NORTH VIEW HOLDINGS LLC
2700 NORTH HIGHWAY 89
WEBER COUNTY, UTAH
STORM WATER STUDY
Project No. 08N222
2-8-2013
Revised 2-26-13
Revised 5-6-13
Revised 6-24-13

General Site Information:

A proposed medical building is located immediately north of the front runner station at 2700 North and Highway 89 in Weber County, Utah. Construction will include parking lots in the front and rear of the building, sidewalk, curb and gutter, and other surface improvements including landscaping. Also included are underground utilities such as sewer, water, and storm drain. The site has an area of about 1.49 acres within the limits of this study. Storm water from site will be collected in inlet boxes in the parking areas and drive aisles throughout the site and continue via storm drain to a proposed retention facility located above ground in the west parking area, and be released into an existing storm drain pipe at the southwest corner of the site. The attached figure shows the project site and location of detention facility. Detention calculations have been provided for the site. (See attached figure and calculations).

The proposed site is broken into three drainage areas (labeled A-1, A-2 and A-3). Area A-3 calculations are from highway 89, and are not counted as detained flow. A runoff coefficient of 0.15 was used for natural ground and landscaped areas. A runoff coefficient of 0.90 was used for asphalt, concrete, buildings, and other hard surfaced areas. An average runoff coefficient of 0.74 was calculated for the detained portion of the site in the proposed conditions which is equivalent to about 78% of hardscape. A runoff coefficient of 0.86 was calculated for A-3.

A time of concentration for the 100-year design storm was calculated using the FAA method and rational coefficients of 0.35 for grass and 0.91 for concrete for each of the areas. The time of concentration is 9 minutes for A-1 and 11 minutes for A-2. A conservative time of concentration for A-3 was assumed to be 5 minutes. This time is based on the longest path inside the detention area over grass, asphalt, concrete, or through a pipeline as applicable. Five minutes is the shortest time allowed using this method. Rainfall intensities were found on the NOAA website. The values obtained were interpolated as necessary.

Data showing area information, runoff coefficient, time of concentration, peak flow, and required detention for the site is also provided and can be found in the attached calculations.

Pipe Sizes:

Storm water pipes in the project are proposed to be PVC (polyvinyl chloride) and/or CP (concrete pipe). All pipes in the project are sloped to provide the design capacity while maintaining a minimum scour velocity of 2 feet per second when the pipes are flowing full. The pipes are designed to convey the 10-year storm without surcharging. The pipes also have additional capacity to allow for pass-through flow from Highway 89 immediately adjacent to the North View Holdings Property, some of which flows under Highway 89 via two storm drainage pipes shown on the attached figure. A total of

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1.6 cfs has been added to the required piping flow for pipe sizing. Half of this has been applied to node 7 and half to node 11 to account for this pass-through flow.

<u>Orifice Plate:</u>

An orifice plate will be used to control the rate that storm water flows from the project. It is located at the downstream side of the western-most catch basin in the west parking lot. It is labeled as catch basin #2 on the attached figure. The orifice is calculated to be 5.58 inches. This includes the pass through flow of 1.6 cfs mentioned previously.

<u>Required Detention:</u>

The available detention volume in the ponding area is 7,230 cubic feet. The required detention for the 100-year storm with a release rate of 0.1 cfs/acre is 7,162 cubic feet. In the event the pond experiences a storm larger than the design storm water will then spill out of the pond, flow to the west along a swale toward the railroad tracks in a historical fashion.

Great Basin Engineering, Inc.

Prepared by Ryan Bingham, P.E.

Reviewed by Mark Babbitt, P.E.

