APPENDIX D
Hydrologic Analysis and SWQMP

Mammoth Arts and Cultural Center
Mammoth Lakes, California

Hydrologic Analysis and
Storm Water Quality Management Plan

Project 1278.19

September 2018

Prepared for:
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September 21, 2018

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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

This drainage report addresses the hydrologic impacts of the proposed Mammoth Arts and Cultural Center (MACC). The site is located in Mammoth Lakes, California, at the Cerro Coso Community College site, approximately two miles west of U.S. Route 395 and approximately 0.45-mile south of State Route 203. For the project vicinity see Figures 1 below:

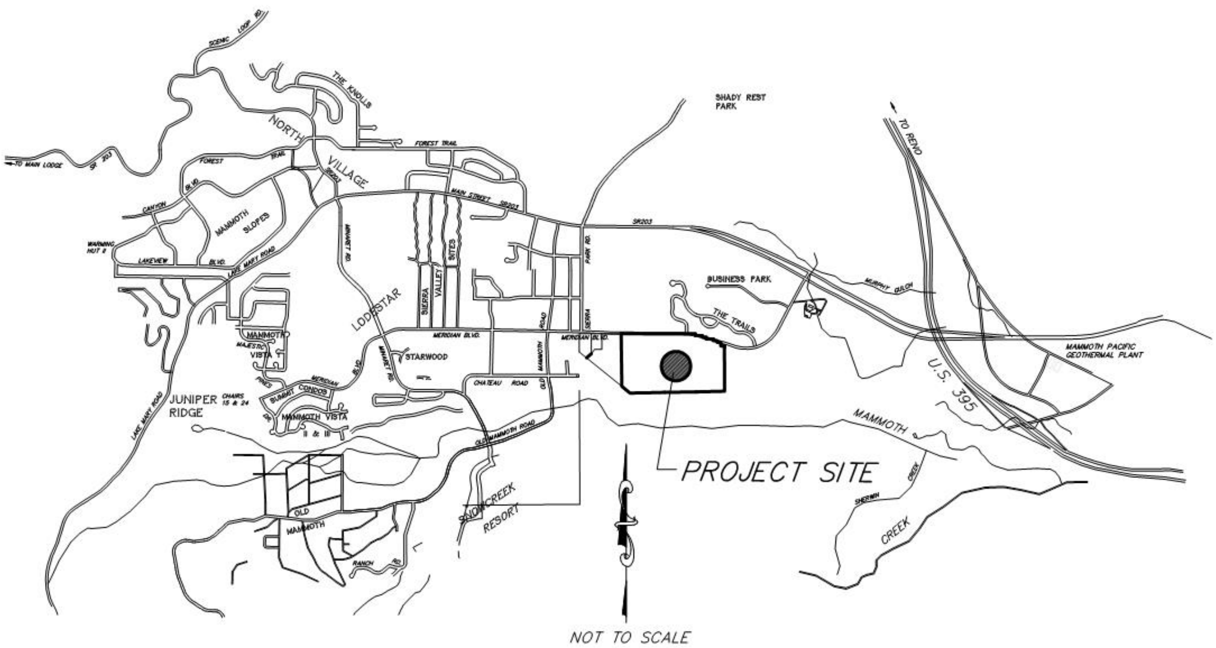

Figure 1 – Site Location

MACC would include a 298-seat Performing Arts Theatre, 500-seat outdoor amphitheater, a new parking lot, and a workshop and storage building. Additionally, the project proposes renovations to the existing Edison Theatre, including roof replacement and parking lot improvements.

Primary access to the project site would be provided via the existing unsignalized entryway from Meridian Boulevard to College Parkway. Two driveways currently provide access to the site, specifically the Edison Theatre Parking Lot located in the western portion of the project site. A new parking lot would be constructed near the southwest corner of the project site that would provide another access point. Refer to Figure B in Appendix A for proposed project.

The total project development area including the existing Edison parking lot is approximately 4.82 acres. It is important to note that the Edison Theatre is not considered in this drainage analysis since the only improvements to the Theatre include roof replacement.

2. Objective

The objective of this study is to provide hydrologic analysis of the site runoff for pre- and post-development conditions. 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.

