KR

PIMA ROAD DESERT GREENBELT CHANNEL AND DETENTION BASIN

PRELIMINARY DESIGN REPORT

For:

GRAYHAWK DEVELOPMENT
7377 E. Doubletree Ranch, Suite 100
Scottsdale, AZ 85258
(602) 998-4144

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

September 15, 1995

REGISTERED PROFESSIONAL ENGINEER CIVIL
CERTIFICATE NO. 27388
MARK E. KREBS
Date Signed 9-15-95
ARIZONA U.S.A.

by:

PACIFIC ADVANCED CIVIL ENGINEERING
PACE
17902 Georgetown Lane
Huntington Beach , CA 92627

Table of Contents

Table of Contents continued **Page No.**

Appendices

List of Exhibits

List of Figures

List of Tables

I. EXECUTIVE SUMMARY

This preliminary design report represents the culmination of the efforts of Grayhawk Development and PACE to work with the City of Scottsdale to improve the currently proposed Pima Road Desert Greenbelt drainage plan. The intention of this report is to provide additional insightful design input to the Desert Greenbelt design team for incorporation to the final design. The goal is to improve and enhance the current Pima Road Desert Greenbelt design concept.

As an active Development Community in north Scottsdale, Grayhawk is dependent upon the completion of the Pima Road Channel. And as such, we are acutely aware of the City of Scottsdale's concerns regarding any change of plan, impact to the schedule and public notification regarding the Pima Road Channel project. However, we are confident that the proposed detention design alternative is well worth the effort. Concern for **public safety and enhancement of the desert greenbelt concept** will be improved by the design advances in the proposed detention alternate.

With the pro-active design approach, the detention basin alternative provides a benefit to the public and the City of Scottsdale with every rainfall event, by reducing channel; flow rates, velocity and depth of flow. As such, the detention alternate provides a significantly less hazardous drainage system design.

The proposed detention design alternative has the support of the City of Scottsdale, Maricopa County Flood Control District, Arizona State Land Department, Arizona Department of Water Resources, and the Arizona Department of Transportation.

The reader and reviewer of this preliminary design report must realize that the Pima Road Drainage System design is a complex and large task. It is not the intent of this report to provide final design data and address every possible design element of the project. Instead, the intent is to assure the reader that the **detention alternate is a feasible alternative with numerous substantial benefits. None of the technical engineering challenges associated with the proposed alternative are unresolvable or cost prohibitive.** With the appropriate direction and dedication to resolve the design issues, the proposed alternative can easily and quickly be incorporated into the Pima Road Channel Desert Greenbelt Plan.

The major issues which have been pointed out as potential stumbling blocks for the alternate design are summarized below:

1. **Detention Basins**
   a. Safety
   ADWR - Dam Safety Preliminary Review found "No fatal Flaws" regarding dam safety and or construction feasibility. The proposed detention basins improve the drainage system safety by reducing the Pima Road Channel flows. The enclosed Figure I-1 is a graphical comparison of the Pima Road Channel flows with and without detention. The reduced flows associated with the detention alternate provide safe flows, depths and velocities.

b. Aesthetics - Land Use

The enclosed *Exhibit I-1* is an example of the proposed detention basin landscaping potential. Each basin is a 20 to 30 acre revegetated open space or potential park; providing benefit to the citizens during dry and wet conditions, a truly pro-active and environmentally sound plan.

2. Alternate Channel Sections

a. Design and Construction Feasibility

The proposed channel design includes standard design and construction techniques such as equilibrium slope design, soil cement, and drop structures.

b. Aesthetic Compatibility with Desert Greenbelt

The proposed detention alternate design eliminates the "Los Angeles River" type concrete channel alternative. **It would be nearly impossible for anyone to escape the non-detention channel when it is flowing above the 5 year event**. In addition, the reduced bank heights and natural channel bottom will enhance the desert greenbelt plan and eliminate the need for revegetation and aesthetic treatment to hide a concrete channel. *Exhibit I-2* which compare the detention and no detention Pima Road Channel alternates is an obvious illustration as to the benefits of the detention alternate. *Table I-1* compares the flow rate, depth of flow and velocity for various rainfall events for both alternatives, this is an additional illustration indicating dramatic safety concerns for the non-detention alternative.

3. Construction Cost

The construction cost comparisons presented in Section VI of this report indicate that the alternatives are nearly identical in cost. With incorporation of potential savings the detention alternative becomes significantly less costly (approximately 10 million). In addition, the detention alternative has three times more funds expended on salvage and revegetation which will enhance the desert greenbelt.

To summarize, the detention alternate provides technically feasible improvements to the Pima Road Channel Desert Greenbelt project which dramatically improve the drainage system from a public safety and engineering standpoint without increasing the project cost.

EXHIBIT I - 1

Proposed Desert Greenbelt Detention Basin Embankment Concept

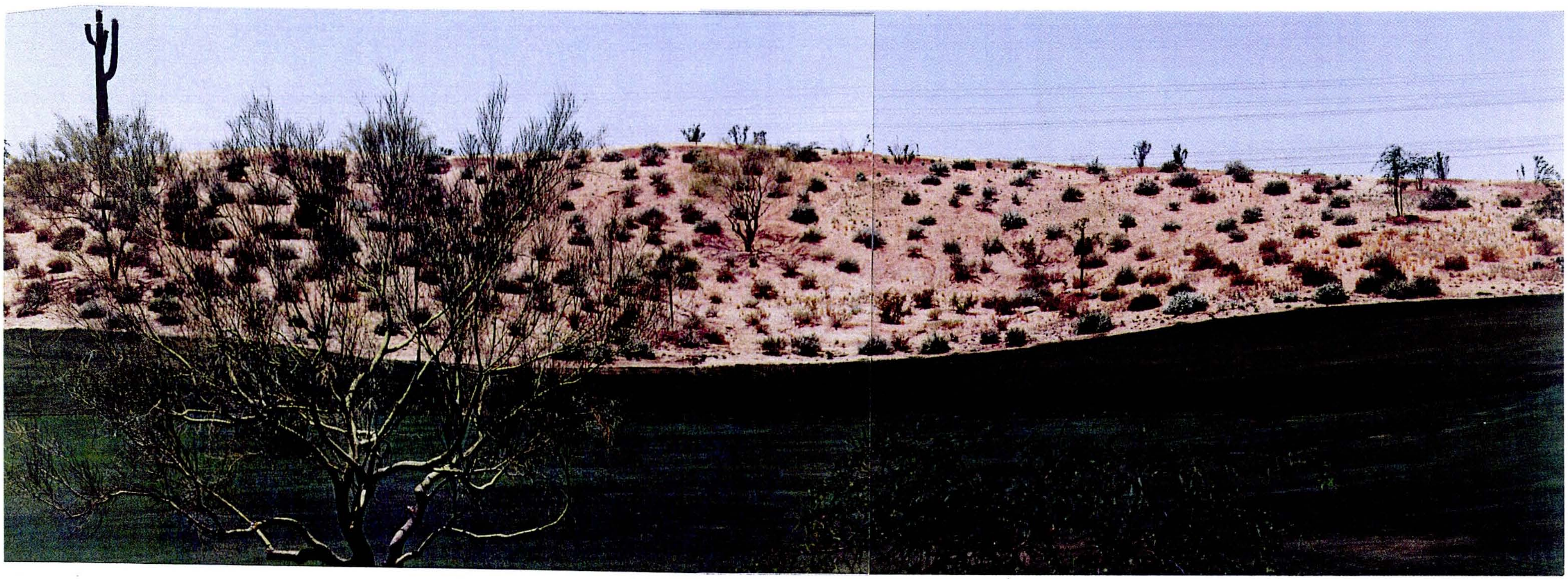
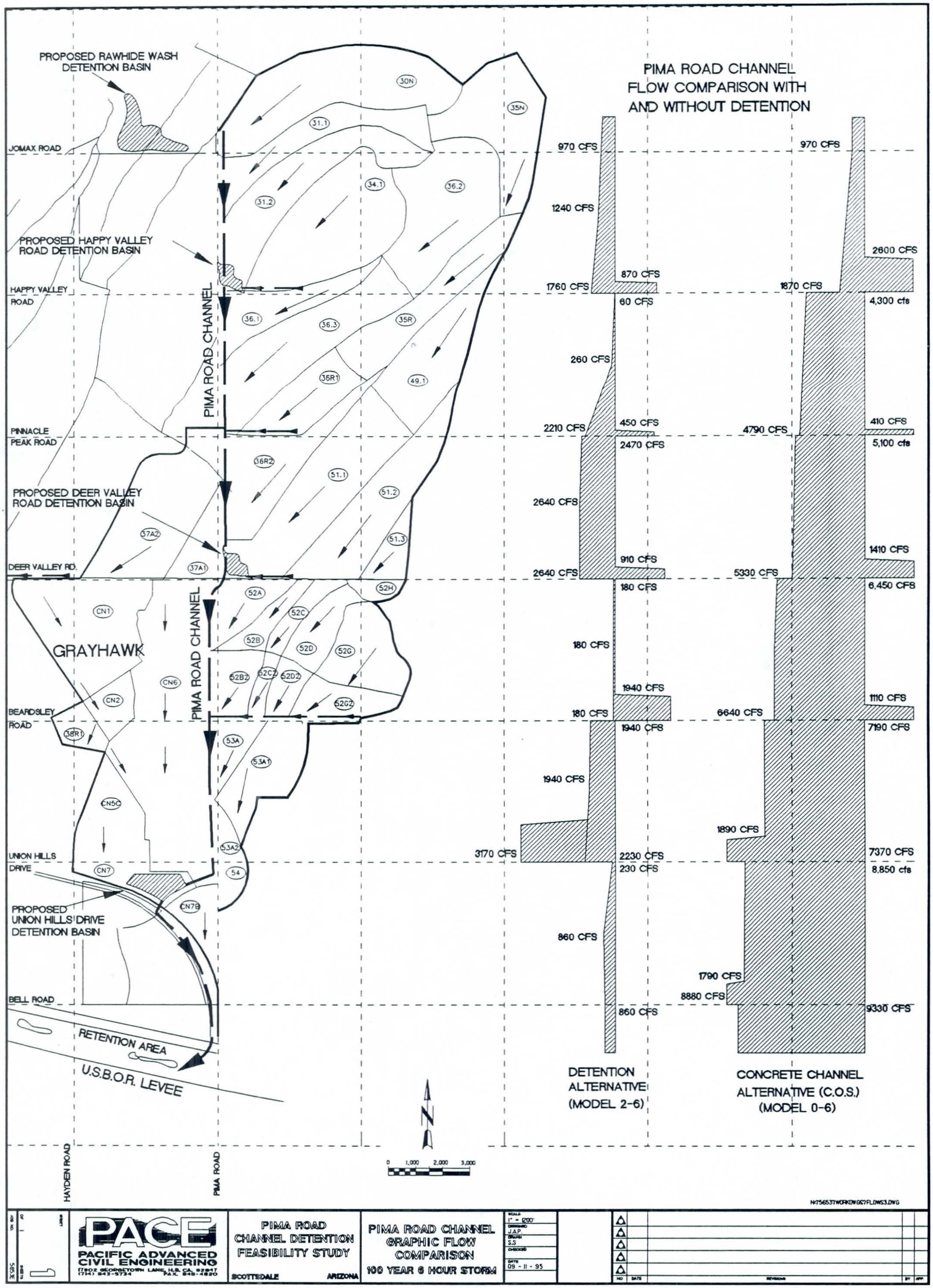


Photo taken on recently constructed Grayhawk Talon Golf Course area. Desert landscaping of embankment. Total embankment height approximately 30 - 40 feet (higher than any of the proposed Pima Road Detention Basin Embankments)

N



PIMA ROAD CHANNEL FLOW COMPARISON WITH AND WITHOUT DETENTION
PROPOSED RAWHIDE WASH DETENTION BASIN
JOMAX ROAD
PROPOSED HAPPY VALLEY ROAD DETENTION BASIN
HAPPY VALLEY ROAD
PIMA ROAD CHANNEL
PINNACLE PEAK ROAD
PROPOSED DEER VALLEY ROAD DETENTION BASIN
DEER VALLEY RD.
GRAYHAWK
BEARDSLEY ROAD
UNION HILLS DRIVE
PROPOSED UNION HILLS DRIVE DETENTION BASIN
BELL ROAD
RETENTION AREA
U.S.B.O.R. LEVEE
HAYDEN ROAD
PIMA ROAD
30N
35N
31.1
31.2
34.1
36.2
36.1
36.3
35R
36R1
49.1
36R2
51.1
51.2
51.3
37A2
37A1
52H
52A
52C
52B
52D
52G
52B2
52C2
52D2
52G2
CN1
CN6
CN2
38R1
53A
53A1
CN5C
53A2
54
CN7
CN7B
970 CFS
1240 CFS
870 CFS
1760 CFS
60 CFS
260 CFS
2210 CFS
450 CFS
2470 CFS
2640 CFS
910 CFS
2640 CFS
180 CFS
180 CFS
1940 CFS
180 CFS
1940 CFS
1940 CFS
3170 CFS
2230 CFS
230 CFS
860 CFS
860 CFS
DETENTION ALTERNATIVE (MODEL 2-6)
970 CFS
2600 CFS
1870 CFS
4,300 cfs
4790 CFS
410 CFS
5,100 cfs
1410 CFS
5330 CFS
6,450 CFS
1110 CFS
6640 CFS
7190 CFS
1890 CFS
7370 CFS
8,850 cfs
1790 CFS
8880 CFS
9330 CFS
CONCRETE CHANNEL ALTERNATIVE (C.O.S.) (MODEL 0-6)
N
0 1,000 2,000 3,000
PACE
PACIFIC ADVANCED CIVIL ENGINEERING
PIMA ROAD CHANNEL DETENTION FEASIBILITY STUDY
SCOTTSDALE ARIZONA
PIMA ROAD CHANNEL GRAPHIC FLOW COMPARISON
100 YEAR 6 HOUR STORM
1" = 1200'
J.A.P.
S.S.
09 - 11 - 95

FIGURE I-1

TABLE I - 1
FLOW VELOCITY AND DEPTH COMPARISON FOR PIMA ROAD CHANNEL WITH AND WITHOUT DETENTION

LOCATION ALONG PIMA ROAD	PIMA CHANNEL MODEL 0 - NO DETENTION ALTERNATE											
	2-yr.			5-yr.			10-yr.			100-yr.		
	FLOW (CFS)	VEL. (FPS)	DEPTH (FT)	FLOW (CFS)	VEL. (FPS)	DEPTH (FT)	FLOW (CFS)	VEL. (FPS)	DEPTH (FT)	FLOW (CFS)	VEL. (FPS)	DEPTH (FT)
Jomax Road	150	5.9	0.6	290	7.6	0.9	410	8.7	1.1	970	11.9	1.9
Happy Valley Road	660	9.8	1.6	1,280	12.5	2.3	1,770	**14.0**	2.8	4,300	**18.8**	4.7
Pinnacle Peak Road	750	10.3	1.7	1,480	**13.1**	2.5	2,060	**14.7**	3.0	5,100	**19.8**	5.1
Deer Valley Road	900	**16.5**	1.3	1,790	**21.2**	1.9	2,530	**24.0**	2.4	6,450	**33.0**	4.1
Beardsley Road	990	**16.9**	1.4	1,990	**21.7**	2.1	2,810	**24.5**	2.5	7,190	**33.6**	4.4
Union Hills Drive	1,340	**16.4**	1.5	2,570	**20.9**	2.3	3,590	**23.5**	2.8	8,850	**32.0**	4.7
Bell Road	1,440	10.7	2.2	2,730	**13.4**	3.2	3,790	**15.0**	3.9	9,330	**20.1**	6.5

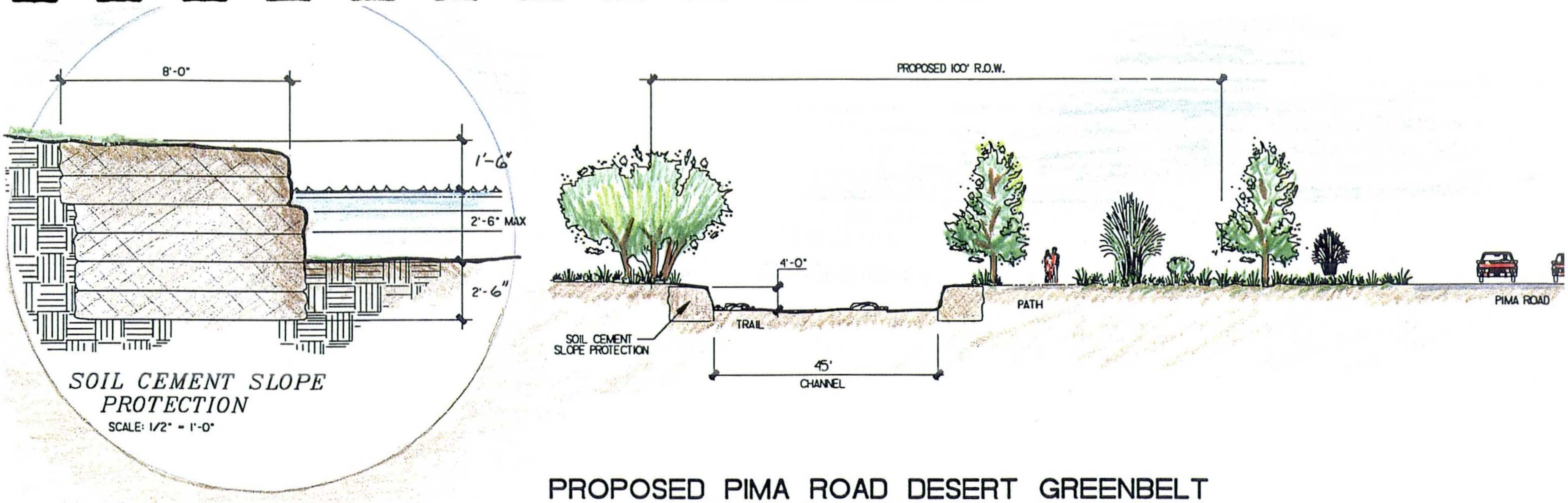
NOTE:

LIGHT SHADED AREAS INDICATE CHANNEL REACHES WITH VELOCITIES BETWEEN 14 AND 9 FPS.
DARK SHADED AREAS INDICATE CHANNEL REACHES WITH VELOCITIES GREATER THAN 13 FPS.

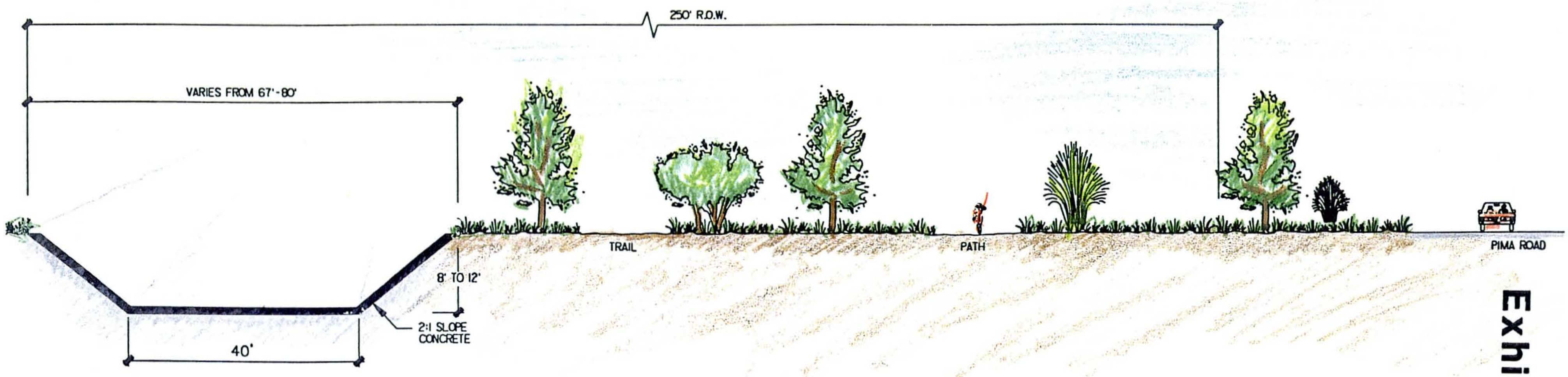
LOCATION ALONG PIMA ROAD	PIMA CHANNEL MODEL 2 - WITH DETENTION ALTERNATE											
	2-yr.			5-yr.			10-yr.			100-yr.		
	FLOW (CFS)	VEL. (FPS)	DEPTH (FT)	FLOW (CFS)	VEL. (FPS)	DEPTH (FT)	FLOW (CFS)	VEL. (FPS)	DEPTH (FT)	FLOW (CFS)	VEL. (FPS)	DEPTH (FT)
Jomax Road	150	5.3	0.7	290	6.8	1.0	410	7.7	1.3	970	10.7	2.2
Happy Valley Road	240	5.4	0.7	500	7.2	1.1	710	8.3	1.4	1,760	11.7	2.4
Pinnacle Peak Road	400	5.8	0.9	740	7.4	1.2	1,030	8.4	1.5	2,470	11.7	2.5
Deer Valley Road	410	6.1	0.8	780	7.9	1.2	1,090	9.0	1.5	2,640	12.6	2.5
Beardsley Road	360	5.8	0.9	600	7.1	1.2	770	7.9	1.4	1,940	11.2	2.4
Union Hills Drive	450	6.4	0.9	750	7.8	1.2	980	8.6	1.4	2,230	11.8	2.3
Bell Road	290	5.4	1.8	430	6.1	2.2	520	6.5	2.5	860	7.6	3.3

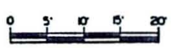
Assumptions:

1. Values for Model 0 are based on results obtained by executing HEC-1 model PIMA4B.DAT obtained from the City of Scottsdale and substituting 2,5 and 10 year rainfall depths. Slopes, n bottom width and side slopes per recent project reports.
2. Model 2 values were obtained by utilizing file MODEL2-6.HC1. This file, originally PIMA4B.DAT, contains numerous modifications by PACE including the addition of detention basins at Happy Valley Road. Channel Slope, n, bottom width, and side slopes per this report. Deer Valley Road and Union Hills Drive. Rainfall depths were modified to obtain 2, 5 and 10 year flows.
3. Rainfall depths used are 1.52", 1.97", 2.27", and 3.31" for the 2, 5, 10 and 100 year events.
4. All storm events used are 6 hour duration.



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





PROPOSED PIMA ROAD CHANNEL
AT BELOW DEER VALLEY ROAD
WITHOUT DETENTION

Exhibit I-2

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

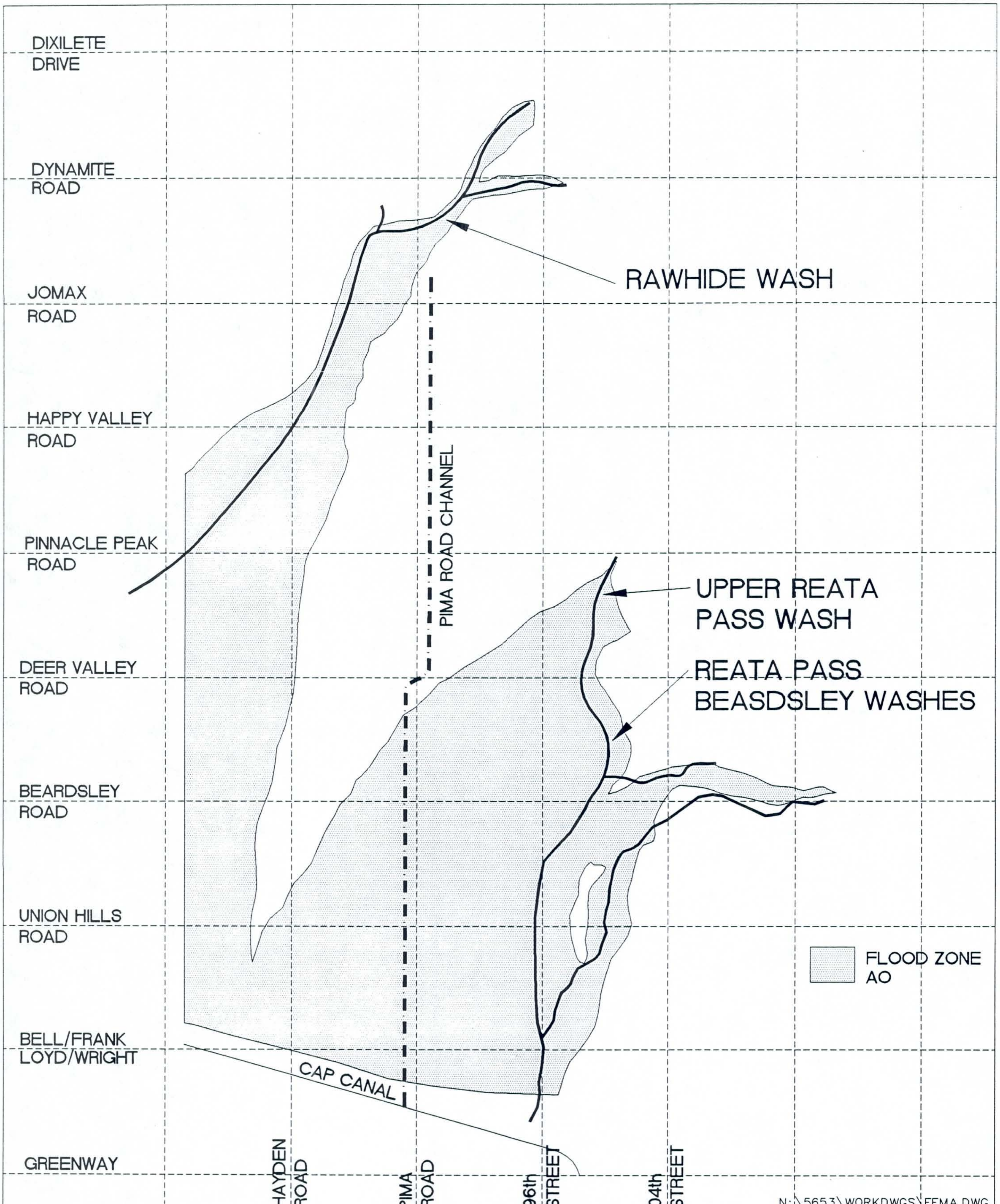
The purpose of this study is to determine the effectiveness of the addition of regional detention basins to the Pima Road Channel Desert Greenbelt Alternative. Our design goals included identifying a more proactive, safe, aesthetically pleasing and cost effective drainage solution, which will enhance 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 I-1, 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:	JOB:		
FEMA MAP	PIMA ROAD DETENTION BASIN FEASIBILITY STUDY	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
	SCOTTSDALE AZ		

FIGURE II–1

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. Shorter east-west collector channel at Happy Valley Road allow more flow to bypass the Happy Valley Road detention basin and enter the Deer Valley detention basin directly. Model 1 has approximately 1.1 square miles more of tributary drainage area entering the Happy Valley Road detention basin as compared to model 2. This modification in effect double counts the 1.1 square miles and provides for a conservative design since both Happy Valley and Deer Valley Road detention basins include the same 1.1 square miles as entering the basins directly. 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**

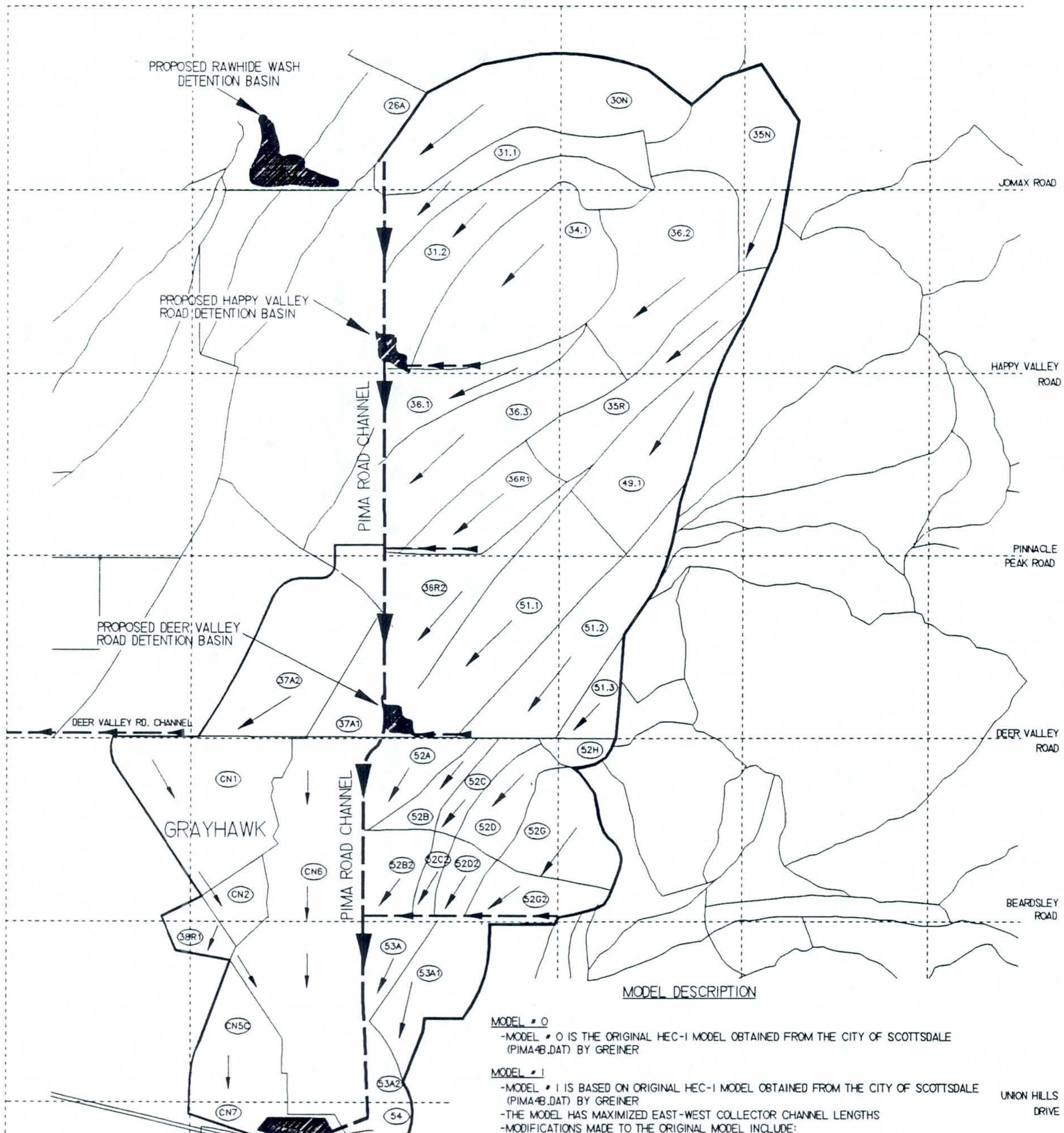
Model 3 is identical to Model 2 except it includes an additional detention basin at Beardsley Road.

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 east-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

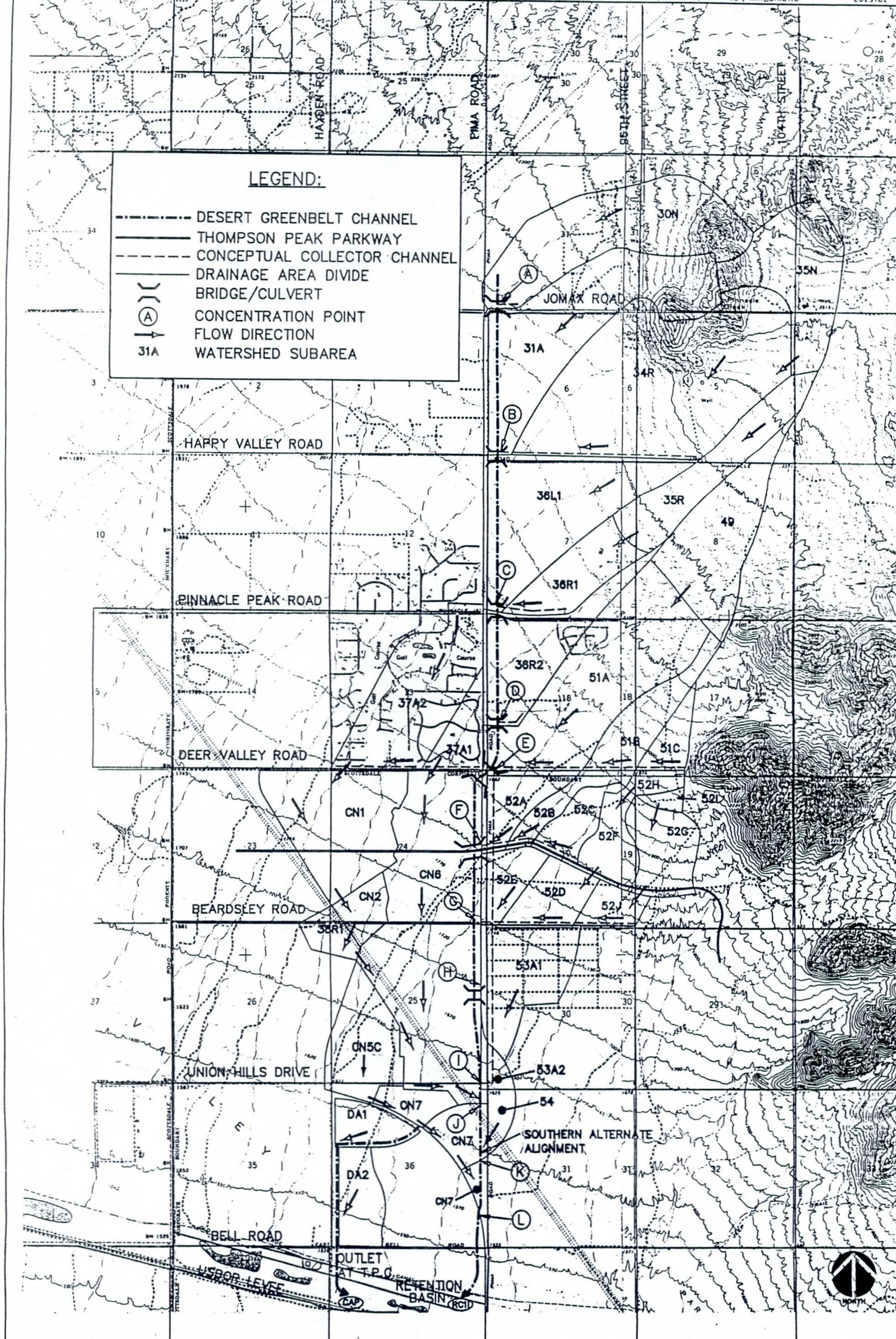
MODEL # 2
- MODEL # 2 WAS DERIVED FROM MODEL # 1
- THIS MODEL WILL BE USED TO DESIGN THE DEER VALLEY ROAD AND UNION HILLS DETENTION BASINS
- MODIFICATIONS TO THE ORIGINAL MODEL INCLUDE:
  A. CHANGE FROM THE 100 YEAR 6 HOUR STORM EVENT AS THE DESIGN STORM TO A 100 YEAR 24 HOUR STORM
  B. ADDITION OF DETENTION 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	FIGURE III-1
	CHKD M.E.K.		
JOB PIMA ROAD CHANNEL DETENTION FEASIBILITY STUDY	DATE 08-23-95		
	JOB NO 5653		

N:\5653\WORKDWGS\NEWMAP.DWG

10.A 042595 A.L. E1PC26 Scottsdale Desert Greenbelt P:\CADD\EXHIBITS\DRAINAGE\PIMA_DR.DWG E029102



Pima Road Channel

Drainage Area Map

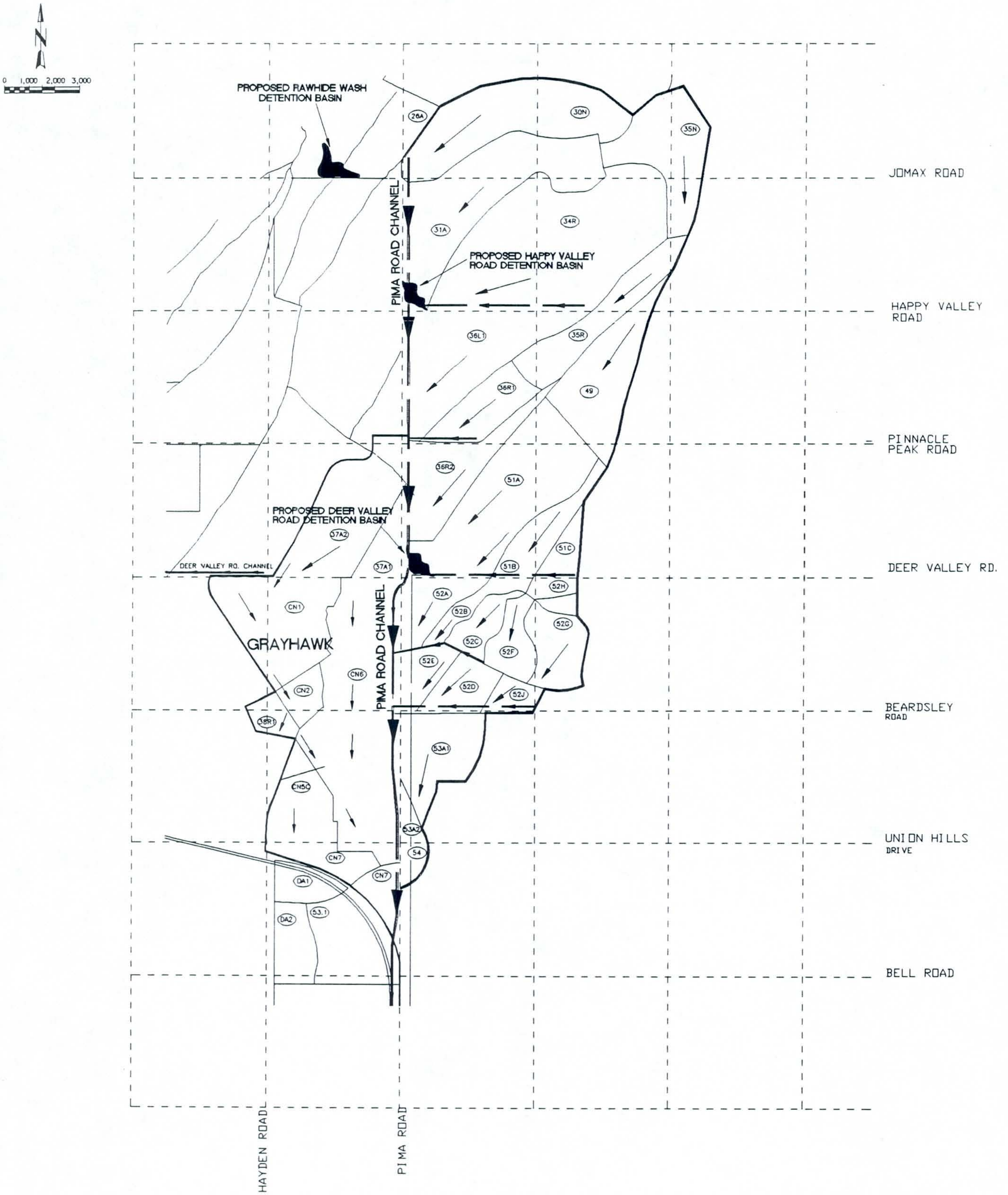
Overall View 14

Figure III-2

Greiner

1"=3000'

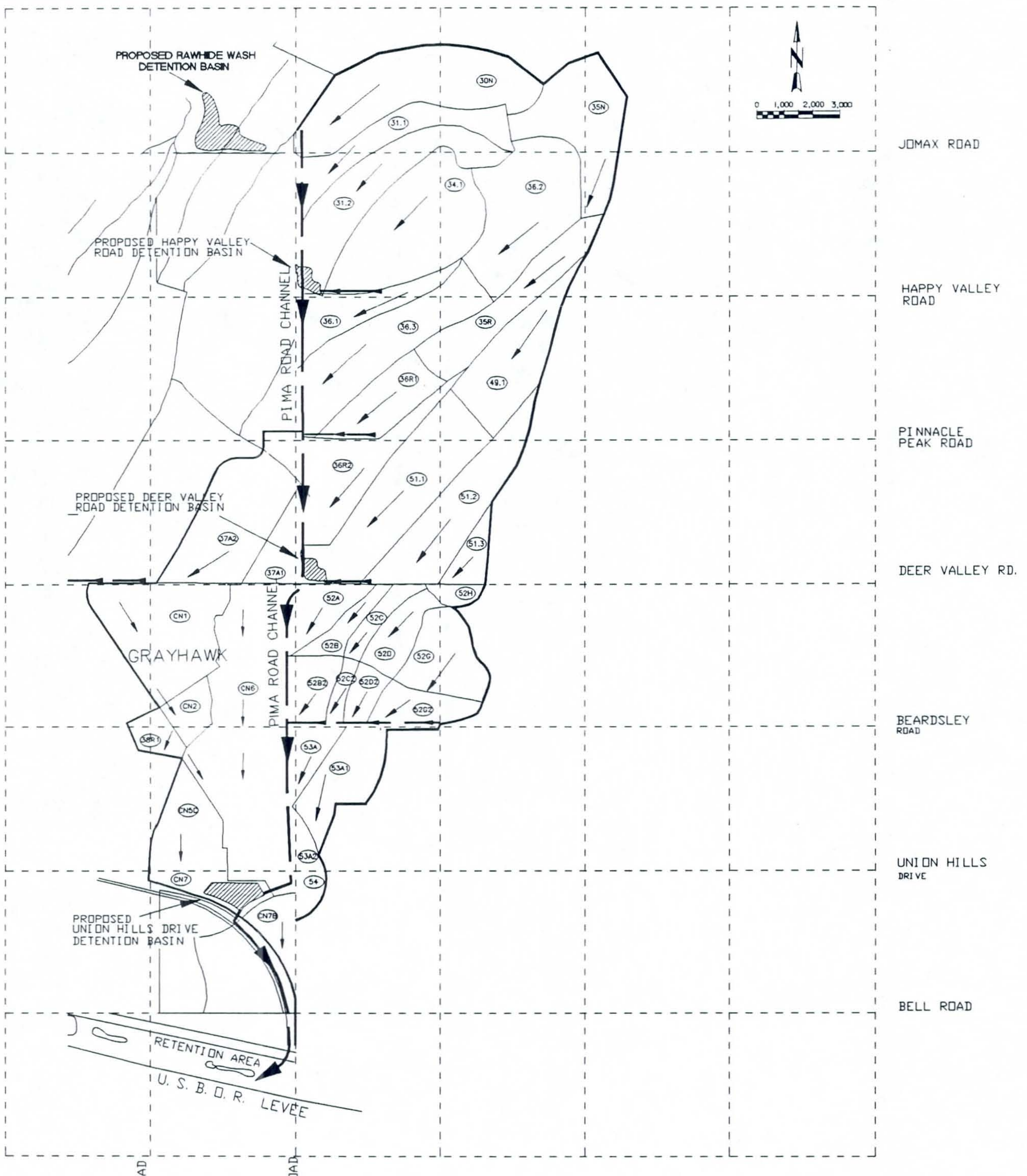
Figure 2



N: \5653\WORKDWGS\MODEL1A.DWG

TITLE:	JOB:		
MODEL 1 WATERSHED DRAINAGE MAP	PIMA ROAD DETENTION BASIN FEASIBILITY STUDY	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
	SCOTTSDALE AZ		

FIGURE III-3



N: \5653\WORKDWGS\MODEL2A.DWG

TITLE:
MODEL 2 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-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 indicates 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 F. 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 F).

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	Sedimentation Analysis and Flow Comparison
5-yr/6-hr	1.97	Sedimentation Analysis/Comparison and Flow
10-yr/6-hr	2.27	Dominant Discharge - Equilibrium Slope Calculations
PMP 6-hr Happy Valley Watershed	13.05	Happy Valley Rd. Detention Basin Spillway Design 0.5 PMF
PMP 6-hr Deer Valley Watershed	12.12	Deer Valley Rd. Detention Basin Spillway Design 0.5 PMF

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 indicate 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 IIA 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 $(mi)^2$	PMP Rainfall (in)[1]	Peak Basin Inflow (cfs)[2]	Peak Basin Outfall (cfs)[2]	Peak Basin Storage (acre-feet)[2]	Peak Stage (elev.)[2]
Happy Valley Road	0.5PMF-HV.HC1	3.37	13.05	9,960	8,800	454	2,094.5
Deer Valley Road	0.5PMF-DV.HC1	5.98	12.12	13,730	13,620	360	1,894.3

Notes:

1. See Appendix for PMP calculations from hydrometerological report #49 and the HEC-1 models for 0.5 PMF routing.
2. PMF runoff hydrograph 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 - Detention Alternate

Based upon COS design criteria, the 100 year- 6 hour storm event will be used for channel design. HEC-1 model Model2-6.hc1 was used to determine the flows in the Pima Road Channel. As discussed earlier in this report, Model2-6 includes detention basins at Happy Valley Road, Deer Valley Road and Union Hills Drive. The model utilizes the 6 hour 100 year storm event. The east-west collector channels along Happy Valley and Deer Valley Roads which bring the flows into the detention basins are assumed to be 1/2 mile in length. Final design of the Pima Road Channel must include a detailed analysis of the collector channels and proposed development drainage plans. 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 1/2 mile intervals. The table also separates the inflows into the Pima Channel by the direction from which the flows enter (i.e. east, west, north). The highest expected 100-year design flow rate in the Pima Road Channel is 2,640 cfs with the detention alternate.

The proposed Pima Road Channel hydraulic design calculations (Section V) utilize the peak flow rates within each reach of the Pima Road Channel as the design flow for that entire reach.

A comparison of the flows in the Pima Road Channel with and without detention is shown on *Table III-6, Peak Flow and Volume Comparison With and Without Detention*. The no detention alternative flows were obtained from Model0-6.hc1 HEC-1 model. This model, as described earlier in this report, is identical to the PIMA4B.DAT model developed by the Greiner Team for the City of Scottsdale. The model assumes 1.5 mile long east-west collector channels along Happy Valley and Deer Valley Roads. The table clearly shows that a significant reduction in peak flows is possible with the inclusion of detention facilities at Happy Valley Road, Deer Valley Road and Union Hills Drive. With the detention basins in place, the highest expected flow in the Pima Road Channel is expected to be 2,640 cfs. Without the detention basins flows can be as high as 9,330 cfs. A more visual comparison of the flow reduction provided by the detention basins can be seen *on Figure I-2, Pima Road Channel Graphic Flow Comparison* located in Section I of this report.

TABLE III-5

PIMA ROAD CHANNEL DESIGN FLOWS

WITH DETENTION AT HAPPY VALLEY, DEER VALLEY & UNION HILLS ROADS

PIMA ROAD CHANNEL REACH LOCATION[(1)]	APPROX. HEC-1 NODE	Q_{100} From North (Channel Design) (cfs)[2]	Q_{100} From East (cfs)[2]	Q_{100} From West (cfs)[2]	Q_{100} TOTAL FLOW (cfs)[2]
STA 365+60 At Jomax Road	30N	**970**	0	0	970
STA 339+20 (1/2 Mile Point)	CP31.1	**1,240**	0	0	1,240
STA 324+80 Above Happy Valley Det.	CP31.2	**1,760**	870	0	2,600
Happy Valley Detention Basin					
STA 314+80 Below Happy Valley Det.	DET-HV	**60**	0	0	60
STA 288+40 (1/2 Mile Point)	CP36.1	**260**	0	0	260
STA 262+00 At Pinnacle Peak Road	CP36.4	2,210	450	0	**2,470**
STA 235+60 (1/2 Mile Point)	C36R2	**2,640**	0	0	2,640
STA 221+20 Above Deer Valley Rd. Det.	CP51.1	**2,640**	910	0	3,400
Deer Valley Detention Basin					
STA 205+20 Below Deer Valley Det.	DET-DV	**180**	0	0	180
STA 182+80 (1/2 Mile Point)	R52A2	**180**	0	0	180
STA 156+40 Beardsley Road	52E6A	180	1,940	0	**1,940**
STA 130+00 (1/2 Mile Point)	CP53A2	**1,940**	0	0	1,940
STA 96+00 Above Union Hills Dr. Det.	C53A21	**2,230**	0	3,170	4,870
Union Hills Detention Basin					
STA 82+00 Below Union Hills Dr. Det.	DET-UH	**230**	0	0	230
STA 30+00 At Bell Road	C54	**860**	0	0	860
STA 10+00 Channel Outlet @ B.O.R.	ROBELL	**860**	0	0	860

Notes:

1. Stationing approximate and based upon revised alignment with proposed detention basins.
2. Flows based upon HEC-1 "Model 2-6" for 100 Year-6 Hour Rainfall Event.
3. **The Pima Road Channel reach design flows are shown in bold type face.**

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

LOCATION	WITHOUT DETENTION			WITH DETENTION		
	Drainage $Area_{(sm)}$	HEC-1 Node	Q_{100} (cfs)	Drainage $Area_{(sm)}$	HEC-1 Node	Q_{100} (cfs)
Happy Valley Road						
from North	1.56	C31	1,870	1.58	CP31.2	1,760
from east	1.82	C34R	2,600	0.67	SB34.1	870
Detention basin inflow	3.37	C31A	4,300	2.24	CP34.1	2,600
Detention basin outflow	3.37	C31A	4,300	2.24	DET-HV	60
Pinnacle Peak Road						
from north	3.97	C36L	4,790	4.00	CP36N	2,210
from east	0.65	C36R1	410	0.65	CP36R1	450
combined	4.62	C36L1	5,100	4.65	CP36.4	2,470
Deer Valley Road						
from north	5.00	C36R2	5,330	5.02	C36R2	2,640
from east	1.63	C51A1	1,410	0.96	CP51.1	910
Detention basin inflow	6.62	C51A2	6,450	5.98	CP51.2	3,400
Detention basin outflow	6.62	C51A2	6,450	5.98	DET-DV	180
Beardsley Road						
from north	6.62	R52A2	6,450	5.98	R52A2	180
from east	0.85	C52E1	1,110		CP52E4	1,940
combined	7.87	C52E2	7,190	7.44	C52E6A	1,940
Union Hills Drive						
from north	8.40	C53A2	7,370	7.97	CP53A2	2,230
from west	2.59	CDB2.1	1,890	2.97	CDB2.1	3,170
Detention basin inflow	11.00	C53A21	8,850	10.94	C53A21	4,870
Detention basin outflow	11.00	C53A21	8,850	10.94	DET-UH	230
Bell Road						
from north	11.00	RC53	8,850	10.94	ROCN7B	230
from east	0.04	54	180	0.04	SUB54	180
from west	0.56	CCN7	1,790	0.19	SCN7B	780
combined	11.60	CCN7.1	9,330	11.17	CP54	860

Assumptions:

1. HEC-1 model corresoponding to the "Without Detention Alternative" is Model0-6.hc1 as described in this report.
2. HEC-1 model corresponding to the "With Detention Alternatiive" is Model2-6.hc1 as described in this report.

E. SEDIMENTATION

1. Study Background

The sediment analyses prepared in this report are preliminary and will be refined with the final design process.

The purpose of this analysis was to determine the amount of sediment from the upstream watershed areas which may impact the proposed detention basins. The Bureau of Reclamation defines sediment yield as, "That portion of eroded material that travels through a drainage system to a downstream measuring or control point". Calculation of sediment yield is not an exact science; therefore, extensive judgment in conjunction with sound engineering is required. Calculations are based on various basin parameters, some of which are stated in Golze's *Handbook of Dam Engineering*:

- Land and river slopes
- Land use
- Geology and soil cover
- Vegetal cover, which is dependent on rainfall
- Climate, particularly annual rainfall and resulting runoff

Generally, burn history (the likelihood of fire), and area of the watershed are also important factors in determining sediment yield. The amount of debris produced is inversely proportional to the size of the watershed. Smaller watersheds (under 1 square mile) generally produce more yield than the larger watersheds due to higher concentrations of rainfall over smaller areas.

It is necessary to calculate sediment yield for the drainage areas in order to adequately size the proposed detention basins. The detention basins will be designed to hold the bulked water flows without overtopping the structure for the 100 year 24 hour storm event and pass clear flows into the Pima Road Channel. Several sediment yield models were investigated to determine the amount of annual sediment each basin would produce. Based on this analysis, it will be possible to reasonably define potential annual maintenance and removal requirements, as sediment build-up occurring over time will necessitate maintenance to remove accumulated debris. Other scientifically appropriate methods were utilized to establish a "per major storm" yield. This prediction led to an estimated bulking factor which is a necessary parameter for detention basin and outlet structure design.

Preliminary geotechnical exploration was performed by ATL, Inc. as shown in Sediment Field Tests, City of Scottsdale Desert Greenbelt Project, July 1994, Appendix H. Additional geotechnical investigations were performed by AGRA Earth & Environmental (Appendix G) for the Pima Road Channel and a supplemental study for the proposed detention basins.

2. Study Overview

This analysis was conducted to determine debris yield on an annual as well as per major storm basis.

a. Annual Debris Production

Annual yields are estimated mainly for maintenance requirements. In order to estimate debris deposits, various accepted scientific sediment yield equations were analyzed and the results were compared. Methods which provide estimates of annual debris production are:

- Dendy/Bolton
- Flaxman
- Bureau of Reclamation Sediment Surveys
- Renard
- PSIAC

Calculations for the annual debris production are summarized in the following section and are shown in detail in Appendix J.

Assumptions used in the calculations include:

1. Drainage areas tributary to a detention basin are assumed to contribute no sediment to areas downstream of that detention basin.
2. Soil characteristics were taken from the previously mentioned Sediment Field Test by ATL, Inc., Appendix H.

b. "Per Major Storm" Sediment Production

The "per major storm" is identified as the 100 year recurrence interval. Storm yields are necessary for sizing detention basins to hold bulked flows and pass clear flows. Methods which yield "per major storm" values are:

- Modified Universal Soil Loss Equation
- Sediment Transport Rate

Calculations for the "per major storm" debris production are summarized in the following sections and are shown in detail in Appendix J.

3. Sedimentation Calculation Results and Conclusions

As discussed earlier, sedimentation calculations are not an exact science as is evident from the variation in results. Final design of the detention basins and the channel will require additional geotechnical evaluation and subsequent refinement of the sedimentation evaluation.

a. Annual Sediment Yield

Results of the annual sediment yield calculations for each detention basin are summarized in *Table III-7* below.

Table III - 7
Annual Sediment Yield Summary Table

Calculation Method	Happy Valley Road Detention Basin Annual Sediment Yield (AF/year)	Deer Valley Road Detention Basin Annual Sediment Yield (AF/year)	Union Hills Drive Detention Basin Annual Sediment Yield (AF/year)
Dendy/Bolton	1.2	1.3	1.6
Flaxman	2.4	2.6	3.4
Bureau of Reclamation	4.6	5.0	6.2
Renard	1.6	1.8	2.2
Pacific Southwest Inter-Agency Committee	0.8 - 3.4	0.9 - 3.7	1.2 - 4.9
Average	**2.5**	**2.7**	**3.4**

The results for the three detention basins range from 1.2 to 6.2 AF/year of sediment yield. Due to the variation of results for the individual basins, it was decided to use the average of the 4 calculation methods for each of the detention basins.

The Happy Valley Road Detention Basin was found to have an annual sediment yield of 2.5 AF with a set aside sedimentation storage capacity of 14 AF. This would require a maintenance schedule of every 5.6 years. The Deer Valley Road Detention Basin with an annual sediment yield of 2.7 AF and a set aside sedimentation storage capacity of 33 AF will require a maintenance schedule of every 12.2 years. The Union Hills Drive Detention Basin was found to have an annual sediment yield of 3.4 AF, with a set aside sedimentation storage capacity of 30 AF. This would require a maintenance schedule of every 8.8 years.

Final design of the detention basins can be adjusted to accommodate reasonable adjustments to the estimated annual sediment yield and resulting maintenance schedule.

4. Per Major Storm Sediment Yield

The per major storm sediment yield calculations are summarized in *Table III-8.*

Table III - 8
Per Major Storm (100 year-6 hour) Sediment Yield Calculations

Calculation Method	Happy Valley Road Detention Basin Sediment Yield (AF)	Deer Valley Road Detention Basin Sediment Yield (AF)	Union Hills Drive Detention Basin Sediment Yield (AF)
MUSLE	6.1	7.0	8.6
[1]Sediment Transport Rate Equation/Power Relationship	3.0	2.6	N/A

[1] Sediment transport rate equation provides Q_{S100} result in CFS. Which is then converted to AF of sediment by discretizing the Q_{100} hydrograph see Appendix J for calculations.

5. Detention Basin Design

Shown in the table below are the volumes allocated for sedimentation for the proposed detention basins.

Table III - 9
Detention Basin Sediment Storage Allocation

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

Final design of the sediment storage requirements for the detention basins will include an analysis of the Union Hills detention basin (which is preliminarily designed with approximately 30 AF of sediment storage). The Union Hills sediment supply calculations and storage volume are impacted by the Grayhawk Development and the reduced sediment yields which will be associated with development. Proposed development will impact to allot the sediment calculations and requirements.