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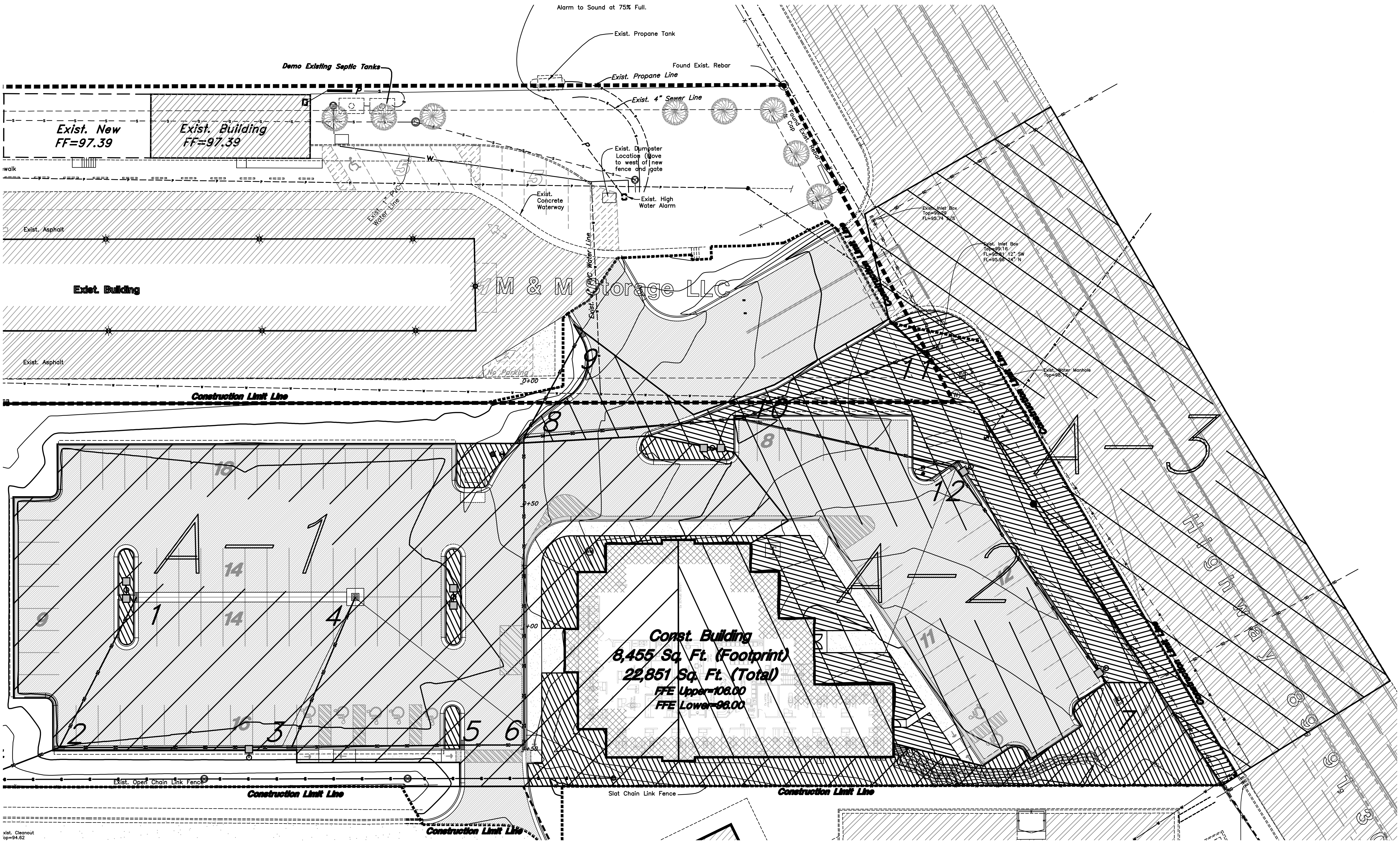


Alarm to Sound at 75% Full.
Exist. Propane Tank
Found Exist. Rebar
Demo Existing Septic Tanks
Exist. Propane Line
Exist. 4" Sewer Line
Exist. New
FF=97.39
Exist. Building
FF=97.39
Exist. Dumpster Location (Move to west of new fence and gate)
Exist. Concrete Waterway
Exist. High Water Alarm
Exist. 1" PVC Water Line
Exist. Asphalt
Exist. Building
M & M Storage LLC
Exist. Asphalt
No Parking
Exist. Water Manhole Top=98.17
Construction Limit Line
A-1
A-2
A-3
Const. Building
8,455 Sq. Ft. (Footprint)
22,851 Sq. Ft. (Total)
FFE Upper=106.00
FFE Lower=96.00
Exist. Open Chain Link Fence
Construction Limit Line
Slat Chain Link Fence
Construction Limit Line
Construction Limit Line
Exist. Cleanout
Top=94.62

