PRELIMINARY ASSESSMENT

OF FLOODING PROBLEMS ALONG

VALLEY VIEW WASH IN THE VICINITY

OF THE FLECHA CAIDA SUBDIVISION

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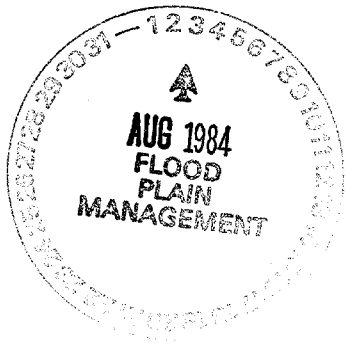

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July 26, 1984

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I. RESULTS AND CONCLUSIONS

This report presents a preliminary evaluation of the flooding problems which have impacted upon the Flecha Caida subdivision. This site is located southwest of the intersection of Swan Road and Sunrise Drive along Calle del Pantera.

The Pima County Department of Transportation & Flood Control District (PCDOT&FCD) requested Simons, Li & Associates, Inc. (SLA) to make an evaluation of the flooding problems which impact upon this subdivision, and to determine if any upstream construction activity resulted in an increase in flooding to the Flecha Caida subdivision. In particular, the PCDOT&FCD requested an assessment as whether or not the peak-flow rate was increased by any unusual diversion or concentration of flow caused by construction of a box culvert at the Valley View Wash crossing of ongoing Sunrise Drive during a rainfall runoff event that occurred on June 27, 1984. The first field investigation was made by Mr. Michael E. Zeller, P.E., and Mr. Clinton M. Glass, P.E. on June 29, 1984. A summary of the findings of both that field investigation and the ensuing study are as follows:

1. A determination of whether or not flood waters backed up behind an artificial dam in the vicinity of the Sunrise Road box culvert construction area could not be made during the field visit, since significant regrading and clean-up of the area had already been undertaken prior to our arrival. However, we were able to assess the elevation of flood waters based upon debris lines along the channel banks and along the side walls of the box culvert. To further understand the flooding conditions at the Sunrise Road box culvert site, we contacted Mr. Nino Gazzi of M.M. Sundt Construction Company, the Construction Manager for the Sunrise Road project, and Mr. Charles Music, with the Pima County Inspections Division. Both men were at the site on June 27th, and witnessed the flooding. In

addition, several photographs were taken in the area of the Valley View Wash crossing of Sunrise Road. A summary of the meeting with Mr. Gazzi, along with copies of the photographs which he took during this flood, are provided in the following section of this report.

2. A drive down Valley View Road revealed that a significant volume of runoff had collected against the curb of the roadway, and then drained south until it was recaptured by Valley View Wash at a point located approximately one-quarter mile south of Sunrise Road. This runoff apparently came from some of the high-density urbanized area in the vicinity of the Swan and Sunrise intersection.

3. Examination of old aerial photographs found that Calle del Pantera was constructed along the alignment of one of the old channel braids. During the June 27, 1984 event, flood waters broke out into this old channel braid just upstream of Calle del Pantera; and then flowed southeasterly in the roadway to Cerco del Corazon, where they then flowed southerly within that roadway (and across adjacent subdivision lots) until they were finally recaptured by the natural channel at the south end of the subdivision. A 1941 photograph and a 1978 photograph of the area is provided on Figures 1.1 and 1.2 of this report.

4. Runoff generated in the vicinity of the Swan/Sunrise intersection is either conveyed to Valley View Wash by storm-sewer systems, or if flows overland until intercepted by the curb along Valley View Road. In either instance, this runoff is collected back into the natural channel at a point approximately one-quarter mile upstream of the Calle del Pantera crossing. Other than these modifications to the upstream drainage,

