The Villas at Obsidian
Phase 3
Mammoth Lakes, California

Drainage Analysis and
Storm Water Quality Management Plan

Project 01.0240.11

February 2021

Prepared for:
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Thomas A. Platz, P.E. C41039		February 2, 2021 Date

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Appendix

- The Town of Mammoth Lakes 2005 Storm Drain Master Plan Update, 2005
- Design Manual, Mammoth Lakes Storm Drainage and Erosion Control, Prepared for Mono County Public Works Department, July 1984, Brown and Caldwell and Triad Engineering
- Water Quality Control Plan for the Lahontan Region, North and South Basins, prepared by the State of California, Regional Water Quality Control Board, Lahontan Region.

1. Project

The total project encompasses approximately 4.1 acres and is located on the north side of Meridian Blvd between Minaret Road and Joaquin Street, in Mammoth Lakes, California. For the project vicinity see Figures 1 below:

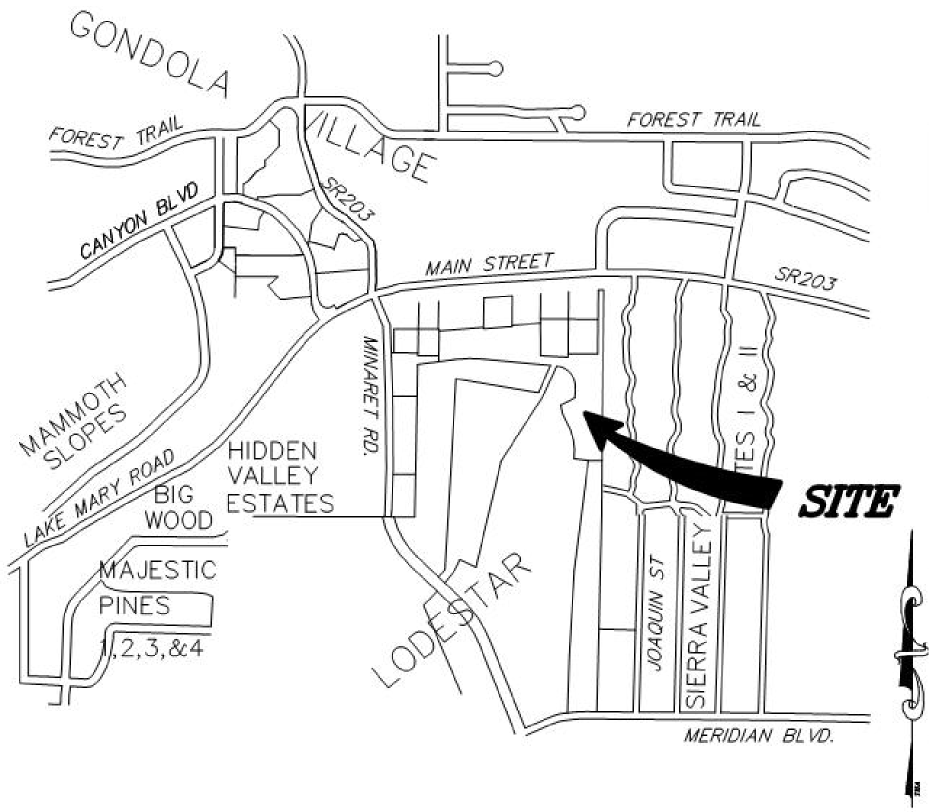


Figure 1 – Site Location

Existing site is mostly undeveloped with a paved bike path located along the eastern property line. The site is bounded by the Sierra Star Golf Course to the west, San Juaquin Villas to the north, Sierra Valley sites to the east, and Obsidian development to the south.

Two drainage courses traverse the site from west to east. The northern drainage picks up the storm water runoff from the northern half of the property where the site slopes vary from 7% to 11%. The southern drainage channel collects the runoff from the southern half of the site with slopes of about 2%- 4.5%. This channel enters 2-24" culverts under the existing bike path, as shown in Exhibit A, Appendix A. Both of the drainage channels conveying offsite drainage are identified in the Town of Mammoth Lakes Storm Drain Master Plan[1] and their flows will be allowed to pass through the project without being impeded or detained.

Vegetation consists of scattered pine trees and various species of small scrub and sage brush throughout the site. Soil types on this project are typically made up of silty sands.

The development proposes to subdivide the entire 4.1 acres for the purpose of constructing 34 townhomes dwellings (18 buildings), as shown in Exhibit B, Appendix A. A 24-foot-wide paved road and typical underground utility infrastructure is proposed to serve the residential project. The existing 8-foot-wide paved recreational trail will be realigned as part of the project.

2. Watershed and Hydrologic Conditions

The site is located on the north side (Murphy Gulch side) of a ridge that separates the Murphy Gulch and the Mammoth Creek drainage systems. Drainage from the site enters a 42-inch diameter Town of Mammoth Lakes Storm Sewer System (TMLSSS) which connects to a 48-inch diameter TMLSSS and continues along Joaquin Street to Dorrance Street and exits into a natural channel. This natural channel is a water of the state. The natural channel re-enters a 72-inch diameter TMLSSS, which is connected to the 66-inch diameter TMLSSS located in Highway 203. This TMLSSS outlets to Murphy Gulch. Murphy Gulch is tributary to Mammoth Creek downstream of a culvert crossing under Highway 203. Mammoth Creek is listed for sediment in the State Water Resources Control Board 303 (d) list.

The Watershed Drainage Areas and Facilities Map in the Storm Drain Master Plan[1], shows that the project is located in the Watershed Tributary Subareas 3.6.4 and 3.6.5 (refer to attachment included in Appendix D). The Master Plan[1] has estimated the 100-year storm flows for the northern and southern drainage channels entering the site from the west to be 46 cfs and 92 cfs, respectively. The 20-year flows are 24 cfs and 50 cfs, respectively for northern and southern channel. Also, per the Master Plan[1], the entire project has a "B" soil type (refer to attachment included in Appendix D).

3. Objectives

The objective of this study is to provide hydrologic analysis of the site runoff for pre- and post-development conditions and design facilities necessary to convey the onsite and offsite flows through the project site. This study also provides a stormwater quality plan to improve stormwater quality from the impervious surfaces and attenuate stormwater flow increases due to the development.

4. Assumptions

The hydrology calculations for this drainage report are based on the Design Manual[2], written to excel spreadsheets, and included in Appendix B. Hydrologic flow rates from offsite areas are based on the Storm Drain Master Plan[1].

Hydraulic Calculations are included in Appendix B and are generally based on Manning's, Darcy-Weisbech, and Bernoulli's equations. Hydroflow Express and Hydroflow Storm Sewer Extension for AutoCAD programs were used for the calculations.

Retention systems have been designed to contain 1 hour of a 20-year intensity storm, which is assumed to be 1 inch (0.83 feet) * Area (square feet) * C (infiltration coefficient). Because the infiltration facilities are designed for first inch of runoff, the conveyance systems are designed to contain the maximum peak flows without reduction for detention. There will be some reduction in peak flow due to these retention systems, so the conveyance systems are conservatively sized. Retention system calculations are included in Appendix C.

5. Offsite Drainage Facilities

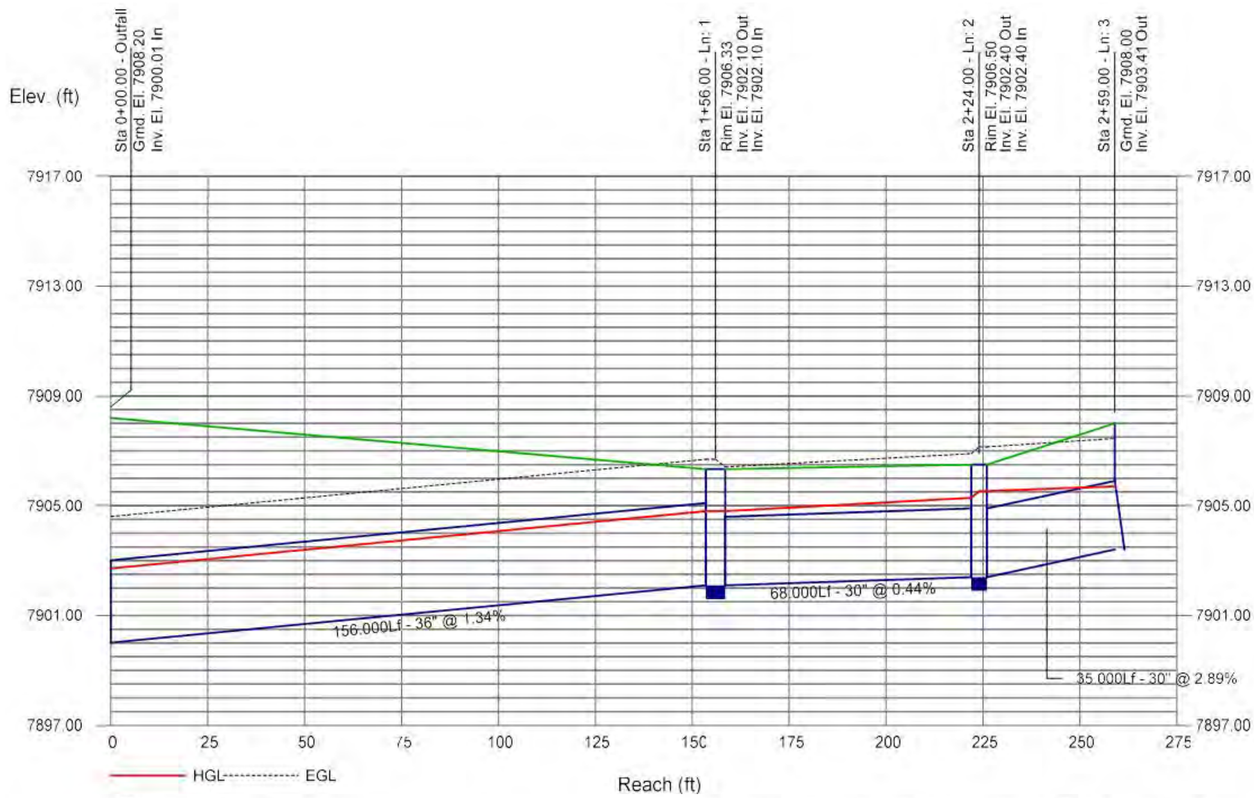
Drainage facilities to convey offsite runoff through the project are sized based on Master Plan[1] flowrates shown on plates 8.13 and 8.14, Tributary Subareas 3.6.4 and 3.6.5, referenced in Appendix D. Hydraulic Calculations for the offsite drainage facilities are shown in Appendix B. Per the discussions with the Town of Mammoth Lakes, 20-year intensity offsite flows are required to be safely carried through the site.