Storm Water Study
North View Holdings
2700 North Highway 89, Weber County, Utah
08N222_S-4.dwg
2/8/2013

2 Detained Areas

Hardscape Cd =	0.90
Landscape Cd =	0.15

Drainage Areas	Total Area (ft^2)	Total Area (acres)	Hardscape Area (ft^2)	Hardscape Area (acres)	Landscape Area (ft^2)	Landscape Area (acres)	**C**
Σ Det. Areas	64674	1.485	50742	1.165	13932	0.320	0.738
Σ All Areas	64674	1.485	50742	1.165	13932	0.320	0.738
A-1	40144	0.922	32999	0.758	7145	0.164	0.767
A-2	24530	0.563	17743	0.407	6787	0.156	0.692

Time of Concentration--use FAA Method

For FAA Method, use C's of..

C =	0.35	for landscape
C =	0.91	for hardscape

$$t_c = \frac{1.8(1.1 - C)\sqrt{L}}{\sqrt[3]{S}}$$

Assume Pipe Flow is at 2 ft/s

**Note: S is in percent, 5 min is smallest allowed Tc

Area	Length on Landscape (ft)	Slope of Landscape (%)	Time on Landscape (min.)	Length on Hardscape (ft)	Slope of Hardscape (%)	Time on Hardscape (min.)	Length in Pipe (ft)	Time in Pipe (min.)	TC for entire Area (min.)
A-1	43.00	2.00	7.03	87.00	2.00	2.53	161.00	1.34	10.90
A-2	28.00	2.00	5.67	80.00	3.00	2.12	179.00	1.49	9.28

Rainfall Intensities
Data From NOAA

10-Year and 100-Year Intensities

The equations used for the 10-Year and 100-Year Intensities were found using the attached Rainfall data as well as Interpolated data from the produced graphs. The equations developed are 6th order polynomials, which give very high "R^2" values.

The equations used are: $$I = At^6 + Bt^5 + Ct^4 + Dt^3 + Et^2 + Ft + G$$

where……

	10-Yr. Coeff.	100-Yr. Coeff.
A =	2.832E-11	5.818E-11
B =	-1.207E-08	-2.480E-08
C =	2.064E-06	4.235E-06
D =	-1.822E-04	-3.727E-04
E =	8.963E-03	1.823E-02
F =	-2.529E-01	-5.095E-01
G =	4.475E+00	8.919E+00

		Storm Intensities	
AREA	Tc (minutes)	I (10-yr.) (in./hr.)	I (100-yr.) (in./hr.)
A-1	10.9	2.57	5.10
A-2	9.3	2.77	5.49

Peak Flow Information
Use Rational Method
10-Year and 100-Year Intensities

Q=CIA

AREA	C	I10 (in./hr.)	I100 (in./hr.)	A (acres)	Q (10-yr.) (cfs)	Q (100-yr.) (cfs)
					Peak Flows	
				Σ detained =	2.90	5.75
A-1	0.767	2.574	5.105	0.92	1.82	3.61
A-2	0.692	2.768	5.492	0.56	1.08	2.14

Node Inlet Requirements

Size pipes for 10 year storm

Area	Node #	% of Total	Q (cfs)
A-1	1	30.0%	0.55
A-1	2	10.0%	0.18
A-1	3	10.0%	0.18
A-1	4	30.0%	0.55
A-1	5	5.0%	0.09
A-1	6	15.0%	0.27
A-1	7	44.0%	0.80
A-2	8	5.0%	0.05
A-2	9	5.0%	0.05
A-2	10	30.0%	0.32
A-2	11	74.1%	0.80
A-2	12	60.0%	0.65

