REVISED HYDROLOGIC AND HYDRAULIC REPORT FOR UNION HILLS DRIVE STORM DRAIN 16TH STREET TO CAVE CREEK ROAD PROJECT NO. P900621

Prepared by:

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ASL Project No. 1152.0007
January, 1999

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1. INTRODUCTION

1.1 Purpose

The purpose of this drainage report is to revise the original report, *Hydrologic and Hydraulic Report for Union Hills Drive Storm Drain 16th Street to Cave Creek Road Project No. 900621*, prepared by Erikson and Salmon, Inc. in January of 1992. The revisions are required because of significant development adjacent to Union Hills Drive and within the watershed boundaries of the project.

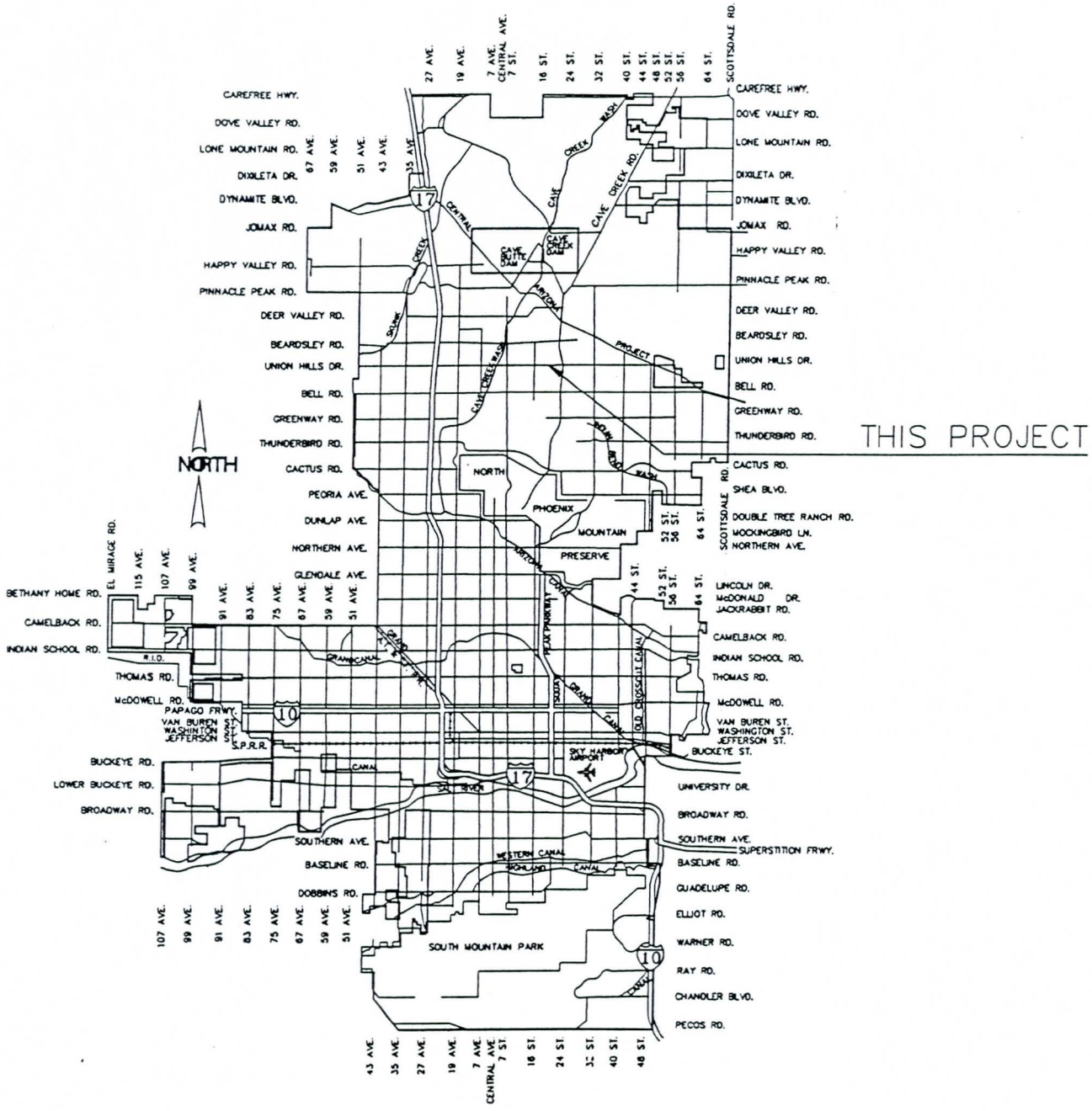
1.2 Project Description

The proposed Union Hills improvements are located in the City of Phoenix, Arizona. The project is located along the south and east borders of Section 27 of Township 4 North, Range 3 East of the Gila and Salt River Base and Meridian, Maricopa County, Arizona; see the Vicinity Map on Page 2.

Pavement improvements for this project commence along Union Hills Drive approximately 200ft west of 16th Street and extend approximately 300ft east of the intersection with Cave Creek Road. Along Cave Creek Road, pavement improvements commence approximately 1000ft south of the intersection with Union Hills Drive and extend 1400ft north of the intersection.

The drainage system for this project consists of two separate storm drain lines. The first line in Union Hills Drive begins at the 16th Way intersection where it will connect to project ST-885752 which is the outfall trunk line to the south. The proposed line will extend east along Union Hills Drive to its terminus at Sta. 42+70. This termination point was primarily dictated by the roadway grading criteria which created a sump at this location. The second storm drain line extends from the west curb returns of the Union Hills Drive - Cave Creek Road intersection and terminates east of the intersection at Station 57+20 where it will connect with the future outfall line being constructed on Project P-900639. This second system also includes a storm drain extension north on Cave Creek Road which terminates at Station 28+25.

Vicinity Map



2. DRAINAGE BASIN CHARACTERISTICS

2.1 Mapping

Base mapping for the Drainage Map included as Exhibit A includes three digital R.O.W. quarter section maps from the C.O.P.. Specifically, the maps used were Q.S.#39-31, Q.S.#39-32, and Q.S.#40-32 as received from C.O.P. personnel in November of 1998.

Contours used in the drainage analysis were taken from C.O.P. topography quarter section maps (reference numbers same as above) with photo dates of 10/2/80. Since the drainage on the project is mostly dictated by residential subdivisions and other facilities constructed since the time of the photographs, the contours are not entirely reproduced on Exhibit A. Some contours are included on Exhibit A (digitized from the topo maps) to show drainage patterns where natural flow still exists.

2.2 Watershed Boundaries

The watershed boundaries for the project have not changed substantially from the original report. Basically they include the area north of Union Hills to Behrend Road, and east of 19th Place to Cave Creek Road. There is also a portion of Union Hills R.O.W. from 16th Street to 19th Place that is included in the project. The watershed boundaries are shown on Exhibit A.

2.3 Land Use

Changes in land use in comparison to the original report include commercial development adjacent to the southeast quadrant of the Union Hills Drive and Cave Creek Road intersection, and several residential developments. The residential developments include Mountain Rose Units I-III and Arizona Heights which are located north of Union Hills between 20th Street and Cave Creek Road, and Mountainside Ranch located off of Cave Creek Road north of Union Hills Drive.

2.4 Existing Drainage Facilities

Existing drainage facilities include retention basins, culverts, and street sections.

Some of the residential areas that have been developed since the time of the previous report include onsite retention. Specifically, Mountain Rose Units I-III and the Arizona Heights developments have onsite retention. From field investigation these developments retain onsite runoff in facilities that were assumed to have capacity for the 2-year event. The retention basin in Mountain Rose Unit II also receives runoff from a large offsite area. This basin was also assumed to have capacity for the 2-year event. Subbasins 94, 95, 96, and 97 are therefore not considered as part of the contributing area in calculations contained herein.

Three existing cross culvert locations that potentially impact the project are as follows: 1) Cave Creek Road Sta. 42+25 (outside the limits of the plans), 2) Union Hills Drive Sta. 27+30, and 3) Union Hills Drive Sta. 48+29.

Location 1), inlet identifier 26 on Exhibit A, is an existing 36" RCP that was checked for capacity to drain subbasins 26A, 26B, and 26C. Location 1) has sufficient capacity for the 2-year event therefore these subbasins do not contribute to flows within the project. Location 2), at the 20th Street intersection, is 2-36" steel pipes that will be partially removed, plugged, and abandoned as shown on the project construction plans. The abandonment is a result of a field investigation that showed very little flow would ultimately get into these existing pipes. The displaced flow will contribute to street flow along the north curb of Union Hills Drive and ultimately to the storm drain system. Location 3) is a 42"x29" CMPA that drains subbasin 22 (see Exhibit A); a portion of the commercial property on the northwest corner of the intersection of Union Hills Drive and Cave Creek Road. This culvert is to remain in place because of the inability to drain the subbasin to a proposed inlet.

19th Place and 20th Street both convey significant amounts of flow within their respective street sections. This causes a flooding condition on both of these streets as well as introducing significant surface flows at the Union Hills Drive intersections of 19th Place and 20th Street.

3. HYDROLOGIC ANALYSIS

3.1 Hydrologic Methodology

Drainage facilities were designed in accordance with the *Storm Drain Design Manual, Storm Drains with Paving of Major Streets, City of Phoenix*, Revised July 1987. Hydrologic calculations were performed using methodology presented in the *Storm Drain Design Manual, Subdivision Drainage Design, City of Phoenix*, November 1985. Peak flows were determined using the Rational Method; Q=C*A*I.

Q = Peak Flow in cubic, feet per second (cfs)

C = Runoff Coefficient, unit less

A = Area, acres

I = Intensity, inches per hour (in/hr)

Composite runoff coefficients (see Appendix A for calculations) were used for each subbasin based on combinations of the following land uses and their associated C value:

		2yr	10yr	LU-CODE
Paved Street or Parking Lot;	C = 0.95		.85	Pavement
Residential Areas;	C = 0.45		.55	~~Residential~~
Mountain Terrain w/ slope>10%	C = 0.70		.80	~~Mountain Terrain~~ OS-Mtn
Undeveloped Desert;	C = 0.35		.40	Undeveloped OS-Desert

Areas (A) for each subbasin were determined from their respective boundaries as shown on Exhibit A.

3.2 Inlets

Calculated times of concentration (Tc) for each subbasin were less than 10 minutes. Using the minimum Tc of 10 minutes, the corresponding intensity (I) for the 2-year event was 2.4in/hr. Peak flows were then used for inlet design with flowby accounted for in the inflow of downstream inlets. All peak flows are based on the original Tc, even when flowby from upstream inlets contributes to inflow. See Appendix B for the Inlet Capacity Summary Sheet which includes design flows, inlet design parameters, and proposed inlets.

Inlet capacities were determined with a computer program that utilizes HEC-12 methodology and City of Phoenix inlet characteristics. See Appendix C for Inlet Capacity Calculations.

Disregarding the excessive depths and spreads on 19th Place and 20th Street, there are two inlets where the depth exceeds the maximum desired depth of 5" (0.42ft). At inlets 16 and 18 depths of 0.5ft occur. The excessive depths at inlets 16 and 18 are a direct result of the surface flows conveyed by 19th Place and 20th Street. Since significant changes in inlet sizes only marginally improve flow depths, and because flow depths are still contained by the top of curb with acceptable spread, these inlets are presented as satisfactory.

3.3 Connector Pipes

Connector pipes were designed based on the peak flow intercepted by its respective inlet. Connector Pipe Calculations are included in Appendix E.

3.4 Storm Drain

Storm drain calculations used the same methodology as the inlets and connector pipes but utilized different times of concentration (Tc) and therefore different flows. Beginning at the furthest upstream inlet, the Tc was set to the minimum of 10 minutes and the flow was calculated based on the total contributing area. For each successive storm drain reach going downstream, the Tc was recalculated based on the previous Tc plus the travel time of the calculated flow through that reach of storm drain. This process was continued down each reach of storm drain using the total cumulative area, its associated weighted C value, and an intensity (I) corresponding to the lengthening Tc.

Hydraulic grade lines were calculated based on an assumed elevation at each respective storm drain terminus and using the Manning's equation to determine the slope of the HGL. A Manning's "n" value of 0.013 was arbitrarily utilized to compensate for manhole losses. See Appendix D for Storm Drain Calculations.

Box .017

4. CONCLUSIONS

The design of the two proposed storm drains presented herein is in general conformance with the lines recommended in the master drainage study prepared and submitted by NBS/Lowry, Update of North Central Area Master Storm Drainage Study - East Half - Project No. St-893248. However, upon a more detailed analysis associated with the drainage design of this project, the following modifications to the study are proposed:

1. The first line, which was designated as "Union Hills Lateral 2" in the study terminated at the 20th Street intersection. To gravity drain the roadway sump previously mentioned, the storm drain needs to be extended past 22nd Street to the 22nd Place intersection at Sta. 42+70. The study specified a two year storm discharge of 77cfs in the lateral at the 16th Way intersection. Our design yielded a value of 69cfs at this concentration point. The proposed pipe sizes of 36" to 48" between 16th Way and 20th Street are consistent with the study results.

