DRAINAGE REPORT

SCOTT RANCH ROAD
SR-260 TO PENROD ROAD

ADOT TRACS NO: SS673 01C
FEDERAL AID NO: HPP-SLW-(200)A

PREPARED FOR:

CITY OF SHOW LOW
550 N. 9TH PLACE
SHOW LOW, AZ 85901

PREPARED BY:
IRONSIDE ENGINEERING & DEVELOPMENT, INC.
401 South White Mountain Road
Show Low, Arizona 85901-6112

JULY 2009

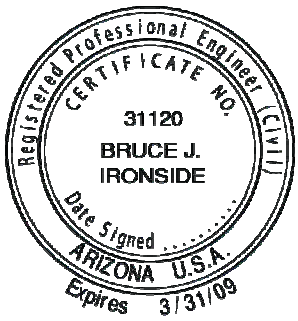
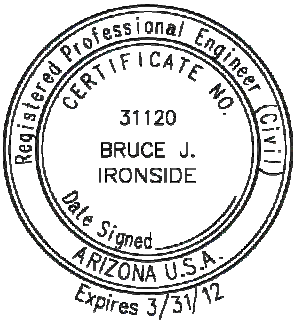


TABLE OF CONTENTS

1.0 Introduction **1**
2.0 Objective **1**
3.0 Mapping **1**
4.0 Site Description **1**
4.1 Existing Conditions 1
4.1.1 General 1
4.1.2 Soil Conditions 1
4.1.3 Vegetation 2
4.2 Future Development 2
5.0 Hydrology **2**
5.1 HEC-1 Method 2
5.1.1 Rainfall 2
5.1.2 Rainfall Losses 2
5.1.3 Runoff 3
5.2 Rational Method 3
5.3 Offsite Runoff 4
6.0 Hydraulics **4**
6.1 Pavement Drainage 4
6.2 Roadside Channels 5
6.3 Culvert Crossings 5
6.4 Bridge Hydraulics 5
6.5 Construction Stormwater Runoff 5
7.0 Conclusions and Recommendations **6**
8.0 Limitations **6**
9.0 References **6**
APPENDIX A – FIGURES & EXHIBITS **7**
Figure A1 – Vicinity Map 8
Exhibit A – Drainage Area Map 9
APPENDIX B – HYDROLOGIC DATA **10**
Table B1 – NOAA Atlas 14 Rainfall Statistics 11
Figure 2-1 – Generalized I-D-F Graph 12
Figure 2-3 – Developed Watershed Rational “C” Coefficient 13
Figure 2-7 – Mountain Rational “C” Coefficient 14
Table 3-1 – Surface Retention Loss 15
Table 3-2 – Green and Ampt Infiltration Parameters 16
APPENDIX C – RATIONAL METHOD RESULTS **17**
Table C1 – 2-yr Peak Discharge 18
Table C2 – 10-yr Peak Discharge 19
Table C3 – 100-yr Peak Discharge 20
APPENDIX D – HEC-HMS RESULTS **21**
Table D1 – 2-yr Peak Discharge 22
Table D2 – 10-yr Peak Discharge 23
Table D3 – 100-yr Peak Discharge 24

APPENDIX E – HYDRAULIC DATA 25
Figure E1 – Culvert Crossing 1 26
Figure E2 – Culvert Crossing 2 27
Figure E3 – Culvert Crossing 3 28
Figure E4 – Culvert Crossing 4 29
Figure E5 – Culvert Crossing 5 30
Figure E7 – Typical Channel Cross Section 31
APPENDIX F – PAVEMENT DRAINAGE 32
Table F1 – Gutter Spread Summary 33
Visual Urban Calculation Outputs



1.0 Introduction

This report has been prepared to support the construction of Scott Ranch Road, located in Show Low, Arizona. The proposed project consists of a new roadway, with two lane and three lane portions, that connects State Route 260 to Penrod Road in Show Low, Arizona. The proposed roadway will form an intersection with Show Low Lake Road, and cross Show Low Creek with a bridge.

The project is located in a portion of the SW ¼ of Section 4, Township 9 North, Range 22 East, Gila and Salt River Meridian, City of Show Low, Navajo County, Arizona. See Appendix A, Figure A1 – Vicinity Map for the project location.

2.0 Objective

This report summarizes the hydrologic and hydraulic analyses performed by Ironside Engineering & Development, Inc. The objectives of this report are to demonstrate the proposed roadway will have no anticipated negative drainage impact on the surrounding area, and that adequate drainage is provided within the project limits.

3.0 Mapping

Topographic mapping was provided by the City of Show Low and modified by Ironside Engineering & Development to include USGS mapping. Show Low South and Lakeside 7.5 minute quadrangle maps, both dated 1998, were utilized in the drainage analysis.

4.0 Site Description

4.1 Existing Conditions

4.1.1 General

Currently, the existing Scott Ranch Road is approximately 700 LF long and is adjacent to the Home Depot and home improvement store, in Show Low, Arizona. The area of the proposed roadway is mainly undeveloped forest, with some developed areas on the west side of the project.

The land between SR-260 and Show Low Lake Road is privately owned. Home Depot is the only developed land in this area that accesses Scott Ranch Road. The City of Show Low owns the land between Show Low Lake Road and Show Low Creek, which is undeveloped. The United States Forest Service (USFS) owns the land adjacent to Show Low Creek. The remaining land, east of Show Low Creek, is owned by Freeport-McMoran and is currently undeveloped forest.

4.1.2 Soil Conditions

A preliminary geotechnical evaluation of the project area was performed by Terracon Consulting Engineers & Scientists in March, 2008. It was discovered that the soil is mainly paiso stony clay loam, overlying basalt bedrock. It was assumed that the offsite soil conditions are consistent with the onsite soil conditions, as most soil types in the region fall into this category.

4.1.3 Vegetation

Onsite and offsite vegetation consists of moderately dense stands of Ponderosa Pine trees, and Alligator and Shaggy Bark Juniper trees with large areas of open meadows covered with native grasses.

4.2 Future Development

It is anticipated that the entire length of Scott Ranch Road will eventually be developed. It is the policy of The City of Show Low that stormwater discharge from any future developments meets the runoff flow rates of the pre-developed conditions, therefore, any future development along the corridor must detain stormwater runoff before discharging under Scott Ranch Road.

Drainage basins in the area have been identified, and are illustrated on Exhibit A – Drainage Area Map, in Appendix A. These natural flowpaths of the drainage basins will be routed under the roadway, and discharged at their historic locations.

5.0 Hydrology

The hydrologic analyses performed for this project were carried out following the general guidance of The Arizona Department of Transportation (ADOT), Highway Drainage Design Manual, 1993 (ADOT Manual). The ADOT Manual utilized two separate methods for hydrology: the Rational Method and rainfall-runoff modeling (HEC-1 Method). The Army Corps of Engineers Hydrologic Engineering Center program "Hydrologic Modeling System" (HEC-HMS 3.3) was used to determine the peak runoff rates for drainage areas larger than 160 acres, and the Rational Method was used to determine peak runoff rates for drainage areas smaller than 160 acres.

5.1 HEC-1 Method

5.1.1 Rainfall

Rainfall Depth-Duration-Frequency (D-D-F) data from NOAA Atlas 14 was utilized for the design storms in the analysis. The rainfall depths were used to create frequency design storms within HEC-HMS 2.2.2. According to the ADOT Manual, the design storm duration is six hours if the total watershed area is less than or equal to 1.0 square mile. The D-D-F rainfall data from NOAA Atlas 14 is illustrated in Table B1 – NOAA Atlas 14 Rainfall Statistics, in Appendix B.

5.1.2 Rainfall Losses

The Green & Ampt method was utilized for estimated rainfall losses. The parameters used in this method are determined by the soil type of the area. The preliminary geotechnical report indicates the soil type in the area contains mostly clay loam. The input parameters were obtained from Tables 3-1 & 3-2 of the ADOT Manual. The tables used in the estimation of the rainfall losses are illustrated in Appendix B.

According to the ADOT Manual, the effective impervious area for undeveloped areas is 0 percent. The effective impervious area was estimated for the areas

where significant development is present, such as the apartment complex located on Show Low Lake Road.

5.1.3 Runoff

The Clark Unit Hydrograph Method was used to develop runoff hydrographs for the analysis. The use of this method requires the estimation of three input parameters; the time of concentration (T_c), the storage coefficient (R), and a time-area relation. The following equations were used to determine the input parameters:

Time of Concentration for desert/mountain areas:

$$T_c = 2.4*A^{0.1}*L^{0.25}*L_{ca}^{0.25}*S^{-0.2}$$

where,

T_c = time of concentration (hours)
A = Watershed Area (square miles)
S = Watercourse Slope (feet/mile)
L = Length of watercourse to the hydraulically most distant point (miles)
L_{ca} = Length measured from the concentration point along L to a point on L that is perpendicular to the watershed centroid (miles)

Storage Coefficient (R):

$$R = 0.37*T_c^{1.11}*L^{0.80}*A^{-0.57}$$

where R is in hours, and the remaining variable are as defined in the time of concentration equation.

The time-area relation was determined by the use of synthetic time-area relations. Table 4-1, in the ADOT Manual, provides the values for the time-area relations based upon the travel time as a percent of the time of concentration. Curve B, within Table 4-1, is the HEC-1 default Time-Area relation. HEC-HMS 3.3 uses this default curve in the Clark Unit Hydrograph calculation.

5.2 Rational Method

The 1-hour rainfall depths for the 2-yr, 10-yr, and 100-yr storm events were obtained from NOAA Atlas 14 maps. Using the rainfall depths, the rainfall intensities for determined from the generalized I-D-F graph for Zone 6 of Arizona. Iteration was performed to determine the times of concentration for each drainage area. The graphs and charts used for the rational method can be viewed in Appendix B.

It was determined that the times of concentration for pavement runoff were well below the ADOT allowable minimum of ten minutes. As a result, a ten minute time of concentration was utilized for all pavement drainage calculations.

5.3 Offsite Runoff

Offsite runoff from both The Home Depot and Walmart impact a portion of the proposed roadway. Due to the large amount of impervious area, the runoff rates are significantly increased compared to that of the natural conditions. A drainage report was obtained from the City of Show Low for The Home Depot. The report contains runoff rates from both The Home Depot and Walmart. An analysis was performed on the two areas and it was determined that the runoff rates from the drainage report are sufficient for the analysis.

6.0 Hydraulics

This project lies within the limits of the City of Show Low. The City's drainage requirements are outlined in code sections 12-3-5 and 12-4-F. These code sections include, but are not limited to, the following hydraulic design information:

- Culverts for streets shall be designed to convey at the 50 year peak discharge with no flow over the roadway.

- The flow depth over the street shall be limited to 1.0 feet for 100 year peak discharge.

- Street drainage shall be designed to provide for one lane of traffic in both directions for all collectors and arterials for the 10-year peak discharge.

Scott Ranch Road is classified as a class 3 highway, according to the ADOT Roadway Design Guidelines. The minimum design storm frequency for the construction of a new class 3 highway is the 25 year storm event. Because the proposed roadway is located within the limits of the City of Show Low, the more stringent local ordinances will be followed for the design storm used in all hydraulic analyses.