Pipe Sizes Between the Specified Nodes

Up Stream Node	Dn Stream Node	Q (cfs)	Pipe Size (in)	Design Min Slope (%)	Area (ft^2)	Rh (ft)	Manning's n	Scour Min. Slope (%)	First Trial Pipe Size
1	2	0.55	8	0.204%	0.349	0.167	0.013	0.400%	8
		0.55	10	0.062%	0.545	0.208	0.013	0.280%	
		0.55	12	0.023%	0.785	0.250	0.013	0.200%	
2	Outlet	4.50	12	1.594%	0.785	0.250	0.013	0.200%	15
		4.50	15	0.485%	1.227	0.313	0.013	0.150%	
		4.50	18	0.183%	1.767	0.375	0.013	0.120%	
3	2	3.77	10	2.961%	0.545	0.208	0.013	0.280%	15
		3.77	12	1.120%	0.785	0.250	0.013	0.200%	
		3.77	15	0.341%	1.227	0.313	0.013	0.150%	
4	3	0.55	8	0.204%	0.349	0.167	0.013	0.400%	8
		0.55	10	0.062%	0.545	0.208	0.013	0.280%	
		0.55	12	0.023%	0.785	0.250	0.013	0.200%	
5	3	3.04	10	1.929%	0.545	0.208	0.013	0.280%	15
		3.04	12	0.730%	0.785	0.250	0.013	0.200%	
		3.04	15	0.222%	1.227	0.313	0.013	0.150%	
6	5	2.95	10	1.815%	0.545	0.208	0.013	0.280%	15
		2.95	12	0.687%	0.785	0.250	0.013	0.200%	
		2.95	15	0.209%	1.227	0.313	0.013	0.150%	
7	12	0.80	8	0.438%	0.349	0.167	0.013	0.400%	8
		0.80	10	0.133%	0.545	0.208	0.013	0.280%	
		0.80	12	0.050%	0.785	0.250	0.013	0.200%	
8	6	2.68	10	1.495%	0.545	0.208	0.013	0.280%	15
		2.68	12	0.566%	0.785	0.250	0.013	0.200%	
		2.68	15	0.172%	1.227	0.313	0.013	0.150%	
9	8	0.05	8	0.002%	0.349	0.167	0.013	0.400%	8
		0.05	10	0.001%	0.545	0.208	0.013	0.280%	
		0.05	12	0.000%	0.785	0.250	0.013	0.200%	
10	8	2.57	10	1.377%	0.545	0.208	0.013	0.280%	15
		2.57	12	0.521%	0.785	0.250	0.013	0.200%	
		2.57	15	0.158%	1.227	0.313	0.013	0.150%	
11	12	0.80	8	0.438%	0.349	0.167	0.013	0.400%	8
		0.80	10	0.133%	0.545	0.208	0.013	0.280%	
		0.80	12	0.050%	0.785	0.250	0.013	0.200%	
12	10	2.25	8	3.459%	0.349	0.167	0.013	0.400%	12
		2.25	10	1.052%	0.545	0.208	0.013	0.280%	
		2.25	12	0.398%	0.785	0.250	0.013	0.200%	