2. The second storm drain, as previously described, is designated in the master study as "Cave Creek Road Lateral No. 4" and "Union Hills Drive Lateral No. 3", and specified two year storm discharge values of 53 cfs (with a 30" pipe) and 68 cfs (with a 48" pipe) respectively. For the Cave Creek Lateral, our drainage analysis only yielded a discharge value of 30cfs. As stated previously, runoff from subbasin 26 was not included in the Cave Creek Lateral since this flow is conducted easterly across Cave Creek Road. Our estimated design flow for the Union Hills segment of the lateral is only 40cfs. Although our design flows are substantially less than that shown in the study, to be conservative and consistent with study recommendations, we have proposed that the 30" and 48" pipe sizes be utilized.

APPENDIX A

Rational Method Calculations

ASL CONSULTING ENGINEERS

Project: Union Hills Drive - 16th Street to Cave Creek Road

City Project #: P-900621

Rainfall Event: 2-year

AREA NO.	INLET NO.	INLET STATION	LAND USE TRIBUTARY AREA: RESIDENTIAL ACRES	STREETS ACRES	MOUNT. TERRAIN ACRES	UNDEV. DESERT ACRES	A TOTAL ACRES	C WEIGHTED C-VALUE	OVERLAND FLOW: LENGTH FT	HIGH FT	LOW FT	SLOPE %	Ti MIN.	TRAVEL TIME: MAX. DIST. FT	HIGH FT	LOW FT	STREET SLOPE %	GUTTER VELOCITY FT/S	Tt MIN.	Tc Ti + Tt MIN.	Tc DESIGN Tmin=10 MIN.	I RAINFALL INTENSITY IN/HR	Q PEAK FLOW CFS	COMMENTS
2	2	42+70 RT	0.08	0.76	-	-	0.84	0.90	-	-	-	N/A	N/A	580	1472	1468	0.69	2.6	3.8	3.8	10.0	2.40	1.8	
4	4	41+20 LT	0.24	2.15	-	-	2.39	0.90	-	-	-	N/A	N/A	1850	1510	1467	2.32	4.1	7.6	7.6	10.0	2.40	5.2	
5	5	38+00 RT	0.06	0.49	-	-	0.55	0.90	-	-	-	N/A	N/A	390	1468	1465	0.77	2.7	2.4	2.4	10.0	2.40	1.2	
6	6	34+00 LT	0.10	0.91	-	-	1.01	0.90	-	-	-	N/A	N/A	1000	1478	1461	1.70	3.6	4.6	4.6	10.0	2.40	2.2	
7	7	33+50 RT	0.06	0.51	-	-	0.57	0.90	-	-	-	N/A	N/A	450	1465	1460	1.11	3.1	2.4	2.4	10.0	2.40	1.2	
8	8	28+50 RT	0.08	0.68	-	-	0.76	0.90	-	-	-	N/A	N/A	510	1460	1457	0.59	2.4	3.5	3.5	10.0	2.40	1.6	
11	-	-	8.48	1.52	17.54	17.54	45.08	0.53	1100	1670	1480	17.27	3.37	1100	1480	1458	2.00	3.8	4.8	8.2	10.0	2.40	57.3	
-	11A	27+03 LT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	28.7	
-	11B	28+75 LT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	28.7	
12	12	22+85 RT	0.05	0.44	-	-	0.49	0.90	-	-	-	N/A	N/A	380	1456	1454	0.53	2.3	2.7	2.7	10.0	2.40	1.1	
13	13	21+04 LT	0.09	0.80	-	-	0.89	0.90	-	-	-	N/A	N/A	620	1458	1452	0.97	2.9	3.5	3.5	10.0	2.40	1.9	
14	-	-	17.58	1.12	-	-	18.70	0.48				N/A	N/A	1500	1476	1452	1.60	3.5	7.1	7.1	10.0	2.40	21.5	
-	14A	20+24 LT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10.8	
-	14B	20+60 LT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10.8	
15	15	18+73 RT	0.06	0.54	-	-	0.60	0.90	-	-	-	N/A	N/A	420	1454	1450	0.95	2.9	2.4	2.4	10.0	2.40	1.3	
16	16	16+05 LT	0.06	0.51	-	-	0.57	0.90	-	-	-	N/A	N/A	430	1452	1448	0.93	2.9	2.5	2.5	10.0	2.40	1.2	
17	17	13+16 RT	0.08	0.75	-	-	0.83	0.90	-	-	-	N/A	N/A	520	1450	1446	0.77	2.7	3.2	3.2	10.0	2.40	1.8	
18	18	11+20 LT	0.07	0.60	-	-	0.67	0.90	-	-	-	N/A	N/A	485	1448	1445	0.62	2.5	3.3	3.3	10.0	2.40	1.4	
19	19	6+16 RT	0.09	0.77	-	-	0.86	0.90	-	-	-	N/A	N/A	650	1445	1442	0.46	2.2	4.9	4.9	10.0	2.40	1.9	
20	20	6+16 LT	0.13	1.20	-	-	1.33	0.90	-	-	-	N/A	N/A	550	1456	1443	2.36	4.1	2.2	2.2	10.0	2.40	2.9	
21	N/A	N/A	-	5.20	-	-	5.20	0.95	800	1514	1480	4.25	4.52	-	-	-	N/A	N/A	N/A	4.5	10.0	2.40	11.9	Flow does not impact project
22	N/A	N/A	3.93	-	-	-	3.93	0.45	800	1488	1470	2.25	5.78	-	-	-	N/A	N/A	N/A	5.8	10.0	2.40	4.2	Flow does not impact project
23A	-	-	4.92	-	-	-	4.92	0.45	800	1488	1470	2.25	5.78	-	-	-	N/A	N/A	N/A	5.8	10.0	2.40	5.3	
23B	-	-	0.11	1.03	-	-	1.14	0.90	-	-	-	N/A	N/A	400	1472	1469	0.75	2.7	2.5	2.5	10.0	2.40	2.5	
-	23	52+68 LT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7.8	Combined Flow from 23A+23B
24A	24A	28+25 LT	18.57	1.50	-	-	20.07	0.49	-	-	-	N/A	N/A	950	1500	1488	1.26	3.2	4.9	4.9	10.0	2.40	23.6	
24B	24B	25+25 LT	0.34	0.04	-	-	0.38	0.50	-	-	-	N/A	N/A	700	1488	1476	1.71	3.6	3.2	3.2	10.0	2.40	0.5	
25A	25A	28+25 RT	0.10	0.91	-	-	1.01	0.90	-	-	-	N/A	N/A	800	1495	1481	1.75	3.6	3.7	3.7	10.0	2.40	2.2	
25B	25B	21+71 RT	0.08	0.74	-	-	0.82	0.90	-	-	-	N/A	N/A	650	1481	1470	1.69	3.6	3.0	3.0	10.0	2.40	1.8	
26A	-	-	29.31	-	-	-	29.31	0.45	-	-	-	N/A	N/A	1500	1560	1534	1.73	3.6	6.9	6.9	-	-	-	Flow does not impact project
26B	-	-	-	-	8.41	8.41	16.82	0.53	-	-	-	N/A	N/A	1000	1534	1512	2.20	4.0	4.2	4.2	-	-	-	Flow does not impact project
26C	-	-	2.26	-	-	5.25	7.51	0.38	-	-	-	N/A	N/A	400	1512	1508	1.00	3.0	2.3	2.3	-	-	-	Flow does not impact project
-	26	42+30 LT	-	-	-	-	53.6	0.47				N/A	N/A	-	-	-	-	-	13.3	13.3	13.3	2.21	55.2	Combined Flow from 26A+26B+26C
28	28	52+75 RT	0.05	0.49	-	-	0.54	0.90	-	-	-	N/A	N/A	430	1471	1469	0.47	2.2	3.2	3.2	10.0	2.40	1.2	
95	N/A	N/A	1.96	-	-	-	1.96	0.45	-	-	-	N/A	N/A	650	1482	1461	3.23	4.6	2.4	2.4	10.0	2.40	2.1	Detention, Flow does not impact project
96	N/A	N/A	7.36	-	-	-	7.36	0.45	-	-	-	N/A	N/A	1000	1482	1461	2.10	3.9	4.3	4.3	10.0	2.40	7.9	Detention, Flow does not impact project
97	N/A	N/A	5.16	-	34.17	-	39.33	0.67	930	1670	1496	18.71	2.87	850	1496	1474	2.59	4.2	3.4	6.2	10.0	2.40	63.2	Detention, Flow does not impact project
			101.46	23.66	60.12	31.20	216.44																	

NOTE:

C-VALUES UTILIZED AS PER THE CITY OF PHOENIX STORM DRAIN DESIGN MANUAL, SUBDIVISION DRAINAGE DESIGN, JULY 1988

RESIDENTIAL AREAS =	0.45
PAVED AREAS =	0.95
MOUNTAIN TERRAIN S>10%=	0.70
UNDEVELOPED DESERT=	0.35

Note: ROW estimated as 90% street, and 10 residential.

FOR GUTTER FLOW CALCULATIONS, ALSO PER THE CITY OF PHX STORM DRAIN DESIGN MANUAL,

Assume manning's coeff n=	0.015	
Assume cross slope Sc=	0.031	ft/ft
Assumed gutter flowrate Q=	3.000	ft^3/sec

APPENDIX A

RATIONAL METHOD CALCULATIONS

By:	Guy Zeigler
Date:	January 18, 1999
Checked:	Mike Salmon
Project No.	11520007

APPENDIX B

Inlet Capacity Summary Sheet

ASL CONSULTING ENGINEERS

Project: Union Hills Drive - 16th Street to Cave Creek Road

City Project #: P-900621

Rainfall Event: 2-year

How if in Sag?

