

WEST I-40 DMP

VOLUME I

DRAINAGE MANAGEMENT PLAN

JUNE 29, 2000

PREPARED FOR:

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- Draft Working Hydrology
- Preliminary Options Summary
- Sediment Reconnaissance
- Analysis of Existing Conditions Sediment Yields and Detention Dam Trap Efficiencies
- Sediment Erosion Analysis Within Petroglyph National Monument
- Public Meeting Minutes and Survey Results
- Cultural Resource Survey

EXECUTIVE SUMMARY

I. Introduction

The west side of Albuquerque is the last remaining area of the City that has an excess of developable land to meet the City's growth needs well into the 21st Century. Several issues must be resolved before responsible development can occur. One major issue, which is the subject of this study, is drainage management.

The West Interstate 40 Diversion Drainage Management Plan (West I-40 DMP), authorized by the Albuquerque Metropolitan Arroyo Flood Control Authority (AMAFCA), provides the framework for safe and orderly planning and implementation of drainage improvements. This DMP, and supporting documents, provide a comprehensive drainage management plan for the DMP study area, which covers approximately 40 square miles of the west side. The DMP boundaries are: the Rio Puerco escarpment on the west, Double Eagle II Airport and Vulcan Volcano on the north, Coors Boulevard and the Rio Grande Bluff on the east, and Bluewater Road and I-40 on the south.

The West I-40 DMP is named for the proposed West I-40 Diversion Channel. This drainage diversion structure is proposed to run north of, and parallel to, I-40 from the East Arroyo to the West Bluff Outfall to the Rio Grande. The **Amole-Westgate Dam Drainage Management Plan** (Amole-Westgate DMP), Debra Vaughan-Cleff, P.E., June, 1994, adopted by AMAFCA in 1994, recommended the diversion of flows from the Amole watershed into the West I-40 Diversion. The function of the West I-40 Diversion is to, divert a portion of the Amole watershed flows to relieve capacity problems of existing facilities, accept diverted flows from the parallel Ladera System, and intercept flows from the West Mesa north of I-40.

The West Interstate 40 Diversion Drainage Management Plan Working Draft Hydrology Report (Volume IV), Bohannan Huston, Inc, June 1996, showed that the existing 100-year flows can be accommodated by the existing drainage facilities, but developed 100-year flow rates will exceed the capacity of many of the existing facilities. Some of the West I-40 DMP's critical drainage facilities are: proposed West I-40 Diversion Channel, Amole East Dam, and Dam 12 Diversion to the West I-40 Diversion Channel; and the existing West Bluff Outfall, Ladera Dam 12, and Mirehaven Arroyo.

The National Park Service, one of the major landowners in the area, prefers Option 2 in general, and Option 2D in particular. Option 2D proposes diversion of flows west of the Monument via a combination of detention dams and buried storm drains, known as the Petroglyph Diversion, to a new dam at the top of the Dam 5 Arroyo. Flow is then conveyed to Ladera Dam 5 by a storm drain or open channel. To avoid exceeding the capacity of the existing Ladera System, the increased flow at Dam 5 is diverted to the I-40 Diversion Channel at 98th Street. Runoff from developed areas between the Petroglyph Diversion and the West Monument Boundary will enter the Monument at historic levels (for the 100-year event). Flows will pass through the Monument through the existing Mirehaven A, B, and C arroyos in drainage easements retained by Westland Development Corporation.

A. Option 2D – Divert Mirehaven Arroyos in Pipe to New D5 Dam and Build Dam 5 Diversion (Estimated Project Cost: \$44,760,000)

The two preferred options are similar in cost but present two philosophically different approaches to drainage management within the upper portion of the West I-40 DMP study area. One option (Option 2D) proposes diverting developed flows around the Petroglyph National Monument with a series of detention dams and buried storm drains. The other option (Option 3C.1) proposes carrying flows through the Monument via Mirehaven Arroyos B and C with a series of detention dams and buried storm drains that follow the natural path of the existing arroyos.

II. PREFERRED OPTIONS

A total of fourteen options to eliminate flooding and provide an overall drainage management plan for the project area, plus a "Take No Action" option, have been studied. The options have been investigated and presented to the AMAFCA Board and the West I-40 Technical Team. The Tech Team, comprised of Landowners, City and County staff, Neighborhood Association and National Park Service representatives, and AMAFCA staff and their consultants, narrowed the selection to two preferred options. At the direction of the AMAFCA Board, a final recommended Option was developed considering the two preferred options. A brief summary of the options is provided below. Additional information on the preferred and recommended options is discussed in detail in the DMP (Volume I), while the rejected preliminary options are provided in the Preliminary Options Summary (Volume IV).

Option 6A addresses the immediate needs in the downstream portion of the watershed and puts in place the trunk of the drainage system. This option also defers the decision of whether or not to divert flows around the Monument, allowing the two majority landowners time to reach an agreement. The estimated cost for Option 6A is \$27,870,000, with a deferred cost of \$16,500,000

from development of the area between the Monument/Atrisco Terrace and the Ladera Dams. than existing conditions flow rates, plus sediment. This increase is due to the increase in runoff Mirehaven, between the Monument/Atrisco Terrace, and the Ladera Dams are only slightly larger both Options 2D and 3C.1, the flow rates used to size conveyances for arroyos, such as the portion of the watershed are nearly identical. Further, due to upstream detention proposed with portion of the watershed in both Options 2D and 3C.1, the flow rates for each option in the lower then be existing facilities. It should be noted that, with the multiple detention facilities in the upper or 3C.1 could be implemented in the future without costly retrofitting or expansion of what would volume from either option 2D or 3C.1. By sizing drainage facilities in this manner, either option 2D Terrace. Facilities under this option would be sized for the worst case (highest) flow rate and to as Option 6A, is a variation of option 6, which assumed phased growth to the base of the Atrisco version of an earlier option became the recommended option. This recommended option, referred ramifications of the other option. Consequently, at the direction of the AMAFCA Board, a modified the study area indicated support for one option or the other, with neither party able to accept the recommending a single preferred option could not be reached. The two majority landowners within While the Tech Team successfully reduced the number of options to two, a consensus

III. RECOMMENDED OPTION

B and C Arroyo alignments via storm drains. flow rates to enable economic conveyance through the Monument along both the Mirehaven Monument. Two detention dams along the Mirehaven A2 and C Arroyos attenuate the peak Petroglyph Diversion is constructed to divert runoff from Mirehaven A to B upstream of the Option 3 in general, and Option 3C.1 specifically. Under Option 3C.1, a portion of the Westland Development Corporation, the second major landowner in the area, prefers

B. Option 3C.1–Divert Mirehaven Arroyos “A” to “B” with Detention at “C” and Through Monument (Estimated Project Cost: \$46,040,000)

or \$18,710,000, depending on the future selection of Option 2D or 3C.1. For these reasons, option 6A is the recommended option.

Projects Common to 2D, 3C.1 and 6A

Project Description	Est. Cost	Est. Completion
I-40 Diversion From West Bluff Outfall to West Mesa Diversion Channel	-	In place
I-40 Diversion From West Mesa Diversion Channel to and including Unser Blvd Pond	\$3,310,000	by 2002
Parkway Storm Drain (Dam 12 Diversion)	\$730,000	by 2002
West Mesa Diversion Channel including West Mesa Pond*	\$3,410,000	by 2003
I-40 Diversion From Unser Blvd Pond to and including 98 th Street Pond	\$2,560,000	by 2005
I-40 Diversion From 98 th Street Pond to East Amole Dam	\$4,320,000	2005 to 2010
Amole Diversion From East Amole Dam to West Amole Dam	\$2,750,000	after 2010
Mirehaven Channel from Monument Boundary to Dam 12	\$2,320,000	2005 to 2010

*Currently under design by the City of Albuquerque

Projects Common to 2D, and 3C.1

Project Description	Est. Cost	Est. Completion
Arroyo Stabilization in Atrisco Terrace and Upsizing Dams 1 and 3 of Ladera System	\$3,600,000	after 2010
Paseo Del Volcan Dam	\$3,540,000	after 2010
West Amole Dam	\$3,460,000	after 2010
Petroglyph Diversion from PDV Dam to A2 Dam	\$1,220,000	after 2010
A2 Dam	\$440,000	after 2010
Dam 5 Arroyo	\$3,710,000	2005 to 2010
East Amole Dam	\$3,520,000	2005 to 2010



Projects Specific to Option 2D

Project Description	Est. Cost	Est. Completion
Petroglyph Diversion from A2 Dam to C dam	\$1,000,000	after 2010
C dam	\$880,000	after 2010
Petroglyph Diversion from C dam to D5 Dam	\$270,000	after 2010
D5 Dam	\$1,810,000	after 2010
C1 and C2 Storm Drains	\$710,000	after 2010
Arroyo Stabilization Inside Petroglyph National Monument	\$490,000	after 2010
Relocate Ladera Training dike	\$100,000	after 2010
Enlarge Ladera Dam 5	\$70,000	after 2010
Dam 5 Diversion	\$540,000	after 2010