3. Project Background and Observations

The site is located north of College Parkway and the existing Cerro Coso College. The project property encompasses 9.8 acres that is predominantly comprised of vacant land. The existing Edison Theatre and the associated parking lot are located in the western third of the property. The Edison Theatre is a 100-seat performing arts theatre and includes a 40-stall parking lot located within the western portion of the site and covers approximately 0.9 acres of the property. The Edison Theatre Parking Lot is currently accessed via two driveways along College Parkway. Pedestrian access is afforded along both sides of College Parkway, south of the project site. A Class I, off-site bike trail is present to the south, and along College Parkway.

Surrounding land uses include recreational, institutional, and residential uses to the north; open space uses to the east; recreational and institutional uses to the south; recreational and open space uses to the west.

The westerly third of the site drains from southwest to northwest at a grade of 2 percent. This includes the Edison Theater and the existing parking lot. This portion of the site enters an onsite storm drain which outfalls to a channel on the east side of the elementary school. A low ridge trending from the northwest to the southeast directs drainage from the are of the proposed development to the south (to College Parkway). College Parkway drains to the east into a storm drain in Meridian Blvd.

Ground surface elevations range from approximately 7845' MSL in the southwest corner of the site to approximately 7823' MSL in the northeast corner. Soils are granular, typical of SCS Type "B" based on Figure 1-7 in the Town of Mammoth Lakes Design Manual[2].

The proposed development will create approximately 116,830 sf of impervious surface, including roof, amphitheater, concrete walkways and AC pavement. The remaining area of the site is to be landscaped or left in a natural state. An existing parking lot west of the proposed PAC building will be improved. See Appendix A, Figure B for the plan view of proposed improvements and Table 1 below for impervious area breakdown:

Table 1 – Project Impervious Area Breakdown

	West Parking Lot	East Parking Lot	PAC and Amphitheater	Driveways
Roof/Concrete	35,083 sf	29,270 sf	22,242 sf	-
AC	24,220 sf	-	6,538 sf	3,045 sf

In addition, approximately 1.1 acres of ground will be graded to create an outdoor amphitheater and to daylite grading. College Parkway takes all runoff from south to the east then north into the Meridian Boulevard storm drain.

It is important to note that the property lines do not delineate this project's limits. The project boundaries are based on the disturbance.

4. Hydrologic Conditions

The site is located in the northeastern portion of the Town of Mammoth Lakes. Runoff from the site enters the Town storm drain system which outlets into Murphy Gulch. Murphy Gulch intermittently flows on the north side of Hwy 203 entering into Mammoth Creek approximately 1.5 miles east of the site, near the intersection of Hwy 203 and 395. The majority of the runoff from the Town of Mammoth Lakes is conveyed to Mammoth Creek via Murphy Gulch. There are two existing desiltation basins in Murphy Gulch near Hwy 203 which intercepts and retains most runoff from entering Mammoth Creek except during significant years of snowmelt runoff and rain on snow events that occur every few years in the Town.

5. Project Hydrologic and Hydraulic Analysis

Runoff rate calculations are based on the Town of Mammoth Lakes 2005 Storm Drain Master Plan Update (Master Plan)1. These calculations are included in Appendix B. Drainage facilities have been preliminary designed using Hydraflow Express Extension for Autodesk AutoCAD, which utilizes Manning's equations. Calculations are included in Appendices B and C.

In this report "on-site" refers to project area within the property designated to the Performing Arts Center (4.8 acres). "Off-site" refers to areas directly adjacent to "on-site". The offsite flows are within the boundary of the Edison Theater and MACC property. Refer to Figure A, Appendix A for existing conditions and tributary areas' delineation.

<u>Off-Site Drainage</u>

There is one small undeveloped tributary area flowing into the project area, labeled Area B, which contribute sheet flows onto the project site from the north. The size of this offsite area is 0.4 acres, contributing 0.2 cfs of peak runoff during the storm of 100-year intensity. Since this runoff quantity is relatively small, the stormwater will be allowed to enter the site similar to the present conditions and will be drained into the proposed onsite storm drain retention systems.

On-Site Drainage

On-site drainage is labeled as Area A. The existing 20- and 100-year peak runoffs for the entire project area are 1.7 cfs and 2.9 cfs, respectively. After the proposed improvements, the 20- and 100-year peak runoff quantities increase to 4.5 cfs and 7.2 cfs. The runoff volume was calculated to be 9,700 cf for the 20-year intensity event.

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 basins.

6. Stormwater Quality Management Plan

6.1 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 R`5.b requirement parking lot drainage systems include facilities to separate oil and silt from storm water. The 1 in runoff volume collected by the retention facilities is 9,700 cf. This eliminates runoff from leaving the project site during a 20-year storm event.

