ADOBE
DAM/DESERT HILLS

AREA DRAINAGE MASTER PLAN

Part 8

Phase I
Alternatives Formulation and Preliminary Analysis

Volume 1

Flood Control District of Maricopa County

June 2005

A520.215

ADOBE DAM/DESERT HILLS AREA DRAINAGE MASTER PLAN

PHASE I ALTERNATIVES FORMULATION AND PRELIMINARY ANALYSIS
PART 8, VOLUME 1

Flood Control District of Maricopa County

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June 2005

PHASE I ALTERNATIVES FORMULATION AND PRELIMINARY ANALYSIS

PART 8, VOLUME 1

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DATA CD:

The Data CD is included at the end of Part 8, Phase I, Volume 2.

Please refer to that report for a digital copy of the Report in PDF format and GIS shapefile coverages of project elements.

SECTION 1: INTRODUCTION

The Phase I Alternatives Formulation and Preliminary Analysis Report comprises the Potential Alternatives Submittal (Task 2.2.8) for the Adobe Dam/Desert Hills Area Drainage Master Plan (ADMP). The Phase I report is presented in two volumes. Part 8 Volume 1 contains general information, including a description of the project area, a brief summary of the project scope with emphasis on the Phase I work tasks and deliverables, and the approach used to develop structural and nonstructural alternative measures addressing identified drainage and flooding problems. Part 8 Volume 1 also documents the evaluation criteria applied to sort and select alternative measures and presents the resultant Phase I Preliminary Alternatives. Part 8 Volume 2 contains the documentation for the floodway residence risk assessment, floodproofing evaluation, Phase I Interim Development Guidelines, and roadway drainage crossing hydraulics. These work products are appurtenant to the development of the Phase I Preliminary Alternatives.

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.

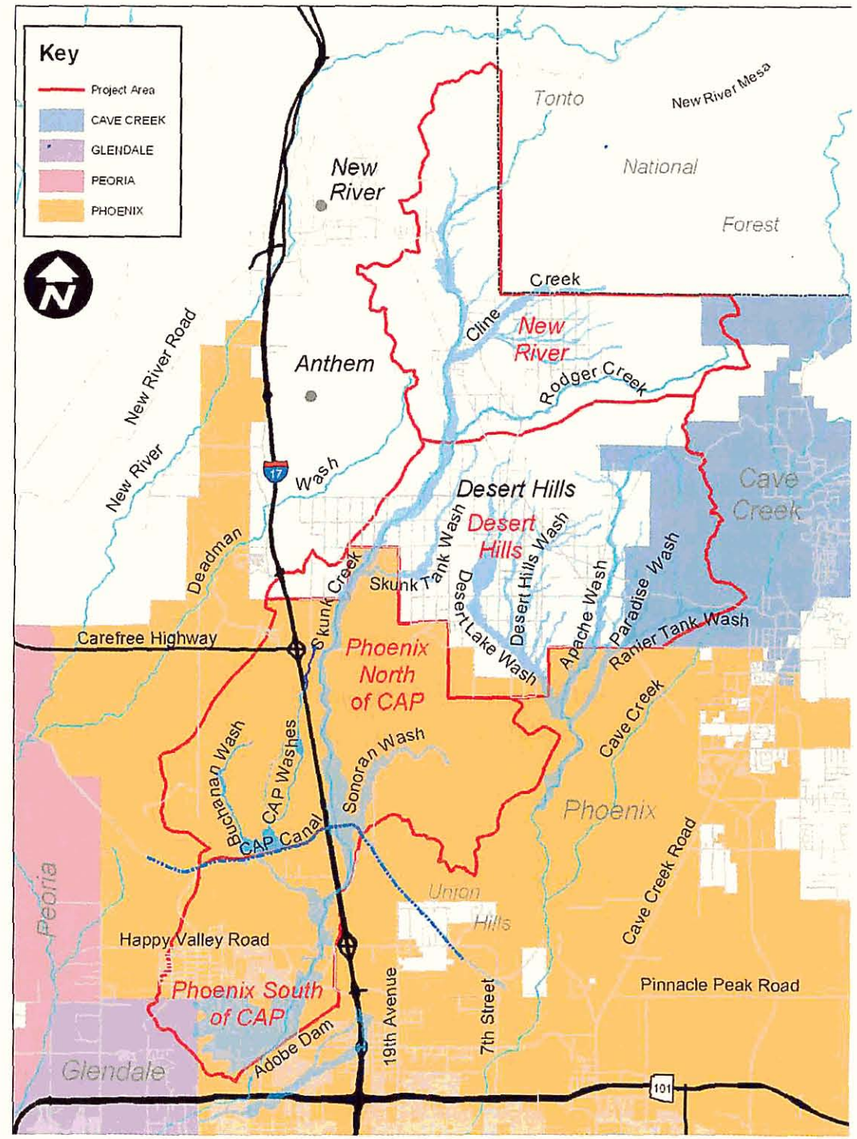


Figure 2.1 Adobe Dam/Desert Hills ADMP Study Area

The study area was further subdivided into four subareas: Phoenix South of the Central Arizona Project aqueduct (CAP), Phoenix North of CAP, Desert Hills, and New River. 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 four subareas of the ADMP project area are described below:

Phoenix South of CAP – Lower Skunk Creek from Adobe Dam to the CAP aqueduct and lower Buchanan Wash from the Skunk Creek confluence to the CAP aqueduct;

Phoenix North of CAP – 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 public and stakeholder coordination; hydrology, hydraulics, sedimentation and geomorphic evaluations; environmental and visual resources overviews; identification of drainage problems; development of alternative structural and nonstructural solutions, including landscape aesthetics considerations; preparation of concept design plans documenting the structural alternative measures; 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 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.

3.2 Project Approach

The approach used for the development of alternatives for the 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

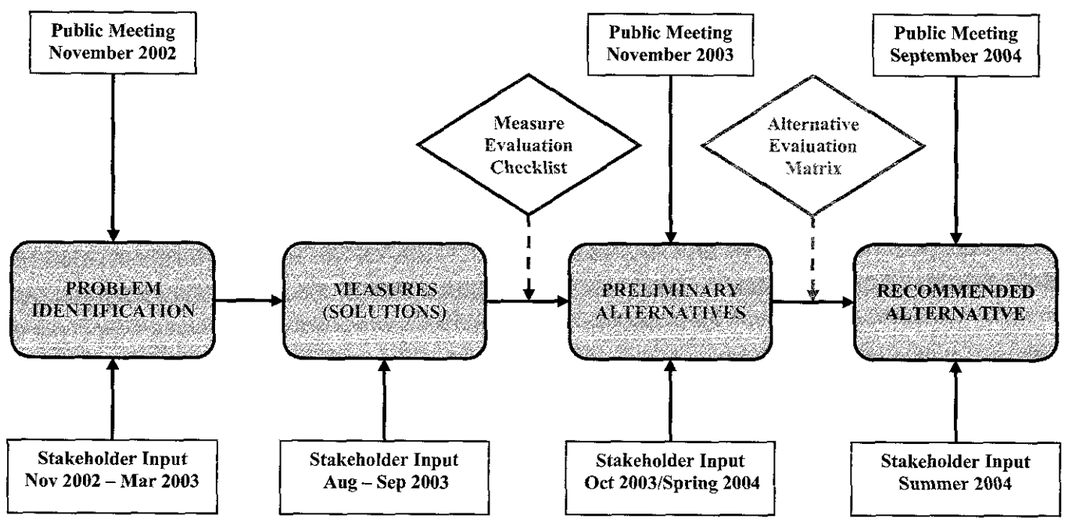


Figure 3.1 Adobe Dam/Desert Hills ADMP Alternatives Development Process Flowchart

Adobe Dam/ Desert Hills ADMP
Alternatives Development Process Description

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 initiated 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

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.

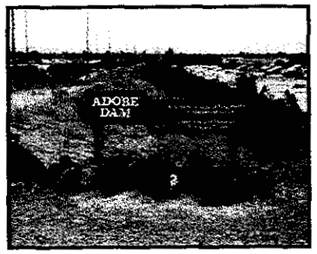


Figure 3.2 Looking south along 35th Avenue from Adobe Dam crest (10-15-02)

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	
	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)	2.4.2 CO4
	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

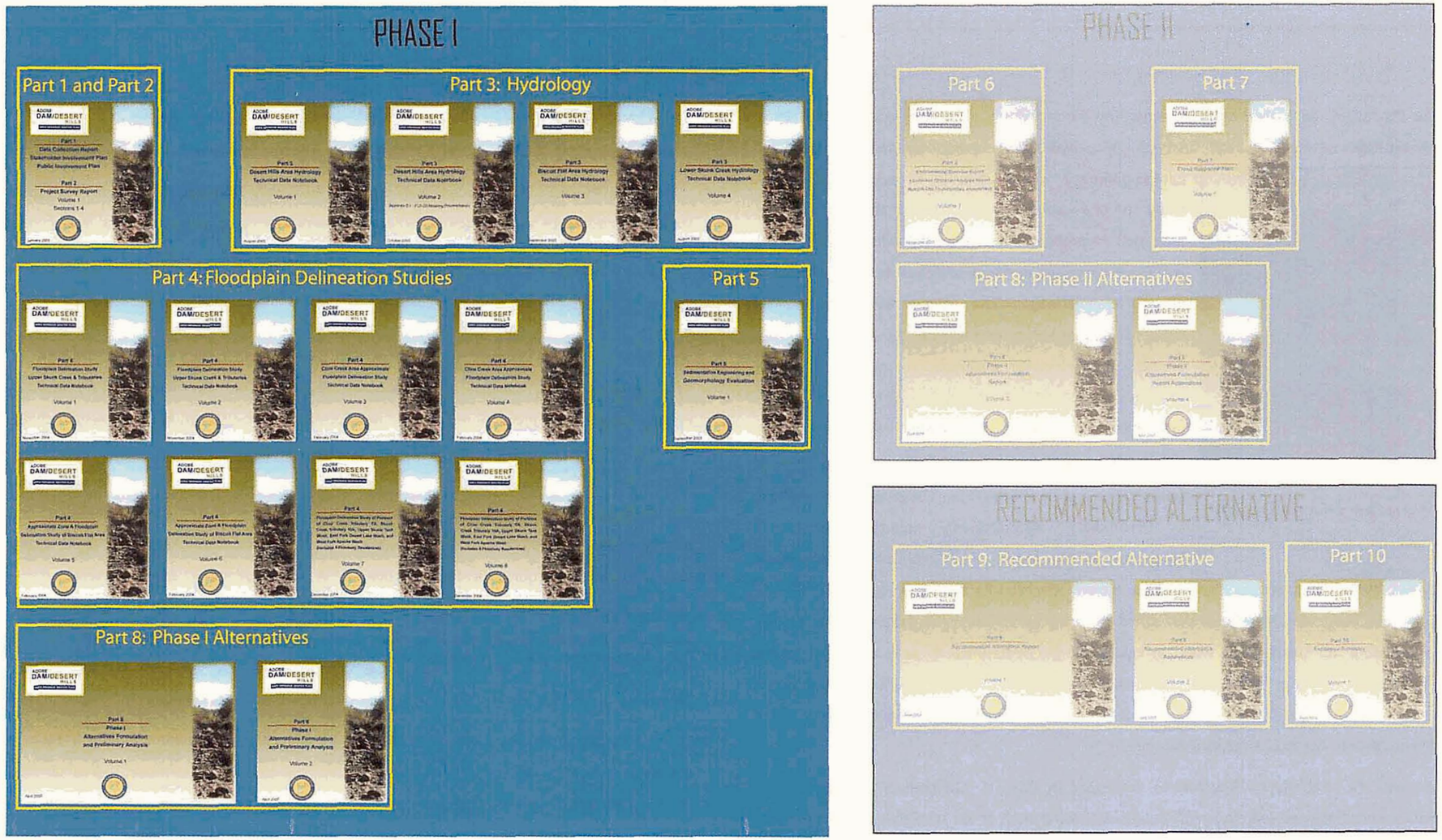


Figure 3.3 Adobe Dam/Desert Hills ADMP Phase I Deliverables Summary

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). 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 Preliminary Alternatives 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.

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

This report documents the Preliminary Alternatives developed in Phase I Alternatives Formulation and Preliminary Analysis. Brief descriptions and summaries of findings follow for each of the key Phase I work tasks.

4.1.1 Data Collection and Existing Condition Analysis

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 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 more complete information.

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 Assesor parcel information, among others. The GIS database incorporates a hyperlink feature that allows the user to pick an existing drainage structure and digitally link to a screen display of ground photographs of that site. In addition, attribute data are provided describing key features of the existing drainage facilities; for example, structure identifier, type and size of structure, and street and watercourse location information. A sample of the ground photo screen display that is hyperlinked to the GIS database is shown in Figure 4.2. Similarly, input received from area residents at the public meetings was incorporated in the GIS database to spatially identify locations of historical drainage and flooding problems; such as, flooded streets, ponding areas, erosion hazards, mud and debris deposition, flooded homes, and drainage structure problems.

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 of flooding and drainage problems requiring further investigation.

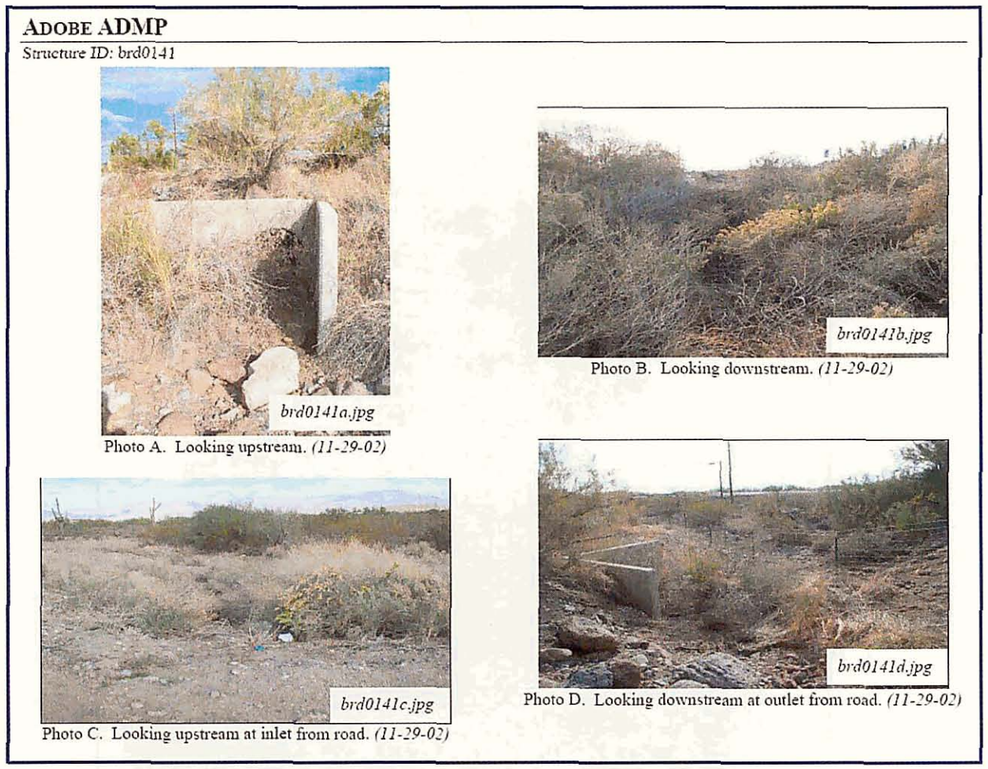


Figure 4.2 Example of GIS Hyperlink to Ground Photos

4.1.2 *Alternatives Formulation and Preliminary Analysis*

The Phase I work tasks were performed for the purpose of formulating Preliminary Alternatives to address identified flooding and drainage problems. Refer to Section 5 of this report for full presentation of the alternative formulation and evaluation process and the resultant Preliminary Alternatives.

4.1.3 *Field Survey*

The Project Survey Report is provided in Part 2, Volume 1, Section 4. Field surveys were performed during Phase I for two purposes. First, an as-built survey was performed of the New River Road bridge at Cline Creek, culverts and road profiles on New River Road and Circle Mountain Road. The purpose of this survey was to provide base data for use in the hydraulic modeling for the approximate floodplain delineation study for Cline Creek. As-constructed drawings were generated from the survey data and these are included in the Cline Creek Area Approximate Floodplain Delineation Study Technical Data Notebook (TDN) presented in Part 4, Volumes 3 & 4.

The second field survey was performed to gather finished floor elevations (FFE) for selected residential structures located in FEMA regulatory floodways of watercourses in the ADMP study area and for which no elevation certificates were available. The FFE survey data were used as input to the risk assessment performed to rank residential structures located in the floodways by severity of hazard for the purpose of the voluntary Floodprone Property Acquisition Program (FPAP). The risk assessment is documented in Part 8, Volume 2, Section 1.

4.1.4 *FEMA Floodplain and Floodway Delineations*

Based upon review of previously completed floodplain delineation studies, areas of identified flooding and drainage problems, and areas of anticipated future development, the District selected watercourse reaches within the ADMP study area for new or revised, approximate or detailed floodplain and floodway delineations. A total of 19.2 miles were delineated; consisting of 8.2 miles of detailed studies and 11.0 miles of approximate studies as summarized in Table 4.1. A brief discussion follows of the rationale for floodplain and floodway delineation of the selected watercourse reaches. Figure 4.3 shows the location of the selected reaches.

Table 4.1 Watercourse Reach Lengths for Floodplain and Floodway Delineation

Name	Description of Reach (d/s to u/s limits)	FDS Type	Reach Length (mi.)
Upper Skunk Creek mainstem	Upstream limit of existing FEMA model to State trust land boundary	Detailed	1.9
Tributary 6B	Confluence with upper Skunk Creek to upstream limit of new topographic mapping provided for the ADMP	Detailed	1.4
Cline Creek mainstem	Confluence with Skunk Creek to upstream limit of current FEMA study within Tonto National Forest boundary	Detailed	4.9
Subtotal Length of Detailed Studies			**8.2**
Upper Skunk Creek mainstem	State trust land boundary to headwaters	Approximate	1.6
Unnamed tributary to upper Skunk Creek upstream of New River Road bridge	Confluence with upper Skunk Creek to Tonto National Forest boundary	Approximate	0.9
Upper Buchanan Wash	CAP aqueduct to headwaters	Approximate	2.6
West Branch of CAP Wash	CAP aqueduct to headwaters	Approximate	2.0
East Branch of CAP Wash	CAP aqueduct to Carefree Highway	Approximate	3.9
Subtotal Length of Approximate Studies			**11.0**
Total Length of FDS Watercourses			**19.2**

Detailed Study (8.2 miles total)

- *Upper Skunk Creek mainstem from upstream limit of existing FEMA model upstream of New River Road bridge to State trust land boundary (1.9 miles)* – This reach was previously delineated; however, split flows on upper Skunk Creek in the vicinity of the New River Road bridge were recommended for further evaluation as a finding of the Skunk Creek Watercourse Master Plan. The District is currently working on a FLO-2D hydraulic model of the split flow area. There are several low-lying residential structures in close proximity to this reach of Skunk Creek. Therefore, this reach was recommended for detailed floodplain and floodway delineation.
- *Tributary 6B from confluence with upper Skunk Creek to upstream limit of new topographic mapping provided for the ADMP (1.4 miles)* – This reach was previously delineated; however, the area of the confluence with upper Skunk Creek had not previously been modeled as one together with the Tributary 6B model. Several discontinuities between the models were noted; therefore, this reach was recommended for detailed floodplain and floodway delineation.
- *Cline Creek mainstem from the confluence with upper Skunk Creek to upstream limit of current FEMA study within the Tonto National Forest boundary (4.9 miles)* – This reach was previously delineated in 1990. The mapping used for the previous delineation was not available digitally and was outdated. Field review of the floodplain and floodway limits indicated that updated delineations were needed; therefore, this reach was recommended for detailed redelineation. The limits of the study reach match those of the previous delineation, including the portion within the Tonto National Forest boundary.

Approximate Study (11.0 miles total)

- *Upper Skunk Creek from the State trust land boundary to headwaters (1.6 miles)* – This reach was not previously delineated. The reach is located wholly on State trust land. There is currently no development along this reach, but future development could occur as the Arizona State Land Department (ASLD) disposes these lands.
- *Unnamed tributary to upper Skunk Creek upstream of the State trust land boundary from the confluence with Skunk Creek to the Tonto National Forest boundary (0.9 miles)* – This reach has not been previously delineated. Land ownership along this reach is both State trust and private.
- *Upper Buchanan Wash from the CAP aqueduct to headwaters (2.6 miles)* – This reach has not been previously delineated. The reach is located wholly on State trust land. There is currently no development along this reach, but future development could occur as ASLD disposes these lands.
- *West Branch of CAP Wash from the CAP aqueduct to headwaters (2.0 miles)* – This reach has not been previously delineated. The reach is located wholly on State trust land. There is currently no development along this reach, but future development could occur as ASLD disposes these lands.
- *East Branch of CAP Wash from the CAP aqueduct to Carefree Highway (3.9 miles)* – This reach has not been previously delineated. The majority of this reach is located on State trust land; a very small portion is located on private land upstream of the I-17 crossing. There is currently no development along this reach, but future development could occur as ASLD disposes these lands.

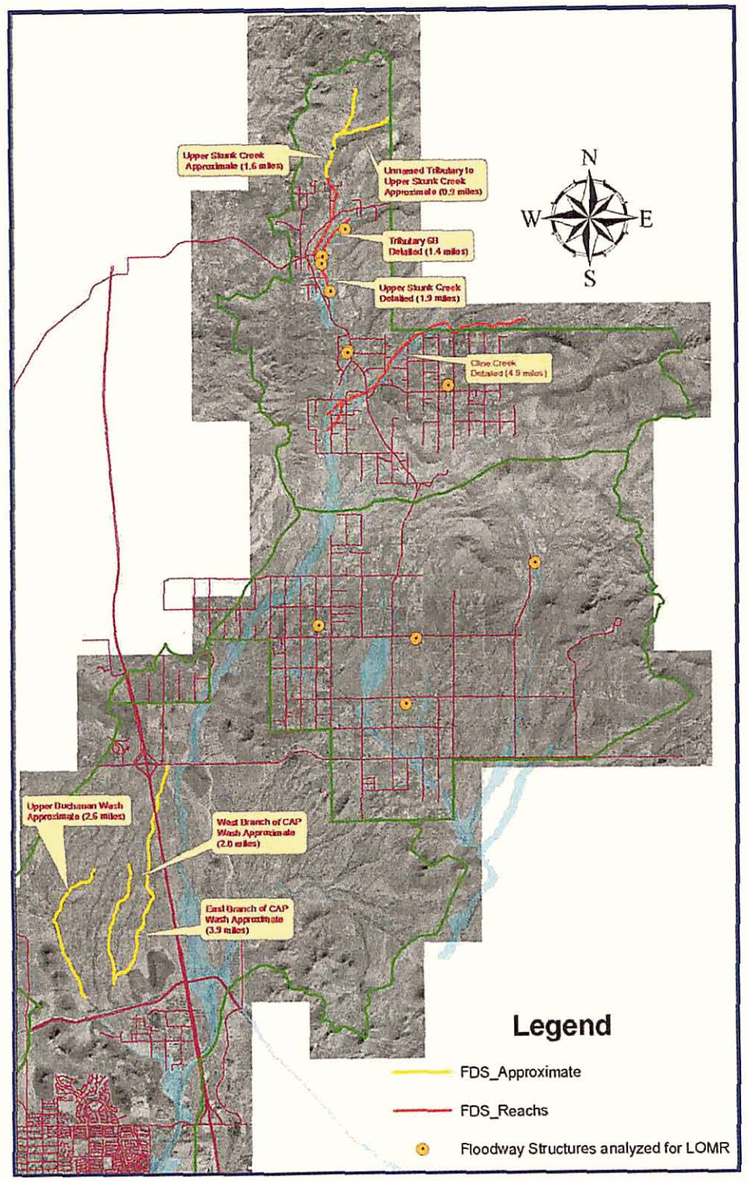


Figure 4.3 Floodplain and Floodway Delineation Watercourse Reach Locations

The ADMP also included the re-evaluation of the existing regulatory floodplain and floodway delineations for limited reaches of various watercourses at site-specific locations impacting 12 selected floodway residences. The locations of these residences are shown in Figure 4.3. The rationale for the re-evaluation was to determine whether or not re-evaluation of the hydraulic models would effectively remove the residences from the mapped floodways. The result of the evaluation of the 12 floodway residences is as follows:

- Five (5) residences removed from the floodway with re-evaluation of the delineations. Of these five residences, three (3) were removed from the floodway, but still remain in the floodplain, one (1) residence was removed from the floodway/floodplain of Tributary 10A, but is still in the floodplain of Skunk Creek, and one (1) residence was removed from the floodway and the floodplain. LOMRs were prepared and submitted to FEMA. Refer to Part 4, Volumes 7 & 8 for more detailed information.
- Four (4) residences were removed from the floodway with the re-evaluation of the confluence area of upper Skunk Creek and Tributary 6B. Of these residences, three (3) were removed from the floodway to a shaded Zone X designation and one (1) was removed from the floodway but is still in the floodplain. Refer to Part 4, Volume 1 & 2 for more detailed information.
- Two (2) residences could only be removed from the floodway if culvert upgrades and vertical realignment of New River Road occurred. Comparison of the cost of the culvert and roadway work versus the cost of acquisition of the floodway residences indicated that voluntary buyout was the preferred alternative. Rather than prepare a CLOMR submittal to FEMA, these 2 residences were included in the FPAP program.
- One (1) residence was located on a watercourse for which the hydraulic model used for floodplain and floodway delineation had larger problems beyond the small reach impacting the floodway residence. This residence was included in the FPAP program. No LOMR was prepared.

The FEMA floodplain delineation studies are nonstructural components of the Preliminary Alternatives for the ADMP as described in Section 5 of this report. All TDNs were reviewed and approved by FEMA. Final FIRM panels were produced by FEMA. Refer to the following deliverables for more detailed information:

- Part 4, Volumes 1 & 2 – FDS Upper Skunk Creek and Tributaries
- Part 4, Volumes 3 & 4 – Cline Creek Area Approximate FDS
- Part 4, Volumes 5 & 6 – Approximate Zone A FDS of Biscuit Flats Area
- Part 4, Volumes 7 & 8 - 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).

4.1.5 Hydrologic Analysis

Hydrologic analyses were performed for three watershed areas in the ADMP study area. These areas are Desert Hills, Biscuit Flat, and Lower Skunk Creek. The area locations, previous hydrologic studies, current hydrologic study purpose, methodologies employed, and study results are briefly described below:

Desert Hills – The watershed is bounded by the Skunk Creek watershed to the west and Cave Creek to the east. The majority of the watershed lies north of Carefree Highway between about 7th Avenue and 36th Street. The watercourses within the study area are all tributary to Cave Creek and enter Cave Creek within the pool area of the old Cave Creek Dam.

The hydrology of the Desert Hills area was previously studied for the purpose of floodplain delineation first in 1991 resulting in delineation of long reaches of Desert Hills, Apache, and Paradise Washes. The hydrology for the area was revised in 1997 with refinements to the 1991 hydrology to compute discharges at additional concentration points. The result was the extension of the floodplain delineations further upstream and into numerous tributaries within the greater Apache Wash system.

The primary purpose of the current hydrology study was to develop a HEC-1 model using methods consistent with the most recent version of the Drainage Design Manual for Maricopa County, Volume I, Hydrology. In addition, future condition land use was also evaluated. Finally, the existing and future conditions land use models served as a basis for the alternatives formulation and evaluation for the ADMP. In general, conceptual alternatives design was based on the 100-year, 6-hour existing condition discharges. However, where no retention is planned as part of the alternatives, future condition hydrology was used as a basis for design.

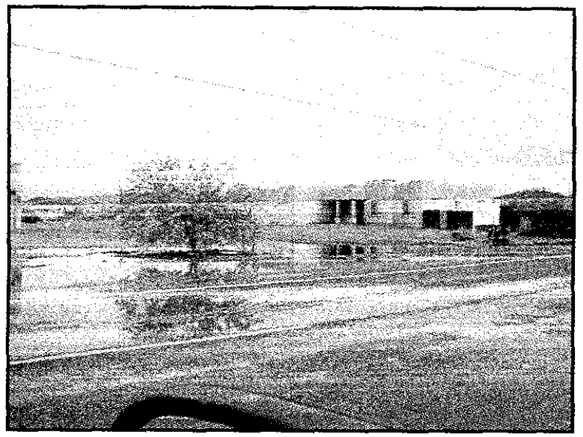


Figure 4.4 Joy Ranch Road between 7th Avenue and 7th Street (10-15-03)

The methods employed in the Desert Hills hydrology study were those outlined in the Drainage Design Manuals for Maricopa County. The U.S. Army Corps of Engineers HEC-1 model (version 4.1) was used to compute runoff hydrographs and peak discharges. In addition, the FLO-2D computer model (version 2001.06) was used to perform the hydrologic analyses for about a five square mile portion along the western side of the study area. The results of the FLO-2D model at its downstream limit near Carefree Highway and 7th Street were then inserted into the final HEC-1 models for determination of discharges further downstream.

The Desert Hills area hydrology study resulted in the development of rainfall-runoff models for the 2-year, 10-year, and 100-year 6-hour duration events for the 26.8 square mile watershed. Refer to Part 3, Volume 1 for the Desert Hills Hydrology TDN and Part 3, Volume 2 for Appendix D.7 FLO-2D modeling documentation.

Biscuit Flat – The study are is generally bounded by Interstate 17 on the east, Carefree Highway on the north, the CAP aqueduct on the south, and the drainage divide to Deadman Wash on the west. The watershed drains from north to south with a culvert crossing under the CAP canal metering flows into Buchanan Wash and further downstream to Skunk Creek. The watershed encompasses approximately 9.62 square miles. The Biscuit Flat study area includes three watercourse reaches; Upper Buchanan Wash, CAP Wash – West, and CAP Wash – East.

Figure 4.5 Biscuit Flat area wash (09-26-02)

The hydrology of the Biscuit Flat area was analyzed to provide a basis for delineation of floodplains in the area. Additionally, the resultant discharges computed using the HEC-1 models for the Biscuit Flat area serve as a basis for evaluation of flood control alternatives developed for the ADMP. The hydrologic impact of future development was evaluated in the hydrologic modeling in support of the ADMP.

The U.S. Army Corps of Engineers HEC-1 model (version 4.1) was used to compute runoff hydrographs and peak discharges. The HEC-1 models developed for the Biscuit Flat hydrology study use methods consistent with the most recent version of the Drainage Design Manual for Maricopa County, Volume I, Hydrology.

The study resulted in the development of rainfall-runoff models for the 2-year, 10-year, and 100-year events of both 6- and 24-hour durations for the existing and future watershed conditions. This study resulted in the new delineation of approximately 8.30 miles of approximate Zone A floodplain using the existing condition 100-year 6-hour model. Refer to Part 3, Volume 3 for Biscuit Flat Area Hydrology TDN.

Lower Skunk Creek – The study area is located south of the CAP aqueduct, west of Interstate 17, east of about 55th Avenue, and north of Adobe Dam. The primary purpose of the current study was to develop a HEC-1 model to connect models previously developed in the Skunk Creek Watercourse Master Plan hydrology and the Buchanan Wash hydrology conducted for the ADMP. The results will be used to investigate the performance of Adobe Dam and the channelized reach on Skunk Creek downstream of Interstate 17.

Existing condition and future condition land uses were evaluated. The existing and future conditions land use models serve as the basis of formulation and evaluation of flood control alternatives for the Lower Skunk Creek area within the ADMP. Rainfall-runoff models for the 100-year, 10-year, and 2-year 24-hour events were computed for both land use conditions using U.S. Army Corps of Engineers HEC-1 model (version 4.1). The hydrographs from the Skunk Creek and Sonoran Wash Watercourse Master Plan and the Buchanan Wash Hydrology HEC-1 models were exported into HEC-1 input files for the Lower Skunk Creek area. For future conditions, no retention was assumed to accompany future development in the Skunk Creek watershed upstream of the confluence of Sonoran Wash due to: 1) the effect of retention in this small area of the watershed is likely negligible to the peak discharge in Skunk Creek at the CAP; and 2) the discharges resulting by not modeling retention for these areas in the ADMP, while not significantly different, will be conservative for planning purposes in the Lower Skunk Creek area. The Sonoran Wash and Buchanan Wash watersheds were assumed to have 100-year 2-

Figure 4.6 Lower Skunk Creek grade control structure upstream of Pinnacle Peak Road Crossing (03-05-04)

hour retention for all new development due to the type of master planned subdivision development occurring in the area. The remaining portions of developable area in the Lower Skunk Creek area were also assumed to include 100-year 2-hour retention.

The study resulted in the development of rainfall-runoff models for the 2-year, 10-year, and 100-year 24-hour duration events for the watershed contributing to the Adobe Dam pool area for existing and future land use conditions. No floodplains were delineated for the Lower Skunk Creek area under this contract. Refer to Part 3, Volume 4 for the Lower Skunk Creek Hydrology TDN.

4.1.6 Hydraulic Analysis

In addition to the hydraulic computations and water surface profiles prepared for the floodplain delineations described in Section 4.1.4, hydraulic analyses were prepared for alternatives development purposes. Separate evaluations were performed to assess the complex hydraulics in a low-relief area of Desert Hills using FLO-2D modeling methods, assess hydraulic capacity for drainage crossings at roadways, and quantify flow conditions to assess risk at residences located in regulatory floodways. A brief description of each of these hydraulic evaluations follows.

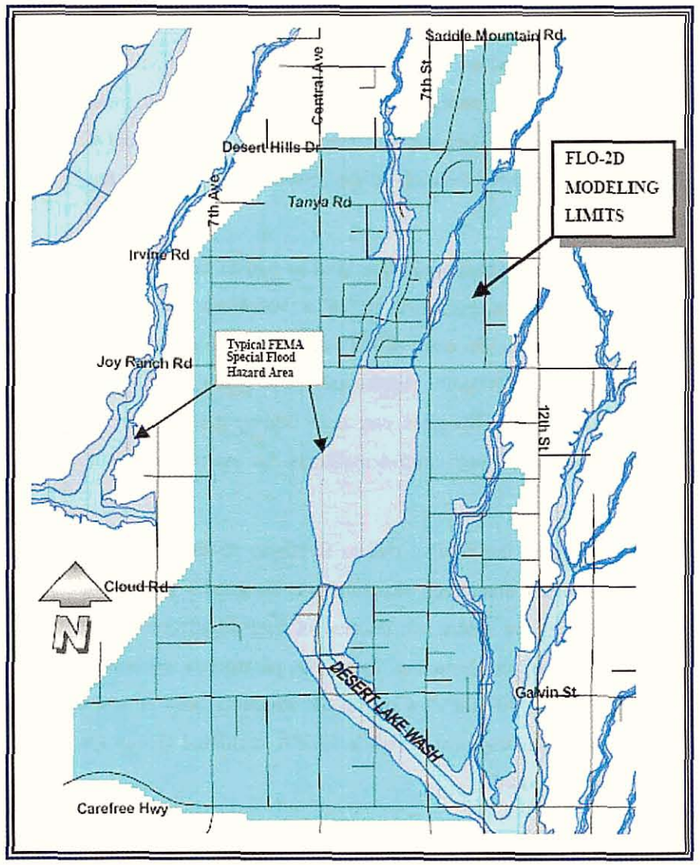


Figure 4.7 Desert Hills Two-dimensional Model Area Boundary Map

Desert Hills FLO-2D Analysis – Figure 4.7 depicts the general boundaries of the area modeled using two-dimensional analyses. The current FEMA Flood Insurance Study (FIS) special flood hazard areas are also indicated to highlight the primary watercourses of Desert Lake Wash and tributaries. The area modeled encompasses approximately five square miles and is generally bounded by Saddle Mountain Road on the north, 10th Street on the east, Carefree Highway on the south, and 7th Avenue on the west. The two-dimensional model area is located along the western watershed boundary that separates the Desert Hills area from the Skunk Creek watershed, with Desert Hills runoff flowing southeasterly towards Cave Creek.

The movement of stormwater runoff and prediction of peak discharges at key locations within the area depicted in Figure 4.7 is difficult to analyze using one-dimensional modeling techniques. Previous studies, along with recent field observations and review of aerial photographs for this area, have identified complicated breakout/ diversion locations and areas of unconfined sheet flooding. Existing hydrology and hydraulic analyses are based on simplifying assumptions and significant engineering judgment, and may not adequately reflect the true hydrology and flood routing impacts of those unique conditions. Accordingly, a two-dimensional model analysis of this area was conducted to better identify and quantify the hydrology and flood routing characteristics for the unusual flow conditions.

There are two primary focus areas that justify the need for a two-dimensional analysis. The first area is generally north of Joy Ranch Road and is characterized by small, incised washes with capacities that decrease as the washes continue southerly. The FLO-2D analysis results for this area were used to quantify the flows which break out of Desert Lake Wash and continue southwesterly to Skunk Tank Wash. This information was used to determine the impact the breakout flows had on the floodplain delineation for Skunk Tank Wash. The second area is the relatively flat broad terrain south of Joy Ranch Road characterized by unconfined sheet flow at slow velocities. This combination equates to significant hydrologic storage not accounted for in previous one-dimensional models. The results of the FLO-2D analysis were used to assess impacts of the ADMP alternatives on the existing condition flooding. Refer to Part 3, Volume 2 for the technical documentation and results of the two-dimensional modeling analyses that were performed for the Desert Hills area.

Roadway Drainage Crossings Hydraulics – Roadway crossings of drainages were identified from examination of maps, aerial photographs, field observations, and existing hydraulic models. The roadway crossings included in the level of service determination are shown in Figure 4.8. These are the same streets considered in the Flood Response Plan (FRP) (Part 7, Volume 1) developed as part of Phase II of the ADMP (Part 8, Volumes 3 & 4).

Hydraulic models from existing floodplain delineation studies were used, where available, to determine the degree of overtopping of roadways. Flood depth and velocity were taken from the HEC-2 or HECRAS model output files. In addition, the discharge rates flowing under and over the roadway were recorded as shown in the model

output. Where no floodplain delineation hydraulic model was available or the crossing was not reflected in the applicable FDS model, HY8 depictions of the crossings were developed. The data for the HY8 models were taken from existing topographic maps, interpretation of aerial photographs, and field data collected as part of the ADMP structure inventory.

In addition to the hydraulic performance at the crossings for the 100-year flood, discharge values from available hydrologic models were recorded for the 2-year and 10-year discharges. These data were used in the determination of the approximate frequency of the maximum safe passable discharge at each crossing.

Based on the convention for passability used previously by Maricopa County, a crossing was deemed passable if the maximum flow depth was less than 0.5 ft during the 100-year flow. For crossings with depths greater than 0.5 ft at the 100-year flow, the recurrence interval of the 0.5 foot overtopping discharge was determined for the flow rate in the culvert and/or over the crossing structure at 0.5 feet depth. The discharge rate that at 0.5 depth over the crossing (including the culvert flows, if any) was compared to the flood frequency at the crossing as indicated by the 100-year FDS discharge, the available 10-year and 2-year discharges, and the synthetic frequency curve developed for the floodway residences risk assessment (Part 8, Volume 2, Section 1).

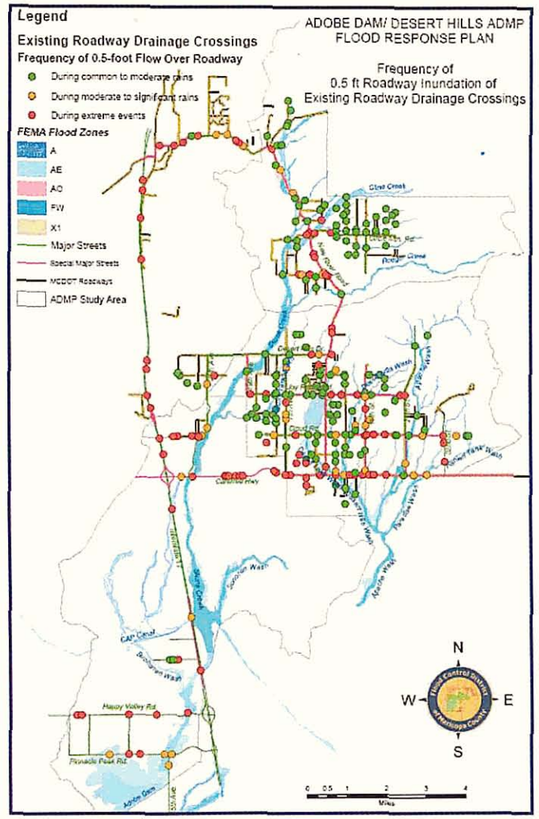


Figure 4.8 Frequency of 0.5 ft Roadway Inundation of Existing Roadway Drainage Crossings

Figure 4.9 Desert Hills Roadway Drainage Crossing (10-15-02)

Figure 4.8 shows the spatial summary of the results of the determination of the recurrence interval of the 0.5 foot overtopping discharge for the primary arterial roadways in the study area. What these data show is that access to or from almost anywhere in the study area is limited during even the most frequent flood events. Although 100-year capacity is provided at many crossings, a larger number of critical locations would be hazardous to vehicular traffic during flood events. Refer to Part 8, Volume 2, Section 4 for detailed results of the roadway drainage crossing hydraulics.

Floodway Residence Risk Assessment – Residences within existing FEMA floodways were identified for the ADMP. Floodway residences are of particular interest because no new building or building permits would be allowed in these most hazardous areas per Maricopa County floodplain regulations. Figure 4.10 shows the location of the residences included in the assessment.

These residences were identified as part of the ADMP to provide a basis for prioritization of a voluntary Floodprone Property Acquisition Program (FPAP) as one of the nonstructural alternatives for the ADMP. Additionally, the spatial distribution of the most at-risk structures can help inform the location of potential structural flood control measures for evaluation in the ADMP.