Projects Specific to Option 3c.1

Project Description	Est. Cost	Est. Completion
Paseo Del Volcan Mirehaven "B" Pipe from A2 Dam to Confluence w/ C	\$1,910,000	after 2010
C1 and C2 Storm Drains	\$1,540,000	after 2010
Mirehaven "C" Dam	\$1,030,000	after 2010
Mirehaven Diversion from "C" Dam to Confluence w/ Mirehaven "B"	\$590,000	after 2010
Pipe from Confluence to Boundary	\$1,810,000	after 2010
Upsize Dams 5 and 11	\$270,000	by 2005

Projects Specific to 6A

Project Description	Est. Cost	Est. Completion
Dam 5 Diversion	\$540,000	2010
Arroyo Stabilization in Atrisco Terrace (Dam 1 Arroyo)	\$760,000	After 2010
Dam 5 Arroyo	\$2,440,000	2005 to 2010
East Amole Dam	\$1,330,000	2005 to 2010
West Amole Dam	\$2,860,000	after 2010
Upsize Dams 5 and 11	\$270,000	By 2005

Description	Option 2D		Option 3C.1		Option 6A	
	Pipe/ Channel (cfs)	In Out (cfs)	Pipe/ Channel (cfs)	In Out (cfs)	Pipe/ Channel (cfs)	In Out (cfs)
West Amole Dam	-	3880	-	3880	-	3880
Amole Diversion - West Amole Dam to Paseo del Volcan	665	-	665	-	665	-
Amole Diversion - Paseo del Volcan to East Amole Dam	1715	-	1715	-	1715	-
East Amole Dam	-	2650	-	2650	-	2650
Paseo del Volcan Dam	-	2060	-	2060	-	300
Petroglyph Diversion - Paseo del Volcan to A2 Dam	510	-	510	-	-	-
Mirehaven A2 Dam	-	510	-	510	-	-
Petroglyph Diversion - A2 Dam to C Dam	265	-	-	-	-	-
C Dam	-	1125	-	1290	-	-
Petroglyph Diversion C Dam to D5 Dam	340	-	-	260	-	-
D5 Dam	-	340	-	-	-	-
C1 and C2 Storm Drains	190 ea.	-	645 ea.	-	-	-
Dam 5 Arroyo	1135	-	1135	-	1135	-
Dam 1 Arroyo	745	-	745	-	745	-
Dam 0 Arroyo	460	-	460	-	460	-
A2 Dam Outfall - A2 Dam to Training Dike	-	-	450	-	-	-
Mirehaven Pipe from C Dam to Confluence	-	-	255	-	-	-
Mirehaven Channel from Confluence to National Monument Boundary	-	-	1325	-	-	-
Mirehaven Channel - Petroglyph National Monument to 98 th Street	1405	-	1495	-	1495	-
Mirehaven Channel - 98 th Street to Dam 12	1655	-	1650	-	1655	-
Ladera Dam 5 (Enlarge)	-	1145	-	1105	-	320
Dam 5 Diversion from Ladera Dam 5 to I-40 Diversion	255	-	-	-	255	-
Ladera Dam 11 (Enlarge for 3C.1 and 6A)	-	-	-	290	45	290
Dam 12 Diversion from Ladera Dam 12	-	300	-	-	-	300
Parkway Storm Drain (Dam 12 Diversion)	555	-	615	-	615	-
I-40 Diversion: East Amole to 98 th Street	1805	-	1805	-	1805	-
I-40 Pond at 98 th Street	-	2120	-	2120	-	765
I-40 Diversion Channel - 98 th Street to Unser Boulevard	1090	-	1090	-	1090	-
I-40 Pond at Unser Boulevard	-	1565	-	1565	-	1170
I-40 Diversion Channel - Unser Boulevard to West Mesa Diversion	1350	-	1360	-	1360	-
Laurelwood Pond	-	440	-	440	-	440
West Mesa Diversion Pond	-	530	-	530	-	420
West Mesa Diversion Channel	255	-	255	-	255	-
West Mesa Diversion Channel Concrete Box Culvert	790	-	790	-	790	-
Confluence of I-40 and West Mesa Diversion Channel	2030	-	2060	-	2060	-
West Bluff Outfall	2545	-	2585	-	2585	-

SUMMARY OF KEY FLOW RATES

SUMMARY OF PROPOSED DAM SITES

Option 6A	Option 3C.1	Option 2D	Description		Sized for existing conditions flows.											
					Flow	Out	Area	100 Yr. Storage Volume	Flow	Out	Area	100 Yr. Storage Volume	Flow	Out	Area	100 Yr. Storage Volume
			West Amole Dam	3880	250	-	600	3880	250	-	600	3880	250	-	600	3880
			East Amole Dam	2650	300	-	270	2650	300	-	270	2650	300	-	270	2650
			Paseo del Volcan Dam	2060	300	30	198.3	2060	300	30	198.3	2060	300	30	198.3	2060
			Mirahaven A2 Dam	510	265	-	21.8	510	265	-	21.8	510	265	-	21.8	510
			Mirahaven C Dam	925	335	-	42.5	1285	255	-	54	1285	255	-	54	1285
			D5 Dam	340	270	-	102	-	-	-	-	-	-	-	-	-
			Ladera Dam 1	1110	265	-	41	1110	265	-	41	1110	265	-	41	1110
			Ladera Dam 3	180	45	-	45.4	180	45	-	45.4	180	45	-	45.4	180
			Ladera Dam 5 (Enlarge for All Options)	1145	320	-	37.8	1105	220	-	35.8	1145	320	-	37.8	1145
			Ladera Dam 11 (Enlarge for 3C.1 and 6A)	565	55	-	36.2	290	45	-	45.5	290	45	-	45.5	290
			I-40 Pond at 98 th Street	2120	765	8	49	2120	745	8	49	2120	765	8	49	2120
			I-40 Pond at Unser Boulevard	1555	1170	6	44.4	1565	1165	6	44.4	1565	1170	6	44.4	1565
			West Mesa Diversion Pond	530	425	1	6.5	530	425	1	6.5	530	425	1	6.5	530

IV. REJECTED OPTIONS

A. Take No Action

The option to take no action is not acceptable for a number of reasons. Existing drainage problems, both north and south of I-40, will remain if no action is taken. The Amole-Hubbell DMP is based on the assumption that all runoff north and south of I-40 will be diverted to the West Bluff Outfall at I-40. If no action is taken, the Amole-Hubbell DMP cannot be implemented.

B. Option 1

Option 1 proposes to allow fully developed flow from above the Petroglyph National Monument to flow through the Monument, with detention of developed flows either in the Monument, just below the Monument, or at Ladera Dam 12. Additionally, some expansion to the other existing Ladera Dams, and diversion of flows from Ladera Dam 12 to the I-40 Channel, is required under Option 1. Four sub options of Option 1 are summarized as follows:

1. Option 1A – Expand Dam 12 (Estimated Project Cost: \$49,310,000)

To accommodate increased runoff from development of the watershed, this sub option proposes a nearly 400 percent expansion of Ladera Dam 12, and the diversion of over 1,300 cfs from the Ladera system to the I-40 Diversion Channel. Concerns over extensive construction activity within the Monument to convey developed flows through the Monument, and the requirement to meet National Environment Preservation Act (NEPA) guidelines, ultimately led to the elimination of this option.

2. Option 1B – Build Mirehaven Dam (Estimated Project Cost: \$51,080,000)

Option 1B is similar to Option 1A, with one major exception. Rather than expanding Ladera Dam 12, a new dam (Mirehaven Dam) would be constructed just downstream (east) of the Monument, below the confluence of the Mirehaven A, B and C Arroyos. The cost of Option 1B is approximately 2.0 million more than 1A, causing its elimination in favor of 1A.

3. Option 1C – Build Lower Ladera West Dam (Estimated Project Cost:

\$50,410,000)

The primary difference between Option 1C and Option 1B is the location of the new detention dam (Ladera West Dam). Option 1C proposes to construct this Dam approximately 2500' further west, placing it within the Monument.

The Tech Team concluded that expansion of Dam 12 was preferred to the construction of a new dam within the Monument, as land adjacent to Dam 12 is already encumbered with power lines and a blanket drainage easement. Consequently, this option was not given further consideration

4. Option 1D – Build Upper Ladera West Dam and Expand Dam 12

(Estimated Project Cost: \$50,870,000)

Similar to Option 1C, this option also proposes the construction of a detention facility within the Monument. However, with Option 1D, the dam is located further upstream at the confluence of the Mirehaven Arroyos B and C and is smaller,

requiring expansion of Dam 12. Due to the requirement for a new dam as well as expansion of Dam 12, Option 1D is more costly than Option 1A and 1C. As a result Option 1D was eliminated.

C. OPTION 2

Option 2 proposes to divert developed flows around the Petroglyph National Monument with the construction of a new diversion facility, referred to as the Petroglyph Diversion. With the diversion in place, discharge to the Monument under developed conditions will remain equal to or less than historic peak rates for the 100-year event. This option minimizes the impact on the Monument. Three sub options to Option 2 are summarized as follows:

1. Option 2A – Divert Mirehaven Arroyos to New D5 Dam (Estimated Project Cost: \$46,250,000)

Option 2A proposes diversion of flows west of the Monument via a combination pipe and open channel system running north to south to a new dam at the top of the Dam 5 Arroyo. Flow is then conveyed to Ladera Dam 5 and, ultimately, Ladera Dam 12. This option requires upsizing the principal spillways for Ladera Dams 5 through 11 to convey the additional runoff reaching Dam 5 to Dam 12. This option was rejected primarily based on the requirement to breach Ladera Dams 5 through 11.