6.1 Pavement Drainage

Vertical curb and gutter is proposed throughout the areas containing the commercial pavement section. Scuppers are the proposed method of pavement drainage. Channels are provided behind the sidewalks on both sides of the road, unless grading limits exceeded the allowable right of way.

Curb inlets are proposed for locations requiring a storm drain system. There are two locations where a drainage channel could not be graded within the right of way limits. Each storm drain system only drains one catch basin each, and as a result of the, the ADOT minimum allowable storm drain pipe size of 24" was used for the design. The curb inlet capacity is approximately 2 cfs, which is far below the approximate 15 cfs capacity of a 24" pipe. No formal calculations are included for the proposed 24" storm drain. The locations of the proposed storm drain systems are illustrated in the 30% plans.

City of Show Low Code will be followed in the pavement drainage design. One travel lane in each direction, with a minimum width of 10 feet, will be provided

during the 10-year storm event. The allowable spread for this project will be the shoulder width plus half the travel lane, equating to 10 feet. The proposed pavement drainage system calculations, along with the program outputs, are included in Appendix F – Pavement Drainage.

6.2 Roadside Channels

Roadside channels will be used throughout the project to collect any runoff that may potentially flow onto Scott Ranch Road, and to collect pavement runoff as well. Any channels located within the recovery zone of the highway will be designed in accordance with the *AASHTO Roadside Design Guide, 2006*. This includes, but is not limited to, the foreslope and backslope of the channels. The typical channels throughout the project are proposed to consist of a 3:1 foreslope with a 3:1 backslope. A 6:1 foreslope is used until the recovery zone requirements are met, which then transitions into a 3:1 foreslope due to right of way constraints.

All roadside channels have been designed to convey the 100-year peak runoff rates without overtopping. Channel calculations were carried out with the use of Hydraflow Express. Channel calculation outputs can be viewed in Appendix E – Hydraulic Data.

6.3 Culvert Crossings

The proposed roadway crosses numerous drainage basins, and will require culvert crossings. Drainage Area 9 (DA-9) produces a significant amount of runoff, which will require the use of (2) 4' x 8' box culverts to adequately convey the 100-yr peak runoff under the roadway. The remaining drainage areas within the area produce smaller runoff rates that will require the use of smaller culverts. The locations and culvert types are illustrated in Exhibit A – Drainage Map, in Appendix A.

Although the conveyance of the 50-year storm is the minimum requirement, all culvert crossings have been designed to convey the 100-year peak runoff rates without overtopping the roadway. Culvert calculations were carried out with the use of Hydraflow Express, and can be viewed in Appendix E – Hydraulic Data.

6.4 Bridge Hydraulics

Scott Ranch Road will cross Show Low Creek, a designated FEMA floodplain, with a proposed bridge. A separate bridge hydraulics report will be prepared with the final design of the bridge. A hydraulic analysis of Show Low Creek, including scour analysis, will also be prepared with the final design. Due to the geometric constraints and the length of the bridge, one or more bridge piers may be located within the floodplain. These issues will be discussed in greater detail in the final bridge hydraulics report.

6.5 Construction Stormwater Runoff

A separate Stormwater Pollution Prevention Plan (SWPPP) will be included in the Stage III submittal. The SWPPP plan will address the issues of stormwater

runoff generated within construction areas, and how pollution of Show Low Creek and the surrounding areas will be prevented.

7.0 Conclusions and Recommendations

The construction of Scott Ranch Road will have no negative drainage impacts on the surrounding area. The drainage structures associated with the project will have sufficient capacity to convey the estimated 100-year peak runoff rates without overtopping the roadway. The close proximity to Show Low Creek also ensures rapid runoff from the proposed roadway, therefore, no detention is being proposed for the construction of Scott Ranch Road.

8.0 Limitations

The results provided within this report consist of opinions and conclusions of the consulting engineer. The only warranty or guarantee made by the consultant, in connection with the services performed for this project, is that such services are performed with the care and skill ordinarily exercised by members of the profession practicing under similar conditions, at the same time, and in the same or similar locality. No other warranty, expressed or implied, is made or intended by rendering such consulting services or by furnishing written reports of the findings. However, any deviation from the above recommendations may nullify the conclusions of this report, as may variations in climatic or environmental conditions.

9.0 References

AutoDesk, Civil 3D Land Desktop Companion, 2009

Delph Engineering, Inc. Drainage Report for Mountain Meadows, April 2006.

City of Show Low, Arizona. Land Division Ordinance, *Sections 12-3-5 & 12-4-F*. December, 1999

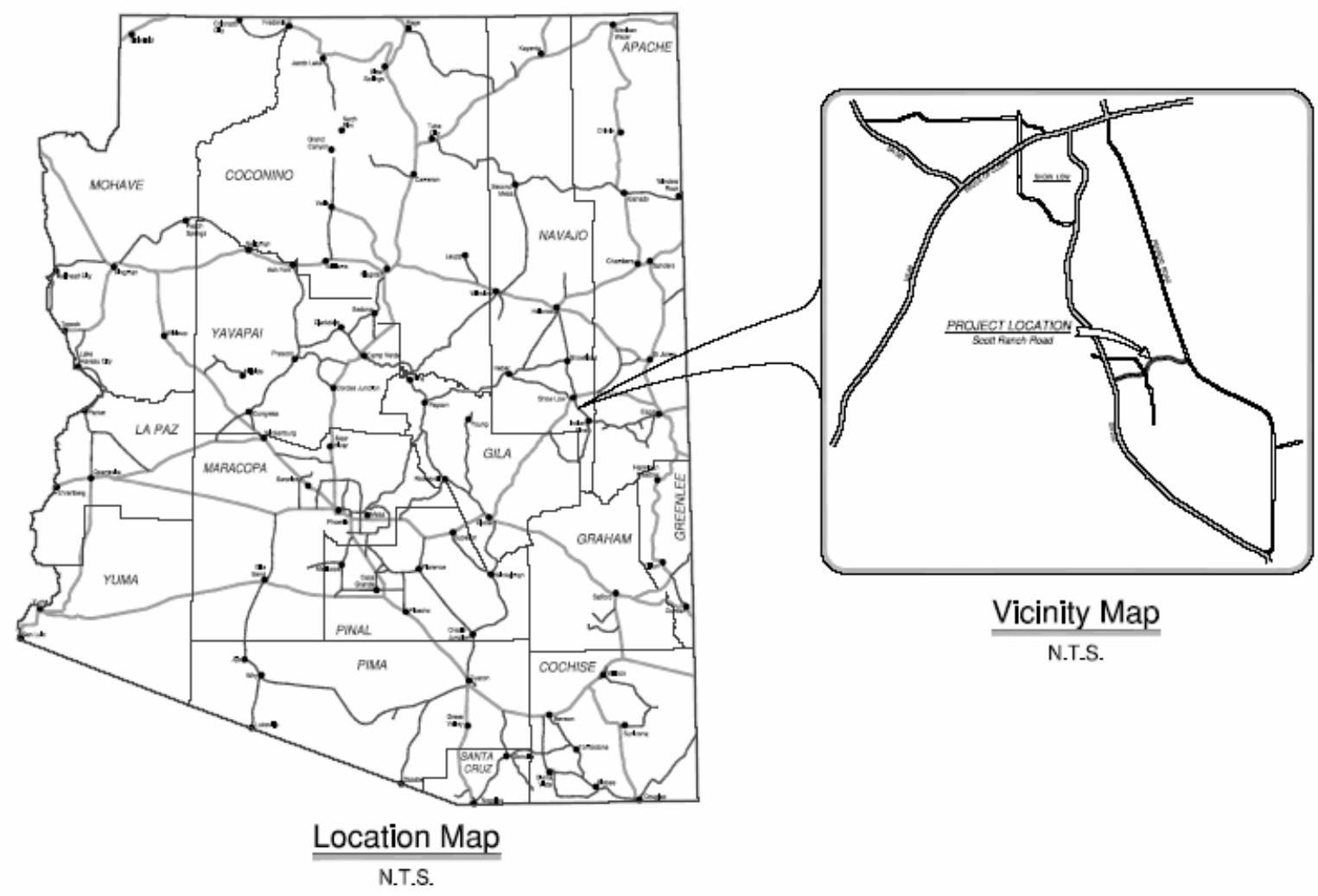
Soil Conservation Service (SCS). Urban Hydrology for Small Watersheds (TR-55). June 1986

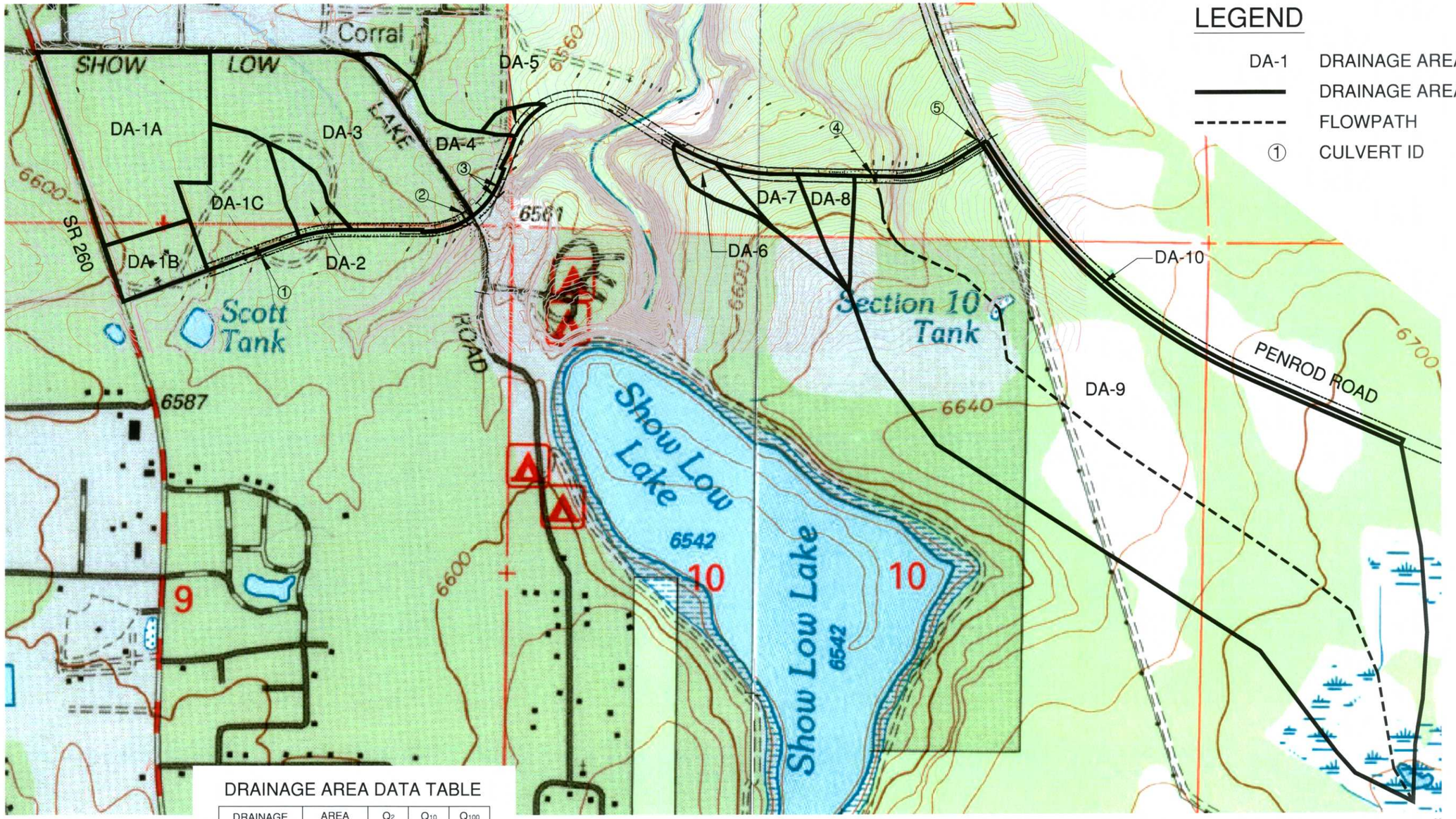
AutoDesk, Hydraflow Express Extension for AutoCAD Civil 3D, 2009