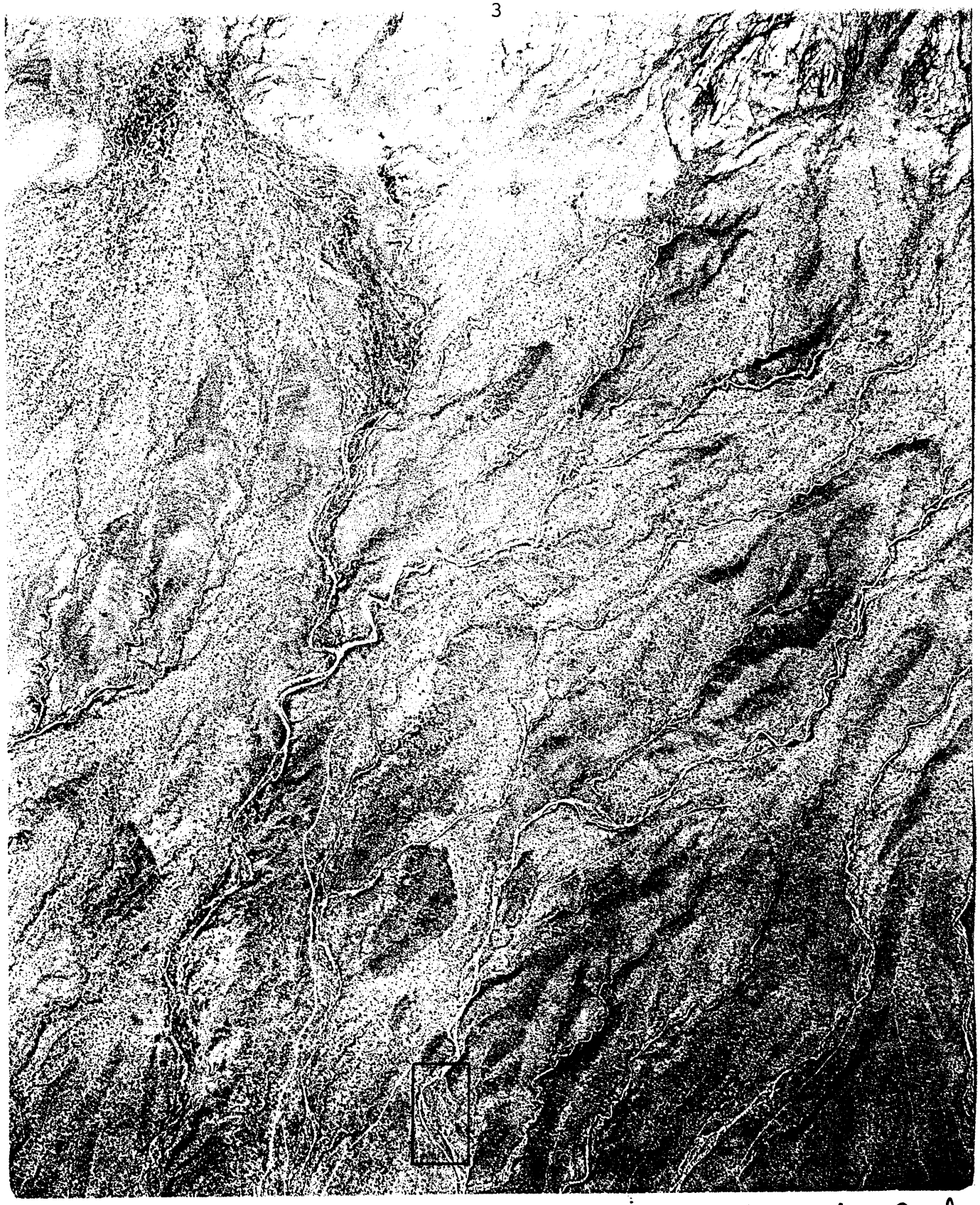


Figure 1.1 - 1941 Photograph, Valley View Wash through Fleche Caida

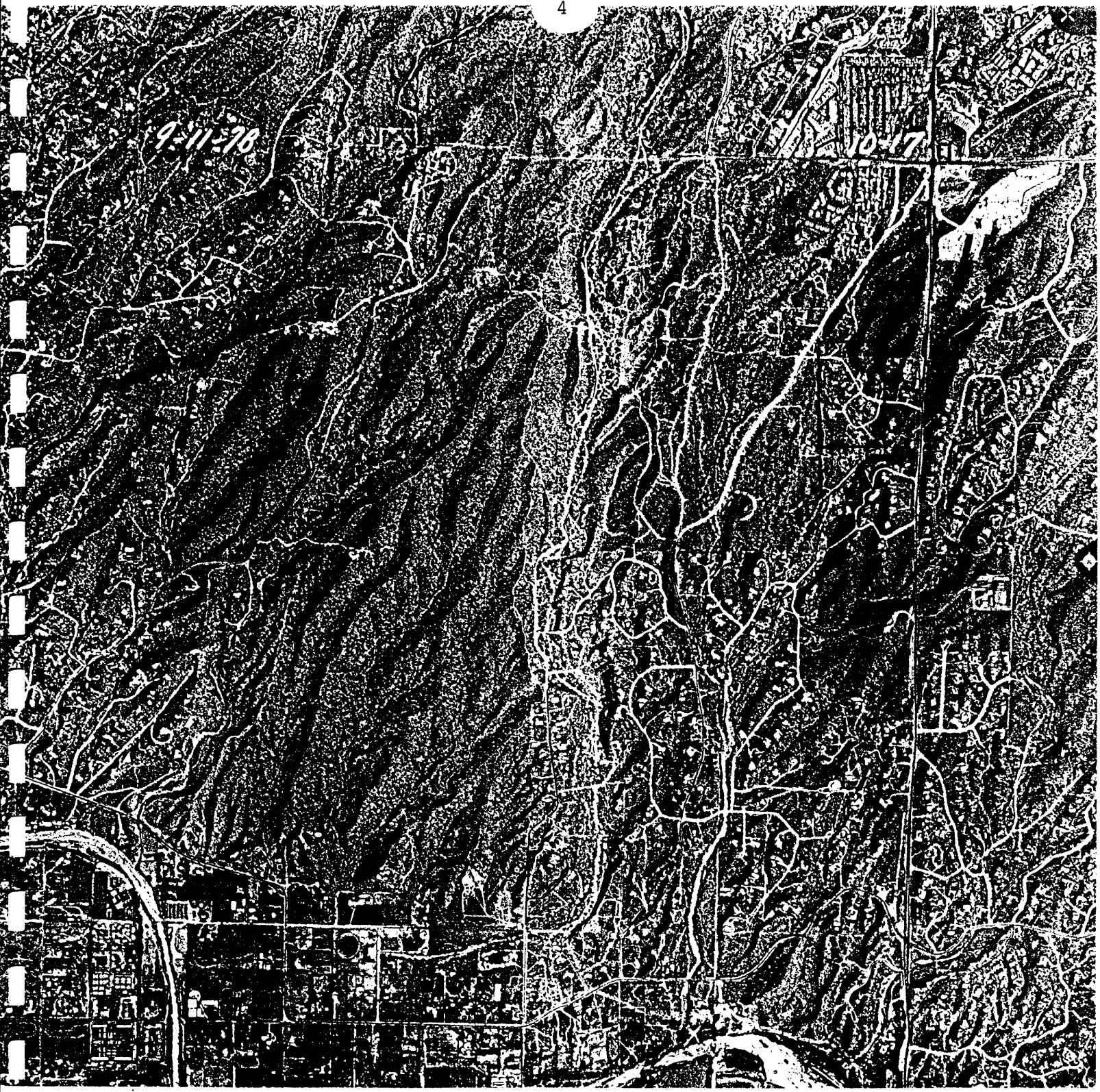


Figure 1.2 - 1978 Photograph, Valley View Wash through Flecha Caida

which resulted from recent urbanization, there were no apparent diversions of flow which either increased the contributing basin area or further concentrated the flow within the study area.

5. Examination of historical photographs showing the pre-development channel conditions through the Flecha Caida subdivision area revealed that the homes which have been impacted during recent flooding were constructed within the natural floodplain area of Valley View Wash. Prior to being developed, the channel through this reach consisted of a network of braided channels that spread across the entire low-lying area between adjacent terraces. Flooding along this type of alluvial sand-bed channel is typically characterized by periodic lateral shifts of the channel from one point to another across the floodplain area.

6. Considering the nature of the natural channel geomorphology and hydraulics, totally inadequate provisions for drainage were provided at the time of platting this subdivision. Many of the existing homes within the subdivision area are only located one to two feet above the adjacent channel thalweg, and within just a few feet of the channel banks. Based upon the historical photographs it appears that some of the structures within the subdivision were constructed directly on top of the old channel system.