2. Option 2B – Divert Mirehaven Arroyos to New D5 Dam and Build Dam 5 Diversion (Estimated Project Cost: \$45,890,000)

Option 2B is identical to Option 2A except flow is diverted from Ladera Dam 5 to the I-40 Diversion Channel, rather than modifying the principal spillways of Ladera Dams 6 through 11. This option formed the basis for Option 2D that later emerged as one of two preferred options and was hence rejected in favor of Option 2D.

storm drain, rather than allowing flows to cross the Monument in the existing will be diverted to Mirehaven C Arroyo and conveyed through the Monument in a Option 3C is a slight variation of Option 3 in that runoff from upstream areas Monument (Estimated Project Cost: \$45,830,000)

2. Option 3C – Divert Mirehaven Arroyos “A” and “B” to “C” Through

Option 3C.

be required. Option 3 was refined to create Option 3C and rejected in favor of Some stabilization of the arroyo in the form of drop structures, or other means will discharge from these dams and flow through the Monument to Ladera Dam 12. Monument. Flows attenuated to historic flow rates for the 100-year event will then dams along the Mirehaven A2 and C Arroyos just upstream (west) of the Option 3 proposes construction of the Paseo del Volcan Dam and detention Project Cost: \$44,090,000)

1. Option 3 – Detention Above Petroglyph National Monument (Estimated

referred to as Options 3, 3C and 3C.1.

develop an option that is acceptable to both parties. Three sub options evolved and are for Westland Development Corporation and the National Park Service in an attempt to AMAFCA West I-40 DMP. These options were developed as part of an analysis completed Option 3 represents a hybrid between Options 1 and 2 originally proposed in the

D. OPTION 3

of adverse impacts on the Monument.

because it is more expensive than Options 2A and 2B, and has a greater number constructed as necessary to control arroyo erosion. This Option was rejected allowed to flow through the Monument in the existing arroyo with drop structures Arroyo. Runoff is then released at historic levels (for the 100-year event) and diverted to a dam at the head of the Mirehaven C Arroyo, rather than the Dam 5 Option 2C is similar to Options 2A and 2B. Under Option 2C flows are (Estimated Project Cost: \$46,050,000)

3. Option 2C – Divert Mirehaven Arroyos to New Mirehaven “C” Dam



arroyos. Developed flows cross the Monument in only one location and in a pipe, rather than the existing unlined arroyo. Consequently, only very minimal arroyo stabilization within the Monument is anticipated with Option 3C. Option 3C was modified slightly to create Option 3C.1 and rejected in favor of Option 3C.1.

E. OPTION 4 – Unrestrained Flow (Estimated Project Cost: \$60,950,000)

Option 4 is an unrestrained flow option, in which the capacity of the West Bluff Outfall would be increased and the two Amole Dams would be the only additional detention facilities constructed. This option requires construction of a culvert, equal in size and parallel to the existing West Bluff Outfall, from Coors to the Rio Grande to convey the developed condition flow rate of over 5,000 cfs. In addition the crossing structures at Unser Boulevard and 98th Street must be upsized.

This option presents many problems, including a cost of over 8 million dollars more than the next most costly option. In addition to the cost are some very difficult construction operations and potential traffic control problems associated with the construction of a CBC parallel to the existing outfall along I-40 and the construction of additional culverts at Unser Boulevard and 98th Street. Based on these considerations, this option is not feasible.

F. OPTION 5 - Ladera Dam 15 (Estimated Project Cost: \$52,460,000)

Option 5 proposes diversion of all developed runoff from the Ladera Watershed to the Ladera Golf Course (Dam 15). This option attempts to utilize some of the extra capacity that exists in Dam 15. Major modifications to the existing Ladera System are required, including reconstruction of both Ladera Dams 12 and 14 to enlarge their principal spillways, and the removal of Dam 13. Additionally, reconstruction of portions of Unser Boulevard and Ouray Boulevard are required which will be very disruptive, expensive, and create substantial delays to the traveling public. For these reasons, Option 5 was rejected.

G. OPTION 6 Phased Growth (Estimated Project Cost: \$27,030,000)

Option 6 assumes phased growth to the base of the Atrisco Terrace, without provisions for future expansion. While runoff volumes and flow rates would reflect development only to the Atrisco Terrace, the two Amole Dams and the Amole Diversion would be included so that

the Amole-Hubbell DMP could be implemented. The two dams would, however, only be constructed at this time to accommodate existing undeveloped conditions runoff. Under this option, the necessary improvements to the watershed are reduced substantially. Option 6 was revised to create Option 6A, which incorporates provisions for future expansion. Option 6 was rejected in favor of Option 6A.

I. INTRODUCTION

The West Interstate 40 Diversion Drainage Management Plan (West I-40 DMP) study area is located on the west side of Albuquerque and is composed of the Upper Amole, Ladera, and West Bluff watersheds. The Albuquerque Metropolitan Arroyo Flood Control Authority (AMAFCA) contracted with Bohannan Huston, Inc. (BHI) to provide a comprehensive drainage management plan of the region. The project area encompasses approximately 40 square miles (see Vicinity Map, Figure 1). The general limits of the project are: the Rio Puerco escarpment on the west, Double Eagle II Airport and Vulcan Volcano on the north, Coors Boulevard and the Rio Grande Bluff on the east, and Bluewater Road and I-40 on the south.

The project area has three outfalls to the Rio Grande: the West Bluff Outfall to the Rio Grande, the Ladera Dam 15 outfall pipe to the San Antonio Arroyo, and the Westgate Dam outfall pipe to the Amole-Hubbell detention facilities. Each of the outfalls has deficiencies as summarized below:

- The West Bluff Outfall has a capacity of 2,585 cubic feet per second (cfs), but, due to the lack of additional drainage infrastructure, upstream flows cannot reach the facility.
- The 60" outfall pipe from Ladera Dam 15 is at capacity.
- The Westgate Dam and the downstream Amole-Hubbell System do not have the capacity for fully developed conditions flows. This situation resulted in the adoption of the **Amole Arroyo – Westgate Dam Drainage Management Plan** (Amole-Westgate DMP), Debra Vaughan-Cleff, P.E., June, 1994. The primary recommendation of this DMP was to detain and divert all runoff from the Amole-Hubbell Watershed north of I-40 to the West Bluff Outfall.

The **Amole-Westgate DMP**, adopted by the AMAFCA Board via Resolution 1994-4, April 28, 1994, served as the starting point for the development of the West I-40 DMP. Significant capacity and flooding problems exist south of I-40.

The connection between Dam Zero and Dam 1 is the earthen channel stabilized with gabion drop structures and riprap. Mirehaven Diversion Channel. The connection from Dam 12 and Dam 13 is an earthen channel stabilized with gabion drop structures. The Mirehaven Diversion Channel connects Dam 13 and Dam 14 and is an earthen channel with gabion drop structures. All other dams in the system are connected by one or more RCP's.

a) Ladera System of Dams

The Ladera System, completed in 1977, consists of a series of sixteen dams. Dam Zero is the first dam, and the Ladera Golf Course (Dam 15) is the last in the series. The system was designed to divert 100-year undeveloped flows (based on the criteria in effect at the time) from the Ladera Watershed to the Ladera Golf Course and ultimately to the Rio Grande via the San Antonio Arroyo (see Figure 6 and Table 4).

3. Ladera Watershed Drainage Facilities

Analysis PT	Description of Analysis Point	Existing Flow at Analysis PT (cfs)	Developed Flow at Analysis PT (cfs)	Capacity of Existing Structure* (cfs)	* Structure under I-40	
					West Amole at West Amole Dam Site	East Amole at East Amole Dam Site
AP1	West Amole at West Amole Dam Site	649	3881	435		
AP2	East Amole at East Amole Dam Site	482	2650	700		

TABLE 3
Key 100yr Flows - Amole Watershed

2. Amole Watershed Drainage Facilities

The West and East Amole Arroyos convey flows from north to south. These arroyos cross under I-40 through culverts. The West Amole Arroyo crosses I-40 2,000 feet west of Paseo del Volcan through three 48" reinforced concrete pipes (RCP's). The East Amole Arroyo crosses I-40, 2,000 feet east of Paseo del Volcan through two 10' x 4' Concrete Box Culverts (CBC's), see Figure 6 and Table 3.