Federal Highway Administration (FHWA), Visual Urban (HY-22) Urban Drainage Design, 2002

APPENDIX A – FIGURES & EXHIBITS

Figure A1 – Vicinity Map





DRAINAGE AREA DATA TABLE

DRAINAGE AREA ID	AREA [ACRES]	Q_2 [CFS]	Q_{10} [CFS]	Q_{100} [CFS]
DA-1A	33	110	128	211
DA-1B	7	23	30	46
DA-1C	14	19	20	46
DA-2	5	6	9	18
DA-3	37	48	50	100
DA-4	9	25	26	47
DA-5	2	3	4	9
DA-6	3	4	6	12
DA-7	6	8	12	24
DA-8	5	6	10	19
DA-9	216	111	250	430
DA-10	4	3	6	13

CULVERT SCHEDULE

CULVERT ID	APPROXIMATE STATION	Q_2 [CFS]	Q_{10} [CFS]	Q_{100} [CFS]	DESCRIPTION
1	21+00	152	178	303	(6) 36" CULVERT
2	37+50	48	50	100	(2) 36" CULVERT
3	41+00	25	26	47	(2) 30" CULVERT
4	75+40	111	250	430	(2) 4'x8' BOX CULVERT
5	84+10	3	6	13	(1) 24" CULVERT

N
W E
S

Scale (ft)
0 400 800 1200

EXHIBIT A - DRAINAGE AREA MAP

SCOTT RANCH ROAD AND BRIDGE PROJECT
SR-260 TO PENROD ROAD

APPENDIX B – HYDROLOGIC DATA

Table B1 – NOAA Atlas 14 Rainfall Statistics

POINT PRECIPITATION FREQUENCY ESTIMATES FROM NOAA ATLAS 14

LAKESIDE RANGER STN, ARIZONA (02-4779) 34.1667 N 109.9833 W 6653 feet

from "Precipitation-Frequency Atlas of the United States" NOAA Atlas 14, Volume 1, Version 4
G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley
NOAA, National Weather Service, Silver Spring, Maryland, 2006

Extracted: Tue Jun 30 2009

ence Limits | Seasonality | Location Maps | Other Info. | GIS data | Maps | Docs | Return to State Ma

Precipitation Frequency Estimates (inches)

ARI* (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day	45 day	60 day
1	0.29	0.44	0.55	0.73	0.91	1.02	1.08	1.26	1.52	1.68	2.00	2.38	2.84	3.26	4.30	5.29	6.41	7.46
2	0.37	0.57	0.70	0.94	1.17	1.31	1.36	1.58	1.89	2.10	2.48	2.97	3.53	4.05	5.33	6.54	7.94	9.24
5	0.49	0.74	0.92	1.24	1.54	1.69	1.73	1.97	2.34	2.61	3.09	3.71	4.38	4.99	6.44	7.88	9.56	11.06
10	0.58	0.88	1.09	1.47	1.82	1.99	2.04	2.29	2.71	3.02	3.58	4.33	5.08	5.74	7.30	8.89	10.81	12.41
25	0.70	1.06	1.31	1.77	2.19	2.41	2.46	2.75	3.21	3.60	4.26	5.20	6.06	6.75	8.42	10.19	12.43	14.11
50	0.79	1.20	1.48	2.00	2.47	2.74	2.80	3.12	3.61	4.05	4.80	5.88	6.85	7.54	9.24	11.13	13.62	15.34
100	0.88	1.34	1.66	2.24	2.77	3.08	3.16	3.51	4.03	4.52	5.36	6.62	7.67	8.34	10.05	12.05	14.78	16.50
200	0.97	1.48	1.84	2.47	3.06	3.43	3.54	3.92	4.46	4.99	5.94	7.38	8.53	9.15	10.84	12.93	15.91	17.61
500	1.10	1.67	2.08	2.79	3.46	3.92	4.06	4.47	5.06	5.65	6.73	8.46	9.72	10.24	11.85	14.05	17.36	18.97
1000	1.20	1.83	2.27	3.06	3.78	4.31	4.49	4.93	5.54	6.17	7.36	9.31	10.66	11.08	12.59	14.86	18.42	19.95

* These precipitation frequency estimates are based on a partial duration series. ARI is the Average Recurrence Interval.
Please refer to NOAA Atlas 14 Document for more information. NOTE: Formatting forces estimates near zero to appear as zero.

FIGURE 2-1
GENERALIZED I-D-F GRAPH FOR ZONE 6 OF ARIZONA

Example: For a selected 10-year return period, P_1 = 2.0 inches. T_C is calculated as 20 minutes. Therefore, (i) = 4.25 in/hr.