For a comparison, detailed studies for the Rawhide Wash Drainage Basin and Proposed Detention Basin prepared by CH_2M Hill, December, 1994 are as follows:

• Tributary Area (SM)	15
• 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

The numbers from the Rawhide Wash Detention Basin Study indicate that the sediment volumes calculated and allocated for the Deer Valley and Happy Valley Detention Basins are reasonable by comparison.

6. Pima Road Channel Design

The long term stability of the Pima Road Channel was analyzed through the application of the equilibrium slope concept (see Section V-D). The equilibrium slope analysis provides insight into the gradual change that can be expected in the channel bed profile over a long period of time. An estimate of the equilibrium slope is obtained by comparing the sediment supply to the Pima Road Channel with the sediment transport rate capacity of the channel. The sediment supply to the various channel reaches was calculated by analyzing the flows in the washes and sheet flow tributary to the channel. With the Power equation, the total sediment supply was calculated for the various Pima Channel reaches. With the estimated sediment supply as a known, the sediment transport capacity of the Pima Road Channel can be adjusted to match the sediment supply rate by adjusting the slope of the channel. The channel slope at which the sediment transport capacity of the channel equals the sediment supply rate is the equilibrium slope.

Due to the fact that many parameters in the Power Equations for sediment transport are based on visual inspection of the site and a lack of sufficient geotechnical data, a comparison of the results for the sediment supply calculations was completed. The comparison consisted of a conversion of the sediment transport rate (cfs) to a per major storm volume (AF). The storms analyzed include the 100 year 6 hour, 10 year 6 hour and the 2 year 6 hour storm events. The total sediment inflow for the three storms were calculated for each of the proposed detention basins. This sediment inflow was then compared to the sediment inflow rate for the various storms and detention basins calculated with the MUSLE Method. A comparison of the sediment inflow calculation results into the detention basins under the MUSLE and Power Equations are shown in *Table III-10* below. See Appendix J for detailed calculations.

Table III - 10
Comparison/Verification of Sediment Supply Calculations and MUSLE Calculations for the Happy Valley and Deer Valley Detention Basins

Calculation Method	Happy Valley 100 yr (AF)	Happy Valley 10 yr (AF)	Deer Valley 100 yr (AF)
MUSLE	6.1	2.6	7.0
[1] Sediment Transport Rate Equation/With Power Relationships	3.0	1.4	2.6

[1] Sediment transport rate equation provides Q_{S100} result in CFS. Which is then converted to AF of sediment by discretizing the Q_{100} hydrograph see Appendix J for calculations.

As indicated earlier in this report, sediment calculations are not an exact science, therefore, extensive engineering judgment is required. The results of the comparison indicate that the assumptions made regarding the sediment supply rate are within an acceptable range. See Section V-D for further discussion of sediment transportation and Pima Road Channel Design.

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.

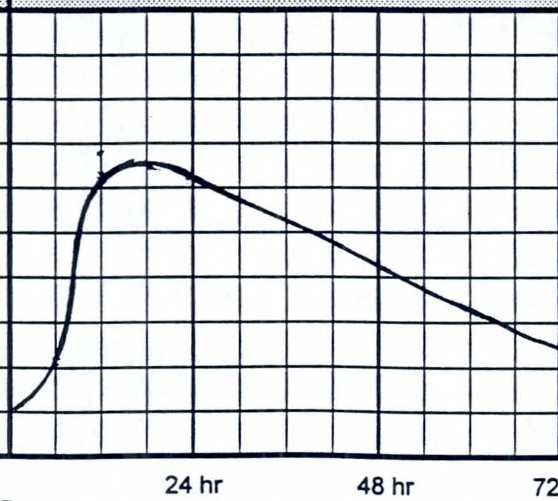
A. HAPPY VALLEY ROAD DETENTION BASIN

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 I-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

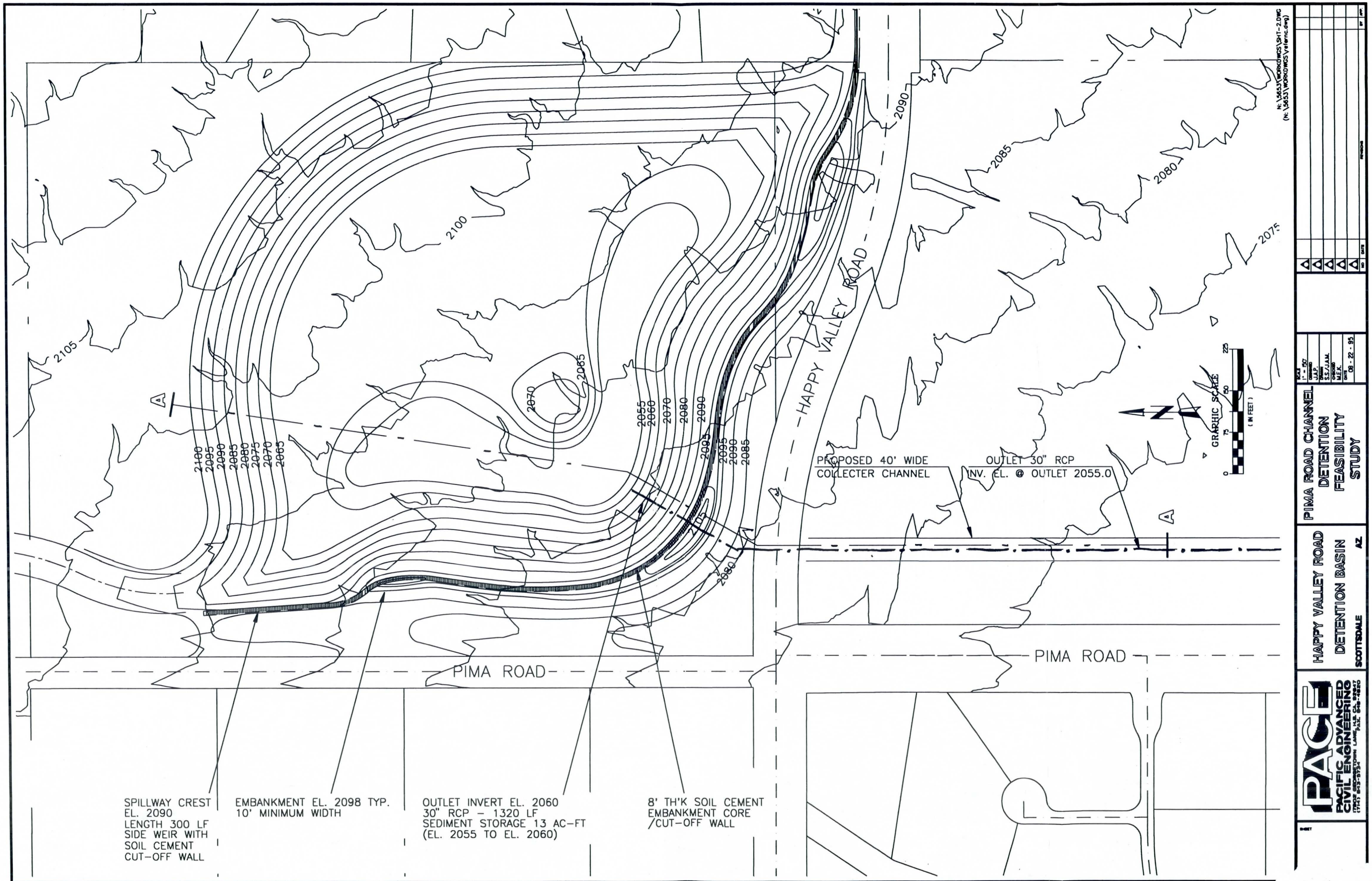
ELEVATION	DEPTH (ft)	AREA INUNDATED (ac)	CUM. STORAGE VOLUME (ac-ft)	DISCHARGE Capacity(cfs)
2,098.00	43.00	19.60	520	20,450
2,095.00	40.00	18.90	462	10,500
2,090.00	35.00	17.30	372	80
2,085.00	30.00	15.80	290	72
2,080.00	25.00	14.40	214	65
2,075.00	20.00	13.00	146	56
2,070.00	15.00	11.50	85	46
2,065.00	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-3* 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-4.*

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 PMF - 6 Hour Storm** Drainage Area - 3.37 sq. mi. Total Rainfall - 13.05 inches Peak Inflow - 9,960 cfs Volume of Inflow Hydrograph 930 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)	
Storm Routing:	**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 PMF - 6 Hour Storm** Peak Stage - 2,094.5 ft. Peak Storage - 454 AF Peak Outlfow - 8,780 cfs Freeboard to Crest - 3.5 ft.



PROPOSED 40' WIDE
COLLECTER CHANNEL
OUTLET 30" RCP
INV. EL. @ OUTLET 2055.0
HAPPY VALLEY ROAD
PIMA ROAD
PIMA ROAD
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 - 1320 LF
SEDIMENT STORAGE 13 AC-FT
(EL. 2055 TO EL. 2060)
8' TH'K SOIL CEMENT
EMBANKMENT CORE
/CUT-OFF WALL
GRAPHIC SCALE
(IN FEET)
PIMA ROAD CHANNEL
DETENTION
FEASIBILITY
STUDY
HAPPY VALLEY ROAD
DETENTION BASIN
SCOTTSDALE
AZ
PACE
PACIFIC ADVANCED
CIVIL ENGINEERING
08-22-95

Figure IV-1

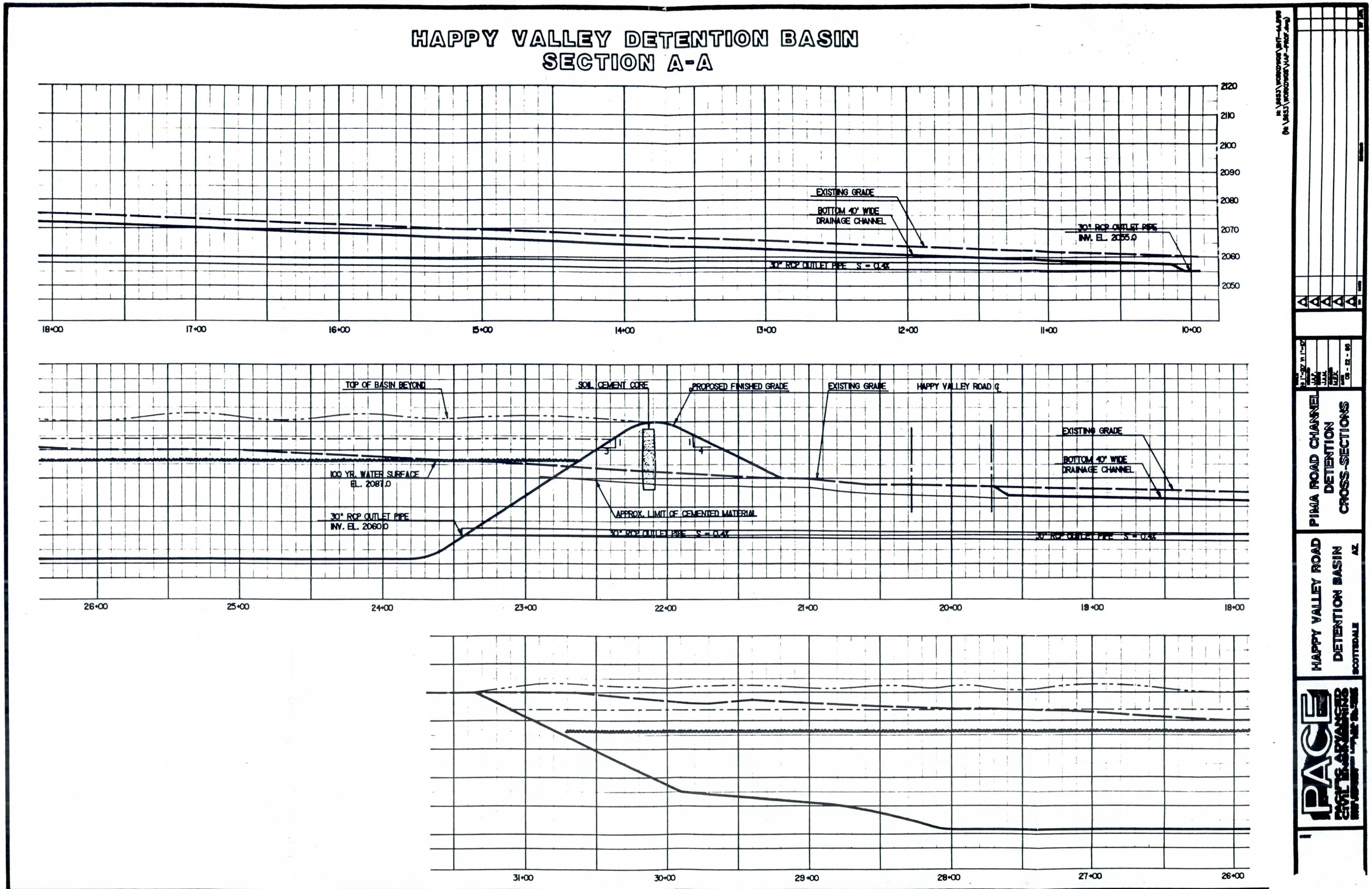

HAPPY VALLEY DETENTION BASIN
SECTION A-A
EXISTING GRADE
BOTTOM 40' WIDE DRAINAGE CHANNEL
30" RCP OUTLET PIPE INV. EL. 2055.0
30" RCP OUTLET PIPE S = 0.4%
2120
2110
2100
2090
2080
2070
2060
2050
18+00
17+00
16+00
15+00
14+00
13+00
12+00
11+00
10+00
TOP OF BASIN BEYOND
SOIL CEMENT CORE
PROPOSED FINISHED GRADE
EXISTING GRADE
HAPPY VALLEY ROAD ℄
EXISTING GRADE
BOTTOM 40' WIDE DRAINAGE CHANNEL
100 YR. WATER SURFACE EL. 2087.0
30" RCP OUTLET PIPE INV. EL. 2060.0
APPROX. LIMIT OF CEMENTED MATERIAL
30" RCP OUTLET PIPE S = 0.4%
30" RCP OUTLET PIPE S = 0.4%
26+00
25+00
24+00
23+00
22+00
21+00
20+00
19+00
18+00
31+00
30+00
29+00
28+00
27+00
26+00
PIMA ROAD CHANNEL
DETENTION
CROSS-SECTIONS
HAPPY VALLEY ROAD
DETENTION BASIN
SCOTTSDALE
AZ
PACE

Figure IV-2

FIGURE IV- 3

Inflow & Outflow Hydrographs
Happy Valley Road Detention Basin

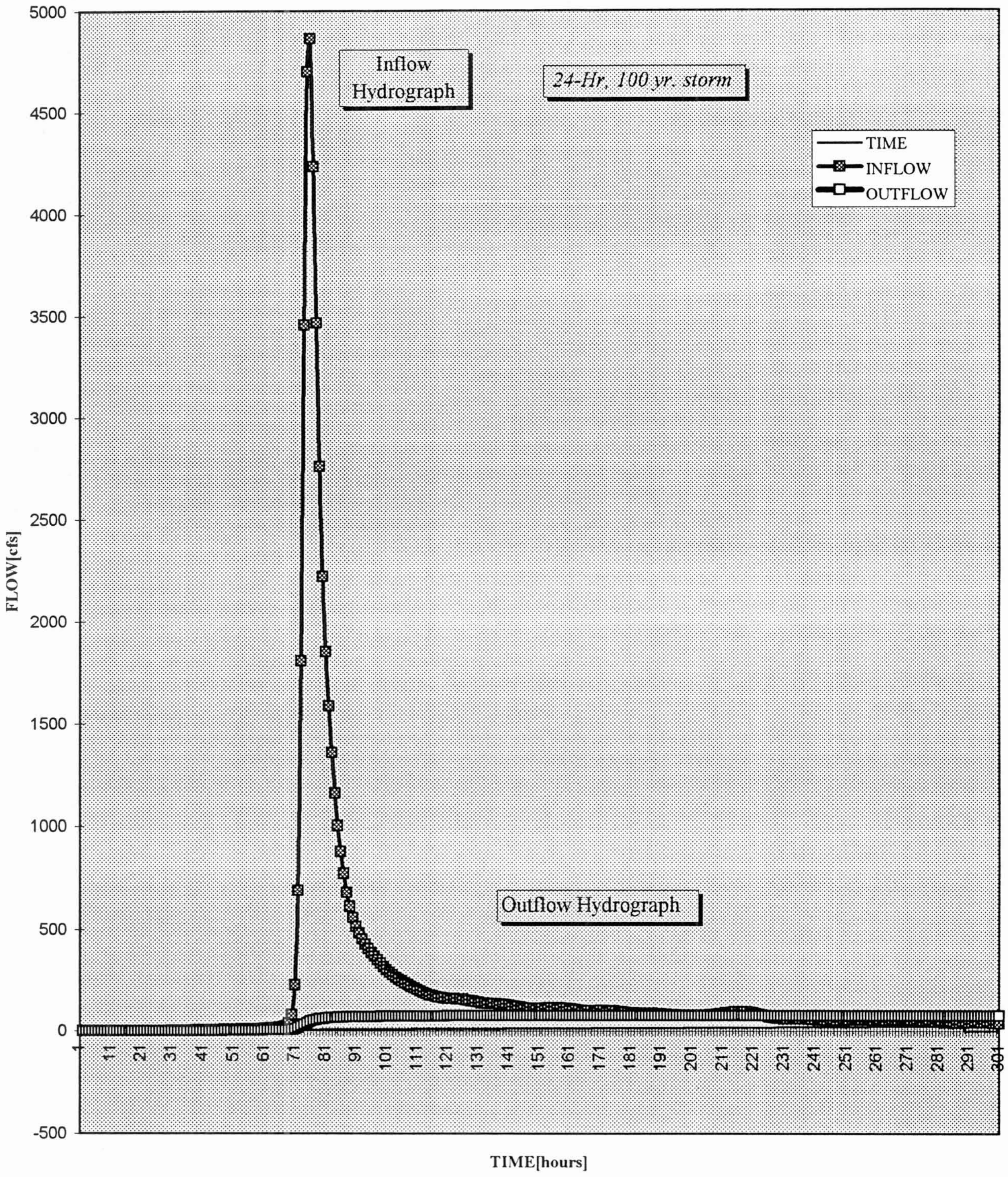
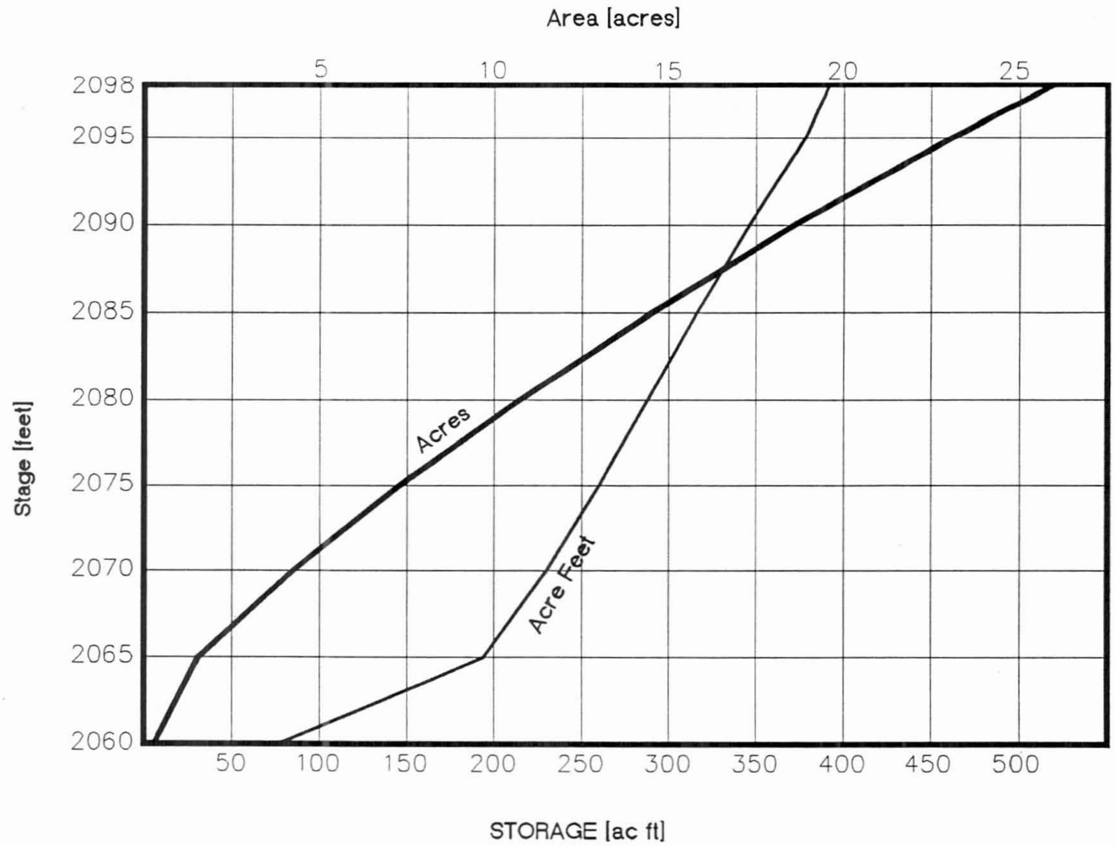


FIGURE IV-4

Happy Valley Road Detention Basin

100 YEAR-24 HOUR

Stage-Area & Stage-Storage Curves



N: \5653\WORKDWGS\FLOWCHTS.DWG

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-5* and cross sections *Figure IV-6*. 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-7* 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-8*.

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

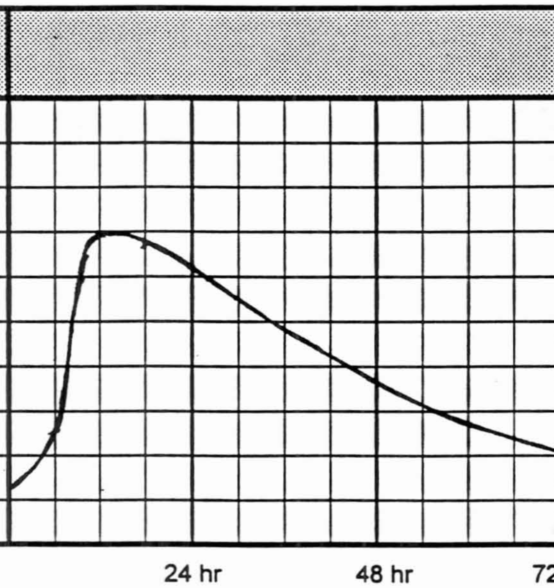
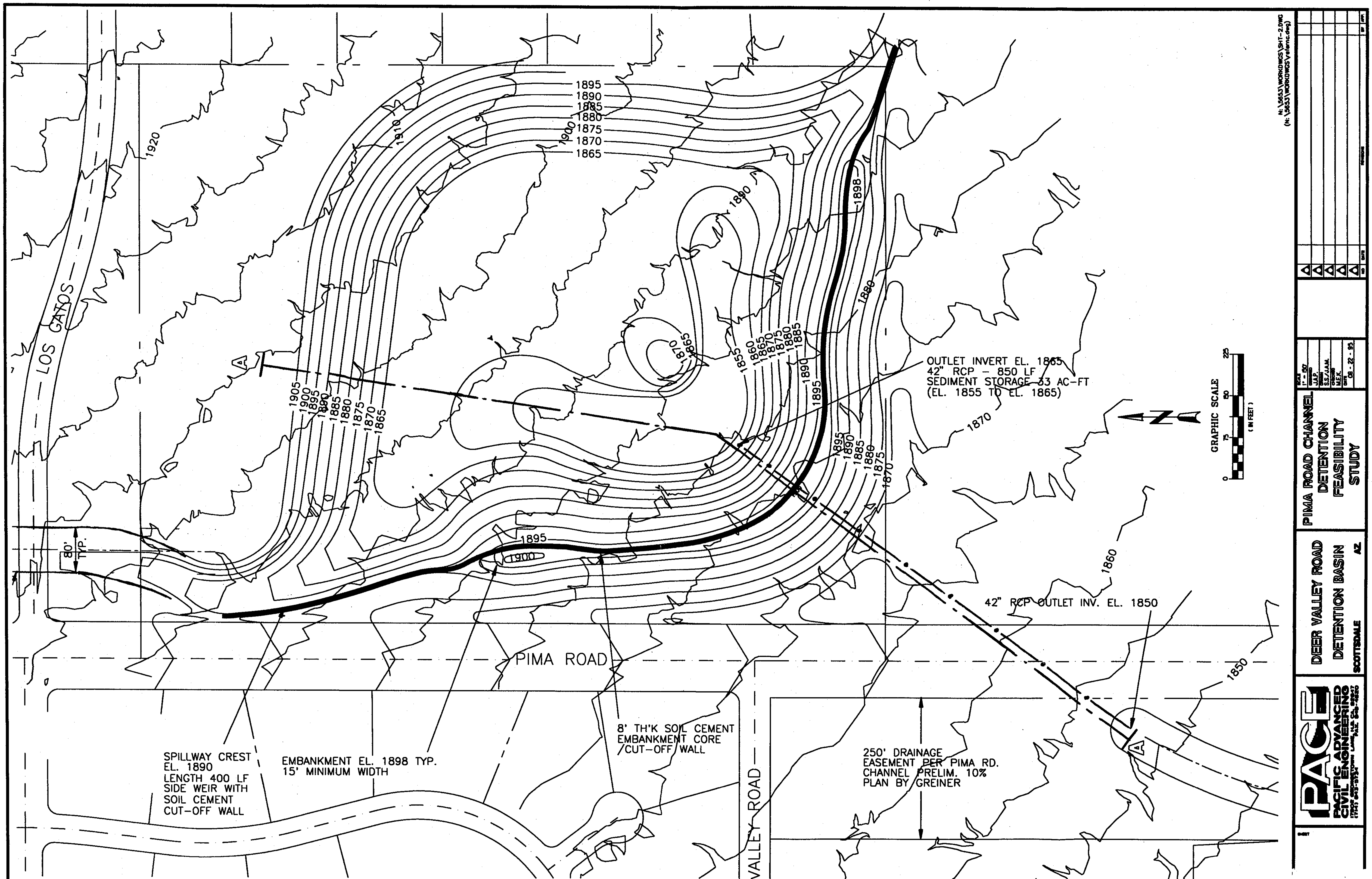


Table IV-4
Deer Valley Road Detention Basin
Design Criteria

Location	Section: 18 Township: 4 North Range: 5 East Maricopa County, Arizona	
Basin Area:	25 Acres	
Design Storms:	100 year, 24-hour storm Drainage Area - 5.98 sq. mi. Total Rainfall - 4.25 inches Peak Inflow - 3,960 cfs Volume of Inflow Hydrograph - 528 AF	**0.5 PMP - 6 Hour Storm** Drainage Area - 5.98 sq. mi. Total Rainfall - 12.12 inches Peak Inflow - 13,730 cfs Volume of Inflow Hydrograph - 1,473 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)	
Storm Routing:	**100 -Year 6-Hour Storm** Peak Stage - 1,889.6 ft Peak Storage - 286 AF Peak Outflow - 196 cfs Freeboard Spillway 0.4 ft.	**0.5 PMP - 6 Hour Storm** Peak Stage - 1,894.3 ft. Peak Storage - 360 AF Peak Outflow - 13,620 cfs Freeboard to Crest - 3.7 ft.



38

Figure IV-5

DEER VALLEY DETENTION BASIN
SECTION A-A

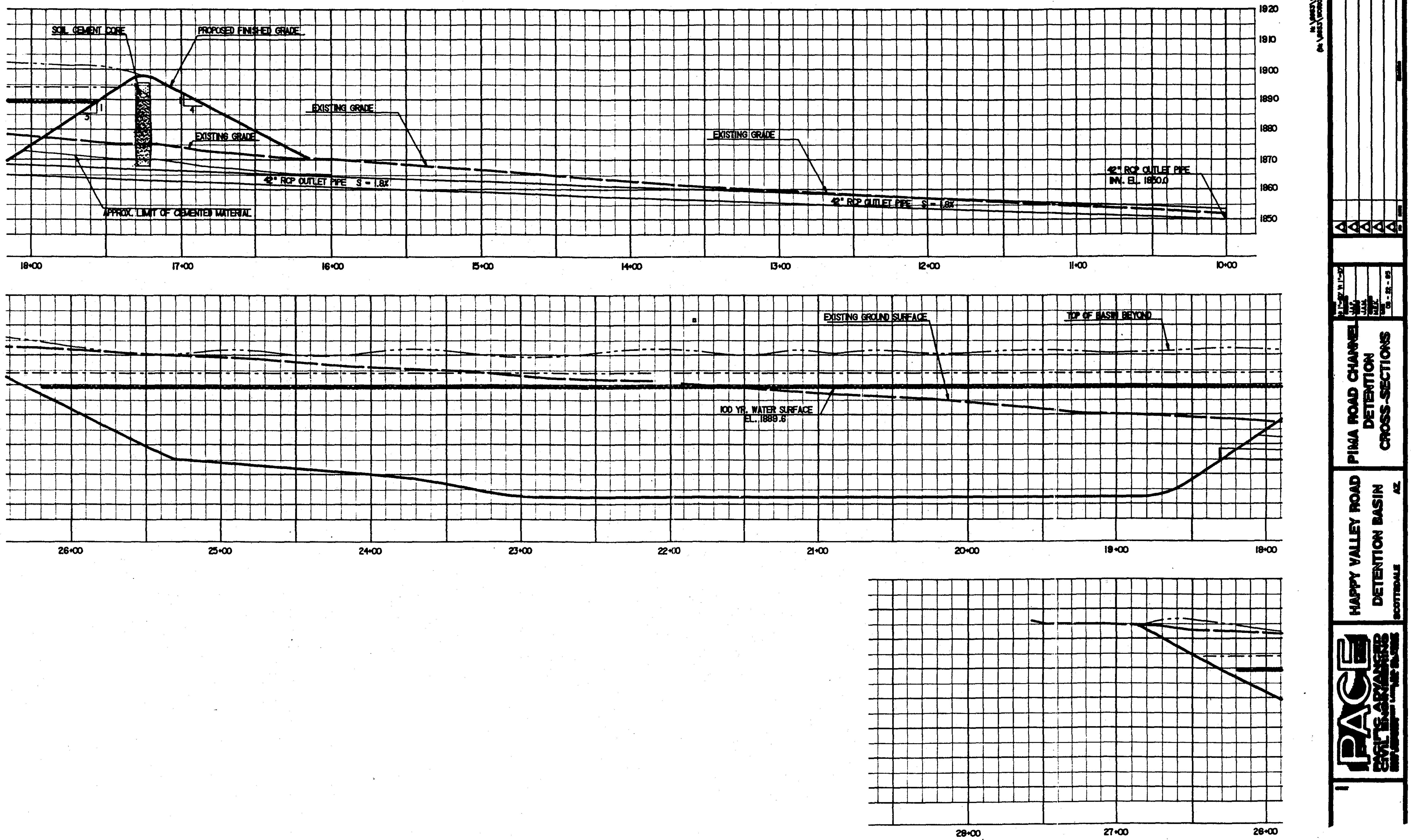


Figure IV-6

FIGURE IV- 7

Inflow & Outflow Hydrographs
Deer Valley Road Detention Basin

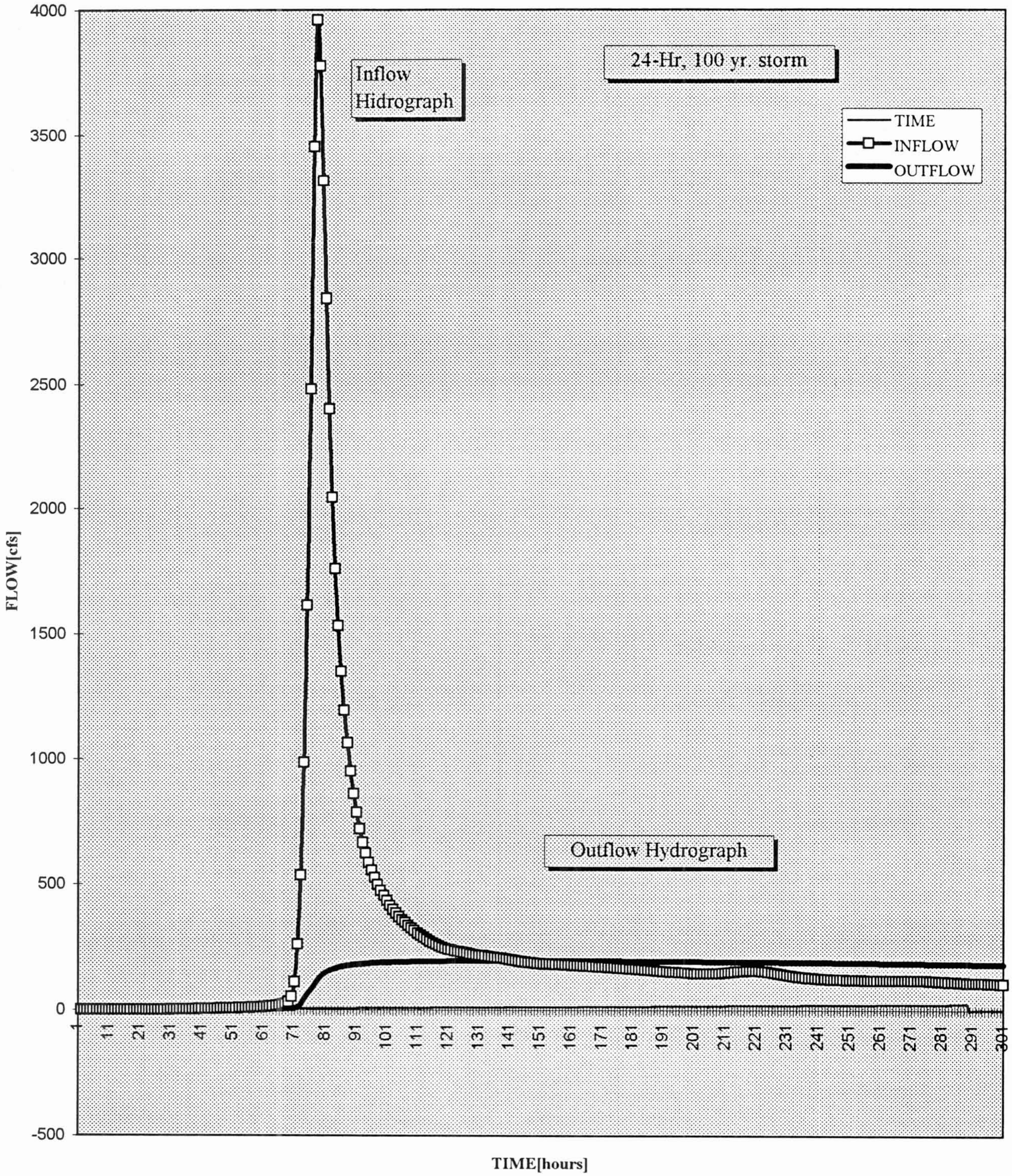
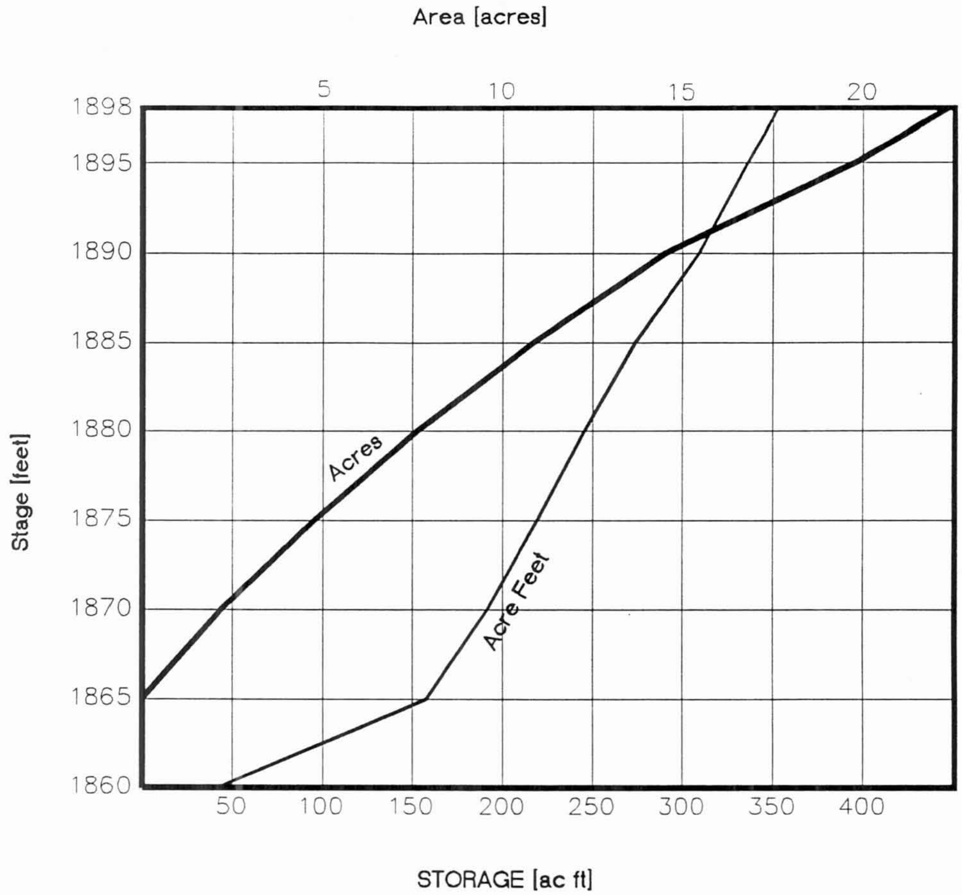


FIGURE IV-8

Deer Valley Road Detention Basin

100 YEAR-24 HOUR

Stage-Area & Stage-Storage Curves



N: \5653\WORKDWGS\FLOWCHTS.DWG

C. UNION HILLS/COS WASTE TRANSFER STATION DETENTION BASIN

Detailed preliminary design of the Union Hills Detention Basin has not been a part of this 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 and detention basin site plan has been prepared and is presented as *Figure IV-9.*

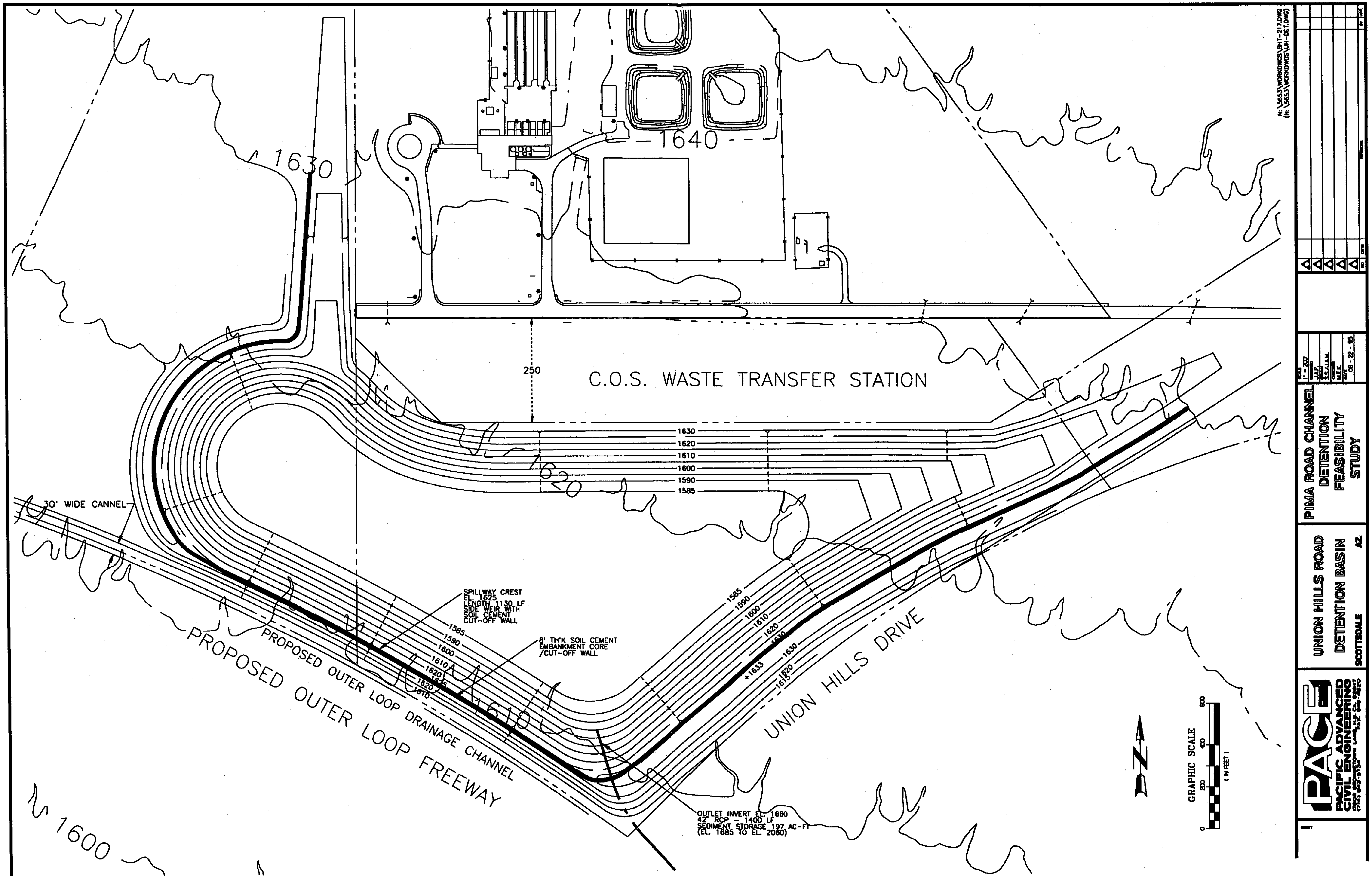
The conceptual detention basin sizing is as proposed in *Table III-3* and as follows Peak Inflow 6,040 cfs, Peak Outflow 250 cfs, with maximum storage volume 610 AF.

During the design development stage of this report, we have had several meetings with the ADOT Outer Loop design team. They have indicated that such a proposed basin would not be a cause for concern regarding the locationing and construction of the Outer Loop. The proposed Union Hills detention basin embankment will be set back a minimum of 30 feet from the ADOT Outer Loop Right of Way. The local drainage channel proposed by ADOT/COS for the flows along the north side of the Outer Loop will be utilized as the detention basin low flow outlet conveyance channel; as well as the continuation of the Pima Road Channel from the basin to the BOR.

ADOT indicated that the significant reduction in the Outer Loop/Pima Channel flow (± 8000 cfs to 800 cfs) would be a tremendous benefit to the project. However, they are concerned regarding design direction changes and the impact to the Outer Loop construction schedule.

ADOT also indicated that the construction of the Outer Loop Phase I will require approximately 200,000 cubic yards of import and the ultimate Outer Loop construction will require 1,900,000 cy of borrow (from Scottsdale Road to Bell Road). ADOT project manager indicated that they have not secured the future borrow sites and would strongly consider importing the required material for the ultimate road construction during the Phase I construction if a nearby source was available. The total export of material from the Pima Channel and three detention basins is approximately 1.8 million cubic yards.

Final 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 Deer Valley Basins.



1630
1640
C.O.S. WASTE TRANSFER STATION
250
1630
1620
1610
1600
1590
1585
1620
30' WIDE CANNEL
SPILLWAY CREST
EL. 1625
LENGTH 1130 LF
SIDE WEIR WITH
SOIL CEMENT
CUT-OFF WALL
8' TH'K SOIL CEMENT
EMBANKMENT CORE
/CUT-OFF WALL
PROPOSED OUTER LOOP DRAINAGE CHANNEL
PROPOSED OUTER LOOP FREEWAY
UNION HILLS DRIVE
+1633
1610
1600
OUTLET INVERT EL. 1660
42" RCP - 1400 LF
SEDIMENT STORAGE 197 AC-FT
(EL. 1685 TO EL. 2060)
GRAPHIC SCALE
(IN FEET)
N: \5653\WORKDWGS\SHT-217.DWG
(N: \5653\WORKDWGS\UH-DET.DWG)
PIMA ROAD CHANNEL
DETENTION
FEASIBILITY
STUDY
1" = 200'
J.A.P.
S.S./J.A.M.
M.E.K.
08 - 22 - 95
UNION HILLS ROAD
DETENTION BASIN
SCOTTSDALE AZ
PACE
PACIFIC ADVANCED
CIVIL ENGINEERING

Figure IV-9

D. DETENTION BASIN GEOTECHNICAL DESIGN

Due to the sensitive locations of the proposed detention basin (particularly Happy Valley and Deer Valley) the safety considerations of the proposed basins and how they are conceived by the public requires the utmost attention. A draft of this report, dated August 28, 1995 was submitted to ADWR Dam Safety for preliminary review and response. The application submittal forms and ADWR review response letter is included as Appendix I. The ADWR review stated that there are no fatal flows with the proposed basin designs. Final design and submittal will include further investigation of the PMP routing. However, the current spillway design is conservative and can be adapted to meet additional ADWR requirements.

In line with that, PACE proposes basin embankment side slopes of 4:1 maximum on the outside and 3:1 on the inside. 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 18 hours.

As the geotechnical consultant for the City of Scottsdale Desert Greenbelt design team, AGRA Earth Environmental provided preliminary geotechnical design for the detention basins and alternate Pima Road Channel design. The report is referenced in Appendix G and bound separately.

The interested reader should read the entire geotechnical design report. However, a brief summary is provided below.

The detention basin embankment can be constructed with the native material excavated from the basin. Typical embankment construction would utilize a select material core and/or toe drain system. Without any select core or tow drains, due to the below grade storage and embankment slopes, the basins would have to remain full to capacity for greater than 30 days to begin experiencing water on the down stream face.

For an additional level of protection and conservatism, the current basin design is based upon the construction of a soil cement core wall 8 feet thick extending the entire length of the basin embankment and the spillway from ± 7 below existing grade to the top of the basin freeboard.

The design of the detention basin including all of the above parameters is highly conservative and safety conscious.

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 than 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 contrast to the no detention alternative which confluence's flows and creates potential hazard with even relatively minor rainfall events.

V. PIMA ROAD DESERT GREENBELT CHANNEL DESIGN - DETENTION ALTERNATE

A. CHANNEL DESIGN SUMMARY

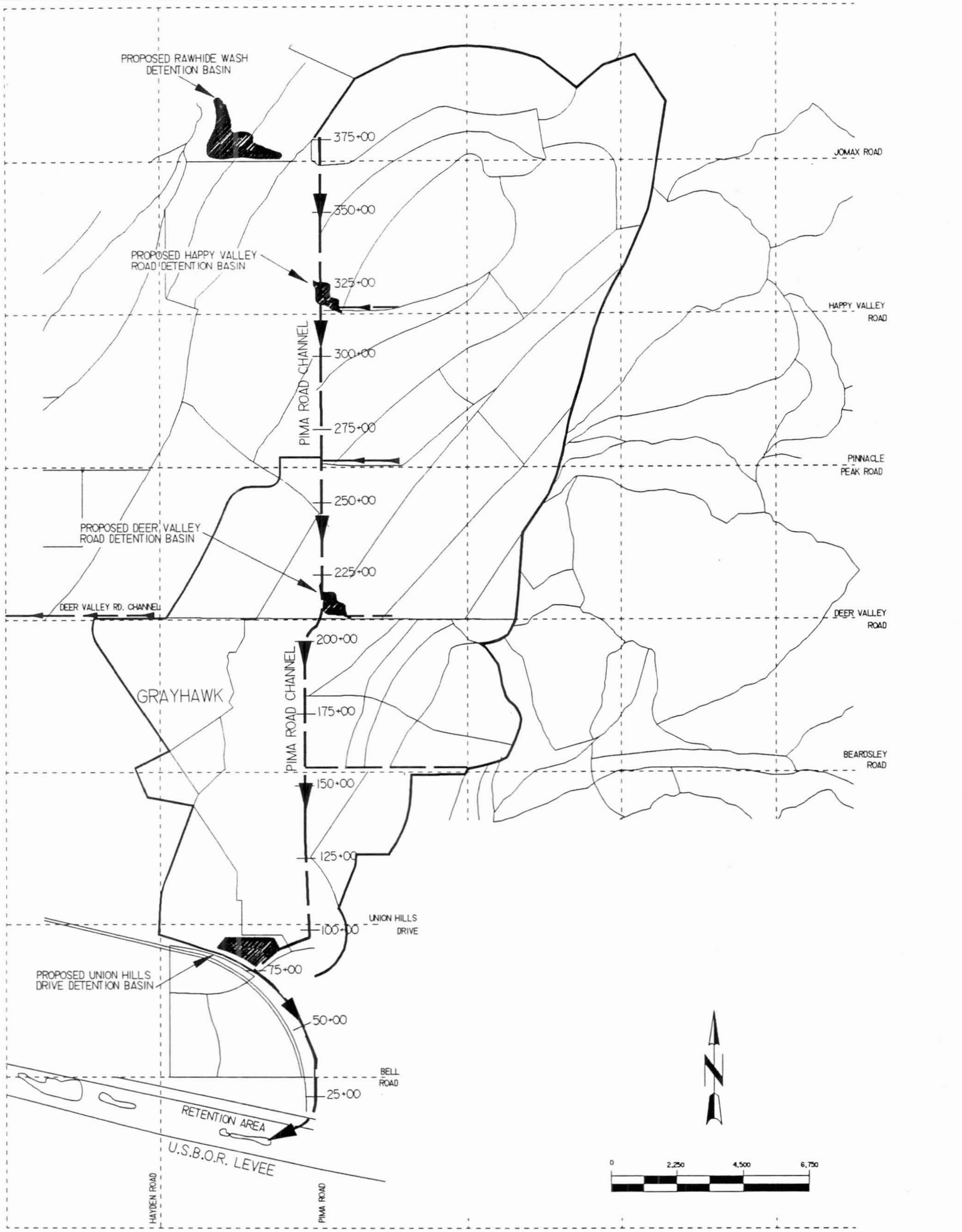
The proposed detention alternate channel design follows the same alignment (see *Figure V-1*) as the current COS proposed channel with the exception of the Happy Valley, Deer Valley and Union Hills detention basin routing. In addition, below Union Hills, the detention alternate channel is routed along the north side of the Outer Loop Freeway to the Freeway/Pima Channel crossing where it is discharged to the BOR retention area.

The proposed Pima Road Channel design utilizes the detention basin to significantly reduce runoff flows and control sediment transportation.

The channel design and hydraulic criteria are presented in *Table V-1* and as shown in the channel section, *Figures V-2 and V-3.* In addition to the significantly reduced flows (see *Table III-6* and *Figures I-1*) the detention alternate provides significant reduction of maximum flow depths and velocities. The maximum design flow of 2,640 cfs results in a maximum flow depth of 2.5 feet and velocity of 12.6 fps.

The channel design is based upon the principals of equilibrium slope design which is essential for the design of a natural sand bottom channel. The criteria of a maximum flow depth of 2.5 feet and velocities less than 15 feet per second were also critical due to safety considerations. The channel top widths have been limited to the proposed top widths as shown in the Pima Road channel design report without detention. The channel widths are a maximum of 80 feet.

The information presented in this design report is preliminary. However, the results are conclusive that a safe, and hydraulically effective engineering solution can be achieved with the use of detention. The detention alternate enables the true goals of desert greenbelt plan to be more fully realized. The reduced flow depth allows for steep channel side slopes which are easily accessible. The lower flow velocities enable soil cement to be utilized for the embankment stabilization. The 4 foot vertical (1:1) soil cement embankment can more easily be incorporated into the desert greenbelt aesthetic requirements without needing to be hidden. The reduced velocities will also enable significant revegetation within the natural bottom channel. Due to the natural topography of the channel alignment and the sediment transport requirements of the channel, the super critical flow regime cannot be avoided above Union Hills. However, the maximum velocities of less than 13 feet per second as compared to the non-detention alternate which are in excess of 30 fps are much safer and require much less design conservatism.



TITLE	DRAWN J.A.M.		
PIMA ROAD CANNEL STATION MAP	CHKD M.E.K.	PACE PACIFIC ADVANCED CIVIL ENGINEERING 17902 GEORGETOWN LANE H.B. CA. 92647 (714) 843-5734 FAX 848-4820	V-1
JOB PIMA ROAD CHANNEL DETENTION FEASIBILITY STUDY	DATE 09-15-95		
	JOB NO 5653		FIGURE

N: \5653\WORKDWGS\STATIONS.DWG

TABLE V - 1
CHANNEL DESIGN AND HYDRAULIC DATA
PIMA ROAD CHANNEL DETENTION ALTERNATE

PIMA ROAD CHANNEL REACH LOCATION	"n"	Q_{100} (cfs)	Slope (%)	Channel Invert Material	Channel Side Slope Material	Channel Bottom Width (ft)	Channel Side Slope	Flow Depth (ft)	Channel Velocity (fps)	Froude No. (fps)	Time w/ Velocity > 9 fps (Hours)
STA 365+60 At Jomax Road	.025	970	1.3	Native	Soil Cement	40	1:1	2.2	10.7	1.31	.5
STA 339+20 (1/2 Mile Point)	.025	1240	1.3	Native	Soil Cement	50	1:1	2.2	10.9	1.32	.5
STA 324+80 Above Happy Vly. Det.	.025	1760	1.3	Native	Soil Cement	60	1:1	2.4	11.7	1.35	.6
Happy Valley Detention Basin											
STA 314+80 Below Happy Vly. Det.	.025	60	1.2	Native	Soil Cement	30	1:1	.5	4.0	1.01	0
STA 288+40 (1/2 Mile Point)	.025	260	1.2	Native	Soil Cement	30	1:1	1.2	7.0	1.15	0
STA 262+00 At Pinnacle Peak Road	.025	2470	1.2	Native	Soil Cement	80	1:1	2.5	11.7	1.3	.5
STA 235+60 (1/2 Mile Point)	.025	2640	1.4	Native	Soil Cement	80	1:1	2.5	12.6	1.42	.7
STA 221+20 Above Deer Vly. Det.	.025	2640	1.4	Native	Soil Cement	80	1:1	2.5	12.6	1.42	.7
Deer Valley Road Detention Basin											
STA 205+20 Below Deer Vly. Det.	.025	180	1.2	Native	Soil Cement	30	1:1	1.0	6.1	1.11	0
STA 182+80 (1/2 Mile Point)	.025	180	1.2	Native	Soil Cement	30	1:1	1.0	6.1	1.11	0
STA 156+40 At Beardsley Road	.025	1940	1.2	Native	Soil Cement	70	1:1	2.4	11.2	1.30	.4
STA 130+00 (1/2 Mile Point)	.025	1940	1.4	Native	Soil Cement	70	1:1	2.3	11.8	1.39	.5
STA 96+00 Above Union Hls. Det.	.025	2230	1.4	Native	Soil Cement	80	1:1	2.3	11.8	1.4	.6
Union Hills Detention Basin											
STA 82+65 Below Union Hls. Det.	.03	230	.7	Grass Lined	Grass Lined	20	3:1	1.7	5.2	.77	0
STA 30+00 At Bell Road	.03	860	.7	Grass Lined	Grass Lined	25	3:1	3.3	7.6	.84	0
STA 10+00 Channel Outlet At B.O.R.	.03	860	.7	Grass Lined	Grass Lined	25	3:1	3.3	7.6	.84	0

ASSUMPTIONS:

1. Peak flows estimated based on HEC-1 Model #2 (with detention basins at Happy Valley, Deer Valley and Union Hills Roads)
2. Peak flows used for each 1/2 mile reach is the peak 100 year-6 hour flow anywhere in that reach.

B. CHANNEL FREEBOARD REQUIREMENTS AND CHANNEL ROUGHNESS ESTIMATES

There are numerous standards and equations to calculate channel freeboard requirements. For the purpose of this feasibility study, the maximum channel reach, flow rate and depth of flow combination has been utilized for freeboard calculations. With final design, reduced flow depths and velocities for each reach of the channel could be evaluated independently to optimize the design embankment requirements. The flow conditions utilized in the enclosed freeboard calculation are as listed below:

Q100 (cfs)	Bottom (FT)	Slope (FT/FT)	Side Slope	n	Depth (FT)	Velocity (fps)	Fn
2640	80	.014	1:1	.025	2.5	12.6	1.4

Due to the steepness of the existing site topography within the Pima Road Channel Alignment (1 to 2% slopes), it will not be practical to design a conveyance facility with a subcritical flow regime. However, as stated in numerous other sections of this report with the proposed detention basins, the flow depths and velocities can be maintained at manageable levels. It is critical to note that channel design within the critical flow regime is not acceptable. The US Army Corps of Engineers Hydraulic Design Manual states that channel design should avoid area of hydraulic unstability associated with Froude Numbers between .86 and 1.13. The proposed detention channel alternate maintain Froude Numbers greater than 1.13 for all of the critical design flows, upstream of the Union Hills detention basin and less than .86 for the channel down stream of the Union Hills detention basin.