North View Holdings

Combined Detention Pond

C = 0.74

Area = 1.48 acres

Allowable Discharge Rate = 0.100 cfs/acre

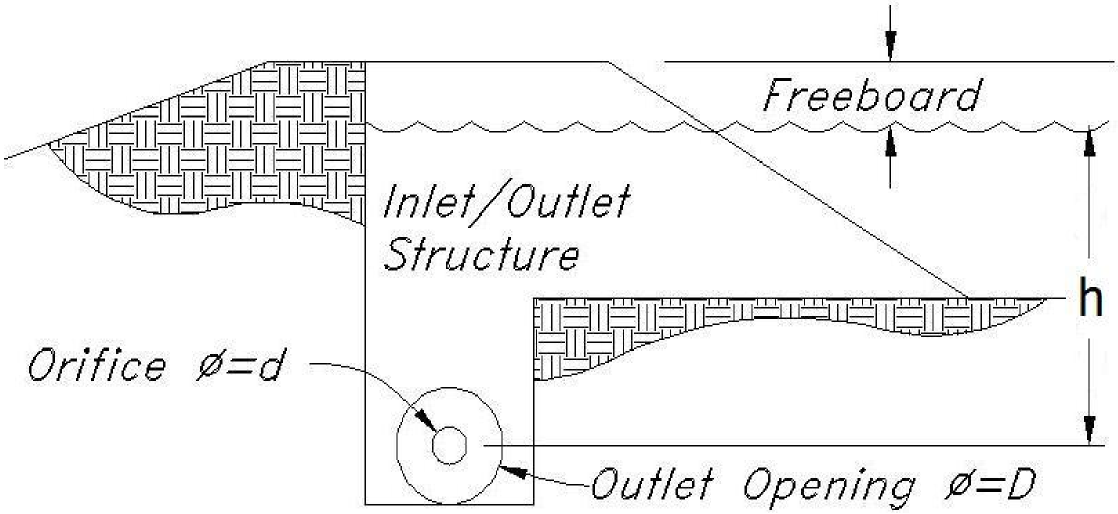
Total Release Rate = 0.148 cfs

Detention Pond Sized For The 100 Year Storm

Time	Rainfall Intensity	Accumulated Volume	OR Allowable Release	Needed Detention	Needed Detention	
min	in./hr.	(CF)	(CF)	(CF)	(acre-ft)	
5	6.78	2231	45	2186	0.050	
10	5.31	3496	89	3407	0.078	
15	4.32	4260	134	4126	0.095	
20	3.64	4791	178	4613	0.106	
25	3.18	5227	223	5005	0.115	
30	2.85	5622	267	5354	0.123	
35	2.60	5983	312	5671	0.130	
40	2.39	6300	356	5944	0.136	
45	2.22	6563	401	6162	0.141	
50	2.06	6767	445	6322	0.145	
55	1.91	6922	490	6432	0.148	
60	1.78	7045	534	6510	0.149	
90	1.35	7963	802	7162	0.164	<- Max Detention
120	1.02	8050	1069	6981	0.160	
180	0.68	8064	1603	6460	0.148	
360	0.38	8999	3207	5792	0.133	
720	0.23	11083	6414	4669	0.107	
1440	0.13	12504	12828	-324	-0.007	

So, our detention pond needs to hold 7162 ft^3 of water

ORIFICE PLATE CALCULATIONS



$$Q = 0.62 \cdot A_o \cdot \sqrt{2 \cdot g \cdot h}$$

Q = Total Discharge Rate

$$A_o = \frac{\pi \cdot d^2}{4}$$

$$g = 32.2$$

h= 4.275

Q = 1.748 <- Includes pass-through flow from Hwy. 89

pass-through = 1.6 cfs

Solving for d, we have.....

$$d = \sqrt{\frac{4 \cdot Q}{0.62 \cdot \pi \cdot \sqrt{2 \cdot g \cdot h}}}$$

Substituting Q, G, and H, we have.....

d = 0.465 feet

OR

d = 5.582 inches

NOAA Atlas 14, Volume 1, Version 5
Location name: Ogden, Utah, US*
Coordinates: 41.3090, -112.0090
Elevation: 4294ft*
* source: Google Maps

