PIMA ROAD DETENTION BASIN FEASIBILITY STUDY

PRELIMINARY DESIGN REPORT

For:

GRAYHAWK DEVELOPMENT
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For Submittal to:

Arizona Department of Water Resources
Dam Safety Division

City of Scottsdale
Pima Road Desert Greenbelt Design Team

Arizona State Land Department

Maricopa County Flood Control District

August 23, 1995 (Draft)

by:

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17902 Georgetown Lane
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DRAFT REPORT FOR ADWR REVIEW ONLY

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II. INTRODUCTION

Pacific Advanced Civil Engineering (PACE) has been retained by Grayhawk Development to provide hydraulic and hydrologic value engineering design services regarding the proposed Pima Road Desert Greenbelt Channel including; conceptual design coordination efforts with the City if Scottsdale (COS) and Arizona State Land Department (ASLD). The existing Pima Road Desert Greenbelt Channel design as proposed by the Greiner Team for the City of Scottsdale as presented in the "Pima Road Channel Preferred Alternative" dated April 1995 includes in excess of 6 miles (34,000 feet) of concrete lined channel. The location of the proposed "Pima Road Desert Greenbelt Channel" alignment is shown on *Figure II-1, Regional FEMA Map*, and is proposed to convey stormwater runoff in a southerly direction along Pima Road from north of Jomax Road, to the Central Arizona Project Canal/Bureau of Reclamation Retention Area.

This report assesses the feasibility of two regional detention basis, one at Happy Valley Road and the second at Deer Valley Road. Included in the report are results of hydraulic and hydrologic modeling as well as preliminary designs for the two detention basins. The modeling also includes a third regional detention basin at Union Hills Drive. Preliminary designs for the Union Hills Detention Basin are not included in this report. The Union Hills Detention Basin site has been master planned as a regional detention basin for many years and can be incorporated into the proposed Pima Road Desert Greenbelt.

A. OBJECTIVE OF THE STUDY

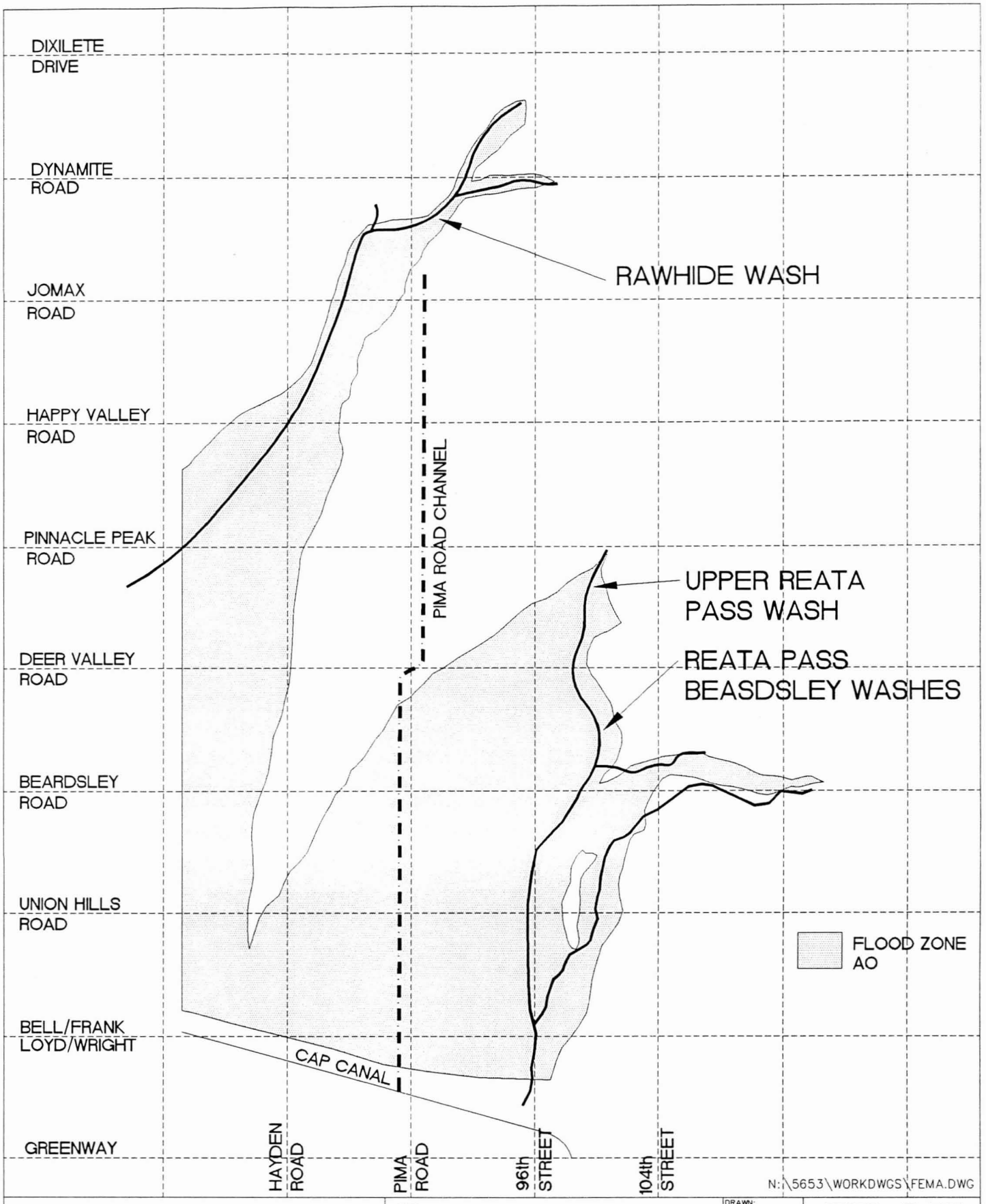
The purpose of this study is to determine the effectiveness of the addition of regional detention basins to the Pima Road Channel Desert Greenbelt Alternative. Our design goals included identifying a more proactive, safe, aesthetically pleasing and cost effective drainage solution, which will enhance the Desert Greenbelt concept and minimize the potential flood hazards associated with high velocity flows in steep walled concrete channels. Hydrologic and hydraulic designs and modeling have been prepared to confirm the effectiveness of detention basin as a key element to the proposed Pima Road Channel Desert Greenbelt. This study is a feasibility analysis and final design of the proposed detention basins and drainage facilities will require additional detailed analysis.

As stated above, a main concern of the proposed Pima Road Channel Desert Greenbelt channelization alternative is the danger associated with high velocity concrete channel storm runoff. The proposed channel design without detention includes 100 year runoff flows in excess of 9,000 cfs (cubic feet per second) and corresponding velocities of 20 to 30 fps (feet per second). A graphical comparison of the peak flows in the Pima Road Channel, with and without detention, is presented in *Figure II-2, Pima Road Channel Flow Comparison Drainage Map.*

These large flows and high velocities are a very dangerous combination and should be eliminated where possible in urban settings. In addition to the reduced safety hazard, incorporation of the proposed detention basins is a key element to the proposed Pima Road flood control facilities. The elimination/reduction of the concrete lined channels provides more area for true desert greenbelt uses; open space, recreational, wildlife habitat, while providing a more hydraulically stable and cost effective engineering solution.

B. DETENTION BASIN ALTERNATIVES

In the preliminary phase of this report, numerous drainage/flood control facility design alternatives were considered. Configurations included single as well as multiple detention basins along the Pima Road Channel. These alternatives are not represented in this report and can be found in the Pima Road Detention Basin Draft Feasibility Study Preliminary Report by PACE, May 1995.



TITLE: FEMA MAP

JOB: PIMA ROAD DETENTION BASIN FEASIBILITY STUDY

SCOTTSDALE AZ

DRAWN:	S.S.
CHKD:	M.E.K.
DATE:	08-22-95
JOB No.	5653-11

PACE
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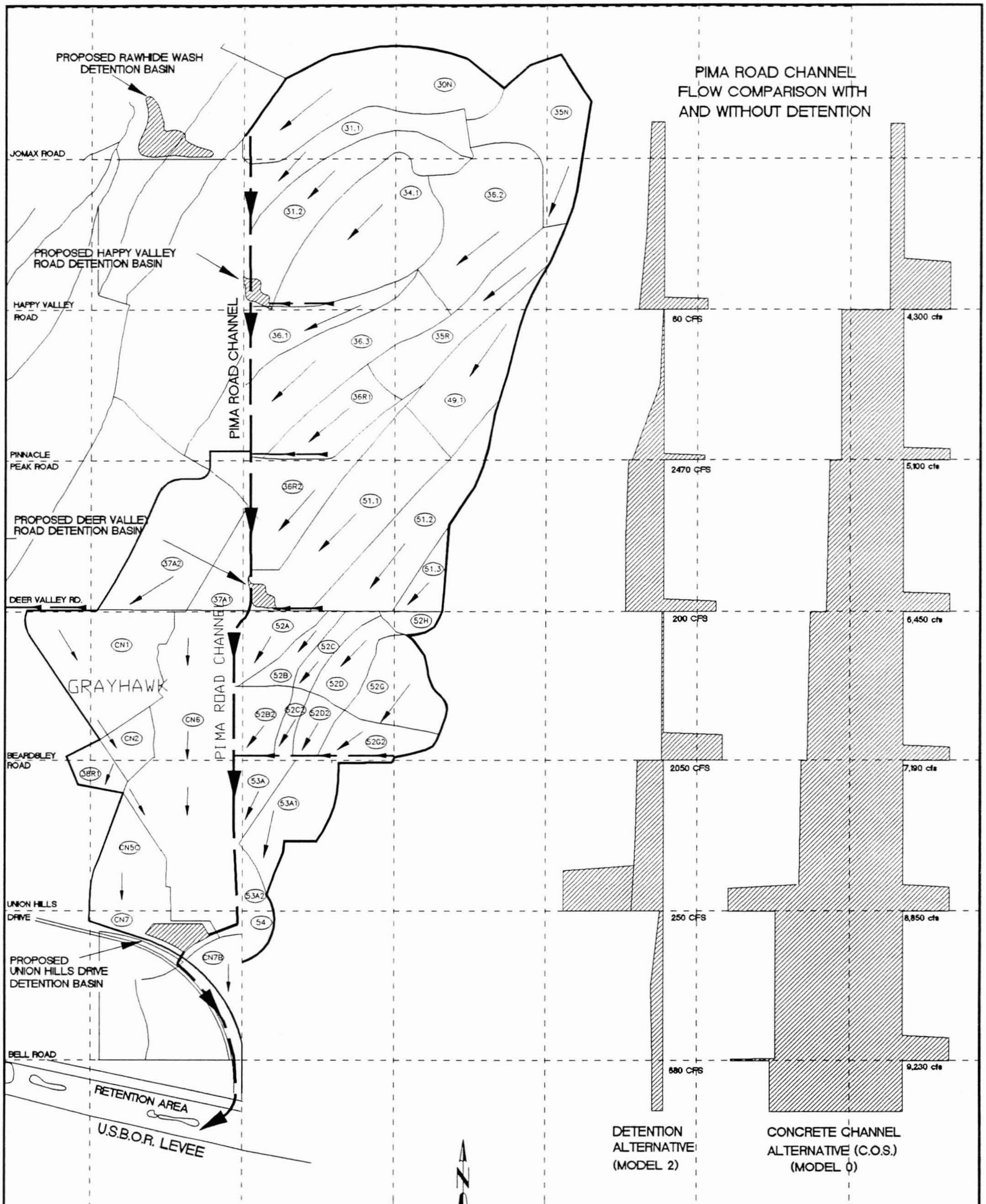
17902 GEORGETOWN LANE H.B. CA. 92647
(714) 843-5734 FAX 848-4820

FIGURE II-1



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CIVIL ENGINEERING

PIMA ROAD
CHANNEL DETENTION
FEASIBILITY STUDY

SCOTTSDALE ARIZONA

PIMA ROAD CHANNEL
GRAPHIC FLOW
COMPARISON

SCALE 1" = 1200'
DESIGNED J.A.P.
DRAWN S.S
DATE 08 - 18 - 95

III. HYDROLOGY

Drainage areas tributary to the proposed Happy Valley and Deer Valley Road Detention Basins as well as the Pima Road Channel are shown on *Figure III-1, Watershed Drainage Map*. HEC-1 computer program, developed by the Corps. of Engineers, was used in the hydraulic and hydrologic modeling of the watersheds. The following sections include a discussion of the HEC-1 models, precipitation, routing, design flows/volumes and sedimentation.

A. HEC-1 MODELING

The General Drainage Plan for North Scottsdale by Water Resources and Associates, Inc., April 14, 1988, contains the initial study and HEC-1 models developed for this area. Subsequently, the HEC-1 models have been modified by several engineering firms including AN-West, Gilbertson & Associates and Greiner. PACE developed several models in the design of the Pima Road Detention Basins and the Pima Road Channel. Model variation was utilized to allow for the estimation of most conservative design flows for each detention basin and channel reach. Below is a brief description of each of the models: A summary of the HEC-1 models can be found in *Table III-1, HEC-1 Model Summary.*

1. HEC-1 Model 0 (Baseline Model)

a. Description

Model 0 is the baseline model for the Pima Road Channel Watershed. Originally called PIMA4B.DAT, it was developed by The Greiner Team for the City of Scottsdale for the Pima Road Desert Greenbelt Channel design.

The design storm is the 100 year 6 hour rainfall event. The watershed drainage map for Model 0 prepared by Greiner is included as *Figure III-2*. The model assumes that the Pima Road Channel is in place along Pima Road from Jomax Road to the north, south to the Bureau of Reclamation detention area located south of Bell Road. The model also assumes the existence of east-west collector channels along Happy Valley, Pinnacle Peak, Deer Valley and Beardsley Roads. These collector channels would intercept runoff coming from the north east and route it west to the Pima Road Channel.

b. Purpose

Model 0 (PIMA4B.DAT) was developed with the maximized east west collector channels to provide the most conservative routing in the Pima Road Channel. The collector channels serve to bring the flows into the Pima Road Channel at points upstream from their natural drainage path. This approach maximizes the flows in the Pima Road Channel.

2. **HEC-1 Model 1 (Happy Valley Road Detention Basin)**

a. **Description**

Model 1 was derived directly from Model 0. The Watershed Drainage Map for Model 1 is included as *Figure III-3*. The model assumes maximized east-west collector channels (1.5 miles) along Happy Valley Road east of Pima Road as proposed by the City of Scottsdale. The model was modified to include the Happy Valley Road Detention Basin. The design storm was changed to a 100 year 24 hour event.

b. **Purpose**

This model was developed as the design storm model to determine the requirements for the Happy Valley Road Detention Basin. The model is the most conservative approach for the design of the Happy Valley Road Detention Basin, as it maximizes the area contributing runoff to the basin with the maximized Happy Valley Road collector channel.

3. **HEC-1 Model 2 (Deer Valley Road Detention Basin)**

a. **Description**

Model 2 was derived from Model 1. The watershed drainage map for Model 2 is included as *Figure III-4*. Changes made to Model 1 include the limiting of the east west collector channels along Happy Valley and Deer Valley Roads to 1/2 mile east of Pima Road. The modification routes more of the upstream drainage areas directly into the Deer Valley Detention Basin. Approximately 1.1 square miles of tributary drainage area is being routed into both the Happy Valley and Deer Valley Detention Basins to provide conservative design. Per COS direction and as per the most currently submitted development drainage plans the Deer Valley Road Collector channel extends east 1/2 mile from Pima Road. Other changes made to the HEC-1 model include minor changes in drainage area sub-basins to reflect the shorter east-west collector channel at Happy Valley Road. Routing changes for flows along the Pima Road Channel were also made to reflect the decreased size requirement for the Pima Road Channel. The design storm used for this model is the 100 year 24 hour storm.

b. **Purpose**

Model 2 was used in the design of the Deer Valley Road Detention Basin. By including a portion of the drainage area which is tributary to the Happy Valley Road Detention Basin, it maximizes the area contributing runoff flows directly to the Deer Valley Detention Basin.

4. **HEC-1 Model 2-6 (Pima Road Channel Design)**

   a. **Description**

   Model 2-6 is identical to Model 2 except the rainfall event was modified from the 100 year 24 hour storm to the 100 year 6 hour storm.

   b. **Purpose**

   Model 2-6 was developed for the design of the Pima Road Channel. It includes the detention basins at Happy Valley, Deer Valley and Union Hills sized for the 100 year 24 hour storm.

5. **HEC-1 Model 3 (Beardsley Detention Basin) - Conceptual Only**

   a. **Description**

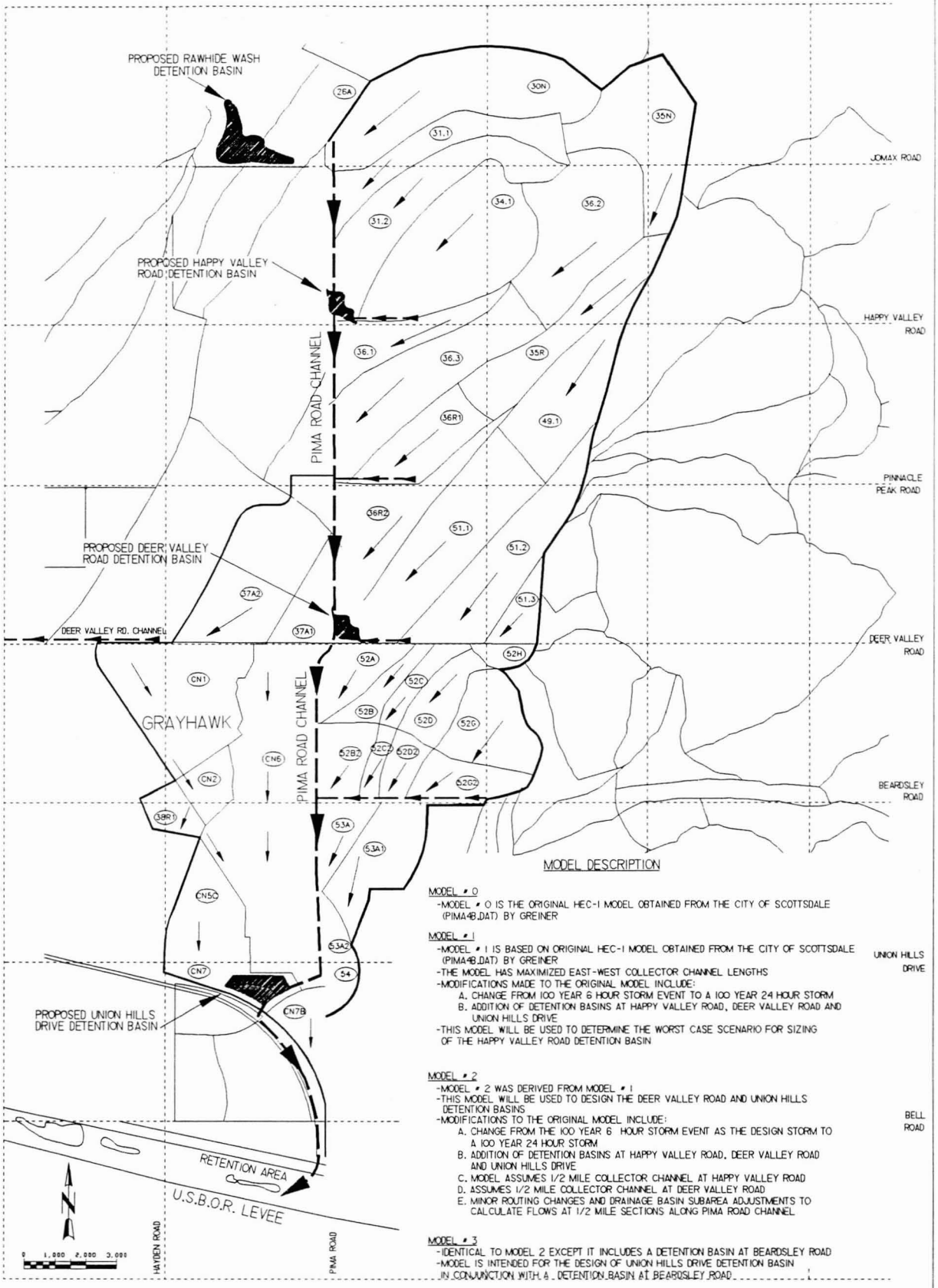
   Model 3 is identical to Model 2 except it includes an additional detention basin at Beardsley Road.

   b. **Purpose**

   Model 3 was developed for the design of the Beardsley Detention Basin. It further decreases the flows along the Pima Road Channel by intercepting high flow rates entering the Pima Road Channel at Beardsley Road. It includes the detention basins at Happy Valley, Deer Valley and Union Hills sized for the 100 year 24 hour storm.