Freeboard Calculation Summary:

1. Clark Co. $F_b = 1.0 + .025\ V\ (d)^{1/3}$ (for super critical flow)
   $= 1.4$ FT

2. ADOT - "Roadway Design Guide" - (Greiner Pima Rd. Channel 7/95 Study Equation)
   $F_b = .2\ (y + (V^2/2g))$
   $= .2\ (2.5 + (12.6^2/64.4))$
   $= 1.0$ FT

3. Maricopa County (Per FEMA Requirements)
   $F_b = 1.0$ FT Minimum (for non levee conditions)

4. ADWR - D.M. for Fluvial Systems

F_b (B.L.) $= .5\ ha + \Delta Yse + \Delta Ys$ (Bank lining freeboard)

Where, ha $= .027V^2 \leq Y_h$

Therefore, ha $= .027\ (12.6)^2 \leq 2.5$

$= 4.3 \leq 2.5$

$= 2.5$ FT

F_b (B.L.) $= .5\ (2.5) + 0 + 0$

$= 1.3$ FT

5. ADWR - D.M. for Fluvial Systems

F_b (T.E.M.) $= .5\ ha + \Delta Yse + \Delta Ys + \Delta Yd + \Delta Yagg$

(Total embankment freeboard)

F_b (T.E.M.) $= .5\ (2.5) + 0 + 0 + 0 + 0$

$= 1.3$ FT

Note: ΔYd and $\Delta Yagg$ are both assumed to be zero as the channel is design at equilibrium slope, see Section V-E of this report. An additional factor which reduces the potential of deposition of sediments within the channel is the water shed will yield less sediments with the future developed condition. In addition, there is sufficient channel embankment (unlined) which could be utilized for additional freeboard, if required.

Based upon the above freeboard analysis, it is recommended that a bank lining freeboard of 1.5 feet be provided throughout the Pima Road Channel. Final determination will be dependent upon MCFCD design reviews. For channel capacity and embankment design in this study we have estimated 1.5 feet of freeboard, and channel design flow depths and maximum channel capacity results are summarized in *Table V-2*.

Manning roughness coefficient for channel design and for sediment transport studies has been estimated based upon ADWR - Design Manual...Fluvial Systems Table 4.2 "...Channels with fine to medium sand beds". Based upon the natural bottom, soil cement side slopes and the project flow regime, it was determined that the channel will exhibit bed roughness characteristics associated with anti-dunes and flat beds. The estimated Mannings Roughness Coefficient for all design calculations in this report from north of Union Hills utilizes n=.025 and south of Union Hills utilizes n=.030.

TABLE V - 2
DESIGN AND FULL FLOW CAPACITY
PIMA ROAD CHANNEL DETENTION ALTERNATE

PIMA ROAD CHANNEL REACH LOCATION	Design Flow Q_{100} (cfs)	Design Flow Depth d_{100} (ft)[1]	Minimum Channel Depth (ft)[2]	Channel Full Flow Capacity (cfs)[2]
STA 365+60 At Jomax Road	970	2.2	4.0	2,710
STA 339+20 (1/2 Mile Point)	1240	2.2	4.0	3,390
STA 324+80 Above Happy Valley Rd. Det. Basin	1760	2.4	4.0	4,070
Happy Valley Detention Basin				
STA 314+80 Below Happy Valley Rd. Det. Basin	60	0.5	4.0	1,960
STA 288+40 (1/2 Mile Point)	260	1.2	4.0	1,960
STA 262+00 At Pinnacle Peak Road	2470	2.5	4.0	5,210
STA 23+560 (1/2 Mile Point)	2640	2.5	4.0	5,630
STA 221+20 Above Deer Valley Rd. Det. Basin	2640	2.5	4.0	5,630
Deer Valley Road Detention Basin				
STA 205+20 Below Deer Valley Rd. Det. Basin	180	1.0	4.0	1,960
STA 182+80 (1/2 Mile Point)	180	1.0	4.0	1,960
STA 156+40 At Beardsley Road	1940	2.4	4.0	4,560
STA 130+00 (1/2 Mile Point)	1940	2.3	4.0	4,930
STA 96+00 Above Union Hills Dr. Det. Basin	2230	2.3	4.0	5,630
Union Hills Detention Basin				
STA 82+65 Below Union Hills Dr. Det. Basin	230	1.7	4.0	1,330
STA 30+00 At Bell Road	860	3.3	4.0	1,570
STA 10+00 Channel Outlet At B.O.R.	860	3.3	4.0	1,570

1. See Table - V1 For channel reach parameters, slope, bottom width, side slope & Mannings No.
2. Minimum channel depth estimated @ 4.0 ft (2.5 ft plus 1.5 ft freeboard and 1:1 side slopes. from Jomax to Union Hills, and 4.5 ft south.
   Channel flow at capacity does not account for sloped (± 8:1) over bank area at soil cement.

C. CHANNEL EMBANKMENT DESIGN

Due to the erodible native soils in the proposed channel alignment, the channel side slopes (or embankment) must be protected. Preliminary design for the embankment based upon; the critical channel flow depth, freeboard, and toe down is as follows:

Freeboard	1.5 Feet	(See Section V - B)
Flow Depth	2.5 Feet	(See Section V - A)
Toe Down	2.5 Feet	(See Section V - F)

The primary forms of bank protection analyzed for this channel design are soil cement and concrete. Critical factors in determining the final design of the embankment protection were based upon the following criteria:

1. Stability and durability of bank protection.
2. Safety concerns regarding access to and from channel in dry and wet conditions.
3. Aesthetic compatibility with Desert Greenbelt concept.
4. Cost of construction, constructability.
5. Maintenance requirements.

Based upon review of the above criteria, it is recommended that the channel embankment lining be soil cement. The soil cement section shall be as shown in the enlarged section on *Figure V-2 and V-3.* This method of soil cement construction (i.e. 8 foot by 12 inch lifts) has been used widely across the entire Phoenix Valley and Southwestern United States. The proposed soil cement embankment addresses all of the above design criteria successfully as follows:.

1. Provides very stable embankment, both from surface erosion and from the stability of an 8 foot by 6 foot stabilized gravity wall. The AGRA Earth Environmental Preliminary Geotechnical Analysis (Appendix G) indicates that the native soils are "considered good to excellent for the use of soil cement".

   Based upon the minimum length of time (less than 1 hour for the 100 year event) when the channel velocities exceed 9 feet per second the wearing of the soil cement based upon particle size of the native soils and the transported sediment should not be a concern. Final design will require further geotechnical analysis and recommendation.

2. The soil cement embankment height of 4 feet maximum above the channel bottom will enable easy and safe mechanical and pedestrian access to and from the channel bed. It is proposed to construct the soil cement embankment on a vertical to 1:1 vertical side slope with a 6" to 9" horizontal step at the wall mid point. The step will provide additional access ability for pedestrians.

3. The soil cement embankment will provide aesthetic compatibility with the revegetated desert greenbelt channel. The low wall height, minimum exposed vertical soil cement face, and natural material color make the soil cement face and natural material color make the soil cement embankment highly desirable.

4. The soil cement 8 by 6 foot section at 1.8 cubic yards (cy) per linear foot with a cost of $20/cy, cost $36/LF. As compared to an 8 inch thick concrete wall with 8 square feet per foot of wall and a unit cost of $6.00/SF which cost $48/LF. Soil cement cost for the recommended placement technique have been verified with the Portland Cement Association and local area contractors.

5. Erosion associated with the soil cement embankment should be expected to be greater than a concrete embankment. However, given the mass of the soil cement neither should be significant with the infrequent rainfall and reduced velocities.

The proposed soil cement embankment may be constructed with a 16:1 (or possibly 8:1) top slope to gain an additional 0.5 (1.0) feet of freeboard. In addition, the distribution of the flows (greater than Q_{100}) in the proposed shallow overbank will decrease velocities and wave impacts. The inventory of the soil cement embankment could also be constructed with a 16:1 (8:1) slope to gain an additional 0.5 (1.0) feet of toe down.

D. SEDIMENT TRANSPORTATION AND EQUILIBRIUM SLOPE ANALYSIS

As stated in Part A of this section of this study, the proposed Pima Road Channel is to be designed within the parameters of equilibrium slope channel design. Due to the feasibility level of this study, a detailed sediment analysis was not performed. This study does include Level I - Qualitative Analysis and preliminary Level II Quantitative and Basic Engineering Analysis of sediment transportation for the proposed Pima Road Channel. The calculations, data and assumptions used for this section are summarized in Appendix J. A detailed sediment transport Level II analysis (possibly Level - III) should be completed prior to final design of the channel sections.

Based upon COS/Greiner Pima Road Channel design for the no detention alternate indicate that (HEC-6 modeling) equilibrium slope design is feasible for the channel from Jomax to Deer Valley, where the unrestrained flows are from 970 to 5400 cfs. Therefore it is reasonable to assume that it is feasible for the detention alternate channel to be able to be designed within the parameter of the equilibrium slope concept.

The Level I analysis is limited to review of: tributary drainage area, washes, field investigations and collection of geomorphic data from the proposed alignment. As the channel proposed does not currently exist, evaluation of existing conditions and sediment transportation is limited.

The preliminary Level II analysis focused primarily on the following three elements:

1. Estimation of sediment supply from tributary drainage area.
2. Estimation of equilibrium slopes.
3. Estimation of potential scour/deposition within channel for freeboard and toe-down calculations.

The main calculation efforts were focused on utilizing the power relationship formula for sediment transport capacity as follows:

$$q_s = 0.0064 \frac{n^{1.77} V^{4.32} G^{0.45}}{y_n^{0.30} D_{50}^{0.61}}$$

Where: q_s = Sediment Transport Rate in (cfs/ft)
n = Mannings Roughness Coefficient for Sediment Transport
V = Average Velocity in (fps)
G = Gradation Coefficient
Yn = Hydraulic Depth in feet
D_{50} = Median Particle Diameter (mm)

The above sediment yield and transport calculations were compared to other methods for verification of results.

1. Estimation of sediment supply tributary drainage area sediment supply (or yield) calculations were discussed in Section III-E for both the detention basin and channel design parameters. To obtain an estimated sediment supply to the channel reaches for design purposes, the above power relationship equation was utilized for calculations. The methodology used followed ADWR format of estimating the sediment supply to a particular channel reach as the sum of the following elements for each design flow rate:

   - Sediment transport capacity of upstream reach of channel.
   - Sediment transport capacity of tributary drainage area natural washes.
   - Sediment transport capacity of tributary drainage area sheet flow.

   The sediment supply rates for the 10 year and 100 year design flow events were evaluated and are shown in *Table V-3* . Appendix J has a comparison of sediment supply for the power relationship method and the MUSLE method (see Section III-E).

Sediment Supply Summary Table V - 3		
Pima Road Channel Reach Location	**Q_s 10 year (CFS)**	**Q_s 100 year (CFS)**
Jomax Road	4	7
Happy Valley Road	7	18
Happy Valley Detention Basin	17	43
Pinnacle Peak Road	8	15
Deer Valley Road	12	20
Deer Valley Detention Basin	15	25
Beardsly Road	5	11
Union Hills (*Pima Channel contribution only, no G.H.)	7	15

Note: 1. See Appendix J for detailed sediment supply calculations.
2. 10 year and 100 year - 6 hour rainfall events.

As defined by the power relationship equation supply, the sediment transport rate calculations are dependent upon the flow characteristics of the channel and the tributary drainage area and channel soil characteristics. The soil gradation samples utilized are from geotechnical site evaluations performed by ATL, Inc. and AGRA Earth Environmental (Appendix G). The various gradation samples were evaluated and the values utilized for D_{50} and G are 1.5 and 3.75 respectively. Alternate values for D_{50} and G of 1.1 and 6.4 were also evaluated for comparison purposes (Appendix J).

2. Equilibrium Slope Calculations

As stated in the ADWR Design Manual "The equilibrium slope methodology is utilized to evaluate long-term channel response (aggradation/degradation), specifically, the slope the channel ultimately wants to achieve".

The proposed Pima Road Channel equilibrium slopes were determined based upon the calculated dominant discharge (10 year flows) and sediment supply rates. Due to the preliminary level of this study, the equilibrium slopes were calculated for only one section within each mile of channel reach.

Instead of calculating a (seemingly) exact equilibrium slope for the channel section based upon the sediment supply rates, sediment transport tables (Appendix J) were prepared for representative channel dimensions to estimate the sediment transportation capacities of the proposed channel sections for various possible equilibrium slopes. Based upon the 10 year flood and sediment supply rate, the sediment transport tables were utilized to approximate the equilibrium slopes, *Table V-4.* The estimated equilibrium slopes were then utilized to finalize the proposed channel design parameters *Table V-2.*

It is critical to note that the channel equilibrium slopes are estimates and even further analysis will only provide better estimates. The key to this channel design is the accommodation for change in sediment supply (due to impending tributary area development).

The use of drop and grade control structures at regular intervals (approximately 300 - 400 feet) will minimize the impact of equilibrium slope adjustments due to outside changes. For example, the estimated Pima Road Channel flow regime has the capacity to accept changes in sediment supply/transport rates of 50% with only minor changes (.002 ft/ft) in the equilibrium slope which would result in less than 0.8 feet of long term bed adjustment based upon a distance of 400 feet.

3. Estimation of Potential Scour/Deposition

Determination of general scour/deposition was accomplished for freeboard and toe down calculations as follows:

a. Freeboard

As listed in Section V-B, some freeboard calculations account for long term aggradation associated with equilibrium flow and deposition associated with short term responses during a single flood (100 year). Based upon the channel design criteria of equilibrium slope, it can be stated that there will be no long term aggradation. If any response to the equilibrium slope is to be realized, it would most likely be degradation of the channel associated with reduced sediment supply rates due to upstream development.

The evaluation of single flood short term response was evaluated based upon review of the Pima Road channel sediment transportation rate tables developed (Appendix J) and comparison of the 100 year sediment supply rate and the 100 year sediment transportation rate. In all instances the channel transportation rate is greater than the sediment supply rate for the 100 year flood, thus indicating that deposition due to single storm events is unlikely.

b. Toe-Down

As discussed in Section V-F, determination of the total channel toe down requires an estimation of long term degradation and general scour. Again, based upon the principal of equilibrium slope channel design, long term degradation would be estimated at zero.

Based upon the application of the equilibrium slope concepts and the use of frequent drop/grade control structures will limit the amount of possible long term degradation. Based upon the reduction of the sediment supply yield due to future development changes in the equilibrium slope are possible, however, the impact to the channel due to a 30% reduction in the sediment yield will be minimal due to the drop structures.

Estimation of general scour was based upon the use of the Pima Road Channel sediment transport rate calculation tables (Appendix J) and comparison of the actual channel equilibrium slope (based upon the dominant discharge) and the estimated 100 year flow channel sediment transport capacity equilibrium slope. The calculation estimates are included in Appendix J. Based upon the proposed spacing of the channel drop and grade control structures, the estimated maximum general scour is 0.8 feet, with most channel reaches at approximately 0.5 feet.

E. CHANNEL DROP STRUCTURES AND GRADE CONTROL STRUCTURES

The use of drop structures is a critical design element for the proposed Pima Road natural bottom channel alternate with detention. The drop structures are an integral part of the design, functioning as follows:

1. Provide vertical drops which enable the natural gradient to be reduced within the channel section, which allows the channel to flow at equilibrium slope condition.
2. Provides control points for equilibrium slope adjustments to take place. These control points buffer the magnitude of the equilibrium slope adjustments.

The proposed channel design philosophy utilizes the equilibrium slope methodology to establish the required channel bed slope. The drop structures are used to adjust the actual channel alignment slope to the required channel equilibrium slope. The maximum drop structure height will be limited to 3 feet for aesthetic and construction criteria. Longitudinal distances between the drop structures will be limited to a maximum of 400 feet. The 400 foot distance between the drop structure will allow for substantial changes in the equilibrium slope due to potential changes in the sediment supply rates (see discussions, Section V-D-3 of this report.

The proposed number, height and spacing of the proposed drop structures, based upon the channel equilibrium design slope are as shown on *Table V-1*. These slopes and corresponding drop structures have been estimated based upon this preliminary design. Final design of the drop structures will include exact height, location, construction materials, details and toe down (channel and local scour requirements).

Drop structures will be constructed of soil cement or reinforced concrete or a combination of both. Final design will incorporate the actual channel design section and flows. The drop structures estimated in *Table V-4* and the construction cost estimate, is based upon maximum channel height, width and flows.

TABLE V - 4
DROP STRUCTURE DESIGN
PIMA ROAD CHANNEL DETENTION ALTERNATE

PIMA ROAD CHANNEL REACH LOCATION	Approx. HEC-1 NODE	Channel Length (ft)	Existing Elevation (ft)	Existing Slope (%)	Proposed Slope (%)	Required Drop (ft)	Number of Structures	Approx. Height of Struct. (ft)	Approx. Distance Between Struct. (ft)
STA 365+60 At Jomax Road	30N		2184						
		2640		2.05	1.3	19.8	6	3	400
STA 339+20 (1/2 Mile Point)	CP31.1		2130						
		1440		2.27	1.3	13.2	4	3	400
STA 324+80 Above Happy Valley Rd. Det. Basin	CP31.2		2098						
Happy Valley Detention Basin		(1000)							
STA 314+80 Below Happy Valley Rd. Det. Basin	DET-HV		2075						
		2640		1.89	1.2	18.2	6	3	400
STA 288+40 (1/2 Mile Point)	CP36.1		2025						
		2640		1.78	1.2	15.3	6	2.5	400
STA 262+00 At Pinnacle Peak Road	CP36N		1978						
		2640		2.05	1.4	17.2	6	3	400
STA 23+560 (1/2 Mile Point)	C36R2		1924						
		1440		1.67	1.4	3.9	4	1	350
STA 221+20 Above Deer Valley Rd. Det. Basin	CP51.1		1900						
Deer Valley Road Detention Basin		(1600)							
STA 205+20 Below Deer Valley Rd. Det. Basin	DET-DV		1850						
		2240		2.23	1.2	23.1	8	3	300
STA 182+80 (1/2 Mile Point)	R52A2		1800						
		2640		2.20	1.2	26.3	8	3	300
STA 156+40 At Beardsley Road	52E6A		1742						
		2640		2.12	1.4	19.0	6	3	400
STA 130+00 (1/2 Mile Point)	CP53A		1686						
		3400		1.65	1.4	8.5	8	1	400
STA 96+00 Above Union Hills Dr. Det. Basin	C53A2		1630						
Union Hills Detention Basin		(1400)							
STA 82+65 Below Union Hills Dr. Det. Basin	DET-UH		1608						
		5200		0.92	.7	11.4	4	3	1200
STA 30+00 At Bell Road	C54		1560						
		2000		1.50	.7	16	5	3	400
STA 10+00 Channel Outlet At B.O.R.	ROBELL		1530						
TOTAL		31,560	564	1.8		190	70		

ASSUMPTIONS:

1. Channel bottom width varies & 1:1 side slopes, see Table V - 1.
2. Mannings "n" assumed at .025 for soil cement channel side slopes with natural bottom
3. Peak flows estimated based on HEC-1 Model #2 (with detention basins at Happy Valley, Deer Valley and Union Hills Roads)
4. Peak flows used for each 1/2 mile reach is the peak 100 year-6 hour flow anywhere in that reach.

F. CHANNEL TOE DOWN REQUIREMENT ESTIMATE

The Pima Road Channel soil cement embankment toe down requirement has been estimated based upon the ADWR Design Manual formula for total vertical adjustment as listed below.

$$\Delta Z_{TOT} = \Delta Z_{deg} + \Delta Z_{LS} + \Delta Z_{g.s} + \Delta Z_{bs} + \Delta Z_i + .05 \text{ ha}$$

$$\Delta Z_{TOT} = 0 + 0 + 0.8 + 0 + 0.5 + .5\ (.027\ (12.6)^2 \leq 2.5)$$
$$= 2.5 \text{ ft.}$$

Where:

ΔZ_{TOT}	=	Total Vertical Adjustment (ft)
ΔZ_{deg}	=	Long Term Degradation (ft)
ΔZ_{LS}	=	Local Sour (ft)
$\Delta Z_{g.s}$	=	General Scour (ft)
ΔZ_{bs}	=	Bend Scour (ft)
ΔZ_i	=	Low Flow Incisement (ft)
ha	=	Anti Dune Wave Height (ft) where ha = $.027\ V^2 \leq Yn$

Long term degradation is estimated at zero based upon principals of channel equilibrium slope design. This appears to be an approximate estimate, however, an allowance of 0.5 feet has been estimated to account for future development and subsequent reduction of the sediment supply rate and ensuing reduction of the equilibrium slope to reduce the channel sediment transport capacity.

Local scour is not estimated and assumed zero for the purposes of this report, where only generalized channel sections are being analyzed. Based upon final design plans, estimates of local scour will be required for drop structure design and at culverts and other structures within the channel sections.

General scour as discussed in Section V-D of this report, general scour has been estimated based upon the use of prepared Pima Road Channel sediment transportation capacity tables (Appendix J). Based upon the average condition of the 100 year flood event and the proposed drop structure spacing, the general scour is estimated at 0.8 feet.

Bend scour is not estimated for the purposes of this report where only generalized channel sections are being analyzed. Based upon final channel alignment and the requirement of channel bends, the bend scour analyses may be required. In general, the Pima Road Channel as proposed is straight for practical design purposes.

Low flow channel incisement estimates for this study is 0.5 feet. Based upon the location and spacing of the drop and grade control, structures, the low flow incisement can be minimized. The drop structures are particularly critical at the outset of the detention basin drain pipes, as this flow will be relatively free of sediment. Based upon the proposed 8 foot by 6 foot soil cement embankment, low flow incisement should not be a major factor due to the limited scour potential and limited detrimental impact to the embankment.

For anti dune wave height calculations, see Section V-B of this report for discussion and evaluation.

Based upon the above conservative assumptions regarding toe down, the frequency of the drop structures and the size and stability of the proposed 8 x 6 foot soil cement embankment, it is suggested that a factor of safety of 1.0 be utilized for maximum tow down requirements. Final toe down design requirements will be based upon final channel design parameters and in coordination with MCFCD.

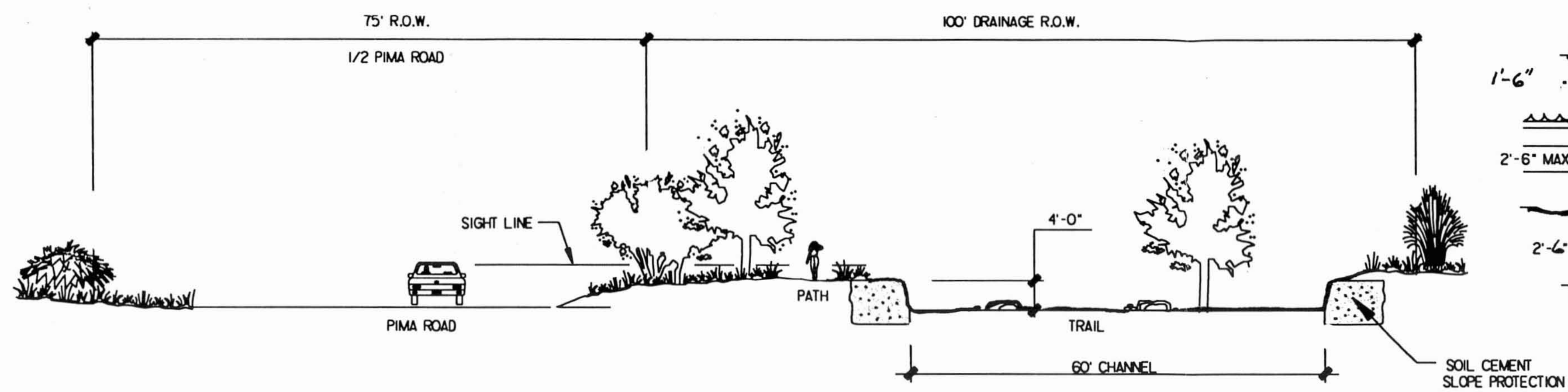
G. COMPARISON OF PIMA ROAD DESERT GREENBELT CHANNEL WITH AND WITHOUT DETENTION

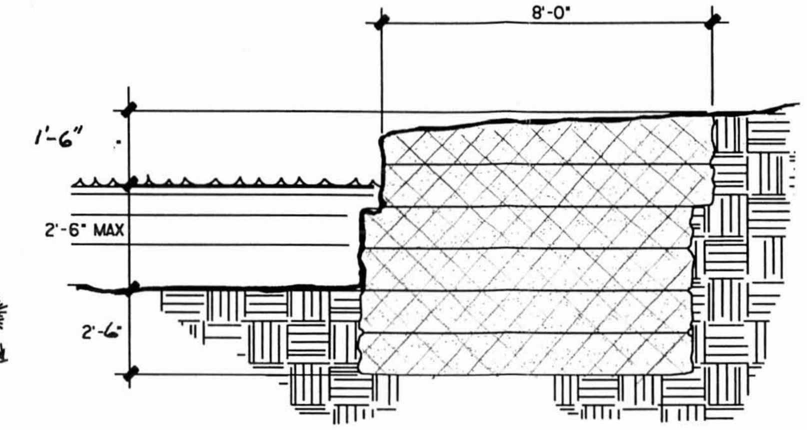
By review of this report and in particular *Exhibit I-2, Figure I-1 and Table I-1*, it is clear that the detention alternate provides a superior design approach which is more in alignment with the goals of the desert green belt concept. A comparison of representative channel sections for both alternatives are shown *in Figure V-1 and V-3* for proposed typical sections north and south of Deer Valley Road.

The main channel design improvements focus on reduced flow, depth and velocity as listed below.

Storm	No Detention Alternate		Detention Alternate	
	Velocity (fps)	Depth (ft)	Velocity (fps)	Depth (ft)
2	15	1.5	6	.8
10	22	3.0	9	1.5
100	30	4.5	13	2.5

In conclusion, if the Pima Road Channel without detention can be engineered to provide a safe and effective drainage facility, the proposed detention alternates will only prove to be a more acceptable and feasible alternative.



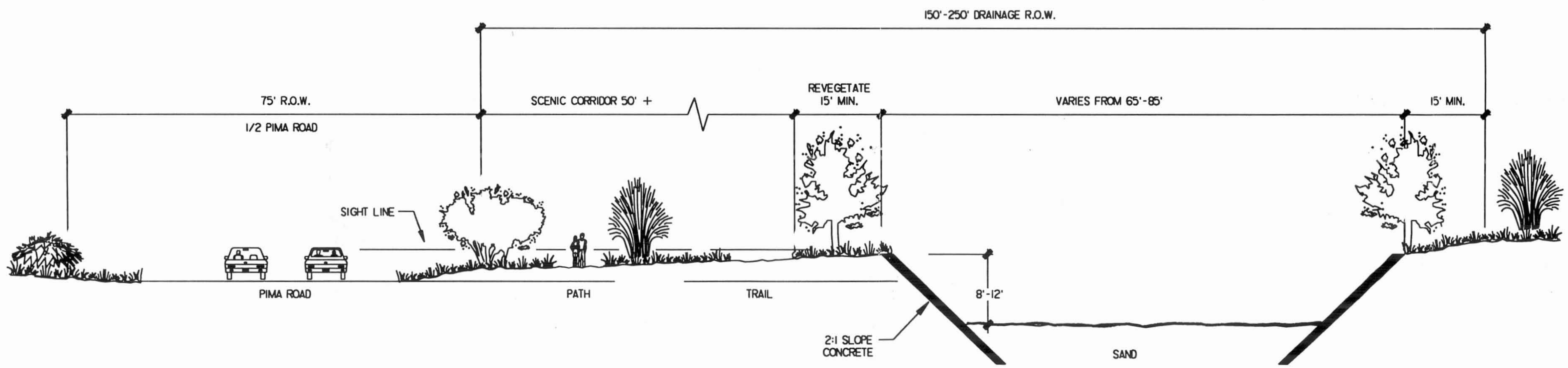


SOIL CEMENT SLOPE PROTECTION
SCALE: 1/2" = 1'-0"

N:\5653\WORKDWGS\SECTNS.DWG

PROPOSED PIMA ROAD DESERT GREENBELT AT PINNACLE PEAK ROAD

WITH DETENTION



PROPOSED PIMA ROAD CHANNEL AT PINNACLE PEAK ROAD

WITHOUT DETENTION

SCALE 1" = 10'
DESIGNED CMS
DRAWN SS, JAM & MJ
CHECKED CMS
DATE 09 - 5 - 95

PIMA ROAD DETENTION BASIN FEASIBILITY STUDY

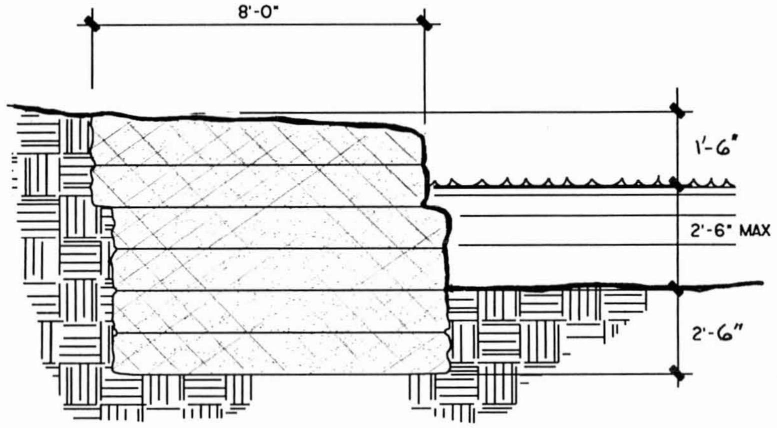
DESERT GREENBELT CROSS SECTION BELOW PINNACLE PEAK ROAD

SCOTTSDALE AZ

PACE
PACIFIC ADVANCED CIVIL ENGINEERING

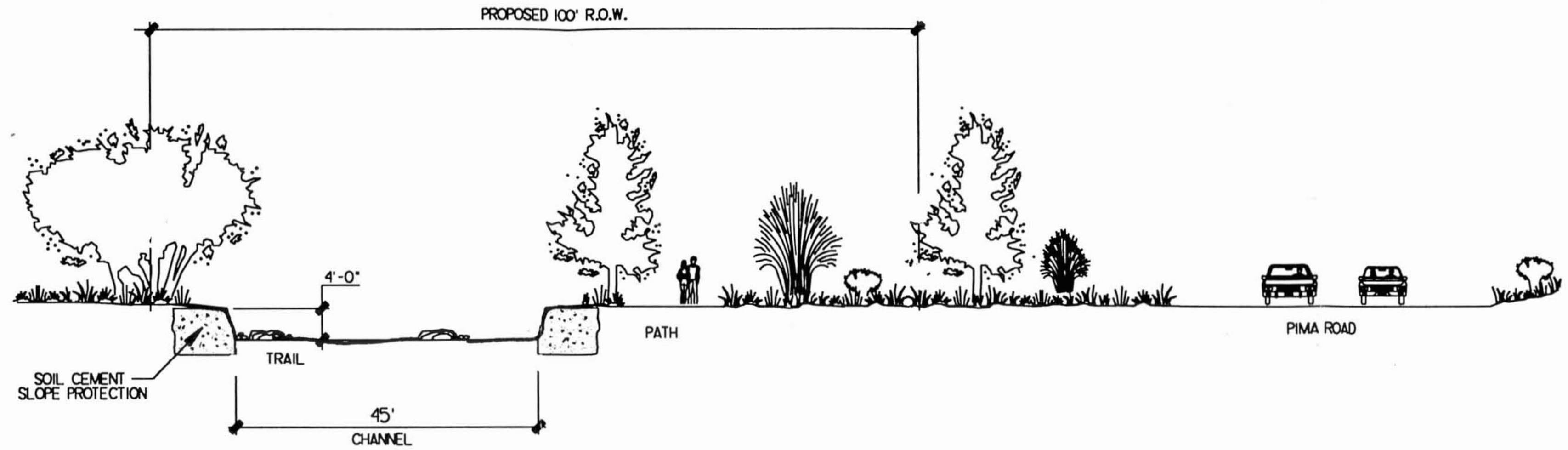
SHEET

Figure V-2



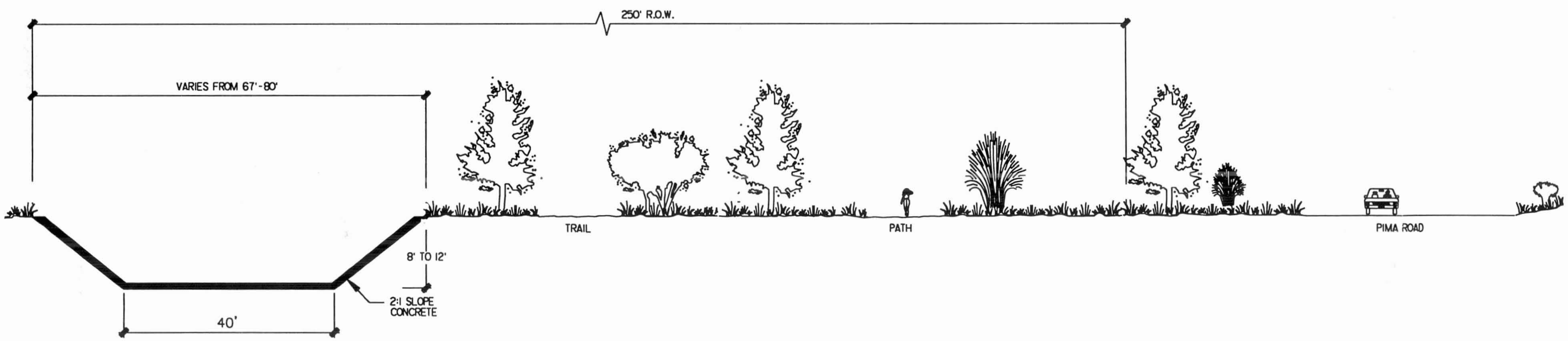
SOIL CEMENT SLOPE PROTECTION

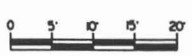
SCALE: 1/2" = 1'-0"



PROPOSED PIMA ROAD DESERT GREENBELT AT BELOW DEER VALLEY ROAD

WITH DETENTION





PROPOSED PIMA ROAD CHANNEL AT BELOW DEER VALLEY ROAD

WITHOUT DETENTION

N:\5653\WORKDWGS\SECTNS.DWG

SCALE 1" = 10'; DESIGNED CKS; DRAWN SS, JAM & MJ; CHECKED CKS; DATE 09-5-95

PIMA ROAD DETENTION BASIN FEASIBILITY STUDY

DESERT GREENBELT CROSS SECTION BELOW DEER VALLEY ROAD

SCOTTSDALE AZ

PACE PACIFIC ADVANCED CIVIL ENGINEERING

Figure V-3

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 hard construction costs due to smaller/unlined channel and more funds expended in channel area of for the Desert Greenbelt.
- 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.
- Less detrimental effects to adjoining properties.
- Provides natural energy dissipaters for confluencing flows at collector channels.
- 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.

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 drainage facilities.	2. Constructed concrete channel and fencing velocity in excess of 30 fps.
3. Active and Passive Recreation in Desert Green Belt	3. No recreational opportunities within the Desert Green Belt channel.
4. Active or passive recreation at basin sites	4. Corridor & urban development at basin sites.
5. Basin reduces visual impact vs. zoning Maximum height of basin above existing grade 25 ft.	5. Development at site - 30 ft allowable (vertical) residential development.
6. Eliminates or reduces downstream bridges and flood control features.	6. Required numerous new bridge crossings for existing and future developments.

TABLE VI-1
PIMA ROAD CHANNEL
COST COMPARISON
WITH AND WITHOUT DETENTION

Estimator: JAP
Project Manager: MEK
Job No.: 5653
Date: 9/15/95

ITEM/DESCRIPTION	NO DETENTION	WITH DETENTION
CHANNEL AND APPURTENANCES CONSTRUCTION	16,728,000	4,670,000
CHANNEL SALVAGE AND REVEGETATION	2,388,000	3,255,000
DETENTION BASINS CONSTRUCTION	N/A	7,369,000
DETENTION BASIN SALVAGE REVEGETATION	N/A	4,000,000
SUBTOTAL CONSTRUCTION	$19,116,000	$19,294,000
ENGINEERING AND CONTINGENCY	4,780,000	4,780,000
RIGHT OF WAY PURCHASE	450,000	2,172,000
AESTHETIC TREATMENT	3,777,000	755,000
TOTAL	$28,123,000	$27,001,000
POTENTIAL DEDUCTS/ADDITIONS:		
1. ADDITIONAL PRIVATE ROAD CROSSINGS CHANNEL	2,000,000	N/A
2. ELIMINATION OF ADOT CROSSING (Reallocation of ADOT Funding to Detention	N/A	-1,200,000
3. INCREASE CHANNEL COST (FENCE AND CONCRETE)		
CONCRETE 400,000 SF @ $6/SF = $2,400,000	3,100,000	N/A
FENCING 70,000 FT @ $10/FT = $700,000		
4. REDUCTION IN LANDSCAPE COST (Grayhawk Estimate Attached)	-1,367,000	-3,900,000
5. LAND COST NOT COUNTED ASLD (66 AC)		
25,000/AC vs. $5,000/AC = $20,000/AC	1,323,000	N/A
6. ADDITIONAL COST TO ADDRESS DRAINAGE ENTERING TPC & BOR	1,000,000	N/A
ESTIMATED GRAND TOTAL	$34,179,000	$21,901,000

Table VI-2
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

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

Estimator: JAP
Proj. Manager: MEK
Job No. 5653
Date: 9/15/95

Item #	Description	Quantity	Unit	Unit Cost $	Total $	Notes	Quantity	Unit	Unit Cost $	Total $	Difference $
	Pima Road Channel					***Pima Road Channel with Detention***					
J2-0101	Excavation (Sandy Gravel)	314,420	CY	3.00	943,260	(Avg. flow reduced from 4,000 cfs to 1000 cfs	230,000 *	CY	3.00	690,000	-253,260
J2-0102	Excavation (Short Haul)	178,741	CY	2.00	357,482	cost reduction. Based on 31,000ft x 50ft x4ft channel.)	0 *	CY	2.00	0	-357,482
J2-0208	Concrete	1,100	SF	16.00	17,600	No Change	1,100	SF	16.00	17,600	0
J2-0210	8" Reinforced Concrete Lining	1,815,830	SF	6.00	10,894,980	Soil Cement Channel Side Slopes 2x6x8x31,000	110,000 *	CY	20.00	2,200,000	-8,694,980
J2-0216	Grade Control Structures	12	EA	12,588	151,056	Reduce cost of structures by 60% Max. 4' Drop	65 *	EA	5,000 *	325,000	173,944
J2-0401	Multi-use Concrete Path	27,850	LF	15.00	417,750	No Change	27,850	LF	15	417,750	0
J2-0402	Signage	1	LS	75,000	75,000	No Change	1	LS	75,000	75,000	0
J2-0403	Horse Trail	27,850	LF	0.25	6,963	No Change	27,850	LF	0.25	6,963	0
J2-0404	Emergency Access	6	EA	20,000	120,000	Reduced based on depth of flow reduction	0	EA	7,000.00 *	0	-120,000
J2-0501	Revegetation (Average width 30 ft)	668,000	SF	1.00	668,000	Reveg. entire channel 31,000x65ft avg. width	2,015,000 *	SF	1.00	2,015,000	1,347,000
J2-0502	Salvage (Average width 100 ft)	3,439,000	SF	0.50	1,719,500	20% reduction - average channel width 80 ft.	2,480,000 *	SF	0.50	1,240,000	-479,500
J2-0701	Culverts (CBC)		EA	18,000	0	Culverts (CBC) crossing @ 10 Bridge loc.	10 *	EA	25,000	250,000	250,000
J2-1002	Bridges (Less than 150')	44,080	SF	45	1,983,600	All Eliminated (Replace w/5 grade seperated				0	-1,983,600
J2-1102	Bridges (Greater than 150')	32,800	SF	50	1,640,000	" crossings for pedestrian and	5 *	EA	50,000	250,000	-1,390,000
J2-1201	Utility Relocation (Drop Existing Lines)	7	EA	15,000	105,000	No Change equestrian crossings)	7	EA	15,000	105,000	0
J2-1202	Utility Relocation (Drop Existing Stubout)	8	EA	2,000	16,000	No Change	8	EA	2,000	16,000	0
	Collector Channel @ Happy Valley					Collector Channel @ Happy Valley 1,320 LF	1 *	LS	240,000	240,000	
	Collector Channel @ Deer Valley					Collector Channel @ Deer Valley 400 LF	1 *	LS	75,000	75,000	
	Happy Valley Rd. Det. Basin/Park					(See separate cost estimate -attached) Reveg. $1.3M	1 *	LS	3,445,530	3,445,530	3,445,530
	Deer Valley Rd. Det. Basin/Park					(See separate cost estimate -attached) Reveg. $1.2M	1 *	LS	3,419,944	3,419,944	3,419,944
	Union Hills Rd. Det. Basin/Park					(See separate cost estimate -attached) Reveg. $1.5M	1 *	LS	4,504,038	4,504,038	4,504,038
	SUBTOTAL DESERT GREENBELT CONSTRUCTION COST				**19,116,191**	**SUBTOTAL PIMA ROAD GREENBELT & DETENTION CONSTRUCTION COST**				**19,292,825**	**176,634**
J2-7000	Engineering	10%	PCT	19,116,191	1,911,619		10%	PCT	19,292,825 *	1,929,282	17,663
J2-9000	Contingency (Excludes R/W)	15%	PCT	19,116,191	2,867,429	(Excludes R/W & Aesthetic Treatment)	15%	PCT	19,292,825 *	2,893,924	26,495
J2-8000	Right-of-way Purchase Easement/Channel	4.68	AC	25,000	117,080	No Change	4.68	AC	25,000	117,080	0
	Right-of-way					Purchase Easement for Detention Basins	69.00 *	AC	25,000	1,725,000	1,725,000
J2-8001	Right-of-way Lease Acreage	66.16	AC	5,000	330,780	No Change	66.16	AC	5,000	330,780	0
J2-6000	Aesthetic Treatment	1	LS	3,777,383	3,777,383	Eliminate 80% as entire channel revegetated	1	LS	755,000 *	755,000	-3,022,383
			ESTIMATE TOTAL		**$ 28,120,481**			**ESTIMATE TOTAL**		**$ 27,043,890**	**-1,076,591**

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.

Conservative cost esitmate assumptions for Pima Road Channel with Detention Alternate

1. 100% of channel excavation included @ $3.00/cy.
2. 100% of channel embankment estimated @ + 6 feet total depth, which is maximum section not average final design likely to reduce final quantity.
3. Deer Valley and Happy Valley detention basins are both oversized to account for the maximum possible collector channel lengths. Approximately a total of 150 to 200 AF of detention basin storage is therefore duplicated and could be eliminated in final design.

Table VI-3
Happy Valley Detention Basin Cost Estimate

Estimator: JAP
Project Manager: MEK
Job No.: 5653
Date: 9/15/95

#	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. (Assume 25% shrinkage.) See overall project estimate.	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.	10,000	SY	8.00	80,000
B.	**Earth Dam Embankment Construction**				
1.	Earth Embankment Construction:				
a.	Soil cement core	18,000	CY	20.00	360,000
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 - 30" 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 DETENTION BASIN				**1,823,000**
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 LANDSCAPING				**1,309,300**
F.	**Construction Contractor Mark-ups**				
	Overhead and Profit Mobilization, bonds & insurance	10%	PCT	3,132,300	313,230
	Total Pima/Happy Valley Road Detention Basin Construction Cost				**$3,445,530**

Table VI-4
Deer Valley Detention Basin Cost Estimate

Estimator: JAP
Project Manager: MEK
Job No.: 5653
Date: 9/15/95

#	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. (Assume 25% shrinkage.) See overall project estimate.	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.	10,000	SY	8.00	80,000
B.	**Earth Dam Embankment Construction**				
1.	Earth Embankment Construction:				
a.	Soil cement core	20,000	CY	20.00	400,000
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.	400 LF spillway w/soil cement cutoff wall (part of item B1a).				
2.	Low Flow Outlet - 42" RCP	800	LF	90	72,000
D.	**Downstream Improvements**				
1.	Downstream improvements to channel @ low flow outlet	1	LS	20,000	20,000
	SUBTOTAL DETENTION BASIN				**1,897,300**
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 LANDSCAPING				**1,211,740**
F.	**Construction Contractor Mark-ups**				
	Overhead and Profit Mobilization, bonds & insurance	10%	PCT	$3,109,040	310,904
	Total Pima/Deer Valley Road Detention Basin Construction Cost				**$3,419,944**

Table VI-5
Union Hills Detention Basin Cost Estimate

Estimator: JAP
Project Manager: MEK
Job No.: 5653
Date: 9/15/95

#	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. (Assume 25% shrinkage.) See overall project cost estimate.	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.	10,000	SY	8.00	80,000
B.	**Earth Dam Embankment Construction**				
1.	Earth Embankment Construction:				
a.	Soil cement core	25,000	CY	20.00	500,000
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.	500 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 DETENTION BASIN				**2,574,500**
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 LANDSCAPING				**1,520,080**
F.	**Construction Contractor Mark-ups**				
	Overhead and Profit Mobilization, bonds & insurance	10%	PCT	4,094,580	409,458
	Total Pima/Deer Valley Road Detention Basin Construction Cost				**$4,504,038**

Table VI-6
Salvage Revegetation Cost Comparison
City of Scottsdale vs. Grayhawk Cost
for Pima Road Channel Desert Greenbelt
Alternate with Detention

Estimator: JAP
Project Manager: MEK
Job No.: 5653
Date: 9/15/95

I.	**Total Salvage/Reveg. Cost per C.O.S. Unit Costs**		
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	3,255,000	
	TOTAL		$7,275,000

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	60 ac @	$10,000/ac	=	600,000
	c. Revegetation	46.25 ac @	$15,000/ac	=	693,750
	SUBTOTAL				$1,293,750
	GRAND TOTAL SALVAGE AND REVEGETATION				**$3,373,750**

POTENTIAL SAVINGS $3,900,000

Note: Revised landscape salvage and revegetation based upon actual Grayhawk Golf Course construction cost plus 35% for public bidding overhead.

References

CH2M Hill, et al, 1994, Rawhide Wash Detention Basin Feasibility Study Draft Final Report.

Greiner, 1995, City of Scottsdale Desert Greenbelt Project Phase One Design, Design memorandum.

Greiner, 1995, City of Scottsdale Desert Greenbelt Project, Pima Road Channel Preferred Alternative.

Greiner, 1995, City of Scottsdale Desert Greenbelt Project, Sediment Field Tests

NBS Lowry Engineers & Planners & McLaughlin Water Engineers Ltd., 1991, Drainage Design Manual for Maricopa County, Arizona.

Pemberton, Ernest L. and Lara, Joseph M., 1984, Computing Degradation and Local Scour, Technical Guideline for Bureau of Reclamation.

Simons, Li & Associates, Inc., 1985, Design Manual for Engineering Analysis of Fluvial Systems, Arizona Department of Water Resources.

U.S. Army Corps of Engineers, 1970, Hydraulic Design of Flood Control Channels.

APPENDIX

PIMA ROAD DESERT GREENBELT CHANNEL AND DETENTION BASIN

PRELIMINARY DESIGN REPORT

For:

GRAYHAWK DEVELOPMENT
7377 E Doubletree Ranch, Suite 100
Scottsdale, AZ 85258
(602) 998-4144

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

September 15, 1995

by:

Pacific Advanced Civil Engineering (PACE)
17902 Georgetown Lane
Huntington Beach, CA 92647

Appendix
Table of Contents

Appendix A

HEC-1 Model 0

Bound Separately

Appendix B

HEC-1 Model 1

Bound Separately

Appendix C

HEC-1 Model 2

Bound Separately

Appendix D

HEC-1 Model 2-6

Bound Separately

Appendix F

PMP/0.5 PMF Calculation and HEC-1 Models

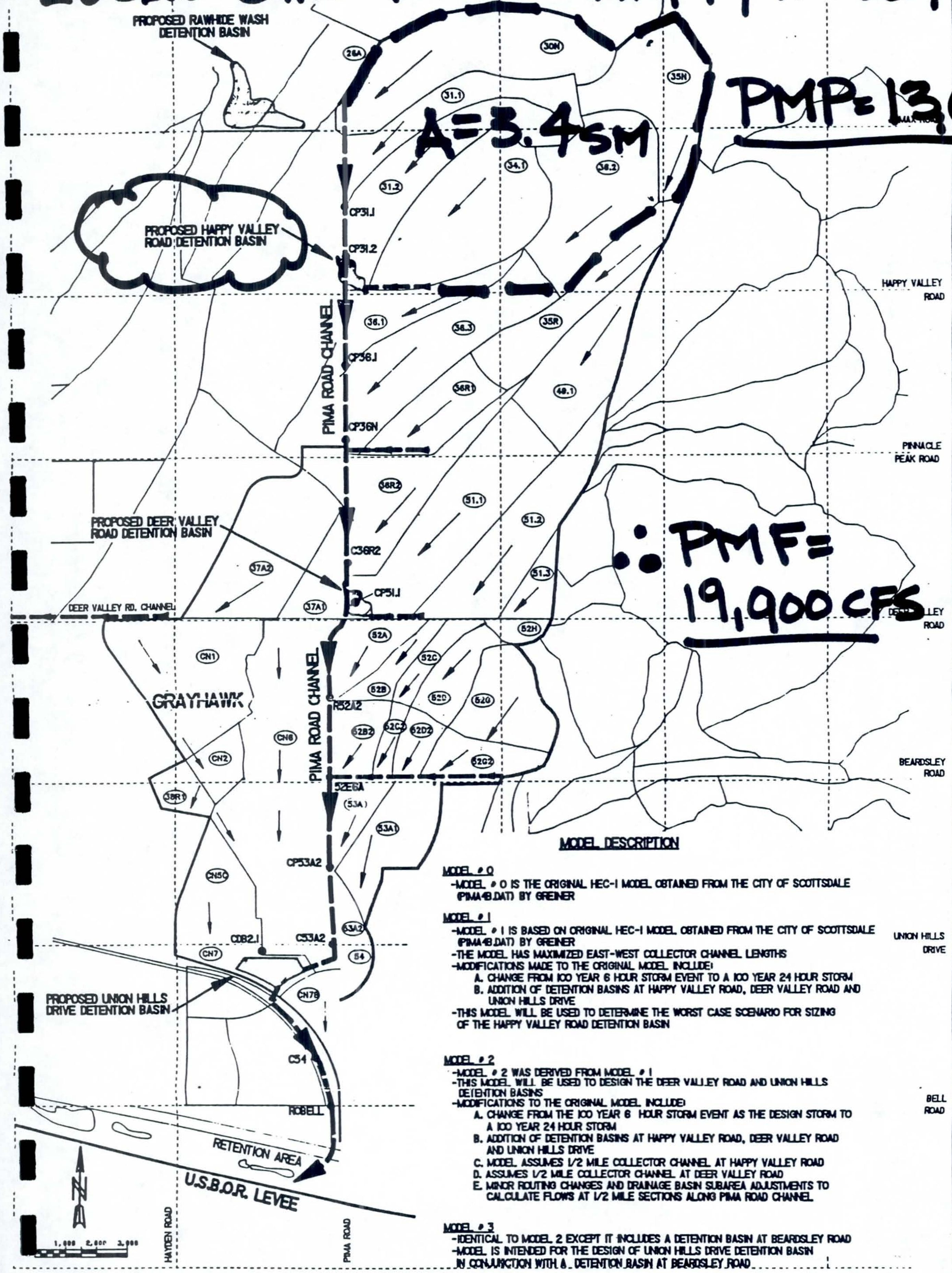
PROBABLE MAXIMUM PRECIPITATION AND FLOOD CALCULATION SUMMARY

Detention Basin	HEC-1 Model(s)	Drainage Area (mi^2)	PMP Rainfall (in)	PMF Runoff (cfs)
Happy Valley Road	hv.hc1	3.37	13.05	19,900
Deer Valley Road	dv.hc1	5.98	12.12	27,500

Notes:

1. Single drainage basin PMP calculations were completed using the Hydrometereological Report #49, Probable Maximum Precipitation Estimates For The Colorado River and Great Basin Drainages by the NOAA. Calculations were modeled after the calculations completed by the Maricopa County Flood Control District in the PMF Estimation For the Proposed Rawhide Wash Detention Basin, 10/06/94.
2. Deer Valley Road Detention Basin single drainage basin calculation is based on no upstream detention (ie. Happy Valley Road Detention Basin not in place), as it is not significant vs. storm volume.
3. HEC-1 models and PMP calculations included in Appendix.

LOCAL 6HR-PMP HAPPY VALLEY



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

HV-2

MODEL-2 WATERSHED DRAINAGE MAP WITH HAPPY VALLEY, DEER VALLEY AND UNION HILLS DETENTION BASINS	DRAWN S.S.	
	CHKD M.E.K.	PACE

LOCAL STORM P.M.P - 6 HOUR 1 OF 4

SINGLE DRAINAGE BASIN MODEL - HAPPY VALLEY BASIN

Table 6.3B.—Local-storm PMP computation, Colorado River and Great Basin, and California drainages. (Giving areal distribution of PMP).

Steps correspond to those in sec. 6.3B.

1. Place idealized isohyetal pattern [fig. 4.10] over drainage adjusted to 1:500,000 scale to obtain most critical placement.
2. Note the isohyets within drainage.
3. Average 1-hr 1-mi^2 (2.6-km^2) PMP for drainage [fig. 4.5]. 10.04 in. (mm)
4. a. Reduction for elevation. [No adjustment for elevations up to 5,000 feet (1,524 m), 5% decrease per 1,000 feet (305 m) above 5,000 feet (1,524 m)]. 100 %
   b. Multiply step 3 by step 4a. 10.04 in. (mm)
5. Average 6/1-hr ratio for drainage [fig. 4.7]. 1.3
6. Obtain isohetal labels for 15-min incremental and the highest PMP from table 4.5 corresponding 6/1-hr ratio of step 5.

PMP Increment	Isohyet A	B	C	D	E	F	G	H	I	J	
Highest 1-hr	100										
Highest 15-min.	74										
2nd "	15										in %
3rd "	6										
4th "	5										

7. Obtain isohyetal labels in % of 1-hr PMP for 2nd to 6th highest hourly incremental PMP values from table 4.6 using 6/1-hr ratio of step 5.