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches/hour)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**1.61** (1.40–1.86)	**2.03** (1.79–2.34)	**2.76** (2.42–3.18)	**3.44** (3.00–3.98)	**4.57** (3.88–5.32)	**5.60** (4.61–6.59)	**6.84** (5.45–8.15)	**8.30** (6.37–10.1)	**10.7** (7.74–13.4)	**12.9** (8.89–16.6)
10-min	**1.22** (1.07–1.41)	**1.54** (1.36–1.78)	**2.10** (1.84–2.42)	**2.63** (2.29–3.04)	**3.48** (2.95–4.04)	**4.27** (3.51–5.02)	**5.21** (4.15–6.20)	**6.32** (4.85–7.68)	**8.14** (5.89–10.2)	**9.82** (6.76–12.6)
15-min	**1.01** (0.884–1.17)	**1.27** (1.12–1.47)	**1.74** (1.52–2.00)	**2.17** (1.89–2.51)	**2.87** (2.44–3.34)	**3.52** (2.90–4.14)	**4.30** (3.42–5.12)	**5.22** (4.01–6.35)	**6.72** (4.86–8.42)	**8.12** (5.59–10.4)
30-min	**0.680** (0.594–0.786)	**0.858** (0.758–0.990)	**1.17** (1.03–1.35)	**1.46** (1.27–1.69)	**1.93** (1.64–2.25)	**2.37** (1.95–2.79)	**2.90** (2.31–3.45)	**3.52** (2.70–4.27)	**4.53** (3.28–5.67)	**5.47** (3.76–7.01)
60-min	**0.421** (0.368–0.486)	**0.531** (0.469–0.613)	**0.724** (0.635–0.834)	**0.904** (0.787–1.05)	**1.20** (1.02–1.39)	**1.47** (1.21–1.73)	**1.79** (1.43–2.13)	**2.18** (1.67–2.65)	**2.80** (2.03–3.51)	**3.38** (2.33–4.34)
2-hr	**0.269** (0.239–0.306)	**0.336** (0.298–0.383)	**0.434** (0.384–0.494)	**0.528** (0.461–0.602)	**0.684** (0.584–0.787)	**0.826** (0.690–0.961)	**0.996** (0.804–1.18)	**1.20** (0.932–1.45)	**1.52** (1.11–1.90)	**1.82** (1.27–2.33)
3-hr	**0.208** (0.187–0.233)	**0.256** (0.231–0.289)	**0.321** (0.287–0.360)	**0.381** (0.339–0.429)	**0.478** (0.417–0.543)	**0.569** (0.487–0.653)	**0.681** (0.567–0.794)	**0.813** (0.655–0.968)	**1.03** (0.789–1.28)	**1.23** (0.903–1.56)