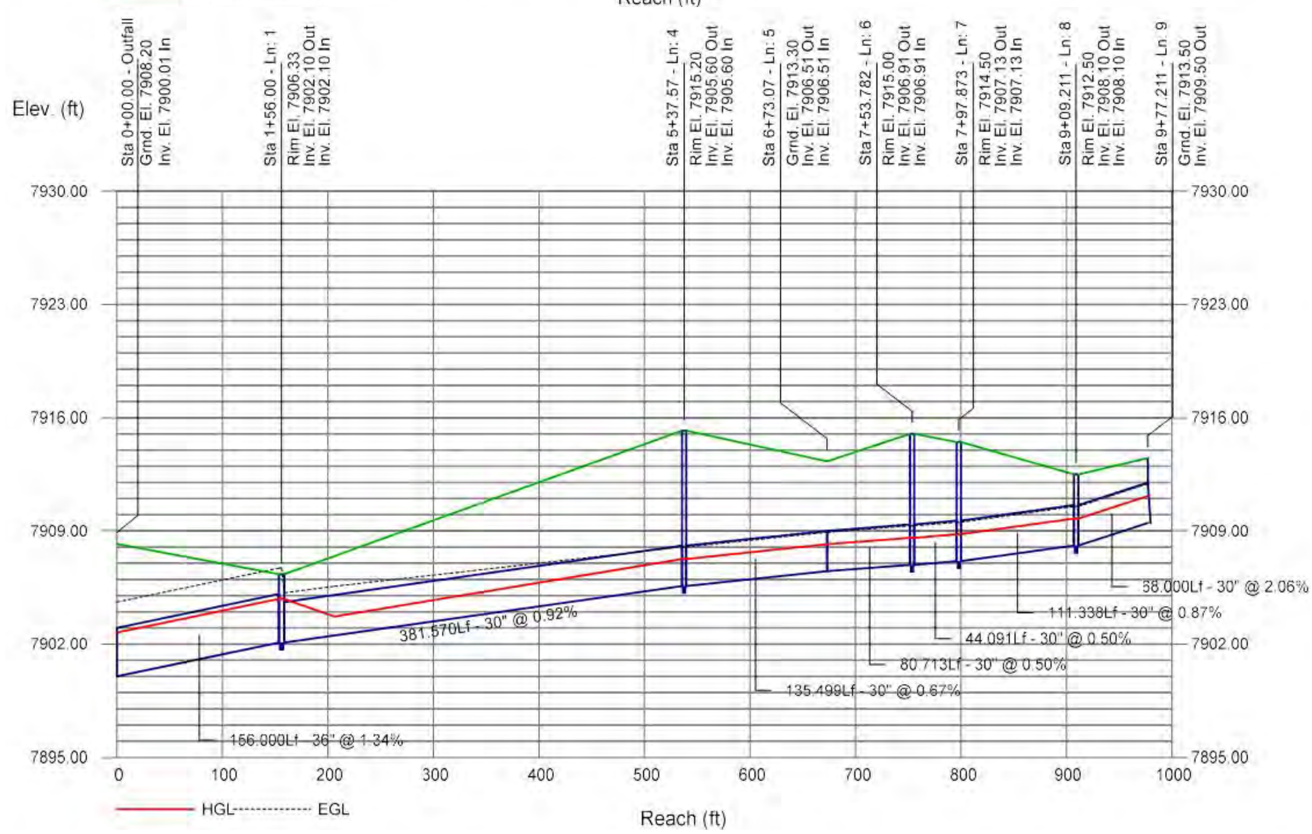
The flow in the northern drainage channel is proposed to be conveyed through the site via a 30" storm drain pipe. The Master Plan[1] Plate 8.13 indicates that this drainage course has a 20-year intensity design flow of 24 cfs. Concrete headwall will be designed at the site entry point.

Similarly, the southern drainage course will be conveyed in a 30" storm drain pipe with a concrete headwall. The 20-year intensity flow in the southern channel is 50 cfs, based on Plate 8.14.

Both 30" storm drain pipes will connect to a new 36" pipe in Callahan Way in the southeastern portion of the site and continue south to the existing 42" storm drain in Dorrance Street. Refer to Exhibit B in Appendix A for the proposed improvements.

This new storm drain system is sized using the Hydroflow Storm Sewer Extension for AutoCAD. The pipes are sized to convey the required 20-year flows and as seen in the profile below, the flow is contained within the pipes.


Elev. (ft)
Sta 0+00.00 - Outfall
Grnd. El. 7908.20
Inv. El. 7900.01 In
Sta 1+56.00 - Ln: 1
Rim El. 7906.33
Inv. El. 7902.10 Out
Inv. El. 7902.10 In
Sta 2+24.00 - Ln: 2
Rim El. 7906.50
Inv. El. 7902.40 Out
Inv. El. 7902.40 In
Sta 2+59.00 - Ln: 3
Grnd. El. 7908.00
Inv. El. 7903.41 Out
156.000Lf - 36" @ 1.34%
68.000Lf - 30" @ 0.44%
35.000Lf - 30" @ 2.89%
HGL
EGL
Reach (ft)


Elev. (ft)
Sta 0+00.00 - Outfall
Grnd. El. 7908.20
Inv. El. 7900.01 In
Sta 1+56.00 - Ln: 1
Rim El. 7906.33
Inv. El. 7902.10 Out
Inv. El. 7902.10 In
Sta 5+37.57 - Ln: 4
Rim El. 7915.20
Inv. El. 7905.60 Out
Inv. El. 7905.60 In
Sta 6+73.07 - Ln: 5
Grnd. El. 7913.30
Inv. El. 7906.51 Out
Inv. El. 7906.51 In
Sta 7+53.782 - Ln: 6
Rim El. 7915.00
Inv. El. 7906.91 Out
Inv. El. 7906.91 In
Sta 7+97.873 - Ln: 7
Rim El. 7914.50
Inv. El. 7907.13 Out
Inv. El. 7907.13 In
Sta 9+09.211 - Ln: 8
Rim El. 7912.50
Inv. El. 7908.10 Out
Inv. El. 7908.10 In
Sta 9+77.211 - Ln: 9
Grnd. El. 7913.50
Inv. El. 7909.50 Out
381.570Lf - 30" @ 0.92%
58.000Lf - 30" @ 2.06%
111.338Lf - 30" @ 0.87%
44.091Lf - 30" @ 0.50%
80.713Lf - 30" @ 0.50%
135.499Lf - 30" @ 0.67%
156.000Lf - 36" @ 1.34%
HGL
EGL
Reach (ft)

The new system ties into the existing Town of Mammoth Lakes 42"/48" storm drain line in Joaquin and Dorrance. Based on the previous drainage analysis for original Obsidian Subdivision (formerly Tallus Subdivision), Joaquin/Dorrance SD was designed using the Town standards to convey a 20-year storm event and cannot convey the 100-year storm runoff. In the event of a significant storm, the SD will overflow and continue as surface flow similar to present conditions. Safe overflow passage will be provided on site.

6. Onsite Drainage Facilities

Onsite storm drain facilities will be sized for the 20-year storm event. Detailed drainage plan and facility sizing will be provided during the construction document preparation. The following Table 1 compares the existing and proposed runoff rates calculated for the site. Refer to Appendix B for detailed calculations.

Table 1 – Existing and Proposed Runoff Rates

Area	Q20 (cfs)		Q100 (cfs)	
	Existing	Proposed	Existing	Proposed
Site	0.94	1.23	4.64	7.73

As expected, the increase in impervious area due to the proposed improvements increases the runoff rates. The increase in flow will be retained on-site as described in Section 7 below.

On-site drainage improvements will include inlets at low points, storm drain pipes, and swales as necessary that will be directed to on-site retention systems. An 8" pipe has enough capacity to convey 20-year flow of 1.23 cfs at 1% grade.

7. Stormwater Quality Management Plan

7.1 Stormwater Management Requirements

The Town of Mammoth Lakes adopted the requirement for stormwater retention on projects with a site coverage exceeding 4,000 sf with the 1987 Storm drain Design Manual. The TOML requirement is retention of a 20-year 1-hour storm event or 1 inch of precipitation. In addition, the 2007 General Plan established the policy R5.b requirement parking lot drainage systems include facilities to separate oil and silt from storm water. The 1-inch runoff volumes collected by the retention facilities are shown in the Table 2 below. This eliminates runoff from leaving the project site during a 20-year storm event.

Table 2 – Town of Mammoth Lakes Retention Volume

	Retention Volume Required
Site	8,802 cf

All parking and driveway inlets will be installed with oil removal inserts or a separate oil treatment unit will be installed between the inlets and the retention basin.

The time of concentration due to the developed conditions is very short and, thus all of the storm water will be retained onsite from a site-specific peak storm event since the retention system as designed will retain the 20-year 1-inch event volume.

7.2 Stormwater Quality During Construction

The State Water Quality Control Board has established the implementation of a construction Storm Water Pollution Prevention Plan (SWPPP). For projects with one acre or more od disturbance. The SWPPP provides Best Management Practices (BMPs) for erosion, sediment, dust, and site housekeeping during construction.

To retain and infiltrate the increase in on-site runoff into the ground, several retention basin systems have been preliminary proposed, in conformance with the Water Quality Control Plan for the Lahontan Region 3, to contain a 20-year intensity storm for 1 hour, which is assumed to be 1 inch (0.83 feet) * Area (square feet) * C (infiltration coefficient). Refer to Section 7.3 below for the retention facilities sizing.

7.3 Retention Facilities

Preliminary, two retention systems are proposed for the site, as shown in Exhibit B, Appendix A. Approximately half of the site will drain to the retention system at the northern end of Callahan Way and the other half of the site will be contained in the system at the southern end of Callahan Way.

Both systems will include 2-42" perforated pipes wrapped in gravel. The minimum length of each system will be 143 feet. Overflow from these retention systems will be directed via surface flow south to Dorrance Street.

Facilities to separate oil and silt from storm water will be installed prior to stormwater entering the retention facilities.

It should be noted that these basins present a preliminary drainage solution and final design of the retention facilities will be based on input from the Town of Mammoth Lakes.

8. Erosion Protection

Grading shall be limited to the extent possible. Graded areas shall be protected against erosion once they are brought to final grade. No graded areas are to be left unstabilized between April 15th and October 15th. This project lies within the boundaries of the Lahontan Regional Water Quality Control Board and shall conform to the requirements of the SWPPP, the National Pollutant Discharge Elimination System (NPDES) Permit for General Construction Activities.

9. Conclusion

This drainage analysis provides the hydrologic calculations and the preliminary storm drain design for the proposed project. All of the requirements for conveyance, retention, and water quality management have been addressed. Offsite drainage facilities as selected by this drainage study have adequate capacity to convey stormwater through the site based on the 100-year flows estimated in the Storm Drain Master Plan[1].

Both the on-site and off-site storm drainage facilities and water quality management facilities must be maintained to continue to work as designed. Particular items requiring maintenance include, but are not limited to, cleaning of the grates, removal of foreign materials from storm drainage pipes, maintenance as necessary to outlet facilities, and repairs as necessary to damaged facilities. Special attention should be paid to any storm drain pipe with the slope of less than 0.5%. This storm drain will require more frequent maintenance due to its low incline. Additionally, snow removal must be performed in a way so as not to restrict drainage collection in gutters, inlets, and flow paths.

Construction shall comply with an approved SWPPP such that offsite runoff will not interact with construction activities or permanent facilities onsite.

The retention system selected will include underground pipe systems with the capacity to contain the first inch of runoff as required by the Basin Plan[3].