Sub-Basin AREA NO.	INLET ID. NO.	INLET STATION	Q1 RUNOFF FLOW CFS	Q2 FLOWBY REC'D CFS	Q TOTAL FLOW CFS	AVG UPSTREAM GUTTER SLOPE FT/FT	CROSS SLOPE @ INLET FT/FT	INLET TYPE	(1) DEPTH OF WATER FT	MAX (3) DEPTH OF WATER FT	HALF STREET SECTION WIDTH FT	(1) WIDTH OF WATER FT	MAX (2) WIDTH OF WATER FT	(1) GUTTER VELOCITY FT/S	(4) FLOW INTERCEPTED CFS	FLOWBY CFS	TO INLET NO.	COMMENTS
2	2	42+70 RT	1.8	N/A	1.8	0.0060	0.020	M-1, L=3', P1569	0.27	0.27	37.0	12.0	25.0	N/A	1.8	0.0	5	Sag; Flowby causes depth > 0.42'.
4	4	41+20 LT	5.2	N/A	5.2	0.0074	0.027	M-2, L=6', P1569	0.18	0.18	37.0	5.9	25.0	N/A	2.2	3.0	6	Sag; max depth limited by depth of sump.
5	5	38+00 RT	1.2	0.0	1.2	0.0120	0.020	M-1, L=3', P1569	0.18	0.42	37.0	7.3	25.0	2.5	0.6	0.6	7	On Grade;
6	6	34+00 LT	2.2	3.0	5.2	0.0091	0.027	Q, dbl, P1572	0.32	0.42	37.0	11.0	25.0	3.9	3.0	2.2	11B	On Grade;
7	7	33+50 RT	1.2	0.6	1.8	0.0095	0.020	M-1, L=3', P1569	0.20	0.42	37.0	8.9	25.0	2.7	0.8	1.0	8	On Grade;
8	8	28+50 RT	1.6	1.0	2.6	0.0027	0.027	M-1, L=3', P1569	0.24	0.24	37.0	8.1	25.0	N/A	1.9	0.8	N/A	Sag;
11	-	-	57.3															
-	11A	27+03 LT	28.7	N/A	28.7	0.0050	0.013	M-1, L=17', P1569	0.52	0.16	20.0	20.0	8.0	4.1	10.5	18.2	13	On Grade;
-	11B	28+75 LT	28.7	2.2	30.9	0.0029	0.027	M-2, L=17', P1569	0.50	0.42	37.0	35.3	25.0	N/A	25.7	5.2	13	Sag;
12	12	22+85 RT	1.1	N/A	1.1	0.0082	0.020	M-1, L=3', P1569	0.18	0.42	37.0	7.6	25.0	2.2	0.6	0.5	15	On Grade;
13	13	21+04 LT	1.9	28.1	30.0	0.0089	0.020	M-2, L=17', P1569	0.28	0.28	37.0	12.5	25.0	N/A	10.8	19.2	16	Sag; max depth limited by depth of sump.
14	-	-	21.5															
-	14A	20+24 LT	10.8	N/A	10.8	0.0100	0.020	M-1, L=17', P1569	0.37	0.18	18.0	17.2	6.0	4.5	6.1	4.7	15	On Grade;
-	14B	20+60 LT	10.8	N/A	10.8	0.0100	0.020	M-1, L=17', P1569	0.37	0.18	18.0	17.2	6.0	4.5	6.1	4.7	13	On Grade;
15	15	18+73 RT	1.3	0.5	1.8	0.0092	0.016	M-1, L=3', P1569	0.20	0.42	37.0	10.2	25.0	2.4	0.7	1.1	17	On Grade;
16	16	16+05 LT	1.2	23.9	25.1	0.0090	0.020	M-1, L=10', P1569	0.51	0.42	37.0	23.9	25.0	5.5	7.0	18.1	18	On Grade;
17	17	13+16 RT	1.8	1.1	2.9	0.0060	0.024	M-1, L=3', P1569	0.27	0.42	37.0	10.3	25.0	2.8	1.2	1.7	19	On Grade;
18	18	11+20 LT	1.4	18.1	19.5	0.0060	0.020	M-1, L=10', P1569	0.50	0.42	37.0	23.6	25.0	4.4	6.7	12.8	20	On Grade;
19	19	6+16 RT	1.9	1.7	3.6	0.0060	0.020	M-1, L=17', P1569	0.28	0.42	37.0	12.5	25.0	2.8	3.3	0.3	N/A	On Grade; Flowby offsite
20	20	6+16 LT	2.9	12.8	15.7	0.0060	0.020	M-2, L=17', P1569	<0.42	0.42	37.0	<19.5	25.0	N/A	15.7	0.0	N/A	Sag; Q/2 used in Manning's Equation
21	N/A	N/A	11.9															
22	N/A	N/A	4.2															
23A	-	-	5.3															
23B	-	-	2.5															
-	23	52+68 LT	7.8	10.9	18.7	0.0040	0.020	M-2, L=17', P1569	0.42	0.42	37.0	<23.5	25.0	N/A	18.7	0.0	N/A	Sag; Flowby offsite
24A	24A	28+25 LT	23.6	N/A	23.6	0.0195	0.023	M-1, L=13', P1569	0.45	0.42	47.0	18.6	35.0	7.5	7.2	16.4	24B	On Grade;
24B	24B	25+25 LT	0.5	16.4	16.9	0.0195	0.023	M-1, L=13', P1569	0.41	0.42	47.0	16.9	35.0	7.0	6.0	10.9	23	On Grade;
25A	25A	28+25 RT	2.2	N/A	2.2	0.0195	0.022	M-1, L=3', P1569	0.20	0.42	47.0	7.9	35.0	3.7	0.8	1.4	25B	On Grade; Flowby offsite
25B	25B	21+71 RT	1.8	1.4	3.2	0.0195	0.022	M-1, L=17', P1569	0.23	0.42	47.0	9.1	35.0	4.2	2.6	0.6	N/A	On Grade; Flowby offsite
26A	-	-																
26B	-	-																
26C	-	-																
-	26	42+30 LT	55.2															
28	28	52+75 RT	1.2	N/A	1.2	0.0065	0.020	M-1, L=3', P1569	0.19	0.42	47.0	8.2	35.0	2.1	0.7	0.5	N/A	On Grade; Flowby offsite
95	N/A	N/A	2.1															
96	N/A	N/A	7.9															
97	N/A	N/A	63.2															

NOTES: (1) - Based on Manning's calculations; see specific inlet in Appendix C.

(2) - Assume a 12 ft travel lane is required for each half street at maximum flow width [cross slope * (half street width - travel lane width)]
Unless noted otherwise. Does not inlcude any depth created by depressed curb.

(3) - Assume a maximum depth of 5.00 inches = 0.42 ft, based on a 6 inch curb height,
or cross slope times maximum flow width (2) plus the depth of the curb = 0.06 ft, whichever is less.

(4) - Capacities determined by use of a HEC-12 based inlet analysis program, results are included in Appendix C.

APPENDIX B

INLET CAPACITY SUMMARY SHEET

By:	Guy Zeigler
Date:	January 15, 1999
Checked:	Mike Salmon
Project No.	11520007

APPENDIX C

Inlet Capacity Calculations

CATCH BASIN DESIGN

Program Version 1.13 (MSDOS), dated 12/18/96.

Job Number = 11520007.
Job Name = Union Hills Drive - 16th Street to Cave Creek Road.

Description = UNION HILLS DRIVE NORTH CURB.

Definitions and Notes:

A. HEC 12 - Corresponds to "Drainage of Highway Pavements", Hydraulic Engineering Circular No. 12, U.S. Department of Transportation, Federal Highway Administration, March, 1984.

B. ADOT - Corresponds to the "Arizona Department of Transportation".

C. MAG - Corresponds to the "Maricopa Association of Governments".

D. Standard, Other - Corresponds to user input parameters for curb and gutter and catch basins in lieu of ADOT or MAG standard details.

E. All inlet design equations used in this program are based on the assumption that weir flow controls, with the exception of slotted drains in a sag. For slotted drain in a sag, orifice flow has been assumed. It is the users responsibility to determine that these assumptions are valid for the application being processed.

F. Inlet clogging factors default to those listed in ADOT Roadway Design Guidelines, May 1996, Table 606.2.

Union Hills Drive - South Curb

Union Hills Drive - North Curb

Cave Creek Road - East Curb

CATCH BASIN NAME	TOTAL DESIGN DISCHARGE	DESIGN CONDITION	DESIGN TYPE	QUANTITY AND DESCRIPTION	TOTAL FLOW INTERCEPTED (cfs)	TOTAL FLOW NOT INTERCEPTED (cfs)	CARRY OVER SENT TO CATCH BASIN
A-28	1.20	ON-GRADE	Curb Opening	(1) PHX C.B. Type M-1 - Std. Detail P-1569 w/sngl. 3' wing.	0.68	0.52	
A-2	1.80	SAG	Curb Opening	(1) PHX C.B. Type M-1 - Std. Detail P-1569 w/sngl. 3' wing.	1.80	0.00	
A-5	1.20	ON-GRADE	Curb Opening	(1) PHX C.B. Type M-1 - Std. Detail P-1569 w/sngl. 3' wing.	0.60	0.60	
A-7	1.80	ON-GRADE	Curb Opening	(1) PHX C.B. Type M-1 - Std. Detail P-1569 w/sngl. 3' wing.	0.79	1.01	
A-8	2.60	SAG	Curb Opening	(1) PHX C.B. Type M-1 - Std. Detail P-1569 w/sngl. 3' wing.	1.85	0.75	
A-12	1.10	ON-GRADE	Curb Opening	(1) PHX C.B. Type M-1 - Std. Detail P-1569 w/sngl. 3' wing.	0.62	0.48	
A-15	1.80	ON-GRADE	Curb Opening	(1) PHX C.B. Type M-1 - Std. Detail P-1569 w/sngl. 3' wing.	0.72	1.08	
A-17	2.90	ON-GRADE	Curb Opening	(1) PHX C.B. Type M-1 - Std. Detail P-1569 w/sngl. 3' wing.	1.24	1.66	
A-19	3.60	ON-GRADE	Curb Opening	(1) PHX C.B. Type M-1 - Std. Detail P-1569 w/sngl. 17' wing.	3.26	0.34	

CATCH BASIN NAME	TOTAL DESIGN DISCHARGE	DESIGN CONDITION	DESIGN TYPE	QUANTITY AND DESCRIPTION	TOTAL FLOW INTERCEPTED (cfs)	TOTAL FLOW NOT INTERCEPTED (cfs)	CARRY OVER SENT TO CATCH BASIN
A-4	5.20	SAG	Curb Opening	(1) PHX C.B. Type M-1 - Std. Detail P-1569 w/sngl. 10' wing.	2.19	3.01	
A-6	5.20	ON-GRADE	Grate	(2) PHX C.B. Type Q - Std. Detail P-1572 (sngl. dbl. trpl.).	2.96	2.24	
A-11B	30.90	SAG	Curb Opening	(1) PHX C.B. Type M-2 - Std. Detail P-1569 w/dbl. 17' wing.	25.73	5.17	
A-11A	28.70	ON-GRADE	Curb Opening	(1) PHX C.B. Type M-1 - Std. Detail P-1569 w/sngl. 17' wing.	10.51	18.19	
A-14B	10.80	ON-GRADE	Curb Opening	(1) PHX C.B. Type M-1 - Std. Detail P-1569 w/sngl. 17' wing.	6.13	4.67	
A-13	30.00	SAG	Curb Opening	(1) PHX C.B. Type M-2 - Std. Detail P-1569 w/dbl. 17' wing.	10.78	19.22	
A-14A	10.80	ON-GRADE	Curb Opening	(1) PHX C.B. Type M-1 - Std. Detail P-1569 w/sngl. 17' wing.	6.13	4.67	
A-16	25.10	ON-GRADE	Curb Opening	(1) PHX C.B. Type M-1 - Std. Detail P-1569 w/sngl. 10' wing.	7.02	18.08	
A-18	19.50	ON-GRADE	Curb Opening	(1) PHX C.B. Type M-1 - Std. Detail P-1569 w/sngl. 10' wing.	6.74	12.76	
A-20	15.70	SAG	Curb Opening	(1) PHX C.B. Type M-2 - Std. Detail P-1569 w/dbl. 17' wing.	15.70	0.00	

CATCH BASIN NAME	TOTAL DESIGN DISCHARGE	DESIGN CONDITION	DESIGN TYPE	QUANTITY AND DESCRIPTION	TOTAL FLOW INTERCEPTED (cfs)	TOTAL FLOW NOT INTERCEPTED (cfs)	CARRY OVER SENT TO CATCH BASIN
A-24A	23.60	ON-GRADE	Curb Opening	(1) PHX C.B. Type M-1 - Std. Detail P-1569 w/sngl. ~~10'~~ 13' wing.	~~5.97~~ 7.24	~~17.63~~ 16.36	
A-24B	16.90	ON-GRADE	Curb Opening	(1) PHX C.B. Type M-1 - Std. Detail P-1569 w/sngl. ~~10'~~ wing.	~~4.96~~ 5.99	~~11.94~~ 10.91	
A-23	18.70	SAG	Curb Opening	(1) PHX C.B. Type M-2 - Std. Detail P-1569 w/dbl. 17' wing.	18.70	0.00	

CATCH BASIN NAME	TOTAL DESIGN DISCHARGE	DESIGN CONDITION	DESIGN TYPE	QUANTITY AND DESCRIPTION	TOTAL FLOW INTERCEPTED (cfs)	TOTAL FLOW NOT INTERCEPTED (cfs)	CARRY OVER SENT TO CATCH BASIN
A-25A	2.20	ON-GRADE	Curb Opening	(1) PHX C.B. Type M-1 - Std. Detail P-1569 w/sngl. 3' wing.	0.78	1.42	
A-25B	3.20	ON-GRADE	Curb Opening	(1) PHX C.B. Type M-1 - Std. Detail P-1569 w/sngl. 17' wing.	2.57	0.63	

****

CATCH BASIN A-2
****

C102

Union Hills Drive Sta. 42+70 RT

SAG Condition - Curb Opening Only Catch Basin

Design Discharge = 1.80 cfs, Incoming Overflow = 0.00 cfs

Total Design Q = 1.80 cfs

PHX Type A Vert Curb & Gutter H=6 in. - MAG Std Dtl 220.

Curb Height = 0.50 ft., Gutter Width = 1.42 ft. Width
Gutter Drop = 0.71 in. Gutter Depression = 2.00 in.
nSw Gutter Cross Slope = 4.165 %, Gutter C/S w/depn. = 15.931 %
Street Cross Slope = 2.000 %,

KVC
Calc .27'
Given 12'

Ponding Depth At Face Of Curb = 0.27 ft. (control)
Pavement Spread = 11.97 ft. (calculated)

(1) PHX C.B. Type M-1 - Std. Detail P-1569 w/sngl. 3' wing.

Curb Opening Inlet Data :

For Design Flow = 1.80 cfs

KVC
Length of Curb Opening Required For 100 % Int. = 3.79 ft. 3.75

Total Catch Basin Curb Opening Length = 6.00 ft.
Length Of Curb Opening Used In Analysis = 6.00 ft.

Curb Opening Clogging Factor = 1.25
Curb Opening Inlet Capacity = 2.21 cfs
Flow Intercepted By Curb Opening = 1.80 cfs
Carry Over = 0.00 cfs

TOTAL INLET CAPACITY = 2.21 cfs

TOTAL FLOW INTERCEPTED = 1.80 cfs
TOTAL FLOW NOT INTERCEPTED = 0.00 cfs

CATCH BASIN NUMBER FOR CARRY OVER = None

OK.

****

CATCH BASIN A-4
****

Union Hills Drive Sta.
41+10 LT

SAG Condition - Curb Opening Only Catch Basin

Design Discharge = 5.20 cfs, Incoming Overflow = 0.00 cfs

Total Design Q = 5.20 cfs

PHX Type A Vert Curb & Gutter H=6 in. - MAG Std Dtl 220.