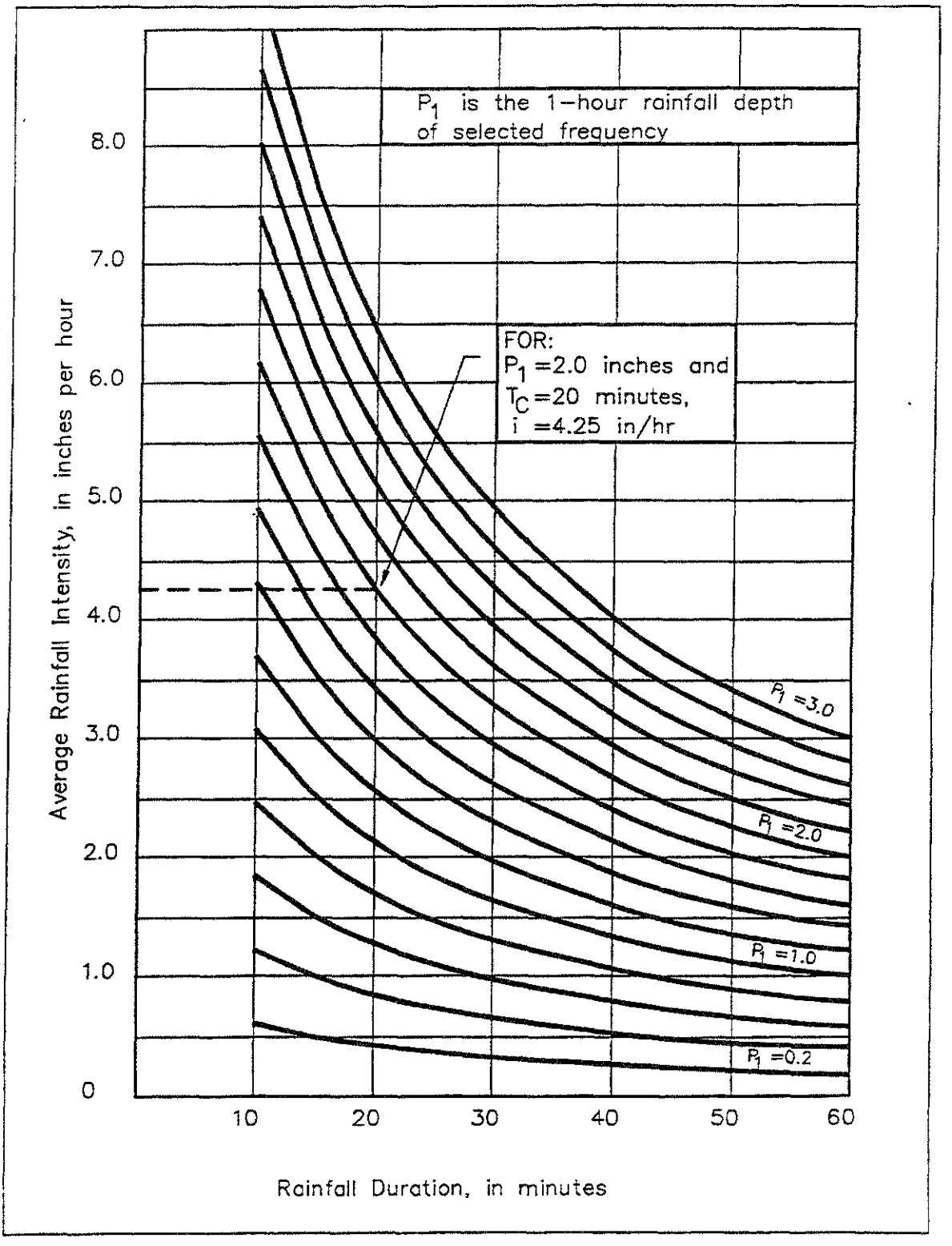


FIGURE 2-3
RATIONAL "C" COEFFICIENT
DEVELOPED WATERSHEDS

AS A FUNCTION OF RAINFALL DEPTH AND TYPE OF DEVELOPMENT

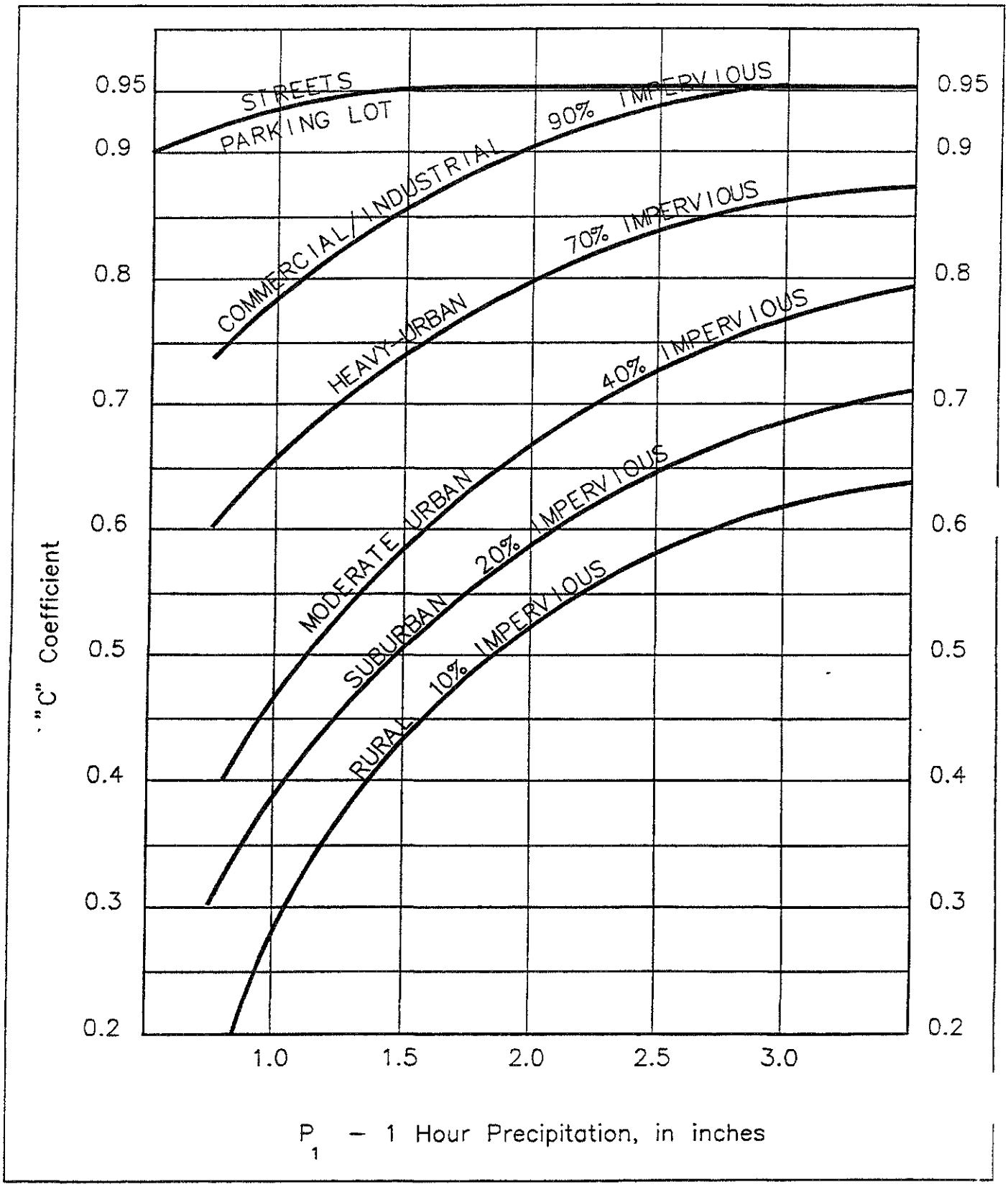


FIGURE 2-7
RATIONAL "C" COEFFICIENT
MOUNTAIN
(JUNIPER & GRASS)

AS A FUNCTION OF RAINFALL DEPTH, HYDROLOGIC SOIL GROUP (HSG), AND % OF VEGETATION COVER

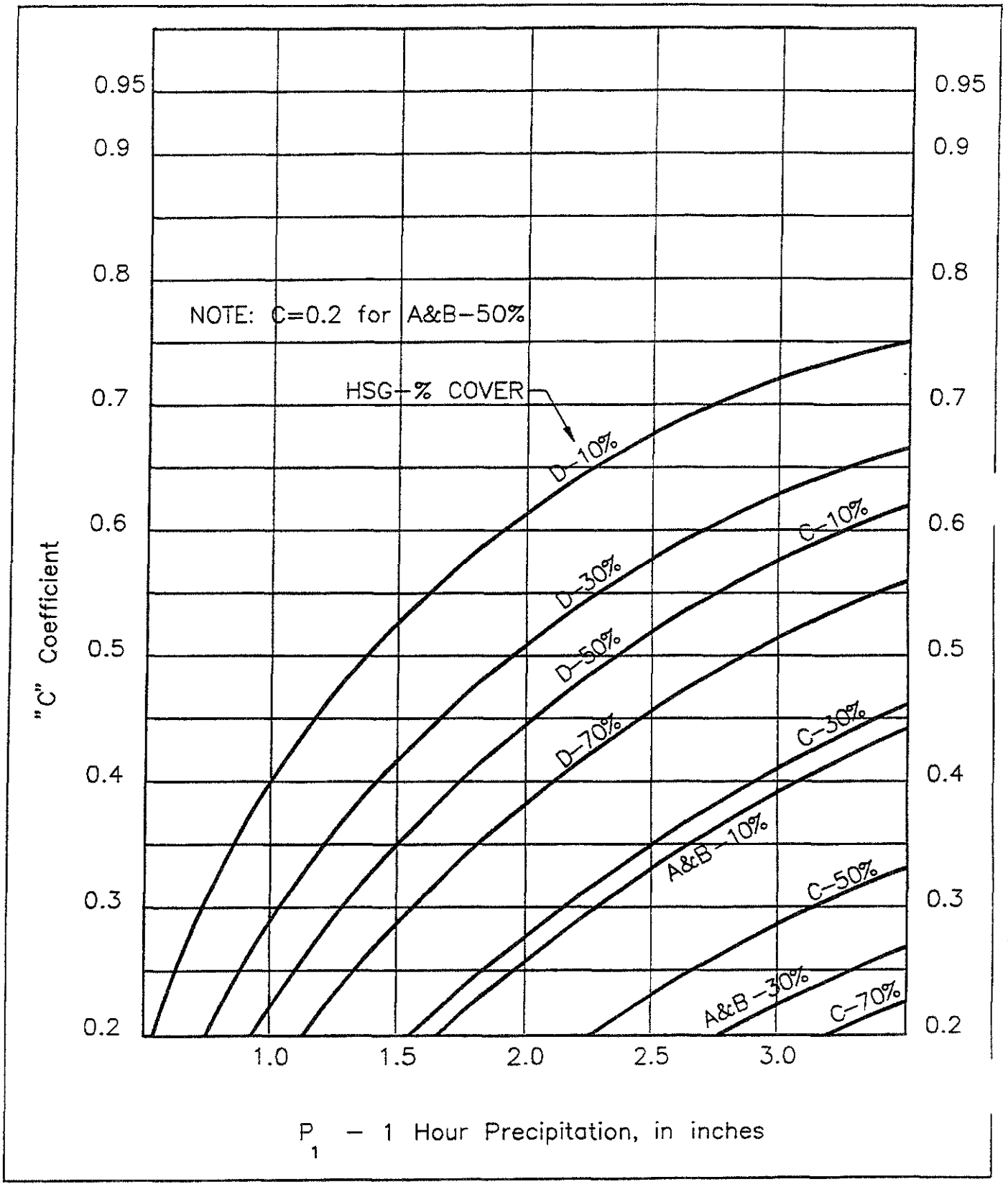


TABLE 3-1

SURFACE RETENTION LOSS FOR VARIOUS LAND SURFACES IN ARIZONA

(To be used with the Green and Ampt Infiltration Equation for estimating rainfall losses.)

Land-use and/or Surface Cover (1)	Surface Retention Loss (IA) inches (2)
Natural	
Desert and rangeland, flat slope	.35
Desert and rangeland, hill slopes	.15
Mountain, with vegetated surface	.25
Developed (Residential and Commercial)	
Lawn and turf	.20
Desert Landscape	.10
Pavement	.05
Agricultural	
Tilled fields and irrigated pasture	.50

TABLE 3-2

GREEN AND AMPT INFILTRATION EQUATION LOSS RATE PARAMETER VALUES FOR BARE GROUND

Soil Texture	DTHETA[a]			XKSAT	PSIF
Classification	Dry	Normal	Saturated	in/hr	inches
(1)	(2)	(3)	(4)	(5)	(6)
sand[b]	.35	.30	0	4.6	1.9
loamy sand	.35	.30	0	1.2	2.4
sandy loam	.35	.25	0	.40	4.3
loam	.35	.25	0	.25	3.5
silt loam	.40	.25	0	.15	6.6
silt	.35	.15	0	.10	7.5
sandy clay loam	.25	.15	0	.06	8.6
clay loam	.25	.15	0	.04	8.2
silty clay loam	.30	.15	0	.04	10.8
sandy clay	.20	.10	0	.02	9.4
silty clay	.20	.10	0	.02	11.5
clay	.15	.05	0	.01	12.4

[a] Selection of DTHETA:

Dry - for nonirrigated lands such as desert and rangeland
Normal - for irrigated lawn, turf, and permanent pasture
Saturated - for irrigated agricultural lands

[b] The use of the Green and Ampt Infiltration Equation for drainage areas or subbasins that are predominantly sand should be avoided and the IL+ULR method should be used.

APPENDIX C – RATIONAL METHOD RESULTS

Table C1 – 2-yr Peak Discharge

DRAINAGE AREA ID	RATIONAL COEFFICIENT [C]	RAINFALL INTENSITY [IN/HR]	AREA [ACRES]	Q2 [CFS]
1A	0.90	3.70	33	110
1B	0.90	3.70	7	23
1C	0.35	3.70	14	19
2	0.35	3.70	5	6
3	0.35	3.70	37	48
4	0.73	3.70	9	25
5	0.35	3.70	2	3
6	0.35	3.70	3	4
7	0.35	3.70	6	8
8	0.35	3.70	5	6
10	0.48	1.75	4	3

Table C2 – 10-yr Peak Discharge

DRAINAGE AREA ID	RATIONAL COEFFICIENT [C]	RAINFALL INTENSITY [IN/HR]	AREA [ACRES]	Q10 [CFS]
1A	0.90	4.30	33	128
1B	0.90	4.90	7	30
1C	0.40	3.50	14	20
2	0.40	4.75	5	9
3	0.40	3.40	37	50
4	0.75	3.70	9	26
5	0.40	4.90	2	4
6	0.40	4.90	3	6
7	0.40	4.90	6	12
8	0.40	4.90	5	10
10	0.53	2.60	4	6

Table C3 – 100-yr Peak Discharge

DRAINAGE AREA ID	RATIONAL COEFFICIENT [C]	RAINFALL INTENSITY [IN/HR]	AREA [ACRES]	Q100 [CFS]
1A	0.90	7.10	33	211
1B	0.90	6.75	7	42
1C	0.53	6.00	14	46
2	0.53	7.40	5	18
3	0.53	5.10	37	100
4	0.79	6.30	9	47
5	0.53	7.40	2	9
6	0.53	7.40	3	12
7	0.53	7.40	6	24
8	0.53	7.40	5	19
10	0.67	4.75	4	13

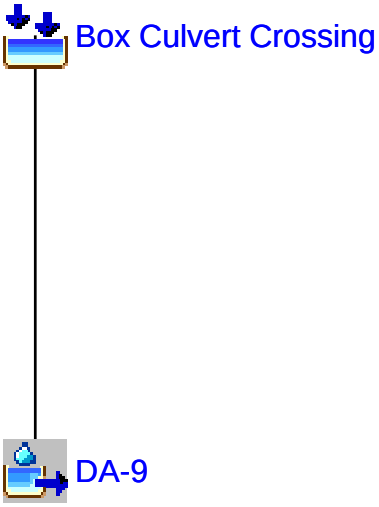
APPENDIX D – HEC-HMS RESULTS

HEC-HMS

Project : Drainage

Basin Model : DA-9

Jun 23 11:47:42 MST 2009



Project: Drainage

Simulation Run: 2-yr_DCR Subbasin: DA-9

Start of Run:	02Sep2008, 00:00	Basin Model:	DA-9
End of Run:	03Sep2008, 01:00	Meteorologic Model:	2-yr_Lakeside Rang.
Compute Time:	23Jun2009, 11:45:47	Control Specifications:	Control 1