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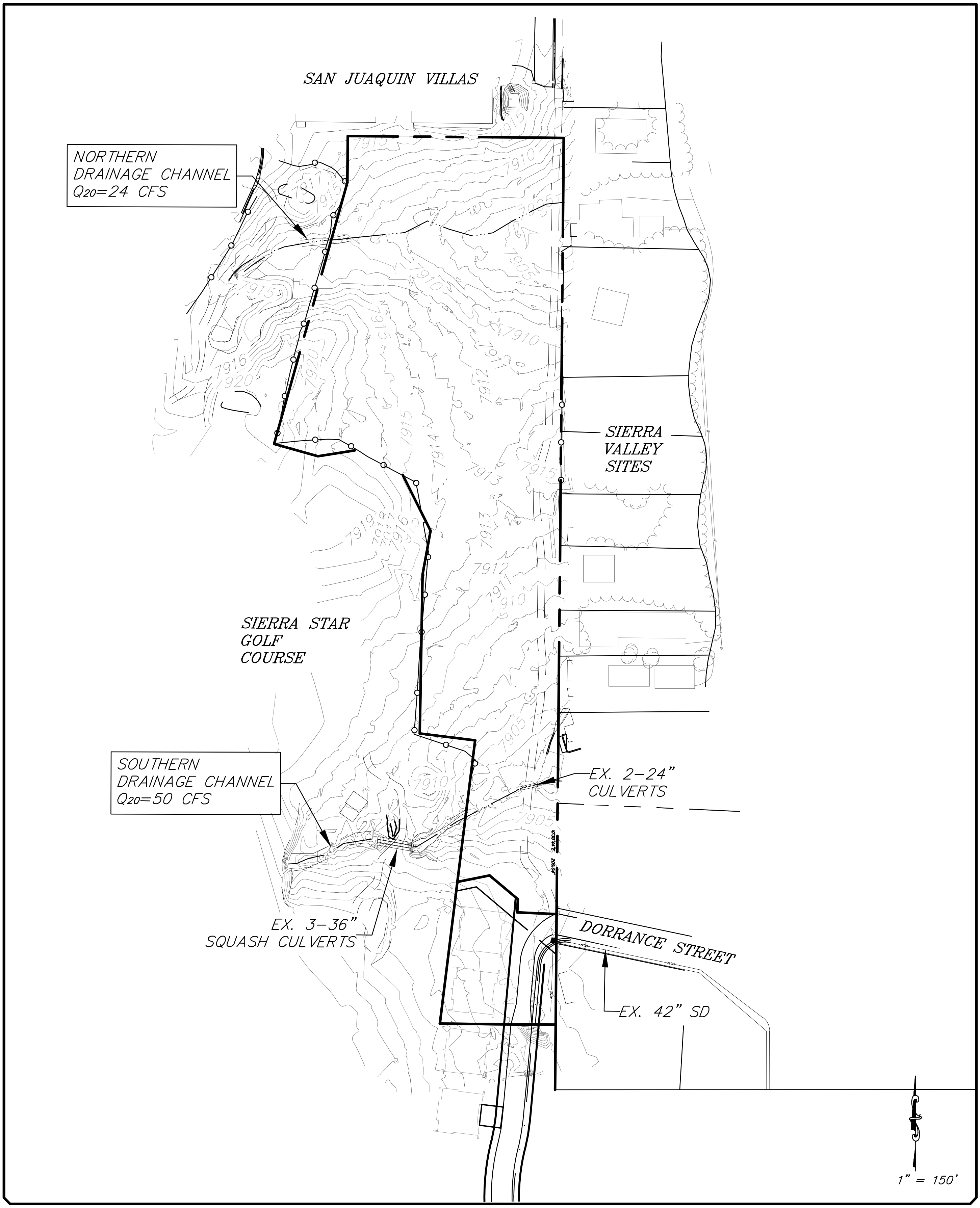
[1]Mammoth Lakes Storm Drainage Master Plan, Prepared for Mono County Public Works Department, July 1984, Brown and Caldwell and Triad Engineering

[2]Design Manual, Mammoth Lakes Storm Drainage and Erosion Control, Prepared for Mono County Public Works Department, July 1984, Brown and Caldwell and Triad Engineering

[3]Water Quality Control Plan for the Lahontan Region, North and South Basins, prepared by the State of California, Regional Water Quality Control Board, Lahontan Region

APPENDIX A – Figures

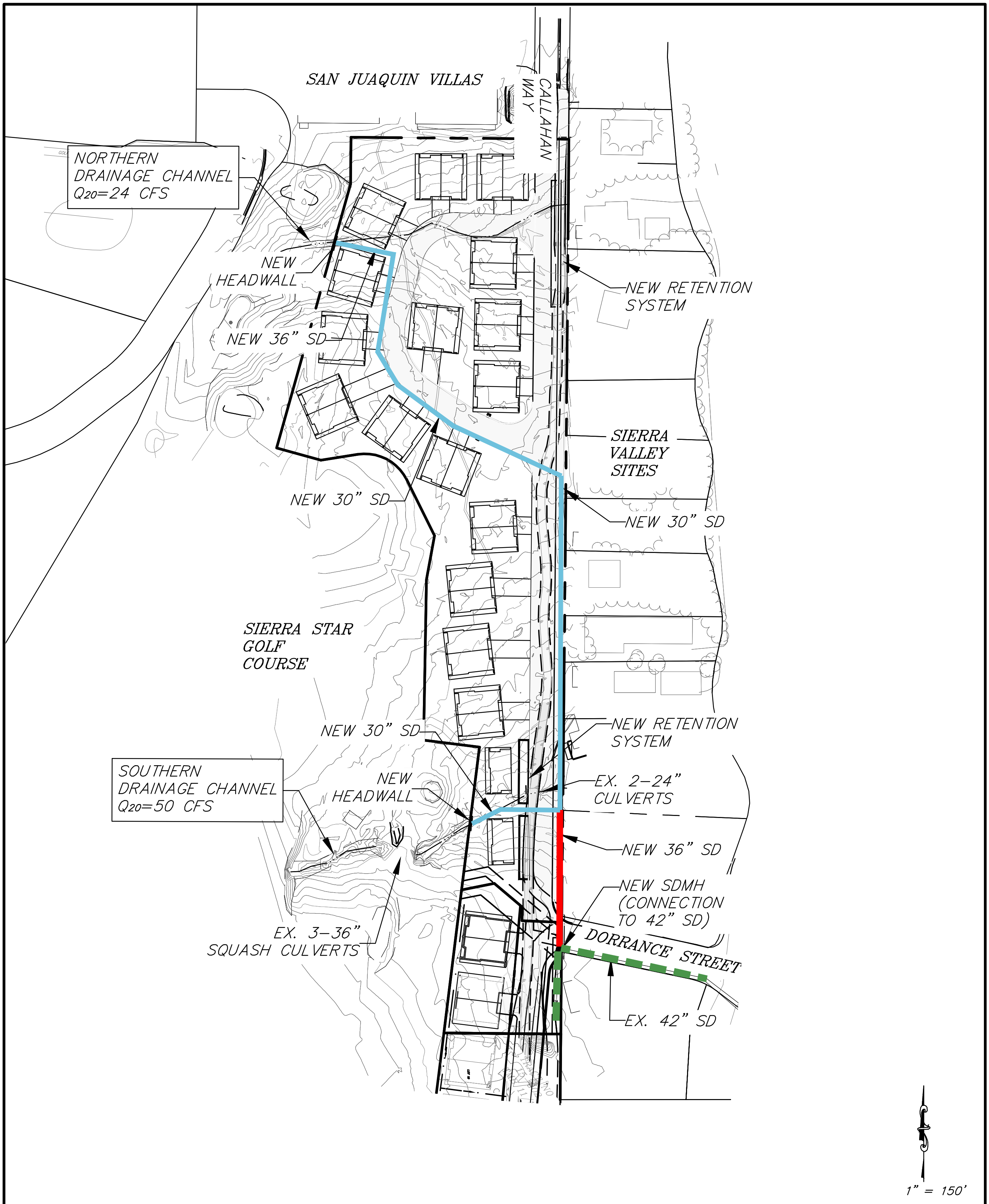


DATE:
01/29/2021

VILLAS AT OBSIDIAN – PHASE 3

EXHIBIT A – EXISTING CONDITIONS

triad/holmes assoc
civil engineering
land surveying



DATE: 01/29/2021

VILLAS AT OBSIDIAN – PHASE 3

EXHIBIT B – PROPOSED CONDITIONS

triad/holmes assoc
civil engineering
land surveying

APPENDIX B – Hydrologic/Hydraulic Calculations

Town of Mammoth Lakes, 2005 Storm Drain Design Manual, Procedure A

Peak Intensity Storm			**Existing**					**Proposed**				
Area	**Design Storm (years)**	**Acres**	**% Natural**	**% HD Residential**	**% Commercial**	**Inensity (cfs/acre)**	**Design Q (cfs)**	**% Natural**	**% HD Residential**	**% Commercial**	**Inensity (cfs/acre)**	**Design Q (cfs)**
Site	Q20	4.07	100%	0%	0%	0.23	**0.94**	0%	100%	0%	1.14	**4.64**
	Q100					0.43	**1.75**				1.90	**7.73**

Land Use Type		**20-Year**	**100-Year**
Commercial	C	1.22	1.93
High Density Residence	H	1.14	1.90
Natural	N	0.23	0.43
Single Family Residence	S	0.65	1.30

Area	**Q20 (cfs)**		**Q100 (cfs)**	
	Existing	Proposed	Existing	Proposed
Site	0.94	4.64	1.75	7.73

Structure Report

Struct No.	Structure ID	Junction Type	Rim Elev (ft)	Structure			Line Out			Line In		
				Shape	Length (ft)	Width (ft)	Size (in)	Shape	Invert (ft)	Size (in)	Shape	Invert (ft)
1		Manhole	7906.33	Cir	5.00	5.00	36	Cir	7902.10	30 30	Cir Cir	7902.10 7902.10
2		Manhole	7906.50	Cir	4.00	4.00	30	Cir	7902.40	30	Cir	7902.40
3		OpenHeadwall	7908.00	n/a	n/a	n/a	30	Cir	7903.41			
4	New	Manhole	7915.20	Cir	4.00	4.00	30	Cir	7905.60	30	Cir	7905.60
5	New	None	7913.30	n/a	n/a	n/a	30	Cir	7906.51	30	Cir	7906.51
6	New	Manhole	7915.00	Cir	4.00	4.00	30	Cir	7906.91	30	Cir	7906.91
7	New	Manhole	7914.50	Cir	4.00	4.00	30	Cir	7907.13	30	Cir	7907.13
8	New	Manhole	7912.50	Cir	4.00	4.00	30	Cir	7908.10	30	Cir	7908.10
9		OpenHeadwall	7913.50	n/a	n/a	n/a	30	Cir	7909.50			

Project File: Villas SD.stm	Number of Structures: 9	Run Date: 2/2/2021

Storm Sewer Tabulation

Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line		Incr	Total		Incr	Total	Inlet	Syst					Size	Slope	Dn	Up	Dn	Up	Dn	Up	
		(ft)	(ac)	(ac)	(C)			(min)	(min)	(in/hr)	(cfs)	(cfs)	(ft/s)	(in)	(%)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	
1	End	156.000	0.01	0.09	0.10	0.00	0.01	0.0	2.8	0.0	74.00	111.5	11.03	36	1.34	7900.01	7902.10	7902.72	7904.81	7908.20	7906.33	36
2	1	68.000	0.01	0.02	0.10	0.00	0.00	0.0	0.1	0.0	50.00	39.33	10.19	30	0.44	7902.10	7902.40	7904.81	7905.29	7906.33	7906.50	30 South
3	2	35.000	0.01	0.01	0.10	0.00	0.00	0.0	0.0	0.0	50.00	100.6	10.39	30	2.89	7902.40	7903.41	7905.53	7905.71	7906.50	7908.00	30 South
4	1	381.570	0.01	0.06	0.10	0.00	0.01	0.0	1.5	0.0	24.00	56.74	5.90	30	0.92	7902.10	7905.60	7904.81	7907.27	7906.33	7915.20	36
5	4	135.499	0.01	0.05	0.10	0.00	0.01	0.0	1.0	0.0	24.00	48.54	6.90	30	0.67	7905.60	7906.51	7907.27	7908.18	7915.20	7913.30	30 North
6	5	80.713	0.01	0.04	0.10	0.00	0.00	0.0	0.8	0.0	24.00	41.72	6.90	30	0.50	7906.51	7906.91	7908.18	7908.58	7913.30	7915.00	30 North
7	6	44.091	0.01	0.03	0.10	0.00	0.00	0.0	0.6	0.0	24.00	41.82	6.90	30	0.50	7906.91	7907.13	7908.58	7908.80	7915.00	7914.50	30 North
8	7	111.338	0.01	0.02	0.10	0.00	0.00	0.0	0.2	0.0	24.00	55.30	6.90	30	0.87	7907.13	7908.10	7908.80	7909.77	7914.50	7912.50	30 North
9	8	68.000	0.01	0.01	0.10	0.00	0.00	0.0	0.0	0.0	24.00	85.00	6.90	30	2.06	7908.10	7909.50	7909.77	7911.17	7912.50	7913.50	30 North