Curb Height = 0.50 ft., Gutter Width = 1.42 ft.
Gutter Drop = 0.71 in., Gutter Depression = 2.00 in.
Gutter Cross Slope = 4.165 %, Gutter C/S w/depn. = 15.931 %
Street Cross Slope = 2.700 %,

Ponding Depth At Face Of Curb = 0.18 ft. (control)
Pavement Spread = 5.90 ft. (calculated) Given 5.90
Why not 12'

(1) PHX C.B. Type M-1 - Std. Detail P-1569 w/sngl. 10' wing.

Curb Opening Inlet Data :

For Design Flow = 5.20 cfs

KVL

Length of Curb Opening Required For 100 % Int. = 33.82 ft. 33.77

Total Catch Basin Curb Opening Length = 13.00 ft.
Length Of Curb Opening Used In Analysis = 13.00 ft.

Curb Opening Clogging Factor = 1.25
Curb Opening Inlet Capacity = 2.19 cfs
Flow Intercepted By Curb Opening = 2.19 cfs
Carry Over = 3.01 cfs

TOTAL INLET CAPACITY = 2.19 cfs

TOTAL FLOW INTERCEPTED = 2.19 cfs
TOTAL FLOW NOT INTERCEPTED = 3.01 cfs

CATCH BASIN NUMBER FOR CARRY OVER = None

OK

****

CATCH BASIN A-5
****

Union Hills Drive Sta. 38+00 RT

ON-GRADE Condition - Curb Opening Only Catch Basin

Design Discharge = 1.20 cfs, Incoming Overflow = 0.00 cfs

Total Design Q = 1.20 cfs

PHX Type A Vert Curb & Gutter H=6 in. - MAG Std Dtl 220.

1/2 Street Flow = 1.20 cfs 1.20

Curb Height	= 0.50 ft.,	Gutter Width	= 1.42 ft.
Gutter Drop	= 0.71 in.,	Gutter Depression	= 2.00 in.
Gutter Cross Slope	= 4.165 % ,	Gutter C/S w/depn.	= 15.931 %
Street Cross Slope	= 2.000 % ,	Street Long. Slope	= 1.200 %
Flow Over Gutter	= 0.53 cfs,	Flow Over Pavement	= 0.67 cfs
Velocity - gutter	= 2.53 fps,	Velocity - 1/2 st.	= 2.26 fps
Flow Depth - curb	= 0.18 ft.,	Depth - Lip Gutter	= 0.12 ft.
Pavement Spread	=7.06 7.28 ft.,	Eo (gutter)	= 0.44 50%

(1) PHX C.B. Type M-1 - Std. Detail P-1569 w/sngl. 3' wing.

Curb Opening Inlet Data :

For Design Flow = 1.20 cfs

Length of Curb Opening Required For 100 % Int.	=	18.91 ft. 17.50
Total Catch Basin Curb Opening Length	=	6.00 ft.
Length Of Curb Opening Used In Analysis	=	6.00 ft.
Curb Opening Efficiency, E	=	49.70 %
Curb Opening Clogging Factor	=	1.25
Flow Intercepted By Curb Opening	=	0.60 cfs
Carry Over	=	0.60 cfs

TOTAL FLOW INTERCEPTED = 0.60 cfs
TOTAL FLOW NOT INTERCEPTED = 0.60 cfs

CATCH BASIN NUMBER FOR CARRY OVER = None

nA = .059

****

CATCH BASIN A-6
****

Union Hills Drive Sta.
34+10 LT

ON-GRADE Condition - Grate Only CATCH BASIN

Design Discharge = 5.20 cfs, Incoming Overflow = 0.00 cfs

Total Design Q = 5.20 cfs

PHX Type A Vert Curb & Gutter H=6 in. - MAG Std Dtl 220.

1/2 Street Flow = 5.20 cfs

Curb Height	= 0.50 ft.	Gutter Width	= 1.42 ft.
Gutter Drop	= 0.71 in.	Gutter Depression	= 2.00 in.
Gutter Cross Slope	= 4.165 %	Gutter C/S w/depn.	= 15.931 %
Street Cross Slope	= 2.700 %	Street Long. Slope	= 0.910 %
Flow Over Gutter	= 1.60 cfs	Flow Over Pavement	= 3.05 cfs
Velocity - gutter	= 3.91 fps	Velocity - 1/2 st.	= 3.17 fps
Flow Depth - curb	= 0.32 ft.	Depth - Lip Gutter	= 0.26 ft.
Pavement Spread	= 11.02 ft.	Eo (gutter)	= 0.31

(2) PHX C.B. Type Q - Std. Detail P-1572 (sngl. dbl. trpl.).

Grate Data :

For Design Flow = 5.20 cfs

Grate Width	= 2.00 ft.		
Ind. Grate Length	= 3.33 ft.	Tot. Grate Length	= 6.66 ft.
Flow Over Grate	= 2.15 cfs	Flow Over Pavement	= 3.05 cfs
Velocity - Grate	= 3.73 fps	Depth at Lip Grate	= 0.26 ft.
Depth Grate Bar	= 3.50 in.	Eo (grate)	= 0.4143
Vo (splash-over)	= 14.87 fps	Rf (frontal flow)	= 1.0000
Rs (side flow)	= 0.2637	Grate Int. Eff., E	= 56.87 %
Grate Clogging Factor			= 2.00
Flow Intercepted By Grate			= 2.96 cfs
Carry Over			= 2.24 cfs

TOTAL FLOW INTERCEPTED = 2.96 cfs
TOTAL FLOW NOT INTERCEPTED = 2.24 cfs

CATCH BASIN NUMBER FOR CARRY OVER = None

Type 1 P1565

P1565 T1-2

What is this?

What is the area of grates?

****

CATCH BASIN A-7
****

Union Hills Drive STa.
33+50 RT

ON-GRADE Condition - Curb Opening Only Catch Basin

Design Discharge = 1.80 cfs, Incoming Overflow = 0.00 cfs

Total Design Q = 1.80 cfs

PHX Type A Vert Curb & Gutter H=6 in. - MAG Std Dtl 220. M1L3

1/2 Street Flow = 1.80 cfs

Curb Height	= 0.50 ft.	Gutter Width	= 1.42 ft.
Gutter Drop	= 0.71 in.	Gutter Depression	= 2.00 in.
Gutter Cross Slope	= 4.165 %	Gutter C/S w/depn.	= 15.931 %
Street Cross Slope	= 2.000 %	Street Long. Slope	= 0.950 %
Flow Over Gutter	= 0.67 cfs	Flow Over Pavement	= 1.13 cfs
Velocity - gutter	= 2.65 fps	Velocity - 1/2 st.	= 2.30 fps
Flow Depth - curb	= 0.21 ft.	Depth - Lip Gutter	= 0.15 ft.
Pavement Spread	= 8.86 ft.	Eo (gutter)	= 0.37

(1) PHX C.B. Type M-1 - Std. Detail P-1569 w/sngl. 3' wing.

Curb Opening Inlet Data :

For Design Flow = 1.80 cfs

Length of Curb Opening Required For 100 % Int.	= 21.87 ft.
Total Catch Basin Curb Opening Length	= 6.00 ft.
Length Of Curb Opening Used In Analysis	= 6.00 ft.
Curb Opening Efficiency, E	= 43.86 %
Curb Opening Clogging Factor	= 1.25
Flow Intercepted By Curb Opening	= 0.79 cfs
Carry Over	= 1.01 cfs

TOTAL FLOW INTERCEPTED = 0.79 cfs
TOTAL FLOW NOT INTERCEPTED = 1.01 cfs

CATCH BASIN NUMBER FOR CARRY OVER = None

****

CATCH BASIN A-8
****

Union Hills Drive Sta.
28+50 RT

SAG Condition - Curb Opening Only Catch Basin

Design Discharge = 2.60 cfs, Incoming Overflow = 0.00 cfs

Total Design Q = 2.60 cfs

PHX Type A Vert Curb & Gutter H=6 in. - MAG Std Dtl 220.

Curb Height	= 0.50 ft.,	Gutter Width	= 1.42 ft.
Gutter Drop	= 0.71 in.,	Gutter Depression	= 2.00 in.
Gutter Cross Slope	= 4.165 % ,	Gutter C/S w/depn.	= 15.931 %
Street Cross Slope	= 2.700 % ,		

Ponding Depth At Face Of Curb = 0.24 ft. (control)
Pavement Spread = 8.12 ft. (calculated)

(1) PHX C.B. Type M-1 - Std. Detail P-1569 w/sngl. 3' wing.

Curb Opening Inlet Data :

For Design Flow = 2.60 cfs

Length of Curb Opening Required For 100 % Int. = 8.83 ft.

Total Catch Basin Curb Opening Length = 6.00 ft.
Length Of Curb Opening Used In Analysis = 6.00 ft.

Curb Opening Clogging Factor = 1.25
Curb Opening Inlet Capacity = 1.85 cfs
Flow Intercepted By Curb Opening = 1.85 cfs
Carry Over = 0.75 cfs

TOTAL INLET CAPACITY = 1.85 cfs

TOTAL FLOW INTERCEPTED = 1.85 cfs
TOTAL FLOW NOT INTERCEPTED = 0.75 cfs

CATCH BASIN NUMBER FOR CARRY OVER = None

****

CATCH BASIN A-11A
****

Union Hills Drive Sta.
27+03 LT

ON-GRADE Condition - Curb Opening Only Catch Basin

Design Discharge = 28.70 cfs, Incoming Overflow = 0.00 cfs

Total Design Q = 28.70 cfs

PHX Type A Vert Curb & Gutter H=6 in. - MAG Std Dtl 220.

1/2 Street Flow = 28.70 cfs

Curb Height	= 0.50 ft.	Gutter Width	= 1.42 ft.
Gutter Drop	= 0.71 in.	Gutter Depression	= 2.00 in.
Gutter Cross Slope	= 4.165 %	Gutter C/S w/depn.	= 15.931 %
Street Cross Slope	= 1.300 %	Street Long. Slope	= 0.500 %
Flow Over Gutter	= 2.85 cfs	Flow Over Pavement	= 25.85 cfs
Velocity - gutter	= 4.09 fps	Velocity - 1/2 st.	= 3.24 fps
Flow Depth - curb	= 0.52 ft.	Depth - Lip Gutter	= 0.46 ft.
Pavement Spread	= 36.93 ft.	Eo (gutter)	= 0.10

(1) PHX C.B. Type M-1 - Std. Detail P-1569 w/sngl. 17' wing.

Curb Opening Inlet Data :

For Design Flow = 28.70 cfs

Length of Curb Opening Required For 100 % Int.	= 89.36 ft.
Total Catch Basin Curb Opening Length	= 20.00 ft.
Length Of Curb Opening Used In Analysis	= 20.00 ft.
Curb Opening Efficiency, E	= 36.62 %
Curb Opening Clogging Factor	= 1.25
Flow Intercepted By Curb Opening	= 10.51 cfs
Carry Over	= 18.19 cfs

Warning - Flow depth exceeds curb height !

TOTAL FLOW INTERCEPTED = 10.51 cfs
TOTAL FLOW NOT INTERCEPTED = 18.19 cfs

CATCH BASIN NUMBER FOR CARRY OVER = None

****

CATCH BASIN A-11B
****

Union Hills Drive Sta.
28+50 LT

SAG Condition - Curb Opening Only Catch Basin

Design Discharge = 30.90 cfs, Incoming Overflow = 0.00 cfs

Total Design Q = 30.90 cfs

PHX Type A Vert Curb & Gutter H=6 in. - MAG Std Dtl 220.

Curb Height	= 0.50 ft.,	Gutter Width	= 1.42 ft.
Gutter Drop	= 0.71 in.,	Gutter Depression	= 2.00 in.
Gutter Cross Slope	= 4.165 % ,	Gutter C/S w/depn.	= 15.931 %
Street Cross Slope	= 1.300 % ,		

Ponding Depth At Face Of Curb = 0.50 ft. (control)
Pavement Spread = 35.34 ft. (calculated)

(1) PHX C.B. Type M-2 - Std. Detail P-1569 w/dbl. 17' wing.

Curb Opening Inlet Data :

For Design Flow = 30.90 cfs

Length of Curb Opening Required For 100 % Int. = 44.31 ft.

Total Catch Basin Curb Opening Length = 37.00 ft.
Length Of Curb Opening Used In Analysis = 37.00 ft.

Curb Opening Clogging Factor = 1.25
Curb Opening Inlet Capacity = 25.73 cfs
Flow Intercepted By Curb Opening = 25.73 cfs
Carry Over = 5.17 cfs

TOTAL INLET CAPACITY = 25.73 cfs

TOTAL FLOW INTERCEPTED = 25.73 cfs
TOTAL FLOW NOT INTERCEPTED = 5.17 cfs

CATCH BASIN NUMBER FOR CARRY OVER = None

****

CATCH BASIN A-12
****

Union Hills Drive Sta.
22+85 RT

ON-GRADE Condition - Curb Opening Only Catch Basin

Design Discharge = 1.10 cfs, Incoming Overflow = 0.00 cfs

Total Design Q = 1.10 cfs

PHX Type A Vert Curb & Gutter H=6 in. - MAG Std Dtl 220.