Volume Units: IN

Computed Results

Peak Discharge :	110.8 (CFS)	Date/Time of Peak Discharge :	02Sep2008, 03:48
Total Precipitation :	1.39 (IN)	Total Direct Runoff :	0.60 (IN)
Total Loss :	0.79 (IN)	Total Baseflow :	0.00 (IN)
Total Excess :	0.60 (IN)	Discharge :	0.60 (IN)

Project: Drainage

Simulation Run: 10-yr_DCR Subbasin: DA-9

Start of Run:	02Sep2008, 00:00	Basin Model:	DA-9
End of Run:	03Sep2008, 01:00	Meteorologic Model:	10-yr_Lakeside Rang.
Compute Time:	23Jun2009, 11:46:36	Control Specifications:	Control 1

Volume Units: IN

Computed Results

Peak Discharge :	247.9 (CFS)	Date/Time of Peak Discharge :	02Sep2008, 03:48
Total Precipitation :	2.27 (IN)	Total Direct Runoff :	1.38 (IN)
Total Loss :	0.89 (IN)	Total Baseflow :	0.00 (IN)
Total Excess :	1.38 (IN)	Discharge :	1.38 (IN)

Project: Drainage

Simulation Run: 100-yr_DCR Subbasin: DA-9

Start of Run:	02Sep2008, 00:00	Basin Model:	DA-9
End of Run:	03Sep2008, 01:00	Meteorologic Model:	100-yr_6-hr
Compute Time:	23Jun2009, 11:47:11	Control Specifications:	Control 1

Volume Units: IN

Computed Results

Peak Discharge :	427.8 (CFS)	Date/Time of Peak Discharge :	02Sep2008, 03:48
Total Precipitation :	3.51 (IN)	Total Direct Runoff :	2.49 (IN)
Total Loss :	1.02 (IN)	Total Baseflow :	0.00 (IN)
Total Excess :	2.49 (IN)	Discharge :	2.49 (IN)

APPENDIX E – HYDRAULIC DATA

Culvert Report

Hydraflow Express Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. Monday, Jun 29 2009

Figure C1 - Culvert Crossing 1

Invert Elev Dn (ft)	= 1.00
Pipe Length (ft)	= 75.00
Slope (%)	= 1.00
Invert Elev Up (ft)	= 1.75
Rise (in)	= 36.0
Shape	= Cir
Span (in)	= 36.0
No. Barrels	= 1
n-Value	= 0.024
Inlet Edge	= 0
Coeff. K,M,c,Y,k	= 0.0045, 2, 0.0317, 0.69, 0.5

Embankment

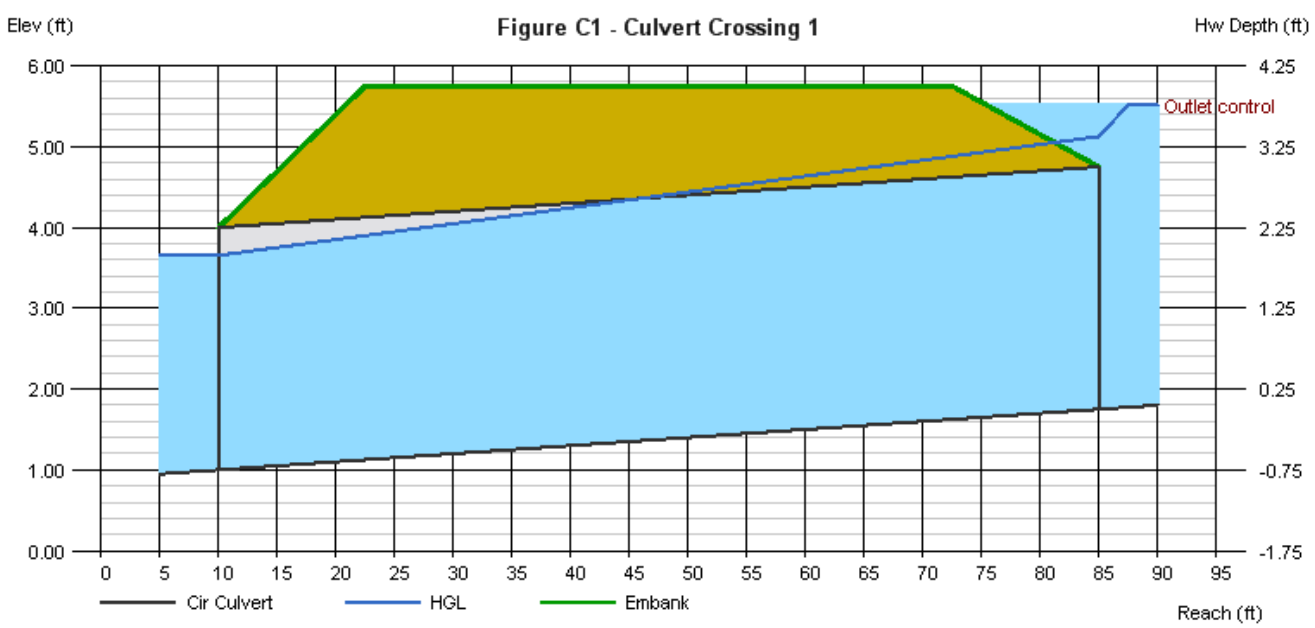
Top Elevation (ft)	= 5.75
Top Width (ft)	= 50.00
Crest Width (ft)	= 50.00

Calculations

Qmin (cfs)	= 0.00
Qmax (cfs)	= 50.00
Tailwater Elev (ft)	= 0

Highlighted

Qtotal (cfs)	= 50.00
Qpipe (cfs)	= 50.00
Qovertop (cfs)	= 0.00
Veloc Dn (ft/s)	= 7.56
Veloc Up (ft/s)	= 7.07
HGL Dn (ft)	= 3.65
HGL Up (ft)	= 5.13
Hw Elev (ft)	= 5.51
Hw/D (ft)	= 1.25
Flow Regime	= Outlet Control



Culvert Report

Hydraflow Express Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. Monday, Jun 29 2009

Figure C2 - Culvert Crossing 2

Invert Elev Dn (ft)	= 1.00
Pipe Length (ft)	= 80.00
Slope (%)	= 1.00
Invert Elev Up (ft)	= 1.80
Rise (in)	= 36.0
Shape	= Cir
Span (in)	= 36.0
No. Barrels	= 2
n-Value	= 0.024
Inlet Edge	= 0
Coeff. K,M,c,Y,k	= 0.0045, 2, 0.0317, 0.69, 0.5

Embankment

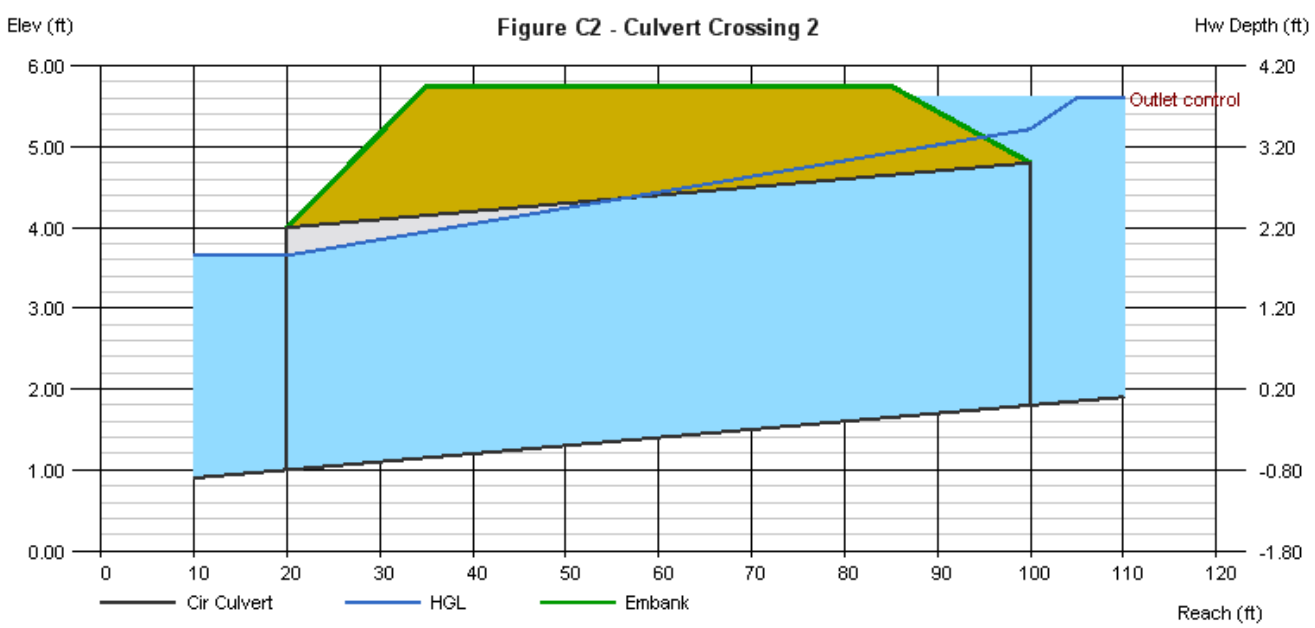
Top Elevation (ft)	= 5.75
Top Width (ft)	= 50.00
Crest Width (ft)	= 50.00

Calculations

Qmin (cfs)	= 0.00
Qmax (cfs)	= 100.00
Tailwater Elev (ft)	= 0

Highlighted

Qtotal (cfs)	= 100.00
Qpipe (cfs)	= 100.00
Qovertop (cfs)	= 0.00
Veloc Dn (ft/s)	= 7.56
Veloc Up (ft/s)	= 7.07
HGL Dn (ft)	= 3.65
HGL Up (ft)	= 5.22
Hw Elev (ft)	= 5.61
Hw/D (ft)	= 1.27
Flow Regime	= Outlet Control



Culvert Report

Hydraflow Express Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. Monday, Jun 29 2009

Figure C3 - Culvert Crossing 3

Invert Elev Dn (ft)	= 1.00
Pipe Length (ft)	= 100.00
Slope (%)	= 1.00
Invert Elev Up (ft)	= 2.00
Rise (in)	= 30.0
Shape	= Cir
Span (in)	= 30.0
No. Barrels	= 2
n-Value	= 0.024
Inlet Edge	= 0
Coeff. K,M,c,Y,k	= 0.0045, 2, 0.0317, 0.69, 0.5