The Mirehaven Diversion Channel and the Ladera Channel discharge into Dam 14, and the Rinconada and Quickwater Channels discharge into Dam 15. The limited outfall for Dam 15 is through a 7,560-foot long 60" RCP with a capacity of 124 cfs, that ultimately discharges to the San Antonio Arroyo downstream of Coors Boulevard. A summary of both the

Volcan Detention Dam.

the lost storage volume could be offset by expanding the Paseo del developed conditions. If this playa is filled in at the time of development, near the Double Eagle II Airport. This playa is assumed to remain under Dam 12, is contained by a large (70 ac-ft) playa on top of the escarpment, that approximately 1.4 square miles of land, once thought to contribute to is resolved by reviewing the new mapping for the DMP, which revealed has found that Dam 12 has sufficient capacity. This apparent discrepancy of the emergency spillway. However, under existing conditions, the DMP Ladera Dam 12 to the West Bluff Outfall to prevent potential overtopping Bohannan Huston, Inc., July 1989, identified the need to divert runoff from

The Ladera Diversion to West Bluff Outfall Drainage Study,

Dam 14 is the only Ladera dam designed with a 100-year water surface elevation above the emergency spillway. Overflow from Dam 14 is designed to spill north into Dam 15, the Ladera Golf Course. The direction of spill from Dam 14 is unique in the Ladera system because it is not designed to spill towards the natural drainage course, generally to the south towards I-40. Flow that overtops the spillway of Dam 14 is either conveyed under Ocuray Boulevard to Dam 15 or flows over Ocuray Boulevard to Dam 15 and Ladera Drive. The existing culverts in Ocuray Boulevard are undersized and during the 100-year event some flow in and over Ocuray Boulevard is anticipated. Determination of the flow path and limits of this flooding from Dam 14 is beyond the scope of the DMP.



existing and developed flows and volumes for each of the Ladera Dams is

provided in Table 4.

TABLE 4
Ladera Dams Hydrology Summary

Dam No.	Flows					Dam			Results
	Existing 100yr Q (cfs)	Existing Volume Into Dam (ac-ft)	Developed 100yr Q (in) (cfs)	Developed Volume Into Dam (ac-ft)	Principal Spillway Desc. (RCP)	Principal Spillway Capacity (cfs)	Existing Volume 100yr (ac-ft)	Flow Out (cfs)	
0	248	11.6	459	22.6	3 - 48"	425	3.2	380	
1	499	29.6	1108	71.3	3 - 30"	200	29.9	609	YES
2	150	32	243	69.2	2 - 24"	105	29.8	100	
3	69	34.5	181	77.4	1 - 24"	54	28.4	62	YES
4	67	36.6	175	78.7	1 - 24"	45	19.0	40	
5	371	65	1106	137.6	3 - 36"	222	31.5	456	YES
6	142	64.9	229	131.9	3 - 30"	162	25.1	143	
7	72	64.9	143	130.9	3 - 30"	180	16.8	130	
8	72	64.8	130	130.3	2 - 24"	90	36.2	77	
9	265	72	559	147.8	2 - 24"	100	21.8	82	
10	48	70.8	82	142.6	1 - 24"	63	51.6	55	
11	223	70.1	567	133.8	1 - 24"	47	28.9	57	YES
12	1331	258.3	4221	682.7	8 - 42"	1175	55.4	4220	YES
13	1002	266.3	1108	473.8	7 - 42"	1070	34.2	1046	
14	969	317	1168	549.2	6 - 36"	594	93.6	1069	YES
15	1281	427.5	1744	698.3	1 - 60"	124	1128.4	107	

* In some instances, the developed flow into the dam is greater than the dam's 100yr volume, but because some of the flow is leaving the dam through the principal spillway, there is not necessarily flow over the emergency spillway. AHYMIC was used to model each dam and determine whether the flow overtops the dam.

The results showed that, without additional drainage improvements, under developed conditions, the existing facilities will receive more runoff than they were designed to accommodate. Because of this, dams 1, 3, 5, 11, 12, and 14 will overtop and potentially cause downstream flooding. Ladera Dams 1, 3, 5, 11, 12, and 14 will spill. Determining the actual depth and extent of the resulting flooding requires a water surface profile analysis, which is beyond the scope of this project.

b) Mirehaven Arroyo

Tributaries to the Mirehaven Arroyo originate southeast of the Double Eagle II Airport, traverses the southern part of the Petroglyph National Monument, and outfalls to Dam 12 of the Ladera System. This arroyo has three principal branches that were given informal names Mirehaven A, B,

and C at the start of the sediment reconnaissance study, in October 1985 (see Figure 6 and Table 5).

The Mirehaven A Arroyo begins just upstream, at Paseo del Volcan. It enters the Petroglyph National Monument and runs east to the escarpment, where it cascades down the face of the escarpment. Mirehaven B and C parallel Mirehaven A, which lies to the north. Mirehaven B and C pass through the Atisisco Terrace and converge upstream of the Ladera Training Dike, continuing as Mirehaven BC. The Ladera Training Dike is a riprap armored levee located at the foot of Mesa Prieta, which maintains the historical course of the Mirehaven B.

Mirehaven BC (combination of Mirehaven B and C Arroyos) turns sharply north after the Training Dike and parallels the escarpment, travelling another 2,500 feet before it converges with the Mirehaven A.

The Mirehaven Main Arroyo shows significant lateral migration below the escarpment. A prudent line study completed in 1994 resulted in the construction of 1,300 feet of soil cement scour wall on the east bank of the arroyo to provide erosion protection for the Las Lomitas Subdivision. The Training Dike and the scour wall are the only improvements made on the Mirehaven Main Arroyo. As part of the Crossings Subdivision project, Westland Development Corporation financially guaranteed improvements to the Mirehaven Arroyo from Dam 12 to the planned intersection with future 98th Street.

TABLE 5
Key 100yr Flows – Ladera Watershed

Analysis PT	Description of Analysis Point	Existing Flow into (cfs)	Developed Flow into (cfs)
AP3	Mirehaven Arroyo at Paseo Del Volcan	658	2061
AP4	Mirehaven "B" at Training Dike	445	1323
AP5	Mirehaven A + B + C	1287	4048
AP6	Mirehaven at Dam 12	1331	4221

c) Ladera and Rinconada Arroyos; Quickwater Channel

The Ladera and Rinconada Arroyos convey flows from the eastern slopes of the volcanoes eastward to Ladera Dam 14 and Dam 15,

respectively. These arroyos originate in the Petroglyph National

Monument, traverse the escarpment, and remain in undeveloped

condition until they enter the developed regions below the escarpment

(see Figure 6). The Ladera Arroyo is concrete-lined from downstream of

the Petroglyph National Monument to Unser Boulevard. From Unser

Boulevard to its outfall to Ladera Dam 14, the arroyo is an improved earth-

lined channel stabilized with gabion drop structures. See Figure 6 and

Table 6.

The Quickwater Channel is a 1,200-foot riprap and grass-lined

channel with concrete drop structures that collects flows from the

residential areas west of Dam 15 and discharge into the west side of Dam

15. See Figure 6 and Table 6.



The region between I-40 and the Ladera system is considered to be in the West Bluff watershed even though existing flows from this region either discharge south under I-40 through numerous culverts, or are held

a) Drainage from North to South of I-40

4. West Bluff Watershed Drainage Facilities

Analysis PT	Description of Analysis Point	Existing Flow into (cfs)	Developed Flow into (cfs)
AP10	Ladera Channel into Dam 1	499	1071
AP11	Ladera Channel into Dam 5	371	1071
AP12	Ladera Channel into Dam 9	265	542

TABLE 7
Key 100yr Flows – Dams 1, 5 and 9

Three arroyos take their names from the Ladera Dams to which they connect. Dam 1 and Dam 5 Arroyos are called Mirehaven Arroyo "C" and Mirehaven Arroyo "B" respectively, on the Bernalillo County FEMA Floodway Maps, but were renamed for the I-40 DMP. Dam 9 Arroyo is likely a man-made ditch that was probably dug to intercept runoff, for stock watering purposes, from the newly named Mirehaven BC Arroyo, where it rounds the bend at Mesa Prieta, below the location of the Ladera Training Dike (see Figure 6 and Table 7).

d) Dam 1, Dam 5, and Dam 9 Arroyos

Analysis PT	Description of Analysis Point	Existing Flow into (cfs)	Developed Flow into (cfs)
AP7	Ladera Channel into Dam 14	968	1160
AP8	Quickwater Channel into Dam 15	805	978
AP9	Rinconada Channel into Dam 15	611	907

TABLE 6
Key 100yr Flows – Ladera, Quickwater and Rinconada Channels

The West Mesa Diversion, a portion of which was recently constructed by the City, discharges to the West Bluff Outfall through the existing pair of 10' x 12' CBC's, buried under I-40 just west of Estancia Drive. The West Mesa Diversion ties into the West Bluff Outfall at this point (see Figure 6 and Table 9). Hydraulic constraints limit the West Mesa Diversion to a maximum flow of approximately 800 cfs. In a 1988 report by BHI, the West Mesa Diversion was found to be the critical upstream system for the West Bluff Outfall/I-40 Channel/Coors Storm

b) West Mesa Diversion

Analysis PT	Description of Analysis Point	CBC Capacity (cfs)	Existing Flow into (cfs)	Developed Flow into (cfs)
AP13	2 - 10' x 8' CBCs at 98 th Street	2000	137	2122
AP14	4 - 6' x 4' CBCs at Unser Boulevard	800	241	2920

TABLE 8
Key 100yr Flows – CBCs at 98th Street and at Unser Boulevard

Under developed conditions, the flows from the region between I-40 and the Ladera system will be intercepted by the proposed West I-40 Diversion. The West I-40 Diversion will discharge flows through the West Bluff Outfall, thereby reducing flow going to the Amole-Hubbell Watershed. North of I-40 under 98th Street and Unser Boulevard are existing culverts which convey runoff from west to east. The structure under 98th Street is a pair of 10' x 8' concrete box culverts (CBC's) and the structure under Unser consists of four 6' x 4' CBC's. These CBC's will be incorporated into the proposed West I-40 Diversion to convey flows to the West Bluff Outfall. (see Figure 6 and Table 8)

In temporary retention ponds located along the north side of I-40. This runoff goes southeast to the Amole del Norte Diversion channel, which discharges to the Hubbell Lake detention area. (see Figure 6)

Drain drainage network. Discharge from the West Mesa Diversion is also limited to 800 cfs by a 1996 agreement between the City and AMAFCA.