Project File: Villas SD.stm | Number of lines: 9 | Run Date: 2/2/2021

NOTES:Known Qs only ; c = cir e = ellip b = box

Inlet Report

Line No	Inlet ID	Q = CIA (cfs)	Q carry (cfs)	Q capt (cfs)	Q Byp (cfs)	Junc Type	Curb Inlet		Grate Inlet			Gutter							Inlet			Byp Line No
							Ht (in)	L (ft)	Area (sqft)	L (ft)	W (ft)	So (ft/ft)	W (ft)	Sw (ft/ft)	Sx (ft/ft)	n	Depth (ft)	Spread (ft)	Depth (ft)	Spread (ft)	Depr (in)	
1		0.00	0.00	0.00	0.00	MH	0.0	0.00	0.00	0.00	0.00	Sag	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	Off
2		0.00	0.00	0.00	0.00	MH	0.0	0.00	0.00	0.00	0.00	Sag	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	Off
3		50.00*	0.00	50.00	0.00	Hdwl	0.0	0.00	0.00	0.00	0.00	Sag	0.00	0.000	0.000	0.013	0.00	0.00	0.00	0.00	0.0	Off
4	New	0.00	0.00	0.00	0.00	MH	0.0	0.00	0.00	0.00	0.00	Sag	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	Off
5	New	0.00	0.00	0.00	0.00	None	0.0	0.00	0.00	0.00	0.00	Sag	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	Off
6	New	0.00	0.00	0.00	0.00	MH	0.0	0.00	0.00	0.00	0.00	Sag	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	Off
7	New	0.00	0.00	0.00	0.00	MH	0.0	0.00	0.00	0.00	0.00	Sag	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	Off
8	New	0.00	0.00	0.00	0.00	MH	0.0	0.00	0.00	0.00	0.00	Sag	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	Off
9		24.00*	0.00	24.00	0.00	Hdwl	0.0	0.00	0.00	0.00	0.00	Sag	0.00	0.000	0.000	0.013	0.00	0.00	0.00	0.00	0.0	Off

Project File: Villas SD.stm	Number of lines: 9	Run Date: 2/2/2021

NOTES: Inlet N-Values = 0.016; Known Qs only; * Indicates Known Q added. All curb inlets are Horiz throat.

FL-DOT Report

Line No	To Line	Type of struc	n - Value	Len (ft)	Drainage Area C1 = 0.2, C2 = 0.5, C3 = 0.9 Incre-ment (ac)	Sub-Total (ac)	Sum CA	Time of conc (min)	Time of Flow in sect (min)	Inten (I) (in/hr)	Total CA	Add Q / Total Flow Q (cfs)	Inlet elev (ft)	Elev of HGL / Elev of Crown / Elev of Invert Up (ft)	Down (ft)	Fall (ft)	Rise / Span Size (in)	HGL / Pipe Slope (%)	ADD / Full Flow Vel (ft/s)	Cap (cfs)	Date: 2/2/2021 / Frequency: (n/a) / Proj: Villas SD.stm Line description
1	End	MH	0.009	156.000	0.00	0.00	0.00	2.80	0.25	0.00	0.01	0.00	7906.33	7904.81	7902.72	2.09	36	1.34	11.03	74.00	36
					0.00	0.00	0.00					74.00		7905.10	7903.01		36	1.34	15.78	111.5	
					0.00	0.00	0.00							7902.10	7900.01	2.09	Cir				
2	1	MH	0.009	68.000	0.00	0.00	0.00	0.06	0.11	0.00	0.00	0.00	7906.50	7905.29	7904.81	0.48	30	0.71	10.19	50.00	30 South
					0.00	0.00	0.00					50.00		7904.90	7904.60		30	0.44	8.01	39.33	
					0.00	0.00	0.00							7902.40	7902.10	0.30	Cir				
3	2	Hdwl	0.009	35.000	0.00	0.00	0.00	0.00	0.06	0.00	0.00	50.00	7908.00	7905.71	7905.53	0.18	30	0.50	10.39	50.00	30 South
					0.00	0.00	0.00					50.00		7905.91	7904.90		30	2.89	20.50	100.6	
					0.00	0.00	0.00							7903.41	7902.40	1.01	Cir				
4	1	MH	0.009	381.570	0.00	0.00	0.00	1.50	1.30	0.00	0.01	0.00	7915.20	7907.27	7904.81	2.46	30	0.64	5.90	24.00	36
					0.00	0.00	0.00					24.00		7908.10	7904.60		30	0.92	11.56	56.74	
					0.00	0.00	0.00							7905.60	7902.10	3.50	Cir				
5	4	None	0.009	135.499	0.00	0.00	0.00	1.04	0.46	0.00	0.01	0.00	7913.30	7908.18	7907.27	0.91	30	0.67	6.90	24.00	30 North
					0.00	0.00	0.00					24.00		7909.01	7908.10		30	0.67	9.89	48.54	
					0.00	0.00	0.00							7906.51	7905.60	0.91	Cir				
6	5	MH	0.009	80.713	0.00	0.00	0.00	0.76	0.28	0.00	0.00	0.00	7915.00	7908.58	7908.18	0.40	30	0.50	6.90	24.00	30 North
					0.00	0.00	0.00					24.00		7909.41	7909.01		30	0.50	8.50	41.72	
					0.00	0.00	0.00							7906.91	7906.51	0.40	Cir				
7	6	MH	0.009	44.091	0.00	0.00	0.00	0.61	0.15	0.00	0.00	0.00	7914.50	7908.80	7908.58	0.22	30	0.50	6.90	24.00	30 North
					0.00	0.00	0.00					24.00		7909.63	7909.41		30	0.50	8.52	41.82	
					0.00	0.00	0.00							7907.13	7906.91	0.22	Cir				
8	7	MH	0.009	111.338	0.00	0.00	0.00	0.23	0.38	0.00	0.00	0.00	7912.50	7909.77	7908.80	0.97	30	0.87	6.90	24.00	30 North
					0.00	0.00	0.00					24.00		7910.60	7909.63		30	0.87	11.27	55.30	
					0.00	0.00	0.00							7908.10	7907.13	0.97	Cir				
9	8	Hdwl	0.009	68.000	0.00	0.00	0.00	0.00	0.23	0.00	0.00	24.00	7913.50	7911.17	7909.77	1.40	30	2.06	6.90	24.00	30 North
					0.00	0.00	0.00					24.00		7912.00	7910.60		30	2.06	17.32	85.00	
					0.00	0.00	0.00							7909.50	7908.10	1.40	Cir				

NOTES: Known Qs only ; Time of flow in section is based on full flow.

Project File: Villas SD.stm

MyReport

Line No.	Area Dn (sqft)	Area Up (sqft)	Byp Ln No	Coeff C1 (C)	Coeff C2 (C)	Coeff C3 (C)	Capac Full (cfs)	Crit Depth (ft)	Cross Sl, Sw (ft/ft)	Cross Sl, Sx (ft/ft)	Curb Len (ft)	Defl Ang (Deg)	Depth Dn (ft)	Depth Up (ft)	DnStm Ln No	Drng Area (ac)	Easting X (ft)	EGL Dn (ft)	EGL Up (ft)	Energy Loss (ft)
1	6.71	6.71	n/a	0.20	0.50	0.90	111.51	2.71	....	....	....	0.000	2.71	2.71**	Outfall	0.01	10729.59	7904.61	7906.70	0.000
2	4.91	4.91	n/a	0.20	0.50	0.90	39.33	2.30	....	....	....	-87.393	2.50	2.50	1	0.01	10732.68	7906.42	7906.90	0.485
3	4.72	4.72	n/a	0.20	0.50	0.90	100.64	2.30	....	....	....	0.000	2.50	2.30**	2	0.01	10734.28	7907.15	7907.45	0.233
4	3.48	3.48	n/a	0.20	0.50	0.90	56.74	1.67	....	....	....	0.039	2.50	1.67**	1	0.01	11111.16	7905.18	7908.01	0.823
5	3.48	3.48	n/a	0.20	0.50	0.90	48.54	1.67	....	....	....	-64.188	1.67	1.67**	4	0.01	11170.24	7908.01	7908.92	0.000
6	3.48	3.48	n/a	0.20	0.50	0.90	41.72	1.67	....	....	....	9.933	1.67	1.67**	5	0.01	11217.44	7908.92	7909.32	0.000
7	3.48	3.48	n/a	0.20	0.50	0.90	41.82	1.67	....	....	....	25.251	1.67	1.67**	6	0.01	11256.02	7909.32	7909.54	0.000
8	3.48	3.48	n/a	0.20	0.50	0.90	55.30	1.67	....	....	....	37.201	1.67	1.67**	7	0.01	11366.21	7909.54	7910.51	0.000
9	3.48	3.48	n/a	0.20	0.50	0.90	85.00	1.67	....	....	....	-87.805	1.67	1.67**	8	0.01	11378.52	7910.51	7911.91	0.000

Project File: Villas SD.stm | Number of lines: 9 | Date: 2/2/2021

NOTES: ** Critical depth

MyReport

Flow Rate (cfs)	Sf Ave (ft/ft)	Sf Dn (ft/ft)	Grate Area (sqft)	Grate Len (ft)	Grate Width (ft)	Gnd/Rim El Dn (ft)	Gnd/Rim El Up (ft)	Gutter Depth (ft)	Gutter Slope (ft/ft)	Gutter Spread (ft)	Gutter Width (ft)	HGL Dn (ft)	HGL Up (ft)	HGL Jnct (ft)	HGL Jmp Dn (ft)	HGL Jmp Up (ft)	Incr CxA	Incr Q (cfs)	Inlet Depth (ft)	Inlet Eff (%)
74.00	0.000	0.000	....	....	....	7908.20	7906.33	....	....	....	....	7902.72	7904.81	7904.81	....	....	0.00	0.00	....	....
50.00	0.713	0.713	....	....	....	7906.33	7906.50	....	....	....	....	7904.81	7905.29	7905.53	....	....	0.00	0.00	....	....
50.00	0.666	0.713	....	....	....	7906.50	7908.00	....	....	....	....	7905.53	7905.71	7905.71	....	....	0.00	50.00	....	100
24.00	0.216	0.164	....	....	....	7906.33	7915.20	....	....	....	....	7904.81	7907.27 j	7907.27	7904.86	7903.70	0.00	0.00	....	....
24.00	0.000	0.000	....	....	....	7915.20	7913.30	....	....	....	....	7907.27	7908.18	7908.18	....	....	0.00	0.00	....	....
24.00	0.000	0.000	....	....	....	7913.30	7915.00	....	....	....	....	7908.18	7908.58	7908.58	....	....	0.00	0.00	....	....
24.00	0.000	0.000	....	....	....	7915.00	7914.50	....	....	....	....	7908.58	7908.80	7908.80	....	....	0.00	0.00	....	....
24.00	0.000	0.000	....	....	....	7914.50	7912.50	....	....	....	....	7908.80	7909.77	7909.77	....	....	0.00	0.00	....	....
24.00	0.000	0.000	....	....	....	7912.50	7913.50	....	....	....	....	7909.77	7911.17	7911.17	....	....	0.00	24.00	....	100

