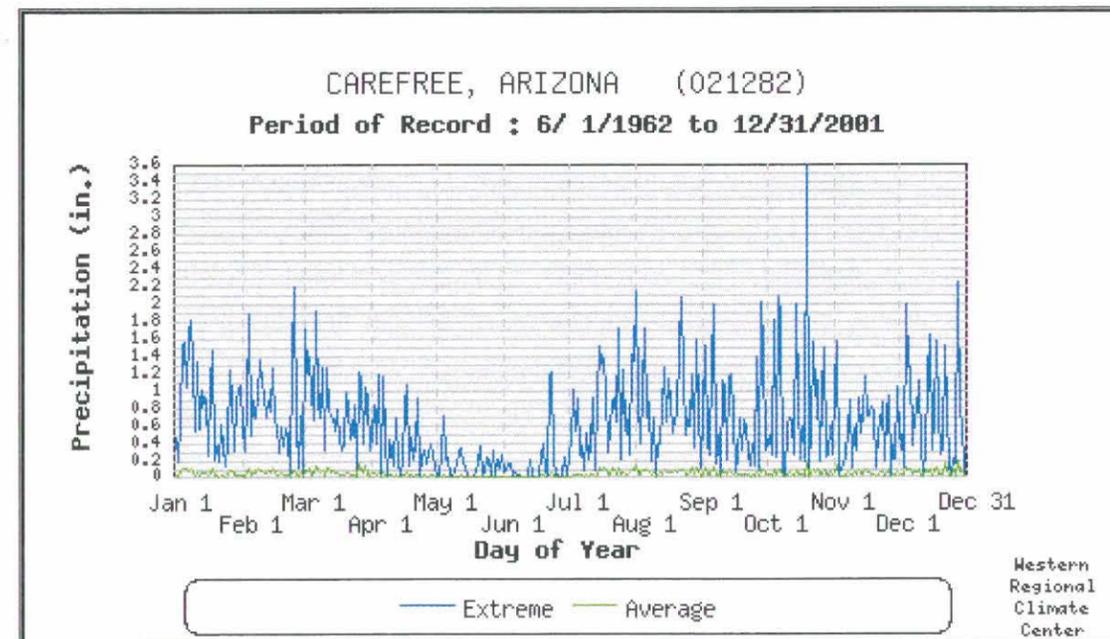
Examination of the Carefree, Arizona maximum daily precipitation gage data (see Figure C.8.1 below) shows that consideration of a rainfall of somewhere around 2.2 inches would capture most of the biggest “typical” rainfall events.

These data are from a nearly 40-year period record. This level of 2.2” matches almost exactly the 10-year 6-hour point

rainfall statistics from NOAA Atlas II (Table C.8.1). If the 10-year event is representative of the “channel forming discharge,” then mitigation of adverse hydrologic impacts at this level should minimize the adverse geomorphologic effects as well.

Applying the same C factor logic from the 100-year 2-hour discussion above:

- $2.2" * 0.15 = 0.33" \rightarrow 0.33"/12" = 0.0275 \text{ ft} * 43,560 \text{ sq.ft} = 1,198 \text{ cu.ft/ac}$
- $2.2" * 0.30 = 0.66" \rightarrow 0.66"/12" = 0.055 \text{ ft} * 43,560 \text{ sq.ft} = 2,396 \text{ cu.ft/ac}$



Maximum Daily Precipitation in Carefree, AZ

Figure C.8.1



Table C.8.1 Rainfall Statistics for Desert Hills Area

*** P R E F R E O U T P U T D A T A ***								
PRECIPITATION FREQUENCY VALUES FOR Desert Hills Area Hydrology								
POINT VALUES								
RETURN PERIOD								
DURATION	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR	500-YR	
5-MIN	.37	.45	.51	.59	.66	.73	.88	5-MIN
10-MIN	.56	.68	.78	.91	1.01	1.11	1.35	10-MIN
15-MIN	.68	.85	.98	1.15	1.29	1.43	1.74	15-MIN
30-MIN	.89	1.14	1.31	1.56	1.75	1.94	2.37	30-MIN
1-HR	1.09	1.41	1.63	1.94	2.18	2.42	2.97	1-HR
2-HR	1.21	1.58	1.83	2.19	2.46	2.74	3.37	2-HR
3-HR	1.29	1.69	1.97	2.35	2.65	2.95	3.64	3-HR
6-HR	1.45	1.91	2.22	2.67	3.01	3.35	4.14	6-HR
12-HR	1.63	2.17	2.55	3.07	3.47	3.88	4.80	12-HR
24-HR	1.80	2.44	2.87	3.47	3.94	4.40	5.47	24-HR

