2nd
3.7

Plan # 3476-06-3
Case # 247-SA-2006
Q-S # 44-45

☑ Accepted
☐ Corrections

3/29/07
Reviewed By Date

3476-06-3

WOOD/PATEL

ROADWAY DRAINAGE REPORT
FOR
PINNACLE PEAK ROAD
SCOTTSDALE ROAD TO MILLER ROAD

March, 2007

WP #042309.06

Prepared for:

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Attn: Mr. Mike Pacheco

Submitted to:

City of Scottsdale
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Scottsdale, Arizona 85251

Prepared by:

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Website: www.woodpatel.com

Engineer-in-Training
Darren Forstie

Engineer

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APPENDICES

PLATES

N:\2004\042309.06\Project Support\Reports\042309.06 Pinnacle Peak Rd, Scottsdale Rd to Miller_12-27-06.doc

1.0 INTRODUCTION

1.1 Project Background

The Pinnacle Peak Road improvement project is located in north Scottsdale beginning at the eastern edge of Scottsdale Road and continues east along Pinnacle Peak Road to the western edge of Miller Road. The project covers approximately 1/2 mile of proposed public roadway.

The proposed project includes the construction of Pinnacle Peak Road as a minor arterial and is proposed as a multi-lane roadway with curb and gutter, a raised median varying in width, as well as other roadway infrastructure.

The project includes drainage improvements for roadway drainage and a channel running along the south side of Pinnacle Peak Road and outletting into Rawhide Wash. This report has been prepared to address drainage requirements for the portion of Pinnacle Peak Road from Scottsdale Road to Miller Road.

This report addresses roadway hydrology and hydraulics. The hydrologic and hydraulic methods utilized within this report are in accordance with the *City of Scottsdale Design Standards and Policy Manual* (Ref. 1). This report also conforms to our understanding of drainage criteria set forth in the *Drainage Design Manual for Maricopa County, Arizona Volume I – Hydrology* (Ref. 2).

1.2 Drainage Background

Pinnacle Peak Road is situated on an alluvial plain within upland Sonoran Desert containing moderate to steep slopes with washes typical to alluvial fans that have various areas developed. One major wash, Rawhide Wash, traverses the project site. The hydrology and hydraulics of Rawhide Wash and the proposed bridge is detailed in the drainage report titled "Design Report for Rawhide Wash Channel at Silverstone" dated November, 2006 (Ref. 4) prepared by Wood, Patel & Associates. The November dated report is subject to updates as it is processed through the City of Scottsdale review and approval process. Therefore, this report will not address the hydrology and hydraulics of Rawhide Wash.

Other potential offsite flow contributing to the project area and the hydraulics of the adjacent channel and cross culverts are addressed in following sections.

2.0 GENERAL LOCATION AND DESCRIPTION

2.1 Location

The proposed Pinnacle Peak Road Improvements Project is along Section 11 and Section 14, Township 4 North, Range 4 East, of the Gila and Salt River Meridian. The location of the site is graphically illustrated on Plate 1 – *Vicinity Map.* The project is within the jurisdiction of the City of Scottsdale.

2.2 Flood Insurance Rate Map (FIRM)

The Flood Insurance Rate Map (FIRM) for Maricopa County, Arizona and incorporated areas, Map Number 04013C1235G, dated September 30, 2005 indicates the site is within Zone "AO."

Zone "AO" is defined by FEMA as follows:

> *Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.*

The average depth displayed on the FEMA FIRM for the Project Area is one (1) foot with a velocity shown as four (4) feet per second. The location of the roadway relative to the FIRM panels is illustrated on Plate 2 – *Flood Insurance Rate Map (FIRM).*

3.0 HYDROLOGY

3.1 Methodology

Peak flow estimates for the roadway were generated using the Rational Method as outlined in the *Design Standards and Policies Manual, City of Scottsdale, Arizona*, (Ref. 1) and the *Drainage Design Manual for Maricopa County, Arizona, Volume I – Hydrology* (Ref. 2). This method assumes the application of a steady, uniform rainfall intensity, which produces a peak flow value when all points within the watershed contribute to outflow at the design point. A runoff coefficient of 0.95 was used to reflect the full section roadway for both 10-year and 100-year events. Please refer to Appendix A – *Hydrology & Hydraulics* for Rational Method calculations.

3.2 Drainage Patterns

The proposed vertical alignment of Pinnacle Peak Road directs roadway flow from east to west. A catch basin/storm drain system has been designed along Pinnacle Peak Road containing on-grade catch basins to drain the anticipated 10-year peak flows from the road surface to the existing drainage corridor, Rawhide Wash. The very western portion of the Pinnacle Peak Road storm drain system captures and conveys flows to the Scottsdale Road scenic corridor. This western storm drain system has additional catch basins for drainage originating from the commercial site (northeast corner of Scottsdale Road and Pinnacle Peak Road) that may enter Pinnacle Peak Road due to historic drainage patterns. The locations of the onsite drainage sub-basins and catch basins are illustrated on Plate 3 – *Roadway Drainage Map*.

3.3 Off-Site Hydrology

As previously mentioned, Rawhide Wash, traverses the project site. This offsite flow and hydraulics of Rawhide Wash and the proposed bridge is detailed in the drainage report titled "Design Report for Rawhide Wash Channel at Silverstone."

Additional offsite flow is the roadway runoff of the western half of Miller Road for approximately 600 feet north of Pinnacle Peak Road. This flow is relatively minor and is accounted for in the proposed storm drain system.

The pre-existing conditions from Rawhide Wash to Scottsdale Road are such that an unknown portion of flow from the upstream commercial property to the north flows onto Pinnacle Peak Road and is conveyed to the west. With improvements to Pinnacle Peak Road, this upstream runoff will flow into the gutter system and be captured by the proposed storm drain system. Additional catch basins are proposed on the north side of Pinnacle Peak Road to serve this purpose (see Plate 3 – *Roadway Drainage Map*).

A proposed private channel on the south side of Pinnacle Peak Road and in the 50-foot setback adjoining the right-of-way has been designed to convey up to approximately 300 cfs starting at Miller Road and ending at Rawhide Wash. This channel is designed to simply provide extra conveyance westward in the event of a major storm. The design of this channel is thought to be prudent based on the unknown nature of alluvial plains on which this project is located.

4.0 HYDRAULICS

4.1 Street Flow Capacity

Street performance was analyzed for the 10-year and 100-year rainfall events occurring within the roadway limits. Per City of Scottsdale design guidelines (Ref. 1) and the *Drainage Design Manual for Maricopa County, Arizona, Volume II – Hydraulics* (Ref. 3), catch basins have been designed to provide one dry driving lane in each direction while containing the 10-year peak flow within the curbs. Catch basin sizing calculations are presented in Appendix A – *Hydrology & Hydraulics.*

Pinnacle Peak Road is designed to contain the 10-year runoff from the roadway within the curbs and the 100-year runoff within the right-of-way or drainage easements. Street flow capacity estimations are included in Appendix B – *Street Capacity Calculations.*

4.2 Storm Drain Design

The storm drain systems have been designed to intercept the anticipated 10-year peak storm flows and discharge them into Rawhide Wash or the Scottsdale Road scenic corridor. StormCAD was used to design the storm drains throughout the project. Several constraints were used in the design, including using a minimum pipe size of 18 inches to reduce clogging and maintaining a hydraulic grade line of at least 6 inches below all catch basins grates for storms of 10-year frequency. Storm drain hydraulic calculations are included in Appendix C – *Storm Drain Design.*

4.3 Channel Design

The proposed private channel adjoining Pinnacle Peak Road right-of-way has been designed to convey up to approximately 300 cfs starting at Miller Road and ending at Rawhide Wash. Box culverts have been utilized at two proposed roadway/driveway crossings into the Silverstone development. A grate opening in the channel bottom adjacent to Rawhide Wash is designed to capture nuisance flow and convey this flow to Rawhide Wash. In addition, an outlet that conveys the channel flow into Rawhide Wash has been designed to weir over the Pinnacle Peak Bridge wingwall. Rip-rap protection along the wingwall and weep holes in the wingwall have been implemented in this design. Channel, culvert, outlet and grate opening calculations are found in Appendix A – *Hydrology & Hydraulics.*

4.4 Rawhide Wash Channel & Pinnacle Peak Bridge

As a part of the Silverstone development, Rawhide Wash will be channelized from Pinnacle Peak Road to Scottsdale Road. The proposed channel design will be designed to convey the anticipated 100-year peak discharge of 10,900 cfs with freeboard sufficient for 12,400 cfs. The channel will be designed in two phases.

The initial or Interim Channel is a short, temporary channel intended to convey flows to mimic historic conditions of a flood event which flows over the historic dip section in Pinnacle Peak Road. This channel will be constructed along with the Pinnacle Peak Bridge and full build out of Pinnacle Peak Road.

The future channel will be constructed at a later time, pending bridge improvements at Scottsdale Road. For design information for both the Interim and Future Rawhide Wash Channels and the Pinnacle Peak Bridge, please refer to the *Design Report for Rawhide Wash Channel at Silverstone* (Ref. 4). For the Pinnacle Peak Bridge Plans, please refer to City of Scottsdale check plan number 3476-06-3.

5.0 MAINTENANCE

Ongoing maintenance of the designed or recommended drainage systems is required to preserve the design integrity and purpose of the drainage system. Failure to provide maintenance can prevent the drainage system from performing to its intended design purpose and can result in reduced performance. Maintenance within the public right-of-way is the responsibility of the governing municipality. However, it is the responsibility of private developers, homeowner associations, etc. for facilities on private property within drainage easements, private streets and right-of-ways, unless accepted by the City of Scottsdale for regular maintenance. A regular maintenance program is required to have drainage systems perform to the level of protection or service as presented in this report and the project's plans and specifications.

6.0 CONCLUSIONS

1. The contents of this report are in accordance with City of Scottsdale design parameters, as understood, applied, and disclosed by the Arizona registered civil engineer of record.

2. Estimates of peak roadway storm flow were made using the Rational Method, as documented in the *Design Standards and Policies Manual, City of Scottsdale, Arizona*, (Ref. 1) and the *Drainage Design Manual for Maricopa County, Volume I – Hydrology* (Ref. 2).

3. The design of hydraulic structures is based on generally accepted engineering practices and is in accordance with the City of Scottsdale guidelines (Ref. 1) and methods documented in the *Drainage Design Manual for Maricopa County, Volume II – Hydraulics* (Ref. 3).

4. Pinnacle Peak Road has been designed to convey the estimated 10-year peak flow between the curbs with at least one dry lane in each direction of travel.

5. A proposed private channel adjacent to Pinnacle Peak Road and outletting into Rawhide Wash is designed to convey up to approximately 300 cfs.

6. On-going maintenance is required for all drainage systems in order to assure design performance as presented herein.

7.0 REFERENCES

1. City of Scottsdale, *City of Scottsdale Design Standards and Policy Manual*, revised July, 2006.

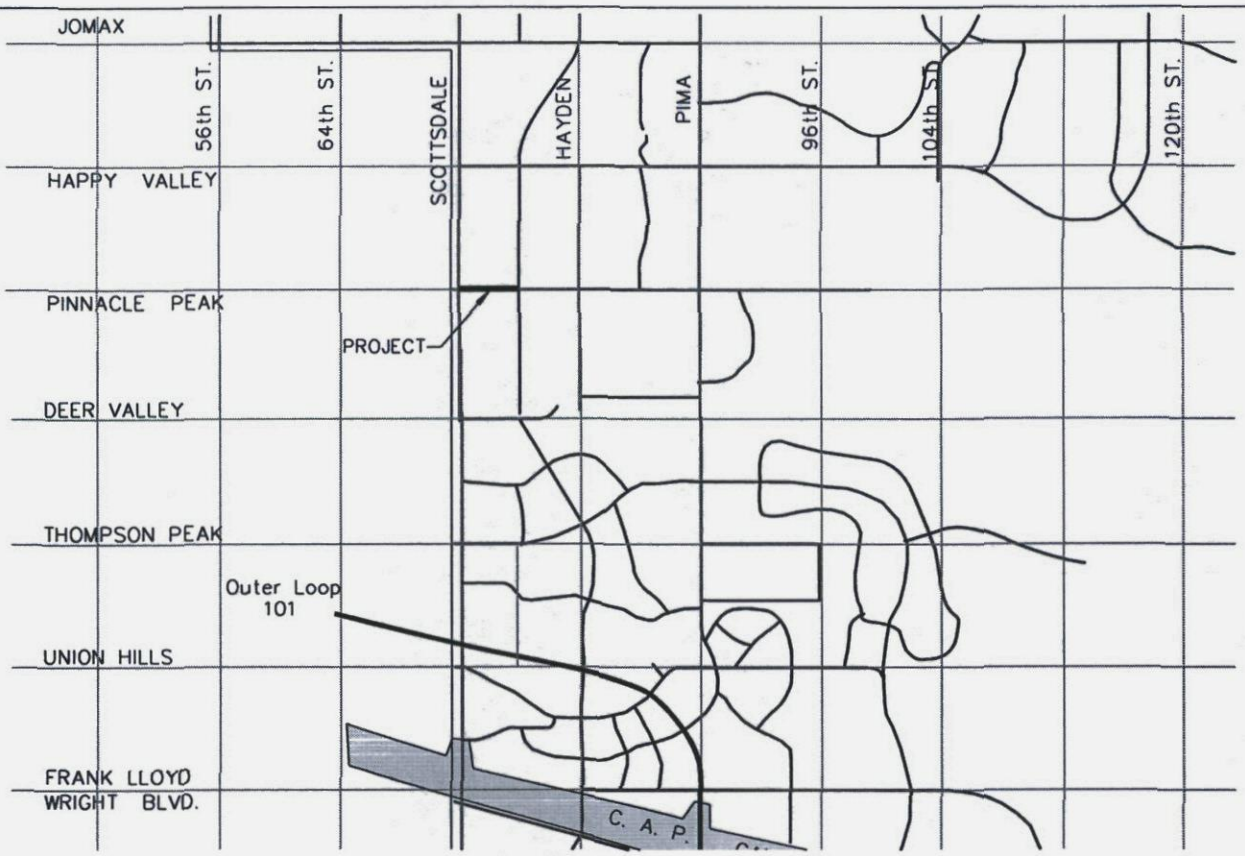
2. Flood Control District of Maricopa County, *Drainage Design Manual for Maricopa County, Arizona: Volume I – Hydrology,* revised January, 1995.

3. Flood Control District of Maricopa County, *Drainage Design Manual for Maricopa County, Arizona; Volume II – Hydraulics*, January 28, 1996.