	A	B	C	D	E	F	G	H	I	J	
2nd Highest 1-hr PMP	14										
3rd "	6										
4th "	5										in %
5th "	3										
6th "	2										

8. Multiply steps 6 and 7 by step 4b to get incremental isohyetal labels of PMP.

	A	B	C	D	E	F	G	H	I	J	
Highest 15-min.	7.43										
2nd "	1.51										
3rd "	.60										
4th "	.50										
Highest 1-hr	10.04										in in. (mm)
2nd "	1.41										
3rd "	.60										
4th "	.50										
5th "	.30										
6th "	.20										

9. Arrange values of step 8 in time sequence [tables 4.7 and 4.8].

6 hour depth = 13.05

HV-1

PMP Local Storm Calculation for Happy Valley Rd. Detention Bas

- Average 1hr. – 1m² PMP for Watershed (figure 4-5 HMR 49) = 11.
- Total Area = 3.37 mi.²

From figure 4-10 Isohyet A – 1 mi.²

Isohyet B – 2.37 mi.²

From table 4-5 Isohyet A – 100%

Isohyet B – 82%

PMP (Average Area Weighting)

$$= (1/3.37)(100\%)(11.5) + (2.37/3.37)(82\%)(11.5)$$

$$= 3.41 + 6.63$$

$$= 10.04''$$

HAPPY VALLEY RD.

y # 1

$$L = 18{,}000/5280 = 3.4 \text{ mi.}$$

$$L_{ca} = 9000/5280 = 1.7 \text{ mi.}$$

$$s = \frac{2680 - 2070}{3.4} = 179.4 \text{ ft./mi.}$$ (Highest peak to lowest p

Assume ⇒ $K_n = 0.035$, $C = 24 K_n$

$$Lag = C\left[\frac{L \cdot L_{ca}}{s^{1/2}}\right]^{.38} = 24(.035)\left[\frac{(3.4)(1.7)}{(179.4)^{1/2}}\right]^{0.38} = 0.61 \text{ hours}$$

Per manual, reduce lag by 15%

$$Lag = = (.61).85 = 0.52 \text{ hours} = \underline{31.1 \text{ minutes}}$$

pace CONTRACTORS CONSULTANTS & ENGINEERS a divison of Pacific Aquascape, Inc.	SCALE	TITLE Happy Valley Road
	DRAWN	
	DATE	JOB HV- 3
	JOB NO	

HAPPY VALLEY DETENTION BASIN
PMP – 6HOUR RUN OFF


```
ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

ID   Pima Road Detention Basin Feasibility Study
ID
IT      5                   300
IO      5

KK
KM   BASIN Happy
KM    THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
KM   L=      3.4  Lca=      1.7   S=  179.4  Kn= .035  LAG=  31.1
KM    PHOENIX VALLEY S-GRAPH WAS USED FOR THIS BASIN
BA    3.37
IN      15
KM   RAINFALL DEPTH OF13.05 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
KM   AN AREAL REDUCTION COEFFICIENT OF .971 WAS USED
PB   12.67
KM   THE FOLLOWING PC RECORD USED A 6-HOUR RAINFALL WITH PATTERN NO. 2.11
PC    .000    .010    .016    .026    .035    .044    .054    .062    .071    .081
PC    .092    .106    .126    .169    .258    .453    .691    .833    .897    .935
PC    .950    .963    .975    .988   1.000
LG     .15     .25    6.60     .16     .00
UI    365.    866.   1686.   2170.   2781.   4184.   3928.   2992.   2322.   1773.
UI   1072.    627.    477.    342.    112.    112.    112.    112.      0.      0.
UI      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
ZZ
```

OUTPUT RESULTS SUMMARY

PEAK FLOW = 19917 CFS ≈ 19,900

TIME TO PEAK = 4.33 HR

VOLUME = ± 1860 AF

BASIN AREA = 3.37 SM

∴ **0.5 PMF = ± 10,000 CFS** (WHITE OUT)

```
1 S/N: 1333000063        HMVersion: 6.40    Data File: 05PMF-HV.hc1

****************************************                                              ****************************************
*                                      *                                              *                                      *
* FLOOD HYDROGRAPH PACKAGE  (HEC-1)    *                                              *     U.S. ARMY CORPS OF ENGINEERS     *
*        SEPTEMBER 1990                *                                              *   HYDROLOGIC ENGINEERING CENTER      *
*         VERSION 4.0                  *                                              *          609 SECOND STREET           *
*                                      *                                              *       DAVIS, CALIFORNIA 95616        *
* RUN DATE  08/28/1995  TIME  11:48:51 *                                              *           (916) 756-1104             *
*                                      *                                              *                                      *
****************************************                                              ****************************************


                              X     X  XXXXXXX   XXXXX          X
                              X     X  X         X     X       XX
                              X     X  X         X              X
                              XXXXXXX  XXXX      X       XXXXX  X
                              X     X  X         X              X
                              X     X  X         X     X        X
                              X     X  XXXXXXX   XXXXX         XXX


                          :::::::::::::::::::::::::::::::::::::::::
                          :::::::::::::::::::::::::::::::::::::::::
                          :::                                   :::
                          :::  Full Microcomputer Implementation :::
                          :::                by                  :::
                          :::        Haestad Methods, Inc.       :::
                          :::                                   :::
                          :::::::::::::::::::::::::::::::::::::::::
                          :::::::::::::::::::::::::::::::::::::::::

               37 Brookside Road * Waterbury, Connecticut  06708 * (203) 755-1666


     THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

     THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
     THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
     NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
     DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
     KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM
```

```
ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

ID               Pima Road Detention Basin Feasibility Study
ID            FILE 05PMF-HV.HC1
ID            PREPARED BY PACE 08-28-95
ID
ID            ROUTING 50% OF PMP THROUGH HAPPY VALLEY DETENTION BASIN WITH
ID            TRIBUTARY AREA MODELED AS A SINGLE BASIN
ID
ID
ID
IT       5                     300
IO       5
JR    FLOW      .5

KK
KM   BASIN Happy
KM    THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
KM    L=      3.4  Lca=      1.7   S=  179.4  Kn= .035  LAG=  31.1
KM    PHOENIX VALLEY S-GRAPH WAS USED FOR THIS BASIN
BA    3.37
IN      15
KM   RAINFALL DEPTH OF13.05 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
KM   AN AREAL REDUCTION COEFFICIENT OF .971 WAS USED
PB   12.67
KM   THE FOLLOWING PC RECORD USED A 6-HOUR RAINFALL WITH PATTERN NO. 2.11
PC    .000    .010    .016    .026    .035    .044    .054    .062    .071    .081
PC    .092    .106    .126    .169    .258    .453    .691    .833    .897    .935
PC    .950    .963    .975    .988   1.000
LG     .15     .25    6.60     .16     .00
UI    365.    866.   1686.   2170.   2781.   4184.   3928.   2992.   2322.   1773.
UI   1072.    627.    477.    342.    112.    112.    112.    112.      0.      0.
UI      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
KO       2

KK  DET-HV
KM            DETENTION BASIN AT HAPPY VALLEY ROAD
RS       1    STOR
SA    3.54    9.65   11.54   12.97   14.37   15.82    17.3    18.9    19.6
SE    2060    2065    2070    2075    2080    2085    2090    2095    2098
SL    2060       3      .6      .5
SS    2090     300       3     1.5
KO       2
ZZ
```

```
nEC1 S/N: 1333000063        HMVersion: 6.40    Data File: 05PMF-HV.hc1

****************************************                      ****************************************
*                                      *                      *                                      *
*  FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                      *    U.S. ARMY CORPS OF ENGINEERS      *
*          SEPTEMBER 1990              *                      *    HYDROLOGIC ENGINEERING CENTER     *
*            VERSION 4.0               *                      *         609 SECOND STREET            *
*                                      *                      *      DAVIS, CALIFORNIA 95616         *
* RUN DATE  08/28/1995  TIME  11:48:51 *                      *          (916) 756-1104              *
*                                      *                      *                                      *
****************************************                      ****************************************


                                   Pima Road Detention Basin Feasibility Study
                                  FILE 05PMF-HV.HC1
                                  PREPARED BY PACE 08-28-95

                                  ROUTING 50% OF PMP THROUGH HAPPY VALLEY DETENTION BASIN WITH
                                  TRIBUTARY AREA MODELED AS A SINGLE BASIN


 11 IO         OUTPUT CONTROL VARIABLES
                     IPRNT           5  PRINT CONTROL
                     IPLOT           0  PLOT CONTROL
                     QSCAL          0.  HYDROGRAPH PLOT SCALE

    IT         HYDROGRAPH TIME DATA
                      NMIN           5  MINUTES IN COMPUTATION INTERVAL
                     IDATE      1    0  STARTING DATE
                     ITIME        0000  STARTING TIME
                        NQ         300  NUMBER OF HYDROGRAPH ORDINATES
                    NDDATE      2    0  ENDING DATE
                    NDTIME        0055  ENDING TIME
                     ICENT          19  CENTURY MARK

                COMPUTATION INTERVAL      .08 HOURS
                     TOTAL TIME BASE    24.92 HOURS

          ENGLISH UNITS
               DRAINAGE AREA          SQUARE MILES
               PRECIPITATION DEPTH    INCHES
               LENGTH, ELEVATION      FEET
               FLOW                   CUBIC FEET PER SECOND
               STORAGE VOLUME         ACRE-FEET
               SURFACE AREA           ACRES
               TEMPERATURE            DEGREES FAHRENHEIT

    JP         MULTI-PLAN OPTION
                     NPLAN           1  NUMBER OF PLANS

    JR         MULTI-RATIO OPTION
                   RATIOS OF RUNOFF
                   .50
```

```
*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

        ***************
        *             *
13 KK   *             *
        *             *
        ***************

31 KO      OUTPUT CONTROL VARIABLES
              IPRNT          2  PRINT CONTROL
              IPLOT          0  PLOT CONTROL
              QSCAL         0.  HYDROGRAPH PLOT SCALE

         SUBBASIN RUNOFF DATA

18 BA      SUBBASIN CHARACTERISTICS
              TAREA       3.37  SUBBASIN AREA

           PRECIPITATION DATA

23 PB         STORM      12.67  BASIN TOTAL PRECIPITATION

23 PI        INCREMENTAL PRECIPITATION PATTERN
              .00      .00      .00      .00      .00      .00      .00      .00      .00      .00
              .00      .00      .00      .00      .00      .00      .00      .00      .00      .00
              .00      .00      .00      .00      .00      .00      .00      .00      .00      .00
              .00      .00      .00      .01      .01      .01      .01      .01      .01      .03
              .03      .03      .06      .07      .06      .08      .08      .08      .05      .05
              .05      .02      .02      .02      .01      .01      .01      .00      .00      .00
              .00      .00      .00      .00      .00      .00      .00      .00      .00      .00
              .00      .00

27 LG      GREEN AND AMPT LOSS RATE
              STRTL        .15  STARTING LOSS
                DTH        .25  MOISTURE DEFICIT
               PSIF       6.60  WETTING FRONT SUCTION
              XKSAT        .16  HYDRAULIC CONDUCTIVITY
              RTIMP        .00  PERCENT IMPERVIOUS AREA

27 UI      INPUT UNITGRAPH,  18 ORDINATES,  VOLUME = 1.00
            365.0    866.0   1686.0   2170.0   2781.0   4184.0   3928.0   2992.0   2322.0   1773.0
           1072.0    627.0    477.0    342.0    112.0    112.0    112.0    112.0

                                                  ***

*****************************************************************************************************

                                          HYDROGRAPH AT STATION

*****************************************************************************************************
                                                   *
  DA MON HRMN  ORD    RAIN    LOSS  EXCESS    COMP Q    *    DA MON HRMN  ORD    RAIN    LOSS  EXCESS    COMP Q
                                                   *
   1     0000    1     .00     .00     .00        0.    *     1     1230  151     .00     .00     .00        0.
   1     0005    2     .04     .04     .00        0.    *     1     1235  152     .00     .00     .00        0.
   1     0010    3     .04     .04     .00        0.    *     1     1240  153     .00     .00     .00        0.
   1     0015    4     .04     .04     .00        0.    *     1     1245  154     .00     .00     .00        0.
```

1	0020	5	.03	.03	.00	0.	*	1	1250	155	.00	.00	.00	0.
1	0025	6	.03	.03	.00	0.	*	1	1255	156	.00	.00	.00	0.
1	0030	7	.03	.03	.00	0.	*	1	1300	157	.00	.00	.00	0.
1	0035	8	.04	.04	.00	0.	*	1	1305	158	.00	.00	.00	0.
1	0040	9	.04	.04	.00	0.	*	1	1310	159	.00	.00	.00	0.
1	0045	10	.04	.04	.00	0.	*	1	1315	160	.00	.00	.00	0.
1	0050	11	.04	.04	.00	0.	*	1	1320	161	.00	.00	.00	0.
1	0055	12	.04	.04	.00	0.	*	1	1325	162	.00	.00	.00	0.
1	0100	13	.04	.04	.00	0.	*	1	1330	163	.00	.00	.00	0.
1	0105	14	.04	.04	.00	0.	*	1	1335	164	.00	.00	.00	0.
1	0110	15	.04	.04	.00	0.	*	1	1340	165	.00	.00	.00	0.
1	0115	16	.04	.04	.00	0.	*	1	1345	166	.00	.00	.00	0.
1	0120	17	.04	.04	.00	0.	*	1	1350	167	.00	.00	.00	0.
1	0125	18	.04	.04	.00	0.	*	1	1355	168	.00	.00	.00	0.
1	0130	19	.04	.04	.00	0.	*	1	1400	169	.00	.00	.00	0.
1	0135	20	.03	.03	.00	0.	*	1	1405	170	.00	.00	.00	0.
1	0140	21	.03	.03	.00	0.	*	1	1410	171	.00	.00	.00	0.
1	0145	22	.03	.03	.00	0.	*	1	1415	172	.00	.00	.00	0.
1	0150	23	.04	.04	.00	0.	*	1	1420	173	.00	.00	.00	0.
1	0155	24	.04	.04	.00	0.	*	1	1425	174	.00	.00	.00	0.
1	0200	25	.04	.04	.00	0.	*	1	1430	175	.00	.00	.00	0.
1	0205	26	.04	.04	.00	0.	*	1	1435	176	.00	.00	.00	0.
1	0210	27	.04	.04	.00	1.	*	1	1440	177	.00	.00	.00	0.
1	0215	28	.04	.04	.00	3.	*	1	1445	178	.00	.00	.00	0.
1	0220	29	.05	.04	.01	10.	*	1	1450	179	.00	.00	.00	0.
1	0225	30	.05	.04	.01	21.	*	1	1455	180	.00	.00	.00	0.
1	0230	31	.05	.04	.01	39.	*	1	1500	181	.00	.00	.00	0.
1	0235	32	.06	.04	.02	69.	*	1	1505	182	.00	.00	.00	0.
1	0240	33	.06	.03	.02	112.	*	1	1510	183	.00	.00	.00	0.
1	0245	34	.06	.03	.03	173.	*	1	1515	184	.00	.00	.00	0.
1	0250	35	.08	.03	.05	249.	*	1	1520	185	.00	.00	.00	0.
1	0255	36	.08	.03	.05	341.	*	1	1525	186	.00	.00	.00	0.
1	0300	37	.08	.03	.05	468.	*	1	1530	187	.00	.00	.00	0.
1	0305	38	.18	.03	.15	637.	*	1	1535	188	.00	.00	.00	0.
1	0310	39	.18	.03	.15	853.	*	1	1540	189	.00	.00	.00	0.
1	0315	40	.18	.03	.15	1173.	*	1	1545	190	.00	.00	.00	0.
1	0320	41	.38	.03	.35	1596.	*	1	1550	191	.00	.00	.00	0.
1	0325	42	.38	.03	.35	2140.	*	1	1555	192	.00	.00	.00	0.
1	0330	43	.38	.03	.35	2956.	*	1	1600	193	.00	.00	.00	0.
1	0335	44	.82	.03	.79	3988.	*	1	1605	194	.00	.00	.00	0.
1	0340	45	.82	.03	.79	5251.	*	1	1610	195	.00	.00	.00	0.
1	0345	46	.82	.03	.79	7074.	*	1	1615	196	.00	.00	.00	0.
1	0350	47	1.01	.03	.98	9072.	*	1	1620	197	.00	.00	.00	0.
1	0355	48	1.01	.03	.98	11180.	*	1	1625	198	.00	.00	.00	0.
1	0400	49	1.01	.03	.98	13885.	*	1	1630	199	.00	.00	.00	0.
1	0405	50	.60	.03	.57	16292.	*	1	1635	200	.00	.00	.00	0.
1	0410	51	.60	.03	.57	18039.	*	1	1640	201	.00	.00	.00	0.
1	0415	52	.60	.03	.57	19298.	*	1	1645	202	.00	.00	.00	0.
1	0420	53	.27	.03	.24	19917.	*	1	1650	203	.00	.00	.00	0.
1	0425	54	.27	.03	.24	19612.	*	1	1655	204	.00	.00	.00	0.
1	0430	55	.27	.03	.24	18102.	*	1	1700	205	.00	.00	.00	0.
1	0435	56	.16	.03	.13	16319.	*	1	1705	206	.00	.00	.00	0.
1	0440	57	.16	.03	.13	14471.	*	1	1710	207	.00	.00	.00	0.
1	0445	58	.16	.03	.13	12158.	*	1	1715	208	.00	.00	.00	0.
1	0450	59	.06	.03	.04	10014.	*	1	1720	209	.00	.00	.00	0.
1	0455	60	.06	.03	.04	8322.	*	1	1725	210	.00	.00	.00	0.
1	0500	61	.06	.03	.04	6756.	*	1	1730	211	.00	.00	.00	0.
1	0505	62	.05	.03	.03	5359.	*	1	1735	212	.00	.00	.00	0.
1	0510	63	.05	.02	.03	4287.	*	1	1740	213	.00	.00	.00	0.
1	0515	64	.05	.02	.03	3384.	*	1	1745	214	.00	.00	.00	0.

1	0520	65	.05	.02	.03	2590.	*	1	1750	215	.00	.00	.00	0.
1	0525	66	.05	.02	.03	2001.	*	1	1755	216	.00	.00	.00	0.
1	0530	67	.05	.02	.03	1586.	*	1	1800	217	.00	.00	.00	0.
1	0535	68	.05	.02	.03	1288.	*	1	1805	218	.00	.00	.00	0.
1	0540	69	.05	.02	.03	1081.	*	1	1810	219	.00	.00	.00	0.
1	0545	70	.05	.02	.03	944.	*	1	1815	220	.00	.00	.00	0.
1	0550	71	.05	.02	.03	865.	*	1	1820	221	.00	.00	.00	0.
1	0555	72	.05	.02	.03	810.	*	1	1825	222	.00	.00	.00	0.
1	0600	73	.05	.02	.03	786.	*	1	1830	223	.00	.00	.00	0.
1	0605	74	.00	.00	.00	765.	*	1	1835	224	.00	.00	.00	0.
1	0610	75	.00	.00	.00	727.	*	1	1840	225	.00	.00	.00	0.
1	0615	76	.00	.00	.00	662.	*	1	1845	226	.00	.00	.00	0.
1	0620	77	.00	.00	.00	594.	*	1	1850	227	.00	.00	.00	0.
1	0625	78	.00	.00	.00	511.	*	1	1855	228	.00	.00	.00	0.
1	0630	79	.00	.00	.00	391.	*	1	1900	229	.00	.00	.00	0.
1	0635	80	.00	.00	.00	280.	*	1	1905	230	.00	.00	.00	0.
1	0640	81	.00	.00	.00	196.	*	1	1910	231	.00	.00	.00	0.
1	0645	82	.00	.00	.00	131.	*	1	1915	232	.00	.00	.00	0.
1	0650	83	.00	.00	.00	82.	*	1	1920	233	.00	.00	.00	0.
1	0655	84	.00	.00	.00	52.	*	1	1925	234	.00	.00	.00	0.
1	0700	85	.00	.00	.00	35.	*	1	1930	235	.00	.00	.00	0.
1	0705	86	.00	.00	.00	22.	*	1	1935	236	.00	.00	.00	0.
1	0710	87	.00	.00	.00	13.	*	1	1940	237	.00	.00	.00	0.
1	0715	88	.00	.00	.00	9.	*	1	1945	238	.00	.00	.00	0.
1	0720	89	.00	.00	.00	6.	*	1	1950	239	.00	.00	.00	0.
1	0725	90	.00	.00	.00	3.	*	1	1955	240	.00	.00	.00	0.
1	0730	91	.00	.00	.00	0.	*	1	2000	241	.00	.00	.00	0.
1	0735	92	.00	.00	.00	0.	*	1	2005	242	.00	.00	.00	0.
1	0740	93	.00	.00	.00	0.	*	1	2010	243	.00	.00	.00	0.
1	0745	94	.00	.00	.00	0.	*	1	2015	244	.00	.00	.00	0.
1	0750	95	.00	.00	.00	0.	*	1	2020	245	.00	.00	.00	0.
1	0755	96	.00	.00	.00	0.	*	1	2025	246	.00	.00	.00	0.
1	0800	97	.00	.00	.00	0.	*	1	2030	247	.00	.00	.00	0.
1	0805	98	.00	.00	.00	0.	*	1	2035	248	.00	.00	.00	0.
1	0810	99	.00	.00	.00	0.	*	1	2040	249	.00	.00	.00	0.
1	0815	100	.00	.00	.00	0.	*	1	2045	250	.00	.00	.00	0.
1	0820	101	.00	.00	.00	0.	*	1	2050	251	.00	.00	.00	0.
1	0825	102	.00	.00	.00	0.	*	1	2055	252	.00	.00	.00	0.
1	0830	103	.00	.00	.00	0.	*	1	2100	253	.00	.00	.00	0.
1	0835	104	.00	.00	.00	0.	*	1	2105	254	.00	.00	.00	0.
1	0840	105	.00	.00	.00	0.	*	1	2110	255	.00	.00	.00	0.
1	0845	106	.00	.00	.00	0.	*	1	2115	256	.00	.00	.00	0.
1	0850	107	.00	.00	.00	0.	*	1	2120	257	.00	.00	.00	0.
1	0855	108	.00	.00	.00	0.	*	1	2125	258	.00	.00	.00	0.
1	0900	109	.00	.00	.00	0.	*	1	2130	259	.00	.00	.00	0.
1	0905	110	.00	.00	.00	0.	*	1	2135	260	.00	.00	.00	0.
1	0910	111	.00	.00	.00	0.	*	1	2140	261	.00	.00	.00	0.
1	0915	112	.00	.00	.00	0.	*	1	2145	262	.00	.00	.00	0.
1	0920	113	.00	.00	.00	0.	*	1	2150	263	.00	.00	.00	0.
1	0925	114	.00	.00	.00	0.	*	1	2155	264	.00	.00	.00	0.
1	0930	115	.00	.00	.00	0.	*	1	2200	265	.00	.00	.00	0.
1	0935	116	.00	.00	.00	0.	*	1	2205	266	.00	.00	.00	0.
1	0940	117	.00	.00	.00	0.	*	1	2210	267	.00	.00	.00	0.
1	0945	118	.00	.00	.00	0.	*	1	2215	268	.00	.00	.00	0.
1	0950	119	.00	.00	.00	0.	*	1	2220	269	.00	.00	.00	0.
1	0955	120	.00	.00	.00	0.	*	1	2225	270	.00	.00	.00	0.
1	1000	121	.00	.00	.00	0.	*	1	2230	271	.00	.00	.00	0.
1	1005	122	.00	.00	.00	0.	*	1	2235	272	.00	.00	.00	0.
1	1010	123	.00	.00	.00	0.	*	1	2240	273	.00	.00	.00	0.
1	1015	124	.00	.00	.00	0.	*	1	2245	274	.00	.00	.00	0.

1	1020	125	.00	.00	.00	0.	*	1	2250	275	.00	.00	.00	0.
1	1025	126	.00	.00	.00	0.	*	1	2255	276	.00	.00	.00	0.
1	1030	127	.00	.00	.00	0.	*	1	2300	277	.00	.00	.00	0.
1	1035	128	.00	.00	.00	0.	*	1	2305	278	.00	.00	.00	0.
1	1040	129	.00	.00	.00	0.	*	1	2310	279	.00	.00	.00	0.
1	1045	130	.00	.00	.00	0.	*	1	2315	280	.00	.00	.00	0.
1	1050	131	.00	.00	.00	0.	*	1	2320	281	.00	.00	.00	0.
1	1055	132	.00	.00	.00	0.	*	1	2325	282	.00	.00	.00	0.
1	1100	133	.00	.00	.00	0.	*	1	2330	283	.00	.00	.00	0.
1	1105	134	.00	.00	.00	0.	*	1	2335	284	.00	.00	.00	0.
1	1110	135	.00	.00	.00	0.	*	1	2340	285	.00	.00	.00	0.
1	1115	136	.00	.00	.00	0.	*	1	2345	286	.00	.00	.00	0.
1	1120	137	.00	.00	.00	0.	*	1	2350	287	.00	.00	.00	0.
1	1125	138	.00	.00	.00	0.	*	1	2355	288	.00	.00	.00	0.
1	1130	139	.00	.00	.00	0.	*	2	0000	289	.00	.00	.00	0.
1	1135	140	.00	.00	.00	0.	*	2	0005	290	.00	.00	.00	0.
1	1140	141	.00	.00	.00	0.	*	2	0010	291	.00	.00	.00	0.
1	1145	142	.00	.00	.00	0.	*	2	0015	292	.00	.00	.00	0.
1	1150	143	.00	.00	.00	0.	*	2	0020	293	.00	.00	.00	0.
1	1155	144	.00	.00	.00	0.	*	2	0025	294	.00	.00	.00	0.
1	1200	145	.00	.00	.00	0.	*	2	0030	295	.00	.00	.00	0.
1	1205	146	.00	.00	.00	0.	*	2	0035	296	.00	.00	.00	0.
1	1210	147	.00	.00	.00	0.	*	2	0040	297	.00	.00	.00	0.
1	1215	148	.00	.00	.00	0.	*	2	0045	298	.00	.00	.00	0.
1	1220	149	.00	.00	.00	0.	*	2	0050	299	.00	.00	.00	0.
1	1225	150	.00	.00	.00	0.	*	2	0055	300	.00	.00	.00	0.
							*							

****

TOTAL RAINFALL = 12.67, TOTAL LOSS = 2.30, TOTAL EXCESS = 10.37

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
(CFS)	(HR)		6-HR	24-HR	72-HR	24.92-HR
19917.	4.33	(CFS)	3751.	938.	903.	903.
		(INCHES)	10.348	10.348	10.348	10.348
		(AC-FT)	1860.	1860.	1860.	1860.

CUMULATIVE AREA = 3.37 SQ MI

****

HYDROGRAPH AT STATION

PLAN 1, RATIO = .50

****

DA	MON	HRMN	ORD	FLOW	*	DA	MON	HRMN	ORD	FLOW	*	DA	MON	HRMN	ORD	FLOW	*	DA	MON	HRMN	ORD	FLOW
1		0000	1	0.	*	1		0615	76	331.	*	1		1230	151	0.	*	1		1845	226	0.
1		0005	2	0.	*	1		0620	77	297.	*	1		1235	152	0.	*	1		1850	227	0.
1		0010	3	0.	*	1		0625	78	255.	*	1		1240	153	0.	*	1		1855	228	0.
1		0015	4	0.	*	1		0630	79	195.	*	1		1245	154	0.	*	1		1900	229	0.
1		0020	5	0.	*	1		0635	80	140.	*	1		1250	155	0.	*	1		1905	230	0.
1		0025	6	0.	*	1		0640	81	98.	*	1		1255	156	0.	*	1		1910	231	0.
1		0030	7	0.	*	1		0645	82	66.	*	1		1300	157	0.	*	1		1915	232	0.
1		0035	8	0.	*	1		0650	83	41.	*	1		1305	158	0.	*	1		1920	233	0.
1		0040	9	0.	*	1		0655	84	26.	*	1		1310	159	0.	*	1		1925	234	0.
1		0045	10	0.	*	1		0700	85	18.	*	1		1315	160	0.	*	1		1930	235	0.
1		0050	11	0.	*	1		0705	86	11.	*	1		1320	161	0.	*	1		1935	236	0.

1	0055	12	0.	*	1	0710	87	6.	*	1	1325	162	0.	*	1	1940	237	0.
	0100	13	0.	*	1	0715	88	5.	*	1	1330	163	0.	*	1	1945	238	0.
	0105	14	0.	*	1	0720	89	3.	*	1	1335	164	0.	*	1	1950	239	0.
1	0110	15	0.	*	1	0725	90	2.	*	1	1340	165	0.	*	1	1955	240	0.
1	0115	16	0.	*	1	0730	91	0.	*	1	1345	166	0.	*	1	2000	241	0.
	0120	17	0.	*	1	0735	92	0.	*	1	1350	167	0.	*	1	2005	242	0.
1	0125	18	0.	*	1	0740	93	0.	*	1	1355	168	0.	*	1	2010	243	0.
1	0130	19	0.	*	1	0745	94	0.	*	1	1400	169	0.	*	1	2015	244	0.
	0135	20	0.	*	1	0750	95	0.	*	1	1405	170	0.	*	1	2020	245	0.
	0140	21	0.	*	1	0755	96	0.	*	1	1410	171	0.	*	1	2025	246	0.
1	0145	22	0.	*	1	0800	97	0.	*	1	1415	172	0.	*	1	2030	247	0.
1	0150	23	0.	*	1	0805	98	0.	*	1	1420	173	0.	*	1	2035	248	0.
	0155	24	0.	*	1	0810	99	0.	*	1	1425	174	0.	*	1	2040	249	0.
1	0200	25	0.	*	1	0815	100	0.	*	1	1430	175	0.	*	1	2045	250	0.
1	0205	26	0.	*	1	0820	101	0.	*	1	1435	176	0.	*	1	2050	251	0.
	0210	27	1.	*	1	0825	102	0.	*	1	1440	177	0.	*	1	2055	252	0.
	0215	28	2.	*	1	0830	103	0.	*	1	1445	178	0.	*	1	2100	253	0.
1	0220	29	5.	*	1	0835	104	0.	*	1	1450	179	0.	*	1	2105	254	0.
	0225	30	10.	*	1	0840	105	0.	*	1	1455	180	0.	*	1	2110	255	0.
	0230	31	20.	*	1	0845	106	0.	*	1	1500	181	0.	*	1	2115	256	0.
1	0235	32	35.	*	1	0850	107	0.	*	1	1505	182	0.	*	1	2120	257	0.
1	0240	33	56.	*	1	0855	108	0.	*	1	1510	183	0.	*	1	2125	258	0.
	0245	34	86.	*	1	0900	109	0.	*	1	1515	184	0.	*	1	2130	259	0.
1	0250	35	124.	*	1	0905	110	0.	*	1	1520	185	0.	*	1	2135	260	0.
1	0255	36	171.	*	1	0910	111	0.	*	1	1525	186	0.	*	1	2140	261	0.
	0300	37	234.	*	1	0915	112	0.	*	1	1530	187	0.	*	1	2145	262	0.
	0305	38	318.	*	1	0920	113	0.	*	1	1535	188	0.	*	1	2150	263	0.
1	0310	39	427.	*	1	0925	114	0.	*	1	1540	189	0.	*	1	2155	264	0.
1	0315	40	587.	*	1	0930	115	0.	*	1	1545	190	0.	*	1	2200	265	0.
	0320	41	798.	*	1	0935	116	0.	*	1	1550	191	0.	*	1	2205	266	0.
1	0325	42	1070.	*	1	0940	117	0.	*	1	1555	192	0.	*	1	2210	267	0.
1	0330	43	1478.	*	1	0945	118	0.	*	1	1600	193	0.	*	1	2215	268	0.
	0335	44	1994.	*	1	0950	119	0.	*	1	1605	194	0.	*	1	2220	269	0.
	0340	45	2626.	*	1	0955	120	0.	*	1	1610	195	0.	*	1	2225	270	0.
1	0345	46	3537.	*	1	1000	121	0.	*	1	1615	196	0.	*	1	2230	271	0.
	0350	47	4536.	*	1	1005	122	0.	*	1	1620	197	0.	*	1	2235	272	0.
	0355	48	5590.	*	1	1010	123	0.	*	1	1625	198	0.	*	1	2240	273	0.
1	0400	49	6942.	*	1	1015	124	0.	*	1	1630	199	0.	*	1	2245	274	0.
1	0405	50	8146.	*	1	1020	125	0.	*	1	1635	200	0.	*	1	2250	275	0.
	0410	51	9019.	*	1	1025	126	0.	*	1	1640	201	0.	*	1	2255	276	0.
1	0415	52	9649.	*	1	1030	127	0.	*	1	1645	202	0.	*	1	2300	277	0.
1	0420	53	9958.	*	1	1035	128	0.	*	1	1650	203	0.	*	1	2305	278	0.
	0425	54	9806.	*	1	1040	129	0.	*	1	1655	204	0.	*	1	2310	279	0.
	0430	55	9051.	*	1	1045	130	0.	*	1	1700	205	0.	*	1	2315	280	0.
1	0435	56	8160.	*	1	1050	131	0.	*	1	1705	206	0.	*	1	2320	281	0.
1	0440	57	7235.	*	1	1055	132	0.	*	1	1710	207	0.	*	1	2325	282	0.
	0445	58	6079.	*	1	1100	133	0.	*	1	1715	208	0.	*	1	2330	283	0.
1	0450	59	5007.	*	1	1105	134	0.	*	1	1720	209	0.	*	1	2335	284	0.
1	0455	60	4161.	*	1	1110	135	0.	*	1	1725	210	0.	*	1	2340	285	0.
	0500	61	3378.	*	1	1115	136	0.	*	1	1730	211	0.	*	1	2345	286	0.
1	0505	62	2679.	*	1	1120	137	0.	*	1	1735	212	0.	*	1	2350	287	0.
1	0510	63	2143.	*	1	1125	138	0.	*	1	1740	213	0.	*	1	2355	288	0.
	0515	64	1692.	*	1	1130	139	0.	*	1	1745	214	0.	*	2	0000	289	0.
	0520	65	1295.	*	1	1135	140	0.	*	1	1750	215	0.	*	2	0005	290	0.
1	0525	66	1001.	*	1	1140	141	0.	*	1	1755	216	0.	*	2	0010	291	0.
1	0530	67	793.	*	1	1145	142	0.	*	1	1800	217	0.	*	2	0015	292	0.
	0535	68	644.	*	1	1150	143	0.	*	1	1805	218	0.	*	2	0020	293	0.
1	0540	69	540.	*	1	1155	144	0.	*	1	1810	219	0.	*	2	0025	294	0.
1	0545	70	472.	*	1	1200	145	0.	*	1	1815	220	0.	*	2	0030	295	0.
	0550	71	433.	*	1	1205	146	0.	*	1	1820	221	0.	*	2	0035	296	0.

1	0555	72	405.	*	1	1210	147	0.	*	1	1825	222	0.	*	2	0040	297	0.
1	0600	73	393.	*	1	1215	148	0.	*	1	1830	223	0.	*	2	0045	298	0.
1	0605	74	382.	*	1	1220	149	0.	*	1	1835	224	0.	*	2	0050	299	0.
1	0610	75	364.	*	1	1225	150	0.	*	1	1840	225	0.	*	2	0055	300	0.
				*					*					*				

****

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
(CFS)	(HR)		6-HR	24-HR	72-HR	24.92-HR
9958.	4.33	(CFS)	1875.	469.	452.	452.
		(INCHES)	5.174	5.174	5.174	5.174
		(AC-FT)	930.	930.	930.	930.

CUMULATIVE AREA = 3.37 SQ MI

*** ***

```
        ***************
        *             *
32 KK   *    DET-HV   *
        *             *
        ***************

39 KO        OUTPUT CONTROL VARIABLES
                   IPRNT          2  PRINT CONTROL
                   IPLOT          0  PLOT CONTROL
                   QSCAL         0.  HYDROGRAPH PLOT SCALE

             HYDROGRAPH ROUTING DATA

34 RS        STORAGE ROUTING
                   NSTPS          1  NUMBER OF SUBREACHES
                    ITYP       STOR  TYPE OF INITIAL CONDITION
                  RSVRIC        .00  INITIAL CONDITION
                       X        .00 WORKING R AND D COEFFICIENT

35 SA              AREA        3.5       9.6      11.5      13.0      14.4      15.8      17.3      18.9      19.6

   SE        ELEVATION     2060.00   2065.00   2070.00   2075.00   2080.00   2085.00   2090.00   2095.00   2098.00

37 SL        LOW-LEVEL OUTLET
                   ELEVL    2060.00  ELEVATION AT CENTER OF OUTLET
                   CAREA       3.00  CROSS-SECTIONAL AREA
                    COQL        .60  COEFFICIENT
                    EXPL        .50  EXPONENT OF HEAD

38 SS        SPILLWAY
                    CREL    2090.00  SPILLWAY CREST ELEVATION
                   SPWID     300.00  SPILLWAY WIDTH
                    COQW       3.00  WEIR COEFFICIENT
                    EXPW       1.50  EXPONENT OF HEAD
```

***

COMPUTED STORAGE-ELEVATION DATA

STORAGE	.00	31.72	84.63	145.87	214.19	289.64	372.41	462.88	520.63	
ELEVATION	2060.00	2065.00	2070.00	2075.00	2080.00	2085.00	2090.00	2095.00	2098.00	

COMPUTED OUTFLOW-ELEVATION DATA

OUTFLOW	.00	14.46	16.11	18.17	20.85	24.45	29.56	37.35	50.74	79.07
ELEVATION	2060.00	2061.00	2061.24	2061.58	2062.09	2062.87	2064.19	2066.69	2072.35	2090.00
OUTFLOW	99.76	243.02	631.23	1385.99	2630.05	4484.64	7072.22	10514.86	14934.65	20453.67
ELEVATION	2090.08	2090.32	2090.72	2091.28	2092.00	2092.88	2093.92	2095.12	2096.48	2098.00

COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

STORAGE	.00	4.04	5.16	6.85	9.57	14.42	24.41	31.72	48.60	84.63
OUTFLOW	.00	14.46	16.11	18.17	20.85	24.45	29.56	32.28	37.35	45.65
ELEVATION	2060.00	2061.00	2061.24	2061.58	2062.09	2062.87	2064.19	2065.00	2066.69	2070.00
STORAGE	112.55	145.87	214.19	289.64	372.41	373.80	377.97	384.97	394.83	407.66
OUTFLOW	50.74	55.91	64.56	72.18	79.07	99.76	243.02	631.23	1385.99	2630.05
ELEVATION	2072.35	2075.00	2080.00	2085.00	2090.00	2090.08	2090.32	2090.72	2091.28	2092.00
STORAGE	423.57	442.68	462.88	465.16	491.11	520.63				
OUTFLOW	4484.64	7072.22	10147.71	10514.86	14934.65	20453.67				
ELEVATION	2092.88	2093.92	2095.00	2095.12	2096.48	2098.00				

****

HYDROGRAPH AT STATION DET-HV
PLAN 1, RATIO = .50

****

DA MON	HRMN	ORD	OUTFLOW	STORAGE	STAGE	*	DA MON	HRMN	ORD	OUTFLOW	STORAGE	STAGE	*	DA MON	HRMN	ORD	OUTFLOW	STORAGE	STAGE
1	0000	1	0.	.0	2060.0	*	1	0820	101	78.	365.4	2089.6	*	1	1640	201	74.	312.9	2086.4
1	0005	2	0.	.0	2060.0	*	1	0825	102	78.	364.9	2089.5	*	1	1645	202	74.	312.4	2086.4
1	0010	3	0.	.0	2060.0	*	1	0830	103	78.	364.4	2089.5	*	1	1650	203	74.	311.9	2086.3
1	0015	4	0.	.0	2060.0	*	1	0835	104	78.	363.8	2089.5	*	1	1655	204	74.	311.4	2086.3
1	0020	5	0.	.0	2060.0	*	1	0840	105	78.	363.3	2089.4	*	1	1700	205	74.	310.9	2086.3
1	0025	6	0.	.0	2060.0	*	1	0845	106	78.	362.7	2089.4	*	1	1705	206	74.	310.4	2086.3
1	0030	7	0.	.0	2060.0	*	1	0850	107	78.	362.2	2089.4	*	1	1710	207	74.	309.8	2086.2
1	0035	8	0.	.0	2060.0	*	1	0855	108	78.	361.7	2089.4	*	1	1715	208	74.	309.3	2086.2
1	0040	9	0.	.0	2060.0	*	1	0900	109	78.	361.1	2089.3	*	1	1720	209	74.	308.8	2086.2
1	0045	10	0.	.0	2060.0	*	1	0905	110	78.	360.6	2089.3	*	1	1725	210	74.	308.3	2086.1
1	0050	11	0.	.0	2060.0	*	1	0910	111	78.	360.0	2089.3	*	1	1730	211	74.	307.8	2086.1
1	0055	12	0.	.0	2060.0	*	1	0915	112	78.	359.5	2089.2	*	1	1735	212	74.	307.3	2086.1
1	0100	13	0.	.0	2060.0	*	1	0920	113	78.	359.0	2089.2	*	1	1740	213	74.	306.8	2086.0
1	0105	14	0.	.0	2060.0	*	1	0925	114	78.	358.4	2089.2	*	1	1745	214	74.	306.3	2086.0
1	0110	15	0.	.0	2060.0	*	1	0930	115	78.	357.9	2089.1	*	1	1750	215	74.	305.8	2086.0
1	0115	16	0.	.0	2060.0	*	1	0935	116	78.	357.4	2089.1	*	1	1755	216	73.	305.3	2085.9
1	0120	17	0.	.0	2060.0	*	1	0940	117	78.	356.8	2089.1	*	1	1800	217	73.	304.8	2085.9
1	0125	18	0.	.0	2060.0	*	1	0945	118	78.	356.3	2089.0	*	1	1805	218	73.	304.3	2085.9
1	0130	19	0.	.0	2060.0	*	1	0950	119	78.	355.8	2089.0	*	1	1810	219	73.	303.8	2085.9
1	0135	20	0.	.0	2060.0	*	1	0955	120	78.	355.2	2089.0	*	1	1815	220	73.	303.3	2085.8
1	0140	21	0.	.0	2060.0	*	1	1000	121	78.	354.7	2088.9	*	1	1820	221	73.	302.8	2085.8
1	0145	22	0.	.0	2060.0	*	1	1005	122	78.	354.2	2088.9	*	1	1825	222	73.	302.2	2085.8
1	0150	23	0.	.0	2060.0	*	1	1010	123	78.	353.6	2088.9	*	1	1830	223	73.	301.7	2085.7
1	0155	24	0.	.0	2060.0	*	1	1015	124	77.	353.1	2088.8	*	1	1835	224	73.	301.2	2085.7
1	0200	25	0.	.0	2060.0	*	1	1020	125	77.	352.6	2088.8	*	1	1840	225	73.	300.7	2085.7

1	0205	26	0.	.0	2060.0	*	1	1025	126	77.	352.0	2088.8	*	1	1845	226	73.	300.2	2085.6
1	0210	27	0.	.0	2060.0	*	1	1030	127	77.	351.5	2088.7	*	1	1850	227	73.	299.7	2085.6
1	0215	28	0.	.0	2060.0	*	1	1035	128	77.	351.0	2088.7	*	1	1855	228	73.	299.2	2085.6
1	0220	29	0.	.0	2060.0	*	1	1040	129	77.	350.4	2088.7	*	1	1900	229	73.	298.7	2085.5
1	0225	30	0.	.1	2060.0	*	1	1045	130	77.	349.9	2088.6	*	1	1905	230	73.	298.2	2085.5
1	0230	31	1.	.2	2060.0	*	1	1050	131	77.	349.4	2088.6	*	1	1910	231	73.	297.7	2085.5
1	0235	32	1.	.4	2060.1	*	1	1055	132	77.	348.8	2088.6	*	1	1915	232	73.	297.2	2085.5
1	0240	33	2.	.7	2060.2	*	1	1100	133	77.	348.3	2088.5	*	1	1920	233	73.	296.7	2085.4
1	0245	34	4.	1.1	2060.3	*	1	1105	134	77.	347.8	2088.5	*	1	1925	234	73.	296.2	2085.4
1	0250	35	7.	1.8	2060.5	*	1	1110	135	77.	347.2	2088.5	*	1	1930	235	73.	295.7	2085.4
1	0255	36	10.	2.8	2060.7	*	1	1115	136	77.	346.7	2088.4	*	1	1935	236	73.	295.2	2085.3
1	0300	37	15.	4.1	2061.0	*	1	1120	137	77.	346.2	2088.4	*	1	1940	237	73.	294.7	2085.3
1	0305	38	17.	5.9	2061.4	*	1	1125	138	77.	345.6	2088.4	*	1	1945	238	73.	294.2	2085.3
1	0310	39	20.	8.3	2061.9	*	1	1130	139	77.	345.1	2088.4	*	1	1950	239	73.	293.7	2085.2
1	0315	40	22.	11.7	2062.4	*	1	1135	140	77.	344.6	2088.3	*	1	1955	240	72.	293.2	2085.2
1	0320	41	25.	16.3	2063.1	*	1	1140	141	77.	344.1	2088.3	*	1	2000	241	72.	292.7	2085.2
1	0325	42	29.	22.5	2063.9	*	1	1145	142	77.	343.5	2088.3	*	1	2005	242	72.	292.2	2085.2
1	0330	43	32.	31.1	2064.9	*	1	1150	143	77.	343.0	2088.2	*	1	2010	243	72.	291.7	2085.1
1	0335	44	36.	42.8	2066.1	*	1	1155	144	77.	342.5	2088.2	*	1	2015	244	72.	291.2	2085.1
1	0340	45	40.	58.5	2067.6	*	1	1200	145	77.	342.0	2088.2	*	1	2020	245	72.	290.7	2085.1
1	0345	46	44.	79.4	2069.5	*	1	1205	146	76.	341.4	2088.1	*	1	2025	246	72.	290.2	2085.0
1	0350	47	50.	106.9	2071.9	*	1	1210	147	76.	340.9	2088.1	*	1	2030	247	72.	289.7	2085.0
1	0355	48	55.	141.4	2074.6	*	1	1215	148	76.	340.4	2088.1	*	1	2035	248	72.	289.2	2085.0
1	0400	49	61.	184.1	2077.8	*	1	1220	149	76.	339.8	2088.0	*	1	2040	249	72.	288.7	2084.9
1	0405	50	67.	235.6	2081.4	*	1	1225	150	76.	339.3	2088.0	*	1	2045	250	72.	288.2	2084.9
1	0410	51	73.	294.3	2085.3	*	1	1230	151	76.	338.8	2088.0	*	1	2050	251	72.	287.7	2084.9
1	0415	52	78.	358.0	2089.1	*	1	1235	152	76.	338.3	2087.9	*	1	2055	252	72.	287.2	2084.8
1	0420	53	3343.	413.8	2092.3	*	1	1240	153	76.	337.7	2087.9	*	1	2100	253	72.	286.8	2084.8
1	0425	54	7401.	444.8	2094.0	*	1	1245	154	76.	337.2	2087.9	*	1	2105	254	72.	286.3	2084.8
1	0430	55	8796.	454.0	2094.5	*	1	1250	155	76.	336.7	2087.8	*	1	2110	255	72.	285.8	2084.7
1	0435	56	8665.	453.1	2094.5	*	1	1255	156	76.	336.2	2087.8	*	1	2115	256	72.	285.3	2084.7
1	0440	57	7999.	448.8	2094.2	*	1	1300	157	76.	335.6	2087.8	*	1	2120	257	72.	284.8	2084.7
1	0445	58	7076.	442.7	2093.9	*	1	1305	158	76.	335.1	2087.7	*	1	2125	258	72.	284.3	2084.6
1	0450	59	6101.	435.5	2093.5	*	1	1310	159	76.	334.6	2087.7	*	1	2130	259	72.	283.8	2084.6
1	0455	60	5136.	428.4	2093.1	*	1	1315	160	76.	334.1	2087.7	*	1	2135	260	72.	283.3	2084.6
1	0500	61	4289.	421.9	2092.8	*	1	1320	161	76.	333.6	2087.7	*	1	2140	261	71.	282.8	2084.5
1	0505	62	3567.	415.7	2092.4	*	1	1325	162	76.	333.0	2087.6	*	1	2145	262	71.	282.3	2084.5
1	0510	63	2905.	410.0	2092.1	*	1	1330	163	76.	332.5	2087.6	*	1	2150	263	71.	281.8	2084.5
1	0515	64	2376.	405.0	2091.9	*	1	1335	164	76.	332.0	2087.6	*	1	2155	264	71.	281.3	2084.4
1	0520	65	1934.	400.5	2091.6	*	1	1340	165	76.	331.5	2087.5	*	1	2200	265	71.	280.8	2084.4
1	0525	66	1541.	396.4	2091.4	*	1	1345	166	76.	330.9	2087.5	*	1	2205	266	71.	280.3	2084.4
1	0530	67	1246.	393.0	2091.2	*	1	1350	167	76.	330.4	2087.5	*	1	2210	267	71.	279.9	2084.4
1	0535	68	1026.	390.1	2091.0	*	1	1355	168	76.	329.9	2087.4	*	1	2215	268	71.	279.4	2084.3
1	0540	69	845.	387.8	2090.9	*	1	1400	169	75.	329.4	2087.4	*	1	2220	269	71.	278.9	2084.3
1	0545	70	704.	385.9	2090.8	*	1	1405	170	75.	328.9	2087.4	*	1	2225	270	71.	278.4	2084.3
1	0550	71	606.	384.5	2090.7	*	1	1410	171	75.	328.3	2087.3	*	1	2230	271	71.	277.9	2084.2
1	0555	72	546.	383.4	2090.6	*	1	1415	172	75.	327.8	2087.3	*	1	2235	272	71.	277.4	2084.2
1	0600	73	499.	382.6	2090.6	*	1	1420	173	75.	327.3	2087.3	*	1	2240	273	71.	276.9	2084.2
1	0605	74	463.	381.9	2090.5	*	1	1425	174	75.	326.8	2087.2	*	1	2245	274	71.	276.4	2084.1
1	0610	75	434.	381.4	2090.5	*	1	1430	175	75.	326.3	2087.2	*	1	2250	275	71.	275.9	2084.1
1	0615	76	406.	380.9	2090.5	*	1	1435	176	75.	325.8	2087.2	*	1	2255	276	71.	275.5	2084.1
1	0620	77	377.	380.4	2090.5	*	1	1440	177	75.	325.2	2087.2	*	1	2300	277	71.	275.0	2084.0
1	0625	78	344.	379.8	2090.4	*	1	1445	178	75.	324.7	2087.1	*	1	2305	278	71.	274.5	2084.0
1	0630	79	306.	379.1	2090.4	*	1	1450	179	75.	324.2	2087.1	*	1	2310	279	71.	274.0	2084.0
1	0635	80	262.	378.3	2090.3	*	1	1455	180	75.	323.7	2087.1	*	1	2315	280	71.	273.5	2083.9
1	0640	81	225.	377.5	2090.3	*	1	1500	181	75.	323.2	2087.0	*	1	2320	281	71.	273.0	2083.9
1	0645	82	195.	376.6	2090.2	*	1	1505	182	75.	322.7	2087.0	*	1	2325	282	70.	272.5	2083.9
1	0650	83	165.	375.7	2090.2	*	1	1510	183	75.	322.1	2087.0	*	1	2330	283	70.	272.1	2083.8
1	0655	84	137.	374.9	2090.1	*	1	1515	184	75.	321.6	2086.9	*	1	2335	284	70.	271.6	2083.8
1	0700	85	113.	374.2	2090.1	*	1	1520	185	75.	321.1	2086.9	*	1	2340	285	70.	271.1	2083.8

1	0705	86	96.	373.6	2090.1	1	1525	186	75.	320.6	2086.9	1	2345	286	70.	270.6	2083.7
1	0710	87	88.	373.0	2090.0	1	1530	187	75.	320.1	2086.8	1	2350	287	70.	270.1	2083.7
1	0715	88	80.	372.4	2090.0	1	1535	188	75.	319.6	2086.8	1	2355	288	70.	269.6	2083.7
1	0720	89	79.	371.9	2090.0	1	1540	189	75.	319.0	2086.8	2	0000	289	70.	269.2	2083.6
1	0725	90	79.	371.4	2089.9	1	1545	190	75.	318.5	2086.7	2	0005	290	70.	268.7	2083.6
1	0730	91	79.	370.9	2089.9	1	1550	191	75.	318.0	2086.7	2	0010	291	70.	268.2	2083.6
1	0735	92	79.	370.3	2089.9	1	1555	192	74.	317.5	2086.7	2	0015	292	70.	267.7	2083.5
1	0740	93	79.	369.8	2089.8	1	1600	193	74.	317.0	2086.7	2	0020	293	70.	267.2	2083.5
1	0745	94	79.	369.2	2089.8	1	1605	194	74.	316.5	2086.6	2	0025	294	70.	266.7	2083.5
1	0750	95	79.	368.7	2089.8	1	1610	195	74.	316.0	2086.6	2	0030	295	70.	266.3	2083.5
1	0755	96	79.	368.1	2089.7	1	1615	196	74.	315.5	2086.6	2	0035	296	70.	265.8	2083.4
1	0800	97	79.	367.6	2089.7	1	1620	197	74.	314.9	2086.5	2	0040	297	70.	265.3	2083.4
1	0805	98	79.	367.1	2089.7	1	1625	198	74.	314.4	2086.5	2	0045	298	70.	264.8	2083.4
1	0810	99	79.	366.5	2089.6	1	1630	199	74.	313.9	2086.5	2	0050	299	70.	264.3	2083.3
1	0815	100	79.	366.0	2089.6	1	1635	200	74.	313.4	2086.4	2	0055	300	70.	263.9	2083.3

****

E FLOW	TIME		MAXIMUM AVERAGE FLOW			
S)	(HR)		6-HR	24-HR	72-HR	24.92-HR
8796.	4.50	(CFS)	1154.	336.	323.	323.
		(INCHES)	3.185	3.706	3.706	3.706
		(AC-FT)	572.	666.	666.	666.

AK STORAGE	TIME	MAXIMUM AVERAGE STORAGE			
(FT)	(HR)	6-HR	24-HR	72-HR	24.92-HR
454.	4.50	380.	288.	277.	277.

E STAGE	TIME	MAXIMUM AVERAGE STAGE			
EET)	(HR)	6-HR	24-HR	72-HR	24.92-HR
2094.53	4.50	2090.43	2084.06	2083.17	2083.17

CUMULATIVE AREA = 3.37 SQ MI

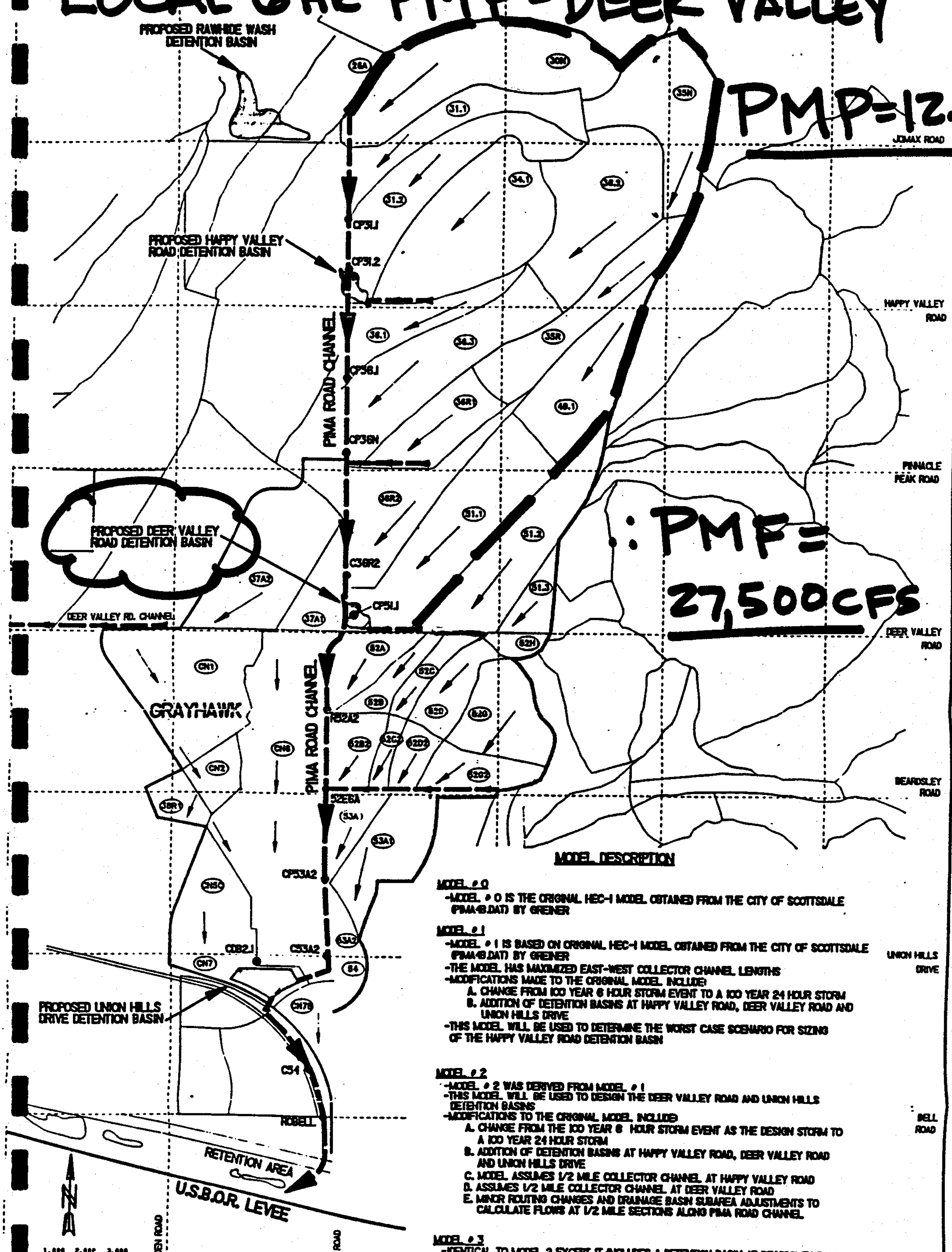
PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND, AREA IN SQUARE MILES
TIME TO PEAK IN HOURS

E TION	STATION	AREA	PLAN		RATIOS APPLIED TO FLOWS RATIO 1 .50
D GRAPH AT		3.37	1	FLOW	9958.
				TIME	4.33
UTED TO	DET-HV	3.37	1	FLOW	8796.
				TIME	4.50
			** PEAK STAGES IN FEET **		
			1	STAGE	2094.53
				TIME	4.50

** NORMAL END OF HEC-1 ***
ORMAL END OF HEC-1

LOCAL 6HR PMP-DEER VALLEY

PMP=12.12"



MODEL DESCRIPTION

MODEL # 0

- MODEL # 0 IS THE ORIGINAL HEC-I MODEL OBTAINED FROM THE CITY OF SCOTTSDALE (PIMA48.DAT) BY GREINER

MODEL # 1

- MODEL # 1 IS BASED ON ORIGINAL HEC-I MODEL OBTAINED FROM THE CITY OF SCOTTSDALE (PIMA48.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

MODEL-2 WATERSHED DRAINAGE MAP WITH HAPPY VALLEY, DEER VALLEY AND UNION HILLS DETENTION BASINS	DRAWN S.S.	PACE
	CHKD M.E.K.	