6-hr	**0.141** (0.130–0.155)	**0.173** (0.158–0.191)	**0.209** (0.190–0.230)	**0.241** (0.218–0.268)	**0.291** (0.260–0.325)	**0.333** (0.293–0.375)	**0.380** (0.329–0.434)	**0.434** (0.366–0.502)	**0.542** (0.443–0.641)	**0.641** (0.508–0.792)
12-hr	**0.090** (0.083–0.099)	**0.110** (0.101–0.121)	**0.133** (0.121–0.146)	**0.153** (0.139–0.168)	**0.183** (0.164–0.203)	**0.207** (0.184–0.232)	**0.234** (0.204–0.265)	**0.263** (0.224–0.302)	**0.306** (0.254–0.360)	**0.342** (0.276–0.411)
24-hr	**0.056** (0.051–0.061)	**0.068** (0.062–0.075)	**0.082** (0.075–0.090)	**0.093** (0.085–0.102)	**0.108** (0.098–0.118)	**0.120** (0.108–0.131)	**0.132** (0.119–0.144)	**0.143** (0.129–0.157)	**0.160** (0.142–0.183)	**0.174** (0.152–0.208)
2-day	**0.033** (0.030–0.036)	**0.040** (0.037–0.044)	**0.048** (0.044–0.052)	**0.054** (0.049–0.059)	**0.062** (0.057–0.068)	**0.068** (0.062–0.075)	**0.075** (0.068–0.082)	**0.081** (0.073–0.089)	**0.089** (0.080–0.098)	**0.095** (0.085–0.106)
3-day	**0.024** (0.022–0.026)	**0.029** (0.027–0.032)	**0.035** (0.032–0.038)	**0.039** (0.036–0.043)	**0.046** (0.042–0.050)	**0.050** (0.046–0.055)	**0.055** (0.050–0.060)	**0.060** (0.054–0.066)	**0.066** (0.060–0.073)	**0.071** (0.063–0.079)
4-day	**0.020** (0.018–0.021)	**0.024** (0.022–0.026)	**0.028** (0.026–0.031)	**0.032** (0.030–0.035)	**0.037** (0.034–0.041)	**0.041** (0.038–0.045)	**0.045** (0.041–0.050)	**0.050** (0.045–0.054)	**0.055** (0.049–0.060)	**0.059** (0.052–0.065)