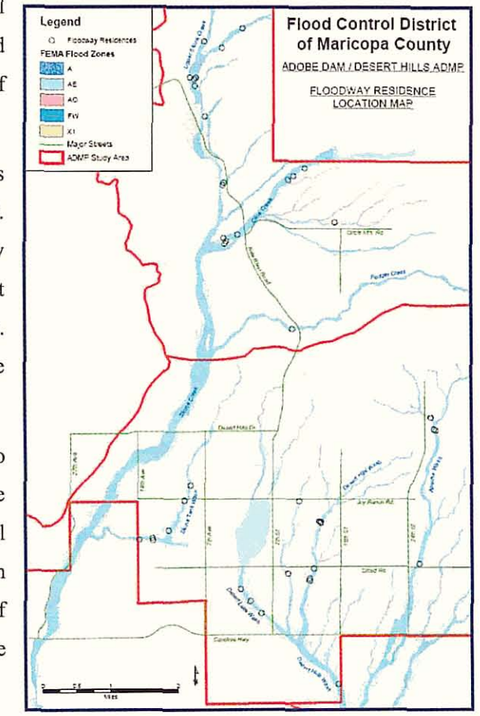


Figure 4.10 Floodway Residence Location Map

To assess the relative risk to floodway residences within the ADMP study area, each structure was assigned a risk factor associated with the recurrence interval of first inundation of the finished floor of the structure, hydraulic parameters associated with the FEMA 100-year flow rate at the structure location, and the erosion hazard designation. The emphasis was placed on residences located within FEMA regulated floodways due to the practicality and cost associated with mitigating the hazards.

The relative flood risk at each residence was evaluated using a procedure developed for the Skunk Creek Watercourse Master Plan. The evaluation is based upon how often a residence is flooded and the depth and velocity of flood water during the 100-year event. The presence of erosion hazards was also included in the evaluation.

The results found 41 residences in the study area within the floodway and ranked their relative risk from 1 to 41. The results show that 16 of the 41 structures in the floodway are inundated by the 100-year flood, five structures are inundated by the 20-year flood, and two structures are inundated by the 10-year flood. These results provide data for evaluation of the flood hazard mitigation alternatives as part of the ADMP. Refer to Part 8, Volume 2 Section 1 for detailed descriptions regarding the data sources, methodology and results of the floodway residence risk assessment.

4.1.7 Sedimentation Engineering and Geomorphic Evaluation

The sedimentation engineering and geomorphic evaluation is a key component of the ADMP. The primary objective of the sedimentation engineering and geomorphic evaluation was to provide a qualitative assessment of potential erosion and scour for the significant streams in the ADMP watershed.

The work tasks for the sedimentation engineering and geomorphic evaluation comprised an existing conditions assessment to evaluate the sedimentation characteristics of the main watercourses in the project area, delineation of erosion hazard setbacks for watercourses within the study area that have existing floodplain delineations but do not already have erosion hazard zone delineations, estimation of existing and future sediment yield for the project area, and preparation of recommended best management practices for managing sediment and scour at drainage crossings and other structural features. A brief description of these four work tasks follows. See Part 5, Volume 1 for full documentation of the sediment engineering and geomorphic evaluation for the ADMP.

Existing Conditions Assessment – An assessment of existing watershed and stream channel conditions was conducted using field observations, interpretation of aerial photographs and topographic mapping, and consideration of existing studies. The objective of the existing conditions assessment was to evaluate the sedimentation and erosion characteristics of the main watercourses in the study area and identify problem areas for incorporation into the ADMP. The existing conditions analysis focused on the following elements:

- Identify stream reaches with historical or recent long-term degradation or aggradation
- Identify stream reaches with historical or recent lateral stability
- Identify sedimentation problems at road crossings or hydraulic structures
- Identify stream responses to watershed and stream corridor development
- Identify points of natural grade control along significant watercourses
- Identify existing sediment sources in the watershed

Refer to Part 5, Volume 1, Section 2 for detailed discussion and summary of results for each of the above tasks relative to the watercourses in the study area. In general, the existing conditions analysis indicates that there are few significant existing or historical sedimentation problems in the ADMP study area. The degree of development that has occurred to date has not significantly impacted channel stability or induced sedimentation problems, except in localized areas in response to specific disturbances of the actual watercourses rather than upland areas. However, new and increased sedimentation problems are likely to occur if the development density increases in the watershed and direct modifications of the trunk streams are made. The magnitude of future development-related erosion problems will be greatest in the reaches with flatter slopes, least topographic confinement, least amount of bedrock control, densest development, and lowest regulatory control of development practices. Lateral erosion of the major watercourses occurs naturally within the canyons throughout the study area and is expected to continue to occur in the future.

Figure 4.11 Evidence of recent long-term degradation on Apache Wash (06-16-03)

Erosion Hazard Zones – Erosion hazard zones were delineated for all the watercourses within the ADMP study area that have detailed floodplain delineations. A total of 75 miles of new erosion hazard zones were delineated as part of the ADMP. Another 17 miles of erosion hazard zones (EHZ) were previously delineated in the study area and approved by the District. Previously delineated EHZ were incorporated without modification into this study from the following studies:

- Skunk Tank Wash Erosion Hazard Study (JEF, 2000)
- Skunk Creek Lateral Stability Assessment (JEF, 2001)
- Sonoran Wash Lateral Stability Assessment (JEF, 2001)
- Rodger Creek Erosion Hazard Study (JEF, 2001)

The methodology used to delineate the erosion hazard for the watercourses in the Adobe ADMP study area generally followed the Level 3 non-detailed analysis procedures outlined in the District's draft *Erosion Hazard Zone Delineation and Development Guidelines.* Erosion hazard zones were delineated using the following types of information and analyses:

- Interpretation of geomorphic mapping
- Interpretation of recent aerial photographs
- Comparison of existing and historical channel position
- Field observations
- Estimation of the Pleistocene/Holocene surface lateral erosion rate
- Interpretation of detailed floodplain/floodway mapping
- Identification of potential channel avulsion areas

Refer to Part 5, Volume 1, Section 3 for detailed discussion and summary of results for each of the above methodologies relative to the delineation of erosion hazard zones for the watercourses in the study area. The recommended erosion hazard zone lines shown in Figure 4.12 are intended to delineate the areas likely to be impacted by future lateral erosion, or the areas for which more detailed analysis is warranted prior to future development. The EHZ delineations were delivered to the District in digital format for use by Regulatory and Permitting staff.

Based on the methodologies used to evaluate the erosion hazards, the following general conclusions can be drawn for the streams in the ADMP study area:

- Cut banks, which are evidence of recent and ongoing bank erosion, occur throughout the study area, especially on channel bends, where the channels have experienced some degree of long-term degradation, and where bank vegetation has been removed.
- Lateral erosion should be expected within the Holocene floodplain.
- Lateral erosion will occur in response to two types of flooding:
  - Single floods – Floods that fill the main channel and flow onto the floodplain will cause significant amounts of lateral erosion at specific locations. Floods greater than about the 5-year peak discharge will typically cause this type of erosion.
  - Series of floods – Lateral erosion will occur in response to series of smaller floods that combine to produce significant amounts of cumulative erosion over time periods equivalent to the design life of the structures proposed in or near the streams in the study area.
- Holocene floodplain soils appear to be composed of highly erosive materials that lack resistance to lateral erosion or formation of avulsive channels.
- The streams in the study area have been subject to channel avulsions, local scour, and channel migration, all of which indicate significant lateral erosion hazards.

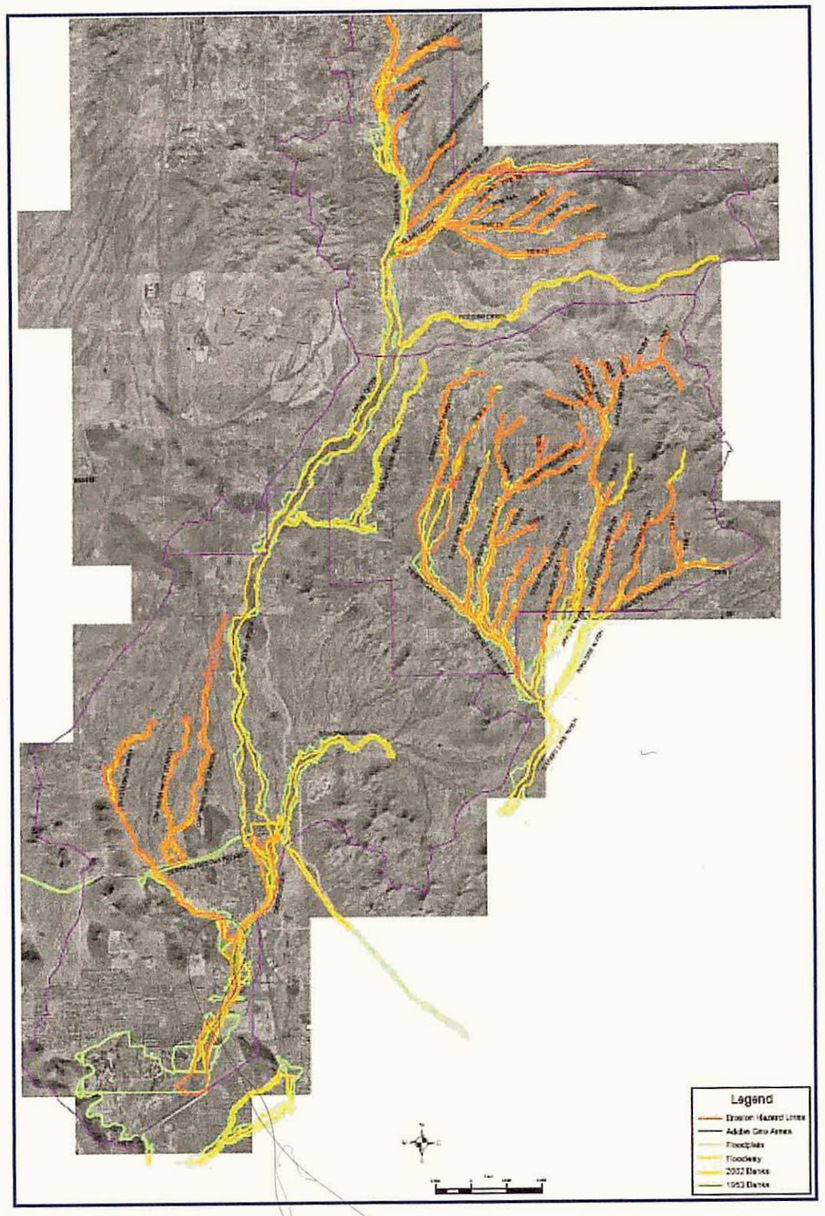


Figure 4.12 Erosion Hazard Lines

- The streams in the study area have a high sediment transport capacity, and could cause significant lateral erosion if sediment supply is decreased.
- Caliche or clay-rich soils do not prevent lateral erosion, though they may significantly slow the rate of lateral erosion.
- Bedrock does prevent lateral erosion.
- Except on portions of Skunk Creek, significant long-term degradation has not occurred in the study area, except where the channel has been disturbed by human impacts such as encroachment, construction of road crossings, or diversion for stock ponds.
- Erosion hazards are most significant on the largest watercourses in the study area.

Sediment Yield - Sediment yield is defined as the volume of soil material and stream sediment that is transported from a watershed through its stream network. Sediment yield is an important design parameter for flood control structures because sediment deposition in dams, reservoirs, or floodways reduces the storage or transport capacity. Reduced capacity of flood control structures increases the likelihood of a spillover during floods, increasing the chance of injuries, damage to the structure itself, downstream property damage, and even loss of human life. Sediment yield is also an important parameter for evaluating erosion and sedimentation hazards of stream systems because a sediment deficit or excess can lead to lateral erosion, long-term degradation, or increased flooding levels.

Planning level estimates of existing and future condition sediment yield for the ADMP study area were made by applying the results from detailed sediment yield analyses performed for previous WCMP and ADMP studies. Sediment yield estimates will be used to predict sediment storage requirements for regional retention/ detention facilities and to predict channel responses to changing watershed conditions. The recommended average annual and single event sediment yield rates are summarized in Table 4.2. Refer to Part 5, Volume 1, Section 4 for a more detailed discussion of sediment yield for the ADMP.

Table 4.2 Adobe ADMP Sedimentation Engineering & Geomorphic Analysis

Recommended Sediment Yield Values	
Event	**Recommended Yield**
Average Annual	0.6 AF/mi2/yr
Single Event	5% of water volume

Future development of the study area is likely to cause changes in sediment yield. In unincorporated areas in the upper watershed, sediment yield will increase due to increased runoff rates and will cause long-term degradation and lateral erosion in minor tributaries and collector channels. In the incorporated areas, changes in sediment yield are unlikely to significantly impact the existing channelized reaches of Skunk Creek.

Best Management Practices - Proposed best management practices for management of sediment and scour at drainage crossings and other structural flood control features were prepared. The best management practice recommendations are intended for use by the City of Phoenix and Maricopa County for management of future development, and were formulated based on the results of the sedimentation engineering and geomorphic evaluation performed for the ADMP.

The following types of best management practices are recommended:

- Erosion Hazard Zones
- Maintenance of Bank Vegetation
- Maintenance of Riparian Corridors
- Drainage Crossing Design
- Conveyance Requirements
- Erosion Hazard Evaluation
- Downstream Impact Assessment
- Channel Restoration

In addition, general design guidelines for structures that may impact sedimentation, erosion, and sediment continuity are provided in Part 5, Volume 1, Section 5. For example, bank vegetation provides habitat, erosion protection, aesthetic benefits, water quality, and other vital functions along stream corridors. Best management practices addressing bank vegetation stipulate replacement of vegetation on disturbed banks with equivalent plants and require adequate irrigation and maintenance to assure survival of the replacement vegetation. Further it is recommended that channel banks and riparian corridors should be held as common areas and dedicated for public ownership.

Figure 4.13 Cutbank along SkunkCreek in New River area (10-15-02)

Application of best management practices during development review and construction can prevent future damage to public and private infrastructure, prevent threats to public safety and welfare, as well as prevent the expenditure of tax dollars to retrofit poorly designed flood control structures.

4.1.8 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 Inform, Involve, and Include 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 4.14).

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.

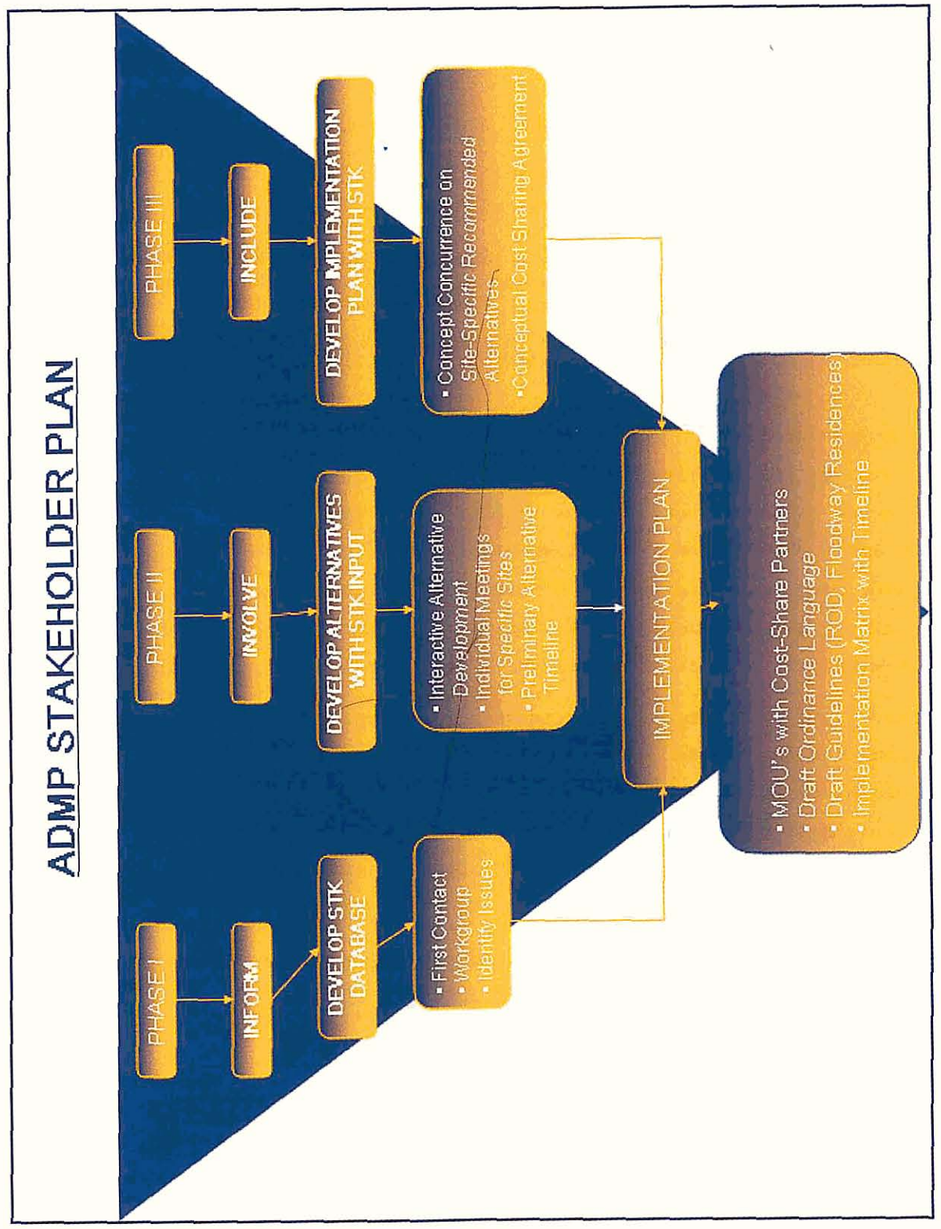


Figure 4.14 ADMP Stakeholder Plan

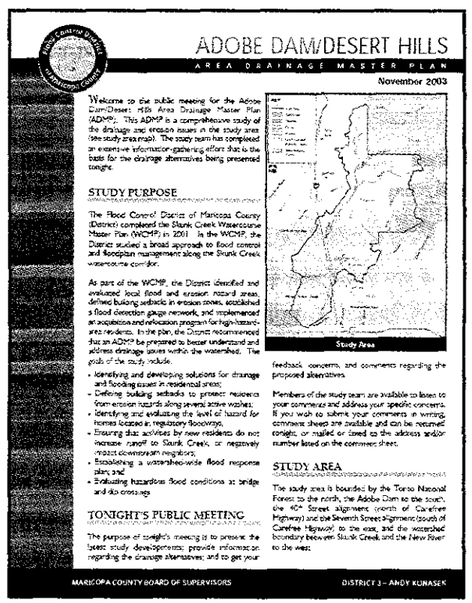
This was accomplished using a combination of workgroups and individual meetings because of the iterative nature of these negotiations. Stakeholders' input was documented in the conceptual design plans and cost estimates contained in Part 9, Volume 1 of the ADMP Recommended Alternative Report.

4.1.9 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
- Newspaper Notices
- Notification Letters
- Handouts



ADOBE DAM/DESERT HILLS
AREA DRAINAGE MASTER PLAN
November 2003

Welcome to the public meeting for the Adobe Dam/Desert Hills Area Drainage Master Plan (ADMP). This ADMP is a comprehensive study of the drainage and erosion issues in the study area (see study area map). The study team has completed an extensive information-gathering effort that is the basis for the drainage alternatives being presented tonight.

STUDY PURPOSE

The Flood Control District of Maricopa County (District) completed the Skunk Creek Watercourse Master Plan (WCMP) in 2001. In the WCMP, the District studied a broad approach to flood control and floodplain management along the Skunk Creek watercourse corridor.

As part of the WCMP, the District identified and evaluated local flood and erosion hazard areas, defined building setbacks in erosion zones, established a flood detection gauge network, and implemented an acquisition and relocation program for high-hazard area residents. In the plan, the District recommended that an ADMP be prepared to better understand and address drainage issues within the watershed. The goals of the study include:

- Identifying and developing solutions for drainage and flooding issues in residential areas;
- Defining building setbacks to protect residents from erosion hazards along several active washes;
- Identifying and evaluating the level of hazard for homes located in regulatory floodways;
- Ensuring that activities by new residents do not increase runoff to Skunk Creek, or negatively impact downstream neighbors;
- Establishing a watershed-wide flood response plan; and
- Evaluating hazardous flood conditions at bridge and culvert crossings.

TONIGHT'S PUBLIC MEETING

The purpose of tonight's meeting is to present the latest study developments; provide information regarding the drainage alternatives; and to get your feedback, concerns, and comments regarding the proposed alternatives.

Members of the study team are available to listen to your comments and address your specific concerns. If you wish to submit your comments in writing, comment sheets are available and can be returned tonight, or mailed or faxed to the address and/or number listed on the comment sheet.

Study Area

STUDY AREA

The study area is bounded by the Tonto National Forest to the north, the Adobe Dam to the south, the 40th Street alignment (north of Carefree Highway) and the Seventh Street alignment (south of Carefree Highway) to the east, and the watershed boundary between Skunk Creek and the New River to the west.

MARICOPA COUNTY BOARD OF SUPERVISORS — DISTRICT 3 – ANDY KUNASEK

Figure 4.15 November 2003 Public Meeting Handout

- Sign-in Sheets
- Meeting Summaries
- Public Meeting Presentations
- Exhibit Boards

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.

4.1.10 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.

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, an informational meeting was held with the Development Guidelines Work Group comprising regulators, planners, hydrologists, land development engineers, and project area residents representing the New River/Desert Hills Community Association. The group was convened to discuss flooding and drainage issues and regulation as input to the interim development guidelines formulation. Refer to Part 8, Volume 2, Section 3 for further information regarding the Phase I development guidelines.

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 4.16). 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.

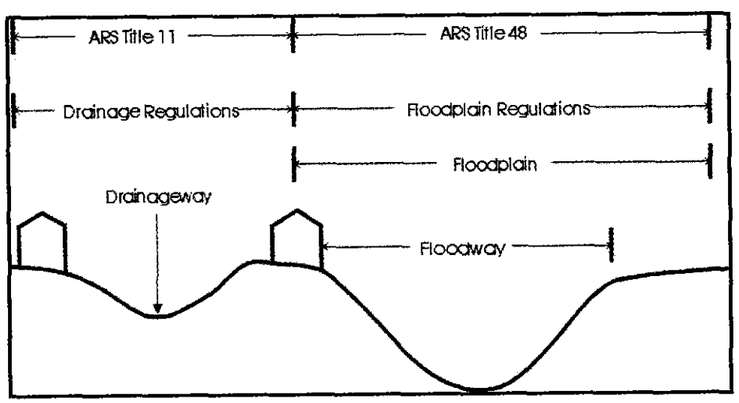


Figure 4.16 Statute Applicability

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. The Interim Rules of Development were further refined in Phase II of the Adobe ADMP and are presented as the Development Guidelines for Individual Single-Family Lots in Part 8, Volume 4, Section 2. 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 near future.

Floodproofing Evaluation – In conjunction with the risk assessment of floodway residences and the alternatives development process of the ADMP, floodproofing options and their associated costs were investigated and comparatively evaluated against the costs of the voluntary Floodprone Property Acquisition Program (FPAP). The preliminary analysis of the Evaluation of Floodproofing for Floodway Residences is documented in Part 8, Volume 2, Section 2.

Floodproofing options were taken from FEMA publication *Homeowner's Guide to Retrofitting, FEMA 312* (FEMA, 1998). Four floodproofing options were evaluated, including elevation, dry floodproofing, levees and floodwalls. Buyout costs were estimated from the Maricopa County Assessor's Office data collected as part of the ADMP. The Total Assessed Value (TAV) was converted to an approximate buyout cost using a factor of 1.25.

The results of the floodproofing evaluation indicate that the costs of floodproofing floodway residences are about half the estimated buyout costs. However, floodproofing does not remove residents from the floodway, thus public safety concerns are not eliminated. Primarily for this reason, floodproofing was dropped as a nonstructural alternative for the ADMP.

4.2 Phase II Tasks

Based on the Phase I work tasks briefly described above 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 as described in Section 5. 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. The ADMP Phase II work tasks are described in Part 8, Volumes 3 & 4 and fully documented under separate cover as listed in Table 3.1. The result of the Phase II alternatives evaluation is the Recommended Alternative as documented in Part 9, Volumes 1 & 2.

SECTION 5: PHASE I ALTERNATIVES FORMULATION AND PRELIMINARY ANALYSIS

The alternatives formulation process is presented in Figure 3.1. The work plan consists of four major components; including Problem Identification, Measures (Solutions), Preliminary Alternatives, and Recommended Alternative. As described in Section 4, the work tasks comprising Phase I addressed problem identification, brainstorming measures (solutions), and alternatives evaluation with the resultant outcome of four Phase I Preliminary Alternatives to be considered for further refinement during Phase II. The end product of Phase II is the Recommended Alternative. The following sections describe the Phase I alternatives formation and preliminary analysis for the Adobe ADMP.

5.1 Problem Identification

The initial step in the alternatives formulation process was to synthesize the results of the data collection effort (Sections 4.1.1, 4.1.2, 4.1.3 & 4.1.10) with the existing and future condition hydrologic, hydraulic, floodplain delineation, sedimentation engineering, and geomorphic analyses (Sections 4.1.4, 4.1.5, 4.1.6, & 4.1.7) into a basic understanding of the flooding, drainage, and erosion hazards in the ADMP study area. Based upon this foundation, and with significant input from stakeholders (Section 4.1.8) and the public (Section 4.1.9), an Alternatives Formulation and Preliminary Analysis Meeting was convened in January 2003.

The purpose of the Alternatives Formulation and Preliminary Analysis Meeting was three-fold:

- First, the project team members reviewed key area-specific characteristics and commonalities for the four subareas (i.e., Phoenix South of CAP, Phoenix North of CAP, Desert Hills, and New River as shown in Figure 2.1) and identified problems for each subarea which were categorized as structural/physical system or nonstructural/policy issues.
- Second, the project team identified desired objectives in each of the subareas and considered both opportunities and constraints to meeting the objectives.
- Third, based on this foundational understanding of problems, opportunities, objectives, and constraints, the project team brainstormed mitigation measures and combined those measures into alternatives.

The GIS database described in Section 4.1.1 served 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 of flooding and drainage problems requiring further investigation. The GIS database was used to facilitate discussion at the Alternatives Formulation and Preliminary Analysis Meeting and at numerous stakeholder, public, and project team meetings. Stakeholder meetings were held during the period from November 2002 through March 2003 to inform them about the Adobe ADMP and to solicit input regarding flooding, drainage, and erosion problems. The first set of public meetings was held in November 2002 for the same purpose. The input received at these meetings was entered into the GIS database, as appropriate. Table 5.1 summarizes the outcome of the Alternatives Formulation and Preliminary Analysis Meeting and subsequent stakeholder meetings. Figure 5.2 shows the spatial locations of flooding and drainage concerns expressed by residents attending the November 2002 public meetings.

Figure 5.1 Skunk Creek at Desert Hills Drive

Table 5.1 Phase I Alternatives Formulation And Preliminary Analysis Meeting (1/14/03)

CHARACTERISTIC		Phoenix S of CAP	Phoenix N of CAP		New River
DESCRIPTION	Key Area-Specific Characteristics	• City services • *Mulit-use recreation in pool area* • Landfills	• Currently largely undeveloped • Future large-scale subdivision development planned south of Carefree Highway and east of Skunk Creek • Large State trust parcel at Biscuit Flat • Future transportation improvements include I-17 corridor widening, Sonoran Parkway, and Loop 303 • City of Phoenix plans transfer station and city complex at confluence of Skunk Creek and Sonoran Wash upstream of CAP	• State trust land parcels • Low-relief topography • Discontinuous drainage corridors • Shallow, unconfined flow • Numerous flow splits • Grid-oriented roadways intercept, pond, and/or divert natural drainages • Unpaved roads erode or *silt during* storm events • Inadequate retention	• Federal land ownership – USFS Tonto National Forest • Higher elevation, relatively higher rainfall amounts and more frequent runoff • Relatively high-relief topography, more incised channels • More dense vegetation, potentially more diverse biological communities • New River Road is only major *ingress/egress*
	Commonalities	• Incorporated City of Phoenix • *Development style - Master planned communities*		• Unincorporated Maricopa County and incorporated Town of Cave Creek • Development style – Lot splits, some small subdivisions • Lack of master drainage planning – *piecemeal solutions* • Lot clearing increases imperviousness and runoff	
PROBLEMS Existing negative conditions	Structural/ Physical	• Flow breakout at discontinuous levees downstream of CAP • *Limited capacity* of lower Skunk Creek levees through landfill area • Flow breakout at Pinnacle Peak Road and 35th Avenue • Roadway ponding along Pinnacle Peak Road west of 43rd Avenue • Limited access across Skunk Creek at Happy Valley Road • Flow across Happy Valley Road west of 51st Avenue • Houses located in 100-year pool behind Adobe Dam	• *Potential conveyance problems of* Skunk Creek channel through Tramanto upstream of Carefree Highway bridge • Aggradation in Skunk Creek channel *at Carefree* Highway bridge • Limited capacity of CAP overchutes at Skunk Creek and Sonoran Wash • Overtopping of I-17 upstream of Skunk Creek crossing of CAP • Hazard due to existing stock tanks	• Development occurring without overall master plan significantly modifying the natural drainage network • Natural drainage pattern is altered by development causing flooding (i.e., fences, walls, roads) • Roadway drainage problems restrict *all-weather access to area* (i.e., silted-in culverts, unpaved dip crossings) particularly in N-S direction • 24th Street aligned in Apache Wash • 32nd Street access across Paradise Wash	• Conveyance problems at New River Road bridge at Skunk Creek (i.e., upstream split flow, sediment deposition at bridge section, abrupt cross section transitions both upstream and downstream) • Limited capacity of New River Road crossing at Roger Creek • Potential conveyance problems at New River Road bridge at Cline Creek • *No all-weather access* • Erosion hazards, bank failures, sedimentation problems • Lot clearing increases runoff
	Non-structural/ Policy		• Uncertainty regarding ASLD disposition plan for State trust parcels	• Fringe development issues – contrasting "old timer" v. newcomer perspectives • Lot split development • Uncertainty regarding ASLD disposition plan for State trust parcels • Lack of *consistent/ cohesive right-of-*way along roadways • Little room for drainage easements given existing parcel ownership • No review required for drainage *structures* (e.g., berms, walls) less than 12" high per current drainage regulations	• Fringe development issues – *contrasting* "old timer" v. newcomer perspectives • Lot split development • Zoning violations – lots are smaller than minimum zoning limits • Residences located in high-hazard floodway along upper Skunk Creek • Active or passive land use management *in Tonto NF impacts* future condition hydrology (e.g., grazing leases)

Table 5.1 Phase I Alternatives Formulation And Preliminary Analysis Meeting (cont'd.)

CHARACTERISTIC	Phoenix S of CAP	Phoenix N of CAP	Desert Hills	New River
OPPORTUNITIES Desirable future conditions	• I-17 Corridor Widening • Landfill closure • New bridge at Happy Valley Road	• Planned COP park SE of Carefree Highway and I-17 TI • Use existing stock tanks for retention • Opportunity to influence ASLD disposition plans for State trust parcels	• Wash corridor preservation • Opportunity to influence ASLD disposition plans for State trust parcels • More public support for structural measures in high frequency flood areas • Improved roadway access • Development guidelines • East access to Anthem • AZ Preserve Initiative (API) opportunity • Piggyback on PM10 roadway paving program	• Wash corridor preservation • Cost-share opportunities with MCDOT for arterial and collector roadway improvements • Regional plan incorporation • Multi-use opportunities (e.g., recreation, trail system, active open space) • Development guidelines
OBJECTIVES Results desired by solving problems and taking advantage of opportunities	• Control flow breakout with levee improvements between CAP and I-17 • Maintain flows at current levels through leveed reach • Provide SPF capacity in leveed reach • Improve access on arterial roadways (i.e., Happy Valley Road, Pinnacle Peak Road, 35th Avenue)	• Improve transport capacity in Skunk Creek at Carefree Highway bridge • Improve conveyance at CAP overchutes • Eliminate I-17 overtopping • Incorporate planned transfer station construction at Skunk/ Sonoran confluence in alternative design	• Mitigate impacts of future development on inundation/ erosion limits (No adverse impact) • Minimize future CIP improvements • Identify all-weather access route • Provide low discharge/ high frequency flood control measures (i.e., lot retention, roadway improvements) • Address local drainage issues with development guidelines • Mitigate risk to residents in high hazard areas	• Mitigate impacts of future development on inundation/ erosion limits (No adverse impact) • Minimize future CIP improvements • Identify all-weather access route • Improve New River Road crossing at Roger Creek • Improve conveyance at New River Road bridge at Skunk Creek • Address conveyance concerns regarding New River Road bridge at Cline Creek • Mitigate risk to residents in high hazard areas
CONSTRAINTS Things to avoid doing and things that cannot be changed while meeting objectives	• Limited capacity of lower Skunk Creek in leveed reach • Performance of Adobe Dam to accommodate future condition inflows	• ASLD disposition plans for trust parcels • Sonoran Parkway bridge at Skunk Creek • Low-water crossing of Skunk Creek from I-17 frontage road to COP transfer station • Limited capacity of existing CAP overchutes	• ASLD disposition plan for trust parcels • Limited MCDOT right-of-way to accommodate roadway/ drainage improvements • Buy-out program precedent • New timer v. old-timer attitudes	• Limited MCDOT right-of-way to accommodate roadway improvements • Buy-out program precedent • Public attitude (leave us alone) • New timer v. old-timer attitudes

Table 5.1 Phase I Alternatives Formulation And Preliminary Analysis Meeting (cont'd.)

CHARACTERISTIC		Phoenix S of CAP	Phoenix N of CAP		New River
MITIGATION MEASURES Feature or activity that can be implemented to address one or more objectives	**Structural**	• Increase Skunk Creek channel capacity downstream of CAP by closing gaps in levees, raising levees, or lining channel to increase hydraulic efficiency OR excavating storage pool upstream of CAP to meter flows through existing channel section • Channel alignment control upstream of Pinnacle Peak Road to prevent breakout at 35th Avenue • Build bridge at Happy Valley Road crossing of Skunk Creek • Improvements to arterial roadways (i.e., Happy Valley Road west of 51st Avenue, Pinnacle Peak Road west of 43rd Avenue)	• Increase channel capacities of Skunk Creek at Tramanto (i.e., widen channel or raise levees) • Levee to protect I-17 from overtopping upstream of CAP overchutes • Excavate detention basin upstream of CAP to meter flows through existing overchutes OR Structural modifications to increase overchute capacities • Bulldoze stock tanks to remove hazard OR Engineer stock tanks to incorporate as retention facilities	• Improvements to existing arterial and collector roadway crossings to provide all-weather access (e.g., Joy Ranch Road, Cloud Road, 7th Street, 24 th Street, 32nd Street) • Drainage improvements for high frequency, nuisance flows (e.g., roadway ditches, channels, retention/ retention basins) • Roadway re-alignment (e.g., 24th Street) • Upgrades to mainstem Skunk Creek crossings (e.g., Desert Hills Drive, 19th Avenue, Cloud Road at 27th Avenue)	• Channel conveyance improvements to Skunk Creek at New River Road bridge (i.e., levee construction to prevent upstream split flow, channel modification to improve transport capacity at bridge section, channel improvements to transition channel cross section at bridge) • Roadway improvements to New River Road crossing at Rodger Creek • Channel improvements at New River Road crossing at Cline Creek • Improvements to existing arterial and collector roadway crossings to provide all-weather access (e.g., Circle Mountain Road in Cline Creek basin)
	Non-Structural	• Erosion hazard delineations for mainstem Skunk Creek below I-17 • Flood Response Plan	• New floodplain, floodway, and erosion hazard delineations of mainstem upper Buchanan Wash and tributaries upstream of CAP • Future build out should follow requirements for retention	• New erosion hazard delineations of Desert Hills Wash, Apache Wash, and Paradise Wash • "Red flag" map (50 cfs corridors + 10' setbacks) for drainage design review • Development guidelines • Extension of voluntary buyout program to residents in high hazard areas • Roadway access evaluation to identify critical aerial and collector crossings for future improvement and/or monitoring • Design and/or maintenance guidelines for non-arterial/ non-collector roadway crossings • Purchase right-of-way for drainage improvements • Flood Response Plan	• New and updated floodplain, floodway, and erosion hazard delineations of mainstem Skunk Creek and tributaries upstream of New River Road bridge • New erosion hazard delineations of mainstem Cline Creek and tributaries • Recommend update of Cline Creek floodplain and floodway delineations from Skunk Creek confluence to the Tonto NF boundary • "Red flag" map (50 cfs corridors + 10' setbacks) for drainage design review • Development guidelines • Extension of voluntary buyout program to residents in high hazard areas • Flood Response Plan – verify all-weather connection along New River Road from Skunk Creek bridge west to I-17 • Design and/or maintenance guidelines for non-arterial/ non-collector roadway crossings • USFS Grazing Allotments

Table 5.1 Phase I Alternatives Formulation And Preliminary Analysis Meeting (cont'd.)