DV-2

LOCAL STORM PMP – 6 HOUR

SINGLE DRAINAGE BASIN MODEL – DEER VALLEY BASIN

Table 6.3B.—Local-storm PMP computation, Colorado River and Great Basin, and California drainages. (Giving areal distribution of PMP).

Steps correspond to those in sec. 6.3B.

1. Place idealized isohyetal pattern [fig. 4.10] over drainage adjusted to 1:500,000 scale to obtain most critical placement.
2. Note the isohyets within drainage.
3. Average 1-hr 1-mi^2 (2.6-km^2) PMP for drainage [fig. 4.5]. 9.32 in. (mm)
4. a. Reduction for elevation. [No adjustment for elevations up to 5,000 feet (1,524 m), 5% decrease per 1,000 feet (305 m) above 5,000 feet (1,524 m)]. 100 %

   b. Multiply step 3 by step 4a. 9.32 in. (mm)
5. Average 6/1-hr ratio for drainage [fig. 4.7]. 1.30
6. Obtain isohetal labels for 15-min incremental and the highest PMP from table 4.5 corresponding 6/1-hr ratio of step 5.

PMP Increment	Isohyet A	B	C	D	E	F	G	H	I	J	
Highest 1-hr	100										
Highest 15-min.	74										
2nd "	15										in %
3rd "	6										
4th "	5										

7. Obtain isohyetal labels in % of 1-hr PMP for 2nd to 6th highest hourly incremental PMP values from table 4.6 using 6/1-hr ratio of step 5.

	A	B	C	D	E	F	G	H	I	J	
2nd Highest 1-hr PMP	14										
3rd "	6										
4th "	5										in %
5th "	3										
6th "	2										

8. Multiply steps 6 and 7 by step 4b to get incremental isohyetal labels of PMP.

	A	B	C	D	E	F	G	H	I	J	
Highest 15-min.	6.90										
2nd "	1.40										
3rd "	.56										
4th "	.47										
Highest 1-hr	9.32										in in. (mm)
2nd "	1.30										
3rd "	.56										
4th "	.47										
5th "	.28										
6th "	.19										

9. Arrange values of step 8 in time sequence [tables 4.7 and 4.8].

6 HOUR DEPTH 12.12"

DV-1

PMP Local Storm Calculation for Deer Valley Road Detention Basin

- Average 1 hr. - 1 m^2 PMP for Watershed (figure 4.5 HMR 49) = 11.5"
- Total Area = 5.98 $mi.^2$
- From figure 4-10 Isohyet A = 1 $mi.^2$, B = 4.0 $mi.^2$, C = .98 $mi.^2$
- From table 4-5 Isohyet A = 100%, B = 82%, C = 58%
- PMP (average area weighting)

$$= (1/5.98)(100\%)(11.5) + (4/5.98)(82\%)(11.5) + \left(\frac{.98}{5.98}\right)(58\%)(11$$

$$= 1.92 + 6.31 + 1.09$$

$$= 9.32"$$

DEER Valley Rd.

$$L = 12.6(2000) = 4.8 \text{ miles}$$

$$L_{ca} = 6.6(2000) = 2.5 \text{ miles}$$

$$S = \frac{2680 - 1870}{4.8} = 168.8$$

Assume $K_n = 0.35$, $C = 24K_n$

$$Lag = C\left[\frac{L \cdot L_{ca}}{S^{1/2}}\right]^{.38} = 24(.035)\left[\frac{(4.8)(2.5)}{(168.8)^{1/2}}\right]^{.38} = .795 \text{ hours}$$

Per manual, reduce lag by 15%

$$Lag = (.795).85 = 0.68 \text{ hours} = \underline{41 \text{ minutes}}$$

DEER VALLEY DETENTION BASIN

PMP - 6 HOUR RUNOFF

(SINGLE DRAINAGE BASIN ASSUMPTION W/OUT HAPPY VALLEY DET. BASIN)

HEC-1 INPUT


```
ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

ID   Pima Road Detention Feasibility Study
ID
IT      5                   300
IO      5

KK
KM   BASIN Deer Valley
KM    THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
KM   L=      4.8  Lca=      2.5   S=  168.8  Kn= .035  LAG=  41.0
KM    PHOENIX VALLEY S-GRAPH WAS USED FOR THIS BASIN
BA   5.98
IN     15
KM   RAINFALL DEPTH OF12.12 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
KM   AN AREAL REDUCTION COEFFICIENT OF .956 WAS USED
PB   11.59
KM   THE FOLLOWING PC RECORD USED A 6-HOUR RAINFALL WITH PATTERN NO. 2.44
PC   .000    .012    .018    .027    .040    .051    .062    .073    .084    .095
PC   .108    .123    .144    .189    .275    .460    .684    .819    .886    .927
PC   .948    .962    .974    .988   1.000
LG    .15     .25    6.60     .16     .00
UI   491.    619.   1777.   2407.   2860.   3445.   4300.   6052.   5354.   4297.
UI  3604.   2944.   2404.   1717.    997.    825.    633.    491.    265.    151.
UI   151.    151.    151.    151.      0.      0.      0.      0.      0.      0.
UI     0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
ZZ
```

OUTPUT RESULTS SUMMARY

PEAK FLOW = 27,452 CFS ≈ **27,500 CFS**

TIME TO PEAK = 4.5 HR

VOLUME = ±2946 AF

BASIN AREA = 5.98 SM

WHIC OUT

∴ 0.5 PMF = ± 13,750 CFS

HEC1 S/N: 1333000063 HMVersion: 6.40 Data File: 05PMF-DV.hc1

```
*****************************************                         *****************************************
*                                       *                         *                                       *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                         *   U.S. ARMY CORPS OF ENGINEERS        *
*           SEPTEMBER 1990              *                         *   HYDROLOGIC ENGINEERING CENTER       *
*             VERSION 4.0               *                         *         609 SECOND STREET             *
*                                       *                         *       DAVIS, CALIFORNIA 95616         *
* RUN DATE  08/28/1995  TIME  14:04:00  *                         *           (916) 756-1104              *
*                                       *                         *                                       *
*****************************************                         *****************************************
```

```
X     X  XXXXXXX   XXXXX          X
X     X  X        X     X        XX
X     X  X        X               X
XXXXXXX  XXXX     X         XXXXX X
X     X  X        X               X
X     X  X        X     X         X
X     X  XXXXXXX   XXXXX         XXX
```

```
:::::::::::::::::::::::::::::::::::::::::
:::::::::::::::::::::::::::::::::::::::::
:::                                   :::
:::  Full Microcomputer Implementation :::
:::                by                 :::
:::       Haestad Methods, Inc.       :::
:::                                   :::
:::::::::::::::::::::::::::::::::::::::::
:::::::::::::::::::::::::::::::::::::::::
```

37 Brookside Road * Waterbury, Connecticut 06708 * (203) 755-1666

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

```
ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

ID                   Pima Road Detention Feasibility Study
ID              FILE 05PMF-DV.HV1
ID              PREPARED BY PACE 08-28-95
ID
ID              ROUTING 50% PMP THROUGH DEER VALLEY DETENTION BASIN WITH
ID              TRIBUTARY AREA MODELED AS A SINGLE BASIN
ID
ID
IT       5                 300
IO       5
JR    FLOW      .5

KK
KM   BASIN Deer Valley
KM    THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
KM    L=       4.8  Lca=      2.5   S=  168.8  Kn= .035  LAG=  41.0
KM    PHOENIX VALLEY S-GRAPH WAS USED FOR THIS BASIN
BA    5.98
IN      15
KM   RAINFALL DEPTH OF12.12 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
KM   AN AREAL REDUCTION COEFFICIENT OF .956 WAS USED
PB   11.59
KM   THE FOLLOWING PC RECORD USED A 6-HOUR RAINFALL WITH PATTERN NO. 2.44
PC    .000    .012    .018    .027    .040    .051    .062    .073    .084    .095
PC    .108    .123    .144    .189    .275    .460    .684    .819    .886    .927
PC    .948    .962    .974    .988   1.000
LG     .15     .25    6.60     .16     .00
UI    491.    619.   1777.   2407.   2860.   3445.   4300.   6052.   5354.   4297.
UI   3604.   2944.   2404.   1717.    997.    825.    633.    491.    265.    151.
UI    151.    151.    151.    151.      0.      0.      0.      0.      0.      0.
UI      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
KO       2

KK  DET-DV
KM              DETENTION BASIN AT DEER VALLEY ROAD
RS       1    FLOW      -1
SA     8.1     9.6      11    12.3    13.7    15.5    16.6    17.7
SE    1865    1870    1875    1880    1885    1890    1895    1898
SS    1890     500       3     1.5
SL    1865     8.2      .6      .5
KO       2
ZZ
```

HEC1 S/N: 1333000063   HMVersion: 6.40   Data File: 05PMF-DV.hc1

```
*****************************************                   *****************************************
*                                       *                   *                                       *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                   *     U.S. ARMY CORPS OF ENGINEERS      *
*            SEPTEMBER 1990             *                   *    HYDROLOGIC ENGINEERING CENTER      *
*              VERSION 4.0              *                   *          609 SECOND STREET            *
*                                       *                   *       DAVIS, CALIFORNIA 95616         *
*  RUN DATE  08/28/1995  TIME  14:04:00 *                   *           (916) 756-1104              *
*                                       *                   *                                       *
*****************************************                   *****************************************
```

```
                              Pima Road Detention Feasibility Study
                        FILE 05PMF-DV.HV1
                        PREPARED BY PACE 08-28-95

                        ROUTING 50% PMP THROUGH DEER VALLEY DETENTION BASIN WITH
                        TRIBUTARY AREA MODELED AS A SINGLE BASIN


 10 IO        OUTPUT CONTROL VARIABLES
                    IPRNT          5  PRINT CONTROL
                    IPLOT          0  PLOT CONTROL
                    QSCAL         0.  HYDROGRAPH PLOT SCALE

    IT        HYDROGRAPH TIME DATA
                     NMIN          5  MINUTES IN COMPUTATION INTERVAL
                    IDATE     1    0  STARTING DATE
                    ITIME       0000  STARTING TIME
                       NQ        300  NUMBER OF HYDROGRAPH ORDINATES
                   NDDATE     2    0  ENDING DATE
                   NDTIME       0055  ENDING TIME
                    ICENT         19  CENTURY MARK

             COMPUTATION INTERVAL     .08 HOURS
                  TOTAL TIME BASE   24.92 HOURS

        ENGLISH UNITS
            DRAINAGE AREA           SQUARE MILES
            PRECIPITATION DEPTH     INCHES
            LENGTH, ELEVATION       FEET
            FLOW                    CUBIC FEET PER SECOND
            STORAGE VOLUME          ACRE-FEET
            SURFACE AREA            ACRES
            TEMPERATURE             DEGREES FAHRENHEIT

    JP        MULTI-PLAN OPTION
                    NPLAN          1  NUMBER OF PLANS

    JR        MULTI-RATIO OPTION
                  RATIOS OF RUNOFF
                  .50
```

```
* *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

          ***************
          *             *
 12 KK    *             *
          *             *
          ***************

 31 KO          OUTPUT CONTROL VARIABLES
                      IPRNT          2  PRINT CONTROL
                      IPLOT          0  PLOT CONTROL
                      QSCAL         0.  HYDROGRAPH PLOT SCALE

              SUBBASIN RUNOFF DATA

 17 BA          SUBBASIN CHARACTERISTICS
                      TAREA       5.98  SUBBASIN AREA

                PRECIPITATION DATA

 22 PB                STORM      11.59  BASIN TOTAL PRECIPITATION

 22 PI            INCREMENTAL PRECIPITATION PATTERN
                        .00      .00      .00      .00      .00      .00      .00      .00      .00      .00
                        .00      .00      .00      .00      .00      .00      .00      .00      .00      .00
                        .00      .00      .00      .00      .00      .00      .00      .00      .00      .00
                        .01      .00      .01      .01      .01      .01      .02      .02      .02      .03
                        .03      .03      .06      .06      .06      .07      .07      .07      .05      .04
                        .05      .02      .02      .02      .01      .01      .01      .01      .01      .01
                        .00      .00      .00      .00      .00      .00      .00      .00      .00      .00
                        .00      .00

 26 LG          GREEN AND AMPT LOSS RATE
                      STRTL        .15  STARTING LOSS
                        DTH        .25  MOISTURE DEFICIT
                       PSIF       6.60  WETTING FRONT SUCTION
                      XKSAT        .16  HYDRAULIC CONDUCTIVITY
                      RTIMP        .00  PERCENT IMPERVIOUS AREA

 26 UI          INPUT UNITGRAPH,  24 ORDINATES,  VOLUME = 1.00
                     491.0    619.0   1777.0   2407.0   2860.0   3445.0   4300.0   6052.0   5354.0   4297.0
                    3604.0   2944.0   2404.0   1717.0    997.0    825.0    633.0    491.0    265.0    151.0
                     151.0    151.0    151.0    151.0

                                                                 ***

***************************************************************************************************************************

                                                    HYDROGRAPH AT STATION

***************************************************************************************************************************
                                                                 *
     DA MON HRMN  ORD    RAIN    LOSS  EXCESS     COMP Q         *     DA MON HRMN  ORD    RAIN    LOSS  EXCESS     COMP Q
                                                                 *
      1     0000    1     .00     .00     .00         0.         *      1     1230  151     .00     .00     .00         0.
      1     0005    2     .05     .05     .00         0.         *      1     1235  152     .00     .00     .00         0.
      1     0010    3     .05     .05     .00         0.         *      1     1240  153     .00     .00     .00         0.
      1     0015    4     .05     .05     .00         0.         *      1     1245  154     .00     .00     .00         0.
```

1	0020	5	.02	.02	.00	0.	*	1	1250	155	.00	.00	.00	0.
1	0025	6	.02	.02	.00	0.	*	1	1255	156	.00	.00	.00	0.
1	0030	7	.02	.02	.00	0.	*	1	1300	157	.00	.00	.00	0.
1	0035	8	.03	.03	.00	0.	*	1	1305	158	.00	.00	.00	0.
1	0040	9	.03	.03	.00	0.	*	1	1310	159	.00	.00	.00	0.
1	0045	10	.03	.03	.00	0.	*	1	1315	160	.00	.00	.00	0.
1	0050	11	.05	.05	.00	0.	*	1	1320	161	.00	.00	.00	0.
1	0055	12	.05	.05	.00	0.	*	1	1325	162	.00	.00	.00	0.
1	0100	13	.05	.05	.00	0.	*	1	1330	163	.00	.00	.00	0.
1	0105	14	.04	.04	.00	0.	*	1	1335	164	.00	.00	.00	0.
1	0110	15	.04	.04	.00	0.	*	1	1340	165	.00	.00	.00	0.
1	0115	16	.04	.04	.00	0.	*	1	1345	166	.00	.00	.00	0.
1	0120	17	.04	.04	.00	0.	*	1	1350	167	.00	.00	.00	0.
1	0125	18	.04	.04	.00	0.	*	1	1355	168	.00	.00	.00	0.
1	0130	19	.04	.04	.00	0.	*	1	1400	169	.00	.00	.00	0.
1	0135	20	.04	.04	.00	0.	*	1	1405	170	.00	.00	.00	0.
1	0140	21	.04	.04	.00	0.	*	1	1410	171	.00	.00	.00	0.
1	0145	22	.04	.04	.00	0.	*	1	1415	172	.00	.00	.00	0.
1	0150	23	.04	.04	.00	0.	*	1	1420	173	.00	.00	.00	0.
1	0155	24	.04	.04	.00	0.	*	1	1425	174	.00	.00	.00	0.
1	0200	25	.04	.04	.00	1.	*	1	1430	175	.00	.00	.00	0.
1	0205	26	.04	.04	.00	3.	*	1	1435	176	.00	.00	.00	0.
1	0210	27	.04	.04	.00	8.	*	1	1440	177	.00	.00	.00	0.
1	0215	28	.04	.04	.01	15.	*	1	1445	178	.00	.00	.00	0.
1	0220	29	.05	.04	.01	31.	*	1	1450	179	.00	.00	.00	0.
1	0225	30	.05	.04	.01	51.	*	1	1455	180	.00	.00	.00	0.
1	0230	31	.05	.03	.02	85.	*	1	1500	181	.00	.00	.00	0.
1	0235	32	.06	.03	.02	135.	*	1	1505	182	.00	.00	.00	0.
1	0240	33	.06	.03	.02	194.	*	1	1510	183	.00	.00	.00	0.
1	0245	34	.06	.03	.03	269.	*	1	1515	184	.00	.00	.00	0.
1	0250	35	.08	.03	.05	369.	*	1	1520	185	.00	.00	.00	0.
1	0255	36	.08	.03	.05	489.	*	1	1525	186	.00	.00	.00	0.
1	0300	37	.08	.03	.05	635.	*	1	1530	187	.00	.00	.00	0.
1	0305	38	.17	.03	.14	838.	*	1	1535	188	.00	.00	.00	0.
1	0310	39	.17	.03	.14	1070.	*	1	1540	189	.00	.00	.00	0.
1	0315	40	.17	.03	.14	1411.	*	1	1545	190	.00	.00	.00	0.
1	0320	41	.33	.03	.30	1894.	*	1	1550	191	.00	.00	.00	0.
1	0325	42	.33	.03	.30	2467.	*	1	1555	192	.00	.00	.00	0.
1	0330	43	.33	.03	.30	3249.	*	1	1600	193	.00	.00	.00	0.
1	0335	44	.71	.03	.69	4366.	*	1	1605	194	.00	.00	.00	0.
1	0340	45	.71	.03	.69	5741.	*	1	1610	195	.00	.00	.00	0.
1	0345	46	.71	.03	.69	7565.	*	1	1615	196	.00	.00	.00	0.
1	0350	47	.87	.03	.84	9724.	*	1	1620	197	.00	.00	.00	0.
1	0355	48	.87	.03	.84	12269.	*	1	1625	198	.00	.00	.00	0.
1	0400	49	.87	.03	.84	15021.	*	1	1630	199	.00	.00	.00	0.
1	0405	50	.52	.03	.49	17803.	*	1	1635	200	.00	.00	.00	0.
1	0410	51	.52	.03	.49	21099.	*	1	1640	201	.00	.00	.00	0.
1	0415	52	.52	.03	.49	23643.	*	1	1645	202	.00	.00	.00	0.
1	0420	53	.26	.03	.23	25456.	*	1	1650	203	.00	.00	.00	0.
1	0425	54	.26	.03	.23	26950.	*	1	1655	204	.00	.00	.00	0.
1	0430	55	.26	.03	.23	27452.	*	1	1700	205	.00	.00	.00	0.
1	0435	56	.16	.03	.13	27030.	*	1	1705	206	.00	.00	.00	0.
1	0440	57	.16	.03	.13	25465.	*	1	1710	207	.00	.00	.00	0.
1	0445	58	.16	.03	.13	23472.	*	1	1715	208	.00	.00	.00	0.
1	0450	59	.08	.03	.06	21330.	*	1	1720	209	.00	.00	.00	0.
1	0455	60	.08	.03	.06	18715.	*	1	1725	210	.00	.00	.00	0.
1	0500	61	.08	.02	.06	16199.	*	1	1730	211	.00	.00	.00	0.
1	0505	62	.05	.02	.03	13871.	*	1	1735	212	.00	.00	.00	0.
1	0510	63	.05	.02	.03	11675.	*	1	1740	213	.00	.00	.00	0.
1	0515	64	.05	.02	.03	9871.	*	1	1745	214	.00	.00	.00	0.

1	0520	65	.05	.02	.02	8229.	*	1	1750	215	.00	.00	.00	0.
1	0525	66	.05	.02	.02	6738.	*	1	1755	216	.00	.00	.00	0.
1	0530	67	.05	.02	.02	5579.	*	1	1800	217	.00	.00	.00	0.
1	0535	68	.05	.02	.03	4597.	*	1	1805	218	.00	.00	.00	0.
1	0540	69	.05	.02	.03	3777.	*	1	1810	219	.00	.00	.00	0.
1	0545	70	.05	.02	.03	3141.	*	1	1815	220	.00	.00	.00	0.
1	0550	71	.05	.02	.02	2623.	*	1	1820	221	.00	.00	.00	0.
1	0555	72	.05	.02	.02	2215.	*	1	1825	222	.00	.00	.00	0.
1	0600	73	.05	.02	.02	1895.	*	1	1830	223	.00	.00	.00	0.
1	0605	74	.00	.00	.00	1677.	*	1	1835	224	.00	.00	.00	0.
1	0610	75	.00	.00	.00	1515.	*	1	1840	225	.00	.00	.00	0.
1	0615	76	.00	.00	.00	1352.	*	1	1845	226	.00	.00	.00	0.
1	0620	77	.00	.00	.00	1226.	*	1	1850	227	.00	.00	.00	0.
1	0625	78	.00	.00	.00	1089.	*	1	1855	228	.00	.00	.00	0.
1	0630	79	.00	.00	.00	948.	*	1	1900	229	.00	.00	.00	0.
1	0635	80	.00	.00	.00	813.	*	1	1905	230	.00	.00	.00	0.
1	0640	81	.00	.00	.00	642.	*	1	1910	231	.00	.00	.00	0.
1	0645	82	.00	.00	.00	487.	*	1	1915	232	.00	.00	.00	0.
1	0650	83	.00	.00	.00	372.	*	1	1920	233	.00	.00	.00	0.
1	0655	84	.00	.00	.00	277.	*	1	1925	234	.00	.00	.00	0.
1	0700	85	.00	.00	.00	202.	*	1	1930	235	.00	.00	.00	0.
1	0705	86	.00	.00	.00	142.	*	1	1935	236	.00	.00	.00	0.
1	0710	87	.00	.00	.00	98.	*	1	1940	237	.00	.00	.00	0.
1	0715	88	.00	.00	.00	72.	*	1	1945	238	.00	.00	.00	0.
1	0720	89	.00	.00	.00	52.	*	1	1950	239	.00	.00	.00	0.
1	0725	90	.00	.00	.00	38.	*	1	1955	240	.00	.00	.00	0.
1	0730	91	.00	.00	.00	27.	*	1	2000	241	.00	.00	.00	0.
1	0735	92	.00	.00	.00	19.	*	1	2005	242	.00	.00	.00	0.
1	0740	93	.00	.00	.00	15.	*	1	2010	243	.00	.00	.00	0.
1	0745	94	.00	.00	.00	10.	*	1	2015	244	.00	.00	.00	0.
1	0750	95	.00	.00	.00	7.	*	1	2020	245	.00	.00	.00	0.
1	0755	96	.00	.00	.00	3.	*	1	2025	246	.00	.00	.00	0.
1	0800	97	.00	.00	.00	0.	*	1	2030	247	.00	.00	.00	0.
1	0805	98	.00	.00	.00	0.	*	1	2035	248	.00	.00	.00	0.
1	0810	99	.00	.00	.00	0.	*	1	2040	249	.00	.00	.00	0.
1	0815	100	.00	.00	.00	0.	*	1	2045	250	.00	.00	.00	0.
1	0820	101	.00	.00	.00	0.	*	1	2050	251	.00	.00	.00	0.
1	0825	102	.00	.00	.00	0.	*	1	2055	252	.00	.00	.00	0.
1	0830	103	.00	.00	.00	0.	*	1	2100	253	.00	.00	.00	0.
1	0835	104	.00	.00	.00	0.	*	1	2105	254	.00	.00	.00	0.
1	0840	105	.00	.00	.00	0.	*	1	2110	255	.00	.00	.00	0.
1	0845	106	.00	.00	.00	0.	*	1	2115	256	.00	.00	.00	0.
1	0850	107	.00	.00	.00	0.	*	1	2120	257	.00	.00	.00	0.
1	0855	108	.00	.00	.00	0.	*	1	2125	258	.00	.00	.00	0.
1	0900	109	.00	.00	.00	0.	*	1	2130	259	.00	.00	.00	0.
1	0905	110	.00	.00	.00	0.	*	1	2135	260	.00	.00	.00	0.
1	0910	111	.00	.00	.00	0.	*	1	2140	261	.00	.00	.00	0.
1	0915	112	.00	.00	.00	0.	*	1	2145	262	.00	.00	.00	0.
1	0920	113	.00	.00	.00	0.	*	1	2150	263	.00	.00	.00	0.
1	0925	114	.00	.00	.00	0.	*	1	2155	264	.00	.00	.00	0.
1	0930	115	.00	.00	.00	0.	*	1	2200	265	.00	.00	.00	0.
1	0935	116	.00	.00	.00	0.	*	1	2205	266	.00	.00	.00	0.
1	0940	117	.00	.00	.00	0.	*	1	2210	267	.00	.00	.00	0.
1	0945	118	.00	.00	.00	0.	*	1	2215	268	.00	.00	.00	0.
1	0950	119	.00	.00	.00	0.	*	1	2220	269	.00	.00	.00	0.
1	0955	120	.00	.00	.00	0.	*	1	2225	270	.00	.00	.00	0.
1	1000	121	.00	.00	.00	0.	*	1	2230	271	.00	.00	.00	0.
1	1005	122	.00	.00	.00	0.	*	1	2235	272	.00	.00	.00	0.
1	1010	123	.00	.00	.00	0.	*	1	2240	273	.00	.00	.00	0.
1	1015	124	.00	.00	.00	0.	*	1	2245	274	.00	.00	.00	0.

1	1020	125	.00	.00	.00	0.	*	1	2250	275	.00	.00	.00	0.
1	1025	126	.00	.00	.00	0.	*	1	2255	276	.00	.00	.00	0.
1	1030	127	.00	.00	.00	0.	*	1	2300	277	.00	.00	.00	0.
1	1035	128	.00	.00	.00	0.	*	1	2305	278	.00	.00	.00	0.
1	1040	129	.00	.00	.00	0.	*	1	2310	279	.00	.00	.00	0.
1	1045	130	.00	.00	.00	0.	*	1	2315	280	.00	.00	.00	0.
1	1050	131	.00	.00	.00	0.	*	1	2320	281	.00	.00	.00	0.
1	1055	132	.00	.00	.00	0.	*	1	2325	282	.00	.00	.00	0.
1	1100	133	.00	.00	.00	0.	*	1	2330	283	.00	.00	.00	0.
1	1105	134	.00	.00	.00	0.	*	1	2335	284	.00	.00	.00	0.
1	1110	135	.00	.00	.00	0.	*	1	2340	285	.00	.00	.00	0.
1	1115	136	.00	.00	.00	0.	*	1	2345	286	.00	.00	.00	0.
1	1120	137	.00	.00	.00	0.	*	1	2350	287	.00	.00	.00	0.
1	1125	138	.00	.00	.00	0.	*	1	2355	288	.00	.00	.00	0.
1	1130	139	.00	.00	.00	0.	*	2	0000	289	.00	.00	.00	0.
1	1135	140	.00	.00	.00	0.	*	2	0005	290	.00	.00	.00	0.
1	1140	141	.00	.00	.00	0.	*	2	0010	291	.00	.00	.00	0.
1	1145	142	.00	.00	.00	0.	*	2	0015	292	.00	.00	.00	0.
1	1150	143	.00	.00	.00	0.	*	2	0020	293	.00	.00	.00	0.
1	1155	144	.00	.00	.00	0.	*	2	0025	294	.00	.00	.00	0.
1	1200	145	.00	.00	.00	0.	*	2	0030	295	.00	.00	.00	0.
1	1205	146	.00	.00	.00	0.	*	2	0035	296	.00	.00	.00	0.
1	1210	147	.00	.00	.00	0.	*	2	0040	297	.00	.00	.00	0.
1	1215	148	.00	.00	.00	0.	*	2	0045	298	.00	.00	.00	0.
1	1220	149	.00	.00	.00	0.	*	2	0050	299	.00	.00	.00	0.
1	1225	150	.00	.00	.00	0.	*	2	0055	300	.00	.00	.00	0.

TOTAL RAINFALL = 11.59, TOTAL LOSS = 2.34, TOTAL EXCESS = 9.25

PEAK FLOW (CFS)	TIME (HR)		MAXIMUM AVERAGE FLOW 6-HR	24-HR	72-HR	24.92-HR
27452.	4.50	(CFS)	5942.	1485.	1431.	1431.
		(INCHES)	9.238	9.238	9.238	9.238
		(AC-FT)	2946.	2946.	2946.	2946.

CUMULATIVE AREA = 5.98 SQ MI

HYDROGRAPH AT STATION

PLAN 1, RATIO = .50

DA	MON	HRMN	ORD	FLOW	*	DA	MON	HRMN	ORD	FLOW	*	DA	MON	HRMN	ORD	FLOW	*	DA	MON	HRMN	ORD	FLOW
1		0000	1	0.	*	1		0615	76	676.	*	1		1230	151	0.	*	1		1845	226	0.
1		0005	2	0.	*	1		0620	77	613.	*	1		1235	152	0.	*	1		1850	227	0.
1		0010	3	0.	*	1		0625	78	545.	*	1		1240	153	0.	*	1		1855	228	0.
1		0015	4	0.	*	1		0630	79	474.	*	1		1245	154	0.	*	1		1900	229	0.
1		0020	5	0.	*	1		0635	80	407.	*	1		1250	155	0.	*	1		1905	230	0.
1		0025	6	0.	*	1		0640	81	321.	*	1		1255	156	0.	*	1		1910	231	0.
1		0030	7	0.	*	1		0645	82	244.	*	1		1300	157	0.	*	1		1915	232	0.
1		0035	8	0.	*	1		0650	83	186.	*	1		1305	158	0.	*	1		1920	233	0.
1		0040	9	0.	*	1		0655	84	139.	*	1		1310	159	0.	*	1		1925	234	0.
1		0045	10	0.	*	1		0700	85	101.	*	1		1315	160	0.	*	1		1930	235	0.
1		0050	11	0.	*	1		0705	86	71.	*	1		1320	161	0.	*	1		1935	236	0.

1	0055	12	0.	*	1	0710	87	49.	*	1	1325	162	0.	*	1	1940	237	0.
1	0100	13	0.	*	1	0715	88	36.	*	1	1330	163	0.	*	1	1945	238	0.
1	0105	14	0.	*	1	0720	89	26.	*	1	1335	164	0.	*	1	1950	239	0.
1	0110	15	0.	*	1	0725	90	19.	*	1	1340	165	0.	*	1	1955	240	0.
1	0115	16	0.	*	1	0730	91	13.	*	1	1345	166	0.	*	1	2000	241	0.
1	0120	17	0.	*	1	0735	92	10.	*	1	1350	167	0.	*	1	2005	242	0.
1	0125	18	0.	*	1	0740	93	7.	*	1	1355	168	0.	*	1	2010	243	0.
1	0130	19	0.	*	1	0745	94	5.	*	1	1400	169	0.	*	1	2015	244	0.
1	0135	20	0.	*	1	0750	95	3.	*	1	1405	170	0.	*	1	2020	245	0.
1	0140	21	0.	*	1	0755	96	2.	*	1	1410	171	0.	*	1	2025	246	0.
1	0145	22	0.	*	1	0800	97	0.	*	1	1415	172	0.	*	1	2030	247	0.
1	0150	23	0.	*	1	0805	98	0.	*	1	1420	173	0.	*	1	2035	248	0.
1	0155	24	0.	*	1	0810	99	0.	*	1	1425	174	0.	*	1	2040	249	0.
1	0200	25	1.	*	1	0815	100	0.	*	1	1430	175	0.	*	1	2045	250	0.
1	0205	26	2.	*	1	0820	101	0.	*	1	1435	176	0.	*	1	2050	251	0.
1	0210	27	4.	*	1	0825	102	0.	*	1	1440	177	0.	*	1	2055	252	0.
1	0215	28	8.	*	1	0830	103	0.	*	1	1445	178	0.	*	1	2100	253	0.
1	0220	29	15.	*	1	0835	104	0.	*	1	1450	179	0.	*	1	2105	254	0.
1	0225	30	25.	*	1	0840	105	0.	*	1	1455	180	0.	*	1	2110	255	0.
1	0230	31	43.	*	1	0845	106	0.	*	1	1500	181	0.	*	1	2115	256	0.
1	0235	32	67.	*	1	0850	107	0.	*	1	1505	182	0.	*	1	2120	257	0.
1	0240	33	97.	*	1	0855	108	0.	*	1	1510	183	0.	*	1	2125	258	0.
1	0245	34	134.	*	1	0900	109	0.	*	1	1515	184	0.	*	1	2130	259	0.
1	0250	35	184.	*	1	0905	110	0.	*	1	1520	185	0.	*	1	2135	260	0.
1	0255	36	244.	*	1	0910	111	0.	*	1	1525	186	0.	*	1	2140	261	0.
1	0300	37	317.	*	1	0915	112	0.	*	1	1530	187	0.	*	1	2145	262	0.
1	0305	38	419.	*	1	0920	113	0.	*	1	1535	188	0.	*	1	2150	263	0.
1	0310	39	535.	*	1	0925	114	0.	*	1	1540	189	0.	*	1	2155	264	0.
1	0315	40	706.	*	1	0930	115	0.	*	1	1545	190	0.	*	1	2200	265	0.
1	0320	41	947.	*	1	0935	116	0.	*	1	1550	191	0.	*	1	2205	266	0.
1	0325	42	1233.	*	1	0940	117	0.	*	1	1555	192	0.	*	1	2210	267	0.
1	0330	43	1624.	*	1	0945	118	0.	*	1	1600	193	0.	*	1	2215	268	0.
1	0335	44	2183.	*	1	0950	119	0.	*	1	1605	194	0.	*	1	2220	269	0.
1	0340	45	2871.	*	1	0955	120	0.	*	1	1610	195	0.	*	1	2225	270	0.
1	0345	46	3782.	*	1	1000	121	0.	*	1	1615	196	0.	*	1	2230	271	0.
1	0350	47	4862.	*	1	1005	122	0.	*	1	1620	197	0.	*	1	2235	272	0.
1	0355	48	6134.	*	1	1010	123	0.	*	1	1625	198	0.	*	1	2240	273	0.
1	0400	49	7511.	*	1	1015	124	0.	*	1	1630	199	0.	*	1	2245	274	0.
1	0405	50	8901.	*	1	1020	125	0.	*	1	1635	200	0.	*	1	2250	275	0.
1	0410	51	10550.	*	1	1025	126	0.	*	1	1640	201	0.	*	1	2255	276	0.
1	0415	52	11821.	*	1	1030	127	0.	*	1	1645	202	0.	*	1	2300	277	0.
1	0420	53	12728.	*	1	1035	128	0.	*	1	1650	203	0.	*	1	2305	278	0.
1	0425	54	13475.	*	1	1040	129	0.	*	1	1655	204	0.	*	1	2310	279	0.
1	0430	55	13726.	*	1	1045	130	0.	*	1	1700	205	0.	*	1	2315	280	0.
1	0435	56	13515.	*	1	1050	131	0.	*	1	1705	206	0.	*	1	2320	281	0.
1	0440	57	12733.	*	1	1055	132	0.	*	1	1710	207	0.	*	1	2325	282	0.
1	0445	58	11736.	*	1	1100	133	0.	*	1	1715	208	0.	*	1	2330	283	0.
1	0450	59	10665.	*	1	1105	134	0.	*	1	1720	209	0.	*	1	2335	284	0.
1	0455	60	9358.	*	1	1110	135	0.	*	1	1725	210	0.	*	1	2340	285	0.
1	0500	61	8099.	*	1	1115	136	0.	*	1	1730	211	0.	*	1	2345	286	0.
1	0505	62	6936.	*	1	1120	137	0.	*	1	1735	212	0.	*	1	2350	287	0.
1	0510	63	5837.	*	1	1125	138	0.	*	1	1740	213	0.	*	1	2355	288	0.
1	0515	64	4936.	*	1	1130	139	0.	*	1	1745	214	0.	*	2	0000	289	0.
1	0520	65	4115.	*	1	1135	140	0.	*	1	1750	215	0.	*	2	0005	290	0.
1	0525	66	3369.	*	1	1140	141	0.	*	1	1755	216	0.	*	2	0010	291	0.
1	0530	67	2790.	*	1	1145	142	0.	*	1	1800	217	0.	*	2	0015	292	0.
1	0535	68	2299.	*	1	1150	143	0.	*	1	1805	218	0.	*	2	0020	293	0.
1	0540	69	1889.	*	1	1155	144	0.	*	1	1810	219	0.	*	2	0025	294	0.
1	0545	70	1570.	*	1	1200	145	0.	*	1	1815	220	0.	*	2	0030	295	0.
1	0550	71	1311.	*	1	1205	146	0.	*	1	1820	221	0.	*	2	0035	296	0.

```
  1    0555  72    1107.  *   1    1210  147       0.  *   1    1825  222       0.  *   2    0040  297       0.
  1    0600  73     948.  *   1    1215  148       0.  *   1    1830  223       0.  *   2    0045  298       0.
  1    0605  74     838.  *   1    1220  149       0.  *   1    1835  224       0.  *   2    0050  299       0.
  1    0610  75     758.  *   1    1225  150       0.  *   1    1840  225       0.  *   2    0055  300       0.
                          *                            *                            *
*****************************************************************************************************************

PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
  (CFS)       (HR)                  6-HR        24-HR        72-HR      24.92-HR
  13726.      4.50       (CFS)      2971.        743.         715.         715.
                       (INCHES)     4.619       4.619        4.619        4.619
                        (AC-FT)     1473.       1473.        1473.        1473.

                      CUMULATIVE AREA =    5.98 SQ MI


* *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


          ***************
          *             *
32 KK     *    DET-DV   *
          *             *
          ***************

39 KO          OUTPUT CONTROL VARIABLES
                     IPRNT            2  PRINT CONTROL
                     IPLOT            0  PLOT CONTROL
                     QSCAL           0.  HYDROGRAPH PLOT SCALE

             HYDROGRAPH ROUTING DATA

34 RS          STORAGE ROUTING
                     NSTPS            1  NUMBER OF SUBREACHES
                      ITYP         FLOW  TYPE OF INITIAL CONDITION
                    RSVRIC        -1.00  INITIAL CONDITION
                         X          .00 WORKING R AND D COEFFICIENT

35 SA                 AREA        8.1        9.6       11.0       12.3       13.7       15.5       16.6       17.7

36 SE          ELEVATION    1865.00    1870.00    1875.00    1880.00    1885.00    1890.00    1895.00    1898.00

38 SL          LOW-LEVEL OUTLET
                     ELEVL      1865.00  ELEVATION AT CENTER OF OUTLET
                     CAREA         8.20  CROSS-SECTIONAL AREA
                      COQL          .60  COEFFICIENT
                      EXPL          .50  EXPONENT OF HEAD

37 SS          SPILLWAY
                      CREL      1890.00  SPILLWAY CREST ELEVATION
                     SPWID       500.00  SPILLWAY WIDTH
                      COQW         3.00  WEIR COEFFICIENT
                      EXPW         1.50  EXPONENT OF HEAD

                                                      ***

                                          COMPUTED STORAGE-ELEVATION DATA
```

STORAGE	.00	44.20	95.66	153.88	218.85	291.80	372.03	423.47
ELEVATION	1865.00	1870.00	1875.00	1880.00	1885.00	1890.00	1895.00	1898.00

COMPUTED OUTFLOW-ELEVATION DATA

OUTFLOW	.00	50.41	55.58	61.94	69.93	80.30	94.28	114.14	144.62	197.29
ELEVATION	1865.00	1866.63	1866.98	1867.46	1868.14	1869.14	1870.71	1873.37	1878.43	1890.00
OUTFLOW	232.15	472.04	1120.44	2380.50	4455.45	7548.51	11863.45	17602.47	24969.26	34167.80
ELEVATION	1890.08	1890.32	1890.72	1891.28	1892.00	1892.88	1893.92	1895.12	1896.48	1898.00

COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

STORAGE	.00	13.61	16.64	20.84	26.89	36.07	44.20	51.07	78.09	95.66
OUTFLOW	.00	50.41	55.58	61.94	69.93	80.30	88.23	94.28	114.14	124.78
ELEVATION	1865.00	1866.63	1866.98	1867.46	1868.14	1869.14	1870.00	1870.71	1873.37	1875.00
STORAGE	134.92	153.88	218.85	291.80	293.05	296.79	303.05	311.85	323.27	337.38
OUTFLOW	144.62	152.82	176.46	197.29	232.15	472.04	1120.44	2380.50	4455.45	7548.51
ELEVATION	1878.43	1880.00	1885.00	1890.00	1890.08	1890.32	1890.72	1891.28	1892.00	1892.88
STORAGE	354.27	372.03	374.05	397.01	423.47					
OUTFLOW	11863.45	16986.63	17602.47	24969.26	34167.80					
ELEVATION	1893.92	1895.00	1895.12	1896.48	1898.00					

** WARNING *** MODIFIED PULS ROUTING MAY BE NUMERICALLY UNSTABLE FOR OUTFLOWS BETWEEN 16987. TO 34168.
THE ROUTED HYDROGRAPH SHOULD BE EXAMINED FOR OSCILLATIONS OR OUTFLOWS GREATER THAN PEAK INFLOWS.
THIS CAN BE CORRECTED BY DECREASING THE TIME INTERVAL OR INCREASING STORAGE (USE A LONGER REACH.)

****

HYDROGRAPH AT STATION DET-DV
PLAN 1, RATIO = .50

****

DA	MON	HRMN	ORD	OUTFLOW	STORAGE	STAGE	*	DA	MON	HRMN	ORD	OUTFLOW	STORAGE	STAGE	*	DA	MON	HRMN	ORD	OUTFLOW	STORAGE	STAGE
1		0000	1	0.	.0	1865.0	*	1		0820	101	192.	273.1	1888.7	*	1		1640	201	153.	154.1	1880.0
1		0005	2	0.	.0	1865.0	*	1		0825	102	192.	271.8	1888.6	*	1		1645	202	152.	153.1	1879.9
1		0010	3	0.	.0	1865.0	*	1		0830	103	191.	270.5	1888.5	*	1		1650	203	152.	152.0	1879.8
1		0015	4	0.	.0	1865.0	*	1		0835	104	191.	269.2	1888.5	*	1		1655	204	152.	151.0	1879.8
1		0020	5	0.	.0	1865.0	*	1		0840	105	190.	267.9	1888.4	*	1		1700	205	151.	149.9	1879.7
1		0025	6	0.	.0	1865.0	*	1		0845	106	190.	266.6	1888.3	*	1		1705	206	151.	148.9	1879.6
1		0030	7	0.	.0	1865.0	*	1		0850	107	190.	265.3	1888.2	*	1		1710	207	150.	147.8	1879.5
1		0035	8	0.	.0	1865.0	*	1		0855	108	189.	264.0	1888.1	*	1		1715	208	150.	146.8	1879.4
1		0040	9	0.	.0	1865.0	*	1		0900	109	189.	262.7	1888.0	*	1		1720	209	149.	145.8	1879.3
1		0045	10	0.	.0	1865.0	*	1		0905	110	189.	261.4	1887.9	*	1		1725	210	149.	144.8	1879.2
1		0050	11	0.	.0	1865.0	*	1		0910	111	188.	260.1	1887.8	*	1		1730	211	148.	143.7	1879.2
1		0055	12	0.	.0	1865.0	*	1		0915	112	188.	258.8	1887.7	*	1		1735	212	148.	142.7	1879.1
1		0100	13	0.	.0	1865.0	*	1		0920	113	187.	257.5	1887.6	*	1		1740	213	148.	141.7	1879.0
1		0105	14	0.	.0	1865.0	*	1		0925	114	187.	256.2	1887.6	*	1		1745	214	147.	140.7	1878.9
1		0110	15	0.	.0	1865.0	*	1		0930	115	187.	254.9	1887.5	*	1		1750	215	147.	139.7	1878.8
1		0115	16	0.	.0	1865.0	*	1		0935	116	186.	253.6	1887.4	*	1		1755	216	146.	138.7	1878.7
1		0120	17	0.	.0	1865.0	*	1		0940	117	186.	252.3	1887.3	*	1		1800	217	146.	137.7	1878.7
1		0125	18	0.	.0	1865.0	*	1		0945	118	186.	251.0	1887.2	*	1		1805	218	145.	136.7	1878.6
1		0130	19	0.	.0	1865.0	*	1		0950	119	185.	249.8	1887.1	*	1		1810	219	145.	135.7	1878.5
1		0135	20	0.	.0	1865.0	*	1		0955	120	185.	248.5	1887.0	*	1		1815	220	144.	134.7	1878.4
1		0140	21	0.	.0	1865.0	*	1		1000	121	185.	247.2	1886.9	*	1		1820	221	144.	133.7	1878.3

1	0145	22	0.	.0	1865.0 *	1	1005	122	184.	245.9	1886.9 *	1	1825	222	143.	132.7	1878.2
1	0150	23	0.	.0	1865.0 *	1	1010	123	184.	244.7	1886.8 *	1	1830	223	143.	131.7	1878.1
1	0155	24	0.	.0	1865.0 *	1	1015	124	183.	243.4	1886.7 *	1	1835	224	142.	130.7	1878.1
1	0200	25	0.	.0	1865.0 *	1	1020	125	183.	242.2	1886.6 *	1	1840	225	142.	129.7	1878.0
1	0205	26	0.	.0	1865.0 *	1	1025	126	183.	240.9	1886.5 *	1	1845	226	141.	128.7	1877.9
1	0210	27	0.	.0	1865.0 *	1	1030	127	182.	239.6	1886.4 *	1	1850	227	141.	127.8	1877.8
1	0215	28	0.	.1	1865.0 *	1	1035	128	182.	238.4	1886.3 *	1	1855	228	141.	126.8	1877.7
1	0220	29	1.	.1	1865.0 *	1	1040	129	182.	237.1	1886.3 *	1	1900	229	140.	125.8	1877.6
1	0225	30	1.	.3	1865.0 *	1	1045	130	181.	235.9	1886.2 *	1	1905	230	140.	124.9	1877.6
1	0230	31	2.	.5	1865.1 *	1	1050	131	181.	234.6	1886.1 *	1	1910	231	139.	123.9	1877.5
1	0235	32	3.	.9	1865.1 *	1	1055	132	181.	233.4	1886.0 *	1	1915	232	139.	123.0	1877.4
1	0240	33	5.	1.4	1865.2 *	1	1100	133	180.	232.1	1885.9 *	1	1920	233	138.	122.0	1877.3
1	0245	34	8.	2.2	1865.3 *	1	1105	134	180.	230.9	1885.8 *	1	1925	234	138.	121.1	1877.2
1	0250	35	12.	3.2	1865.4 *	1	1110	135	180.	229.7	1885.7 *	1	1930	235	137.	120.1	1877.1
1	0255	36	17.	4.6	1865.5 *	1	1115	136	179.	228.4	1885.7 *	1	1935	236	137.	119.2	1877.1
1	0300	37	24.	6.4	1865.8 *	1	1120	137	179.	227.2	1885.6 *	1	1940	237	136.	118.2	1877.0
1	0305	38	32.	8.7	1866.0 *	1	1125	138	178.	226.0	1885.5 *	1	1945	238	136.	117.3	1876.9
1	0310	39	43.	11.7	1866.4 *	1	1130	139	178.	224.7	1885.4 *	1	1950	239	135.	116.4	1876.8
1	0315	40	54.	15.7	1866.9 *	1	1135	140	178.	223.5	1885.3 *	1	1955	240	135.	115.4	1876.7
1	0320	41	62.	21.0	1867.5 *	1	1140	141	177.	222.3	1885.2 *	1	2000	241	134.	114.5	1876.6
1	0325	42	71.	28.0	1868.3 *	1	1145	142	177.	221.1	1885.2 *	1	2005	242	134.	113.6	1876.6
1	0330	43	82.	37.3	1869.3 *	1	1150	143	177.	219.9	1885.1 *	1	2010	243	133.	112.7	1876.5
1	0335	44	93.	49.8	1870.6 *	1	1155	144	176.	218.6	1885.0 *	1	2015	244	133.	111.7	1876.4
1	0340	45	106.	66.5	1872.2 *	1	1200	145	176.	217.4	1884.9 *	1	2020	245	132.	110.8	1876.3
1	0345	46	121.	88.7	1874.4 *	1	1205	146	176.	216.2	1884.8 *	1	2025	246	132.	109.9	1876.2
1	0350	47	136.	117.6	1876.9 *	1	1210	147	175.	215.0	1884.7 *	1	2030	247	132.	109.0	1876.2
1	0355	48	153.	154.4	1880.0 *	1	1215	148	175.	213.8	1884.6 *	1	2035	248	131.	108.1	1876.1
1	0400	49	170.	200.3	1883.6 *	1	1220	149	174.	212.6	1884.5 *	1	2040	249	131.	107.2	1876.0
1	0405	50	187.	255.6	1887.5 *	1	1225	150	174.	211.4	1884.4 *	1	2045	250	130.	106.3	1875.9
1	0410	51	2590.	313.0	1891.4 *	1	1230	151	173.	210.2	1884.3 *	1	2050	251	130.	105.4	1875.9
1	0415	52	9961.	346.8	1893.5 *	1	1235	152	173.	209.0	1884.2 *	1	2055	252	129.	104.5	1875.8
1	0420	53	12144.	355.2	1894.0 *	1	1240	153	172.	207.8	1884.2 *	1	2100	253	129.	103.6	1875.7
1	0425	54	13098.	358.6	1894.2 *	1	1245	154	172.	206.6	1884.1 *	1	2105	254	128.	102.7	1875.6
1	0430	55	13599.	360.3	1894.3 *	1	1250	155	172.	205.5	1884.0 *	1	2110	255	128.	101.9	1875.5
1	0435	56	13621.	360.4	1894.3 *	1	1255	156	171.	204.3	1883.9 *	1	2115	256	127.	101.0	1875.5
1	0440	57	13126.	358.6	1894.2 *	1	1300	157	171.	203.1	1883.8 *	1	2120	257	127.	100.1	1875.4
1	0445	58	12237.	355.6	1894.0 *	1	1305	158	170.	201.9	1883.7 *	1	2125	258	127.	99.2	1875.3
1	0450	59	11244.	351.8	1893.8 *	1	1310	159	170.	200.8	1883.6 *	1	2130	259	126.	98.4	1875.2
1	0455	60	10090.	347.3	1893.5 *	1	1315	160	169.	199.6	1883.5 *	1	2135	260	126.	97.5	1875.2
1	0500	61	8816.	342.3	1893.2 *	1	1320	161	169.	198.4	1883.4 *	1	2140	261	125.	96.6	1875.1
1	0505	62	7601.	337.6	1892.9 *	1	1325	162	169.	197.3	1883.3 *	1	2145	262	125.	95.8	1875.0
1	0510	63	6552.	332.8	1892.6 *	1	1330	163	168.	196.1	1883.2 *	1	2150	263	124.	94.9	1874.9
1	0515	64	5549.	328.3	1892.3 *	1	1335	164	168.	194.9	1883.2 *	1	2155	264	124.	94.1	1874.9
1	0520	65	4668.	324.2	1892.1 *	1	1340	165	167.	193.8	1883.1 *	1	2200	265	123.	93.2	1874.8
1	0525	66	3933.	320.4	1891.8 *	1	1345	166	167.	192.6	1883.0 *	1	2205	266	123.	92.4	1874.7
1	0530	67	3276.	316.8	1891.6 *	1	1350	167	167.	191.5	1882.9 *	1	2210	267	122.	91.5	1874.6
1	0535	68	2712.	313.7	1891.4 *	1	1355	168	166.	190.3	1882.8 *	1	2215	268	122.	90.7	1874.5
1	0540	69	2257.	311.0	1891.2 *	1	1400	169	166.	189.2	1882.7 *	1	2220	269	121.	89.8	1874.5
1	0545	70	1909.	308.6	1891.1 *	1	1405	170	165.	188.1	1882.6 *	1	2225	270	121.	89.0	1874.4
1	0550	71	1600.	306.4	1890.9 *	1	1410	171	165.	186.9	1882.5 *	1	2230	271	120.	88.2	1874.3
1	0555	72	1342.	304.6	1890.8 *	1	1415	172	164.	185.8	1882.5 *	1	2235	272	120.	87.4	1874.2
1	0600	73	1134.	303.1	1890.7 *	1	1420	173	164.	184.7	1882.4 *	1	2240	273	119.	86.5	1874.2
1	0605	74	1005.	301.9	1890.7 *	1	1425	174	164.	183.5	1882.3 *	1	2245	274	119.	85.7	1874.1
1	0610	75	896.	300.9	1890.6 *	1	1430	175	163.	182.4	1882.2 *	1	2250	275	118.	84.9	1874.0
1	0615	76	802.	300.0	1890.5 *	1	1435	176	163.	181.3	1882.1 *	1	2255	276	118.	84.1	1873.9
1	0620	77	719.	299.2	1890.5 *	1	1440	177	162.	180.2	1882.0 *	1	2300	277	117.	83.3	1873.8
1	0625	78	645.	298.5	1890.4 *	1	1445	178	162.	179.0	1881.9 *	1	2305	278	117.	82.5	1873.8
1	0630	79	574.	297.8	1890.4 *	1	1450	179	162.	177.9	1881.9 *	1	2310	279	116.	81.7	1873.7
1	0635	80	503.	297.1	1890.3 *	1	1455	180	161.	176.8	1881.8 *	1	2315	280	116.	80.9	1873.6
1	0640	81	443.	296.3	1890.3 *	1	1500	181	161.	175.7	1881.7 *	1	2320	281	115.	80.1	1873.6

1	0645	82	385.	295.4	1890.2	*	1	1505	182	160.	174.6	1881.6	*	1	2325	282	115.	79.3	1873.5
1	0650	83	323.	294.5	1890.2	*	1	1510	183	160.	173.5	1881.5	*	1	2330	283	114.	78.5	1873.4
1	0655	84	265.	293.6	1890.1	*	1	1515	184	160.	172.4	1881.4	*	1	2335	284	114.	77.7	1873.3
1	0700	85	223.	292.7	1890.1	*	1	1520	185	159.	171.3	1881.3	*	1	2340	285	113.	76.9	1873.3
1	0705	86	199.	291.9	1890.0	*	1	1525	186	159.	170.2	1881.3	*	1	2345	286	113.	76.1	1873.2
1	0710	87	197.	290.9	1889.9	*	1	1530	187	158.	169.1	1881.2	*	1	2350	287	112.	75.4	1873.1
1	0715	88	197.	289.8	1889.9	*	1	1535	188	158.	168.0	1881.1	*	1	2355	288	112.	74.6	1873.0
1	0720	89	196.	288.7	1889.8	*	1	1540	189	158.	166.9	1881.0	*	2	0000	289	111.	73.8	1872.9
1	0725	90	196.	287.5	1889.7	*	1	1545	190	157.	165.9	1880.9	*	2	0005	290	110.	73.1	1872.9
1	0730	91	196.	286.3	1889.6	*	1	1550	191	157.	164.8	1880.8	*	2	0010	291	110.	72.3	1872.8
1	0735	92	195.	285.0	1889.5	*	1	1555	192	156.	163.7	1880.8	*	2	0015	292	109.	71.6	1872.7
1	0740	93	195.	283.7	1889.4	*	1	1600	193	156.	162.6	1880.7	*	2	0020	293	109.	70.8	1872.7
1	0745	94	195.	282.4	1889.4	*	1	1605	194	156.	161.5	1880.6	*	2	0025	294	108.	70.1	1872.6
1	0750	95	194.	281.1	1889.3	*	1	1610	195	155.	160.5	1880.5	*	2	0030	295	108.	69.3	1872.5
1	0755	96	194.	279.8	1889.2	*	1	1615	196	155.	159.4	1880.4	*	2	0035	296	107.	68.6	1872.4
1	0800	97	193.	278.5	1889.1	*	1	1620	197	154.	158.3	1880.3	*	2	0040	297	107.	67.8	1872.4
1	0805	98	193.	277.1	1889.0	*	1	1625	198	154.	157.3	1880.3	*	2	0045	298	106.	67.1	1872.3
1	0810	99	193.	275.8	1888.9	*	1	1630	199	154.	156.2	1880.2	*	2	0050	299	106.	66.4	1872.2
1	0815	100	192.	274.5	1888.8	*	1	1635	200	153.	155.2	1880.1	*	2	0055	300	105.	65.6	1872.1
						*							*						

****

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
(CFS)	(HR)		6-HR	24-HR	72-HR	24.92-HR
13621.	4.58	(CFS)	2457.	710.	684.	684.
		(INCHES)	3.820	4.413	4.413	4.413
		(AC-FT)	1218.	1408.	1408.	1408.

PEAK STORAGE	TIME	MAXIMUM AVERAGE STORAGE			
(AC-FT)	(HR)	6-HR	24-HR	72-HR	24.92-HR
360.	4.58	294.	168.	162.	162.