7. Rainfall data provided by the PCDOT&FCD indicated that the event of June 27, 1984 measured 1.9 inches during a 2-1/2 hour period between 1:00 p.m. and 3:30 p.m. Based upon the magnitude of runoff that was generated and the normal characteristics of the summer thunderstorms in the Tucson area, it is likely that most of this rainfall occurred during a period of one hour, or

less. This event was compared with NOAA rainfall data to estimate its return period. The estimated frequency of this rainfall event, based upon the NOAA data, is between 5 and 10 years.

8. A hydrologic and hydraulic analysis was conducted to estimate the volume of runoff and peak-flow rate during the June 27, 1984 flood, and to assess the degree to which upstream urbanization, particularly in the vicinity of the Swan Road and Sunrise Drive intersection, has increased downstream flooding. An outline of the methodology used in this analysis is described in Section 3 of this report. The basic conclusions of this analysis are that the upstream urbanization has increased the frequency of runoff generating events and has increased the volume of runoff. However, the analysis also found that the actual peak rate of flow and depths of flooding were only marginally increased over and above what would have occurred had the upstream area been only developed at a CR-1 density, rather than the existing higher densities. The principal basis for this conclusion is the differences in time of concentration for runoff generated by the highly urbanized areas in the vicinity of Swan Road and Sunrise Drive versus that of the upstream watershed area, which stretches approximately 4 miles north of the subdivision. The analysis of the June 27th event found that the high-density urbanization increased the flow rate from 530 cfs to 570 cfs; or, corresponding, by a depth of between 0.1 to 0.2 feet.

II. SUMMARY OF DISCUSSIONS WITH NINO GAZZI OF M.M. SUNDT CONSTRUCTION COMPANY (MEMO PREPARED BY MR. JOHN WALLACE, SLA)

On July 10, 1984 I met with Mr. Nino Gazzi to discuss the events that had occurred on June 27, 1984 at his job site (Sunrise Drive just west of Swan Road) which resulted from the rainfall occurring on that day.

At this site, 5-5'x8' concrete box culverts are presently being build to convey flows from a natural channel (wash) under Sunrise Drive at a point just west of Valley View Drive. On the morning of June 27th, the construction of these culverts was limited to that portion extending to the north of the centerline of Sunrise Drive. The westbound lane and supporting embankment of Sunrise Drive had been removed where it crosses the wash to allow construction to proceed. The eastbound lane and supporting embankment were still in place at this time.

Rainfall began in the area at approximately 1:30 p.m. and the photos that accompany this summary were taken at approximately the time the flows concentrating at the culvert construction site reached their peak.

As indicated in the photos, and confirmed by Mr. Gazzi, water from the wash backed up behind the undisturbed portion of the roadway embankment until it reached the top of the roadway, at which point it began to flow over the roadway into the downstream channel. According to Mr. Gazzi, the maximum depth of water flowing over the roadway at any time was approximately 1-foot. After the water had stopped flowing over the roadway, a worker at the site excavated a trench about 3 feet in width through the roadway embankment in order to drain the remaining water ponded behind the embankment. The photo showing the downstream channel was taken at approximately the time of peak flow over the top of the roadway.

According to Mr. Gazzi, there was also a large volume of runoff generated from the developed areas adjacent to the intersection of Sunrise Drive and Swan Road. This runoff flowed down

Valley View Drive and across the natural desert area between the wash and Valley View Drive until it was completely intercepted by the Wash where it crosses Valley View Drive. As a result of heavy flows on the roadway, considerable damage was done to a newly-installed curb alone Valley View Drive.

III. HYDROLOGIC AND HYDRAULIC ANALYSIS OF JUNE 27, 1984 EVENT

A hydrologic and hydraulic analysis was conducted to assess the degree to which upstream urbanization increased runoff during the June 27, 1984 event. This analysis was made as follows:

1. Rainfall measurements were obtained from the PCDOT&FCD at all available surrounding gage sites. The storm pattern or aerial extent of the rainfall over the contributing watershed was estimated from this information. The measured rainfall was then converted from its actual duration (about 2 hours) to a 1 hour storm based upon rainfall distribution data obtained from NOAA.

2. The magnitude of the peak-discharge rate was then computed for the basin area upstream of the Swan Road crossing, and for the urbanized area in the vicinity of the Swan Road and Sunrise Drive intersection. The lower portions of the basin in the vicinity of the Swan Road and Sunrise Drive intersection was computed as a separate tributary, because the degree of urbanization in this area has resulted in significantly different runoff characteristics than for the upstream watershed.

3. Flood hydrographs were developed for each of the contributing areas described in Item 2 above, then lagged to a concentration point at Calle del Pantera. These hydrographs were then summed to determine the peak-flow rate through Flecha Caida.

4. The magnitude of the peak-runoff rate was then computed for a condition that assumed a CR-1 urbanization density in the vicinity of the Swan Road/Sunrise Drive intersection area, rather than the high densities that currently exist. The CR-1 density was chosen as a basis of comparison because this is the general density

of development for much of the surrounding foothills area. A hydrograph for this latter condition was developed, as was done for the case of existing conditions, and lagged to a point of concentration at Calle del Pantera. This hydrograph was then summed with the hydrograph for the upstream area to determine a peak-flow rate for a more moderate urbanization density. The difference in the peak-flow rate from existing conditions (i.e., high-density urbanization) versus the hydrograph for the assumed CR-1 density is the estimate of the increase in peak-flow rate due to the higher-density urbanization.

5. These discharge estimates were checked by taking field cross sections of Valley View Wash between Sunrise Drive and determining the magnitude of the flow rate from high water marks using the standard "Slope-Area Method," as described by the United States Geological Survey. This cross-section data was also used to determine the difference in the depth of flow between existing conditions and the assumed CR-1 density condition.

