

Graphical Hydrograph Method for Stormwater Detention Pond 1

Methodist Hospital for Special Surgery, Town of Addison

Design Frequency:	100 year storm
Purpose:	Use the graphical hydrograph method to determine the volume of stormwater storage needed to compensate for increased runoff due to development.
Method:	Use the Rational Method to determine maximum rate of runoff $Q = c \cdot i \cdot A$ Where: c = Frequency Factor Coefficient i = Rainfall Intensity (in/hr) A = Drainage Area (acres)
Assumptions:	Rainfall Intensity determined from attached graph given Time of Concentration (Tc) or Duration and the Return Period of the storm.
For Existing Conditions:	$c=1.00$, $c=0.30$, $T_c=10$ min, $I=8.74$ in./hr.
For Proposed Conditions:	Use $c=1.00$, $c=0.50$ for Non-Residential Uses, $T_c=10$ min, $I=8.74$

I. Determination of Allowable Release Rate - Existing Site

Total site area	3.02	acres
Detained Time of Concentration (Tc)	10	minutes
Rainfall intensity for one-hundred year storm (I=10 min)	8.74	inches/hr
Frequency Factor coefficient	1.00	
Detained runoff coefficient	0.30	
Allowable total site detained release rate	7.9	cfs
Area of site draining through detention pond	2.60	acres
Area of site draining undetained	0.42	acres
Undetained Time of Concentration (Tc)	10	minutes
Rainfall intensity for one-hundred year storm (I=10 min)	8.74	inches/hr
Frequency Factor coefficient	1.00	
Runoff coefficient for developed conditions	0.90	
Runoff from undetained area	3.3	cfs
Total off-site area passed through	0.00	acres
Time of Concentration (Tc)	10	minutes
Rainfall intensity for one-hundred year storm (I=15 min)	8.74	inches/hr
Frequency Factor coefficient	1.00	
Runoff coefficient	0.90	
Off-site pass-through rate	0.0	cfs
Total release rate from detention pond (allowed)	4.61	cfs
Actual metered release rate from detention pond	4.61	cfs

Total release rate = Allowable total site detained release rate - Runoff from undetained area + Off-site pass-through rate

II. Required Storage Calculations, Return Period = 100 years

Duration (hours)	Duration (min)	Rainfall Intensity (in/hr)	Inflow Rate (cfs)	Inflow Volume (cf)	Outflow Rate (cfs)	Outflow Volume (cf)	Inflow - Outflow Volume (cf)	Required Storage (ac-ft)
0.17	10	8.74	20.5	12,271	4.61	2,769	9,502	0.218
0.25	15	7.52	17.6	15,837	4.61	3,461	12,376	0.284
0.33	20	6.80	15.9	19,094	4.61	4,153	14,941	0.343
0.50	30	5.74	13.4	24,177	4.61	5,338	18,839	0.428
0.67	40	4.94	11.6	27,743	4.61	6,022	20,821	0.478
0.83	50	4.37	10.2	30,677	4.61	6,706	23,971	0.514
1.00	60	3.90	9.1	32,854	4.61	9,691	23,163	0.532
1.17	70	3.65	8.5	35,872	4.61	11,075	24,797	0.569
1.33	80	3.35	7.8	37,627	4.61	12,460	25,167	0.578
1.50	90	3.08	7.2	38,919	4.61	15,229	23,690	0.576
1.67	100	2.87	6.7	40,295	4.61	16,613	23,682	0.576
1.83	110	2.70	6.3	41,699	4.61	16,613	25,086	0.576
2.00	120	2.53	5.9	42,625	4.61	17,997	24,628	0.565
Pond 1 =		60 L.F. 6'x6' RCB	1,440					
		793 L.F. 6'x6' RCB	23,230					
Required Volume =			25,167					
Volume Provided =			25,230					

Pond 1 Outfall Calculations

Purpose: Provide metered flow that meets the 100-year storm event release rate restrictions.

Method: Use weir flow and orifice flow calculations to determine total outflow as a product of pond depth.

Goal: Water surface elevation based upon volume required 100-yr storm requires 0 cf of storage, which occurs at elev 635.42

Where: Use weir equation to determine flow until opening is submerged.
 $Q = C^*b^*H^{3/2}$
 $C =$ discharge coefficient = 3.33
 $b =$ weir base width
 $H =$ water level height above base of weir

Use orifice equation to determine flow once opening is submerged.
 $Q = A^*C^*(2g^*h)^{1/2}$
 $A =$ area of opening = 0.40 SF
 $C =$ discharge coefficient = 0.6
 $h =$ water level height above center of opening