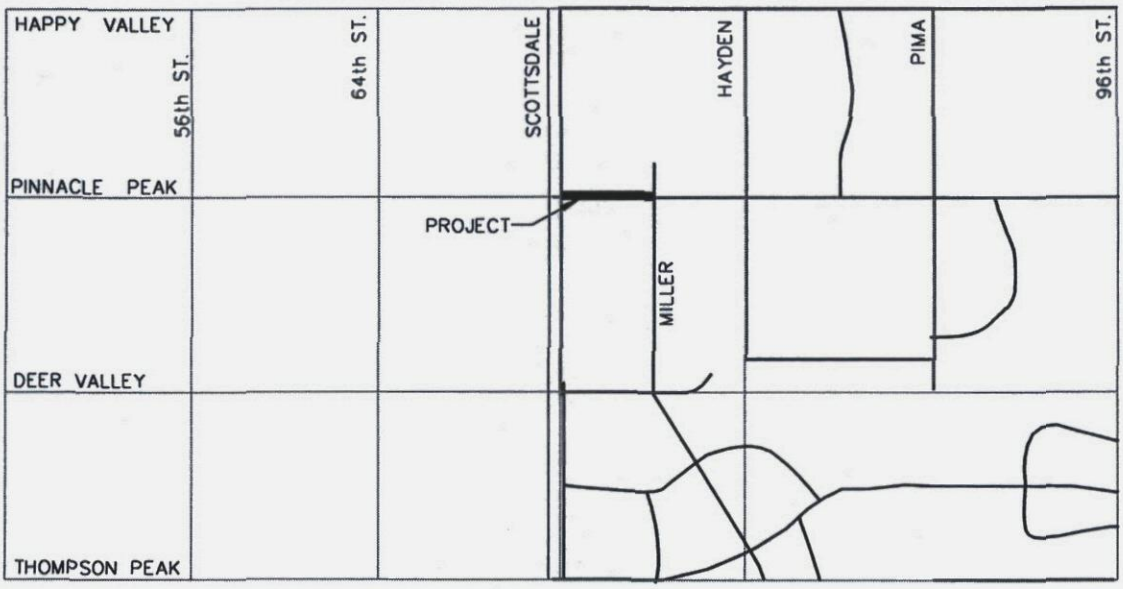
4. Wood, Patel & Associates, Inc., *Design Report for Rawhide Wash Channel at Silverstone,* November 22, 2006.

PLATE 1

Vicinity Map



LOCATION



VICINITY

NOT TO SCALE

LOCATION & VICINITY MAP
Pinnacle Peak Road

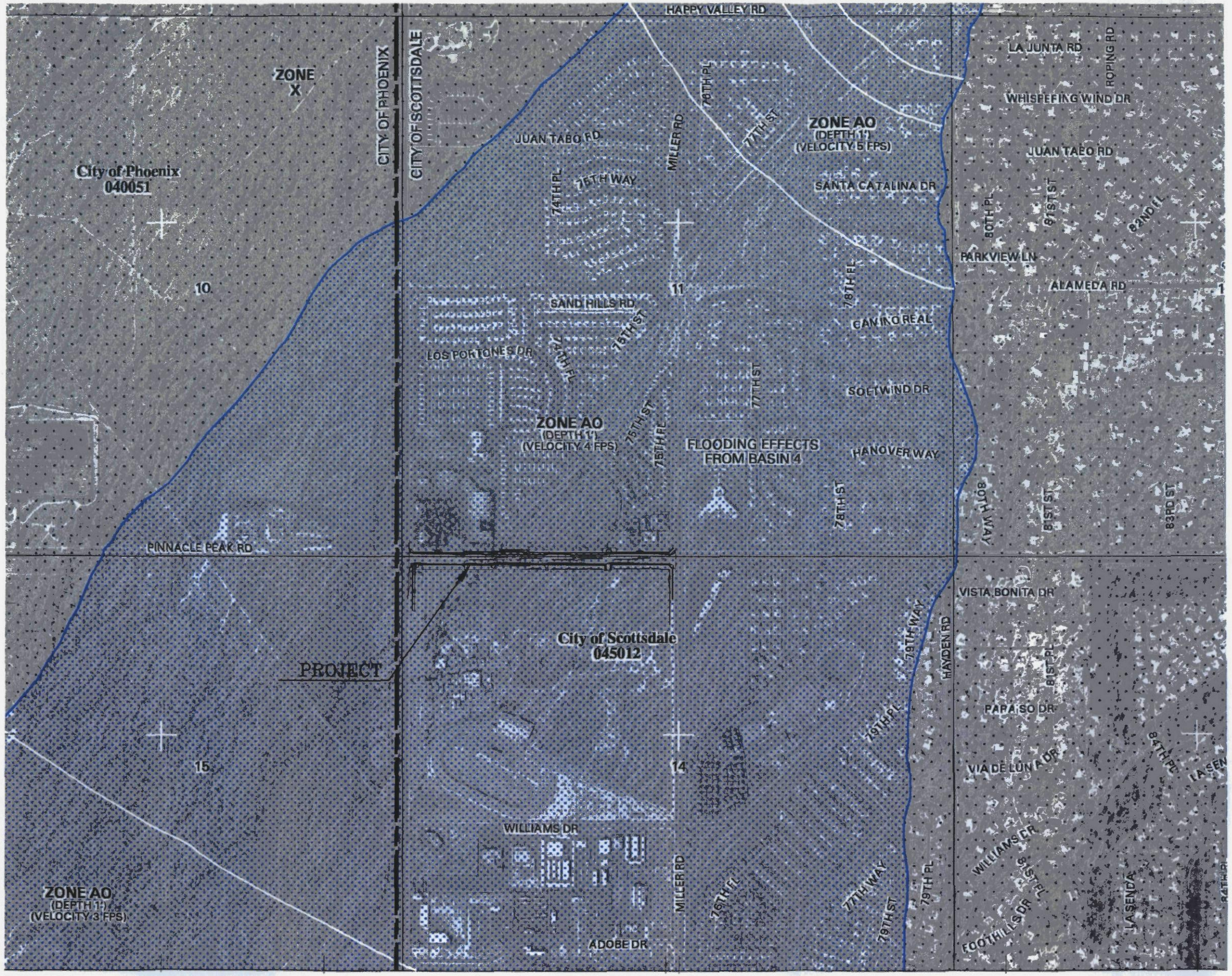
Wood, Patel & Associates, Inc.
2051 West Northern, Suite 100
Phoenix, Arizona 85021 (602) 335-8500

DRAWN BY: D. FORSTIE	Plate 1
JOB NO: 042309.06	

N:\2004\042309.06\Project Support\Hydro\Exhibits\ Vicinity Map_Pinnacle Peak Rd.dwg - Jan 29,2007 10:33am

PLATE 2

Flood Insurance Rate Map (FIRM)



NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 1235G

FIRM

FLOOD INSURANCE RATE MAP

MARICOPA COUNTY, ARIZONA

AND INCORPORATED AREAS

PANEL 1235 OF 4350

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
MARICOPA COUNTY	040037	1235	G
PHOENIX, CITY OF	040051	1235	G
SCOTTSDALE, CITY OF	045012	1235	G

Notice to User: The Map Number shown below should be used when placing map orders; the Community Number shown above should be used on insurance applications for the subject community.

MAP NUMBER
04013C1235G
MAP REVISED
SEPTEMBER 30, 2005

Federal Emergency Management Agency

MAP SCALE 1" = 1000'

0 1000 2000 FEET

Flood Insurance Rate Map (FIRM)

Wood, Patel & Associates, Inc.
2051 West Northern, Suite 100
Phoenix, Arizona 85021 (602) 335-8500

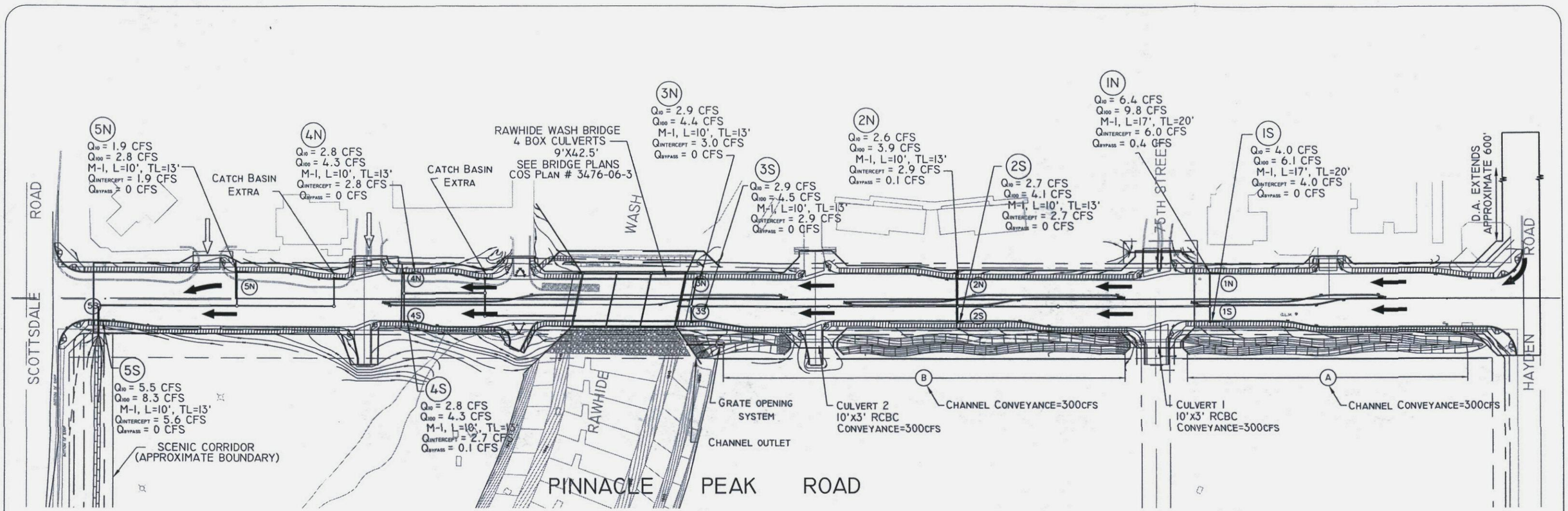
DRAWN BY: D FORSTIE

JOB NO: 042309.06

PLATE 2

PLATE 3

Drainage Map



LEGEND

———	ROADWAY SUBBASIN BOUNDARY
(3S)	CONCENTRATION POINT/CATCH BASIN NUMBER
←	FLOW DIRECTION
⇦	POTENTIAL OFFSITE FLOW
Q_{10} = 2.7 CFS	10-YEAR DISCHARGE
Q_{100} = 4.1 CFS	100-YEAR DISCHARGE
M-I, L=6', TL=9'	CATCH BASIN TYPE, WING LENGTH (L), TOTAL CATCH BASIN LENGTH (TL) (TL = MAINTENANCE BASIN LENGTH (3', TYP.) + L)
$Q_{INTERCEPT}$ = 2.7 CFS	10-YEAR DISCHARGE, INTERCEPTED AT CATCH BASIN
Q_{BYPASS} = 0.4 CFS	10-YEAR DISCHARGE BYPASSED TO DOWNSTREAM CATCH BASIN

N

NTS

ROADWAY DRAINAGE MAP

PINNACLE PEAK ROAD, SCOTTSDALE, ARIZONA
SCOTTSDALE RD TO MILLER RD

Wood, Patel & Associates, Inc.
2051 West Northern, Suite 100
Phoenix, Arizona 85021 (602) 335-8500

DRAWN BY: DF
JOB NO: WP# 042309.06

PLATE 3

N:\2004\042309.06\Project Support\Hydro\Exhibits\ Roadway Drainage Map_for Roadway Report_01-02-07.dwg - Mar 01,2007 1:26pm

APPENDIX A

Hydrology & Hydraulics

Pinnacle Peak Road, Scottsdale Rd to Miller Rd
City of Scottsdale
RATIONAL METHOD
10-YEAR STORM
Wood/Patel Project No: 042309.6

HYDROLOGY/HYDRAULICS SUMMARY

Computed by: DF Date: ___
Checked by: _____ Date: ___
Approved by: _____ Date: ___

NOTES:
1. Runoff Coefficients are area-weighted when more than one land use is present.
2. The minimum time of concentration is 10 minutes.
3. Calculated discharges rounded to 0.1 cfs for design.
4. Catch basins sized using ADOT catch basin sizing program. Scupper type is MAG Std Det 206-1.

Sub Area	Drainage Area		Length	Width	Area	Avg.	Design		Q_{10}	Inlet				U/S Flowby		Total Flow	Wing Length	Flow Spread	Intercepted Flow	Comments
ID	Upstream	Downstream	(ft)	(ft)	(ac)	C	Tc (hr)	i (in/hr)	(cfs)	No.	Station	Dir.	Type[4]	Qc (cfs)	Inlet No.	Qt (cfs)	(ft)	(ft)	Qi (cfs)	
1N	N Miller	22+37	1150	varies	1.42	0.95	0.17	4.75	**6.4**	1N	22+65 LT	W.B.	1569-1	NA	NA	6.4	17	20.9	6.0	Proposed Catch Basin
1S	27+78	22+37	541	varies	0.88	0.95	0.17	4.75	**4.0**	1S	22+65 RT	E.B.	1569-1	NA	NA	4.0	17	8.9	4.0	Proposed Catch Basin
2N	22+37	18+25	412	varies	0.57	0.95	0.17	4.75	**2.6**	2N	18+25 LT	W.B.	1569-1	0.4	1N	3.0	10	10.0	3.0	Proposed Catch Basin
2S	22+37	18+25	412	varies	0.59	0.95	0.17	4.75	**2.7**	2S	18+25 RT	E.B.	1569-1	0.0	1S	2.7	10	7.9	2.7	Proposed Catch Basin
3N	18+25	13+50	475	varies	0.64	0.95	0.17	4.75	**2.9**	3N	13+70 LT	W.B.	1569-1	0.1	2N	3.0	10	10.9	3.0	Proposed Catch Basin
3S	18+25	13+50	475	varies	0.65	0.95	0.17	4.75	**2.9**	3S	13+60 RT	E.B.	1569-1	0.0	2S	2.9	10	9.0	2.9	Proposed Catch Basin
4N	13+50	08+50	500	varies	0.62	0.95	0.17	4.75	**2.8**	4N	08+60 LT	W.B.	1569-1	0.0	3N	2.8	17	8.3	2.8	Proposed Catch Basin
4S	13+50	08+50	500	varies	0.63	0.95	0.17	4.75	**2.8**	4S	08+60 RT	E.B.	1569-1	0.0	3S	2.8	10	8.4	2.7	Proposed Catch Basin
5N	08+50	05+68	282	varies	0.41	0.95	0.17	4.75	**1.9**	5N	05+68 LT	W.B.	1569-1	0.0	4N	1.9	17	11.3	1.9	Proposed Catch Basin, to Scenic Corri
5S	08+50	03+25	525	varies	1.21	0.95	0.17	4.75	**5.5**	5S	03+25 RT	E.B.	1569-1	0.1	4S	5.6	17	8.9	5.6	Proposed Catch Basin, to Scenic Corri
Extra CB	unknown						6 cfs hydraulically modeled			07+38 LT	W.B	1569-1				17				Extra Catch Basin on Grade
Extra CB	unknown						6 cfs hydraulically modeled			10+00 LT	W.B	1569-1				17				Extra Catch Basin on Grade