TABLE III-1
HEC - 1 MODEL SUMMARY

HEC-1 MODEL	PURPOSE	DESCRIPTION
Model 0.HC1	Pima Road Channel Design with out detention	Baseline model obtained from City of Scottsdale. Originally called PIMA4B.DAT
Model 1.HC1	Happy Valley detention basin design	Derived from Model 1.HC1. Storm event changed to 100-yr/24-hr, includes Happy Valley detention basin. Maximizes inflows into Happy Valley detention basin with 1.5 mile ease-west collector channel at Happy Valley Rd.
Model 2.HC1	Deer Valley & Union Hills detention basin design	Derived from Model 1.HC1, includes Deer Valley and Union Hills detention basins. Assumes only 1/2 mile east-west collector channels at Happy Valley, Pinnacle Peak and Deer Valley Roads to maximize inflows into Deer Valley detention basin.
Model 2-6.HC1	Pima Road Channel Design with detention @ Happy Valley and Union Hills	Same as Model 2.HC1 with 100 yr-6 hr storm.



MODEL DESCRIPTION

MODEL # 0
- -MODEL # 0 IS THE ORIGINAL HEC-1 MODEL OBTAINED FROM THE CITY OF SCOTTSDALE (PIMA4B.DAT) BY GREINER

MODEL # 1
- -MODEL # 1 IS BASED ON ORIGINAL HEC-1 MODEL OBTAINED FROM THE CITY OF SCOTTSDALE (PIMA4B.DAT) BY GREINER
- -THE MODEL HAS MAXIMIZED EAST-WEST COLLECTOR CHANNEL LENGTHS
- -MODIFICATIONS MADE TO THE ORIGINAL MODEL INCLUDE:
  - A. CHANGE FROM 100 YEAR 6 HOUR STORM EVENT TO A 100 YEAR 24 HOUR STORM
  - B. ADDITION OF DETENTION BASINS AT HAPPY VALLEY ROAD, DEER VALLEY ROAD AND UNION HILLS DRIVE
- -THIS MODEL WILL BE USED TO DETERMINE THE WORST CASE SCENARIO FOR SIZING OF THE HAPPY VALLEY ROAD DETENTION BASIN

MODEL # 2
- -MODEL # 2 WAS DERIVED FROM MODEL # 1
- -THIS MODEL WILL BE USED TO DESIGN THE DEER VALLEY ROAD AND UNION HILLS DETENTION BASINS
- -MODIFICATIONS TO THE ORIGINAL MODEL INCLUDE:
  - A. CHANGE FROM THE 100 YEAR 6 HOUR STORM EVENT AS THE DESIGN STORM TO A 100 YEAR 24 HOUR STORM
  - B. ADDITION OF DETENTION BASINS AT HAPPY VALLEY ROAD, DEER VALLEY ROAD AND UNION HILLS DRIVE
  - C. MODEL ASSUMES 1/2 MILE COLLECTOR CHANNEL AT HAPPY VALLEY ROAD
  - D. ASSUMES 1/2 MILE COLLECTOR CHANNEL AT DEER VALLEY ROAD
  - E. MINOR ROUTING CHANGES AND DRAINAGE BASIN SUBAREA ADJUSTMENTS TO CALCULATE FLOWS AT 1/2 MILE SECTIONS ALONG PIMA ROAD CHANNEL

MODEL # 3
- -IDENTICAL TO MODEL 2 EXCEPT IT INCLUDES A DETENTION BASIN AT BEARDSLEY ROAD
- -MODEL IS INTENDED FOR THE DESIGN OF UNION HILLS DRIVE DETENTION BASIN IN CONJUNCTION WITH A DETENTION BASIN AT BEARDSLEY ROAD

TITLE PIMA ROAD WATERSHED DRAINAGE MAP WITH HAPPY VALLEY, DEER VALLEY AND UNION HILLS DETENTION BASINS	DRAWN S.S.	PACE PACIFIC ADVANCED CIVIL ENGINEERING 17902 GEORGETOWN LANE H.B. CA. 92647 (714) 843-5734 FAX 848-4820	1 FIGURE
JOB PIMA ROAD CHANNEL DETENTION FEASIBILITY STUDY	CHKD M.E.K.		
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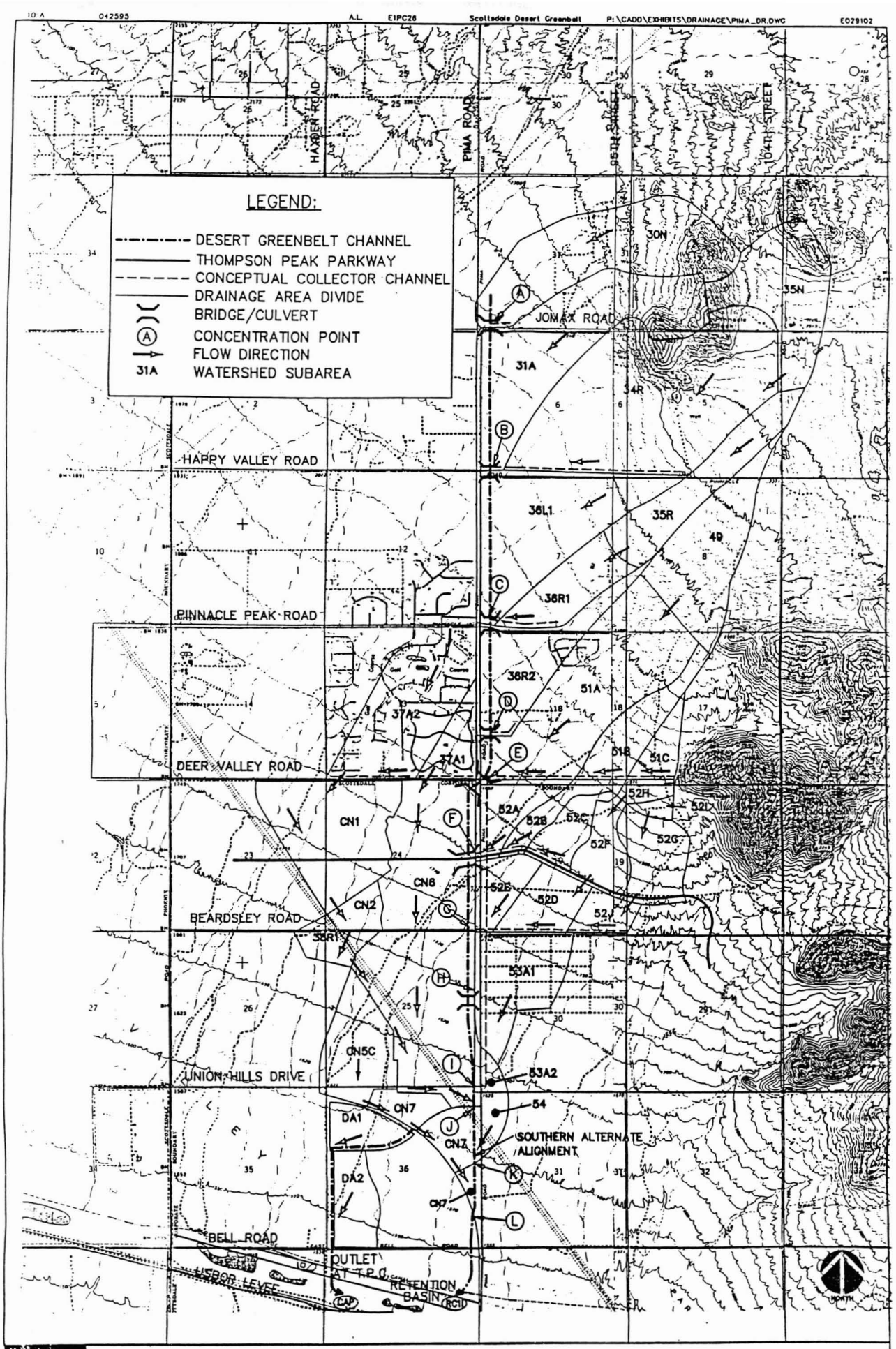
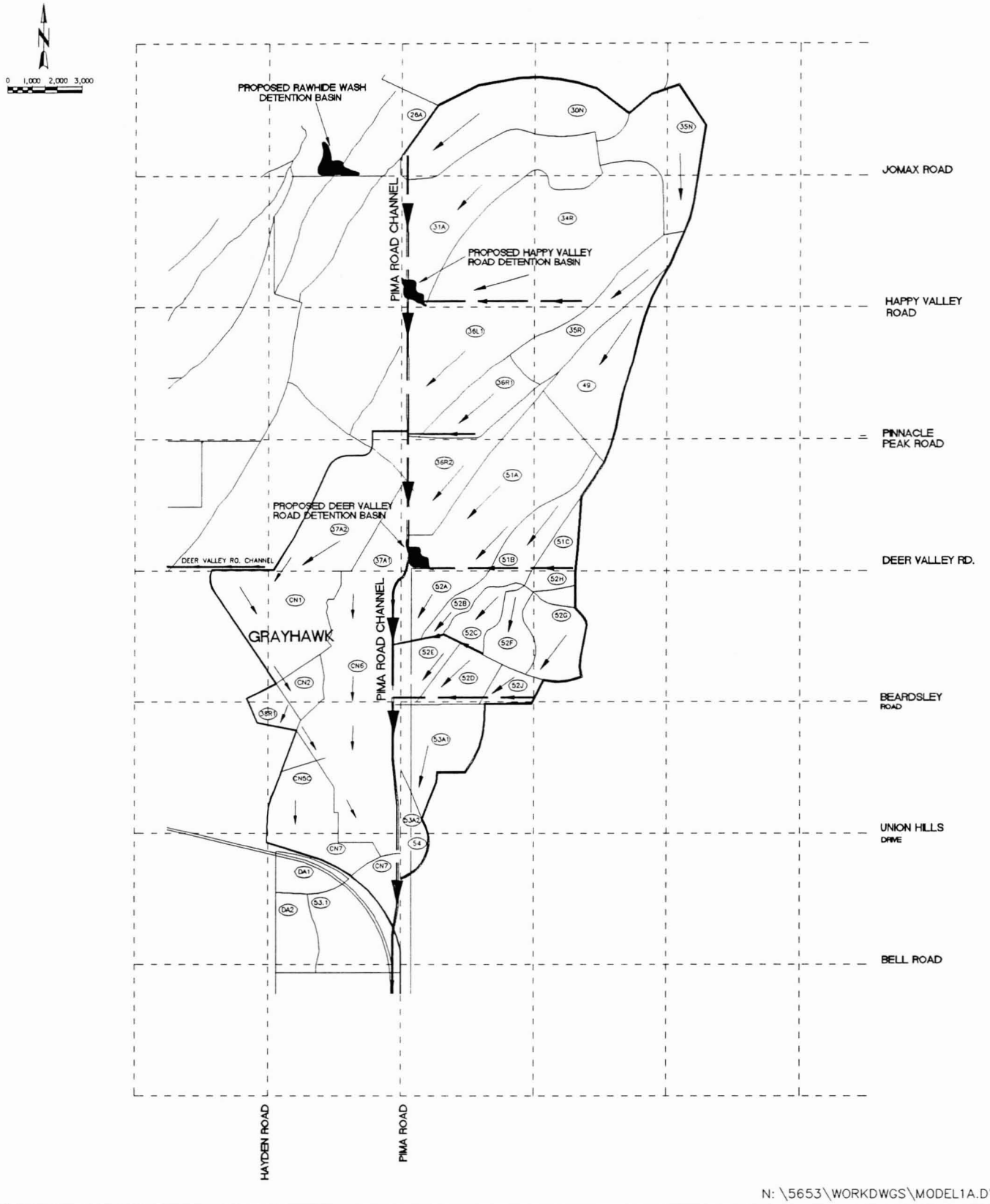


Pima Road Channel
Drainage Area Map
Overall View

FIGURE III-2

Greiner



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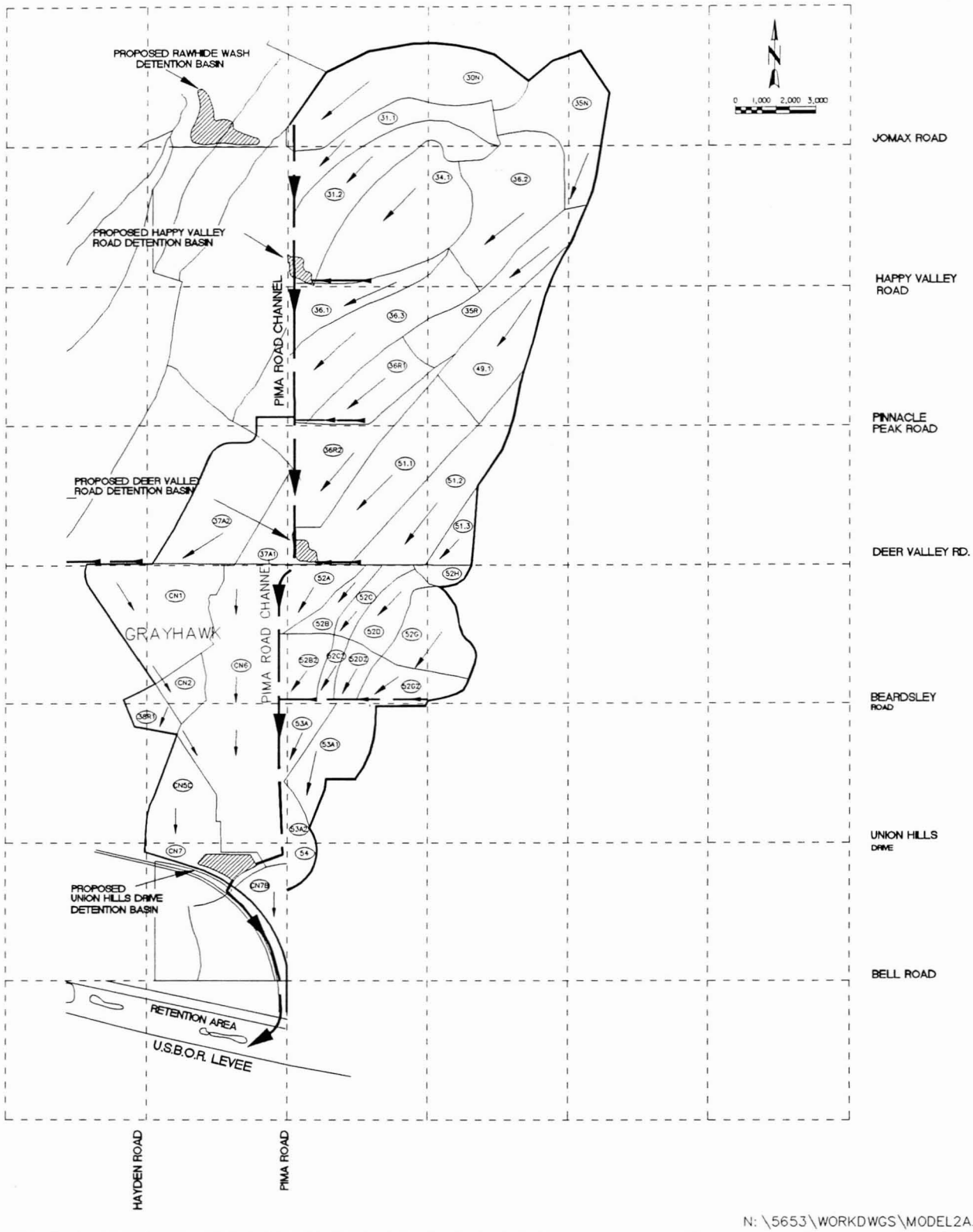
TITLE: MODEL 1 WATERSHED DRAINAGE MAP	JOB: PIMA ROAD DETENTION BASIN FEASIBILITY STUDY SCOTTSDALE AZ	DRAWN: S.S. CHKD: M.E.K. DATE: 08-22-95 JOB No. 5653-11	PACE PACIFIC ADVANCED CIVIL ENGINEERING 17902 GEORGETOWN LANE H.B. CA. 92647 (714) 843-5734 FAX 848-4820

FIGURE III-3



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FIHURE III-4

B. PRECIPITATION

A summary of the storm events and rainfall depths used in the hydrologic modeling is included as *Table III-2, Precipitation Summary*. The City of Scottsdale Drainage Manual recommends the use of a 100 year 6 hour storm in the design of channels and detention basins. The original HEC-1 model obtained from the City of Scottsdale utilized a 100 year 6 hour storm event with a rainfall depth of 3.31". Modeling completed by PACE indicate that the 100 year 24 hour storm would generate higher peak flows and runoff volumes than the 6 hour storm event.

Therefore, the 100 year 24 hour storm was used in the design of the detention basins. The 100 year 6 hour storm event was used in the design of the Pima Road Channel. The rainfall depth used for the 100 year 24 hour storm is 4.25" with and SCS Type IIA distribution. The General Drainage Plan for North Scottsdale, Arizona , 06-07-89, by Water Resources Associates, Inc. also shows that the 24 hour 100 year storm generates higher runoff volumes and peak flows for the area.

Probable Maximum Precipitation (PMP) calculations were also completed for the subject watersheds. Probable Maximum Flood (PMF) is defined by the Arizona Department of Water Resources (ADWR) as the flood runoff that may be expected from the most severe combination of critical metereologic and hydrologic conditions that are reasonably possible in the region. A calculation of the PMF runoff is required in the design of dams and detention basins to protect the integrity of the dam and ensure public safety for downstream areas.

Detailed calculations and backup for the PMP are included in Appendix B. The PMP calculations were completed utilizing the procedures described in the Hydrometereological Report No. 49, Probable Maximum Precipitation Estimates, Colorado River and Great Basin Drainages by National Oceanic and Atmospheric Administration and Army Corps. of Engineers. An additional average area weighting reduction was utilized which is consistent with the PMP calculations completed by the Maricopa County Flood Control District for the Rawhide Wash Detention Basin located nearby. This method was approved by all reviewing agencies for the Rawhide Wash Detention Basin, Preliminary Design.

The estimated Local Storm - 6 Hour PMP for the Happy Valley and Deer Valley Road Detention Basins was found to be 13.05 and 12.12 inches respectively (see Appendix).

TABLE III-2
PRECIPITATION SUMMARY TABLE

Storm Event	Rainfall Depth (in)	Facility Design
100-yr/6-hr	3.31	Pima Rd. Channel Design
100-yr/24-hr	4.25	Happy Valley Rd. & Deer Valley Rd. Detention Basin Design
2-yr/6-hr	1.52	
10-yr/6-hr	2.27	
0.5 PMP 6-hr Happy Valley Watershed	6.53	Happy Valley Rd. Detention Basin Spillway Design
0.5 PMP 6-hr Deer Valley Watershed	6.06	Deer Valley Rd. Detention Basin Spillway Design

C. ROUTING

The flow routing in the HEC-1 models utilized the Muskingum-Cunge routing method where possible. Drainage sub-basins located between Deer Valley Road and Beardsley Road were most recently delineated and routed in the Community Drainage Study for DC Ranch, Wood/Patel Associates, 04-26-95. Routing for these areas was done utilizing the Kinematic Wave Method.