The time of concentration due to the developed conditions is very short and, thus all of the storm water will be retained onsite since the retention system as designed to hold the 20-year 1-inch event volume. The runoff from a 100-year 1-hour event is calculated to be 4.9 cfs. However, the flow leaving the site will be attenuated to will be reduced to 4.5 cfs from the calculated unattenuated flow of 7.2 cfs due to the stormwater retention basins.

6.2 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 6.3 below for retention facilities sizing.

6.3 Retention Facilities

Four retention systems are proposed for the site, as shown on Figure B, Appendix A. Two of the systems are located below the parking lots and two are designed as drywells. The required storage volume for each system is shown in Table 2 below. Refer to Appendix C for the detailed calculations.

Table 2 – Retention Volume

	Volume Required
West Parking Lot Retention	4,594 cf
East Parking Lot Retention	2,317 cf
Performing Arts Center Drywell	2,251 cf
Driveways Drywell	563 cf

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.

7. Mammoth Creek Watershed

The 2005 TOML Storm Drain Master Plan update calculated flows in Murphy Gulch to be 648 cfs for a 20-year storm event and 1,136 cfs for a 100-year event downstream of the project site outflow into Murphy Gulch.

With storm water quality management plan measures installed, the flow into Murphy Gulch will be reduced by a negligible amount during a 20-year storm event. The 100 yr flow of 1,136 cfs will not be increased less than 0.2% with the additional runoff from the site during a 100-year event.

8. Conclusion

With the construction of the stormwater quality management measures, the project will not affect storm water quantity or quality in Mammoth Creek. Also, the implementation of the SWPPP BMPs and inspection of the BMPs during the construction will insure the site meets the requirements of the State Water Quality Control Board to minimize sediment and other potential pollutants due to construction from leaving the site.

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.

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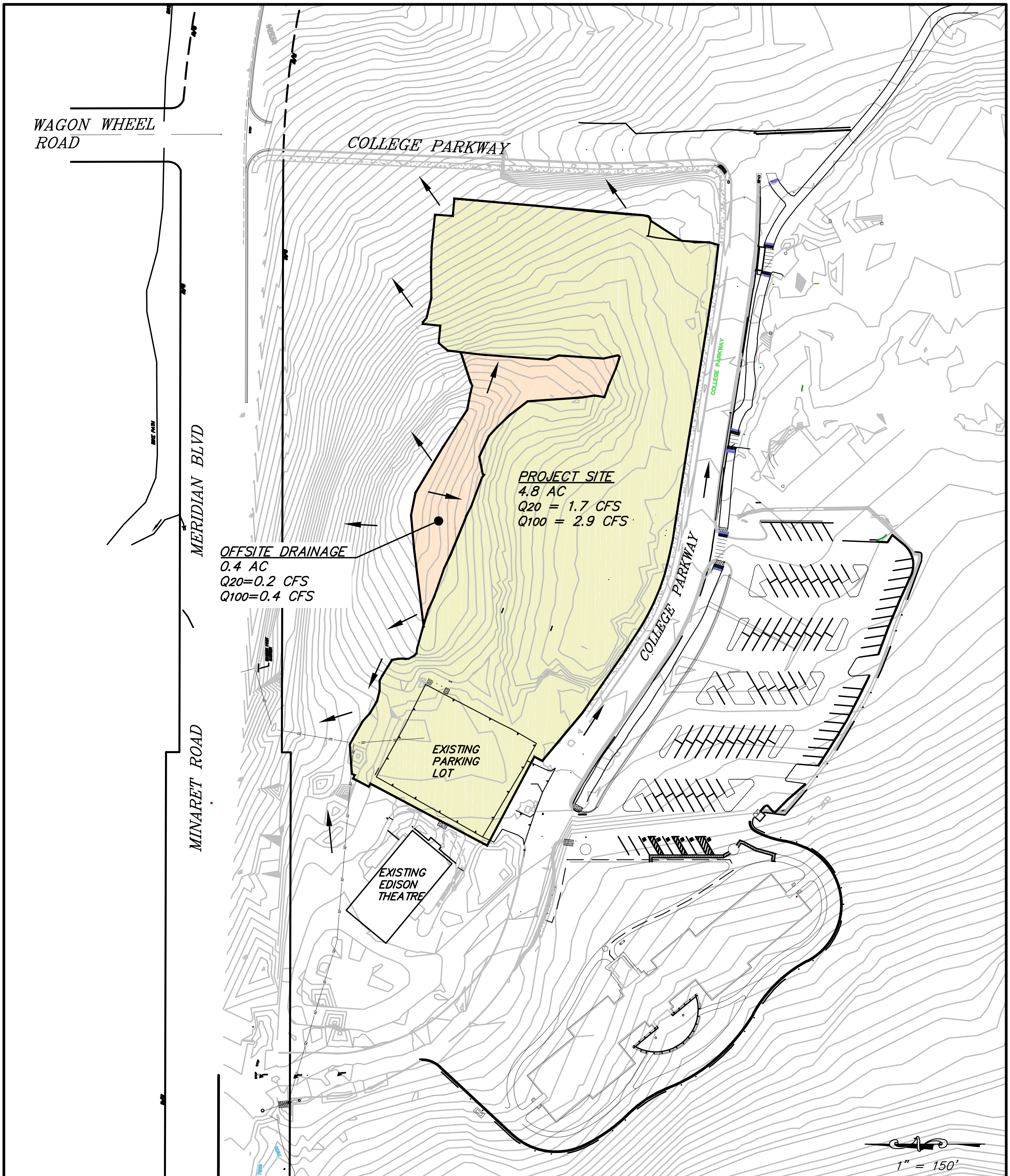
[1]The Town of Mammoth Lakes 2005 Storm Drain Master Update, May 2005, Boyle Engineering Corporation.