CHARACTERISTIC	Phoenix S of CAP	Phoenix N of CAP	Desert Hills	New River
ALTERNATIVES A set of management measures functioning together to address one or more objectives without violating constraints	• Plan Phoenix 1 – Meter Option – Excavate detention upstream of CAP overchutes – Meter Skunk Creek flows through existing CAP overchutes – Close gaps in levee alignment upstream and downstream of I-17 – Requires improved leveed reach through landfills to convey metered flows (raise levees, line channel, or modify channel to more hydraulically efficient cross section) – Close levee gaps upstream of Pinnacle Peak Road and 35th Avenue – Happy Valley Road bridge at Skunk Creek and improvements west of 51st Avenue – Pinnacle Peak Road improvements west of 43rd Avenue – Select either Meter or Flume option for Buchanan Wash – Floodplain and erosion hazard delineation for upper Buchanan Wash and tributaries – Erosion hazard delineation for Skunk Creek • Plan Phoenix 2 – Flume Option – Structural upgrades to CAP overchutes to increase capacity – Flume Skunk Creek flows through improved CAP overchutes – Close gaps in levee alignment upstream and downstream of I-17 – Requires increased capacity of leveed reach through landfills to accommodate flume flows (raise levees, line channel, or modify channel to more hydraulically efficient cross section) – Close levee gaps upstream of Pinnacle Peak Road and 35th Avenue – Happy Valley Road bridge at Skunk Creek and improvements west of 51st Avenue – Pinnacle Peak Road improvements west of 43rd Avenue – Select either Meter or Flume option for Buchanan Wash – Floodplain and erosion hazard delineation for upper Buchanan Wash and tributaries – Erosion hazard delineation for Skunk Creek • No Action		• Plan DH 1 – Meter Option - Provide detention on ASLD parcel - Meter Desert Hills Wash through detention basin - Requires smaller channel downstream to convey metered flows to Apache Wash confluence - Buy relatively less ROW for channel - Arterial E-W access - Mainstem Skunk Creek crossing - Arterial N-S access - Re-align 24th Street/ Channelize Apache Wash; improve 32nd Street - Erosion hazard delineation for Desert Hills Wash, Apache Wash, and Paradise Wash and tributaries - Buy out program - Development guidelines - "Red flag" map • Plan DH 2 – Flume Option - Provide channel conveyance through ASLD parcel - Flume Desert Hills Wash through ASLD parcel - Upgrade downstream channel to convey flume flows to Apache Wash confluence - Buy relatively more ROW for channel - Arterial E-W access - Mainstem Skunk Creek crossing - Arterial N-S access - Re-align 24th Street/ Channelize Apache Wash; improve 32nd Street - Erosion hazard delineation for Desert Hills Wash, Apache Wash, and Paradise Wash and tributaries - Buy out program - Development guidelines - "Red flag" map • No Action	• Plan NR 1 - Channel improvements at New River Road bridge crossings of Skunk Creek and Cline Creek - Roadway improvements to New River Road crossing of Rodger Creek - Arterial roadway improvements to Circle Mountain Road in Cline Creek basin - Floodplain delineation updates and erosion hazard delineation for Cline Creek and tributaries - Floodplain and erosion hazard delineation for upper Skunk Creek and tributaries upstream of New River Road bridge - Buy out program - Development guidelines - "Red flag" map • No Action

NOTE: Development guidelines to address the following: "Red flag" zone (50 cfs corridor + 10' setback), Minimum finished floor elevations, Disturbance envelope criteria, Retention to mitigate increased impervious areas, Fence treatment, Preservation of existing drainage corridors

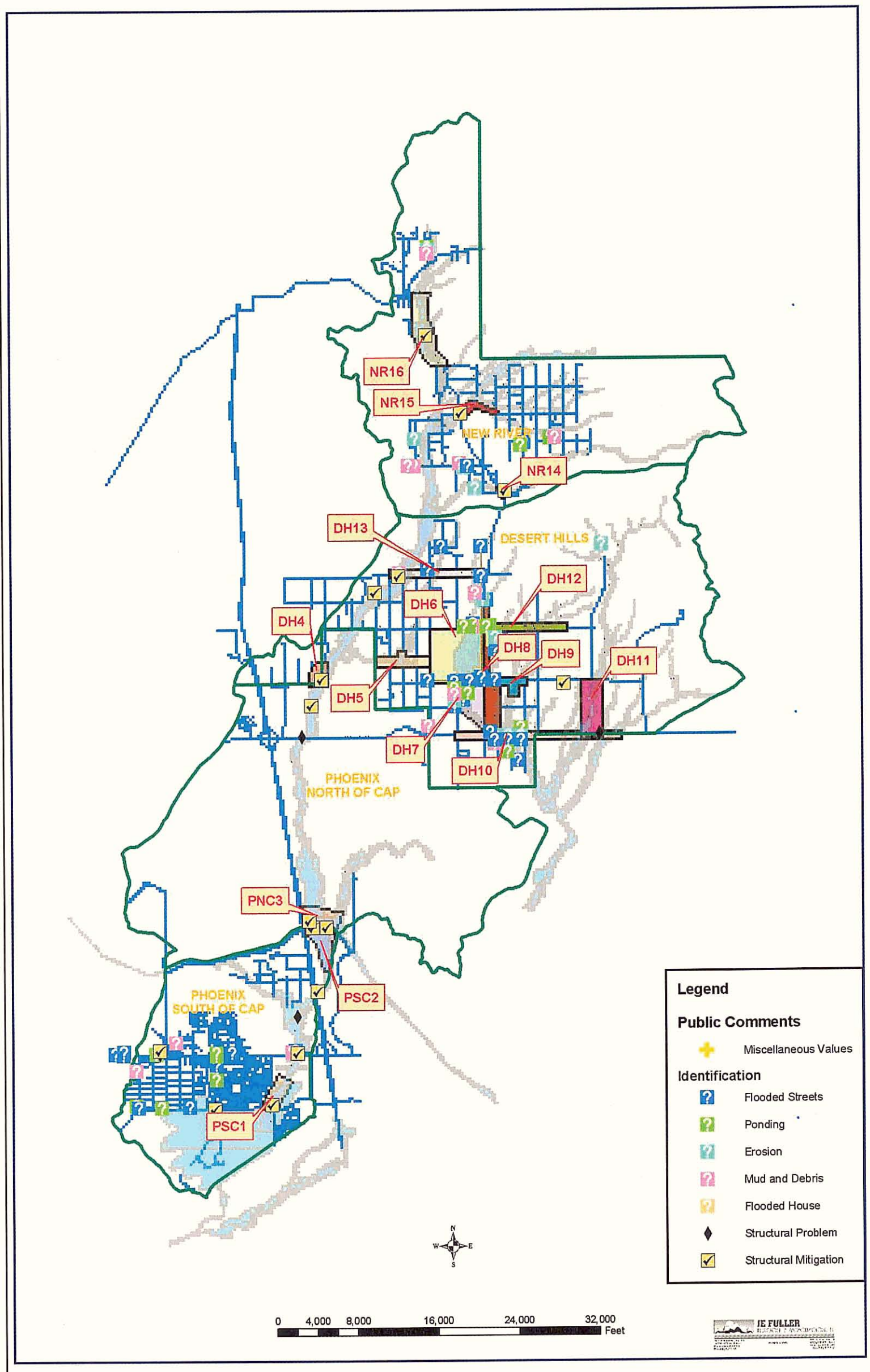


Figure 5.2 Location Map of Public Comments

Table 5.2 Adobe Dam/Desert Hills ADMP Phase I Alternatives Formulation

Subarea Name	Alternative ID	Structural Measures	Non - Structural Measures
Phoenix South of CAP	• **PSC1A (Site 1)** • **PSC2A (Site 2)**	• Pinnacle Peak Rd. at 35th Ave. - Contiguous levees along both right and left banks. • Levee just downstream of CAP - Contiguous levees along both banks to tie into CAP and/or I-17. • No Action **(PSC1B, PSC2C)**.	• Flood Response Plan. • FEMA Floodplain redelineation between I-17 and Skunk Creek Levees. **(PSC2B)**
Phoenix North of CAP	• **PNC3A (Site 2)** • **PNC3B (Site 2)** • **PNC3C (Site 2)**	• Skunk Creek at CAP - Meter option with engineered basin or natural basin with I-17 levees. • Skunk Creek at CAP - Flume option with upsized CAP overchute. • Skunk Creek at CAP - Levee Extension upstream of CAP. • No Action **(PNC3D)**.	• FEMA Floodplain Delineation Study – Upper Buchanan Wash (detailed). • FEMA Floodplain Delineation Study – East and West Branches of CAP Wash (detailed). • Flood Response Plan.
Desert Hills	• **DH4A (Site 3)** • **DH4B (Site 3)** • **DH4C (Site 3)** • **DH4D (Site 3)** • **DH5B (Site 4)** • **DH5C (Site 4)** • **DH6A (Site 4)** • **DH7A (Site 5)** • **DH7B (Site 5)** • **DH7C (Site 5)** • **DH7D (Site 5)** • **DH8A (Site 5)** • **DH9A (N/A)** • **DH10A (Site 6)** • **DH11A (Site 7)** • **DH11B (Site 7)** • **DH12A (N/A)** • **DH12B (N/A)** • **DH13A (Site 8)**	• Cloud Road at 27th Avenue – Realignment of Roadway. • Cloud Road at 27th Avenue – Realignment of Roadway with freeboard. • Cloud Road at 27th Avenue – Bridge the whole floodplain. • Cloud Road at 27th Avenue. – Protection of existing alignment. • Skunk Tank Wash detention basin. • Skunk Tank Wash online detention basin. • Skunk Tank Wash ASLD Detention basin. • Desert Lake Wash Downstream of Cloud Road – Pre ASLD parcel development. • Desert Lake Wash Downstream of Cloud Road – With ASLD parcel developer participation. • Desert Lake Wash Downstream of Cloud Road – ASLD developer participation with basin on ASLD parcel. • Desert Lake Wash Downstream of Cloud Road – Linear On-line Basin on Joy Ranch Road • Desert Lake Wash Tributary 2 at 7th Street. • Desert Hills Wash between Cloud Road and 12th Street.. • Carefree Highway Alignment Crossings and Side Drainage Improvements. • 24th Street at Apache Wash - Road re-alignment. • 24th Street at Apache Wash - Provide channelization and engineered road crossing. • Desert Hills Wash at Joy Ranch Road. • Desert Hills Wash Tributary 6 at 16th Street. • Desert Hills Drive Crossing of Skunk Creek. • No Action **(DH4E, DH5D, DH6C, DH7D, DH8B, DH9B, DH10B, DH11C, DH12C, DH13B)**.	• Development Guidelines. • Flood Response Plan. • Floodway residence buyouts. • FEMA Floodplain Delineation Study – Flow breakout to Skunk Tank Wash (approximate).**(DH6B)** • Skunk Tank Wash hydrology. (**DH5A**).
New River	• **NR14A (Site 9)** • **NR14B (Site 9)** • **NR15A (Site 10)** • **NR15B (Site 10)** • **NR15C (Site 10)** • **NR15D (Site 10)** • **NR16A (Site 11)** • **NR16B (Site 11)** • **NR16C (Site 11)**	• New River Road at Rodger Creek – Bridge crossing upgrade. • New River Road at Rodger Creek – Culvert crossing upgrade. • Circle Mountain Rd. in Cline Creek basin – Dumped Rock Riprap. • Circle Mountain Rd. in Cline Creek basin – Gabion Basket Mattress. • Circle Mountain Rd. in Cline Creek basin – Shotcrete. • Circle Mountain Rd. in Cline Creek basin – Terraced wall, other naturalized treatment. • New River Road Bridge at Skunk Creek – Construct Levees upstream and downstream of Bridge. • New River Road Bridge at Skunk Creek – Construct secondary diversion channel to west of Bridge. • New River Road Bridge at Skunk Creek – Improve the ingress and egress of the flow to the Bridge. • No Action **(NR14C, NR15E, NR16D)**.	• Development Guidelines. • FEMA Floodplain Delineation Study – Cline Creek (detailed & approximate). • FEMA Floodplain Delineation Study – Upper Skunk Creek and tributaries (detailed & approximate). • Flood Response Plan. • Floodway residence buyouts.
ADMP Wide	• **HFW(1-3)** • **HEHZ(1-3)** • **HFWF(1-2)** • **RDC(1-4)** • **RUC(1-4)** • **ST(1-2)** • **FOF(1-2)** • **WMPM(1)** • **NA(1)**	• Homes in the floodway. • Homes in Erosion Hazard Zones. • Homes in Fringe below the BFE. • Roadway dip crossings. • Roadway undersized crossings. • Stock Tanks. • Fences and Obstructions in the floodplain. • Watercourse Master Plan monitoring and maintenance plan. • No Action.	• Flood Response Plan. • Floodway residence buyouts.

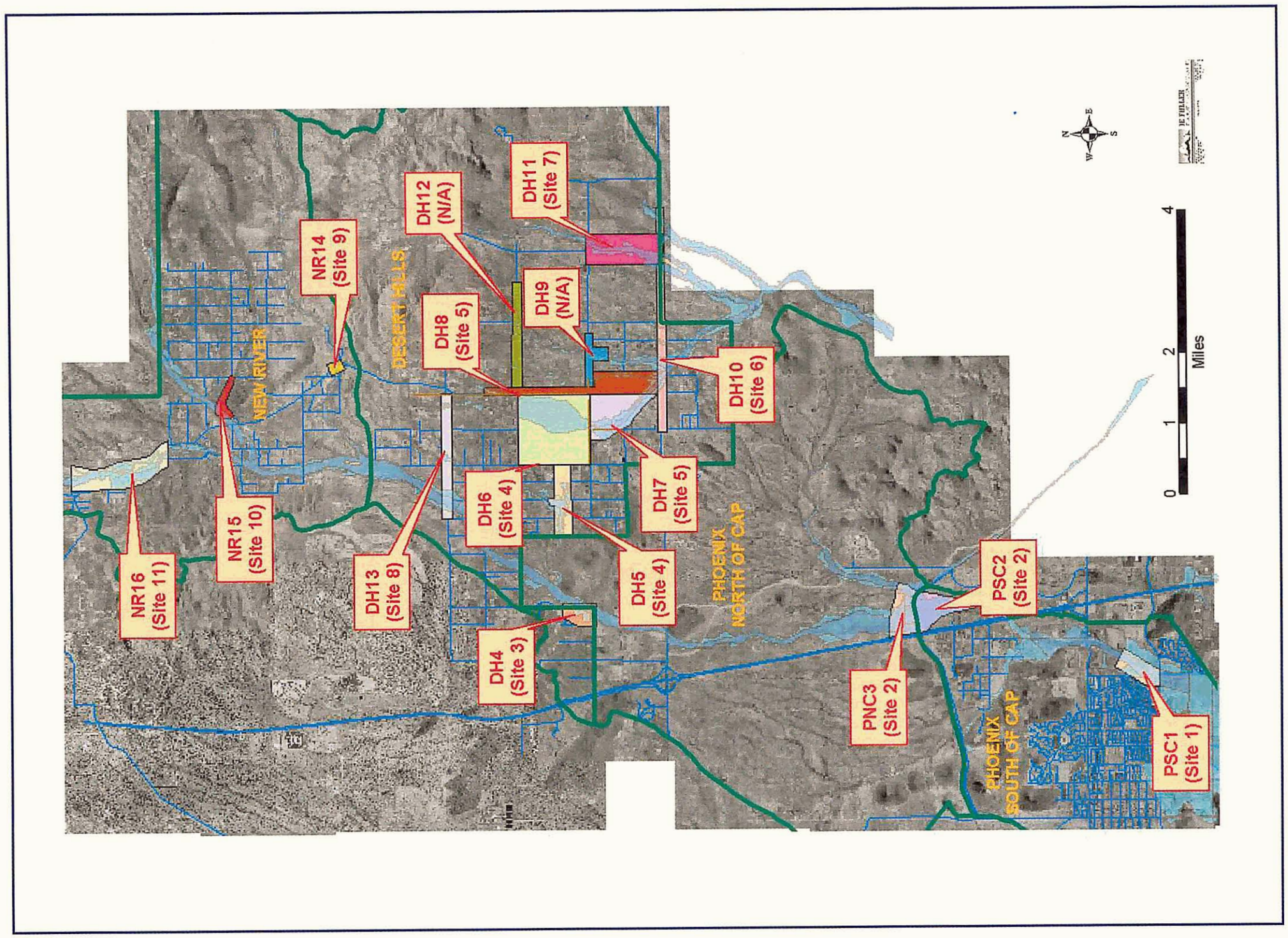


Figure 5.3 Location Map of Phase I Alternative Sites

5.2 Measures (Solutions)

Based upon the Problem Identification task described in Section 5.1 and the collective input of stakeholders and the public, the project team identified sixteen (16) sites throughout the ADMP project area that were considered priority locations requiring mitigation of drainage, flooding and/or erosion problems. A site number was assigned to each of the 16 critical locations (see Figure 5.3). The team brainstormed structural, nonstructural, and 'no action' mitigation measures for each of the 16 sites. An alphanumeric identifier was assigned to each measure based on the subarea in which the measure was located (i.e., Phoenix South of the CAP (PSC), Phoenix North of the CAP (PNC), Desert Hills (DH), or New River (NR)) and the site number. Table 5.2 lists the mitigation measures by subarea and alphanumeric identifier. In addition, ADMP area-wide measures that were not specific to any subarea(s) were formulated. A narrative description and schematic drawing (as appropriate) was prepared for each measure. The team assessed the feasibility of each measure by identifying the associated strengths, weaknesses, estimated costs, opportunities, and constraints. The information generated for each of the alternative measures is presented in summary tables and schematic drawings are provided, as appropriate. These are categorized by subarea and provided in the appendices as shown in Table 5.3.

Table 5.3 Alternative Measures Appendices Index

Adobe ADMP Subarea	Summary of Alternative Measures	Schematic Drawings
Phoenix South of CAP (PSC)	Table A.1	Appendix A – PSC1A, PSC1B, PSC2A, PSC2B, PSC2C
Phoenix North of CAP (PNC)	Table B.1	Appendix B – PNC3A, PNC3C
Desert Hills (DH)	Table C.1	Appendix C – DH4A, DH4B, DH5A, DH5B, DH5C, DH7A, DH7B, DH8A, DH8B, DH8D, DH9A, DH10A, DH11A, DH12A, DH12B, DH13A
New River (NR)	Table D.1	Appendix D – NR14A, NR14B, NR15A, NR15B, NR15C, NR16A, NR16B, NR16C
ADMP – Wide	Table E.1	Appendix E – HFW, HEHZ, HFWF, RDC, RUC

The project team developed a measure evaluation checklist for the purpose of qualitatively sorting the candidate measures to determine if a suitable measure(s) existed to mitigate flooding, drainage, and erosion problems as identified during the Phase I analyses and data collection efforts. Table 5.4 lists the measure evaluation criteria. The evaluation checklist was fully populated by the project team for each measure. Appendix F contains the evaluation checklists for each of the measures at each of the 16 sites. Based on the comparative evaluation of the candidate measures at each site using the checklist, the menu of feasible measures was refined with input from the stakeholder agencies. Even though several measures were found unacceptable they were still carried forward for further quantitative considerations. (see Appendix F).

Table 5.4 Measure Evaluation Checklist

Measure Evaluation Criteria	Assessment Scale		
Public Safety/ Physical System			
Risk to public safety?	low	medium	high
Potential for damage?	low	medium	high
Access-critical location?	no	-	yes
Upstream/ downstream impacts?	minimal	average	significant
Comparative size of watercourse?	small	medium	large
Costs			
Cost of implementation?	$	$$	$$$
ROW acquisition necessary?	no	-	yes
Condemnation required?	no	-	yes
Maintenance costs?	$	$$	$$$
Potential cost sharing partner?	no	-	yes
Comparative benefit:cost?	low	medium	high
Environmental/ Social			
Addresses public complaint/ concern?	no	-	yes
Public support?	minimal	average	significant
Environmental impacts?	minimal	average	significant
Environmental opportunities?	no	-	yes
Acceptability of measure	**Accept**	**-**	**Not Accept**

5.3 Preliminary Alternatives

The measures resulting from the checklist evaluation process were combined into regional watershed-wide alternatives. Initially three Preliminary Alternatives were formulated, including Full Structural Alternative, Nonstructural Alternative, and No Action Alternative. As the names indicate, these alternatives comprised a combination of similar measures for each of the 16 sites. For example, the Full Structural Alternative consisted solely of the structural candidate measures at each of the 16 sites. A fourth Preliminary Alternative, called the Combination Alternative, was formulated comprising the measures at each site considered by the project team to be the most feasible based on the previous technical and economic analyses. The Combination Alternative consisted of a mix of structural, nonstructural, and no action measures at each of the 16 sites.

The project team developed a second set of alternative evaluation criteria for the purpose of quantitatively sorting and selecting candidate alternatives. The Phase I Alternative Evaluation Criteria were formatted as matrices and used as a decision aid to select the preliminary alternatives. Stakeholder input was solicited on the acceptability and completeness of the alternatives evaluation. The alternative evaluation criteria matrix is shown in Table 5.5. Preliminary costs associated with the alternatives were estimated and included in the evaluation matrix. The costs for structural alternatives included land costs, design costs, and contingency costs; but these were not rigorously computed for the Phase I alternative evaluation. The cost estimates were further refined at Phase II for the Recommended Alternative.

The matrices were fully populated by the project team and are included in Appendix G.

Table 5.5 Alternative Evaluation Matrix

Alternative Evaluation Criteria	Rating System Ranking
Public Safety Criteria	
Cumulative encroachment impacts	1 = Negative
Local erosion impacts	2 = Neutral
Hydrologic modeling uncertainty	3 = Positive
Hydraulic modeling uncertainty	
Development opportunity	
Risk of failure	
Flood events greater than design storm	
Flood events less than design storm	
Emergency response	
Incidental use	
Public Safety Average Rating	
Social/ Environmental	
Community acceptance	
Complexity of environmental permitting	
Impact on wildlife habitat	
Visual resource and aesthetic compatibility	
Multi-use opportunities	
Impact on cultural resources	
Social/ Environmental Average Rating	
Economic Criteria	
Implementation cost	
Maintenance cost	
Cost share opportunities	
Economic Average Rating	

Stakeholder meetings were held during the period from October 2003 through Spring 2004 to solicit input regarding the Preliminary Alternatives effectiveness in addressing the identified flooding, drainage, and erosion problems. The second set of public meetings was held in November 2003 for the same purpose and to present the results of the floodplain delineation studies. Table 5.6 summarizes the Phase I Preliminary Alternatives. Based on the results of the alternatives evaluation and the collective input of the stakeholders and the public, the project team recommended, with the District's concurrence, that the Combination Alternative be selected for advancement to further evaluation in Phase II. The District authorized the project team to proceed with Phase II of the ADMP on June 2, 2003. The Phase II Alternatives Formulation is documented in Part 8, Volumes 3 & 4. The outcome of the Phase II alternatives assessment is the Recommended Alternative. The Recommended Alternative is documented in the ADMP Report (Part 9, Volumes 1&2).

Table 5.6 Adobe Dam/ Desert Hills Area Drainage Master Plan Phase I Preliminary Alternatives

Problem Site Identification	Full Structural Alternative	Non-Structural Alternative	Combination Alternative	No Action Alternative
Phoenix South of CAP				
PSC1 - Skunk Creek/ Pinnacle Peak Rd & 35th Ave	PSC1A - Levees/ grade control	Flood Response Plan (FRP)	Channelization/ grade control	PSC1B
PSC2 - Skunk Creek d/s of CAP	PSC2A - Levees	PSC2B - Floodplain Delineation	PSC2A – Levees followed by PSC2B Floodplain Re-Delineation	PSC2C
Phoenix North of CAP				
PNC3 - Skunk Creek u/s of CAP	PNC3A - Basins (Meter) **OR** PNC3B - Widen overchutes (Flume) **OR** PNC3C - Levees		PNC3C – Levees	PNC3D
Desert Hills				
DH4 - Skunk Creek/ 27th Ave & Cloud Rd	DH4A - Roadway realignment **OR** DH4B - Roadway realignment w/ Freeboard **OR** DH4C - Bridge **OR** DH4D - Protection of existing alignment	Flood Response Plan	DH4A – Roadway realignment w/ Flood Response Plan	DH4E
DH5 - Skunk Tank Wash (STW)	DH5B - Interceptor channel/ basin **OR** DH5C - Online basin	DH5A - Revised STW hydrology Floodprone Property Acquisition Program Flood Response Plan	Floodprone Property Acquisition Program (FPAP) Flood Response Plan Joy Ranch Road Interceptor upstream detention basin	DH5D
DH6 - Desert Lake (ASLD parcel)	DH6A - Skunk Tank Wash, ASLD detention basin	DH6B - Floodplain Delineation	DH7C – Basin on ASLD parcel/ channelization and DH8A – 100-yr Channel/ Culverts @ 7th St followed by Floodplain Re-Delineation Development Guidelines	DH6C
DH7 - Desert Lake Wash d/s of Cloud Rd	DH7A - Pre-ASLD parcel development **OR** DH7B - W/ ASLD parcel development **OR** DH7C - Basin on ASLD parcel			DH7D
DH8 - E fork Desert Lake Wash/ 7th St	DH8A - 100-yr Channel/ Culverts @ 7th St			DH8B
DH9 - Desert Hills Wash/ Cloud Rd & 12th St	DH9A - Channel/ Culvert/ Offline basin	Flood Response Plan	DH9B – No Action/ Flood Response Plan	DH9B
DH10 - Carefree Highway/ Central Ave to E of 24th St	DH10A - Culverts	Flood Response Plan	Flood Response Plan/ DH10A – Culverts	DH10B
DH11 - Apache Wash/ 24th St	DH11A - Realign roadway **OR** DH11B - Channel/ Culverts	Flood Response Plan	Flood Response Plan/ DH11A – Realign roadway	DH11C
DH12 - Desert Hills Wash/ Joy Ranch Rd & 16th St	DH12A - Culvert **OR** DH12B - Culvert/ Channel	Flood Response Plan	DH12C – No Action/ Flood Response Plan	DH12C
DH13 - Skunk Creek/ Desert Hills Drive	DH13A - Bridge	Flood Response Plan	Flood Response Plan/ DH13A – Bridge	DH13B
New River				
NR14 - Roger Creek/ New River Rd	NR14A - Bridge **OR** NR14B - Culverts	Flood Response Plan	Flood Response Plan/ NR14A – Bridge	NR14C
NR15 - Cline Creek/ Circle Mountain Rd	NR15A - Riprap bank protection **OR** NR15B - Gabion bank protection **OR** NR15C - Shotcrete bank protection **OR** NR15D - Terraced wall w/naturalized treatment	Floodplain Delineation Study Flood Response Plan	Flood Response Plan/ NR15D – Terraced wall w/ naturalized treatment Floodplain Delineation Study	NR15E
NR16 - Skunk Creek/ New River Rd Bridge	NR16A – Levees/ Channel improvements **OR** NR16B - Secondary diversion channel **OR** NR16C - Channel improvements at bridge	Floodplain Delineation Study Flood Response Plan	NR16A – Levees/ Channel improvements followed by Floodplain Re-Delineation	NR16D

Table 5.6 Adobe Dam/ Desert Hills Area Drainage Master Plan Phase I Preliminary Alternatives (cont'd.)

Problem Site Identification	Full Structural Alternative	Non-Structural Alternative	Combination Alternative	No Action Alternative
[illegible]				
HFW - Residences in floodway		HFW1 – Development Guidelines HFW2 - Floodprone Property Acquisition Program HFW3 – Floodplain Re-Delineation (LOMR)		HFW3 - Notify residents
HEHZ - Residences in erosion hazard zone		HEHZ1 - Development Guidelines HEHZ2 - Floodprone Property Acquisition Program		HEHZ3 - Notify residents
HFWF - Residences in floodplain below BFE		HFWF1 - Development Guidelines HFWF2 - Floodprone Property Acquisition Program		HFWF3 - Notify residents
RDC - Roadway dip crossings	RDC1 - Install new culverts	RDC2 - Flood Response Plan RDC3 - Signage or staff gages		RDC4 - Leave as is
RUC - Roadway undersized crossings	RUC1 - Upgrade culverts	RUC2 - Flood Response Plan RUC3 - Signage or staff gages		RUC4 - Leave as is
FOF - Fences/ obstructions in floodplain		FOF1 - Development Guidelines		FOF2 - Leave as is

REFERENCES

Flood Control District of Maricopa County, 2003, Draft Erosion Hazard Zone Delineation and Development Guidelines.

JE Fuller/Hydrology & Geomorphology, Inc., 2000, Skunk Tank Wash Erosion Hazard Study. Report to the Flood Control District of Maricopa County.

JE Fuller/Hydrology & Geomorphology, Inc., 2001, Rodger Creek Erosion Hazard Study. Report to the Flood Control District of Maricopa County.

JE Fuller/Hydrology & Geomorphology, Inc., 2001, Skunk Creek/Sonoran Wash Watercourse Master Plan – Attachment 6: Lateral Stability Assessment. Report to the Flood Control District of Maricopa County and ASL Consulting.

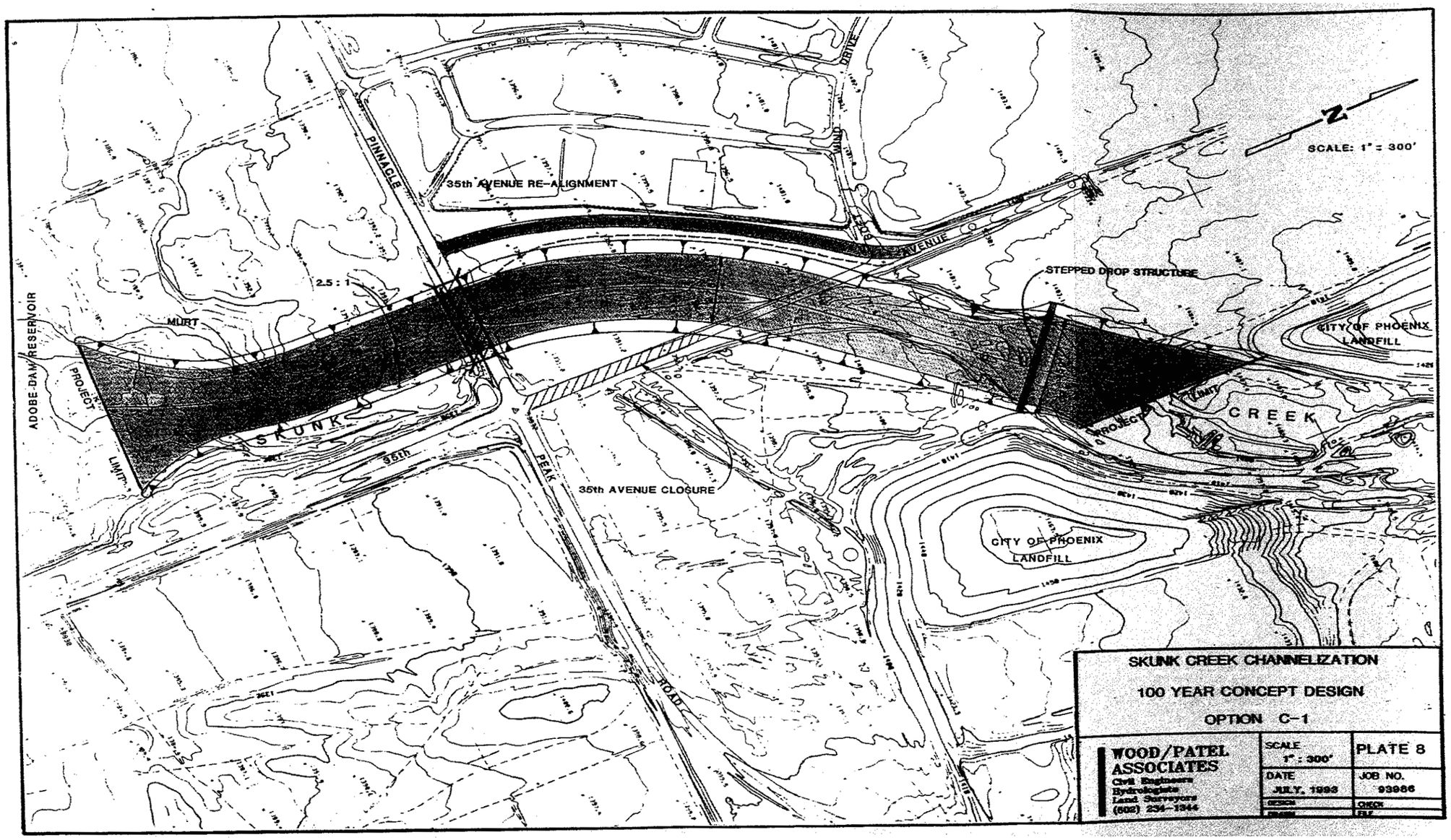
APPENDIX A

Phoenix South of CAP Alternative Measures

Designation	Problem	Description of Problem	Alternative	Typical Alternative	Scan Image	Preliminary Alternative	Pros	Cons	Cost	Opportunities	Constraints
PSC1A (Site 1)	Overflow of Pinnacle Peak Rd. and 35th Ave and flows to west u/s of Pinnacle Peak Rd. on Skunk Creek	Extend grade control and levees u/s of Pinnacle Peak Rd. (Note: 39000 – 15500 – 1000 = 22500 cfs which is about the 70-yr flow (Pope et. al) (maybe 50-yr at this location?))	Rebuild per original recommendations (See Wood/Patel Associates, Phase 1, Design Option Report Pinnacle Peak Road Bridge Over Skunk Creek)	Structural	Scan PSC1.JPG	100-year concept design of Skunk Creek with a new alignment of the future 35th Avenue. Aesthetics, color, and materials, are important.	• Keeps flows in Skunk Creek • Prevents overflows of Pinnacle Peak Rd. & 35th Ave • No Cultural resources identified.	• Cost would be high. • Traffic engineering concerns re: re-aligned 35th Ave.	$7.5 - $8M	• Extension of 35th Ave north from Pinnacle Peak Rd.– without the need of a bridge spanning Skunk Creek. • COP Trails can be incorporated into design.	• Existing investments • Public perception of redo • Moderate Habitat value near breakout. • 404 permit required.
PSC1B (Site 1)			No Action	No Action	Scan PSC1-No Action.JPG	Pinnacle Peak is overtopped. Aesthetics must be addressed during design, and development of design guidelines (i.e. bury structure with soil and plant, vary side slopes, etc.)	• No Cost.	• Roads are closed in high flooding events. • Park Closures. • Park Damage.		• Regional trail planned along Skunk Creek and Sonoran Wash. • I-17 expansion planned in this area.	• Dense, intact vegetation along Sonoran Wash, making 2 years of Pygmy Owl surveys probable. • Old Phoenix-Prescott Rd. is located in the area.

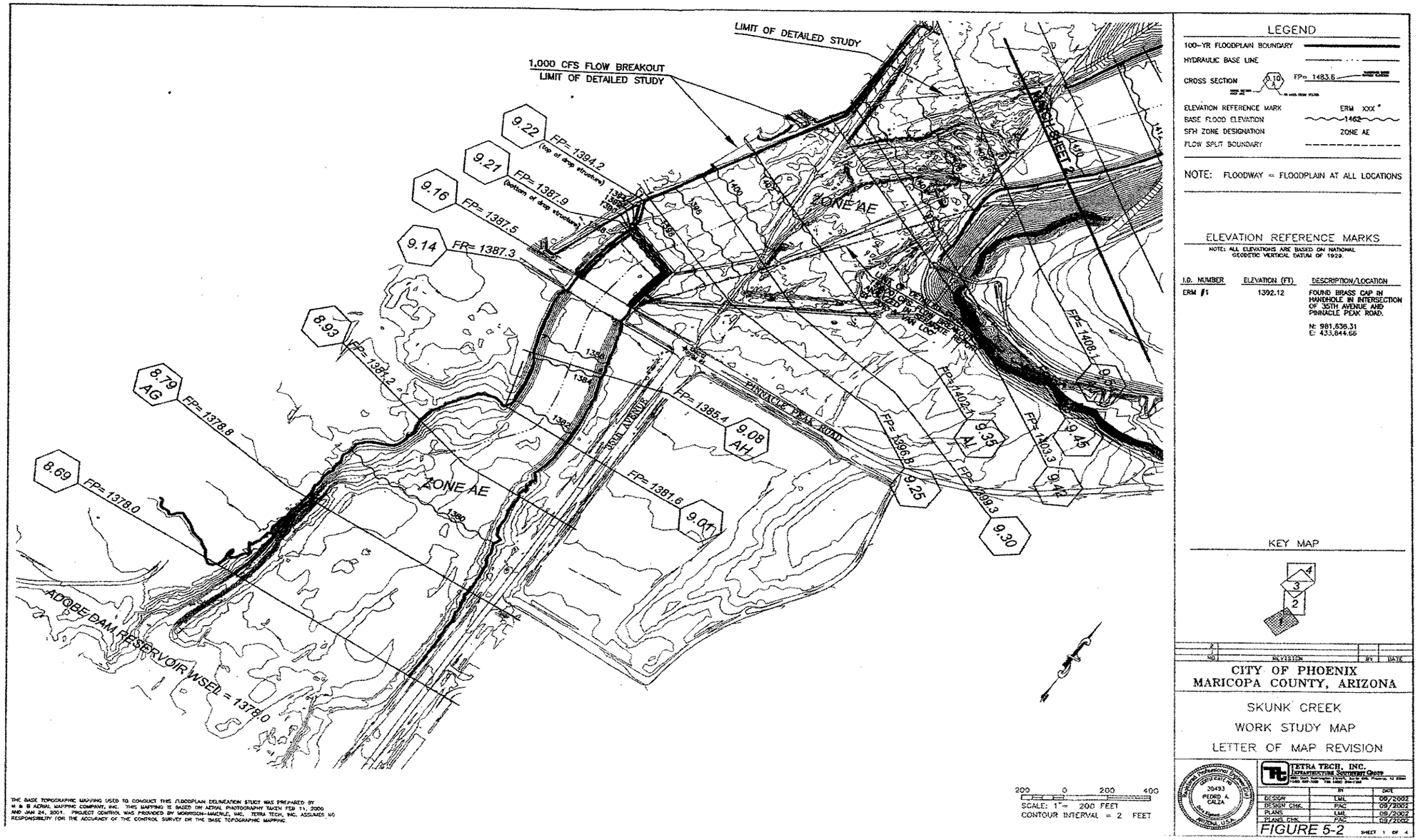
Table A.1: Summary of Measures Phoenix South of The CAP

Description Number	Problem	Description of Problem	Alternative	Type of Alternative	Schematic	Narrative Description	Strengths	Weaknesses	Costs	Description Number	Problem
PSC2A (Site 2)	Flooding on Skunk Creek between I-17 and levee d/s of CAP	Flooding between I-17 and levee d/s of CAP	Levee to control d/s flooding from CAP to existing Skunk Creek Levees	Structural	Figure 5-1.tif and Figure 5-2.tif	Levee on west bank from CAP to existing levee where it's contained	• Removes about 100 acres from inundation area in 100-year event (per TT FLO-2D model)	• Cost of Levee as opposed to mapping flood hazard.	$1-1.5 M		
PSC2B (Site 2)			Redelineate floodplain.	Non-Structural	PSC 2B-No Action.JPG	Redelineate Skunk Creek floodplain to reflect "true" conditions – see TT FLO-2D results for idea of extents	• Analysis essentially complete	• Does not protect 100 acres from inundation in the 100-year event between Skunk Creek and I-17 (per TT FLO-2D model)	Low – FLO-2D done previously could be used for FEMA submittal		
PSC2C (Site 2)			No Action	No Action	PSC 2B-No Action.JPG	100 acres between I-17 and the Skunk Creek Levees is inundated in the 100-year event (per TT FLO-2D model)		• Property owners in the area are not informed or protected from 100-year flooding.			
			Flood Response Plan	Non-Structural	N/A		• Low cost yet addresses access and hazard to existing residents	• Does not solve the problems, only addresses how to react to problems.			



From: Phase 1, Design Option Report Pinnacle Peak Road Bridge Over Skunk Creek, **By:** Wood / Patel Associates, **Dated:** June 25, 1993. 35th Avenue and Pinnacle Peak Road

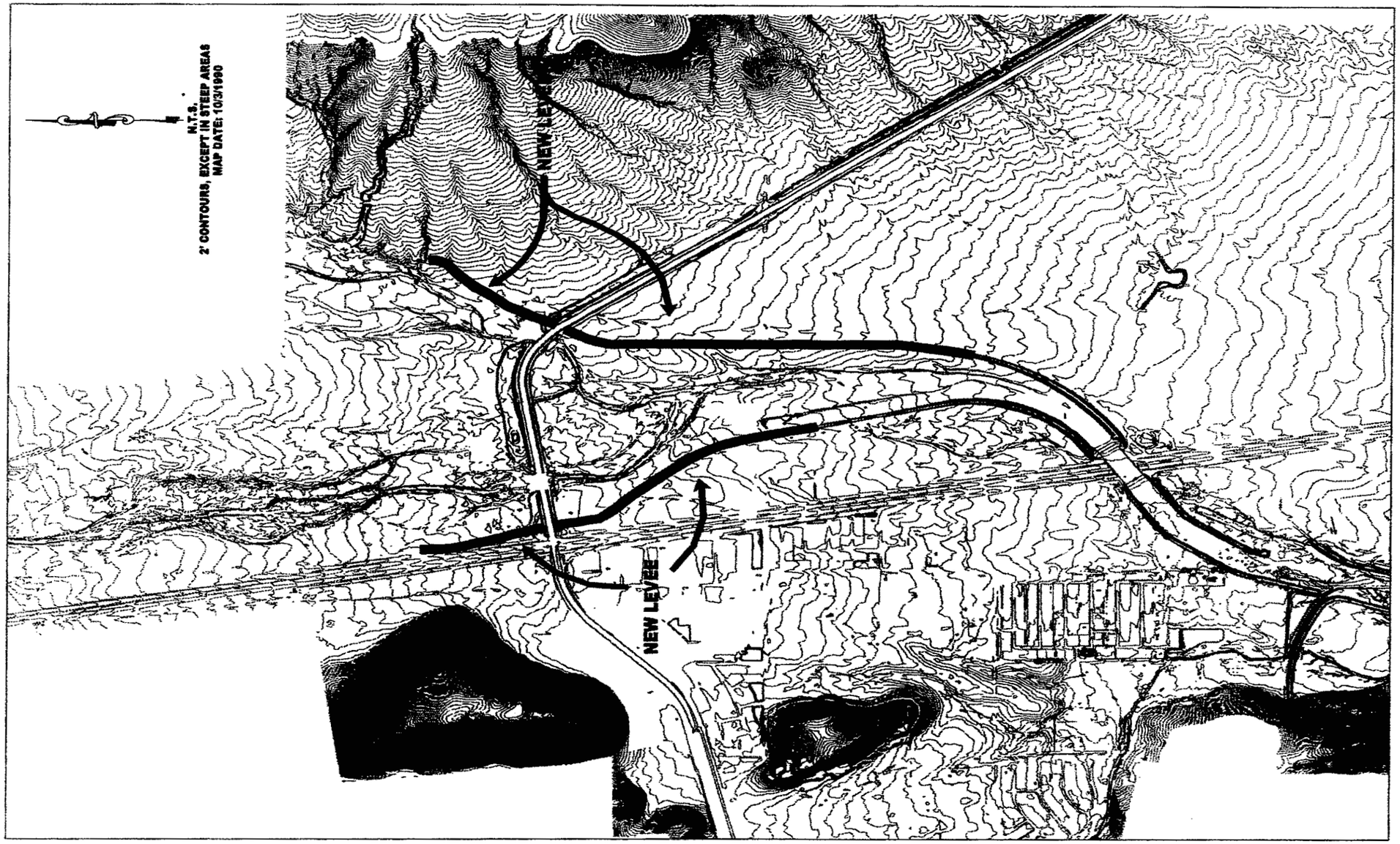
PSC1A



From: Letter of Map Revision Request for Skunk Creek, **By:** Tetra Tech, Inc., **Dated:** November, 2002,.35th Avenue and Pinnacle Peak Road

PSC1B

FIGURE 5-1: Conceptual Levee Design



From: Floodplain Delineation Study for Skunk Creek Between the Central Arizona Project and Happy Valley Road, **By:** Tetra Tech, Inc., **Dated:** June, 2002,.Skunk Creek and the CAP **PSC2A**

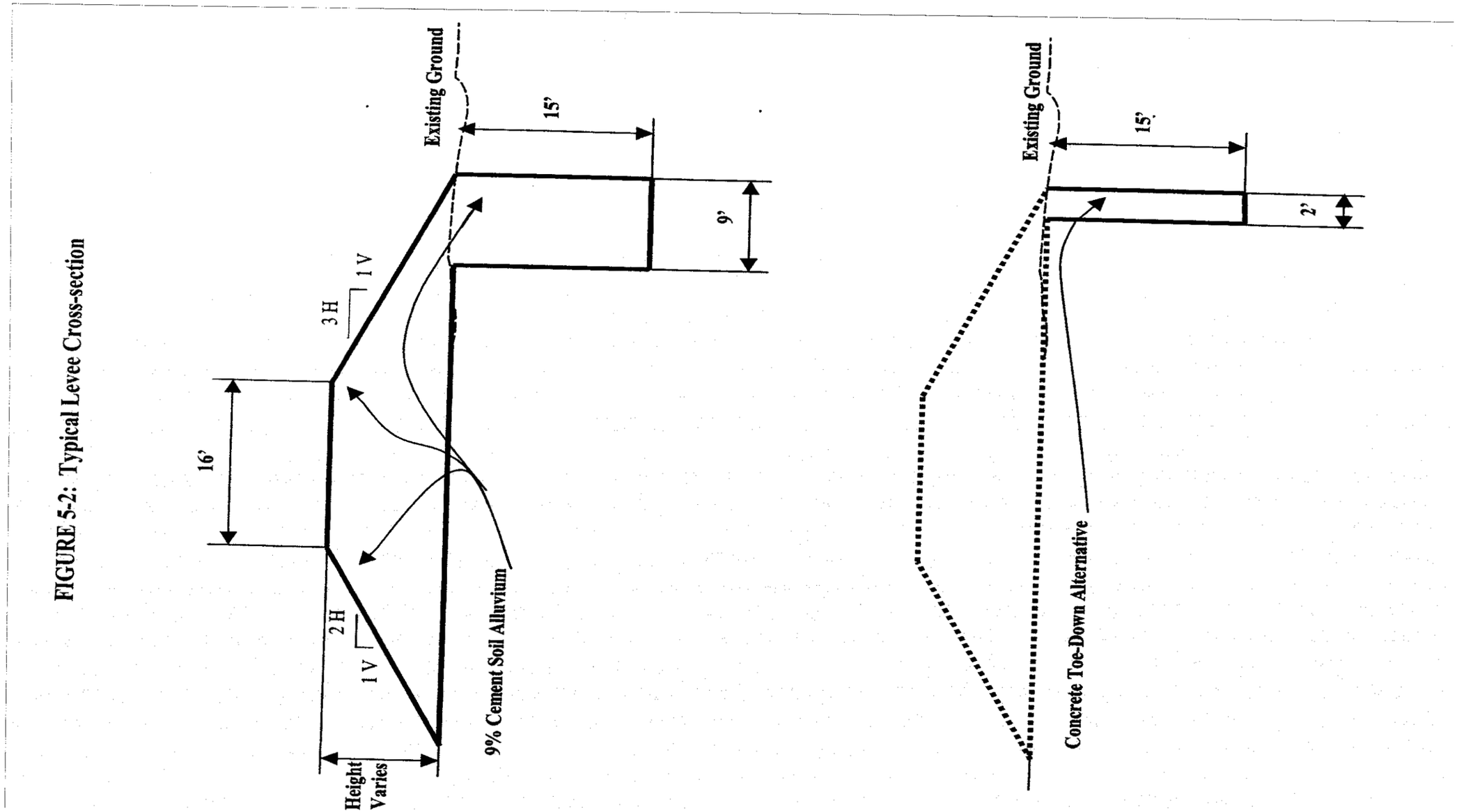
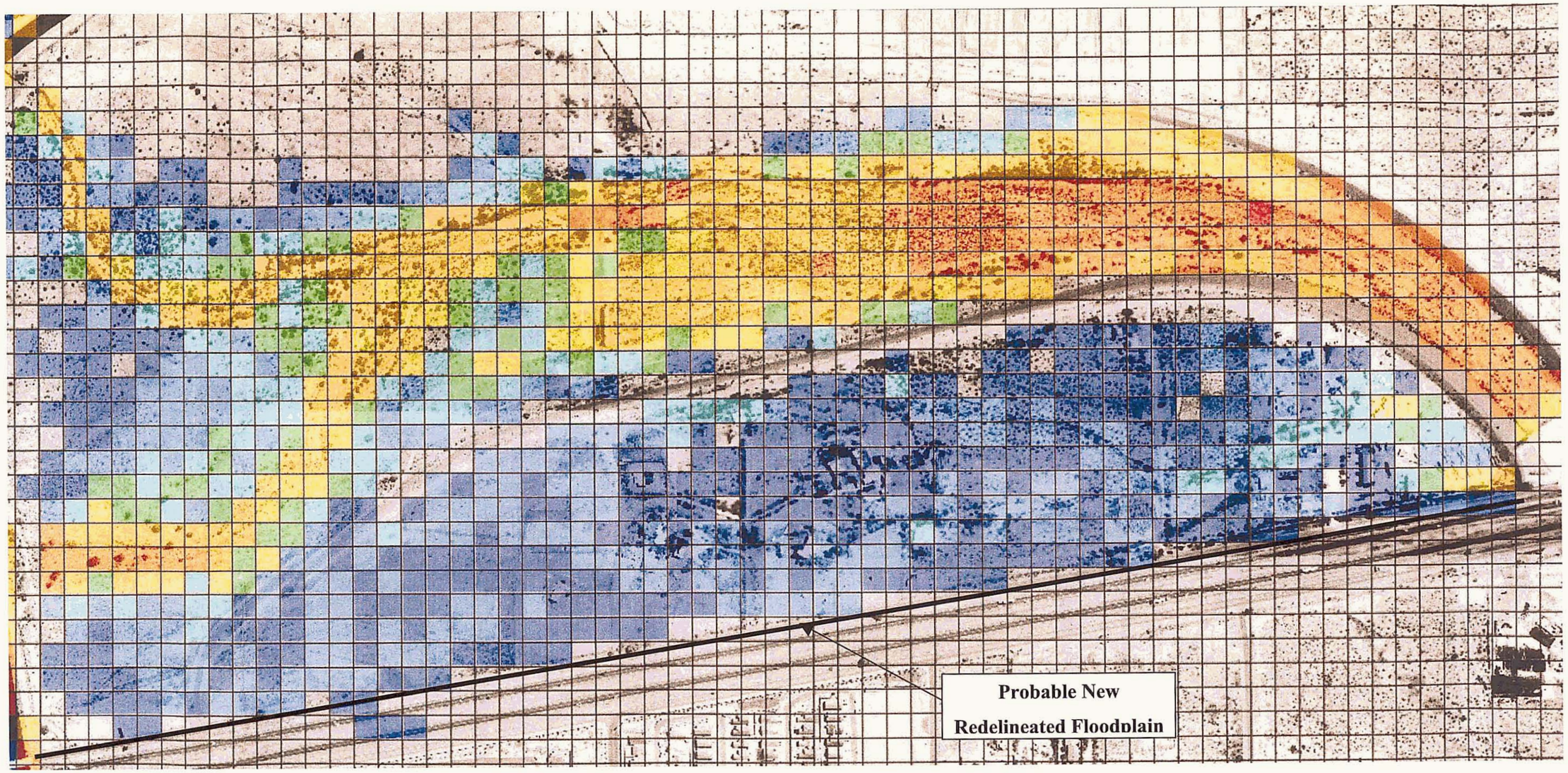