TABLE 9
Key 100yr Flows – West Mesa Diversion

Analysis PT	Description of Analysis Point		AP15 West Mesa Diversion Upstream of I-40
	Existing Flow into (cfs)	Developed Flow into (cfs)	
			790

c) West Bluff Outfall

The West Bluff Outfall currently begins as an open channel inlet leading to a 14' x 14' CBC just west of Estancia Drive. The 14' x 14' CBC then ties to two of the 4 CBC's running east under Coors Boulevard. East of Coors Boulevard, the box increases in slope and transitions from a 14' x 14' CBC to a 12' x 12' CBC. At the downstream end, near the Rio Grande, the CBC dimensions are 10' x 10'. The design flow rate is 2,585 cfs. (see Figure 6 and Table 10).

TABLE 10
Key 100yr Flows – CBC at West Bluff Outfall

Analysis PT	Description of Analysis Point		AP16 West Bluff Outfall
	Existing Flow into (cfs)	Developed Flow into (cfs)	
			2585

III. FACILITIES PLANNING

A. GENERAL

Fifteen options, and numerous suboptions, to eliminate flooding and provide an overall drainage management plan for the 40 square mile project area have been studied. Initially, two primary options with multiple suboptions were developed (Option 1 which allows fully

developed flow from above Petroglyph National Monument, and Option 2 which diverts flow around the Monument) and presented to the AMAFCA Board between August 1996 and March 1997. At of the Board's direction, additional options were developed. The additional options include:

- Option 3 - a hybrid of options 1 and 2 (this option has 2 additional sub options)
- Option 4 - unrestrained flow
- Option 5 - diverts all developed runoff from the Ladera Watershed to the Ladera Golf Course
- Option 6 - phased growth to the base of the Atrisco Terrace.
- Take no action option

The options were evaluated considering: construction costs, concerns over extensive construction activity within the Monument, the requirement to meet National Environment Preservation Act (NEPA) guidelines, constructibility issues, traffic control concerns, and or social costs.

Based on these considerations, the Tech Team narrowed the list of viable options to two. However, the Tech Team was unable to decide between the two options, which differ philosophically, particularly with respect to the management of flows impacting the Monument. Consequently, at the direction of the AMAFCA Board, a third preferred Option 6A is also included in this study. Option 6A is the recommendation Option being adopted within the West I-40 DMP.

The three preferred options, options 2D, and 3C.1, and 6A are discussed in detail in the next section. A summary, along with an explanation of why each of the remaining options were not chosen, can be found in the draft working DMP in Volume IV.

B. TRUNK FACILITIES

All of the options being considered as part of the DMP, with the exception of the "Take No Action Option," include key drainage facilities, referred to as trunk facilities. These trunk facilities are required regardless of the selected option. Many of these facilities were deemed

For routing purposes, either concrete pipes or ten-foot wide channels were assumed for developed conditions. This does not, however, imply that the DMP is requiring all runoff to be conveyed in this manner. Rather, by assuming such conveyances, detention facilities can be designed for the largest peak flows and volumes. Channel treatments such as soil cement and other more naturalistic linings will be considered with the design of the facilities.

DESCRIPTION	Dia.	Pipe		Channel			Dam		100yr Water Storage Volume (ac-ft)
		Length (ft)	Flow (cfs)	Depth (ft)	Length (ft)	Flow (cfs)	Flow In (cfs)	Flow Out (cfs)	
Dam 0 Arroyo	54"	3800	460	-	-	-	-	-	-
Dam 1 Arroyo	48"	9300	300	4	2900	745	-	-	-
Dam 5 Arroyo*	48"	7400	270	5	6900	1135	-	-	-
Dam 5 Arroyo (Option 6A)	-	-	-	5	6900	1135	-	-	-
West Amole Dam*	-	-	-	-	-	-	3880	250	600
West Amole Dam (Option 6A)	-	-	-	-	-	-	840	255	136
Amole Diversion – West Amole Dam to Paseo del Volcan	66"	3000	250	5	3900	665	-	-	-
Amole Diversion – Paseo del Volcan to East Amole Dam	-	-	-	7	1500	1715	-	-	-
East Amole Dam*	-	-	-	-	-	-	2650	300	270
East Amole Dam (Option 6A)	-	-	-	-	-	-	725	320	60
I-40 Diversion: East Amole to 98 th Street	54"-90"	8500	300-810	5-7	3800	805 - 1805	-	-	-
I-40 Pond at 98 th Street	-	-	-	-	-	-	2120	765	49
I-40 Diversion Channel – 98 th Street to Unser Boulevard	-	-	-	5	5500	1090	-	-	-
I-40 Pond at Unser Boulevard	-	-	-	-	-	-	1565	1170	44.4
I-40 Diversion Channel – Unser Boulevard to West Mesa Diversion	-	-	-	6	6850	1360	-	-	-
West Mesa Diversion Pond	-	-	-	-	-	-	530	420	6.5
West Mesa Diversion Channel	90"	2000	255	-	-	-	-	-	-
West Mesa Diversion Channel	10'	5800	790	-	-	-	-	-	-
*Option 2D or 3C.1									

TABLE 11
Trunk Facility Sizes

necessary and recommended in other approved drainage reports, including the Amole-Westgate DMP and the recently adopted Amole-Hubbell DMP. These trunk facilities vary in size slightly between options depending upon the routing and detention of runoff in the upstream watershed (above the Ladera Dams). However, regardless of the final selection of a drainage management plan option for the upstream watershed, a minimum number of trunk facilities are required to accommodate existing development between I-40 and the Ladera Dams, divert flows along I-40 to prevent downstream flooding, and allow the Amole-Hubbell DMP to be implemented. Table 11 summarizes these trunk facilities.

Project Description	Phase	Timing of Construction	Opt. 2D & 3C.1 Total Cost	Opt. 6A Total Cost
West I-40 Division From West Bluff Outfall to West Mesa Division Channel	I and II	Existing	N/A	N/A
West I-40 Division From West Mesa Division Channel to (and including) Unser Blvd Pond	III	By 2002	\$3,310,000	\$3,310,000
West I-40 Division From Unser Blvd Pond to (and including) 98th Street Pond	IV	By 2005	\$2,560,000	\$2,560,000
West I-40 Division From 98th Street Pond to Atrisco Terrace	V	By 2005	\$2,450,000	\$2,450,000
West I-40 Division From Atrisco Terrace to (and including) East Amole Dam	VI	2005 - 2010	\$5,390,000	\$3,200,000
West I-40 Division From East Amole Dam to (and including) West Amole Dam	VII	2005 - 2010	\$6,210,000	\$5,610,000
Dam 5 Arroyo	VIII	After 2010	\$3,710,000	\$2,440,000
Arroyo Stabilization in Atrisco Terrace and Upsizing Dams 1 and 3 of Ladera System	IX	After 2010	\$3,330,000	\$760,000
West Mesa Division Channel Including West Mesa Pond	CITY	By 2003	\$3,410,000	\$3,410,000

TABLE 12
Construction Phases and Costs Associated with Trunk Facilities

Figure 7 illustrates the trunk facilities along with the estimated costs. Table 12 accompanies Figure 7 suggesting possible timing of construction and estimated project costs for the various phases.