1/2 Street Flow = 1.10 cfs

Curb Height	= 0.50 ft.,	Gutter Width	= 1.42 ft.
Gutter Drop	= 0.71 in.,	Gutter Depression	= 2.00 in.
Gutter Cross Slope	= 4.165 % ,	Gutter C/S w/depn.	= 15.931 %
Street Cross Slope	= 2.000 % ,	Street Long. Slope	= 0.820 %
Flow Over Gutter	= 0.47 cfs,	Flow Over Pavement	= 0.63 cfs
Velocity - gutter	= 2.16 fps,	Velocity - 1/2 st.	= 1.92 fps
Flow Depth - curb	= 0.18 ft.,	Depth - Lip Gutter	= 0.12 ft.
Pavement Spread	= 7.57 ft.,	Eo (gutter)	= 0.42

(1) PHX C.B. Type M-1 - Std. Detail P-1569 w/sngl. 3' wing.

Curb Opening Inlet Data :

For Design Flow = 1.10 cfs

Length of Curb Opening Required For 100 % Int.	= 16.41 ft.
Total Catch Basin Curb Opening Length	= 6.00 ft.
Length Of Curb Opening Used In Analysis	= 6.00 ft.
Curb Opening Efficiency, E	= 55.92 %
Curb Opening Clogging Factor	= 1.25
Flow Intercepted By Curb Opening	= 0.62 cfs
Carry Over	= 0.48 cfs

TOTAL FLOW INTERCEPTED = 0.62 cfs
TOTAL FLOW NOT INTERCEPTED = 0.48 cfs

CATCH BASIN NUMBER FOR CARRY OVER = None

****

CATCH BASIN A-14B
****

Union Hills Drive Sta.
20+60 LT

ON-GRADE Condition - Curb Opening Only Catch Basin

Design Discharge = 10.80 cfs, Incoming Overflow = 0.00 cfs

Total Design Q = 10.80 cfs

PHX Type A Vert Curb & Gutter H=6 in. - MAG Std Dtl 220.

1/2 Street Flow = 10.80 cfs

Curb Height	= 0.50 ft.	Gutter Width	= 1.42 ft.
Gutter Drop	= 0.71 in.	Gutter Depression	= 2.00 in.
Gutter Cross Slope	= 4.165 %	Gutter C/S w/depn.	= 15.931 %
Street Cross Slope	= 2.000 %	Street Long. Slope	= 1.000 %
Flow Over Gutter	= 2.22 cfs	Flow Over Pavement	= 8.58 cfs
Velocity - gutter	= 4.54 fps	Velocity - 1/2 st.	= 3.66 fps
Flow Depth - curb	= 0.37 ft.	Depth - Lip Gutter	= 0.32 ft.
Pavement Spread	= 17.17 ft.	Eo (gutter)	= 0.21

(1) PHX C.B. Type M-1 - Std. Detail P-1569 w/sngl. 17' wing.

Curb Opening Inlet Data :

For Design Flow = 10.80 cfs

Length of Curb Opening Required For 100 % Int.	= 53.71 ft.
Total Catch Basin Curb Opening Length	= 20.00 ft.
Length Of Curb Opening Used In Analysis	= 20.00 ft.
Curb Opening Efficiency, E	= 56.76 %
Curb Opening Clogging Factor	= 1.25
Flow Intercepted By Curb Opening	= 6.13 cfs
Carry Over	= 4.67 cfs

TOTAL FLOW INTERCEPTED = 6.13 cfs
TOTAL FLOW NOT INTERCEPTED = 4.67 cfs

CATCH BASIN NUMBER FOR CARRY OVER = None

****

CATCH BASIN A-13
****

Union Hills Drive Sta.
20+80 LT

SAG Condition - Curb Opening Only Catch Basin

Design Discharge = 30.00 cfs, Incoming Overflow = 0.00 cfs

Total Design Q = 30.00 cfs

PHX Type A Vert Curb & Gutter H=6 in. - MAG Std Dtl 220.

Curb Height	= 0.50 ft.,	Gutter Width	= 1.42 ft.
Gutter Drop	= 0.71 in.,	Gutter Depression	= 2.00 in.
Gutter Cross Slope	= 4.165 % ,	Gutter C/S w/depn.	= 15.931 %
Street Cross Slope	= 2.000 % ,		

Ponding Depth At Face Of Curb = 0.28 ft. (control)
Pavement Spread = 12.47 ft. (calculated)

(1) PHX C.B. Type M-2 - Std. Detail P-1569 w/dbl. 17' wing.

Curb Opening Inlet Data :

For Design Flow = 30.00 cfs

Length of Curb Opening Required For 100 % Int. = 106.86 ft.

Total Catch Basin Curb Opening Length = 37.00 ft.
Length Of Curb Opening Used In Analysis = 37.00 ft.

Curb Opening Clogging Factor = 1.25
Curb Opening Inlet Capacity = 10.78 cfs
Flow Intercepted By Curb Opening = 10.78 cfs
Carry Over = 19.22 cfs

TOTAL INLET CAPACITY = 10.78 cfs

TOTAL FLOW INTERCEPTED = 10.78 cfs
TOTAL FLOW NOT INTERCEPTED = 19.22 cfs

CATCH BASIN NUMBER FOR CARRY OVER = None

****

CATCH BASIN A-14A
****

Union Hills Drive Sta.
20+24 LT

ON-GRADE Condition - Curb Opening Only Catch Basin

Design Discharge = 10.80 cfs, Incoming Overflow = 0.00 cfs

Total Design Q = 10.80 cfs

PHX Type A Vert Curb & Gutter H=6 in. - MAG Std Dtl 220.

1/2 Street Flow = 10.80 cfs

Curb Height	= 0.50 ft.	Gutter Width	= 1.42 ft.
Gutter Drop	= 0.71 in.	Gutter Depression	= 2.00 in.
Gutter Cross Slope	= 4.165 %	Gutter C/S w/depn.	= 15.931 %
Street Cross Slope	= 2.000 %	Street Long. Slope	= 1.000 %
Flow Over Gutter	= 2.22 cfs	Flow Over Pavement	= 8.58 cfs
Velocity - gutter	= 4.54 fps	Velocity - 1/2 st.	= 3.66 fps
Flow Depth - curb	= 0.37 ft.	Depth - Lip Gutter	= 0.32 ft.
Pavement Spread	= 17.17 ft.	Eo (gutter)	= 0.21

(1) PHX C.B. Type M-1 - Std. Detail P-1569 w/sngl. 17' wing.

Curb Opening Inlet Data :

For Design Flow = 10.80 cfs

Length of Curb Opening Required For 100 % Int.	= 53.71 ft.
Total Catch Basin Curb Opening Length	= 20.00 ft.
Length Of Curb Opening Used In Analysis	= 20.00 ft.
Curb Opening Efficiency, E	= 56.76 %
Curb Opening Clogging Factor	= 1.25
Flow Intercepted By Curb Opening	= 6.13 cfs
Carry Over	= 4.67 cfs

TOTAL FLOW INTERCEPTED = 6.13 cfs
TOTAL FLOW NOT INTERCEPTED = 4.67 cfs

CATCH BASIN NUMBER FOR CARRY OVER = None

****

CATCH BASIN A-16
****

Union Hills Drive Sta.
16+05 LT

ON-GRADE Condition - Curb Opening Only Catch Basin

Design Discharge = 25.10 cfs, Incoming Overflow = 0.00 cfs

Total Design Q = 25.10 cfs

PHX Type A Vert Curb & Gutter H=6 in. - MAG Std Dtl 220.

1/2 Street Flow = 25.10 cfs

Curb Height	= 0.50 ft.	Gutter Width	= 1.42 ft.
Gutter Drop	= 0.71 in.	Gutter Depression	= 2.00 in.
Gutter Cross Slope	= 4.165 %	Gutter C/S w/depn.	= 15.931 %
Street Cross Slope	= 2.000 %	Street Long. Slope	= 0.900 %
Flow Over Gutter	= 3.76 cfs	Flow Over Pavement	= 21.34 cfs
Velocity - gutter	= 5.51 fps	Velocity - 1/2 st.	= 4.35 fps
Flow Depth - curb	= 0.51 ft.	Depth - Lip Gutter	= 0.45 ft.
Pavement Spread	= 24.03 ft.	Eo (gutter)	= 0.15

(1) PHX C.B. Type M-1 - Std. Detail P-1569 w/sngl. 10' wing.

Curb Opening Inlet Data :

For Design Flow = 25.10 cfs

Length of Curb Opening Required For 100 % Int.	= 78.02 ft.
Total Catch Basin Curb Opening Length	= 13.00 ft.
Length Of Curb Opening Used In Analysis	= 13.00 ft.
Curb Opening Efficiency, E	= 27.97 %
Curb Opening Clogging Factor	= 1.25
Flow Intercepted By Curb Opening	= 7.02 cfs
Carry Over	= 18.08 cfs

Warning - Flow depth exceeds curb height !

TOTAL FLOW INTERCEPTED = 7.02 cfs
TOTAL FLOW NOT INTERCEPTED = 18.08 cfs

CATCH BASIN NUMBER FOR CARRY OVER = None

****

CATCH BASIN A-18
****

Union Hills Drive Sta.
11+20 LT

ON-GRADE Condition - Curb Opening Only Catch Basin

Design Discharge = 19.50 cfs, Incoming Overflow = 0.00 cfs

Total Design Q = 19.50 cfs

PHX Type A Vert Curb & Gutter H=6 in. - MAG Std Dtl 220.

1/2 Street Flow = 19.50 cfs

Curb Height	= 0.50 ft.	Gutter Width	= 1.42 ft.
Gutter Drop	= 0.71 in.	Gutter Depression	= 2.00 in.
Gutter Cross Slope	= 4.165 %	Gutter C/S w/depn.	= 15.931 %
Street Cross Slope	= 2.000 %	Street Long. Slope	= 0.600 %
Flow Over Gutter	= 2.97 cfs	Flow Over Pavement	= 16.53 cfs
Velocity - gutter	= 4.44 fps	Velocity - 1/2 st.	= 3.50 fps
Flow Depth - curb	= 0.50 ft.	Depth - Lip Gutter	= 0.44 ft.
Pavement Spread	= 23.59 ft.	Eo (gutter)	= 0.15

(1) PHX C.B. Type M-1 - Std. Detail P-1569 w/sngl. 10' wing.

Curb Opening Inlet Data :

For Design Flow = 19.50 cfs

Length of Curb Opening Required For 100 % Int.	= 61.97 ft.
Total Catch Basin Curb Opening Length	= 13.00 ft.
Length Of Curb Opening Used In Analysis	= 13.00 ft.
Curb Opening Efficiency, E	= 34.54 %
Curb Opening Clogging Factor	= 1.25
Flow Intercepted By Curb Opening	= 6.74 cfs
Carry Over	= 12.76 cfs

Warning - Flow depth exceeds curb height !

TOTAL FLOW INTERCEPTED = 6.74 cfs
TOTAL FLOW NOT INTERCEPTED = 12.76 cfs

CATCH BASIN NUMBER FOR CARRY OVER = None

****

CATCH BASIN A-15
****

Union Hills Drive Sta.
18+73 RT

ON-GRADE Condition - Curb Opening Only Catch Basin

Design Discharge = 1.80 cfs, Incoming Overflow = 0.00 cfs

Total Design Q = 1.80 cfs

PHX Type A Vert Curb & Gutter H=6 in. - MAG Std Dtl 220.

1/2 Street Flow = 1.80 cfs

Curb Height	= 0.50 ft.	Gutter Width	= 1.42 ft.
Gutter Drop	= 0.71 in.	Gutter Depression	= 2.00 in.
Gutter Cross Slope	= 4.165 %	Gutter C/S w/depn.	= 15.931 %
Street Cross Slope	= 1.600 %	Street Long. Slope	= 0.920 %
Flow Over Gutter	= 0.59 cfs	Flow Over Pavement	= 1.21 cfs
Velocity - gutter	= 2.44 fps	Velocity - 1/2 st.	= 2.14 fps
Flow Depth - curb	= 0.20 ft.	Depth - Lip Gutter	= 0.14 ft.
Pavement Spread	= 10.24 ft.	Eo (gutter)	= 0.33

(1) PHX C.B. Type M-1 - Std. Detail P-1569 w/sngl. 3' wing.