Maximum Lot Coverage Approach

Another way of looking at retention would be to consider just the impervious surfaces added to a lot. Impervious surfaces generate runoff during all but the most minimal rainfall events. The hydrologic impact of impervious surfaces is therefore more profound on the more frequent events. Mitigation of runoff from impervious surfaces would reduce the impacts of development on the magnitude and frequency of storm water runoff.

Looking at a range of possible impervious surface coverage single lot development yields the following potential retention volume criteria:

The maximum lot coverage by zoning is 15% for R-43. Therefore, 43,560 sq. ft * 0.15 = 6534 sq.ft of potential impervious surfaces. Again, the biggest “typical” storm is 2.2” or 0.183 ft and the 100-year 2-hour rainfall is 2.75” or 0.23 ft. The 100-year 6-hour point rainfall is 3.35” for the Desert Hills area, or 3.35”/12” = 0.28 ft.

So, some possible retention volumes for these three storms would be:

For R-43 (maximum lot coverage = 15%):

- 6534 * 0.183 = 1196 cu. ft. retention (per acre) Biggest “typical” storm
- Or, 6534 * 0.230 = 1497 cu. ft retention (per acre) 100-year 2-hour
- Or, 6534 * 0.280 = 1824 cu. ft retention (per acre) 100-year 6-hour

For R-70 (maximum lot coverage = 10%):

- 70000 * 0.1 = 7000 sq.ft * 0.183 = 1281 cu.ft Biggest “typical” storm
- 70000 * 0.1 = 7000 sq.ft * 0.23 = 1610 cu.ft 100-year 2-hour
- 70000 * 0.1 = 7000 sq.ft * 0.28 = 1960 cu.ft 100-year 6-hour

For R-190 (maximum lot coverage = 5%):

- 190000*0.05 = 9500 sq. ft * 0.183 = 1739 cu. ft Biggest “typical” storm
- 190000*0.05 = 9500 sq. ft * 0.23 = 2185 cu. ft 100-year 2-hour
- 190000*0.05 = 9500 sq. ft * 0.28 = 2660 cu. ft 100-year 6-hour

Hypothetical Subbasin HEC-1 Model Approach

Analysis of a hypothetical subbasin using HEC-1 shows an increase in runoff volume due to future development of about 0.30” for all return periods. Therefore, 0.30”/12 * 43560 = 1089 cu. ft / ac. This is approximately the same result via a different argument as the pre-versus post- C-factor approach for the “biggest typical storm”. The result is also substantially similar to the 15% coverage argument for the “biggest typical storm”. The 0.30” hypothetical subbasin result yields 1,750 cu.ft for R-70 and 4,750 cu.ft for R-190.

Table C.8.2 summarizes the possible retention criteria, the parameters associated with the estimation of the retention volumes, and the calculated retention volume for the minimum size lot in each of three zoning categories (i.e., R-43, R-70, and R-190). The recommended retention volume approach is the Maximum Lot Coverage approach. The recommended retention volume to be retained is for the 100-year 2-hour rainfall. Note that the recommended retention volume of 1,500 cu.ft. / ac for R-43 is about 28% of the volume that would be required for a similar zoning in a subdivision.