Project File: Villas SD.stm | Number of lines: 9 | Date: 2/2/2021

NOTES: ** Critical depth

MyReport

Inlet ID	Inlet Loc	(ft)	Inlet Time (min)	i Sys (in/hr)	i Inlet (in/hr)	Invert Dn (ft)	Invert Up (ft)	Jump Loc (ft)	Jump Len (ft)	Vel Hd Jmp Dn (ft)	Vel Hd Jmp Up (ft)	J-Loss Coeff	Junct Type	Known Q (cfs)	Cost RCP	Cost CMP	Cost PVC	Line ID	
	Sag		0.0	0.00	0.00	7900.01	7902.10	....	....	0.00	0.00	1.00 z	MH	0.00	8,976	8,078	7,630	36	
	Sag		0.0	0.00	0.00	7902.10	7902.40	....	....	0.00	0.00	0.15	MH	0.00	3,384	3,046	2,876	30 South	
	Sag		0.0	0.00	0.00	7902.40	7903.41	....	....	0.00	0.00	1.00 z	Hdwall	50.00	1,680	1,512	1,428	30 South	
New	Sag		0.0	0.00	0.00	7902.10	7905.60	38.16	12.03	0.38	1.87	0.92 z	MH	0.00	21,412	19,271	18,200	36	
New	Sag		0.0	0.00	0.00	7905.60	7906.51	....	....	0.00	0.00	0.21 z	None	0.00	8,306	7,475	7,060	30 North	
New	Sag		0.0	0.00	0.00	7906.51	7906.91	....	....	0.00	0.00	0.48 z	MH	0.00	4,692	4,223	3,988	30 North	
New	Sag		0.0	0.00	0.00	7906.91	7907.13	....	....	0.00	0.00	0.66 z	MH	0.00	2,634	2,371	2,239	30 North	
New	Sag		0.0	0.00	0.00	7907.13	7908.10	....	....	0.00	0.00	1.00 z	MH	0.00	5,856	5,270	4,978	30 North	
	Sag		0.0	0.00	0.00	7908.10	7909.50	....	....	0.00	0.00	1.00 z	Hdwall	24.00	3,260	2,934	2,771	30 North	

Project File: Villas SD.stm | Number of lines: 9 | Date: 2/2/2021

NOTES: Known Qs only. ; ** Critical depth

MyReport

Line Length (ft)	Line Size (in)	Line Slope (%)	Line Type	Local Depr (in)	n-val Gutter	n-val Pipe	Minor Loss (ft)	Northing Y (ft)	Pipe Travel (min)	Q Byp (cfs)	Q Capt (cfs)	Q Carry (cfs)	Line Rise (in)	Runoff Coeff (C)	Line Span (in)	Area A1 (ac)	Area A2 (ac)	Area A3 (ac)	Tc (min)	Throat Ht (in)	Total Area (ac)	Total CxA
156.000	36	1.34	Cir	....	....	0.009	n/a	11698.11	0.25	....	....	....	36	0.10	36	0.00	0.00	0.00	2.8	....	0.09	0.01
68.000	30	0.44	Cir	....	....	0.009	0.24	11766.04	0.11	....	....	....	30	0.10	30	0.00	0.00	0.00	0.1	....	0.02	0.00
35.000	30	2.89	Cir	....	....	0.009	n/a	11801.00	0.06	0.00	50.00	0.00	30	0.10	30	0.00	0.00	0.00	0.0	....	0.01	0.00
381.570	30	0.92	Cir	....	....	0.009	n/a	11697.84	1.30	....	....	....	30	0.10	30	0.00	0.00	0.00	1.5	....	0.06	0.01
135.499	30	0.67	Cir	....	....	0.009	n/a	11819.78	0.46	....	....	....	30	0.10	30	0.00	0.00	0.00	1.0	....	0.05	0.01
80.713	30	0.50	Cir	....	....	0.009	n/a	11885.26	0.28	....	....	....	30	0.10	30	0.00	0.00	0.00	0.8	....	0.04	0.00
44.091	30	0.50	Cir	....	....	0.009	n/a	11906.61	0.15	....	....	....	30	0.10	30	0.00	0.00	0.00	0.6	....	0.03	0.00
111.338	30	0.87	Cir	....	....	0.009	n/a	11890.66	0.38	....	....	....	30	0.10	30	0.00	0.00	0.00	0.2	....	0.02	0.00
68.000	30	2.06	Cir	....	....	0.009	n/a	11957.54	0.23	0.00	24.00	0.00	30	0.10	30	0.00	0.00	0.00	0.0	....	0.01	0.00

Project File: Villas SD.stm | Number of lines: 9 | Date: 2/2/2021

NOTES: ** Critical depth

MyReport

Total Runoff (cfs)	Vel Ave (ft/s)	Vel Dn (ft/s)	Vel Hd Dn (ft)	Vel Hd Up (ft)	Vel Up (ft/s)	Cover Dn (ft)	Cover Up (ft)	Storage (cft)
0.00	11.03	11.03	1.89	1.89	11.03	5.19	1.23	1046.96
0.00	10.19	10.19	1.61	1.61	10.19	1.73	1.60	333.73
0.00	10.39	10.19	1.61	1.74	10.59	1.60	2.09	170.69
0.00	5.90	4.89	0.37	0.74	6.90	1.73	7.10	1691.37
0.00	6.90	6.90	0.74	0.74	6.90	7.10	4.29	471.14
0.00	6.90	6.90	0.74	0.74	6.90	4.29	5.59	280.64
0.00	6.90	6.90	0.74	0.74	6.90	5.59	4.87	153.30
0.00	6.90	6.90	0.74	0.74	6.90	4.87	1.90	387.13
0.00	6.90	6.90	0.74	0.74	6.90	1.90	1.50	236.44

Project File: Villas SD.stm | Number of lines: 9 | Date: 2/2/2021

NOTES: ** Critical depth

Hydraulic Grade Line Computations

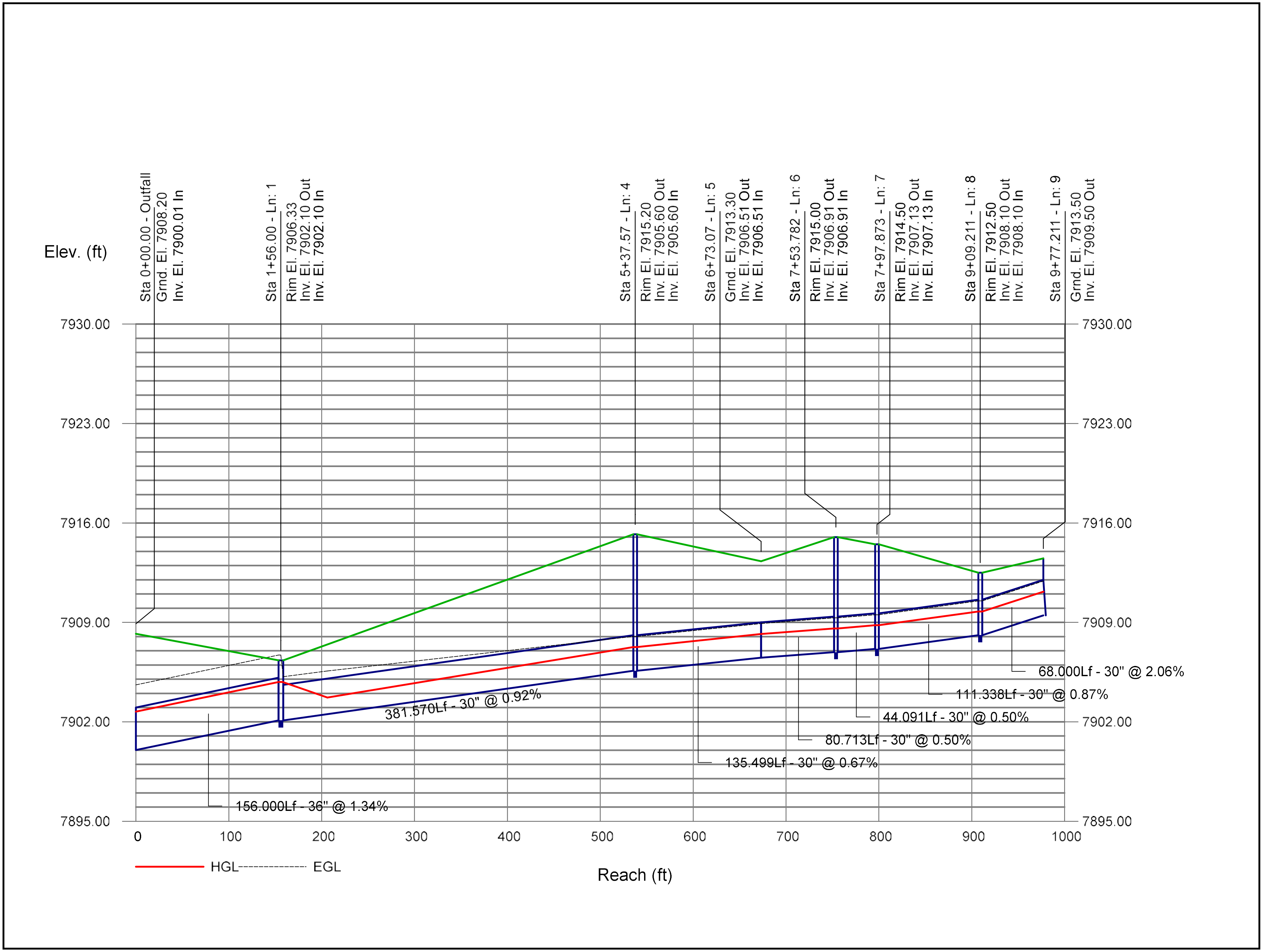
Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
			Invert elev	HGL elev	Depth	Area	Vel	Vel head	EGL elev	Sf		Invert elev	HGL elev	Depth	Area	Vel	Vel head	EGL elev	Sf	Ave Sf	Enrgy loss		
	(in)	(cfs)	(ft)	(ft)	(ft)	(sqft)	(ft/s)	(ft)	(ft)	(%)	(ft)	(ft)	(ft)	(ft)	(sqft)	(ft/s)	(ft)	(ft)	(%)	(%)	(ft)	(K)	(ft)
1	36	74.00	7900.01	7902.72	2.71	6.71	11.03	1.89	7904.61	0.000	156.000	7902.10	7904.81	2.71**	6.71	11.03	1.89	7906.70	0.000	0.000	n/a	1.00	n/a
2	30	50.00	7902.10	7904.81	2.50	4.91	10.19	1.61	7906.42	0.713	68.000	7902.40	7905.29	2.50	4.91	10.19	1.61	7906.90	0.712	0.713	0.485	0.15	0.24
3	30	50.00	7902.40	7905.53	2.50	4.72	10.19	1.61	7907.15	0.713	35.000	7903.41	7905.71	2.30**	4.72	10.59	1.74	7907.45	0.619	0.666	n/a	1.00	n/a
4	30	24.00	7902.10	7904.81	2.50	3.48	4.89	0.37	7905.18	0.164	381.570	7905.60	7907.27 j	1.67**	3.48	6.90	0.74	7908.01	0.267	0.216	n/a	0.92	n/a
5	30	24.00	7905.60	7907.27	1.67*	3.48	6.90	0.74	7908.01	0.000	135.499	7906.51	7908.18	1.67**	3.48	6.90	0.74	7908.92	0.000	0.000	n/a	0.21	n/a
6	30	24.00	7906.51	7908.18	1.67*	3.48	6.90	0.74	7908.92	0.000	80.713	7906.91	7908.58	1.67**	3.48	6.90	0.74	7909.32	0.000	0.000	n/a	0.48	n/a
7	30	24.00	7906.91	7908.58	1.67*	3.48	6.90	0.74	7909.32	0.000	44.091	7907.13	7908.80	1.67**	3.48	6.90	0.74	7909.54	0.000	0.000	n/a	0.66	n/a
8	30	24.00	7907.13	7908.80	1.67*	3.48	6.90	0.74	7909.54	0.000	111.338	7908.10	7909.77	1.67**	3.48	6.90	0.74	7910.51	0.000	0.000	n/a	1.00	n/a
9	30	24.00	7908.10	7909.77	1.67*	3.48	6.90	0.74	7910.51	0.000	68.000	7909.50	7911.17	1.67**	3.48	6.90	0.74	7911.91	0.000	0.000	n/a	1.00	n/a