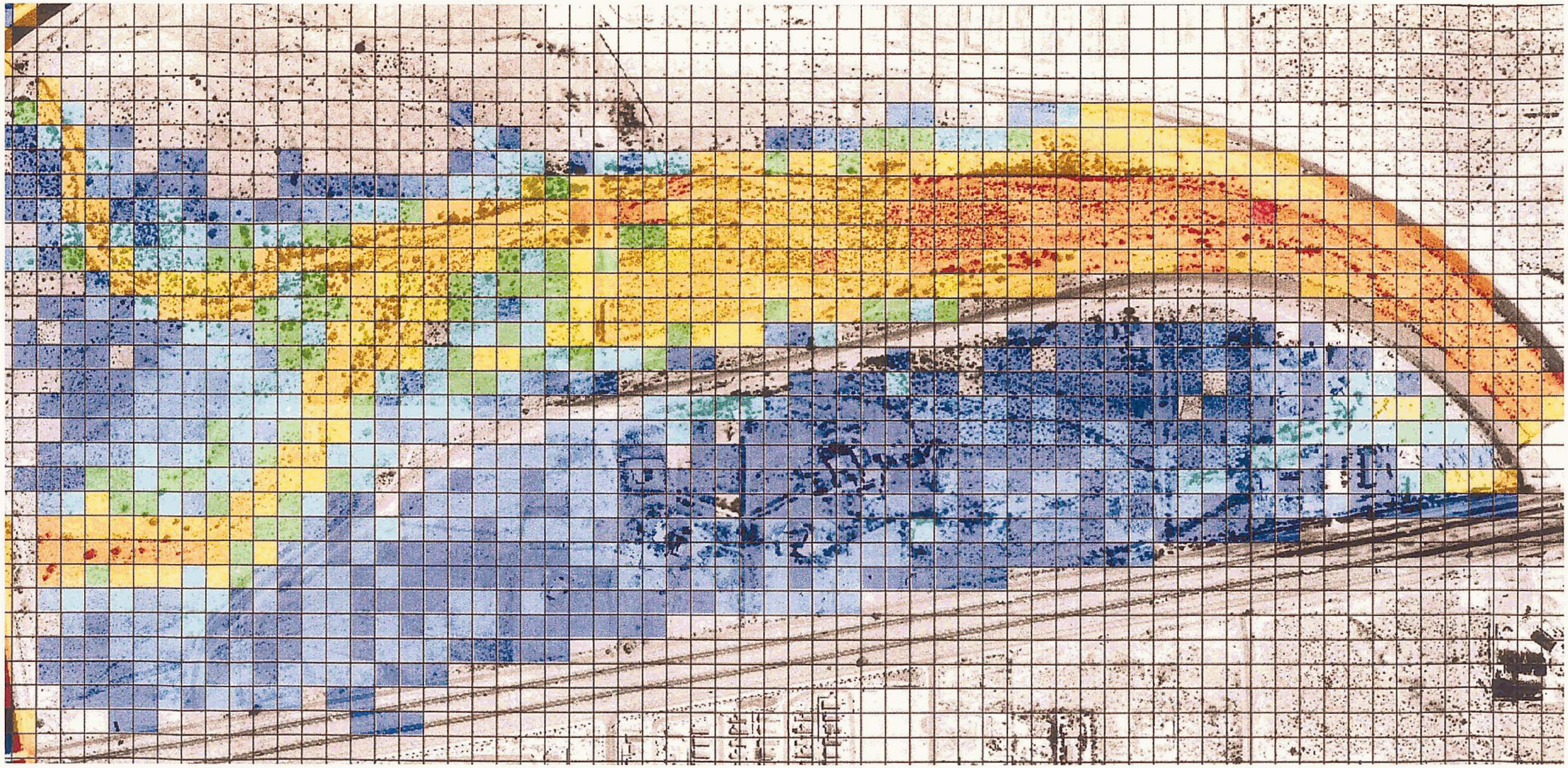
FIGURE 5-2: Typical Levee Cross-section

From: Floodplain Delineation Study for Skunk Creek Between the Central Arizona Project and Happy Valley Road, **By:** Tetra Tech, Inc., **Dated:** June, 2002,.Skunk Creek and the CAP

PSC2A



From: Floodplain Delineation Study for Skunk Creek Between the Central Arizona Project and Happy Valley Road, **By:** Tetra Tech, Inc., **Dated:** June, 2002,.Skunk Creek Between the CAP and I-17 **PSC2B**



From: Floodplain Delineation Study for Skunk Creek Between the Central Arizona Project and Happy Valley Road, **By:** Tetra Tech, Inc., **Dated:** June, 2002,.Skunk Creek Between the CAP and I-17 **PSC2C**

APPENDIX B

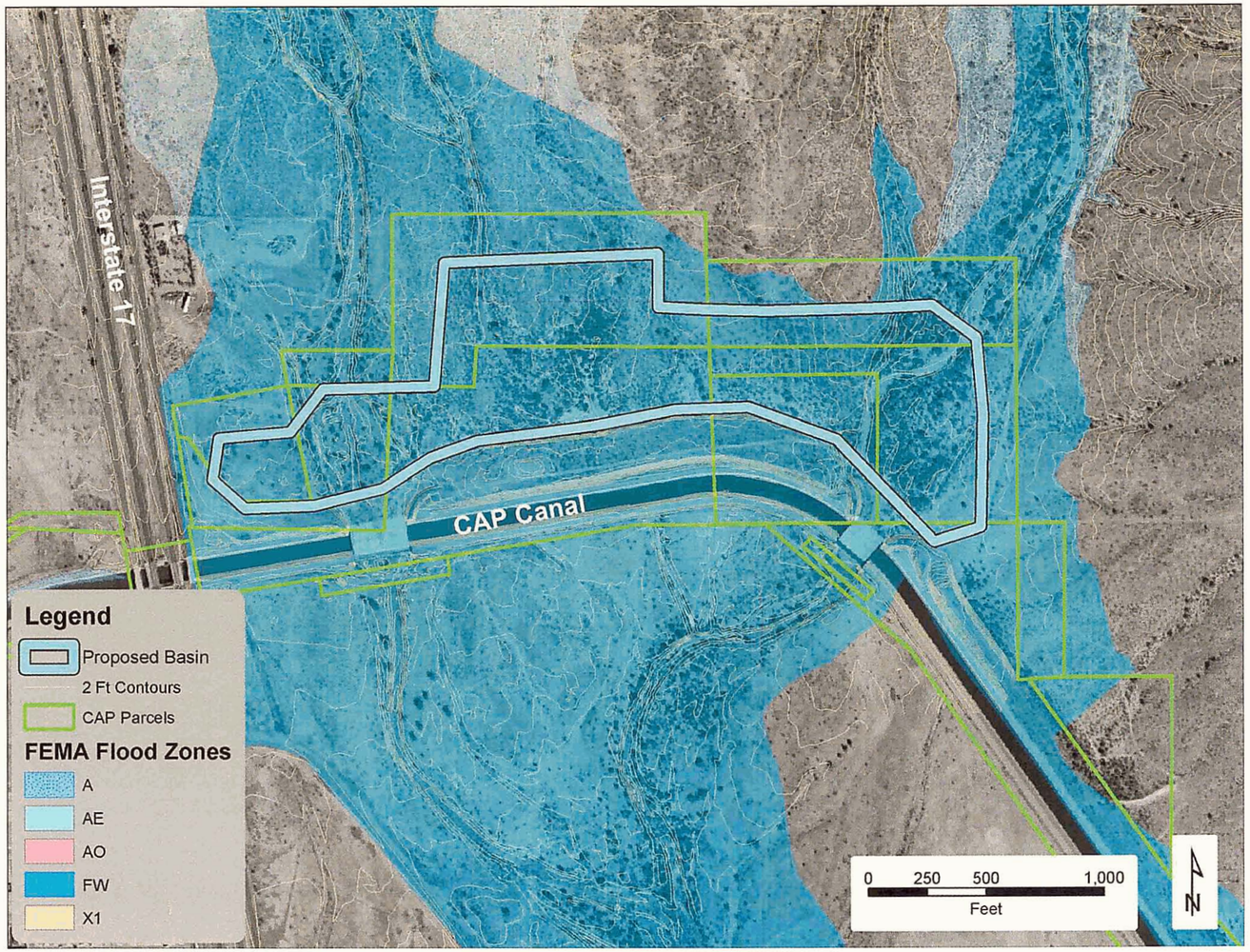
Phoenix North of CAP Alternative Measures

Table B.1: Summary of Measures Phoenix North of The CAP

Description Number	Problem	Description of Problem	Alternative	Type of Alternative	Schematic	Narrative Description	Strengths	Weaknesses	Costs	Opportunities	Constraints
PNC3A (Site 2)	I-17 flooding and CAP ponding.	I-17 flooded in the 100-year u/s of CAP.	Meter Option - Detention basin 855 ac-ft at Skunk - 10 ac, 9ft deep or 20 ac, 5 ft deep 250 ac-ft at Sonoran – 10 ac, 3 ft deep or 20 ac, 2 ft deep.	Structural	CAP_basin_alt.jpg	Two detention basins with a volume of 855 and 250 ac-ft at Skunk and Sonoran, respectively. Will require additional storage for sediment, maintenance plan, and grade control to prevent upstream degradation.	• Possibly prevent I-17 overflows • No cultural resources are identified in area.	• Expense • Doesn't address homes inundated between levee and I-17 d/s. • Maintenance – Sed. Yield to 'assure' performance (63 sq.mi. * 0.3 ac-ft/sq.mi./yr = 19 ac-ft/yr = 58 years filled in); also may need additional 330 ac-ft for 100-year event inflow sediment • Affects USGS gage data • Additional topo needed.	$5.3 M	• Sand & gravel operators to excavate? • Chance to incorporate trail system in design. • High visibility area and aesthetics could improve area.	• Environmental impacts in ponding area. • CAP ROW limited to about 40 acres potential for basin(s) • Avoid negative impacts to COP transfer station access road u/s on Skunk Creek • High to medium habitat is present in area. • NEPA process will be necessary. • Old Phoenix – Prescott Rd. located in area.
PNC3B (Site 2)			Flume Option - Widen CAP overchutes.	Structural	N/A	Widen overchutes 3 times current width	• No cultural resources are identified in area.	• No significant change in headwater elevation - i.e. still overtops I-17.	$5 M	• High visibility area and aesthetics could improve area. • High to medium habitat is present in area • Old Phoenix – Prescott Rd. located in area	

Table B.1: Summary of Measures Phoenix North of The CAP

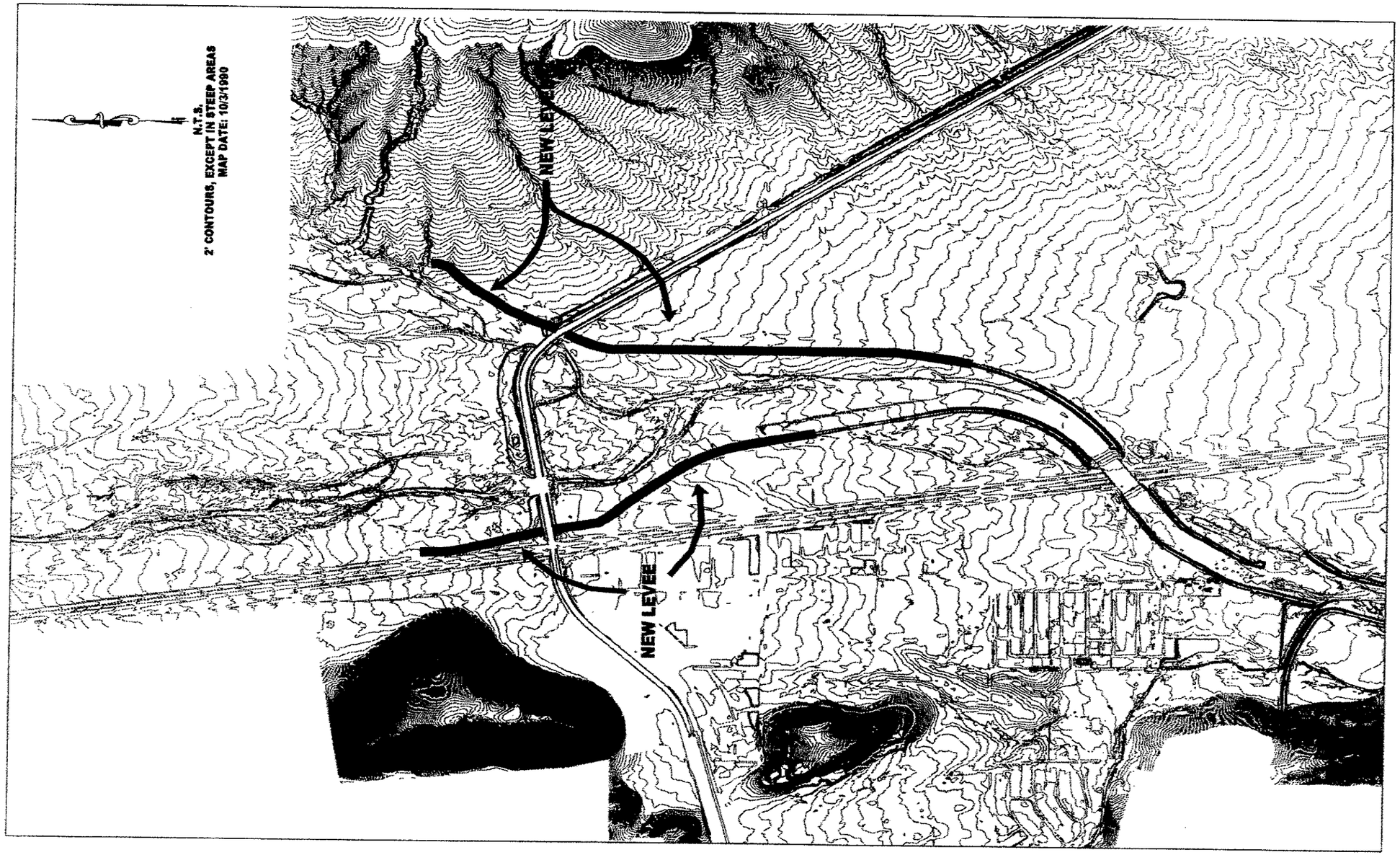
Description Number	Problem	Description of Problem	Alternative	Type of Alternative	Schematic	Narrative Description	Strengths	Weaknesses	Costs	Opportunities	Constraints
PNC3C (Site 2)			Levee Extension	Structural	Figure 5-1.tif and Figure 5-2.tif	Extend levees from existing COE levees to CAP and upstream of CAP east of I-17 and Sonoran Wash to prevent overflows east or west	• Contains flows. • Prevents I-17 flooding from Skunk Creek. • Removes large area from inundation between I-17 and levee d/s of CAP. • Fixes for SPF down to just u/s of Buchanan Wash.	• Uncertain 50-yr impacts on CAP – i.e. does water enter CAP in 50-yr that didn't before new levee extension? • Flows into CAPare worse than before extension. • Flooding behind extended levee u/s of CAP?	$4-6 M (Both sites PSC2 & PNC3)	• Preserve habitat u/s of CAP in Skunk Creek & Sonoran Wash. • High visibility area and aesthetics could improve area.	• Avoid negative impacts to COP transfer station access road u/s on Skunk Creek
PNC3D (Site 2)			No Action	No Action	N/A			• I-17 will still be flooded.			
			Flood Response Plan	Non-Structural	N/A		• Low cost yet addresses access and hazard to existing residents	• Does not solve the problems, only addresses how to react to problems.			



Skunk Creek and the CAP

PNC3A

FIGURE 5-1: Conceptual Levee Design



From: Floodplain Delineation Study for Skunk Creek Between the Central Arizona Project and Happy Valley Road, **By:** Tetra Tech, Inc., **Dated:** June, 2002,.Skunk Creek and the CAP

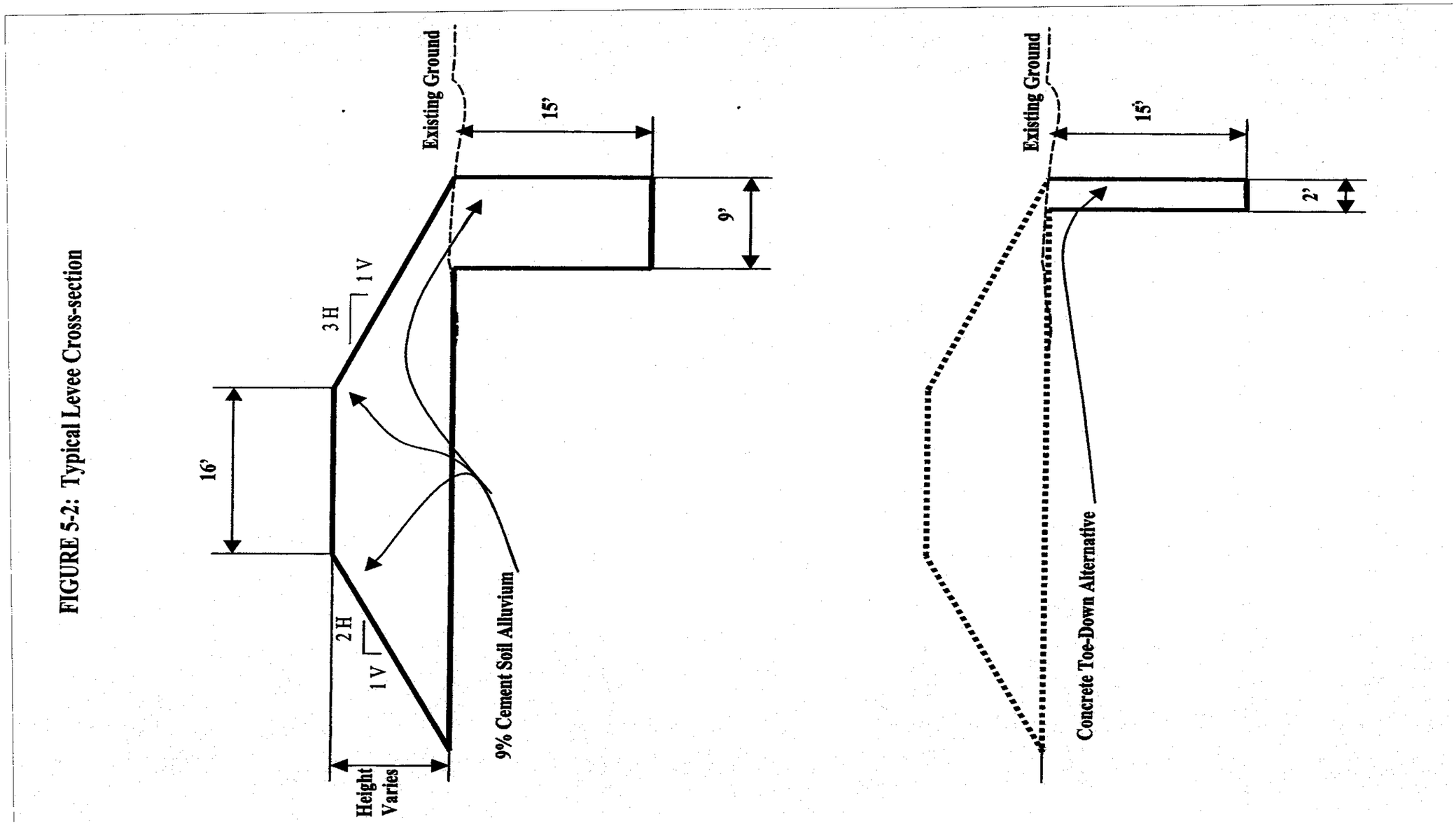


FIGURE 5-2: Typical Levee Cross-section

From: Floodplain Delineation Study for Skunk Creek Between the Central Arizona Project and Happy Valley Road, **By:** Tetra Tech, Inc., **Dated:** June, 2002,.Skunk Creek and the CAP

PNC3C

APPENDIX C

Desert Hills Alternative Measures

DH4A (Site 3)	Cloud Rd & 27th Ave in the floodway	Current alignment of Cloud Rd. and 27th Ave. passes for about 2700 ft length through the Skunk Creek floodplain – about 1600 ft of this is in the floodway	Realignment of roadway	Structural	DH4A-B.jpg	Current all-weather access level ≈ 9000 cfs ≈ 15-yr Remove existing road and culverts Realign road near floodway limit and as needed for street curve constraints. New roadway about 2400 ft long Raise roadway embankment to above 100-yr level Bank protect roadway	• Provide all weather access. • Possibly remove about 12 ac from floodplain. • No cultural resources have been identified.	• Cost • ROW (Private property "taking"). • FEMA freeboard issues. • Potential noise issue moving closer to new homes being constructed. • Road safety issues.	$850,000	• Extends Via Palooza Scenic Dr.. • Alternative would improve moderate habitat to high.	• Private property "taking". • Two historic roads in area. • High habitat value to east.
DH4B (Site 3)			Same as above with FEMA freeboard	Structural	DH4A-B.jpg	Road is raised to include FEMA freeboard.	• Includes FEMA freeboard room • No cultural resources have been identified • Removes acreage from the f/p.	• Cost • ROW • Potential noise issue moving closer to new homes being constructed. • Road safety issues	$1 M	• Demolition/removal of existing roadway could possibly lower levee requirements slightly. • Alternative would improve moderate habitat to high.	• Vertical transitions into existing roadway • Driveway interfaces? • Two historic roads in area. • High habitat value to east.
DH4C (Site 3)			Bridge the whole floodplain	Structural	N/A	Build a bridge spanning the entire length of the floodplain along the existing roadway alignment	• No ROW costs	• High construction costs • Doesn't remove anything from floodplain	$12 M		
DH4D (Site 3)			Protection of existing alignment	Structural	N/A	Construct Floodwalls and erosion protection to protect the existing alignment.	• No ROW costs	• High construction costs • Doesn't remove anything from floodplain • Reconstruction would be necessary because of probable "Washout"	$1.5 M		

DH4E (Site 3)			No Action	No Action	N/A			• Access is lost when flooded • a "washout" is probable.			
DH5A (Site 4)	Skunk Tank Wash hydrology Skunk Tank Wash homes in the FW	There is a breakout of flows from DLW that is unaccounted for in the STW hydrology. Also, the subbasin delineation that was used to generate the STW Q100 misses about 0.4 square miles of area. Impact to STW flows is unknown. Several residences are currently located within the floodway along STW.	Revised STW hydrology to reflect breakout and errant subbasin delineation using HEC-1 and FLO-2D results.	Non-Structural	DH5A.jpg		• Accurate Delineation of the watershed. • Better indication of people located in the floodplain / floodway.		$25,000		
DH5B (Site 4)			7th Ave Interception Channel and Detention Basin	Structural	DH5B.jpg	Construct a collection channel along 7th Ave starting approximately ¼ mile north of Joy Ranch Rd and extending south to a detention basin that is approximately 800 feet south of Maddock Road. The channel will intercept drainage from approximately 620 acres plus the DLW breakout and convey it to a detention basin with about 50 acft of storage. Flows will be metered back to STW. System will consist of small 200 cfs channel north of Joy Ranch Road, 700 cfs channel for approximately 1500 feet south of Joy Ranch Road, and a 1200 cfs channel south to basin. System will require 3 single bbl 8'x 4' RCB, one 4 bbl 10' x 4' RCB, one single bbl 12' x 4' RCB	• Remedies issues along 7th Ave and the East Branch of STW • Handles breakout flows • Addresses low point flooding at 7th Ave • Provides all weather access route along 7th Ave.	• Does not help the 2 residences u/s of confluence. • May not completely remove FW issues d/s of confluence (need further detailed analysis to discover) • Low B/C ratio • Maintenance issues for Basins	$4.2M	• MCDOT roadway – Cost share opps • Provides ASLD with outfall to the west. May be able to get land donated. • Trail may be incorporated along channel.	• Basin may be too large for area. • Habitat value is moderate in area.

DH5C (Site 4)			STW regrade with online detention basin Includes residence buyout.	Structural	DH5C.jpg	Enlarge portions of STW and provide a detention basin with sufficient storage capacity to reduce Q100 d/s to about 2,000 cfs. Channels will be graded along existing wash alignments. Low flow culverts will be provided at driveways and a primary culvert at Maddock Rd.	• Removes all residences from FW	• Engineered Look • 404 Issues – uphill battle • Low B/C ratio • Maintenance issues for basin and channels • Engineered basin would be difficult to fit into the area because of aesthetics.	$3.1M.	• Maddock is MCDOT Road. May be able to cost share culvert. • Aesthetic concerns can be incorporated into design. • Multi-use opportunities possible.	• Obtaining ROW or Drainage Easements for channel work. • 404 permit required. • Habitat value is moderate
DH5D (Site 4)			No Action	No Action	N/A			• Flooding will continue along the corridor.			
DH6A (Site 4)	Flow Breakout to Skunk Tank Wash.	Approximately 400 cfs breaks out of Desert Lake Wash and flows into Skunk Tank Wash. These flows are currently un-accounted for. This breakout plus the intervening area flows are causing flooding of the area generally located between 7th Ave and STW, and between Joy Ranch Road and ¼ mile south of Maddock Road.	7th Avenue interception channel and offline detention basin on ASLD parcel, and downstream pilot channel	Structural	DH6A.jpg	Construct a collection channel along 7th Ave starting approximately ¼ mile north of Joy Ranch Rd and extending south to an offline detention basin located on ASLD parcel just south of Maddock Road alignment. The channel will intercept approximately 620 acres plus the DLW breakout. The offline detention basin will have about 50 acft of storage. West of 7th Ave., flows will be directed back to STW in a small pilot channel.	• Provide flooding relief to residences west of 7th Ave and south of Joy Ranch Road. • Reduce FP/FW on branch extending east of STW. • Reduce FP/FW on mainstem below Joy Ranch Road • Provides developer of ASLD a template for passing through offsite flows.	• Cost – low B/C ratio • Maintenance and ownership issues	$4.78M	• Potential for aesthetic enhancement, and multi –use opportunities. • Potential for cost share with ASLD parcel developer	• Habitat (Mesquite bosque) high on west side of parcel. • Culturally two old houses, two old roads and one trail are present in area.
DH6B (Site 4)			FEMA Floodplain Delineation	Non-Structural	N/A		• Defines Floodplain and Floodway.	• Does not remove homes from floodway.	$70K		
DH6C (Site 4)			No Action	No Action	N/A		•	• Homes are still flooded.			

DH7A (Site 5)	Desert Lake Wash d/s of Cloud Road	Flooding of residences along the primary flowpaths of Desert Lake Wash. Includes problems along 3rd Street.	*(PRE-ASLD Parcel Development)* Temporary collection channels along the north side of Cloud Road and a channel and offline detention basin south of Cloud Road, with a pilot channel continuing south.	Structural	DH7A-B.jpg	According to FLO2D, Q100=990 cfs (137cfs at 3rd St. and 853cfs at DLW) approaches Cloud from north. Collection channels will be parkway type channels with well defined low-flows. Assume a total ROW of 80 ft. Channel south of Cloud will be more engineered to operate with offline detention basin. Goal of system is to reduce discharges downstream to around 300-400 cfs. Will require approximately 40 acre-feet of offline storage. Culverts will need to be 3 bbl, 10' x 4' RCB. Channel d/s of Cloud to basin will be a trapezoidal section with a 25 foot bottom, 3:1 sides. d/s of basin, grade a pilot channel using a trapezoidal section that is 4 feet deep and has an 8 foot bottom and 3:1 sides and provide single bbl, 10' x 4' RCB culverts at Galvin and 3rd Street.	• Remove most of the FP and all residences from the FW. • Addresses most of the drainage issues for residences south of Cloud Rd. • Provides developer of ASLD a template for passing through offsite flows.	• Cost – low B/C ratio • Requires donation of easements for pilot channel.	$3.67M	• Some of the road crossings are on MCDOT roadways. May be able to cost share with them. • Opportunity for multi-use trail connection to school. • Opportunity to connect habitat north of Cloud Rd. and enhance value in this area. • Channel could be designed to be more natural.	• Need to obtain temporary drainage easement from ASLD. • Homes are currently being built in channel alignment.

DH7B (Site 5)			*(With ASLD Parcel Developer Participation)* Same as previous only the developer is responsible for providing the collection channel.	Structural	DH7A-B.jpg	If ASLD parcel is developed, the developer will likely construct the collection system along the south side of Joy Ranch Road, with a conveyance system traversing the site from north to south. Channel will be drained to FCDMC facility.	• Same as above plus developers pay for the collection system		$2.69M	• Opportunity for multi-use trail connection to school. • Opportunity to connect habitat north of Cloud Rd. and enhance value in this area. • Channel could be designed to be more natural.	• Homes are currently being built in channel alignment
DH7C (Site 5)			*(With ASLD Parcel Developer Participation and offline detention basin location on ASLD parcel)* Same as previous only locating offline detention basin on ASLD parcel.	Structural	DH7C.jpg	If ASLD parcel is developed, the developer will likely construct the collection system along the south side of Joy Ranch Road, with a conveyance system traversing the site from north to south. This alternative assumes that the offline detention basin is provided on the ASLD parcel. This basin volume will need to be ADDITIONAL to the site's 100-yr, 2-hr requirements. Un-detained flows will then drain to an FCDMC constructed pilot channel system. It is assumed that the FCDMC will have to pay for most of the detention basin costs except landscaping beyond typical FCDMC minimums.	Remove most of the FP and all residences from the FW. Addresses most of the drainage issues for residences south of Cloud Rd. Provides developer of ASLD a template for passing through offsite flows. Development cost sharing May answer maintenance issues if basin can be constructed and turned over to an HOA.	Coordination and programming the construction of the pilot channel and culverts to coincide with an unknown development schedule. Improvements are tied to development of the ASLD parcel. Cost (low B/C ratio) 404 Issues	$2.38M	Multi-use park facility Cost share of roadway crossings for pilot channels with MCDOT.	Timing issues

DH7D (Site 5)			*(With ASLD Parcel Developer Participation and a linear online detention basin located along Joy Ranch Road on ASLD parcel).* Linear on-line detention basin along Joy Ranch Road and outlet channel through ASLD parcel to Cloud Road. Channel downstream of Central Ave to be a pilot channel with erosion set-backs	Structural	DH7D.jpg	This alternative assumes that an on-line detention basin is provided along the south side of Joy Ranch Rd with an outlet channel. The basin and channel will be located on the ASLD parcel. This basin volume will need to be ADDITIONAL to the site's 100-yr, 2-hr requirements. Downstream of Central Ave, post-detention flows will then drain to an FCDMC constructed pilot channel system. It is assumed that the FCDMC will have to pay for most of the detention basin costs except landscaping beyond typical FCDMC minimums.	Remove most of the FP and all residences from the FW. Addresses most of the drainage issues for residences south of Cloud Rd. Provides developer of ASLD a template for passing through offsite flows. Development cost sharing. Reduced size of outlet channel as compared to Alternative DH7C May answer maintenance issues if basin and outlet channel can be constructed and turned over to an HOA.	Coordination and programming the construction of the pilot channel and culverts to coincide with an unknown development schedule. Improvements are tied to development of the ASLD parcel. Cost (low B/C ratio) 404 Issues Larger basin storage volume and land area than that required for Alternative DH7C due to on-line status	$3.35M	Multi-use park facility Cost share of roadway crossings for pilot channels with MCDOT.	Timing issues
DH7E (Site 5)			No Action	No Action	N/A			• Flooding will continue south of Cloud Rd.			

DH8A (Site 5)	Desert Lake Wash Tributary 2 at 7th Street	Flooding at dip crossing in 7th Street and alongside 7th Street for approximately 1,000 feet north. 7th Street is a major arterial north (turns into New River Road). Also flooding in the cul-de-sac roadways (Blue Eagle Lane and Desert Ranch Road) west of 7th Street due to runoff at this crossing	Combination of channels and culverts to intercept and convey most of 100-year flows and provide an all-weather access crossing. Also mitigate the flooding in d/s cul-de-sacs	Structural	DH8A.jpg	Provide a channel with 100-year capacity along the east side of 7th Street, from Irvine Rd to Joy Ranch Rd. Maintain a sag in 7th Street at the current low point and size the culvert at Blue Eagle Lane to pass most of the the 100-year south with less than 0.5 feet of spill over 7th Street to the west. Daylight the channel system onto the ASLD parcel at historic outflow point. Outfall will depend on development of ASLD parcel. Q100=750 cfs (per FLO2D). Channel is a trapezoidal section 5 feet deep with 3:1 sides and 8 foot bottom. Both culverts are 3 bbl, 10' x 4' RCB	• Provides all-weather access. • Eliminates flooding at cul-de-sacs to west. • Removes drainage hazard from regionally significant roadway	• Low B/C ratio • Stark, engineered look	$1.23M	• 7th Street is part of MCDOT CARs list	• Utilities? • ROW and agreement from ASLD to daylight channel.
DH8B (Site 5)			No Action	No Action	N/A			• Access is threatened north to New River.			

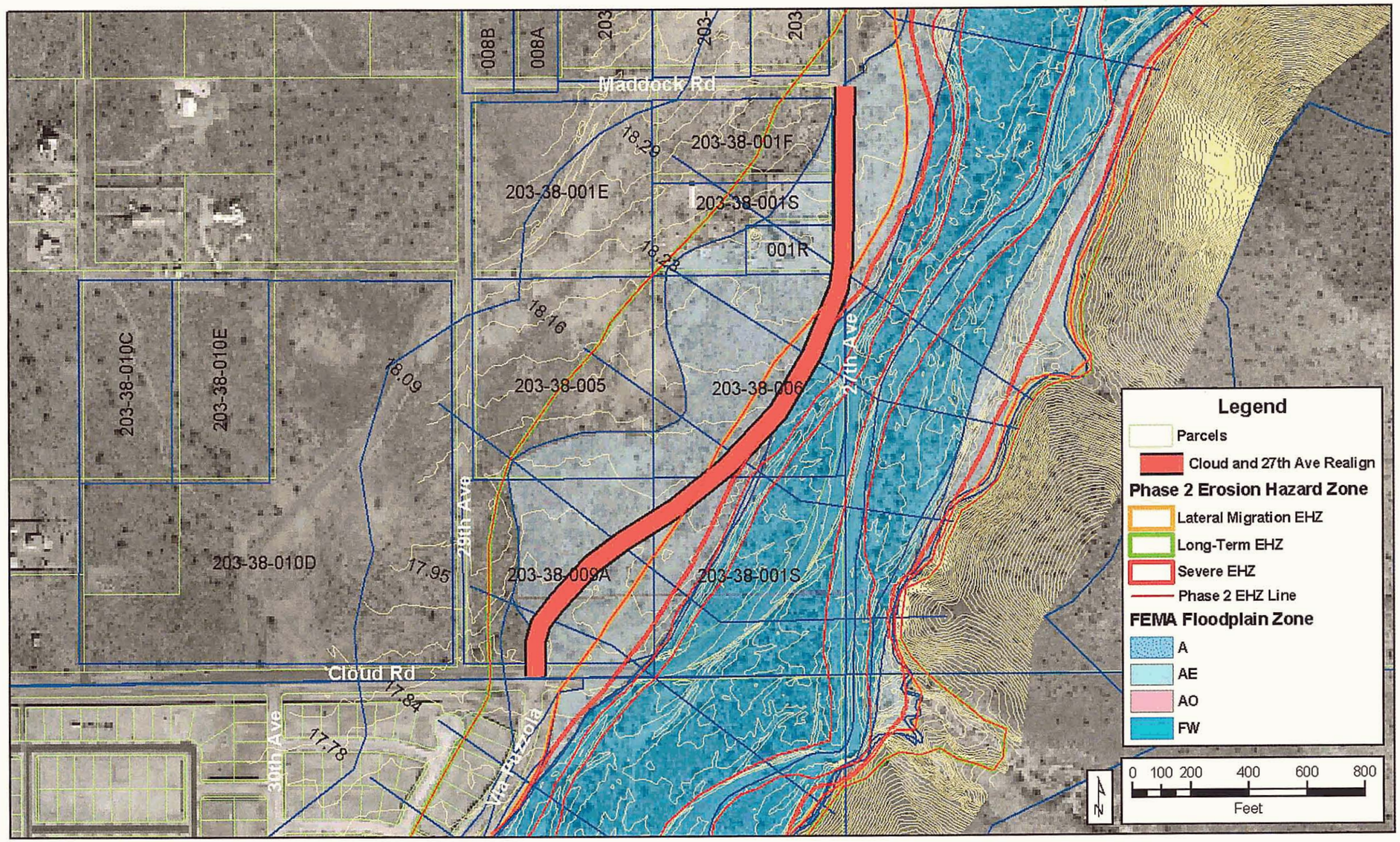
DH9A (N/A)	Desert Hills Wash between Cloud Road and 12th Street	Paved dip crossing with 100-yr flow depths around 4-5 feet. There are 3 residences within the FW and the one along Cloud Road is in significant danger of flooding.	Combination of a culvert at Cloud Rd, channels, and offline detention.	Structural	DH9A.jpg	Provide a new culvert and regrade Cloud Rd to provide an all-weather crossing. Downstream of culvert, grade a low-flow channel with 10-yr capacity and an offline detention basin. Will require the purchase of the parcel in FW along Cloud Rd. Downstream of basin, provide a transition channel to return reduced flows back to FP. Q100=3300 cfs, Q10=1200 cfs. Approx culvert for Cloud Rd is 9 bbl, 10'x 4' RCB. The low-flow channel is a trapezoidal section with a 30 foot bottom, 3:1 side slopes, and 4 feet deep. The transition channel is similar.	• Remove all residences from FW. • Reduce Q and possibly FP downstream • Provides all-weather crossing at Cloud Rd • Potential to remove 7+ homes from the FP depending on the amount of Q reduced.	• Low B/C ratio • Requires buying out or possibly condemning an existing residence • Perception to community that FCD is protecting only a few	$1.7M	• Multi-use of basin • Emergency routes • Opportunity to reconstruct connection, enhance habitat.	• Property acquisition • Who maintains basin? • 404 permit required.
DH9B (N/A)			No Action	No Action	N/A			• Residents still in floodway.			

DH10A (Site 6)	Carefree Highway Flooding	Carefree Highway has many undersized crossings and insufficient roadside ditches Probable impassable crossings at Desert Lake Wash, Desert Hills Wash, Apache Wash, West Branch Paradise Wash and Paradise Wash on CFH	Increase channel capacity along CFH and upsize crossings to 100-yr	Structural	DH10A.jpg	Concrete channel from 7th Ave to DLW BW=10 ft Z = 1:1 D = 6 ft S = 0.01 Q = 1100 cfs L = 6800 ft New culverts at Central, 10th St. and 7th St. and maybe convenience store driveways Upgraded culverts east of Desert Lake Wash to Paradise Wash	• Reduce flooding • Increase access	• Costs	Channel = 6800 ft at $310 + 3 culverts at $120K each = $2.5 million Plus additional $400K per DLW, DHW, AW, WBPW, PW = $2 million	• Existing ROW may be enough except at convenience store development • Maybe conveyence thru parking lot would be acceptable above say 10-yr Q • Combine with fixes for DLW and/or AW in other DH alts	• ROW • Slope – invert at Desert Lake Wash • Culvert outlet at DLW • Carefree Hwy. is Rd. of regional significance, needs to accommodate multi-use trails. • Apache and Paradise Washes have high habitat value. • Need to accommodate habitat crossings. • Carefree Hwy.is scenic road so design guidelines apply
DH10B (Site 6)			No Action	No Action	N/A			• Carefree Hwy. flooding probable • Possible "washouts"A • ccess is lost to many residents.			