[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.

[4]The Town of Mammoth Lakes Stormwater Master Plan 2015, prepared by NCE.

APPENDIX A – Figures



DATE:
09/12/2018

PERFORMING ARTS CENTER

DRAINAGE ANALYSIS
FIGURE A – EXISTING CONDITIONS

triad/holmes assoc
civil engineering
land surveying

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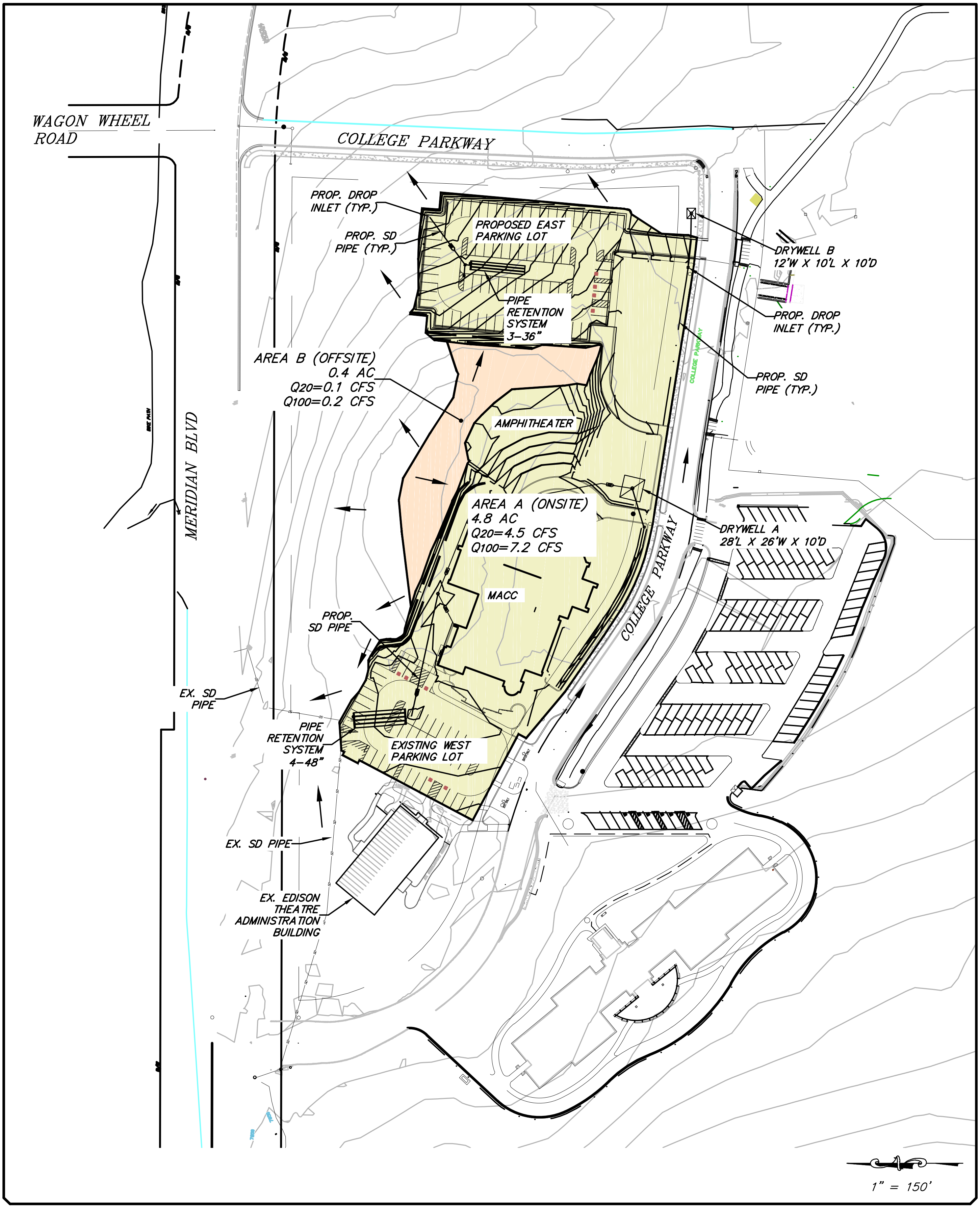