Opening 1	
b =	0.80 ft
Height =	0.50 ft
A =	0.40 SF
base elev =	629.41 ft

WSEL	H1	Q1	h1	Q1	Qtotal	Event	Q allow
629.41	0.00	0.00	0.00	0.00	0.00		
629.51	0.10	0.08	0.00	0.00	0.08		
629.61	0.20	0.24	0.00	0.00	0.24		
629.71	0.30	0.44	0.00	0.00	0.44		
629.81	0.40	0.67	0.00	0.00	0.67		
629.91	0.00	0.00	0.25	0.96	0.96		
631.91	0.00	0.00	2.25	2.88	2.88		
632.01	0.00	0.00	2.35	2.95	2.95		
632.11	0.00	0.00	2.45	3.01	3.01		
632.21	0.00	0.00	2.55	3.07	3.07		
632.31	0.00	0.00	2.65	3.13	3.13		
632.41	0.00	0.00	2.75	3.19	3.19		
632.51	0.00	0.00	2.85	3.25	3.25		
632.61	0.00	0.00	2.95	3.30	3.30		
632.71	0.00	0.00	3.05	3.36	3.36		
632.81	0.00	0.00	3.15	3.41	3.41		
632.91	0.00	0.00	3.25	3.47	3.47		
633.01	0.00	0.00	3.35	3.52	3.52		
633.11	0.00	0.00	3.45	3.57	3.57		
633.21	0.00	0.00	3.55	3.62	3.62		
633.31	0.00	0.00	3.65	3.67	3.67		
633.41	0.00	0.00	3.75	3.72	3.72		
633.51	0.00	0.00	3.85	3.77	3.77		
633.61	0.00	0.00	3.95	3.82	3.82		
633.71	0.00	0.00	4.05	3.87	3.87		
633.81	0.00	0.00	4.15	3.92	3.92		
633.91	0.00	0.00	4.25	3.96	3.96		
634.01	0.00	0.00	4.35	4.01	4.01		
634.11	0.00	0.00	4.45	4.05	4.05		
634.21	0.00	0.00	4.55	4.10	4.10		
634.31	0.00	0.00	4.65	4.15	4.15		
634.41	0.00	0.00	4.75	4.19	4.19		
634.51	0.00	0.00	4.85	4.23	4.23		
634.61	0.00	0.00	4.95	4.28	4.28		
634.71	0.00	0.00	5.05	4.32	4.32		
634.81	0.00	0.00	5.15	4.36	4.36		
634.91	0.00	0.00	5.25	4.40	4.40		
635.01	0.00	0.00	5.35	4.45	4.45		
635.11	0.00	0.00	5.45	4.49	4.49		
635.21	0.00	0.00	5.55	4.53	4.53		
635.31	0.00	0.00	5.65	4.57	4.57		
635.41	0.00	0.00	5.75	4.61	4.61		
635.42	0.00	0.00	5.76	4.61	4.61	100 yr	4.61

Graphical Hydrograph Method for Stormwater Detention Pond 2

Methodist Hospital for Special Surgery, Town of Addison

Design Frequency:	100 year storm
Purpose:	Use the graphical hydrograph method to determine the volume of stormwater storage needed to compensate for increased runoff due to development.
Method:	Use the Rational Method to determine maximum rate of runoff $Q = c \cdot i \cdot A$ Where: c = Frequency Factor Coefficient i = Rainfall Intensity (in/hr) A = Drainage Area (acres)
Assumptions:	Rainfall Intensity determined from attached graph given Time of Concentration (Tc) or Duration and the Return Period of the storm.
For Existing Conditions:	$c=1.00$, $c=0.30$, $T_c=10$ min, $I=8.74$ in./hr.
For Proposed Conditions:	Use $c=1.00$, $c=0.50$ for Non-Residential Uses, $T_c=10$ min, $I=8.74$

I. Determination of Allowable Release Rate - Existing Site

Total site area	1.95	acres
Detained Time of Concentration (Tc)	10	minutes
Rainfall intensity for one-hundred year storm (I=10 min)	8.74	inches/hr
Frequency Factor coefficient	1.00	
Detained runoff coefficient	0.30	
Allowable total site detained release rate	5.1	cfs
Area of site draining through detention pond	1.74	acres
Area of site draining undetained	0.21	acres
Undetained Time of Concentration (Tc)	10	minutes
Rainfall intensity for one-hundred year storm (I=10 min)	8.74	inches/hr
Frequency Factor coefficient	1.00	
Runoff coefficient for developed conditions	0.90	
Runoff from undetained area	1.7	cfs
Total off-site area passed through	0.00	acres
Time of Concentration (Tc)	10	minutes
Rainfall intensity for one-hundred year storm (I=15 min)	8.74	inches/hr
Frequency Factor coefficient	1.00	
Runoff coefficient	0.90	
Off-site pass-through rate	0.0	cfs
Total release rate from detention pond (allowed)	3.46	cfs
Actual metered release rate from detention pond	3.46	cfs

Total release rate = Allowable total site detained release rate - Runoff from undetained area + Off-site pass-through rate