DH11A (Site 7)	Apache Wash at 24th Street	Roadway and wash co-exist for nearly 700 feet at one location and about 250 feet at another. Road is impassable during flooding and is a primary artery for areas to the north.	Re-align roadway away from and generally parallel to the wash.	Structural	DH11A.jpg	Re-align 24th Street to the west side of the wash, generally along the natural ridge. At Carefree Hwy, shift intersection to the west. At Cloud Road, maintain the current alignment. Road could be built in FP fringe and elevated to preserve land. No new culverts would be required to cross Apache Wash. A relief culvert may be required at Carefree Hwy intersection to allow breakout to continue to west.	• Road out of flood hazard and maintained passable. • No new crossings of Apache Wash needed.	• Alignment will be off sectional alignment at Carefree Hwy. • Requires all new ROW. • Need easement from ASLD.	$4M	• May be able to incorporate a trail system. • Realignment would enhance habitat value • Five stock tanks provide fresh water source for wildlife. • Potential habitation site in SWC of area.	• Old alignment likely has utilities within the ROW or parallel easements. That means the ROW must be maintained or the utilities relocated. • Scenic road design guidelines apply at intersection with Carefree Hwy.
DH11B (Site 7)			Provide channelization and engineered road crossings.	Structural	N/A	An extensive network of channels and roadway crossings would need to be analyzed and designed to carry the water from one side of 24th street to the other. The roadway would need to be elevated for much of it's length.	• No new ROW.	• Cost .	$8 million.	• Potential habitation site in SWC of area.	• Scenic road design guidelines apply at intersection with Carefree Hwy.
DH11C (Site 7)			No Action	No Action	N/A			• Access north is cut off during flooding. • Probable costly "washouts'.			

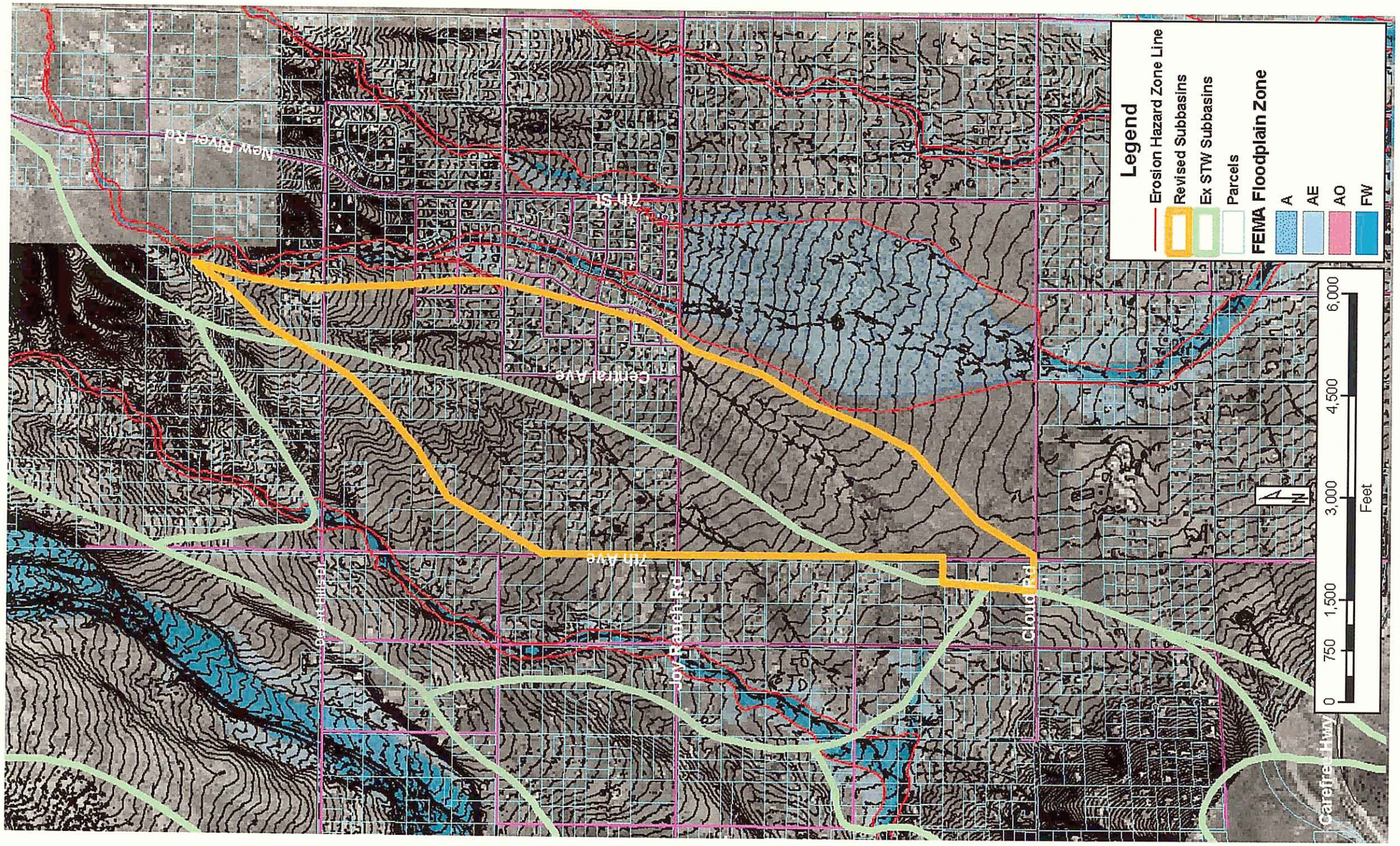
DH12A (N/A)	Desert Hills Wash at Joy Ranch Road	Significantly undersized culvert causes flows to spread and overtop roadway. Residence on south side of Joy Ranch Rd in FP because of overtopping. Erosion control for house.	Replace culvert	Structural	DH12A.jpg	Upsize culvert to limit roadway overtopping to max 100-year depth of 0.5 feet. Q100=1300 cfs. Approx culvert is an 80 foot long, 4 bbl, 12'x 4' RCB (see HY8 – JRR_DHW.lst). Minor regrading and erosion protection at d/s end.	• Provide all-weather crossing. • Possibly remove residence from FP	• Low B/C ratio • Local fix with little regional benefit	$160K for culvert and erosion protection	• Emergency routes	• May have to look at erosion protection d/s. • Already a problem.
DH12B (N/A)	Desert Hills Wash Tributary 6 at 16th Street	Significantly undersized culvert causes flows to pond upstream. Residence on south side wash in FP because of ponding	Replace culvert and grade new channel	Structural	DH12B.jpg	Upsize culvert to reduce ponding u/s; regrade wash d/s of culvert to confluence with Desert Hills Wash, and provide erosion protection. Q100=600 cfs. Approx. culvert is a 120 foot long 2bbl, 10' x 4' RCB. DS channel will be 250 feet of trapezoidal section 10 feet wide with 2:1 side slopes and bank armoring.	• Provide all-weather crossing. • Likely remove residence from FP. • Mitigate erosion hazard d/s	• Low B/C ratio • Local fix with little regional benefit	$166K	• Emergency routes	• Property acquisition for channel.
DH12C (N/A)			No Action	No Action	N/A			• Flooding within the area will continue the • Possibility of damage to property is high			
DH13A (Site 8)	Desert Hills Road flooding	Desert Hills Drive is impassible during flood events and does not provide access.	Bridge Skunk Creek at Desert Hills Drive.	Structural	DH13A.jpg	Span the Skunk Creek Floodplain with a bridge.	• Access to residents cut off during flood events. • Emergency access across Skunk Creek.	• Cost. • Low B/C Ratio. • Access from side streets. • Access to structures already in fp/fw.	$6-$7 M	• Emergency route	• Side Street access. • High habitat value along Skunk Creek corridor

DH13B (Site 8)			No Action	No Action	N/A			• Desert Hills Drive will continue to be impassable during flooding events.			
			Flood Response Plan	Non-Structural	N/A		• Low cost yet addresses access and hazard to existing residents	• Does not solve the problems, only addresses how to react to problems.			



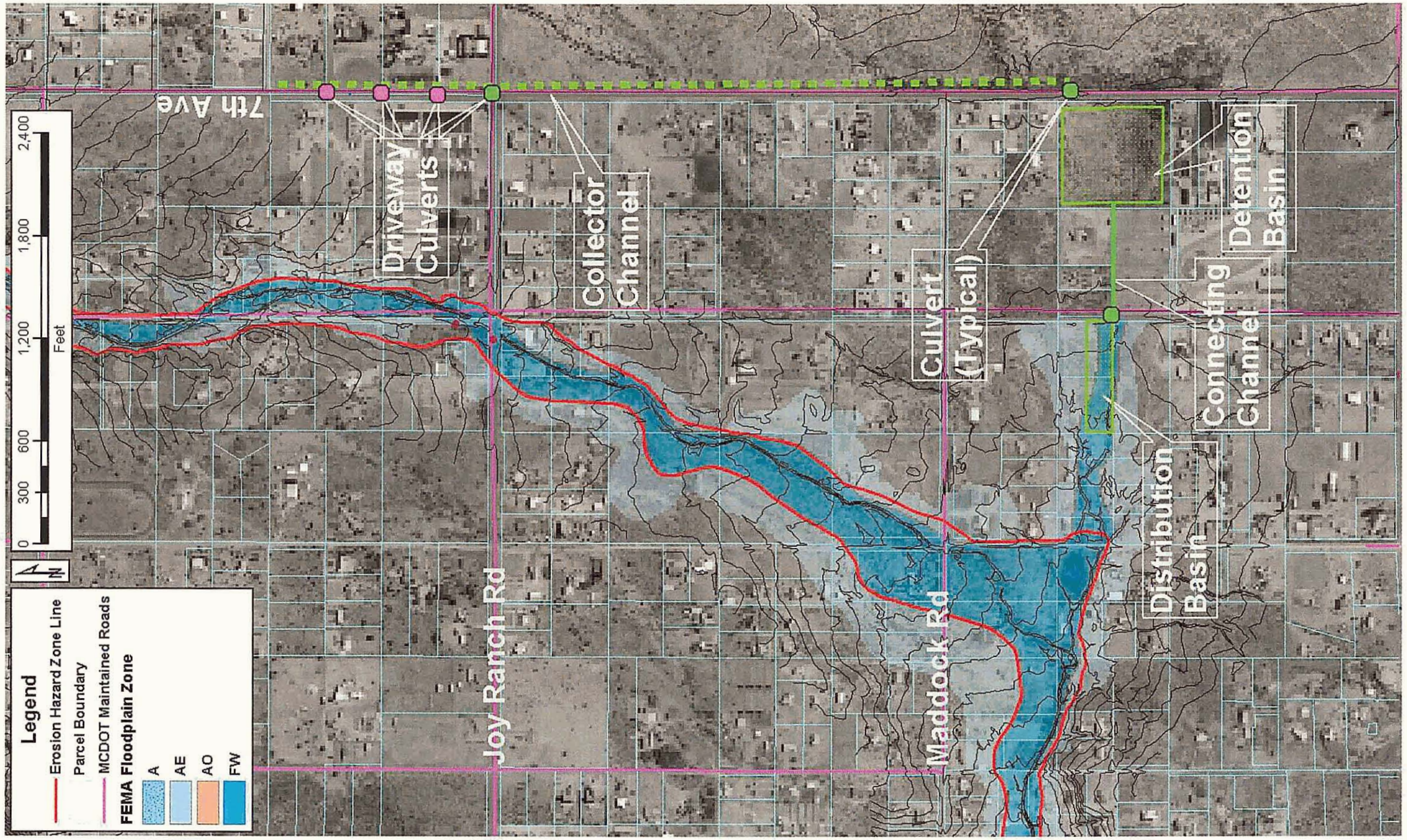
Cloud at 27th Avenue

DH4A &DH4B



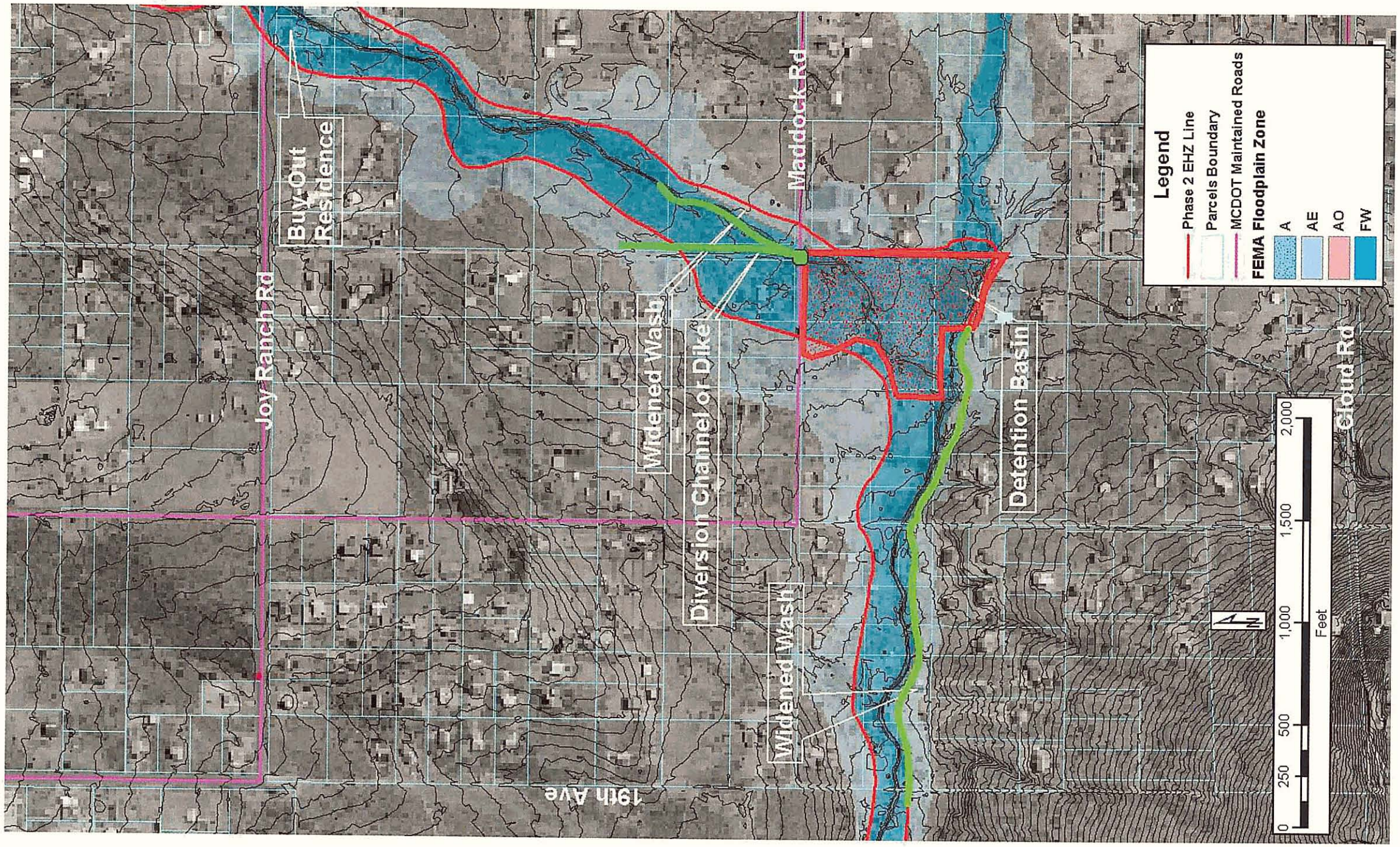
Hydrology around Skunk Tank Wash

DH5A



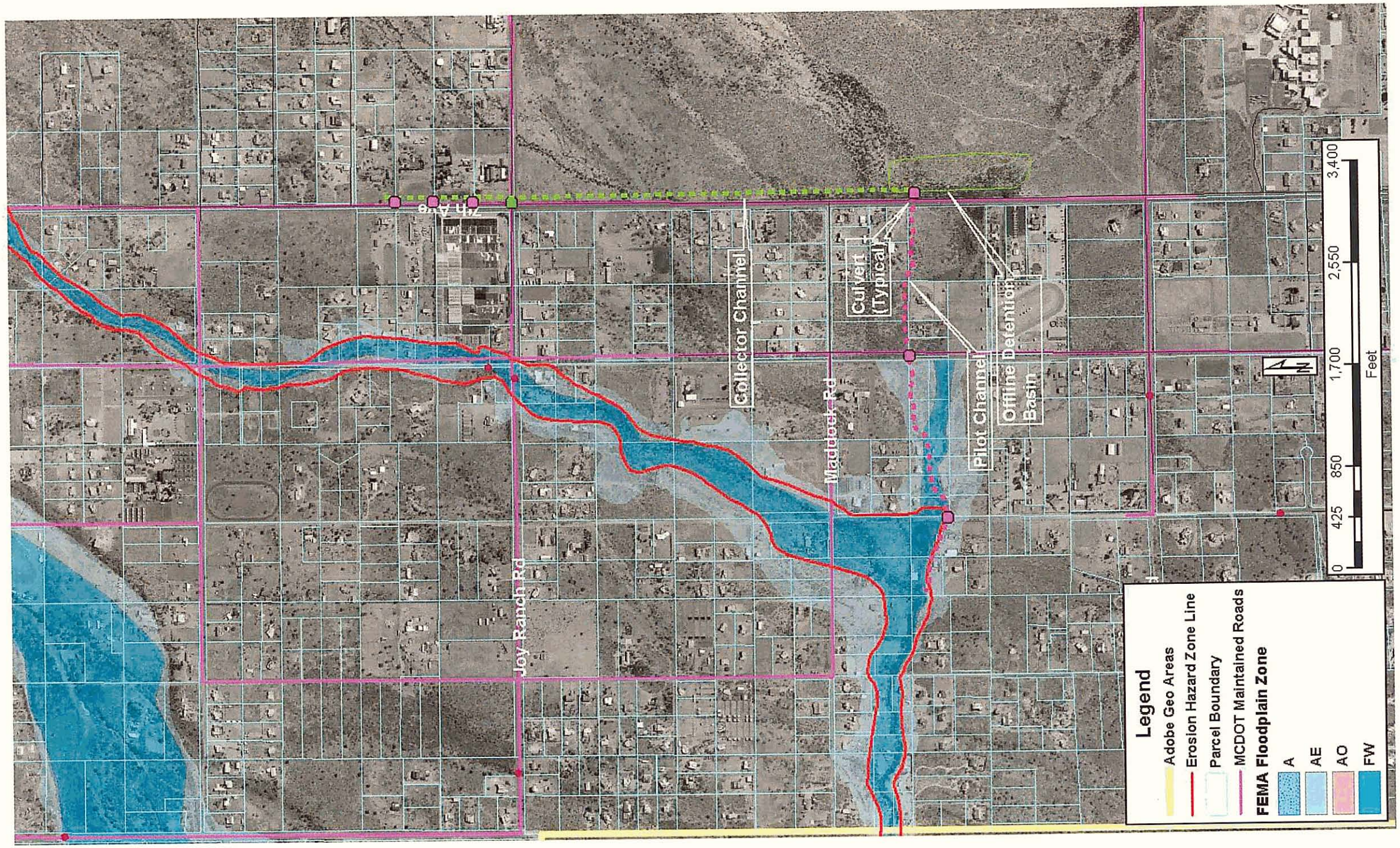
7th Avenuebetween Cloud Road and the Carefree Highway

DH5B



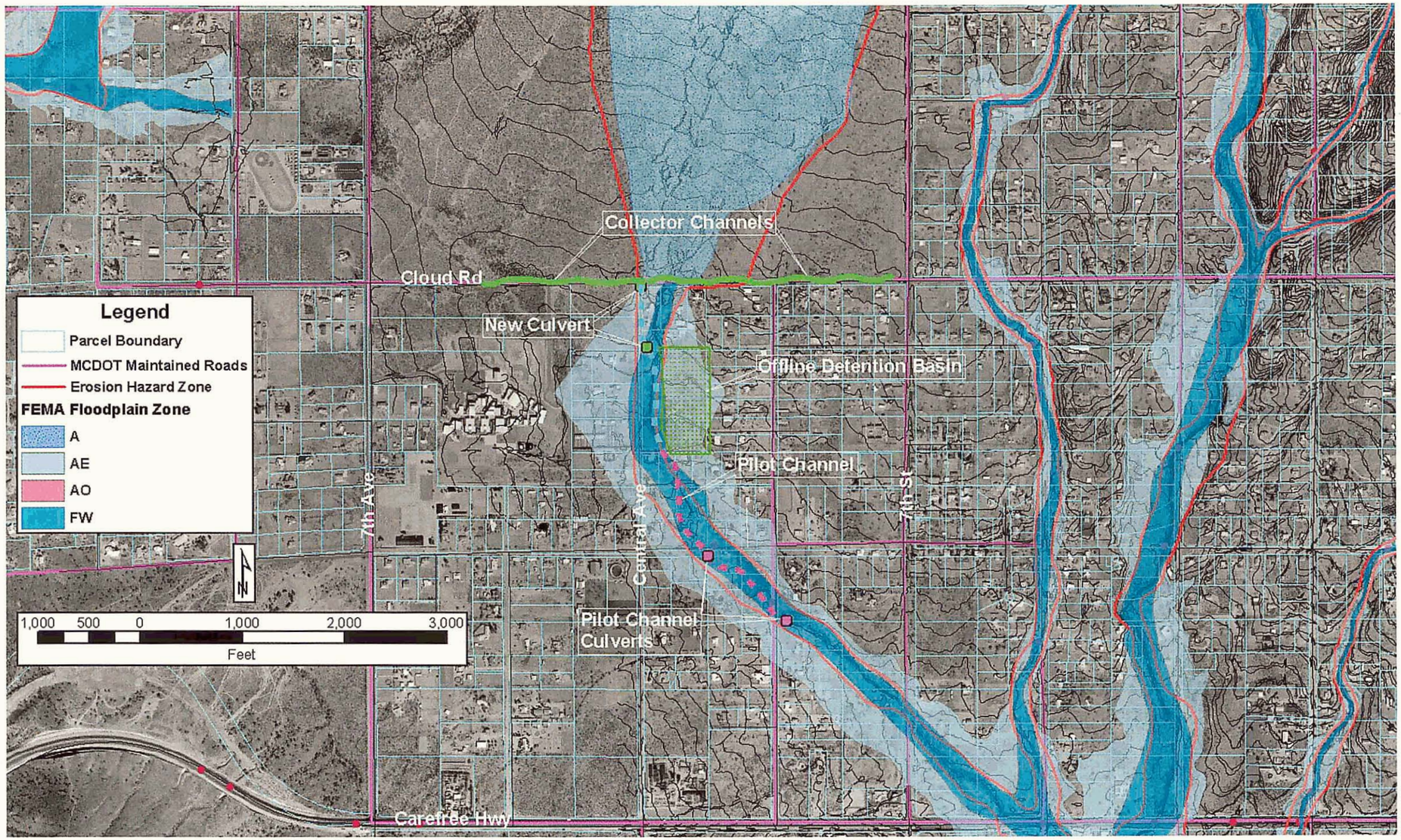
Skunk Tank Wash Regrade

DH5C



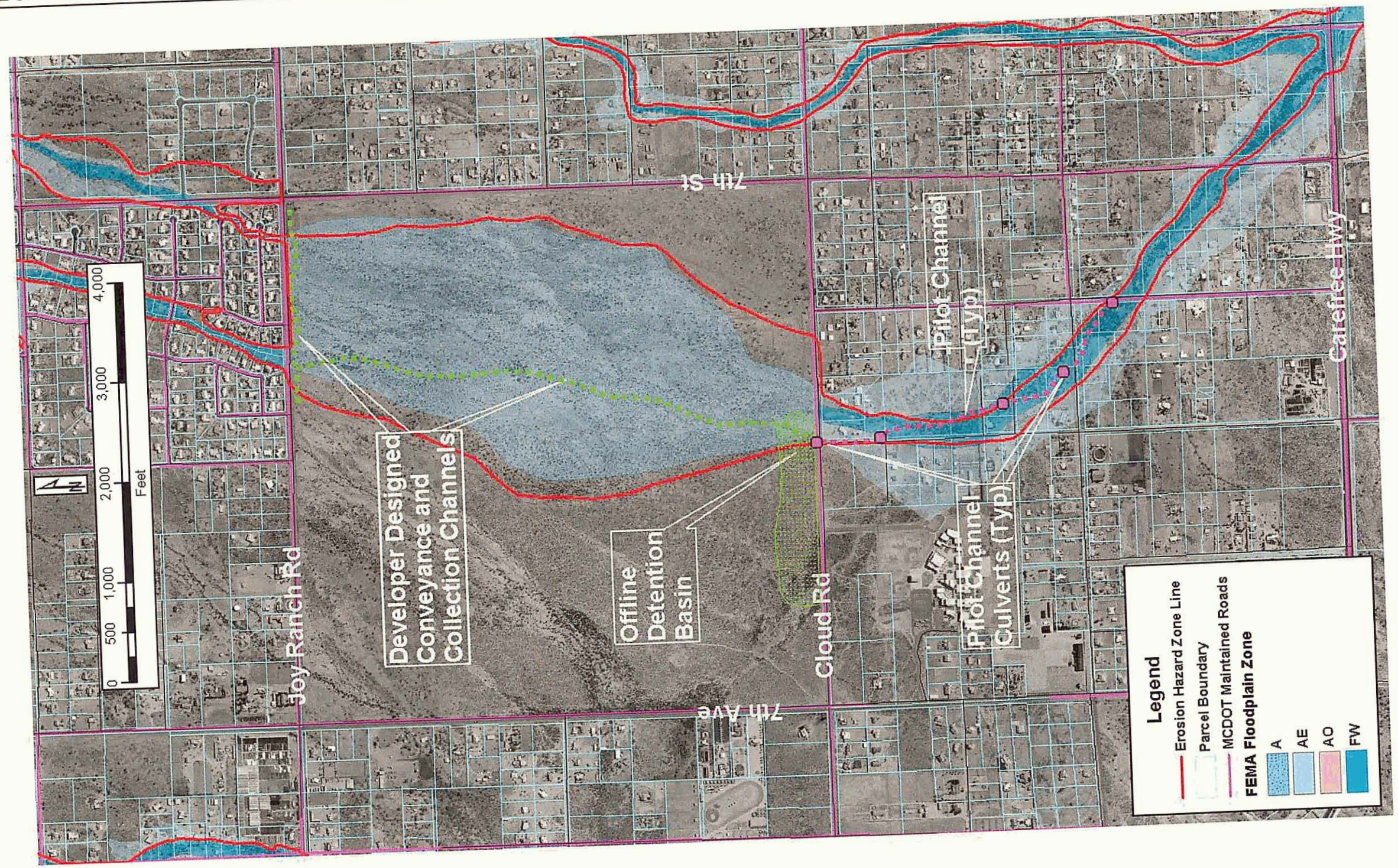
Desert Lake Wash Breakout – 7th Avenue Interceptor Channel and Basin

DH6A



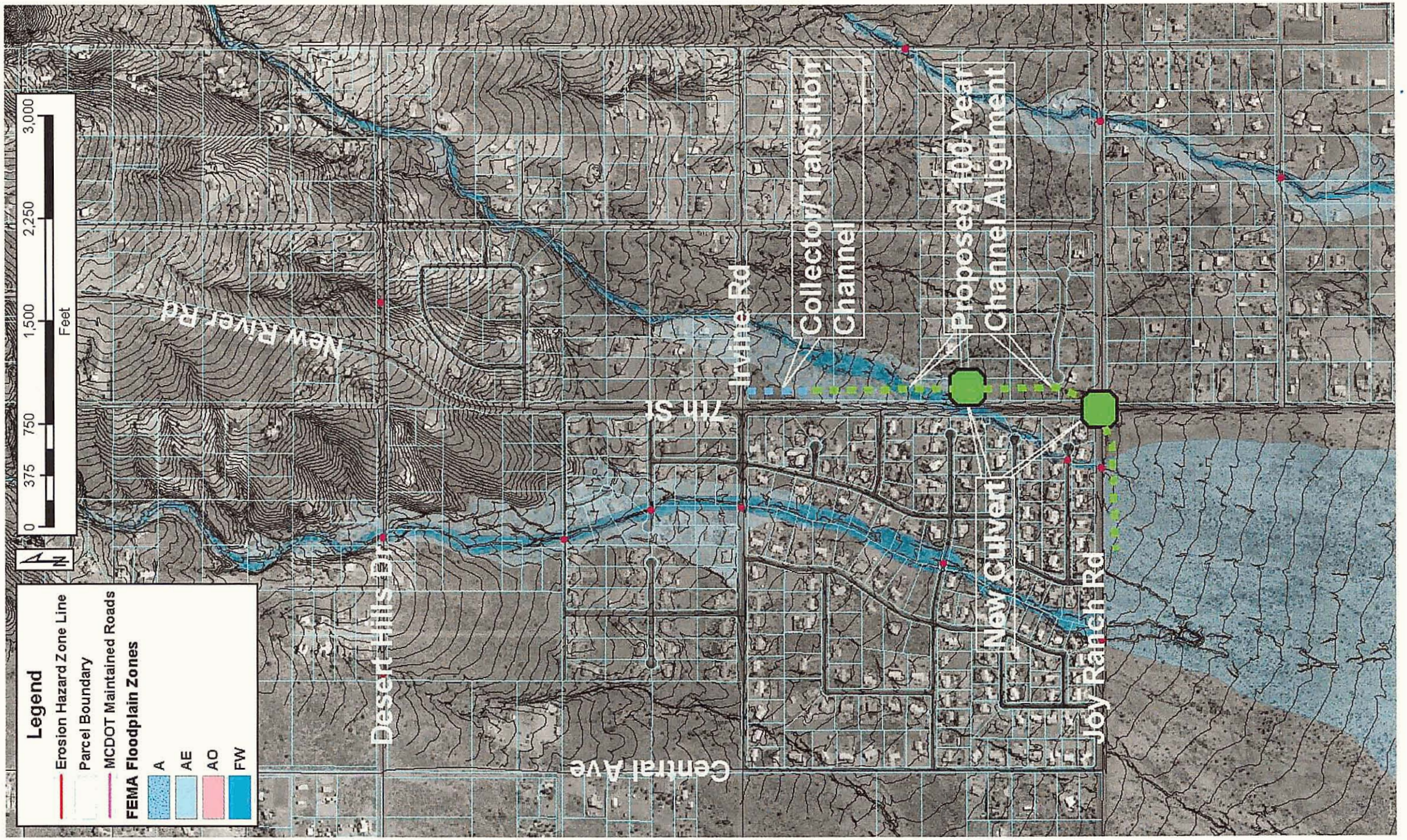
Desert Lake Wash Downstream of Cloud Road

DH7A & DH7B



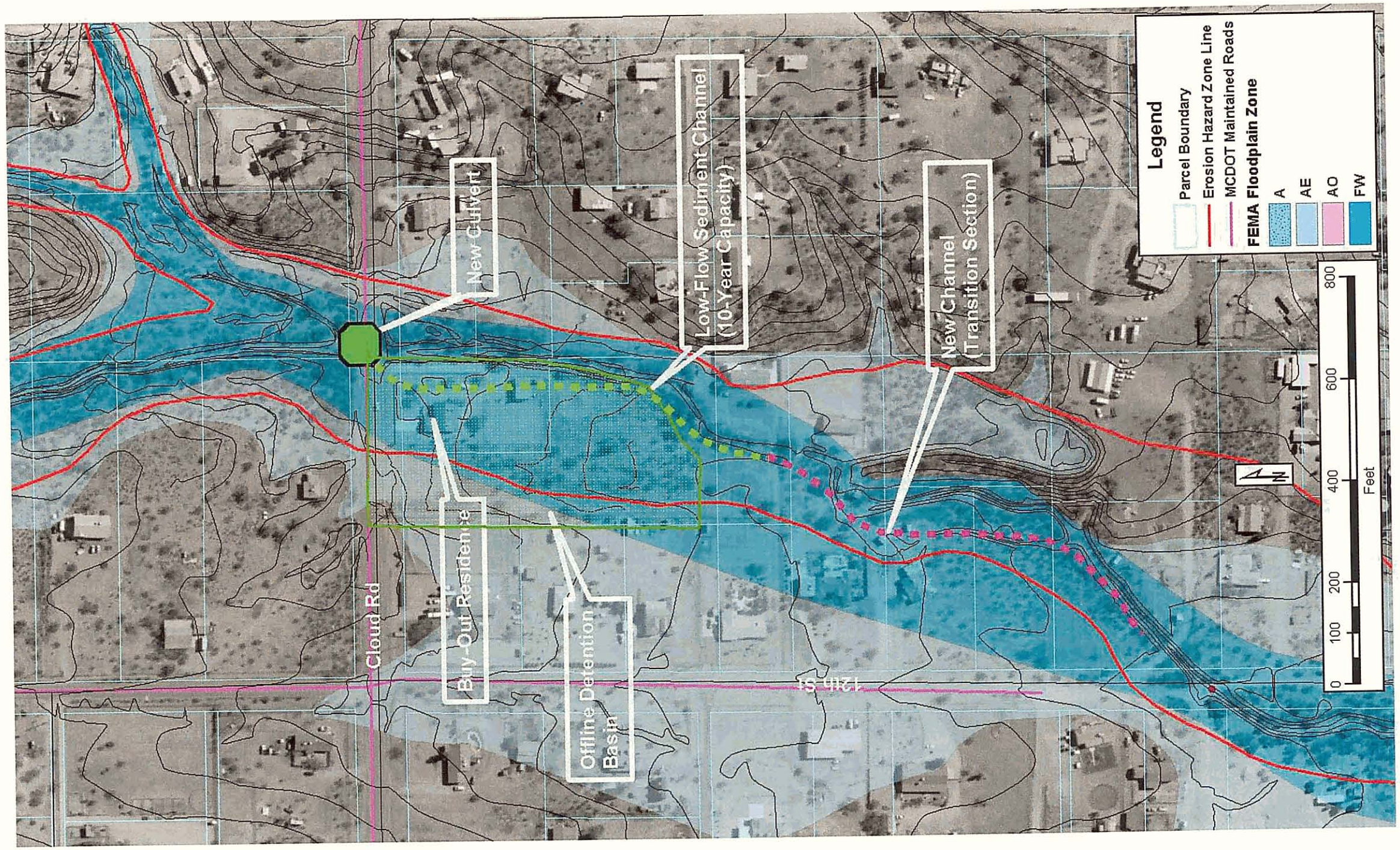
DH7C

Desert Lake Wash Downstream of Cloud Road – Basin on ASLD Parcel



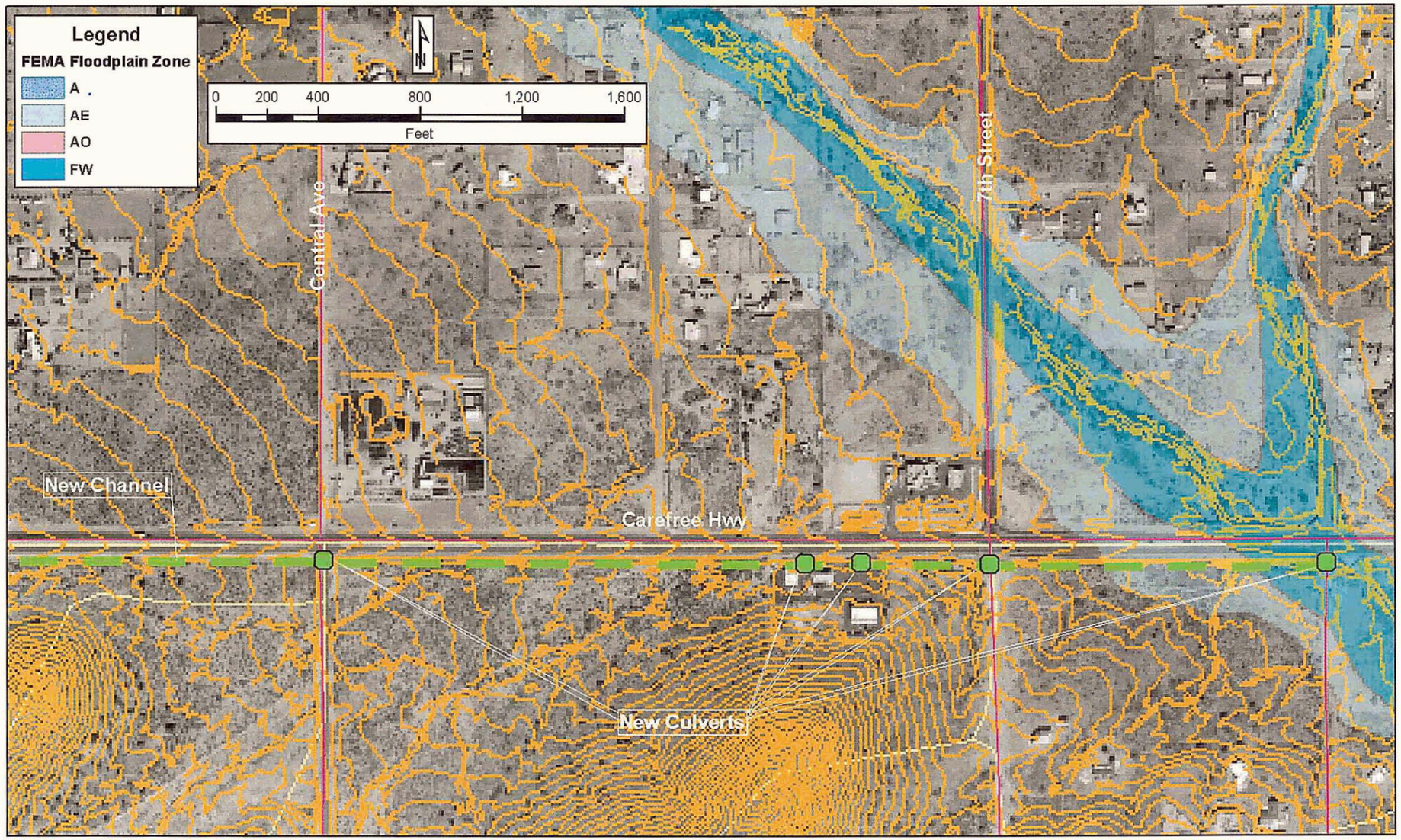
Desert Lake Wash Tributary 2 along 7th Street