Curb Opening Inlet Data :

For Design Flow = 1.80 cfs

Length of Curb Opening Required For 100 % Int.	= 24.12 ft.
Total Catch Basin Curb Opening Length	= 6.00 ft.
Length Of Curb Opening Used In Analysis	= 6.00 ft.
Curb Opening Efficiency, E	= 40.23 %
Curb Opening Clogging Factor	= 1.25
Flow Intercepted By Curb Opening	= 0.72 cfs
Carry Over	= 1.08 cfs

TOTAL FLOW INTERCEPTED = 0.72 cfs
TOTAL FLOW NOT INTERCEPTED = 1.08 cfs

CATCH BASIN NUMBER FOR CARRY OVER = None

****

CATCH BASIN A-17
****

Union Hills Drive Sta.
13+16 RT

ON-GRADE Condition - Curb Opening Only Catch Basin

Design Discharge = 2.90 cfs, Incoming Overflow = 0.00 cfs

Total Design Q = 2.90 cfs

PHX Type A Vert Curb & Gutter H=6 in. - MAG Std Dtl 220.

1/2 Street Flow = 2.90 cfs

Curb Height	= 0.50 ft.	Gutter Width	= 1.42 ft.
Gutter Drop	= 0.71 in.	Gutter Depression	= 2.00 in.
Gutter Cross Slope	= 4.165 %	Gutter C/S w/depn.	= 15.931 %
Street Cross Slope	= 2.400 %	Street Long. Slope	= 0.600 %
Flow Over Gutter	= 0.95 cfs	Flow Over Pavement	= 1.95 cfs
Velocity - gutter	= 2.75 fps	Velocity - 1/2 st.	= 2.28 fps
Flow Depth - curb	= 0.27 ft.	Depth - Lip Gutter	= 0.21 ft.
Pavement Spread	= 10.30 ft.	Eo (gutter)	= 0.33

(1) PHX C.B. Type M-1 - Std. Detail P-1569 w/sngl. 3' wing.

Curb Opening Inlet Data :

For Design Flow = 2.90 cfs

Length of Curb Opening Required For 100 % Int.	= 22.49 ft.
Total Catch Basin Curb Opening Length	= 6.00 ft.
Length Of Curb Opening Used In Analysis	= 6.00 ft.
Curb Opening Efficiency, E	= 42.80 %
Curb Opening Clogging Factor	= 1.25
Flow Intercepted By Curb Opening	= 1.24 cfs
Carry Over	= 1.66 cfs

TOTAL FLOW INTERCEPTED = 1.24 cfs
TOTAL FLOW NOT INTERCEPTED = 1.66 cfs

CATCH BASIN NUMBER FOR CARRY OVER = None

****

CATCH BASIN A-19
****

Union Hills Drive Sta.
6+16 RT

ON-GRADE Condition - Curb Opening Only Catch Basin

Design Discharge = 3.60 cfs, Incoming Overflow = 0.00 cfs

Total Design Q = 3.60 cfs

PHX Type A Vert Curb & Gutter H=6 in. - MAG Std Dtl 220.

1/2 Street Flow = 3.60 cfs

Curb Height	= 0.50 ft.	Gutter Width	= 1.42 ft.
Gutter Drop	= 0.71 in.	Gutter Depression	= 2.00 in.
Gutter Cross Slope	= 4.165 %	Gutter C/S w/depn.	= 15.931 %
Street Cross Slope	= 2.000 %	Street Long. Slope	= 0.600 %
Flow Over Gutter	= 0.99 cfs	Flow Over Pavement	= 2.61 cfs
Velocity - gutter	= 2.77 fps	Velocity - 1/2 st.	= 2.30 fps
Flow Depth - curb	= 0.28 ft.	Depth - Lip Gutter	= 0.22 ft.
Pavement Spread	= 12.52 ft.	Eo (gutter)	= 0.27

(1) PHX C.B. Type M-1 - Std. Detail P-1569 w/sngl. 17' wing.

Curb Opening Inlet Data :

For Design Flow = 3.60 cfs

Length of Curb Opening Required For 100 % Int.	= 27.42 ft.
Total Catch Basin Curb Opening Length	= 20.00 ft.
Length Of Curb Opening Used In Analysis	= 20.00 ft.
Curb Opening Efficiency, E	= 90.48 %
Curb Opening Clogging Factor	= 1.25
Flow Intercepted By Curb Opening	= 3.26 cfs
Carry Over	= 0.34 cfs

TOTAL FLOW INTERCEPTED = 3.26 cfs
TOTAL FLOW NOT INTERCEPTED = 0.34 cfs

CATCH BASIN NUMBER FOR CARRY OVER = None

****

CATCH BASIN A-20
****

Union Hills Drive Sta.
6+16 LT

SAG Condition - Curb Opening Only Catch Basin

Design Discharge = 15.70 cfs, Incoming Overflow = 0.00 cfs

Total Design Q = 15.70 cfs

PHX Type A Vert Curb & Gutter H=6 in. - MAG Std Dtl 220.

Curb Height	= 0.50 ft.,	Gutter Width	= 1.42 ft.
Gutter Drop	= 0.71 in.,	Gutter Depression	= 2.00 in.
Gutter Cross Slope	= 4.165 % ,	Gutter C/S w/depn.	= 15.931 %
Street Cross Slope	= 2.000 % ,		

Ponding Depth At Face Of Curb = 0.42 ft. (control)
Pavement Spread = 19.47 ft. (calculated)

(1) PHX C.B. Type M-2 - Std. Detail P-1569 w/dbl. 17' wing.

Curb Opening Inlet Data :

For Design Flow = 15.70 cfs

Length of Curb Opening Required For 100 % Int. = 28.16 ft.

Total Catch Basin Curb Opening Length = 37.00 ft.
Length Of Curb Opening Used In Analysis = 37.00 ft.

Curb Opening Clogging Factor = 1.25
Curb Opening Inlet Capacity = 19.81 cfs
Flow Intercepted By Curb Opening = 15.70 cfs
Carry Over = 0.00 cfs

TOTAL INLET CAPACITY = 19.81 cfs

TOTAL FLOW INTERCEPTED = 15.70 cfs
TOTAL FLOW NOT INTERCEPTED = 0.00 cfs

CATCH BASIN NUMBER FOR CARRY OVER = None

****

CATCH BASIN A-23
****

Union Hills Drive
52+68 LT

SAG Condition - Curb Opening Only Catch Basin

Design Discharge = 18.70 cfs, Incoming Overflow = 0.00 cfs

Total Design Q = 18.70 cfs

PHX Type A Vert Curb & Gutter H=6 in. - MAG Std Dtl 220.

Curb Height	= 0.50 ft.,	Gutter Width	= 1.42 ft.
Gutter Drop	= 0.71 in.,	Gutter Depression	= 2.00 in.
Gutter Cross Slope	= 4.165 % ,	Gutter C/S w/depn.	= 15.931 %
Street Cross Slope	= 2.000 % ,		

Ponding Depth At Face Of Curb = 0.42 ft. (control)
Pavement Spread = 19.47 ft. (calculated)

(1) PHX C.B. Type M-2 - Std. Detail P-1569 w/dbl. 17' wing.

Curb Opening Inlet Data :

For Design Flow = 18.70 cfs

Length of Curb Opening Required For 100 % Int. = 34.15 ft.

Total Catch Basin Curb Opening Length = 37.00 ft.
Length Of Curb Opening Used In Analysis = 37.00 ft.

Curb Opening Clogging Factor = 1.25
Curb Opening Inlet Capacity = 19.81 cfs
Flow Intercepted By Curb Opening = 18.70 cfs
Carry Over = 0.00 cfs

TOTAL INLET CAPACITY = 19.81 cfs

TOTAL FLOW INTERCEPTED = 18.70 cfs
TOTAL FLOW NOT INTERCEPTED = 0.00 cfs

CATCH BASIN NUMBER FOR CARRY OVER = None

****

CATCH BASIN A-24A
****

Cave Creek Road
Sta. 28+25 LT

ON-GRADE Condition - Curb Opening Only Catch Basin

Design Discharge = 23.60 cfs, Incoming Overflow = 0.00 cfs

Total Design Q = 23.60 cfs

PHX Type A Vert Curb & Gutter H=6 in. - MAG Std Dtl 220.

1/2 Street Flow = 23.60 cfs

Curb Height	= 0.50 ft.	Gutter Width	= 1.42 ft.
Gutter Drop	= 0.71 in.	Gutter Depression	= 2.00 in.
Gutter Cross Slope	= 4.165 %	Gutter C/S w/depn.	= 15.931 %
Street Cross Slope	= 2.300 %	Street Long. Slope	= 1.950 %
Flow Over Gutter	= 4.50 cfs	Flow Over Pavement	= 19.10 cfs
Velocity - gutter	= 7.47 fps	Velocity - 1/2 st.	= 5.92 fps
Flow Depth - curb	= 0.45 ft.	Depth - Lip Gutter	= 0.40 ft.
Pavement Spread	= 18.61 ft.	Eo (gutter)	= 0.19

(1) PHX C.B. Type M-1 - Std. Detail P-1569 w/sngl. ~~10'~~ 13' wing.

Curb Opening Inlet Data :

For Design Flow = 23.60 cfs

Length of Curb Opening Required For 100 % Int. = 86.85 ft.

Total Catch Basin Curb Opening Length	16.00ft =	~~13.00~~ ft.
Length Of Curb Opening Used In Analysis	16.00ft =	~~13.00~~ ft.
Curb Opening Efficiency, E	30.69% =	~~25.31~~ %
Curb Opening Clogging Factor	=	1.25
Flow Intercepted By Curb Opening	7.24cfs =	~~5.97~~ cfs
Carry Over	16.36cfs =	~~17.63~~ cfs

TOTAL FLOW INTERCEPTED 7.24cfs = ~~5.97~~ cfs
TOTAL FLOW NOT INTERCEPTED 16.36cfs = ~~17.63~~ cfs

CATCH BASIN NUMBER FOR CARRY OVER = None

****

CATCH BASIN A-24B
****

Cave Creek Road
25+25 LT

ON-GRADE Condition - Curb Opening Only Catch Basin

Design Discharge = 16.90 cfs, Incoming Overflow = 0.00 cfs

Total Design Q = 16.90 cfs

PHX Type A Vert Curb & Gutter H=6 in. - MAG Std Dtl 220.

1/2 Street Flow = 16.90 cfs

Curb Height	= 0.50 ft.,	Gutter Width	= 1.42 ft.
Gutter Drop	= 0.71 in.,	Gutter Depression	= 2.00 in.
Gutter Cross Slope	= 4.165 % ,	Gutter C/S w/depn.	= 15.931 %
Street Cross Slope	= 2.300 % ,	Street Long. Slope	= 1.950 %
Flow Over Gutter	= 3.62 cfs,	Flow Over Pavement	= 13.28 cfs
Velocity - gutter	= 6.82 fps,	Velocity - 1/2 st.	= 5.45 fps
Flow Depth - curb	= 0.40 ft.,	Depth - Lip Gutter	= 0.35 ft.
Pavement Spread	= 16.42 ft.,	Eo (gutter)	= 0.21

(1) PHX C.B. Type M-1 - Std. Detail P-1569 w/sngl. ~~10'~~ 13' wing.

Curb Opening Inlet Data :

For Design Flow = 16.90 cfs

Length of Curb Opening Required For 100 % Int. = 74.09 ft.

Total Catch Basin Curb Opening Length	16.00ft =	~~13.00~~ ft.
Length Of Curb Opening Used In Analysis	16.00ft =	~~13.00~~ ft.
Curb Opening Efficiency, E	35.46% =	~~29.34~~ %
Curb Opening Clogging Factor	=	1.25
Flow Intercepted By Curb Opening	5.99cfs =	~~4.96~~ cfs
Carry Over	10.91cfs =	~~11.94~~ cfs

TOTAL FLOW INTERCEPTED 5.99cfs = ~~4.96~~ cfs
TOTAL FLOW NOT INTERCEPTED 10.91cfs = ~~11.94~~ cfs

CATCH BASIN NUMBER FOR CARRY OVER = None

****

CATCH BASIN A-25A
****

Cave Creek Road
Sta. 28+25 RT

ON-GRADE Condition - Curb Opening Only Catch Basin

Design Discharge = 2.20 cfs, Incoming Overflow = 0.00 cfs

Total Design Q = 2.20 cfs

PHX Type A Vert Curb & Gutter H=6 in. - MAG Std Dtl 220.

1/2 Street Flow = 2.20 cfs

Curb Height	= 0.50 ft.	Gutter Width	= 1.42 ft.
Gutter Drop	= 0.71 in.	Gutter Depression	= 2.00 in.
Gutter Cross Slope	= 4.165 %	Gutter C/S w/depn.	= 15.931 %
Street Cross Slope	= 2.200 %	Street Long. Slope	= 1.950 %
Flow Over Gutter	= 0.91 cfs	Flow Over Pavement	= 1.29 cfs
Velocity - gutter	= 3.73 fps	Velocity - 1/2 st.	= 3.24 fps
Flow Depth - curb	= 0.20 ft.	Depth - Lip Gutter	= 0.14 ft.
Pavement Spread	= 7.86 ft.	Eo (gutter)	= 0.41

(1) PHX C.B. Type M-1 - Std. Detail P-1569 w/sngl. 3' wing.