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09/21/2018

PERFORMING ARTS CENTER

DRAINAGE ANALYSIS
FIGURE B – PROPOSED IMPROVEMENTS

triad/holmes assoc
civil engineering
land surveying

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APPENDIX B – Hydrologic Calculations

triad/holmes associates
civil engineering
land surveying
mammoth lakes • bishop • redwood city • napa
san luis obispo • lompoc • pleasanton

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)**
A (Onsite)	Q20	4.82	88%	0%	12%	0.35	**1.68**	29%	0%	71%	0.93	**4.48**
	Q100					0.61	**2.94**				1.49	**7.18**
B (Offiste)	Q20	0.43	100%	0%	0%	0.23	**0.10**					
	Q100					0.43	**0.19**					

1-hr Intensity Storm

Area	C	I	Acres	**Q100 (cfs)**
A (Onsite)	0.72	1.4 in/hr	4.8	**4.90**

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

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Storage Volume Calculation

Rainfall Quantity	1 in	=	0.083 ft

Tributary Area and Average Runoff Coefficient

	West Parking Lot Retention			East Parking Lot Retention			Performing Arts Center Drywell A			Driveways Drywell B		
	Area		C	Area		C	Area		C	Area		C
Roof/Conc	35,083 sf	59%	0.95	29,270 sf	100%	0.95	22,242 sf	77%	0.95			
AC	24,220 sf	41%	0.90				6,538 sf	23%	0.90	3,045 sf	19%	0.9
Natural										13,400 sf	81%	0.3
Total Area	59,303 sf		**0.93**	29,270 sf		**0.95**	28,780 sf		**0.94**	16,445 sf		**0.41**