ARIZONA DEPARTMENT OF TRANSPORTATION
BRIDGE DRAINAGE SECTION
PAVEMENT DRAINAGE CALCULATIONS

01-29-2007

PROJECT NAME- Pinnacle Peak Rd TRACS NO.- _____
HIGHWAY NAME- _____ DESIGNER - _____
LOCATION - _____ CHECKER - _____
VER 3.41 October 1996

CB IN

CURB OPENING INLET -- ON GRADE

GUTTER FLOW HYDRAULICS
GUTTER DESCRIPTION

Roadway Grade-% Per cent--G	=	1.100
Roadway Cross-Slope-Ft./Ft.--Sx	=	0.010
Shoulder Width-Ft.--	=	2.000
Shoulder Slope-Ft./Ft.--Ss	=	0.010
Gutter Width-Ft.--W	=	1.500
Gutter Slope-Ft./Ft.--Sw	=	0.059
Gutter Depression-Inches--	=	1.062
Manning's 'N	=	0.015
Flow-CFS--Q	=	6.400
SPREAD-Ft.--T	=	20.923
Average Velocity-V-fps	=	2.852
FLOW in Gutter-CFS--Q	=	1.446
% Flow in Gutter-CFS	=	22.588
Velocity of Flow in Gutter-fps	=	4.041
Depth at Curb Line-Inches--d	=	3.393

CURB OPENING--ADOT STD. C-15.20

Flow-CFS--Q	=	6.400
Gutter Velocity at INLET-fps	=	4.922
GUTTER FLOW at INLET-CFS--Q	=	2.280
Depth at INLET Curb Line-Inches--d	=	7.236
Local Gutter Depression-Inches	=	2.000
Length of opening: TOTAL Intercept--Ft.	=	26.587
Capture Ratio -- CURB OPENING	=	0.800

LENGTH	Efficiency	Q(Captured)	Q(By-Pass)
3.083	0.199	1.273	5.127
6.583	0.401	2.565	3.835
9.583	0.553	3.537	2.863
13.583	0.724	4.634	1.766
→ 20.583	0.931	5.961	0.439 ←

ARIZONA DEPARTMENT OF TRANSPORTATION
BRIDGE DRAINAGE SECTION
PAVEMENT DRAINAGE CALCULATIONS

01-29-2007

PROJECT NAME- Pinnacle Peak Rd TRACS NO.- _____
HIGHWAY NAME- _____ DESIGNER - _____
LOCATION - _____ CHECKER - _____
VER 3.41 October 1996

CB 15

CURB OPENING INLET -- ON GRADE

GUTTER FLOW HYDRAULICS
GUTTER DESCRIPTION

Roadway Grade-% Per cent--G	=	1.800
Roadway Cross-Slope-Ft./Ft.--Sx	=	0.025
Shoulder Width-Ft.--	=	2.000
Shoulder Slope-Ft./Ft.--Ss	=	0.025
Gutter Width-Ft.--W	=	1.500
Gutter Slope-Ft./Ft.--Sw	=	0.059
Gutter Depression-Inches--	=	1.062
Manning's 'N	=	0.015
Flow-CFS--Q	=	4.000
SPREAD-Ft.--T	=	8.937
Average Velocity-V-fps	=	3.859
FLOW in Gutter-CFS--Q	=	1.744
% Flow in Gutter-CFS	=	43.599
Velocity of Flow in Gutter-fps	=	5.051
Depth at Curb Line-Inches--d	=	3.293

CURB OPENING--ADOT STD. C-15.20

Flow-CFS--Q	=	4.000
Gutter Velocity at INLET-fps	=	5.996
GUTTER FLOW at INLET-CFS--Q	=	2.560
Depth at INLET Curb Line-Inches--d	=	6.947
Local Gutter Depression-Inches	=	2.000
Length of opening: TOTAL Intercept--Ft.	=	18.030
Capture Ratio -- CURB OPENING	=	0.800

LENGTH	Efficiency	Q(Captured)	Q(By-Pass)
3.083	0.286	1.146	2.854
6.583	0.559	2.234	1.766
9.583	0.745	2.978	1.022
13.583	0.920	3.678	0.322
→ 20.583	1.000	4.000	0.000 ←

ARIZONA DEPARTMENT OF TRANSPORTATION
BRIDGE DRAINAGE SECTION
PAVEMENT DRAINAGE CALCULATIONS

01-29-2007

PROJECT NAME- Pinnacle Peak Rd TRACS NO.- _____
HIGHWAY NAME- _____ DESIGNER - _____
LOCATION - _____ CHECKER - _____
VER 3.41 October 1996

CB 2N

CURB OPENING INLET -- ON GRADE

GUTTER FLOW HYDRAULICS
GUTTER DESCRIPTION

Roadway Grade-% Per cent--G	=	1.600
Roadway Cross-Slope-Ft./Ft.--Sx	=	0.018
Shoulder Width-Ft.--	=	2.000
Shoulder Slope-Ft./Ft.--Ss	=	0.018
Gutter Width-Ft.--W	=	1.500
Gutter Slope-Ft./Ft.--Sw	=	0.059
Gutter Depression-Inches--	=	1.062
Manning's 'N	=	0.015
Flow-CFS--Q	=	3.000
SPREAD-Ft.--T	=	9.957
Average Velocity-V-fps	=	3.197
FLOW in Gutter-CFS--Q	=	1.266
% Flow in Gutter-CFS	=	42.208
Velocity of Flow in Gutter-fps	=	4.296
Depth at Curb Line-Inches--d	=	2.889

CURB OPENING--ADOT STD. C-15.20

Flow-CFS--Q	=	3.000
Gutter Velocity at INLET-fps	=	5.263
GUTTER FLOW at INLET-CFS--Q	=	1.989
Depth at INLET Curb Line-Inches--d	=	6.554
Local Gutter Depression-Inches	=	2.000
Length of opening: TOTAL Intercept--Ft.	=	15.349
Capture Ratio -- CURB OPENING	=	0.800

LENGTH	Efficiency	Q(Captured)	Q(By-Pass)
3.083	0.332	0.996	2.004
6.583	0.635	1.906	1.094
9.583	0.828	2.485	0.515
→ 13.583	0.980	2.939	0.061 ←
20.583	1.000	3.000	0.000

ARIZONA DEPARTMENT OF TRANSPORTATION
BRIDGE DRAINAGE SECTION
PAVEMENT DRAINAGE CALCULATIONS

01-29-2007

PROJECT NAME- Pinnacle Peak LD TRACS NO.- _____
HIGHWAY NAME- _____ DESIGNER - _____
LOCATION - _____ CHECKER - _____
VER 3.41 October 1996

CB 25

CURB OPENING INLET -- ON GRADE

GUTTER FLOW HYDRAULICS
GUTTER DESCRIPTION

Roadway Grade-% Per cent--G	=	1.200
Roadway Cross-Slope-Ft./Ft.--Sx	=	0.027
Shoulder Width-Ft.--	=	2.000
Shoulder Slope-Ft./Ft.--Ss	=	0.027
Gutter Width-Ft.--W	=	1.500
Gutter Slope-Ft./Ft.--Sw	=	0.059
Gutter Depression-Inches--	=	1.062
Manning's 'N	=	0.015
Flow-CFS--Q	=	2.700
SPREAD-Ft.--T	=	7.905
Average Velocity-V-fps	=	3.069
FLOW in Gutter-CFS--Q	=	1.294
% Flow in Gutter-CFS	=	47.916
Velocity of Flow in Gutter-fps	=	3.971
Depth at Curb Line-Inches--d	=	3.137

CURB OPENING--ADOT STD. C-15.20

Flow-CFS--Q	=	2.700
Gutter Velocity at INLET-fps	=	4.722
GUTTER FLOW at INLET-CFS--Q	=	1.897
Depth at INLET Curb Line-Inches--d	=	6.744
Local Gutter Depression-Inches	=	2.000
Length of opening: TOTAL Intercept--Ft.	=	12.911
Capture Ratio -- CURB OPENING	=	0.800

LENGTH	Efficiency	Q(Captured)	Q(By-Pass)
3.083	0.388	1.048	1.652
6.583	0.723	1.952	0.748
9.583	0.913	2.465	0.235
→13.583	1.000	2.700	0.000←
20.583	1.000	2.700	0.000

ARIZONA DEPARTMENT OF TRANSPORTATION
BRIDGE DRAINAGE SECTION
PAVEMENT DRAINAGE CALCULATIONS

01-29-2007

PROJECT NAME- Pinnacle Peak Rd TRACS NO.- _____
HIGHWAY NAME- _____ DESIGNER - _____
LOCATION - _____ CHECKER - _____
VER 3.41 October 1996

CB 3N

CURB OPENING INLET -- ON GRADE

GUTTER FLOW HYDRAULICS
GUTTER DESCRIPTION

Roadway Grade-% Per cent--G	=	0.740
Roadway Cross-Slope-Ft./Ft.--Sx	=	0.020
Shoulder Width-Ft.--	=	2.000
Shoulder Slope-Ft./Ft.--Ss	=	0.020
Gutter Width-Ft.--W	=	1.500
Gutter Slope-Ft./Ft.--Sw	=	0.059
Gutter Depression-Inches--	=	1.062
Manning's 'N	=	0.015
Flow-CFS--Q	=	3.000
SPREAD-Ft.--T	=	10.904
Average Velocity-V-fps	=	2.433
FLOW in Gutter-CFS--Q	=	1.136
% Flow in Gutter-CFS	=	37.852
Velocity of Flow in Gutter-fps	=	3.259
Depth at Curb Line-Inches--d	=	3.319

CURB OPENING--ADOT STD. C-15.20

Flow-CFS--Q	=	3.000
Gutter Velocity at INLET-fps	=	3.900
GUTTER FLOW at INLET-CFS--Q	=	1.705
Depth at INLET Curb Line-Inches--d	=	7.029
Local Gutter Depression-Inches	=	2.000
Length of opening: TOTAL Intercept--Ft.	=	13.093
Capture Ratio -- CURB OPENING	=	0.800

LENGTH	Efficiency	Q(Captured)	Q(By-Pass)
3.083	0.383	1.150	1.850
6.583	0.716	2.147	0.853
9.583	0.906	2.719	0.281
→ 13.583	1.000	3.000	0.000 ←
20.583	1.000	3.000	0.000

ARIZONA DEPARTMENT OF TRANSPORTATION
BRIDGE DRAINAGE SECTION
PAVEMENT DRAINAGE CALCULATIONS

01-29-2007

PROJECT NAME- Pinnacle Peak Rd TRACS NO.- _____
HIGHWAY NAME- _____ DESIGNER - _____
LOCATION - _____ CHECKER - _____
VER 3.41 October 1996

CB 35

CURB OPENING INLET -- ON GRADE

GUTTER FLOW HYDRAULICS
GUTTER DESCRIPTION

Roadway Grade-% Per cent--G	=	0.800
Roadway Cross-Slope-Ft./Ft.--Sx	=	0.026
Shoulder Width-Ft.--	=	2.000
Shoulder Slope-Ft./Ft.--Ss	=	0.026
Gutter Width-Ft.--W	=	1.500
Gutter Slope-Ft./Ft.--Sw	=	0.059
Gutter Depression-Inches--	=	1.062
Manning's 'N	=	0.015
Flow-CFS--Q	=	2.900
SPREAD-Ft.--T	=	9.023
Average Velocity-V-fps	=	2.647
FLOW in Gutter-CFS--Q	=	1.244
% Flow in Gutter-CFS	=	42.913
Velocity of Flow in Gutter-fps	=	3.459
Depth at Curb Line-Inches--d	=	3.409

CURB OPENING--ADOT STD. C-15.20

Flow-CFS--Q	=	2.900
Gutter Velocity at INLET-fps	=	4.083
GUTTER FLOW at INLET-CFS--Q	=	1.806
Depth at INLET Curb Line-Inches--d	=	7.070
Local Gutter Depression-Inches	=	2.000
Length of opening: TOTAL Intercept--Ft.	=	12.485
Capture Ratio -- CURB OPENING	=	0.800

LENGTH	Efficiency	Q(Captured)	Q(By-Pass)
3.083	0.400	1.159	1.741
6.583	0.740	2.147	0.753
9.583	0.928	2.690	0.210
→13.583	1.000	2.900	0.000 ←
20.583	1.000	2.900	0.000

ARIZONA DEPARTMENT OF TRANSPORTATION
BRIDGE DRAINAGE SECTION
PAVEMENT DRAINAGE CALCULATIONS

01-29-2007

PROJECT NAME- Pinnacle Peak Rd TRACS NO.- _____
HIGHWAY NAME- _____ DESIGNER - _____
LOCATION - _____ CHECKER - _____
VER 3.41 October 1996

CB 4N

CURB OPENING INLET -- ON GRADE

GUTTER FLOW HYDRAULICS
GUTTER DESCRIPTION

Roadway Grade-% Per cent--G	=	2.400
Roadway Cross-Slope-Ft./Ft.--Sx	=	0.020
Shoulder Width-Ft.--	=	2.000
Shoulder Slope-Ft./Ft.--Ss	=	0.020
Gutter Width-Ft.--W	=	1.500
Gutter Slope-Ft./Ft.--Sw	=	0.059
Gutter Depression-Inches--	=	1.062
Manning's 'N	=	0.015
Flow-CFS--Q	=	2.800
SPREAD-Ft.--T	=	8.349
Average Velocity-V-fps	=	3.779
FLOW in Gutter-CFS--Q	=	1.358
% Flow in Gutter-CFS	=	48.489
Velocity of Flow in Gutter-fps	=	4.994
Depth at Curb Line-Inches--d	=	2.706

CURB OPENING--ADOT STD. C-15.20

Flow-CFS--Q	=	2.800
Gutter Velocity at INLET-fps	=	6.133
GUTTER FLOW at INLET-CFS--Q	=	2.122
Depth at INLET Curb Line-Inches--d	=	6.300
Local Gutter Depression-Inches	=	2.000
Length of opening: TOTAL Intercept--Ft.	=	15.683
Capture Ratio -- CURB OPENING	=	0.800

LENGTH	Efficiency	Q(Captured)	Q(By-Pass)
3.083	0.326	0.912	1.888
6.583	0.625	1.749	1.051
9.583	0.817	2.288	0.512
13.583	0.973	2.725	0.075
→ 20.583	1.000	2.800	0.000 ←