Embankment

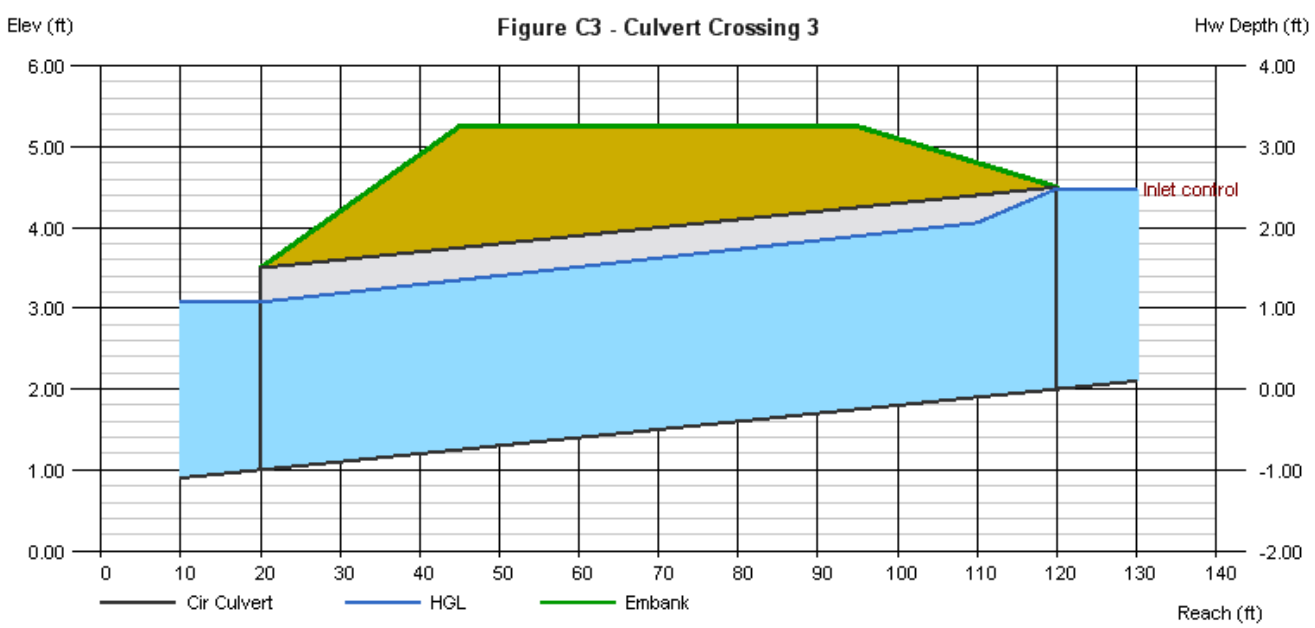
Top Elevation (ft)	= 5.25
Top Width (ft)	= 50.00
Crest Width (ft)	= 50.00

Calculations

Qmin (cfs)	= 0.00
Qmax (cfs)	= 47.00
Tailwater Elev (ft)	= 0

Highlighted

Qtotal (cfs)	= 47.00
Qpipe (cfs)	= 47.00
Qovertop (cfs)	= 0.00
Veloc Dn (ft/s)	= 5.39
Veloc Up (ft/s)	= 5.20
HGL Dn (ft)	= 3.08
HGL Up (ft)	= 4.17
Hw Elev (ft)	= 4.48
Hw/D (ft)	= 0.99
Flow Regime	= Inlet Control



Culvert Report

Hydraflow Express Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. Monday, Jun 29 2009

Figure C4 - Culvert Crossing 4

Invert Elev Dn (ft)	= 1.00
Pipe Length (ft)	= 60.00
Slope (%)	= 1.00
Invert Elev Up (ft)	= 1.60
Rise (in)	= 48.0
Shape	= Box
Span (in)	= 96.0
No. Barrels	= 2
n-Value	= 0.013
Inlet Edge	= 0
Coeff. K,M,c,Y,k	= 0.061, 0.75, 0.04, 0.8, 0.5

Embankment

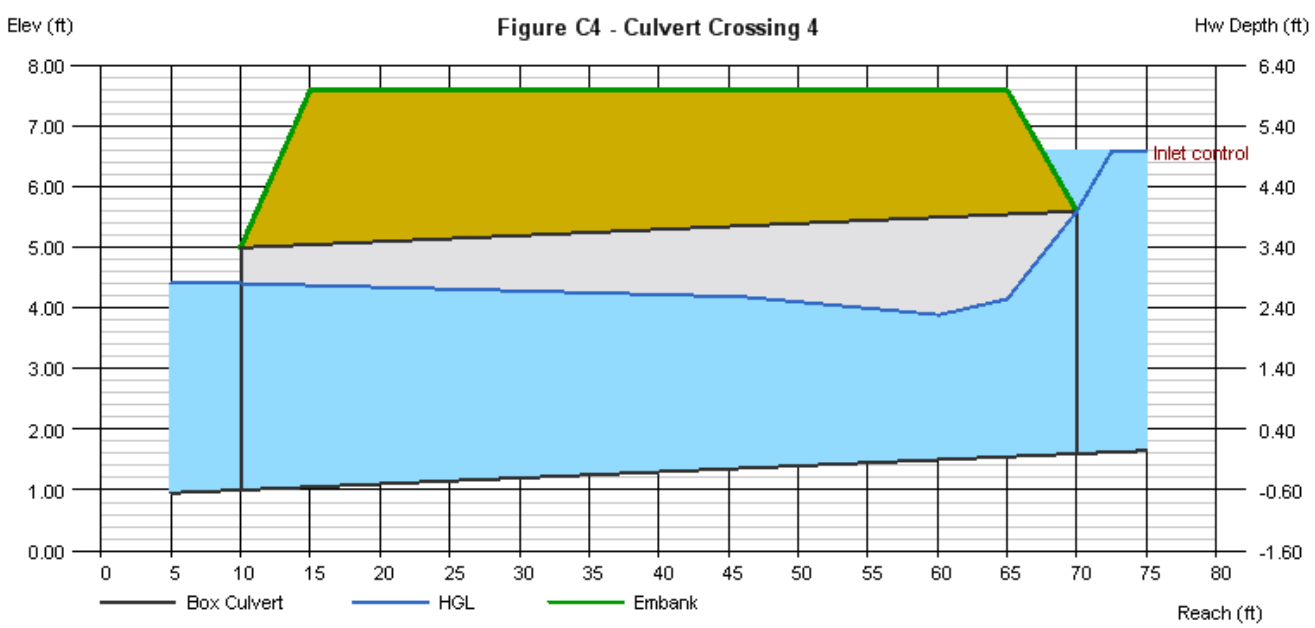
Top Elevation (ft)	= 7.60
Top Width (ft)	= 50.00
Crest Width (ft)	= 50.00

Calculations

Qmin (cfs)	= 420.00
Qmax (cfs)	= 430.00
Tailwater Elev (ft)	= 0

Highlighted

Qtotal (cfs)	= 430.00
Qpipe (cfs)	= 430.00
Qovertop (cfs)	= 0.00
Veloc Dn (ft/s)	= 7.88
Veloc Up (ft/s)	= 9.54
HGL Dn (ft)	= 4.41
HGL Up (ft)	= 4.42
Hw Elev (ft)	= 6.59
Hw/D (ft)	= 1.25
Flow Regime	= Inlet Control



Culvert Report

Hydraflow Express Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. Monday, Jun 29 2009

Figure C5 - Culvert Crossing 5

Invert Elev Dn (ft)	= 1.00
Pipe Length (ft)	= 76.00
Slope (%)	= 1.00
Invert Elev Up (ft)	= 1.76
Rise (in)	= 24.0
Shape	= Cir
Span (in)	= 24.0
No. Barrels	= 1
n-Value	= 0.024
Inlet Edge	= 0
Coeff. K,M,c,Y,k	= 0.0045, 2, 0.0317, 0.69, 0.5

Embankment

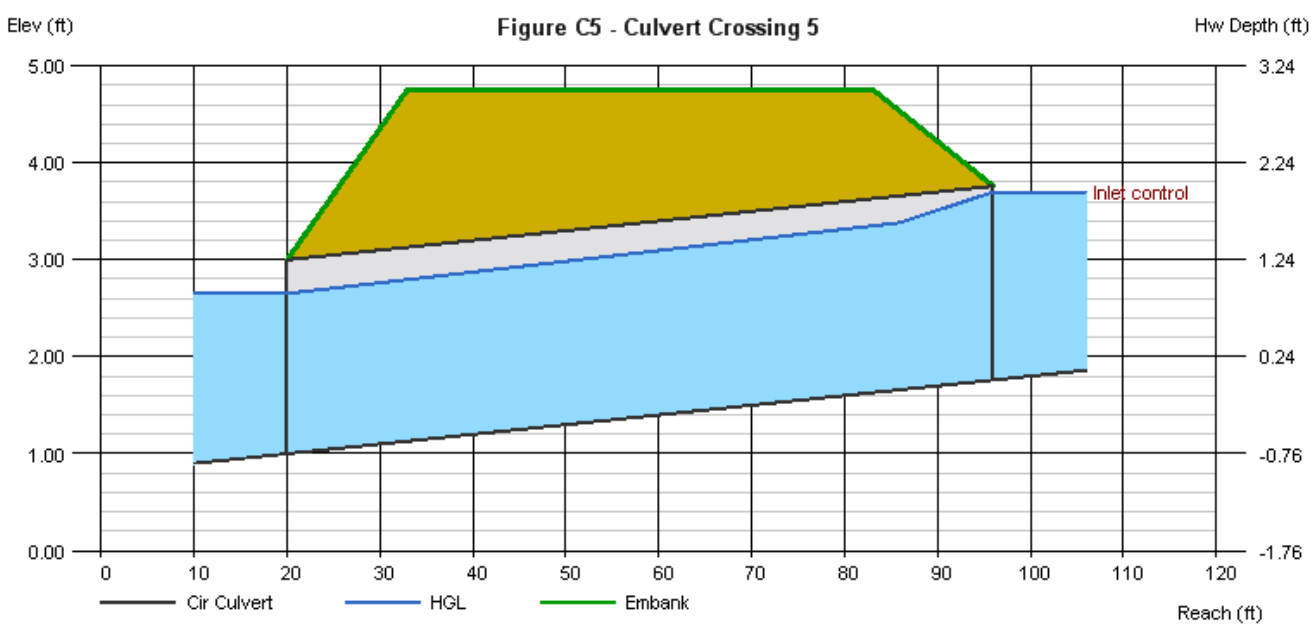
Top Elevation (ft)	= 4.76
Top Width (ft)	= 50.00
Crest Width (ft)	= 50.00

Calculations

Qmin (cfs)	= 10.00
Qmax (cfs)	= 13.00
Tailwater Elev (ft)	= 0

Highlighted

Qtotal (cfs)	= 13.00
Qpipe (cfs)	= 13.00
Qovertop (cfs)	= 0.00
Veloc Dn (ft/s)	= 4.68
Veloc Up (ft/s)	= 4.49
HGL Dn (ft)	= 2.65
HGL Up (ft)	= 3.49
Hw Elev (ft)	= 3.70
Hw/D (ft)	= 0.97
Flow Regime	= Inlet Control



Channel Report

Hydraflow Express Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. Monday, Jun 29 2009