Project File: Villas SD.stm	Number of lines: 9	Run Date: 2/2/2021

Notes: * Normal depth assumed; ** Critical depth.; j-Line contains hyd. jump ; c = cir e = ellip b = box

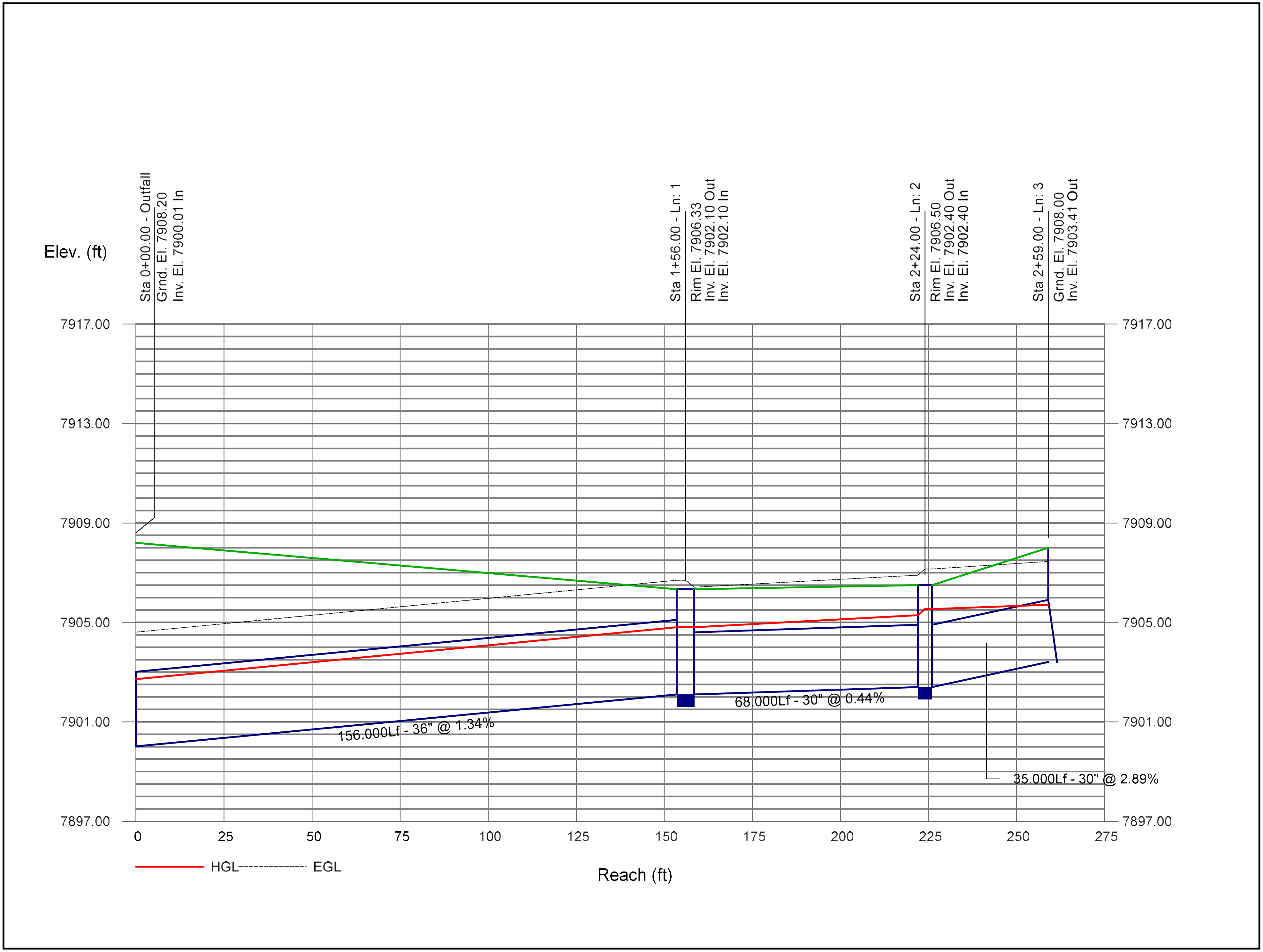
Storm Sewer Profile

Proj. file: Villas SD.stm



Storm Sewer Profile

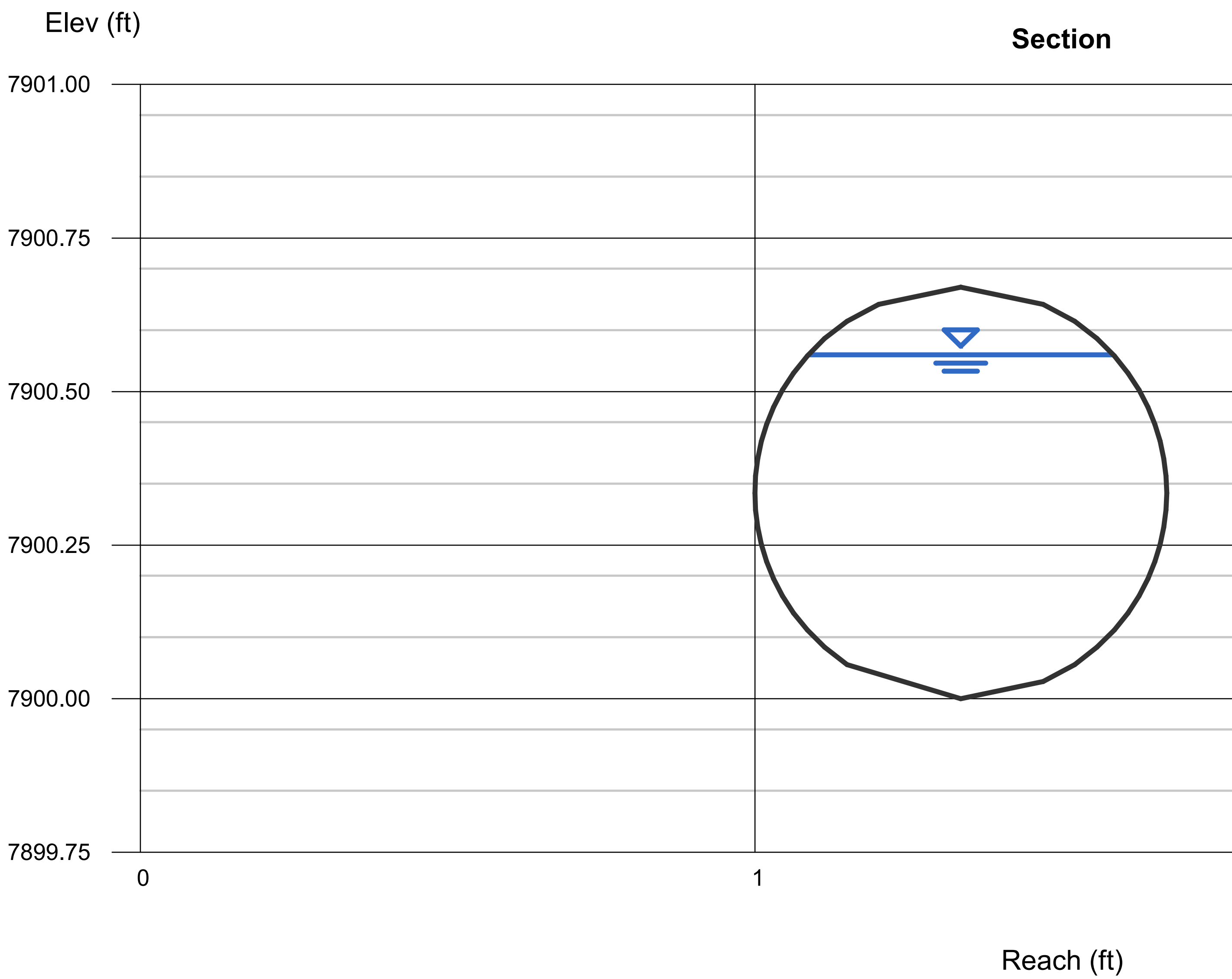
Proj. file: Villas SD.stm



Channel Report

8-inch pipe

Circular		**Highlighted**	
Diameter (ft)	= 0.67	Depth (ft)	= 0.56
		Q (cfs)	= 1.230
		Area (sqft)	= 0.32
Invert Elev (ft)	= 7900.00	Velocity (ft/s)	= 3.90
Slope (%)	= 1.00	Wetted Perim (ft)	= 1.55
N-Value	= 0.013	Crit Depth, Yc (ft)	= 0.53
		Top Width (ft)	= 0.50
Calculations		EGL (ft)	= 0.80
Compute by:	Known Q		
Known Q (cfs)	= 1.23		



APPENDIX C – Retention Calculations

The Villas at Obsidian
Retention Volume

Rainfall Quantity	1 in	=	0.083 ft

Tributary Area and Average Runoff Coefficient

	Onsite		
	Area		C
Roof	39,720 sf	22%	0.95
AC	44,440 sf	25%	0.90
Concrete	0,000 sf	0%	0.95
Natural/Landscaped	92,969 sf	52%	0.30
Total Area	177,129 sf	100%	**0.60**

Volume Required = Tributary Area * Average Runoff Coefficient * Rainfal

Storage Sizing Calculations

	Volume Required
Area A	8,802 cf

Onsite

PIPE DIAMETER		PIPE VOLUME	STONE VOID VOLUME	TOTAL RETENTION STORAGE	PERC VOLUME	RETENTION STORAGE W/ PERC	LENGTH OF TYPICAL CROSS SECTION	BASIN DIMENSIONS		
								TOTAL BASIN LENGTH	CROSS SECTION WIDTH (TOTAL BASIN WIDTH)	DEPTH OF STORAGE (NOT INCLUDING EARTH COVER)
in.	ft.	ft^3/cs-ft	ft^3/cs-ft	ft^3/cs-ft	ft^3/cs-ft	ft^3/cs-ft	ft.	ft^3/cs-ft	ft.	ft.
12	1.00	1.57	1.98	3.55	1.50	5.05	1744	1748	5.00	1.50
15	1.25	2.45	2.39	4.84	1.67	6.51	1352	1356	5.50	1.75
18	1.50	3.53	2.82	6.36	1.83	8.19	1075	1079	6.00	2.00
24	2.00	6.28	3.74	10.02	2.17	12.19	722	727	7.00	2.50
30	2.50	9.82	5.73	15.54	2.75	18.29	481	487	9.00	3.00
36	3.00	14.14	6.95	21.09	3.08	24.17	364	370	10.00	3.50
42	**3.50**	**19.24**	**8.25**	**27.49**	**3.42**	**30.91**	**285**	**291**	**11.00**	**4.00**
48	4.00	25.13	9.62	34.76	3.75	38.51	229	236	12.00	4.50
54	4.50	31.81	11.06	42.87	4.08	46.96	187	195	13.00	5.00
60	5.00	39.27	12.58	51.85	4.42	56.26	156	164	14.00	5.50

INPUT SIZE OF PIPES (ft):	**3.50**
INPUT NUMBER OF ROWS OF PIPES:	**2**
INPUT PERCOLATION RATE (ft/hr):	**0.25**
INPUT REQ'D. STORAGE VOLUME (cf):	**8802**

APPENDIX D – References

B. Procedure A Development

Two types of rare event precipitation-runoff conditions pertain to the meteorological characteristics of the Town and need to be considered jointly. They are subject to two physically distinct events: a rainfall-only condition and the rainfall-on-snow condition, referred to as the summer and winter conditions, respectively. The idea that one should consider each condition separately and then choose the most extreme result is a sound one and will be adopted in this study as well.