As described in the Section III A. of this report, the HEC-1 drainage sub-basin routing between the different models was varied in order to maximize the peak flows and volumes into each of the detention basins. This conservative approach takes into account any uncertainty with regards to the length of the east west collector channels to be located along Happy Valley, Deer Valley and Pinnacle Peak Roads.

Model 1 which was used for the design of the Happy Valley Road Channel assumes the existence of a 1 1/2 mile east west collector channel along Happy Valley Road. This collector would to bring flows which would normally enter the Pima Road Channel south of Happy Valley Road, into the Happy Valley Road Detention basin. It is therefore a conservative approach that maximizes the tributary area to 3.37 square miles for the Happy Valley Road Detention Basin.

Model 2 was used in the design of the Deer Valley Road Detention Basin. Key feature of Model 2 is that it limits the east-west collector channels along Happy Valley, Deer Valley and Pinnacle Peak Roads to 1/2 mile. Shortened collector channels allow the flows, which in Model 1 would enter the Happy Valley Road Detention Basin, to bypass it and go into the Deer Valley Road Detention Basin, thereby maximizing the inflows into the Deer Valley Road Detention Basin. The tributary area for the Deer Valley Road Detention Basin was found to be 5.98 square miles.

D. STORM RUNOFF DESIGN FLOWS AND VOLUMES

1. Detention Basin Design Flows and Volumes

a. 100 Year-24 Hour

The 100 year-24 hour detention basin design storm peak runoff and volumes are summarized on *Table III-3*. The bolded runoff and volume quantities in the table indicated the selected design peak inflow and storm volume. The design as summarized below indicates a duplication of detention basin tributary area which is a level of design conservatism which addresses the uncertainties surrounding the proposed east/west collection channels. The HEC-1 computer output results for each of the following models are included in the report appendices.

Table III-3
Detention Basin Design HEC-1 Model Comparison
For Critical Design Runoff Flows and Volumes

	100 YEAR - 24 HOUR STORM													
	Model 0* (No Detention)		Model 1 (Happy Valley Detention Basin)				Model 2 (Deer Valley/Union Hills Detention)				Model 3 (Beardsley Detention Basin)			
Confluence Location/ Detention Basin	Drg. Area (s.m.)	Flow (cfs)	Drg. Area (s.m.)	Inflow (cfs)	Outflow (cfs)	Storage (AF)	Drg. Area (s.m.)	Inflow (cfs)	Outflow (cfs)	Storage (AF)	Drg. Area (s.m.)	Inflow (cfs)	Outflow (cfs)	Storage (AF)
Happy Valley	3.4	4,860	3.4	**4,860**	**80**	**327**	2.2	3,000	60	200	2.2	3,000	60	200
Deer Valley	6.6	7,740	6.6	2,970	180	233	6.0	**3,960**	**200**	**286**	6.0	3,960	200	286
Beardsley Road	7.9	8,770	7.9	n/a	n/a	n/a	7.4	n/a	n/a	n/a	1.5	**2,040**	**90**	**119**
Union Hills	11.0	11,020	11.0	4,480	240	503	10.9	**6,040**	**250**	**610**	10.9	4,130	250	560

*100 yr-24 hour event

Notes

1. Detention Basin Design Storm - 100 year-24 hour storm event (4.25", SCS Type 11A distribution, from General Drainage Plan for North Scottsdale, Water Resources and Associates).
2. Model 0 - Original unmodified HEC-1 model obtained from (COS) PIMA4B.DAT by Greiner (i.e. maximized east-west collector channel lengths.
   - No detention.
3. Model 1 - Derived from original HEC-1 model obtained from (COS) PIMA4B.DAT by Greiner (i.e. maximized east-west collector channel length at Happy Valley Road.
   - Modifications include:
     a: change from 100 year-6 hour storm event to a 100 year-24 hour storm
     b: detention basins at Happy Valley, Deer Valley and Union Hills Roads
   - This model will be used to determine worst case scenario for sizing Happy Valley Road Detention Basin.
4. Model 2 - Model built on Model 1 with the following modifications
     a: Assumes 1/2 mile collector channel at Happy Valley Road
     b: Assumes 1/2 mile collector channel at Deer Valley Road
     c: Minor routing changes and drainage basin subarea adjustments to calculate flows at 1/2 mile sections along Pima Road Channel.
     d: Detention basins at Happy Valley Road, Deer Valley Road and Union Hills Drive.
     e: Changes in channel routing to reflect the new Pima Road Channel.
   - This model will be used to design the Deer Valley Road and Union Hills Drive Detention Basins.
5. Model 3 - Possible future refinement identical to Model 2 except includes a detention basin at Beardsley Road
   - Model intended for the design of Deer Valley Road and Union Hills Drive Detention Basin in conjunction with a detention basin at Beardsley Road.

b. 0.5 Probable Maximum Flood

Based upon the following ADWR classifications, the recommended spillway design flood is 0.5 PMF for both the Happy Valley and Deer Valley Detention Basins.

Dam size and hazard classifications were determined based upon the State of Arizona Department of Water Resources (ADWR) Safety of Dams and Flood Engineering Unit design guidelines entitled "Emergency Spillway Capacity, Reservoir Routing, and Freeboard Requirements" dated September, 1994.

Detention Basin	Embankment Height (Ft)	Storage Capacity (AF)	Size Classification	Downstream Hazard Classification
Happy Valley	18	520	Small	High
Deer Valley	28	448	Small	High

The Probable Maximum Flood (PMF) is described in the Chow/Maidment/May Applied Hydrology text as "the greatest flood to be expected assuming complete coincidence of all factors that would produce the heaviest rainfall and maximum runoff... and hence its frequency can not be determined." The Standard Project Flood (SPF) is defined in the COE engineering manual EM 1110-2-1411 "Standard Project Flood Determination" as the "Most severe flood... of any storm that is considered reasonably characteristic of the region in which the drainage basin is located...." The SPF spillway design provides an additional level of protection for loss of life and excessive property damage. The following PMF-SPF relationship is also stated, "Past estimates have indicated that SPF magnitudes and discharges are generally in the range of 40 to 60 percent of the PMF for this same basin.

The 0.5 PMF routing for the Happy Valley and Deer Valley Detention Basins are as shown on *Table III-4* below.

TABLE III-4
0.5 PMF DETENTION BASIN STORM ROUTING

Detention Basin	HEC-1 Model	Drainage Area (mi^2)	Rainfall (in)	Peak Basin Inflow (cfs)	Peak Basin Outfall (cfs)	Peak Basin Storage (acre-feet)	Peak Stage (elev.)
Happy Valley Road	0.5PMF-HV.HC1	3.37	6.53	9,400	7,700	447	2,094.1
Deer Valley Road	0.5PMF-DV.HC1	5.98	6.06	12,800	12,700	357	1,894.1

Notes:
1. See Appendix for PMP calculations from hydrometerological report #49 and the HEC-1 models for 0.5 PMP routing.
2. PMP scaled down 50% to reflect the 1/2 PMF requirement by ADWR for dams/detention basins of this size and classification.

2. Pima Road Channel Design Flows (Section Not Complete) Section Enclosed from May 1995 PACE Draft Report

Based upon COS design criteria, the 100 year- 6 hour event will be used for channel design. The design flows in the Pima Road Channel are shown in *Table III-5, Pima Road Channel Design Flows*. The table shows the peak flows in the Pima Road Channel at every 1/2 mile interval. The table also separates the inflows into the channel by the direction from which the flows enter (i.e. east, west, north). As indicated earlier in this report, the Pima Road Channel design flows are based on a 100 year 6 hour storm event. The table clearly shows that a significant reduction in peak flows is possible with the inclusion of detention facilities at Happy Valley, Deer Valley and Union Hills Drive Roads. With the detention basins in place, the highest expected flow in the Pima Road Channel is expected to be 2,500 cfs. Without the detention basins flows can be as high as 11,000 cfs.

Pages 10 and 11 of the May 1995 PACE Draft Report are also included for reference.

TABLE III-5

MODEL #2 - 100 YEAR 6 HOUR STORM EVENT
PIMA ROAD CHANNEL DESIGN FLOWS WITH DETENTION
AT HAPPY VALLEY, DEER VALLEY & UNION HILLS ROADS

CHANNEL SECTION LOCATION	HEC-1 NODE	CHANNEL LENGTH (ft)	Flow From North Q_{100} (cfs)	Flow From East Q_{100} (cfs)	Flow From West Q_{100} (cfs)	TOTAL FLOW Q_{100} (cfs)
STA 348+20 At Jomax Road	30N		0	970	0	970
STA 322+00	CP31.1	2620	960	510	0	1,270
STA 295+30 At Happy Valley Road	CP31.2	2670	1270	910	0	1,950
STA 295+30 At Happy Valley Road	DET-HV		40	0	0	40
STA 269+30	CP36.1	2600	40	250	0	250
STA 245+56 At Pinnacle Peak Road	CP36.4	2374	240	1770	0	2,260
STA 219+56	C36R2	2600	2220	510	0	2,490
STA 193+00 AT Deer Valley Road	CP51.1	2656	2480	860	0	3,240
STA 193+00 AT Deer Valley Road	DET-DV		130	0	0	130
STA 170+00	R52A2	2300	130	0	0	130
STA 136+25 At Beardsley Road	52E6A	3375	130	1940	0	1,810
STA 110+25	CP53A2	2600	1770	310	0	2,010
STA 82+65 At Union Hills Drive	C53A21	2760	2350	0	3190	5,010
STA 82+65 At Union Hills Drive	DET-UH	2760	230	0	0	230
STA 29+05 At Bell Road	C54	5360	230	960	0	850
STA 0+00 At B.O.R.	ROBELL	2905	760	0	0	760

A major point of concern with the proposed concrete channel are the safety issues surrounding the design of 1.5 to 1 or 2 to 1 concrete channel side slopes, 6-12 foot depths of flow and velocities in excess of 30 fps. This type of channel would most likely require fencing for protection of the public. This type of channel can be a hazard when dry and an extreme hazard when flowing, even the more frequent rainfall events will produce flows in excess of 20 fps.

The issue of channel flow conveyance and confluencing is also a significant issue which must be addressed for the no detention desert greenbelt. The case is nearly identical for all of the major east-west collector channels (5 locations) as they confluence with the Main Pima Road Channel. This confluencing of channels with flows of approximately 4,000 cfs and 1,000 cfs at 90 degrees is difficult, costly and land intensive.

Pima Road Channel With Detention

The proposed Happy Valley Road and Deer Valley Road detention basins significantly decrease peak flows in the Pima Road Channel. As stated above, Table III-1 shows a comparison of the peak flows in the Pima Road Channel for the 6-hour 100-year storm event with and without detention. The 100 year Pima Road Channel flows at Pinnacle Peak Road are decreased from 5,100 cfs to 935 cfs. This decreased flow can be conveyed in a 30-foot bottom width native channel with a flow depth of 2.2 feet. Calculations for the Pima Road Channel cross section at Pinnacle Peak Road can be found in the Appendix. The calculations indicate that in addition to the decreased channel width requirement, benefits of lower peak flows include lower flow velocities which permit the elimination of concrete lining of the channels. At Deer Valley Road peak flows are decreased from 6,000 cfs to 230 cfs.

As shown in Figures III-1 and III-2 the detention alternative enhances the Desert Greenbelt concept by eliminating the concrete lining and decreasing the depth and width of the channels. As a result of the proposed detention basins, the reduced flow rates on the Pima Road Channel do not require significant improvements such as concrete linings, drop structures or screening from Pima Road. The reduced flows can be introduced into the Desert Greenbelt without degradation of the proposed aesthetic character and vision. In addition, the sediment transportation issue is resolved by providing sediment storage in the detention basin and constructing the proposed reduced flow channels at the existing native material slope. By utilizing the native area channel bed slope, the sediment transportation will be minimized and controlled; this also eliminates the cost of the grade control/drop structures. The proposed channel flow depths of less than 3 feet and velocities less than 10 fps will significantly reduce the safety issue surrounding the proposed channels. The additional 44 acres required for the construction of the proposed detention basins would be offset by and average decrease in the desert greenbelt width for the entire length. The total desert greenbelt/flood control land requirement can be adjusted to be the same for both the detention and no detention alternatives.

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III. Hydraulics

Summarized in this section are results of the hydraulic analyses and a comparison of the Pima Road Channel flows with and without the proposed detention basins at Happy Valley and Deer Valley.

Pima Road Channel Without Detention

The Pima Road Channel as proposed by the Greiner Team for the Pima Road Desert Greenbelt is a trapezoidal shaped concrete lined channel with bottom widths varying from 40'-60' and depths up to 12 feet. The Desert Greenbelt concept includes a greenbelt of widths up to 170' between Pima Road and the channel. The purpose of the greenbelt is two fold; to provide greenbelt/native area open space, and to limit the visual impact of the concrete channel from Pima Road. However, the greenbelt does not address the visual impact to the neighbors on the opposite side of the channel. Figures III-1 and III-2 show the Pima Road Channel cross sections as proposed by Greiner, at Pinnacle Peak and Deer Valley Roads in comparison to the required desert greenbelt channel section with detention. The variation in the proposed channel; geometry, flow location, and aesthetic treatment are as defined in the April 1995 report "Pima Road Channel Preferred Alternative". Table III-1 compares 100 year peak flows and runoff volumes at 1 mile intervals in the Pima Road Channel for comparison of the channel with and without detention.

Table III-1
PIMA ROAD CHANNEL 100 YEAR - 6 HOUR
PEAK FLOW AND VOLUME COMPARISON
WITH AND WITHOUT DETENTION

LOCATION	DRAINAGE AREA (s.m.)	WITHOUT DETENTION Q_{100} (cfs)	WITHOUT DETENTION V_{100} (AF)	WITH DETENTION Q_{100} (cfs)	WITH DETENTION V_{100} (AF)
Happy Valley Road at Pima Road					
From north (R31A3)	0.76	849	70	849	70
From East (C3A1)	2.61	3,328	225	3,228	225
Detention Basin Inflow (C3A2)	3.37	4,177	295	4,177	295
Detention Basin Outflow (DET-HV)	n/a	n/a	n/a	87	n/a
Pinnacle Peak at Pima Road					
From North (R36L1)	3.37	4,082	295	87	290
From East (C36L1)	1.24	951	90	951	90
Combined (C36L2)	4.62	5,033	385	982	382
Deer Valley at Pima Road					
From North (R51A1)	5.00	4,735	413	1,172	410
From East (C51A1)	1.63	1,337	119	1,337	119
Detention Basin Inflow (C51A1)	6.62	6,073	532	2,443	533
Detention Basin Outflow (DET-DV)	n/a	n/a	n/a	227	n/a
Beardsley at Pima Road					
From North (R52E)	7.02	6,635	561	595	562
From East (C52E1)	0.85	952	71	982	71
Combined (C52E2)	7.87	7,051	631	1,470	635
Union Hills at Pima Road					
From North (R53A2)	7.87	7,280	631	1,651	635
From East (C53A1)	0.53	769	49	770	49
From West (CDB2.1)	2.59	1,907	239	1,907	239
Combined (C53A21)	11.00	8,927	917	4,190	934
Bell at Pima Road					
From North (RC53)	11.00	9,079	917	4,249	481
From East (54)	0.04	139	6	139	6
From West (CCN7)	0.56	1,549	91	1,549	91
Combined (CCN71)	11.60	9,583	1,041	5,202	1,033

E. SEDIMENTATION

1. Detention Basins

Sediment deposition from major storm events and/or over periods of time can significantly reduce the storage capacity within the detention basin. For the purposes of this feasibility study, the sediment storage within the detention basin has been estimated. A detailed sediment yield analysis for the study detention basins will be required for final design.

Detention Basin	Tributary Area (SM)	100 yr - 24 Hr. Q(cfs)	100 yr - 24 Hr. Vol (AF)	Basin Sediment Storage Allocation (AF)
Happy Valley	3.4	4,860	430	14
Deer Valley	6.0	3,960	530	33

For a comparison, detailed studies for the Rawhide Wash Drainage Basin and Proposed Detention Basin are as follows:

- Tributary Area (SM) 15
- 100 YR - 24 Hr Runoff Peak Flow and Volume
  - Q (cfs) 13,900
  - Volume (AF) 1,910
- Estimated Annual Sediment Yield (AF/YR) 3.9
- Estimated Q_{100} Sediment Yield (AF) 13.3

Based upon the above referenced data, it is both feasible and recommended that sufficient sediment storage be provided within the Pima Road Desert Greenbelt Detention Basins to provide a minimum of a 20 year scheduled maintenance removal program.

In the proposed Happy Valley and Deer Valley Detention Basin design, the sediment storage has been provided below the detention basin outlet and could be combined with a groundwater recharge system to provide percolation of low flow event runoff. In addition, the sediment storage portion of the detention basins have been located to facilitate secondary uses of the remainder of the detention basins such as parks, ball fields and other recreational areas.

2. Pima Road Desert Greenbelt Channel

Sediment deposition within the desert greenbelt channel is a significant design consideration and a detailed sediment analysis including HEC-6 modeling of the proposed channel shall be provided with the final design. The design concepts for the channel sedimentation include the following elements:

- Proposed detention basins are sized to accommodate channel sediment deposition.
- Determine equilibrium bed scope of proposed channels and utilize drop structures to facilitate channel slope.
- Increased urbanization of entire drainage basin over time will reduce annual and major storm event sediment yields.

IV. PIMA ROAD DESERT GREENBELT DETENTION BASIN DESIGN

Summarized in this section are the design criteria of the proposed Happy Valley Road and Deer Valley Road Detention Basins. Both of the proposed detention basins are located within a linear strip of Arizona State Land (ASL) which extends from Deer Valley Road, to north of Jomax Road, on the east side of Pima Road. The ASL parcels are slightly less than 1/4 mile in width (i.e. east - west), approximately 1050 feet.

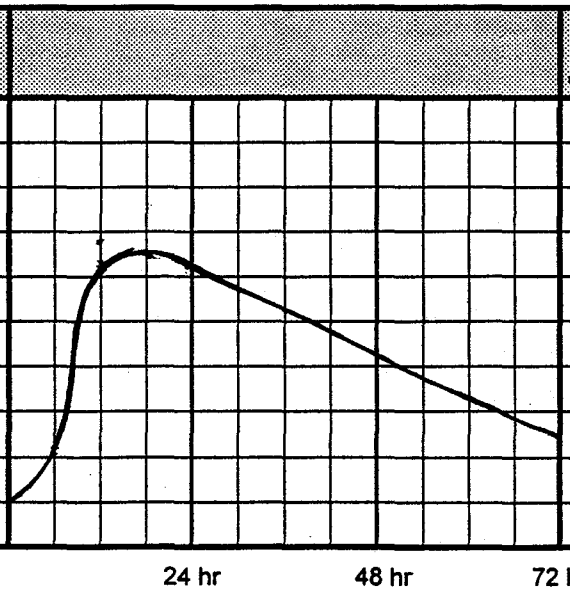
A. HAPPY VALLEY ROAD DETENTION BASIN

The proposed Happy Valley Road Detention Basin is located in the southwest quarter of the southwest quarter of Section 6, Township 4 North, Range 5 East. The general location of the basin was selected as a result of the availability of the State Trust Lands and being the first major collection point of the Pima Road Channel. The location of the proposed Happy Valley Road Detention basin will provide drainage improvement to downstream developments including the ASL parcels south along Pima Road.