PEAK STAGE	TIME	MAXIMUM AVERAGE STAGE			
(FEET)	(HR)	6-HR	24-HR	72-HR	24.92-HR
1894.29	4.58	1890.10	1880.42	1879.86	1879.86

CUMULATIVE AREA = 5.98 SQ MI

PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND, AREA IN SQUARE MILES
TIME TO PEAK IN HOURS

					RATIOS APPLIED TO FLOWS
E TION	STATION	AREA	PLAN		RATIO 1
					.50
D GRAPH AT		5.98	1	FLOW	13726.
				TIME	4.50
UTED TO	DET-DV	5.98	1	FLOW	13621.
				TIME	4.58
			** PEAK STAGES IN FEET **		
			1	STAGE	1894.29
				TIME	4.58

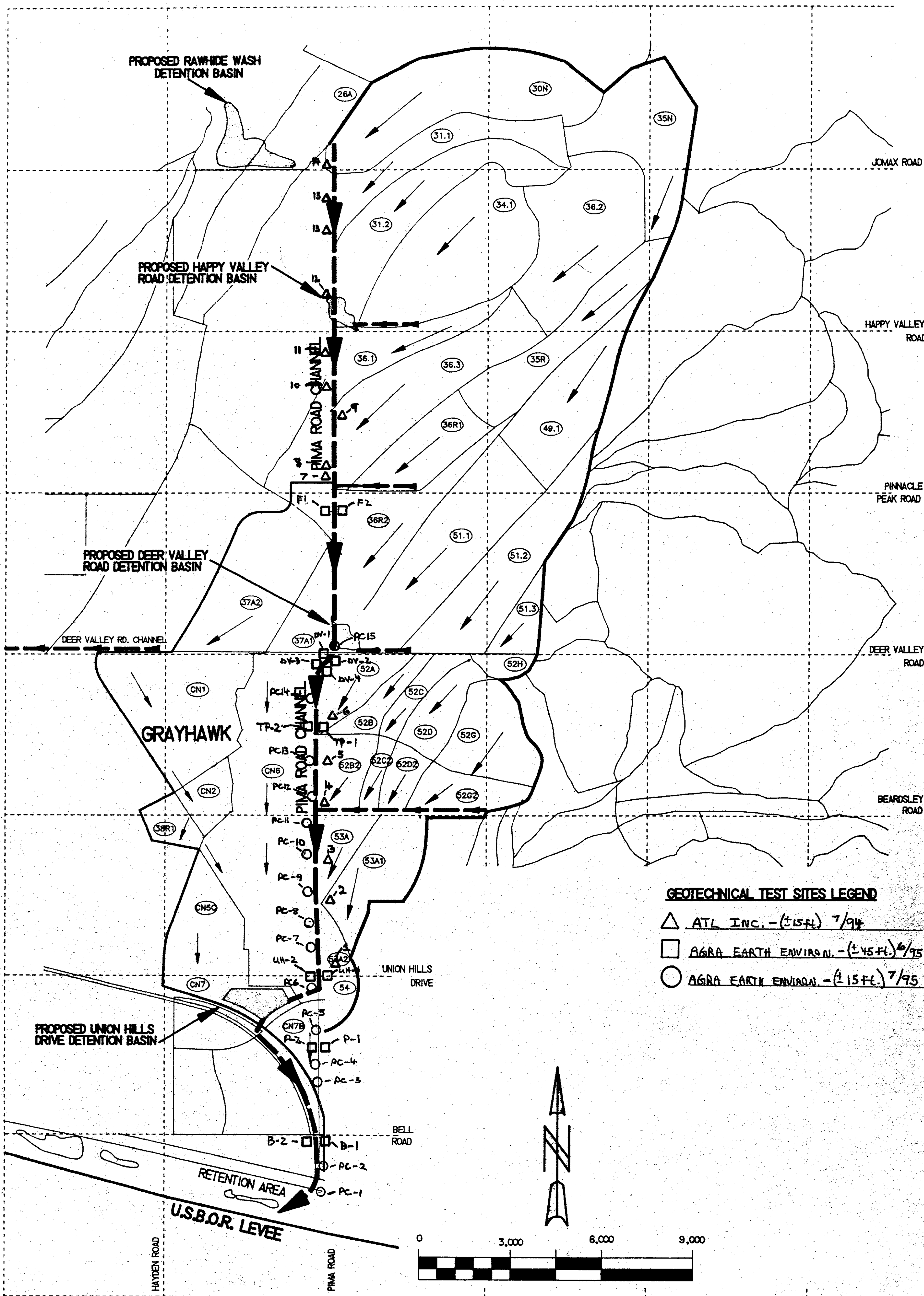
** NORMAL END OF HEC-1 ***
RMAL END OF HEC-1

Appendix G

Pima Road Channel With Detention
PACE Engineering Alternative Concept
Scottsdale Desert Greenbelt
Pima Road North of Bell Road
Scottsdale, Arizona

AGRA Earth & Environmental, Inc.
September 7, 1995

Bound Separately



TITLE PIMA ROAD GEOTECHNICAL TEST SITES LOCATION MAP	DRAWN S.S.	PACE PACIFIC ADVANCED CIVIL ENGINEERING 17902 GEORGETOWN LANE H.B. CA. 92647 (714) 843-5734 FAX 848-4820	1
	CHKD M.E.K.		
JOB PIMA ROAD CHANNEL DETENTION FEASIBILITY STUDY	DATE 09-05-95		
	JOB NO 5653		FIGURE

N:\5653\WORKDWGS\BORINGS.DWG

PIMA ROAD CHANNEL WITH DETENTION
PACE ENGINEERING ALTERNATIVE CONCEPT
SCOTTSDALE DESERT GREENBELT
PIMA ROAD NORTH OF BELL ROAD
SCOTTSDALE, ARIZONA

Registered Professional Engineer (Civil)
CERTIFICATE NO.
25151
KEITH H.
DAHLEN
Date Signed 9/7/95
ARIZONA, U.S.A.

Submitted To:

Greiner, Inc.
7310 North 16th Street
Suite 160
Phoenix, Arizona 85020-2402

Submitted By:

AGRA Earth & Environmental, Inc.
3232 West Virginia Avenue
Phoenix, Arizona 85009-1502

7 September 1995

AEE Job No. E95-139
Letter No. 2

AGRA
Earth & Environmental

AGRA
Earth & Environmental

AGRA Earth &
Environmental, Inc.
3232 West Virginia Avenue
Phoenix, Arizona 85009-1502
Tel (602) 272-6848
Fax (602) 272-7239

7 September 1995
AEE Job No. E95-139
Letter No. 2

Greiner, Inc.
7310 North 16th Street
Suite 160
Phoenix, Arizona 85020-2402

Attention: Ron Price, P.E.

Gentlemen:

**RE: PIMA ROAD CHANNEL WITH DETENTION
PACE ENGINEERING ALTERNATIVE CONCEPT
SCOTTSDALE DESERT GREENBELT
PIMA ROAD NORTH OF BELL ROAD
SCOTTSDALE, ARIZONA**

Our Geotechnical Investigation Report for the above referenced project is submitted herewith. Included are preliminary design recommendations for embankments and stormwater conveyance channels.

1.0 PROJECT DESCRIPTION

Details of the project were provided to AGRA Earth & Environmental, Inc. (AEE) by Mark E. Krebs, P.E. and Mr. Johan A. Perslow of Pacific Advanced Civil Engineering (PACE). PACE has prepared an alternative concept for the Pima Road Channel which will be part of the Desert Greenbelt project in north Scottsdale, Arizona. The alternative concept includes the construction of two stormwater detention basins on the east side of Pima Road, at Happy Valley Road and Deer Valley Road, respectively. A third basin is planned to be located just south of the existing City of Scottsdale Waste Transfer Station to the west of Pima Road. The detention basins would be fed by east-west running lateral stormwater interceptor channels. A continuous channel, connecting the basins and lateral channels into one drain system, would drain to the south, parallel to Pima Road (similar to the current Greiner design) beginning at about Jomax Road and discharge into the Central Arizona Project (CAP) Retention Area. Currently, PACE is considering constructing unlined east-west running interceptor channels and a partially lined north-south running main channel. The main channel along Pima Road, based on preliminary hydraulic analyses performed by PACE, would consist of a channel 40 to 70 feet wide and approximately 2 feet in depth.

In order to minimize the size of channels that are required to handle the design storm runoff, detention basins will be required at the three above-described locations. The basins will vary in size, with storage capacities varying from about 300 to 600 acre-feet. The purpose of the basins will be to detain stormwater, thus reducing peak flows within the channels. The downstream embankments would be constructed of the materials excavated from the adjacent basins, to the extent possible. The dam embankments would vary in height, generally not exceeding about 30 feet from the crest to the downstream toe. In order to meet the maximum retention time requirement of 72 hours for detention basins, normal drainage would be handled through 30- to 42-inch diameter reinforced concrete pipe (RCP) low level outlets. Emergency spillways would be designed to pass water from the basins prior to the basins becoming completely filled, thereby preventing dam embankments from overtopping.

2.0 REVIEW OF EXISTING DATA

AEE has recently performed the geotechnical investigation for the Desert Greenbelt Project for Greiner, Inc. (AEE Job No. E95-86). Included within the scope of that investigation were test borings drilled at five bridge site locations along Pima Road and 15 borings drilled along the proposed Pima Road Channel alignment. AEE also performed test borings for the proposed Arizona Department of Transportation (ADOT) drainage channels that will parallel the north side of the proposed Pima Freeway alignment. Along this alignment, we completed one of the borings (Boring No. CN5C-1) to a depth of about 45 feet in the vicinity of the PACE alternative detention basin located just south of the waste transfer station.

No borings were drilled in the vicinity of Happy Valley Road as the Phase I portion of the current Greiner design extends just to Deer Valley Road. Four 45-foot deep test borings (Boring Nos. DV1 through DV4) were drilled adjacent to Pima Road for the Deer Valley crossing. In addition to the current project performed for Greiner, we have reviewed our Preliminary Geotechnical Investigation Report for the Rawhide Wash Detention Basin (AEE Job No. E94-172, dated 29 August 1994).

3.0 INVESTIGATION

3.1 GEOTECHNICAL INVESTIGATION

Three test borings were drilled to depths of about 45 feet below existing site grades (one at each of the proposed detention basin locations) using a CME-55 drill rig advancing 6 5/8-inch hollow-stem auger. Standard penetration testing and open-end drive sampling were performed at selected intervals. The results of the field investigation are attached, including boring logs, and site plans showing the boring locations. The field investigation was supervised by Elizabeth A. Judd, E.I.T., staff engineer of AEE. Attached also are the site plans and boring logs prepared for the Greiner investigation, which were drilled in the near proximity to the improvements as proposed by PACE.

3.2 LABORATORY ANALYSIS

The moisture contents of selected samples recovered were determined. The results of these tests are shown on the boring logs. Grain-size analysis, Atterberg limits, and a direct shear test were performed on selected samples. The results of these tests are attached. Also included are the results of laboratory test data of testing performed for samples collected during our investigation for the Greiner project (E95-86, Report Nos. 1 and 2, and Report No. 2, Addendum No. 1), as deemed applicable to this project. The results include soil-cement mix design recommendations for a sample collected from Boring No. CN5C-6 along the Pima Road Channel/ADOT Channel alignment.

3.3 SITE CONDITIONS & GEOTECHNICAL PROFILE

3.4 SITE CONDITIONS

The general site area is native desert which slopes gently to the southwest. The McDowell Mountains extend north-south just to the east of the Desert Greenbelt Project area. Upscale residential development is present at the north end of the site. Vegetation consists of desert trees including palo verde and mesquite. A moderate growth of smaller brush, wild grasses and several cactus varieties are also present. As previously discussed, the City of Scottsdale Waste Transfer Station is located just to the northeast of the proposed Union Hills Drive Detention Basin.

3.5 GEOTECHNICAL PROFILE

The general project site is underlain by Quaternary alluvium consisting of granite-derived silty sands and sandy silts with minor amounts of clay and relatively clean sand. The cleaner sand exists mainly in active wash areas as recent alluvium. The soils are generally weakly cemented to uncemented in the upper 5 to 10 feet, becoming moderately cemented with calcium carbonate with depth. Based on borings and test pits completed for the Reatta Wash Pass, the soils become coarser grained to the east containing considerable gravel, cobbles and boulders. The coarser grained soils likely will be encountered within the eastern portions of the east-west running lateral drainage interceptors. No investigation was performed along the alignment of the lateral channels.

Relative to specific test borings drilled at each of the proposed detention basin sites, the geologic profiles encountered were as follows:

Happy Valley Road Detention Basin

Silty to clayey sand was encountered within Boring No. HV-1 to a depth of about 13 feet below existing grade. The sandy soils are nonplastic to low in plasticity and are moderately firm to firm in their present relatively dry condition.

A layer of relatively clean sand with some silt was encountered from a depth of 13 feet to 21 feet within the boring. The sand varies from soft to firm and is nonplastic.

Silty sand with considerable gravel was encountered below the sand layer and extended to the full depth of the test boring. This stratum is very firm to hard and is weakly to moderately cemented with calcium carbonate.

Deer Valley Road Detention Basin

Silty sand containing some fine grained gravel was encountered in Boring No. D-1 from the surface to a depth of 27 feet below existing grade. The material is nonplastic to medium in plasticity (in lenses) and is weakly to moderately cemented with calcium carbonate. Considerable clay was encountered from a depth of 4 to 8 feet.

Silty sand and gravel was encountered beneath the silty sand layer and extended to the full depth of the boring. The coarser grained material is nonplastic, and moderately cemented with calcium carbonate.

Union Hills Drive Detention Basin

The soils encountered in Boring No. CN5C-1, drilled along the proposed adjacent ADOT Drainage Channel, consisted mainly of clayey sand to the full depth of the boring. These soils are low to medium in plasticity, and are weakly to moderately cemented with calcium carbonate. A lens of nonplastic sand was encountered from 15 1/2 to 19 feet below grade.

4.0 DISCUSSION & RECOMMENDATIONS

It appears that the proposed improvements can be constructed using the existing site soils. However, stabilization of the soils will be required as they are highly erodible, even at low flow velocities. According to Brater and King (1976)*, permissible canal velocities for alluvial silty soils containing suspended loads are 2 to 3 feet per second. Velocities for the PACE alternative channels will exceed the allowable velocities (up to 12 feet per second over short intervals), thus erosion of unprotected channels would be high. Included in the following sections is a discussion of the PACE alternative with respect to channels and the detention basins and recommendations for using soil-cement for channel linings and for the core of the detention basin dams.

4.1 CHANNEL PROTECTION

According to Mr. Krebs, the maximum flow velocity that will be experienced within the main channel during the 100-year/6-hour storm would be a maximum of 14 feet per second over a period of several minutes and flows of around 5 to 9 feet per second over a longer period. Such velocities would cause significant erosion and sediment transport of natural unlined channels. A soil-cement lining could be utilized to prevent erosion of either the channel sides or bottom (if desired). The soils in the general site area are considered good to excellent for the use of soil-cement.

The PACE concept for the main channel includes placing the soil-cement in two vertical trenches excavated below the natural ground surface. The trenches would be excavated to a sufficient depth below anticipated scour depths to assure that undermining would not occur. The wall thickness would be reduced near the top to enhance stability. The construction of the walls appears feasible using compaction equipment suited for trench work. The stability of the walls would be the critical design element. It is unlikely that trenches excavated with vertical walls within the upper 6 to 8 feet of existing site grades, would remain vertical due to caving. Most likely temporary excavations could be safely completed to slopes of about 0.5 to 0.75H:1V (horizontal to vertical). OSHA regulations would have to be adhered to if workers were to enter the trenches.

Based on the recommendations by the Portland Cement Association (PCA) (1975, 1982), the finer grained soils present in the vicinity of Pima Road likely would require about 7 to 9 percent by weight cement to achieve a soil-cement with a 7-day compressive strength of at least 1,000 pounds per square inch (psi) after proper placement and compaction. A 1,000 psi compressive strength is recommended in lieu of the normally used requirement of 750 pounds, considering the method of construction and the erosive nature of locally higher velocity flows.

*References are listed at the end of this report.

The coarser grained soils present to the east also could be used in the soil-cement, following screening of particles larger than about 3 inches in diameter. Similar compressive strengths could likely be achieved with more cement in the coarser grained soils as compared to the soils along Pima Road. Testing performed on a sample collected along Reatta Pass Wash indicates that 9 percent by weight cement would be required for a 7-day compressive strength of 1,000 psi. However, screening of the large particle sizes would be required as the mixers utilized cannot operate properly. Crushing of the oversize particles could be considered for use in the soil-cement mix. Results of the soil-cement mix designs are attached.

4.2 DETENTION BASIN EMBANKMENTS

PACE currently plans to utilize the soils that would be excavated from the basins for fill within the dam embankments. These soils consist of sandy materials and are sucseptible to piping. It is estimated that a full phreatic surface will develop through the embankment in about 30 days. Thus, with retention times of 72 hours, the full phreatic surface will not be developed. As shown on the attached calculation sheet, using the Casagrande Method (Huang, 1983), the phreatic surface through the embankment would daylight about 4.5 feet above the dam toe, assumes a fully developed phreatic surface. However, it has been our experience that flood control embankments made from homogeneous materials have developed cracks due to drying and/or differential settlements. Cracks in the embankments could lead to piping. For this reason, zoned embankments are recommended to prevent piping. Internal drains or barrier materials have been used to prevent piping. A method that could be utilized to restrict the seepage which passes through the dam would be a soil-cement cutoff wall. The wall could be constructed with a standard machine width of about 8.0 feet, utilizing the on-site soils mixed with cement. Such a cutoff would be significantly lower in permeability than the surrounding embankment materials, thus lowering the phreatic surface and reducing the quantity of flow. The recommended soil-cement mix would be similar to that recommended in the previous section, however the strength requirement could be reduced to the standard compressive strength of 750 psi as the materials would not be exposed to erosive surface flows. It is further recommended that the soil-cement cutoff extend vertically downward at least 1.0 foot into the native cemented stratum, which is likely about 6.0 to 9.0 feet below existing grade. The cutoff could be constructed in a nearly vertical fashion and brought up with the adjacent embankment. Current design cross-sections, provided to us by PACE, indicate a soil-cement core that extends vertically about 8.0 feet above the design water level. The high core zone would aid in overall stability and provide protection against failure of the dam due to overtopping.

It is recommended that the embankment slopes be constructed no steeper than 4H:1V. The upstream embankment could likely be steepened to 3H:1V below the contact of the cemented soils present below existing site grades. Some erosion due to direct precipitation, as well as wave action (when partially filled or full), would be expected given the sandy nature of the soils. Revegetation of the slopes, as is currently planned by PACE, could possibly be achieved. However, a revegetation mat would also be recommended to protect the slopes prior to development of the vegetation.

Other, possibly less attractive slope protection measures such as soil-cement, riprap, gabion mattresses or geomembrane liner could be utilized, if desired.

4.3 OUTLET PIPING

PACE currently plans to use 30- to 42-inch reinforced concrete RCP pipe for the low flow outlet from the detention basins. It is recommended that pressure rated bell and spigot RCP pipe be utilized. It is further recommended that the pipe be embedded in lean concrete to the pipe springline throughout the entire dam section.

Should you have any questions regarding this preliminary report, we would appreciate the opportunity to review and clarify.

Respectfully submitted,

AGRA Earth & Environmental, Inc.

Registered Professional Engineer (Civil) Certificate No. 25151 KEITH H. DAHLEN Date Signed 9/7/95 ARIZONA, U.S.A.

Keith H. Dahlen, P.E.
Project Engineer

Reviewed by:

Registered Professional Engineer (Civil) Certificate No. 12176 NORMAN HAROLD WETZ Date Signed 9/7/95 ARIZONA, U.S.A.

Norman H. Wetz, P.E.
Senior Geotechnical Engineer

c: Addressee (2)
PACE Engineering
Attn: Mark E. Krebs, P.E. (1)
City of Scottsdale
Attn: Mr. Mark Landsiedel (1)

ld/jls/J2-95/09-05-95

Appendix H

City of Scottsdale Desert Greenbelt Project
Sediment Field Tests
by The Greiner Team

CITY OF SCOTTSDALE
DESERT GREENBELT PROJECT

Sediment Field Tests

by: The Greiner Team

The Desert Greenbelt

Professional Engineer (Civil)
Certificate No.
17756
SHI-EN
SHIAU
Date Signed 10-3-94
ARIZONA, U.S.A.

JULY 1994

INTRODUCTION

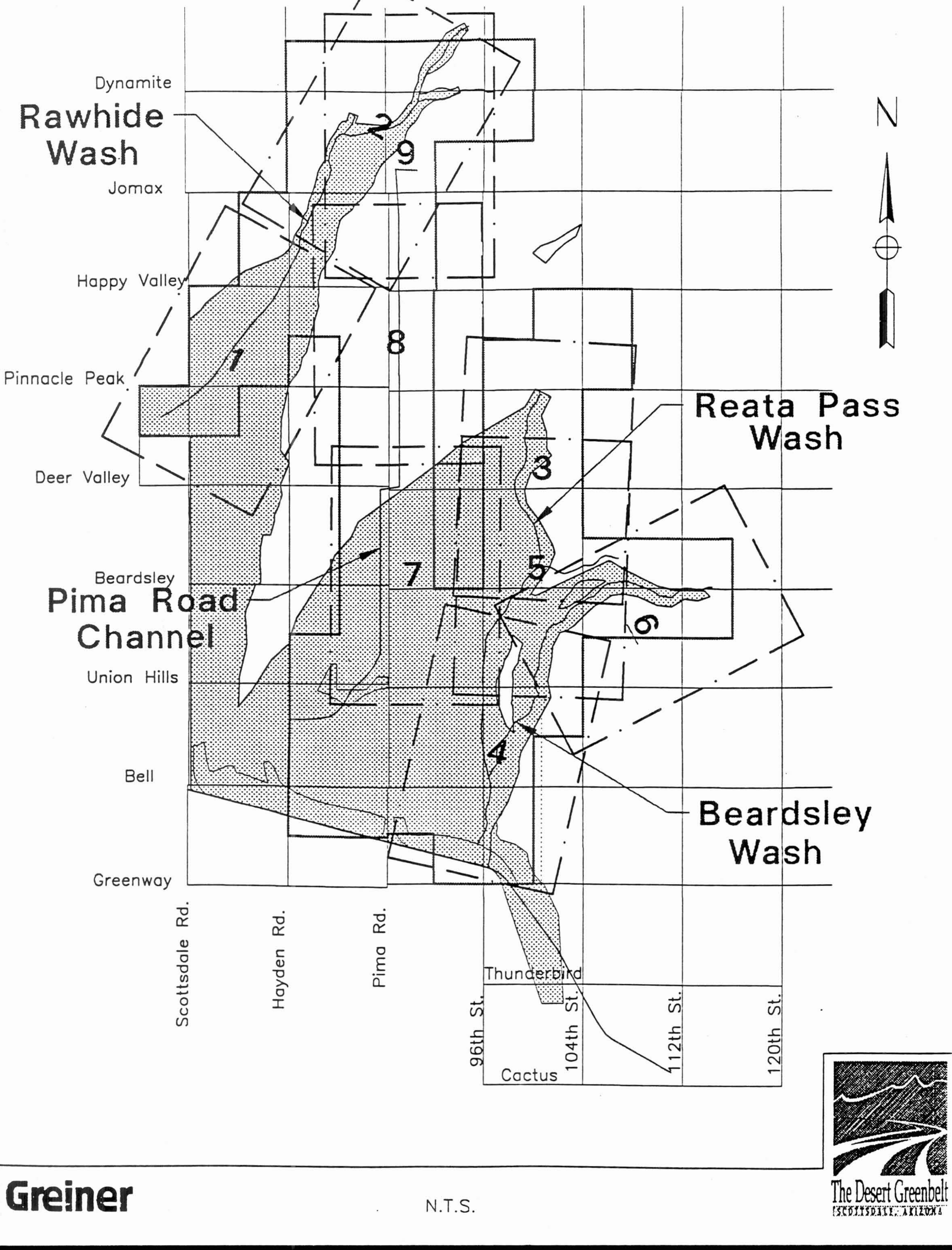
Sediment samples were collected for all reaches within the Desert Greenbelt corridors. Each sample was taken for a reach of similar sediment characteristics. In sandy areas, the sample was collected from about one to two feet below the existing grade and a sieve test determined the gradation. In areas of larger sediment, a pebble counting method, a variation of Wolman's technique, was used to determine gradation. The results for each sample are included in this report. The results are divided into sections by wash area. Each section begins with a map identifying the sediment sample locations by number corresponding to the gradation results.The weight gradations will be used as the reach sediment pool in HEC-6.

In washes of a high degree of variance in gradation results, graphical representations of the weight gradation, sieve size versus percent passing by weight, are included. Areas of high variance include reaches for which the pebble counting method was used. The gradation of sediment size by number of particles in transformed to gradation by weight by applying a spherical volume to each particle. In washes of a low degree of variance, graphical representations for the most coarse and most fine samples are included.

Table of Contents

Registered Professional Engineer (Civil)
CERTIFICATE NO.
17756
SHI-EN
SHIAU
Date Signed 10/3/94
ARIZONA, U. S. A.

Index to Sediment Sample Map Sheet Locations



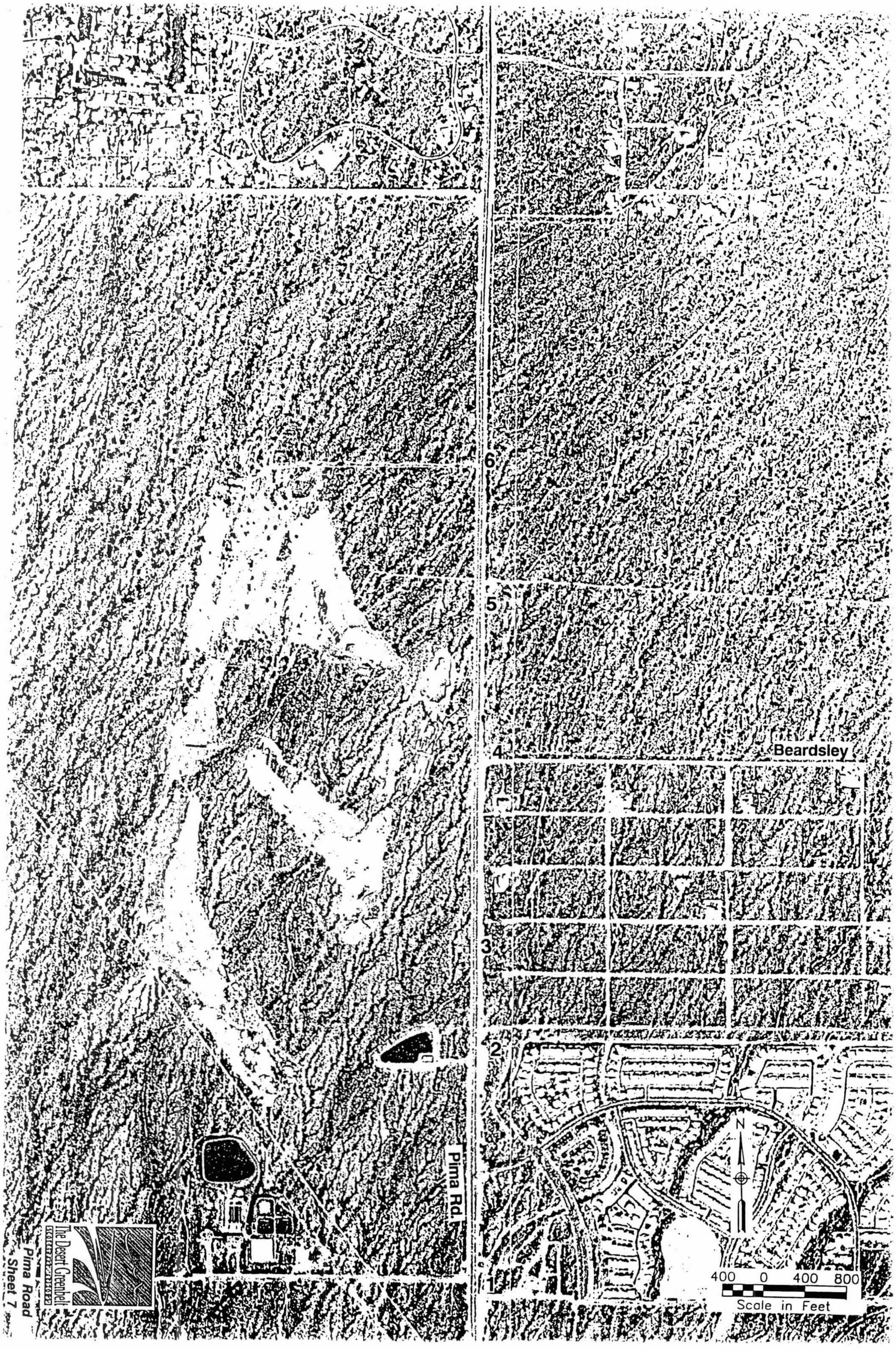
Greiner

N.T.S.

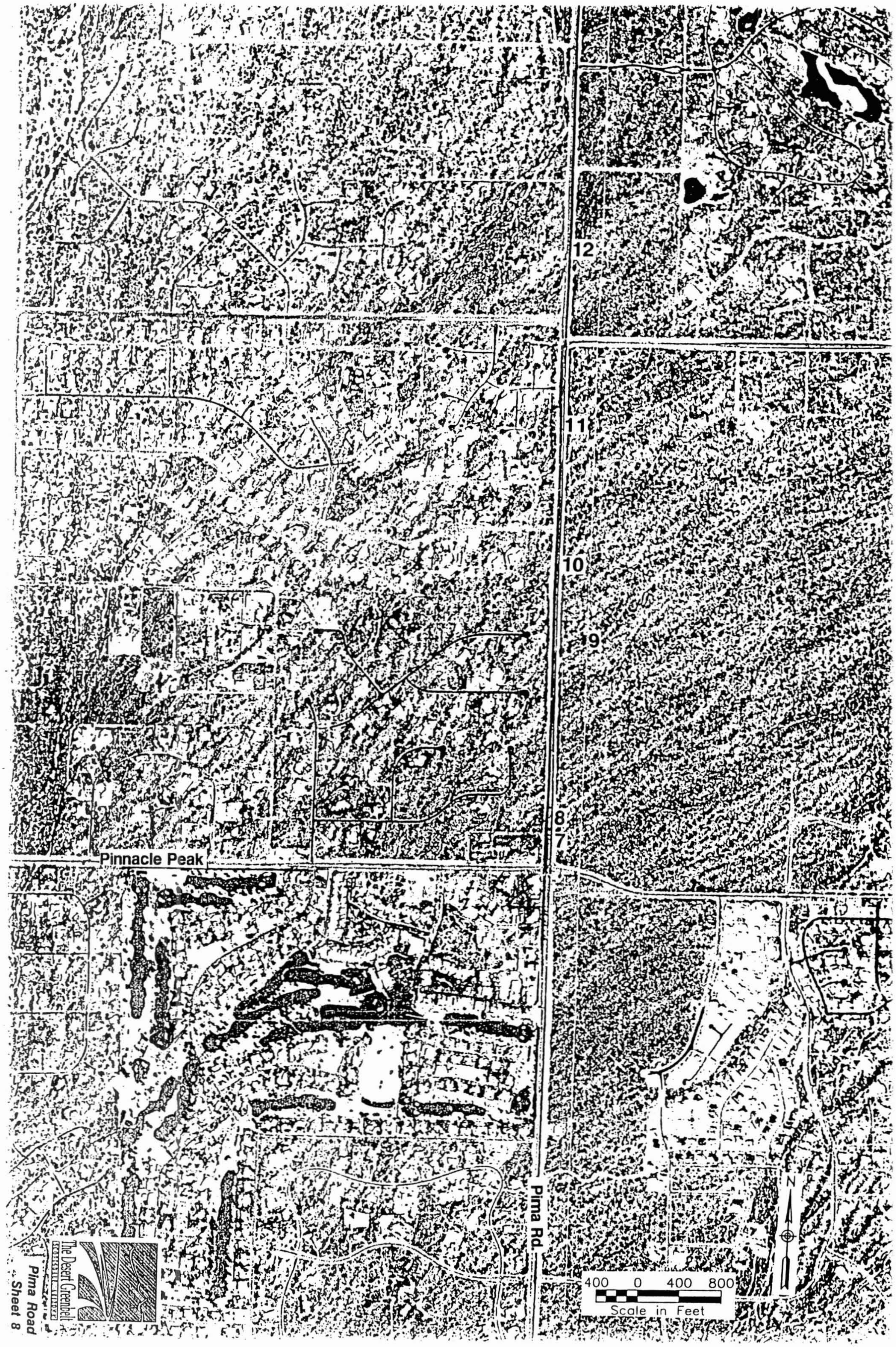
Sediment Field Tests

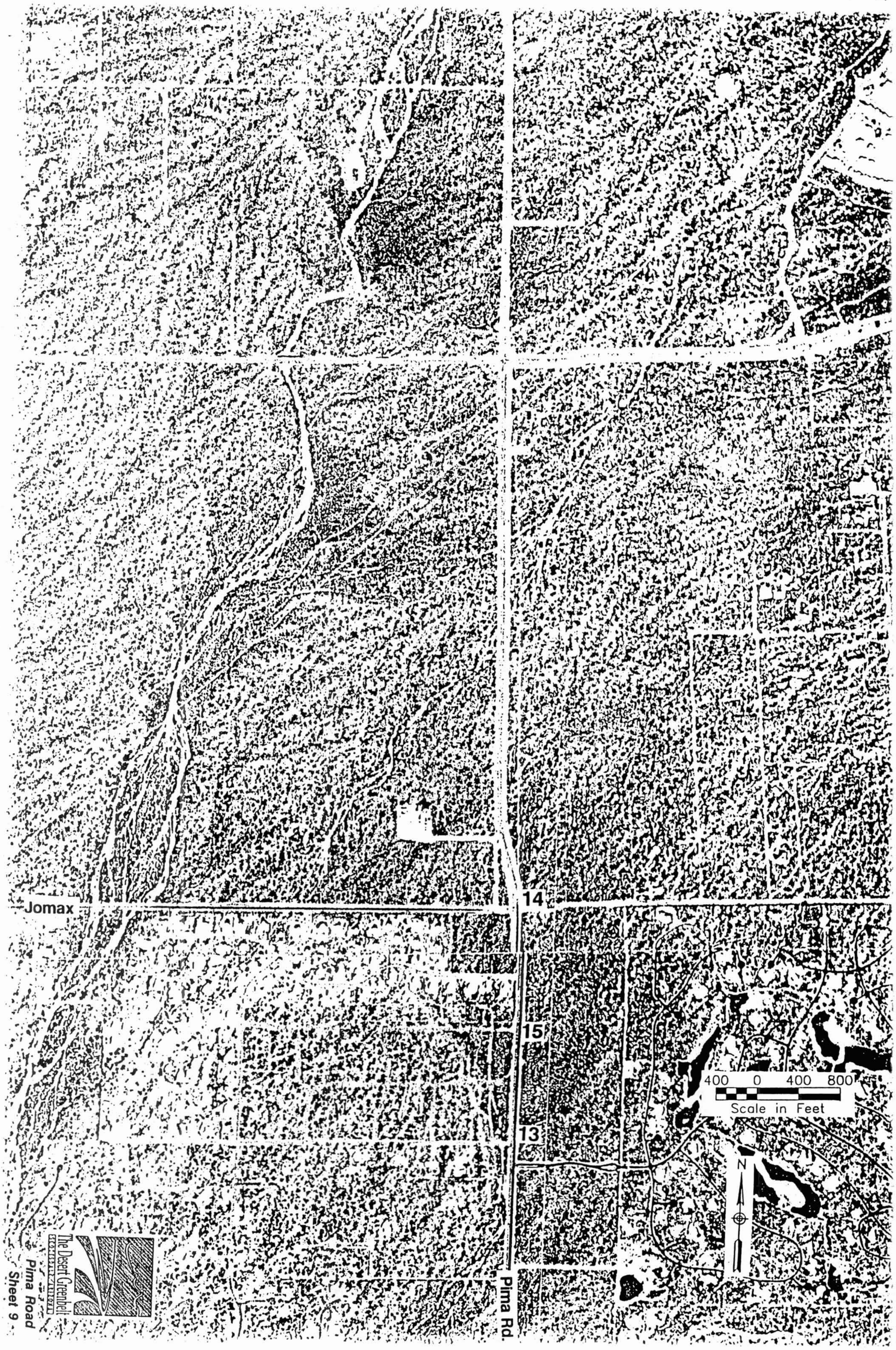
<u>Section 6</u>

Pima Road Channel

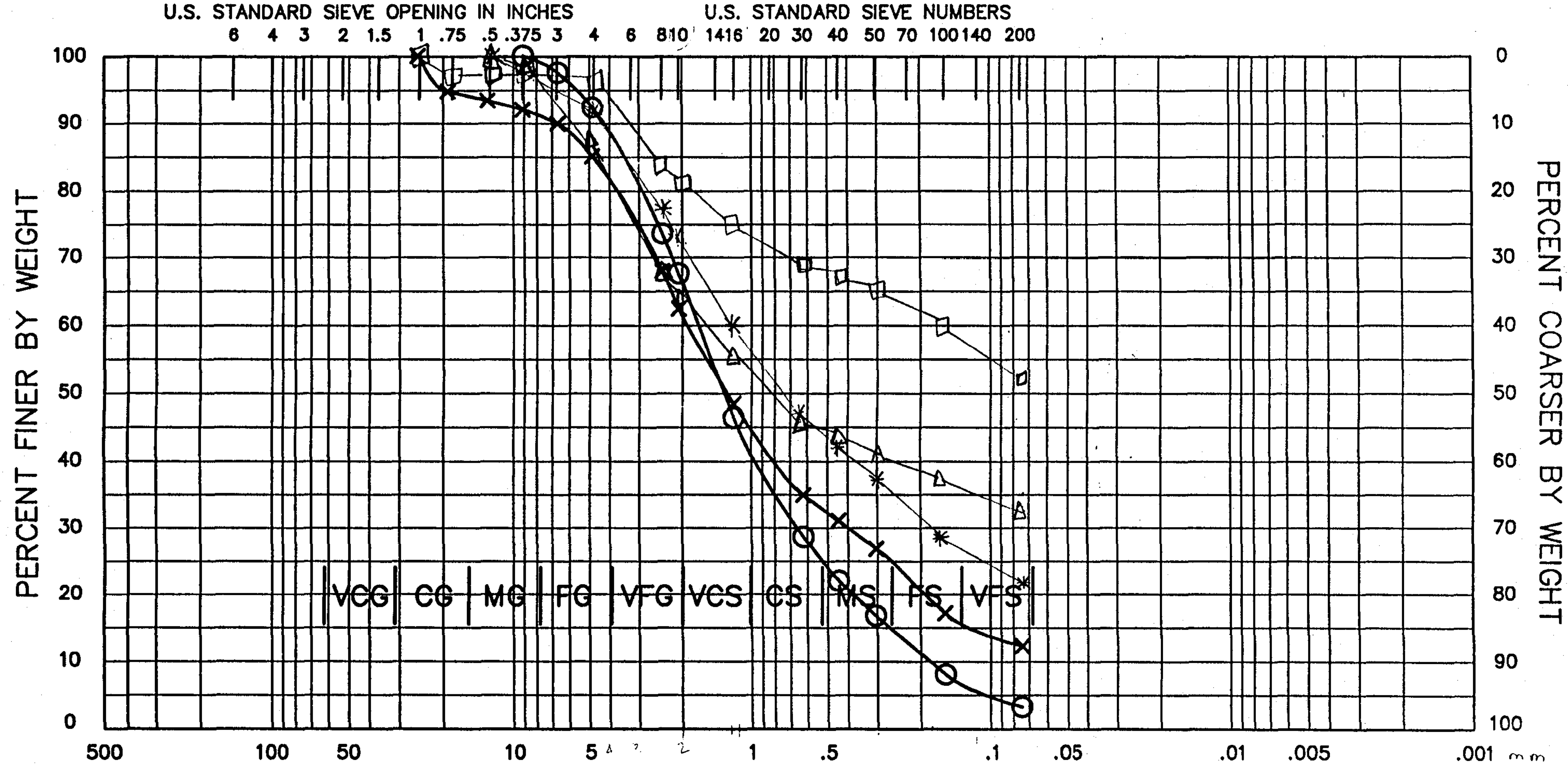


6
5
4
Beardsley
3
2
1
Pima Rd.
N
400 0 400 800
Scale in Feet
The Desert Greenbelt
Pima Road
Sheet 7


12
11
10
9
8
7
Pinnacle Peak
Pima Rd
400 0 400 800
Scale in Feet
N
The Desert Greenbelt
Pima Road
Sheet 8


Jomax
14
15
13
Pima Rd.
400 0 400 800
Scale in Feet
N
The Desert Greenbelt
Pima Road
Sheet 9

[redacted]DI[redacted]T [redacted]MPL[redacted]CO[redacted]NT[redacted]RAF[redacted]



Cobbles	Gravel		Sand			Silt or Clay
	Coarse	Fine	Coarse	Medium	Silt or Clay	

Sample	Elev or Depth	Classification	Nat. W%	LL	PL	PL
× 1	Top 2 Feet	Very Coarse Sand				
O 7	Top 2 Feet	Very Coarse Sand				
* DV-2@0-1.5'						
△ PC-14@0-1.5'						
□ PC5@0-1.5'						

Scottsdale Desert Greenbelt

Pima Road

Boring No.:

Sample Date: 4/18/94

P:\AARON\SEDMENT2.DWG

Project: e029102

The Desert Greenbelt

Greiner

ATL Inc.
GEOTECHNICAL AND MATERIALS CONSULTANTS

CLIENT:	Greiner, Inc. 7310 North 16th Street, #160 Phoenix, Az. 85020	DATE:	07-25-94
		LAB NO.:	94-0895
		PROJECT NO.:	794043
ATTN.:	Mr. Bill Lace	DATE RVCD.:	07-21-94
PROJECT:	Sieve Evaluations	SAMPLED BY:	Client
MATERIAL:	Native	TESTED BY:	M. DeWaard
SOURCE:	Pima #1	METHOD:	ASTM C136

PARTICLE SIZE ANALYSIS OF SOILS

SIEVE SIZE	% PASSING
2"	
1 1/2"	
1"	100
3/4"	95
1/2"	94
3/8"	93
1/4"	90
#4	85
#8	68
#10	63
#16	49
#30	35
#40	31
#50	27
#100	17
#200	12.5

Remarks: Moisture content = 1.3 %

Respectfully Submitted,

Thomas M. Gordon
Laboratory Supervisor

2922 WEST CLARENDON PHOENIX, ARIZONA 85017 TELEPHONE (602) 241-1097 / FAX (602) 234-0699
16921 S. WESTERN AVE., SUITE 109 GARDENA, CALIFORNIA 90247 TELEPHONE (310) 538-3757 / FAX (310) 538-0725

Testing Laboratories

ATL Inc.

GEOTECHNICAL AND MATERIALS CONSULTANTS

CLIENT:	Greiner, Inc. 7310 North 16th Street, #160 Phoenix, Az. 85020	DATE:	07-25-94
		LAB NO.:	94-0896
		PROJECT NO.:	794043
ATTN.:	Mr. Bill Lace	DATE RVCD.:	07-21-94
PROJECT:	Sieve Evaluations	SAMPLED BY:	Client
MATERIAL:	Native	TESTED BY:	M. DeWaard
SOURCE:	Pima #2	METHOD:	ASTM C136

PARTICLE SIZE ANALYSIS OF SOILS

SIEVE SIZE	% PASSING
2"	
1 1/2"	100
1"	98
3/4"	95
1/2"	92
3/8"	89
1/4"	81
#4	72
#8	53
#10	46
#16	30
#30	17
#40	13
#50	10
#100	5
#200	2.9

Remarks: Moisture content = 0.6 %

Respectfully Submitted,

Thomas M. Gordon
Laboratory Supervisor

2922 WEST CLARENDON PHOENIX, ARIZONA 85017 TELEPHONE (602) 241-1097 / FAX (602) 234-0699
16921 S. WESTERN AVE., SUITE 109 GARDENA, CALIFORNIA 90247 TELEPHONE (310) 538-3757 / FAX (310) 538-0725

ATL Inc.
GEOTECHNICAL AND MATERIALS CONSULTANTS

CLIENT:	Greiner, Inc. 7310 North 16th Street, #160 Phoenix, Az. 85020	DATE:	07-25-94
		LAB NO.:	94-0897
		PROJECT NO.:	794043
ATTN.:	Mr. Bill Lace	DATE RVCD.:	07-21-94
PROJECT:	Sieve Evaluations	SAMPLED BY:	Client
MATERIAL:	Native	TESTED BY:	D. Johnson
SOURCE:	Pima #3	METHOD:	ASTM C136

PARTICLE SIZE ANALYSIS OF SOILS

SIEVE SIZE	% PASSING
2"	
1 1/2"	100
1"	97
3/4"	97
1/2"	97
3/8"	96
1/4"	93
#4	88
#8	72
#10	67
#16	51
#30	32
#40	25
#50	19
#100	8
#200	3.4

Remarks: Moisture content = 1.0 %

Respectfully Submitted,

Thomas M. Gordon
Laboratory Supervisor

2922 WEST CLARENDON PHOENIX, ARIZONA 85017 TELEPHONE (602) 241-1097 / FAX (602) 234-0699
16921 S. WESTERN AVE., SUITE 109 GARDENA, CALIFORNIA 90247 TELEPHONE (310) 538-3757 / FAX (310) 538-0725

ATL Inc.

GEOTECHNICAL AND MATERIALS CONSULTANTS

CLIENT:	Greiner, Inc. 7310 North 16th Street, #160 Phoenix, Az. 85020	DATE: LAB NO.: PROJECT NO.:	07-25-94 94-0898 794043
ATTN.:	Mr. Bill Lace	DATE RVCD.:	07-21-94
PROJECT:	Sieve Evaluations	SAMPLED BY:	Client
MATERIAL:	Native	TESTED BY:	M. DeWaard
SOURCE:	Pima #4	METHOD:	ASTM C136

PARTICLE SIZE ANALYSIS OF SOILS

SIEVE SIZE	% PASSING
2"	
1 1/2"	
1"	100
3/4"	96
1/2"	94
3/8"	91
1/4"	82
#4	74
#8	61
#10	58
#16	46
#30	33
#40	27
#50	21
#100	10
#200	4.9

Remarks: Moisture content = 0.9 %

Respectfully Submitted,

Thomas M. Gordon
Laboratory Supervisor

2922 WEST CLARENDON PHOENIX, ARIZONA 85017 TELEPHONE (602) 241-1097 / FAX (602) 234-0699
16921 S. WESTERN AVE., SUITE 109 GARDENA, CALIFORNIA 90247 TELEPHONE (310) 538-3757 / FAX (310) 538-0725

ATL Inc.
GEOTECHNICAL AND MATERIALS CONSULTANTS

CLIENT:	Greiner, Inc. 7310 North 16th Street, #160 Phoenix, Az. 85020	DATE: LAB NO.: PROJECT NO.:	07-25-94 94-0899 794043
ATTN.:	Mr. Bill Lace	DATE RVCD.:	07-21-94
PROJECT:	Sieve Evaluations	SAMPLED BY:	Client
MATERIAL:	Native	TESTED BY:	D. Johnson
SOURCE:	Pima #5	METHOD:	ASTM C136

PARTICLE SIZE ANALYSIS OF SOILS

SIEVE SIZE	% PASSING
2"	
1 1/2"	100
1"	97
3/4"	95
1/2"	94
3/8"	93
1/4"	89
#4	84
#8	67
#10	61
#16	46
#30	31
#40	25
#50	19
#100	9
#200	6.2

Remarks: Moisture content = 0.8 %

Respectfully Submitted,

Thomas M. Gordon
Laboratory Supervisor

2922 WEST CLARENDON
16921 S. WESTERN AVE., SUITE 109
PHOENIX, ARIZONA 85017
GARDENA, CALIFORNIA 90247
TELEPHONE (602) 241-1097 / FAX (602) 234-0699
TELEPHONE (310) 538-3757 / FAX (310) 538-0725

ATL Inc.
GEOTECHNICAL AND MATERIALS CONSULTANTS

CLIENT:	Greiner, Inc. 7310 North 16th Street, #160 Phoenix, Az. 85020	DATE:	07-25-94
		LAB NO.:	94-0900
		PROJECT NO.:	794043
ATTN.:	Mr. Bill Lace	DATE RVCD.:	07-21-94
PROJECT:	Sieve Evaluations	SAMPLED BY:	Client
MATERIAL:	Native	TESTED BY:	M. DeWaard
SOURCE:	Pima #6	METHOD:	ASTM C136

PARTICLE SIZE ANALYSIS OF SOILS

SIEVE SIZE	% PASSING
2"	
1 1/2"	100
1"	95
3/4"	93
1/2"	93
3/8"	93
1/4"	91
#4	87
#8	73
#10	68
#16	50
#30	33
#40	27
#50	21
#100	9
#200	3.9

Remarks: Moisture content = 1.0 %

Respectfully Submitted,

Thomas M. Gordon
Laboratory Supervisor

ATL Inc.
GEOTECHNICAL AND MATERIALS CONSULTANTS

CLIENT:	Greiner, Inc. 7310 North 16th Street, #160 Phoenix, Az. 85020	DATE:	07-25-94
		LAB NO.:	94-0901
		PROJECT NO.:	794043
ATTN.:	Mr. Bill Lace	DATE RVCD.:	07-21-94
PROJECT:	Sieve Evaluations	SAMPLED BY:	Client
MATERIAL:	Native	TESTED BY:	M. DeWaard
SOURCE:	Pima #7	METHOD:	ASTM C136

PARTICLE SIZE ANALYSIS OF SOILS

SIEVE SIZE	% PASSING
2"	
1 1/2"	
1"	
3/4"	
1/2"	
3/8"	100
1/4"	98
#4	93
#8	74
#10	68
#16	46
#30	29
#40	23
#50	17
#100	8
#200	3.9

Remarks: Moisture content = 1.3 %

Respectfully Submitted,

Thomas M. Gordon
Laboratory Supervisor

2922 WEST CLARENDON, PHOENIX, ARIZONA 85017 TELEPHONE (602) 241-1097 / FAX (602) 234-0699
16921 S. WESTERN AVE., SUITE 109, GARDENA, CALIFORNIA 90247 TELEPHONE (310) 538-3757 / FAX (310) 538-0725

ATL Inc.

GEOTECHNICAL AND MATERIALS CONSULTANTS

Testing Laboratories

CLIENT:	Greiner, Inc. 7310 North 16th Street, #160 Phoenix, Az. 85020	DATE:	07-25-94
		LAB NO.:	94-0902
		PROJECT NO.:	794043
ATTN.:	Mr. Bill Lace	DATE RVCD.:	07-21-94
PROJECT:	Sieve Evaluations	SAMPLED BY:	Client
MATERIAL:	Native	TESTED BY:	D. Johnson
SOURCE:	Pima #8	METHOD:	ASTM C136

PARTICLE SIZE ANALYSIS OF SOILS

SIEVE SIZE	% PASSING
2"	
1 1/2"	
1"	
3/4"	100
1/2"	98
3/8"	97
1/4"	93
#4	85
#8	63
#10	55
#16	39
#30	23
#40	17
#50	12
#100	5
#200	3.4

Remarks: Moisture content = 0.9 %

Respectfully Submitted,

Thomas M. Gordon
Laboratory Supervisor

2922 WEST CLARENDON, PHOENIX, ARIZONA 85017, TELEPHONE (602) 241-1097 / FAX (602) 234-0699
16921 S. WESTERN AVE., SUITE 109, GARDENA, CALIFORNIA 90247, TELEPHONE (310) 538-3757 / FAX (310) 538-0725

ATL Inc.

GEOTECHNICAL AND MATERIALS CONSULTANTS

CLIENT:	Greiner, Inc. 7310 North 16th Street, #160 Phoenix, Az. 85020	DATE: LAB NO.: PROJECT NO.:	07-25-94 94-0903 794043
ATTN.:	Mr. Bill Lace	DATE RVCD.:	07-21-94
PROJECT:	Sieve Evaluations	SAMPLED BY:	Client
MATERIAL:	Native	TESTED BY:	D. Johnson
SOURCE:	Pima #9	METHOD:	ASTM C136

PARTICLE SIZE ANALYSIS OF SOILS

SIEVE SIZE	% PASSING
2"	
1 1/2"	
1"	
3/4"	
1/2"	
3/8"	100
1/4"	98
#4	93
#8	80
#10	75
#16	59
#30	41
#40	35
#50	26
#100	7
#200	3.7

Remarks: Moisture content = 0.8 %

Respectfully Submitted,

Thomas M. Gordon
Laboratory Supervisor

2922 WEST CLARENDON PHOENIX, ARIZONA 85017 TELEPHONE (602) 241-1097 / FAX (602) 234-0699
16921 S. WESTERN AVE., SUITE 109 GARDENA, CALIFORNIA 90247 TELEPHONE (310) 538-3757 / FAX (310) 538-0725

ATL Inc.

GEOTECHNICAL AND MATERIALS CONSULTANTS

CLIENT:	Greiner, Inc. 7310 North 16th Street, #160 Phoenix, Az. 85020	DATE:	07-25-94
		LAB NO.:	94-0904
		PROJECT NO.:	794043
ATTN.:	Mr. Bill Lace	DATE RVCD.:	07-21-94
PROJECT:	Sieve Evaluations	SAMPLED BY:	Client
MATERIAL:	Native	TESTED BY:	M. DeWaard
SOURCE:	Pima #10	METHOD:	ASTM C136

PARTICLE SIZE ANALYSIS OF SOILS

SIEVE SIZE	% PASSING
2"	
1 1/2"	
1"	
3/4"	
1/2"	100
3/8"	99
1/4"	95
#4	86
#8	61
#10	56
#16	40
#30	26
#40	21
#50	16
#100	8
#200	4.3

Remarks: Moisture content = 1.4 %

Respectfully Submitted,

Thomas M. Gordon

Thomas M. Gordon
Laboratory Supervisor

2922 WEST CLARENDON PHOENIX, ARIZONA 85017 TELEPHONE (602) 241-1097 / FAX (602) 234-0699
16921 S. WESTERN AVE., SUITE 109 GARDENA, CALIFORNIA 90247 TELEPHONE (310) 538-3757 / FAX (310) 538-0725

ATL Inc.

GEOTECHNICAL AND MATERIALS CONSULTANTS

CLIENT:	Greiner, Inc. 7310 North 16th Street, #160 Phoenix, Az. 85020	DATE:	07-25-94
		LAB NO.:	94-0905
		PROJECT NO.:	794043
ATTN.:	Mr. Bill Lace	DATE RVCD.:	07-21-94
PROJECT:	Sieve Evaluations	SAMPLED BY:	Client
MATERIAL:	Native	TESTED BY:	D. Johnson
SOURCE:	Pima #11	METHOD:	ASTM C136

PARTICLE SIZE ANALYSIS OF SOILS

SIEVE SIZE	% PASSING
2"	
1 1/2"	
1"	
3/4"	
1/2"	100
3/8"	99
1/4"	96
#4	89
#8	72
#10	68
#16	48
#30	27
#40	20
#50	13
#100	6
#200	3.2

Remarks: Moisture content = 1.1 %

Respectfully Submitted,

Thomas M. Gordon
Laboratory Supervisor

2922 WEST CLARENDON PHOENIX, ARIZONA 85017 TELEPHONE (602) 241-1097 / FAX (602) 234-0699
16921 S. WESTERN AVE., SUITE 109 GARDENA, CALIFORNIA 90247 TELEPHONE (310) 538-3757 / FAX (310) 538-0725

ATL Inc.