The methodology used to determine peak flows is based on the Rational Formula

$$Q = CiA$$

Where:

Q	=	the discharge measured in cfs
C	=	the runoff coefficient, having no physical dimensions
i	=	the rainfall intensity measured in inches per hour
A	=	the area of the watershed basin measured in acres

The above formula is simply a version of the "continuity equation" in the study of hydraulics. Any consistent set of units may be chosen, however the customary units for Q, i, and A are cubic feet per second (cfs), inches per hour (in/hr), and acres (ac) respectively. For this particular choice of units, the product CiA is to be multiplied by a small correction factor of 1.008, which is often neglected in view of the probabilistic nature of hydrologic calculations mentioned above.

It was observed from the 1984 study that flows within the local storm drains experience little attenuation. In other words, individual hydrographs from individual storm drains have nearly coincidental (in time) peaks when a flow confluence occurs. This finding from the 1984 study helps to provide a simple way to determine peak discharge values. Additionally, the assumption of no attenuation is a conservative one.

While it is true that any point on a stream has a watershed area associated with it, one should not compare watersheds having widely ranging area values. Former procedures specified in the 1984 study allow for areas within the town to have an area anywhere between 0 and 1,600 acres, which is too much of a variation. Problems with comparing a 10 acre subarea with a 1000 acre subarea are obvious in that calculated times of concentrations (t_c) would be vastly different. Hence for this updated study a standard of 40-80 acres is taken as the range of watershed size used to apply cfs/acre peak values[3]. In practice, developers within subareas (if more than one subarea is involved a weighted average should be taken) of this order of magnitude can design systems for their projects using the cfs/acre values that are called out in this study (see **Table 3-1A**).

Another fact that applies to storm drains in the Town is that peak flows within the local storm drain system occur at a time much earlier than offsite flows in major streams. Hence, storm drain design in the Town is mainly independent of offsite drainage and drainage methodology (with the exception of conveyance structures that route large offsite watersheds). For those properties that are affected by large offste watersheds, a reduction factor may be applied, as shown in **Table 3-1B**.

In order to develop a "cfs/acre" approach in lieu of a detailed hydrograph for storm drain flows, a lower bound for cfs/acre value within the Mammoth Basin was first established for comparative purposes. By the term "lower bound", we mean that the estimates made by the following analysis are expected to be less than cfs/acre values that actually apply within the Town for the purpose of pipe design. Such an estimate has some value, since it acts as a safeguard against the use of values that would result in the design of conveyance systems that are inadequate for a given return period.

From the Federal Emergency Management Agency (FEMA) Flood Insurance study [6], it was estimated that the 100-year[4] discharge rate for Mammoth Creek was 640 cubic feet per second (cfs) for a tributary watershed area of 13.12 square miles (8,397 acres) at a stream location taken 650 feet downstream of Old Mammoth Road. Hence for this

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[3] This standard is used in several communities within the State of California, including Los Angeles [5] and Ventura Counties.

[4] A 10-year storm is defined as a storm event that is equaled or exceeded every 10 years on average. Another way to define a 10-year storm is to say that the probability of an event of having a 10-year magnitude or more has a 1/10 chance in a given year. Likewise, a 100-year storm is defined as a storm that is equaled or exceeded every 100 years on average. The 100-year storm can alternatively be defined by saying that the probability of an event of having a 100-year magnitude or more has a 1/100 chance in a given year [7].

watershed, a cfs/acre ratio is equal to 640/8397 ≈ 0.076 cfs/acre for 100-year conditions. This value is clearly low since it includes an extremely large and predominantly natural watershed (consisting of subareas including portions of the Town) subject to the attenuation process. From the same study, it was estimated that the 100-year discharge rate for Mammoth Creek increased from 350 cfs to 610 cfs between Waterford Street upstream and a point 650 feet upstream of Minaret Road downstream. The increase in the watershed area between these two stations is given as 0.49 square miles (314 acres) and lies within the Town. For this watershed from Waterford Street to 650 feet upstream of Minaret Road, the cfs/acre ratio is equal to (610 – 350)/314 ≈ 0.828 cfs/acre for 100-year conditions.

Next, a statistical analysis was made of the cfs/acre data contained in the 1984 study. Not surprisingly, a strong dependence (on cfs/acre rates) was found on the degree of natural land cover. This data was applied to the individual subareas delineated in this study for the purpose of obtaining a reasonable estimate of cfs/acre value for particular land use types, and were adjusted for consistency. These values were conservatively estimated to be those as given in **Table 3-1** below:

Table 3-1A. Applicable cfs/acre Values by Land Use Type

Land Use Type	20-Year	100-Year
Natural	0.23	0.43
Single Family Residence	0.65	1.30
High Density Residence	1.14	1.90
Commercial	1.22	1.93

Table 3-1B. Reduction Factors for Large Basins

Drainage Area (acres)	Reduction Factor
80	1.00
100	0.97
200	0.88
500	0.77
1,000	0.69
2,000	0.63
5,000	0.55
7,744	0.52

The values for the tables above were determined primarily for the purpose of determining the discharge values within the elements of the storm drain system as outlined in Section 5.

C. Procedure B Development

Procedure B is intended for use in larger, natural areas. A flow-frequency analysis approach was adopted, based on the flow data available and the ease with which it could be applied. Sufficient concurrent precipitation and runoff data were not available to develop a hydrograph method with reasonable accuracy.

The flow out of a large, natural basin in the Mammoth Lakes area has two principal components--snowmelt and rain flood flows. In general, flow records indicate that the peak flows in Mammoth Creek at Highway 395 are produced by snowmelt. Extreme rainfall events may produce short-term peaks on an annual hydrograph, which is dominated by flows produced by snowmelt. This situation is typical of major basins on the eastern side of the Sierra Nevada.

The mean daily flow records for Hot Creek at Highway 395 were used to develop the flow-frequency relationships. Snowmelt flows were segregated from rain flood flows by plotting flow-frequency relationships separately for rainy and non-rainy periods.

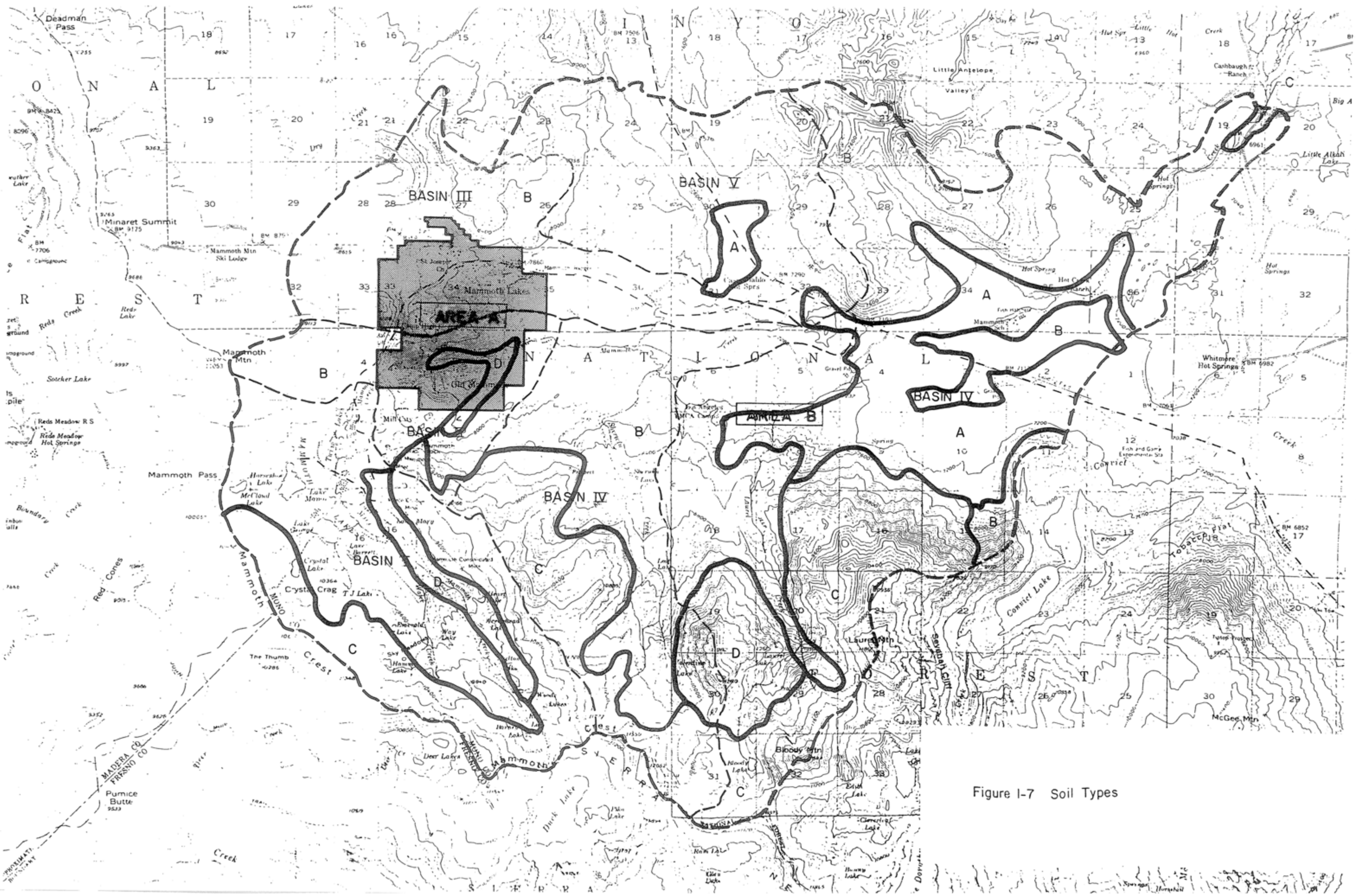

Figure I-7 Soil Types

4.8 LAND DEVELOPMENT

The construction and maintenance of urban and commercial developments can impact water quality in many ways. Construction activities inherently disturb soil and vegetation, often resulting in accelerated erosion and sedimentation. Stormwater runoff from developed areas can also contain petroleum products, nutrients, and other contaminants.

This section contains a discussion of the potential water quality impacts expected to result from land development activities, followed by control measures to reduce or offset water quality impacts from such activities.

Construction Activities and Guidelines

Construction activities often produce erosion by disturbing the natural ground surface through scarifying, grading, and filling. Floodplain and wetland disturbances often reduce the ability of the natural environment to retain sediment and assimilate nutrients. Construction materials such as concrete, paints, petroleum products, and other chemicals can contaminate nearby water bodies. Construction impacts such as these are typically associated with subdivisions, commercial developments, and industrial developments.

Control Measures for Construction Activities

The Regional Board regulates the construction of subdivisions, commercial developments, industrial developments, and roadways based upon the level of threat to water quality. The Regional Board will request a Report of Waste Discharge and consider the issuance of an appropriate permit for any proposed project where water quality concerns are identified in the California Environmental Quality Act (CEQA) review process. Any construction activity whose land disturbance activities exceed five acres must also comply with the statewide general NPDES permit for stormwater discharges (see "Stormwater" section of this Chapter).

The following are guidelines for construction projects regulated by the Regional Board, particularly for projects located in portions of the Region where erosion and stormwater threaten sensitive watersheds. The Regional Board recommends that each county within the Region adopt a grading/erosion control ordinance to require implementation of these same guidelines for all soil disturbing activities:

1. Surplus or waste material should not be placed in drainageways or within the 100-year floodplain of any surface water.