Volume Required = Tributary Area * Average Runoff Coefficient * Rainfall

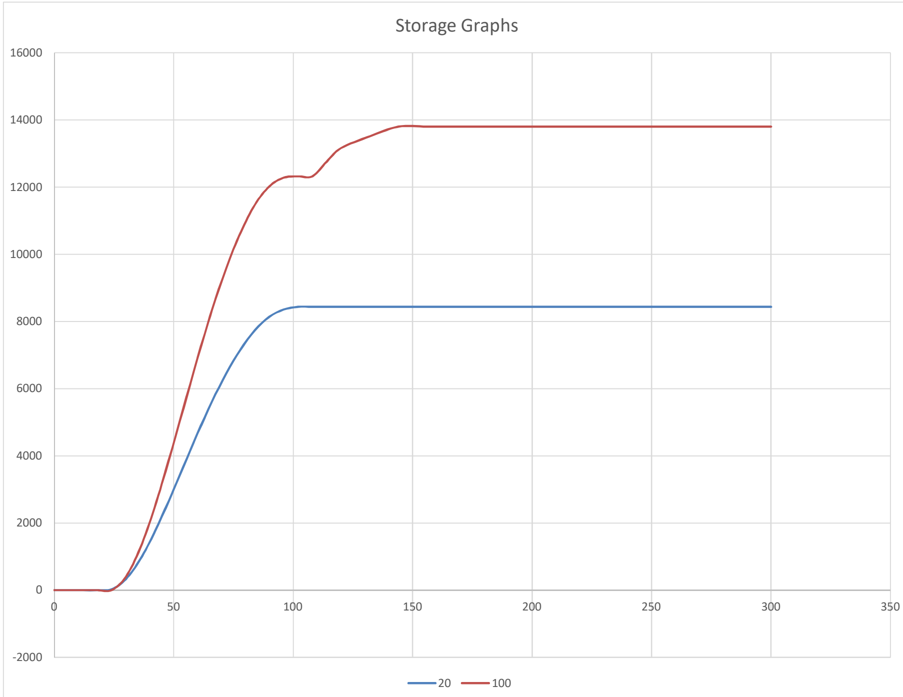
Storage Sizing Calculations

	Volume Required
West Parking Lot Retention	4,594 cf
East Parking Lot Retention	2,317 cf
Performing Arts Center Drywell	2,251 cf
Driveways Drywell	563 cf

MACC Atteniation Calculations

			tp =	60	min	tp =	60	min
Dimensionless Hydrograph			20 yr Q=	4.48	cfs dev	100 yr Q=	7.18	cfs dev
T/tc	Q/Qp	Qa/Qp	20 yr Q=	1.68	cfs pre	100 yr Q=	2.94	cfs pre
0	0	0	0	0.00	0.0	0	0.00	0.0
0.1	0.03	0.001	6	0.13	0.0	6	0.22	0.0
0.2	0.1	0.006	12	0.45	0.0	12	0.72	0.0
0.3	0.19	0.017	18	0.85	0.0	18	1.36	0.0
0.4	0.31	0.035	24	1.39	24.2	24	2.23	0.0
0.5	0.47	0.065	30	2.11	306.4	30	3.37	402.0
0.6	0.66	0.107	36	2.96	588.7	36	4.74	854.4
0.7	0.82	0.163	42	3.67	806.4	42	5.89	1203.3
0.8	0.93	0.228	48	4.17	943.5	48	6.68	1423.0
0.9	0.99	0.3	54	4.44	999.9	54	7.11	1513.5
1	1	0.375	60	4.48	999.9	60	7.18	1513.5
1.1	0.99	0.45	66	4.44	943.5	66	7.11	1423.0
1.2	0.93	0.522	72	4.17	838.7	72	6.68	1255.0
1.3	0.86	0.589	78	3.85	717.7	78	6.17	1061.1
1.4	0.78	0.65	84	3.49	572.5	84	5.60	828.5
1.5	0.68	0.705	90	3.05	395.1	90	4.88	544.2
1.6	0.56	0.751	96	2.51	217.7	96	4.02	259.8
1.7	0.46	0.79	102	2.06	80.6	102	3.30	40.1
1.8	0.39	0.822	108	1.75	0.0	108	2.80	0.0
1.9	0.33	0.849	114	1.48	0.0	114	2.37	435.0
2	0.28	0.871	120	1.25	0.0	120	2.01	405.0
2.2	0.207	0.908	132	0.93	0.0	132	1.49	350.0
2.4	0.147	0.934	144	0.66	0.0	144	1.06	290.0
2.6	0.107	0.953	156	0.48	0.0	156	0.77	0.0
2.8	0.077	0.967	168	0.34	0.0	168	0.55	0.0
3	0.055	0.977	180	0.25	0.0	180	0.39	0.0
3.2	0.04	0.984	192	0.18	0.0	192	0.29	0.0
3.4	0.029	0.989	204	0.13	0.0	204	0.21	0.0
3.6	0.021	0.993	216	0.09	0.0	216	0.15	0.0
3.8	0.015	0.995	228	0.07	0.0	228	0.11	0.0
4	0.011	0.997	240	0.05	0.0	240	0.08	0.0
4.5	0.005	0.999	270	0.02	0.0	270	0.04	0.0
5	0	1	300	0.00	0.0	300	0.00	0.0
			Total Volume		8434.9	Total Volume		13801.4