GEOTECHNICAL AND MATERIALS CONSULTANTS

CLIENT:	Greiner, Inc. 7310 North 16th Street, #160 Phoenix, Az. 85020	DATE:	07-25-94
		LAB NO.:	94-0906
		PROJECT NO.:	794043
ATTN.:	Mr. Bill Lace	DATE RVCD.:	07-21-94
PROJECT:	Sieve Evaluations	SAMPLED BY:	Client
MATERIAL:	Native	TESTED BY:	D. Johnson
SOURCE:	Pima #12	METHOD:	ASTM C136

PARTICLE SIZE ANALYSIS OF SOILS

SIEVE SIZE	% PASSING
2"	
1 1/2"	
1"	
3/4"	100
1/2"	98
3/8"	96
1/4"	88
#4	75
#8	53
#10	47
#16	32
#30	17
#40	13
#50	10
#100	6
#200	3.6

Remarks: Moisture content = 1.2 %

Respectfully Submitted,

Thomas M. Gordon
Laboratory Supervisor

2922 WEST CLARENDON PHOENIX, ARIZONA 85017 TELEPHONE (602) 241-1097 / FAX (602) 234-0699
16921 S. WESTERN AVE., SUITE 109 GARDENA, CALIFORNIA 90247 TELEPHONE (310) 538-3757 / FAX (310) 538-0725

ATL Inc.
GEOTECHNICAL AND MATERIALS CONSULTANTS

CLIENT:	Greiner, Inc. 7310 North 16th Street, #160 Phoenix, Az. 85020	DATE:	07-25-94
		LAB NO.:	94-0907
		PROJECT NO.:	794043
ATTN.:	Mr. Bill Lace	DATE RVCD.:	07-21-94
PROJECT:	Sieve Evaluations	SAMPLED BY:	Client
MATERIAL:	Native	TESTED BY:	M. DeWaard
SOURCE:	Pima #13	METHOD:	ASTM C136

PARTICLE SIZE ANALYSIS OF SOILS

SIEVE SIZE	% PASSING
2"	
1 1/2"	
1"	
3/4"	
1/2"	
3/8"	
1/4"	100
#4	98
#8	85
#10	78
#16	55
#30	33
#40	26
#50	20
#100	10
#200	5.8

Remarks: Moisture content = 0.3 %

Respectfully Submitted,

Thomas M. Gordon
Laboratory Supervisor

ATL Inc.
GEOTECHNICAL AND MATERIALS CONSULTANTS

CLIENT:	Greiner, Inc. 7310 North 16th Street, #160 Phoenix, Az. 85020	DATE:	07-25-94
		LAB NO.:	94-0908
		PROJECT NO.:	794043
ATTN.:	Mr. Bill Lace	DATE RVCD.:	07-21-94
PROJECT:	Sieve Evaluations	SAMPLED BY:	Client
MATERIAL:	Native	TESTED BY:	D. Johnson
SOURCE:	Pima #14	METHOD:	ASTM C136

PARTICLE SIZE ANALYSIS OF SOILS

SIEVE SIZE	% PASSING
2"	
1 1/2"	
1"	
3/4"	
1/2"	100
3/8"	98
1/4"	91
#4	78
#8	58
#10	54
#16	38
#30	24
#40	19
#50	13
#100	6
#200	3.2

Remarks: Moisture content = 0.6 %

Respectfully Submitted,

Thomas M. Gordon
Laboratory Supervisor

2922 WEST CLARENDON, PHOENIX, ARIZONA 85017, TELEPHONE (602) 241-1097 / FAX (602) 234-0699
16921 S. WESTERN AVE., SUITE 109, GARDENA, CALIFORNIA 90247, TELEPHONE (310) 538-3757 / FAX (310) 538-0725

ATL Inc.

GEOTECHNICAL AND MATERIALS CONSULTANTS

CLIENT: Greiner, Inc.
7310 North 16th Street, #160
Phoenix, Az. 85020

ATTN.: Mr. Bill Lace
PROJECT: Sieve Evaluations
MATERIAL: Native
SOURCE: Pima #15

DATE: 07-25-94
LAB NO.: 94-0909
PROJECT NO.: 794043
DATE RVCD.: 07-21-94
SAMPLED BY: Client
TESTED BY: M. DeWaard
METHOD: ASTM C136

PARTICLE SIZE ANALYSIS OF SOILS

SIEVE SIZE	% PASSING
2"	
1 1/2"	
1"	
3/4"	
1/2"	
3/8"	100
1/4"	99
#4	95
#8	84
#10	79
#16	62
#30	40
#40	32
#50	23
#100	9
#200	4.6

Remarks: Moisture content = 0.5 %

Respectfully Submitted,

Thomas M. Gordon
Laboratory Supervisor

2922 WEST CLARENDON PHOENIX, ARIZONA 85017 TELEPHONE (602) 241-1097 / FAX (602) 234-0699
16921 S. WESTERN AVE., SUITE 109 GARDENA, CALIFORNIA 90247 TELEPHONE (310) 538-3757 / FAX (310) 538-0725

Appendix I

ADWR Dam Safety
Preliminary Application Submittal Form
and
ADWR Review Response Letter

ARIZONA DEPARTMENT OF WATER RESOURCES
Dam Safety & Flood Mitigation Section
500 North Third Street, Phoenix, Arizona 85004-3903
Telephone (602) 417-2445
Fax (602) 417-2423

FIFE SYMINGTON
Governor

RITA P. PEARSON
Director

September 14, 1995

Mr. Alex McLaren
Transportation Planning Director
City of Scottsdale
P.O. Box 1000
Scottsdale, Arizona 85252-1000

Subject: Pima Road Channel with Detention

Dear Mr. McLaren:

As requested during the course of the meeting held at your offices on August 24, 1995, the Department has completed a very brief review of the materials provided to us by both PACE and the City of Scottsdale. Our preliminary review reveals no obvious fatal flaws in the conceptual level designs of the proposed detention basins. Accordingly, we tentatively conclude that final designs could be developed that would meet the minimum standards necessary for the Department to approve construction of the dams.

We do have some questions/comments with respect to PACE's development of the PMF. If it is decided to pursue this design concept, we recommend that PACE contact us early on to resolve these concerns.

Sincerely,

William C. Jenkins, P.E.
Chief
Safety of Dams & Flood Engineering

cc: Mark Krebs/PACE

PACE

PACIFIC ADVANCED CIVIL ENGINEERING

17902 GEORGETOWN LANE HUNTINGTON BEACH CALIFORNIA 92647
TEL: 714-843-5734 • FAX: 714-848-4820

August 28, 1995

Mr. Bill Jenkins
Engineering Division/Safety of Dams Section
Arizona Department of Water Resources
500 North 3rd Street
Phoenix, AZ 85004

Dear Mr. Jenkins:

I would like to take this opportunity to thank you for your comments during our meeting Wednesday August 23, 1995 regarding the Pima Road Detention Basins. Per our conversation, we made the changes in the 0.5 PMF routing that you requested. The HEC-1 model now includes the full Probable Maximum Precipitation with a 50% reduction of the runoff.

Enclosed you will find a revised copy of the Pima Road Detention Basin Feasibility Study, Preliminary Design Report. Bound with the report is a printout of the revised 0.5 PMF HEC-1 model as well as a computer disk. Please discard the report dated August 23 and the HEC-1 printouts for the PMF routing found in the Appendix, Pima Road Detention Basin Feasibility Study, Preliminary Design Report dated August 23, 1995 which you currently have. As we discussed, the above changes increased the water surface elevations less that 0.5' in the detention basins (0.4' for Happy Valley and 0.2' for Deer Valley Detention Basin). Both detention basins still have over 3 feet of freeboard with the 0.5 PMF routing. Also included with this letter are the revised Preliminary Applications for Approval of Plans.

Should you have any questions or need further clarification, please call. We look forward to working with you on this project. Again, we would be happy to attend the working meeting with the review staff to facilitate the project review.

Sincerely,
PACIFIC ADVANCED CIVIL ENGINEERING

Mark E. Krebs, P.E.
Vice President

MEK/dm
Enc.
cc: *Mark Landsiedel/COS*
Brian Baehr/Grayhawk
Ottozawa Chatupron/ASLD

ARIZONA DEPARTMENT OF WATER RESOURCES
Safety of Dams & Flood Engineering Unit

FIFE SYMINGTON
Governor

RITA P. PEARSON
Director

Application No. ____________ Filed ____________
(Applicant shall not fill in above blanks)

PRELIMINARY

APPLICATION for APPROVAL of the PLANS and SPECIFICATIONS for the CONSTRUCTION, ENLARGEMENT, REPAIR, ALTERATION or REMOVAL of a DAM and RESERVOIR

This application is for the Construction Feasibility (Construction, Enlargement, Repair, etc.) of the Pima Rd Desert Greenbelt-Happy Valley Rd (Name of Dam) Dam.

LOCATION OF DAM

This dam is in Maricopa County, in the S.W. 1/4, Sec. 6, Twp. T.4N, Rge. R.5E, G&SR B&M, at North Latitude 33 °, 42 ', 48 " and West Longitude 111 °, 53 ', 22 ", on USGS Quad Currys Corner, and is located on Proposed Pima Rd Desert Greenbelt (Wash, Creek, River or Watershed), tributary to USBOR/CAP Levee - Reach (Wash, Creek or River).

OWNER

(Proposed)
Name: City of Scottsdale, Arizona

Telephone: (602) 994-7754

Mailing Address: 7447 E. Indian School Road., Suite 125
Scottsdale, AZ 85251
Attn: Mark Landsiedel, Desert Greenbelt Project Manager

If this application is for construction of a new dam complete all items (1 through 21) except item 12. For enlargement, repair, alteration or removal complete items 12 through 21 and those other items where a change is being made.

DESCRIPTION OF DAM AND RESERVOIR

1. Type of dam earth w/soil cement cutoff wall (Earth, Rock, Concrete Gravity, etc.) Purpose of dam Flood Control.
2. Dam crest elevation 2,098 feet. Spillway crest elev. 2,090 feet. Outlet invert elev. 2,060 feet.
3. Dam height is 18 feet (Measured from the lowest elevation of the outside limit of the dam at its intersection with the natural ground surface to the crest of the spillway - ARS 45-1201.2).
4. Dam crest length ±1,300 feet. Dam crest width 10' min feet. Dam Crest Camber (if any) N/A feet.
5. Dam slope: Upstream 3 : 1 (horizontal:vertical); Downstream 4 : 1 (horizontal:vertical).
   Maximum - varies   Maximum - varies
6. Spillway (type, dimensions, control(s), design capacity, flow depth, etc.):
   Broad crested weir at existing grade with soil cement cutoff wall. Length = 300'
   Design Capacity: 20,450 cfs Flow Depth: 4.5' Height = 8.0'
7. Outlet (type, internal diameter, dimensions, control(s), capacity, trashrack, energy dissipator):
   30" Ø Reinforced Concrete Pipe. To be detailed with final submittal
8. Reservoir at spillway crest elevation: Storage capacity 385 acre-feet; Surface area 17.3 acres.
   Reservoir at dam crest elevation: Storage capacity 533 acre-feet; Surface area 19.6 acres.
   *Including 13 AF of sediment storage below outlet invert.

HYDROLOGIC DATA

9. Drainage area 3.4* square miles. Names of upstream dams None
   *Including area tributary via 1.5 miles of Pima Road Channel & 1.5 miles of Happy Valley Rd Channel
10. Downstream Hazard: Residential, Commercial, development, Hazard Potential Class - High
   (Nearest downstream town, population, distance, other inhabitants or development, Downstream Hazard Potential Classification)

11. Inflow design flood: 0.5 PMF (100-year, 0.5 PMF, PMF). Duration 6 hours. Precipitation 13.05 inches.

Peak inflow rate 9960 cfs. Water surface elevation is 2094.5 feet at the time of the maximum spillway discharge of 8800 cfs during routing of the Inflow Design Flood.

GENERAL INFORMATION

12. Description of Work (enlargement, repair, alteration, etc.):

    Potential construction, preliminary submittal for design feasibility.

13. Use of stored water: None, flood control, potential groundwater recharge site.

14. Other federal, state or local permits (to be) applied for; Give details, include date(s):

    To be determined

15. Describe provisions to divert flood flows during construction; include frequency (years) and flow rate (cfs):

    To be determined

16. Construction is expected to begin To be determined (Month and Year). Estimated completion To be determined (Month and Year).

17. Estimated cost of dam, reservoir and appurtenances (ARS 45-1204.A): ±$3,300,000 estimate

18. Fees accompanying this application (fees based on cost; R12-15-151): To be determined by ADWR dam safety upon completion of preliminary review

19. Investigations, design, drawings and specifications prepared by (identify firm and Engineer of Record; attach resume highlighting dam design experience): Pacific Advanced Civil Engineering
    Johan A. Perslow, P.E., Mark E. Krebs, P.E.

20. Construction Quality Assurance & Quality Control to be performed by (identify firm, Site Engineer, and Engineer of Record; attach resume(s) highlighting dam construction experience): To be determined

21. Emergency Action Plan prepared by: To be determined

Application submitted by (signature): [signature] Date: 8-28-95

Name: Mark E. Krebs, P.E.
Pacific Advanced Civil Engineering

Mailing Address: 17902 Georgetown Lane
Huntington Beach, CA 92647
(714) 843-5734

Legal capacity if other than owner:

PRELIMINARY

APPROVAL OF APPLICATION No. _______

This is to certify that Application No. _________, including the drawings and specifications for ____________________ Dam and Reservoir has been examined and the same is hereby approved, subject to the following terms and limitations:

1. Construction work shall be started within one (1) year from date.

2. No foundations or abutments shall be covered by the material of the dam until the Department has been given an opportunity to inspect and approve the same.

Dated this _______ day of ________________________, 19___

95/04

Assistant Director, Surface Water Division

ARIZONA DEPARTMENT OF WATER RESOURCES
Safety of Dams & Flood Engineering Unit

FIFE SYMINGTON
Governor

RITA P. PEARSON
Director

Application No. ____________ Filed ____________
(Applicant shall not fill in above blanks)

PRELIMINARY

APPLICATION for APPROVAL of the PLANS and SPECIFICATIONS for the CONSTRUCTION, ENLARGEMENT, REPAIR, ALTERATION or REMOVAL of a DAM and RESERVOIR

This application is for the Construction Feasibility (Construction, Enlargement, Repair, etc.) of the Pima Rd. Desert Greenbelt - Deer Valley Road (Name of Dam) Dam.

LOCATION OF DAM

This dam is in Maricopa County, in the S.W. 1/4, Sec. 18, Twp. T.4N, Rge. R.5E, G&SR B&M, at North Latitude 35 °, 41 ', 4 " and West Longitude 11 °, 53 ', 22 ", on USGS Quad Currys Corner, and is located on proposed Pima Rd. Desert Greenbelt channel (Wash, Creek, River or Watershed), tributary to US BOR/CAD Levee - Reach (Wash, Creek or River).

OWNER

Name: (Proposed) City of Scottsdale, Arizona
Telephone: (602) 994-7754

Mailing Address: 7447 E. Indian School Road, Suite 125
Scottsdale, AZ 85251
Attn: Mark Landsiedel

If this application is for construction of a new dam complete all items (1 through 21) except item 12. For enlargement, repair, alteration or removal complete items 12 through 21 and those other items where a change is being made.

DESCRIPTION OF DAM AND RESERVOIR

1. Type of dam Earth w/soil cement cutoff wall (Earth, Rock, Concrete Gravity, etc.). Purpose of dam Flood Control.

2. Dam crest elevation 1,898 feet. Spillway crest elev. 1,890 feet. Outlet invert elev. 1,860 feet.

3. Dam height is 28 feet (Measured from the lowest elevation of the outside limit of the dam at its intersection with the natural ground surface to the crest of the spillway - ARS 45-1201.2).

4. Dam crest length ±1,300 feet. Dam crest width 15' min feet. Dam Crest Camber (if any) N/A feet.

5. Dam slope: Upstream 3 : 1 (horizontal:vertical); Downstream 4 : 1 (horizontal:vertical).
   Slope varies, Max 3:1 — Slope varies, Max 4:1

6. Spillway (type, dimensions, control(s), design capacity, flow depth, etc.):
   Broad crested weir at existing grade with soil cement cutoff wall. Length = 400 ft
   Design Capacity: 34,160 Flow Depth: 4.3 Height = 8.0 ft

7. Outlet (type, internal diameter, dimensions, control(s), capacity, trashrack, energy dissipator):
   42" diameter reinforced concrete pipe. Detailed design and sizing to be determined and submitted with final design.

8. Reservoir at spillway crest elevation: Storage capacity 324 acre-feet; Surface area 15.5 acres.
   Reservoir at dam crest elevation: Storage capacity 481 acre-feet; Surface area 17.7 acres.
   * Including 33 acre feet of sediment storage below outlet invert.

HYDROLOGIC DATA

9. Drainage area 6.0* square miles. Names of upstream dams Proposed Pima Rd. Desert Greenbelt - Happy Valley Road Dam
   *Including area tributary via 3.2 miles of Pima Rd. channel & 0.5 miles of Deer Valley Rd Channel

10. Downstream Hazard: City of Scottsdale residential & commercial - Hazard Potential Classification High
   (Nearest downstream town, population, distance, other inhabitants or development, Downstream Hazard Potential Classification)

11. Inflow design flood: 0.5 PMF (100-year, 0.5 PMF, PMF). Duration 6 hours. Precipitation 12.12 inches.

Peak inflow rate 13,730 cfs. Water surface elevation is 1,894.3 feet at the time of the maximum spillway discharge of 13,620 cfs during routing of the Inflow Design Flood.

GENERAL INFORMATION

12. Description of Work (enlargement, repair, alteration, etc.):

    Potential construction, preliminary submittal for design feasibility.

13. Use of stored water: None, flood control, potential ground water recharge site.

14. Other federal, state or local permits (to be) applied for; Give details, include date(s):

    To be determined

15. Describe provisions to divert flood flows during construction; include frequency (years) and flow rate (cfs):

    To be determined

16. Construction is expected to begin To be determined (Month and Year). Estimated completion To be determined (Month and Year).

17. Estimated cost of dam, reservoir and appurtenances (ARS 45-1204.A): ± $3,330,000 Estimated

18. Fees accompanying this application (fees based on cost; R12-15-151): To be determined by ADWR dam safety upon completion of preliminary review.

19. Investigations, design, drawings and specifications prepared by (identify firm and Engineer of Record; attach resume highlighting dam design experience): Pacific Advanced Civil Engineering
    Johan A. Perslow, P.E., Mark E. Krebs, P.E.

20. Construction Quality Assurance & Quality Control to be performed by (identify firm, Site Engineer, and Engineer of Record; attach resume(s) highlighting dam construction experience): To be determined

21. Emergency Action Plan prepared by: To be determined

Application submitted by (signature): ______________ Date: 8-28-95

Name: Mark E. Krebs, P.E.
Pacific Advanced Civil Engineering

Mailing Address: 17902 Georgetown Lane
Huntington Beach, CA 92647
(714) 843-5734

Legal capacity if other than owner:

RELIMINARY

APPROVAL OF APPLICATION No. _______

This is to certify that Application No. _________, including the drawings and specifications for ____________________ Dam and Reservoir has been examined and the same is hereby approved, subject to the following terms and limitations:

1. Construction work shall be started within one (1) year from date.

2. No foundations or abutments shall be covered by the material of the dam until the Department has been given an opportunity to inspect and approve the same.

Dated this _______ day of ____________________, 19___

05/04

Assistant Director, Surface Water Division

Appendix J

Sedimentation Analysis
and
Sedimentation Transport Analysis Calculations

SEDIMENTATION CALCULATIONS

Annual Yield

1. Dendy/Bolton Method

$$S = 1280\ Q^{0.46}\ (1.43 - 0.26 \log A) \qquad (1)$$

where S = sediment yield (tons/sq. mi./yr)
Q = annual runoff (inches)
A = watershed area (sq. mi.)

This equation was developed in 1976 by Dendy and Bolton and is based on data from more than 800 reservoirs across the nation. The equation is recommended for areas with less than 2 inches of runoff per year but can be adjusted for areas with greater than 2 inches of runoff per year. The annual runoff, Q, is adjusted according to the following equation:

$$Q = 0.4501\ A^{-0.1449}\ (x/14) \qquad (1.1)$$

where Q and A retain their definitions from equation (1)
x = annual rainfall (inches)

Equation (1.1) was developed by Renard for the Walnut Gulch Experimental Watershed which is lodated in southern Arizona. This watershed has an annual rainfall close to 14 inches, therefore, the equation requires modification to reflect the annual rainfall for the North Scottsdale area. The runoff from equation (1.1) is reduced by a ratio of 7/14 to reflect the 7 inch annual rainfall that the North Scottsdale area receives. A linear reduction of equation (1.1) is considered an acceptable modification for use in equation (1) to establish the annualized sediment yield for the area. The volume of debris calculation was based on a sediment weight of 100 lb/ft^3.

Table 1
Dendy/Bolton Method

Debris Production Parameters	Happy Valley Road Detention Basin	Deer Valley Road Detention Basin	Union Hills Drive Detention Basin
A (sq. mi)	3.37	3.74	4.9
Q (inches)	0.19	0.19	0.18
S (tons/sq. mi./yr)	771	764	728
Total S (AF/yr)	1.2	1.3	1.6

2. Flaxman Method

This method is useful for small drainage areas, and is quite suitable for the Pima Road Channel Detention Basins. Flaxman's method is based on data from 27 watersheds found in 10 western states that range from 12 to 54 square miles. Flaxman's empirical regression equation is:

$$\log(Y + 100) = 6.21301 - 2.19113 \log(X_1 + 100) + 0.06034 \text{ Log } (X_2 + 100) - 0.01944 \log(X_3 + 100) + 0.04250 \log(X_4 + 100) \quad (2)$$

where

Y = average annual sediment yield (AF/sq. mi./yr)
X_1 = ratio of average annual precipitation (inches) to average annual temparature (°F)
X_2 = average watershed slope (%)
X_3 = percent of soil particles greater than 1.0 mm (in mean diameter)
X_4 = soil aggradation index (is zero if more than 25% of the soil sample is coarser than 1.0 mm)

Table 2
Flaxman Method

Debris Production Parameters	Happy Valley Road Detention Basin	Deer Valley Road Detention Basin	Union Hills Drive Detention Basin
X_1 (inches/°F)	7/85	7/85	7/85
X_2 (%)	2	2	2
X_3 (%)	61.3	58.9	60.2
X_4	0	0	0
Y (AF/sq. mi./yr.)	0.7	0.7	0.7
Total Y (AF/yr)	2.4	2.6	3.4

3. Bureau of Reclamation Sediment Surveys

This method is based on data published in the 1987 edition of Design of Small Dams, Bureau of Reclamation. The data was comprised of sediment measurements from 28 reservoirs in semi arid regions of the U.S. A regression line was drawn through the points to create the following equation.

$$Q_S = 1.84A^{-0.24} \qquad (3)$$

where Q_S = annual sediment yield (AF/sq. mi./yr)
A = drainage area (sq. mi.)

Table 3
Bureau of Reclamation Method

Debris Production Parameters	Happy Valley Road Detention Basin	Deer Valley Road Detention Basin	Union Hills Drive Detention Basin
A (sq. mi.)	3.37	3.74	4.9
Q_S (AF/sq. mi./yr)	1.37	1.34	1.26
Total Q_S (AF/yr)	4.6	5.0	6.2

4. Renard Method

This method is based on data from the Walnut Gulch Experimental Watershed. The equation was formed from a stochastic runoff model and a deterministic sediment transport relationship developed by Renard and Laursen (1975). The equation is:

$$Y = 0.001846A_S^{-0.1187} \qquad (4)$$

where Y = average annual sediment yield (AF/acre/year)
A_S = drainage area (acres)

Table 4
Renard Method

Debris Production Parameters	Happy Valley Road Detention Basin	Deer Valley Road Detention Basin	Union Hills Drive Detention Basin
A_S (acres)	2157	2394	3136
Y (AF/acre/yr)	7.42×10^{-4}	7.33×10^{-4}	7.10×10^{-4}
Total Y (AF/yr)	1.6	1.8	2.2

5. PSIAC Method

The Pacific Southwest Inter-Agency Committee developed this method to deal with specific conditions whiich exist in Southern California. This method was published in a report entiteled Factors Affecting Sediment Yield and Measures for the Reduction of Erosion and Sediment Yield. Nine factors are gauged to determine the yield for a given area. The nine factors are as follows:

- Surface Geology
- Soils
- Climate
- Runoff
- Topography
- Ground Cover
- Land Use
- Upland Erosion
- Channel Erosion

Each of the nine factors uses a rating system to aid in characterization of the watershed. Once each of the factors is rated, the nine ratings are summed. The sum will fall between 1 and 100 and into one of five classifications. The classifications describe the yield for the watershed and are as follows:

Classification	Rating	Yield
1	100	>3.0 AF/sq. mi./yr.
2	75-100	1.0-3.0 AF/sq.mi./yr.
3	50-75	0.5-1.0 AF/sq.mi./yr.
4	25-50	0.2-0.5 AF/sq.mi/yr.
5	0-25	<0.2 AF/sq.mi/yr.

As a result of similarity among the watersheds, they all have identical sediment yields. Based on the nine factors, the Pima Road Channel watershed sum of 50 is represented by classifications 3 & 4. The corresponding sediment yield is between 0.2 and 1.0 AF/sq.mi./yr.

B. Per Major Storm

1. Modified Universal Soil Loss Equation

Originally, the Universal Soil Loss Equation was utilized in the farming industry as an aid to predicting soil loss, but has since been modified and is accepted as a method to predict sediment yield from watersheds. The equation is :

$$S = 95(Q*q)^{0.56}K(LS)(C)(P)$$

where S = sediment yield (tons)
Q = runoff volume (AF)
q = peak discharge (cfs)
K = soil erodibility factor
LS = slope length and gradient factor
C = cropping management factor
P = erosion control practice factor

The LS factor is calculated with the following equation:

$$LS = (\lambda/72.6)^{n}(0.065 + 0.0454S + 0.0065S^{2})$$

where S = percent slope
λ = slope length
n = 0.3 for slope < 3%, 0.4 for slope = 4%, 0.5 for slope > 5%

Erosion control factor P has no significance in wildland areas and was set to 0. Cropping management factor C was calculated to be 0.45. Soil erodibility factor K was estimated at 0.15.

Calculations were completed for the 100 year 6 hour, 10 year 6 hour and 2 year 6 hour storm events. The results are shown in the tables below.

Table 6
MUSLE Method for Happy Valley Road Detention Basin

Variable	100 year 6 hour	10 year 6 hour	2 year 6 hour
Q (AF)	293	157	75
q (cfs)	4,300	1,790	660
K	0.15	0.15	0.15
LS	0.79	0.79	0.79
C	0.45	0.45	0.45
P	1	1	1
Y_S (tons)	13,192	5,694	2,153
Y_S (AF)	6.1	2.6	1.0

MUSLE Method for Deer Valley Road Detention Basin

Variable	100 year 6 hour	10 year 6 hour	2 year 6 hour
Q (AF)	477	250	119
q (cfs)	3,400	1,360	500
K	0.15	0.15	0.15
LS	0.79	0.79	0.79
C	0.45	0.45	0.45
P	1	1	1
Y_S (tons)	15,197	6,335	2,387
Y_S (AF)	7.0	2.9	1.1

MUSLE Method for Union Hills Drive Detention Basin

Variable	100 year 6 hour	10 year 6 hour	2 year 6 hour
Q (AF)	942	520	273
q (cfs)	5,100	2,280	1,100
K	0.15	0.15	0.15
LS	0.53	0.53	0.53
C	0.45	0.45	0.45
P	1	1	1
Y_S (tons)	18,758	8,568	3,971
Y_S (AF)	8.6	3.9	1.8

2. Sediment transport rate

An alternate approach to the determination of sediment yield is through the use of watershed hydrographs and a sediment transport rate equation. The hydrograph provides an incremental flow rate distribution which can be utilized with the Manning equation to calculate parameters needed to produce a unit sediment transport rate q_S (cfs/ft). The following equation appears in the Arizona Department of Water Resources Design Manual for Engineering Analysis of Fluvial Systems.

$$q_s = \frac{0.0064 n^{1.77} V^{4.32} G^{0.45}}{Y_b^{0.30} D_{50}^{0.61}}$$

where q_s = unit sediment transport rate (cfs/ft)
n = mannings roughness coefficient
V = velocity (ft/sec)
G = gradation coefficient
Y_b = hydraulic depth (ft)
D_{50} = median diameter of bed material

The equation relates grain particle size (weight), the effect of saltation, and kenetic energy (velocity) to approach the problem from a somewhat more physical approach than other methods.

A q_s is calculated for each incremental flow rate. That result is then multiplied by the natural channel bottom width and the time increment between flow rates to produce a volume of sediment yielded by the basin. A summary of the calculations is shown in the table below.

Table 7
100 Year Storm Sediment Transport Rate Calculation Volume

Detention Basin	Volume (AF)
Happy Valley Road	3.0
Deer Valley Road	2.6
Union Hills Drive	n/a

Sediment Transport Rate Method Conversion From (cfs) to (AF) For the 100-Year Storm

Total Happy Valley Detention Basin 2 year storm sediemnt inflow rate Q_s = 6.0 cfs

Total Happy Valley Detention Basin 2 year storm runoff inflow rate Q = 660 cfs

From hydrograph duration of flow at 2 year Q_s is 144 minutes

Area under hydrograph at 2 year Q_s 6*144*60/43560 = 1.2 AF

Total Happy Valley Detention Basin 100 year storm sediment inflow rate Q_s = 43.1 cfs

Total Happy Valley Detention Basin 100 year storm runoff inflow rate Q = 4300 cfs

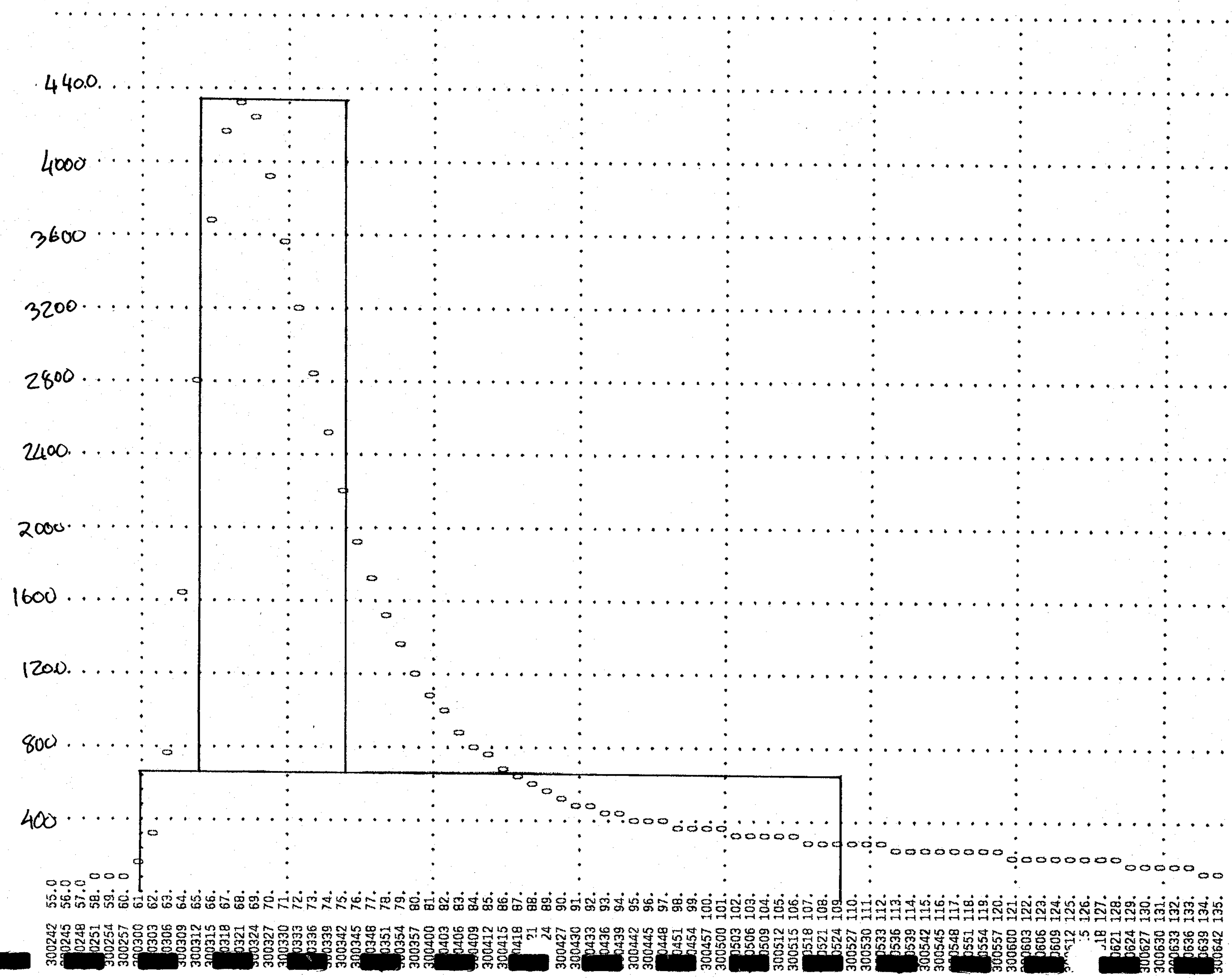
From hydrograph duration of flow at 100 year Q_s 30 minutes

Area under hydrograph at 100 year Q_s 43.1*30*60/43560 = 1.8 AF

Total sediment inflow into Happy Valley detention basins for 100 year storm

1.2 + 1.8 = 3.0 AF

C31A (INCLUDES ALL FLOWS COMMING INTO H.V. DET. BASIN)



[redacted]

<u>Sediment Transport Rate Method Conversion From (cfs) to (AF) For the 10-Year Storm</u>

Total Happy Valley Detention Basin 2 year storm sediment inflow rate Q_s = 6.0 cfs

Total Happy Valley Detention Basin 2 year storm runoff inflow rate Q = 660 cfs

From hydrograph duration of flow at 2 year Q_s is 100 minutes

Area under hydrograph at 2 year Q_s 6*100*60/43560 = 0.8 AF

Total Happy Valley Detention Basin 10 year storm sediment inflow rate Q_s = 16.9 cfs

Total Happy Valley Detention Basin 10 year storm runoff inflow rate Q = 1790 cfs

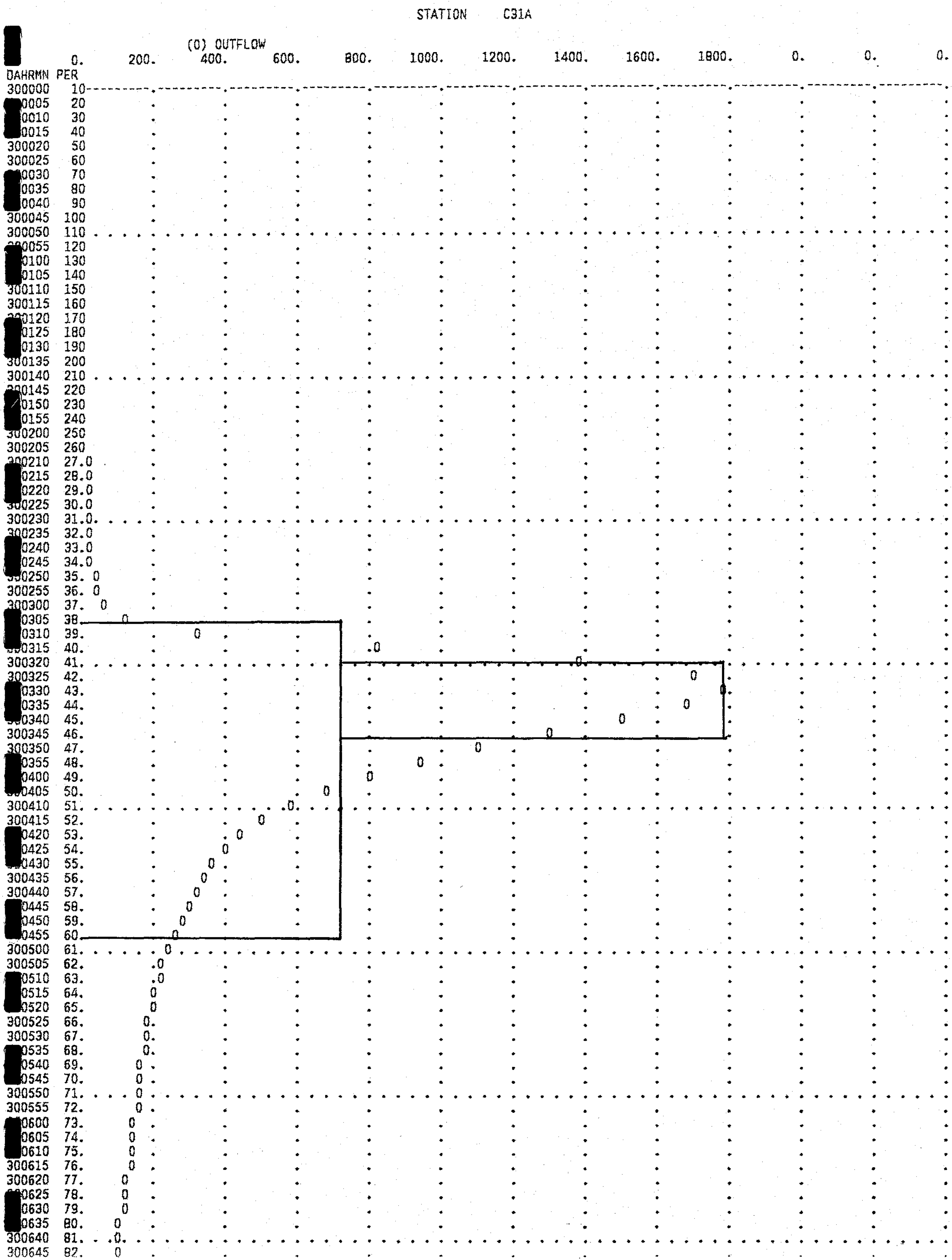
From hydrograph duration of flow at 10 year Q_s 25 minutes

Area under hydrograph at 10 year Q_s 16.9*25*60/43560 = 0.6 AF

Total sediment inflow into Happy Valley detention basins for 100 year storm

0.8 + 0.6 = 1.4 AF

INFLOW HYDROGRAPH FOR 10 YEAR 6 HOUR STORM FOR HAPPY VALLEY ROAD DETENTION BASIN



Sediment Transport Rate Method Conversion From (cfs) to (AF) For the 100-Year Storm

Total Deer Valley Detention Basin 10 year storm sediemnt inflow rate Q_s = 11.8 cfs

Total Deer Valley Detention Basin 10 year storm runoff inflow rate Q = 1360 cfs

From hydrograph duration of flow at 10 year Q_s is 111 minutes

Area under hydrograph at 10 year Q_s 11.8*111*60/43560 = 1.8 AF

Total Deer Valley Detention Basin 100 year storm sediment inflow rate Q_s = 24.5 cfs

Total Deer Valley Detention Basin 100 year storm runoff inflow rate Q = 3400 cfs

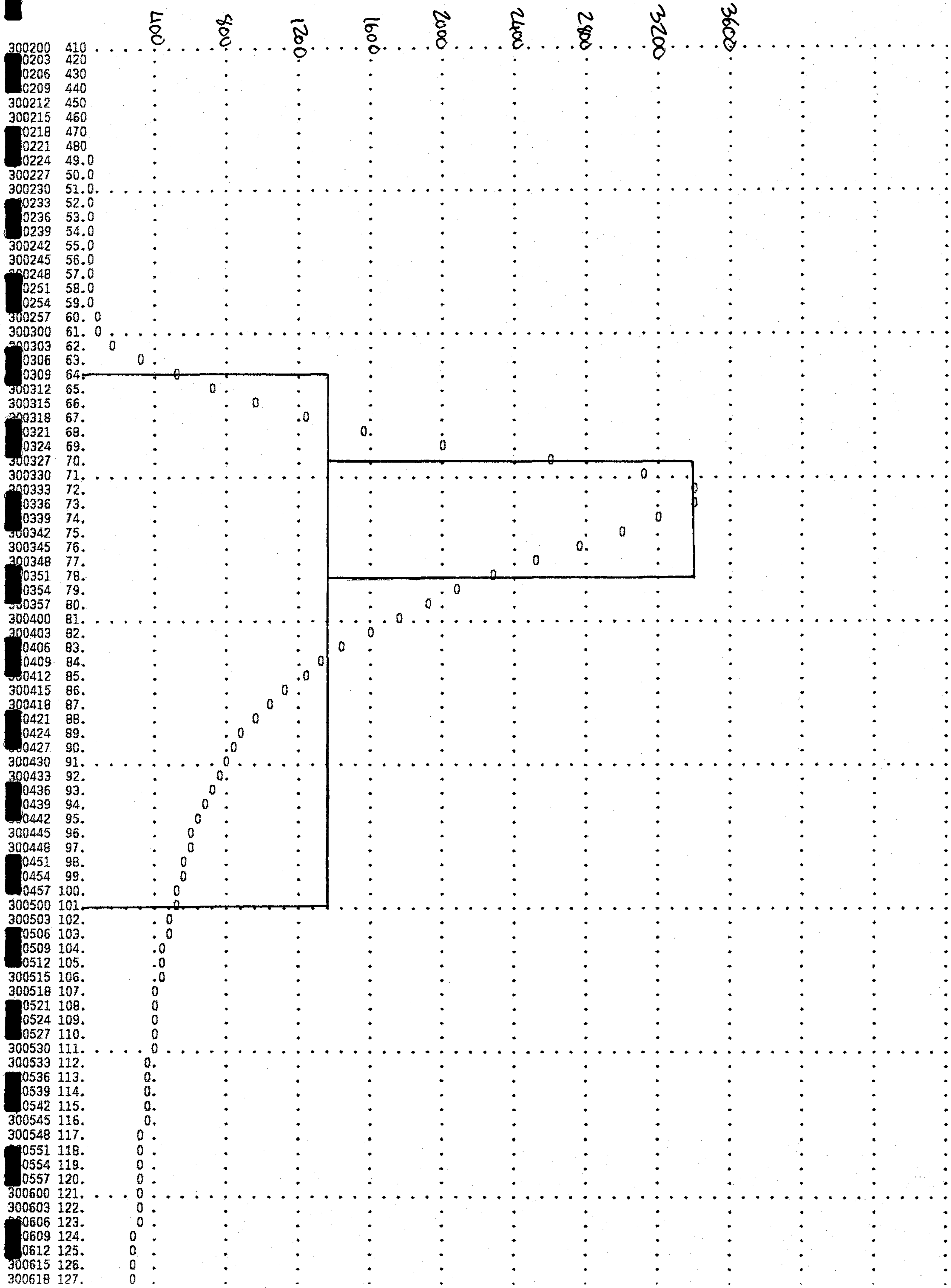
From hydrograph duration of flow at 100 year Q_s 24 minutes

Area under hydrograph at 100 year Q_s 24.5*24*60/43560 = 0.8 AF

Total sediment inflow into Deer Valley detention basins for 100 year storm

1.8 + 0.8 = 2.6 AF

DEER VALLEY ROAD DETENTION BASIN INFLOW
HYDROGRAPH FOR THE 100 YEAR 6 HOUR STORM



SEDIMENT SUPPLY CALCULATIONS
FOR PIMA ROAD CHANNEL TO HAPPY VALLEY ROAD
2 year 6 hour storm

SEDIMENT FLOW IN TRIBUTARY WASHES

Sub basin	No. of Washes	Wash width (ft)	Depth (ft)	n	Slope (ft/ft)	Max Q (cfs)	V (ft/sec)	Q2 (cfs	Sheet flow Q (cfs)	D_{50}	G	q_s (cfs/ft)	Q (cfs)
30N	1	20	0.61	0.045	0.0371	57	4.3			1.5	3.8	0.02	0.5
	3	10	0.63	0.045	0.0371	93	4.2	150	0	1.5	3.8	0.02	0.6
31A	1	20	0.97	0.045	0.035	124	5.6			1.5	3.8	0.06	1.3
	1	10	0.98	0.045	0.035	66	5.2	190	0	1.5	3.8	0.05	0.5
34R	7	10	0.61	0.045	0.055	250	5	250	0	1.5	3.8	0.05	3.2

Tributary Sediment Sheet Flow

Sub basin	Sheet flow Q (cfs)	n	Slope (ft/ft)	BW (ft)	Depth (ft)	Velocity (ft/sec)	D_{50}	G	q_s (cfs/ft)	Q (cfs)
30N	0	0.04	0.0371	1000	0	0	1.5	3.8	0.0000	0.00
31A	0	0.04	0.035	1000	0	0	1.5	3.8	0.0000	0.00
34R	0	0.04	0.055	1000	0	0	1.5	3.8	0.0000	0.00

Total Q (cfs)
1.1
1.8
3.2
6.0

Assumptions
1. Number of washes and their depths obtained by visual inspection of 1"=800' scale aerial photographs, flight date 10-10-91
2. Other flow parameters such as Manning's n and slope obtained from HEC-1 model model110..hc1
3. Flows in Pima Road Channel to Jomax Road would correspond to sub basin 30N
4. Flows in Pima Road Channel Between Jomax and Happy Valley Roads corresponds to sub basin 30N + 31A
5. Total Sediment inflow into the Happy Valley Road Detention Basin is a summary of 30N + 31A + 34R
6. Soil characteristics (D_{50} and G) obtained from Sediment Field Tests, City of Scottsdale Greenbelt Project, 07/94 by Greiner
   Sample 14 was used fro sub basin 30N, sample 15 for sub basin 31A and sample 12 for sub basin 34R
7. Washes were assumed to have side slopes of 3:1 and sheet flow was assumed to have side slopes of 1:1

SEDIMENT SUPPLY CALCULATIONS
FOR PIMA ROAD CHANNEL TO HAPPY VALLEY ROAD
100 year 6 hour storm
GENERAL SCOUR / DEPOSITION CALCULATIONS

SEDIMENT FLOW IN TRIBUTARY WASHES

Sub basin	No. of Washes	Wash width (ft)	Depth (ft)	n	Slope (ft/ft)	Max Q (cfs)	V (ft/sec)	Q_{100} (cfs	Sheet flow Q (cfs)	D_{50}	G	q_s (cfs/ft)	Q (cfs)
30N	1	20	1	0.045	0.0371	134	5.8			1.5	3.8	0.07	1.5
	3	10	1	0.045	0.0371	213	5.5	970	623	1.5	3.8	0.06	1.8
31A	1	20	1	0.045	0.035	130	5.7			1.5	3.8	0.07	1.4
	1	10	1	0.045	0.035	69	5.3	1490	1291	1.5	3.8	0.05	0.5
34R	7	10	1	0.045	0.055	609	6.7	1780	1171	1.5	3.8	0.14	9.7

Tributary Sediment Sheet Flow

Sub basin	Sheet flow Q (cfs)	n	Slope (ft/ft)	BW (ft)	Depth (ft)	Velocity (ft/sec)	D_{50}	G	q_s (cfs/ft)	Q (cfs)
30N	623	0.04	0.0371	1000	0.23	2.69	1.5	3.8	0.00	3.39
31A	1291	0.04	0.035	1000	0.36	3.5	1.5	3.8	0.01	9.25
34R	1171	0.04	0.055	1000	0.3	3.9	1.5	3.8	0.02	15.60

Total Q (cfs)
6.7
11.1
25.3
43.1

Therefore, for general (scour/deposition) calculations evaluate the following 100 year Qs as related to sediment transport capacity of the subject reach.

@ Jomax 100 year sediment into channel = Qs=6.7cfs

@ Happy Valley 100 year sediment into channel = Qs=17.8cfs

@ Happy Valley detention basin Qs=43.1cfs

<u>Assumptions</u>

1. Number of washes and their depths obtained by visual inspection of 1"=800' scale aerial photographs, flight date 10-10-91
2. Other flow parameters such as Manning's n and slope obtained from HEC-1 model
3. Flows in Pima Road Channel to Jomax Road would correspond to sub basin 30N
4. Flows in Pima Road Channel Between Jomax and Happy Valley Roads corresponds to sub basin 30N + 31A
5. Total Sediment inflow into the Happy Valley Road Detention Basin is a summary of 30N + 31A + 34R
6. Soil characteristics (D50 and G) obtained from Sediment Field Tests, City of Scottsdale Greenbelt Project, 07/94 by Greiner

SEDIMENT SUPPLY CALCULATIONS
FOR PIMA ROAD CHANNEL TO DEER VALLEY ROAD
100 year 6 hour storm

FLOWS IN WASHES

Sub basin	No. of Washes	Wash width (ft)	Depth (ft)	n	Slope (ft/ft)	Max Q (cfs)	V (ft/sec)	Q_{100} (cfs	Sheet flow Q (cfs)	D_{50}	G	q_s (cfs/ft)	Q (cfs)
36.1	2	10	1	0.045	0.0379	144	5.5	250	106	1.5	3.8	0.06	1.2
35N, 36.2, 36.3	3	20	1.5	0.045	0.03	729	6.5	2030	1301	1.5	3.8	0.11	6.5
35R, 36R1	4	10	1	0.045	0.033	268	5.2	450	182	1.5	3.8	0.05	1.8
36R2	1	20	1	0.045	0.0325	125	5.5	510	385	1.5	3.8	0.06	1.2
49.1, 51.1	6	10	1	0.045	0.0329	401	5.2	910	509	1.5	3.8	0.05	2.8

Sheet Flow Condition

Sub basin	Sheet flow Q (cfs)	n	Slope (ft/ft)	BW (ft)	Depth (ft)	Velocity (ft/sec)	D_{50}	G	q_s (cfs/ft)	Q (cfs)	Total Q (cfs)
36.1	106	0.045	0.0379	1000	0.09	1.2	1.5	3.8	0.0002	0.17	1.4
35N,36.2,36.3	1301	0.045	0.03	1000	0.41	3.2	1.5	3.8	0.0074	7.44	13.9
35R,36R1	182	0.045	0.033	1000	0.12	1.5	1.5	3.8	0.0004	0.41	2.2
36R2	385	0.045	0.0325	1000	0.19	2	1.5	3.8	0.0012	1.23	2.4
49.1,51.1	509	0.045	0.0329	1000	0.23	2.2	1.5	3.8	0.0018	1.80	4.6
											24.51

Assumptions
1. Number of washes and their depths obtained by visual inspection of 1"=800' scale aerial photographs, flight date 10-10-91.
2. Other flow parameters such as Manning's n and slope obtained from HEC-1 model.
3. Flows in Pima Road Channel between Happy Valley and Pinnacle Peak Roads corresponds to sub basins 36.1,35N,36.2 and 36.3.
4. Flows in Pima Road Channel between Pinnacle Peak and Deer Valley Roads corresponds to sub basins 36R2, 49.1 and 51.1.
5. Total Sediment inflow into the Deer Valley Road Detention Basin is a sum of all sub basins shown above.
6. Soil characteristics (D_{50} and G) obtained from Sediment Field Tests, City of Scottsdale Greenbelt Project, 07/94 by Greiner.
7. Washes were assumed to have side slopes of 3:1 and sheet flow was assumed to have side slopes of 1:1.

SEDIMENT SUPPLY CALCULATIONS
FOR PIMA ROAD CHANNEL TO UNION HILLS DRIVE
100 year 6 hour storm

SEDIMENT FLOW IN TRIBUTARY WASHES

Sub basin	No. of Washes	Wash width (ft)	Depth (ft)	n	Slope (ft/ft)	Max Q (cfs)	V (ft/sec)	Q_{100} (cfs	Sheet flow Q (cfs)	D_{50}	G	q_s (cfs/ft)	Q (cfs)
BEARDSLEY	13	10	1	0.045	0.03	832	4.9	1940	1108	1.5	3.8	0.04	4.7
53A	2	10	1	0.045	0.032	136	5.1	310	174	1.5	3.8	0.04	0.9
53A2	3	10	1	0.045	0.025	174	4.6	690	516	1.5	3.8	0.03	0.8

Tributary Sediment Sheet Flow

Sub basin	Sheet flow Q (cfs)	n	Slope (ft/ft)	BW (ft)	Depth (ft)	Velocity (ft/sec)	D_{50}	G	q_s (cfs/ft)	Q (cfs)	Total Q (cfs)
BEARDSLEY	1108	0.04	0.03	1000	0.35	3.2	1.5	3.8	0.0063	6.34	11.0
53A	174	0.04	0.032	1000	0.11	1.6	1.5	3.8	0.0004	0.45	1.3
53A2	516	0.04	0.025	1000	0.23	2.2	1.5	3.8	0.0014	1.42	2.2
											14.5

Assumptions
1. Number of washes and their depths obtained by visual inspection of 1"=800' scale aerial photographs, flight date 10-10-91
2. Other flow parameters such as Manning's n and slope obtained from HEC-1 model model110..hc1
3. Flows in Pima Road Channel to Beardsley Road would correspond to Beardsley above.
4. Flows in Pima Road Channel Between Beardsley and the 1/2 section point corresponds to sub basin 53A.
5. Flows in Pima Road Channel to Union Hills Road correspond to sub basin 53A2.
6. Washes were assumed to have side slopes of 3:1 and sheet flow was assumed to have side slopes of 1:1

PIMA ROAD CHANNEL & TRIBUTARY AREA

SOIL SIEVE ANALYSIS COMPARISON

JOMAX TO HAPPY VALLEY				
SAMPLE #	D_{15}	D_{50}	D_{85}	G
14[1]	.35	1.8	5.8	4.18
15[1]	.2	.9	2.4	3.58
13[1]	.2	1	2.5	3.75
12[1]	.55	2.25	6.5	3.49
AVG.		1.5		3.75
HV-1[2]	.075	.17	2.25	7.75

— SOIL CONDITION No. 1

HAPPY VALLEY TO DEER VALLEY				
SAMPLE #	D_{15}	D_{50}	D_{85}	G
11[1]	.32	1.4	4	3.62
10[1]	.3	1.8	4.75	4.32
9[1]	.2	.85	3	3.89
8[1]	.35	1.75	4.75	3.86
7[1]	.28	1.4	3.25	3.66
AVG.		1.5		3.75
F1[2]	.075	.63	3.5	6.98
F2[2]	.075	.9	3.3	7.83
PC15[2]	.075	.6	6.5	9.42
DV2[2]	.075	.7	3.3	7.02
DV2[2]	.55	2.25	7.5	3.71
DV3[2]	.26	1.25	4.75	4.30
DV4[2]	.22	1.50	7.50	5.91
AVG.		1.1		6.4

— SOIL CONDITION No 1 (AVG. 3.75)

— SOIL CONDITION No. 2 (AVG. 6.4)

Note:

1. Sample from ATL laboratories. APPENDIX H
2. Sample from AGRA Earth Environmental. APPENDIX G

~~See geotechnical appen~~dix.

PIMA ROAD CHANNEL SEDIMENT TRANSPORT RATE TABLE FOR EQUILIBRIUM SLOPE ESTIMATION

70 Foot Channel Width Slope = .01 (Ft./Ft.)			Soil Condition #1		Soil Condition #2	
Flow (cfs)	Velocity (fps)	Depth (ft.)	qs (cfs/ft.)	Qs (cfs)	qs (cfs/ft.)	Qs (cfs)
400	5.8	1.0	.026	1.82	0.0	2.80
900	7.9	1.6	.087	6.09	.133	9.3
1800	10.3	2.4	.241	16.9		
2200	11.1	2.7	.322	22.54	.495	34.65
2500	11.6	2.9	.381	26.69		

70 Foot Channel Width Slope = .012 (Ft./Ft.)			Soil Condition #1		Soil Condition #2	
Flow (cfs)	Velocity (fps)	Depth (ft.)	qs (cfs/ft.)	Qs (cfs)	qs (cfs/ft.)	Qs (cfs)
400	6.1	0.9	.034	2.36		
900	8.4	1.5	.115	8.06		
1800	10.9	2.3	.312	21.86		
2200	11.8	2.6	.424	29.69		
2500	12.33	2.79	.502	35.14		

70 Foot Channel Width Slope = .014 (Ft./Ft.)			Soil Condition #1		Soil Condition #2	
Flow (cfs)	Velocity (fps)	Depth (ft.)	qs (cfs/ft.)	Qs (cfs)	qs (cfs/ft.)	Qs (cfs)
400	6.4	0.9	.042	2.94	0.10	4.48
900	8.8	1.4	.144	10.08	.221	15.47
1800	11.4	2.2	.384	26.89		
2200	12.3	2.5	.513	35.91	.789	55.23
2500	12.9	2.7	.616	43.14		

70 Foot Channel Width Slope = .015 (Ft./Ft.)			Soil Condition #1		Soil Condition #2	
Flow (cfs)	Velocity (fps)	Depth (ft.)	qs (cfs/ft.)	Qs (cfs)	qs (cfs/ft.)	Qs (cfs)
400	6.5	0.9	.44	3.1		
900	8.9	1.4	.151	10.67		
1800	11.7	2.1	.436	30.51		
2200	12.6	2.4	.577	40.37		
2500	13.2	2.6	.688	48.19		

70 Foot Channel Width Slope = .018 (Ft./Ft.)			Soil Condition #1		Soil Condition #2	
Flow (cfs)	Velocity (fps)	Depth (ft.)	qs (cfs/ft.)	Qs (cfs)	qs (cfs/ft.)	Qs (cfs)
200	5.2	0.5	0.02	1.41		
400	6.9	0.8	.059	4.13	.091	6.37
900	9.5	1.3	.205	14.35	.315	22.05
1800	12.3	2	.549	38.42		
2200	13.3	2.3	.738	51.66	1.13	79.38
2500	14	2.5	.898	62.87		

Notes

1. The flow velocity and flow depth values were determined using a Manning's roughness coefficient of n=0.25, and channel side Slopees of 1:1.

2. Soil condition #1 is defined as soils with the following parameters: G=3.75 and D_{50} = 1.5 mm. Surface Samples

3. Soil condition #2 is defined as soils with the following parameters: G=6.4 and D_{50} = 1.1 mm. Below Surface Samples.