DH8A



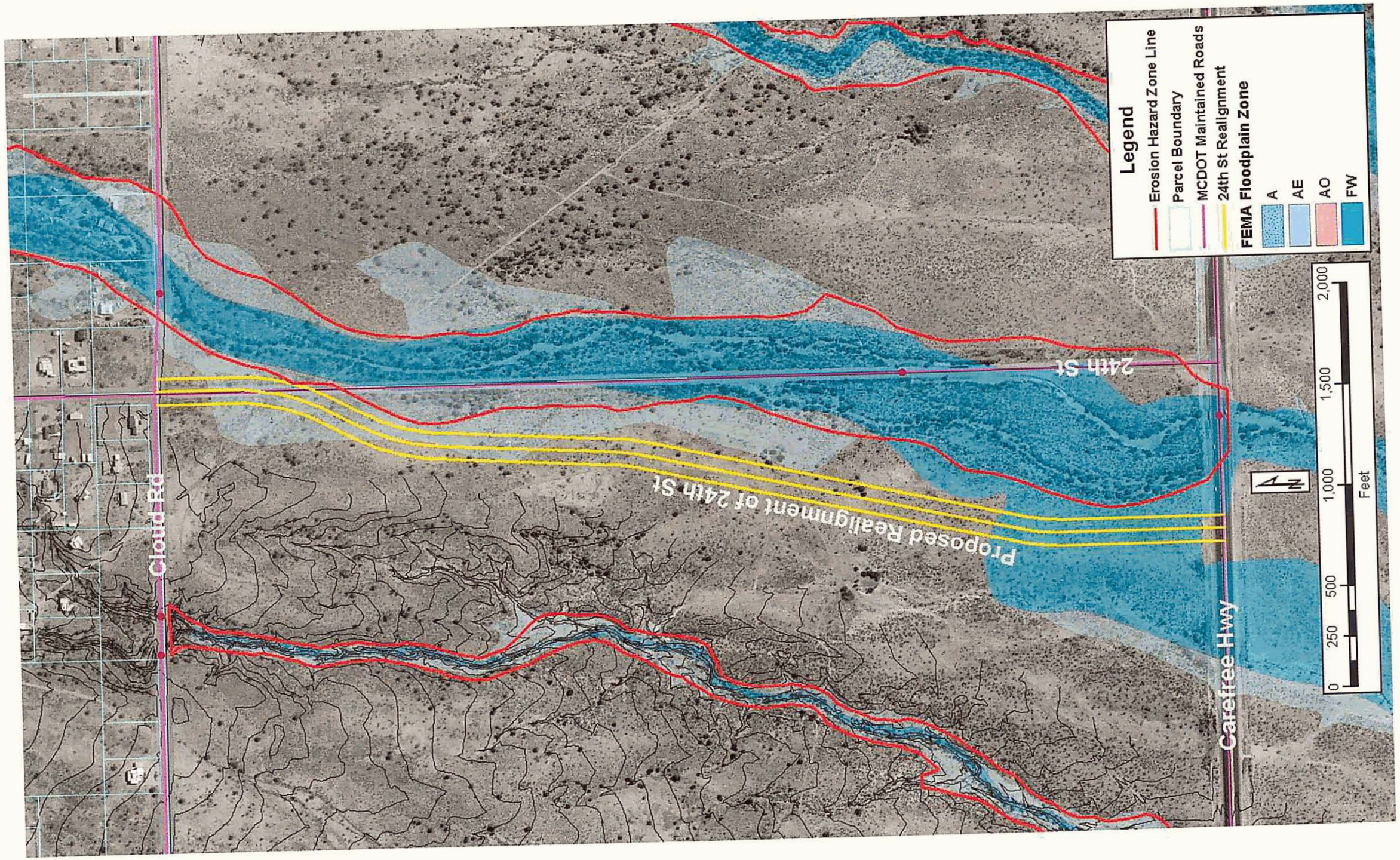
DH9A

Desert Hills Wash from Cloud Road to 12th Street



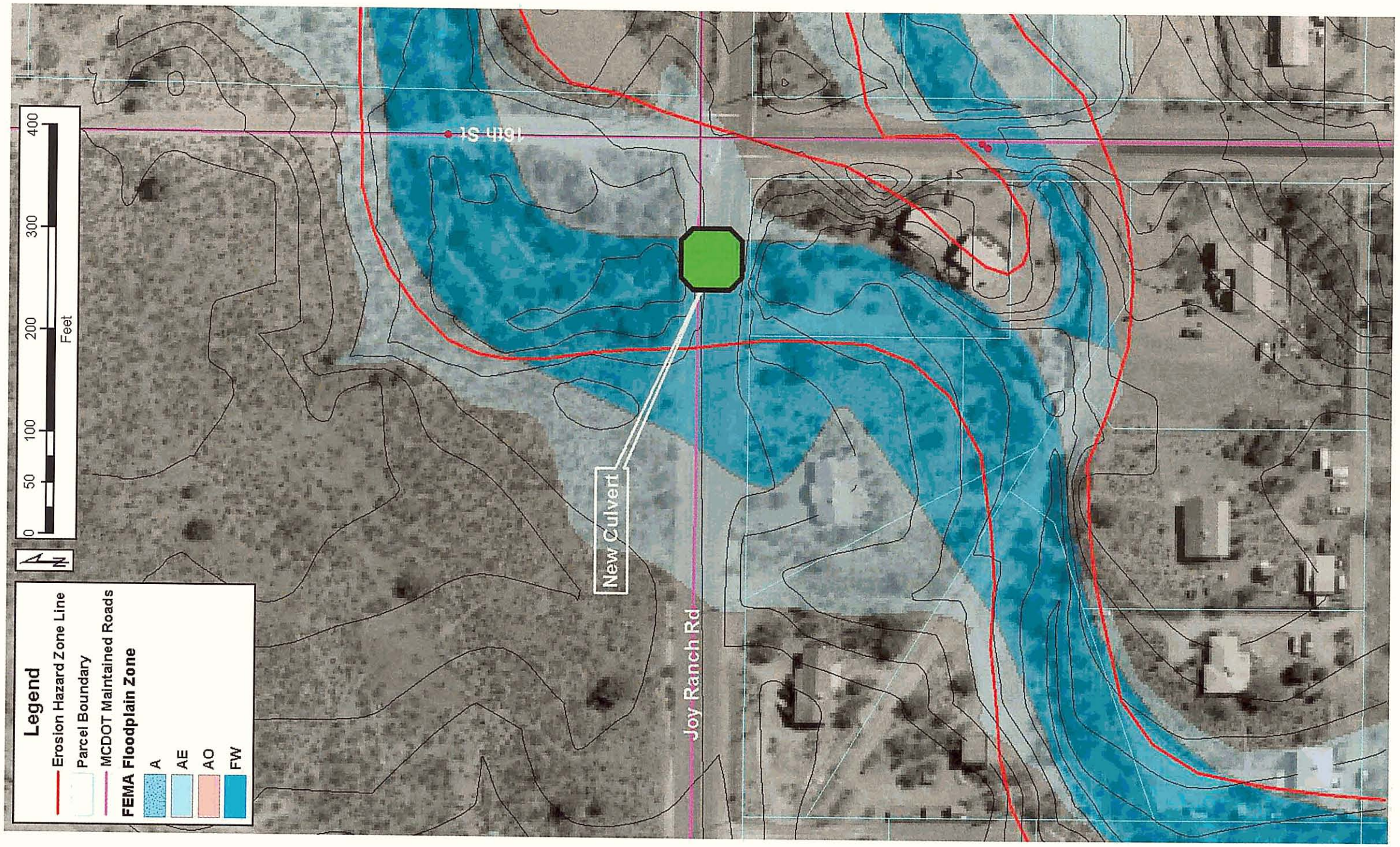
Carefree Highway Flooding

DH10A



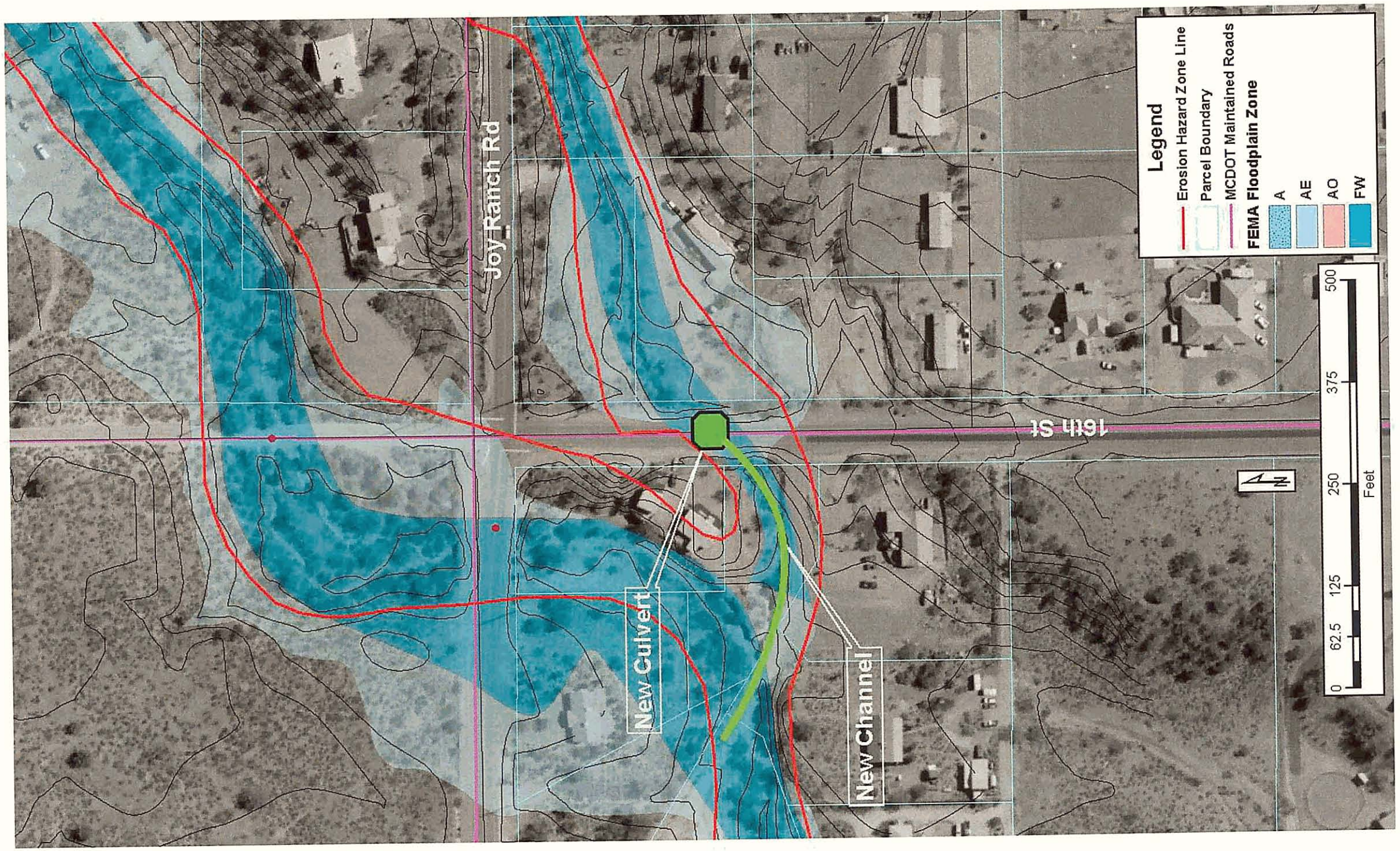
DH11A

24th Street Alignment between Cloud Road and the Carefree Highway



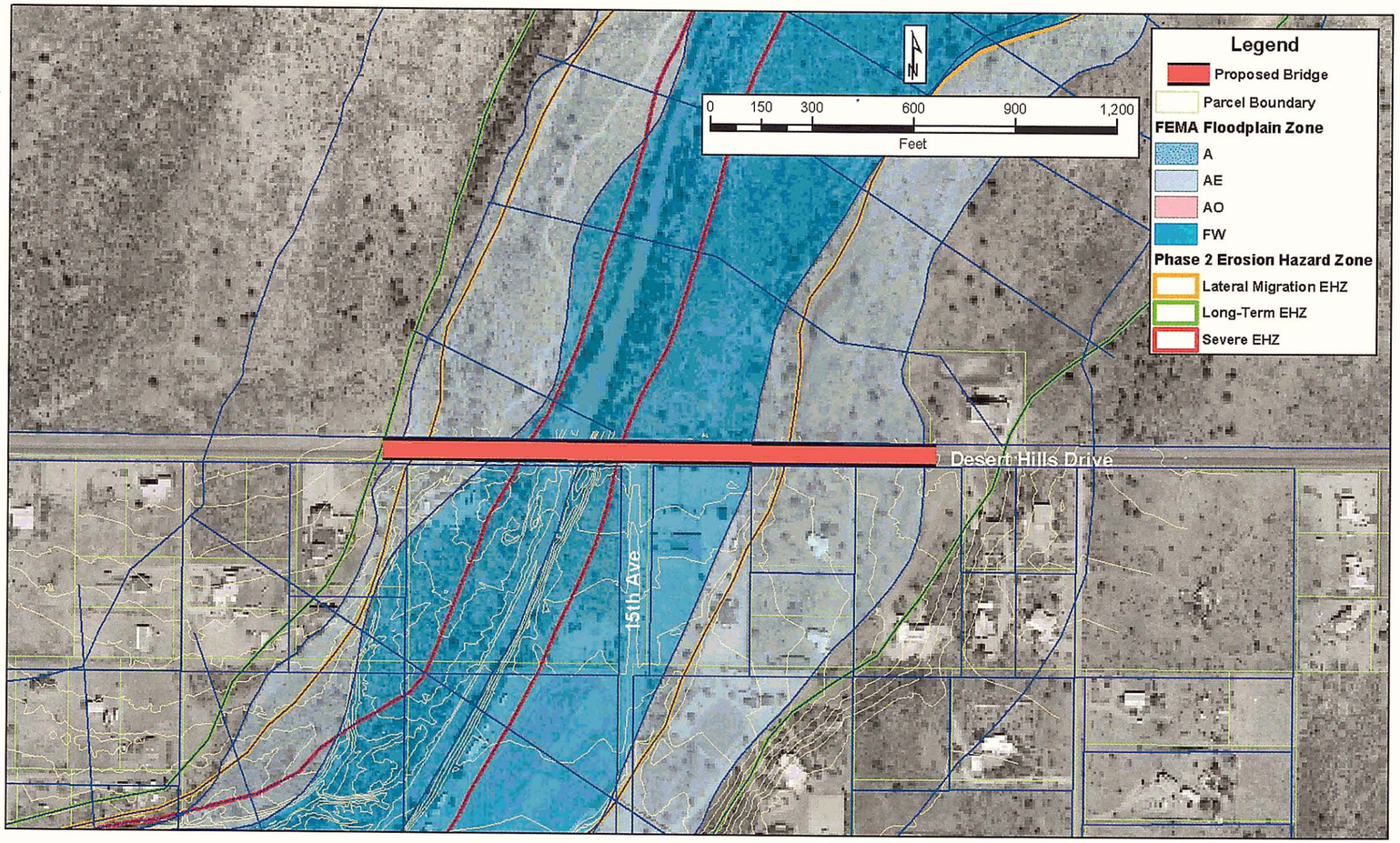
Desert Hills Wash at Joy Ranch Road

DH12A



DH12B

Desert Hills Wash Tributary 6 at 16th Street



Skunk Creek and Desert Hills Drive

DH13A

APPENDIX D

New River Alternative Measures

Table D.1: Summary of Measures New River

Description Number	Problem	Description of Problem	Alternative	Type of Alternative	Schematic	Narrative Description	Strengths	Weaknesses	Costs	Opportunities	Constraints
NR14A (Site 9)	Rodger Creek overtopping New River Road	Rodger Creek crossing does not provide all weather access	Full span bridge of crossing	Structural	RC_alts.jpg	400-foot span bridge over Rodger Creek with minimum low cord elevation of 2036 ft (tailwater control otherwise) 70 feet wide Raise road embankment and perform other roadway work as required	• Provides 100-year crossing protection • Reduces floodplain elevation and limits upstream somewhat • Potentially reduces scour of left bank downstream due to existing culvert outflows	• Costs	$2.5 M	• MCDOT Partnering. • Alternative would improve moderate habitat to high. • Rodger Creek is part of the Maricopa County regional trail system.	• ROW. • Horizontal curve of roadway. • MCDOT agreements. • Arizona Upland Vegetation area with moderate habitat value. • Sonoran Desert Tortoise habitat. • Headwalls are potentially historic, hand placed river rock. • Culturally, two roads and one pre-historic sites are in the area.
NR14B (Site 9)			Culverts	Structural	See XS plot from RAS (RM 1.749)	4 – 10'x8' 4 – 6'x8' 6 – 4'x8' RCBs with tallest in main channel stepping up into ROB	• Costs maybe half of bridge. • Deal with curve in road better than bridge. • Rigid boundary	• Tailwater control greatly reduces effectiveness of culverts (more not better) • Rigid boundary	$1.63 M	• MCDOT Partnering. • Alternative would improve moderate habitat to high. • Rodger Creek is part of the Maricopa County regional trail system.	• ROW? • Arizona Upland Vegetation area with moderate habitat value. • Sonoran Desert Tortoise habitat. • Headwalls are potentially historic, hand placed river rock. • Culturally, two roads and one pre-historic sites are in the area.

Table D.1: Summary of Measures New River

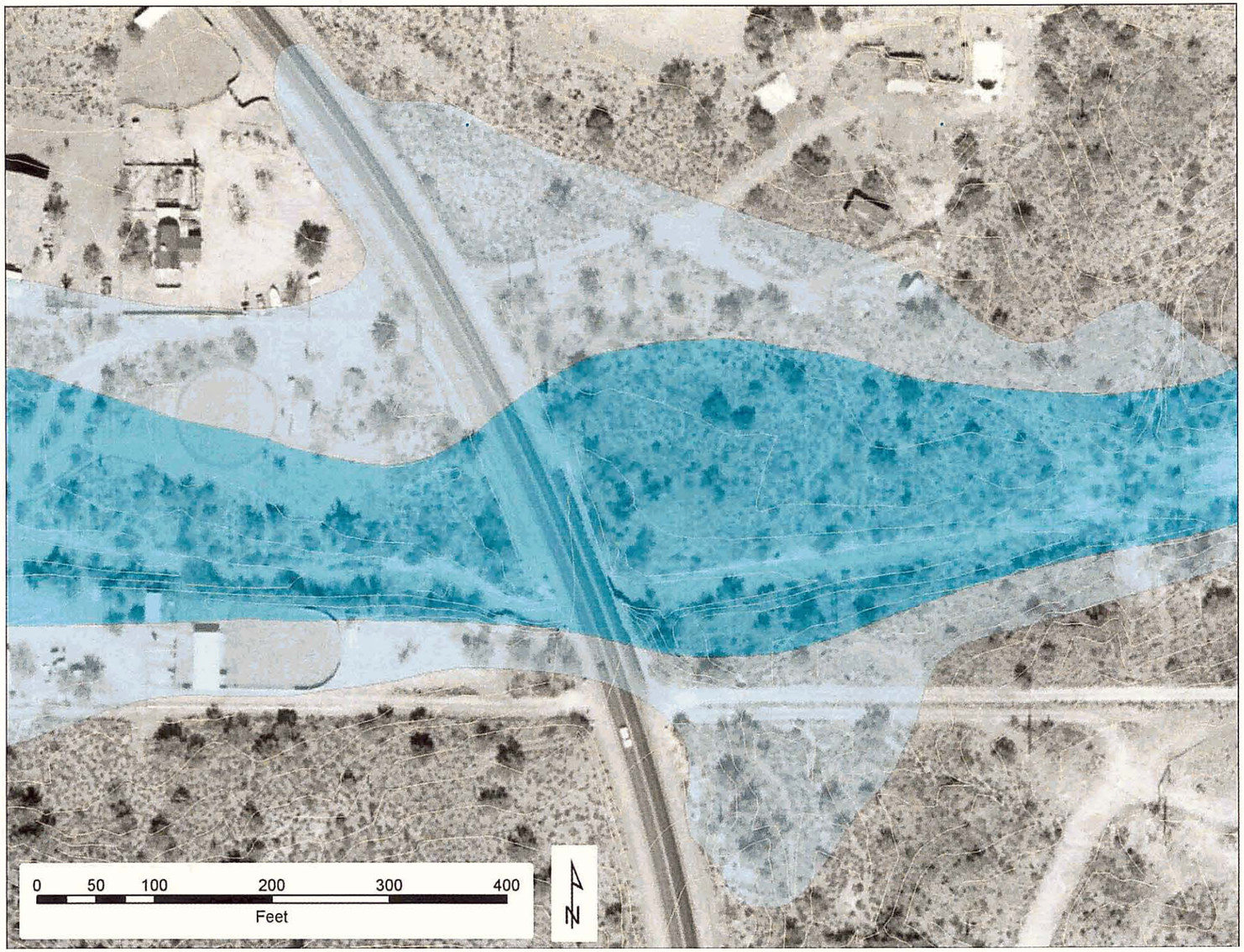
Description Number	Problem	Description of Problem	Alternative	Type of Alternative	Schematic	Narrative Description	Strengths	Weaknesses	Costs	Opportunities	Constraints
NR14C (Site 9)			No Action	No Action	N/A			• Roadway access is still an issue during flood events • Probable "washout" could occur.			
NR15A (Site 10)	Erosion potential of Circle Mountain Road embankment along Cline Creek	Circle Mountain Rd. is unprotected from erosion on LB of Cline Creek upstream of New River Road. Angle of flow from Cline is pointing steeply toward road embankment	Dumped riprap	Structural	circle_mtn_alts .jpg	Approx. 1200 LF well-graded large angular stone along vulnerable portion of embankment Toe down to prevent undermining		• Vegetation is disturbed along edge of road.	$120,000	• Potential aesthetic considerations in a highly visible area can be addressed in design.	• Permitting? • Availability of suitable material • A cultural site is located in the northwest corner of the site.
NR15B (Site 10)			Gabion basket/mattress	Structural	Same as above	Line bank with gabion baskets or mattresses		• Visual impact • Vegetation is disturbed along edge of road.	Similar to riprap	• Potential aesthetic considerations in a highly visible area can be addressed in design.	• Public/visual acceptance • A cultural site is located in the northwest corner of the site
NR15C (Site 10)			Shotcrete	Structural	Same as above	Line bank with shotcrete		• Visual impact • Vegetation is disturbed along edge of road.	Similar to riprap	• Potential aesthetic considerations in a highly visible area can be addressed in design.	• Public/visual acceptance • A cultural site is located in the northwest corner of the site
NR15D (Site 10)			Terraced wall, other more naturalized treatment	Structural	Same as above	Terrace the embankment and treat with a more natural erosion protection	• Visually pleasing	• Vegetation is disturbed along edge of road.	$200,000	• Potential aesthetic considerations in a highly visible area can be addressed in design.	• A cultural site is located in the northwest corner of the site
NR15E (Site 10)			No Action	No Action	N/A						

Table D.1: Summary of Measures New River

Description Number	Problem	Description of Problem	Alternative	Type of Alternative	Schematic	Narrative Description	Strengths	Weaknesses	Costs	Opportunities	Constraints
NR16A (Site 11)	Flow breakouts above New River Road Bridge	Flow breaking out east and west of the bridge. Homes in the floodway.	Construct levees upstream and downstream of the bridge.	Structural	Skunk Bridge_alt1.jpg	Approximately 6200 LF of levees are constructed along both banks confining the flows in Skunk Creek u/s and d/s of the bridge.	• Removes homes from the FW. • Keeps New River Road Passable at the Bridge. • Confines flows to Skunk Creek.	• Cost is high. • Inflows to Skunk along the reach will be difficult to bring back in. • Negative visual impact. • Doesn't solve sedimentation problem.	$4-6 M	• Possible MCDOT cost sharing.	• Acquisition of private property • 404 permit required. • Habitat value moderate the the north of the bridge and high south of the bridge.
NR16B (Site 11)			Construct a secondary diversion west of the bridge.	Structural	Skunk Bridge_alt.jpg	Approximately 4500 LF of secondary channel would be constructed to the west of Skunk Creek	• Removes homes from the FW. • Allows for side drainage. • Keeps New River Rd. Passable at the Bridge.	• Cost is Very High • Doesn't solve sedimentation problem.	$8-10 M	• Possible MCDOT cost sharing • Possibility of reinstating habitat.	• Acquisition of private property and new ROW. • 404 permit required.
NR16C (Site 11)			Improve the inlet and outlet of the bridge.	Structural	Skunk Bridge_alt3.jpg	The inlet and outlet to the New River Rd. Bridge would be widened to allow for better conveyance through the bridge.	• Cost is lower than other alternatives.	• Homes would still be in the FW. • Breakouts above the bridge would continue. • Sediment would continue to accumulate at the bridge.	$2-4 M	• Possible MCDOT cost sharing	• Habitat impacts are much higher than other alternatives. • Acquisition of private property • 404 permit required. • Habitat value moderate the the north of the bridge and high south of the bridge
NR16D (Site 11)			No Action	No Action				• Homes would still be in the FW. • Breakouts above the bridge would continue. Sediment would continue to accumulate at the bridge.			

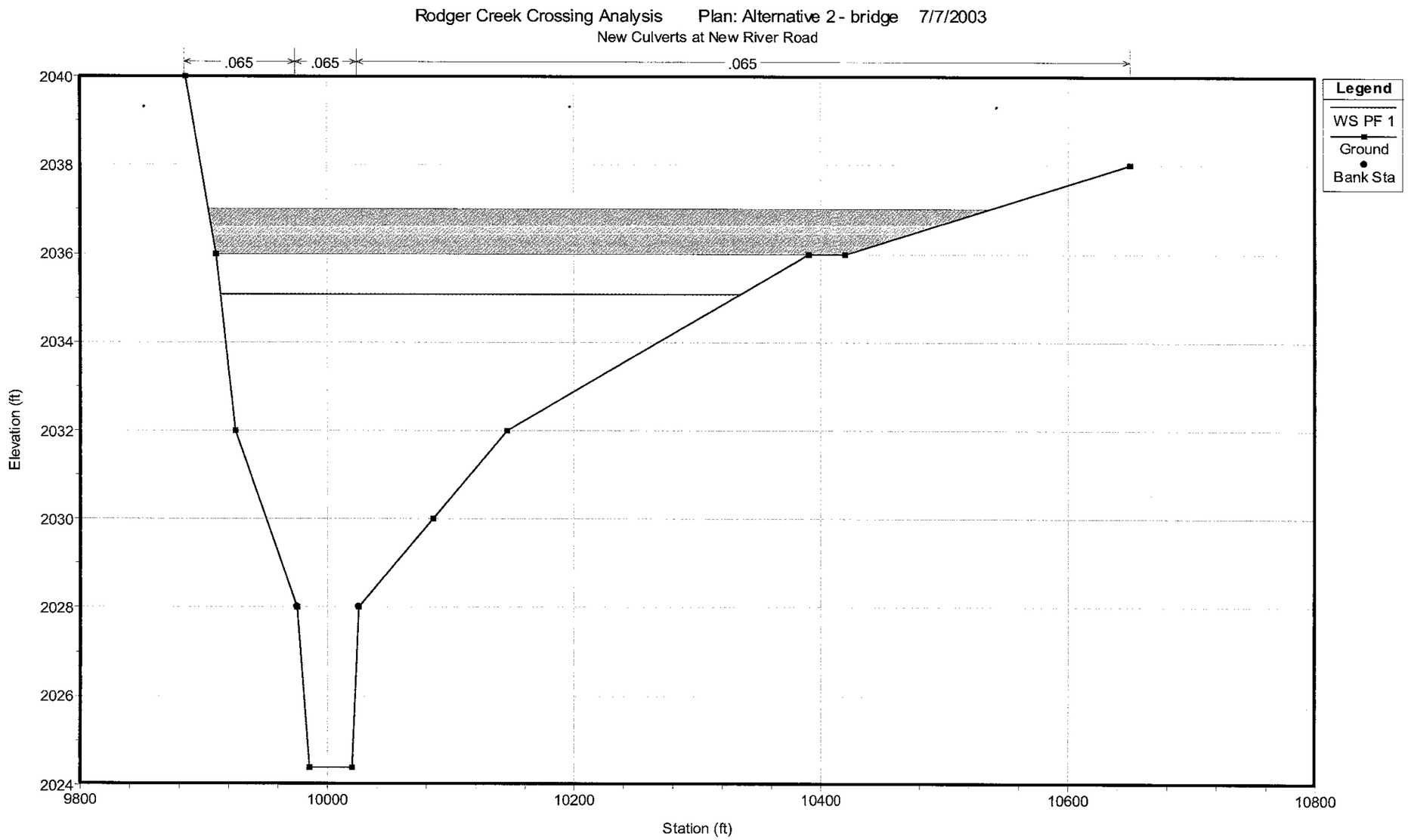
Table D.1: Summary of Measures New River

Description Number	Problem	Description of Problem	Alternative	Type of Alternative	Schematic	Narrative Description	Strengths	Weaknesses	Costs	Opportunities	Constraints
			Flood Response Plan	Non-Structural	N/A		• Low cost yet addresses access and hazard to existing residents	• Does not solve the problems, only addresses how to react to problems.			



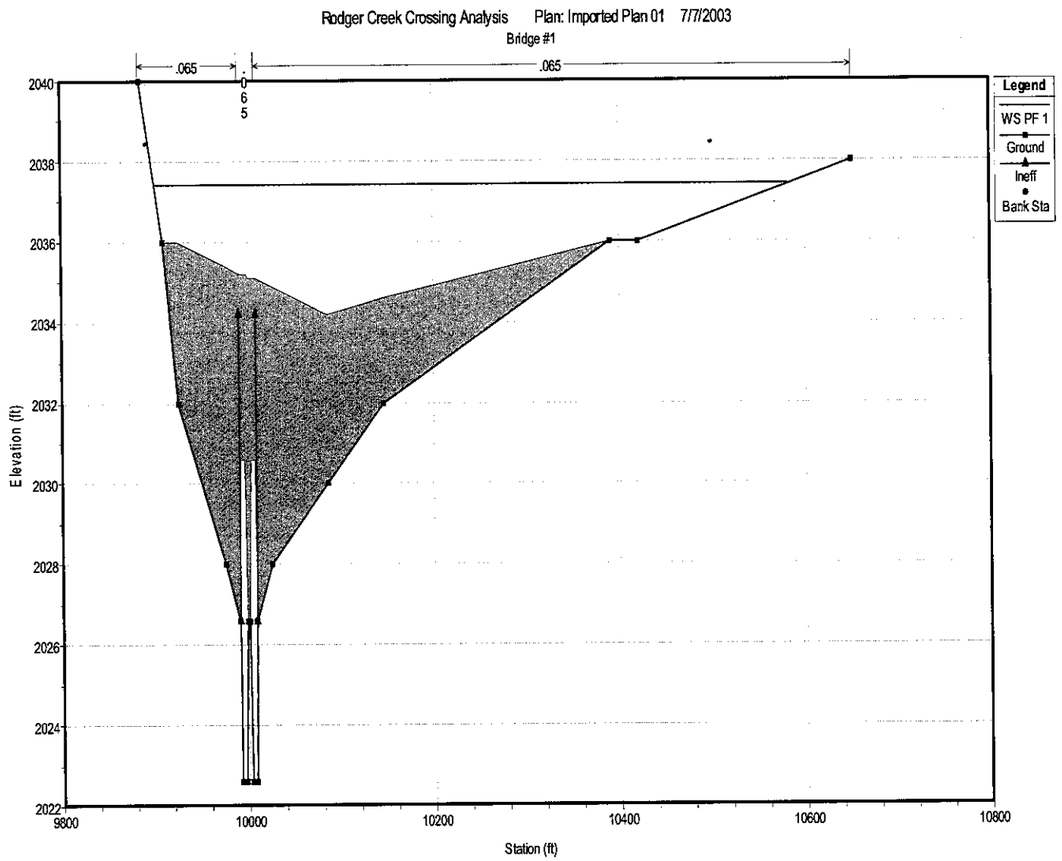
Rodger Creek and New River Road

NR14A

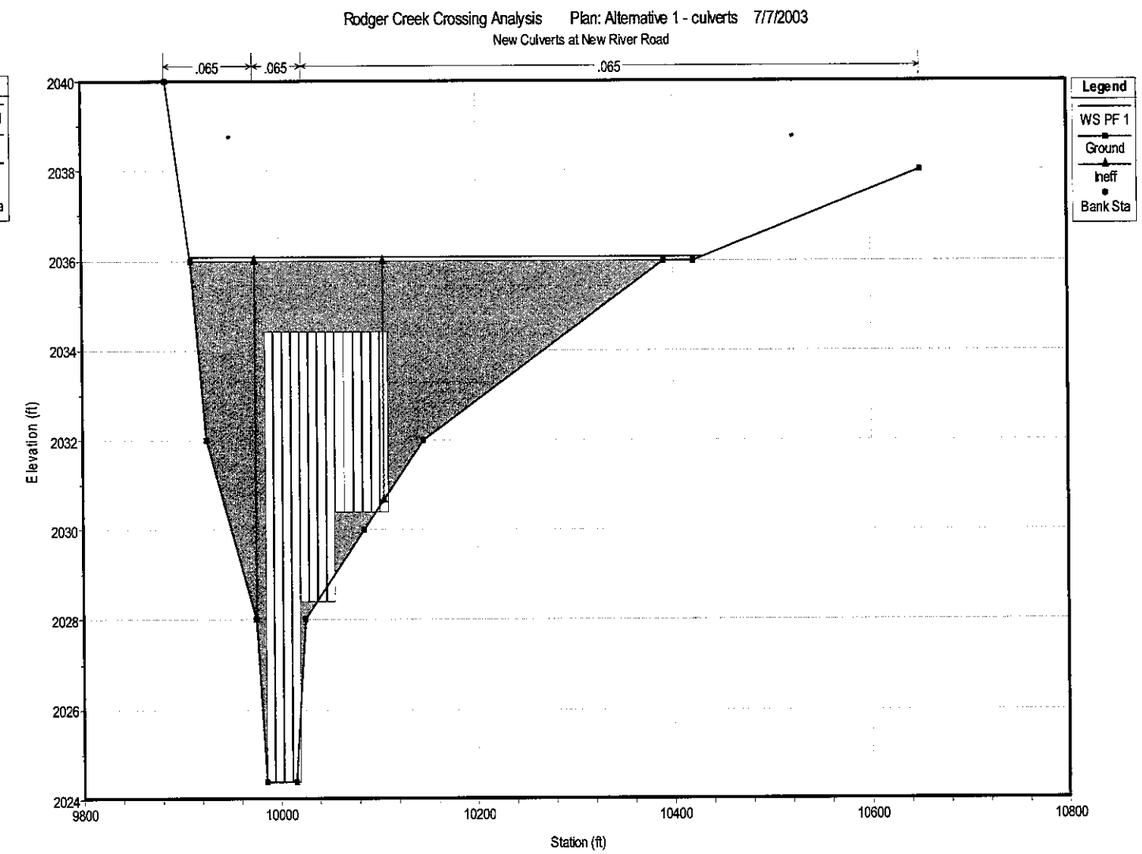


Rodger Creek and New River Road From: RAS (RM 1.749), Spanning Bridge

NR14B



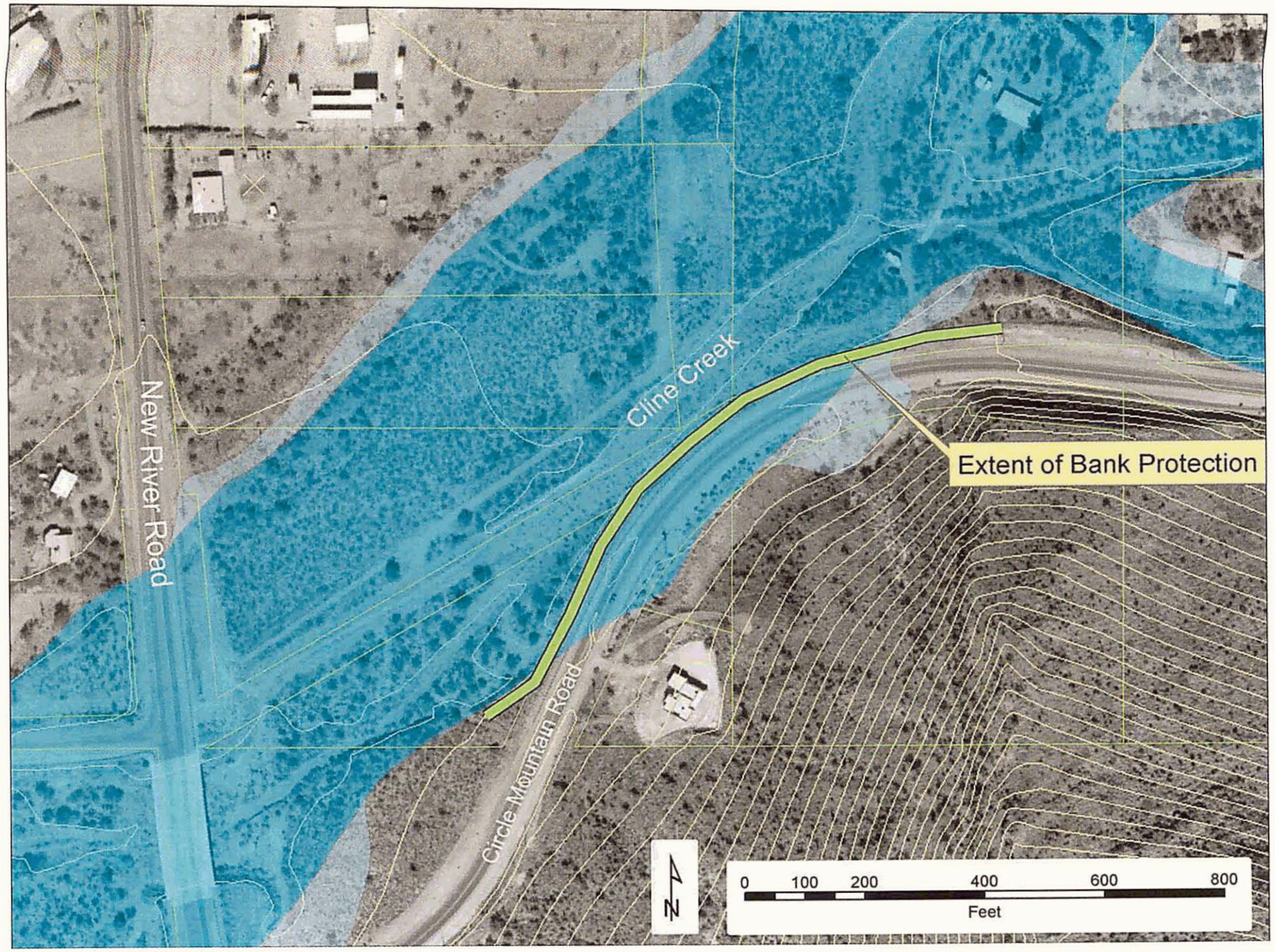
Existing Crossing at New River Road



Culvert Alternative

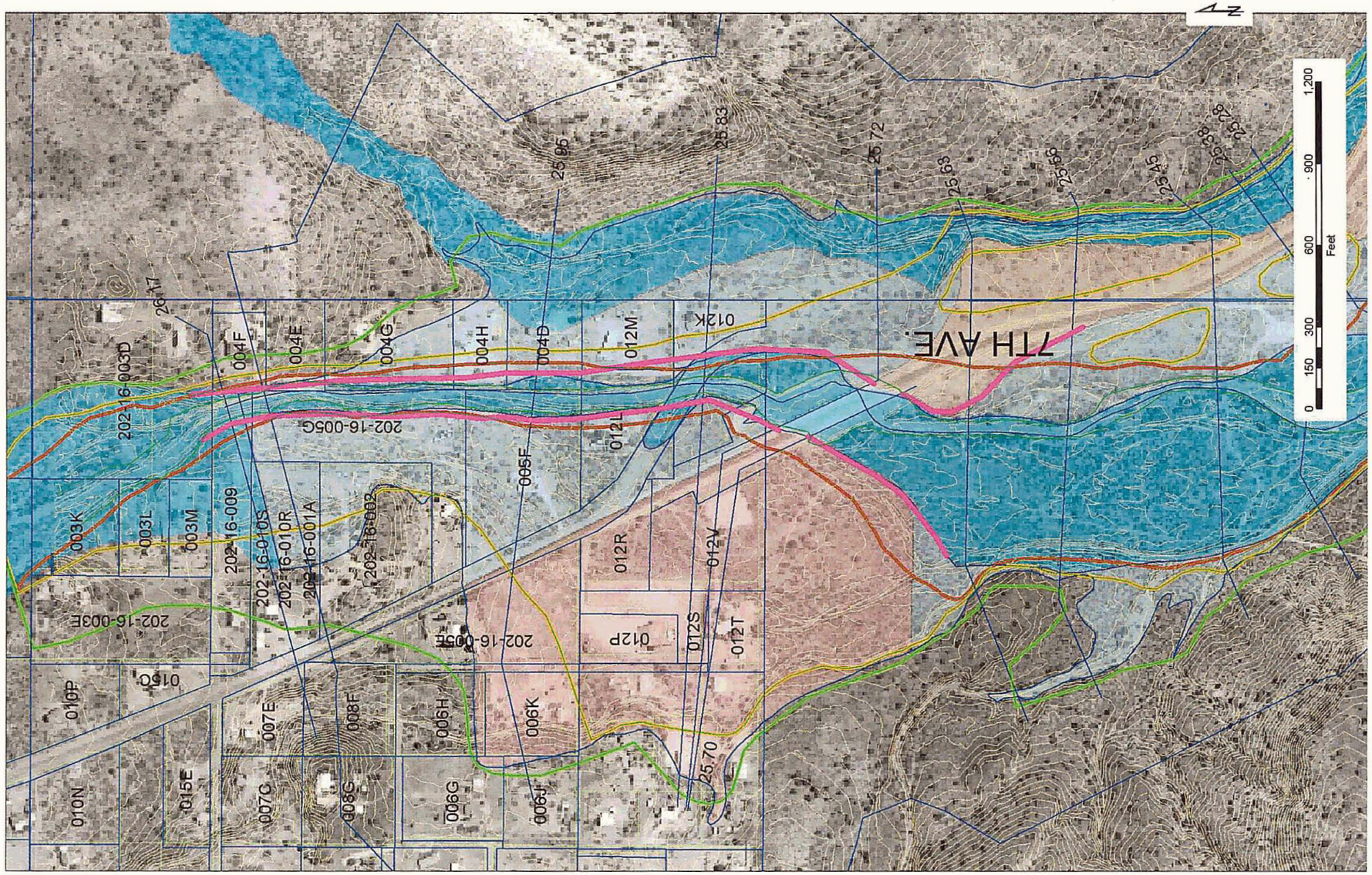
Rodger Creek and New River Road From: RAS (RM 1.749)