Table C.8.2. Summary of Possible Retention Criteria for Adobe ADMP

	R-43		R-70		R-190		Desert
C100	0.53		0.50		0.41		0.38
Pre vs. Post 100	0.15		0.12		0.03		
C10	0.42		0.40		0.33		0.30
Pre vs. Post 10	0.12		0.10		0.03		
Area (sq.ft.)	43560		70000		190000		
Max Lot Coverage (%)	15%		10%		5%		

	R-43		R-70		R-190	
Storm Depth (inches)	2.2	2.75	2.2	2.75	2.2	2.75
Storm Depth (feet)	0.183	0.229	0.183	0.229	0.183	0.229
	Retention Volume (cu. ft.)					
All Runoff Retained (D x A x C)	3354	5287 ¹	5133	8021 ¹	11495	17852 ¹
Pre vs Post (D x A x ΔC)	958	1497	1283	1925	1045	1306
Max. Lot Coverage (D x A x % Cover)	1198	1497	1283	1604	1742	2177
HEC-1	1089	1089	1750	1750	4750	4750

Shaded cells are the recommended retention volumes for a minimum sized lot in each zoning type.

¹ This is equivalent to the current retention requirements for subdivisions

The recommended retention volumes shown in Table C.8.2 are for the minimum sized lot in each zoning category. The recommended retention volume for each single-lot zoning category in the Adobe ADMP study area can be simplified to a volume per acre figure for any sized lot within the zoning type using 1,500 ac-ft/acre for R-43, 1,000 ac-ft/acre for R-70, and 500 ac-ft/acre for R-190. The required volume per acre decreases from R-43 to R-190 because of the reduction in maximum lot coverage allowed for each zoning category (i.e. 15% to 5%).

Lot disturbance in excess of the 50% value recommended can be allowed by providing for additional retention in direct proportion to the increased disturbance. In addition, the retention area is considered part of the disturbed area.

Figure C.5.1 (see Section C.5) and Table C.8.3 show examples of disturbed areas and proposed retention volumes for some example lots in the Desert Hills area.

Table C.8.3 Retention Requirement Statistics for Example Lots in Desert Hills Area
(continuation of Table C.5.1)

Parcel ID (see Fig. C.5.1)	"Required" Retention (cu.ft.)	Additional "Required" Retention (cu.ft.)	Total "Required" Retention (cu.ft.)	Retention Area assumed 1.5 ft deep (sq.ft)
1	1656	42	1698	1132
2	1872	344	2215	1477
3	1702	202	1904	1269
4	1656	0	1656	1104

The location and configuration of retention areas shall be shown on the site plan. In general, the same criteria and guidelines for retention facilities outlined in the Drainage Design Manual, Volume II should be followed. In particular, the location of basins shall meet the following objectives:

- Retention areas shall be located such that they effectively capture runoff from the impervious surfaces on the lot.
- Retention areas do not have to be located in a single basin; multiple retention areas are allowed.
- Retention areas shall not be placed in a regulatory floodplain or otherwise such that off-site runoff is intercepted in the retention area. The regulatory floodplain includes delineated floodplains and watercourses that have flows greater than 50 cfs during a 100-year flood.
- Approval of site suitability (with respect to percolation rates) for a standard septic system will constitute site suitability for retention.
- Retention areas may be landscaped (with appropriate types of ground cover vegetation).



C.9 Summary and Recommendations

Table C.9.1 summarizes the recommended tools and measures for the Development Guidelines for the Adobe ADMP.

Table C.9.1 Summary of Development Guidelines Criteria for Adobe ADMP

Tool	Measure	Source/Basis
Erosion Hazard Setback	<ul style="list-style-type: none"> ▪ Function of discharge ▪ Minimum 15 ft or 2 times bank height (whichever is greater) 	<ul style="list-style-type: none"> ▪ Riverine Erosion Hazard Delineation ▪ Development Guidelines
Minimum Floor Elevation	<ul style="list-style-type: none"> ▪ 1 ft above highest adjacent natural ground ▪ 1 ft above regulatory base flood 	<ul style="list-style-type: none"> ▪ Drainage Regulations ▪ Floodplain Regulations
Disturbance Envelope	50% of lot; additional allowed with increased retention	Consistent with current zoning regulatory environment
Culverts, driveways, roads	<ul style="list-style-type: none"> ▪ Prefer dips ▪ Maintain sediment transport continuity ▪ Prevent base level lowering ▪ Do not divert flow 	<ul style="list-style-type: none"> ▪ Drainage Design Manual Vol. II ▪ Drainage Regulations
Walls, Fences, Berms	Open-type fencing & Courtyard fencing allowed	Floodplain Regulations
Retention	2.75"/12 x max cover for zoning (in %) x lot size (in sq.ft) = retention volume required	<ul style="list-style-type: none"> ▪ 100-yr 2-hr ▪ Drainage Design Manual Vol. II