The proposed Happy Valley Road detention basin can be utilized as a regional park connected by the Pima Road Channel Desert Greenbelt. With the introduction of the Happy Valley Road Detention Basin the dedicated channel portion (65-85 foot width) of the Desert Greenbelt can be significantly reduced in width. In keeping with the Pima Road Desert Greenbelt set back philosophy the Happy Valley detention basin will have a minimum 75 foot setback from Pima and Happy Valley Roads. The proposed grading plan for the Happy Valley Road Detention basin is shown in *Figure IV-1* and cross sections Figure IV-2 and IV-3. The design concepts include excavating a large portion of the detention storage volume and constructing the basins with maximum side slopes of 3:1 inside and 4:1 outside. The Desert Greenbelt design concept will be utilized to provide a revegetated buffer between Pima Road and the proposed drainage facility. Example of a typical revegetated buffer can be found in Exhibit 1, a photograph taken from the revegetated Grayhawk Golf Course. With the revegetated 75 foot setback and the proposed grading, the visual impact of the detention basin from all directions can be minimized. The detention basin bottoms will be graded relatively level to provide adequate area for park and other recreational activities with a lower waste area for sedimentation and possibly riparian habitat.

Table IV-1
Happy Valley Road Detention Basin 100 Year - 24 Hour
Stage, Area, Volume and Discharge Summary

ELEVATION	DEPTH (ft)	AREA INUNDATED (ac)	CUM. STORAGE VOLUME (ac-ft)	DISCHARGE Capacity(cfs)
2,098.00	43.00	19.60	520	20,450
2,095.00	40.00	18.90	462	10,500
2,090.00	35.00	17.30	372	80
2,085.00	30.00	15.80	290	72
2,080.00	25.00	14.40	214	65
2,075.00	20.00	13.00	146	56
2,070.00	15.00	11.50	85	46
2,065.00	10.00	9.70	32	33
2,060.00	5.00	3,50	sed.14 0	0
2,055.00	0.00	2.20	sed. 0 0	0



Design data for the Happy Valley Detention Basin is shown in *Table IV-2*. *Figure IV-4* shows the Inflow and Outflow hydrographs for the 24-hour 100-year storm event. Elevation vs. Storage vs. Area graph is shown on *Figure IV-5*.

Table IV-2
Happy Valley Road Detention Basin
Design Criteria

Location	Section: 6 Township: 4 North Range: 5 East Maricopa County, Arizona	
Basin Area:	25 Acres	
Design Storms:	100 year, 24-hour storm Drainage Area - 3.37 sq. mi. Total Rainfall - 4.25" inches Peak Inflow - 4,860 cfs Volume of Inflow Hydrograph - 431 AF	**0.5 PMP - 6 Hour Storm** Drainage Area - 3.37 sq. mi. Total Rainfall - 6.53 inches Peak Inflow - 9,400 cfs Volume of Inflow Hydrograph 790 AF

Detention Basin Embankment:

Type - Homogeneous Earthfill (with 8 foot thick soil cement core)
Length - 1,300 ft
Maximum Height - 18 ft
Crest Elevation - 2,098, width = 10 ft. minimum
Slopes: Upstream Slope - 3:1 Maximum
Downstream Slope - 4:1 Maximum
Maximum Storage - 520 AF
Area at Crest - 19.6 acres

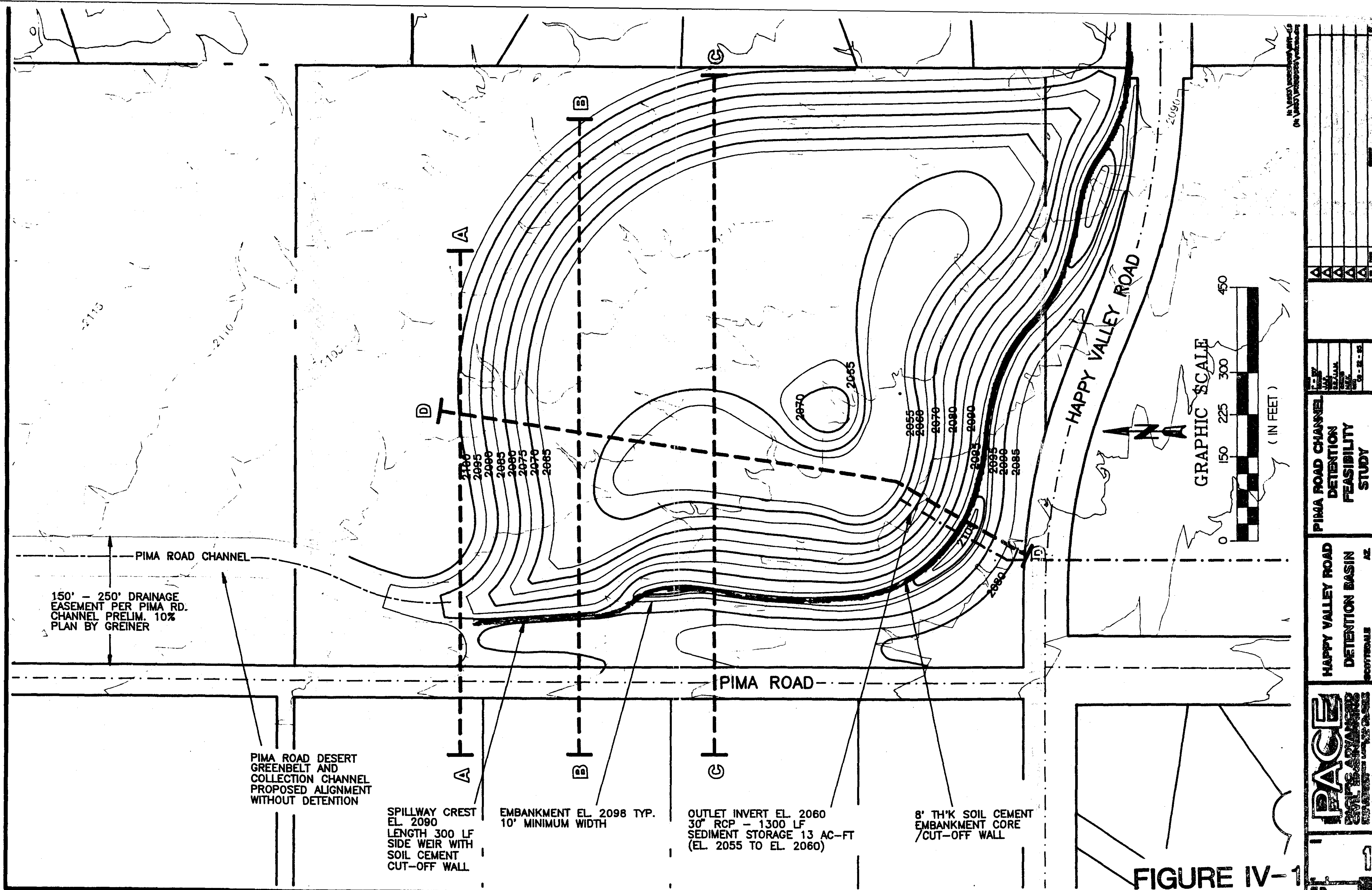
Spillway:

Type - At grade/Below Grade (with soil cement cutoff wall)
Elevation - 2,090 ft
Length - 300 ft
Width - 10 ft
Height - 5 ft

Low Level Outlet:

Type - Reinforced Concrete Pipe. Invert Elevation 2,060
Dimensions - 30" diameter, 1,300 ft long
Discharge Capacity @ 100-year 24-hour - 80 cfs
Sediment storage - 14 AF (Elevation 2,055 - 2,060)

100 -year 24-hour storm:	Peak Stage - 2,087.3 ft Peak Storage - 327 AF Peak Outflow - 75 cfs Freeboard to Spillway - 2.7 ft.	**0.5 PMP - 6 Hour Storm** Peak Stage - 2,094.1 Peak Storage - 447 Peak Outlfow - 7,670 Freeboard to Crest - 3.9 ft.


PIMA ROAD CHANNEL
150' - 250' DRAINAGE EASEMENT PER PIMA RD. CHANNEL PRELIM. 10% PLAN BY GREINER
PIMA ROAD
HAPPY VALLEY ROAD
PIMA ROAD DESERT GREENBELT AND COLLECTION CHANNEL PROPOSED ALIGNMENT WITHOUT DETENTION
SPILLWAY CREST EL. 2090 LENGTH 300 LF SIDE WEIR WITH SOIL CEMENT CUT-OFF WALL
EMBANKMENT EL. 2098 TYP. 10' MINIMUM WIDTH
OUTLET INVERT EL. 2060 30" RCP - 1300 LF SEDIMENT STORAGE 13 AC-FT (EL. 2055 TO EL. 2060)
8' TH'K SOIL CEMENT EMBANKMENT CORE /CUT-OFF WALL
A
B
C
D
2100
2095
2090
2085
2080
2075
2070
2065
2055
2060
2110
2105
GRAPHIC SCALE
0
150
225
300
450
(IN FEET)
PIMA ROAD CHANNEL DETENTION FEASIBILITY STUDY
HAPPY VALLEY ROAD DETENTION BASIN
SCOTTSDALE AZ
PACE
FIGURE IV-1