NR14B



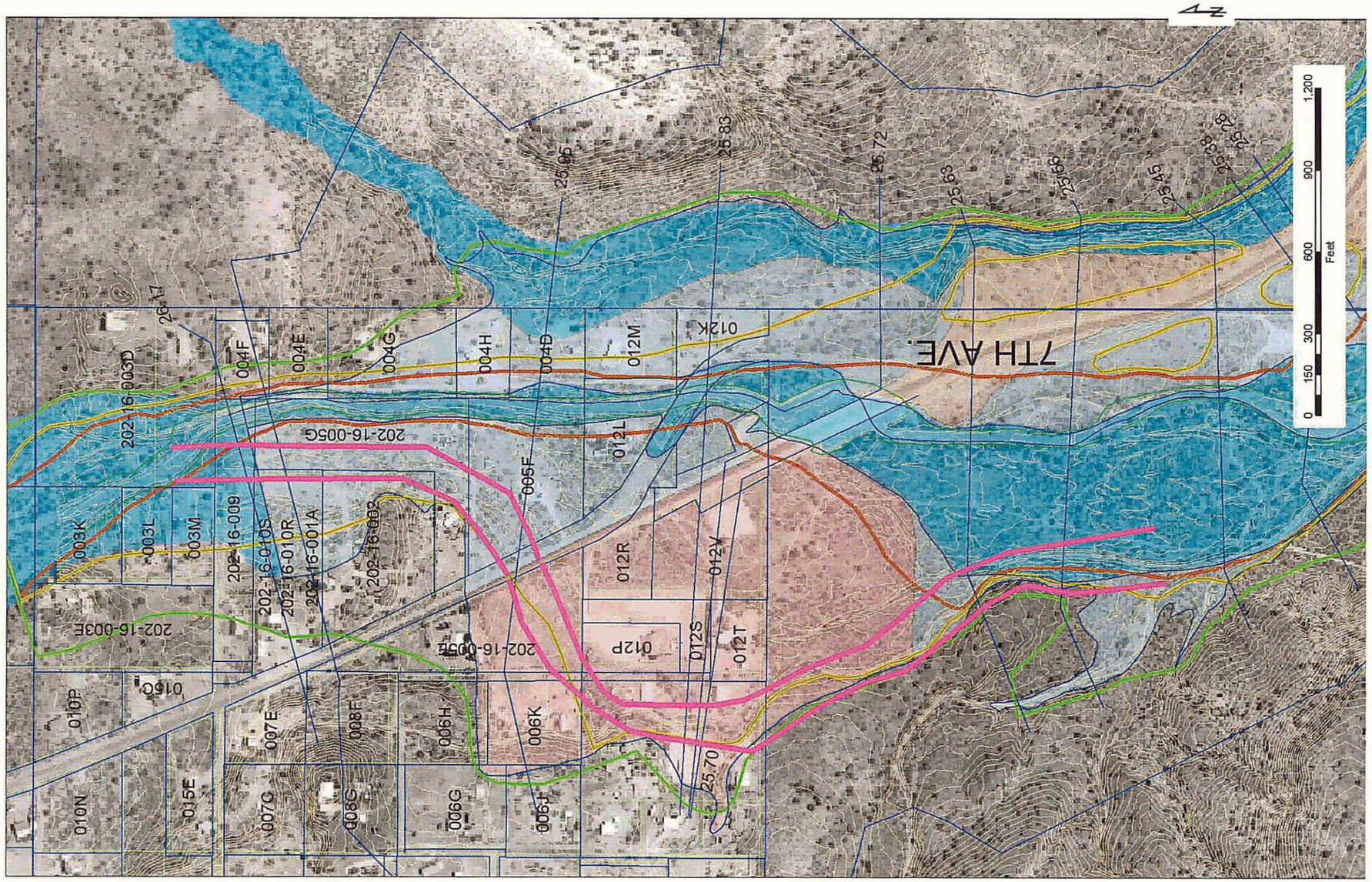
Circle Mountain Road and Cline Creek

NR15A, NR15B, & NR15C



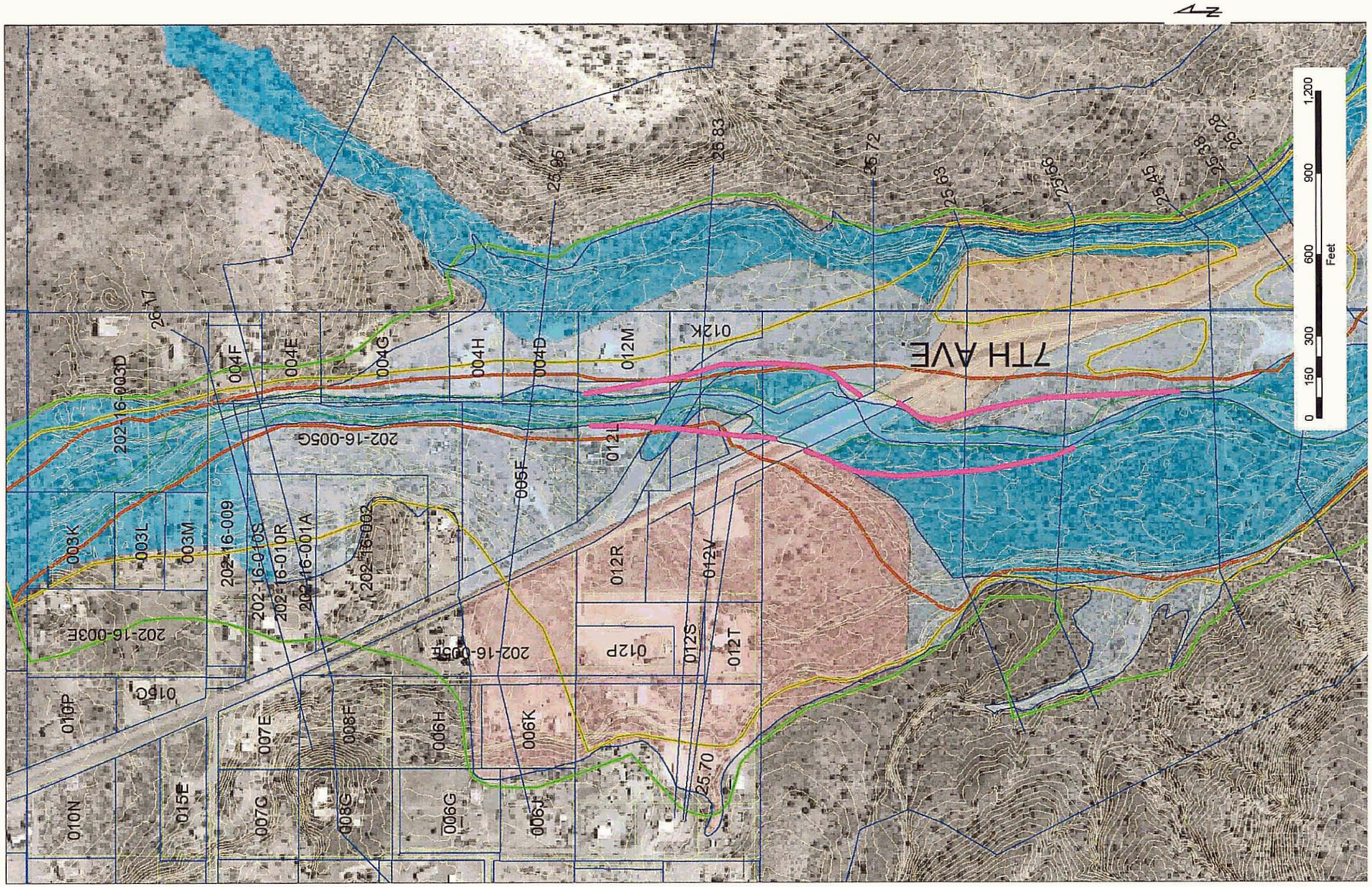
New River Road Bridge Levee Alternative

NR16A



New River Road Bridge Bypass Channel Alternative

NR16B



New River Road Bridge Inlet and Outlet Improvement Alternative

NR16C

APPENDIX E

ADMP-Wide Alternative Measures

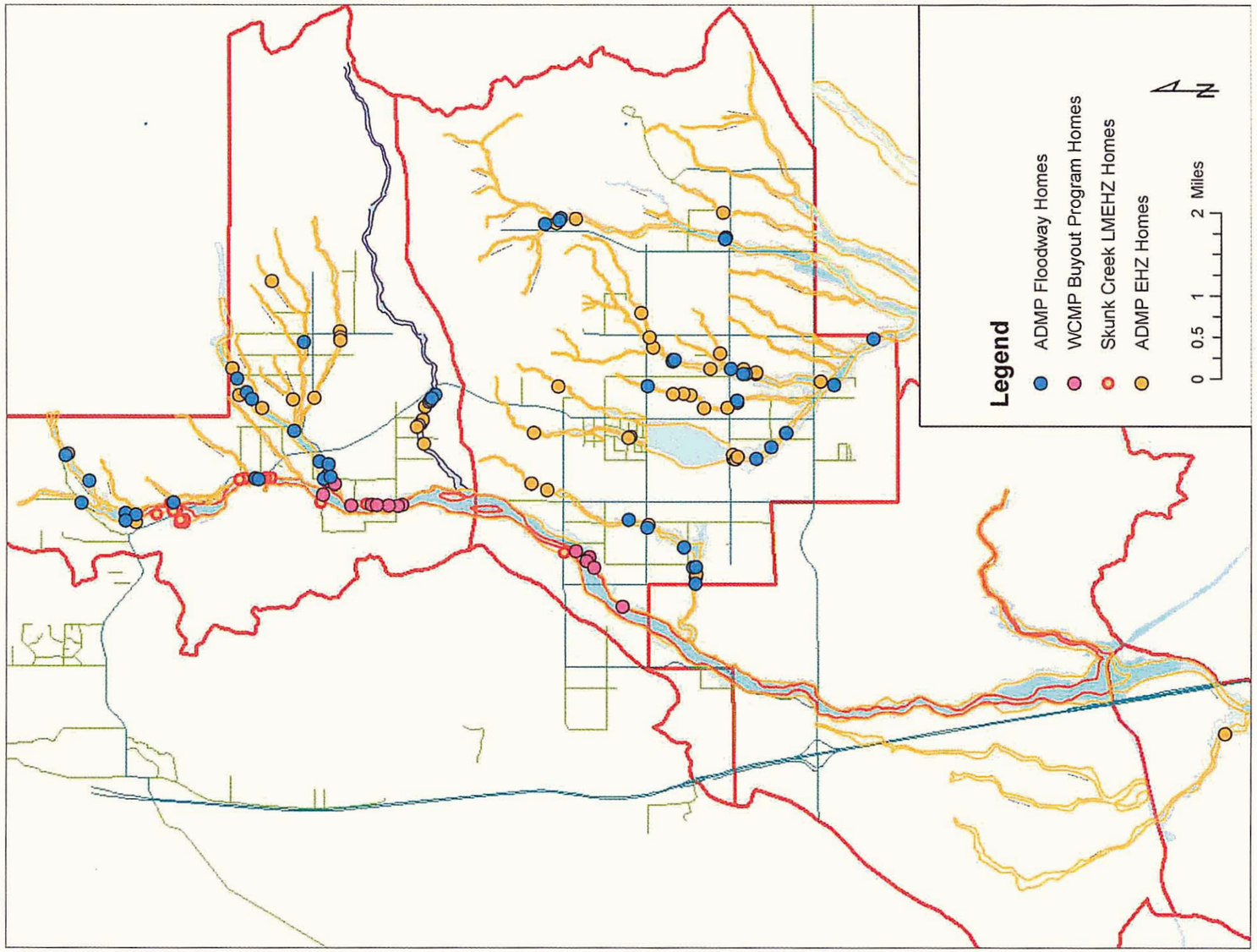
HFW1	Homes in Floodway	Approximately 54 homes planmetrically located in regulatory floodway are at risk due to inundation. Public safety and emergency access concerns.	Rules of Development	Non-Structural	N/A	Adoption of rules of development, along with existing floodplain regulations, avoids future construction within floodway by establishing criteria for setbacks, minimum finished floor elevation, etc.	• Avoids future floodway residence construction	• Does not address existing floodway residences.			
HFW2			Voluntary Buyout Program	Non-Structural	Floodway residences map	Risk assessment to determine severity of hazard at each structure based upon criteria including depth of inundation, velocity, frequency of threshold discharge, erosion potential, lag time, etc.	• Removes current residents from floodway. • Public acceptance, voluntary participation	• Cost • Public acceptance, voluntary participation		• Possibility for wash corridor and/or habitat restoration. • If residence found to be elevated more than 1' above floodway elevation (>2' above BFE), investigate processing of LOMA as non-structural alternative.	• Requires detailed analysis for prioritization of buyout program candidates. Extensive coordination necessary with residents.
HFW3			No Action	No Action	N/A	Notify owners		• Floodway residences remain at risk • Opportunities for sale/ use of floodway properties limited			

HEHZ1	Homes in Erosion Hazard Zone	Approximately 85 homes located in delineated erosion hazard zones are at risk due to sedimentation and erosion. Public safety and emergency access concerns.	Rules of Development	Non-Structural	N/A	Adoption of rules of development, along with existing drainage ordinances and floodplain regulations, addresses future construction within erosion hazard zones by establishing criteria for setbacks, minimum finished floor elevation, etc.	• Avoids future erosion hazard zone residence construction	• Does not address existing floodway residences.			
HEHZ2			Voluntary Buyout Program	Non-Structural	Erosion hazard zone residences map	Risk assessment to determine severity of hazard at each structure based upon criteria including depth/ velocity relationships, erosion potential, etc.	• Removes residents from erosion hazard zone. • Public acceptance, voluntary participation	• Cost • Public acceptance, voluntary participation		• Possibility for wash corridor or habitat restoration	• Requires detailed prioritization of buyout program candidates. • Extensive coordination necessary with residents.
HEHZ3			No Action	No Action	N/A	Notify owners		• Erosion hazard zone residences remain at risk.			
HFWF1	Homes in floodway fringe below base flood elevation (BFE)	Approximately xx homes planmetrically located in regulatory floodway fringe. Of those, yy are below BFE and at risk due to inundation. Public safety and emergency access concerns.	Rules of Development	Non-Structural	N/A	Adoption of rules of development, along with existing floodplain regulations, guides future construction within floodway fringe by establishing criteria for setbacks, minimum finished floor elevation, etc.	• Guides future floodway fringe residence construction	• Does not address existing floodway fringe residences.			
HFWF2			No Action	No Action	N/A	Notify owners		• Floodway fringe residences remain at risk			

RDC1	Roadway dip crossings	Multiple dip roadway crossings throughout the watershed are inundated by minimal flows creating nuisance access issues. Major flows significantly overtop dip sections creating hazardous traffic conditions and public safety concerns.	Install new culverts	Structural	Typical Sections	Install new culverts at key access-critical locations to provide improved access.	• Mitigate threats to public safety during flow events. • Provide improved emergency access. • Avoid frequent need for traffic barricades.	• Cost • ROW • Traffic or flooding solution? • Dip crossings are least friendly to habitat. Bridges are most favorable. Culverts can be designed to enhance wildlife migration.		• MCDOT roads Cost share opportunities	• Numerous locations - requires prioritization
RDC2			Flood Response Plan	Non-Structural	FloodResponse -Cline.pdf	Implement Flood Response Plan to identify/ document flood vulnerability, flood detection, information dissemination, emergency action protocols, post-flood actions/ follow-up, emergency access routes, etc.	• Provides emergency access route information. • Provides action protocols for emergency responders. • Low cost yet addresses access and hazard to existing residents. • Improves safety.	• Does not solve the problems, only addresses how to react to problems.		• Aesthetics can be addressed in design.	
RDC3			Signage or staff gages	Non-Structural	N/A	Install flooded crossing signage or install staff gages indicating depth of flow in crossing.	• Addresses public safety concerns by providing flooding information • Comparatively low cost	• Inaccurate staff gage readings during "washout" or misinterpretation of gage/ signage. • Maintenance of signage/ staff gages. • Liability.			• Numerous locations - requires prioritization

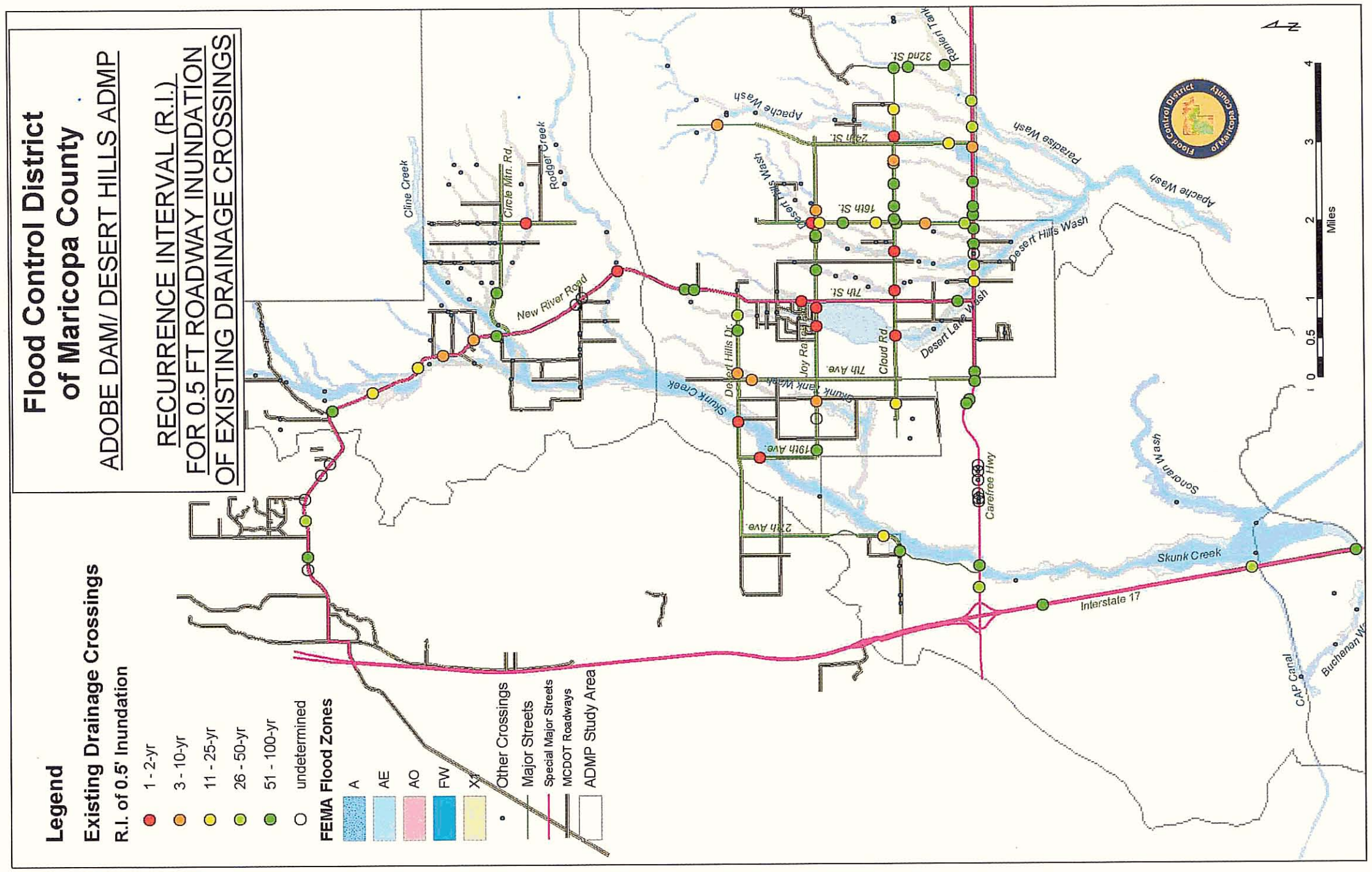
RDC4			No Action	No Action	N/A			• No access when flooded. • Public safety concerns not addressed. • Interrupted emergency response access during flows.			
RUC1	Roadway undersized crossings	Multiple roadway crossings throughout the watershed are inundated by flows overtopping the roadway due to undersized culverts. Major flows significantly overtop roadways creating hazardous traffic conditions and public safety concerns.	Upgrade existing culverts	Structural	Typical Sections	Upgrade existing culverts at prioritized locations to provide improved access.	• Mitigate threats to public safety during flow events. • Provide improved emergency access. • Avoid frequent need for traffic barricades.	• Cost • ROW • Traffic or flooding solution? • Dip crossings are least friendly to habitat. Bridges are most favorable. Culverts can be designed to enhance wildlife migration • Maintenance.		• MCDOT roads Cost share opportunities	• Numerous locations - requires prioritization
RUC2			Flood Response Plan	Non-Structural	FloodResponse -Cline.pdf	Implement Flood Response Plan to identify/ document flood vulnerability, flood detection, information dissemination, emergency action protocols, post-flood actions/ follow-up, emergency access routes, etc.	• Provides emergency access route information. • Provides action protocols for emergency responders. • Low cost yet addresses access and hazard to existing residents.	• Does not solve the problems, only addresses how to react to problems.			

RUC3			Signage or staff gages	Non-Structural	N/A	Install flooded crossing signage or install staff gages indicating depth of flow across roadway.	• Addresses public safety concerns by providing flooding information. • Comparatively low cost. • No ROW costs.	• Inaccurate staff gage readings during "washout" or misinterpretation of gage/ signage. • Maintenance of signage/ staff gages. • Liability.			• Numerous locations - requires prioritization
RUC4			No Action	No Action	N/A			• No access when flooded • Public safety concerns not addressed • Interrupted emergency response access during flows			
FOF1	Fences & Obstructions in Floodplain	Numerous locations with obstructions in floodplain including fences, wall, berms, auxiliary structures, etc. Diverts/ concentrates flow, neighbor-to-neighbor impacts, hydrologic & hydraulic impacts.	Rules of Development	Non-Structural	N/A	Adoption of rules of development, along with existing drainage ordinances and floodplain regulations, guides future construction within floodplain by establishing criteria for setbacks, minimum finished floor elevation, disturbance envelope, culverts, driveways, roads, walls, fences, berms, etc.	• Guides future floodplain construction • Addresses frequent resident complaints about this issue	• Does not address existing floodplain obstructions.			• May require frequent and repetitive enforcement
FOF2			No Action	No Action	N/A	Enforcement		• Residents complaints about neighbor-to-neighbor impacts continues.			



Homes in Hazard

HFW, HEHZ, & HFWF



Roadway Crossings

RDC & RUC

Table E.2: Culvert Data

Stream Name	Street Name	No. of Barrels	Structure Description	Structure Material	Q 2	Q 10	Q 100	Q100 weir	OT Depth	OT Velocity	Q100 in Pipe	Level of Service
Rodger Creek	New River Road	2	8'	CMP	1699	3310	6500	5200	3.2	1.9	1300	< 2-yr
Skunk Creek	19th Avenue	1	n/a	Paved Dip	4900	14000	26500	26500	7.0	9.0	N/A	< 2-yr
Skunk Creek	Desert Hills Drive	1	n/a	Paved Dip	4900	14000	26500	26500	10.0	12.0	N/A	< 2-yr
Skunk Creek	I-17	1	8-barrel box	Bridge	5400	14800	28700	0	0.0	0.0	28700	100-yr
Jonathan Wash	Carefree Highway	4	12' x 6.5'	RCBC	137	674	4772	2900	1.8	4.8	1872	30-yr
Jonathan Wash	7th Street	6	12' x 6.5'	RCBC	341	1192	3406	200	0.5	1.7	3200	90-yr
Jonathan Wash - East Branch	Cloud Road	1	n/a	Paved Dip	148	519	1484	1484	3.0	2.6	N/A	< 2-yr
Jonathan Wash - West Branch	Joy Ranch	1	n/a	Paved Dip	92	320	915	915	1.0	2.0	N/A	< 2-yr
Jonathan Wash - West Branch	Desert Hills Drive	6	3-4' x 3.2', 2-4.5'x3.3'	CMPA & CMP	110	410	992	653	0.9	2.8	339	10-yr
Jonathan Wash - West Branch	New River Road	1	6'	CMP	92	321	645	260	0.5	2.2	386	30-yr
Cline Wash Tributary C8	Circle Mountain Road	1	2 cell arch (est. 24' x 6')	Steel	228	780	2280	60	0.3	1.4	2220	100-yr
Cline Wash Tributary C8	16th Street	1	n/a	Paved Dip	228	800	2280	2280	5.0	11.3	N/A	< 2-yr
Desert Hills Wash	Carefree Highway	3	10' x 5'	RCBC	243	928	4143	2700	2.4	2.2	1420	20-yr
Jonathan Wash East Braid	Joy Ranch Road	4	n/a	Paved Dip	52	182	520	520	0.8	1.8	N/A	2-yr
Desert Hills Wah Tributary 5	Carefree Highway	5	4.5'x6.5'	CMPA	46	155	562	0	-4.0	0.0	562	100-yr
Desert Hills Wah Tributary 6	Carefree Highway	2	10'x5'	RCBC	39	160	417	0	-4.0	0.0	417	100-yr
Skunk Creek Tributary 12	New River Road	2	5'	CMP	499	1230	2255	1930	2.5	4.3	302	< 2-yr
Desert Hills Wah Tributary 6	Cloud Road	3	24"	CMP	17	60	171	102	0.2	1.3	69	10-yr
Desert Hills Wah Tributary 2	16th Street	2	48"	CMP	39	157	437	275	1.3	2.3	162	10-yr
Desert Hills Wah Tributary 1	16th Street	2	24"	CMP	39	160	417	253	0.7	1.6	164	10-yr
Skunk Creek Tributary10B	New River Road	2	5'	CMP	182	640	1820	1406	2.7	4.7	388	5-yr
Apache Wash tributary 7	Carefree Highway	2	4'x10'	RCBC	67	232	641	0	-3.7	0.0	641	100-yr
Paradise Wash West Branch	Cloud Road	1	6'	CMP	101	377	798	610	1.5	2.6	188	5-yr
Paradise Wash West Branch	Carefree Highway	3	5'x10'	RCBC	136	523	1023	558	1.0	2.1	455	10-yr
Skunk Creek	Carefree Highway	1	4-Pier Bridge	Bridge	4872	13837	27283	0	-1.0	0.0	27300	100-yr
Desert Hills Wash Trib 5	Joy Ranch Road	2	48"	CMP	82	286	782	495	0.6	2.6	250	10-yr
Desert Hills West Branch	Joy Rach Road	2	48"	CMP	53	176	692	483	0.5	2.5	209	20-yr
Desert Hills West Branch	Cloud Road	1	n/a	Paved Dip	93	327	933	933	4.8	1.7	N/A	< 2-yr
unnamed	I-17	2	10' x 5'	RCBC	46	160	720	0	0.0	0.0	720	100-yr
unnamed	Carefree Highway	1	2.5'	CMP	17	60	172	0	0.0	0.0		unknown
unnamed	Carefree Highway	1	2'	CMP	3	9	25	0	0.0	0.0		unknown
unnamed	Carefree Highway	1	2.5'	CMP	12	42	120	0	0.0	0.0		unknown
unnamed	Carefree Highway	2	2.5'	CMP	8	27	76	0	0.0	0.0		unknown
unnamed	Carefree Highway	1	2'	CMP	5	18	50	0	0.0	0.0		unknown
unnamed	Carefree Highway	2	5'	CMP	7	26	73	0	0.0	0.0		unknown
Trib to Desert Hills Wash Trib 5	Joy Ranch Road	1	3'	CMP	82	286	782	495	0.6	2.6	37	< 2-yr
unnamed	New River Road	1	4'	CMP	13	45	129	37	0.1	1.2	92	100-yr
unnamed	New River Road	4	4'	RCP	179	365	622	26	0.2	0.4	592	100-yr
unnamed	New River Road	1	2'	CMP	2150	6975	13750	0	0.0	0.0	13750	100-yr
Skunk Tank Wash	7th Ave	2	5'	CMP	157	550	1570	1160	1.5	2.4	413	10-yr
Skunk Tank Wash	Desert Hills Drive	2	5'	CMP	142	497	1420	1010	1.5	1.5	410	10-yr

Table E.2: Culvert Data

Stream Name	Street Name	No. of Barrels	Structure Description	Structure Material	Q 2	Q 10	Q 100	Q100 weir	OT Depth	OT Velocity	Q100 in Pipe	Level of Service
unnamed	Desert Hills Drive	1	2.5' x 2'	CMP	11	37	105	70	0.3	1.2	35	100-yr
unnamed	Cloud Road	3	2.5' x 2'	CMP	59	187	585	520	0.8	2.0	60	2-yr
Skunk Tank Wash	Cloud Road	3	5'	CMP	211	740	2110	1825	2.2	1.8	285	2-yr
unnamed	Cloud Road	1	3' x 2'	ECMP	33	114	325	281	0.5	2.2	42	2-yr
unnamed	Cloud Road	1	6' x 4'	RCBC	92	153	327	55	0.2	1.0	270	100-yr
Paradise Wash Trib	32nd Street	1	3'	CMP	3	11	30	0	0.0	0.0	> 40	100-yr
unnamed	Carefree Highway	2	3.5'	CMP	43	151	432	370	0.5	2.5	60	2-yr
unnamed	Carefree Highway	3	3' x 2'	CMP	7	25	71	0	0.0	0.0	15	100-yr
unnamed	16th Street	2	2'	CMP	4	12	35	27	0.2	1.1	8	100-yr
unnamed	16th Street	2	2'	CMP	4	12	35	27	0.2	1.1	8	100-yr
Desert Hills Wash Trib 5	Cloud Road	2	2'	CMP	20	72	205	163	0.3	1.6	43	100-yr
Apache Wash Trib 7	Cloud Road	2	5'	CMP	54	190	543	256	0.7	1.3	233	10-yr
Apache Wash Trib 7	Cloud Road	1	3'	CMP	54	190	543	256	0.7	1.3	54	2-yr
Desert Hills Wash Tributary 4	16th Street	1	3' x 2'	CMP	33	116	330	300	0.5	2.0	30	2-yr
Desert Hills Wash	Joy Ranch Road	3	2-48", 1-5'	CMP	117	411	1787	1343	1.7	3.2	445	10-yr
Desert Hills Wash	16th Street	1	n/a	Unpaved Dip	117	411	1787	1787	6.9	2.0	N/A	< 2-yr
Desert Hills Wash Tributary 2	Joy Ranch Road	1	48"	CMP	38	180	430	332	1.9	2.6	98	5-yr
Desert Hills Wash Tributary 2	16th Street	1	48"	CMP	38	180	430	306	1.2	3.0	124	5-yr
Desert Hills Wash Tributary 4 South	16th Street	2	48"	CMP	48	169	532	322	1.0	1.1	210	10-yr
Desert Hills Wash	Cloud Road	1	n/a	Paved Dip	260	1006	3669	3669	4.8	7.0	N/A	< 2-yr
Apache Wash	Carefree Highway	3	5' x 7'	RCBC	505	1748	7213	4215	2.0	4.3	1486	10-yr
Paradise Wash	Carefree Highway	4	8' x 8'	RCBC	256	1300	4179	2000	1.0	3.0	2200	20-yr
Apache Wash	Cloud Road	0	n/a	Paved Dip	515	1943	7213	7213	5.2	5.2	N/A	< 2-yr
Paradise Wash Left Braid	32nd Street/Cloud Road	2	8' x 6'	RCBC	224	852	1701	0	-5.5	0.0	1701	100-yr
Ranier Tank Wash	32nd Street	9	2.5' to 6' diameter	CMP	207	726	2074	85	0.2	1.0	2000	100-yr
unnamed	Carefree Highway	4	1'	CMP	5	63	233	200	0.4	3.6	35	100-yr
unnamed	Carefree Highway	2	2'	CMP	26	91	260	0	0.0	0.0	58	100-yr
unnamed	Carefree Highway	2	2'	CMP	5	17	49	5	0.1	0.5	45	100-yr
unnamed	Carefree Highway	2	5'	CMP	4	13	38	0	0.0	0.0	> 40	100-yr
unnamed	Carefree Highway	1	3.5'	CMP	100	350	1000	970	0.8	2.6	30	50-yr
unnamed	New River Road	2	10' x 5'	RCBC	228	797	2277	980	1.0	3.5	1300	30-yr
unnamed	New River Road	3	12' x 5.5'	RCBC	407	1424	4070	1520	0.8	3.2	2550	30-yr
Skunk Creek	I-17	0	none	N/A	0	0	6000	6000	2.5	0.0	N/A	50-yr
Skunk Creek Tributary 10A-1	New River Road	2	5'	CMP	187	529	1215	642	0.8	2.3	364	5-yr
unnamed	New River Road		unknown	unknown	430	1500	4310	0	0.0	0.0		unknown
unnamed	New River Road		unknown	unknown	53	186	531	0	0.0	0.0		unknown
unnamed	New River Road		unknown	unknown	9	33	93	0	0.0	0.0		unknown
unnamed	New River Road		unknown	unknown	88	308	880	0	0.0	0.0		unknown
unnamed	New River Road		unknown	unknown	48	167	478	0	0.0	0.0		unknown
unnamed	New River Road		unknown	unknown	12	41	117	0	0.0	0.0		unknown
unnamed trib of Skunk Tank Wash	Cloud Road		unknown	unknown	27	93	266	0	0.0	0.0		unknown
unnamed trib of Desert Hills Wash	Carefree Hwy		unknown	unknown	9	31	89	0	0.0	0.0		unknown

Table E.2: Culvert Data

Stream Name	Street Name	No. of Barrels	Structure Description	Structure Material	Q 2	Q 10	Q 100	Q100 weir	OT Depth	OT Velocity	Q100 in Pipe	Level of Service
Skunk Creek	Cloud/27th Ave	3	6'	CMP	4900	13800	27300	18000	2.8	3.5	N/A	10-yr
East Fork Desert Lake	7th Street	1	N/A	Paved Dip	112	430	1330	1330	1.3	2.1	N/A	2-yr
Skunk Creek	New River Road	0	Bridge	Bridge	1463	4063	7840	3700	2.2	5.1	4000	10-yr
West Branch Apache Wash	26th Street	2	5'	CMP	180	690	2191	1730	1.8	3.8	360	5-yr
Apache Wash	24th Street	2	2.5'x5'	ERCP	515	1943	7213	7000	2.0	7.0	200	< 2-yr

APPENDIX F

Measure Evaluation Checklists

Adobe Dam/ Desert Hills Area Drainage Master Plan
Alternative Formulation - Measure Evaluation Checklist
Site Location: PSC1 (Site1) - Skunk Creek/ Pinnacle Peak Road & 35th Avenue

Measure Evaluation Criteria	Assessment Scale			Structural Measures	Non-Structural Measures	No Action
				PSC1A - Levees/ Grade Control	N/A	PSC1B
Public Safety/ Physical System						
Public safety enhancement?	low	medium	high	high		low
Level of damage reduction?	low	medium	high	low		low
Access-critical location?	no	maybe	yes	yes		yes
Upstream/ downstream impacts?	minimal	average	significant	significant		- significant
Comparative size of watercourse?	small	medium	large	large		large
Eliminates flood problem?	no	maybe	yes	yes		no
Eliminates erosion problem?	no	maybe	yes	yes		no
Costs						
Cost of implementation?	$	$$	$$$	$$$		N/A
ROW acquisition necessary?	no	maybe	yes	no		no
Condemnation required?	no	maybe	yes	no		no
Maintenance costs?	$	$$	$$$	$$$		N/A
Potential cost sharing partner?	no	maybe	yes	yes		no
Comparative benefit:cost?	low	medium	high	low		low
Environmental/ Social						
Addresses public complaint/ concern?	no	maybe	yes	maybe		no
Public support?	low	medium	high	high		low
Agency acceptance?	low	medium	high	high		low
Environmental impacts?	+	none	-	+		none
Multi-use opportunities?	no	maybe	yes	maybe		no
Flood control method compatible with setting?	no	maybe	yes	yes		no
Acceptability of measure	**accept**	**-**	**not accept**	**accept**		**not accept**

Adobe Dam/ Desert Hills Area Drainage Master Plan
Alternative Formulation - Measure Evaluation Checklist
Site Location: PSC2 (Site 2) - Skunk Creek downstream of CAP

Measure Evaluation Criteria	Assessment Scale			Structural Measures	Non-Structural Measures	No Action
				PSC2A - Levees	PSC2B - Floodplain Delineation	PSC2C
Public Safety/ Physical System						
Public safety enhancement?	low	medium	high	high	low	low
Level of damage reduction?	low	medium	high	high	low	low
Access-critical location?	no	maybe	yes	no	no	no
Upstream/ downstream impacts?	minimal	average	significant	significant	- significant	- significant
Comparative size of watercourse?	small	medium	large	large	large	large
Eliminates flood problem?	no	maybe	yes	yes	no	no
Eliminates erosion problem?	no	maybe	yes	yes	no	no
Costs						
Cost of implementation?	$	$$	$$$	$$$	$	N/A
ROW acquisition necessary?	no	maybe	yes	yes	no	no
Condemnation required?	no	maybe	yes	yes	no	no
Maintenance costs?	$	$$	$$$	$	$	N/A
Potential cost sharing partner?	no	maybe	yes	yes	maybe	no
Comparative benefit:cost?	low	medium	high	medium	low	low
Environmental/ Social						
Addresses public complaint/ concern?	no	maybe	yes	no	no	no
Public support?	low	medium	high	medium	low	low
Agency acceptance?	low	medium	high	high	low	low
Environmental impacts?	+	none	-	+	none	none
Multi-use opportunities?	no	maybe	yes	maybe	no	no
Flood control method compatible with setting?	no	maybe	yes	yes	maybe	no
Acceptability of measure	**accept**	**-**	**not accept**	**accept**	**not accept**	**not accept**

Adobe Dam/ Desert Hills Area Drainage Master Plan
Alternative Formulation - Measure Evaluation Checklist
Site Location: PNC3 (Site 2) - Skunk Creek upstream of CAP

Measure Evaluation Criteria	Assessment Scale			Structural Measures			Non-Structural Measures	No Action
				PNC3A - Basins (Meter)	PNC3B - Widen overchutes (Flume)	PNC3C - Levees	N/A	PNC3D
Public Safety/ Physical System								
Public safety enhancement?	low	medium	high	high	low	high		low
Level of damage reduction?	low	medium	high	high	low	high		low
Access-critical location?	no	maybe	yes	yes	yes	yes		yes
Upstream/ downstream impacts?	minimal	average	significant	significant	significant	significant		- significant
Comparative size of watercourse?	small	medium	large	large	large	large		large
Eliminates flood problem?	no	maybe	yes	yes	no	yes		no
Eliminates erosion problem?	no	maybe	yes	yes	no	yes		no
Costs								
Cost of implementation?	$	$$	$$$	$$$	$$$	$$$		N/A
ROW acquisition necessary?	no	maybe	yes	yes	no	yes		no
Condemnation required?	no	maybe	yes	yes	no	yes		no
Maintenance costs?	$	$$	$$$	$$$	$	$$		N/A
Potential cost sharing partner?	no	maybe	yes	yes	yes	yes		no
Comparative benefit:cost?	low	medium	high	medium	low	medium		low
Environmental/ Social								
Addresses public complaint/ concern?	no	maybe	yes	maybe	no	maybe		no
Public support?	minimal	average	significant	minimal	minimal	average		minimal
Agency acceptance?	low	medium	high	low	low	high		low
Environmental impacts?	+	none	-	-	none	+		none
Multi-use opportunities?	no	maybe	yes	yes	no	yes		no
Flood control method compatible with setting?	no	maybe	yes	yes	yes	yes		no
Acceptability of measure	**accept**	**-**	**not accept**	**not accept**	**not accept**	**accept**		**not accept**

Adobe Dam/ Desert Hills Area Drainage Master Plan
Alternative Formulation - Measure Evaluation Checklist
Site Location: DH4 (Site 3) - Skunk Creek/ 27th Avenue & Cloud Road

Measure Evaluation Criteria	Assessment Scale			Structural Measures				Non-Structural Measures	No Action
				DH4A - Roadway realignment	DH4B - Roadway realignment w/ FB	DH4C - Bridge	DH4D - Protection of exist. alignment	N/A	DH4E
Public Safety/ Physical System									
Public safety enhancement?	low	medium	high	high	high	high	low		low
Level of damage reduction?	low	medium	high	high	high	high	low		low
Access-critical location?	no	maybe	yes	yes	yes	yes	yes		yes
Upstream/ downstream impacts?	minimal	average	significant	minimal	minimal	minimal	minimal		minimal
Comparative size of watercourse?	small	medium	large	large	large	large	large		large
Eliminates flood problem?	no	maybe	yes	yes	yes	yes	no		no
Eliminates erosion problem?	no	maybe	yes	yes	yes	yes	yes		no
Costs									
Cost of implementation?	$	$$	$$$	$$	$$$	$$$	$$$		N/A
ROW acquisition necessary?	no	maybe	yes	yes	yes	yes	no		no
Condemnation required?	no	maybe	yes	yes	yes	yes	no		no
Maintenance costs?	$	$$	$$$	$$	$$	$$$	$$$		N/A
Potential cost sharing partner?	no	maybe	yes	yes	yes	yes	yes		no
Comparative benefit:cost?	low	medium	high	medium	low	low	low		low
Environmental/ Social									
Addresses public complaint/ concern?	no	maybe	yes	yes	yes	yes	no		no
Public support?	minimal	average	significant	average	minimal	minimal	minimal		minimal
Agency acceptance?	low	medium	high	high	low	low	low		low
Environmental impacts?	+	none	-	+	+	-	-		none
Multi-use opportunities?	no	maybe	yes	no	no	no	no		no
Flood control method compatible with setting?	no	maybe	yes	yes	yes	no	no		no
Acceptability of measure	**accept**	**-**	**not accept**	**accept**	**not accept**	**not accept**	**not accept**		**not accept**

Adobe Dam/ Desert Hills Area Drainage Master Plan
Alternative Formulation - Measure Evaluation Checklist
Site Location: DH5 (Site 4) - Skunk Tank Wash

Measure Evaluation Criteria	Assessment Scale			Structural Measures		Non-Structural Measures	No Action
				DH5B - Interceptor channel/ basin	DH5C - Online basin	DH5A - Revised STW hydrology	DH5D
Public Safety/ Physical System							
Public safety enhancement?	low	medium	high	low	medium	low	low
Level of damage reduction?	low	medium	high	low	low	low	low
Access-critical location?	no	maybe	yes	maybe	no	maybe	maybe
Upstream/ downstream impacts?	minimal	average	significant	average	average	minimal	- significant
Comparative size of watercourse?	small	medium	large	medium	medium	medium	medium
Eliminates flood problem?	no	maybe	yes	maybe	yes	no	no
Eliminates erosion problem?	no	maybe	yes	no	yes	no	no
Costs							
Cost of implementation?	$	$$	$$$	$$$	$$$	$	N/A
ROW acquisition necessary?	no	maybe	yes	yes	yes	no	no
Condemnation required?	no	maybe	yes	yes	yes	no	no
Maintenance costs?	$	$$	$$$	$$$	$$$	$	N/A
Potential cost sharing partner?	no	maybe	yes	no	no	no	no
Comparative benefit:cost?	low	medium	high	low	low	medium	low
Environmental/ Social							
Addresses public complaint/ concern?	no	maybe	yes	yes	yes	maybe	no
Public support?	low	medium	high	medium	medium	low	low
Agency acceptance?	low	medium	high	medium	medium	low	low
Environmental impacts?	+	none	-	+	-	none	none
Multi-use opportunities?	no	maybe	yes	yes	maybe	none	no
Flood control method compatible with setting?	no	maybe	yes	yes	yes	N/A	no
Acceptability of measure	**accept**	**-**	**not accept**	**accept**	**accept**	**not accept**	**not accept**

Adobe Dam/ Desert Hills Area Drainage Master Plan
Alternative Formulation - Measure Evaluation Checklist
Site Location: DH6 (Site 4) - Desert Lake (ASLD Parcel)

Measure Evaluation Criteria	Assessment Scale			Structural Measures	Non-Structural Measures	No Action
				DH6A - STW/ ASLD detention basin	DH6B - F/P Delineation	DH6C
Public Safety/ Physical System						
Public safety enhancement?	low	medium	high	high	low	low
Level of damage reduction?	low	medium	high	high	low	low
Access-critical location?	no	maybe	yes	yes	yes	yes
Upstream/ downstream impacts?	minimal	average	significant	significant	- significant	- significant
Comparative size of watercourse?	small	medium	large	small	small	small
Eliminates flood problem?	no	maybe	yes	yes	no	no
Eliminates erosion problem?	no	maybe	yes	yes	no	no
Costs						
Cost of implementation?	$	$$	$$$	$$$	$	N/A
ROW acquisition necessary?	no	maybe	yes	yes	no	no
Condemnation required?	no	maybe	yes	yes	no	no
Maintenance costs?	$	$$	$$$	$$	$	N/A
Potential cost sharing partner?	no	maybe	yes	maybe	no	no
Comparative benefit:cost?	low	medium	high	low	low	low
Environmental/ Social						
Addresses public complaint/ concern?	no	maybe	yes	yes	no	no
Public support?	low	medium	high	high	low	low
Agency acceptance?	low	medium	high	high	low	low
Environmental impacts?	+	none	-	-	none	none
Multi-use opportunities?	no	maybe	yes	yes	no	no
Flood control method compatible with setting?	no	maybe	yes	yes	no	no
Acceptability of measure	**accept**	**-**	**not accept**	**accept**	**not accept**	**not accept**

Adobe Dam/ Desert Hills Area Drainage Master Plan
Alternative Formulation - Measure Evaluation Checklist
Site Location: DH7 (Site 5) - Desert Lake Wash downstream of Cloud Road