Figure C6 - Typical Channel Section

User-defined

Invert Elev (ft)	= 2.58
Slope (%)	= 1.00
N-Value	= Composite

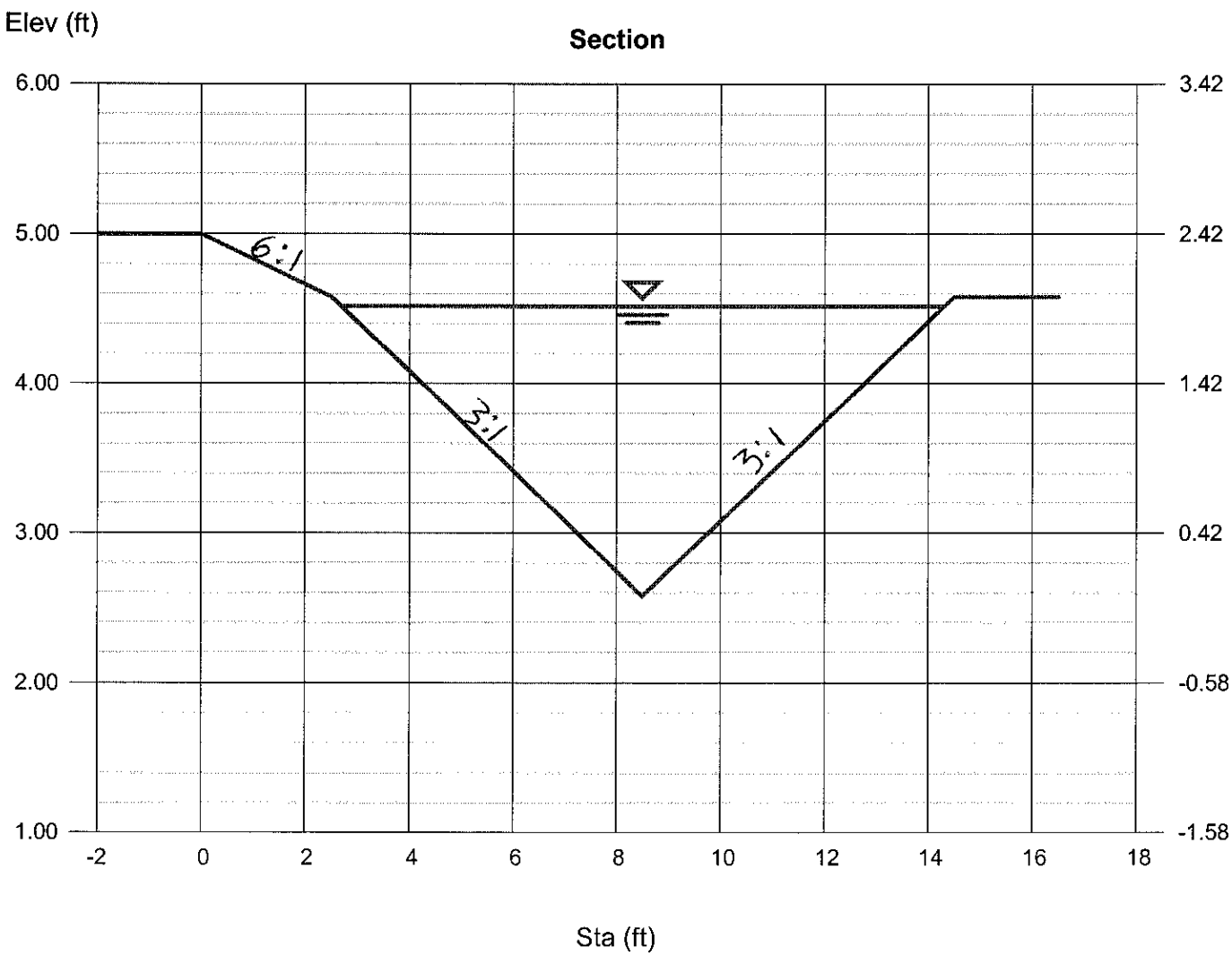
Calculations

Compute by:	Q vs Depth
No. Increments	= 10

(Sta, El, n)-(Sta, El, n)... (-8.00, 5.00)-(2.50, 4.58, 0.033)-(8.50, 2.58, 0.033)-(14.50, 4.58, 0.033)

Highlighted

Depth (ft)	= 1.94
Q (cfs)	= 47.92 ← capacity
Area (sqft)	= 11.24
Velocity (ft/s)	= 4.26
Wetted Perim (ft)	= 12.24
Crit Depth, Yc (ft)	= 1.51
Top Width (ft)	= 11.62
EGL (ft)	= 2.22



APPENDIX F – PAVEMENT DRAINAGE

Table F1 – Gutter Spread Summary

STATION	STRUCTURE	GUTTER SPREAD [FT]
16+93.78 LT	MAG STD. DTL. 206 (1) 4' OPENING	6.92
16+93.78 RT	MAG STD. DTL. 206 (1) 4' OPENING	6.24
19+93.79 LT	MAG STD. DTL. 206 (1) 4' OPENING	7.76
19+93.79 RT	MAG STD. DTL. 206 (1) 4' OPENING	7.22
22+92.21 LT	MAG STD. DTL. 206 (1) 4' OPENING	7.22
24+50.00 RT	ADOT C-15.20 L = 3'-6"	7.17
27+00.00 RT SAG	MAG STD. DTL. 206 (2) 4' OPENINGS	7.10
32+30.00 LT	MAG STD. DTL. 206 (2) 4' OPENINGS	6.70
32+30.00 RT	MAG STD. DTL. 206 (2) 4' OPENINGS	6.70
36+65.00 LT	MAG STD. DTL. 206 (3) 4' OPENINGS	6.13
37+40.00 RT	ADOT C-15.20 L = 3'-6"	3.85
41+00.00 LT SAG	ADOT C-15.20 L = 3'-6"	4.87
76+53.00 LT	GUTTER FLOW	7.72
82+42.00 RT	MAG STD. DTL. 206 (1) 4' OPENING	5.24

Sta. 16 + 93.78 LT

FHWA Urban Drainage Design Program, HY-22
Drainage of Highway Pavements

Inlets on Grade
Date: 06/29/2009

Project No. :10131
Project Name.:Scott Ranch Road
Computed by :Stephen Irwin, EIT

Inlets on Grade: Curb Opening Inlet

Roadway and Discharge Data

	Cross Slope	Composite
S	Longitudinal Slope (ft/ft)	0.0152
Sx	Pavement Cross Slope (ft/ft)	0.0200
Sw	Gutter Cross Slope (ft/ft)	0.0680
n	Manning's Coefficient	0.015
W	Gutter Width (ft)	2.00
a	Gutter Depression (inch)	1.62
Q	Discharge (cfs)	1.750
T	Width of Spread (ft)	6.92

Gutter Flow

Eo	Gutter Flow Ratio	0.728
d	Depth of Flow (ft)	0.23
V	Average Velocity (ft/sec)	3.04

Inlet Interception

	Inlet Type	Curb-Opening
LT	Length for 100% Inteception (ft)	10.44
L	Curb-Opening Length (ft)	4.00
e	Inlet Efficiency	0.581
Qi	Intercepted Flow (cfs)	1.017
Qb	By-pass Flow (cfs)	0.733

Sta. 16+93.78 RT

FHWA Urban Drainage Design Program, HY-22
Drainage of Highway Pavements

Inlets on Grade
Date: 06/29/2009

Project No. :10131
Project Name.:Scott Ranch Road
Computed by :Stephen Irwin, EIT

Inlets on Grade: Curb Opening Inlet

Roadway and Discharge Data

	Cross Slope	Composite
S	Longitudinal Slope (ft/ft)	0.0152
Sx	Pavement Cross Slope (ft/ft)	0.0200
Sw	Gutter Cross Slope (ft/ft)	0.0680
n	Manning's Coefficient	0.015
W	Gutter Width (ft)	2.00
a	Gutter Depression (inch)	1.62
Q	Discharge (cfs)	1.430
T	Width of Spread (ft)	6.24

Gutter Flow

Eo	Gutter Flow Ratio	0.777
d	Depth of Flow (ft)	0.22
V	Average Velocity (ft/sec)	2.95

Inlet Interception

	Inlet Type	Curb-Opening
LT	Length for 100% Inteception (ft)	9.29
L	Curb-Opening Length (ft)	4.00
e	Inlet Efficiency	0.637
Qi	Intercepted Flow (cfs)	0.911
Qb	By-pass Flow (cfs)	0.519

Sta. 19+93.79 LT

FHWA Urban Drainage Design Program, HY-22
Drainage of Highway Pavements

Inlets on Grade
Date: 06/29/2009

Project No. :10131
Project Name.:Scott Ranch Road
Computed by :Stephen Irwin, EIT

Inlets on Grade: Curb Opening Inlet

Roadway and Discharge Data

	Cross Slope	Composite
S	Longitudinal Slope (ft/ft)	0.0080
Sx	Pavement Cross Slope (ft/ft)	0.0200
Sw	Gutter Cross Slope (ft/ft)	0.0680
n	Manning's Coefficient	0.015
W	Gutter Width (ft)	2.00
a	Gutter Depression (inch)	1.62
Q	Discharge (cfs)	1.590
T	Width of Spread (ft)	7.76

Gutter Flow

Eo	Gutter Flow Ratio	0.673
d	Depth of Flow (ft)	0.25
V	Average Velocity (ft/sec)	2.28

Inlet Interception

	Inlet Type	Curb-Opening
LT	Length for 100% Inteception (ft)	8.59
L	Curb-Opening Length (ft)	4.00
e	Inlet Efficiency	0.676
Qi	Intercepted Flow (cfs)	1.076
Qb	By-pass Flow (cfs)	0.514

Sta. 19+93.79 RT

FHWA Urban Drainage Design Program, HY-22
Drainage of Highway Pavements

Inlets on Grade
Date: 06/29/2009

Project No. :10131
Project Name.:Scott Ranch Road
Computed by :Stephen Irwin, EIT

Inlets on Grade: Curb Opening Inlet

Roadway and Discharge Data

	Cross Slope	Composite
S	Longitudinal Slope (ft/ft)	0.0080
Sx	Pavement Cross Slope (ft/ft)	0.0200
Sw	Gutter Cross Slope (ft/ft)	0.0680
n	Manning's Coefficient	0.015
W	Gutter Width (ft)	2.00
a	Gutter Depression (inch)	1.62
Q	Discharge (cfs)	1.370
T	Width of Spread (ft)	7.22

Gutter Flow

Eo	Gutter Flow Ratio	0.708
d	Depth of Flow (ft)	0.24
V	Average Velocity (ft/sec)	2.22

Inlet Interception

	Inlet Type	Curb-Opening
LT	Length for 100% Inteception (ft)	7.88
L	Curb-Opening Length (ft)	4.00
e	Inlet Efficiency	0.721
Qi	Intercepted Flow (cfs)	0.988
Qb	By-pass Flow (cfs)	0.382

Sta. 22+92.21 LT

FHWA Urban Drainage Design Program, HY-22
Drainage of Highway Pavements

Inlets on Grade
Date: 06/29/2009

Project No. :10131
Project Name.:Scott Ranch Road
Computed by :Stephen Irwin, EIT