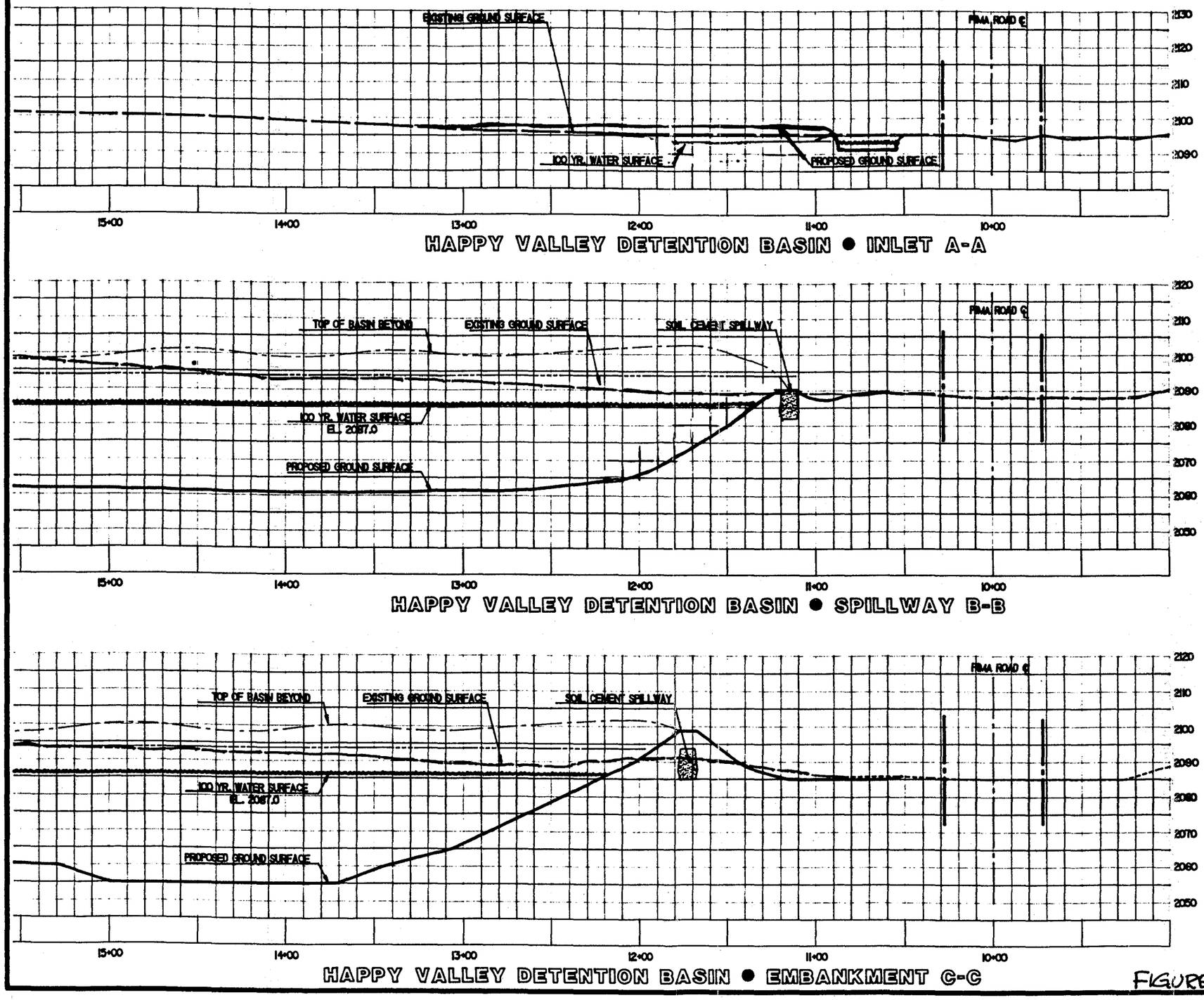


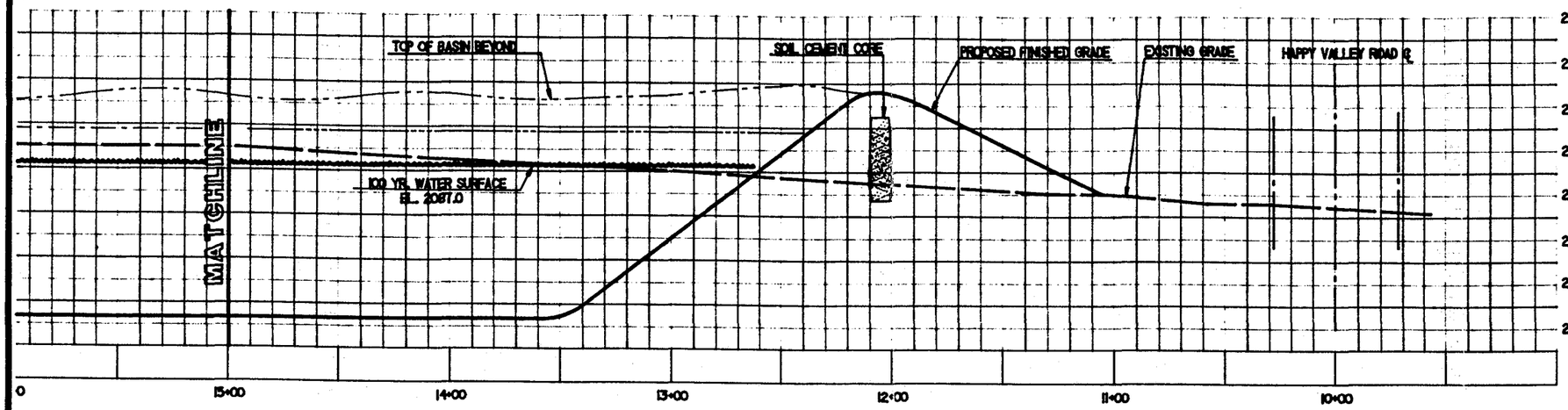
FIGURE IV-2

PACE CIVIL & ARCHITECTS

HAPPY VALLEY ROAD DETENTION BASIN

FRMA ROAD CHANNEL & DETENTION CROSS-SECTIONS

4



SECTION TROUGH HAPPY VALLEY DETENTION BASIN D-D

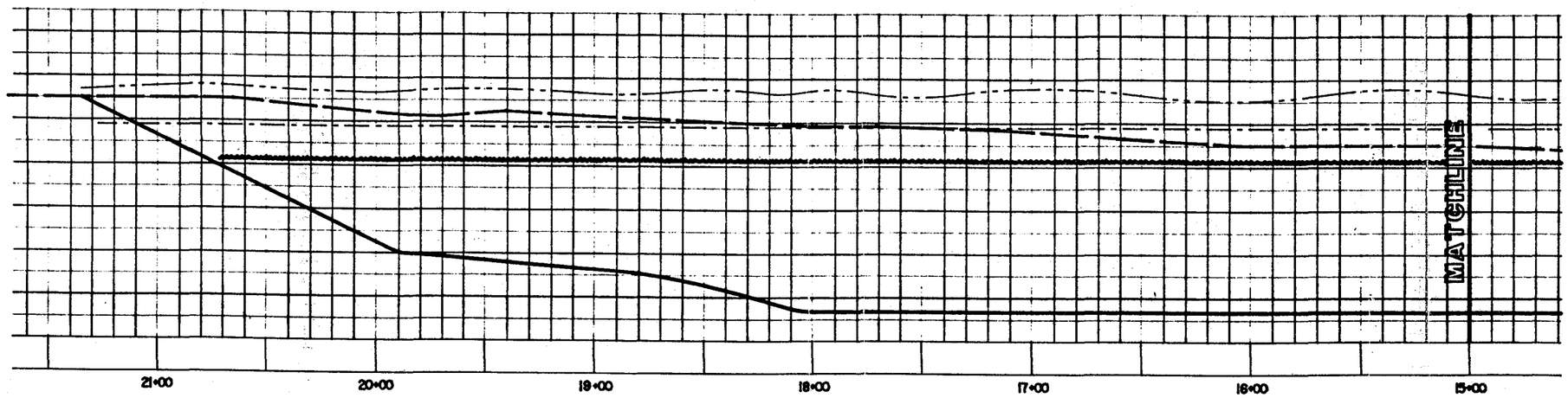


FIGURE IV-3

PIMA ROAD CHANNEL
DETENTION
CROSS-SECTIONS

HAPPY VALLEY ROAD
DETENTION BASIN

PACE
CIVIL ENGINEERS

4A

FIGURE IV-4

Inflow & Outflow Hydrographs
Happy Valley Road Detention Basin

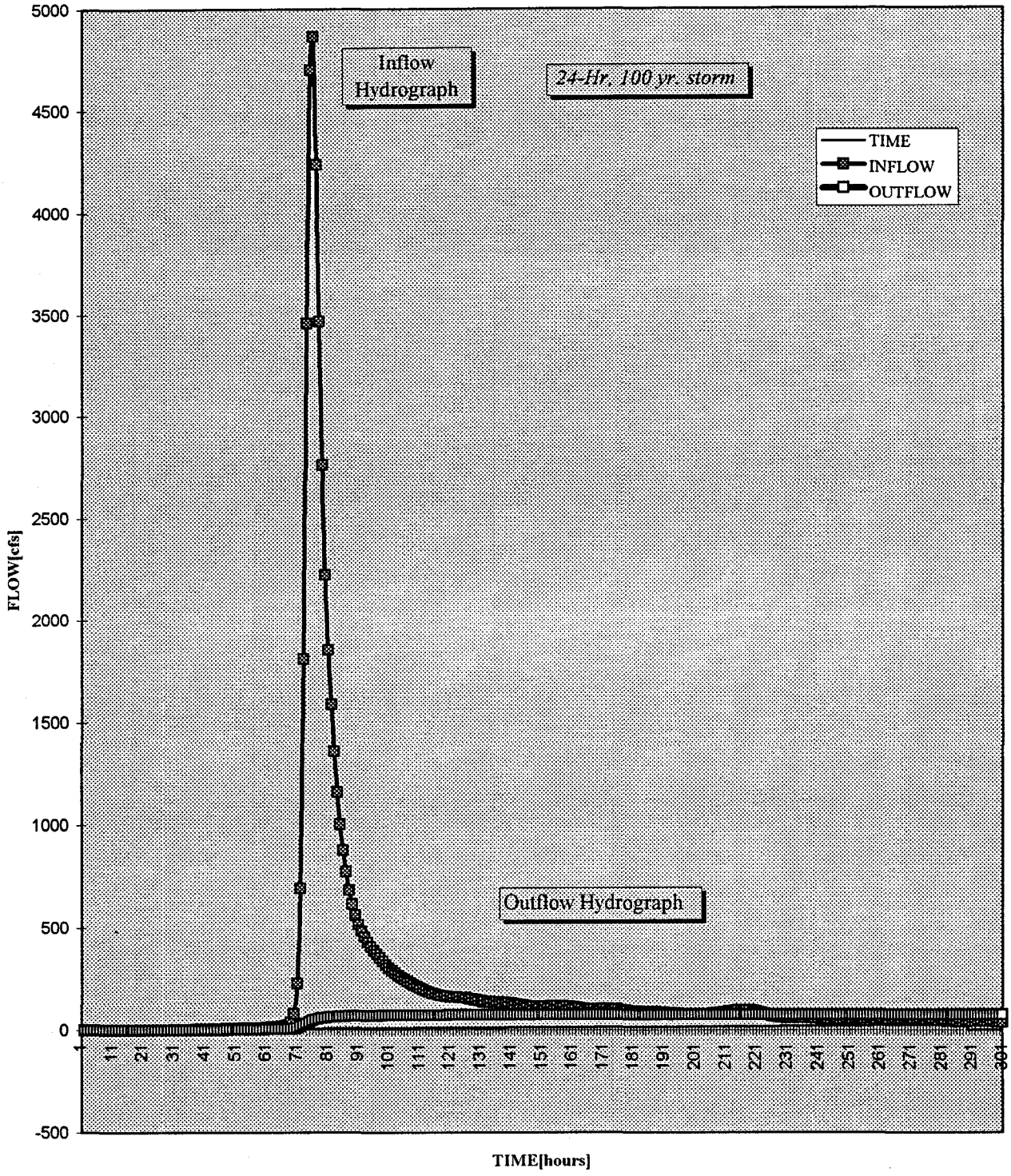
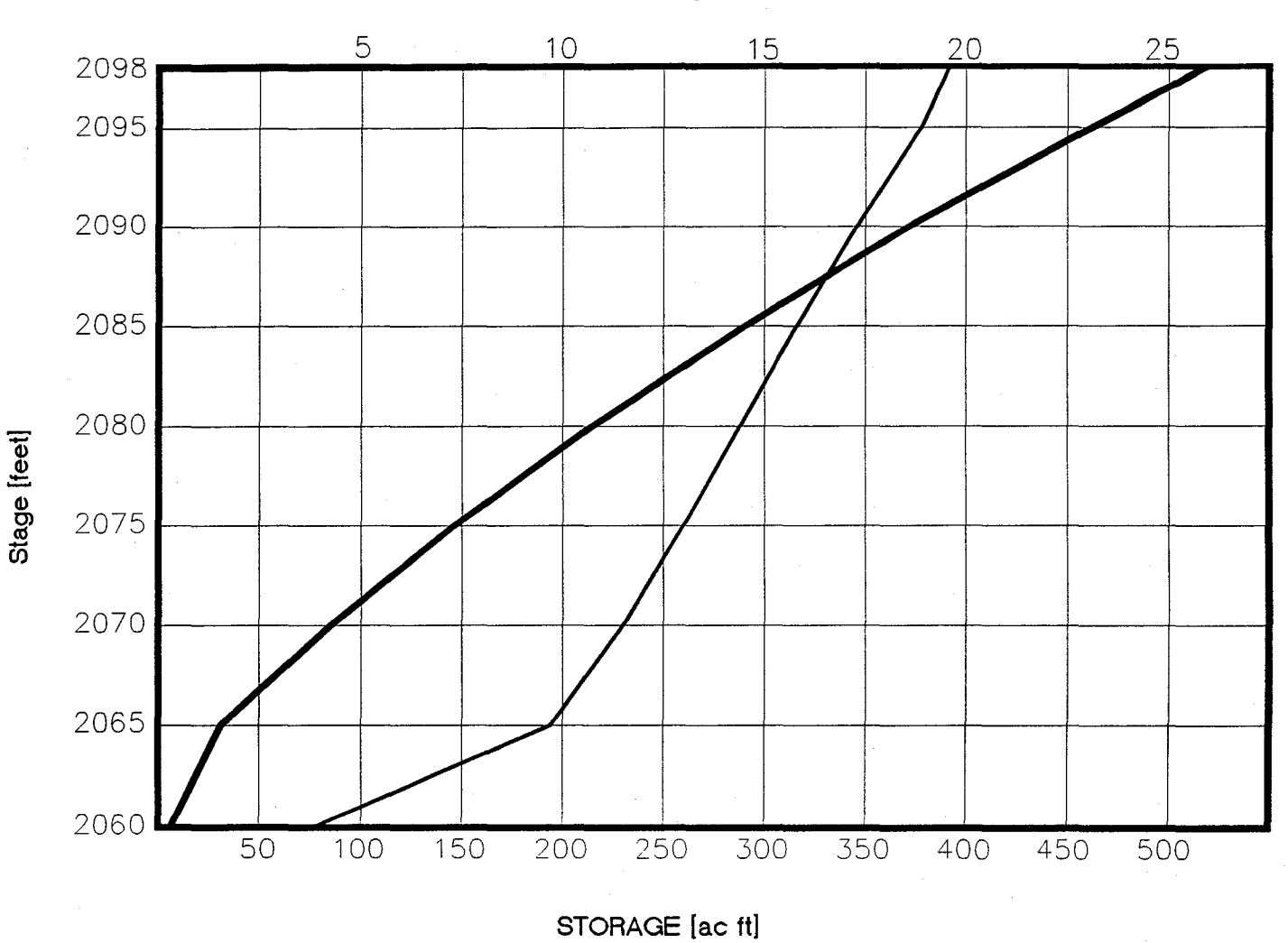


FIGURE IV-5

Happy Valley Road Detention Basin
100 YEAR-24 HOUR
Stage-Area & Stage-Storage Curves



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B. DEER VALLEY ROAD DETENTION BASIN

The proposed Deer Valley Road Detention Basin is located in a 32 acre ASL parcel in the southwest quarter of the southwest quarter of Section 18 (U.S.G.L.O. Lot # 4, Section 18). This lot was scheduled for auction June 14, 1995 by the ASLD (See Notice in Appendix) as part of a 64 acre parcel including lots 3 and 4 of section 18. The appraised value of the 64 acre parcel is $2,050,000. The parcel was not sold. The southwesterly 32 acre lot (#4) is zoned (residential at 1 du/ac). The proposed detention basin encompasses 25 acres of Lot # 4. The remaining 7 acres could be utilized for additional park area or for residential lot development.

Proposed grading plan for the Deer Valley Road Detention Basin is shown in *Figure IV-6* and cross sections *Figure IV-7 and IV-8*. The design of the Deer Valley Detention Basin is identical in design concept to the Happy Valley Detention Basin. The only variation is based upon the differing hydrologic inflow criteria. In keeping with the Desert Greenbelt concept, a 75 foot setback from Pima Road will be maintained. With grading and revegetation, the visual impact of the detention basin will be minimized.

The design data for the Deer Valley Detention Basin are shown in *Table IV-4*. *Figure IV-9* shows the Inflow and Outflow hydrographs for the 24-hour 100-year storm event. Stage vs. Storage vs. Area graph is shown on *Figure IV-10*.

Table IV-3
Deer Valley Road Detention Basin 100 Year-24 Hour
Stage, Area, Volume and Discharge Summary

ELEVATION	DEPTH (ft)	AREA INUNDATED (ac)	CUM. STORAGE VOLUME (ac-ft)	DISCHARGE Capacity(cfs)
1,898	43	17.7	448	27,379
1,895	40	16.6	391	13,617
1,890	35	15.5	291	197
1,885	30	13.7	218	177
1,880	25	12.3	153	153
1,875	20	11.0	95	122
1870	15	9.6	44	88
1865	10	8.1	sed. 33 0	0
1860	5	2.1	sed. 9	0
1855	0	1.5	sed. 0	0

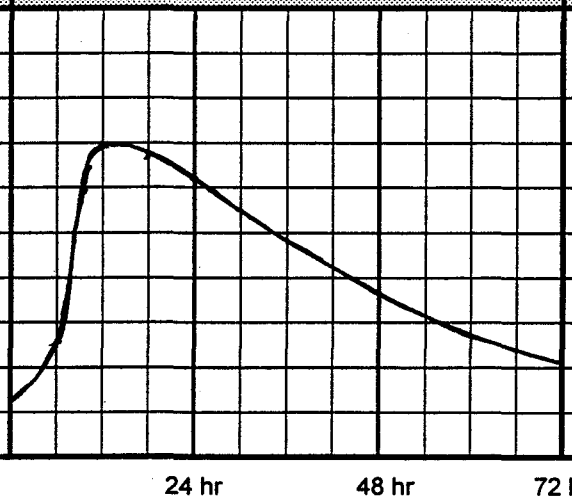

Table IV-4
Deer Valley Road Detention Basin
Design Criteria

Location
Section: 18
Township: 4 North Range: 5 East
Maricopa County, Arizona

Basin Area: 25 Acres

Design Storms:

100 year, 24-hour storm	**0.5 PMP - 6 Hour Storm**
Drainage Area - 5.98 sq. mi.	Drainage Area - 5.98 sq. mi.
Total Rainfall - 4.25 inches	Total Rainfall - 6.06 inches
Peak Inflow - 3,960 cfs	Peak Inflow - 12,800 cfs
Volume of Inflow Hydrograph - 528 AF	Volume of Inflow Hydrograph - 1,220 AF

Detention Basin Embankment:
Type - Homogeneous Earthfill (with 8 foot thick soil cement core)
Length - 1,300 ft
Maximum Height - 28 ft
Top Elevation - 1,898 ft, width 15 ft. minimum
Slopes: Upstream Slope - 3:1 Maximum
Downstream Slope - 4:1 Maximum
Maximum storage - 448 AF
Area at Crest - 17.7 AC

Spillway:
Type - At grade/Below grade (with soil cement cutoff wall)
Elevation - 1,898 ft
Length - 400 ft
Width - 10 ft
Height - 5 ft

Low Level Outlet:
Type - Reinforced Concrete Pipe. Invert Elevation 1,865.
Dimensions - 42" diameter, 850 ft long
Discharge Capacity @ 100-year 24-hour pool - 200 cfs
Sediment Storage - 33 AF. (Elevation 1,855 - 1,865)

100 -year 6-hour storm:

	0.5 PMP - 6 Hour Storm
Peak Stage - 1,889.6 ft	Peak Stage - 1,894.1 ft.
Peak Storage - 286 AF	Peak Storage - 357 AF
Peak Outflow - 196 cfs	Peak Outflow - 12,670 cfs
Freeboard Spillway 0.4 ft.	Freeboard to Crest - 3.9 ft.

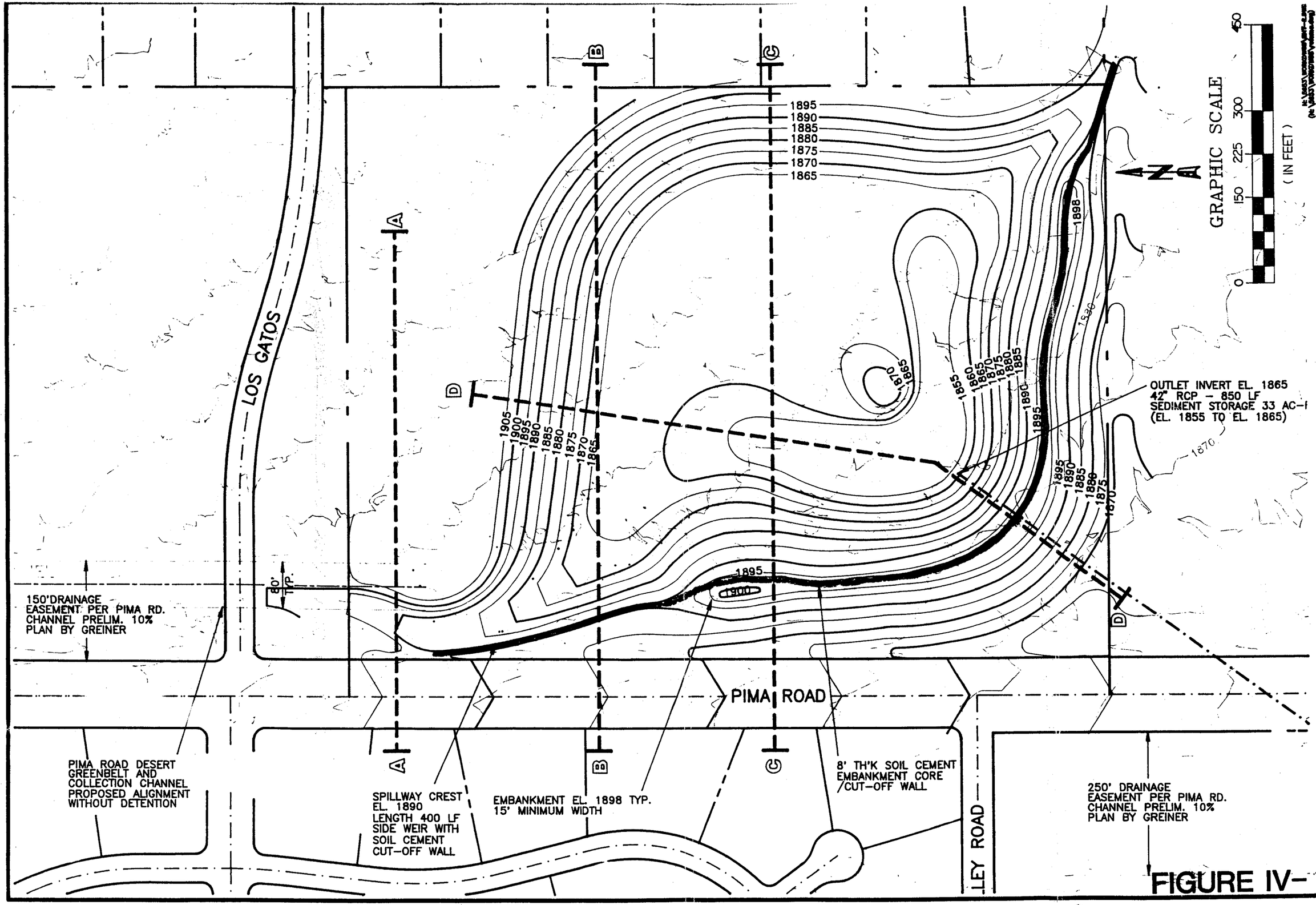

FIGURE IV-

PIMA ROAD CHANNEL
DETENTION
FEASIBILITY
STUDY

DEER VALLEY ROAD
DETENTION BASIN
AZ
SCOTTSDALE

PACE
CIVIL ENGINEERING
ADVANCED

9-22-89

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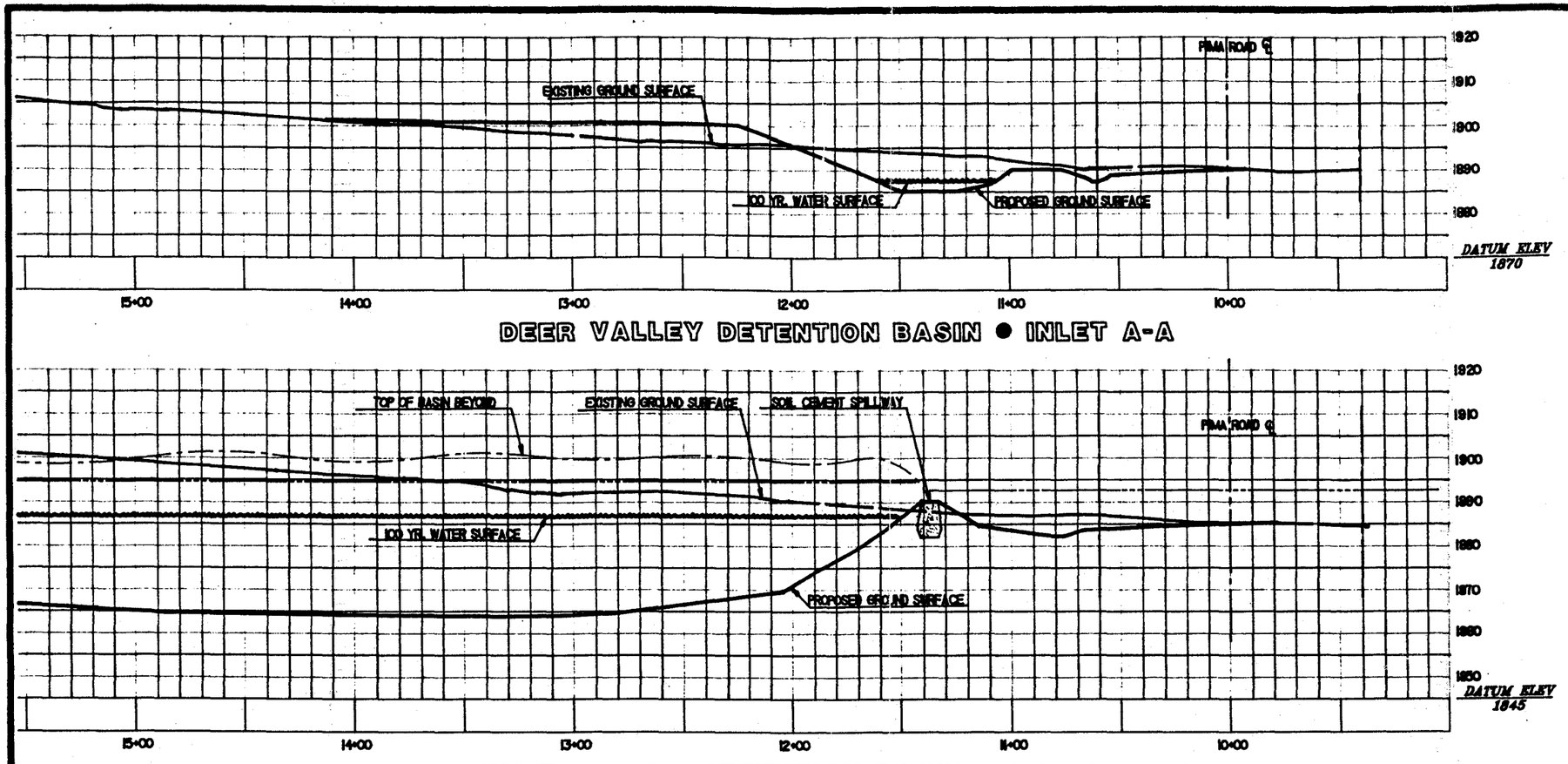
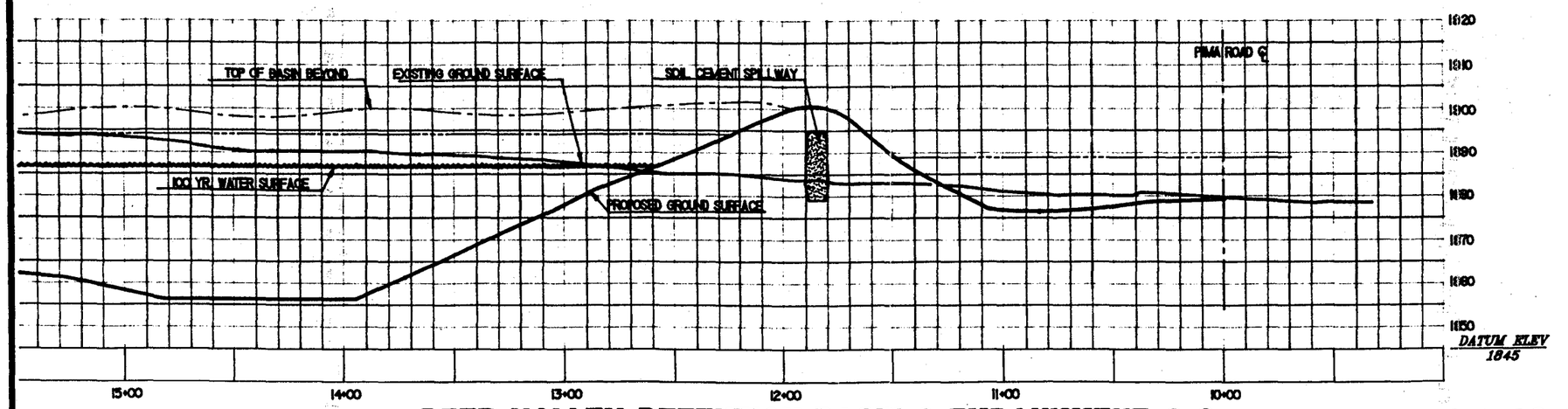