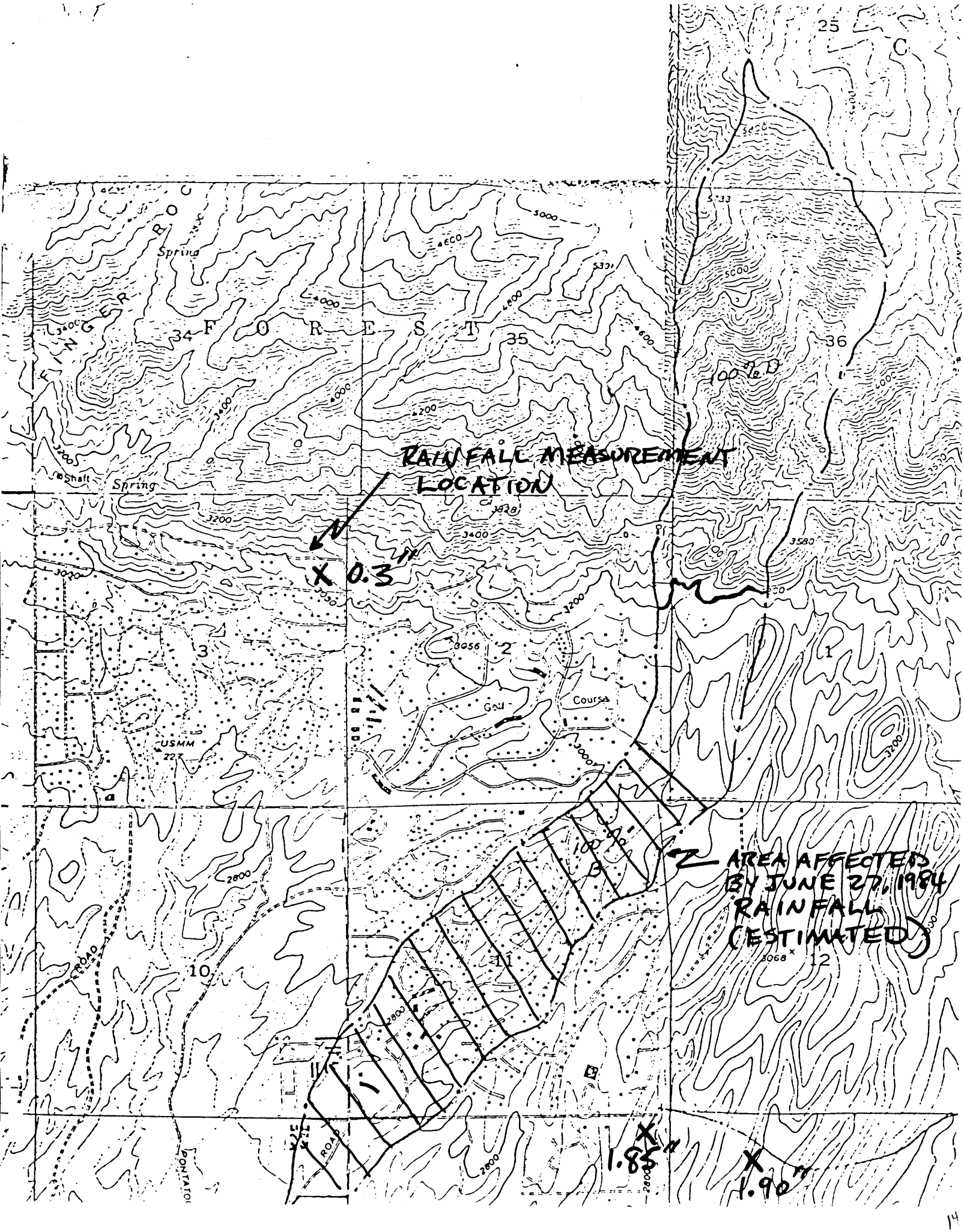
The results of the analysis described above found that the higher-density urbanization increased the peak-flow rate by about 5% over and above what would have occurred with a more moderate urbanization density. This increase in discharge increased the flow depth by about 0.1 to 0.2 feet at the channel cross-section locations surveyed as a part of this study.

All hydrologic and hydraulic computation sheets are provided in Appendix A of this report.

R21/R484-32

APPENDIX A

HYDROLOGIC AND HYDRAULIC COMPUTATIONS


RAINFALL MEASUREMENT LOCATION
X 0.3"
AREA AFFECTED BY JUNE 27, 1984 RAINFALL (ESTIMATED)
X 1.85"
X 1.90"
FOREST
Spring
Shaft
Golf
Course
USMM
ROAD
PONTATOC
100% D
100% B

HYDROLOGIC DATA SHEET

Project Name and Location: Valley View Wash, tributary areas in vicinity of Sun Tan

Drainage Concentration Point: Pantano Dr. (existing urbanized conditions)

Watershed Area (A): 126 acres/square miles.

Length of Watercourse (L_c): 5300 ft. Length to Center of Gravity (L_{ca}): 2450 ft.

Incremental Change in Length (L_i) - ft.	Incremental Change in Elevation (H_i) - ft.
5300	2840 - 2670 - 170

Mean Slope (S_c): 0.032 ft./ft. Watershed Type(s): Urban (Heavy) (future)

Basin Factor (n_b): 0.030 (future) Flood Frequency: June 27, 1911 yrs.

P_{24} (24 hour): _____ in. Areal Value: _____ in.

P_6 (6 hour): _____ in. Areal Value: _____ in.

P_1 (1 hour): 1.66 in. Areal Value: _____ in.

P_2 (2 hour): _____ in. Areal Value: _____ in.

P_3 (3 hour): _____ in. Areal Value: _____ in.

Soil Group(s): 100% B Cover Type(s): Desert Brush, Urban

Cover Density (pervious areas): 30% Impervious Cover: 60% (future)

CN(s): 82 (curve number) (pervious & impervious areas) CN*(s): 82.69 (adjusted curve number)

Runoff to Rainfall Ratio(s), (C): 0.2784 (pervious areas) 0.955 (impervious areas)

Runoff Supply Rate (q): 0.6844 i in./hr. (function of i)

Time of Concentration (T_c): 0.3767 $i^{-.4}$ hrs. ~~/mins~~. (function of i)

Iterative Solution of T_c: 13 ~~hrs.~~/mins.

Rainfall Intensity (i) at T_c: 4.96 in./hr.

Runoff Supply Rate (q) at T_c: 2.77 in./hr.

Equation for T_c:

$$T_c = \frac{n_b}{50} \frac{(L_c L_{ca})^{.3}}{(S_c)^{.4}} q^{-.4} \text{ hours.}$$

Peak Discharge:

1.008 qA (acres): 352 cfs.

645.33qA (square miles): _____ cfs.

Note: For impervious areas, CN* = 99 (constant).