ARIZONA DEPARTMENT OF TRANSPORTATION
BRIDGE DRAINAGE SECTION
PAVEMENT DRAINAGE CALCULATIONS

01-29-2007

PROJECT NAME- Pinnacle Peak Rd TRACS NO.- _____
HIGHWAY NAME- _____ DESIGNER - _____
LOCATION - _____ CHECKER - _____
VER 3.41 October 1996

CB 45

CURB OPENING INLET -- ON GRADE

GUTTER FLOW HYDRAULICS
GUTTER DESCRIPTION

Roadway Grade-% Per cent--G	=	2.300
Roadway Cross-Slope-Ft./Ft.--Sx	=	0.020
Shoulder Width-Ft.--	=	2.000
Shoulder Slope-Ft./Ft.--Ss	=	0.020
Gutter Width-Ft.--W	=	1.500
Gutter Slope-Ft./Ft.--Sw	=	0.059
Gutter Depression-Inches--	=	1.062
Manning's 'N	=	0.015
Flow-CFS--Q	=	2.800
SPREAD-Ft.--T	=	8.423
Average Velocity-V-fps	=	3.717
FLOW in Gutter-CFS--Q	=	1.347
% Flow in Gutter-CFS	=	48.108
Velocity of Flow in Gutter-fps	=	4.915
Depth at Curb Line-Inches--d	=	2.724

CURB OPENING--ADOT STD. C-15.20

Flow-CFS--Q	=	2.800
Gutter Velocity at INLET-fps	=	6.031
GUTTER FLOW at INLET-CFS--Q	=	2.104
Depth at INLET Curb Line-Inches--d	=	6.322
Local Gutter Depression-Inches	=	2.000
Length of opening: TOTAL Intercept--Ft.	=	15.553
Capture Ratio -- CURB OPENING	=	0.800

LENGTH	Efficiency	Q(Captured)	Q(By-Pass)
3.083	0.328	0.919	1.881
6.583	0.629	1.760	1.040
9.583	0.822	2.300	0.500
→13.583	0.976	2.732	0.068 ←
20.583	1.000	2.800	0.000

ARIZONA DEPARTMENT OF TRANSPORTATION
BRIDGE DRAINAGE SECTION
PAVEMENT DRAINAGE CALCULATIONS

01-29-2007

PROJECT NAME- Pinnacle Peak Rd TRACS NO.- _____
HIGHWAY NAME- _____ DESIGNER - _____
LOCATION - _____ CHECKER - _____
VER 3.41 October 1996

CB 5N

CURB OPENING INLET -- ON GRADE

GUTTER FLOW HYDRAULICS
GUTTER DESCRIPTION

Roadway Grade-% Per cent--G	=	1.500
Roadway Cross-Slope-Ft./Ft.--Sx	=	0.011
Shoulder Width-Ft.--	=	2.000
Shoulder Slope-Ft./Ft.--Ss	=	0.011
Gutter Width-Ft.--W	=	1.500
Gutter Slope-Ft./Ft.--Sw	=	0.059
Gutter Depression-Inches--	=	1.062
Manning's 'N	=	0.015
Flow-CFS--Q	=	1.900
SPREAD-Ft.--T	=	11.302
Average Velocity-V-fps	=	2.512
FLOW in Gutter-CFS--Q	=	0.805
% Flow in Gutter-CFS	=	42.363
Velocity of Flow in Gutter-fps	=	3.529
Depth at Curb Line-Inches--d	=	2.356

CURB OPENING--ADOT STD. C-15.20

Flow-CFS--Q	=	1.900
Gutter Velocity at INLET-fps	=	4.568
GUTTER FLOW at INLET-CFS--Q	=	1.418
Depth at INLET Curb Line-Inches--d	=	6.013
Local Gutter Depression-Inches	=	2.000
Length of opening: TOTAL Intercept--Ft.	=	11.790
Capture Ratio -- CURB OPENING	=	0.800

LENGTH	Efficiency	Q(Captured)	Q(By-Pass)
3.083	0.421	0.799	1.101
6.583	0.770	1.464	0.436
9.583	0.951	1.807	0.093
13.583	1.000	1.900	0.000
→ 20.583	1.000	1.900	0.000 ←

ARIZONA DEPARTMENT OF TRANSPORTATION
BRIDGE DRAINAGE SECTION
PAVEMENT DRAINAGE CALCULATIONS

01-29-2007

PROJECT NAME- Pinnacle Peak Rd TRACS NO.- _____
HIGHWAY NAME- _____ DESIGNER - _____
LOCATION - _____ CHECKER - _____
VER 3.41 October 1996

CB 55

CURB OPENING INLET -- ON GRADE

GUTTER FLOW HYDRAULICS
GUTTER DESCRIPTION

Roadway Grade-% Per cent--G	=	2.010
Roadway Cross-Slope-Ft./Ft.--Sx	=	0.030
Shoulder Width-Ft.--	=	2.000
Shoulder Slope-Ft./Ft.--Ss	=	0.030
Gutter Width-Ft.--W	=	1.500
Gutter Slope-Ft./Ft.--Sw	=	0.059
Gutter Depression-Inches--	=	1.062
Manning's 'N	=	0.015
Flow-CFS--Q	=	5.600
SPREAD-Ft.--T	=	8.942
Average Velocity-V-fps	=	4.546
FLOW in Gutter-CFS--Q	=	2.363
% Flow in Gutter-CFS	=	42.201
Velocity of Flow in Gutter-fps	=	5.890
Depth at Curb Line-Inches--d	=	3.741

CURB OPENING--ADOT STD. C-15.20

Flow-CFS--Q	=	5.600
Gutter Velocity at INLET-fps	=	6.842
GUTTER FLOW at INLET-CFS--Q	=	3.319
Depth at INLET Curb Line-Inches--d	=	7.411
Local Gutter Depression-Inches	=	2.000
Length of opening: TOTAL Intercept--Ft.	=	22.013
Capture Ratio -- CURB OPENING	=	0.800

LENGTH	Efficiency	Q(Captured)	Q(By-Pass)
3.083	0.238	1.332	4.268
6.583	0.472	2.646	2.954
9.583	0.643	3.598	2.002
13.583	0.822	4.605	0.995
→ 20.583	0.993	5.559	0.041 ←

Pinnacle Peak Road, Scottsdale Rd to Miller Rd
City of Scottsdale
RATIONAL METHOD
100-YEAR STORM
Wood/Patel Project No: 042309.6

NOTES:

1. Runoff Coefficients are area-weighted when more than one land use is present.
2. The minimum time of concentration is 10 minutes.
3. Calculated discharges rounded to 0.1 cfs for design.

Sub Area ID	Drainage Area		Length (ft)	Width (ft)	Area (ac)	Avg. C	Design Tc (hr)	Design i (in/hr)	Q_{100} (cfs)
	Upstream	Downstream							
1N	N Miller	22+37	1150	varies	1.42	0.95	0.17	7.25	**9.8**
1S	27+78	22+37	541	varies	0.88	0.95	0.17	7.25	**6.1**
2N	22+37	18+25	412	varies	0.57	0.95	0.17	7.25	**3.9**
2S	22+37	18+25	412	varies	0.59	0.95	0.17	7.25	**4.1**
3N	18+25	13+50	475	varies	0.64	0.95	0.17	7.25	**4.4**
3S	18+25	13+50	475	varies	0.65	0.95	0.17	7.25	**4.5**
4N	13+50	08+50	500	varies	0.62	0.95	0.17	7.25	**4.3**
4S	13+50	08+50	500	varies	0.63	0.95	0.17	7.25	**4.3**
5N	08+50	05+68	282	varies	0.41	0.95	0.17	7.25	**2.8**
5S	08+50	03+25	525	varies	1.21	0.95	0.17	7.25	**8.3**

Channel Hydraulics

Worksheet for Section - A

Project Description		
Flow Element:	Trapezoidal Channel	
Friction Method:	Manning Formula	
Solve For:	Normal Depth	

Input Data		
Roughness Coefficient:	0.035	
Channel Slope:	0.01500	ft/ft
Left Side Slope:	5.00	ft/ft (H:V)
Right Side Slope:	5.00	ft/ft (H:V)
Bottom Width:	0.00	ft
Discharge:	300.00	ft^3/s

Results		
Normal Depth:	2.99	ft
Flow Area:	44.71	ft^2
Wetted Perimeter:	30.49	ft
Top Width:	29.90	ft
Critical Depth:	2.95	ft
Critical Slope:	0.01610	ft/ft
Velocity:	6.71	ft/s
Velocity Head:	0.70	ft
Specific Energy:	3.69	ft
Froude Number:	0.97	
Flow Type:	Subcritical	

GVF Input Data		
Downstream Depth:	0.00	ft
Length:	0.00	ft
Number Of Steps:	0	

GVF Output Data		
Upstream Depth:	0.00	ft
Profile Description:		
Headloss:	0.00	ft
Downstream Velocity:	Infinity	ft/s
Upstream Velocity:	Infinity	ft/s
Normal Depth:	2.99	ft
Critical Depth:	2.95	ft
Channel Slope:	0.01500	ft/ft

Worksheet for Section - A

Critical Slope:	0.01610	ft/ft

Worksheet for Section - B

Project Description		
Flow Element:	Trapezoidal Channel	
Friction Method:	Manning Formula	
Solve For:	Normal Depth	

Input Data		
Roughness Coefficient:	0.035	
Channel Slope:	0.01400	ft/ft
Left Side Slope:	5.00	ft/ft (H:V)
Right Side Slope:	5.00	ft/ft (H:V)
Bottom Width:	2.00	ft
Discharge:	300.00	ft^3/s

Results		
Normal Depth:	2.84	ft
Flow Area:	45.90	ft^2
Wetted Perimeter:	30.93	ft
Top Width:	30.36	ft
Critical Depth:	2.76	ft
Critical Slope:	0.01608	ft/ft
Velocity:	6.54	ft/s
Velocity Head:	0.66	ft
Specific Energy:	3.50	ft
Froude Number:	0.94	
Flow Type:	Subcritical	

GVF Input Data		
Downstream Depth:	0.00	ft
Length:	0.00	ft
Number Of Steps:	0	

GVF Output Data		
Upstream Depth:	0.00	ft
Profile Description:		
Headloss:	0.00	ft
Downstream Velocity:	Infinity	ft/s
Upstream Velocity:	Infinity	ft/s
Normal Depth:	2.84	ft
Critical Depth:	2.76	ft
Channel Slope:	0.01400	ft/ft

Worksheet for Section - B

Critical Slope:	0.01608	ft/ft

Box Culverts 1 & 2

BOX CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE

October 25, 2006

PROGRAM INPUT DATA

DESCRIPTION	VALUE
Culvert Span (ft)	10.0
Culvert Rise (ft)	3.0
FHWA Chart Number	9
FHWA Scale Number (Type of Culvert Entrance)	1
Manning's Roughness Coefficient (n-value)	0.025
Entrance Loss Coefficient of Culvert Opening	0.05
Culvert Length (ft)	95.0
Invert Elevation at Downstream end of Culvert (ft)	1,864.15
Invert Elevation at Upstream end of Culvert (ft)	1,865.44
Culvert Slope (ft/ft)	0.0136
Starting Flow Rate (cfs)	280.0
Incremental Flow Rate (cfs)	10.0
Ending Flow Rate (cfs)	380.0
Starting Tailwater Depth (ft)	0.0
Incremental Tailwater Depth (ft)	1.0
Ending Tailwater Depth (ft)	10.0

COMPUTATION RESULTS

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
280.0	0.0	5.07	0.0	2.76	2.9	2.76	10.16
290.0	1.0	5.27	0.0	2.82	2.97	2.82	10.27
→ 300.0	2.0	5.47	0.0	2.89	3.0	2.89	10.37 ←
310.0	3.0	5.68	5.82	2.96	3.0	3.0	10.33
320.0	4.0	5.9	7.09	3.0	3.0	3.0	10.67
330.0	5.0	6.12	8.37	3.0	3.0	3.0	11.0
340.0	6.0	6.35	9.66	3.0	3.0	3.0	11.33
350.0	7.0	6.59	10.96	3.0	3.0	3.0	11.67
360.0	8.0	6.83	12.26	3.0	3.0	3.0	12.0
370.0	9.0	7.08	13.57	3.0	3.0	3.0	12.33
380.0	10.0	7.34	14.89	3.0	3.0	3.0	12.67

Project SILVERSTONE
Project No. 042309.06
Sheet No. 1 of 1
Calculated by JLL Date 1-29-07

WEIR FLOW COMPUTATIONS

LOCATION/DESCRIPTION:

PINNACLE PEAK CHANNEL OUTFALL OVER SOUTHEAST WINGWALL OF PINNACLE PEAK BRIDGE. Q ≅ 256 CFS

CROSS SECTION PARAMETERS: FILENAME: PPWEIR1.SEC

No. of Cross Section Points:	4	Bed Slope:	0.00500	Max Elev.:	59.70
Bank Stations.....Left:	0.0	Right....:	63.1	Min Elev.:	51.00
Encroachment Stations..Left:		Right....:		Weir Coef:	2.700

CROSS SECTION POINTS - Elevations & Stations in feet:

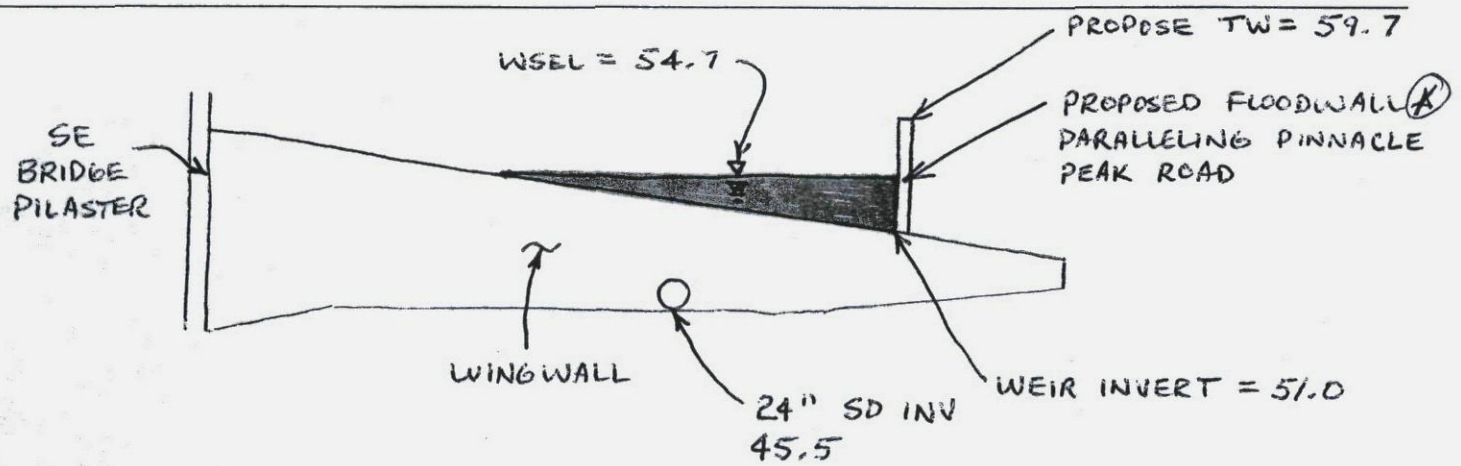
No.	Elev.	Sta.	No.	Elev.	Sta.	No.	Elev.	Sta.
1)	59.70	0.00	2)	57.90	0.10	3)	51.00	63.00
4)	59.70	63.10						

COMPUTED PARAMETERS:

WSEL(ft)	Q(cfs)	H:max(ft)	H:ave(ft)	TW(ft)	A(sf)
53.00	55.8	2.00	1.00	18.3	18.3
54.00	153.7	3.00	1.50	27.4	41.1
54.50	225.9	3.50	1.75	31.9	55.9
54.60	242.4	3.60	1.80	32.9	59.1
→ 54.70	259.6	3.70	1.85	33.8	62.5

NOTES:

(A) Future Proposed Floodwall is being done "by others." The conditions with the floodwall is beleived to be the worst case scenario. Without the floodwall, the water would weir over a lot greater area.