DEER VALLEY DETENTION BASIN ● INLET A-A

DEER VALLEY DETENTION BASIN ● SPILLWAY B-B



DEER VALLEY DETENTION BASIN ● EMBANKMENT C-C

FIGURE IV-7

PIMA ROAD CHANNEL
DETENTION
CROSS-SECTIONS

DEER VALLEY ROAD
DETENTION BASIN
SCOTTSDALE

PACE
CIVIL ENGINEERS
ENVIRONMENTAL SCIENTISTS

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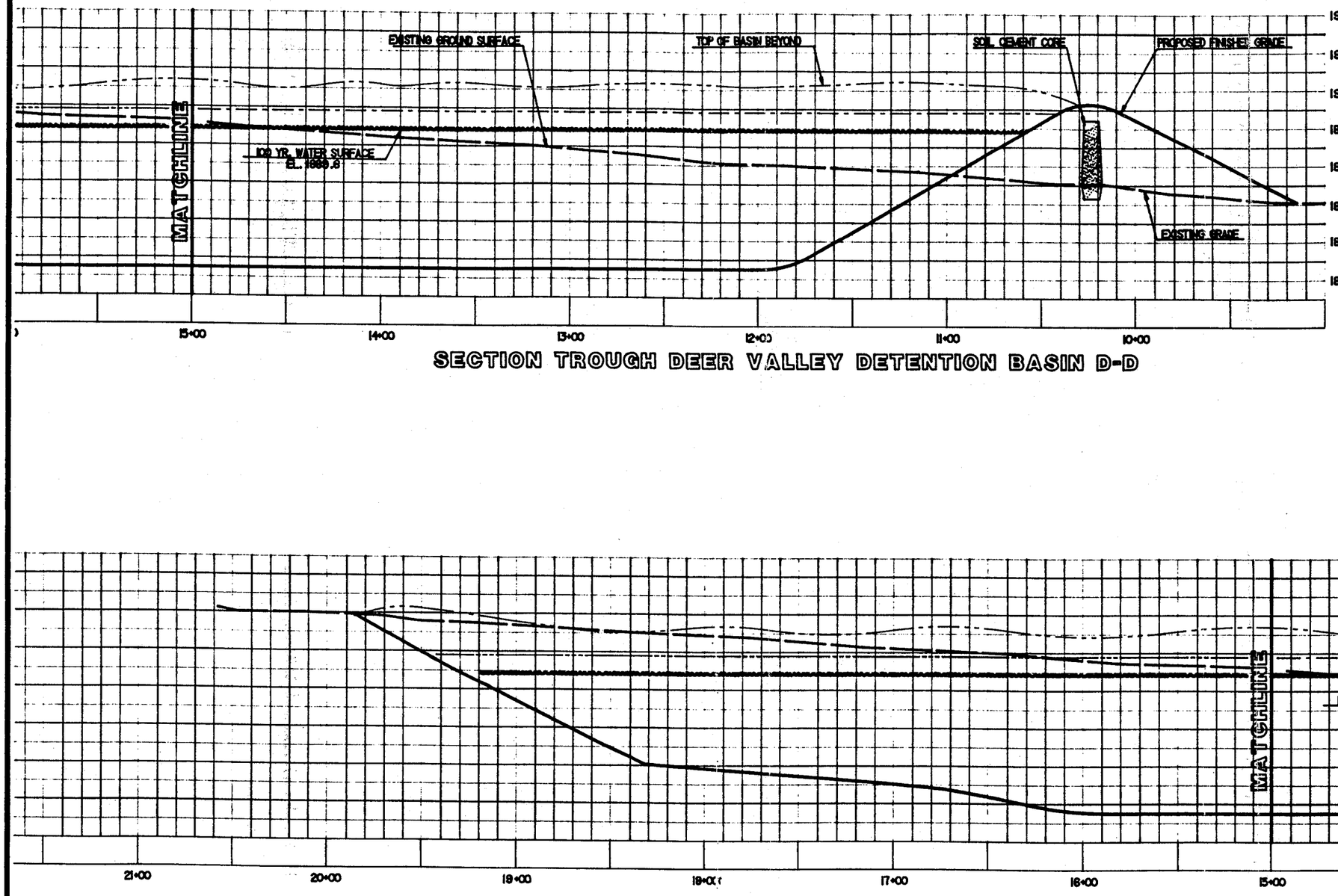


SECTION TROUGH DEER VALLEY DETENTION BASIN D-D

FIGURE IV-8

FIGURE IV-9

Inflow & Outflow Hydrographs
Deer Valley Road Detention Basin

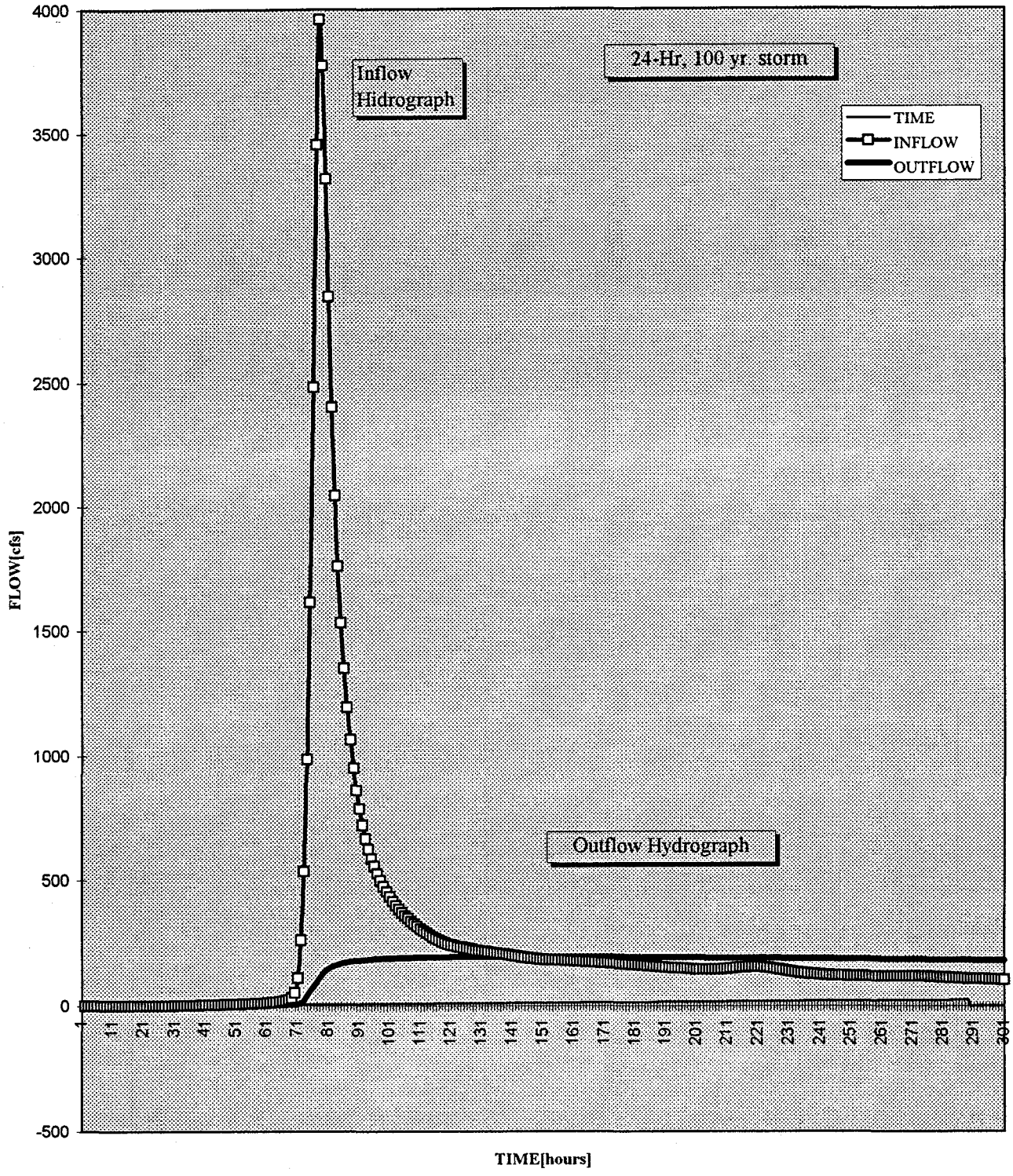
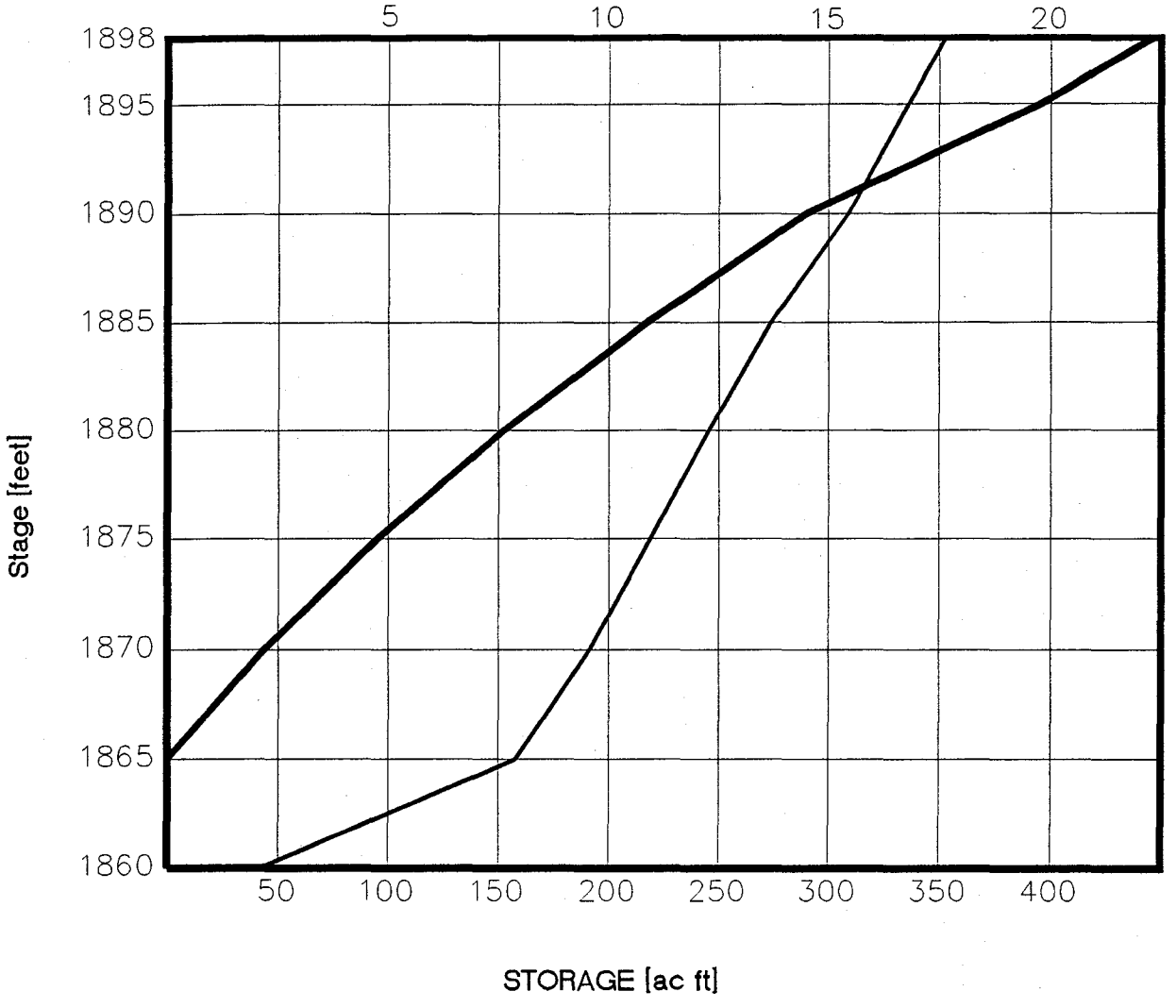


FIGURE IV-10

Deer Valley Road Detention Basin
100 YEAR-24 HOUR
Stage-Area & Stage-Storage Curves



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C. UNION HILLS/COS WASTE TRANSFER STATION DETENTION BASIN

Design of the Union Hills Detention Basin is not part of this Draft Feasibility Report. The proposed detention basin location has been Master Planned by Grayhawk Development, City of Scottsdale and Arizona State Land Department as a detention basin approximately 50 acres with a volume in excess of 500 acre feet. The overall design concept related to the Pima Road Desert Greenbelt detention alternative utilizes the Master Plan Detention Basin at the Union Hills/COS Waste Transfer Station Site.

A conceptual location plan copied form a Grayhawk Development Master Plan is enclosed as *Figure IV-11.*

The conceptual detention basin sizing is as proposed in *Table III-3* and as follows Peak Inflow 6,040 cfs, Peak Outflow 250 cfs, with maximum storage volume 610 AF.

Design coordination with ADWR and particularly ADOT regarding the location of the basin adjacent to the outer loop freeway will be required to finalize the proposed detention basin design. The Union Hills Detention Basin will follow the same hydraulic and geotechnical design criteria as established for the Happy Valley and Union Hills Basin.

D. DETENTION BASIN GEOTECHNICAL DESIGN

Due to the very sensitive location and the limited time for government and public approval, the safety of the dam and how it is conceived as safe by the public requires the utmost attention.

In line with that, PACE proposes dam side slopes of 4:1 maximum on the outside and 3:1 on the inside.

Although the first geotechnical indications are that no core would be needed due to the proposed height of the dam in comparison to side slopes and duration of potential saturation, we are still proposing a light soil cement mix in the core. It should also be noted that more than half of stored water is stored below existing grade, thereby making the saturation cycle effecting hydraulic conductivity through the dam very short, less that 12 hours.

Additional facts that ensure very little impact of hydraulic penetration of the dam is it's thickness. As the minimum width at three feet above PMF flood level is 15 feet and saturation lasting over an hour would be below emergency spillway the width at the emergency spillway level is at least 70 feet, it is quite clear that our design is conservative. The entire side is designed to be people friendly with no slopes or structures requiring fencing.

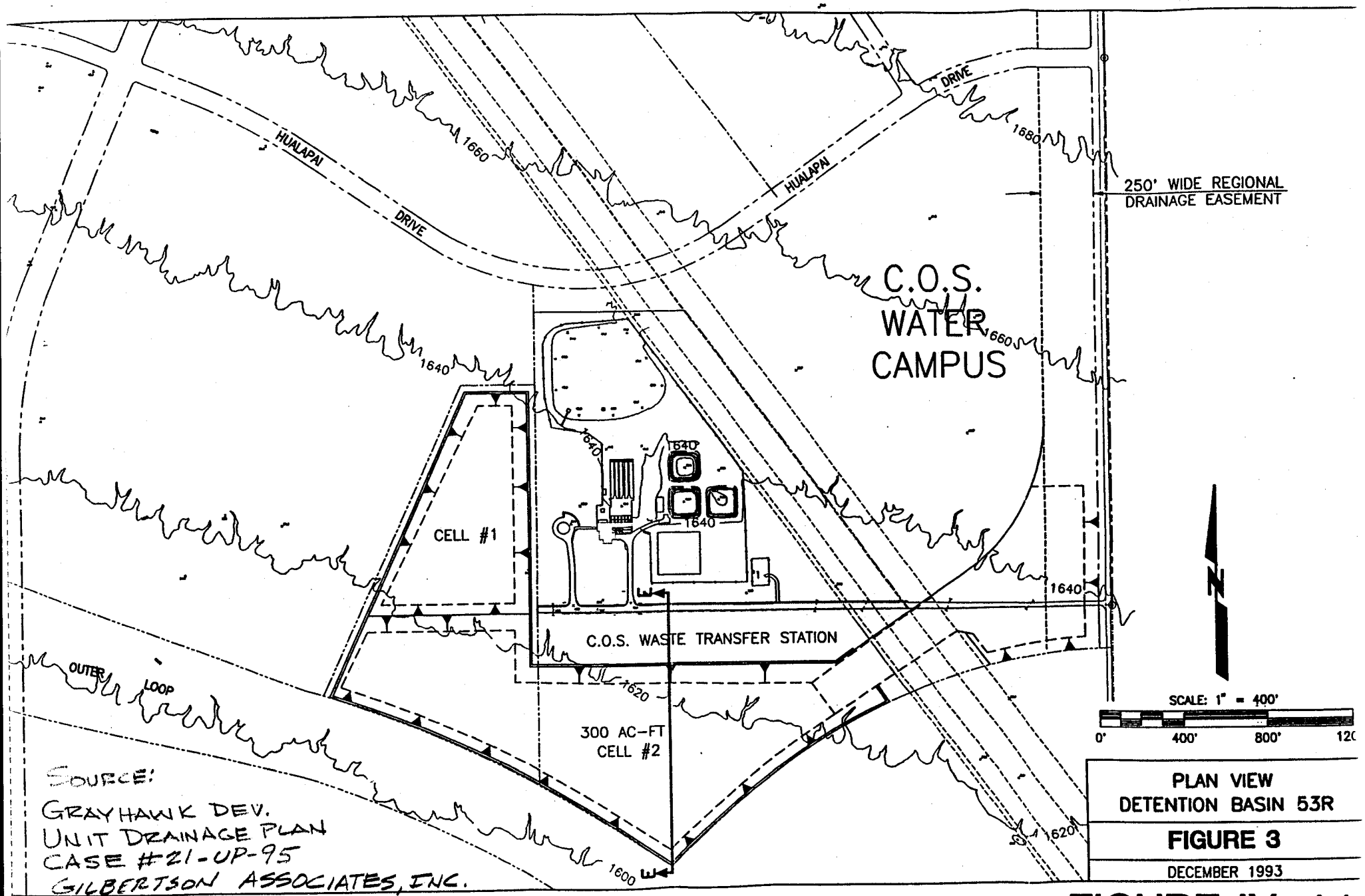
The preliminary geotechnical investigation prepared by AGRA Earth and Environmental is included as Appendix G.

E. DETENTION BASIN POTENTIAL FAILURE RISK

Based upon the previously discussed detention basin design criteria presented for the Happy Valley and Deer Valley Basins, it may be concluded that the following statements are true.

1. The proposed detention basins are not located within natural drainage flow paths.
2. More that half of basin storage volume is below existing and proposed finish grade.
3. The detention basin storage volume above embankment is less than 20% of total 0.5 PMP runoff volume.

Therefore by inspection, it is clear that the construction of the proposed detention basins do not pose any additional downstream hazard relative to the 0.5 PMP event and potential dam failure. On the contrary, the detention basins provide a proactive drainage facility which is a benefit to the surrounding community with every rainfall. Even this is in contract to the no detention alternative which confluence's flows and creates potential hazard with even relatively minor tainfall events.



PLAN VIEW
DETENTION BASIN 53R

FIGURE 3

DECEMBER 1993

FIGURE IV-11

V. PIMA ROAD DESERT GREENBELT CHANNEL DESIGN

This draft report does not include the completed sections regarding the Pima Road Desert Greenbelt Channel Design. This section will be completed prior to final submittal of this report prior to September 16, 1995.