	20	100
0	0	0
6	0.0	0.0
12	0.0	0.0
18	0.0	0.0
24	24.2	0.0
30	330.6	402.0
36	919.3	1256.4
42	1725.7	2459.7
48	2669.2	3882.7
54	3669.1	5396.1
60	4669.1	6909.6
66	5612.5	8332.6
72	6451.2	9587.6
78	7168.9	10648.8
84	7741.4	11477.3
90	8136.6	12021.4
96	8354.3	12281.3
102	8434.9	12321.4
108	8434.9	12321.4
114	8434.9	12756.4
120	8434.9	13161.4
132	8434.9	13511.4
144	8434.9	13801.4
156	8434.9	13801.4
168	8434.9	13801.4
180	8434.9	13801.4
192	8434.9	13801.4
204	8434.9	13801.4
216	8434.9	13801.4
228	8434.9	13801.4
240	8434.9	13801.4
270	8434.9	13801.4
300	8434.9	13801.4



APPENDIX C – Retention Calculations

West Parking Lot Retention System

PIPE DIAMETER in.	PIPE DIAMETER ft.	PIPE VOLUME ft^3/cs-ft	STONE VOID VOLUME ft^3/cs-ft	TOTAL RETENTION STORAGE ft^3/cs-ft	PERC VOLUME ft^3/cs-ft	RETENTION STORAGE W/ PERC ft^3/cs-ft	LENGTH OF TYPICAL CROSS SECTION ft.	BASIN DIMENSIONS: TOTAL BASIN LENGTH ft^3/cs-ft	BASIN DIMENSIONS: CROSS SECTION WIDTH (TOTAL BASIN WIDTH) ft.	BASIN DIMENSIONS: DEPTH OF STORAGE (NOT INCLUDING EARTH COVER) ft.
12	1.00	3.14	3.45	6.59	0.83	7.43	569	573	9.00	1.50
15	1.25	4.91	4.20	9.11	0.93	10.04	421	425	10.00	1.75
18	1.50	7.07	4.98	12.05	1.03	13.07	323	328	11.00	2.00
24	2.00	12.57	6.64	19.21	1.22	20.43	207	212	13.00	2.50
30	2.50	19.63	12.46	32.09	1.75	33.84	125	130	19.00	3.00
36	3.00	28.27	15.08	43.35	1.94	45.29	93	99	21.00	3.50
42	3.50	38.48	17.84	56.32	2.14	58.46	72	79	23.00	4.00
48	**4.00**	**50.27**	**20.74**	**71.01**	**2.33**	**73.34**	**58**	**65**	**25.00**	**4.50**
54	4.50	63.62	23.79	87.41	2.53	89.94	47	54	27.00	5.00
60	5.00	78.54	26.99	105.53	2.72	108.25	39	47	29.00	5.50

INPUT SIZE OF PIPES (ft):	**4.00**			
INPUT NUMBER OF ROWS OF PIPES:	**4**		**Header Length (ft) =**	**15**
INPUT PERCOLATION RATE (ft/hr):	**0.08**			
INPUT REQ'D. STORAGE VOLUME (cf):	**4448**			
Less storage volume of header (cf)	222			
Cross-Sect STORAGE VOLUME (cf):	4225	(see table above for amount of pipe required)		

East Parking Lot Retention System

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	BASIN DIMENSIONS: CROSS SECTION WIDTH (TOTAL BASIN WIDTH)	BASIN DIMENSIONS: 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	2.36	2.71	5.07	0.64	5.71	382	386	7.00	1.50
15	1.25	3.68	3.29	6.98	0.71	7.69	284	288	7.75	1.75
18	1.50	5.30	3.90	9.20	0.79	9.99	219	223	8.50	2.00
24	2.00	9.42	5.19	14.62	0.93	15.55	140	145	10.00	2.50
30	2.50	14.73	8.59	23.32	1.24	24.56	89	94	13.50	3.00
36	**3.00**	**21.21**	**10.43**	**31.64**	**1.39**	**33.02**	**66**	**72**	**15.00**	**3.50**
42	3.50	28.86	12.38	41.24	1.53	42.78	51	58	16.50	4.00
48	4.00	37.70	14.43	52.13	1.68	53.81	41	48	18.00	4.50
54	4.50	47.71	16.60	64.31	1.83	66.14	33	41	19.50	5.00
60	5.00	58.90	18.87	77.77	1.97	79.74	27	35	21.00	5.50

INPUT SIZE OF PIPES (ft):	**3.00**		
INPUT NUMBER OF ROWS OF PIPES:	**3**	**Header Length (ft) =**	**15**
INPUT PERCOLATION RATE (ft/hr):	**0.08**		
INPUT REQ'D. STORAGE VOLUME (cf):	**2317**		
Less storage volume of header (cf)	134		
Cross-Sect STORAGE VOLUME (cf):	2183	(see table above for amount of pipe required)	

Performing Arts Center Drywell System

	Volume Required	r	h	**L**	**W**	**D**	n	**Volume Provided**	
Performing Arts Center Drywell A	2,251 cf	3.0 ft	8	**28**	**26**	**10**	0.3	**2,407 cf**	ok
Driveways Drywell B	563 cf	3.0 ft	8	**12**	**10**	**10**	0.3	**583 cf**	ok

APPENDIX E – 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.