7-day	**0.013** (0.012–0.015)	**0.016** (0.015–0.018)	**0.019** (0.018–0.021)	**0.022** (0.020–0.024)	**0.025** (0.023–0.028)	**0.028** (0.026–0.031)	**0.031** (0.028–0.034)	**0.033** (0.030–0.037)	**0.037** (0.033–0.040)	**0.039** (0.035–0.043)
10-day	**0.011** (0.010–0.012)	**0.013** (0.012–0.014)	**0.015** (0.014–0.017)	**0.017** (0.016–0.019)	**0.020** (0.018–0.022)	**0.022** (0.020–0.024)	**0.023** (0.021–0.026)	**0.025** (0.023–0.028)	**0.027** (0.025–0.030)	**0.029** (0.026–0.032)
20-day	**0.007** (0.006–0.008)	**0.008** (0.008–0.009)	**0.010** (0.009–0.011)	**0.011** (0.010–0.012)	**0.013** (0.012–0.014)	**0.014** (0.013–0.015)	**0.015** (0.013–0.016)	**0.016** (0.014–0.017)	**0.017** (0.015–0.018)	**0.018** (0.016–0.019)
30-day	**0.006** (0.005–0.006)	**0.007** (0.006–0.007)	**0.008** (0.007–0.009)	**0.009** (0.008–0.010)	**0.010** (0.009–0.011)	**0.011** (0.010–0.012)	**0.012** (0.011–0.013)	**0.012** (0.011–0.013)	**0.013** (0.012–0.014)	**0.014** (0.013–0.015)
45-day	**0.005** (0.004–0.005)	**0.006** (0.005–0.006)	**0.007** (0.006–0.007)	**0.007** (0.007–0.008)	**0.008** (0.008–0.009)	**0.009** (0.008–0.010)	**0.010** (0.009–0.010)	**0.010** (0.009–0.011)	**0.011** (0.010–0.012)	**0.011** (0.010–0.012)
60-day	**0.004** (0.004–0.004)	**0.005** (0.005–0.005)	**0.006** (0.005–0.006)	**0.006** (0.006–0.007)	**0.007** (0.007–0.008)	**0.008** (0.007–0.008)	**0.008** (0.008–0.009)	**0.009** (0.008–0.010)	**0.009** (0.009–0.010)	**0.010** (0.009–0.011)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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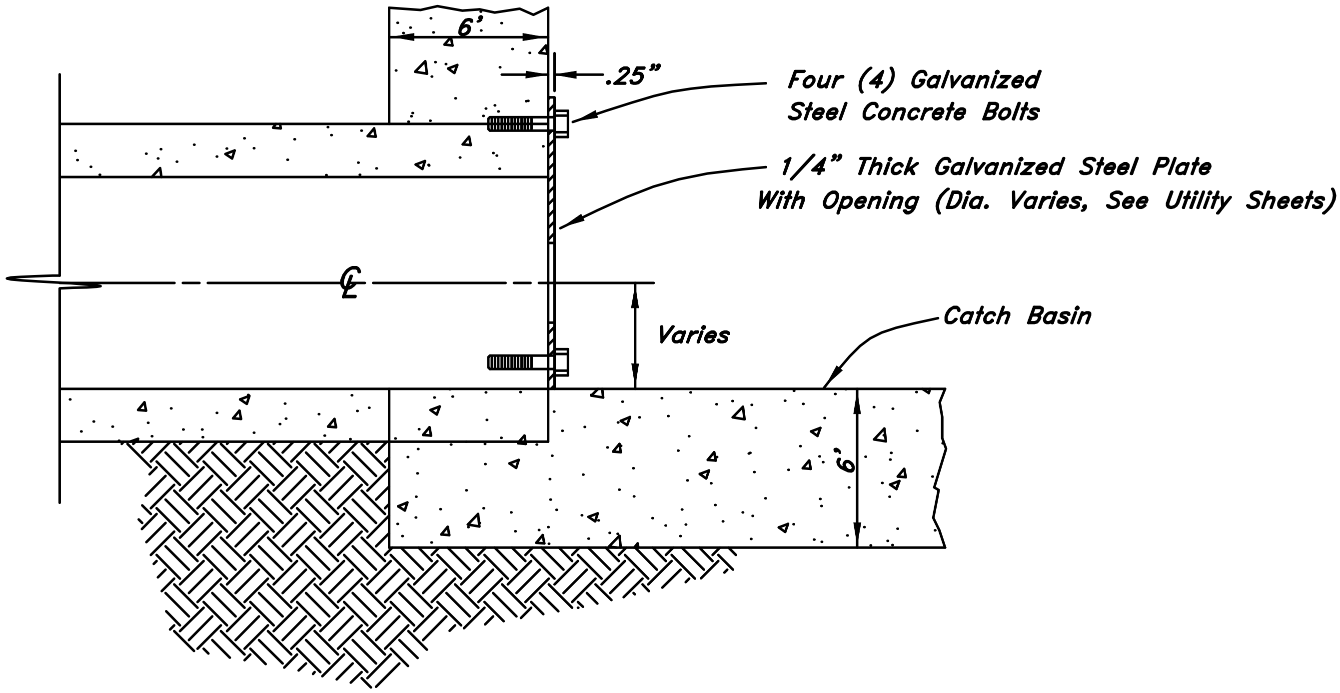
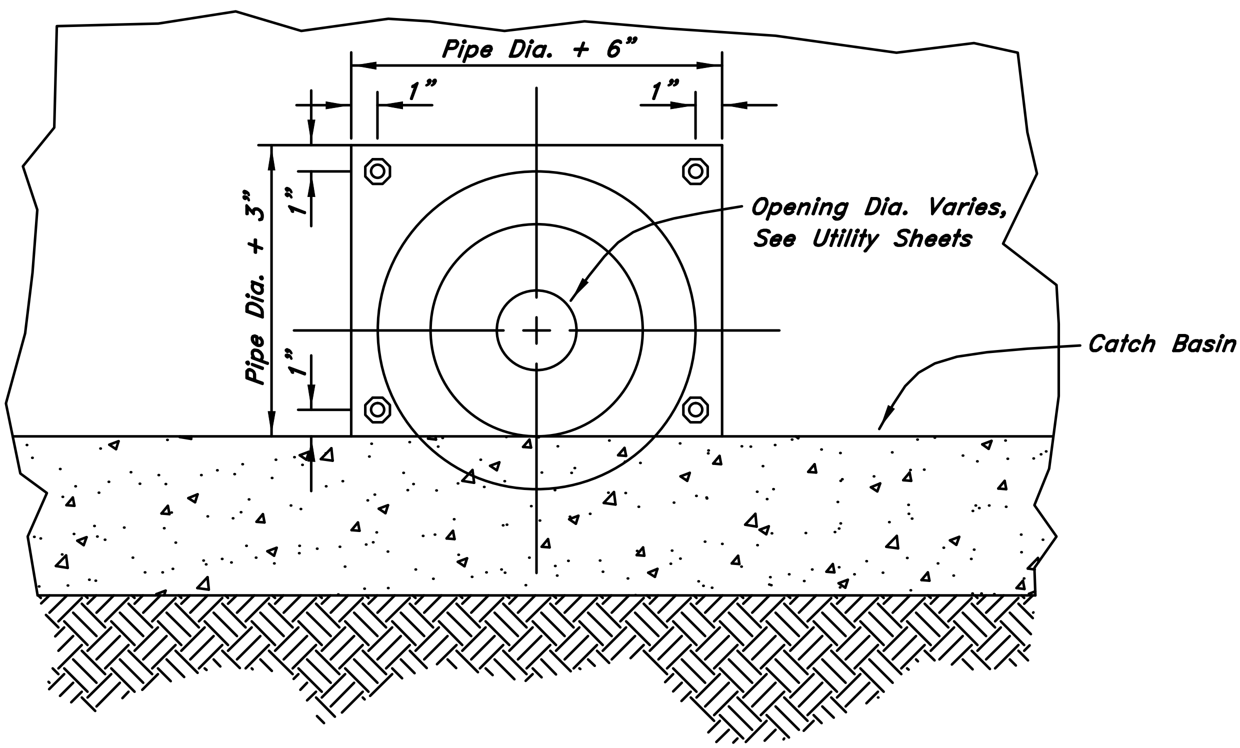
PF graphical





Orifice Plate Detail