Grate Opening System in Pinnacle Peak Channel

(Just east of Rawhide Wash)

SILVERSONE PINNACLE PEAK ROAD CHANNEL

Weir EQ. $Q_i = C_w P d^{1.5} Cf$ Orifice EQ. $Q_i = C_o A (2gd)^{0.5} Cf$

Where: C_w = 3.0 and C_o = 0.67 and Cf = clogging factor = 0.5

Double Grate

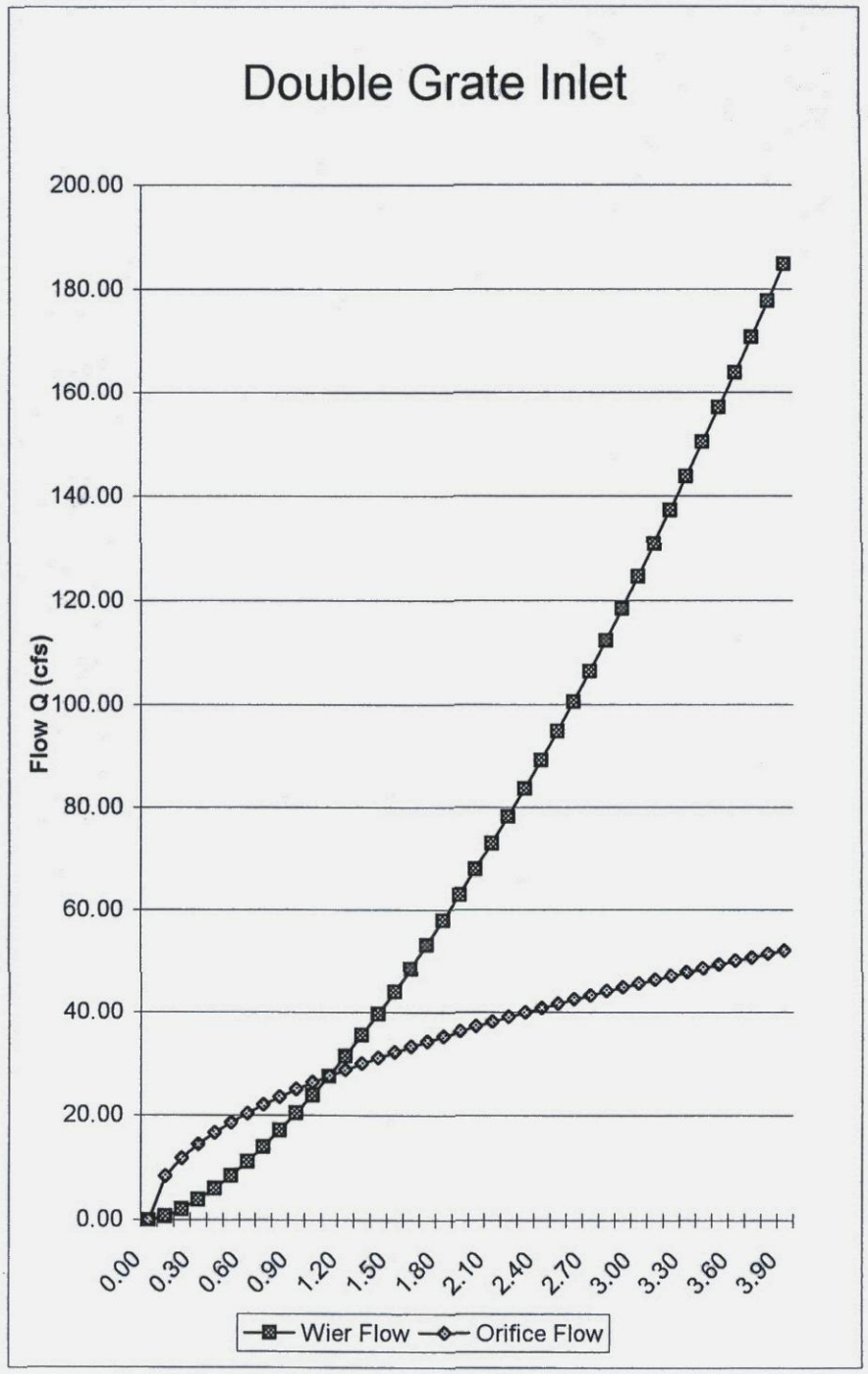
P = 16.00 ft

A = 9.82 ft^2

ADOT, C 15.80 double catch basin

Grate Opening

	Depth (ft)	Weir Qi (cfs)	Orifice Qi (cfs)
	0.00	**0.00**	0.00
	0.10	**0.76**	8.35
	0.20	**2.15**	11.81
	0.30	**3.94**	14.46
	0.40	**6.07**	16.70
NUISANCE FLOW HEAD	0.50	**8.49**	18.67
	0.60	**11.15**	20.45
	0.70	**14.06**	22.09
	0.80	**17.17**	23.61
	0.90	**20.49**	25.04
	1.00	**24.00**	26.40
	1.10	27.69	**27.69**
	1.20	31.55	**28.92**
	1.30	35.57	**30.10**
	1.40	39.76	**31.24**
	1.50	44.09	**32.33**
	1.60	48.57	**33.39**
	1.70	53.20	**34.42**
	1.80	57.96	**35.42**
	1.90	62.86	**36.39**
	2.00	67.88	**37.33**
	2.10	73.04	**38.26**
	2.20	78.32	**39.16**
	2.30	83.71	**40.04**
	2.40	89.23	**40.90**
	2.50	94.87	**41.74**
	2.60	100.62	**42.57**
	2.70	106.48	**43.38**
NORMAL DEPTH IN CHANNEL	2.80	112.45	**44.18**
	2.90	118.52	**44.96**
	3.00	124.71	**45.73**
	3.10	130.99	**46.48**
	3.20	137.38	**47.23**
	3.30	143.87	**47.96**
	3.40	150.46	**48.68**
	3.50	157.15	**49.39**
	3.60	163.93	**50.09**
	3.70	170.81	**50.78**
	3.80	177.78	**51.46**
	3.90	184.85	**52.14**

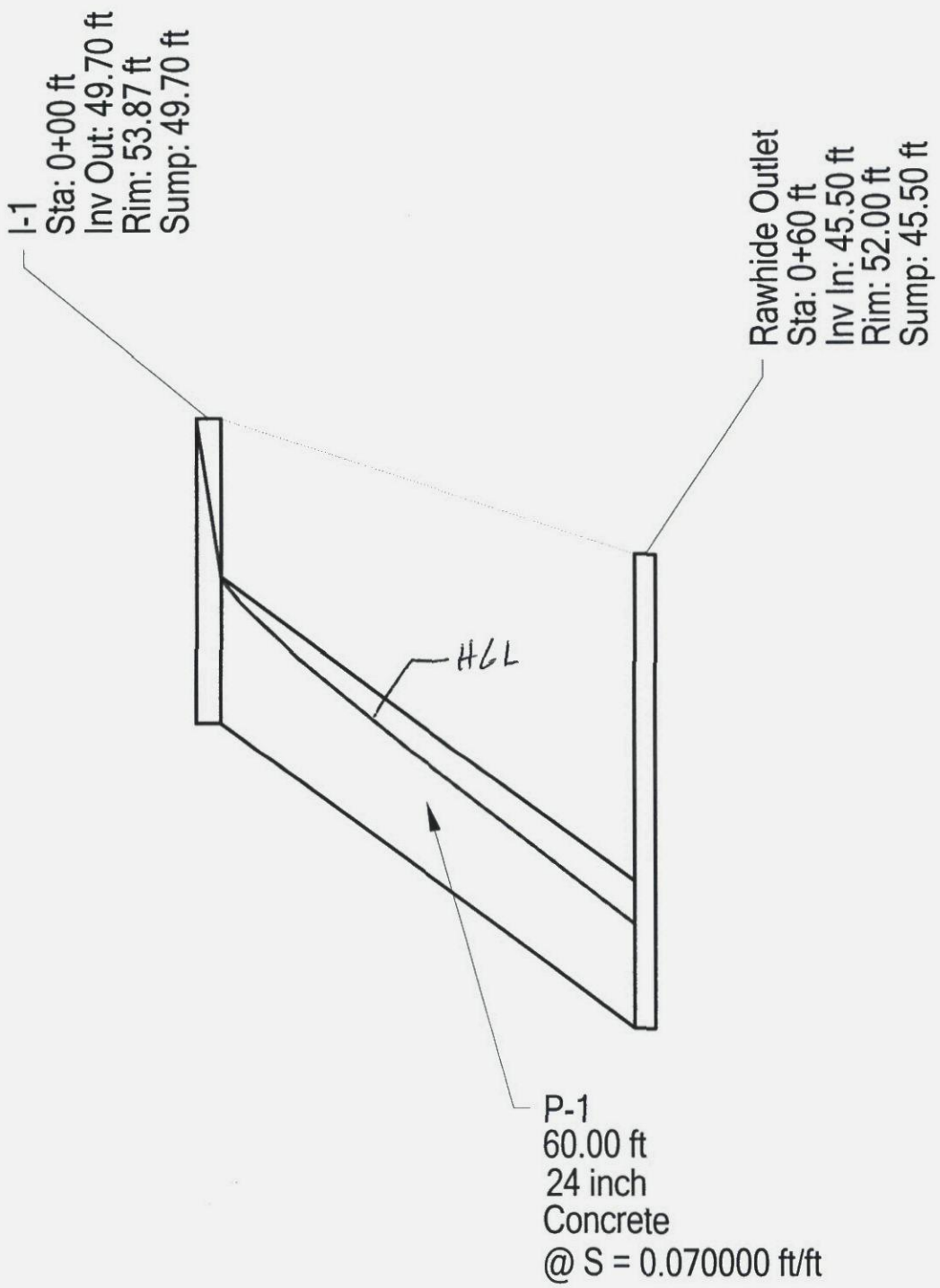


Scenario: Base

Pipe Report

Label	Upstream Node	Downstream Node	Total System Flow (cfs)	Length (ft)	Constructed Slope (ft/ft)	Section Size	Mannings n	Full Capacity (cfs)	Upstream Invert Elevation (ft)	Downstream Invert Elevation (ft)	Upstream Ground Elevation (ft)	Downstream Ground Elevation (ft)	Upstream Cover (ft)	Downstream Cover (ft)	Hydraulic Grade Line In (ft)	Hydraulic Grade Line Out (ft)	Description
P-1	I-1	Rawhide Out	44.18	60.00	0.070000	24 inch	0.013	59.85	49.70	45.50	53.87	52.00	2.17	4.50	51.67	46.93	

Profile: Grate Opening Profile



Riprap Design

Box Culvert 1 & 2

Riprap Design Spreadsheet

References: US DOT, FHWA, Highways in the River Environment
Hydraulic and Environmental Design Considerations
May 1975, pVI-24.

US DOT, FHWA, Hydraulic Design of Energy Dissipators
for Culverts and Channel. Sept. 1983, pII-5-II-9.

FCDMC, Drainage Design Manual for Maricpa County
Arizona, Vol. II - Hydraulics. January 1996, p5.75-5.77.

Project Name: Williams Drive

Wood/Patel # 042309.05
Location: @Sta 21&15+00

1. Riprap Size D50

Max. flow width Wo =	30	ft
Max. culvert flow depth h =	3	ft
Tailwater depth TW =	2.8	ft
Exit Velocity Ve =	10.4	fps
Tailwater velocity Vd =	6.5	fps
Wash bottom width =	2	ft
Computed Riprap Size D50 =	8.5	in
Design Riprap Size D50 =	**9**	in

2. Riprap Sizes D15 and D85

Design Riprap Size D15 =	**4**	in
Design Riprap Size D85 =	**14**	in

3. Riprap Apron Length

Riprap Apron Length =	**20**	ft

4. Rirap Apron Width

Max. Riprap Apron Width =	**36**	ft
Min. Riprap Apron Width =	**8**	ft

5. Riprap Thickness

Riprap Thickness =	**18**	in

6. Total Riprap Volume

Riprap Rock Volume =	**24**	CY

APPENDIX B

Street Capacity Calculations

Street Capacity Computations

10-year Flow Depth

Description: Calculation of Arterial Street Flow Conveyance Capacity with 12' dry lane

References: Federal Highway Administration, Hydraulic Engineering Circular No. 22, "Drainage of Highway Pavements", Novemer 1996

Known Values:

Depth of Flow = 0.28 ft (10-Year)

Cross Slope = 0.02 $^{ft}/_{ft}$

Street Width (F/C to F/C) = 60 ft

Manning's "n" Value= 0.015

Calculated Values:

Referenced Equations:

$Q = 0.56 * (S_x^{1.67}) * (S^{0.5}) * (T^{2.67}) / n$ for flow below crown (FHWA Procedure)

$Q = 1.486 * A * (R^{0.67}) * (S^{0.5}) / n$ for flow above crown (Manning's equation)

where Q = flow rate, cfs; T = width of flow, ft

S_x = cross slope, ft/ft; A = conveyance area, sq ft

S = longitudinal slope, ft/ft; R = hydraulic radius, ft

	Longitudinal Slope ft/ft	*Conveyance Area sq ft*	*Velocity fps*	*Full Street Flow Capacity (1) cfs*	*1/2 Street Flow Without Overtopping, cfs (1)(2)*	*1/2 Street Flow with Overtopping, cfs (1)(3)*
	0.0010	3.92	1.01	4	2	2
	0.0020	3.92	1.42	6	3	3
	0.0030	3.92	1.74	7	3	3
	0.0040	3.92	2.01	8	4	4
	0.0050	3.92	2.25	9	4	4
	0.0060	3.92	2.46	10	5	5
	0.0070	3.92	2.66	10	5	5
	0.0080	3.92	2.85	11	6	6
	0.0090	3.92	3.02	12	6	6
	0.0100	3.92	3.18	12	6	6
	0.0110	3.92	3.34	13	7	7
	0.0120	3.92	3.49	14	7	7
	0.0130	3.92	3.63	14	7	7
Avg Slope	0.0140	3.92	3.77	15	7	7
	0.0150	3.92	3.90	15	8	8
	0.0160	3.92	4.03	16	8	8
	0.0170	3.92	4.15	16	8	8
	0.0180	3.92	4.27	17	8	8
	0.0190	3.92	4.39	17	9	9
	0.0200	3.92	4.50	18	9	9
	0.0210	3.92	4.61	18	9	9
	0.0220	3.92	4.72	19	9	9

Notes:

1.) Street flow capacity does not include local gutter depression effect.