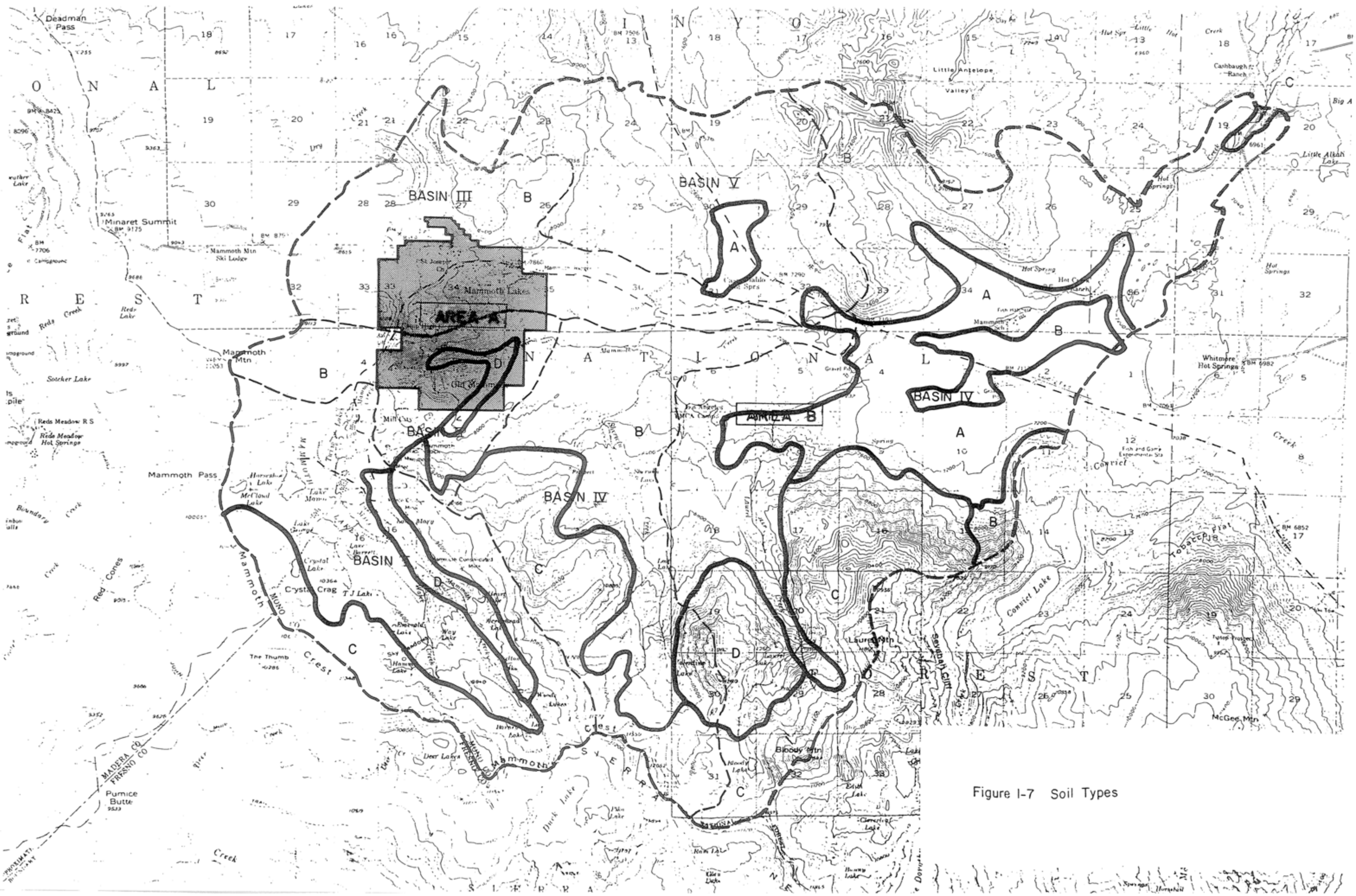

Figure I-7 Soil Types

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