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HYDROLOGIC DATA SHEET

Project Name and Location: Valley View Wash, tributaries in vicinity of Sunset & Sunrise

Drainage Concentration Point: Pantera Dr. (assumed CR-1 density)

Watershed Area (A): 126 acres/square miles.

Length of Watercourse (L_c): 5300 ft. Length to Center of Gravity (L_{ca}): 2450 ft.

Incremental Change in Length (L_1) - ft.	Incremental Change in Elevation (H_1) - ft.
5300	2840-2670 = 170

Mean Slope (S_c): 0.032 ft./ft. Watershed Type(s): suburban (future)

Basin Factor (n_b): 0.032 (future) Flood Frequency: June 27, 1984 yrs.

P_{24} (24 hour): ____ in. Areal Value: ____ in.

P_6 (6 hour): ____ in. Areal Value: ____ in.

P_1 (1 hour): 1.66 in. Areal Value: ____ in.

P_2 (2 hour): ____ in. Areal Value: ____ in.

P_3 (3 hour): ____ in. Areal Value: ____ in.

Soil Group(s): 100% B Cover Type(s): Desert Brush, Urban

Cover Density (pervious areas): 30% Impervious Cover: 20% (future)

CN(s): 82 (curve number) (pervious & impervious areas) CN*(s): 82.69 (adjusted curve number)

Runoff to Rainfall Ratio(s), (C): 0.2784 (pervious areas) 0.955 (impervious areas)

Runoff Supply Rate (q): 0.4137 i in./hr. (function of i)

Time of Concentration (T_c): 0.4914 $i^{-.4}$ hrs./mins. (function of i)

Iterative Solution of T_c: 18 hrs./mins.

Rainfall Intensity (i) at T_c: 3.48 in./hr.

Runoff Supply Rate (q) at T_c: 1.44 in./hr.

Equation for T_c:

$$T_c = \frac{n_b}{50} \frac{(L_c L_{ca})^{.3}}{(S_c)^{.4}} q^{-.4} \text{ hours.}$$

Peak Discharge:

1.008 qA (acres): 183 cfs.

645.33qA (square miles): ____ cfs.

Note: For impervious areas, CN* = 99 (constant).

16

HYDROLOGIC DATA SHEET

Project Name and Location: Valley View Wash

Drainage Concentration Point: at Swan Road, area of watershed south of section 11

Watershed Area (A): 375 acres/square miles.

Length of Watercourse (L_c): 8300 ft. Length to Center of Gravity (L_{ca}): 4000 ft.

Incremental Change in Length (L_i) - ft.	Incremental Change in Elevation (H_i) - ft.
8300	3000 - 2750 = 250

Mean Slope (S_c): 0.0301 ft./ft. Watershed Type(s): suburban (future)

Basin Factor (n_b): 0.032 (future) Flood Frequency: June 27, 1984 yrs.

P_{24} (24 hour): _____ in. Areal Value: _____ in.

P_6 (6 hour): _____ in. Areal Value: _____ in.

P_1 (1 hour): 1.66 in. Areal Value: _____ in.

P_2 (2 hour): _____ in. Areal Value: _____ in.

P_3 (3 hour): _____ in. Areal Value: _____ in.

Soil Group(s): 100% B Cover Type(s): Desert Brush

Cover Density (pervious areas): 30% Impervious Cover: 20% (future)

CN(s): 82 (curve number) (pervious & impervious areas) CN*(s): 82.69 (adjusted curve number)

Runoff to Rainfall Ratio(s),(C): 0.2784 (pervious areas) 0.955 (impervious areas)

Runoff Supply Rate (q): 0.4137 i in./hr. (function of i)

Time of Concentration (T_c): 0.6675 $i^{-.4}$ hrs./mins. (function of i)

Iterative Solution of T_c: 27 hrs./mins.

Rainfall Intensity (i) at T_c: 2.78 in./hr.

Runoff Supply Rate (q) at T_c: 1.15 in./hr.

Equation for T_c:

$$T_c = \frac{n_b}{50} \frac{(L_c L_{ca})^{.3}}{(S_c)^{.4}} q^{-.4} \text{ hours.}$$

Peak Discharge:

1.008 qA (acres): 435 cfs.

645.33qA (square miles): _____ cfs.

Note: For impervious areas, CN* = 99 (constant).

$Q_p = 435$
$T_c = 27$
(CR-1)

VVW @ Sun/Sunrise

$T_c = 28$

	ΔT	ΔQ
(lag)	8	0
	11	11
	16	70
	22	151
	28	251
	33	386
	36	435
	39	402
	42	365
	47	295
	64	141
	81	59
	137	5

$Q_p = 352$
$T_c = 13$
(Urban)