2.) Half-street flow capacity is limited to the lower of the crown elevation or top of curb elevation.

3.) Includes flows above the crown elevation up to the specified flow depth elevation.

Street Capacity Computations

100-year Flow Depth

Description: Calculation of Arterial Street Flow Conveyance Capacity

References: Federal Highway Administration, Hydraulic Engineering Circular No. 22, "Drainage of Highway Pavements", Novemer 1996

Known Values:

Depth of Flow = 1 ft (100-Year)

Cross Slope = 0.02 $^{ft}/_{ft}$

Street Width (**F/C to F/C**) = 60 ft

Manning's "n" Value= 0.015

Calculated Values:

Referenced Equations:

$Q = 0.56 * (S_x^{1.67}) * (S^{0.5}) * (T^{2.67}) / n$ for flow below crown (FHWA Procedure)

$Q = 1.486 * A * (R^{0.67}) * (S^{0.5}) / n$ for flow above crown (Manning's equation)

where Q = flow rate, cfs; T = width of flow, ft

S_x = cross slope, ft/ft; A = conveyance area, sq ft

S = longitudinal slope, ft/ft; R = hydraulic radius, ft

	Longitudinal Slope ft/ft	*Conveyance Area sq ft*	*Velocity fps*	*Full Street Flow Capacity[1] cfs*	*1/2 Street Flow Without Overtopping, cfs[1][2]*	*1/2 Street Flow with Overtopping, cfs[1][3]*
	0.0020	42.00	3.41	143	21	72
	0.0030	42.00	4.18	176	26	88
	0.0040	42.00	4.83	203	30	101
	0.0050	42.00	5.40	227	34	113
	0.0060	42.00	5.91	248	37	124
	0.0070	42.00	6.38	268	40	134
	0.0080	42.00	6.82	287	43	143
	0.0090	42.00	7.24	304	45	152
	0.0100	42.00	7.63	320	48	160
	0.0110	42.00	8.00	336	50	168
	0.0120	42.00	8.36	351	52	176
	0.0130	42.00	8.70	365	54	183
Avg Slope	0.0140	42.00	9.03	379	56	190
	0.0150	42.00	9.35	393	58	196
	0.0160	42.00	9.65	405	60	203
	0.0170	42.00	9.95	418	62	209
	0.0180	42.00	10.24	430	64	215
	0.0190	42.00	10.52	442	66	221
	0.0200	42.00	10.79	453	67	227
	0.0210	42.00	11.06	464	69	232
	0.0220	42.00	11.32	475	71	238
	0.0230	42.00	11.57	486	72	243
	0.0240	42.00	11.82	496	74	248
	0.0250	42.00	12.06	507	75	253

Notes:

1.) Street flow capacity does not include local gutter depression effect.

2.) Half-street flow capacity is limited to the lower of the crown elevation or top of curb elevation.

3.) Includes flows above the crown elevation up to the specified flow depth elevation.

APPENDIX C

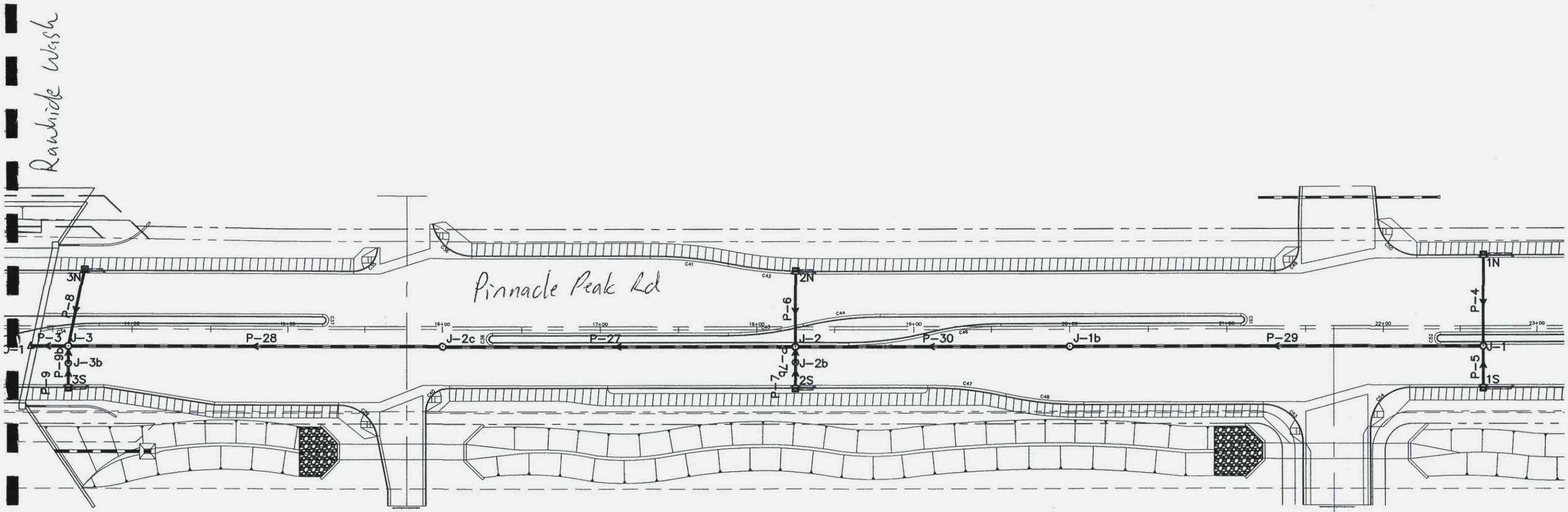
Storm Drain Design

Scenario: Base

Pipe Report

Label	Upstream Node	Downstream Node	Total System Flow (cfs)	Length (ft)	Constructed Slope (ft/ft)	Section Size	Mannings n	Full Capacity (cfs)	Upstream Invert Elevation (ft)	Downstream Invert Elevation (ft)	Upstream Ground Elevation (ft)	Downstream Ground Elevation (ft)	Upstream Cover (ft)	Downstream Cover (ft)	Hydraulic Grade Line In (ft)	Hydraulic Grade Line Out (ft)	Description
P-14	J-5	O-2	11.50	158.00	0.006582	24 inch	0.013	18.35	1,845.74	1,844.70	1,854.43	1,855.00	6.69	8.30	1,846.96	1,845.85	
P-13	Extra 1	J-5b	6.00	26.00	0.198462	18 inch	0.013	46.79	1,851.06	1,845.90	1,854.72	1,854.76	2.16	7.36	1,852.01	1,848.31	
P-13b	J-5b	J-5	11.50	25.20	0.006349	18 inch	0.013	8.37	1,845.90	1,845.74	1,854.76	1,854.43	7.36	7.19	1,847.72	1,847.42	
P-11	4S	J-4	2.70	50.00	0.007600	18 inch	0.013	9.16	1,846.90	1,846.52	1,850.94	1,850.99	2.54	2.97	1,848.84	1,848.80	
P-10	4N	J-4	2.80	36.00	0.010833	18 inch	0.013	10.93	1,847.17	1,846.78	1,850.71	1,850.99	2.04	2.71	1,848.83	1,848.80	
P-12	J-4	J-5b	5.50	140.00	0.004429	18 inch	0.013	6.99	1,846.52	1,845.90	1,850.99	1,854.76	2.97	7.36	1,848.70	1,848.31	
P-22	5S	O-3	13.50	27.00	0.006296	30 inch	0.013	32.54	1,836.67	1,836.50	1,842.40	1,842.00	3.23	3.00	1,837.91	1,837.64	
P-21	J-9	5S	7.90	27.00	0.012222	30 inch	0.013	45.34	1,837.00	1,836.67	1,843.23	1,842.40	3.73	3.23	1,838.35	1,838.39	
P-15	Extra 2	J-6	6.00	49.00	0.029592	18 inch	0.013	18.07	1,844.33	1,842.88	1,848.37	1,848.57	2.54	4.19	1,845.28	1,844.19	
P-16	J-6	J-7	6.00	170.00	0.009059	18 inch	0.013	10.00	1,842.88	1,841.34	1,848.57	1,846.29	4.19	3.45	1,843.83	1,842.63	
P-17	5N	J-7	1.90	60.00	0.019167	18 inch	0.013	14.54	1,842.39	1,841.24	1,845.90	1,846.29	2.01	3.55	1,842.91	1,842.63	
P-20	J-7	J-9	7.90	243.00	0.009218	24 inch	0.013	21.72	1,841.24	1,839.00	1,846.29	1,843.23	3.05	2.23	1,842.24	1,839.83	
P-3	J-3	O-1	22.00	24.00	0.012500	24 inch	0.013	25.29	1,845.30	1,845.00	1,857.88	1,858.50	10.58	11.50	1,846.98	1,846.51	
P-8	3N	J-3	3.00	51.00	0.157843	18 inch	0.013	41.73	1,853.35	1,845.30	1,857.58	1,857.88	2.73	11.08	1,854.01	1,847.64	
P-9	3S	J-3b	3.00	9.00	0.753333	18 inch	0.013	91.17	1,853.15	1,846.37	1,857.18	1,857.20	2.53	9.33	1,853.81	1,847.66	
P-9b	J-3b	J-3	3.00	22.00	0.048636	18 inch	0.013	23.16	1,846.37	1,845.30	1,857.20	1,857.88	9.33	11.08	1,847.65	1,847.64	
P-6	2N	J-2	2.90	49.00	0.116939	18 inch	0.013	35.92	1,858.94	1,853.21	1,862.98	1,863.05	2.54	8.34	1,859.59	1,855.13	
P-7	2S	J-2b	2.70	8.00	0.563750	18 inch	0.013	78.87	1,858.47	1,853.96	1,862.52	1,862.50	2.55	7.04	1,859.09	1,855.13	
P-7b	J-2b	J-2	2.70	21.00	0.035714	18 inch	0.013	19.85	1,853.96	1,853.21	1,862.50	1,863.05	7.04	8.34	1,855.12	1,855.13	
P-27	J-2	J-2c	16.00	225.00	0.016844	24 inch	0.013	29.36	1,853.21	1,849.42	1,863.05	1,860.67	7.84	9.25	1,854.65	1,850.47	
P-28	J-2c	J-3	16.00	240.00	0.016875	24 inch	0.013	29.39	1,849.35	1,845.30	1,860.67	1,857.88	9.32	10.58	1,850.79	1,847.64	
P-4	1N	J-1	6.40	59.00	0.016610	18 inch	0.013	13.54	1,866.73	1,865.75	1,870.81	1,870.88	2.58	3.63	1,867.71	1,867.04	
P-5	1S	J-1	4.00	27.00	0.006667	18 inch	0.013	8.58	1,865.93	1,865.75	1,869.98	1,870.88	2.55	3.63	1,867.05	1,867.04	
P-29	J-1	J-1b	10.40	265.00	0.027698	24 inch	0.013	37.65	1,865.50	1,858.16	1,870.88	1,865.94	3.38	5.78	1,866.65	1,858.88	
P-30	J-1b	J-2	10.40	175.00	0.027657	24 inch	0.013	37.62	1,858.05	1,853.21	1,865.94	1,863.05	5.89	7.84	1,859.20	1,855.13	