ALL CALCULATIONS BASED UPON SOIL CONDITION #1
SOIL COND. #2 PROVIDED FOR COMPARISON. SEDIMENT SUPPLY ESTIMATES
AS WELL AS SEDIMENT TRANSPORT ESTIMATES WILL BE INCREASED WITH
[illegible]

PIMA ROAD CHANNEL SEDIMENT TRANSPORT RATE TABLE FOR EQUILIBRIUM SLOPE ESTIMATION

40 Foot Channel Width Slope = .01 (Ft./Ft.)			Soil Condition #1		Soil Condition #2	
Flow (cfs)	Velocity (fps)	Depth (ft.)	qs (cfs/ft.)	Qs (cfs)	qs (cfs/ft.)	Qs (cfs)
200	5.4	0.90	0.02	0.80	0.31	1.24
400	7.1	1.4	.057	2.28	0.87	3.48
900	9.6	2.2	.183	7.32	.281	11.24

40 Foot Channel Width Slope = .012 (Ft./Ft.)			Soil Condition #1		Soil Condition #2	
Flow (cfs)	Velocity (fps)	Depth (ft.)	qs (cfs/ft.)	Qs (cfs)	qs (cfs/ft.)	Qs (cfs)
200	5.7	.9	.025	1.01		
400	7.5	1.3	.074	2.95		
900	10.1	2.1	.231	9.24		

40 Foot Channel Width Slope = .014 (Ft./Ft.)			Soil Condition #1		Soil Condition #2	
Flow (cfs)	Velocity (fps)	Depth (ft.)	qs (cfs/ft.)	Qs (cfs)	qs (cfs/ft.)	Qs (cfs)
200	6.	0.80	.033	1.3	.045	1.8
400	7.8	1.2	.089	3.56	.138	5.52
900	10.6	2.	.289	11.56	.444	17.76

40 Foot Channel Width Slope = .015 (Ft./Ft.)			Soil Condition #1		Soil Condition #2	
Flow (cfs)	Velocity (fps)	Depth (ft.)	qs (cfs/ft.)	Qs (cfs)	qs (cfs/ft.)	Qs (cfs)
200	6.1	.8	.035	1.4		
400	8.	1.2	.1	3.99		
900	10.9	2.	.326	13.03		

40 Foot Channel Width Slope = .018 (Ft./Ft.)			Soil Condition #1		Soil Condition #2	
Flow (cfs)	Velocity (fps)	Depth (ft.)	qs (cfs/ft.)	Qs (cfs)	qs (cfs/ft.)	Qs (cfs)
200	6.5	0.80	.046	1.84	.071	2.84
400	8.5	1.2	.13	5.2	.199	3.98
900	11.5	1.9	.417	16.68	.64	25.6

Notes

1. The flow velocity and flow depth values were determined using a Manning's roughness coefficient of n=0.25, and channel side Slopees of 1:1.

2. Soil condition #1 is defined as soils with the following parameters: G=3.75 and D_{50} = 1.5 mm. Surface Samples

3. Soil condition #2 is defined as soils with the following parameters: G=6.4 and D_{50} = 1.1 mm. Below Surface Samples.

ESTIMATION OF EQULIBRUM CHANNEL SLOPE (Q_{10})
& GENERAL SCOUR/DEPOSITION FOR (Q_{100})

BASED UPON USE OF ATTACHED "PIMA ROAD CHANNEL SEDIMENT TRANSPORT RATE TABLES" & ESTIMATES OF SEDEMENT SUPPLY FOR $Q_{S_{10}}$ & $Q_{S_{100}}$ (ATTACHED)

@ JOMAX ROAD

	10 YEAR FLOW (CFS)	10 YEAR DEPTH (FT)	10 YEAR VELOC (FPS)	100 YR FLOW (CFS)	100 YR DEPTH (FT)	100 YR VELOCITY (FPS)
Q	410	1.3	7.7	970	2.2 ✓	10.7 ✓ OK
Q_S	3.4	NA	NA	6.7	NA	NA

BASED UPON SED. TRANS. TABLE SELECT APPROP. CHAN WIDTH & SLOPE TO TRANSPORT $Q_{S_{10}} = 3.4$ CFS

Try $b = 40'$ & $S_{eq} = .013$ ⇒ $Q_{S_{10}} \leq 3.4$ ∴ GOOD FOR AREA W/ POTENTIAL FOR REDUCED SED. SUPPLY

CHECK Q_{100} FR Channel/CAPACITY w/ $d \leq 2.5'$ & $V < 13$ fps ✓OK
& $Q_{S_{100}}$ SUPPLY VS. CAPACITY WHICH IS

$Q_{S_{100}}$ CAPACITY From TABLE = 10.4 CFS > 6.7 CFS Supply

∴ CHANNEL WILL Experience General Scour DUE TO Q_{100}

ESTIMATE AMOUNT OF GEN. SCOUR by SELECTING EQUIB SLOPE FOR $Q_{S_{100}}$ SUPPLY RATE (=6.7 CFS) & subtracting From $Q_{S_{10}}$ EQUIB. SLOPE RELATIVE TO LENGTH BTWN DROP STRUCTURES.

$S^{eq}_{S_{100}} = .01$ SUPPLY $(.013 - .01)400 = $ 1.2 FEET 100 YEAR SCOUR ESTIMATE

∴ REDUCE SPACING TO 300 FT

PACE ENGINEERS CONTRACTORS & CONSULTANTS, a divison of Pacific Aquascape, Inc.	DRAWN: MEK	TITLE: EQUILBRUM SLOPE & 100 YEAR SCOUR ESTIMATES
	CHKD:	
	DATE: 9/95	JOB: PIMA RD.
	JOB NO: 5653E	

SHEET 1 OF 3

@ HAPPY VALLEY ROAD

	10 YR			100 YR		
	Q CFS	d (FT)	V (fps)	Q	d	V
Q	700	1.4	8.2	1760	2.4 ✓	11.7 ✓ OK
Q_s	6.8	NA	NA	17.8	NA	NA

↳ For b=60 S_{eq}=.013% $Q_{s_{10}}$ (CAPACITY) ≈ 7. ✓ OK ≈ $Q_{s_{10}}$ supply

$Q_{s_{100}}$ CAPACITY ≈ 20.9 CFS SLIGHTLY > $Q_{s_{100}}$ SUPPLY <u>SCOUR</u>

∴ $S^{eq}_{s_{100}}$ ≈ .012 (.013 - .012) 400' = <u>.4 FT</u> 100YR SCOUR ESTIMATE

SUPPLY

@ PINNACLE PEAK ROAD

	10YR			100YR		
	Q	d	V	Q	d	V
Q	1030	1.5	8.4	2470	2.5	11.7
Q_s	7.5	NA	NA	15.3	NA	NA

↳ FOR b = 80' S_{eq} = .012 $Q_{s_{10}}$ (CAPACITY) ≈ 8.5 ✓ OK ≈ $Q_{s_{10}}$ supply

$Q_{s_{100}}$ CAPACITY ≈ 26 CFS > $Q_{s_{100}}$ SUPPLY = 15.3 <u>SCOUR</u>

∴ $S^{eq}_{s_{100}}$ ≈ .01 (.012 - .010) 400 = <u>.8 FT</u> 100 YEAR SCOUR ESTIMATE

SUPPLY

PACE ENGINEERS CONTRACTORS & CONSULTANTS a divison of Pacific Aquascape, Inc.	DRAWN MEK	TITLE EQULIBRUM SLOPE & SCOUR (100 YR) EST.	SHEET 2 OF 3
	CHKD		
	DATE 9/95	JOB PIMA	
	JOB NO 5653E		

@ DEER VALLEY ROAD

	10YR Q	d	V	100YR Q	d	V
Q	1030	1.5	8.9	2640	2.5	12.6
Q_s	11.8	NA	NA	24.5	NA	NA

↳ FOR **b=80' S_{eq}=.014** $Q_{s_{10}}$ (CAPACITY) ≈ 11.5 ✓OK ≈ $Q_{s_{10}}$ SUPPLY

$Q_{s_{100}}$ CAPACITY ≈ 36 CFS > $Q_{s_{100}}$ SUPPLY = 24.5 ∴ SCOUR

$S^{eq}_{s_{100}}$ ≈ .012 SUPPLY (.014 − .012) 400 = .8 FT 100 YR SCOUR ESTIMATE

@ BEARDSLEY ROAD

	10YR Q	d	V	100YR Q	d	V
Q	790	1.4	7.9	1940	2.4	11.2
Q_s	4.7	NA	NA	11	NA	NA

↳ FOR **b=70' S_{eq}=.012** $Q_{s_{10}}$ (CAPACITY) ≈ 6 ✓OK ≈ $Q_{s_{10}}$ SUPPLY

$Q_{s_{100}}$ CAPACITY ≈ 26 > $Q_{s_{100}}$ SUPPLY = 11 ∴ SCOUR

$S^{eq}_{s_{100}}$ ≈ .009 SUPPLY (.012 − .009) 300 = 0.9 FT 100 YEAR SCOUR ESTIMATE

@ UNION HILLS

	10YR Q	d	V	100YR Q	d	V
Q	990	1.4	8.6	2230	2.3	11.8
Q_s	6.4	NA	NA	14.5	NA	NA

↳ FOR **b=80 SEQ=.014** $Q_{s_{10}}$ (CAPACITY) ≈ 8 ✓OK ≈ $Q_{s_{10}}$ SUPPLY

$Q_{s_{100}}$ CAPACITY ≈ 30 > $Q_{s_{100}}$ SUPPLY = 14.5 ∴ SCOUR

$S^{eq}_{s_{100}}$ = .011 SUPPLY (.014 − .011) 300 = 0.9 FT 100 YEAR SCOUR ESTIMATE

PACE ENGINEERS CONTRACTORS & CONSULTANTS — a divison of Pacific Aquascape, Inc.	DRAWN: MEK	TITLE: EQULIBRUM SLOPE & 100 YEAR SCOUR ESTIMATES	SHEET 3 OF 3
	CHKD:		
	DATE: 9/95	JOB: PIMA	
	JOB NO: 5653		

Appendix K

Miscellaneous Project Correspondence

RECEIVED
AUG 1 1995

August 17, 1995

Mr. Mark Krebs, P.E.
PACE
17902 Georgetown Lane
Huntington Beach, CA 92647

RE: PIMA ROAD DAM AND CHANNEL CONCEPT

Dear Mr. Krebs:

Attached you will find the analysis of your most recent submittal to the City. The analysis report of your report was performed by City staff and Greiner. It was extremely difficult to analyze this report as it is incomplete and extremely contradictory. We have attempted to provide a very professional, fair analysis of this report and in doing so have had to make numerous assumptions. Please review our assumptions and provide immediate comment as to their validity.

You presented the alternative of a dam and channel to the Pima Road Channel Desert Greenbelt many months ago. At that time all parties agreed that time was of the essence in providing a quality engineering analysis to prove that such a concept will work. The original schedule dates have been totally ignored. This is creating many difficulties for the City, its staff and the numerous projects which are counting on a regional flood control solution in the Pima Road corridor.

In order to continue to consider the dam and channel alternative, the City must receive the following by Thursday, August 24th, when you are in town for our scheduled meeting:

1. A completed, detailed report on the entire proposal.

2. Engineering details which match the cost estimates.

3. The HEC-2 models for the entire system.

4. A copy of the dam analysis which you are submitting to DWR.

5. A written response to the attached memo from Griener, dated August 17, 1995.

In addition, we would like to schedule a meeting with you and Greiner to participate with City staff to resolve all outstanding issues related to the cost and design. This meeting will be held on Thursday, August 24th either before or after our schedule meeting of that day. We will call you to arrange the specific time. Following this meeting, you will have an additional 3 weeks (until September 16th) to demonstrate the superiority of your proposal in the areas of technical criteria, aesthetics, costs, and land use. It is the City's intention to no longer consider the dam and channel alternative after September 16th unless we are able to reach an agreement that this concept is the appropriate alternative.

The City has made major commitments regarding the construction of a regional flood control system along Pima Road. We have redirected existing resources to ensure that the dam and channel alternative is fairly and comprehensively reviewed. Now is the time when we must move forward with the preferred solution.

Please review the attached memo immediately. If there is anything which you are uncertain about, please call Ron Price at Greiner or me.

Sincerely,

Mark G. Landsiedel
Desert Greenbelt Project Manager

c: Brian Baehr, Grayhawk
Mike Phalen, ASLD

Greiner

Greiner, Inc.
7310 N. 16th Street, Suite 160
Phoenix, Arizona 85020-2402
(602) 275-5400
FAX: (602) 943-1891

MEMORANDUM

DATE: August 17, 1995

TO: Mark Landsiedel
Alex McLaren
Collis Lovely
Bill Erickson

FROM: Vince Gibbons
Ron Price
Marty Bressor

SUBJECT: DGB- PACE Preliminary Report Review

Per your request, we have reviewed PACE Engineers' preliminary report, including the 14 supplemental spreadsheets, cost estimates, hand sketch details and cross-sections, for their alternative design of the Pima Road Channel. It is evident that each of the four facilities identified as detention basins in the report will fall within ADWR jurisdiction. Throughout this project, the City of Scottsdale and Greiner have had open and clear communication with the public. Considering the risks associated with constructing these four facilities upstream of populated, urbanized areas, we believe there is an ethical issue and a professional liability issue surrounding the use of the term detention basins to describe these four facilities. We strongly recommend referring to the facilities as flood retarding structures (dams) rather than detention basins in order to not mislead the general public. Upon completion of our review, the following issues remain outstanding:

a) A substantial number of inconsistencies exist throughout the PACE preliminary report and the supporting supplemental documentation. These inconsistencies prohibit a complete and thorough assessment of the hydrologic and hydraulic performance of the PACE concept using the material presented. The impoundment stage-storage charts are inconsistent with a spreadsheet indicating outflow and storage volumes. The cost estimate is inconsistent with a spreadsheet indicating hydraulic characteristics. The cost estimate is also inconsistent with the spreadsheet indicating the outflow and storage charts. The cost estimate is inconsistent with the HEC-1 models concerning the use of collector channels. PACE needs to demonstrate on their plans and in the HEC-1 model that the flow is actually routed to, and 100% contained, by the proper flood retarding structure. The quantity of flow and the location of the flow that bypasses each structure, as a result of the probable maximum flood, should also be demonstrated. When these conditions are defined, they should be incorporated into the present plans as soon as possible to avoid future revisions as they impact properties downstream.

b) Common engineering practice for flood retarding structures design the facility to contain the runoff for a 100-year frequency storm event, with a 24 hour duration. The facilities as presented by PACE have been sized for the 100-year/6-hour storm event. Considering the liability associated with high hazard dams, we strongly suggest the facilities be designed for a 24 hour event.

c) The PACE cost estimate (Table I-1), plotted cross-sections, and hand-drafted cross-sections for the soil cement lining depict (2) 2'x6' vertical walls for side slope protection whereas their spreadsheet presenting the hydraulic parameters of the channel is based on 4:1 channel side slopes. In order to compare the differences between the vertical scenario and the 4:1 scenario, Greiner has developed two separate spreadsheets. Spreadsheet No. 1 displays the hydraulic parameters associated with the vertical configuration. Spreadsheet No. 2 displays the hydraulic parameters associated with the 4:1 configuration. In comparing the two spreadsheets, it should be noted that the maximum velocity within the channel for the vertical scenario is 15.3 fps. This velocity is an increase over the 14.3 fps presented in the report for the 4:1 scenario.

In addition, these two spreadsheets also estimate the required channel depth associated with each configuration using a minimum 2-foot freeboard and considering allowances for superelevations. The superelevations are based on the Corps of Engineers' recommended minimum radii. The 3-foot channel depth shown on the PACE cross-sections, and used in their cost estimate, does not provide this freeboard as required for supercritical flow.

d) The structural stability, feasibility and constructability of a vertical soil cement wall is a concern. It does not appear as though the structure could sustain overturning moments nor provide the necessary resistance to sliding as shown in PACE's typical cross-section. This becomes even more critical considering that the depth of the channel must increase to provide adequate freeboard as discussed. A 2-foot toe down depth is insufficient for general and local scour conditions.

Assuming the vertical wall is stable and may be constructed using formwork, the cost advantage of using soil cement in-lieu of concrete would be partially negated because of the additional material and labor costs. Therefore, the $25/CY estimate is probably inaccurate. In addition, by only providing a 2-foot thick wall, the quality control of soil cement would have to be monitored very closely during construction to ensure material consistency and structural integrity.

There is considerable question as to the feasibility of 2-foot wide soil cement plating and the long-term stability of such structures. Soil cement is generally placed in about 8-foot widths because of the equipment used to place the material. A common failure mode of soil cement plating is the collapse under its own weight when the support soil behind the structure is undermined. When the support soil is removed, the soil cement is required to support its own weight, which it is not very capable of doing. The mass of an 8-foot wide structure lends stability and prevents the mode of failure as described.

e) Neither the report nor the cost estimate indicate that the 40 drop structures required by the PACE concept will be constructed using an improved liner. Considering that the grade control structures are imperative for the hydraulics model to perform as presented, these structures would require improved lining at all locations along the channel. Since the flow within the channel is expected to exceed the maximum permissible velocity for soil cement, as documented in the Flood Control District Hydraulics Manual (9 fps), and considering nonuniform flow associated with drop structures, soil cement may not be suitable for use as grade control structures. Because of the hydraulics and flow considerations relating to the drop structures, each structure may need to be constructed of concrete to ensure erosion does not compromise the long term ability of the channel to perform as demonstrated.

The feasibility and aesthetic value of constructing 40 drop structures is a question. The hydraulic influence of the drop structures on supercritical flow must be considered. Drop structures tend to induce hydraulic jumps for supercritical flow and the likelihood of sustaining supercritical flow for the entire channel length is doubtful considering this configuration. Therefore, it would then be necessary to design portions of the channel based on subcritical flow depths and associated freeboard requirements. The required channel depth near the drop structures and where subcritical flow prevails will be greater than estimated by PACE.

f) Safety issues surround the use of soil cement as core material for an earthen dam and should be further investigated. In addition to the safety concerns, the unit cost provided for the soil cement in the PACE cost estimate appears to be low when considering the cement content and lift thickness that will be required. Reasonable design parameters for soil cement used for a dam core would require a 9-percent cement content and placement in lifts 6 inches thick. The lifts would be rolled using a sheepsfoot roller to ensure there are no smooth bedding planes. Cost estimates from PCA and other sources indicate the unit cost for soil cement is approximately $35/CY as opposed to the $15/CY presented in the PACE cost estimate.

g) Each dam appears to fall under ADWR jurisdiction. Under ADWR jurisdiction, the spillway of each dam would be required to be sized to convey a significantly greater flowrate than the attenuated 100-yr/6-hour storm event currently considered by the PACE concept and cost estimate. The sizing of all downstream facilities could significantly increase for greater storm events as previously discussed.

h) Outstanding issues surround the overall estimate of the cost of construction for the

PACE alternative concept. The overall estimate provided by PACE may not accurately depict the total cost of construction because: 1) the omission of improved drop structures; 2) the cost estimate of the channel using vertical side slopes versus 4:1 side slopes; 3) the unit cost for box culverts; 4) the unit cost for soil cement as dam core material and the unit cost for soil cement plating; 5) the estimated quantities for vegetation salvage and revegetation; 6) the cost for aesthetic treatment for the PACE alternative concept; 7) the volume of excavated material; 8) the omission of collector channels required for the hydraulic performance of the alternative concept; 9) the unit cost of dumped riprap with geotextile underlining; 10) the estimated excavation volume required for the construction of the detention facilities to be hauled from the side; and 11) the cost for engineering and contingency of the alternative concept.

1) As discussed above, a prudent design will require improved drop structures to ensure the performance of the alternative concept as presented. The total estimated cost of improved drop structures is $500,000 using a unit cost of $12,500 per grade control structure consistent with the Pima Road Channel cost estimate. The PACE estimate for grade control structures is $80,000.

2) Using the 4:1 side slope configuration consistent with the hydraulic model for the PACE concept, the cost of soil cement channel protection is $2.70 million. The PACE cost estimate is based on a vertical wall configuration with an estimated cost of $693,750.

3) PACE shows a cost of $180,000 for the 10 box culverts. This appears to be an unconservative cost estimate considering the typical length of the road crossings, the opening area required to ensure flow velocities as presented in the hydraulic model, and the size of the boxes required to prevent sedimentation and allow for regular maintenance. Most of the roads that will require bridging are major arterials ranging in width from 70 feet to 130 feet. To ensure that sedimentation removal can be completed with mechanical equipment, it will be necessary to provide minimum 6-foot depth boxes. The estimated cost for the box culverts would be $368,900. The box culvert sizes are summarized on the attached cost estimates.

4) As previously discussed, soil cement to be used as core material for an earthen dam requires more stringent parameters than soil cement used as channel lining. The unit cost for the soil cement placed as described is approximately $35/CY. PACE uses $15/CY. Using $35/CY, the cost for the soil cement core for three dams s $2.2 million, as compared to $0.9 million using $15/CY. The cost of the fourth dam will be considered separately.

5) The quantity and cost for vegetation salvage and revegetation presented in the PACE cost estimate is $2.3 million based on the vertical side slope configuration. The

total cost for both of these items using the 4:1 side slope configuration, including a 15-foot easement on both sides of the proposed channel for construction, is approximately $4.2 million.

6) The PACE concept estimates the cost for aesthetic improvements to be approximately 10-percent of the cost for aesthetic improvements for the Greiner/City of Scottsdale Pima Road Channel concept. Considering the use of concrete drop structures and soil cement, instead of natural lining as originally planned for the PACE concept, a more realistic 60-percent estimate has been used for purposes of cost comparison. The PACE cost estimate provides $380,000 for aesthetic treatment whereas a 60-percent estimate would be $2.27 million.

7) The quantity of excavated material estimated by PACE was based on the vertical side slope configuration. Using the 4:1 side slope configuration consistent with the hydraulic model, the volume of excavated material is approximately 321,000 CY instead of 150,000 CY. The cost of 321,000 CY is $845,000 as opposed to $395,000 submitted by PACE. These quantities do not include the volume required for construction of the detention facilities nor the volume required for the construction of the collector channels which are discussed separately.

8) Collector channels located at Happy Valley Road and Deer Valley Road do not appear to have been considered in the cost estimate provided by PACE. The collector channels are essential to ensure the proper flow is routed to the proper structure as supported by the hydrology. The excavation, vegetation salvage and revegetation costs for the two collector channels is estimated to cost $1.03 million. The right-of-way cost to lease the land is estimated at $62,400; however, this cost is based on the lease unit price for the mainline Pima Road alignment. As the collector channels will extend east into private development, the estimated cost for the right-of-way could be substantially greater.

9) The unit cost used by PACE for dumped riprap with a geotextile underlining was $8/SY. Unit costs based on bid tabs for local projects and ADOT indicate the cost for dumped riprap ranges between $40-$45/CY. Assuming a minimum 18-inch thickness for the dumped riprap the unit cost would be about $20/SY. This unit cost does not include the cost of the geotextile. Using the $20/SY, the cost of the dumped riprap would increase from $144,000 to $360,000.

10) The volume of excess material to be excavated and hauled from the site associated with the construction of the detention facilities has been estimated by PACE to be 1.9 million cubic yards. To estimate the cost to haul the material offsite, PACE has applied a 25-percent shrinkage factor to the excess material volume. Typically, a swell factor is applied to excavated material to account for the change in density

from the in-situ state. Without considering a swell factor, the cost to excavate the excess material and haul it offsite is $3.8 million. PACE estimated the cost to be $2.8 million.

11) The cost for engineering and contingencies will increase proportionately with the individual cost increases described above. The modifications in quantities and unit costs described result in approximately a $1.0 million increase for engineering costs and a $1.4 million increase for contingency costs.

The attached Spreadsheet No. 3 compares the cost estimate that was presented in the PACE report based on the vertical side slope configuration to a cost estimate developed by Greiner based on a 4:1 side slope configuration with the 11 cost parameters discussed above. The 4:1 side slope configuration was used by PACE for the hydraulic model. This spreadsheet shows that the cost would increase by approximately 14.0 million for the 4:1 configuration with the 11 cost parameters included.

Three individual cost breakdowns, one for each flood retarding structure, are also attached and have been included in the overall cost estimates. These breakdowns include the 11 parameters discussed above.

Neither the overall comparative cost estimates, nor the cost estimates for the dams, consider flow rates greater than those presented by PACE. In all likelihood, the size of the facilities will increase as the design progresses and the longer duration storm events are considered for impoundment and the Probable Maximum Flood is considered for routing through the spillways. The total cost of the alternative concept is certain to increase, likewise.

The PACE design concept was originally presented to the City as an alternative concept using detention basins to attenuate the flow along Pima Road, and release the flow at a controlled rate in the subcritical flow regime. Excluding the deficiencies with the design parameters used to develop the alternative concept, the concept fails to accomplish its primary goal, reducing potential liability to the City by eliminating supercritical flow alongside Pima Road.

We hope this memorandum assists in your review and assessment of the PACE alternative concept. Please call if we can be of more assistance with your review.

Pacific Advanced Civil Engineering
17902 Georgetown Lane, Huntington Beach , CA 92647
(714) 843-5734 (714) 848-4820 FAX

MEETING SUMMARY

JOB NAME: Pima Road Channel **CALLED BY:** Mark Krebs/PACE
JOB #: 5653E **DATE:** 8/30/95 **MEETING LOCATION:** Maricopa County Flood Control District

PURPOSE: Follow-up to the 8/24/95 meeting.

ATTENDEES:

Dave Minehart/MCFCD	Ed Raleigh/MCFCD	
Pedro Calea/MCFCD	Johan Perslow/PACE	
Russ Miracle/MCFCD	Mark Krebs/PACE	
Raju Shah/MCFCD		

1. Meeting was a follow-up to the August 24th meeting at the City of Scottsdale at which PACE introduced the proposed Pima Road Desert Greenbelt detention alternative.

2. MCFCD and PACE discussed proposed Pima Desert Greenbelt detention alternative. PACE clarified that draft feasibility report dated 8/23/95. The draft report which was submitted to ADWR dam safety, included only preliminary design data regarding the proposed channel. The purpose of the meeting with MCFCD today is to review preliminary channel design concepts and establish design guidelines from MCFCD for the channel design. The channel feasibility study is scheduled to be completed within 3 weeks.

3. The following channel design issues regarding the detention alternative were discussed:

   a. Channel freeboard per MCFCD manual.
   b. MCFCD has significant experience with soil cement embankments in local rivers (less experience regarding use of soil cement on more ephemeral type channels). For soil cements with velocities greater than 9 fps it is critical to consider time exceeding and percentage of soil cement material greater than 3/8" (for increased durability ± 25% > 3/8"). County requires batch mixing of soil cement and strict quality control. Most typical soil cement placement is with 8 foot wide 12 inch thick lifts. MCFCD would consider less soil cement width if substantiated by geotechnical and hydrologic data.
   c. Low flow/clear water scour is a point of concern of MCFCD. PACE suggests this issue is addressed with numerous smaller (i.e. 2-4 foot drop/grade control structures).
   d. Regarding embankment toe-down design will follow MCFCD guidelines. The MCFCD typically uses a 50% minimum factor of safety.
   e. Address issues of construction phasing and design coordination with proposed D.C. Ranch Development.
   f. Channel inlet design for sheet flow from east.

4. Regarding design guidelines in addition to the MCFCD "Drainage Design Manual - Volume II - Hydraulics", the MCFCD provided the following design manuals.

    a. ADWR "Design Manual for Engineering Analysis of Fluvial Systems", dated 1985.
    b. BOR technical guide "Computing Degradation and Local Scour", dated 1/94.

    These three manuals will be utilized by PACE in the preparation of the channel design feasibility report.

5. MCFCD provided soil cement cost estimate information from Mr. Kenneth Hansen, P.E./Portland Cement Association (PCA) dated 2/95. The cost estimate for material preparation and installation of soil cement for quantities between 7,000 and 40,000 cubic yards for difficult construction conditions is $21.00/cubic yards.

6. Regarding the Pima Road Desert Greenbelt Channel without Detention, the following points of concern were stated by MCFCD staff:

    a. Public safety regarding high velocities, deep channels and steep side slopes. MCFCD would require complete project fencing to address minimize public safety liability.
    b. High flows, velocities and channel depth would most likely require complete channel concrete lining to control sediment/erosion.
    c. MCFCD has issued a letter, dated August 24, 1995, to COS listing numerous design consideration concerns regarding the non-detention alternate.

cc: *Dave Minehart/MCFCD*
Brian Baehr/Grayhawk
Mark Landsiedel/COS
Ottozawa Chatupron/ASLD
Bill Jenkins/ADWR
Ray Jordon/ADOT

FLOOD CONTROL DISTRICT
of
Maricopa County

2801 West Durango Street • Phoenix, Arizona 85009
Telephone (602) 506-1501
Fax (602) 506-4601
TT (602) 506-5859

AUG 2 4 1995

Mr. Mark G. Landsiedel
City of Scottsdale Transportation
Post Office Box 1000
7447 East Indian School Road, #205
Scottsdale, Arizona 85252

SUBJECT: Final Design of Phase I of the Reata Pass Wash and Pima Road Channels and FEMA Conditional Letter of Map Revision

Dear Mark:

Due to the large number of Desert Greenbelt-related items currently under review by the District, I will try to capture each of them under the cover a single letter organized into various subheadings.

<u>Public Safety Concerns Regarding Supercritical Flow</u>
Public safety issues are a serious concern in channels designed for supercritical flow. According to the District's Hydraulics Manual, a channel carrying supercritical flow should not be allowed in residential areas. This should be especially true in the Reata Pass Wash Channel, due to the flashiness of the watershed and the fact that upstream rainfall intensity may be shielded from view by the McDowell Mountains. Encouraging recreational use in such a situation may also increase the City's future liability exposure. Therefore, we strongly recommend that the final design either include the use of security fencing, and possibly warning systems, along the channel or look to reduce velocities through upstream detention and/or other modifications to the proposed channel configuration.

<u>Corps of Engineers Involvement</u>
With the COE Phoenix Planning Section currently preparing their Reconnaissance Study of the McDowell Mountain alluvial fan area, all design plans should also be forwarded to the Corps for review. Unless we can get the Corps to agree that the project is compatible with their findings, and economically feasible, the potential for future Federal reimbursements will be reduced substantially. Our review of the alluvial fan Feasibility Study completed by the Corps for the Las Vegas area shows that the Corps' recommended the use of trapezoidal concrete-lined channels in a supercritical flow regime. The Corps compared the cost of a fully-lined alternative to soil cement with earthen bottoms and estimated the cost of the former, including future O&M, to be 71% less per linear foot of channel improvements (copy of table attached).

<u>Arizona Department of Water Resources Involvement</u>
Since, in addition to FEMA, ADWR must also be in agreement with any proposed changes to delineated floodplains, we suggest that all reports on the Reata Pass/Beardsley Wash Project be submitted for their review.

Design Memorandums

To date, the District has submitted comments on the design memorandums for the Reata Pass Wash channel and the Pima Road channel. We have provided comments and raised concerns on each which have not been incorporated and/or resolved prior to these memorandums being finalized by the consultant. Pursuant to IGA FCD 95002, Paragraph 10.4, the City shall incorporate and/or resolve the District's comments, prior to the completion of the final design contract.

Pima Road Channel - Use of Reinforced Grass in Reach 1

From Sta. 10+00 to 84+00, the consultant has proposed reinforced grass channel lining. The velocity within this reach of the channel ranges from 17 fps to 20 fps. We have reviewed the literature provided by Greiner regarding the proposed PYRAMAT lining material for Reach 1. The performance data indicates that the product will not fail at velocities up to 25 fps for a duration up to 1/2 hour and at velocities of 14 ft/sec for durations up to 50 hours. During the 100-year event, how long does the velocity exceed 25 fps and 14 fps? Is this information also available for the 10-, 25-, and 50-year events?

Additionally, we request information regarding whether this product has been used at other locations for similar purposes and/or under similar hydraulic conditions. Due to public safety concerns, the District would be hesitant to support the use of a technology that does not have a proven track record under similar circumstances. We would also like to review the experimental assumptions and conditions used during the tests that were used to generate the information provided in the table.

Pima Road Channel HEC-1, HEC-2 and HEC-6 Comments

- HEC-1

1) Subbasins 52H, 52I, 53A2, and 54 in the HEC-1 model produce high flows per the subbasin areas. The areas for each of these subbasins is very small. Since subbasins 52H and 52I ultimately have the same outfall as subbasins 52G and 52F, it is suggested that these areas be added together. The same solution could be utilized for the other two subbasins.

2) The KK block DB2.1 Cp, should be checked for the routing reach used in the RC card. Detention basin 53R is eliminated in this study; therefore, this distance should have changed. The KM card under this KK block should also be re-written, as it still refers to detention basin 53R as a concentration point.

3) Page 1 of the report states that the "new option for Pima Road channel by-passes and eliminates the need for basin 53R. The channel in this option continues straight south under the Outer Loop Freeway and into the TPC Desert course lake, just west of Pima Road." It is not shown in the report whether this lake has the capacity to handle these flows, since the timing of the flows reaching this site would change with the elimination of basin 53R. This change should be considered in the hydrology model and addressed in the report.

4) Page 2 of the report states, "The HEC-1 model created by Gilbertson Associates for the drainage of Grayhawk Development of Detention Basin 53R was added to the Pima Road channel HEC-1 model to represent the basin's purpose of reducing the peak inflows to a maximum outflow of 2500 cfs per an agreement between ADOT and

City of Scottsdale." The report suggests that this agreement will need to be modified and agreed upon for the Southern Alignment. Has this agreement been reached between the two entities?

5) The hydrology model is based on conceptual channels being present, and the design of the channel at different locations relies on these conceptual channels being built. What mechanism does the City propose to use to ensure that these conceptual channels, or other improvements with similar hydrologic effects, will be built in the future?

- HEC-2 -

1) Details on the reasoning for eliminating other options that may have reduced velocities, such as additional drop structures or the use of gabions, should be provided.

2) The Manning's "n" value used for the concrete lining is .015. We recommend that, for velocity calculations with concrete lining, a Manning's "n" value of .012 to .014 be used. For the channel profile calculations, did the consultant consider using a higher "n" value to account for sediment and debris entrained in the flow?

3) Contraction and expansion coefficients should be used on the "NC" card to account for any losses due to contraction and expansion.

4) Please explain how the starting water surface elevation was calculated.

5) The hydraulic design of drop structures near the bridge crossings has not been submitted to the District for review. Please provide this information.

6) How will the side flows be accommodated into the channel? The consultant should prepare, and submit for review, a design for spillways to accept the side flows.

7) We request that slope stability calculations for the concrete side slope be analyzed and submitted to the District for review. These calculations should assume both water in the channel and sudden drawdown conditions.

8) Please provide the scour calculations used to determine the toe down depths of the concrete lining from Sta. 195+00 to Sta. 350+00.

9) Substantial scour protection and cut-off walls should be provided at the entrance of the channel to prevent flows going under the channel lining. Also, the consultant should ensure that all of the run-off will flow into the channel without bypassing and flooding Pima Road.

10) The design should include weep holes and cutoff walls along the channel to relieve uplift pressure.

11) At sta. 95+00 to sta. 140+00, meandering should be minimized as much as possible, since it is recommended that curves or bends be avoided under supercritical flow. If the meanders can not be avoided, super elevation should be calculated and added to

the WSE. Also, adequate protection must be provided to account for the increase in shear stresses at the outside bank of the channel.

12) Channel bends at sta.65+00, 184+00, 190+00 and 220+00 should be analyzed using hand calculations, since HEC-II software is not designed to adequately analyze the effects of bends in a channel under a supercritical regime. The effects of super elevation should be added to the freeboard requirement.

13) If the channel is concrete-lined for the full length, there should be no scour at the channel invert and there should be no sediment movement, except the sediment coming from the watershed. The consultant should calculate the annual sediment yield, consider that yield for the design of detention basin, and recommend a maintenance schedule for the basin. The consultant should also analyze whether sediment-mixed flow may reduce the conveyance capacity of the channel.

14) Although the channel is flowing supercritical for the 100-year event, the consultant should check the flow regime and depths for 10-year, 25-year and 50-year event to insure that the flow regime is not changing to subcritical and overtopping the banks.

15) Using the equation from the FCD's Hydraulics Manual for channel freeboard, the following cross-sections do not meet the criteria: 32960, 30161, 29983, 26160, 25962, 25212, 24863, 24701, 19746, 19424, 19356 to 18863, 18331 to 16635, 16370, 14363, 13742 to 11328, 11304, 9943 to 8409, 7300 to 4771, 4081 to 3061, and 2462 to 1139.

16) The design flow is very unstable, thus increasing the instability of the channel. The high velocities may cause translatory waves in the channel. These waves may cause the channel to overtop and flood nearby homes and businesses, the channel lining may be undermined and washed out, or excessive water pressure may be placed on the bridge decks or culverts. The potential for translatory waves is based on equations presented in *Free-Surface Instability Corrections*, Water Supply Paper 1992 - U.S. Geological Survey, 1-72. The consultant should analyze this situation and recommend any necessary solution.

- HEC-6 -

1) Please explain how the sediment inflow hydrograph was developed.

2) At the outlet of the channel, the consultant has proposed the use of reinforced grass lining. In the "HD" card, the consultant has input 10' of sediment reservoir. Does the reinforced grass lining erode at the design velocity and create a scour hole?

3) The sand bottom channel starts from approximately Sta. 184. However, in the "HD" card, the consultant has input "0" for a sediment reservoir depth. Please explain.

Comments on HEC-2 Model for Conditional Letter of Map Revision for Reata Pass Wash

- Main Channel:

1) According to literature research conducted by District staff, channels carrying supercritical flow are recommended to be lined with continuously reinforced concrete linings. The reinforcement should be continuous both longitudinally and laterally. The sand bottom channel will be subject to scour. This scour needs to be calculated and the toe-down depth determined.

   The high channel velocities will subject the soil-cement levees to high abrasion. The literature researched recommends about 20% or more aggregate to be 3/4" or larger for an abrasion- resistant soil-cement mix design. The native soils available at the site may be too fine to produce an abrasion-resistant mix; therefore, we request that any information regarding on-site soils testing be forwarded for our review.

2) At cross-section 390, the Pinnacle Peak Road Bridge should be modeled using the "SB" card because of pressure flow through the bridge.

3) The plans submitted by Hendrich, Eberhart & Associates for the Pinnacle Peak Road dated July 1995 call out for four 10'(H) X 28'(W) concrete box culverts. This differs from the bridge used in the HEC-II model submitted by Greiner. Please verify this discrepancy and correct the model, if necessary.

4) The channel is flowing at supercritical velocity through most of the area. Between cross-section 415 and cross-section 100 the velocities ranging from 15-33 fps, which is considered very high for a soil cement lining with natural channel bottom. The consultant should provide scour calculations, so that we may analyze the toe-down depths that are necessary to protect against undermining of the soil cement levee.

5) From cross-section 370 to cross-section 250, the channel does not appear to have adequate freeboard to satisfy the criteria provided by the Flood Control District's Hydraulics Manual. Please verify.

6) Between cross-section 50 and cross-section 44.10, velocities are in the range of 22-27 fps. These velocities are considered very high for the soil-cement and a natural channel invert.

7) Allowances for adequate freeboard should be checked at the following cross-sections: 430, 170, 100, 96.4, 96.3, 96.2, 87, 85, 83, 81, 80, 77, 64, and 17.

8) The consultant has run a separate model to come up with the composite "n" value. In this model, the conveyance area has been blocked by modifying the GR points in locations where trees are present. The location of trees and the width of trees were based on aerial photos. The blocked areas were also assigned an "n" value of .065. By doing both, a double counting of the effects of the trees may be occurring. The consultant should either block the area occupied by a tree or use high "n" values to account for a tree. When blocking an area for the tree, please consider how high a tree's canopy is. If it is higher than the water surface elevation, only the area

occupied by the tree's trunk should be blocked. Please verify and model accordingly.

The BOSS HEC-II model submitted by the consultant with the blocked condition did not run on HEC-II software developed by the COE. In order for the District to run the model, we were required to replace some of the NH cards with NC cards. However, the procedure used by the consultant should use higher "n" values to block the flow to account for the trees.

9) The channel is flowing at supercritical velocity through-out the channel length. The velocities are in the range of 15-35 fps. It is possible that, at this high velocity, the vegetation may be washed out, resulting in a lower "n" value. The consultant should analyze this condition and see what the velocities and depths are for the same flow.

10) The "n" value for the concrete channel used for this project is .015, which seems to be high for smooth finish concrete. We recommend a second run using .013 to check for potential increase in velocity. If an "n" value of .015 must be achieved, it may be necessary to specify a rough or broom finish on the concrete lining in the plans and special provisions. For the channel profile calculations, the consultant should check channel capacity in a second run using a higher "n" value to account for sediment and debris entrained in the flow.

11) The velocities for the south Beardsley channel range from 7-25 fps. The natural channel without armoring can not be expected to withstand such high velocities. The consultant should propose either soil-cement, with adequate toe-down, or concrete lining.

12) The velocity at cross-section 40+00 is 25.89 fps for the south Beardsley channel under supercritical condition. The velocities upstream and downstream of this cross-section are 7.12 fps and 8.70 fps respectively. We recommend that the consultant increase the conveyance area to reduce the velocity at this cross-section.

13) The following cross-sections of the South Beardsley Road channel do not meet the FCD Hydraulics Manual's freeboard criteria: 514, 512, 509 to 505, 70, 67, 62 to 60, 54 to 50, 40, 39, 37, 29, 22, 13, 9.20, 9.10, 8.00, 7.00, and 6.00 to 2.00.

14) The following cross-sections of the North Beardsley Road channel do not meet the FCD Hydraulics Manual's freeboard criteria: 13.00 to 8.00, 4.00 and 2.00.

15) Sec. 410 - Sec. 430: Why is the flow on the road blocked? As shown on the model, for the 100-yr condition the road will be under water. If that is the condition, why are we designing the Pinnacle Peak Road crossing for the 100-yr flow? Please verify and correct accordingly.

16) Please include a HEC-II cross-section between sec. 330 and 340 to model the actual encroachment of the channel.

17) Between Sec. 370 and 380, the road will be under water during the design flow. This condition should be improved.

18) At Sec. 390, please use the "SB" card to model the bridge or culvert.

19) At Sta. 110+00, the west levee should be tied in with the west side of the high ground of the cut channel. If possible, avoid placing the cut channel very close to the retaining wall of the house by shifting it toward the east.

Comments on HEC-6 Model for Conditional Letter of Map Revision for Reata Pass Wash:

- General -

1) In the review meeting with City,consultant and District staff, it was indicated that the HEC-6 model was developed to simulate the sediment transport of a single flood event. The HEC-6 manual dated June 1991, chapter 1.1, paragraph 1 states, "This model was designed to be used for the analysis of long-term river and reservoir behavior rather than the response of stream systems to short-term, single event, floods." Since the model does not simulate the rate of transfer of sediment from or to the stream bed, simulations based upon a single flood hydrograph may produce misleading results. The stability of the Reata Pass Wash channel, as proposed for design, is dependent upon the equilibrium of the rate of sediment inflow with the channel's ability to transport the sediment. Therefore, we remain concerned regarding the proposed application of the HEC-6 model.

2) The submitted report should include more detail on the methods used to develop the input data and interpret the results. This information is necessary to calculate an appropriate confidence level to be used in determining the safety factor for the design parameters.

3) What are the anticipated results if the sediment inflow rate were reduced or if the channel sediment transport capacity exceeds the sediment inflow?

- Specific -

1) The calibration and verification procedures are not clearly documented. Calibration of the channels to given sediment transport functions requires the use of observed historical channel changes. The model or function that best reproduces the observed historical bed changes is taken as the best methodology. Verification of the selected function involves using independent historical data and reproducing it through the calibrated model. Some highlights of these analyses (such as channel bed profile plots of the historical versus reproduced) should be contained in the report.

2) The report states that the calibration model was used to determine the inflowing sediment distribution. It is not clear how this was done, given the fact that an infinite number of sediment distributions for a given total tons per day of sediment load may occur. A more direct approach would be to generate the inflowing sediment using iterative procedures found in the literature.

3) It is not clear how the calibrated model was used to predict the bed material gradation. Since the calibrated model is also an HEC-6 model, bed material gradation is an input to the model (PF card). It is, therefore, not an output of HEC-6 which could be predicted. Furthermore, the 2-year, 6-hour storm was used as a

basis for the calibration, while the discharge of interest is the 100- year event. Please explain how the determination was made, since each sediment transport function may yield no scour or deposition at different flood frequencies.

4) In Table 2, how were the sediment volumes computed? Also, how were the time periods obtained, since the HEC-6 model was not run for hydrologic events that were that long?

5) In Table 3, the *Bed Change* values obtained from the HEC-6 model were slightly different from the *Maximum Scour* values. How were the maximum scour values derived?

6) It is not clear why the South Beardsley Wash tributary was modeled separately from the main Reata Wash. How would the separate results be combined, since it is not appropriate to simply total the sediment discharges from the individual HEC-6 models?

Review and Comment Period

The District will make all efforts to meet the shortened review periods (typically 1-2 weeks) for design memorandums and plans requested by the consultant as a result of the City's fast-track schedule. However, our IGA allows 30 days for our comments to be prepared. Therefore, any comments submitted within the time frame approved in IGA FCD 95002 must be addressed by the City.

Please contact me at your earliest convenience to discuss our comments.

Sincerely,

Dave

David Meinhart, AICP
Flood Control Planner

Enclosure

Copies to: Terry Miller, ADWR
John Drake, COE

Pacific Advanced Civil Engineering
17902 Georgetown Lane, Huntington Beach , CA 92647
(714) 843-5734 (714) 848-4820 FAX

MEETING SUMMARY

JOB NAME: Pima Rd. Channel/Soil Cement Constructability **CALLED BY:** Mark Krebs/PACE
JOB #: 5653E **DATE:** 8/31/95 **MEETING LOCATION:** Via Telephone: Conference Call

ATTENDEES:
Howard Birch/Barnard Construction
Johan Perslow/PACE
Mark Krebs/PACE

1. Barnard Construction, Inc. was contacted by PACE to review constructability aspects of proposed soil cement channel embankment protection. Barnard has recently completed the rehabilitation of the C.A.P. dike/core and several COS drainage construction projects.

2. Mr. Birch stated that most of the soil cement in the Phoenix area has been utilized along the rivers for embankment protection. In this case the material is placed in 8 foot wide by 8 to 12 inch lifts.

3. Regarding the proposed PACE detail for the Pima Road Channel embankment (a vertical or near vertical block of soil cement ± 4 feet wide and ± 6 feet tall). Mr. Birch stated the following:

   a. For the proposed quantities soil cement can be placed efficiently using front end loaders or a conveyor system, and compacted using standard trench backfill equipment.
   b. Barnard Construction has utilized soil cement in numerous instances (not related to 8 ft. x 12 inch lifts) for backfill of pipeline trenches, bedding and backfill of large diameter pipes, etc.
   c. Mr. Birch concurred that the proposed PACE embankment detail could be constructed without the use of specialty construction equipment or incurring major construction difficulties.

4. Mr. Birch stated that regarding soil cement, he was not up to date on bulk cement costs and would not be able to provide unit cost at this time. Given more time and project scope, a budget could be prepared.

5. As stated, all of the above would indicate that a minimal cost increase to the ± $20.00/cubic yard of soil cement would be required (i.e. ± $25/cy would be reasonable).

cc: *Howard Birch/Barnard Const.*
Brian Baehr/Grayhawk
Mark Landsiedel/COS
Ottozawa Chatupron/ASLD
Bill Jenkins/ADWR
Ray Jordon/ADOT
Dave Minehart/MCFCD

Pacific Advanced Civil Engineering
17902 Georgetown Lane, Huntington Beach , CA 92647
(714) 843-5734 (714) 848-4820 FAX

MEETING SUMMARY

JOB NAME: Pima Road Channel **CALLED BY:** Mark Krebs/PACE
JOB #: 5653E **DATE:** 8/30/95 **MEETING LOCATION:** Arizona Department of Transportation

PURPOSE: Follow-up to the 8/24/95 meeting.

ATTENDEES:

Ray Jordon/ADOT	Johan Perslow/PACE
Ron McCally/ADOT	Mark Krebs/PACE

1. Meeting was a follow-up to the August 24th meeting at the City of Scottsdale at which PACE introduced the proposed Pima Road Desert Greenbelt detention alternative.

2. Mr. Jordon stated that any liability issue associated with ADOT funds being used to construct up stream detention basin should not be a concern to PACE. It is a legal issue for COS and ADOT legal council.

3. Regarding placement of proposed Union Hills detention basin, ADOT typically utilizes the following:

   a. 3:1 embankment side slope or flatter.
   b. 15 foot offset from property line.
   c. Do not want highway to serve as embankment. Numerous detention basins/flood control structures located up stream from ADOT roadways.
   d. Down stream conveyance along road sized only for design storm only, no need for PMF or SPF channel conveyance capacity.

4. Regarding specific design consideration for the proposed Union Hills Detention basin, ADOT presented the following issues:

   a. Main concern is that a decision be formalized regarding "Type, Size and Location" for the COS/Pima Road Channel and the ADOT/Outer Loop Freeway crossing.
   b. Proposed detention basin embankment and outlet channel can encroach upon ADOT R.O.W. where space is available.
   c. ADOT would be pleased to see the reduced flows from the proposed Pima Road Detention Alternate. In addition to the significant cost savings of ± $1,000,000, the reduced drainage structure would reduce the critical path project schedule. Also, there are design concerns regarding the currently proposed unrestrained flows and the skew of the drainage facility crossing of the Outer Loop.

d. An additional ADOT/COS coordination issue is the proposed local drainage channel north of the Outer Loop and west of the proposed Union Hills Detention Basin. ADOT suggested that PACE incorporate channel design into detention basin and coordinate with COS. ADOT provided copy of COS and ADOT IGA which includes statement that COS will provide drainage design for the channel adjacent to Outer Loop.

5. ADOT expressed concern regarding the BOR's issue of not modifying the individual BOR/CAP detention reach tributary drainage areas and resulting runoff volumes.

6. Regarding excavation of material from proposed Union Hills, Deer Valley and the Happy Valley Detention basins (total export ± 1.8 million cubic yards). ADOT provided the following borrow quantities for the 30% and 45% submittals from HDR for Outer Loop from Scottsdale Road to Bell Road.

InterimBorrow Required	180,000 cubic yards
Ultimate Borrow Required	1,800,000 cubic yards

There is a need for additional Outer Loop roadway fill material south and east of Bell Road, however, no quantity has been defined by ADOT.

ADOT/HDR are investigating the potential sources for this borrow and would welcome the combination of efforts with the Pima Road Channel/detention alternate. ADOT stated that the ultimate Outer Loop borrow could be placed in the interim phase if the borrow material is available.

7. The main issue ADOT has regarding proposed detention alternate is the delay of current Outer Loop construction bid schedule. The drainage portion of the project is scheduled for bidding April 1996.

8. ADOT has numerous instances of soil cement channel lining with velocities in excess of 20 fps. Suggest 10 year flows not to exceed 9 fps.

cc: *Ray Jordon/ADOT*
Ron McCally/ADOT
Brian Baehr/Grayhawk
Dave Minehart/MCFCD
Mark Landsiedel/COS
Ottozawa Chatupron/ASLD
Bill Jenkins/ADWR

COMBINED ESTIMATE

DATE: 5/26/95

TRACS NO.: H3230-01D

REVISED: 30% SUBMITTAL

PIMA FREEWAY SECTION 9A

FEDERAL NO.: RAM 600-1-335

	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	AMOUNT
2010001	CLEARING AND GRUBBING	L. SUM	1	$20,000.00	$20,000.00
2020001	REMOVAL OF STRUCTURES AND OBSTRUCTIONS	L. SUM	1	$15,000.00	$15,000.00
2020201	SAW CUTTING	L. FT.	2,670	$1.25	$3,337.50
2030301	ROADWAY EXCAVATION	CU. YD.	141,447	$3.00	$424,341.00
2030401	DRAINAGE EXCAVATION	CU. YD.	11,500	$5.00	$57,500.00
2030901	BORROW	CU. YD.	1,833,980	$3.00	$5,501,940.00
2030902	BORROW (GUIDE BANKS)	CU. YD.	4,495	$3.00	$13,485.00
2070001	DUST PALLIATIVE	M. GAL.	3,200	$11.00	$35,200.00
3030022	AGGREGATE BASE, CLASS 2	CU. YD.	40,468	$15.00	$607,020.00
4010008	PORTLAND CEMENT CONCRETE PAVEMENT (8")	SQ. YD.	2,973	$20.00	$59,460.00
4010010	PORTLAND CEMENT CONCRETE PAVEMENT (10")	SQ. YD.	81,750	$22.00	$1,798,500.00
4010012	PORTLAND CEMENT CONCRETE PAVEMENT (12")	SQ. YD.	172,200	$25.00	$4,305,000.00
4040046	ASPHALT CEMENT (AC-40) (FOR 3/4" MIX)	TON	545	$120.00	$65,400.00
4040111	BITUMINOUS TACK COAT	TON	15	$140.00	$2,100.00
4040116	APPLY BITUMINOUS TACK COAT	HOUR	15	$125.00	$1,875.00
4160002	ASPHALTIC CONCRETE (3/4" MIX) (END PRODUCT)	TON	9,060	$18.00	$163,080.00

COMBINED ESTIMATE
INTERIM PIMA FREEWAY SECTION 9A
45% SUBMITTAL

DATE: 8/23/95

REVISED: 45% SUBMITTAL

TRACS NO.: H3230-01D

FEDERAL NO.: RAM 600-1-335

ITEM NO.	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	AMOUNT
2010001	CLEARING AND GRUBBING	L. SUM	1	$15,000.00	$15,000.00
2020001	REMOVAL OF STRUCTURES AND OBSTRUCTIONS	L. SUM	1	$10,000.00	$10,000.00
2020041	REMOVAL OF PIPE	L. FT.	1,910	$15.00	$28,650.00
2020201	SAW CUTTING	L. FT.	4,033	$1.25	$5,041.25
2030301	ROADWAY EXCAVATION	CU. YD.	56,617	$3.00	$169,851.00
2030401	DRAINAGE EXCAVATION	CU. YD.	518	$5.00	$2,590.00
2030901	BORROW	CU. YD.	179,538	$3.00	$538,614.00
2070001	DUST PALLIATIVE	M. GAL.	2,600	$11.00	$28,600.00
3030022	AGGREGATE BASE, CLASS 2	CU. YD.	17,564	$15.00	$263,460.00
3030101	AGGREGATE BASE (CLASS 6)	CU. YD.	12,256	$15.00	$183,840.00
4010008	PORTLAND CEMENT CONCRETE PAVEMENT (8")	SQ. YD.	1,755	$20.00	$35,100.00
4010010	PORTLAND CEMENT CONCRETE PAVEMENT (10")	SQ. YD.	48,604	$22.00	$1,069,288.00
4010012	PORTLAND CEMENT CONCRETE PAVEMENT (12")	SQ. YD.	34,814	$25.00	$870,350.00
4040046	ASPHALT CEMENT (AC-40) (FOR 3/4" MIX)	TON	1,313	$120.00	$157,560.00
4040111	BITUMINOUS TACK COAT	TON	4	$140.00	$560.00
4040116	APPLY BITUMINOUS TACK COAT	HOUR	8	$125.00	$1,000.00

From: Ke[illegible]nson
3/13/95

GUIDE FOR ESTIMATING COST OF SOIL-CEMENT SLOPE PROTECTION

(For Construction In 1995)

TOTAL COST = COST OF PROCESSING +	COST OF CEMENT (cwt cement/cu.yd. x cost/cwt)
Cost of processing depends upon quantity of soil-cement to be placed.	Cement required depends on results of durability testing using soil aggregate proposed for the job.
Cost of processing includes cost of material, hauling, central plant mixing, water for mixing and curing, transporting mixed soil-cement to the embankment, spreading, compacting and curing. This depends to some extent on the quantity of soil-cement to be processed. If the soil to be mixed with cement must be hauled from off the site, an additional cost must be added to the processing costs suggested.	Cost of cement/cwt depends on mill base price and cost of delivery plus contractor's cost for handling, overhead and profit.

	Degree of Construction Difficulty		
Volume of Soil-Cement	Easy	Average	Difficult
less than 7,000 cu.yd.	$14.00/cu.yd.	$20.00/cu.yd.	$40.00/cu.yd.
7,000 - 40,000	10.00	14.00	21.00
40,000 - 100,000	9.00	12.00	18.00
more than 100,000	7.00	10.00	15.00

If no soil-cement tests have been conducted and no cement prices are available, assume 300# cement/cu.yd. and obtain cement cost information from latest Engineering News-Record or other sources.

NOTE: The above estimated costs apply best to soil-cement protection for earth dams and bank protection. For construction in years after 1993, the estimated costs should be increased to include anticipated increases in costs of labor and materials. A contingency factor may be applied to the above costs for estimating purposes.

pca PORTLAND CEMENT ASSOCIATION

KENNETH D. HANSEN, PE
Senior Water Resources Engineer

6880 So. Yosemite Ct. - Suite 150
Englewood, Colorado 80112
Phone: (303) 290-0303
Fax: (303) 290-8008

FILE NAME: COST95.SC