VVW @ Calle Del Pantera

$T_c = 19$

ΔT	ΔQ
2	9
6	56
10	122
13	203
17	312
19	352
23	295
29	213
34	149
38	114
49	48
65	17
87	4

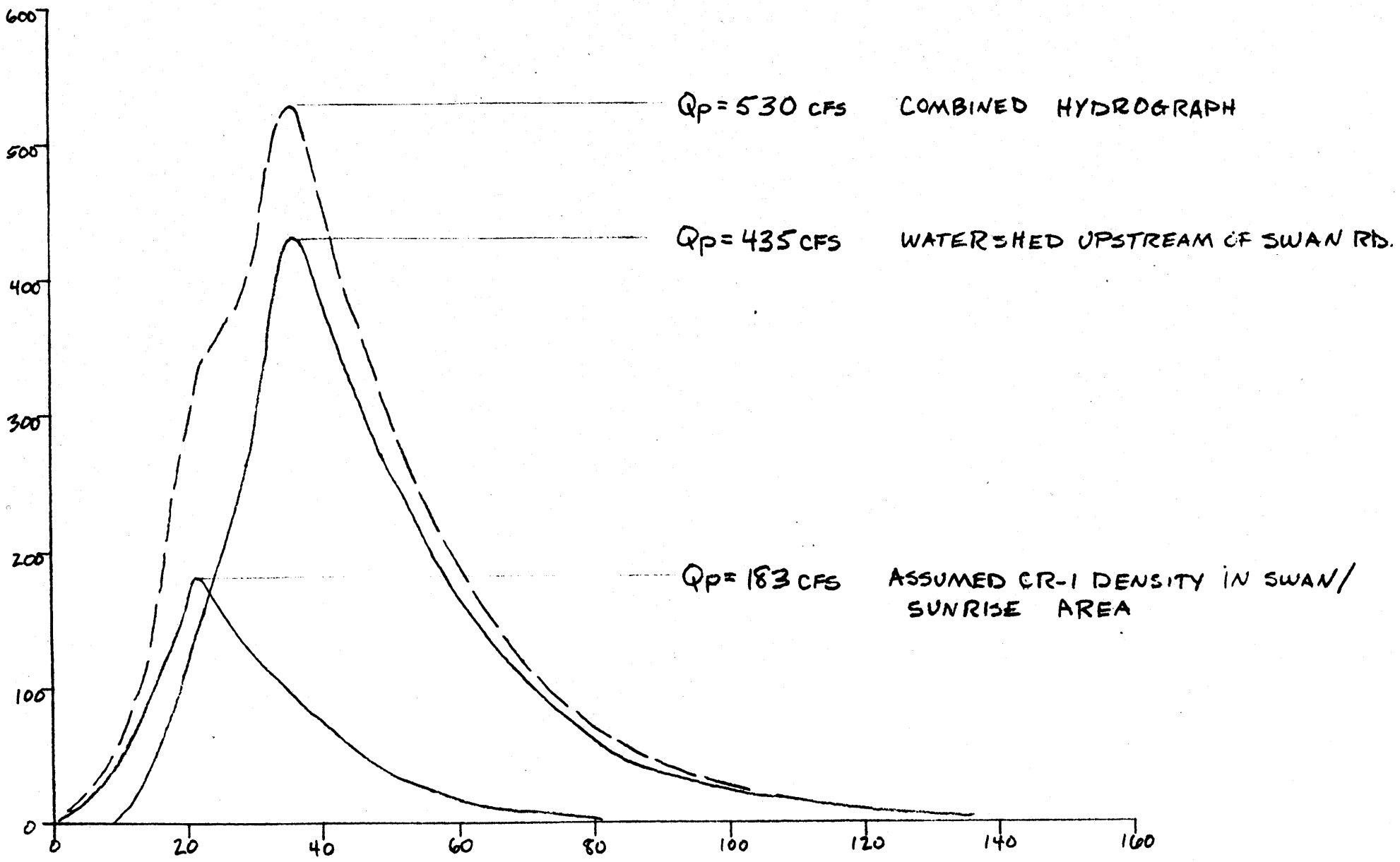
VVW @ Calle Del Pantera (CR-1)

2	5
7	29
11	63
15	105
20	162
22	183
24	169
26	154
33	111
44	59
57	25
101	2

$Q_p = 183$
$T_c = 18$
$T_c = 22$

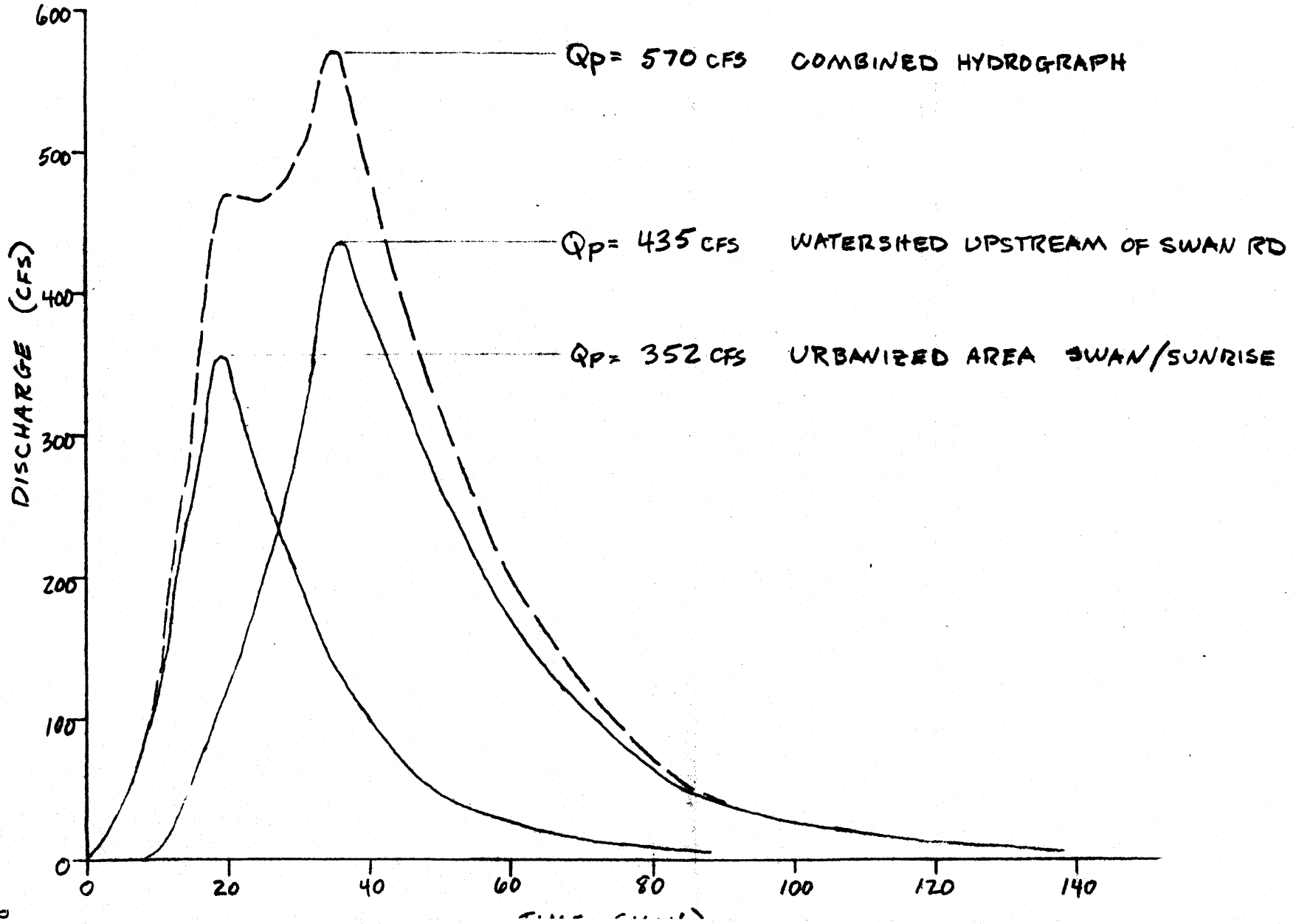
VALLEY VIEW WASH

ESTIMATED HYDROGRAPHS FOR JUNE 27, 1984 FLOODS WITH ASSUMED CR-1 DENSITY IN SWAN/SUNRISE AREA



VALLEY VIEW WASH

ESTIMATED HYDROGRAPHS FOR JUNE 27, 1984 FLOOD



sla
SIMONS, li & ASSOCIATES, INC.