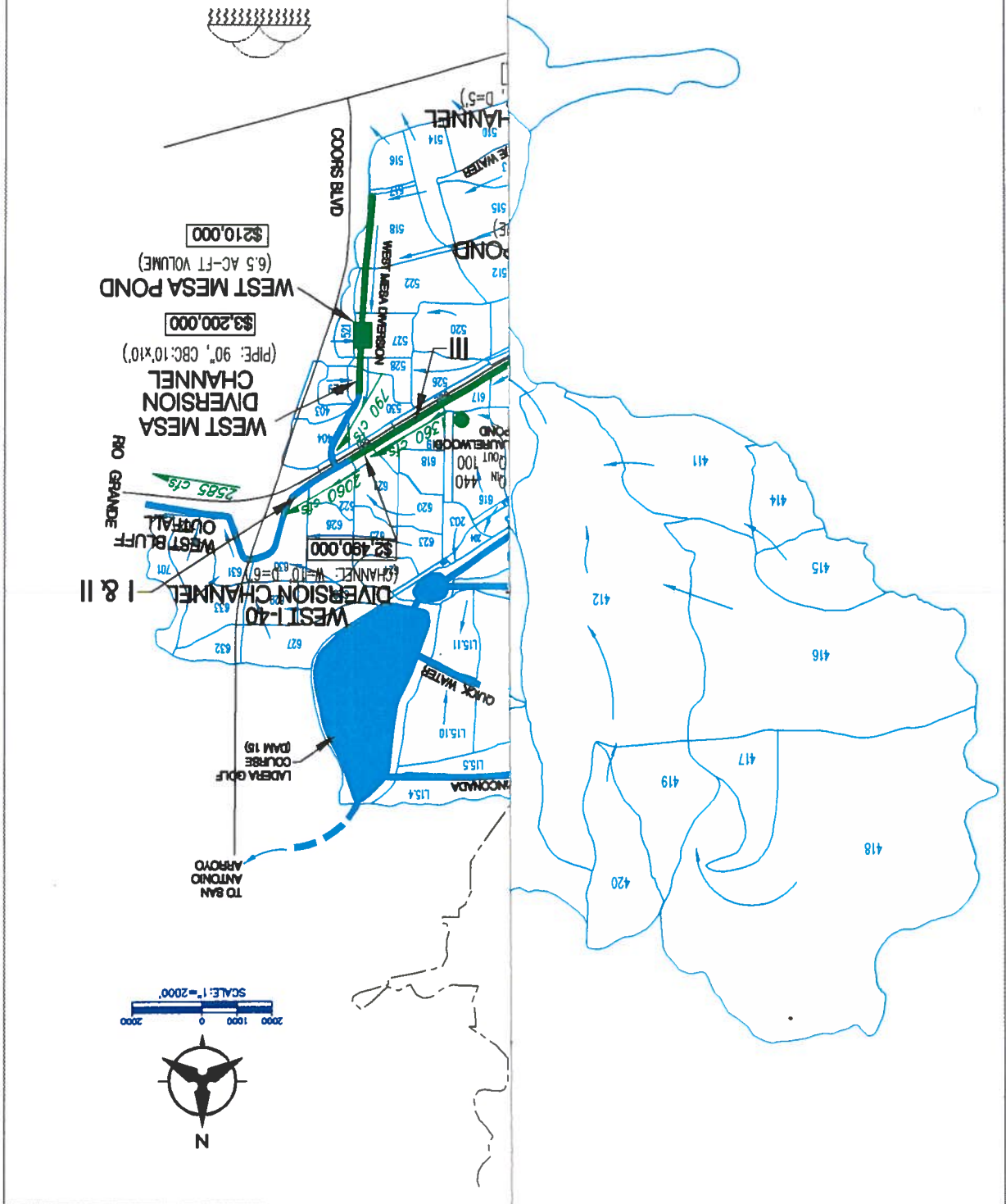
In addition to the new facilities shown in Table 11, the storage volumes at Ladera Dam 1 and 3 need to be increased. Presently, Dam 1 has a 100-year storage volume of 30 ac-ft. This needs to be increased from 11 ac-ft to 41 ac-ft. Similarly, for Dam 3, an increase of 15.7 ac-ft from 29.7 ac-ft to 45.4 ac-ft is required.

Trunk Facilities Cost Summary:

Total Construction Cost:	\$ 19,610,000	Option 2d or 3c.1	\$ 30,640,000
Contingency/Soft Cost	\$ 8,830,000	Option 6A	\$ 15,150,000
Construction Subtotal	\$ 28,440,000		\$ 21,960,000
Total Right-of-Way Cost:	\$ 2,200,000		\$ 2,050,000
Total:	\$ 30,640,000		\$ 24,010,000

FIGURE 7

OPTION 6A	\$19,610,000	OPTION 2D, 3C, 1
CONSTRUCTION	\$16,150,000	
CONTINGENCY/SOFT COST (45%)	\$6,610,000	
RIGHT-OF-WAY	\$2,060,000	
TOTAL	\$24,010,000	
		\$30,640,000



As noted previously, based on extensive review of the options, the Tech Team reduced

the fifteen options to two preferred options, Options 2D and 3C.1. However, agreement on

one option and hence, a decision on how the Monument is treated was not reached.

Consequently, a third preferred option that allows more time to determine a drainage management plan for the upper watershed and the Monument is included and is the

recommended option of this DMP. This option, referred to as Option 6A, along with Options 2D and 3C.1 is described more fully in the following sections.

1. Option 2D

The National Park Service, one of the major landowners in the area, prefers Option 2 in general and Option 2D in particular (see Figure 8). The key elements of this option, not including the trunk facilities, can be seen in the table below.

TABLE 13

Option 2D Key Elements

DESCRIPTION	Dia.	Length (ft)	Flow (cfs)	Depth (ft)	Length (ft)	Flow (cfs)	Dam			Total Cost
							Flow In (cfs)	Flow Out (cfs)	Storage Volume (ac-ft)	
Petroglyph National Monument Arroyo Stabilization (Drop Structures)	-	-	-	-	-	-	-	-	-	\$490,000
Paseo del Volcan Dam	-	-	-	-	-	-	2060	300	198	\$3,540,000
Petroglyph Diversion - Paseo del Volcan to A2 Dam	72"	4000	510	-	-	-	-	-	-	\$1,220,000
Mirrehaven A2 Dam	-	-	-	-	-	-	510	265	22	\$440,000
Petroglyph Diversion - A2 Dam to C Dam	72"	3250	265	-	-	-	-	-	-	\$1,000,000
C Dam	-	-	-	-	-	-	925	335	42.5	\$880,000
Petroglyph Diversion C Dam to D5 Dam	60"	1000	335	-	-	-	-	-	-	\$270,000
D5 Dam	-	-	-	-	-	-	340	270	102	\$1,810,000
C1 and C2 Storm Drains	42"	4800	380	-	-	-	-	-	-	\$710,000
Enlarge Ladera Dam 5	-	-	-	-	-	-	-	-	37.8 (was 31.5)	\$70,000
Dam 5 Diversion from Ladera Dam 5 to I-40 Diversion	54"	2200	255	-	-	-	-	-	-	\$540,000
Mirrehaven Channel - Petroglyph National Monument to Ladera Dam 12	-	-	-	6	6500	1655	-	-	-	\$2,310,000
Parkway Storm Drain (Dam 12 Diversion); Dam 12 to I-40 Diversion	54" - 84"	2250	300-555	-	-	-	-	-	-	\$730,000
Relocate Ladera Training Dike	-	-	-	-	-	635	-	-	-	\$100,000

OPTION 2D COSTS	
CONSTRUCTION	\$8,850,000
CONTINGENCY/SOFT COST (45%)	\$3,980,000
RIGHT-OF-WAY	\$1,280,000
OPTION 2D SUBTOTAL	\$14,110,000
TRUNK	\$30,640,000
OPTION 2D TOTAL	\$44,780,000
LEGEND	
TOTAL	



- a) Option 2D – Divert Mirehaven Arroyos in Pipe to New D5 Dam and Build Dam 5 Diversion (Figure 8)**
- The key elements for this option are:
- Option 2D is essentially the same as Option 2B except the Petroglyph Diversion is an entirely underground facility. This is accomplished the inclusion of two additional detention dams.
 - At Mirehaven A2 Arroyo a 22 ac-ft detention dam, known as the A2 dam, will be constructed at the top of the escarpment.
 - A 43 ac-ft dam referred to as the C Dam will be constructed along the Mirehaven C2 Arroyo at the top of the escarpment.
 - Storm drains will convey runoff below the Petroglyph Diversion and the C Dam to the Monument at historic levels where they will discharge across the Monument in the existing Mirehaven C Arroyo.
 - A diversion from Ladera Dam 12 to the I-40 Diversion is not required.

Option 2D is one of the preferred options because it diverts flows around the Monument, thus protecting the Monument. It accomplishes this diversion with a series of buried storm drain rather than open channels, reducing the potential future constraints on development while also creating several opportunities for neighborhood parks and multi use facilities. Flow from the proposed Paseo Del Volcan Dam will be conveyed in a pipe through two Dams, the A2 Dam and the C Dam, to the D5 Dam. From this point, flow will be conveyed to Ladera Dam 5 via the Dam 5 Arroyo. These dams present opportunities to create ball fields and parks. Flows that enter the Petroglyph National Monument will be maintained at historic levels and follow their natural paths along Mirehaven A, B, and C Arroyos, in existing drainage easements, until the south east boundary of the Monument where an improved channel will convey the flow to Dam 12 of the Ladera system (see Figure 8).



Option 2D Cost Summary:

Total Construction Cost:	\$ 8,850,000
Contingency/Soft Cost:	\$ 3,980,000
Construction Subtotal:	\$ 12,830,000
Total Right-of-Way Cost:	\$ 1,290,000
Option 2D Subtotal:	\$ 14,120,000
Trunk:	\$ 30,640,000
Total:	\$ 44,760,000

2. Option 3C.1

Westland Development Corporation, the second major landowner in the area, prefers Option 3 in general, and Option 3C.1 specifically (see Figure 9). The key elements of this option, not including trunk facilities, can be seen in the table below.