The following Tables and Figures regarding the preliminary work completed for this section in previous draft submittals in enclosed for conceptual design consideration.

Table V-1	100 Year-6 Hour Pima Road Channel Design Section
Table V-2	100 Year-6 Hour Pima Road Channel Design Section
Figure V-1	Pima Road Cross Section Comparison
Figure V-2	Pima Road Cross Section Comparison
Figure V-3	Soil Cement Slope Stabilization Detail

TABLE V-1

PIMA ROAD CHANNEL DESIGN
100 YEAR - 6 HOUR STORM
UN-LINED CHANNEL SECTIONS

LOCATION	HEC-1 NODE	Channel Length (ft)	Elevation (ft)	Existing Slope (%)	Proposed Slope (%)	Drop Structures (ft)	Bottom Width (ft)	Flow Q_{100} (cfs)	Depth (ft)	Velocity (ft/s)	Time Vel > 7 fps (hours)	Time Vel > 4 fps (hours)	Top Width (ft)	Froude NO.
STA 348+20 At Jomax Road	30N		2188											
		2620		2.44	1.50	24.7	70	1,270	1.9	8.7	0.5	1.4	85.1	1.17
STA 322+00	CP31.1		2124											
		2670		1.87	1.50	10.0	70	1,950	2.4	10.1	0.7	1.9	89.4	1.21
STA 295+30 At Happy Valley Road	CP31.2		2074											
STA 295+30 At Happy Valley Road	DET-HV		2074											
		2600		1.77	1.50	7.0	70	250	0.7	4.8	0.0	0.4	75.8	1.00
STA 269+30	CP36.1		2028											
		2374		1.73	1.50	5.4	70	1,970	2.4	10.1	0.8	2.8	89.5	1.21
STA 245+56 At Pinnacle Peak Road	CP36N		1987											
		2600		1.88	1.50	10.0	70	2,490	2.8	11.0	1.1	3.7	92.3	1.24
STA 219+56	C36R2		1938											
		2656		2.41	1.50	24.2	70	2,490	2.8	11.0	0.3	1.4	92.3	1.24
STA 193+00 AT Deer Valley Road	CP51.1		1874											
STA 193+00 AT Deer Valley Road	DET-DV		1874											
		2300		2.48	1.50	22.5	70	130	0.5	3.7	0.0	0.0	73.9	0.94
STA 170+00	R52A2		1817											
		3375		2.22	1.50	24.4	70	130	0.5	3.7	0.0	0.0	73.9	0.94
STA 136+25 At Beardsley Road	52E6A		1742											
		2600		2.08	1.50	15.0	70	2,010	2.5	10.2	0.7	4.3	89.7	1.21
STA 110+25	CP53A		1688											
		2760		1.85	1.50	9.6	70	2,350	2.7	10.8	0.8	5.5	91.6	1.23
STA 82+65 At Union Hills Drive	C53A2		1637											
STA 82+65 At Union Hills Drive	DET-UH		1637											
		5360		1.40	1.40	0.0	70	850	1.5	7.3	0.1	23.5	82.2	1.09
STA 29+05 At Bell Road	C54		1562											
		2905		1.45	1.45	0.0	70	850	1.5	7.4	0.1	23.3	82.1	1.11
STA 0+00 At B.O.R.	ROBELL		1520											

ASSUMPTIONS:

1. Channel bottom 70' & 4:1 side slopes
2. Mannings "n" assumed at 0.03 for un-lined channel
3. Peak flows estimated based on HEC-1 Model #2 (with detention basins at Happy Valley, Deer Valley and Union Hills Roads)
4. Slopes estimated based on having drop structures south of STA 348+20
5. Peak flows used for each 1/2 mile reach is the highest possible flow anywhere in that reach.

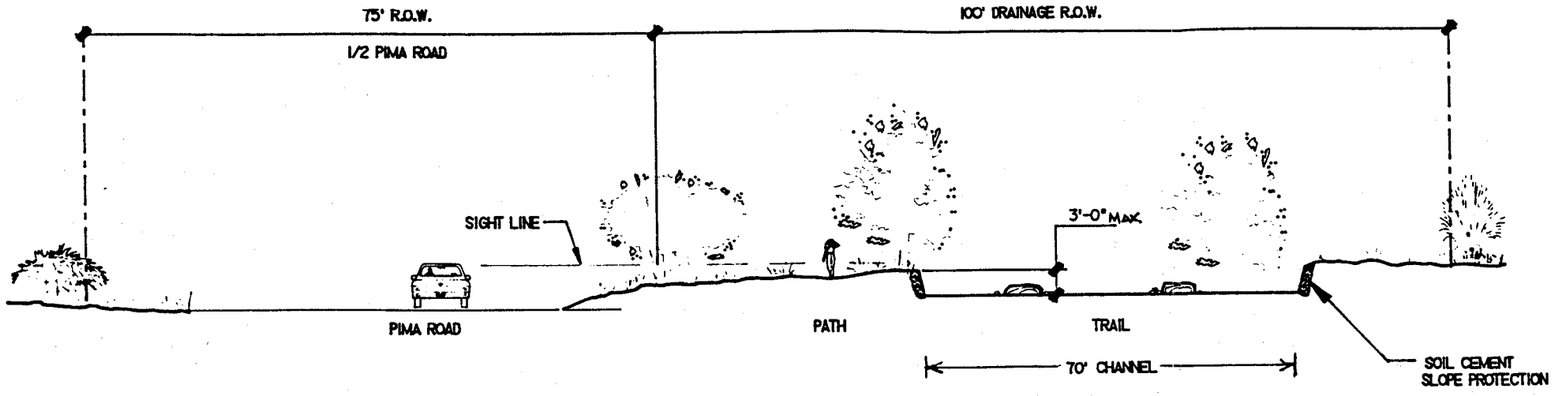
TABLE V-2

PIMA ROAD CHANNEL DESIGN
100 YEAR - 6 HOUR STORM
SIDE SLOPE STABILIZED CHANNEL SECTIONS

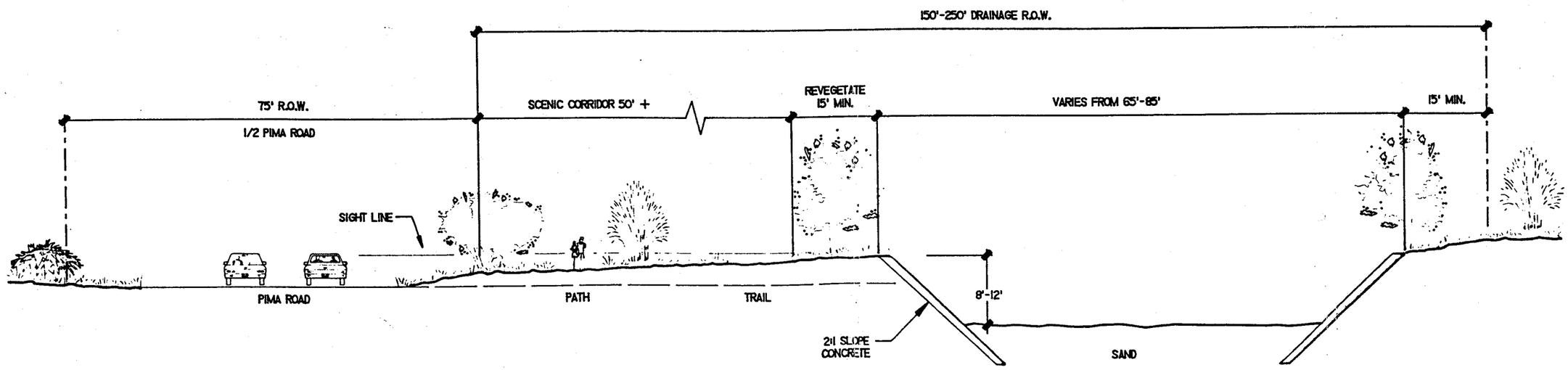
LOCATION	HEC-1 NODE	Channel Length (ft)	Elevation (ft)	Existing Slope (%)	Proposed Slope (%)	Drop Structures (ft)	Bottom Width (ft)	Flow Q_{100} (cfs)	Depth (ft)	Velocity (ft/s)	Time Vel > 7 fps (hours)	Top Width (ft)	Froude NO.
STA 348+20 At Jomax Road	30N		2188										
		2620		2.44	1.70	19.5	50	1,270	1.7	12.9	1.1	63.9	1.83
STA 322+00	CP31.1		2124										
		2670		1.87	1.50	10.0	70	1,950	1.9	13.1	1.1	85.3	1.75
STA 295+30 At Happy Valley Road	CP31.2		2074										
STA 295+30 At Happy Valley Road	DET-HV		2074										
		2600		1.77	1.70	1.8	25	250	1.0	8.8	0.5	32.9	1.66
STA 269+30	CP36.1		2028										
		2374		1.73	1.50	5.4	70	1,970	1.9	13.2	1.2	85.4	1.75
STA 245+56 At Pinnacle Peak Road	CP36N		1987										
		2600		1.88	1.50	10.0	70	2,490	2.2	14.3	1.9	87.7	1.79
STA 219+56	C36R2		1938										
		2656		2.41	1.50	24.2	70	2,490	2.2	14.3	0.8	87.7	1.79
STA 193+00 AT Deer Valley Road	CP51.1		1874										
STA 193+00 AT Deer Valley Road	DET-DV		1874										
		2300		2.48	1.70	17.9	25	130	0.7	7.0	3.0	30.4	1.57
STA 170+00	R52A2		1817										
		3375		2.22	1.70	17.6	25	130	0.7	7.0	7.0	30.4	1.57
STA 136+25 At Beardsley Road	52E6A		1742										
		2600		2.08	1.60	12.4	70	2,010	1.9	13.6	1.3	85.3	1.81
STA 110+25	CP53A		1688										
		2760		1.85	1.50	9.6	70	2,350	2.1	14.0	1.5	87.1	1.78
STA 82+65 At Union Hills Drive	C53A2		1637										
STA 82+65 At Union Hills Drive	DET-UH		1637										
		5360		1.40	1.40	0.0	50	850	1.5	10.5	0.4	61.6	1.62
STA 29+05 At Bell Road	C54		1562										
		2905		1.45	1.45	0.0	50	850	1.4	10.6	0.4	61.5	1.64
STA 0+00 At B.O.R.	ROBELL		1520										

ASSUMPTIONS:

1. Channel bottom width varies & 4:1 side slopes
2. Mannings "n" assumed at 0.02 for soil cement channel
3. Peak flows estimated based on HEC-1 Model #2 (with detention basins at Happy Valley, Deer Valley and Union Hills Roads)
4. Slopes estimated based on having drop structures south of STA 348+20
5. Peak flows used for each 1/2 mile reach is the highest possible flow anywhere in that reach.



PROPOSED PIMA ROAD DESERT GREENBELT
AT PINNACLE PEAK ROAD
WITH DETENTION



0 10' 20' 30' 40'

PROPOSED PIMA ROAD CHANNEL
AT PINNACLE PEAK ROAD
WITHOUT DETENTION

HAPPY VALLEY

Figure V-1

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N:\5653\WORKDWGS\SEC

PIMA ROAD DETENTION BASIN FEASIBILITY STUDY

DESIRERT GREENBELT CROSS SECTION BELOW PINNACLE PEAK ROAD

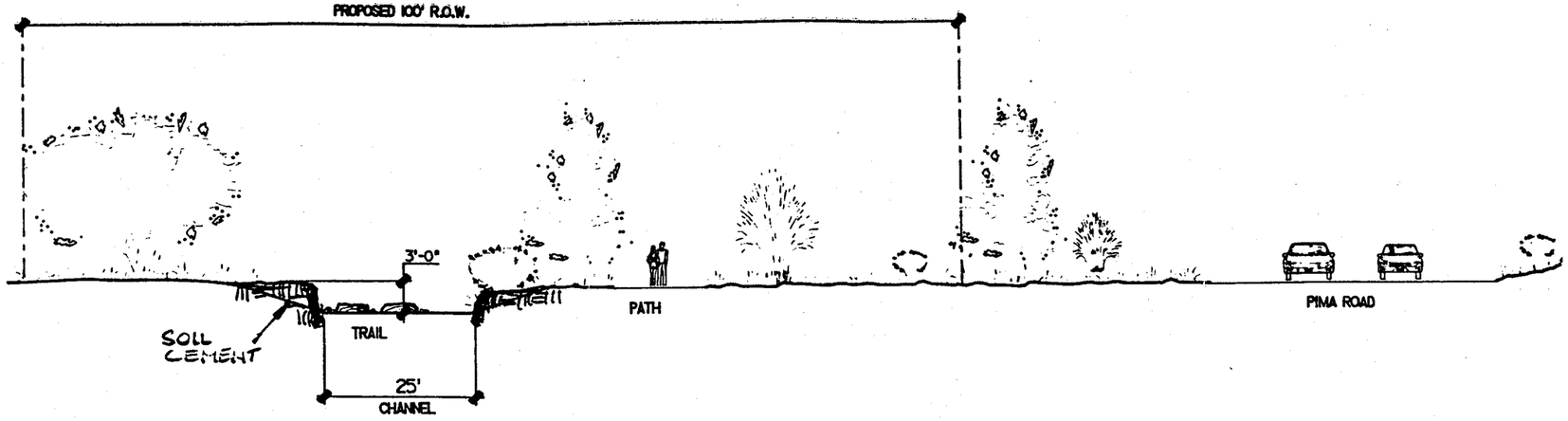
SCOTTSDALE AZ

SCALE 1" = 10'
DESIGNED CMS
DRAWN SS & MJ
CHECKED
CMS
DATE 07 - 31 - 95

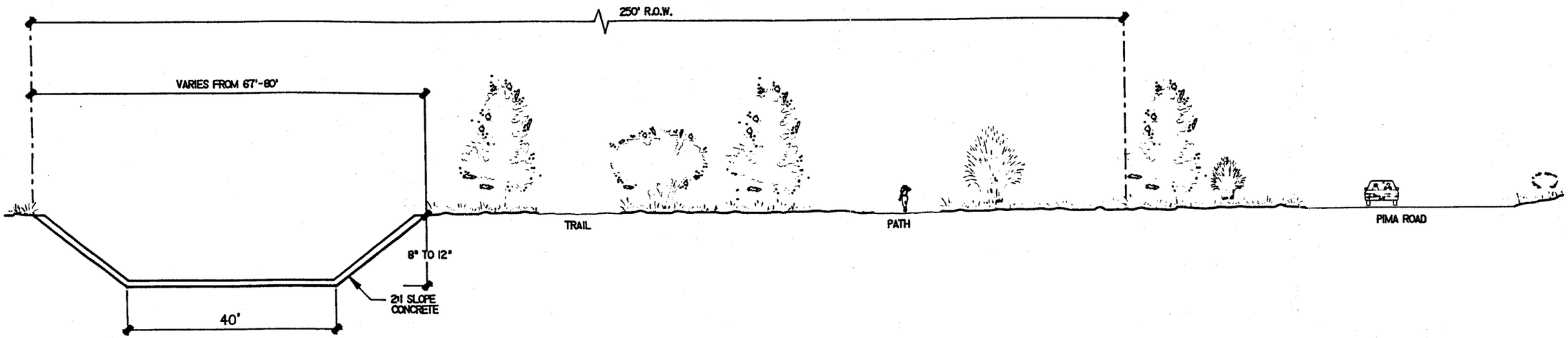
NO DATE REVISION

PACE
PACIFIC ADVANCED CIVIL ENGINEERING
[illegible] GEORGETOWN LANE, [illegible] PHX. [illegible]

SHEET 02 OF 02



PROPOSED PIMA ROAD DESERT GREENBELT
AT BELOW DEER VALLEY ROAD
WITH DETENTION



0 10' 20' 30' 40'

PROPOSED PIMA ROAD CHANNEL
AT BELOW DEER VALLEY ROAD
WITHOUT DETENTION

DEER VALLEY
Figure V-2

42

N:\5653\WORKDWGS

NO	DATE	REVISIONS

SCALE: 1" = 10'
DESIGNED: CMS
DRAWN: SS & MJ
CHECKED: CMS
DATE: 07 - 31 - 95

PIMA ROAD DETENTION BASIN FEASIBILITY STUDY

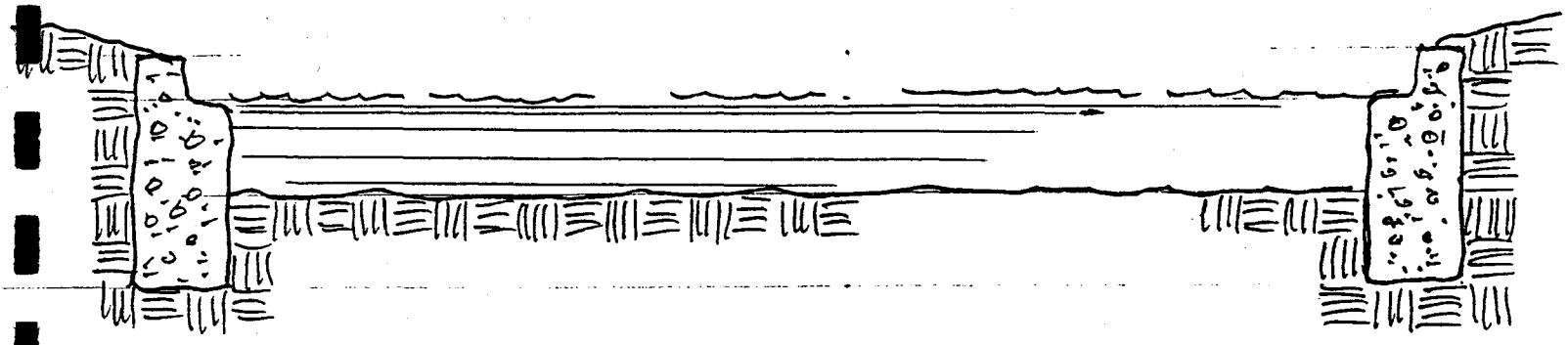
DESERT GREENBELT CROSS SECTION BELOW DEER VALLEY ROAD

SCOTTSDALE AZ

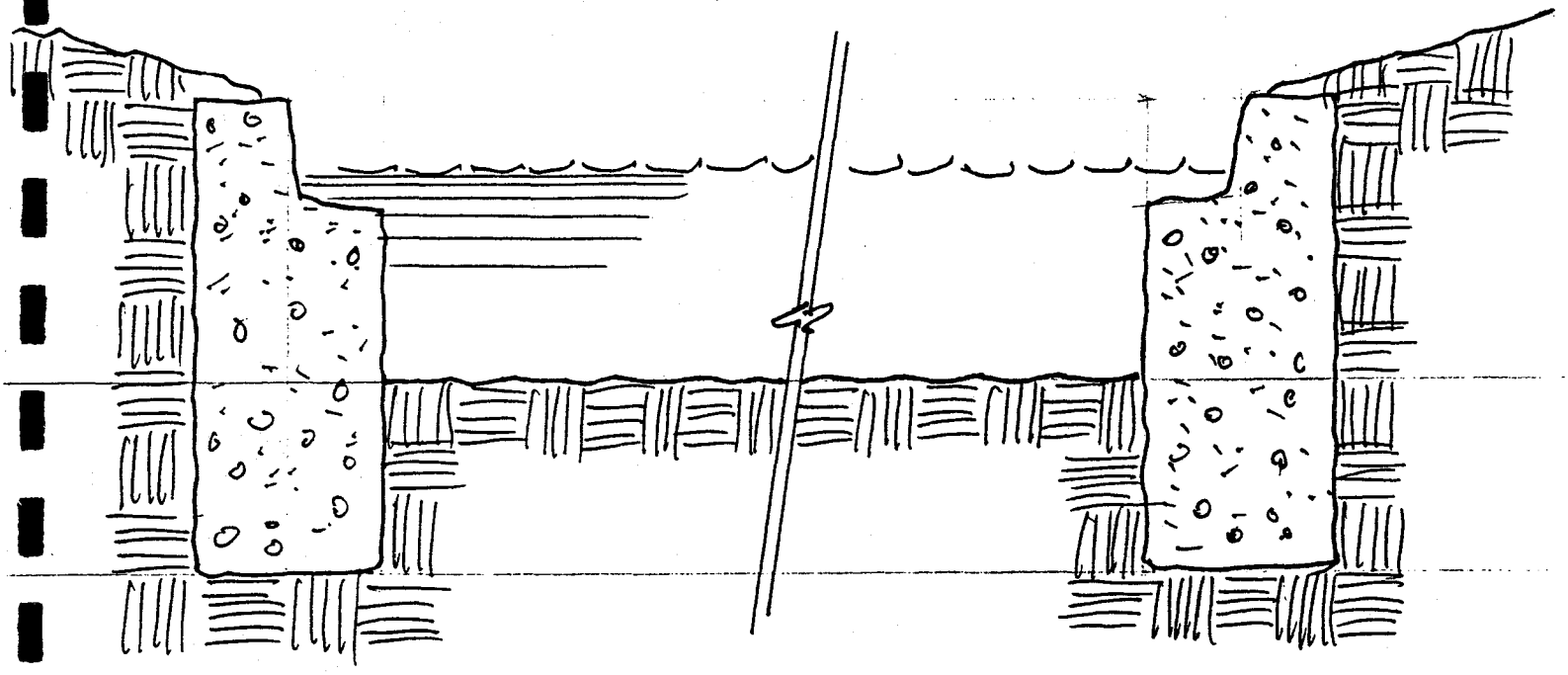
PACE
PACIFIC ADVANCED CIVIL ENGINEERING
16767 N. PERIMETER DR., SUITE 110, SCOTTSDALE, AZ. 85260 (602) 948-7322

SHEET 01 OF 02 SHEETS

FIGURE V-3



SECTION, SOIL CEMENT LINING 1"=4'-0"



SECTION, SOIL CEMENT LINING 1"=2'-0"

PACE
ENGINEERS
CONTRACTORS
& CONSULTANTS
a divison of Pacific Aquascape, Inc.