Drainage impacts of single-lot development need to be addressed in order to prevent unnecessary damages and public expenditures in the future. It is therefore recommended that lots crossed or within a 150-ft buffer of a drainageway be scrutinized closely by reviewers at the District. All single-lot development in the Desert Hills and New River/Cline Creek portions of the ADMP shall henceforth be required to provide the minimum retention as indicated in these Rules of Development. Minimum floor elevation criteria from the Drainage Regulations and the Floodplain Regulations should continue to be enforced. Also, the other components of the Floodplain Regulation with respect to floodplain encroachment and erosion hazard setbacks should continue to be enforced. Development will be limited to a 50% disturbance envelope on the lot unless retention volume in excess of the minimum is provided. Dip crossings for road and driveways, open type fencing, and courtyard fencing will be approved without a drainage report. Any variations from these minimum criteria will require engineering analyses that demonstrate to the satisfaction of the Drainage or Floodplain Administrator that no adverse impact to adjacent properties results from the requested variations, and that the proposed improvements will themselves be free of inundation from the 100-year flood event and protected against erosion.



APPENDIX D

References

Arizona Department of Water Resources, State Standards for Floodplain Management

SS1-97, [Requirement for Flood Study Technical Documentation](#)

Sets technical documentation standards for Flood Studies that are to be submitted to ADWR or FEMA.

SS2-96, [Requirement for Floodplain and Floodway Delineation in Riverine Environments](#)

Provides methodologies for estimating 100-year peak discharges, delineating 100-year floodplain limits, and determining administrative floodway boundaries for riverine floodplains in Arizona.

SS3-94, [State Standard for Supercritical Flow \(Floodway Modeling\)](#)

Provides guidelines to be used when modeling floodways for supercritical or near-critical flow conditions in Arizona.

SS4-95 [State Standard for Identification of and Development within Sheet Flow Areas](#)

Details minimum floodplain management standards for identification of and development within sheet flooding areas in Arizona.

SS5-96 [State Standard for Watercourse System Sediment Balance](#)

Provides guidelines for identification of and development within erosion hazard areas, watercourses with a net sediment deficit, and watercourses with a net sediment surplus. Individual guidelines for: Lateral Migration Setback Allowance, Channel Degradation Estimation, and River Stability Impacts associated with Sand and Gravel Mining.

SS6-96 [State Standard for Development of Individual Residential Lots within Floodprone](#)

[Areas](#)

Site Plan Checklist, Typical Plan and Cross-Section requirements for Individual residential lots within floodprone areas.

SS7-98 [State Standard for Watercourse Bank Stabilization](#)

Provides minimum design standards for several bank stabilization techniques.

SS8-99 [State Standard for Stormwater Detention/Retention](#)

Provides minimum criteria for sizing Detention and/or Retention facilities.

SS9-02 [State Standard for Floodplain Hydraulic Modeling](#)

Provides guidance on mathematical modeling of hydraulic processes in watercourses and floodplains.

Arizona Revised Statutes, Title 11

Arizona Revised Statues, Title 48

FCDMC, 200X, [Riverine Erosion Hazard Delineation and Development Guidelines](#)

FCDMC, 2003, [Drainage Design Manual, Volume I, Hydrology](#), draft dated January 9, 2003.

FCDMC, 1995, [Drainage Design Manual, Volume I, Hydrology](#), revised January 1, 1995.

FCDMC, 1996, [Drainage Design Manual, Volume II, Hydraulics](#)

FCDMC, 1986, [Floodplain Regulations for Maricopa County](#), as revised 11/1/2000

FCDMC, 1988, [The Drainage Regulation for Maricopa County](#), as revised 12/14/1994



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