CLIENT Pima County JOB NO. WR84-32 PAGE
PROJECT DATE CHECKED DATE
DETAIL CHECKED BY COMPUTED BY J.W.

Determination of Peak Discharge by Slope Area Method (by Dalrymple & Benson)

$$Q = K_2 \sqrt{\frac{\Delta h}{\frac{K_2}{K_1} L + \frac{K_2^2}{2g A_2^2}\left[-\alpha\left(\frac{A_2}{A_1}\right)^2(1-k) + \alpha_2(1-k)\right.}}$$

WHERE
- Q = PEAK DISCHARGE (CFS)
- K_n = CONVEYANCE (CFS)
- A_n = CROSS SECTIONAL AREA OF FLOW (FT^2)
- α_n = VELOCITY HEAD COEFFICIENT
- L = REACH LENGTH (FT)
- Δh = " DROP (FT)
- k = 0.5 IF Δh_v IS POSITIVE
  = 0 IF " " NEGATIVE

SECTION 1-2:

$K_1 = 3781$
$K_2 = 2247$
$A_1 = 54\ FT^2$
$A_2 = 40\ FT^2$
$\alpha_1 = \alpha_2 = 1$
$L = 260\ FT$
$\Delta h = 5.28\ FT$
$k = 0.5$

$$Q = (2247)\sqrt{\frac{5.28}{\left(\frac{2247}{3781}\right)(260) + \frac{(2247)^2}{2g(40)^2}\left[-1\left(\frac{40}{54}\right)^2(1-.5)+(1-.5\right.}}$$

$$\boxed{Q = 401\ CFS}$$

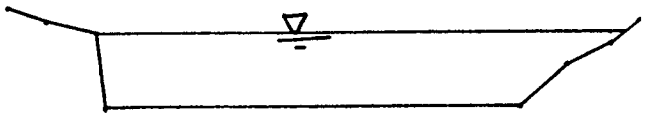
SECTION 3-4 :

$K_1 = 4580$
$K_2 = 3247$
$A_1 = 59\ FT^2$
$A_2 = 48\ FT^2$
$\alpha_1 = \alpha_2 = 1$
$L = 190$
$\Delta h = 4.06$
$K = 0.5$

$$Q = (3247)\sqrt{\frac{4.06}{\left(\frac{3247}{4580}\right)^{(190)} + \frac{(3247)^2}{2g\,(48)^2}\left[-1\left(\frac{48}{59}\right)^2(1-0.5)+(1-0.5)\right]}}$$

$$\boxed{Q = 540\ CFS}$$

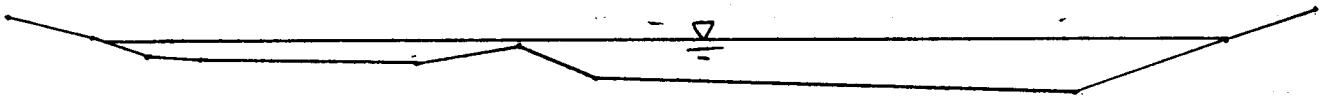
SECTION (4) : (190 FT D/S OF SECTION (3))



n = 0.03
S = 0.0214
D = 1.99 FT

Q = 475 CFS ; V = 9.9 FT/S
K = 3247 F = 1.32
A = 48 FT²

SECTION (5) : (109 FT D/S OF SECTION (4))



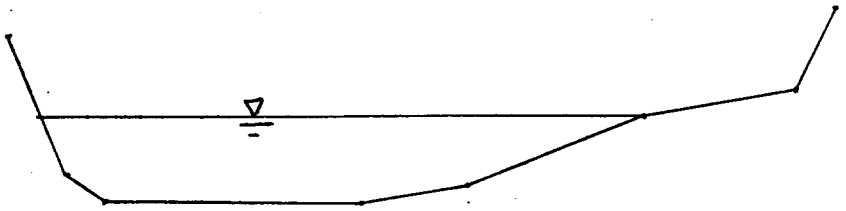
n = 0.03
S = 0.0137
D = 1.43 FT

Q = 245 ; V = 5.1 FT/S
K = 2093 F = 0.99
A = 48 FT²

FOR Q = 475 , D = 1.87 .

Depth	A	P	V	Q
1.43	46.0	58	5.1	245
1.60	58.0	60	5.7	330
1.70	64.0	61	6.0	384
1.80	70.2	63	6.2	435
1.90	76.6	65	6.5	497
2.00	83.2	66	6.8	564

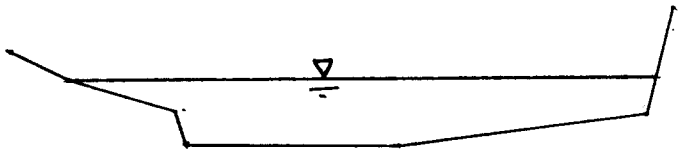
SECTION (1) (120 FT D/S FROM TEMPORARY DIP SECTION AT SUNRISE CROSSING)



n = 0.03
S = 0.0204
D = 2.28 FT

Q = 540 CFS, V = 10 FT/S
K = 3781
A = 54. FT²
IF = 1.34

SECTION (2) (260 FT D/S FROM SECTION 1)

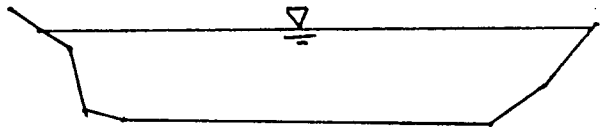


n = .03
S = 0.0204
D = 1.75

Q = 321 CFS; V = 8 FT/S
K = 2247
A = 40 FT²
IF = 1.26

FOR Q = 475 CFS, D = 2.12 FT

SECTION (3) (253 FT D/S FROM CUT WATER STORAGE FACILITY ACCESS RD ℄)



n = 0.03
S = .0214
D = 2.51

Q = 670 CFS, V = 11.4 FT/S
K = 4580
A = 59 FT²
IF = 1.39

FOR Q = 475 CFS; D = 2.06

Photo No. 1 - Valley View Wash, looking upstream across Sunrise Drive at Box Culvert under construction. Note south half of roadway still in place.