Curb Opening Inlet Data :

For Design Flow = 2.20 cfs

Length of Curb Opening Required For 100 % Int.	= 27.84 ft.
Total Catch Basin Curb Opening Length	= 6.00 ft.
Length Of Curb Opening Used In Analysis	= 6.00 ft.
Curb Opening Efficiency, E	= 35.40 %
Curb Opening Clogging Factor	= 1.25
Flow Intercepted By Curb Opening	= 0.78 cfs
Carry Over	= 1.42 cfs

TOTAL FLOW INTERCEPTED = 0.78 cfs
TOTAL FLOW NOT INTERCEPTED = 1.42 cfs

CATCH BASIN NUMBER FOR CARRY OVER = None

****

CATCH BASIN A-25B
****

Cave Creek Road
Sta. 21+71 RT

ON-GRADE Condition - Curb Opening Only Catch Basin

Design Discharge = 3.20 cfs, Incoming Overflow = 0.00 cfs

Total Design Q = 3.20 cfs

PHX Type A Vert Curb & Gutter H=6 in. - MAG Std Dtl 220.

1/2 Street Flow = 3.20 cfs

Curb Height	= 0.50 ft.	Gutter Width	= 1.42 ft.
Gutter Drop	= 0.71 in.	Gutter Depression	= 2.00 in.
Gutter Cross Slope	= 4.165 %	Gutter C/S w/depn.	= 15.931 %
Street Cross Slope	= 2.200 %	Street Long. Slope	= 1.950 %
Flow Over Gutter	= 1.17 cfs	Flow Over Pavement	= 2.03 cfs
Velocity - gutter	= 4.18 fps	Velocity - 1/2 st.	= 3.55 fps
Flow Depth - curb	= 0.23 ft.	Depth - Lip Gutter	= 0.17 ft.
Pavement Spread	= 9.05 ft.	Eo (gutter)	= 0.37

(1) PHX C.B. Type M-1 - Std. Detail P-1569 w/sngl. 17' wing.

Curb Opening Inlet Data :

For Design Flow = 3.20 cfs

Length of Curb Opening Required For 100 % Int.	= 33.58 ft.
Total Catch Basin Curb Opening Length	= 20.00 ft.
Length Of Curb Opening Used In Analysis	= 20.00 ft.
Curb Opening Efficiency, E	= 80.39 %
Curb Opening Clogging Factor	= 1.25
Flow Intercepted By Curb Opening	= 2.57 cfs
Carry Over	= 0.63 cfs

TOTAL FLOW INTERCEPTED = 2.57 cfs
TOTAL FLOW NOT INTERCEPTED = 0.63 cfs

CATCH BASIN NUMBER FOR CARRY OVER = None

****

CATCH BASIN A-28
****

Union Hills Drive Sta. 52+75 RT

ON-GRADE Condition - Curb Opening Only Catch Basin

Design Discharge = 1.20 cfs, Incoming Overflow = 0.00 cfs

Total Design Q = 1.20 cfs

PHX Type A Vert Curb & Gutter H=6 in. - MAG Std Dtl 220.

1/2 Street Flow = 1.20 cfs

Curb Height	= 0.50 ft.	Gutter Width	= 1.42 ft.
Gutter Drop	= 0.71 in.	Gutter Depression	= 2.00 in.
Gutter Cross Slope	= 4.165 %	Gutter C/S w/depn.	= 15.931 %
Street Cross Slope	= 2.000 %	Street Long. Slope	= 0.650 %
Flow Over Gutter	= 0.48 cfs	Flow Over Pavement	= 0.72 cfs
Velocity - gutter	= 2.05 fps	Velocity - 1/2 st.	= 1.80 fps
Flow Depth - curb	= 0.19 ft.	Depth - Lip Gutter	= 0.14 ft.
Pavement Spread	= 8.17 ft.	Eo (gutter)	= 0.40

(1) PHX C.B. Type M-1 - Std. Detail P-1569 w/sngl. 3' wing.

Curb Opening Inlet Data :

For Design Flow = 1.20 cfs

Length of Curb Opening Required For 100 % Int.	= 16.16 ft.
Total Catch Basin Curb Opening Length	= 6.00 ft.
Length Of Curb Opening Used In Analysis	= 6.00 ft.
Curb Opening Efficiency, E	= 56.63 %
Curb Opening Clogging Factor	= 1.25
Flow Intercepted By Curb Opening	= 0.68 cfs
Carry Over	= 0.52 cfs

TOTAL FLOW INTERCEPTED = 0.68 cfs
TOTAL FLOW NOT INTERCEPTED = 0.52 cfs

CATCH BASIN NUMBER FOR CARRY OVER = None

APPENDIX D

Storm Drain Calculations

ASL CONSULTING ENGINEERS
Union Hills Drive - 16th Street to Cave Creek Road

City Project #: P-900621
Rainfall Event: 2-year

AREA NO.	UPSTREAM STORM DRAIN STATION	DOWNSTREAM STORM DRAIN STATION	A TOTAL ACRES	C WEIGHTED C-VALUE	Tc DESIGN Tmin=10 MIN.	I RAINFALL INTENSITY IN/HR	Q PEAK FLOW CFS	SLOPE FT/FT	DEPTH FLOW FT	SIZE PIPE IN	VELOCITY FT/S	LENGTH PIPE RUN FT	TIME INCR. DELTA T MIN	HGL SLOPE FT/FT	PIPE CROWN ELEV FT	UPSTREAM HGL ELEV FT	AMOUNT SURCHARGE FT	COMMENTS
24A			20.07	0.49														
25A	Cave Creek Road		1.01	0.90														
	2825	2525	21.08	0.51	10.0	2.40	25.8	0.0182	1.4	30	9.5	300	0.5	0.0182	1475.08	1474.08	-1.00	030005
24B			0.38	0.50														
25B			0.82	0.90														
	2525	2096	22.28	0.52	10.5	2.57	30.0	0.0182	1.5	30	6.9	429	1.0	0.0182	1469.62	1468.62	-1.00	030010
23A			4.92	0.45														
23B			1.14	0.90														
28	Union Hills Drive		0.54	0.90														
	5268	5365	6.60	0.56	10.0	2.40	21.9	0.0010	*	30	4.1	97	0.4	0.0036	1462.52	1464.80	2.28	Use Q=19.9; Inlet 23 + Subbasin 28
	5365	5712	28.88	0.53	10.4	2.59	39.9	0.0010	*	48	3.1	347	1.9	0.0011	1464.07	1464.45	0.38	
	5712	-														1464.07		Assume HGL=Pipe Crown
2	Union Hills Drive		0.84 ✓	0.90														
	4270	4120 150'	0.84 ✓	0.90	10.0	2.40	1.8 2.8	0.0072	*	18	1.0	3530150	2.5	0.0004	1460.35	1461.34	0.99	010005
4			2.39 –	0.90														
5			0.55 –	0.90														
	4120	3755	3.78	0.90	12.5	2.30	7.8 11.0	0.0055	*	18	4.4	3780365	1.4	0.0084	1459.27	1461.28	2.01	010010
	3755	3435	3.78	0.90	13.9	2.15	7.3 10.9	0.0087	*	18	4.4	3415320	1.2	0.0084	1457.26	1458.21	0.95	010015
6			1.01	0.90														
7			0.57	0.90														
	3435	3115	5.36	0.90	15.1	2.03	9.8 14.3	0.0087	*	24	3.1	3045320	1.7	0.0028	1454.47	1455.53	1.06	010020
	3115	2875	5.36	0.90	16.8	1.90	9.2 13.4	0.0091	*	24	3.1	2775240	1.3	0.0028	1451.69	1454.63	2.94	010025
8			0.76	0.90														
11			45.08	0.53														
	2875	2440	51.20	0.57	18.1	1.81	53.2 88.3	0.0075	*	36	7.7	435	0.9	0.0102	1449.51	1453.96	4.45	010030
12			0.49	0.90														
	2440	2104	51.69	0.58	19.0	1.75	52.2 86.2	0.0075	*	36	7.7	336	0.7	0.0102	1446.25	1449.52	3.27	010035
13			0.89	0.90														
14			18.70	0.48														
15			0.60	0.90														
	2104	1605	71.88	0.56	19.8	1.71	68.7 114.4	0.0064	*	42	7.3	499	1.1	0.0074	1443.70	1446.09	2.39	010040
16			0.57	0.90														
17			0.83	0.90														
	1605	1120	73.28	0.57	20.9	1.65	68.3 109.0	0.0064	*	42	7.3	485	1.1	0.0074	1440.53	1442.40	1.87	010045
18			0.67	0.90														
	1120	640	73.95	0.57	22.0	1.59	66.8 106.9	0.0064	*	42	7.3	480	1.1	0.0074	1437.43	1438.81	1.38	010050
19			0.86	0.90														
20			1.33	0.90														
	640	560	76.14	0.58	23.1	1.54	67.7 107.7	0.0082	*	48	5.7	80	0.2	0.0038	1434.36	1435.26	0.90	010055
	560	340	76.14	0.58	23.4	1.53	67.3 105.4	0.0082	*	48	5.7	220	0.6	0.0038	1433.70	1434.96	1.26	010060
	340	-														1434.12		Existing Manhole Project ST-885152

* - Signifies a surcharged condition

APPENDIX D

STORM DRAIN CALCULATIONS

By:	Guy Zeigler
Date:	January 13, 1999
Checked:	Mike Salmon
Project No.	11520007

ASL Velocities Assume Q/A = V
where A = Area of Pipe !!

APPENDIX E

Connector Pipe Calculations

ASL Consulting Engineers

SHEET NO. 1 OF 10

ENGINEER Guy Zeigler DATE 1/8/99 JOB NO. 14090006 BY

SUBJECT Union Hills Drive - 16th Street to Cave Creek CHECKED BY
Connector Pipe Analysis

OFFICE TELEPHONE

H = Head
TC = Top Curb
FB = Freeboard
CF = Curb Face
HGL = Hydraulic Grade Line

V = minimum catch basin depth
V = velocity
d = diameter of connector pipe
g = gravitational constant = 32.2 ft/s²

From: Storm Drain Design Manual – Storm Drains with Paving of Major Streets, City of Phoenix, July 1987

Available Head (H) = TC - FB - CF - HGL

Minimum Catch Basin Depth (V) = $1.16 + 1.5\frac{v^2}{2g} + d$

Generic Analysis of 15" Connector Pipe

- Using a minimum catch basin depth (V.) of 3'-6" (Per C.O.P. Detail 1569)

$$V = 1.16 + 1.5\frac{v^2}{2g} + d \quad @ \quad d = 1.25$$

solve for vel(v) $3.5' = 1.16 + 1.5\frac{v^2}{(2)(32.2)} + \frac{15''}{12}$

$$v = 6.84 \text{ ft/s}$$

$$Q = vA = (6.84 \text{ ft/s})\left(\frac{15}{(2)(12)}\right)^2 \pi = 8.4 \text{ cfs}$$

using a length of 40 and the nomograph on pg 31

The required Head (H) $= 1.45 \text{ ft} + (3)\frac{(6.84)^2}{(2)(32.2)}$

$$H = 1.7 \text{ ft}$$

Inlet No. 2 Sta 42+70 RT

Available Head = TC − FB − CF − HGL

$H = 1468.75 - 0.5 - 0.66 - 1462.38$

$H = 5.2 \text{ ft}$

Head Available = 5.2ft > 1.7ft = Required Head

Actual Q = 1.8 cfs > 8.4 cfs = Assumed Flow

∴ Use V_{min} = 3'-6" or 4'-0" depending on L

By inspection, 15-inch connector pipe is also satisfactory for the following inlets:

4, 5, 6, 7, 8, 12, 15, 16, 17, 18, 24A, 24B, 25A, 25B, and 28.