Measure Evaluation Criteria	Assessment Scale			Structural Measures				Non-Structural Measures	No Action
				DH7A - Pre-ASLD parcel development	DH7B - W/ ASLD parcel development	DH7C - Off-Line Bsn on ASLD parcel	DH7D - Linear On-line, Joy Ranch Bsn	N/A	DH7E
Public Safety/ Physical System									
Public safety enhancement?	low	medium	high	high	high	high	medium		low
Level of damage reduction?	low	medium	high	high	high	high	low		low
Access-critical location?	no	maybe	yes	yes	yes	yes	yes		yes
Upstream/ downstream impacts?	minimal	average	significant	significant	significant	significant	significant		- significant
Comparative size of watercourse?	small	medium	large	medium	medium	medium	medium		medium
Eliminates flood problem?	no	maybe	yes	yes	yes	yes	no		no
Eliminates erosion problem?	no	maybe	yes	yes	yes	yes	no		no
Costs									
Cost of implementation?	$	$$	$$$	$$$	$$$	$$$	$$$		N/A
ROW acquisition necessary?	no	maybe	yes	yes	yes	yes	yes		no
Condemnation required?	no	maybe	yes	yes	yes	yes	yes		no
Maintenance costs?	$	$$	$$$	$$	$$	$$	$$		N/A
Potential cost sharing partner?	no	maybe	yes	maybe	maybe	maybe	maybe		no
Comparative benefit:cost?	low	medium	high	low	low	low	low		low
Environmental/ Social									
Addresses public complaint/ concern?	no	maybe	yes	yes	yes	yes	maybe		no
Public support?	low	medium	high	high	high	high	medium		low
Agency acceptance?	low	medium	high	low	low	high	low		low
Environmental impacts?	+	none	-	+	+	+	+		none
Multi-use opportunities?	no	maybe	yes	yes	yes	yes	yes		no
Flood control method compatible with setting?	no	maybe	yes	yes	yes	yes	yes		no
Acceptability of measure	**accept**	**-**	**not accept**	**not accept**	**not accept**	**accept**	**not accept**		**not accept**

Adobe Dam/ Desert Hills Area Drainage Master Plan
Alternative Formulation - Measure Evaluation Checklist
Site Location: DH8 (Site 5) - East fork Desert Lake Wash / 7th Street

Measure Evaluation Criteria	Assessment Scale			Structural Measures	Non-Structural Measures	No Action
				DH8A - 100-yr Channel/ Culverts @ 7th St	N/A	DH8B
Public Safety/ Physical System						
Public safety enhancement?	low	medium	high	high		low
Level of damage reduction?	low	medium	high	medium		low
Access-critical location?	no	maybe	yes	yes		yes
Upstream/ downstream impacts?	minimal	average	significant	average		- significant
Comparative size of watercourse?	small	medium	large	small		small
Eliminates flood problem?	no	maybe	yes	yes		no
Eliminates erosion problem?	no	maybe	yes	yes		no
Costs						
Cost of implementation?	$	$$	$$$	$$$		N/A
ROW acquisition necessary?	no	maybe	yes	yes		no
Condemnation required?	no	maybe	yes	yes		no
Maintenance costs?	$	$$	$$$	$$		N/A
Potential cost sharing partner?	no	maybe	yes	maybe		no
Comparative benefit:cost?	low	medium	high	low		low
Environmental/ Social						
Addresses public complaint/ concern?	no	maybe	yes	yes		no
Public support?	low	medium	high	high		low
Agency acceptance?	low	medium	high	high		low
Environmental impacts?	+	none	-	+		none
Multi-use opportunities?	no	maybe	yes	no		no
Flood control method compatible with setting?	no	maybe	yes	yes		no
Acceptability of measure	**accept**	**-**	**not accept**	**accept**		**not accept**

Adobe Dam/ Desert Hills Area Drainage Master Plan
Alternative Formulation - Measure Evaluation Checklist
Site Location: DH9 (Site N/A) - Desert Hills Wash/ Cloud Road & 12th Street

Measure Evaluation Criteria	Assessment Scale			Structural Measures	Non-Structural Measures	No Action
				DH9A - Channel/ Culvert/ Offline basin	N/A	DH9B
Public Safety/ Physical System						
Public safety enhancement?	low	medium	high	medium		low
Level of damage reduction?	low	medium	high	medium		low
Access-critical location?	no	maybe	yes	yes		yes
Upstream/ downstream impacts?	minimal	average	significant	average		- significant
Comparative size of watercourse?	small	medium	large	small		small
Eliminates flood problem?	no	maybe	yes	yes		no
Eliminates erosion problem?	no	maybe	yes	yes		no
Costs						
Cost of implementation?	$	$$	$$$	$$$		N/A
ROW acquisition necessary?	no	maybe	yes	yes		no
Condemnation required?	no	maybe	yes	yes		no
Maintenance costs?	$	$$	$$$	$$		N/A
Potential cost sharing partner?	no	maybe	yes	no		no
Comparative benefit:cost?	low	medium	high	low		low
Environmental/ Social						
Addresses public complaint/ concern?	no	maybe	yes	yes		no
Public support?	low	medium	high	high		low
Agency acceptance?	low	medium	high	low		low
Environmental impacts?	+	none	-	+		none
Multi-use opportunities?	no	maybe	yes	yes		no
Flood control method compatible with setting?	no	maybe	yes	yes		no
Acceptability of measure	**accept**	**-**	**not accept**	**not accept**		**accept**

Adobe Dam/ Desert Hills Area Drainage Master Plan
Alternative Formulation - Measure Evaluation Checklist
Site Location: DH10 (Site 6) - Carefree Highway/ Central Avenue to East of 24th Street

Measure Evaluation Criteria	Assessment Scale			Structural Measures	Non-Structural Measures	No Action
				DH10A - Culverts	N/A	DH10B
Public Safety/ Physical System						
Public safety enhancement?	low	medium	high	medium		low
Level of damage reduction?	low	medium	high	medium		low
Access-critical location?	no	maybe	yes	yes		yes
Upstream/ downstream impacts?	minimal	average	significant	average		minimal
Comparative size of watercourse?	small	medium	large	large		large
Eliminates flood problem?	no	maybe	yes	yes		no
Eliminates erosion problem?	no	maybe	yes	yes		no
Costs						
Cost of implementation?	$	$$	$$$	$$$		N/A
ROW acquisition necessary?	no	maybe	yes	yes		no
Condemnation required?	no	maybe	yes	yes		no
Maintenance costs?	$	$$	$$$	$$		N/A
Potential cost sharing partner?	no	maybe	yes	maybe		no
Comparative benefit:cost?	low	medium	high	low		low
Environmental/ Social						
Addresses public complaint/ concern?	no	maybe	yes	maybe		no
Public support?	low	medium	high	medium		low
Agency acceptance?	low	medium	high	medium		low
Environmental impacts?	+	none	-	+		none
Multi-use opportunities?	no	maybe	yes	yes		no
Flood control method compatible with setting?	no	maybe	yes	yes		no
Acceptability of measure	**accept**	**-**	**not accept**	**accept**		**not accept**

Adobe Dam/ Desert Hills Area Drainage Master Plan
Alternative Formulation - Measure Evaluation Checklist
Site Location: DH11 (Site 7) - Apache Wash/ 24th Street

Measure Evaluation Criteria	Assessment Scale			Structural Measures		Non-Structural Measures	No Action
				DH11A - Realign roadway	DH11B - Channel/ Culverts	N/A	DH11C
Public Safety/ Physical System							
Public safety enhancement?	low	medium	high	high	low		low
Level of damage reduction?	low	medium	high	high	low		low
Access-critical location?	no	maybe	yes	yes	yes		yes
Upstream/ downstream impacts?	minimal	average	significant	average	average		average
Comparative size of watercourse?	small	medium	large	medium	medium		medium
Eliminates flood problem?	no	maybe	yes	yes	no		no
Eliminates erosion problem?	no	maybe	yes	yes	no		no
Costs							
Cost of implementation?	$	$$	$$$	$$$	$$$		N/A
ROW acquisition necessary?	no	maybe	yes	yes	no		no
Condemnation required?	no	maybe	yes	yes	no		no
Maintenance costs?	$	$$	$$$	$	$$$		$$$
Potential cost sharing partner?	no	maybe	yes	maybe	maybe		no
Comparative benefit:cost?	low	medium	high	medium	low		low
Environmental/ Social							
Addresses public complaint/ concern?	no	maybe	yes	yes	no		no
Public support?	low	medium	high	high	medium		low
Agency acceptance?	low	medium	high	high	low		low
Environmental impacts?	+	none	-	+	none		none
Multi-use opportunities?	no	maybe	yes	maybe	no		no
Flood control method compatible with setting?	no	maybe	yes	yes	yes		no
Acceptability of measure	**accept**	**-**	**not accept**	**accept**	**not accept**		**not accept**

Adobe Dam/ Desert Hills Area Drainage Master Plan
Alternative Formulation - Measure Evaluation Checklist
Site Location: DH12 (Site N/A) - Desert Hills Wash/ Joy Ranch Road & 16th Street

Measure Evaluation Criteria	Assessment Scale			Structural Measures		Non-Structural Measures	No Action
				DH12A - Culvert	DH12B - Culvert/ Channel	N/A	DH12C
Public Safety/ Physical System							
Public safety enhancement?	low	medium	high	medium	medium		low
Level of damage reduction?	low	medium	high	medium	medium		low
Access-critical location?	no	maybe	yes	maybe	maybe		maybe
Upstream/ downstream impacts?	minimal	average	significant	average	average		average
Comparative size of watercourse?	small	medium	large	small	small		small
Eliminates flood problem?	no	maybe	yes	yes	yes		no
Eliminates erosion problem?	no	maybe	yes	yes	yes		no
Costs							
Cost of implementation?	$	$$	$$$	$$$	$$$		N/A
ROW acquisition necessary?	no	maybe	yes	yes	yes		no
Condemnation required?	no	maybe	yes	yes	yes		no
Maintenance costs?	$	$$	$$$	$$	$$		$$
Potential cost sharing partner?	no	maybe	yes	no	no		no
Comparative benefit:cost?	low	medium	high	low	low		low
Environmental/ Social							
Addresses public complaint/ concern?	no	maybe	yes	yes	yes		no
Public support?	low	medium	high	medium	medium		medium
Agency acceptance?	low	medium	high	low	low		high
Environmental impacts?	+	none	-	none	none		none
Multi-use opportunities?	no	maybe	yes	no	no		no
Flood control method compatible with setting?	no	maybe	yes	yes	yes		no
Acceptability of measure	**accept**	**-**	**not accept**	**not accept**	**not accept**		**accept**

Adobe Dam/ Desert Hills Area Drainage Master Plan
Alternative Formulation - Measure Evaluation Checklist
Site Location: DH13 (Site 8) - Skunk Creek/ Desert Hills Drive

Measure Evaluation Criteria	Assessment Scale			Structural Measures	Non-Structural Measures	No Action
				DH13A - Bridge	N/A	DH13B
Public Safety/ Physical System						
Public safety enhancement?	low	medium	high	medium		low
Level of damage reduction?	low	medium	high	low		low
Access-critical location?	no	maybe	yes	yes		yes
Upstream/ downstream impacts?	minimal	average	significant	average		average
Comparative size of watercourse?	small	medium	large	large		large
Eliminates flood problem?	no	maybe	yes	yes		no
Eliminates erosion problem?	no	maybe	yes	yes		no
Costs						
Cost of implementation?	$	$$	$$$	$$$		N/A
ROW acquisition necessary?	no	maybe	yes	no		no
Condemnation required?	no	maybe	yes	no		no
Maintenance costs?	$	$$	$$$	$$		$
Potential cost sharing partner?	no	maybe	yes	yes		no
Comparative benefit:cost?	low	medium	high	low		low
Environmental/ Social						
Addresses public complaint/ concern?	no	maybe	yes	maybe		no
Public support?	low	medium	high	medium		medium
Agency acceptance?	low	medium	high	medium		medium
Environmental impacts?	+	none	-	+		none
Multi-use opportunities?	no	maybe	yes	yes		no
Flood control method compatible with setting?	no	maybe	yes	yes		no
Acceptability of measure	**accept**	**-**	**not accept**	**accept**		**not accept**

Adobe Dam/ Desert Hills Area Drainage Master Plan
Alternative Formulation - Measure Evaluation Checklist
Site Location: NR14 (Site 9) - Roger Creek/ New River Road

Measure Evaluation Criteria	Assessment Scale			Structural Measures		Non-Structural Measures	No Action
				NR14A - Bridge	NR14B - Culverts	N/A	NR14C
Public Safety/ Physical System							
Public safety enhancement?	low	medium	high	high	high		low
Level of damage reduction?	low	medium	high	medium	medium		low
Access-critical location?	no	maybe	yes	yes	yes		yes
Upstream/ downstream impacts?	minimal	average	significant	average	average		average
Comparative size of watercourse?	small	medium	large	medium	medium		medium
Eliminates flood problem?	no	maybe	yes	yes	yes		no
Eliminates erosion problem?	no	maybe	yes	yes	yes		no
Costs							
Cost of implementation?	$	$$	$$$	$$$	$$$		N/A
ROW acquisition necessary?	no	maybe	yes	no	no		no
Condemnation required?	no	maybe	yes	no	no		no
Maintenance costs?	$	$$	$$$	$$	$$		$$
Potential cost sharing partner?	no	maybe	yes	yes	yes		no
Comparative benefit:cost?	low	medium	high	low	low		low
Environmental/ Social							
Addresses public complaint/ concern?	no	maybe	yes	maybe	maybe		no
Public support?	low	medium	high	medium	medium		low
Agency acceptance?	low	medium	high	high	low		low
Environmental impacts?	+	none	-	+	-		none
Multi-use opportunities?	no	maybe	yes	yes	no		no
Flood control method compatible with setting?	no	maybe	yes	yes	yes		no
Acceptability of measure	**accept**	**-**	**not accept**	**accept**	**not accept**		**not accept**

Adobe Dam/ Desert Hills Area Drainage Master Plan
Alternative Formulation - Measure Evaluation Checklist
Site Location: NR15 (Site 10) - Cline Creek/ Circle Mountain Road

Measure Evaluation Criteria	Assessment Scale			Structural Measures				Non-Structural Measures	No Action
				NR15A - Riprap Bank Protection	NR15B - Gabion Bank Protection	NR15C - Shotcrete Bank Protection	NR15D - Terraced wall	N/A	NR15E
Public Safety/ Physical System									
Public safety enhancement?	low	medium	high	medium	medium	medium	medium		low
Level of damage reduction?	low	medium	high	medium	medium	medium	medium		low
Access-critical location?	no	maybe	yes	yes	yes	yes	yes		yes
Upstream/ downstream impacts?	minimal	average	significant	minimal	minimal	minimal	minimal		- significant
Comparative size of watercourse?	small	medium	large	medium	medium	medium	medium		medium
Eliminates flood problem?	no	maybe	yes	no	no	no	no		no
Eliminates erosion problem?	no	maybe	yes	yes	yes	yes	yes		no
Costs									
Cost of implementation?	$	$$	$$$	$	$	$	$		N/A
ROW acquisition necessary?	no	maybe	yes	maybe	maybe	maybe	maybe		no
Condemnation required?	no	maybe	yes	maybe	maybe	maybe	maybe		no
Maintenance costs?	$	$$	$$$	$	$	$	$		$
Potential cost sharing partner?	no	maybe	yes	maybe	maybe	maybe	maybe		no
Comparative benefit:cost?	low	medium	high	low	low	low	low		low
Environmental/ Social									
Addresses public complaint/ concern?	no	maybe	yes	no	no	no	maybe		no
Public support?	low	medium	high	low	low	low	medium		low
Agency acceptance?	low	medium	high	low	low	low	high		low
Environmental impacts?	+	none	-	-	-	-	+		none
Multi-use opportunities?	no	maybe	yes	no	no	no	no		no
Flood control method compatible with setting?	no	maybe	yes	yes	yes	yes	yes		no
Acceptability of measure	**accept**	**-**	**not accept**	**not accept**	**not accept**	**not accept**	**accept**		**not accept**

Adobe Dam/ Desert Hills Area Drainage Master Plan
Alternative Formulation - Measure Evaluation Checklist
Site Location: NR16 (Site 11) - Skunk Creek/ New River Road Bridge

Measure Evaluation Criteria	Assessment Scale			Structural Measures			Non-Structural Measures	No Action
				NR16A - Levees	NR16B - Secondary diversion channel	NR16C - Channel improvements at bridge	N/A	NR16D
Public Safety/ Physical System								
Public safety enhancement?	low	medium	high	high	high	medium		low
Level of damage reduction?	low	medium	high	high	high	low		low
Access-critical location?	no	maybe	yes	yes	yes	yes		yes
Upstream/ downstream impacts?	minimal	average	significant	significant	significant	minimal		- significant
Comparative size of watercourse?	small	medium	large	large	large	large		large
Eliminates flood problem?	no	maybe	yes	yes	yes	no		no
Eliminates erosion problem?	no	maybe	yes	yes	yes	no		no
Costs								
Cost of implementation?	$	$$	$$$	$$$	$$$	$$$		N/A
ROW acquisition necessary?	no	maybe	yes	yes	yes	yes		no
Condemnation required?	no	maybe	yes	yes	yes	yes		no
Maintenance costs?	$	$$	$$$	$$	$$	$$		$$
Potential cost sharing partner?	no	maybe	yes	yes	yes	yes		no
Comparative benefit:cost?	low	medium	high	medium	low	low		low
Environmental/ Social								
Addresses public complaint/ concern?	no	maybe	yes	yes	yes	no		no
Public support?	low	medium	high	medium	low	low		low
Agency acceptance?	low	medium	high	high	low	low		low
Environmental impacts?	+	none	-	+	-	-		none
Multi-use opportunities?	no	maybe	yes	yes	yes	no		no
Flood control method compatible with setting?	no	maybe	yes	yes	yes	yes		no
Acceptability of measure	**accept**	**-**	**not accept**	**accept**	**not accept**	**not accept**		**not accept**

APPENDIX G

Alternative Evaluation Matrices

Adobe Dam/ Desert Hills Area Drainage Master Plan
Alternatives Evaluation Matrix
Site Location: PSC1 (Site1) - Skunk Creek/ Pinnacle Peak Road & 35th Avenue

	Rating System Ranking	Full Structural Alternative PSC1A	Non-Structural Alternative FRP	Combination Alternative Channelization/Grade Control	No Action Alternative PSC1B
Evaluation Criteria					
Public Safety Criteria					
Cumulative encroachment impacts	1 = Negative	1	2	1	2
Local erosion impacts	2 =Neutral	2	2	2	2
Hydrologic modeling uncertainty	3 = Positive	3	2	3	2
Hydraulic modeling uncertainty		3	2	3	2
Development opportunity		3	2	3	2
Risk of failure		3	1	3	1
Flood events greater than design storm		3	1	3	1
Flood events less than design storm		3	2	3	2
Emergency response		3	3	3	2
Incidental use		1	2	1	2
Public Safety Average Rating		2.5	1.9	2.5	1.8
Social/ Environmental					
Community acceptance		1	3	1	2
Complexity of environmental permitting		1	2	1	2
Impact on wildlife habitat		1	3	1	3
Visual resource and aesthetic compatibility		1	3	1	3
Multi-use opportunities		3	2	3	2
Impact on cultural resources		2	1	2	1
Social/ Environmental Avg Rating		1.5	2.3	1.5	2.2
Economic Criteria					
Implementation cost		1	2	1	2
Maintenance cost		1	3	1	2
Cost share opportunities		3	2	3	2
Economic Average Rating		1.7	2.3	1.7	2.0

Adobe Dam/ Desert Hills Area Drainage Master Plan
Alternatives Evaluation Matrix
Site Location: PSC2 (Site 2) - Skunk Creek downstream of CAP

	Rating System Ranking	Full Structural Alternative PSC2A	Non-Structural Alternative PSC2B	Combination Alternative PSC2A Followed by PSC2B	No Action Alternative PSC2C
Evaluation Criteria					
Public Safety Criteria					
Cumulative encroachment impacts	1 = Negative	2	3	2	2
Local erosion impacts	2 =Neutral	3	2	3	2
Hydrologic modeling uncertainty	3 = Positive	3	2	3	1
Hydraulic modeling uncertainty		3	2	3	1
Development opportunity		3	2	3	1
Risk of failure		3	1	3	1
Flood events greater than design storm		3	1	3	1
Flood events less than design storm		2	2	2	2
Emergency response		3	2	3	2
Incidental use		1	2	1	2
Public Safety Average Rating		2.6	1.9	2.6	1.5
Social/ Environmental					
Community acceptance		1	3	2	2
Complexity of environmental permitting		2	3	2	2
Impact on wildlife habitat		2	2	2	3
Visual resource and aesthetic compatibility		1	3	1	2
Multi-use opportunities		3	2	3	2
Impact on cultural resources		2	2	2	1
Social/ Environmental Avg Rating		1.8	2.5	2.0	2.0
Economic Criteria					
Implementation cost		1	2	1	2
Maintenance cost		1	2	1	2
Cost share opportunities		3	1	3	2
Economic Average Rating		1.7	1.7	1.7	2.0
Overall Average Rating		2.2	2.1	2.3	1.7

Adobe Dam/ Desert Hills Area Drainage Master Plan
Alternatives Evaluation Matrix
Site Location: PNC3 (Site 2) - Skunk Creek upstream of CAP

	Rating System Ranking	Full Structural Alternative PNC3C	Non-Structural Alternative N/A	Combination Alternative PNC3C	No Action Alternative PNC3D
Evaluation Criteria					
Public Safety Criteria					
Cumulative encroachment impacts	1 = Negative	2	0	2	2
Local erosion impacts	2 =Neutral	2	0	2	2
Hydrologic modeling uncertainty	3 = Positive	3	0	3	1
Hydraulic modeling uncertainty		3	0	3	1
Development opportunity		2	0	2	2
Risk of failure		3	0	3	1
Flood events greater than design storm		3	0	3	1
Flood events less than design storm		2	0	2	2
Emergency response		2	0	2	2
Incidental use		2	0	2	2
Public Safety Average Rating		2.4	0.0	2.4	1.6
Social/ Environmental					
Community acceptance		1	0	1	2
Complexity of environmental permitting		3	0	3	2
Impact on wildlife habitat		1	0	1	2
Visual resource and aesthetic compatibility		1	0	1	2
Multi-use opportunities		3	0	3	2
Impact on cultural resources		2	0	2	2
Social/ Environmental Avg Rating		1.8	0.0	1.8	2.0
Economic Criteria					
Implementation cost		1	0	1	2
Maintenance cost		1	0	1	2
Cost share opportunities		3	0	3	2
Economic Average Rating		1.7	0.0	1.7	2.0

Adobe Dam/ Desert Hills Area Drainage Master Plan
Alternatives Evaluation Matrix
Site Location: DH4 (Site 3) - Skunk Creek/ 27th Avenue & Cloud Road

Evaluation Criteria	Rating System Ranking	Full Structural Alternative DH4A	Non-Structural Alternative FRP	Combination Alternative DH4A with FRP	No Action Alternative DH4E
Public Safety Criteria					
Cumulative encroachment impacts	1 = Negative	3	2	3	1
Local erosion impacts	2 =Neutral	3	2	3	1
Hydrologic modeling uncertainty	3 = Positive	3	2	3	2
Hydraulic modeling uncertainty		3	2	3	2
Development opportunity		2	2	3	2
Risk of failure		3	2	3	1
Flood events greater than design storm		3	2	3	1
Flood events less than design storm		3	2	3	1
Emergency response		3	3	3	1
Incidental use		2	2	2	2
Public Safety Average Rating		2.8	2.1	2.9	1.4
Social/ Environmental					
Community acceptance		3	3	3	2
Complexity of environmental permitting		2	2	2	2
Impact on wildlife habitat		2	2	2	2
Visual resource and aesthetic compatibility		2	2	2	2
Multi-use opportunities		2	2	2	2
Impact on cultural resources		2	2	2	2
Social/ Environmental Avg Rating		2.2	2.2	2.2	2.0
Economic Criteria					
Implementation cost		2	2	2	2
Maintenance cost		2	2	2	2
Cost share opportunities		3	2	3	2
Economic Average Rating		2.3	2.0	2.3	2.0
Overall Average Rating		2.5	2.1	2.6	1.7

Adobe Dam/ Desert Hills Area Drainage Master Plan
Alternatives Evaluation Matrix
Site Location: DH5 (Site 4) - Skunk Tank Wash

	Rating System Ranking	Full Structural Alternative DH5B	Full Structural Alternative DH5C	Non-Structural Alternative DH5A, FPAP, & FRP	*Combination Alternative* FPAP, FRP, & Joy Ranch Int.	No Action Alternative DH5D
Evaluation Criteria						
Public Safety Criteria						
Cumulative encroachment impacts	1 = Negative	1	1	2	2	2
Local erosion impacts	2 =Neutral	2	2	2	2	2
Hydrologic modeling uncertainty	3 = Positive	3	3	3	3	1
Hydraulic modeling uncertainty		3	3	2	3	1
Development opportunity		2	2	2	2	2
Risk of failure		2	2	3	3	1
Flood events greater than design storm		3	3	1	3	1
Flood events less than design storm		3	3	2	3	1
Emergency response		2	2	3	3	2
Incidental use		2	3	2	2	2
Public Safety Average Rating		2.3	2.4	2.2	2.6	1.5
Social/ Environmental						
Community acceptance		1	1	2	3	2
Complexity of environmental permitting		1	1	2	2	2
Impact on wildlife habitat		1	1	2	2	2
Visual resource and aesthetic compatibility		2	2	3	3	3
Multi-use opportunities		1	3	2	2	2
Impact on cultural resources		2	2	2	2	2
Social/ Environmental Avg Rating		1.3	1.7	2.2	2.3	2.2
Economic Criteria						
Implementation cost		1	1	2	3	3
Maintenance cost		1	1	2	2	1
Cost share opportunities		3	3	2	3	2
Economic Average Rating		1.7	1.7	2.0	2.7	2.0

Adobe Dam/ Desert Hills Area Drainage Master Plan
Alternatives Evaluation Matrix
Site Location: DH6 (Site 4) - Desert Lake (ASLD Parcel)

Evaluation Criteria	Rating System Ranking	Full Structural Alternative DH6A	Non-Structural Alternative DH6B	Combination Alternative DH7C, DH8A, & Dev. Guid.	No Action Alternative DH6C
Public Safety Criteria					
Cumulative encroachment impacts	1 = Negative	1	3	1	2
Local erosion impacts	2 =Neutral	2	2	2	2
Hydrologic modeling uncertainty	3 = Positive	3	2	3	1
Hydraulic modeling uncertainty		3	2	3	1
Development opportunity		2	2	3	2
Risk of failure		3	1	3	1
Flood events greater than design storm		3	1	3	1
Flood events less than design storm		3	2	3	1
Emergency response		2	2	2	1
Incidental use		2	2	3	2
Public Safety Average Rating		2.4	1.9	2.6	1.4
Social/ Environmental					
Community acceptance		2	2	2	2
Complexity of environmental permitting		1	2	1	2
Impact on wildlife habitat		1	3	1	2
Visual resource and aesthetic compatibility		1	2	3	2
Multi-use opportunities		2	2	3	2
Impact on cultural resources		1	2	1	2
Social/ Environmental Avg Rating		1.3	2.2	1.8	2.0
Economic Criteria					
Implementation cost		1	2	1	3
Maintenance cost		1	2	1	1
Cost share opportunities		3	2	3	2
Economic Average Rating		1.7	2.0	1.7	2.0
Overall Average Rating		1.9	2.0	2.2	1.7

Adobe Dam/ Desert Hills Area Drainage Master Plan
Alternatives Evaluation Matrix
Site Location: DH7 (Site 5) - Desert Lake Wash downstream of Cloud Road

	Rating System Ranking	Full Structural Alternative DH7C	Non-Structural Alternative N/A	Combination Alternative DH7C, DH8A, & Dev. Guid.	No Action Alternative DH7D
Evaluation Criteria					
Public Safety Criteria					
Cumulative encroachment impacts	1 = Negative	1	0	1	2
Local erosion impacts	2 =Neutral	2	0	2	2
Hydrologic modeling uncertainty	3 = Positive	3	0	3	1
Hydraulic modeling uncertainty		3	0	3	1
Development opportunity		2	0	3	2
Risk of failure		3	0	3	1
Flood events greater than design storm		3	0	3	1
Flood events less than design storm		3	0	3	1
Emergency response		2	0	2	1
Incidental use		3	0	3	2
Public Safety Average Rating		2.5	0.0	2.6	1.4
Social/ Environmental					
Community acceptance		2	0	2	2
Complexity of environmental permitting		1	0	1	2
Impact on wildlife habitat		1	0	1	2
Visual resource and aesthetic compatibility		1	0	3	2
Multi-use opportunities		2	0	3	2
Impact on cultural resources		1	0	1	2
Social/ Environmental Avg Rating		1.3	0.0	1.8	2.0
Economic Criteria					
Implementation cost		1	0	1	3
Maintenance cost		1	0	1	1
Cost share opportunities		3	0	3	2
Economic Average Rating		1.7	0.0	1.7	2.0

Adobe Dam/ Desert Hills Area Drainage Master Plan
Alternatives Evaluation Matrix
Site Location: DH8 (Site 5) - East fork Desert Lake Wash / 7th Street

	Rating System Ranking	Full Structural Alternative DH8A	Non-Structural Alternative N/A	Combination Alternative DH7C, DH8A, & Dev. Guid.	No Action Alternative DH8B
Evaluation Criteria					
Public Safety Criteria					
Cumulative encroachment impacts	1 = Negative	2	0	1	2
Local erosion impacts	2 =Neutral	2	0	2	1
Hydrologic modeling uncertainty	3 = Positive	3	0	3	1
Hydraulic modeling uncertainty		3	0	3	1
Development opportunity		2	0	3	2
Risk of failure		3	0	3	1
Flood events greater than design storm		3	0	3	1
Flood events less than design storm		3	0	3	1
Emergency response		2	0	2	1
Incidental use		2	0	3	2
Public Safety Average Rating		2.5	0.0	2.6	1.3
Social/ Environmental					
Community acceptance		2	0	2	2
Complexity of environmental permitting		2	0	1	2
Impact on wildlife habitat		2	0	1	2
Visual resource and aesthetic compatibility		1	0	3	2
Multi-use opportunities		1	0	3	2
Impact on cultural resources		2	0	1	2
Social/ Environmental Avg Rating		1.7	0.0	1.8	2.0
Economic Criteria					
Implementation cost		1	0	1	3
Maintenance cost		1	0	1	1
Cost share opportunities		3	0	3	2
Economic Average Rating		1.7	0.0	1.7	2.0
Overall Average Rating		2.1	0.0	2.2	1.6

Adobe Dam/ Desert Hills Area Drainage Master Plan
Alternatives Evaluation Matrix
Site Location: DH9 (Site N/A) - Desert Hills Wash/ Cloud Road & 12th Street

	Rating System Ranking	Full Structural Alternative DH9A	Non-Structural Alternative FRP	Combination Alternative DH9B & FRP	No Action Alternative DH9B
Evaluation Criteria					
Public Safety Criteria					
Cumulative encroachment impacts	1 = Negative	1	2	2	2
Local erosion impacts	2 =Neutral	1	2	2	2
Hydrologic modeling uncertainty	3 = Positive	3	2	2	2
Hydraulic modeling uncertainty		3	2	2	2
Development opportunity		1	2	2	2
Risk of failure		3	2	2	2
Flood events greater than design storm		3	2	2	1
Flood events less than design storm		3	2	2	2
Emergency response		2	3	3	2
Incidental use		2	2	2	2
Public Safety Average Rating		2.2	2.1	2.1	1.9
Social/ Environmental					
Community acceptance		1	3	3	3
Complexity of environmental permitting		1	2	2	2
Impact on wildlife habitat		1	2	2	2
Visual resource and aesthetic compatibility		1	2	2	2
Multi-use opportunities		3	2	2	2
Impact on cultural resources		1	2	2	2
Social/ Environmental Avg Rating		1.3	2.2	2.2	2.2
Economic Criteria					
Implementation cost		1	2	2	3
Maintenance cost		1	2	2	1
Cost share opportunities		2	2	2	2
Economic Average Rating		1.3	2.0	2.0	2.0

Adobe Dam/ Desert Hills Area Drainage Master Plan
Alternatives Evaluation Matrix
Site Location: DH10 (Site 6) - Carefree Highway/ Central Avenue to East of 24th Street

	Rating System Ranking	Full Structural Alternative DH10A	Non-Structural Alternative FRP	Combination Alternative DH10A & FRP	No Action Alternative DH10B
Evaluation Criteria					
Public Safety Criteria					
Cumulative encroachment impacts	1 = Negative	2	2	2	2
Local erosion impacts	2 =Neutral	2	2	2	2
Hydrologic modeling uncertainty	3 = Positive	3	2	3	2
Hydraulic modeling uncertainty		3	2	3	2
Development opportunity		2	2	2	2
Risk of failure		3	2	3	2
Flood events greater than design storm		3	2	3	1
Flood events less than design storm		3	2	3	2
Emergency response		2	3	3	2
Incidental use		2	2	2	2
Public Safety Average Rating		2.5	2.1	2.6	1.9
Social/ Environmental					
Community acceptance		2	3	3	3
Complexity of environmental permitting		2	2	2	2
Impact on wildlife habitat		2	2	2	2
Visual resource and aesthetic compatibility		2	2	2	2
Multi-use opportunities		1	2	2	2
Impact on cultural resources		2	2	2	2
Social/ Environmental Avg Rating		1.8	2.2	2.2	2.2
Economic Criteria					
Implementation cost		1	2	1	3
Maintenance cost		1	2	1	1
Cost share opportunities		3	2	3	2
Economic Average Rating		1.7	2.0	1.7	2.0
Overall Average Rating		2.2	2.1	2.3	2.0

Adobe Dam/ Desert Hills Area Drainage Master Plan
Alternatives Evaluation Matrix
Site Location: DH11 (Site 7) - Apache Wash/ 24th Street

	Rating System Ranking	Full Structural Alternative DH11A	Non-Structural Alternative FRP	Combination Alternative DH11A & FRP	No Action Alternative DH11C
Evaluation Criteria					
Public Safety Criteria					
Cumulative encroachment impacts	1 = Negative	3	2	3	2
Local erosion impacts	2 =Neutral	3	2	3	1
Hydrologic modeling uncertainty	3 = Positive	3	2	3	1
Hydraulic modeling uncertainty		3	2	3	1
Development opportunity		3	2	3	2
Risk of failure		3	2	3	1
Flood events greater than design storm		3	2	3	1
Flood events less than design storm		3	2	3	1
Emergency response		3	3	3	1
Incidental use		2	2	2	2
Public Safety Average Rating		2.9	2.1	2.9	1.3
Social/ Environmental					
Community acceptance		3	3	3	3
Complexity of environmental permitting		1	2	1	2
Impact on wildlife habitat		1	2	1	2
Visual resource and aesthetic compatibility		2	2	2	2
Multi-use opportunities		2	2	2	2
Impact on cultural resources		1	2	1	2
Social/ Environmental Avg Rating		1.7	2.2	1.7	2.2
Economic Criteria					
Implementation cost		1	2	1	3
Maintenance cost		2	2	2	1
Cost share opportunities		3	2	3	2
Economic Average Rating		2.0	2.0	2.0	2.0

Adobe Dam/ Desert Hills Area Drainage Master Plan
Alternatives Evaluation Matrix
Site Location: DH12 (Site N/A) - Desert Hills Wash/ Joy Ranch Road & 16th Street

	Rating System Ranking	Full Structural Alternative DH12A or DH12B	Non-Structural Alternative FRP	Combination Alternative DH12C & FRP	No Action Alternative DH12C
Evaluation Criteria					
Public Safety Criteria					
Cumulative encroachment impacts	1 = Negative	1	2	2	2
Local erosion impacts	2 =Neutral	1	2	2	2
Hydrologic modeling uncertainty	3 = Positive	3	2	2	2
Hydraulic modeling uncertainty		3	2	2	1
Development opportunity		2	2	2	2
Risk of failure		3	2	2	2
Flood events greater than design storm		3	2	1	1
Flood events less than design storm		3	2	2	2
Emergency response		2	3	3	2
Incidental use		1	2	2	2
Public Safety Average Rating		2.2	2.1	2.0	1.8
Social/ Environmental					
Community acceptance		2	3	3	3
Complexity of environmental permitting		1	2	2	2
Impact on wildlife habitat		1	2	2	2
Visual resource and aesthetic compatibility		2	2	2	2
Multi-use opportunities		1	2	2	2
Impact on cultural resources		1	2	2	2
Social/ Environmental Avg Rating		1.3	2.2	2.2	2.2
Economic Criteria					
Implementation cost		1	2	2	3
Maintenance cost		1	2	2	2
Cost share opportunities		3	2	2	2
Economic Average Rating		1.7	2.0	2.0	2.3
Overall Average Rating		1.8	2.1	2.1	2.0

Adobe Dam/ Desert Hills Area Drainage Master Plan
Alternatives Evaluation Matrix
Site Location: DH13 (Site 8) - Skunk Creek/ Desert Hills Drive

Evaluation Criteria	Rating System Ranking	Full Structural Alternative DH13A	Non-Structural Alternative FRP	Combination Alternative DH13A & FRP	No Action Alternative DH13B
Public Safety Criteria					
Cumulative encroachment impacts	1 = Negative	2	2	2	2
Local erosion impacts	2 =Neutral	3	2	3	1
Hydrologic modeling uncertainty	3 = Positive	3	2	3	1
Hydraulic modeling uncertainty		3	2	3	1
Development opportunity		2	2	2	2
Risk of failure		3	2	3	1
Flood events greater than design storm		3	2	3	1
Flood events less than design storm		3	2	3	1
Emergency response		3	3	3	1
Incidental use		2	2	2	2
Public Safety Average Rating		2.7	2.1	2.7	1.3
Social/ Environmental					
Community acceptance		2	3	2	3
Complexity of environmental permitting		2	2	2	2
Impact on wildlife habitat		3	2	3	2
Visual resource and aesthetic compatibility		2	2	2	2
Multi-use opportunities		1	2	2	2
Impact on cultural resources		2	2	2	2
Social/ Environmental Avg Rating		2.0	2.2	2.2	2.2
Economic Criteria					
Implementation cost		1	2	1	3
Maintenance cost		1	2	1	1
Cost share opportunities		3	2	3	2
Economic Average Rating		1.7	2.0	1.7	2.0

Adobe Dam/ Desert Hills Area Drainage Master Plan
Alternatives Evaluation Matrix
Site Location: NR14 (Site 9) - Roger Creek/ New River Road

	Rating System Ranking	Full Structural Alternative NR14A	Non-Structural Alternative FRP	Combination Alternative NR14A & FRP	No Action Alternative NR14C
Evaluation Criteria					
Public Safety Criteria					
Cumulative encroachment impacts	1 = Negative	2	2	2	2
Local erosion impacts	2 =Neutral	3	2	3	1
Hydrologic modeling uncertainty	3 = Positive	3	2	3	1
Hydraulic modeling uncertainty		3	2	3	1
Development opportunity		2	2	2	2
Risk of failure		3	2	3	1
Flood events greater than design storm		3	2	3	1
Flood events less than design storm		3	2	3	1
Emergency response		3	3	3	1
Incidental use		2	2	2	2
Public Safety Average Rating		2.7	2.1	2.7	1.3
Social/ Environmental					
Community acceptance		3	3	3	3
Complexity of environmental permitting		2	2	2	2
Impact on wildlife habitat		3	2	3	2
Visual resource and aesthetic compatibility		2	2	2	2
Multi-use opportunities		1	2	1	2
Impact on cultural resources		1	2	1	2
Social/ Environmental Avg Rating		2.0	2.2	2.0	2.2
Economic Criteria					
Implementation cost		1	2	1	3
Maintenance cost		1	2	1	1
Cost share opportunities		3	2	3	2
Economic Average Rating		1.7	2.0	1.7	2.0
Overall Average Rating		2.3	2.1	2.3	1.7

Adobe Dam/ Desert Hills Area Drainage Master Plan
Alternatives Evaluation Matrix
Site Location: NR15 (Site 10) - Cline Creek/ Circle Mountain Road

	Rating System Ranking	Full Structural Alternative NR15D	Non-Structural Alternative FDS & FRP	Combination Alternative NR15D, FDS, & FRP	No Action Alternative NR15E
Evaluation Criteria					
Public Safety Criteria					
Cumulative encroachment impacts	1 = Negative	1	2	1	2
Local erosion impacts	2 =Neutral	3	2	3	1
Hydrologic modeling uncertainty	3 = Positive	2	2	2	2
Hydraulic modeling uncertainty		3	2	3	1
Development opportunity		2	2	2	2
Risk of failure		3	2	3	1
Flood events greater than design storm		2	2	2	2
Flood events less than design storm		2	2	2	2
Emergency response		3	3	3	1
Incidental use		2	2	2	2
Public Safety Average Rating		2.3	2.1	2.3	1.6
Social/ Environmental					
Community acceptance		3	3	3	3
Complexity of environmental permitting		2	2	2	2
Impact on wildlife habitat		2	2	2	2
Visual resource and aesthetic compatibility		1	2	1	2
Multi-use opportunities		1	2	1	2
Impact on cultural resources		2	2	2	2
Social/ Environmental Avg Rating		1.8	2.2	1.8	2.2
Economic Criteria					
Implementation cost		1	2	1	3
Maintenance cost		1	2	1	2
Cost share opportunities		3	2	3	2
Economic Average Rating		1.7	2.0	1.7	2.3

Adobe Dam/ Desert Hills Area Drainage Master Plan
Alternatives Evaluation Matrix
Site Location: NR16 (Site 11) - Skunk Creek/ New River Road Bridge

	Rating System Ranking	Full Structural Alternative NR16A	Non-Structural Alternative FDS & FRP	Combination Alternative NR16A, FDS, & FRP	No Action Alternative NR16D
Evaluation Criteria					
Public Safety Criteria					
Cumulative encroachment impacts	1 = Negative	1	2	1	2
Local erosion impacts	2 =Neutral	1	2	1	1
Hydrologic modeling uncertainty	3 = Positive	3	2	3	1
Hydraulic modeling uncertainty		3	2	3	1
Development opportunity		3	2	3	2
Risk of failure		3	2	3	1
Flood events greater than design storm		3	2	3	1
Flood events less than design storm		3	2	3	1
Emergency response		3	3	3	1
Incidental use		2	2	2	2
Public Safety Average Rating		2.5	2.1	2.5	1.3
Social/ Environmental					
Community acceptance		1	3	1	3
Complexity of environmental permitting		1	2	1	2
Impact on wildlife habitat		2	2	2	2
Visual resource and aesthetic compatibility		1	2	1	2
Multi-use opportunities		1	2	1	2
Impact on cultural resources		1	2	1	2
Social/ Environmental Avg Rating		1.2	2.2	1.2	2.2
Economic Criteria					
Implementation cost		1	2	1	3
Maintenance cost		1	2	1	1
Cost share opportunities		2	2	2	2
Economic Average Rating		1.3	2.0	1.3	2.0
Overall Average Rating		1.9	2.1	1.9	1.7