2. All loose piles of soil, silt, clay, sand, debris, or other earthen materials should be protected in a reasonable manner to prevent any discharge to waters of the State.

3. Dewatering should be performed in a manner so as to prevent the discharge of earthen material from the site.

4. All disturbed areas should be stabilized by appropriate soil stabilization measures by October 15th of each year.

5. All work performed during the wet season of each year should be conducted in such a manner that the project can be winterized (all soils stabilized to prevent runoff) within 48 hours if necessary. The wet season typically extends from October 15th through May 1st in the higher elevations of the Lahontan Region. The season may be truncated in the desert areas of the Region.

6. Where possible, existing drainage patterns should not be significantly modified.

7. After completion of a construction project, all surplus or waste earthen material should be removed from the site and deposited in an approved disposal location.

8. Drainage swales disturbed by construction activities should be stabilized by appropriate soil stabilization measures to prevent erosion.

9. All non-construction areas should be protected by fencing or other means to prevent unnecessary disturbance.

10. During construction, temporary protected gravel dikes, protected earthen dikes, or sand bag dikes should be used as necessary to prevent discharge of earthen materials from the site during periods of precipitation or runoff.

11. Impervious areas should be constructed with infiltration trenches along the downgradient sides to dispose of all runoff greater than background levels of the undisturbed site. Infiltration trenches are not recommended in areas where infiltration poses a risk of ground water contamination.

12. Infiltration trenches or similar protection facilities should be constructed on the downgradient side of all structural drip lines.

13. Revegetated areas should be continually maintained in order to assure adequate growth and root development. Physical erosion control facilities should be placed on a routine maintenance and inspection program to provide continued erosion control integrity.

14. Waste drainage waters in excess of that which can be adequately retained on the property should be collected before such waters have a chance to degrade. Collected water shall be treated, if necessary, before discharge from the property.

15. Where construction activities involve the crossing and/or alteration of a stream channel, such activities should be timed to occur during the period in which stream flow is expected to be lowest for the year.

16. Use of materials other than potable water for dust control (i.e., reclaimed wastewater, chemicals such as magnesium chloride, etc.) is strongly encouraged but must have prior Regional Board approval before its use.

Specific Policy and Guidelines for Mammoth Lakes Area

To control erosion and drainage in the Mammoth Lakes watershed at an elevation above 7,000 feet (Figure 4.8-1), the following policy and guidelines apply:

Policy:

A Report of Waste Discharge is required not less than 90 days before the intended start of construction activities of a **new development** of either (a) six or more dwelling units, or (b) commercial developments involving soil disturbance on one-quarter acre or more.

The Report of Waste Discharge shall contain a description of, and time schedule for implementation, for both the **interim erosion control measures** to be applied during project construction, and **short- and long-term erosion control measures** to be employed after the construction phase of the project. The descriptions shall include appropriate engineering drawings, criteria, and design calculations.

Guidelines:

1. Drainage collection, retention, and infiltration facilities shall be constructed and maintained to prevent transport of the runoff from a 20-year, 1-hour design storm from the project site. A 20-year, 1-hour design storm for the Mammoth Lakes area is equal to 1.0 inch (2.5 cm) of rainfall.

2. Surplus or waste materials shall not be placed in drainageways or within the 100-year flood plain of surface waters.

3. All loose piles of soil, silt, clay, sand, debris, or earthen materials shall be protected in a reasonable manner to prevent any discharge to waters of the State.

4. Dewatering shall be done in a manner so as to prevent the discharge of earthen materials from the site.

5. All disturbed areas shall be stabilized by appropriate soil stabilization measures by October 15 of each year.

6. All work performed between October 15th and May 1st of each year shall be conducted in such a manner that the project can be winterized within 48 hours.

7. Where possible, existing drainage patterns shall not be significantly modified.

8. After completion of a construction project, all surplus or waste earthen material shall be removed from the site and deposited at a legal point of disposal.

9. Drainage swales disturbed by construction activities shall be stabilized by the addition of crushed rock or riprap, as necessary, or other appropriate stabilization methods.

10. All nonconstruction areas shall be protected by fencing or other means to prevent unnecessary disturbance.

11. During construction, temporary erosion control facilities (e.g., impermeable dikes, filter fences, hay bales, etc.) shall be used as necessary to prevent discharge of earthen materials from the site during periods of precipitation or runoff.

12. Revegetated areas shall be regularly and continually maintained in order to assure adequate growth and root development. Physical erosion control facilities shall be placed on a routine maintenance and inspection program to provide continued erosion control integrity.

13. Where construction activities involve the crossing and/or alteration of a stream channel, such activities shall be timed to occur during the period in which streamflow is expected to be lowest for the year.

Land Development/Urban Runoff Control Actions for Susan River Watershed

1. To protect riparian vegetation and wetlands from land disturbance activities, the Regional Board shall recommend that Lassen County and the City of Susanville require new development or any land disturbing activities to include buffer strips of undisturbed land, especially along the Susan River and its tributaries.

2. The Regional Board, with assistance from the City of Susanville and the California Department of Transportation (Caltrans), should conduct monitoring of the Susan River and Piute Creek within the City of Susanville to assess impacts from urban runoff. Control measures should be planned and implemented based on the results of the monitoring. The monitoring plan should be developed to identify nonpoint sources needing control. Monitoring proposals will be submitted by the Regional Board, and work will be conducted as resources allow and as the Susan River gains priority.

3. The Regional Board shall encourage and assist other agencies in watershed restoration efforts along the Susan River.

4. The Regional Board shall encourage the City of Susanville and Lassen County to adopt a comprehensive grading ordinance. These ordinances should require, for all proposed land disturbing activities, the use of Best Management Practices to reduce erosion and stormwater runoff, including but not limited to temporary and permanent erosion control measures.

5. The Regional Board shall encourage the City of Susanville, Lassen County and Caltrans to implement Best Management Practices to reduce erosion and stormwater runoff when constructing and maintaining roads, both paved and unpaved, under their jurisdiction.

Road Construction and Maintenance

Road construction activities often involve extensive earth moving, including clearing, scarifying, excavating for bridge abutments, disturbing or modifying floodplains, cutting, and filling. Additionally, the potential for land disturbance exists from construction materials, equipment maintenance, fuel storage facilities, and general equipment use.

Once constructed, impervious road surfaces create another source of water pollution. Oils, greases, and other petroleum products, along with such toxic materials as battery acid, antifreeze, etc., may be deposited along the road surfaces. These contaminants become suspended or dissolved in any stormwater runoff that is generated on the road surfaces. Unless otherwise treated, these contaminants will flow toward local surface or ground waters. (See "Stormwater" section of this Chapter.)

Road maintenance can be potentially threatening to water quality in a number of ways. Below-grade culverts slowly fill with sediment and are cleaned out periodically, sometimes by flushing accumulated sediment into downstream drainageways. Grading of shoulders and drainageways can detach sediments and increase the risk of erosion into nearby surface waters. Road surfaces may be repainted or resealed with materials that harden quickly, but which can be washed off while still fresh by stormwater runoff.

In the winter, roads are often snowy, icy, or wet. To reduce winter road hazards, maintenance crews may remove the snow or ice, apply sand to provide added traction, and/or apply deicing chemicals to melt the snow and ice. Sand is rapidly dissipated or crushed by the traffic, and must be replaced frequently. Great quantities of sediment enter drainageways and/or surface waters due to this practice. Snow may be removed mechanically via snowplow or snowblower. This practice is not particularly detrimental to water quality in itself, but the snow often carries substances from the roadway when removed. Sediments, chemical deicers, and vehicle fluids may travel much farther than they would otherwise, possibly reaching area surface waters. Ice and small accumulations of snow may be removed with chemical deicers. The deicer in widest use is rock salt (sodium chloride), due to its low cost, high availability, and predictable results.

Winter road maintenance was brought to the forefront in 1989 when significant numbers of roadside trees in the Lake Tahoe Basin suddenly started dying. The public outcry caused many environmental groups and regulatory agencies, including the Regional Board, to look more closely at what had been a more or less unscrutinized, unregulated process in the past. Data began to show that Caltrans was using very high amounts of salt each winter, and the figure seemed to increase from one year to the next. The consensus of the various regulatory agencies was that Caltrans should reduce salt use, explore various alternate deicers, and monitor the impacts of salt applications on soil, water, and vegetation. Salt use decreased significantly from 1989-1992, due to more careful application procedures and to drought conditions.

At least three alternate deicers have been explored: calcium magnesium acetate, potassium acetate, and magnesium chloride with corrosion inhibitors. These products have shown some promise, but further study is required. The cost to switch to an alternate deicer will be significant. The road departments are unwilling to make the switch unless an alternate deicer is demonstrably better environmentally, will not require too much adjustment on the part of the maintenance crews and equipment, and will actually do an effective and predictable job when applied.

However, Caltrans' monitoring of vegetation showed minimal and temporary salt accumulation within the vegetation. During the spring, any salt that had accumulated in the vegetation was flushed out from the plant material. The impacts of chemical deicers on fish and wildlife within the Lahontan Region have not been studied.

Control Measures for Road Construction and Maintenance

(Additional control measures for roads are included in the "Stormwater" section of this Chapter.)

The Regional Board regulates road construction and maintenance projects within the Lahontan Region, concentrating efforts on major construction and construction in sensitive areas. Major construction projects and those projects in sensitive areas are most often regulated under individual WDRs, and are routinely inspected. Less significant projects may be issued conditional waivers of WDRs. The Regional Board has also adopted road maintenance waste discharge requirements for some county governments in the Region. Road construction and maintenance in the Lake Tahoe Basin is also regulated under municipal NPDES Stormwater Permits (see Chapter 5).

For all road projects, the Board requires that construction be conducted in a manner which is protective to water quality, and that, at the end of a given project, the site be restabilized and revegetated. These requirements are detailed in a Management Agency Agreement with Caltrans regarding the implementation of BMPs. Additionally, all road projects are to be in compliance with the Caltrans Statewide 208 Plan (CA Dept. of Transportation 1980), which was approved by the State Board in 1979. This Plan contains a commitment to implement BMPs, but does not include great detail on the BMPs themselves. The State Board should encourage Caltrans to update its 208 plan to provide such detail, with particular attention to:

- stormwater/erosion control along existing highways
- erosion control during highway construction and maintenance

- reduction of direct discharges (e.g., through culverts)
- reduction of runoff velocity
- infiltration, detention and retention practices
- management of deicing compounds, fertilizer, and herbicide use
- spill cleanup measures
- treatment of toxic stormwater pollutants

Since much of the implementation of BMPs on highways is done by Caltrans' contractors, the selection of qualified contractors and ongoing education of construction and maintenance personnel on BMP techniques are particularly important.

In the Lake Tahoe Basin, all governmental agencies assigned to maintain roads are required to bring all roads in the Lake Tahoe Basin into compliance with current "208" standards within a specified time schedule. That is, all existing facilities must be retrofitted to handle the stormwater runoff from the 20-year, 1-hour storm, and to restabilize all eroding slopes. The twenty-year time frame for this compliance process ends in 2008.

The Regional Board should allow salt use to continue as one component of a comprehensive winter maintenance program. However, the Regional Board should continue to require that it be applied in a careful, well-planned manner, by competent, trained crews. Should even the "proper" application of salt be shown to cause adverse water quality impacts, the Regional Board should then require that it no longer be used in environmentally sensitive areas, such as the Lake Tahoe Basin. Similarly, should an alternate deicer be shown to be effective, environmentally safe, and economically feasible, its use should be encouraged in lieu of salt.

Figure 4.8-1
OWENS HYDROLOGIC UNIT