Photo No. 2 - Valley View Wash looking east along Sunrise Drive.

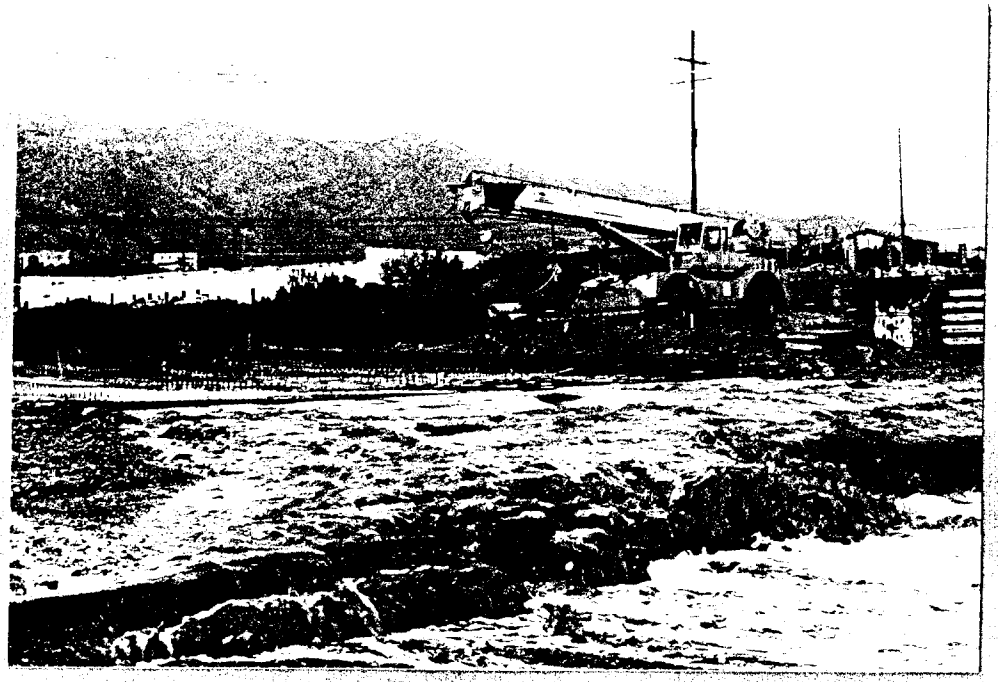


Photo No. 3 - Valley View Wash at Sunrise Drive looking northeast.

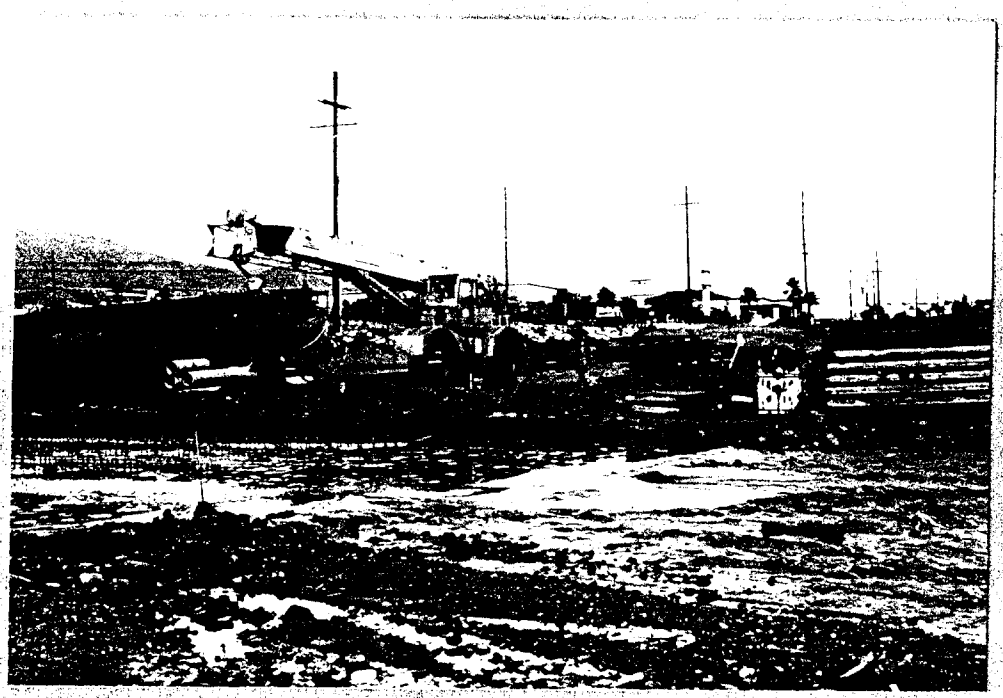


Photo No. 4 - Valley View Wash at Sunrise Drive looking northeast.

Photo No. 5 - Valley View Wash looking downstream from Sunrise Drive.

sla

Simons, Li & Associates, Inc.

120 WEST BROADWAY
SUITE 260
P.O. BOX 2712
TUCSON, ARIZONA 85702

TELEPHONE (602) 884-9594

Transmittal Letter

To Pima County Dept. of Trans. & Flood Control Dist.
1313 S. Mission Road

Date July 26, 1984

Project Misc. Flood Invest. of Flood Problems for Pima Co.

Attention Ms. Suzanne Shields, P.E.

Project Number AZ.WR.84.32

Enclosed please find:

Copies	Of
1	Preliminary Assessment of Flooding Problems Along Valley View Wash in the Vicinity of the Flecha Caida Subdivision

☐ Forwarded
☐ Returned

☐ Prints
☐ Originals
☐ Reports
☐

☐ For Approval
☐ As Requested
☐ For Your Use
☐ For Your Files
☐

☐ Mail
☐ Express Courier
☐

Remarks Attached is one copy of the above-referenced assessment for your review.

From Clinton M. Glass, P.E.

RECEIVED: