Technical Drainage Study

for

Somersett Village 5F

Sierra Canyon
Villages 1 – 3

Reno, NV

Prepared for:

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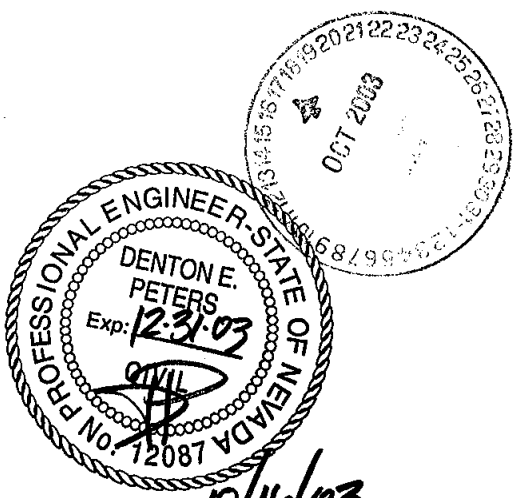


Denton E. Peters, PE #12087 Date
Professional Hydrologist, AIH

1 Introduction

1.1 Purpose of Study.

This report presents the data, hydrologic and hydraulic analyses, and conclusions of a technical drainage study performed for Village 5F of the Somersett master planned development – to be marketed as Sierra Canyon Villages 1-3. This report covers Villages 1-3 and portions of Somersett Parkway and Del Webb Parkway. This report provides updated and detailed information supplemental to the *Conceptual Hydrology Report for Active Adult Community, Villages 5F–5L.* This report was previously prepared and submitted to the City of Reno in support of the project's tentative map application. It is anticipated that readers of this study have thoroughly reviewed the previous report and it is available for ready reference.

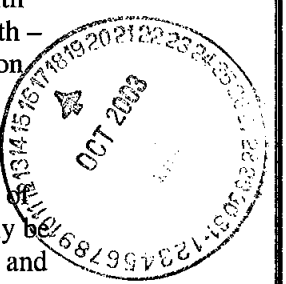
Prepared and submitted concurrently with this study is the *Master Hydrology and Detention Basin Analysis for Sierra Canyon.* This document is the direct follow-up to the *Conceptual Hydrology Report* and presents the detailed analysis and calculations for the overall project hydrology, including the proposed on-site detention basin and temporary erosion control and siltation basins. Like the conceptual study, it is anticipated that readers of this study have the master hydrology and detention basin analysis available for ready reference.

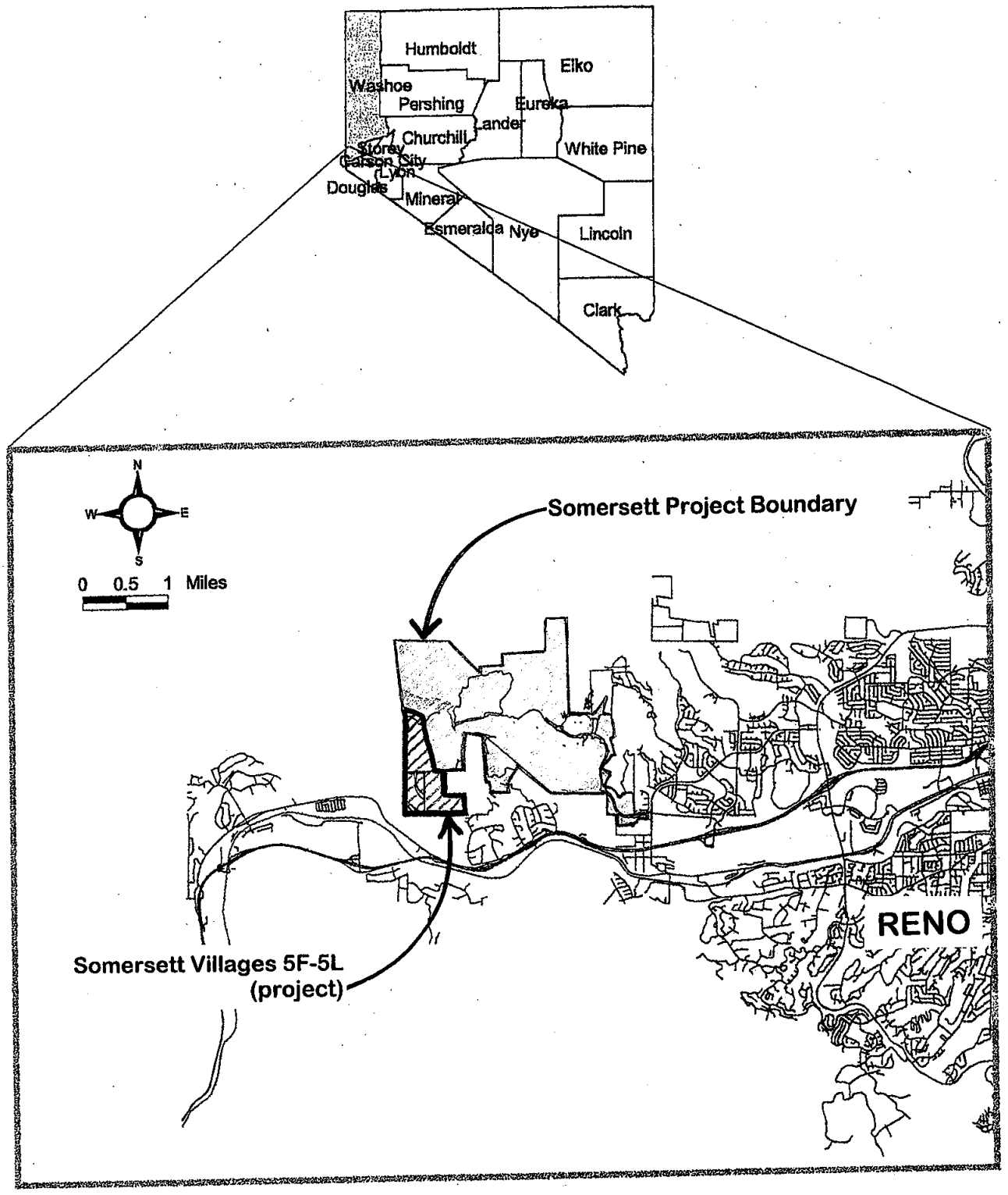
The information, data, and calculations presented herein are intended to support the initial submittals of improvement plans prepared for Sierra Canyon Villages 1-3. A cross-reference with the improvement plans will aid in the understanding of this report. Please note - this study is intended to be a working document and will be updated and/or revised as needed to correspond with future plan-check corrections or project modifications following the first submittal. In addition, in the interest of brevity and clarity, this report will defer to figures, tables, and the data and calculations contained in the appendices whenever possible.

1.2 Project Location and Description

The Somersett Development lies in the northwesterly region of the City of Reno, north of Interstate 80 and the Truckee River. Villages 5F through 5L make op the southwesterly corner of the Somersett project area (see Plate 1, *Vicinity Map*). The site lies in the lower reaches of a very large watershed that drains generally to south toward the Truckee River (see Plate 2, *Project Reference Exhibit*). Formally, the project site is situated in Section 10, Township 10 North, and Range 18 East, of the Mount Diablo Meridian.

The subject site (Village 5F) is undeveloped and consists of range and grasslands with moderate rolling hills and a central valley that slopes typically at 5% toward the south – southeast. Village 5F, consisting of the northern most 66.5 acres of the Sierra Canyon project, will be constructed in three units or sub-villages. Village 1, comprised of approximately 17.5 acres, will provide 57 single-family residential lots and be constructed first. Similarly, Village 2, a 16.5-acre parcel, will follow Village 1 in construction and yield 45 lots and a 4-acre recreation center. Village 3 is the largest of the three at approximately 28.5 acres. This village will contain 90 lots and will likely be the last of the three constructed. Plate 3, the *Village 5F Map*, illustrates the location and orientation of these sub-villages within the Sierra Canyon project.





Modified from Nimbus Engineers (2002)

Vicinity Map
Plate 1

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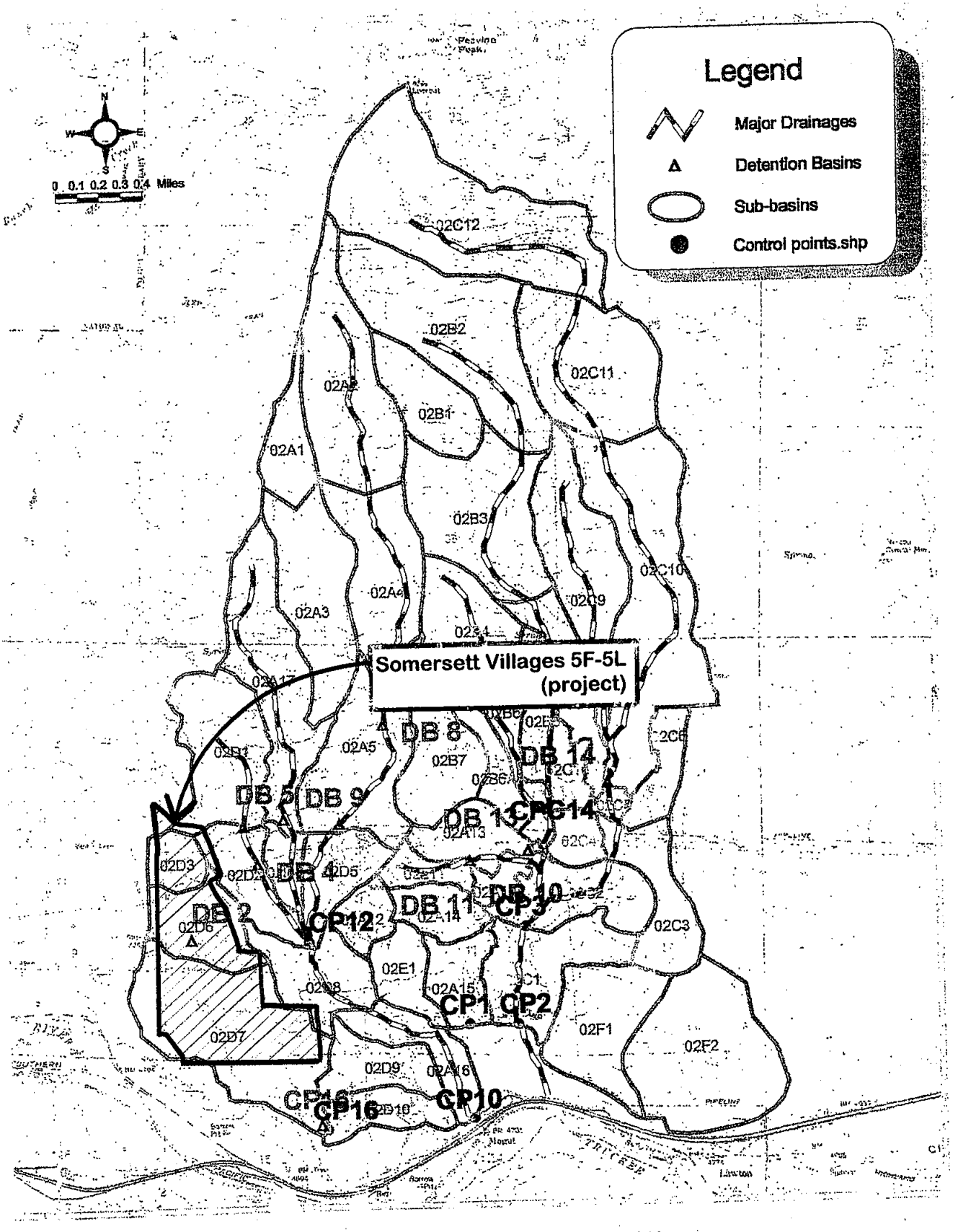


Modified from Nimbus Engineers (2002)

Project Reference Exhibit
Plate 2

MacKay & Somps
ENGINEERS PLANNERS SURVEYORS

The proposed Village 1-3 improvements for Sierra Canyon include full-width interior streets, underground utilities, and storm drain facilities. Longitudinal slopes on proposed roadways will range from mild (1%-2%) to somewhat steep (5% - 7%). The lots will be pad graded and surface drained uniformly to the fronting streets via 1% (minimum) minor on-site drainage swales. A majority of on-site drainage will be collected and conveyed via the proposed storm drain systems. As described in the *Conceptual Hydrology Report,* no "Major Drainageways," as identified in the City of Reno's Major Drainageways Plan, traverse or abut Village 5F.

2 Master Planning Information

2.1 FEMA Floodplain Information.

FEMA floodplain information for Village 5F of Somersett was presented in Appendix A of the *Conceptual Drainage Report.* As depicted therein, the site is located within a FEMA Zone 'X' (an area determined to be outside of the 500-year floodplain).

2.2 Drainage Master Plans.

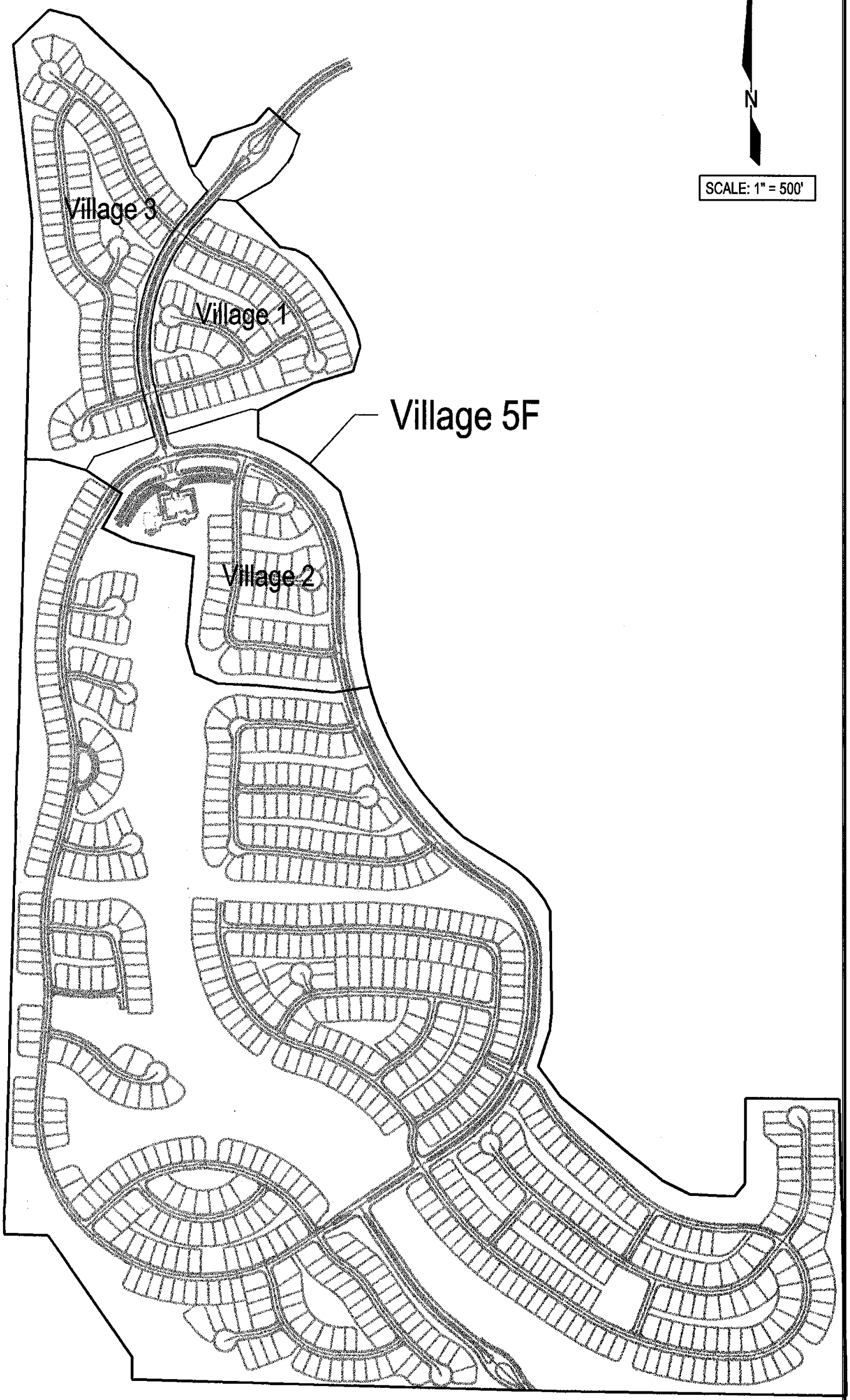
The *Conceptual Drainage Report* describes several hydrologic studies and master drainage planning efforts previously prepared for the Somersett Development. These include the *Somersett Storm Drainage Master Plan* (WRC, 1998), the *Revised Somersett Storm Drainage Master Plan* (Nimbus, 2001), and the *Updated Somersett Storm Drainage Master Plan* (Nimbus, 2002). In addition to these studies, the *Master Hydrology and Detention Basin Analysis* provides specific master planning information for Villages 5F through 5L.

3 Methodologies and Assumptions

3.1 Hydrologic Analysis Methods.

The peak storm flows estimated herein were determined using the data and methodologies presented in the Chapter II – Storm Drainage, of the City of Reno's Public Works Design Manual. For a conservative analysis, a minimum time of concentration of 10-minutes was used for all subbasins. Appendix A contains the data and calculations for estimated peak storm flows for the subbasins defined herein using the Rational Method. Also contained in Appendix A is a table presenting this data and the calculations for the peak 5-year and 100-year storm flows for the drainage subbasins using the Rational Method.

It is important to note that the Rational Method calculations were performed only for the purposes of sizing and analyzing proposed drainage facilities. The results are not analogous with and/or will not correspond to the SCS Unit Hydrograph results from the HEC-1 analyses provided in the *Master Hydrology and Detention Basin Analysis.* The Rational Method typically provides conservative results and is a more reasonable hydrologic determination method for the small subbasin associated with the proposed village 1-3 improvements.



Village 5F Map

Plate 3

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3.2 Hydraulic Modeling Methods.

Appendix B contains a table presenting basic normal depth information for the street flows and capacities using rating curves from the Manning's Formula and Haestad Methods' FlowMaster software (version 5.15). Similarly, Appendix C contains a table presenting basic normal depth information for the drainage swales. Interception capacities and ponding depths for the proposed catch basins within Somersett Parkway and the interior streets were determined using the rating curves produced within FlowMaster and Figure 907 of the City of Sparks Hydrologic Criteria and Drainage Design Manual. This information and additional details regarding the proposed catch basins is included in Appendix D. Appendix E contains the design calculations for proposed flared inlet sections. Again, FlowMaster was used to determine normal depths and flow velocities for the inlet connecting pipes.

3.3 Assumptions.

Since the Rational Method was employed for peak storm flow estimations, reductions associated with hydrograph routing and combining have been neglected from the analyses herein. This contributes to the conservative nature of the 'worst case' analysis methods applied in this study.

4 Existing Drainage Conditions

4.1 Existing Off-Site Drainage.

Existing off-site drainage conditions were analyzed in the *Conceptual Hydrology Report* and are not re-considered herein.

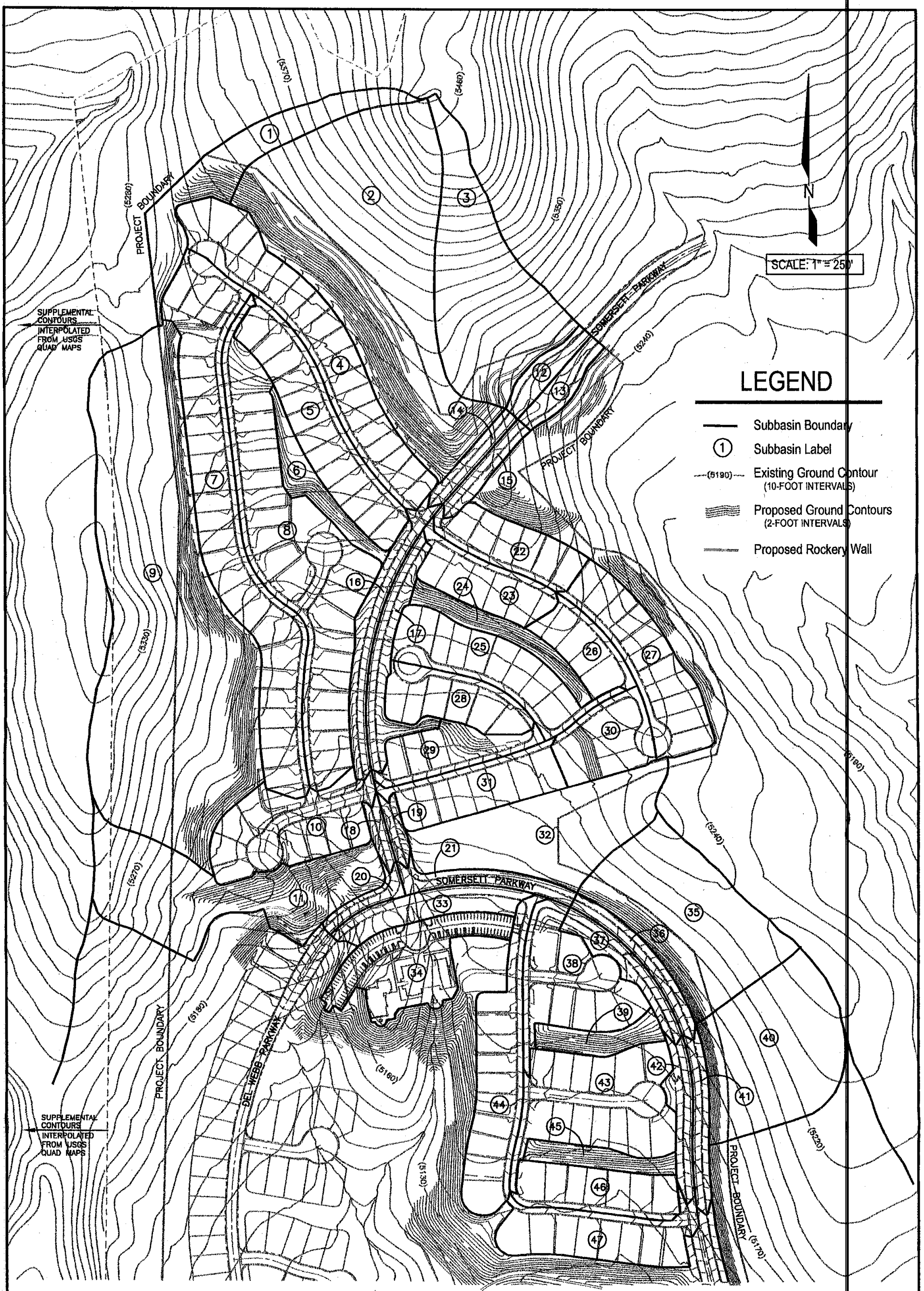
4.2 Existing On-Site Drainage.

Existing on-site drainage conditions were analyzed in the *Conceptual Hydrology Report* and are not re-considered herein.

5 Proposed Drainage Conditions

5.1 Proposed Off-Site Drainage.

Plate 4, the *Drainage Subbasin Map*, provides an illustrative description of the project specific drainage subbasins that develop from off-site areas – specifically subbasins 1, 2, 3, 9, 11, 32, 35, and 40. Flows from these subbasins are routed around and through the project via drainage swales and/or the diversionary nature of the proposed rockery walls at the site perimeter. Appendix A includes the 5-Year and 100-Year peak storm flows for the off-site drainage subbasins. No drainage facilities are proposed beyond the project boundary.



Drainage Subbasin Map

Plate 4

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N

SCALE: 1" = 250'

LEGEND

- Subbasin Boundary
- (1) Subbasin Label
- CB6 Catch Basin Location / Label
- P1 Storm Drain Pipe Label
- S10 Drainage Swale Label
- F1 Flared Pipe Inlet Location / Label
- Flow Patern / Direction
- Drainage Swale
- Storm Drain Pipe

(72% of 9)

(28% of 9)

FUTURE SWALE

Drainage Facilities Plan

Plate 5

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5.2 Proposed On-Site Drainage.

As with the off-site drainage conditions, Plate 4 also illustrates the location and size of the project specific on-site drainage subbasins. Plate 5, the *Drainage Facilities Plan*, provides the labeling and locations for the preliminary catch basins, drainage swales, and storm drain systems proposed for Villages 1-3. Again, Appendix A includes the 5-Year and 100-Year peak storm flows for the on-site drainage subbasins. Appendix B provides roadway flow information based on the location of the defined on-site subbasins. The peak storm flows, flow depths, and velocities for the proposed drainage swales are presented in Appendix C. Appendix D includes the data and calculations for the catch basin sizes and placement as well as a preliminary storm drain analysis.

Given that this study supports three villages and has been prepared in advance of the initial design of Villages 2 and 3, a fully developed hydraulic analysis of the preliminary storm drain systems – including backwater profiles and surcharging characteristics - is not presented herein. It is highly likely that modifications to the designs of these systems are inevitable and a thorough analysis at this time is premature. Rather, a preliminary look at the anticipated peak storm flows, velocities, velocity heads, and possible head-losses for the major storm drain pipes is included in Appendix D. From this preliminary assessment, it appears all proposed pipes will convey the peak 5-year flows within the pipe segments and only a few pipe segments will be pressurized when conveying the 100-year peak flows. Supplemental studies corresponding to the final plan submittals for each village will include complete hydraulic analyses of all storm drain components.

6 Conclusions and Recommendations

6.1 General Considerations.

This study is intended to be a working document and will require updates and revisions to address the status of the final improvement plans for Villages 1-3 of Sierra Canyon. In particular, the storm drain sizes, alignments, and design calculations presented herein are preliminary and will be supplemented by subsequent designs and thorough hydraulic and backwater profile analysis coincident with the final plan submittals for each village. In addition, as grading designs and surface water flow patterns evolve for each village, revisions may be required for the street flow, swale flow, and catch basin interception calculations provided herein. Lastly, given that the Rational Method was employed in this study to determine peak storm flows for facility sizing and designs and that the *Master Hydrology and Detention Basin Analysis* utilizes unit hydrograph methods within the HEC-1 program, the runoff results from each can not be compared.

6.2 Regulations and Master Plans.

The proposed improvements and the analyses presented herein are in accordance with drainage regulations presented in Chapter II – Storm Drainage, of the City of Reno's Public Works Design Manual and adhere to the previous hydrology reports, master planning efforts, and flood control and drainage documents.

6.3 Impacts to Adjacent Properties.

The proposed project improvements and roadway storm water conveyance facilities, once constructed, will not adversely impact upstream or downstream properties adjacent to this site. The development of this site for the uses proposed will not significantly increase upstream or downstream storm flow runoff rates, volumes, velocities, depths, and will not influence floodplain boundaries.

6.4 Standards of Practice

This study was prepared using the degree of care and skill ordinarily exercised, under similar circumstances, by reputable professional engineers practicing in this and similar localities.

Appendix A

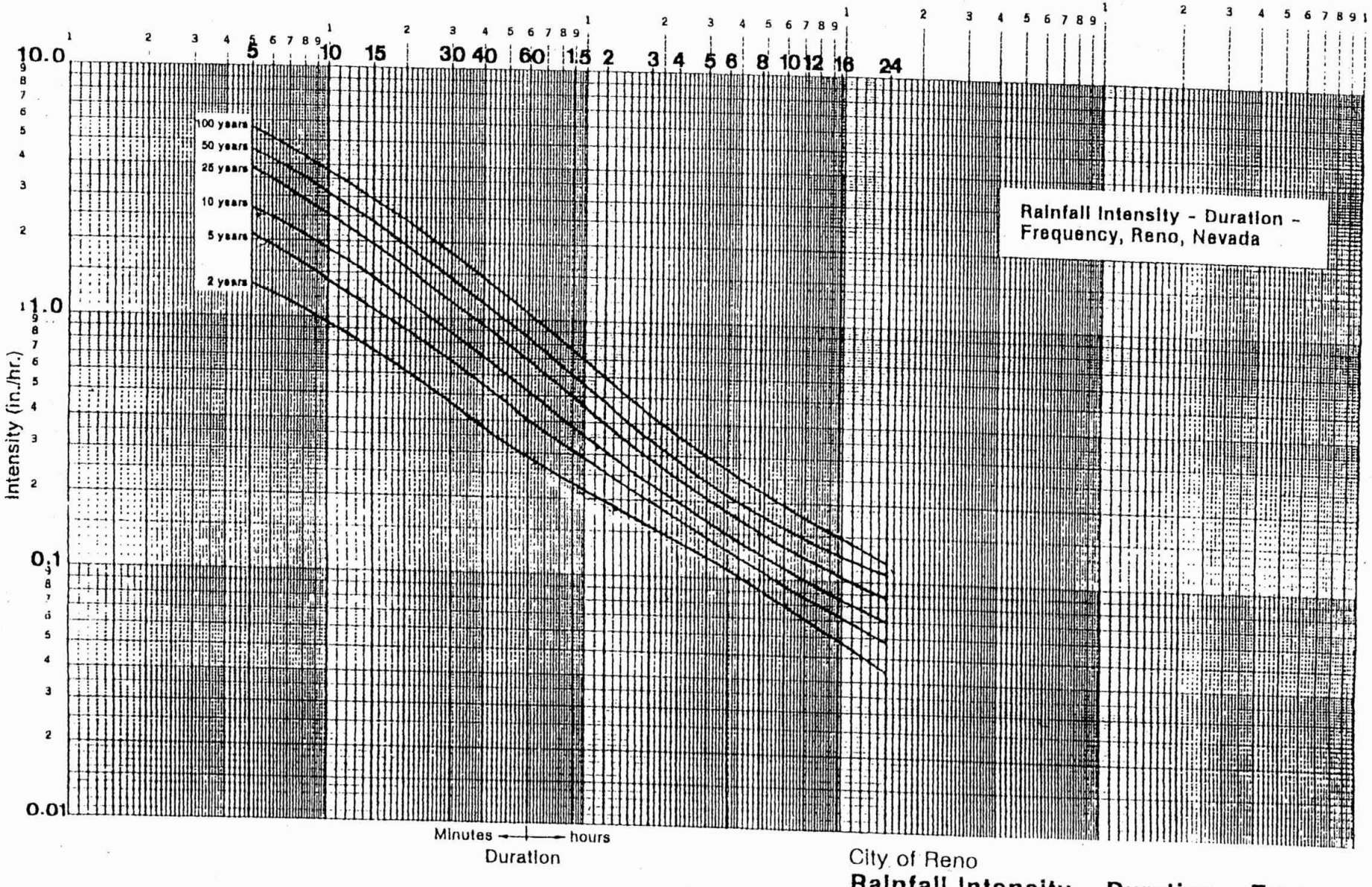
Rainfall and Runoff Calculations

Rational Method Subbasin Data and Runoff Parameters

(Small On-Site Subbasins)

Subbasin		Composite Tc[9]		Runoff Coefficients 'C'													Rational Method Q=CiA			
		Time of Concentration [1]		Runoff Area #1 *Open Space/Lawn/ Undeveloped*			Runoff Area #2 *Residential Area*			Runoff Area #3 *Commercial Area*			Runoff Area #4 *Paved Streets*			Final	Final	5-Year Rainfall Intensity I_5	100-Year Rainfall Intensity I_{100}	5-Year Peak Runoff Q_5	100-Year Peak Runoff Q_{100}
Label	Area (ac)	Tc (min)	Tc (hrs)	Area (ac)	C_5	C_{100}	Area (ac)	C_5	C_{100}	Area (ac)	C_5	C_{100}	Area (ac)	C_5	C_{100}	"C_5"	"C_{100}"	(in/hr)	(in/hr)	(cfs)	(cfs)
1	1.80	10.0	0.17	1.80	0.5	0.5										0.50	0.50	1.40	3.65	1.26	3.29
2	7.89	10.0	0.17	7.89	0.5	0.5										0.50	0.50	1.40	3.65	5.52	14.40
3	3.68	10.0	0.17	3.68	0.5	0.5										0.50	0.50	1.40	3.65	2.58	6.72
4	3.03	10.0	0.17				3.03	0.55	0.55							0.55	0.55	1.40	3.65	2.33	6.08
5	2.18	10.0	0.17				2.18	0.55	0.55							0.55	0.55	1.40	3.65	1.68	4.38
6	0.66	10.0	0.17	0.66	0.5	0.5										0.50	0.50	1.40	3.65	0.46	1.20
7	4.50	10.0	0.17				4.50	0.55	0.55							0.55	0.55	1.40	3.65	3.47	9.03
8	4.68	10.0	0.17				4.68	0.55	0.55							0.55	0.55	1.40	3.65	3.60	9.40
9	10.64	10.0	0.17	10.64	0.5	0.5										0.50	0.50	1.40	3.65	7.45	19.42
10	2.01	10.0	0.17				2.01	0.55	0.55							0.55	0.55	1.40	3.65	1.55	4.04
11	3.53	10.0	0.17	3.53	0.5	0.5										0.50	0.50	1.40	3.65	2.47	6.44
12	0.42	10.0	0.17	0.17	0.35	0.35							0.25	0.95	0.95	0.71	0.71	1.40	3.65	0.42	1.09
13	0.41	10.0	0.17	0.16	0.35	0.35							0.25	0.95	0.95	0.71	0.71	1.40	3.65	0.41	1.06
14	0.33	10.0	0.17	0.13	0.35	0.35							0.20	0.95	0.95	0.71	0.71	1.40	3.65	0.33	0.86
15	0.35	10.0	0.17	0.14	0.35	0.35							0.21	0.95	0.95	0.71	0.71	1.40	3.65	0.35	0.91
16	0.91	10.0	0.17	0.36	0.35	0.35							0.55	0.95	0.95	0.71	0.71	1.40	3.65	0.90	2.36
17	0.92	10.0	0.17	0.37	0.35	0.35							0.55	0.95	0.95	0.71	0.71	1.40	3.65	0.91	2.38
18	0.19	10.0	0.17	0.08	0.35	0.35							0.11	0.95	0.95	0.71	0.71	1.40	3.65	0.19	0.49
19	0.20	10.0	0.17	0.08	0.35	0.35							0.12	0.95	0.95	0.71	0.71	1.40	3.65	0.20	0.52
20	0.27	10.0	0.17	0.15	0.35	0.35							0.12	0.95	0.95	0.62	0.62	1.40	3.65	0.23	0.61
21	0.54	10.0	0.17	0.22	0.35	0.35							0.32	0.95	0.95	0.71	0.71	1.40	3.65	0.54	1.40
22	1.15	10.0	0.17				1.15	0.55	0.55							0.55	0.55	1.40	3.65	0.89	2.31
23	1.11	10.0	0.17				1.11	0.55	0.55							0.55	0.55	1.40	3.65	0.85	2.23
24	0.68	10.0	0.17	0.68	0.5	0.5										0.50	0.50	1.40	3.65	0.48	1.24
25	1.80	10.0	0.17				1.80	0.55	0.55							0.55	0.55	1.40	3.65	1.39	3.61
26	0.85	10.0	0.17				0.85	0.55	0.55							0.55	0.55	1.40	3.65	0.65	1.71
27	1.87	10.0	0.17				1.87	0.55	0.55							0.55	0.55	1.40	3.65	1.44	3.75
28	1.20	10.0	0.17				1.20	0.55	0.55							0.55	0.55	1.40	3.65	0.92	2.41
29	1.03	10.0	0.17	0.52	0.5	0.5	0.52	0.55	0.55							0.53	0.53	1.40	3.65	0.76	1.97
30	1.15	10.0	0.17	0.40	0.5	0.5	0.75	0.55	0.55							0.53	0.53	1.40	3.65	0.86	2.24
31	1.42	10.0	0.17				1.42	0.55	0.55							0.55	0.55	1.40	3.65	1.09	2.85
32	3.04	10.0	0.17	3.04	0.5	0.5										0.50	0.50	1.40	3.65	2.13	5.55
33	0.90	10.0	0.17	0.45	0.35	0.35							0.45	0.95	0.95	0.65	0.65	1.40	3.65	0.82	2.14
34	1.83	10.0	0.17							1.83	0.85	0.85				0.85	0.85	1.40	3.65	2.18	5.68
35	3.58	10.0	0.17	3.58	0.5	0.5										0.50	0.50	1.40	3.65	2.51	6.53
36	0.52	10.0	0.17	0.21	0.35	0.35							0.31	0.95	0.95	0.71	0.71	1.40	3.65	0.52	1.35
37	0.59	10.0	0.17	0.30	0.35	0.35							0.30	0.95	0.95	0.65	0.65	1.40	3.65	0.54	1.40
38	1.90	10.0	0.17				1.90	0.55	0.55							0.55	0.55	1.40	3.65	1.46	3.81
39	0.56	10.0	0.17	0.56	0.5	0.5										0.50	0.50	1.40	3.65	0.39	1.02
40	3.37	10.0	0.17	3.37	0.5	0.5										0.50	0.50	1.40	3.65	2.36	6.15
41	0.49	10.0	0.17	0.20	0.35	0.35							0.29	0.95	0.95	0.71	0.71	1.40	3.65	0.49	1.27
42	0.53	10.0	0.17	0.27	0.35	0.35		0.55	0.55				0.27	0.95	0.95	0.65	0.65	1.40	3.65	0.48	1.26
43	2.58	10.0	0.17				2.58	0.55	0.55							0.55	0.55	1.40	3.65	1.99	5.18
44	2.05	10.0	0.17				1.845	0.55	0.55				0.205	0.95	0.95	0.59	0.59	1.40	3.65	1.69	4.41
45	0.52	10.0	0.17	0.52	0.5	0.5										0.50	0.50	1.40	3.65	0.36	0.95
46	1.26	10.0	0.17				1.26	0.55	0.55							0.55	0.55	1.40	3.65	0.97	2.53
47	1.64	10.0	0.17				1.64	0.55	0.55							0.55	0.55	1.40	3.65	1.26	3.29

Notes: (1) For the Rational Method, a conservative 'Tc' of 10 minutes was applied to all small on-site subbasins.



RAINFALL INTENSITY CHART

FOR MINIMUM T_C OF 10 MINUTES, $i_5 = 1.40$, $i_{100} = 3.65$

City of Reno

Rainfall Intensity - Duration - Frequency Curves for General Reno Area

Based on Rainfall Data from Cannon Airport Gauging Station

Figure 4

RUNOFF COEFFICIENTS "C"

Land Use Type	Runoff Coefficient "C"
Rural	0.25-0.35
Single Family Residential	0.45-0.60
Multi-Residential	0.60-0.70
Neighborhood Commercial	0.85
Community Commercial	0.85
Tourist Commercial	0.85
Office	0.85
Manufacturing	0.85-0.90
Distribution and Warehousing	0.85-0.90
Public Facility	0.50-0.85
Pavement and Concrete Surfaces	0.90-0.95
Park	0.25
Open Space (0-5% grade - vegetated)	0.20-0.30
Open Space (0-5% grade - no vegetation)	0.30-0.40
Open Space (5-15% grade - vegetated or unvegetated)	0.40-0.50
Open Space (Over 15% grade - sparsely vegetated, rock or clay soils)	0.40-0.60

Appendix B

Roadway Flows and Depth Calculations

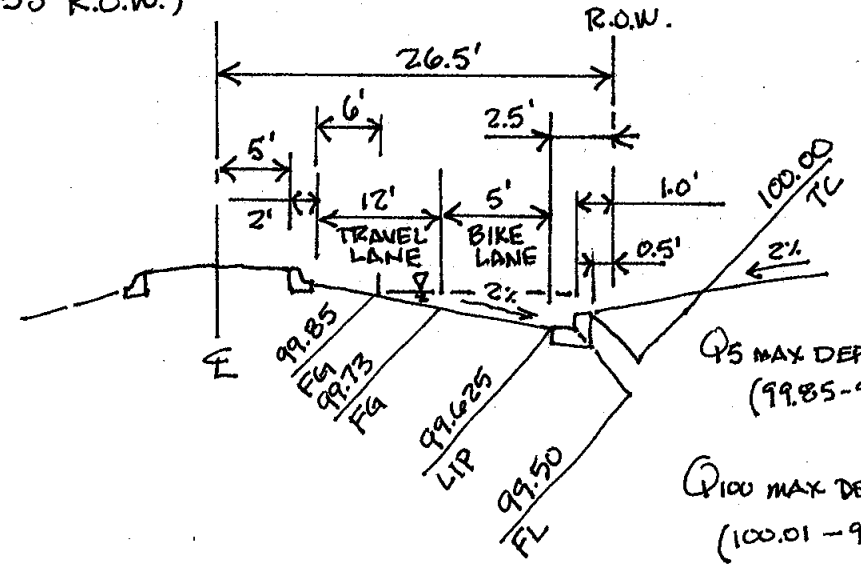
Street Flows and Design Parameters

Subbasin	Roadway	Min. Street Slope (%)	Contributing Drainage Facilities	Q5 Flow (cfs)	Q100 Flow (cfs)	Q5 Flow Depth (ft)	Q100 Flow Depth (ft)	Q5 Max Depth Allowed (ft)	Q100 Max Depth Allowed (ft)
4	Typ. Interior	4.0	-	2.3	6.1	0.25	0.31	0.32	0.52
5	Typ. Interior	4.0	-	1.7	4.4	0.24	0.28	0.32	0.52
7	Typ. Interior	4.4	-	3.5	9.0	0.26	0.34	0.32	0.52
8	Typ. Interior	4.4	-	3.6	9.4	0.26	0.35	0.32	0.52
10	Typ. Interior	5.0	-	1.6	4.0	0.22	0.27	0.32	0.52
12	Somersett	1.0	-	0.4	1.1	0.20	0.24	0.35	0.51
13	Somersett	1.0	-	0.4	1.1	0.20	0.24	0.35	0.51
14	Somersett	1.0	-	0.3	0.9	0.20	0.24	0.35	0.51
15	Somersett	1.0	-	0.4	0.9	0.20	0.24	0.35	0.51
16	Somersett	5.6	Bypass CB 1, 2, 5	1.5	5.3	0.22	0.28	0.35	0.51
17	Somersett	5.6	-	0.9	2.4	0.18	0.24	0.35	0.51
18	Somersett	1.0	Subbasin 10, Bypass CB 3, 4, 7	1.9	5	0.27	0.37	0.35	0.51
19	Somersett	1.0	Node H, Bypass CB 19, Overflow CB 18	1.3	3.4	0.25	0.32	0.35	0.51
20	Somersett	2.0	Bypass CB 9	1.2	3.2	0.23	0.28	0.35	0.51
21	Somersett	1.5	-	0.5	1.4	0.18	0.25	0.35	0.51
22	Typ. Interior	3.0	Bypass CB 6	0.9	2.3	0.20	0.25	0.32	0.52
23	Typ. Interior	3.0	-	0.9	2.2	0.21	0.25	0.32	0.52
25	Typ. Interior	1.4	-	1.4	3.6	0.25	0.32	0.32	0.52
26	Typ. Interior	2.8	Bypass CB 13	0.7	1.8	0.18	0.24	0.32	0.52
27	Typ. Interior	1.4	Bypass CB 12	1.4	3.9	0.25	0.32	0.32	0.52
28	Typ. Interior	1.4	-	0.9	2.4	0.23	0.28	0.32	0.52
29	Typ. Interior	5.0	Bypass CB 8, 17,	0.9	2.3	0.18	0.24	0.32	0.52
30	Typ. Interior	1.4	-	0.9	2.2	0.23	0.27	0.32	0.52
31	Typ. Interior	5.0	Bypass CB 19	1.1	2.9	0.20	0.26	0.32	0.52
33	Somersett	1.5	-	0.8	2.1	0.23	0.26	0.35	0.51
36	Somersett	3.0	-	0.5	1.4	0.17	0.23	0.35	0.51
37	Somersett	3.0	-	0.5	1.4	0.17	0.23	0.35	0.51
38	Typ. Interior	3.3	-	1.5	3.8	0.23	0.28	0.32	0.52
41	Somersett	6.0	Bypass CB 22	0.5	1.3	0.15	0.20	0.35	0.51
42	Somersett	6.0	Bypass CB 23	0.5	1.3	0.15	0.20	0.35	0.51
43	Typ. Interior	1.6	Bypass CB 33	2.3	6.0	0.27	0.36	0.32	0.52
44	Typ. Interior	5.0	-	1.7	4.4	0.22	0.27	0.32	0.52
46	Typ. Interior	1.6	Bypass CB 27	1.5	3.8	0.25	0.32	0.32	0.52
47	Typ. Interior	1.6	Bypass CB 28	1.6	4.1	0.26	0.33	0.32	0.52

PROJECT NO. _____
DATE _____
PREP BY _____ CK BY _____
SHEET _____ OF _____

SOMERSETT PARKWAY

(53' R.O.W.) N.T.S.

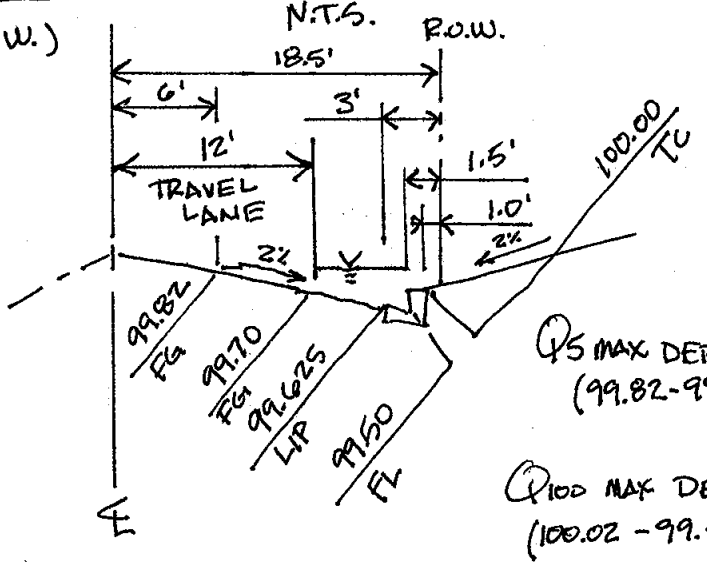


Q5 MAX DEPTH = 0.35'
(99.85 - 99.50 = 0.35')

Q100 MAX DEPTH = 0.51'
(100.01 - 99.50 = 0.51')

TYPICAL INTERIOR STREET

(37' R.O.W.) N.T.S.



Q5 MAX DEPTH = 0.32'
(99.82 - 99.50 = 0.32')

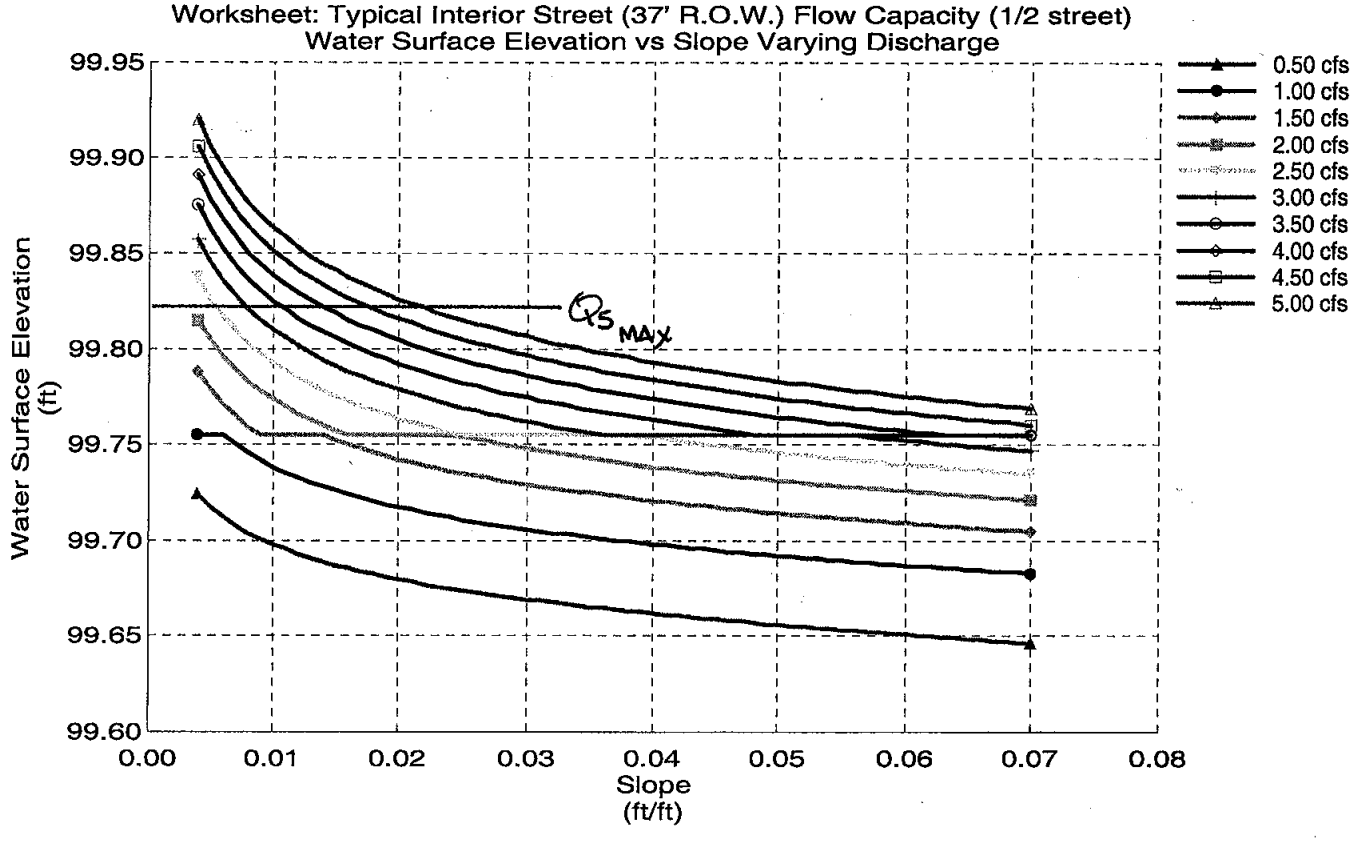
Q100 MAX DEPTH = 0.52'
(100.02 - 99.50 = 0.52')

Rating Curves for Typical 37' R.O.W. Interior Street (1/2 street flow)
Plotted Curves for Irregular Channel

Project Description	
Worksheet	Typical Interior Street (37' R.O.W.) Flow Capacity (1
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Options	
Current Roughness Metho	ved Lotter's Method
Open Channel Weighting	ved Lotter's Method
Closed Channel Weightin	Horton's Method

Attribute	Minimum	Maximum	Increment
Slope (ft/ft)	0.004000	0.070000	0.001000
Discharge (cfs)	0.50	5.00	0.50

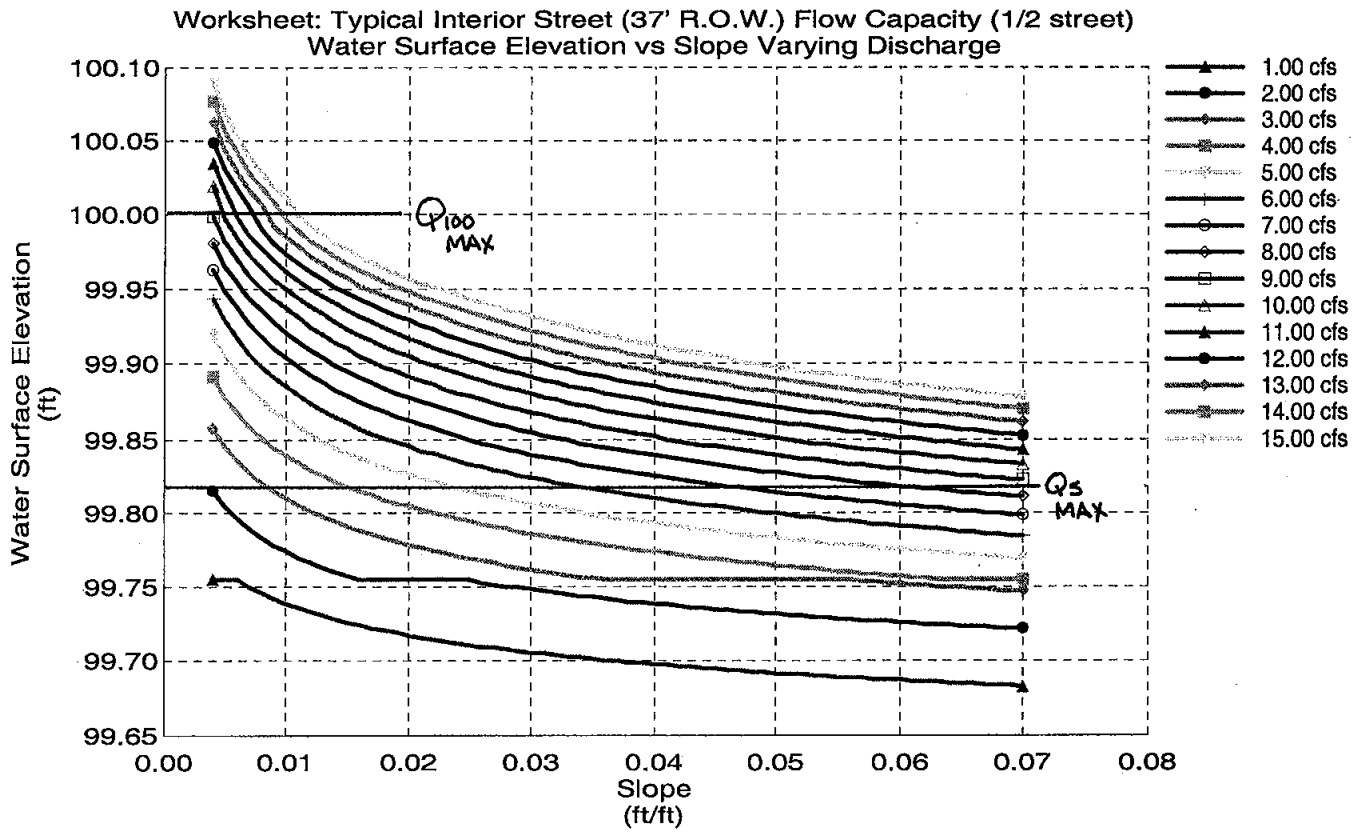


Rating Curves for Typical 37' R.O.W. Interior Street (1/2 street flow)
Plotted Curves for Irregular Channel

Project Description	
Worksheet	Typical Interior Street (37' R.O.W.) Flow Capacity (1
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Options	
Current Roughness Metho	ved Lotter's Method
Open Channel Weighting	ved Lotter's Method
Closed Channel Weightin	Horton's Method

Attribute	Minimum	Maximum	Increment
Slope (ft/ft)	0.004000	0.070000	0.001000
Discharge (cfs)	1.00	15.00	1.00

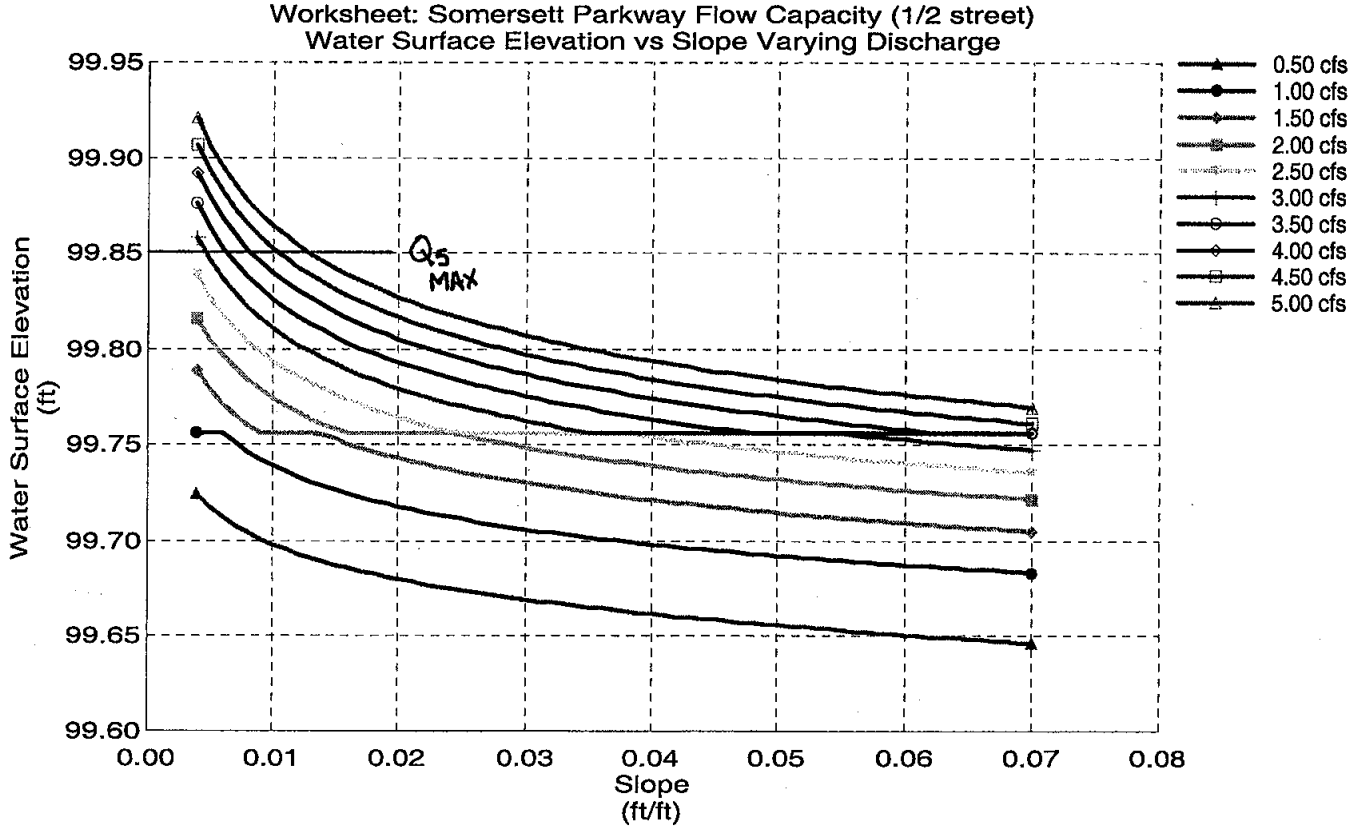


Rating Curves for Somersett Parkway (1/2 street flow)
Plotted Curves for Irregular Channel

Project Description	
Worksheet	Somersett Parkway Flow Capacity ('
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Options	
Current Roughness Metho	ved Lotter's Method
Open Channel Weighting	ved Lotter's Method
Closed Channel Weightin(	Horton's Method

Attribute	Minimum	Maximum	Increment
Slope (ft/ft)	0.004000	0.070000	0.001000
Discharge (cfs)	0.50	5.00	0.50

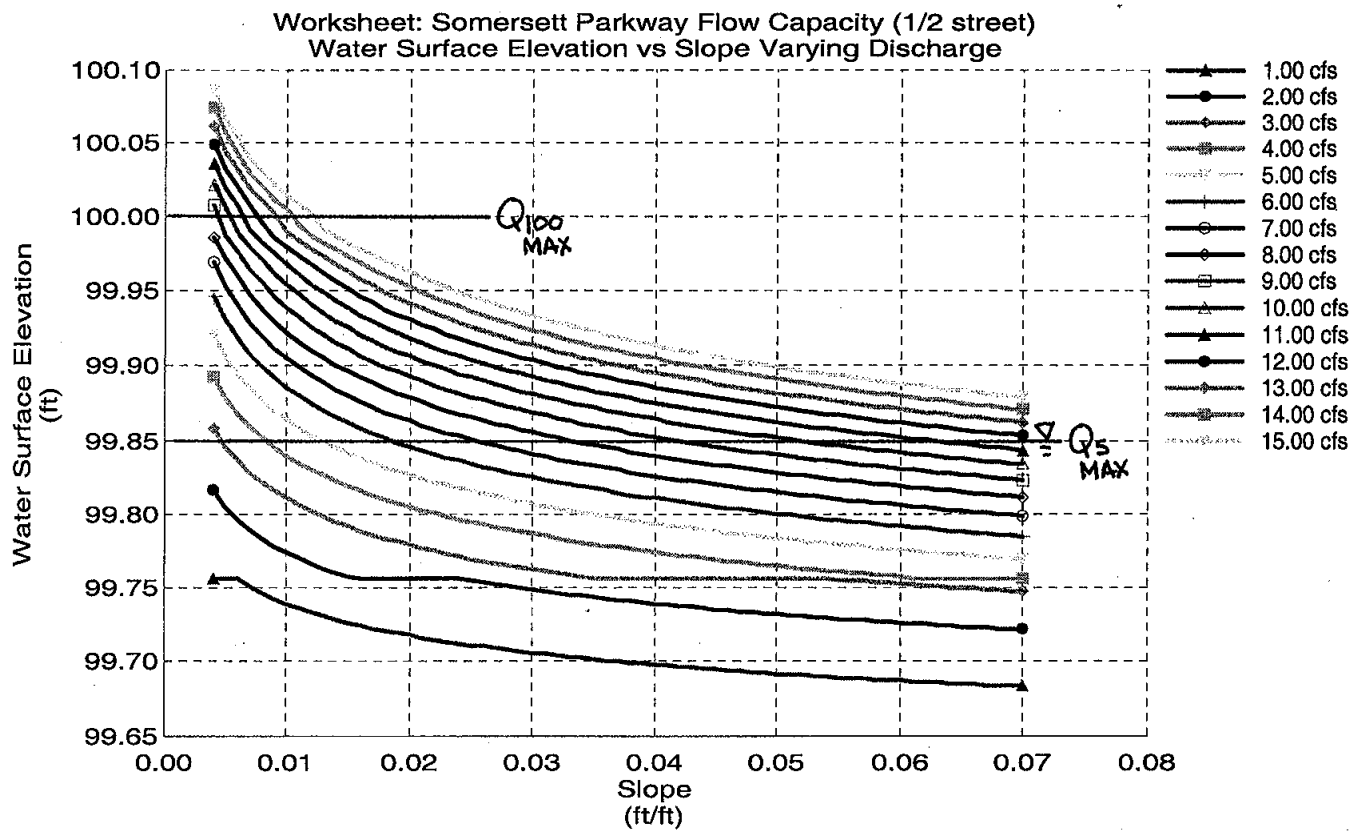


Rating Curves for Somersett Parkway (1/2 street flow)
Plotted Curves for Irregular Channel

Project Description	
Worksheet	Somersett Parkway Flow Capacity ('
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Options	
Current Roughness Metho	ved Lotter's Method
Open Channel Weighting	ved Lotter's Method
Closed Channel Weightin	Horton's Method

Attribute	Minimum	Maximum	Increment
Slope (ft/ft)	0.004000	0.070000	0.001000
Discharge (cfs)	1.00	15.00	1.00



Appendix C

Drainage Swale Flows and Calculations

Drainage Swale Flows and Design Parameters

Swale	Shape	Minimum Channel Depth [1] (ft)	Minimum Channel Depth [2] (ft)	Channel Lining [3]	Flow Sources	Q100 (cfs)	Minimum Slope (%)	Maximum Slope (%)	Side Slopes (Z:1)	Flow Depth at Min. Slope (ft)	Flow Depth at Max. Slope (ft)	Flow Velocity at Min. Slope (fps)	Flow Velocity at Max. Slope (fps)	Freeboard per Min Depth Velocity [4] (ft)	Freeboard per Max Depth Velocity [4] (ft)	Min Flow Depth + Fb (ft)	Max Flow Depth + Fb (ft)	Minimum Freeboard for Design [4] (ft)
S1	'V' Channel	2	13	Grass	Subbasin 1	3.3	1	12	3	0.7	0.43	2.34	5.95	0.04	0.27	0.74	0.70	1.5
S2	'V' Channel	3	16	Grass	Subbasin 2	14.4	1	4.5	3	1.19	0.9	3.38	5.95	0.09	0.27	1.28	1.17	1.5
S3	'V' Channel	2	12	Grass	Subbasin 6	1.2	1	23	3	0.47	0.26	1.82	5.89	0.03	0.27	0.50	0.53	1.5
S4	'V' Channel	3	16	Grass	72% of Subbasin 9	14.0	1	4.5	3	1.18	0.89	3.36	5.91	0.09	0.27	1.27	1.16	1.5
S5	'V' Channel	2	14	Grass	28% of Subbasin 9	4.4	1	10	3	0.76	0.5	2.52	5.97	0.05	0.28	0.81	0.78	1.5
S6	'V' Channel	2	14	Grass	70% of Subbasin 11	4.5	1	9.5	3	0.77	0.5	2.53	5.89	0.05	0.27	0.82	0.77	1.5
S7	'V' Channel	2	12	Grass	Subbasin 24	1.2	1	23	3	0.47	0.26	1.82	5.89	0.03	0.27	0.50	0.53	1.5
S8 [5]	'V' Channel	2	11	Grass	15% of Subbasin 17	0.4	1	49	3	0.31	0.15	1.38	5.95	0.01	0.27	0.32	0.42	1.5
S9	'V' Channel	2	14	Grass	Subbasin 32	5.6	1	8.5	3	0.84	0.56	2.67	5.96	0.06	0.28	0.90	0.84	1.5
S10	'V' Channel	2	14	Grass	Subbasin 35	6.5	1	7.5	3	0.88	0.61	2.77	5.91	0.06	0.27	0.94	0.88	1.5
S11	'V' Channel	2	12	Grass	Subbasin 39	1.0	1	26	3	0.44	0.24	1.74	5.9	0.02	0.27	0.46	0.51	1.5
S12	'V' Channel	2	14	Grass	Subbasin 40	6.2	1	8	3	0.87	0.59	2.74	5.98	0.06	0.28	0.93	0.87	1.5
S13	'V' Channel	2	12	Grass	Subbasin 45	1.0	1	26	3	0.44	0.24	1.74	5.9	0.02	0.27	0.46	0.51	1.5
S14	'V' Channel	2	14	Grass	Subbasin 11	6.4	1	7.5	3	0.88	0.6	2.76	5.88	0.06	0.27	0.94	0.87	1.5

Notes:
(1) Minimum channel depth includes 100-year flow depth @ minimum slope plus the minimum freeboard.
(2) Minimum channel width is minimum channel depth at side slopes 'Z' (both channel sides).
(3) Channel lining based on maximum velocity for 100-year flow.
(4) Freeboard calcualted by: $0.5 \times V^2/(2g)$ --> 1.5' minimum.
(5) Swale 8 is typical of a common (unstudied) on-site drainage swale.

Swale 1 - 100-Yr Flow @ 1% Slope
Worksheet for Triangular Channel

Project Description	
Worksheet	Swale #1
Flow Element	Triangular Char
Method	Manning's Forr
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.030	
Slope	010000	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Discharge	3.30	cfs

Results		
Depth	0.69	ft
Flow Area	1.4	ft²
Wetted Perim	4.33	ft
Top Width	4.11	ft
Critical Depth	0.60	ft
Critical Slope	0.021063	ft/ft
Velocity	2.34	ft/s
Velocity Head	0.09	ft
Specific Ener	0.77	ft
Froude Numb	0.71	
Flow Type	Subcritical	

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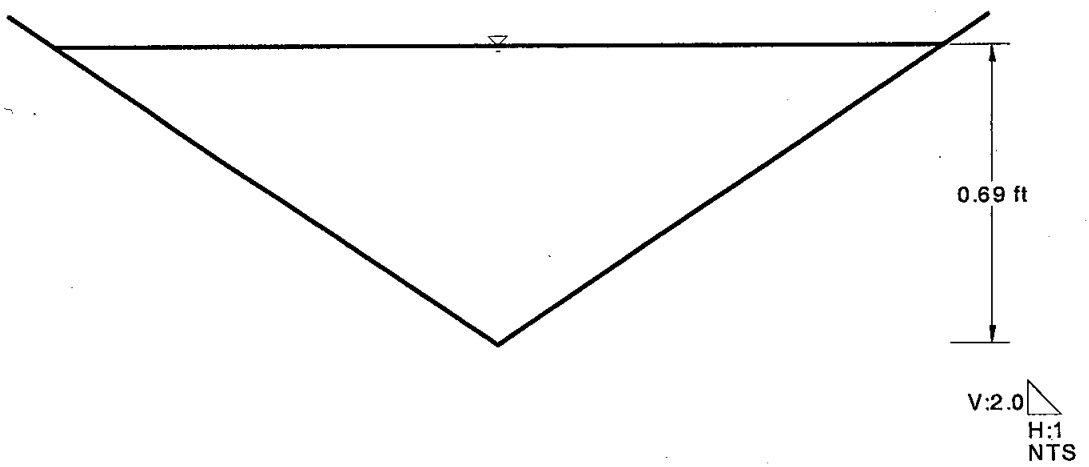
Swale 1 - 100-Yr Flow @ 1% Slope
Cross Section for Triangular Channel

Project Description	
Worksheet	Swale #1
Flow Element	Triangular Char
Method	Manning's Form
Solve For	Channel Depth

Section Data		
Mannings Coeffic	0.030	
Slope	010000	ft/ft
Depth	0.69	ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Discharge	3.30	cfs



Swale 1 - 100-Yr Flow @ Max Slope
Worksheet for Triangular Channel

Project Description	
Worksheet	Swale #1
Flow Element	Triangular Char
Method	Manning's Forr
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.030	
Slope	120000	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Discharge	3.30	cfs

Results		
Depth	0.43	ft
Flow Area	0.6	ft²
Wetted Perim	2.72	ft
Top Width	2.58	ft
Critical Depth	0.60	ft
Critical Slope	0.021063	ft/ft
Velocity	5.95	ft/s
Velocity Head	0.55	ft
Specific Energ	0.98	ft
Froude Numb	2.26	
Flow Type	Supercritical	

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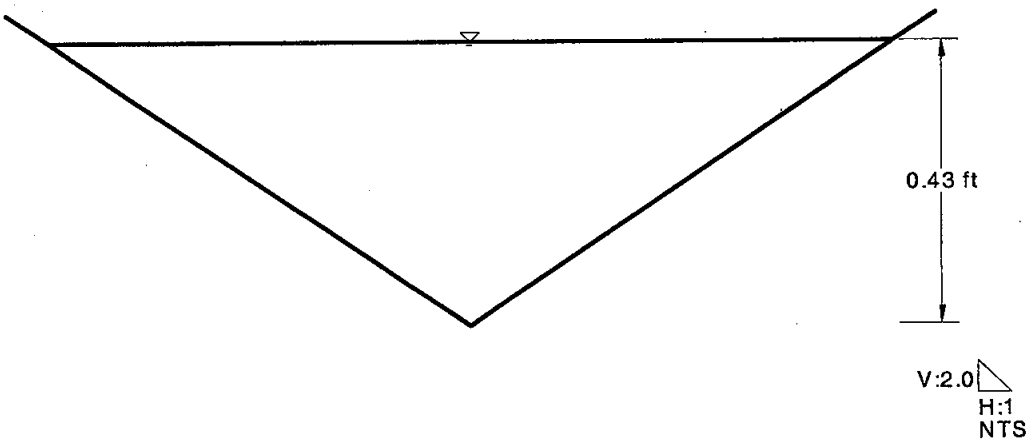
Swale 1 - 100-Yr Flow @ Max Slope
Cross Section for Triangular Channel

Project Description	
Worksheet	Swale #1
Flow Element	Triangular Char
Method	Manning's Form
Solve For	Channel Depth

Section Data		
Mannings Coeffic	0.030	
Slope	120000	ft/ft
Depth	0.43	ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Discharge	3.30	cfs



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Swale 2 - 100-Yr Flow @ 1%
Worksheet for Triangular Channel

Project Description	
Worksheet	Swale #2
Flow Element	Triangular Char
Method	Manning's Forr
Solve For	Channel Depth

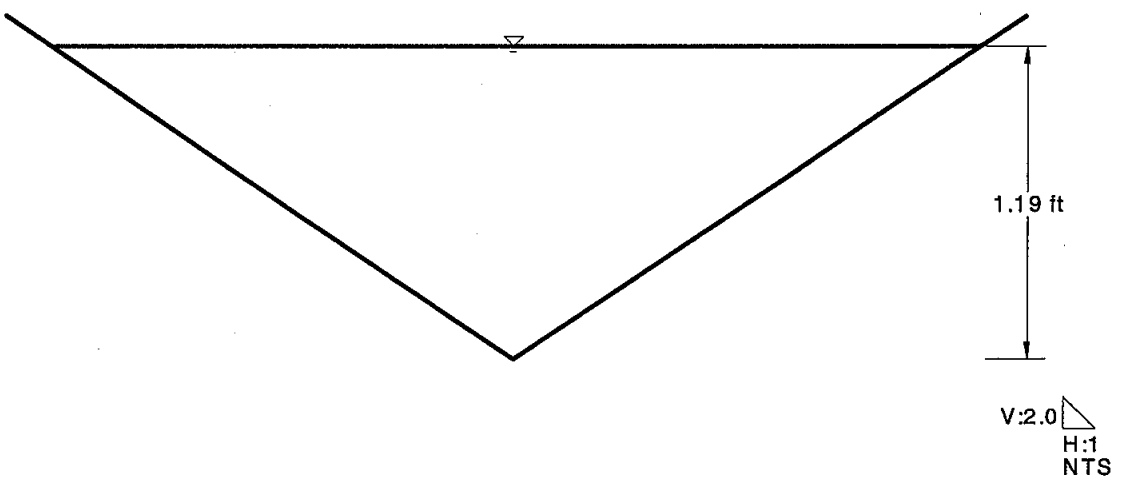
Input Data		
Mannings Coeffic	0.030	
Slope	010000	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Discharge	14.40	cfs

Results		
Depth	1.19	ft
Flow Area	4.3	ft²
Wetted Perim	7.53	ft
Top Width	7.15	ft
Critical Depth	1.07	ft
Critical Slope	0.017306	ft/ft
Velocity	3.38	ft/s
Velocity Head	0.18	ft
Specific Ener	1.37	ft
Froude Numb	0.77	
Flow Type	Subcritical	

Swale 2 - 100-Yr Flow @ 1%
Cross Section for Triangular Channel

Project Description	
Worksheet	Swale #2
Flow Element	Triangular Char
Method	Manning's Form
Solve For	Channel Depth

Section Data		
Mannings Coeffic	0.030	
Slope	010000	ft/ft
Depth	1.19	ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Discharge	14.40	cfs



Swale 2 - 100-Yr Flow @ Max Slope
Worksheet for Triangular Channel

Project Description	
Worksheet	Swale #2
Flow Element	Triangular Char
Method	Manning's Forr
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.030	
Slope	045000	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Discharge	14.40	cfs

Results		
Depth	0.90	ft
Flow Area	2.4	ft²
Wetted Perim	5.68	ft
Top Width	5.39	ft
Critical Depth	1.07	ft
Critical Slope	0.017306	ft/ft
Velocity	5.95	ft/s
Velocity Head	0.55	ft
Specific Ener	1.45	ft
Froude Numb	1.57	
Flow Type	Supercritical	

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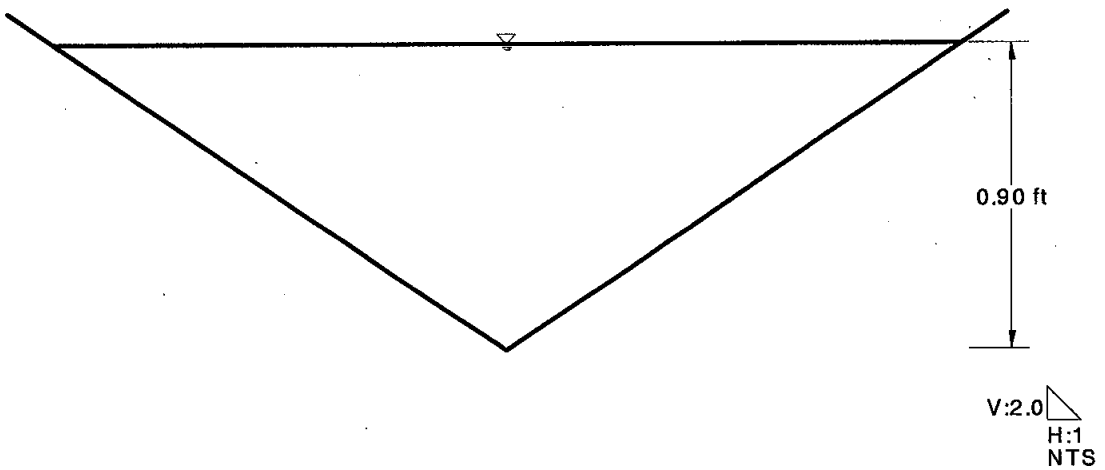
Swale 2 - 100-Yr Flow @ Max Slope
Cross Section for Triangular Channel

Project Description	
Worksheet	Swale #2
Flow Element	Triangular Char
Method	Manning's Form
Solve For	Channel Depth

Section Data		
Mannings Coeffic	0.030	
Slope	045000	ft/ft
Depth	0.90	ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Discharge	14.40	cfs



Swale 3 - 100-Yr Flow @ 1% Slope
Worksheet for Triangular Channel

Project Description	
Worksheet	Swale #3
Flow Element	Triangular Char
Method	Manning's Forr
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.030	
Slope	010000	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Discharge	1.20	cfs

Results		
Depth	0.47	ft
Flow Area	0.7	ft²
Wetted Perim	2.97	ft
Top Width	2.81	ft
Critical Depth	0.40	ft
Critical Slope	0.024104	ft/ft
Velocity	1.82	ft/s
Velocity Head	0.05	ft
Specific Energ	0.52	ft
Froude Numb	0.66	
Flow Type	Subcritical	

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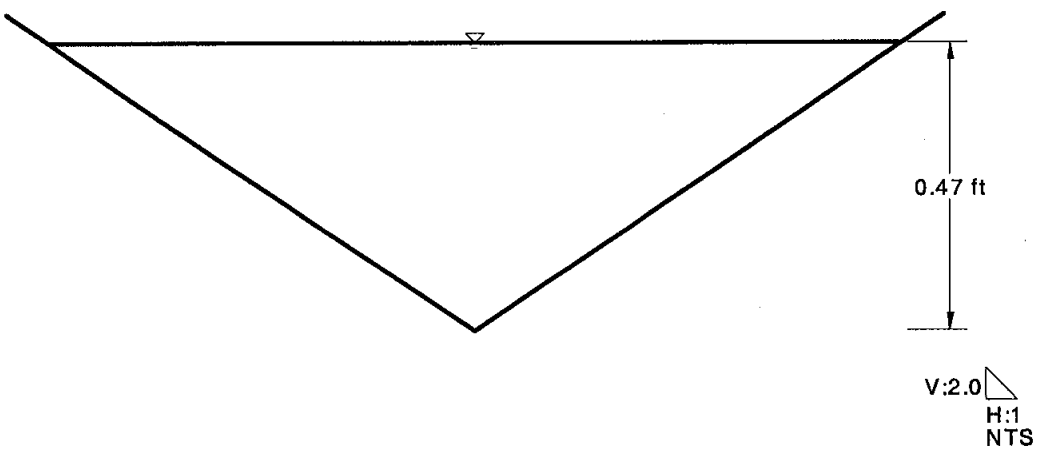
Swale 3 - 100-Yr Flow @ 1% Slope
Cross Section for Triangular Channel

Project Description	
Worksheet	Swale #3
Flow Element	Triangular Char
Method	Manning's Form
Solve For	Channel Depth

Section Data		
Mannings Coeffic	0.030	
Slope	010000	ft/ft
Depth	0.47	ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Discharge	1.20	cfs



Swale 3 - 100-Yr Flow @ Max Slope
Worksheet for Triangular Channel

Project Description	
Worksheet	Swale #3
Flow Element	Triangular Char
Method	Manning's Forr
Solve For	Channel Depth

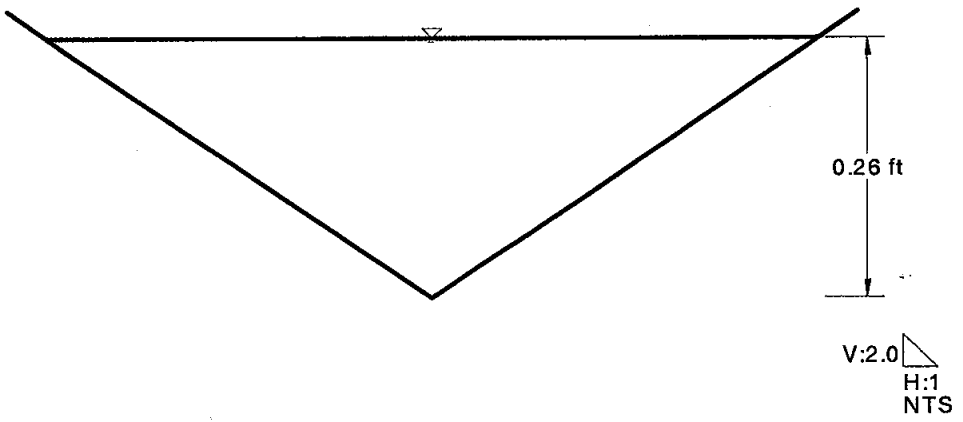
Input Data		
Mannings Coeffic	0.030	
Slope	230000	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Discharge	1.20	cfs

Results		
Depth	0.26	ft
Flow Area	0.2	ft²
Wetted Perim	1.65	ft
Top Width	1.56	ft
Critical Depth	0.40	ft
Critical Slope	0.024105	ft/ft
Velocity	5.89	ft/s
Velocity Head	0.54	ft
Specific Ener	0.80	ft
Froude Numb	2.88	
Flow Type	Supercritical	

Swale 3 - 100-Yr Flow @ Max Slope
Cross Section for Triangular Channel

Project Description	
Worksheet	Swale #3
Flow Element	Triangular Char
Method	Manning's Form
Solve For	Channel Depth

Section Data		
Mannings Coeffic	0.030	
Slope	230000	ft/ft
Depth	0.26	ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Discharge	1.20	cfs



Swale 4 - 100-Yr Flow @ 1% Slope
Worksheet for Triangular Channel

Project Description	
Worksheet	Swale #4
Flow Element	Triangular Char
Method	Manning's Forr
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.030	
Slope	010000	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Discharge	14.00	cfs

Results		
Depth	1.18	ft
Flow Area	4.2	ft²
Wetted Perim	7.45	ft
Top Width	7.07	ft
Critical Depth	1.06	ft
Critical Slope	0.017371	ft/ft
Velocity	3.36	ft/s
Velocity Head	0.18	ft
Specific Ener	1.35	ft
Froude Numb	0.77	
Flow Type	Subcritical	

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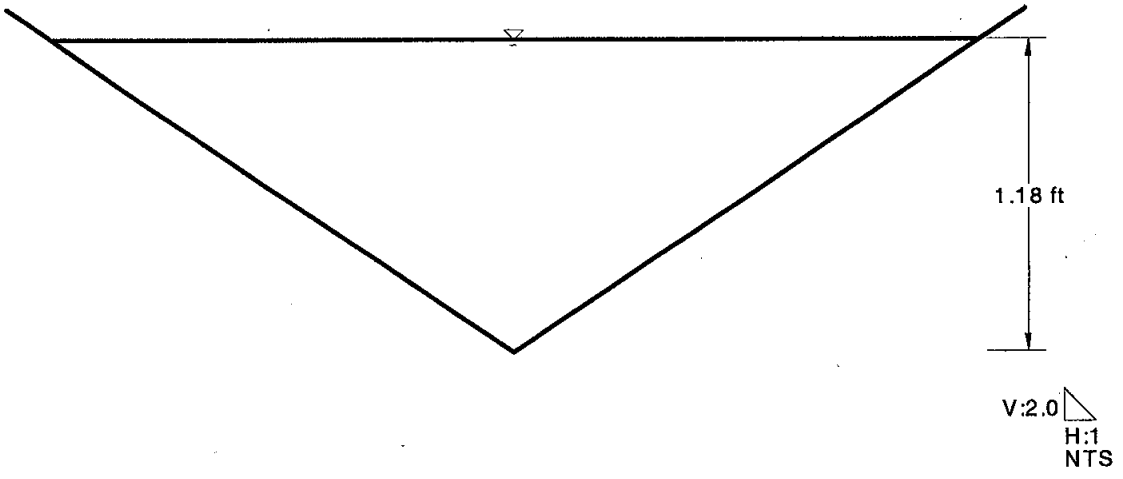
Swale 4 - 100-Yr Flow @ 1% Slope
Cross Section for Triangular Channel

Project Description	
Worksheet	Swale #4
Flow Element	Triangular Char
Method	Manning's Form
Solve For	Channel Depth

Section Data		
Mannings Coeffic	0.030	
Slope	010000	ft/ft
Depth	1.18	ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Discharge	14.00	cfs



Swale 4 - 100-Yr Flow @ Max Slope
Worksheet for Triangular Channel

Project Description	
Worksheet	Swale #4
Flow Element	Triangular Char
Method	Manning's Form
Solve For	Channel Depth

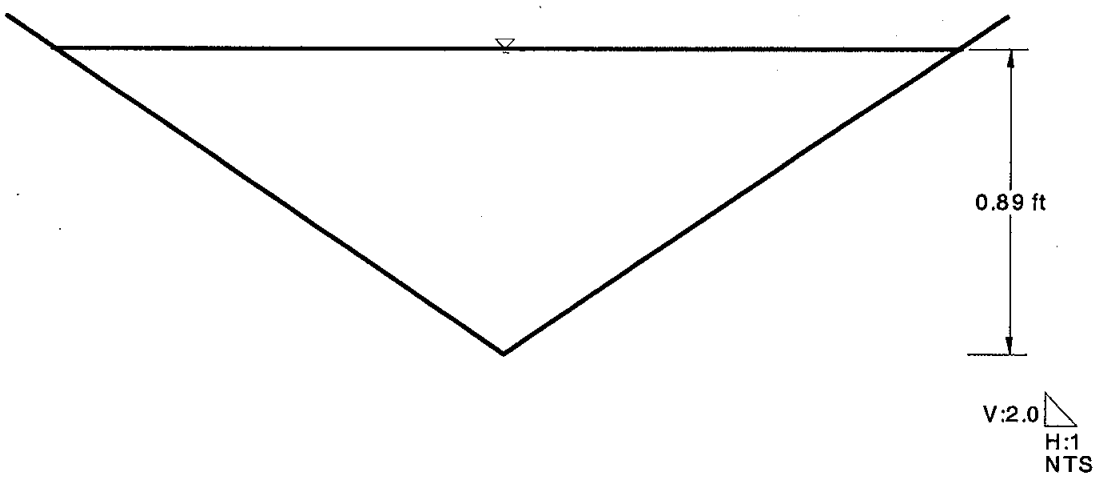
Input Data		
Mannings Coeffic	0.030	
Slope	045000	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Discharge	14.00	cfs

Results		
Depth	0.89	ft
Flow Area	2.4	ft²
Wetted Perim	5.62	ft
Top Width	5.33	ft
Critical Depth	1.06	ft
Critical Slope	0.017371	ft/ft
Velocity	5.91	ft/s
Velocity Head	0.54	ft
Specific Ener	1.43	ft
Froude Numb	1.56	
Flow Type	Supercritical	

Swale 4 - 100-Yr Flow @ Max Slope
Cross Section for Triangular Channel

Project Description	
Worksheet	Swale #4
Flow Element	Triangular Char
Method	Manning's Forr
Solve For	Channel Depth

Section Data		
Mannings Coeffic	0.030	
Slope	045000	ft/ft
Depth	0.89	ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Discharge	14.00	cfs



Swale 5 - 100-Yr Flow @ 1% Slope
Worksheet for Triangular Channel

Project Description	
Worksheet	Swale #5
Flow Element	Triangular Char
Method	Manning's Form
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.030	
Slope	010000	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Discharge	4.40	cfs

Results		
Depth	0.76	ft
Flow Area	1.7	ft²
Wetted Perim	4.83	ft
Top Width	4.58	ft
Critical Depth	0.67	ft
Critical Slope	0.020270	ft/ft
Velocity	2.52	ft/s
Velocity Head	0.10	ft
Specific Energ	0.86	ft
Froude Numb	0.72	
Flow Type	Subcritical	

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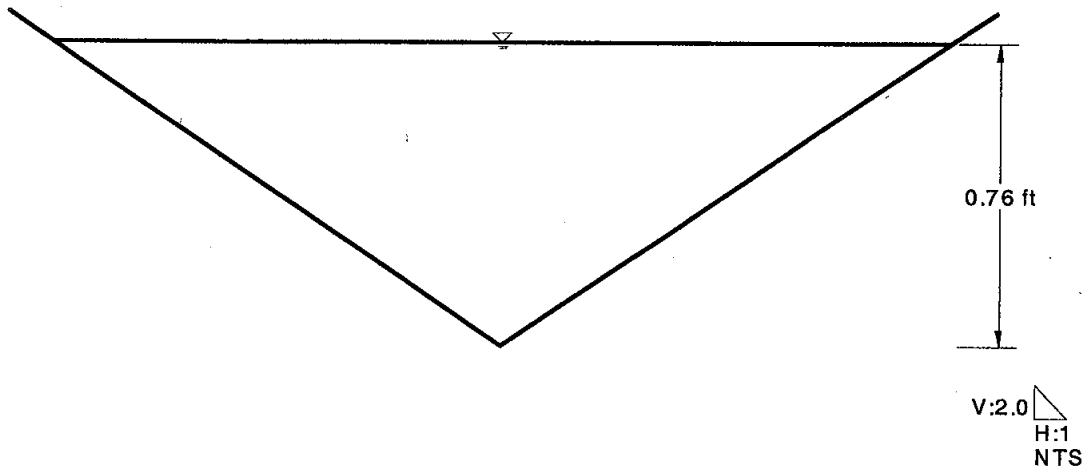
Swale 5 - 100-Yr Flow @ 1% Slope
Cross Section for Triangular Channel

Project Description	
Worksheet	Swale #5
Flow Element	Triangular Char
Method	Manning's Form
Solve For	Channel Depth

Section Data		
Mannings Coeffic	0.030	
Slope	010000	ft/ft
Depth	0.76	ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Discharge	4.40	cfs



Swale 5 - 100-Yr Flow @ Max Slope
Worksheet for Triangular Channel

Project Description	
Worksheet	Swale #5
Flow Element	Triangular Char
Method	Manning's Forr
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.030	
Slope	100000	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Discharge	4.40	cfs

Results		
Depth	0.50	ft
Flow Area	0.7	ft²
Wetted Perim	3.14	ft
Top Width	2.97	ft
Critical Depth	0.67	ft
Critical Slope	0.020271	ft/ft
Velocity	5.97	ft/s
Velocity Head	0.55	ft
Specific Ener	1.05	ft
Froude Numb	2.11	
Flow Type	Supercritical	

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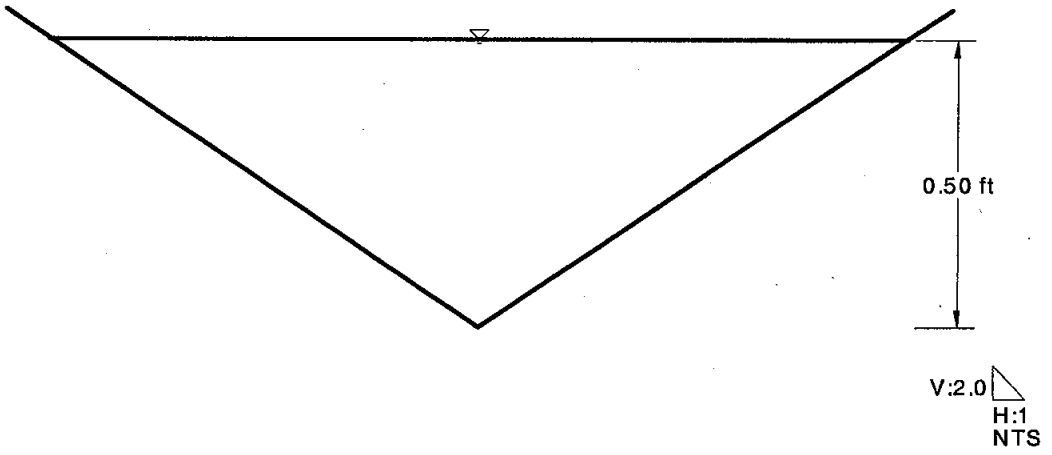
Swale 5 - 100-Yr Flow @ Max Slope
Cross Section for Triangular Channel

Project Description	
Worksheet	Swale #5
Flow Element	Triangular Char
Method	Manning's Form
Solve For	Channel Depth

Section Data		
Mannings Coeffic	0.030	
Slope	100000	ft/ft
Depth	0.50	ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Discharge	4.40	cfs



Swale 6 - 100-Yr Flow @ 1% Slope
Worksheet for Triangular Channel

Project Description	
Worksheet	Swale #6
Flow Element	Triangular Char
Method	Manning's Form
Solve For	Channel Depth

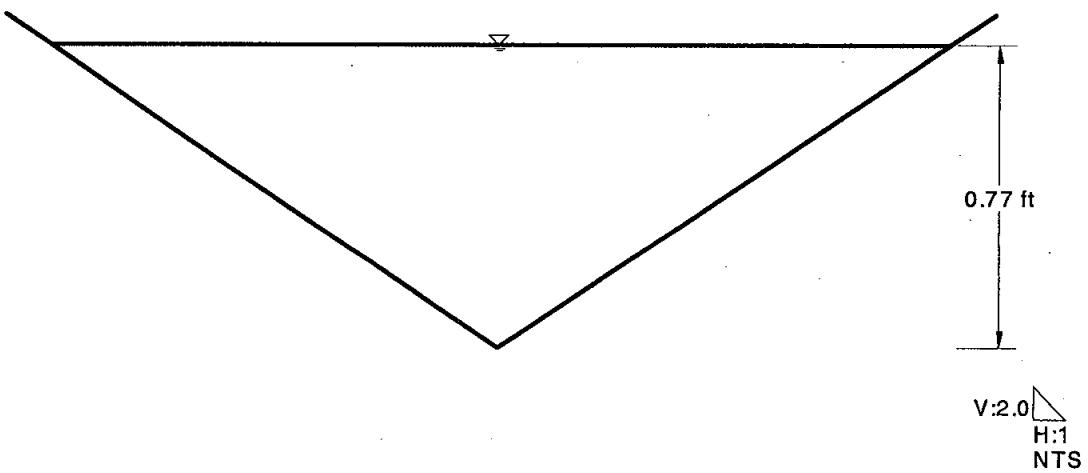
Input Data		
Mannings Coeffic	0.030	
Slope	010000	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Discharge	4.50	cfs

Results		
Depth	0.77	ft
Flow Area	1.8	ft²
Wetted Perim	4.87	ft
Top Width	4.62	ft
Critical Depth	0.67	ft
Critical Slope	0.020210	ft/ft
Velocity	2.53	ft/s
Velocity Head	0.10	ft
Specific Ener	0.87	ft
Froude Numb	0.72	
Flow Type	Subcritical	

Swale 6 - 100-Yr Flow @ 1% Slope
Cross Section for Triangular Channel

Project Description	
Worksheet	Swale #6
Flow Element	Triangular Char
Method	Manning's Forr
Solve For	Channel Depth

Section Data		
Mannings Coeffic	0.030	
Slope	010000	ft/ft
Depth	0.77	ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Discharge	4.50	cfs



Swale 6 - 100-Yr Flow @ Max Slope
Worksheet for Triangular Channel

Project Description	
Worksheet	Swale #6
Flow Element	Triangular Char
Method	Manning's Forr
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.030	
Slope	095000	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Discharge	4.50	cfs

Results		
Depth	0.50	ft
Flow Area	0.8	ft²
Wetted Perim	3.19	ft
Top Width	3.03	ft
Critical Depth	0.67	ft
Critical Slope	0.020209	ft/ft
Velocity	5.89	ft/s
Velocity Head	0.54	ft
Specific Ener	1.04	ft
Froude Numb	2.07	
Flow Type	Supercritical	

Swale 6 - 100-Yr Flow @ Max Slope
Worksheet for Triangular Channel

Project Description	
Worksheet	Swale #6
Flow Element	Triangular Char
Method	Manning's Form
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.030	
Slope	095000	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Discharge	4.50	cfs

Results		
Depth	0.50	ft
Flow Area	0.8	ft²
Wetted Perim	3.19	ft
Top Width	3.03	ft
Critical Depth	0.67	ft
Critical Slope	0.020209	ft/ft
Velocity	5.89	ft/s
Velocity Head	0.54	ft
Specific Ener	1.04	ft
Froude Numb	2.07	
Flow Type	Supercritical	

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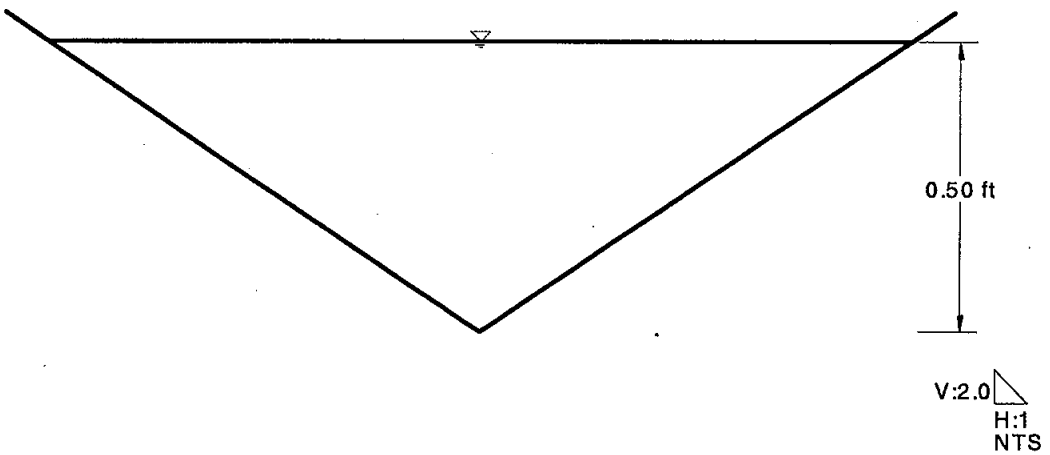
Swale 6 - 100-Yr Flow @ Max Slope
Cross Section for Triangular Channel

Project Description	
Worksheet	Swale #6
Flow Element	Triangular Char
Method	Manning's Form
Solve For	Channel Depth

Section Data		
Mannings Coeffic	0.030	
Slope	095000	ft/ft
Depth	0.50	ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Discharge	4.50	cfs



Swale 7 - 100-Yr Flow @ 1% Slope
Worksheet for Triangular Channel

Project Description	
Worksheet	Swale #7
Flow Element	Triangular Char
Method	Manning's Forr
Solve For	Channel Depth

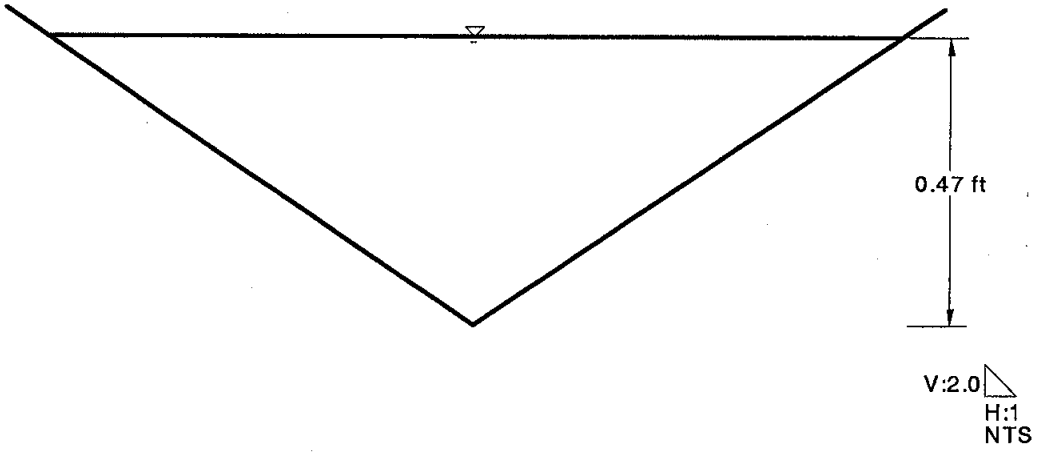
Input Data		
Mannings Coeffic	0.030	
Slope	010000	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Discharge	1.20	cfs

Results		
Depth	0.47	ft
Flow Area	0.7	ft²
Wetted Perim	2.97	ft
Top Width	2.81	ft
Critical Depth	0.40	ft
Critical Slope	0.024104	ft/ft
Velocity	1.82	ft/s
Velocity Head	0.05	ft
Specific Ener	0.52	ft
Froude Numb	0.66	
Flow Type	Subcritical	

Swale 7 - 100-Yr Flow @ 1% Slope
Cross Section for Triangular Channel

Project Description	
Worksheet	Swale #7
Flow Element	Triangular Char
Method	Manning's Form
Solve For	Channel Depth

Section Data		
Mannings Coeffic	0.030	
Slope	010000	ft/ft
Depth	0.47	ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Discharge	1.20	cfs



Swale 7 - 100-Yr Flow @ Max Slope
Worksheet for Triangular Channel

Project Description	
Worksheet	Swale #7
Flow Element	Triangular Char
Method	Manning's Forr
Solve For	Channel Depth

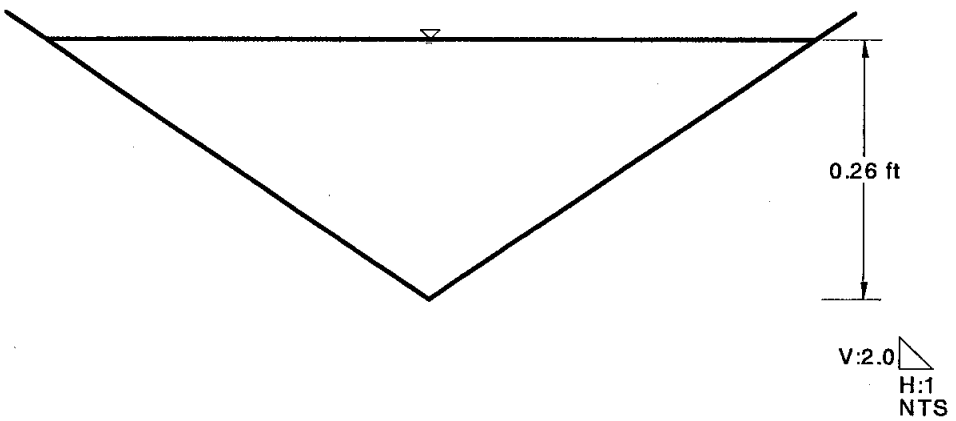
Input Data		
Mannings Coeffic	0.030	
Slope	230000	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Discharge	1.20	cfs

Results		
Depth	0.26	ft
Flow Area	0.2	ft²
Wetted Perim	1.65	ft
Top Width	1.56	ft
Critical Depth	0.40	ft
Critical Slope	0.024105	ft/ft
Velocity	5.89	ft/s
Velocity Head	0.54	ft
Specific Ener	0.80	ft
Froude Numb	2.88	
Flow Type	Supercritical	

Swale 7 - 100-Yr Flow @ Max Slope
Cross Section for Triangular Channel

Project Description	
Worksheet	Swale #7
Flow Element	Triangular Char
Method	Manning's Forr
Solve For	Channel Depth

Section Data		
Mannings Coeffic	0.030	
Slope	230000	ft/ft
Depth	0.26	ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Discharge	1.20	cfs



Swale 8 - 100-Yr Flow @ 1% Slope
Worksheet for Triangular Channel

Project Description	
Worksheet	Swale #8
Flow Element	Triangular Char
Method	Manning's Form
Solve For	Channel Depth

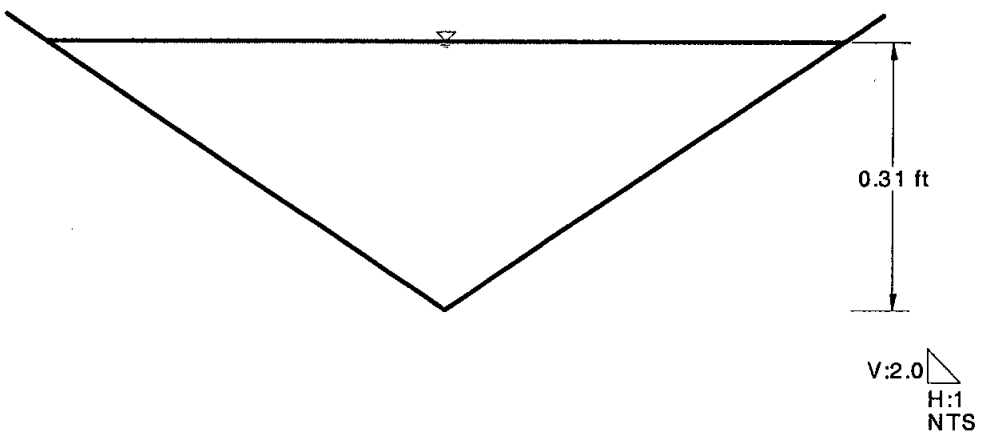
Input Data		
Mannings Coeffic	0.030	
Slope	010000	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Discharge	0.40	cfs

Results		
Depth	0.31	ft
Flow Area	0.3	ft²
Wetted Perim	1.96	ft
Top Width	1.86	ft
Critical Depth	0.26	ft
Critical Slope	0.027907	ft/ft
Velocity	1.38	ft/s
Velocity Head	0.03	ft
Specific Energ	0.34	ft
Froude Numb	0.62	
Flow Type	Subcritical	

Swale 8 - 100-Yr Flow @ 1% Slope
Cross Section for Triangular Channel

Project Description	
Worksheet	Swale #8
Flow Element	Triangular Char
Method	Manning's Form
Solve For	Channel Depth

Section Data		
Mannings Coeffic	0.030	
Slope	010000	ft/ft
Depth	0.31	ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Discharge	0.40	cfs



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Swale 8 - 100-Yr Flow @ Max Slope
Worksheet for Triangular Channel

Project Description	
Worksheet	Swale #8
Flow Element	Triangular Char
Method	Manning's Form
Solve For	Channel Depth

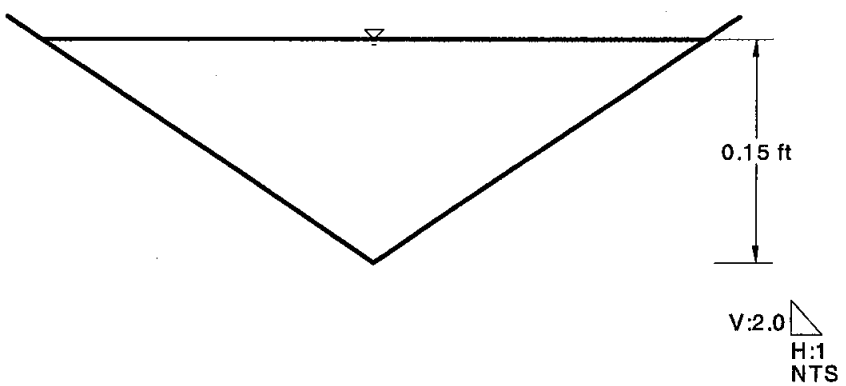
Input Data		
Mannings Coeffic	0.030	
Slope	490000	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Discharge	0.40	cfs

Results		
Depth	0.15	ft
Flow Area	0.1	ft²
Wetted Perim	0.95	ft
Top Width	0.90	ft
Critical Depth	0.26	ft
Critical Slope	0.027907	ft/ft
Velocity	5.95	ft/s
Velocity Head	0.55	ft
Specific Ener	0.70	ft
Froude Numb	3.83	
Flow Type	Supercritical	

Swale 8 - 100-Yr Flow @ Max Slope
Cross Section for Triangular Channel

Project Description	
Worksheet	Swale #8
Flow Element	Triangular Char
Method	Manning's Form
Solve For	Channel Depth

Section Data		
Mannings Coeffic	0.030	
Slope	490000	ft/ft
Depth	0.15	ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Discharge	0.40	cfs



Swale 9 - 100-Yr Flow @ 1% Slope
Worksheet for Triangular Channel

Project Description	
Worksheet	Swale #9
Flow Element	Triangular Char
Method	Manning's Form
Solve For	Channel Depth

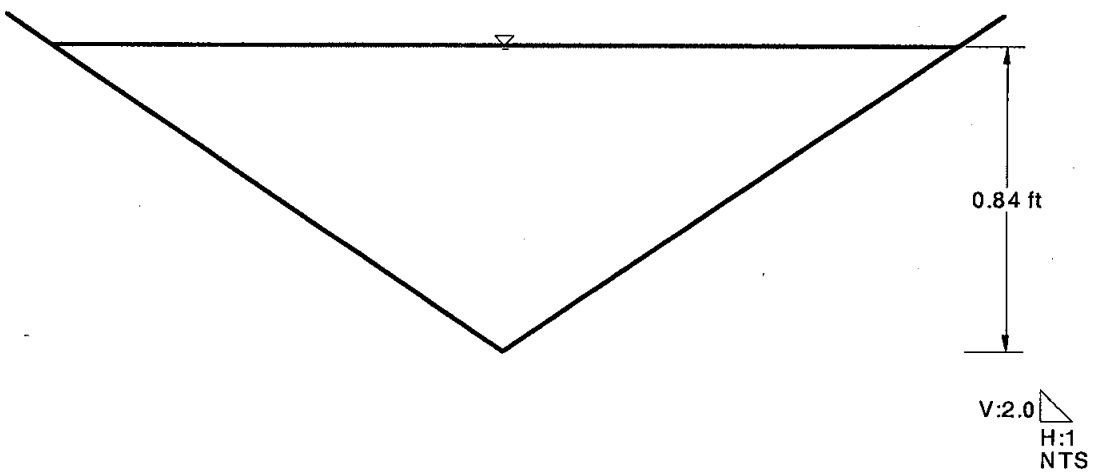
Input Data		
Mannings Coeffic	0.030	
Slope	010000	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Discharge	5.60	cfs

Results		
Depth	0.84	ft
Flow Area	2.1	ft²
Wetted Perim	5.29	ft
Top Width	5.01	ft
Critical Depth	0.74	ft
Critical Slope	0.019629	ft/ft
Velocity	2.67	ft/s
Velocity Head	0.11	ft
Specific Ener	0.95	ft
Froude Numb	0.73	
Flow Type	Subcritical	

Swale 9 - 100-Yr Flow @ 1% Slope
Cross Section for Triangular Channel

Project Description	
Worksheet	Swale #9
Flow Element	Triangular Char
Method	Manning's Forr
Solve For	Channel Depth

Section Data		
Mannings Coeffic	0.030	
Slope	010000	ft/ft
Depth	0.84	ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Discharge	5.60	cfs



Swale 9 - 100-Yr Flow @ Max Slope
Worksheet for Triangular Channel

Project Description	
Worksheet	Swale #9
Flow Element	Triangular Char
Method	Manning's Forr
Solve For	Channel Depth

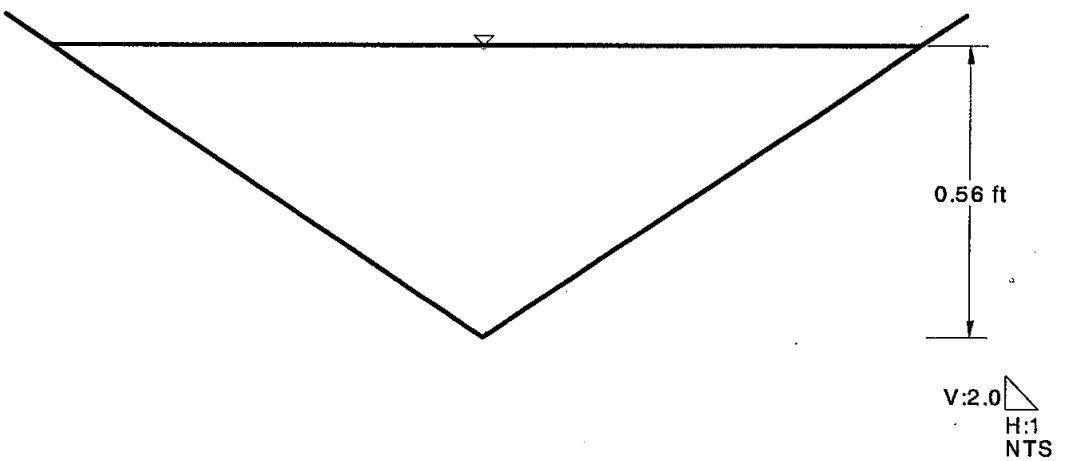
Input Data		
Mannings Coeffic	0.030	
Slope	085000	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Discharge	5.60	cfs

Results		
Depth	0.56	ft
Flow Area	0.9	ft²
Wetted Perim	3.54	ft
Top Width	3.36	ft
Critical Depth	0.74	ft
Critical Slope	0.019629	ft/ft
Velocity	5.96	ft/s
Velocity Head	0.55	ft
Specific Ener	1.11	ft
Froude Numb	1.99	
Flow Type	Supercritical	

Swale 9 - 100-Yr Flow @ Max Slope
Cross Section for Triangular Channel

Project Description	
Worksheet	Swale #9
Flow Element	Triangular Char
Method	Manning's Forr
Solve For	Channel Depth

Section Data		
Mannings Coeffic	0.030	
Slope	085000	ft/ft
Depth	0.56	ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Discharge	5.60	cfs



Swale 10 - 100-Yr Flow @ 1% Slope
Worksheet for Triangular Channel

Project Description	
Worksheet	Swale #10
Flow Element	Triangular Char
Method	Manning's Form
Solve For	Channel Depth

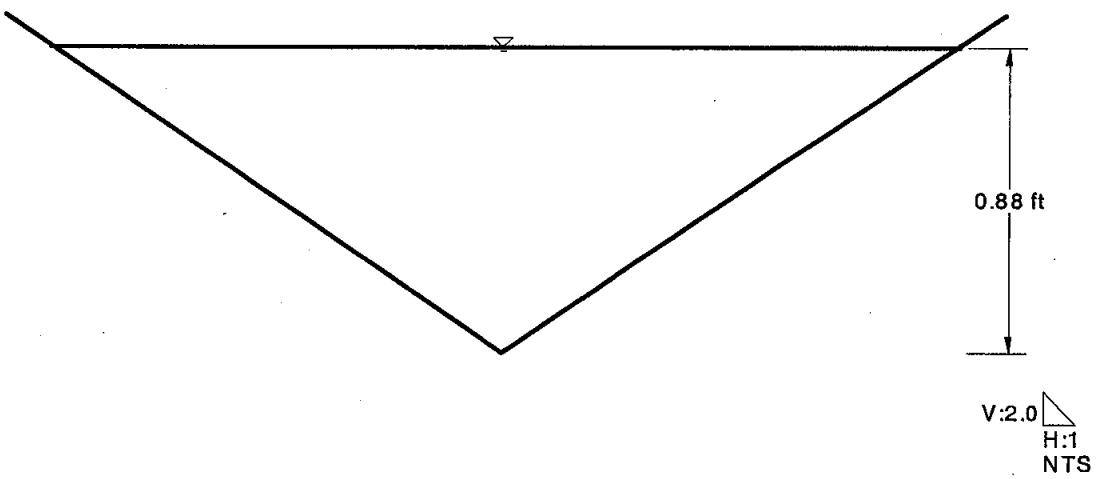
Input Data		
Mannings Coeffic	0.030	
Slope	010000	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Discharge	6.50	cfs

Results		
Depth	0.88	ft
Flow Area	2.3	ft²
Wetted Perim	5.59	ft
Top Width	5.30	ft
Critical Depth	0.78	ft
Critical Slope	0.019243	ft/ft
Velocity	2.77	ft/s
Velocity Head	0.12	ft
Specific Energ	1.00	ft
Froude Numb	0.74	
Flow Type	Subcritical	

Swale 10 - 100-Yr Flow @ 1% Slope
Cross Section for Triangular Channel

Project Description	
Worksheet	Swale #10
Flow Element	Triangular Char
Method	Manning's Form
Solve For	Channel Depth

Section Data		
Mannings Coeffic	0.030	
Slope	010000	ft/ft
Depth	0.88	ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Discharge	6.50	cfs



Swale 10 - 100-Yr Flow @ Max Slope
Worksheet for Triangular Channel

Project Description	
Worksheet	Swale #10
Flow Element	Triangular Char
Method	Manning's Form
Solve For	Channel Depth

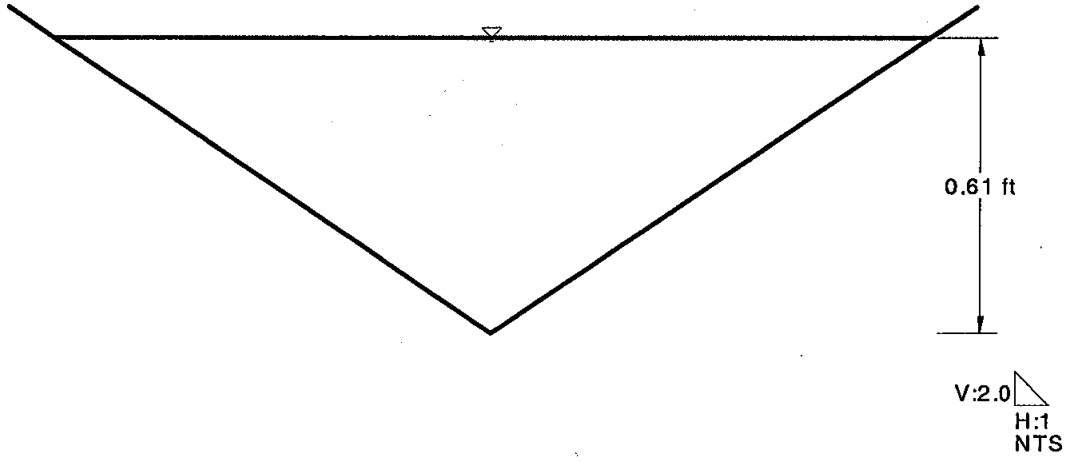
Input Data		
Mannings Coeffic	0.030	
Slope	075000	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Discharge	6.50	cfs

Results		
Depth	0.61	ft
Flow Area	1.1	ft²
Wetted Perim	3.83	ft
Top Width	3.63	ft
Critical Depth	0.78	ft
Critical Slope	0.019243	ft/ft
Velocity	5.91	ft/s
Velocity Head	0.54	ft
Specific Ener	1.15	ft
Froude Numb	1.89	
Flow Type	Supercritical	

Swale 10 - 100-Yr Flow @ Max Slope
Cross Section for Triangular Channel

Project Description	
Worksheet	Swale #10
Flow Element	Triangular Char
Method	Manning's Forr
Solve For	Channel Depth

Section Data		
Mannings Coeffic	0.030	
Slope	075000	ft/ft
Depth	0.61	ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Discharge	6.50	cfs



Swale 11 - 100-Yr Flow @ 1% Slope
Worksheet for Triangular Channel

Project Description	
Worksheet	Swale #11
Flow Element	Triangular Char
Method	Manning's Form
Solve For	Channel Depth

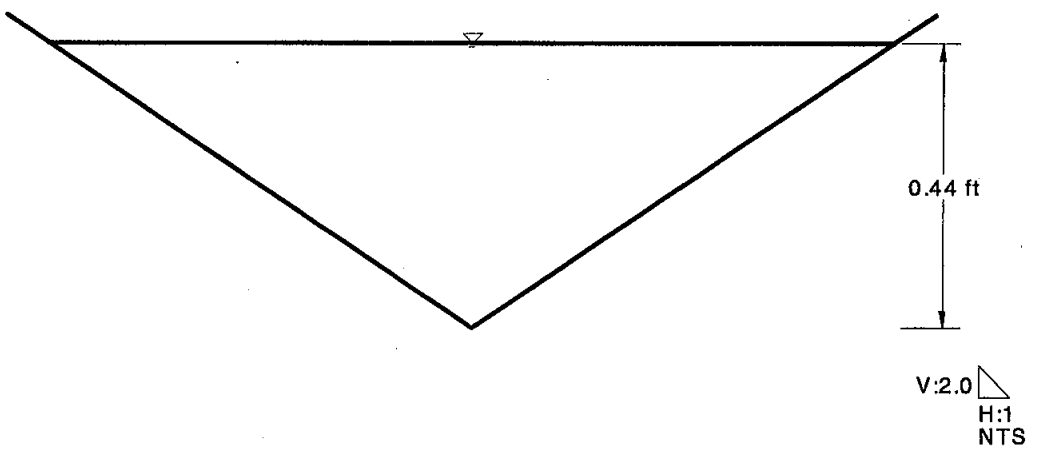
Input Data		
Mannings Coeffic	0.030	
Slope	010000	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Discharge	1.00	cfs

Results		
Depth	0.44	ft
Flow Area	0.6	ft²
Wetted Perim	2.77	ft
Top Width	2.63	ft
Critical Depth	0.37	ft
Critical Slope	0.024698	ft/ft
Velocity	1.74	ft/s
Velocity Head	0.05	ft
Specific Energ	0.48	ft
Froude Numb	0.65	
Flow Type	Subcritical	

Swale 11 - 100-Yr Flow @ 1% Slope
Cross Section for Triangular Channel

Project Description	
Worksheet	Swale #11
Flow Element	Triangular Char
Method	Manning's Forr
Solve For	Channel Depth

Section Data		
Mannings Coeffic	0.030	
Slope	010000	ft/ft
Depth	0.44	ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Discharge	1.00	cfs



Swale 11 - 100-Yr Flow @ Max Slope
Worksheet for Triangular Channel

Project Description	
Worksheet	Swale #11
Flow Element	Triangular Char
Method	Manning's Form
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.030	
Slope	260000	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Discharge	1.00	cfs

Results		
Depth	0.24	ft
Flow Area	0.2	ft²
Wetted Perim	1.50	ft
Top Width	1.43	ft
Critical Depth	0.37	ft
Critical Slope	0.024697	ft/ft
Velocity	5.90	ft/s
Velocity Head	0.54	ft
Specific Energ	0.78	ft
Froude Numb	3.01	
Flow Type	Supercritical	

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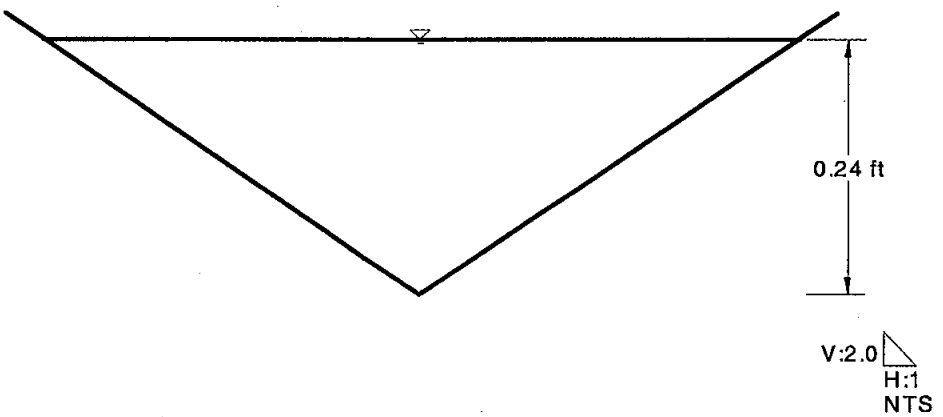
Swale 11 - 100-Yr Flow @ Max Slope
Cross Section for Triangular Channel

Project Description	
Worksheet	Swale #11
Flow Element	Triangular Char
Method	Manning's Form
Solve For	Channel Depth

Section Data		
Mannings Coeffic	0.030	
Slope	260000	ft/ft
Depth	0.24	ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Discharge	1.00	cfs



Swale 12 - 100-Yr Flow @ 1% Slope
Worksheet for Triangular Channel

Project Description	
Worksheet	Swale #12
Flow Element	Triangular Char
Method	Manning's Form
Solve For	Channel Depth

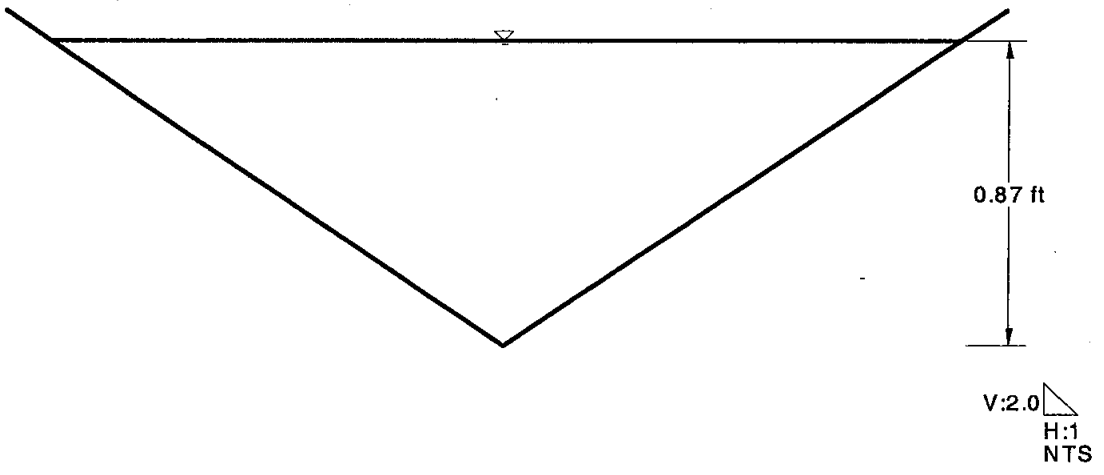
Input Data		
Mannings Coeffic	0.030	
Slope	010000	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Discharge	6.20	cfs

Results		
Depth	0.87	ft
Flow Area	2.3	ft²
Wetted Perim	5.49	ft
Top Width	5.21	ft
Critical Depth	0.77	ft
Critical Slope	0.019364	ft/ft
Velocity	2.74	ft/s
Velocity Head	0.12	ft
Specific Energ	0.99	ft
Froude Numb	0.73	
Flow Type	Subcritical	

Swale 12 - 100-Yr Flow @ 1% Slope
Cross Section for Triangular Channel

Project Description	
Worksheet	Swale #12
Flow Element	Triangular Char
Method	Manning's Form
Solve For	Channel Depth

Section Data		
Mannings Coeffic	0.030	
Slope	010000	ft/ft
Depth	0.87	ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Discharge	6.20	cfs



Swale 12 - 100-Yr Flow @ Max Slope
Worksheet for Triangular Channel

Project Description	
Worksheet	Swale #12
Flow Element	Triangular Char
Method	Manning's Form
Solve For	Channel Depth

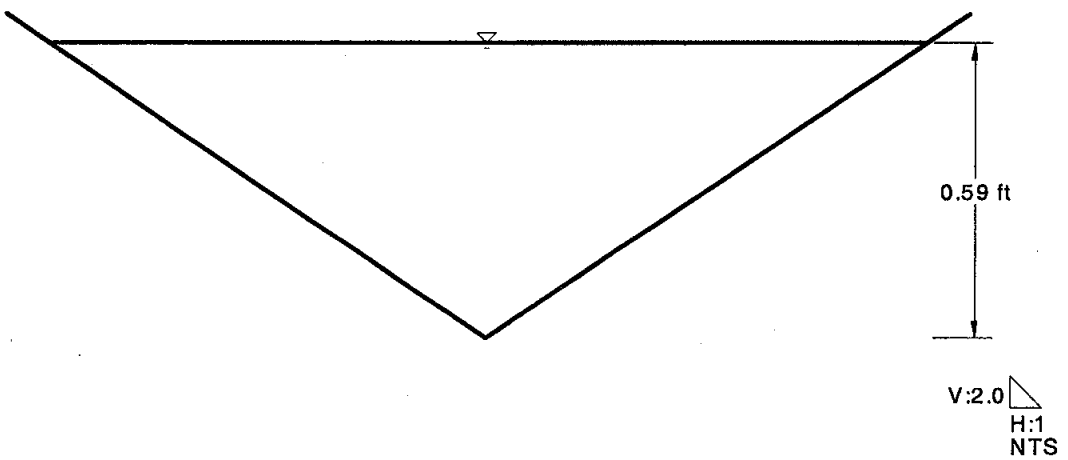
Input Data		
Mannings Coeffic	0.030	
Slope	080000	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Discharge	6.20	cfs

Results		
Depth	0.59	ft
Flow Area	1.0	ft²
Wetted Perim	3.72	ft
Top Width	3.53	ft
Critical Depth	0.77	ft
Critical Slope	0.019364	ft/ft
Velocity	5.98	ft/s
Velocity Head	0.56	ft
Specific Energ	1.14	ft
Froude Numb	1.94	
Flow Type	Supercritical	

Swale 12 - 100-Yr Flow @ Max Slope
Cross Section for Triangular Channel

Project Description	
Worksheet	Swale #12
Flow Element	Triangular Char
Method	Manning's Form
Solve For	Channel Depth

Section Data		
Mannings Coeffic	0.030	
Slope	080000	ft/ft
Depth	0.59	ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Discharge	6.20	cfs



Swale 13 - 100-Yr Flow @ 1% Slope
Worksheet for Triangular Channel

Project Description	
Worksheet	Swale #13
Flow Element	Triangular Char
Method	Manning's Form
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.030	
Slope	010000	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Discharge	1.00	cfs

Results		
Depth	0.44	ft
Flow Area	0.6	ft²
Wetted Perim	2.77	ft
Top Width	2.63	ft
Critical Depth	0.37	ft
Critical Slope	0.024698	ft/ft
Velocity	1.74	ft/s
Velocity Head	0.05	ft
Specific Ener	0.48	ft
Froude Numb	0.65	
Flow Type	Subcritical	

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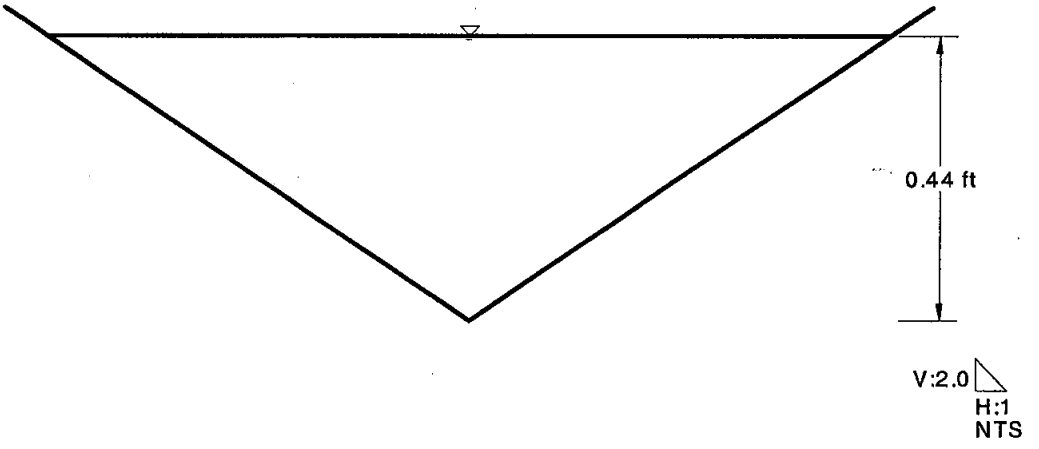
Swale 13 - 100-Yr Flow @ 1% Slope
Cross Section for Triangular Channel

Project Description	
Worksheet	Swale #13
Flow Element	Triangular Char
Method	Manning's Form
Solve For	Channel Depth

Section Data		
Mannings Coeffic	0.030	
Slope	010000	ft/ft
Depth	0.44	ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Discharge	1.00	cfs



Swale 13 - 100-Yr Flow @ Max Slope
Worksheet for Triangular Channel

Project Description	
Worksheet	Swale #13
Flow Element	Triangular Char
Method	Manning's Form
Solve For	Channel Depth

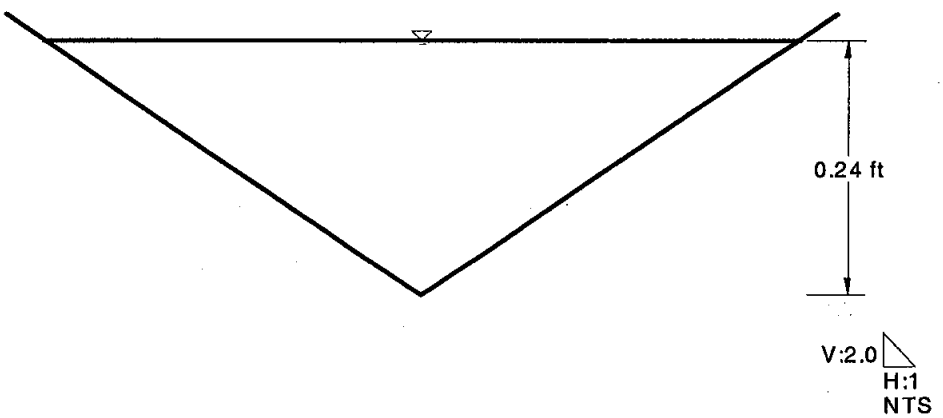
Input Data		
Mannings Coeffic	0.030	
Slope	260000	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Discharge	1.00	cfs

Results		
Depth	0.24	ft
Flow Area	0.2	ft²
Wetted Perim	1.50	ft
Top Width	1.43	ft
Critical Depth	0.37	ft
Critical Slope	0.024697	ft/ft
Velocity	5.90	ft/s
Velocity Head	0.54	ft
Specific Energ	0.78	ft
Froude Numb	3.01	
Flow Type	Supercritical	

Swale 13 - 100-Yr Flow @ Max Slope
Cross Section for Triangular Channel

Project Description	
Worksheet	Swale #13
Flow Element	Triangular Char
Method	Manning's Form
Solve For	Channel Depth

Section Data		
Mannings Coeffic	0.030	
Slope	260000	ft/ft
Depth	0.24	ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Discharge	1.00	cfs



Swale 14 - 100-Yr Flow @ 1% Slope
Worksheet for Triangular Channel

Project Description	
Worksheet	Swale #14
Flow Element	Triangular Char
Method	Manning's Forr
Solve For	Channel Depth

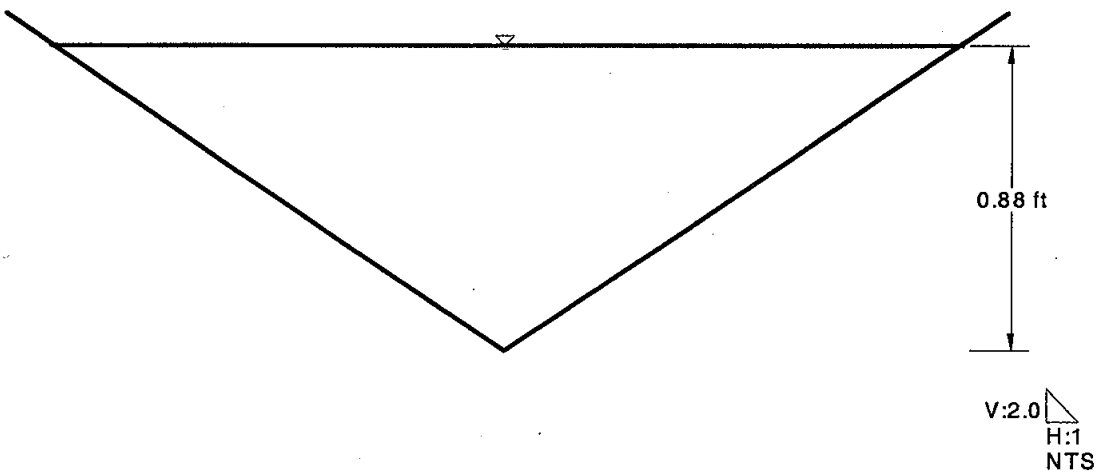
Input Data		
Mannings Coeffic	0.030	
Slope	010000	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Discharge	6.40	cfs

Results		
Depth	0.88	ft
Flow Area	2.3	ft²
Wetted Perim	5.56	ft
Top Width	5.27	ft
Critical Depth	0.78	ft
Critical Slope	0.019282	ft/ft
Velocity	2.76	ft/s
Velocity Head	0.12	ft
Specific Ener	1.00	ft
Froude Numb	0.74	
Flow Type	Subcritical	

Swale 14 - 100-Yr Flow @ 1% Slope
Cross Section for Triangular Channel

Project Description	
Worksheet	Swale #14
Flow Element	Triangular Char
Method	Manning's Form
Solve For	Channel Depth

Section Data		
Mannings Coeffic	0.030	
Slope	010000	ft/ft
Depth	0.88	ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Discharge	6.40	cfs



Swale 14 - 100-Yr Flow @ Max Slope
Worksheet for Triangular Channel

Project Description	
Worksheet	Swale #14
Flow Element	Triangular Char
Method	Manning's Form
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.030	
Slope	075000	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Discharge	6.40	cfs

Results		
Depth	0.60	ft
Flow Area	1.1	ft²
Wetted Perim	3.81	ft
Top Width	3.61	ft
Critical Depth	0.78	ft
Critical Slope	0.019282	ft/ft
Velocity	5.88	ft/s
Velocity Head	0.54	ft
Specific Energ	1.14	ft
Froude Numb	1.89	
Flow Type	Supercritical	

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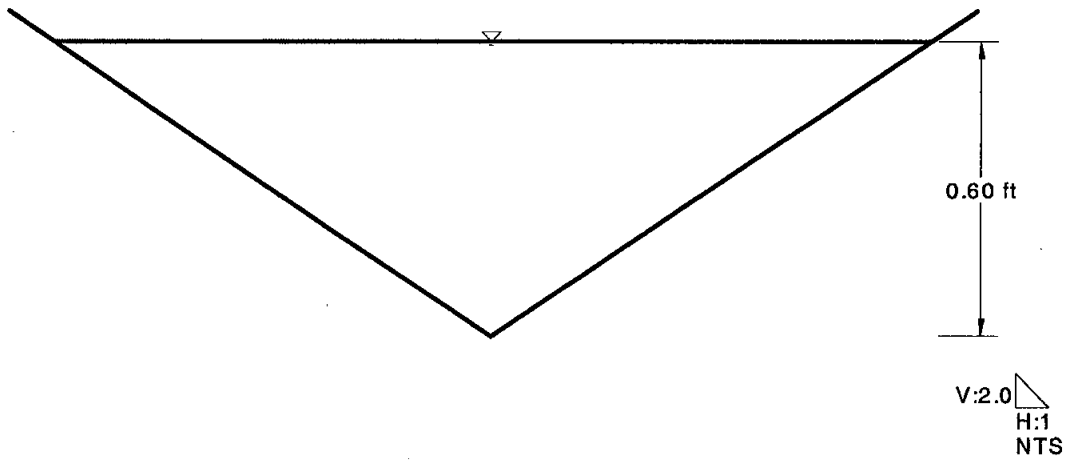
Swale 14 - 100-Yr Flow @ Max Slope
Cross Section for Triangular Channel

Project Description	
Worksheet	Swale #14
Flow Element	Triangular Char
Method	Manning's Form
Solve For	Channel Depth

Section Data		
Mannings Coeffic	0.030	
Slope	075000	ft/ft
Depth	0.60	ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Discharge	6.40	cfs

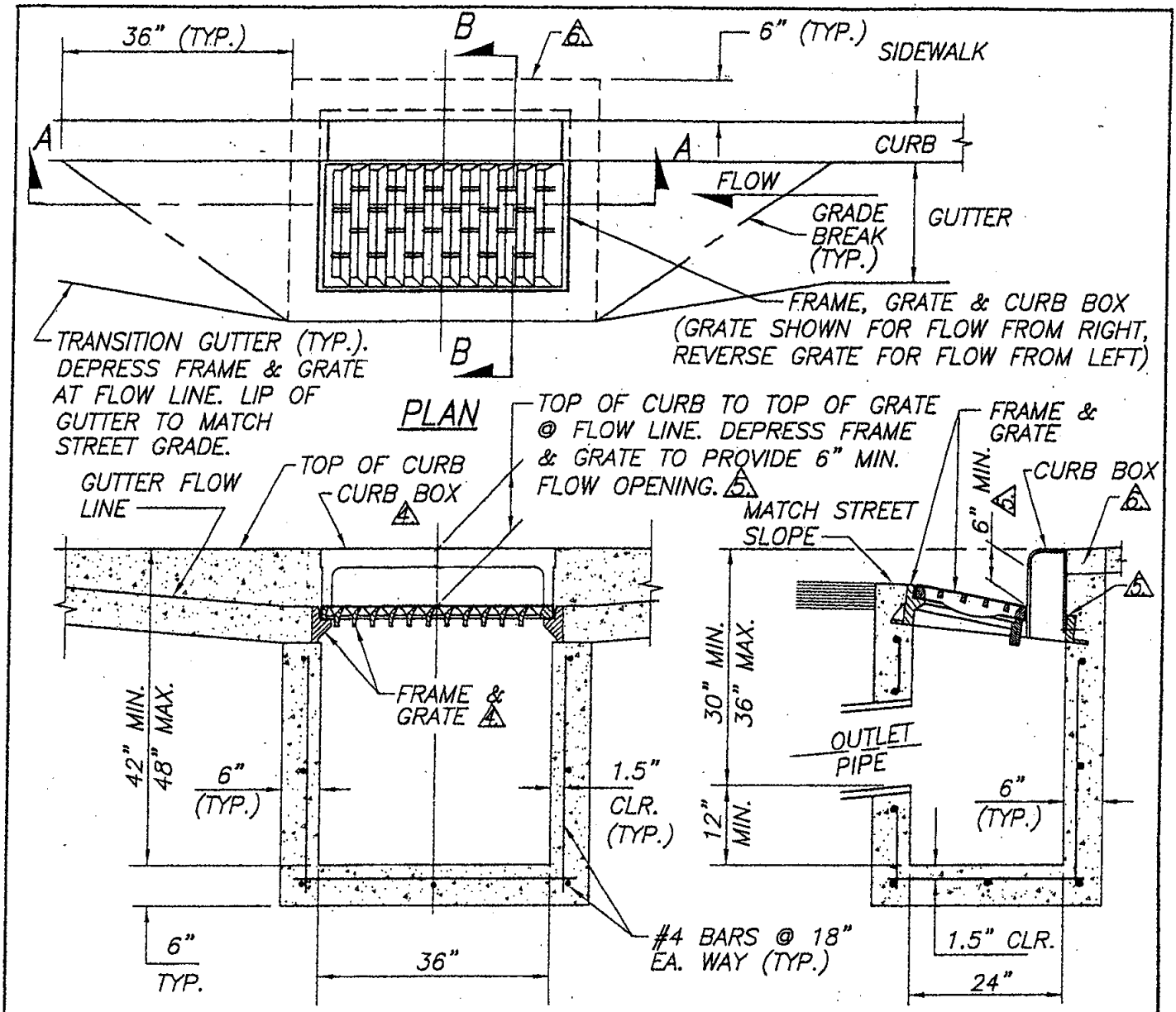


Appendix D

Catch Basin and Storm Drain Calculations

Catch Basin Flows and Design Parameters

Catch Basin	Roadway	Orientation	Street Slope (%)	Size & Type	Contributing Subbasins	Contributing Drainage Facilities	Q5 Approaching	Q100 Approaching	Q5 Interception Efficiency (%)	Q100 Interception Efficiency (%)	Q5 Ponding Depth (ft)	Q100 Ponding Depth (ft)	Q5 Intercepted	Q100 Intercepted	Q5 Bypassed	Q100 Bypassed
CB 1	Typ. Interior	Cont. Grade	4.0	Single - Type 4-R	4	-	2.3	6.1	82	60	-	-	1.9	3.7	0.4	2.4
CB 2	Typ. Interior	Cont. Grade	4.0	Single - Type 4-R	5	-	1.7	4.4	88	68	-	-	1.5	3.9	0.2	0.5
CB 3	Typ. Interior	Cont. Grade	4.4	Single - Type 4-R	-	Bypass CB 31	0.9	2.3	97	83	-	-	0.8	2.2	0.0	0.1
CB 4	Typ. Interior	Cont. Grade	4.4	Single - Type 4-R	-	Bypass CB 32	0.9	2.4	97	83	-	-	0.9	2.4	0.0	0.1
CB 5	Somersett	Cont. Grade	5.0	Single - Type 4-R	14	-	0.3	0.9	100	98	-	-	0.3	0.9	0.0	0.0
CB 6	Somersett	Cont. Grade	5.0	Single - Type 4-R	15	-	0.4	0.9	100	98	-	-	0.4	0.9	0.0	0.0
CB 7	Somersett	Cont. Grade	7.5	Single - Type 4-R	16	Bypass CB 1, 2, 5	0.96	5.3	94	63	-	-	0.9	5.0	0.1	0.3
CB 8	Somersett	Cont. Grade	7.5	Single - Type 4-R	17	-	0.9	2.4	96	79	-	-	0.9	2.3	0.0	0.1
CB 9	Somersett	Cont. Grade	4.0	Single - Type 4-R	10, 18	Bypass CB 3, 4, 7	3.7	9.5	73	48	-	-	2.7	6.9	1.0	2.6
CB 10	Somersett	Sump	-	Single - Type 4-R	19	Node H, Bypass CB 19, Overflow CB 18	1.1	2.9	100	100	0.19	0.36	1.1	2.9	0.0	0.0
CB 11	Somersett	Cont. Grade	7.5	Single - Type 4-R	20	Bypass CB 9	1.2	3.2	92	72	-	-	1.1	2.9	0.1	0.3
CB 12	Typ. Interior	Cont. Grade	3.2	Single - Type 4-R	22	Bypass CB 6	0.9	2.3	96	81	-	-	0.9	2.2	0.0	0.1
CB 13	Typ. Interior	Cont. Grade	3.2	Single - Type 4-R	23	-	0.9	2.2	96	82	-	-	0.9	2.1	0.0	0.1
CB 14	Typ. Interior	Sump	-	Single - Type 4-R	25	Bypass CB 15	1.4	3.6	100	100	0.22	0.40	1.4	3.6	0.0	0.0
CB 15	Typ. Interior	Cont. Grade	4.4	Single - Type 4-R	26	Bypass CB 13	0.7	1.8	98	88	-	-	0.7	1.8	0.0	0.0
CB 16	Typ. Interior	Sump	-	Single - Type 4-R	27	Bypass CB 12	1.4	3.9	100	100	0.22	0.43	1.4	3.9	0.0	0.0
CB 17	Typ. Interior	Cont. Grade	1.4	Single - Type 4-R	28	-	0.9	2.4	92	74	-	-	0.8	2.2	0.1	0.2
CB 18	Typ. Interior	Sump	-	Single - Type 4-R	29	Bypass CB 8, 17,	0.9	2.3	100	100	0.17	0.3	0.9	2.3	0.0	0.0
CB 19	Typ. Interior	Cont. Grade	5.0	Single - Type 4-R	30	-	0.9	2.2	98	86	-	-	0.9	2.2	0.0	0.0
CB 20	Somersett	Cont. Grade	7.5	Single - Type 4-R	33	-	0.8	2.1	96	82	-	-	0.8	2.0	0.0	0.1
CB 21	Parking Area	Sump	-	Single - Type 4-R	34	-	2.2	5.7	100	100	0.29	0.56	2.2	5.7	0.0	0.0
CB 22	Somersett	Cont. Grade	5.6	Single - Type 4-R	36	-	0.5	1.4	100	94	-	-	0.5	1.4	0.0	0.0
CB 23	Somersett	Cont. Grade	5.6	Single - Type 4-R	37	-	0.5	1.4	100	94	-	-	0.5	1.4	0.0	0.0
CB 24	Typ. Interior	Cont. Grade	5.0	Single - Type 4-R	38	-	1.5	3.8	92	72	-	-	1.4	3.5	0.1	0.3
CB 25	Somersett	Cont. Grade	6.0	Single - Type 4-R	41	Bypass CB 22	0.5	1.3	100	95	-	-	0.5	1.3	0.0	0.0
CB 26	Somersett	Cont. Grade	6.0	Single - Type 4-R	42	Bypass CB 23	0.5	1.3	100	95	-	-	0.5	1.3	0.0	0.0
CB 27	Typ. Interior	Cont. Grade	1.6	Single - Type 4-R	-	Bypass CB 33	0.3	0.8	100	93	-	-	0.3	0.8	0.0	0.0
CB 28	Typ. Interior	Cont. Grade	1.6	Single - Type 4-R	44	-	1.7	4.4	82	62	-	-	1.4	3.6	0.3	0.8
CB 29	Typ. Interior	Cont. Grade	3.9	Single - Type 4-R	46	Bypass CB 27	1.5	3.8	91	72	-	-	1.4	3.5	0.1	0.3
CB 30	Somersett	Cont. Grade	6.0	Single - Type 4-R	47	Bypass CB 28	1.6	4.1	92	67	-	-	1.5	3.8	0.1	0.3
CB 31	Typ. Interior	Cont. Grade	4.4	Single - Type 4-R	7	-	3.5	9.0	75	49			2.6	6.8	0.9	2.3
CB 32	Typ. Interior	Cont. Grade	4.4	Single - Type 4-R	8	-	3.6	9.4	74	48			2.7	7.0	0.9	2.4
CB 33	Typ. Interior	Cont. Grade	5.0	Single - Type 4-R	43	Bypass CB 24	2.1	5.5	86	62	-	-	1.8	4.7	0.3	0.8



NOTES:

1. PORTLAND CEMENT CONCRETE (P.C.C.) SHALL HAVE THE FOLLOWING CHARACTERISTICS: 4000 PSI MIN. COMPRESSIVE STRENGTH @ 28 DAYS, (CURB AND GUTTER TRANSITION ONLY, ALL UNEXPOSED CONCRETE MAY BE 3000 PSI) MIN. 6 SACKS OF CEMENT PER CUBIC YARD WITH A MAX. WATER/CEMENT RATIO OF 0.45, AIR ENTRAINMENT 6% ±1.5%, SLUMP AT 1 TO 4 INCHES. ALL MATERIALS SHALL CONFORM TO SSPWC SECTION 202.
2. REINFORCING STEEL SHALL BE GRADE 40 AND HAVE 1.5" MINIMUM CLEAR COVER.
3. CONCRETE STRUCTURE MAY BE A PRE–CAST CONCRETE UNIT UPON APPROVAL OF THE CITY ENGINEER. BASE OF PRE–CAST CONCRETE UNIT SHALL BE PLACED ON 6" COMPACTED DRAIN ROCK.

4 FRAME SHALL BE NEENAH R–3294, R–3295 OR R–3067 SINGLE CURB UNIT WITH A TYPE L "VANE GRATE" AND CURB BOX, SOUTH BAY FOUNDRY VANE GRATE SBF 1947 OR APPROVED EQUAL, INSTALLED WITH PROPER FLOW DIRECTION.

5 TILT FRAME & GRATE AS REQUIRED TO ATTAIN 6" MIN. FLOW OPENING & INSTALL DURABLE SHIMS BETWEEN THE CURB BOX & FRAME AS REQUIRED TO MATCH CURB BOX TO TOP OF CURB AND FACE OF CURB (SEE SECTION B–B).

6 CONCRETE SHALL BE PLACED AS SHOWN WHEN NOT LOCATED IN A SIDEWALK.

7. INSTALL GREASE TRAP PER STANDARD DETAIL DRAWING NO. R–213 (311).

NO.	REVISION	DATE
1	REV. NOTE 4	02/01
APPROVED BY S.V.		02/01

STANDARD DETAILS FOR PUBLIC WORKS CONSTRUCTION

CATCH BASIN TYPE 4–R

SECTION	RENO
DRAWING NO.	R–206 (311)
DATE	08/00
PAGE	36

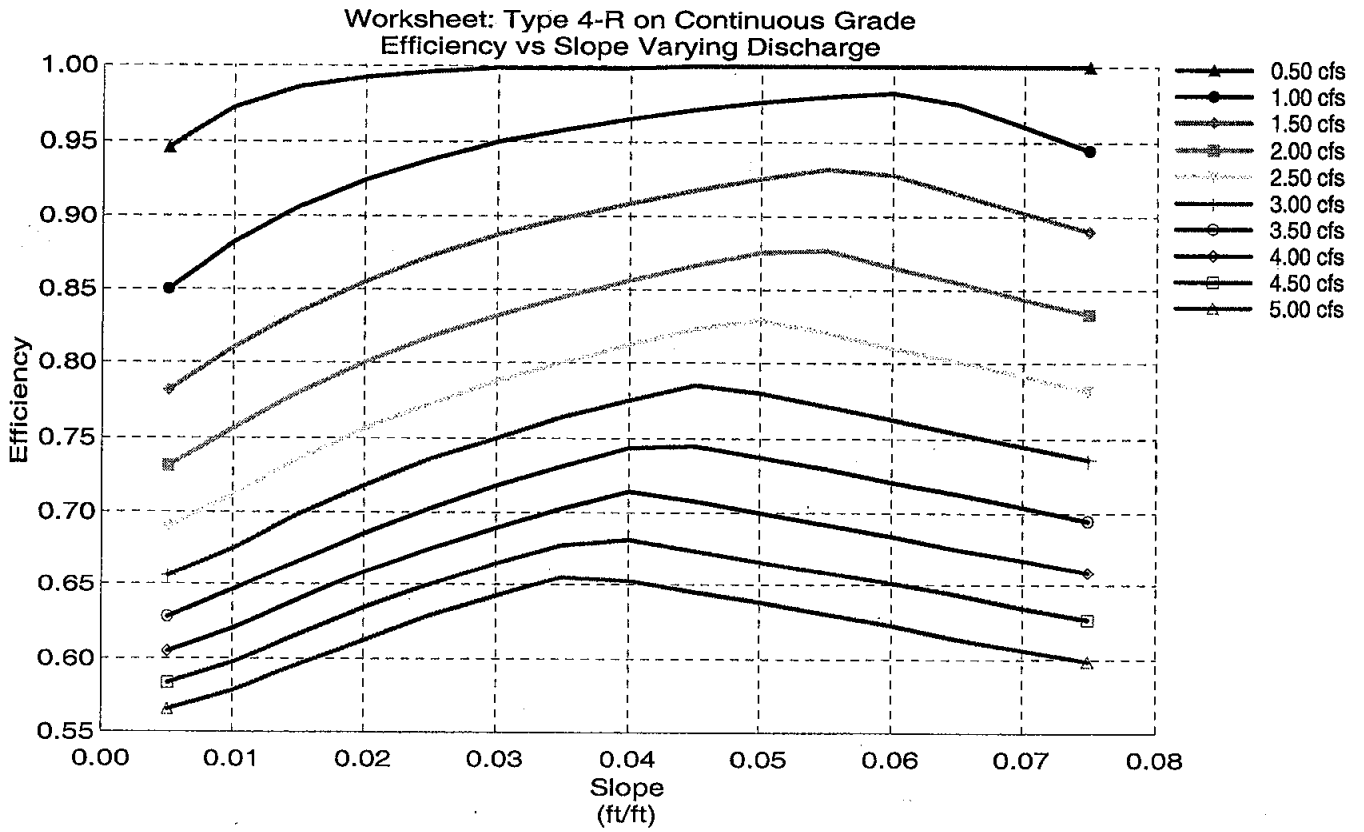
Rating Curve for Catch Basin Type 4-R - Continuous Grade
Plotted Curves for Combination Inlet On Grade

Project Description	
Worksheet	Type 4-R on Continuou
Type	Combination Inlet On G
Solve For	Efficiency

Input Data		
Local Depression	3.0	in
Local Depression \	2.00	ft
Gutter Width	1.50	ft
Gutter Cross Slope	0.083000	ft/ft
Road Cross Slope	0.020000	ft/ft
Mannings Coefficie	0.013	
Curb Opening Len	3.00	ft
Grate Width	1.50	ft
Grate Length	3.00	ft
Grate Type	Reticuline	
Clogging	0.7	%

Options	
Calculation Opt	Use Both
Grate Flow Opti	lude None

Attribute	Minimum	Maximum	Increment
Slope (ft/ft)	0.005000	0.075000	0.005000
Discharge (cfs)	0.50	5.00	0.50



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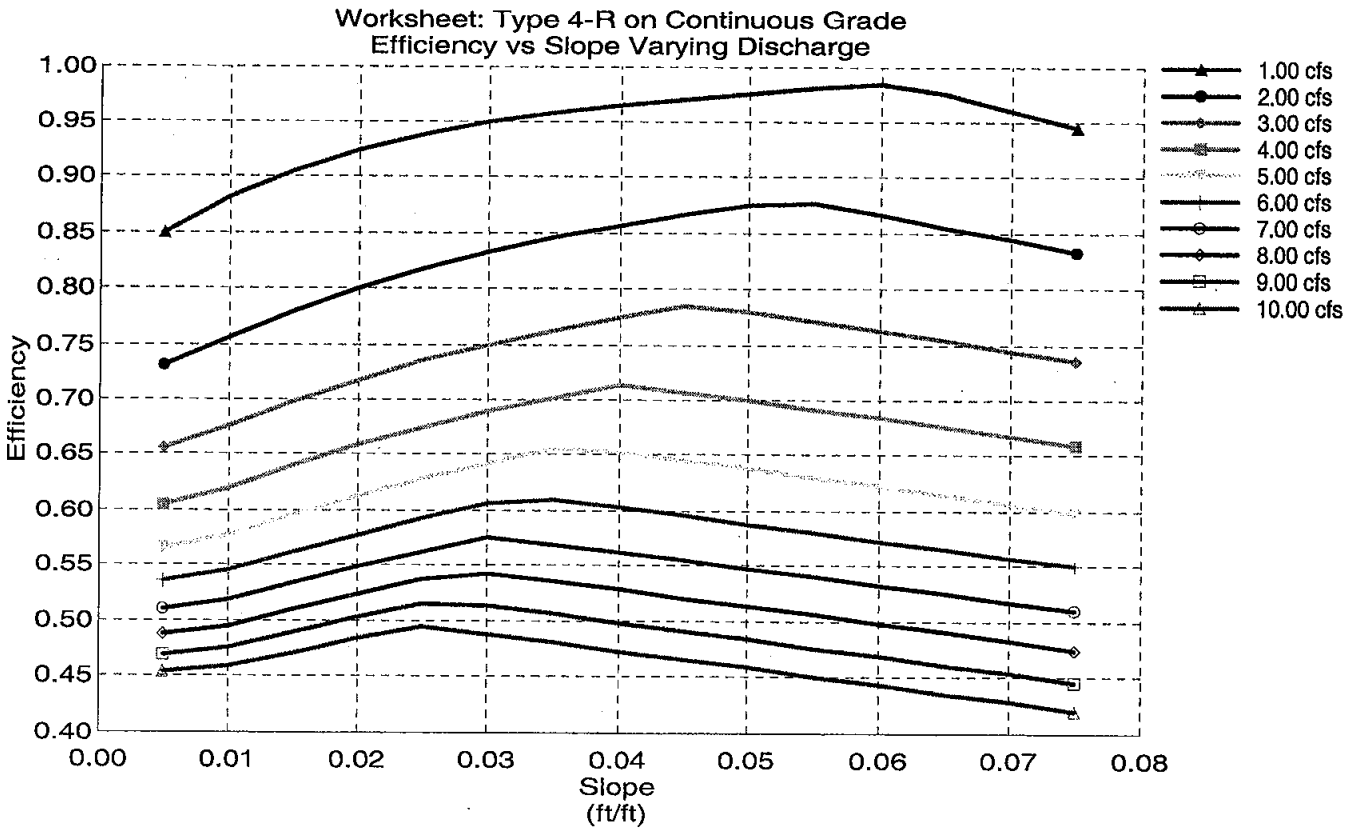
Rating Curve for Catch Basin Type 4-R - Continuous Grade
Plotted Curves for Combination Inlet On Grade

Project Description	
Worksheet	Type 4-R on Continuou
Type	Combination Inlet On G
Solve For	Efficiency

Input Data		
Local Depression	3.0	in
Local Depression \	2.00	ft
Gutter Width	1.50	ft
Gutter Cross Slope	0.083000	ft/ft
Road Cross Slope	0.020000	ft/ft
Mannings Coefficie	0.013	
Curb Opening Leng	3.00	ft
Grate Width	1.50	ft
Grate Length	3.00	ft
Grate Type	Reticuline	
Clogging	0.7	%

Options	
Calculation Opt	Use Both
Grate Flow Opti	clude None

Attribute	Minimum	Maximum	Increment
Slope (ft/ft)	0.005000	0.075000	0.005000
Discharge (cfs)	1.00	10.00	1.00



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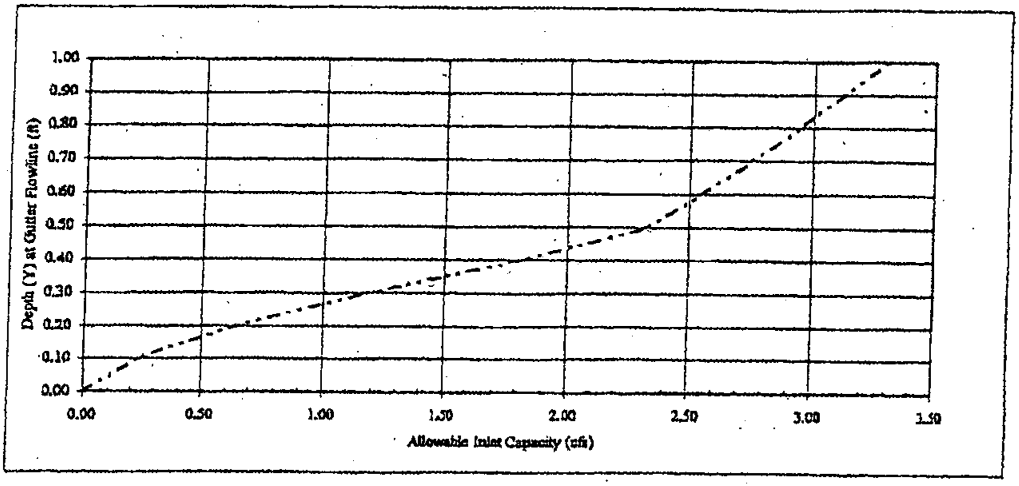
CITY OF SPARKS

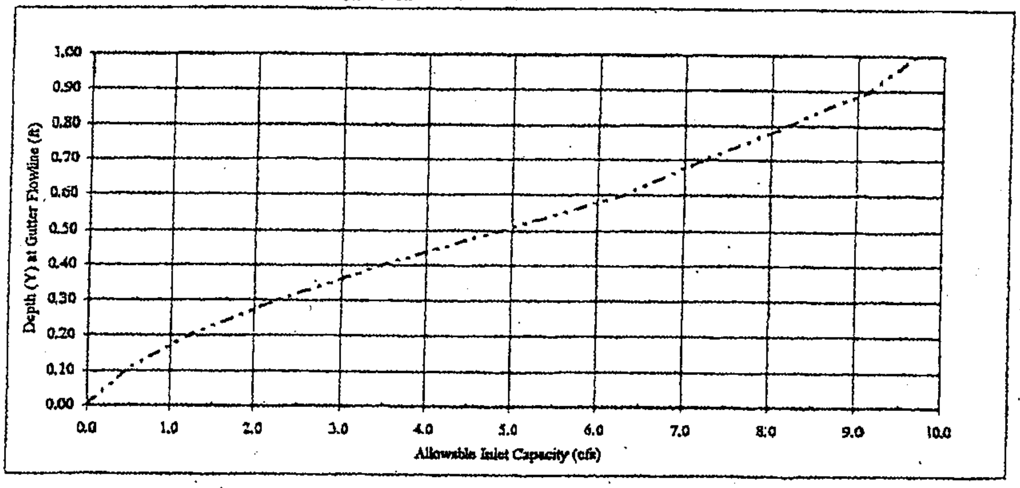
HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL

ALLOWABLE INLET CAPACITY
SUMP CONDITION

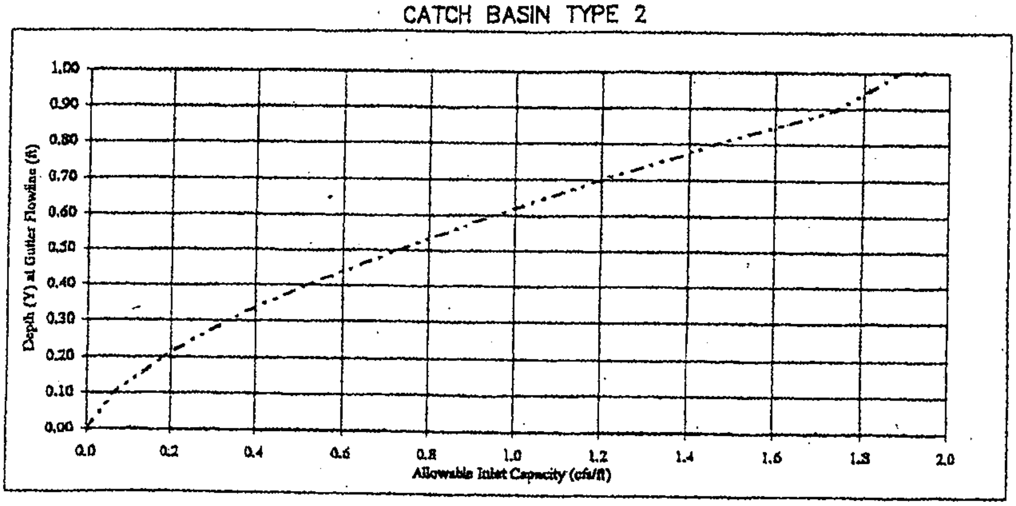
SINGLE CATCH BASIN TYPE 1



SINGLE CATCH BASIN TYPE 4–R



CATCH BASIN TYPE 2



NOTE: 1) INCLUDES CAPACITY REDUCTION FACTOR OF 0.5 FOR GRATE AND 0.7 FOR CURB OPERNING

VERSION: August 18, 1998	REFERENCE:	FIGURE
WRC NEVADA, INC		907

Pipe #	Diameter (in)	Design Slope (%)	Flow Sources	Q100 Flow Depth at Down Stream Structure [3] (ft)	Possible Dist. Down Stream Q5 HGL above Pipe Crown [4] (ft)	Possible Dist. Down Stream Q100 HGL above Pipe Crown [4] (ft)
P1	24	3	Swale 2	2.24	-0.7	0.2
P2	18	5	Pipe 1, CB 6	3.47	0.4	2.0
P3	18	1	CB 1, 2, 5	1.38	-0.6	-0.1
P4	18	6	Pipe 2, 3	4.53	1.2	3.0
P5	18	6	Pipe 5, CB 8	4.69	1.3	3.2
P6	24	2	Swale 4, 5	2.27	-0.6	0.3
P7	24	3	Pipe 6, CB 4, 31, 3	3.51	0.2	1.5
P8	24	3	Pipe 7, CB 3	3.62	0.2	1.6
P9	12	2	CB 12, 13	1.20	-0.2	0.2
P10	15	3	Pipe 9, CB 15, 16	2.03	0.0	0.8
P11	12	5	Swale 7	0.83	-0.5	-0.2
P12	15	3	Pipe 10, 11	2.15	0.1	0.9
P13	18	3	Pipe 12, CB 14, 17, 18	2.90	0.3	1.4
P14	36	3	Pipe 5, 8, 13, CB 7, 9,	5.87	0.3	2.9
P15	15	5	Swale 9	1.85	-0.2	0.6
P16	36	3	Pipe 14, 15	6.03	0.4	3.0
P17	36	2	Pipe 16, CB 11, 20	5.28	0.0	2.3
P18	36	3	Pipe 17, CB 21	6.31	0.6	3.3
P19	12	5	Swale 11	0.75	-0.6	-0.2
P20	12	3	Pipe 19	0.62	-0.6	-0.4
P21	15	2	Pipe 20, CB 24, 33	1.72	-0.2	0.5
P22	15	5	Swale 10	2.01	-0.1	0.8
P23	15	3	Pipe 22, CB 22, 23	1.96	-0.1	0.7
P24	15	5	Swale 12	1.95	-0.1	0.7
P25	12	5	Swale 13	0.75	-0.6	-0.2
P26	18	3	Pipe 23, 24, 25	2.55	0.0	1.0
P27	24	1	Pipe 26, CB 25	1.87	-0.9	-0.1
P28	24	1	Pipe 26, CB 26, 29, 3	2.35	-0.6	0.4
P29	24	3	Pipe 21, 28, CB 27, 2	3.84	0.3	1.8
P30	12	5	Swale 3	0.83	-0.5	-0.2

Notes: (1) Velocity head: (v^2)/(2*g)
(2) Head Loss at down stream structu
(3) Flow depth = pipe normal depth +
(4) Possible distance down stream HC

Appendix E

Flared Inlet Calculations

Flared Inlet Flows and Design Parameters

Flared Pipe Inlet	Connecting Pipe	Pipe Diameter (in)	Max Pipe Slope [1] (%)	Contributing Subbasins	Q100 for Pipe (cfs)	Pipe Normal Depth for Q100 (ft)	Velocity in Pipe (fps)	Velocity Head [2] (ft)	Head Loss at Entrance [3] (ft)	Ponding Depth at Inlet [4] (ft)	Freeboard at Entrance (ft)
F1	P1	24	5	2	14.4	0.64	16.77	4.37	0.87	1.51	0.49
F2	P30	12	5	6	1.2	0.23	8.80	1.20	0.24	0.47	0.53
F3	P11	12	5	23	1.2	0.23	8.80	1.20	0.24	0.47	0.53
F4	P6	24	5	9	19.4	0.74	18.21	5.16	1.03	1.77	0.23
F5	P15	15	5	32	5.6	0.47	13.35	2.77	0.55	1.02	0.23
F6	P19	12	5	39	1.0	0.21	8.35	1.08	0.22	0.43	0.57
F7	P22	15	5	35	6.5	0.51	13.90	3.00	0.60	1.11	0.14
F8	P24	15	5	40	6.2	0.49	13.73	2.93	0.59	1.08	0.17
F9	P25	12	5	45	1.0	0.21	8.35	1.08	0.22	0.43	0.57

Notes:
(1) Maximum pipe slope estimated for worst case head loss at flared inlet.
(2) Velocity head: (v^2)/(2*g)
(3) Head Loss at entrance assumes minor loss at entrance of 0.2 x velocity head.
(4) Ponding depth = pipe normal depth + head loss at entrance.

Flared Inlet 1 / Pipe 1 - 100-Yr Flow @ 5%
Worksheet for Circular Channel

Project Description	
Worksheet	24" PVC Storm I
Flow Element	Circular Channe
Method	Manning's Form
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.010	
Slope	050000	ft/ft
Diameter	24	in
Discharge	14.40	cfs

Results		
Depth	0.64	ft
Flow Area	0.9	ft²
Wetted Perime	2.40	ft
Top Width	1.86	ft
Critical Depth	1.37	ft
Percent Full	31.8	%
Critical Slope	0.003641	ft/ft
Velocity	16.77	ft/s
Velocity Head	4.37	ft
Specific Energ	5.00	ft
Froude Numbe	4.35	
Maximum Disc	70.74	cfs
Discharge Full	65.76	cfs
Slope Full	0.002398	ft/ft
Flow Type	Supercritical	

Flared Inlet 2 / Pipe 30 - 100-Yr Flow @ 5%
Worksheet for Circular Channel

Project Description	
Worksheet	12" PVC Storm I
Flow Element	Circular Channe
Method	Manning's Form
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.010	
Slope	050000	ft/ft
Diameter	12	in
Discharge	1.20	cfs

Results		
Depth	0.23	ft
Flow Area	0.1	ft²
Wetted Perime	1.00	ft
Top Width	0.84	ft
Critical Depth	0.46	ft
Percent Full	23.0	%
Critical Slope	0.003526	ft/ft
Velocity	8.80	ft/s
Velocity Head	1.20	ft
Specific Energ	1.43	ft
Froude Numbe	3.85	
Maximum Disc	11.14	cfs
Discharge Full	10.36	cfs
Slope Full	0.000671	ft/ft
Flow Type	Supercritical	

Flared Inlet 3 / Pipe 11 - 100-Yr Flow @ 5%
Worksheet for Circular Channel

Project Description	
Worksheet	12" PVC Storm I
Flow Element	Circular Channe
Method	Manning's Form
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.010	
Slope	050000	ft/ft
Diameter	12	in
Discharge	1.20	cfs

Results		
Depth	0.23	ft
Flow Area	0.1	ft²
Wetted Perime	1.00	ft
Top Width	0.84	ft
Critical Depth	0.46	ft
Percent Full	23.0	%
Critical Slope	0.003526	ft/ft
Velocity	8.80	ft/s
Velocity Head	1.20	ft
Specific Energ	1.43	ft
Froude Numbe	3.85	
Maximum Disc	11.14	cfs
Discharge Full	10.36	cfs
Slope Full	0.000671	ft/ft
Flow Type	Supercritical	

Flared Inlet 4 / Pipe 6 - 100-Yr Flow @ 5%
Worksheet for Circular Channel

Project Description	
Worksheet	24" PVC Storm I
Flow Element	Circular Channe
Method	Manning's Form
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.010	
Slope	050000	ft/ft
Diameter	24	in
Discharge	19.40	cfs

Results		
Depth	0.74	ft
Flow Area	1.1	ft²
Wetted Perime	2.62	ft
Top Width	1.93	ft
Critical Depth	1.58	ft
Percent Full	37.2	%
Critical Slope	0.004649	ft/ft
Velocity	18.21	ft/s
Velocity Head	5.16	ft
Specific Energ	5.90	ft
Froude Numbe	4.33	
Maximum Disc	70.74	cfs
Discharge Full	65.76	cfs
Slope Full	0.004352	ft/ft
Flow Type	Supercritical	

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Flared Inlet 5 / Pipe 15 - 100-Yr Flow @ 5%
Worksheet for Circular Channel

Project Description	
Worksheet	15" PVC Storm I
Flow Element	Circular Channe
Method	Manning's Form
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.010	
Slope	050000	ft/ft
Diameter	15	in
Discharge	5.60	cfs

Results		
Depth	0.47	ft
Flow Area	0.4	ft²
Wetted Perime	1.65	ft
Top Width	1.21	ft
Critical Depth	0.96	ft
Percent Full	37.4	%
Critical Slope	0.005086	ft/ft
Velocity	13.35	ft/s
Velocity Head	2.77	ft
Specific Energ	3.24	ft
Froude Numbe	4.00	
Maximum Disc	20.20	cfs
Discharge Full	18.78	cfs
Slope Full	0.004447	ft/ft
Flow Type	Supercritical	

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Flared Inlet 6 / Pipe 19 - 100-Yr Flow @ 5%
Worksheet for Circular Channel

Project Description	
Worksheet	12" PVC Storm I
Flow Element	Circular Channe
Method	Manning's Form
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.010	
Slope	050000	ft/ft
Diameter	12	in
Discharge	1.00	cfs

Results		
Depth	0.21	ft
Flow Area	0.1	ft²
Wetted Perime	0.95	ft
Top Width	0.81	ft
Critical Depth	0.42	ft
Percent Full	21.0	%
Critical Slope	0.003437	ft/ft
Velocity	8.35	ft/s
Velocity Head	1.08	ft
Specific Energ	1.29	ft
Froude Numbe	3.84	
Maximum Disc	11.14	cfs
Discharge Full	10.36	cfs
Slope Full	0.000466	ft/ft
Flow Type	Supercritical	

Flared Inlet 7 / Pipe 22 - 100-Yr Flow @ 5%
Worksheet for Circular Channel

Project Description	
Worksheet	15" PVC Storm I
Flow Element	Circular Channe
Method	Manning's Form
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.010	
Slope	050000	ft/ft
Diameter	15	in
Discharge	6.50	cfs

Results		
Depth	0.51	ft
Flow Area	0.5	ft²
Wetted Perime	1.73	ft
Top Width	1.23	ft
Critical Depth	1.03	ft
Percent Full	40.6	%
Critical Slope	0.005965	ft/ft
Velocity	13.90	ft/s
Velocity Head	3.00	ft
Specific Energ	3.51	ft
Froude Numbe	3.97	
Maximum Disc	20.20	cfs
Discharge Full	18.78	cfs
Slope Full	0.005992	ft/ft
Flow Type	Supercritical	

Flared Inlet 8 / Pipe 24 - 100-Yr Flow @ 5%
Worksheet for Circular Channel

Project Description	
Worksheet	15" PVC Storm I
Flow Element	Circular Channe
Method	Manning's Form
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.010	
Slope	050000	ft/ft
Diameter	15	in
Discharge	6.20	cfs

Results		
Depth	0.49	ft
Flow Area	0.5	ft²
Wetted Perime	1.70	ft
Top Width	1.22	ft
Critical Depth	1.01	ft
Percent Full	39.6	%
Critical Slope	0.005645	ft/ft
Velocity	13.73	ft/s
Velocity Head	2.93	ft
Specific Energ	3.42	ft
Froude Numbe	3.98	
Maximum Disc	20.20	cfs
Discharge Full	18.78	cfs
Slope Full	0.005451	ft/ft
Flow Type	Supercritical	

Flared Inlet 9 / Pipe 25 - 100-Yr Flow @ 5%
Worksheet for Circular Channel

Project Description	
Worksheet	12" PVC Storm I
Flow Element	Circular Channe
Method	Manning's Form
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.010	
Slope	050000	ft/ft
Diameter	12	in
Discharge	1.00	cfs

Results		
Depth	0.21	ft
Flow Area	0.1	ft²
Wetted Perime	0.95	ft
Top Width	0.81	ft
Critical Depth	0.42	ft
Percent Full	21.0	%
Critical Slope	0.003437	ft/ft
Velocity	8.35	ft/s
Velocity Head	1.08	ft
Specific Energ	1.29	ft
Froude Numbe	3.84	
Maximum Disc	11.14	cfs
Discharge Full	10.36	cfs
Slope Full	0.000466	ft/ft
Flow Type	Supercritical	