TABLE 14
Option 3C.1 Key Elements

DESCRIPTION	Dia.	Length (ft)	Flow (cfs)	Depth (ft)	Length (ft)	Flow (cfs)	Channel		Dam	100yr Storage Volume (ac-ft)	Total Cost
							Flow In (cfs)	Flow Out (cfs)			
Paseo del Volcan Dam							2060	300		198	\$3,540,000
Paseo del Volcan Dam Outfall - PDV Dam to A2 Dam	72"	4000	510	-	-	-	-	-	-	-	\$1,220,000
Mirehaven A2 Dam	-	-	-	-	-	-	510	265	21.8		\$440,000
A2 Dam Outfall - A2 Dam to Training Dike	60"	8000	450	-	-	-	-	-	-	-	\$1,910,000
Mirehaven C1 and C2 Storm Drain	72"	5200	645	-	-	-	-	-	-	-	\$1,540,000
Mirehaven C Dam	-	-	-	-	-	-	1290	260	54		\$1,030,000
Mirehaven Pipe from C Dam to Confluence	48"	3600	260	-	-	-	-	-	-	-	\$590,000
Mirehaven Pipe from Mirehaven Confluence to National Monument Boundary	84"	4500	1325	-	-	-	-	-	-	-	\$1,810,000
Mirehaven Channel - Petroglyph National Monument to 98th Street	-	-	-	6	3250	1495	-	-	-	-	\$1,190,000
Mirehaven Channel - 98th Street to Dam 12	-	-	-	6	3250	1650	-	-	-	-	\$1,130,000
Parkway Storm Drain (Dam 12 to I-40 Diversion)	54" - 84"	2250	300-615	-	-	-	-	-	-	-	\$710,000
Enlarge Ladera Dam 5	-	-	-	-	-	-	-	-	35.8 (was 31.5)		\$60,000
Enlarge Ladera Dam 11	-	-	-	-	-	-	-	-	45.5 (was 29)		\$210,000

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**ALBUQUERQUE METROPOLITAN
ARROYO FLOOD CONTROL AUTHORITY**

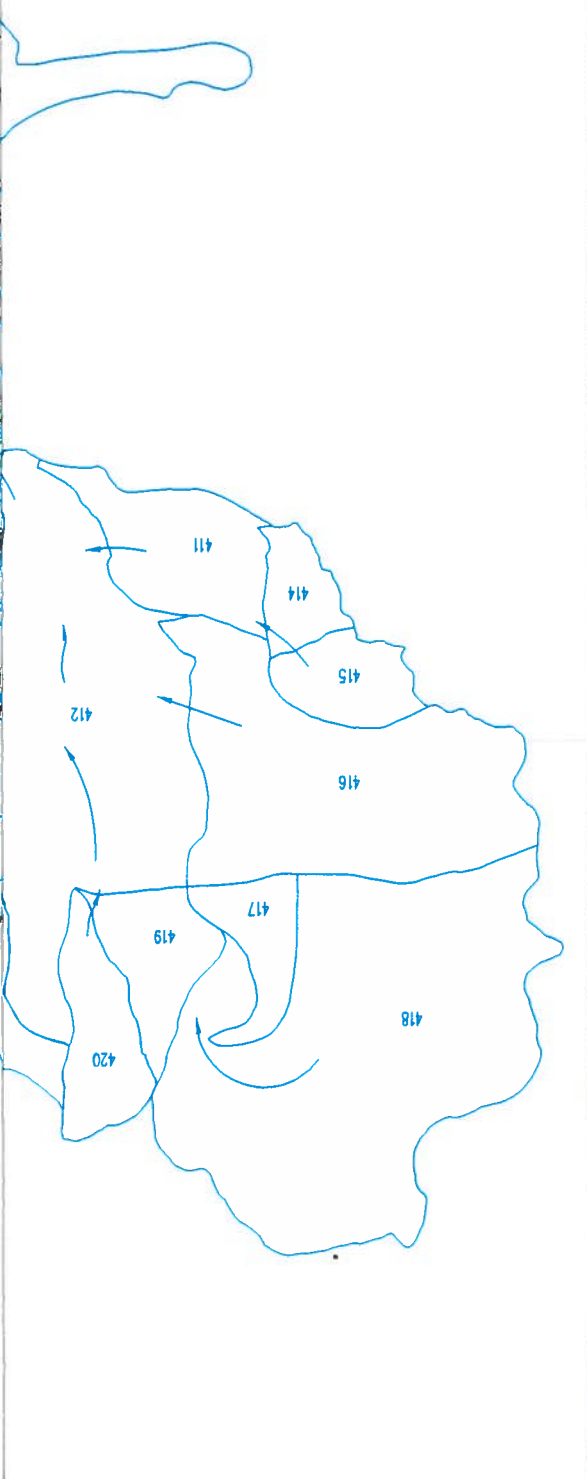
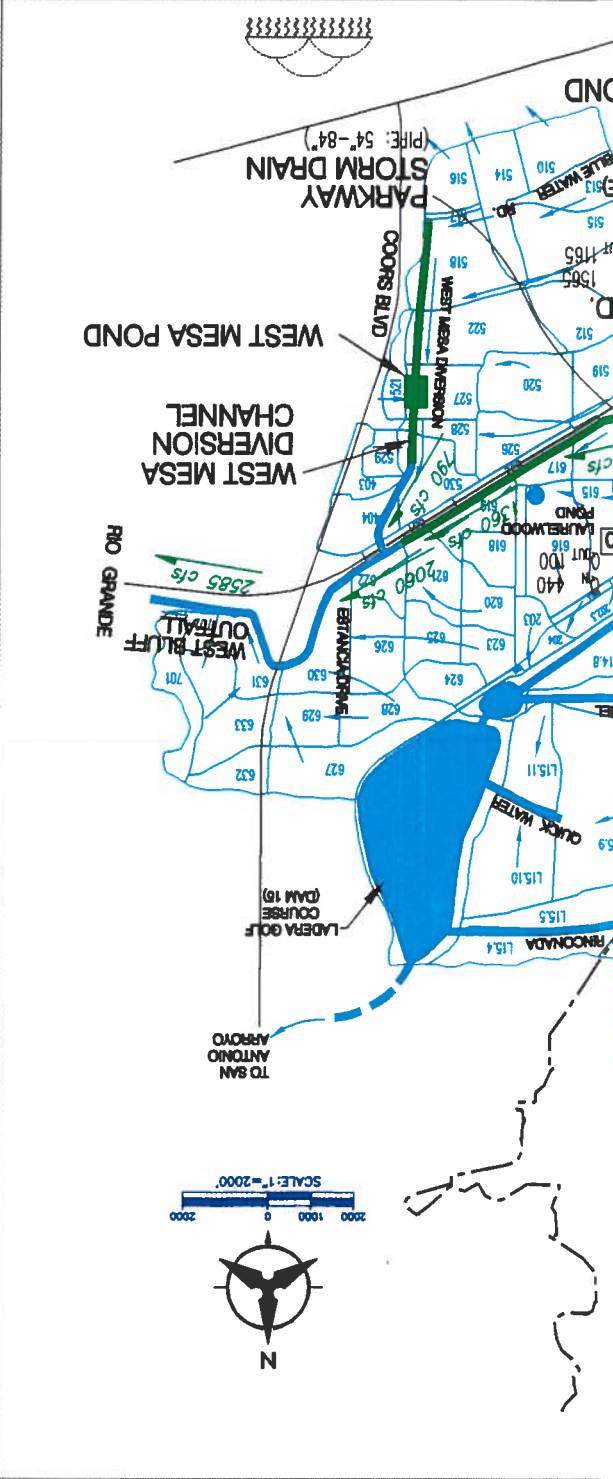
**MANAGEMENT PLAN
WEST I-40 DRAINAGE**

**PROPOSED DMP FACILITIES MAPPINGS
OPTION 3C.1**

DRAWING NO. _____

MAP NO. _____

SHEET N-3 OF 29



OPTION 3C.1 COSTS	
CONSTRUCTION	\$9,830,000
CONTINGENCY/SOFT COST (45%)	\$4,420,000
RIGHT-OF-WAY	\$1,160,000
OPTION 3C.1 SUBTOTAL	\$15,410,000
TRUNK	\$30,640,000
OPTION 3C.1 TOTAL	\$46,050,000

LEGEND

FIGURE 9

Option 3C.1 is one of the preferred options because it has less of a negative impact on the Monument compared to Option 1 but also places fewer constraints on Westland's property upstream of the Monument. Option 3C.1 proposes to convey flows through the Monument using a series of buried storm drain that follow the natural path of the existing arroyos. Flow from the proposed Paseo del Volcan Dam is diverted to Mirehaven A2 Dam in a pipe and then diverted to Mirehaven Arroyo B. Mirehaven C flows are regulated by Mirehaven C Dam before entering the Monument. Flows are conveyed through the Monument along both Mirehaven B and Mirehaven C Arroyos in buried storm drains in existing drainage easements. These Mirehaven flows exit the Petroglyph Monument Boundary at the southeast boundary and are then conveyed in an improved channel to Ladera Dam 12.

a) Option 3C.1– Divert Mirehaven Arroyos “A” to “B” with Detention at “C” and Through Monument (Figure 9)

- Flows are diverted from Mirehaven A to B upstream of the Monument.
- Runoff is conveyed through the Monument along both the Mirehaven B and C Arroyo alignments via storm drains.
- The need to relocate the Ladera Training Dike is eliminated since the flow is conveyed in a storm drain rather than in the existing, unlined arroyos.
- Developed flows cross the Monument in a pipe rather than the existing, unlined arroyo. Consequently, only minimal arroyo stabilization within the Monument is anticipated with this option.