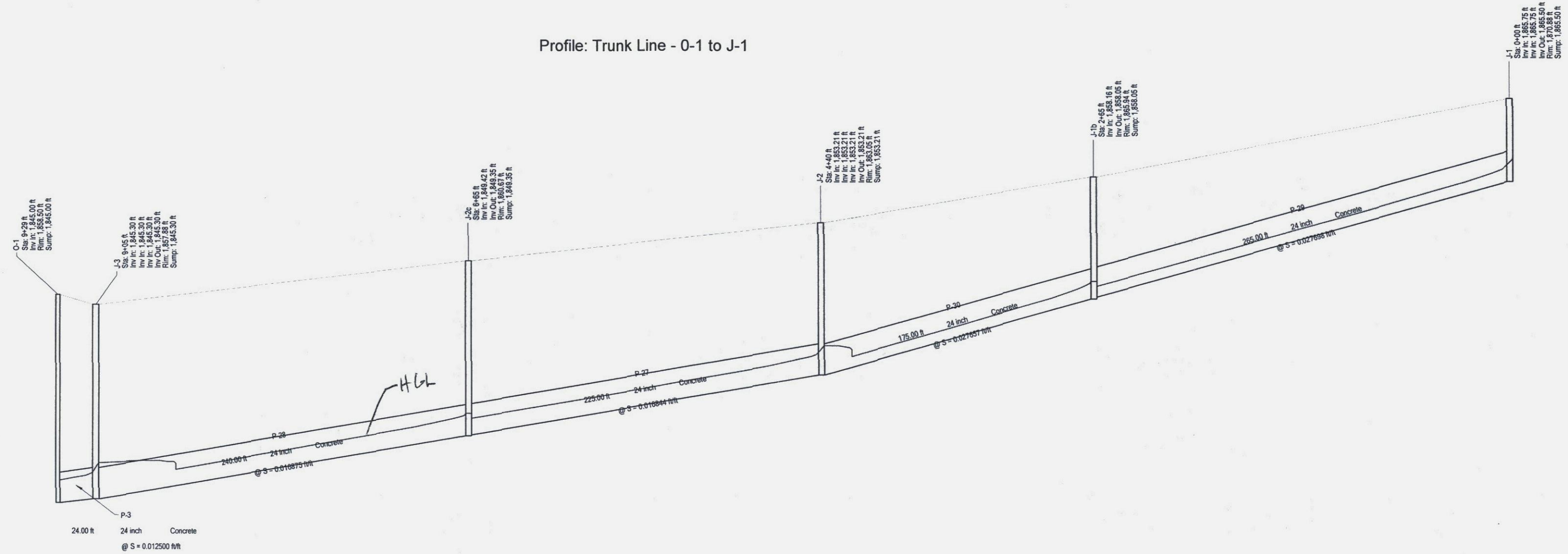
StormCad Model - Pinnacle Peak Rd



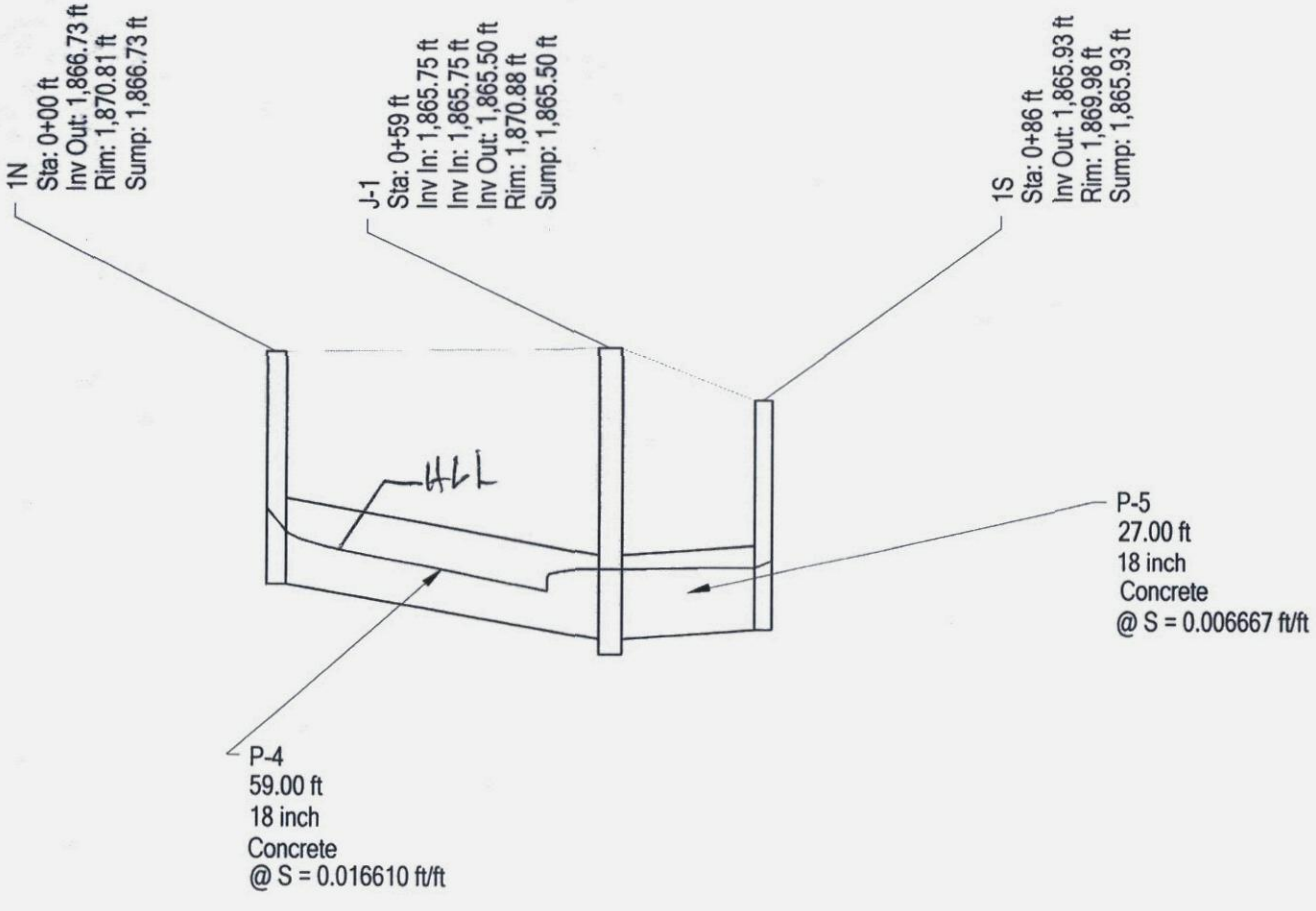
1N 1"=60'

Profile
Scenario: Base

Profile: Trunk Line - 0-1 to J-1



Profile: Lateral 1N&1S



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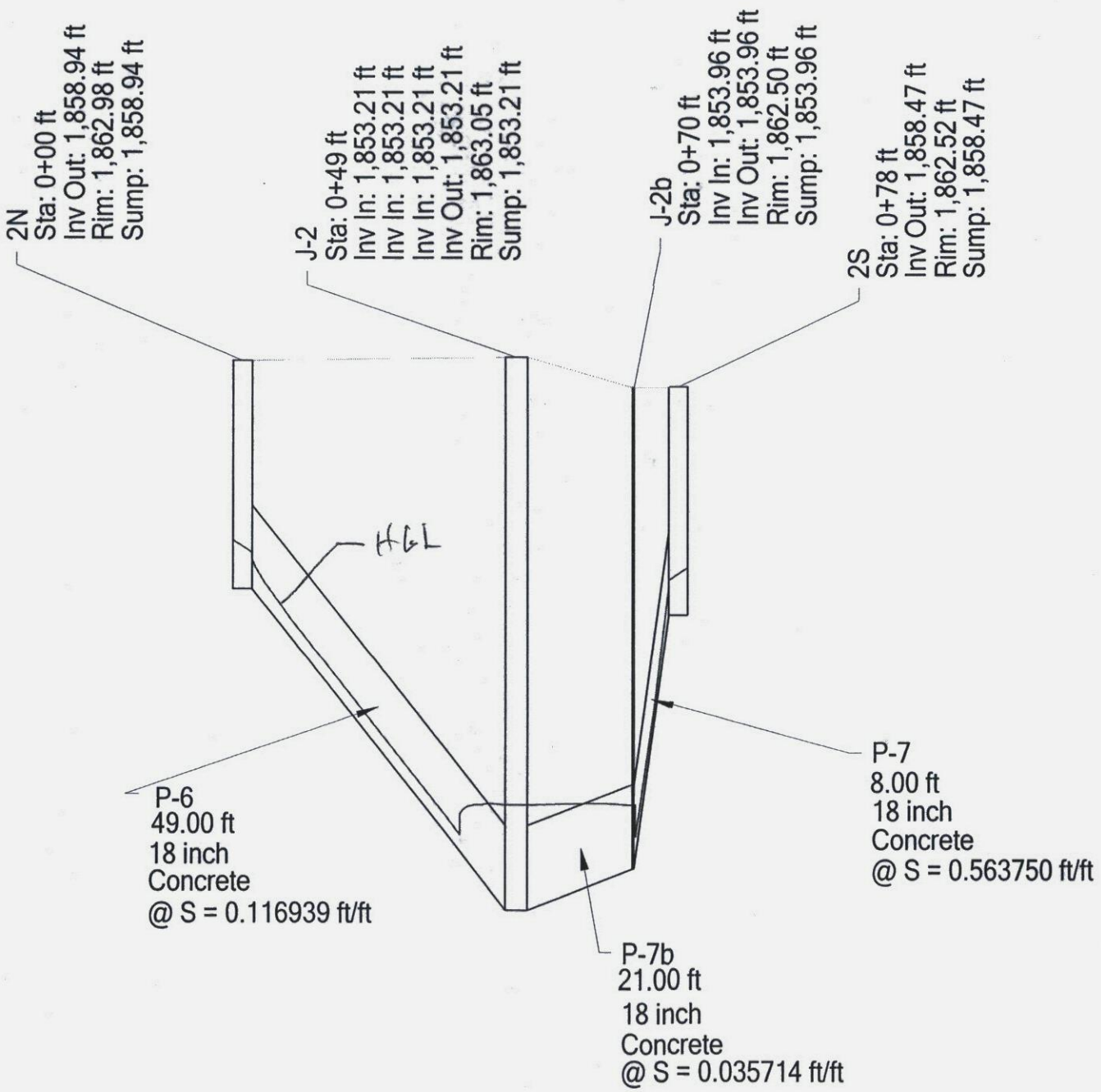

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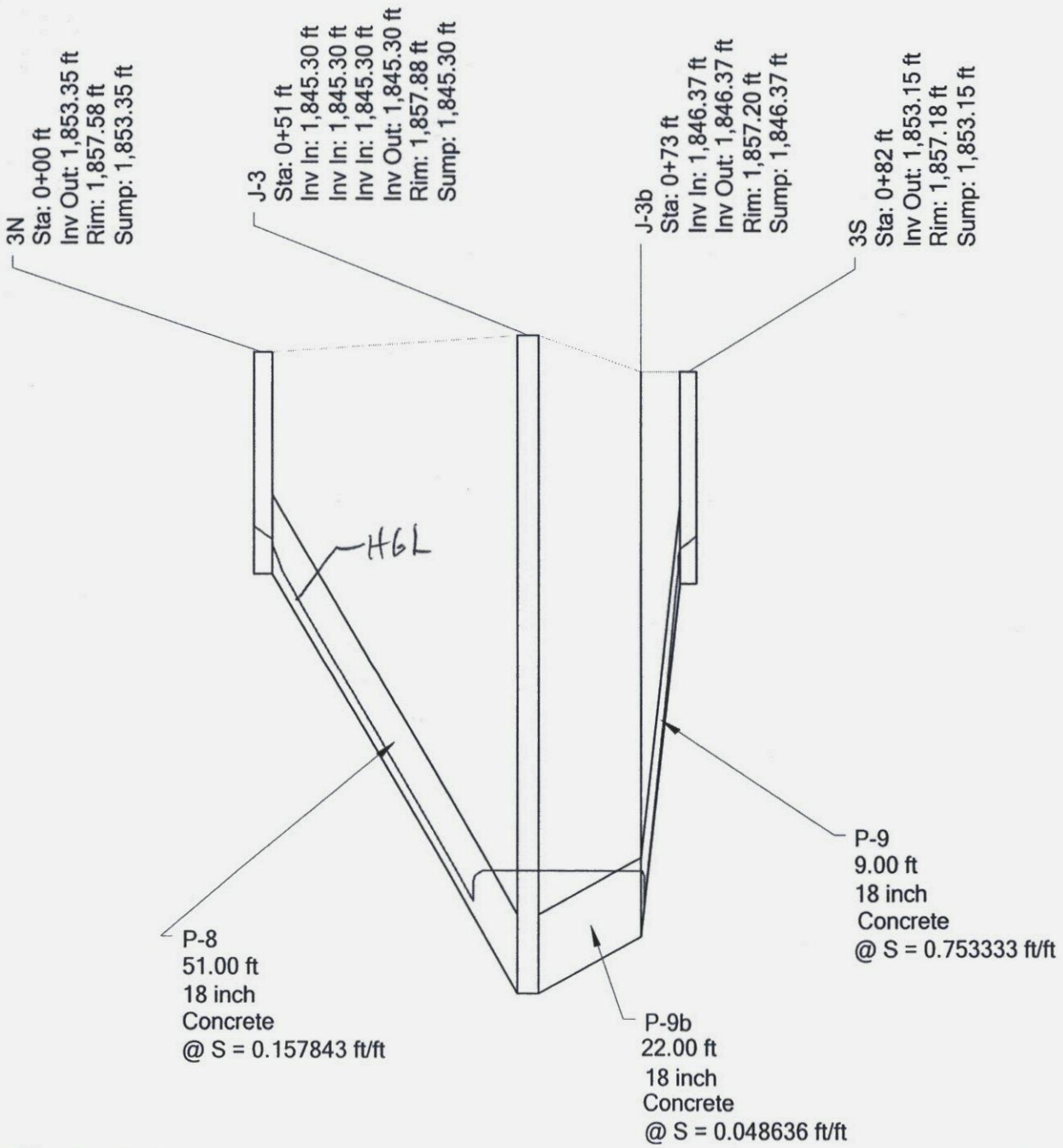
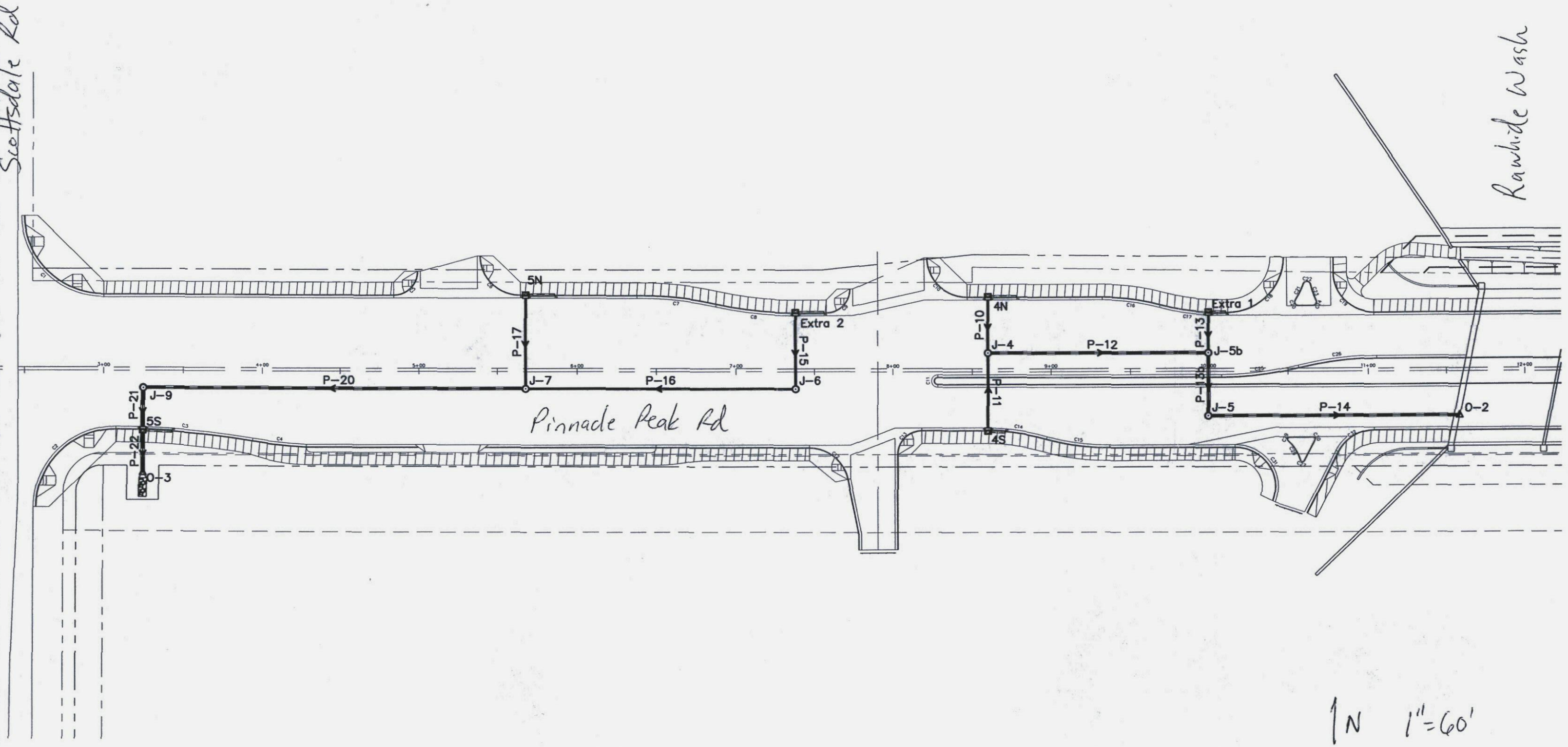