ENGINEER Guy Zeigler DATE 1/8/99 JOB NO. 14090006 BY

SUBJECT Union Hills Drive
Connector Pipe Analysis CHECKED BY

OFFICE TELEPHONE

Inlet No. 11A sta 27+03 LT

- Available Head

$H = TC - FB - CF - HGL$

$H = 1458.61 - 0.5 - 0.66 - 1452.20$

$H = 5.25$ ft available

- Minimum Catch Basin Depth

$$V = 1.16 + 1.5\frac{V^2}{2g} + d$$

$Q = 10.5\ ft^3/s$, $d = 15''$

$Q = VA$

$10.5\ ft^3/s = V\left(\frac{1.25}{2}\right)^2 \pi$ $V = 8.56$ ft/s

$$V = 1.16 + 1.5\frac{(5.9)^2}{2(32.2)} + 1.5 = 4.4 ft$$

$V_{min} = 4.4$ ft

- Head required (pg 31), $L = 80$ ft

$$H = 3.7 + .3\frac{(8.56)^2}{2(32.2)} = 4.0 ft$$

Head Available = 5.3 ft > 4.0 ft Head Required

Use $d = 15''$

Inlet No 11B Sta 28+75 LT

- Available Head

from SD

$H = TC - FB - CF - HGL$

$H = 1458.05 - 0.5 - 0.66 - 1453.96$

$H = 2.93$ ft available

- Minimum Catch Basin Depth

$V = 1.16 + 1.5 \frac{V^2}{2g} + d$

$Q = 25.7 \text{ ft}^3/\text{s}$, $d = 24''$

$Q = vA$

$25.7 \text{ ft}^3/\text{s} = v \left(\frac{2}{2}\right)^2 \pi$ $\quad v = 8.2$ ft/s

$V = 1.16 + 1.5 \frac{(8.2)^2}{2(32.2)} + 2 = 4.7$ ft

$V_{min} = 4.7$ ft

- Head Required (pg 31), $L = 40$ ft

$H = 1.8 + (.3 \frac{(8.2)^2}{2(32.2)} = 2.1$

Head Available = 2.9 ft > 2.1 ft Head Required

Use $d = 24''$

ENGINEER Guy Zeigler DATE 1/8/99 JOB NO. _____ BY _____

SUBJECT Union Hills Drive
Connector Pipe Analysis

CHECKED BY _____

OFFICE _____ TELEPHONE _____

Inlet No 13 Sta 21+04 LT

— Available Head

$H = TC - FB - CF - HGL$

$H = 1452.67 - 0.5 - 0.66 - 1446.09$

$H = 5.42$ ft available

— Minimum Catch Basin Depth

$$V = 1.16 + 1.5 \frac{v^2}{2g} + d$$

$Q = 10.8$ ft^3/s, $d = 15''$

$Q = vA$

$10.8 = v \left(\frac{1.25}{2}\right)^2 \pi$ $\quad v = 8.8$ ft/s

$$V = 1.16 + 1.5 \frac{(8.8)^2}{(2)(32.2)} + 1.25 = 4.21$$

$V_{min} = 4.2$ ft

— Head Required (pg 31), $L = 45'$

$$H = 2.6 + \frac{(.3)(8.8)^2}{2(32.2)} = 3.0$$

Head Available = 5.4 ft > 3.0 ft = Head Required

Use $d = 15''$

Inlet No. 14B Sta 20+60 LT

— Head Available

$H = TC - FB - CF - HGL$ (@ 20+15)

$H = 1453 - 0.5 - 0.66 - 1445.43$

$H = 6.41$ ft

— Minimum Catch Basin Depth

$$V = 1.16 + 1.5\frac{v^2}{2g} + d$$

$Q = 6.1$ cfs, 15"

$Q = vA$

$6.1\ ft^3/s = v\,\pi\left(\frac{1.25}{2}\right)^2$ $\quad v = 5.0$ ft/s

$$V = 1.16 + 1.5\frac{(5.0)^2}{(2)(32.2)} + 1.25 = 3.0$$

$V_{min} = 4.0$ ft

— Headloss into catch basin 2 (pg 31), $L = 40'$

$$H = 0.8 + (.3)\frac{(5.01)^2}{2(32.2)} = 0.91$$

Inlet No 14A Sta 20+24 LT

— Head Available

$H = TC - FB - CF - HGL$ (@ 20+15)

$H = 1452.95 - 0.5 - 0.66 - 1445.43$

$H = 6.36$ ft

ENGINEER Guy Zeigler DATE 1/11/99 JOB NO. 14090006 BY

SUBJECT Union Hills Drive
Connector Pipe Analysis CHECKED BY

OFFICE TELEPHONE

Inlet No. 14A cont.

— Minimum Catch Basin Depth

$$V = CF_1 + FB + HL_1 + \frac{1.5\,v^2}{2g} + d_2 - G$$

G = difference in elevation of top of curb

$G = 1453.00 - 1452.95 = 0.05$

$$V = 0.66 + 0.5 + 0.91 + \frac{1.5\,(6.8)^2}{2(32.2)} + d_2 - .05$$

d_2 = 18"

$Q = vA$

$Q = 6.1\,cfs + 6.1\,cfs = 12.2\,cfs$, 18"

$12.1\,ft^3/s = v\,\pi\left(\frac{1.5}{2}\right)^2$ $\quad v = 6.8\,ft/s$

$V = 4.6'$

— Head Required pg 31, L = 70'

$$H = 1.7 + .3\,\frac{(6.8)^2}{2(32.2)} = 1.9\,ft$$

Head Available = 6.4 ft > 1.9 ft = Head Available

Use d = 15" 14B – 14A

Use d = 18" 14A – Main line

ENGINEER Guy Zeigler DATE 1/10/99 JOB NO. 14090006 BY

SUBJECT Union Hills Drive
Connector Pipe Analysis

CHECKED BY

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Inlet No 19 (Existing) Sta 6+16 RT

— Head Available

$H = TC - FB - CF - HGL$

$H = 1442.7 - 0.5 - 0.66 - 1435.17$

$H = 6.37$

— Minimum Catch Basin Depth

$$V = 1.16 + 1.5\frac{v^2}{2g} + d$$

$Q = 3.3$ cfs, 24" (existing) $Q = vA$

$3.3\ ft^3/s = v\ \pi(1)^2$ $v = 1.1$ ft/s

$$V = 1.16 + 1.5\frac{(1.1)^2}{(2)(32.2)} + 2 = 3.19$$

$V_{min} = 3.5$ ft

— Head Required (pg 31), $L = 25'$

$$H = <.5 + \frac{(.3)(1.1)^2}{(2)(32.2)} = 0.5 \text{ ft}$$

Head Available = 6.4 ft > 0.5 ft Head Required

Use d = 24"

Inlet No 20 (Existing) Sta 6+16 LT

- Head Available

$H = TC - FB - CF - HGL$

$H = 1442.7 - 0.5 - 0.66 - 1435.17$

$H = 6.37 ft$

- Minimum Catch Basin Depth

$$V = 1.16 + \frac{1.5\,v^2}{2g} + d$$

$Q = 15.7$ cfs, 24" (existing)

$Q = vA$

$15.7\ ft^3/s = v\,(1)^2\pi \qquad v = 5.0\ ft/s$

$$V = 1.16 + \frac{(1.5)(5.0)^2}{(2)(32.2)} + 2 = 3.74\ ft$$

$V_{min} = 4.0\ ft$

- Head Required (pg 31), $L = 50'$

$$H = 0.7\ ft + \frac{(.3)(5.0)^2}{(2)(32.2)} = 0.82\ ft$$

Head Available = 6.4 ft > 0.8 ft = Head Required

Existing d = 24" ok

ENGINEER Guy Zeigler DATE 1/8/99 JOB NO. 1409c006 BY

SUBJECT Union Hills Drive
Connector Pipe Analysis CHECKED BY

OFFICE TELEPHONE

Inlet No. 23 Sta 52+68 LT

- Head Available

$H = TC - FB - CF - HGL$

Note: Because of exceptionally tight cond, $FB = 0$

$H = 1469.73 - 0 - 0.66 - 1464.80$

$H = 4.27$ ft

- Minimum Catch Basin Depth

$$V = 1.16 + 1.5 \frac{v^2}{2g} + d$$

$Q = 18.7 \text{ ft}^3/\text{s}$, $d = 18''$

$Q = vA$

$18.7 \text{ ft}^3/\text{s} = V \pi \left(\frac{1.50}{2}\right)^2$ $V = 10.6$ ft/s

$$V = 1.16 + 1.5 \frac{(10.6)^2}{2(32.2)} + 1.5 = 5.3 \text{ ft}$$

$V_{MIN} = 5.3$ ft

- Head Required (pg 31), $L = 55$ ft

$$H = 3.5 + (.3)\frac{(10.6)^2}{2(32.2)} = 4.0 \text{ ft}$$

Head Available = 4.3 ft > 4.0 ft = Head Required

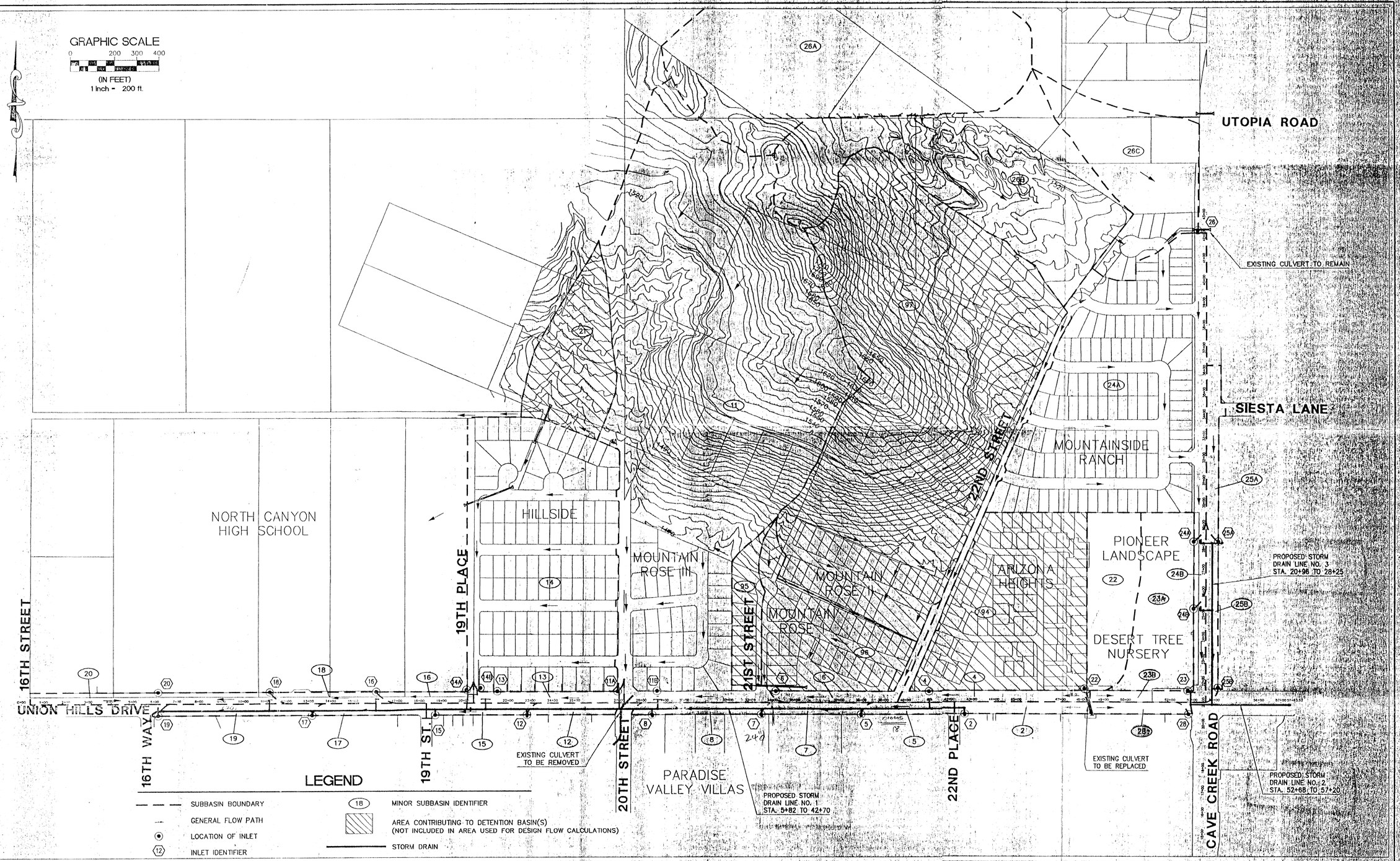
Use $d = 18''$

GRAPHIC SCALE

0 200 300 400

(IN FEET)

1 inch = 200 ft.



LEGEND

- SUBBASIN BOUNDARY
- GENERAL FLOW PATH
- LOCATION OF INLET
- (12) INLET IDENTIFIER
- (18) MINOR SUBBASIN IDENTIFIER
- AREA CONTRIBUTING TO DETENTION BASIN(S) (NOT INCLUDED IN AREA USED FOR DESIGN FLOW CALCULATIONS)
- STORM DRAIN

NO.	REVISIONS	DATE	BY	CHK.

900621DEXA.DWG

ASL Consulting Engineers

426 S. 44th Street, Suite 350, Phoenix, Arizona 85008, PH: (602) 244-2624, FAX: (602) 244-1164

431 S. Beeline Highway, Payson, Arizona 85541, PH: (520) 474-4638, FAX: (520) 474-4867

UNION HILLS

16TH STREET TO CAVE CREEK ROAD

JOB NO.	11520007
DESIGNED BY:	GEZ
DRAWN BY:	GEZ
CHECKED BY:	MS
APPROVED BY:	MS
DATE:	1/99

EXHIBIT A
DRAINAGE MAP
CITY OF PHOENIX PROJECT P-900621

SCALE: HORIZ. 1" = 200'
VERT. 1" = N/A

DRAWING NO. DEXA

SHEET NO. 1 OF 1