Inlets on Grade: Curb Opening Inlet

Roadway and Discharge Data

	Cross Slope	Composite
S	Longitudinal Slope (ft/ft)	0.0080
Sx	Pavement Cross Slope (ft/ft)	0.0200
Sw	Gutter Cross Slope (ft/ft)	0.0680
n	Manning's Coefficient	0.015
W	Gutter Width (ft)	2.00
a	Gutter Depression (inch)	1.62
Q	Discharge (cfs)	1.370
T	Width of Spread (ft)	7.22

Gutter Flow

Eo	Gutter Flow Ratio	0.708
d	Depth of Flow (ft)	0.24
V	Average Velocity (ft/sec)	2.22

Inlet Interception

	Inlet Type	Curb-Opening
LT	Length for 100% Inteception (ft)	7.88
L	Curb-Opening Length (ft)	4.00
e	Inlet Efficiency	0.721
Qi	Intercepted Flow (cfs)	0.988
Qb	By-pass Flow (cfs)	0.382

Sta. 24+50 RT

FHWA Urban Drainage Design Program, HY-22
Drainage of Highway Pavements

Inlets on Grade
Date: 06/29/2009

Project No. :10131
Project Name.:Scott Ranch Road
Computed by :Stephen Irwin, EIT

Inlets on Grade: Curb Opening Inlet

Roadway and Discharge Data

	Cross Slope	Composite
S	Longitudinal Slope (ft/ft)	0.0080
Sx	Pavement Cross Slope (ft/ft)	0.0320
Sw	Gutter Cross Slope (ft/ft)	0.0680
n	Manning's Coefficient	0.015
W	Gutter Width (ft)	2.00
a	Gutter Depression (inch)	1.62
Q	Discharge (cfs)	2.450
T	Width of Spread (ft)	7.17

Gutter Flow

Eo	Gutter Flow Ratio	0.650
d	Depth of Flow (ft)	0.30
V	Average Velocity (ft/sec)	2.74

Inlet Interception

	Inlet Type	Curb-Opening
LT	Length for 100% Inteception (ft)	10.20
L	Curb-Opening Length (ft)	6.50
e	Inlet Efficiency	0.839
Qi	Intercepted Flow (cfs)	2.055
Qb	By-pass Flow (cfs)	0.395

Sta. 27+00 RT

FHWA Urban Drainage Design Program, HY-22
Drainage of Highway Pavements

Inlets on Sag
Date: 06/30/2009

Project No. :10131
Project Name.:Scott Ranch Road
Computed by :Stephen Irwin, EIT

Inlets on Sag: Curb-Opening Inlet

Roadway and Discharge Data

	Cross Slope	Composite/Dep
Sx	Pavement Cross Slope (ft/ft)	0.0320
Sw	Gutter Cross Slope (ft/ft)	0.0680
n	Manning's Coefficient	0.015
W	Gutter Width (ft)	2.00
a	Gutter Depression (inch)	1.62

Inlet Interception

	Inlet Type *Sag*	Curb-Opening
T	Width of Spread (ft)	7.10
L	Curb-Opening Length (ft)	8.00
H	Curb-Opening Height (in)	5.00
d_curb	Depth at Curb (ft)	0.434
Qi	Intercepted Flow (cfs)	2.890

Sta. 32+30 LT

FHWA Urban Drainage Design Program, HY-22
Drainage of Highway Pavements

Inlets on Grade
Date: 06/29/2009

Project No. :10131
Project Name.:Scott Ranch Road
Computed by :Stephen Irwin, EIT

Inlets on Grade: Curb Opening Inlet

Roadway and Discharge Data

	Cross Slope	Composite
S	Longitudinal Slope (ft/ft)	0.0100
Sx	Pavement Cross Slope (ft/ft)	0.0200
Sw	Gutter Cross Slope (ft/ft)	0.0680
n	Manning's Coefficient	0.015
W	Gutter Width (ft)	2.00
a	Gutter Depression (inch)	1.62
Q	Discharge (cfs)	1.330
T	Width of Spread (ft)	6.70

Gutter Flow

Eo	Gutter Flow Ratio	0.744
d	Depth of Flow (ft)	0.23
V	Average Velocity (ft/sec)	2.44

Inlet Interception

	Inlet Type	Curb-Opening
LT	Length for 100% Inteception (ft)	8.12
L	Curb-Opening Length (ft)	8.00
e	Inlet Efficiency	1.000
Qi	Intercepted Flow (cfs)	1.329
Qb	By-pass Flow (cfs)	0.001

Sta. 32+30 RT

FHWA Urban Drainage Design Program, HY-22
Drainage of Highway Pavements

Inlets on Grade
Date: 06/29/2009

Project No. :10131
Project Name.:Scott Ranch Road
Computed by :Stephen Irwin, EIT

Inlets on Grade: Curb Opening Inlet

Roadway and Discharge Data

	Cross Slope	Composite
S	Longitudinal Slope (ft/ft)	0.0100
Sx	Pavement Cross Slope (ft/ft)	0.0200
Sw	Gutter Cross Slope (ft/ft)	0.0680
n	Manning's Coefficient	0.015
W	Gutter Width (ft)	2.00
a	Gutter Depression (inch)	1.62
Q	Discharge (cfs)	1.330
T	Width of Spread (ft)	6.70

Gutter Flow

Eo	Gutter Flow Ratio	0.744
d	Depth of Flow (ft)	0.23
V	Average Velocity (ft/sec)	2.44

Inlet Interception

	Inlet Type	Curb-Opening
LT	Length for 100% Inteception (ft)	8.12
L	Curb-Opening Length (ft)	8.00
e	Inlet Efficiency	1.000
Qi	Intercepted Flow (cfs)	1.329
Qb	By-pass Flow (cfs)	0.001

Sta. 36+65 LT

FHWA Urban Drainage Design Program, HY-22
Drainage of Highway Pavements

Inlets on Grade
Date: 06/29/2009

Project No. :10131
Project Name.:Scott Ranch Road
Computed by :Stephen Irwin, EIT

Inlets on Grade: Curb Opening Inlet

Roadway and Discharge Data

	Cross Slope	Composite
S	Longitudinal Slope (ft/ft)	0.0284
Sx	Pavement Cross Slope (ft/ft)	0.0200
Sw	Gutter Cross Slope (ft/ft)	0.0680
n	Manning's Coefficient	0.015
W	Gutter Width (ft)	2.00
a	Gutter Depression (inch)	1.62
Q	Discharge (cfs)	1.890
T	Width of Spread (ft)	6.13

Gutter Flow

Eo	Gutter Flow Ratio	0.785
d	Depth of Flow (ft)	0.22
V	Average Velocity (ft/sec)	4.01

Inlet Interception

	Inlet Type	Curb-Opening
LT	Length for 100% Inteception (ft)	12.54
L	Curb-Opening Length (ft)	12.00
e	Inlet Efficiency	0.997
Qi	Intercepted Flow (cfs)	1.883
Qb	By-pass Flow (cfs)	0.007

Sta. 37+40 RT

FHWA Urban Drainage Design Program, HY-22
Drainage of Highway Pavements

Inlets on Grade
Date: 06/30/2009

Project No. :10131
Project Name.:Scott Ranch Road
Computed by :Stephen Irwin, EIT

Inlets on Grade: Curb Opening Inlet

Roadway and Discharge Data

	Cross Slope	Composite
S	Longitudinal Slope (ft/ft)	0.0150
Sx	Pavement Cross Slope (ft/ft)	0.0100
Sw	Gutter Cross Slope (ft/ft)	0.0680
n	Manning's Coefficient	0.015
W	Gutter Width (ft)	2.00
a	Gutter Depression (inch)	1.62
Q	Discharge (cfs)	0.470
T	Width of Spread (ft)	3.85

Gutter Flow

Eo	Gutter Flow Ratio	0.977
d	Depth of Flow (ft)	0.15
V	Average Velocity (ft/sec)	2.47

Inlet Interception

	Inlet Type	Curb-Opening
LT	Length for 100% Inteception (ft)	5.18
L	Curb-Opening Length (ft)	6.50
e	Inlet Efficiency	1.000
Qi	Intercepted Flow (cfs)	0.470
Qb	By-pass Flow (cfs)	0.000

Sta. 41+00 LT

FHWA Urban Drainage Design Program, HY-22
Drainage of Highway Pavements

Inlets on Sag
Date: 06/29/2009

Project No. :10131
Project Name.:Scott Ranch Road
Computed by :Stephen Irwin, EIT

Inlets on Sag: Curb-Opening Inlet

Roadway and Discharge Data

	Cross Slope	Composite/Dep
Sx	Pavement Cross Slope (ft/ft)	0.0400
Sw	Gutter Cross Slope (ft/ft)	0.0680
n	Manning's Coefficient	0.015
W	Gutter Width (ft)	2.00
a	Gutter Depression (inch)	1.62

Inlet Interception

	Inlet Type *Sag*	Curb-Opening
T	Width of Spread (ft)	4.87
L	Curb-Opening Length (ft)	6.50
H	Curb-Opening Height (in)	7.60
d_curb	Depth at Curb (ft)	0.386
Qi	Intercepted Flow (cfs)	2.000

Sta. 76 + 53 LT

FHWA Urban Drainage Design Program, HY-22
Drainage of Highway Pavements

Inlets on Grade
Date: 06/29/2009

Project No. :10131
Project Name.:Scott Ranch Road
Computed by :Stephen Irwin, EIT

Inlets on Grade: Gutter Flow Parameters

Roadway and Discharge Data

	Cross Slope		Composite
S	Longitudinal Slope	(ft/ft)	0.0550
Sx	Pavement Cross Slope	(ft/ft)	0.0200
Sw	Gutter Cross Slope	(ft/ft)	0.0680
n	Manning's Coefficient		0.015
W	Gutter Width (ft)		2.00
a	Gutter Depression (inch)		1.62
Q	Discharge (cfs)		4.130
T	Width of Spread (ft)		7.72

Gutter Flow

Eo	Gutter Flow Ratio	0.675
d	Depth of Flow (ft)	0.25
V	Average Velocity (ft/sec)	5.97

Sta. 82+42 RT

FHWA Urban Drainage Design Program, HY-22
Drainage of Highway Pavements

Inlets on Grade
Date: 06/29/2009

Project No. :10131
Project Name.:Scott Ranch Road
Computed by :Stephen Irwin, EIT

Inlets on Grade: Curb Opening Inlet

Roadway and Discharge Data

	Cross Slope	Composite
S	Longitudinal Slope (ft/ft)	0.0089
Sx	Pavement Cross Slope (ft/ft)	0.0200
Sw	Gutter Cross Slope (ft/ft)	0.0680
n	Manning's Coefficient	0.015
W	Gutter Width (ft)	2.00
a	Gutter Depression (inch)	1.62
Q	Discharge (cfs)	0.800
T	Width of Spread (ft)	5.24

Gutter Flow

Eo	Gutter Flow Ratio	0.851
d	Depth of Flow (ft)	0.20
V	Average Velocity (ft/sec)	2.16

Inlet Interception

	Inlet Type	Curb-Opening
LT	Length for 100% Inteception (ft)	5.93
L	Curb-Opening Length (ft)	4.00
e	Inlet Efficiency	0.868
Qi	Intercepted Flow (cfs)	0.694
Qb	By-pass Flow (cfs)	0.106