Option 3C.1 Cost Summary:

Total Construction Cost:	\$ 9,830,000
Contingency/Soft Cost:	\$ 4,420,000
Construction Subtotal:	\$ 14,250,000
Total Right-of-Way Cost:	\$ 1,150,000
Option 3C.1 Subtotal:	\$ 15,400,000
Trunk:	\$ 30,640,000
Total:	\$ 46,040,000

3. Option 6A

Option 6A (see Figure 10) is the recommended option for a number of reasons. Under this option, the immediate needs in the lower watershed and the requirements of the adopted Amole Westgate and Amole Hubbell DMP's are met. Option 6A also establishes sizes for drainage facilities in the lower portion of the watershed (below the Atrisco Terrace and along the Amole Watershed at I-40) without precluding future selection on either option 2D or 3C.1. This is accomplished by sizing the drainage facilities for the worst case (highest) flow rate and volume from either option 2D or 3C.1 with the exception of the two Amole Dams which are sized for existing conditions.

Under option 6A, the Amole dams will be designed to allow expansion of the dams pools to accommodate developed conditions runoff and volumes, should development occur on the top of the escarpment. The costs included in Option 6A size the dam pools for existing conditions. The dams principal spillway will be the same for both existing and developed conditions, while the dam should be designed with provisions to expand the dam's emergency spillway to handle the Probable Maximum Flood (PMF) under fully developed conditions. It should be noted that, with the multiple detention facilities in the upper portion of the watershed in both option 2D and 3C.1 that the developed flow rates for each option in the lower portion of the watershed are nearly identical. Further, due to upstream detention proposed with both Options 2D and 3C.1, the flow rates to size conveyances for arroyos, such as the Mirehaven, between the Monument/Atrisco Terrace, and the Ladera Dams are only slightly larger than existing conditions flow rates, plus sediment. This increase is due to the increase in runoff from development of the area between the Monument/Atrisco Terrace and the Ladera Dams. Finally, Option 6A allows more time for the two major landowners, Westland Development and the National Park Service, to reach an agreement concerning drainage and the Monument.

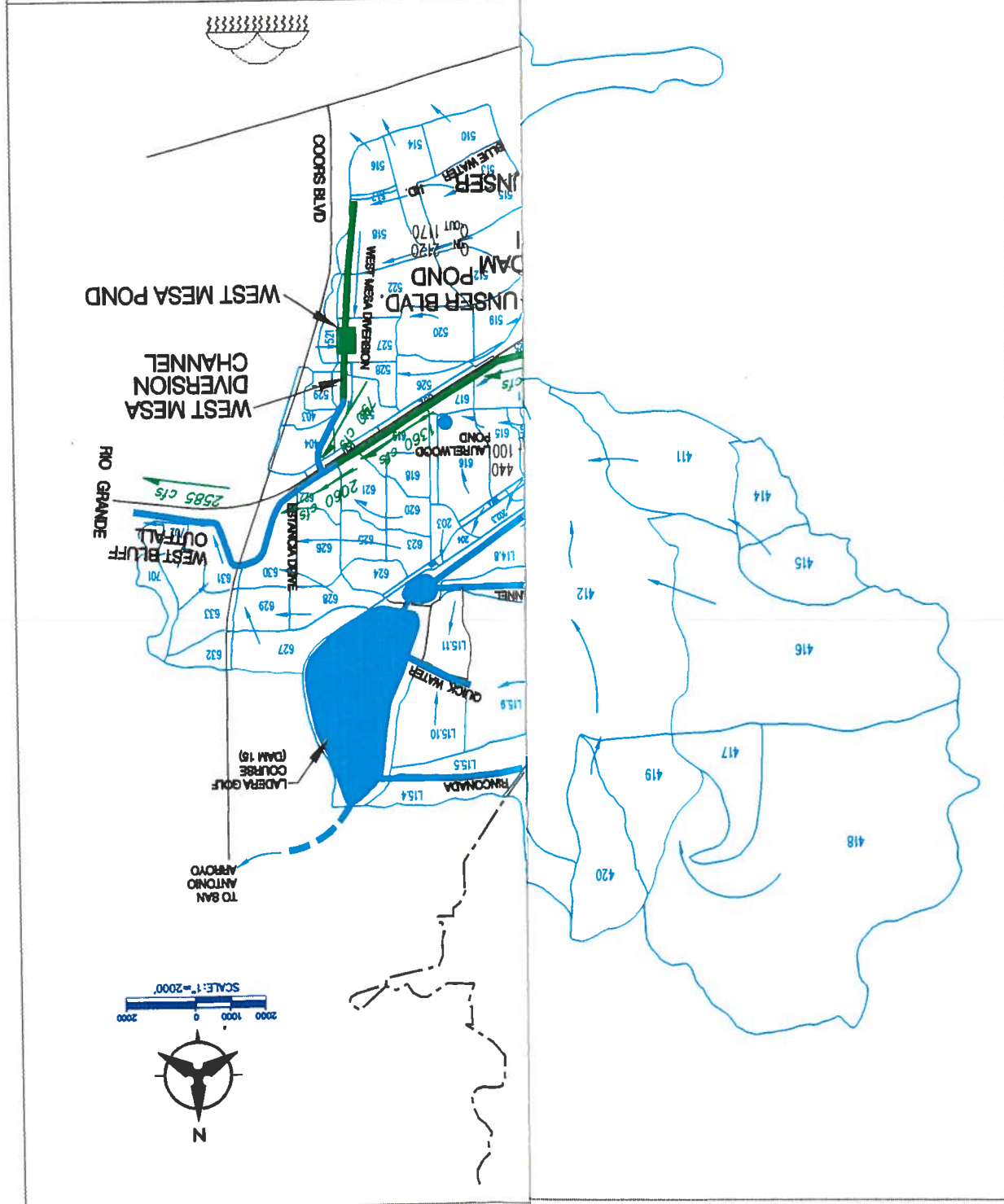
OPTION 6A COSTS	
CONSTRUCTION	\$2,510,000
CONTINGENCY/SOFT COST (45%)	\$1,130,000
RIGHT-OF-WAY	\$220,000
OPTION 6A SUBTOTAL	\$3,860,000
TRUNK (6A)	\$24,010,000
OPTION 6A TOTAL	\$27,870,000

NOTE:
FLOW RATES REPRESENTED IN
AND SC.1 FOR ANY GIVEN PA

DRAWING NO. _____
 MAP NO. _____
 SHEET N-4 OF 29

**ALBUQUERQUE METROPOLITAN
ARROYO FLOOD CONTROL AUTHORITY**
**MANAGEMENT PLAN
WEST I-40 DRAINAGE
PROPOSED DMP FACILITIES MAPPING
OPTION 6A**


 Bohannon & Huston
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Option 6A Cost Summary:

Total Construction Cost:	\$ 2,510,000
Contingency/Soft Cost:	\$ 1,130,000
Construction Subtotal:	\$ 3,640,000
Total Right-of-Way Cost:	\$ 220,000
Option 6A Subtotal	\$ 3,860,000
Trunk	\$ 24,010,000
Total: (w/trunk)	\$ 27,870,000

- Drainage facilities, including Trunk Facilities but not the two Amole Dams, are sized for the highest flow rate from either option 2D or 3C.1.
- The West and East Amole dam flood pools are sized for existing conditions flow rates and volumes.
- The length of the Dam 5 and Dam 1 conveyances are substantially reduced and extend only to the base of the Atrisco Terrace and the Dam 0 Arroyo improvements are not required.
- The Dam 5 Diversion is included so as to not preclude the future selection of Option 2D.
- Enlarge Ladera Dams 5 and 11.

Full Watershed Development (Figure 10)

a) Option 6A-Growth to the Atrisco Terrace with Consideration of

DESCRIPTION	Dia.	Length (ft)	Flow (cfs)	Depth (ft)	Length (ft)	Flow (cfs)	Flow In (cfs)	Flow Out (cfs)	100yr Storage Volume (ac-ft)	Total Cost
Dam 5 Diversion from Ladera Dam 5 to I-40 Diversion	54"	2200	260	-	-	-	-	-	-	\$540,000
Mitrehaven Channel - Petroglyph National Monument to Ladera Dam 12	-	-	-	6	6500	1655	-	-	-	\$2,320,000
Parkway Storm Drain	54"-84"	2600	300-615	-	-	-	-	-	-	\$730,000

TABLE 15
Option 6A Key Elements

The key elements of Option 6A, not including trunk facilities) are as shown in the table below:

The three preferred options represent the best options for drainage management within the West I-40 study area. These options are the result of years of analysis and refinement based on input from both the AMAFCA Board and the Tech Team.

Based on the inability of the two major landowners to reach an agreement concerning either Option 2D or 3C.1, Option 6A is the recommended option. This option addresses immediate and short-term drainage needs in the study area, while allowing the two majority landowners more time to reach an agreement with regard to management of drainage relating to the Monument.

IV. CONCLUSION