DRAWN	TITLE: CHANNEL LINING.
CHKD	
DATE: 7-31-95	JOB: PIMA ROAD CHANNEL
JOB NO: 5653E	

SHEET ____ OF ____

Table 1

Desert Greenbelt vs. Detention Basin Alternative Cost Estimate Comparison

Job Number: EO291.01
Location: Scottsdale, AZ
Client: City of Scottsdale

The Desert Greenbelt
Pima Road Channel Construction Cost
Estimate (without Detention)[1]

Run Date:
Mar 15, 1995 2:19PM

Item #	Description		Quantity	Unit	Unit Cost $	Total $
			Pima Road Channel			
J2-0101	Excavation	(Sandy Gravel)	314,420	CY	3.00	943,260
J2-0102	Excavation	(Short Haul)	178,741	CY	2.00	357,482
J2-0208	Concrete		1,100	SF	16.00	17,600
J2-0210	8" Reinforced	Concrete Lining	1,815,830	SF	6.00	10,894,980
J2-0216	Grade Control	Structures	12	EA	12,588	151,056
J2-0401	Multi-use Concrete Path		27,850	LF	15.00	417,750
J2-0402	Signage		1	LS	75,000	75,000
J2-0403	Horse Trail		27,850	LF	0.25	6,963
J2-0404	Emergency Access		6	EA	20,000	120,000
J2-0501	Revegetation (Average width 30 ft)		668,000	SF	1.00	668,000
J2-0502	Salvage (Average width 100 ft)		3,439,000	SF	0.50	1,719,500
J2-0701	Culverts (CBC)			EA	18,000	0
J2-1002	Bridges	(Less than 150')	44,080	SF	45	1,983,600
J2-1102	Bridges	(Greater than 150')	32,800	SF	50	1,640,000
J2-1201	Utility Relocation (Drop Existing Lines)		7	EA	15,000	105,000
J2-1202	Utility Relocation (Drop Existing Stubout)		8	EA	2,000	16,000
	Happy Valley Rd. Det. Basin/Park					
	Deer Valley Rd. Det. Basin/Park					
	Union Hills Rd. Det. Basin/Park					
	SUBTOTAL DESERT GREENBELT CONSTRUCTION COST					**19,116,191**
J2-7000	Engineering		10%	PCT	19,116,191	1,911,619
J2-9000	Contingency	(Excludes R/W)	15%	PCT	19,116,191	2,867,429
J2-8000	Right-of-way	Purchase Easement/Channel	4.68	AC	25,000	117,080
J2-8001	Right-of-way	Lease Acreage	66.16	AC	5,000	330,780
J2-6000	Aesthetic Treatment		1	LS	3,777,383	3,777,383
					ESTIMATE TOTAL	**$ 28,120,481**

Notes:
1. Entire cost estimate excerpted from "City of Scottsdale Desert Greenbelt project - cost estimates" by The Greiner Team, March 1995.
2. Item Number, descriptions and unit cost taken from "City of Scottsdale Desert Greenbelt Project - Cost Estimate" by: The Greiner Team, March 1995.
3. *Indicates modified unit cost item.

Estimator: JAP
Proj. Manager: MEK
Job No. 5653
Date: 7/31/95

Pima Road Channel Desert Greenbelt - Construction Cost Estimate
(With Proposed Detention Basins at Happy Valley & Deer Valley)[2]
PACE Cost Estimate

Notes	Quantity	Unit	Unit Cost $	Total $	Difference $
	Pima Road Channel with Detention				
(Avg. flow reduced from 4,000 cfs to 1000 cfs	95,000 *	CY	3.00	285,000	-658,260
cost reduction. Based on 31,000ft x 50ft x3ft channel.)	55,000 *	CY	2.00	110,000	-247,482
No Change	1,100	SF	16.00	17,600	0
Soil Cement Channel Side Slopes 2x6x2x31,000	27,750 *	CY	25.00	693,750	-10,201,230
Reduce cost of structures by 40%	40 *	EA	2,000 *	80,000	-71,056
No Change	27,850	LF	15	417,750	0
No Change	1	LS	75,000	75,000	0
No Change	27,850	LF	0.25	6,963	0
Eliminated based on depth of flow reduction	0	EA	7,000.00 *	0	-120,000
Reveg. entire channel 31,000x50ft avg. width	1,550,000 *	SF	1.00	1,550,000	882,000
50% reduction - average channel width 50 ft.	1,550,000 *	SF	0.50	775,000	-944,500
Culverts (CBC) crossing @ 10 Bridge loc.	10 *	EA	18,000	180,000	180,000
All Eliminated (Replace w/5 grade seperated				0	-1,983,600
" crossings for pedestrian and	5 *	EA	50,000	250,000	-1,390,000
No Change equestrian crossings)	7	EA	15,000	105,000	0
No Change	8	EA	2,000	16,000	0
(See separate cost estimate - attached)	1 *	LS	3,302,530	3,302,530	3,302,530
(See separate cost estimate - attached)	1 *	LS	3,265,944	3,265,944	3,265,944
(See separate cost estimate - attached)	1 *	LS	4,240,038	4,240,038	4,240,038
* Excess Excavated Material 1.9 mcy - .5 mcy	1,400,000 *	CY	2.00	2,800,000	2,800,000
SUBTOTAL PIMA ROAD GREENBELT & DETENTION CONSTRUCTION COST				**18,170,575**	**-945,616**
	10%	PCT	18,170,575 *	1,817,057	-94,562
(Excludes R/W & Aesthetic Treatment)	15%	PCT	18,170,575 *	2,725,586	-141,842
No Change	4.68	AC	25,000	117,080	0
Purchase Easement for Detention Basins	69.00 *	AC	25,000	1,725,000	1,725,000
No Change	66.16	AC	5,000	330,780	0
Eliminate 90% as entire channel revegetated	1	LS	380,000 *	380,000	-3,397,383
			ESTIMATE TOTAL	**$ 25,266,078**	**-2,854,403**
Potential Deduct for Excess Material				($2,800,000)	
Potential Deduct for Landscaping - attached				($3,365,000)	

4. Additional drainage improvement construction cost associated with the proposed Desert Greenbelt with out Detention but not included in Greiner cost estimate above.
   --Numerous private/development Pima Road Channel Crossings (estimated additional cost: 15 ea @ $150,000 ea = $2,250,000)
   --ADOT outer loop crossing (estimated additional cost: 42,000 SF @ $50/SF = $2,100,000)
   --Additional land cost due to ASLD proposed value of $25,000/acre vs. leased @ $5,000/acre (estimated additional cost: 66.16 AC @ $20,000 AC = $1,323,200)
   --Additional drainage improvement cost for existing T.P.C. golf course modify to accept concentrated Pima Road Channel flows in excess of 7400 cfs (No $ Estimate)
   --Concentrated Pima Road Channel flows will also impact the existing Bureau of Reclamation Flood Control dike system by using additional retention capacity (No $ Estimate)

Table #2
Happy Valley Detention Basin Cost Estimate

Estimator: JAP
Project Manager: MEK
Job No.: 5653
Date: 7/31/95

#	Description	Quantity	Unit	Unit Cost $	Total $
A	**Detention Basin Construction**				
1.	Clear & grub	25	AC	1,600	40,000
2.	Prewetting Operation:				
a.	Develop water supply	1	LS	40,000	40,000
b.	Water for embankments (@90gal/cy of fill mat.)	250	MGA	2.00	500
3.	Excavate reservoir and haul fill to embankment. Utilize portion of excess fill on down slope of basin. Remainder of excess fill (600,000 cy) hauled off-site at no cost. (Assume 25% shrinkage.)	650,000	CY	1.60	1,040,000
4.	Finish Grading	50,000	SY	0.25	12,500
5.	Slope protection at inlet(s) to Basin, Riprap w/geotex.	5,000	SY	8.00	40,000
B.	**Earth Dam Embankment Construction**				
1.	Earth Embankment Construction:				
a.	Soil cement core	18,000	CY	15	270,000
b.	Spread fill, received from scraper operation and Compact fill material.	50,000	CY	2.75	137,500
c.	Finish grading slopes	30,000	SY	0.25	7,500
C.	**Spillway**				
1.	300 LF spillway w/soil cement cutoff wall (part of item B1a).				
2.	Low Flow Outlet - 36" RCP	1,200	LF	75	90,000
D.	**Downstream Improvements**				
1.	Downstream improvements to channel @ low flow outlet	1	LS	15,000	15,000
	SUBTOTAL				**1,693,000**
E.	**Site Development and Lanscaping**				
1.	Landscaping w/salvaged native plants				
a.	Salvage of existing plants, to be reused as revegetation	25	AC	21,780	544,500
b.	Exterior slopes of embankment, maximum areas	5	AC	43,560	217,800
c.	Basin vegetation w/revegetation and hydroseeding	20	AC	27,000	540,000
2.	Archaeological Site Investigation	1	LS	7,000	7,000
	SUBTOTAL				3,002,300
F.	**Construction Contractor Mark-ups**				
	Overhead and Profit Mobilization, bonds & insurance	10%	PCT	3,002,300	300,230
	Total Pima/Happy Valley Road Detention Basin Construction Cost				**$3,302,530**

Table #3
Deer Valley Detention Basin Cost Estimate

Estimator: JAP
Project Manager: MEK
Job No.: 5653
Date: 7/31/95

#	Description	Quantity	Unit	Unit Cost $	Total $
A	**Detention Basin Construction**				
1.	Clear & grub	23	AC	1,600	36,800
2.	Prewetting Operation:				
a.	Develop water supply	1	LS	40,000	40,000
b.	Water for embankments (@90gal/cy of fill mat.)	500	MGA	2.00	1,000
3.	Exc. reservoir, haul fill to embankment. Utilize portion of excess fill on down slope of basin. Remainder of excess fill (485,000 cy) hauled off-site, at no cost. (Assume 25% shrinkage.)	600,000	CY	1.60	960,000
4.	Finish Grading	55,000	SY	0.25	13,750
5.	Slope protection at inlet(s) to Basin, Riprap w/geotex.	5,000	SY	8.00	40,000
B.	**Earth Dam Embankment Construction**				
1.	Earth Embankment Construction:				
a.	Soil cement core	20,000	CY	15.00	300,000
b.	Spread fill, received from scraper operation and compact fill material.	95,000	CY	2.75	261,250
c.	Finish grading slopes	50,000	SY	0.25	12,500
C.	**Spillway**				
1.	300 LF spillway w/soil cement cutoff wall (part of item B1a).				
2.	Low Flow Outlet - 48" RCP	800	LF	90	72,000
D.	**Downstream Improvements**				
1.	Downstream improvements to channel @ low flow outlet	1	LS	20,000	20,000
	SUBTOTAL				**1,757,300**
E.	**Site Development and Landscaping**				
1.	Landscaping w/salvaged native plants				
a.	Salvage of existing plants, to be reused as revegetation	23	AC	21,780	500,940
b.	Exterior slopes of embankment, maximum areas	5	AC	43,560	217,800
c.	Basin vegetation w/revegetation and hydroseeding	18	AC	27,000	486,000
2.	Archaeological Site Investigation	1	LS	7,000	7,000
	SUBTOTAL				2,969,040
F.	**Construction Contractor Mark-ups**				
	Overhead and Profit Mobilization, bonds & insurance	10%	PCT	2,969,040	296,904
	Total Pima/Deer Valley Road Detention Basin Construction Cost				**$3,265,944**

Table #4
Union Hills Detention Basin Cost Estimate

Estimator: JAP
Project Manager: MEK
Job No.: 5653
Date: 7/31/95

#	Description	Quantity	Unit	Unit Cost $	Total $
A	**Detention Basin Construction**				
1.	Clear & grub	30	AC	1,600	48,000
2.	Prewetting Operation:				
a.	Develop water supply	1	LS	40,000	40,000
b.	Water for embankments (@90gal/cy of fill mat.)	500	MGA	2.00	1,000
3.	Exc. reservoir, haul fill to embankment. Utilize portion of excess fill on down slope of basin. Remainder of excess fill (800,000 cy) hauled off-site, at no cost. (Assume 25% shrinkage.)	900,000	CY	1.60	1,440,000
4.	Finish Grading	70,000	SY	0.25	17,500
5.	Slope protection at inlet(s) to Basin, Riprap w/geotex.	5,000	SY	8.00	40,000
B.	**Earth Dam Embankment Construction**				
1.	Earth Embankment Construction:				
a.	Soil cement core	25,000	CY	15.00	300,000
b.	Spread fill, received from scraper operation and compact fill material.	110,000	CY	2.75	302,500
c.	Finish grading slopes	70,000	SY	0.25	17,500
C.	**Spillway**				
1.	300 LF spillway w/soil cement cutoff wall (part of item B1a).				
2.	Low Flow Outlet - 48" RCP	1,200	LF	90	108,000
D.	**Downstream Improvements**				
1.	Downstream improvements to channel @ low flow outlet	1	LS	20,000	20,000
	SUBTOTAL				**2,334,500**
E.	**Site Development and Landscaping**				
1.	Landscaping w/salvaged native plants				
a.	Salvage of existing plants, to be reused as revegetation	30	AC	21,780	653,400
b.	Exterior slopes of embankment, maximum areas	3	AC	43,560	130,680
c.	Basin vegetation w/revegetation and hydroseeding	27	AC	27,000	729,000
2.	Archaeological Site Investigation	1	LS	7,000	7,000
	SUBTOTAL				3,854,580
F.	**Construction Contractor Mark-ups**				
	Overhead and Profit Mobilization, bonds & insurance	10%	PCT	3,854,580	385,458
	Total Pima/Deer Valley Road Detention Basin Construction Cost				**$4,240,038**

Table #5
Salvage Revegetation Cost Comparison

Estimator: JAP
Project Manager: MEK
Job No.: 5653
Date: 7/31/95

I.	**Total Salvage/Reveg. Cost per C.O.S. Comparison Estimate**				
1.	Happy Valley Detention Basin	1,302,300			
2.	Deer Valley Detention Basin	1,205,000			
3.	Union Hills Detention Basin	1,513,000			
4.	Pima Road Channel	2,325,000			
	TOTAL				$6,345,000
II.	**Cost of Salvage/Reveg. based upon Grayhawk Actual Construction Costs**				
1.	Happy Valley Detention Basin				
	a. Salvage	25 ac @	$10,000/ac	=	250,000
	b. Reveg. basin interior	20 ac @	$15,000/ac	=	300,000
	c. Reveg. basin exterior	5 ac @	$25,000/ac	=	125,000
	SUBTOTAL				$675,000
2.	Deer Valley Detention Basin				
	a. Salvage	23 ac @	$10,000/ac	=	230,000
	b. Reveg. basin interior	18 ac @	$15,000/ac	=	270,000
	c. Reveg. basin exterior	5 ac @	$25,000/ac	=	125,000
	SUBTOTAL				$625,000
3.	Union Hills Detention Basin				
	a. Salvage	30 ac @	$10,000/ac	=	300,000
	b. Reveg. basin interior	27 ac @	$15,000/ac	=	405,000
	c. Reveg. basin exterior	3 ac @	$25,000/ac	=	75,000
	SUBTOTAL				$780,000
4.	Pima Road Channel				
	a. Salvage	36 ac @	$10,000/ac	=	360,000
	c. Revegetation	36 ac @	$15,000/ac	=	540,000
	SUBTOTAL				$900,000
	GRAND TOTAL SALVAGE AND REVEGETATION				**$2,980,000**

Comparison of the Pima Road Detention Greenbelt With and Without Detention

The significant benefits of the Pima Road Channel with the proposed detention can be summarized as follows:

- Hazard risk reduction associated with high volume high velocity flows
- Decreased costs due to smaller/unlined channel and reduced area of disturbed Desert Greenbelt area
- Decreased costs associated with the size reduction of downstream hydraulic structures such as bridges and culverts for existing, proposed (ADOT - outer loop), as well as future unplanned crossings
- Reduced greenbelt channel width requirement due to hydraulics
- No need to hide channel as it is part of the Desert Greenbelt
- Reduced visual impacts due to the elimination of concrete lining of the channels
- Increased area available for desert open space, greenbelt, and recreational purposes
- Controls sedimentation in detention basins
- With natural soils, stability can be maintained
- Less maintenance due to reduced flows
- No concrete structures
- No detrimental effects on adjoining property
- Provides natural energy dissipaters for confluencing flows
- Routing of reduced flow channel is more flexible and downstream property owners are less encumbered by drainage facility
- Reduction in flow to TPC Golf Course and entire BOR Retention Area

A detailed estimate summarizing the cost savings of the detention alternative can be found in Section VI of this report.

Pima Road Channel/Desert GreenBelt with Detention Basins	Pima Road Channel/Desert Green Belt without Detention Basins
1. Significantly reduces channel flows.	1. Does not reduce channel flows.
2. Minimizes safety concern for channel.	2. Constructed concrete channel and fencing velocity in excess of 20 fps.
3. Active and Passive Recreation in Desert Green Belt	3. Active and Passive recreation in Wash Desert Green Belt to hide.
4. Active or passive recreation at basin site	4. Corridor & urban development at basin site.
5. Basin reduces visual impact vs. zoning Maximum height of basin above existing grade 20 ft.	5. Development at site - 30 ft allowable residential development.
6. Eliminates or reduces downstream bridges and flood control features.	6. Required numerous new bridges downstream accounted and unaccounted in cost estimate.
7. Costs less ($14 million)	7. Costs more ($28 million)
8. Maintenance of confined sites.	8. Maintenance of miles of channel area with high flows and sediment loads.