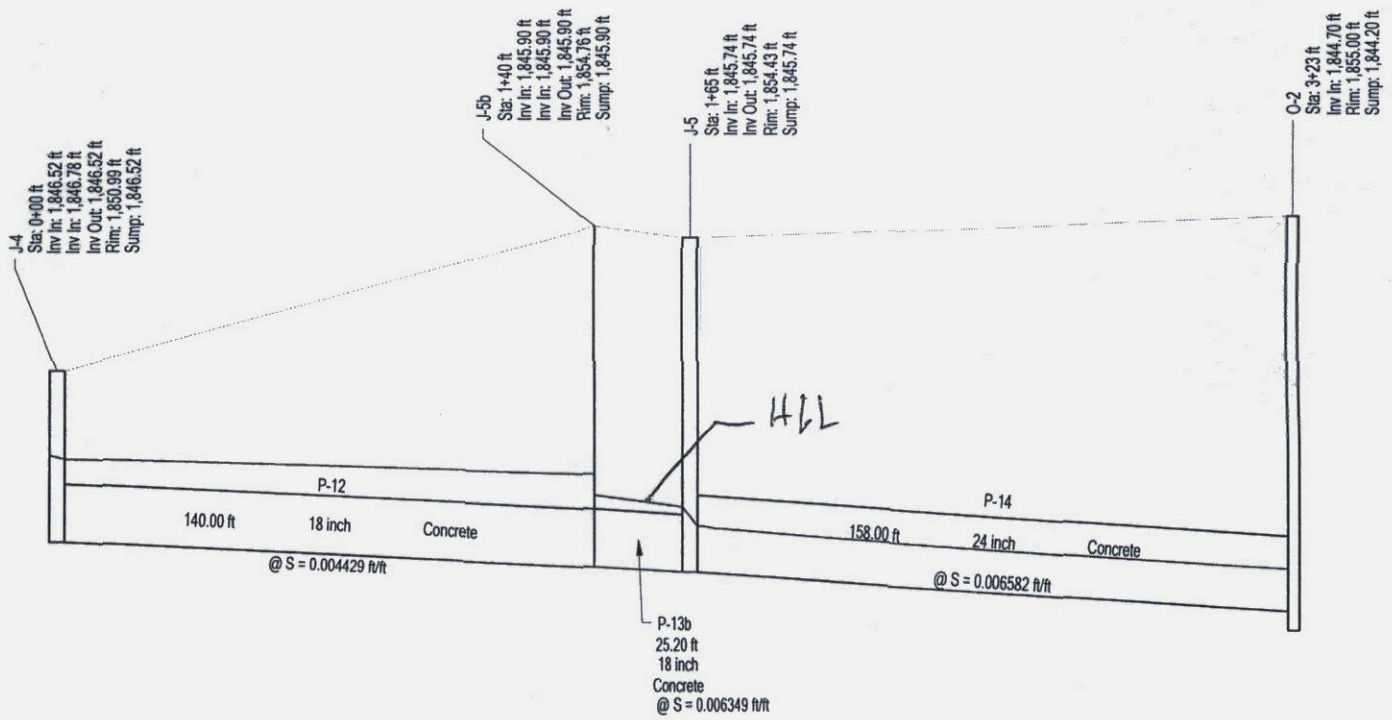
StormCad Model - Pinnacle Peak Rd



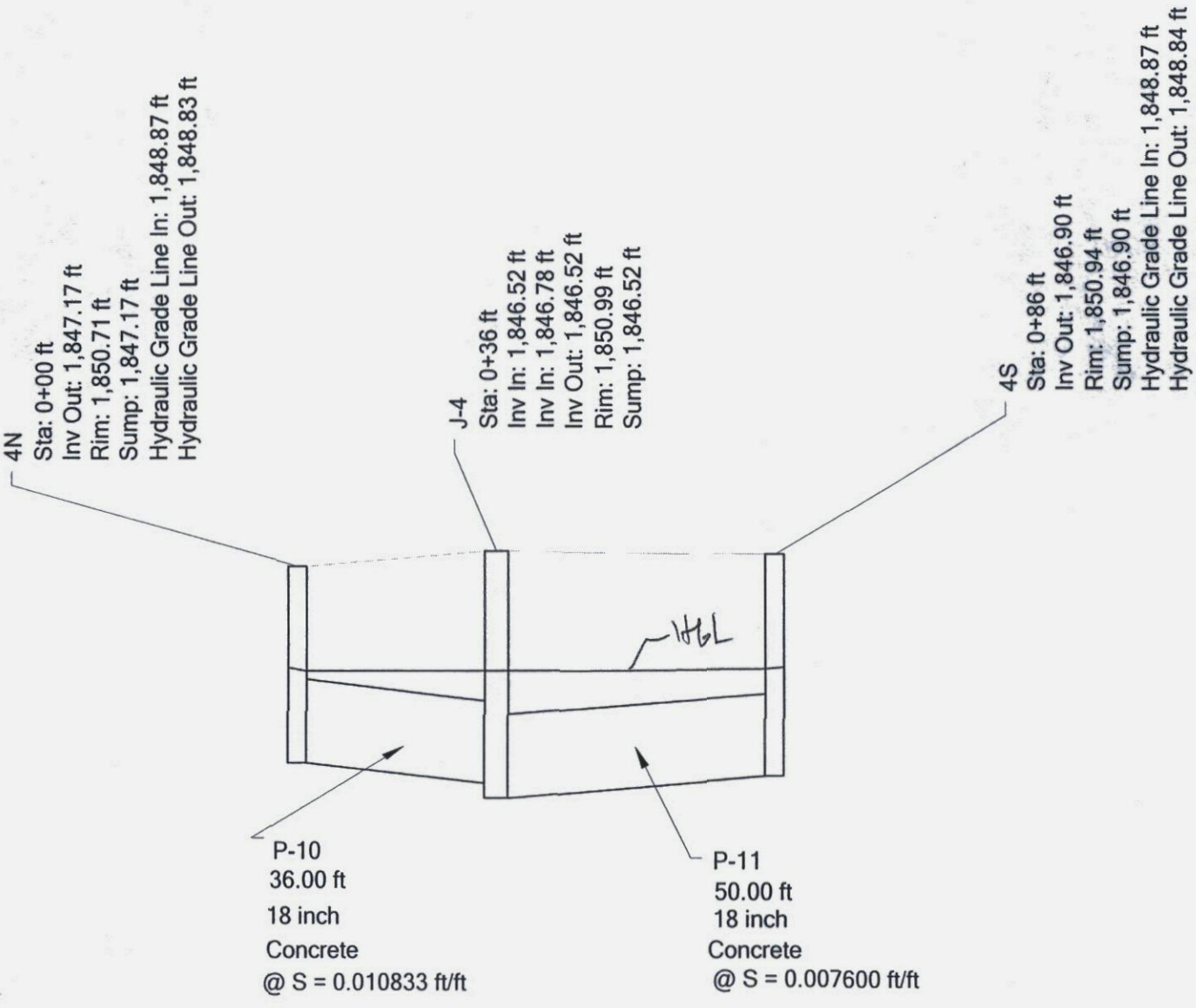
N 1"=60'

Profile
Scenario: Base

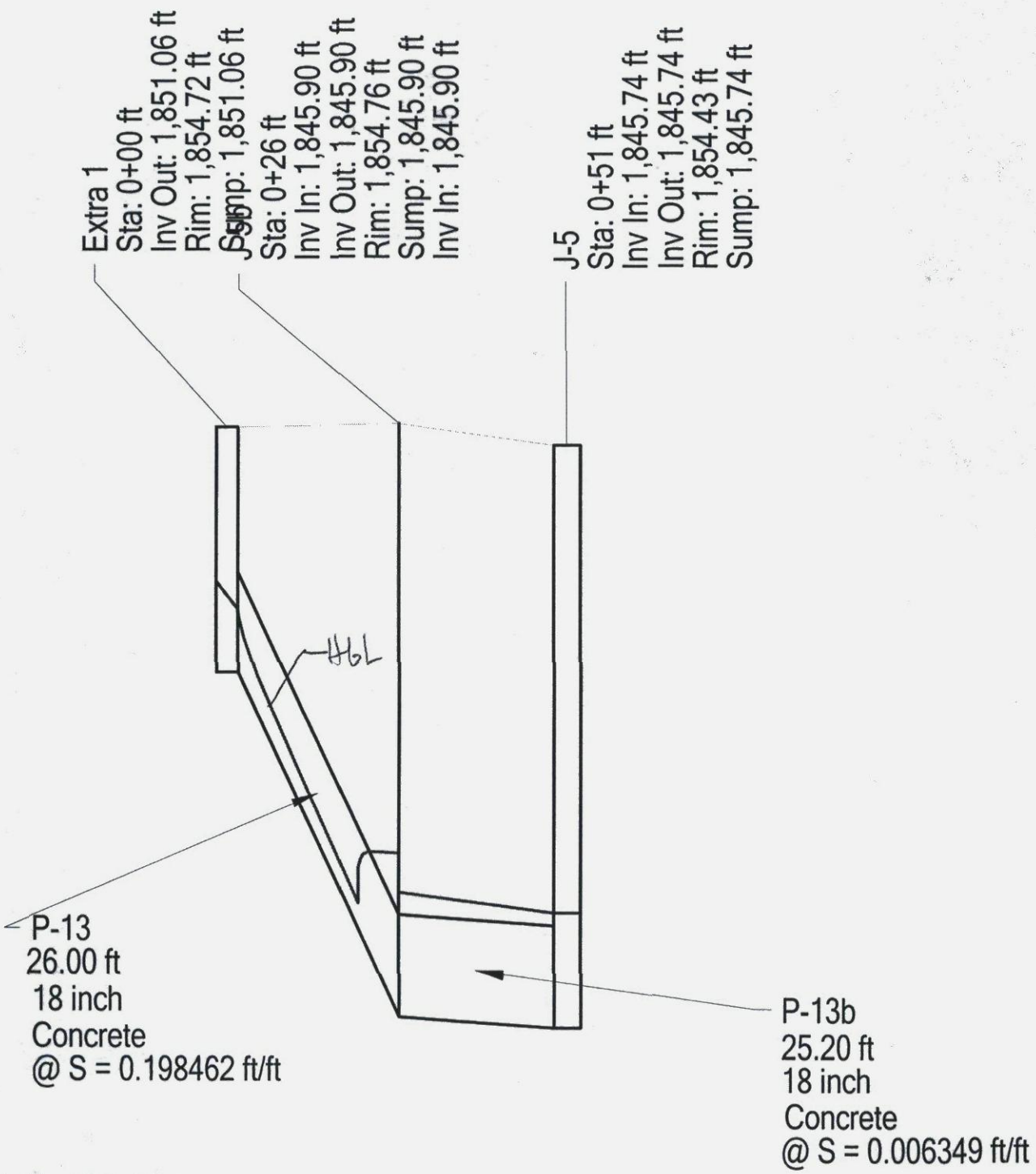
Profile: Trunk Line - J-4 to 0-2



Profile: Lateral 4N&4S

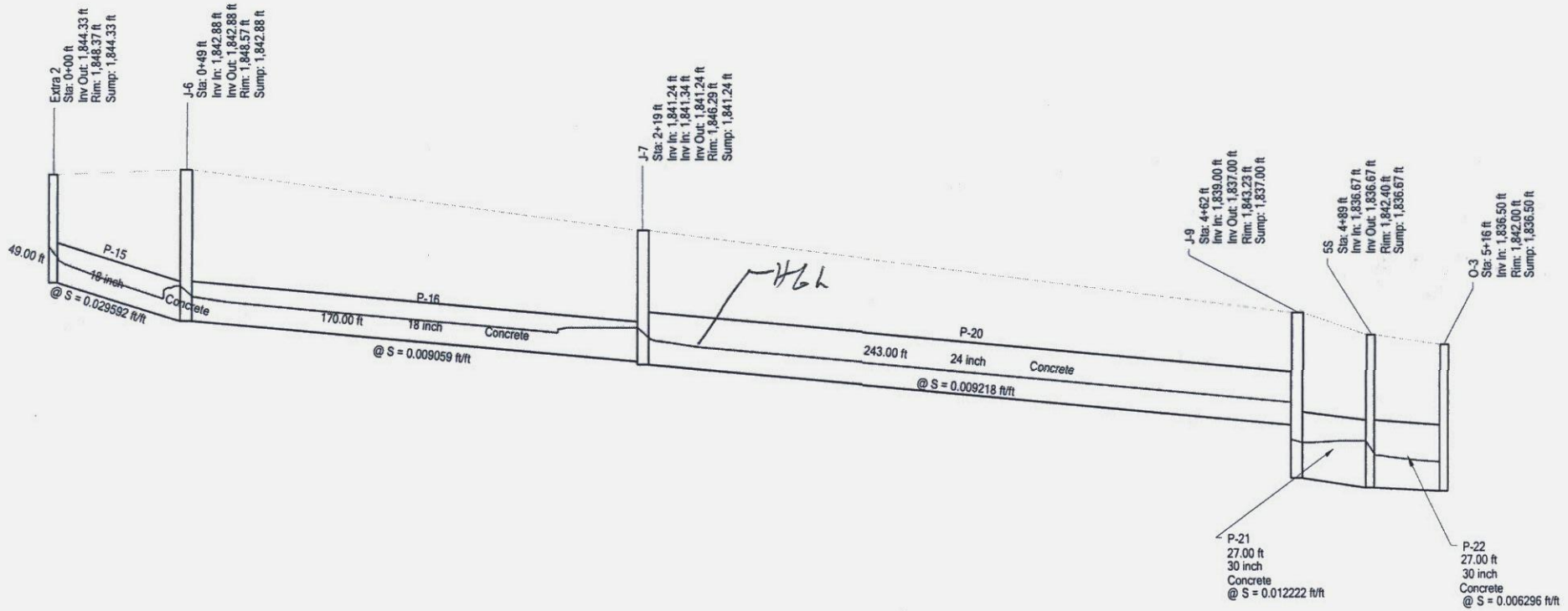


Profile: Extra 1



Profile
Scenario: Base

Profile: Trunk Line - Extra 2 to O-3



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