II. Required Storage Calculations, Return Period = 100 years

Duration (hours)	Duration (min)	Rainfall Intensity (in/hr)	Inflow Rate (cfs)	Inflow Volume (cf)	Outflow Rate (cfs)	Outflow Volume (cf)	Inflow - Outflow Volume (cf)	Required Storage (ac-ft)
0.17	10	8.74	13.7	8,212	3.46	2,077	6,135	0.141
0.25	15	7.52	11.8	10,599	3.46	2,596	8,003	0.184
0.33	20	6.80	10.6	12,779	3.46	3,115	9,664	0.222
0.50	30	5.74	9.0	16,180	3.46	4,153	12,027	0.276
0.67	40	4.94	7.7	18,566	3.46	5,192	13,375	0.307
0.83	50	4.37	6.8	20,530	3.46	6,230	14,300	0.328
1.00	60	3.90	6.1	21,987	3.46	7,268	14,718	0.338
1.17	70	3.65	5.7	24,007	3.46	8,306	15,700	0.364
1.33	80	3.35	5.2	25,181	3.46	9,345	15,836	0.364
1.50	90	3.08	4.8	26,046	3.46	10,383	15,663	0.360
1.67	100	2.87	4.5	26,967	3.46	11,421	15,545	0.357
1.83	110	2.70	4.2	27,906	3.46	12,460	15,446	0.355
2.00	120	2.53	4.0	28,526	3.46	13,498	15,028	0.345
Pond 2 =		888 L.F. 6'x6' RCB	15,984					
TOTAL			15,984					
Required Volume =			15,836					
Volume Provided =			15,984					

Pond 2 Outfall Calculations

Purpose: Provide metered flow that meets the 100-year storm event release rate restrictions.

Method: Use weir flow and orifice flow calculations to determine total outflow as a product of pond depth.

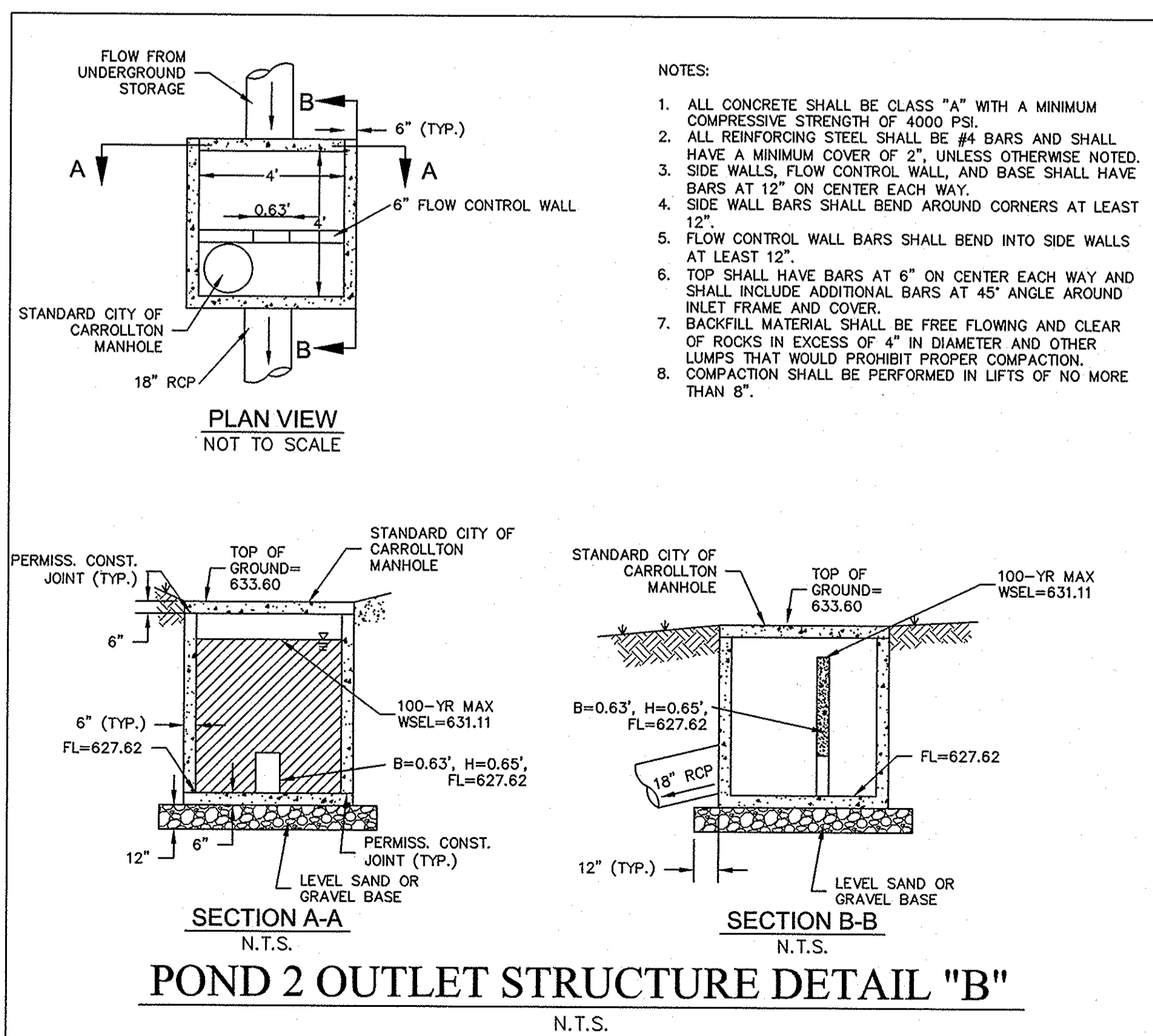
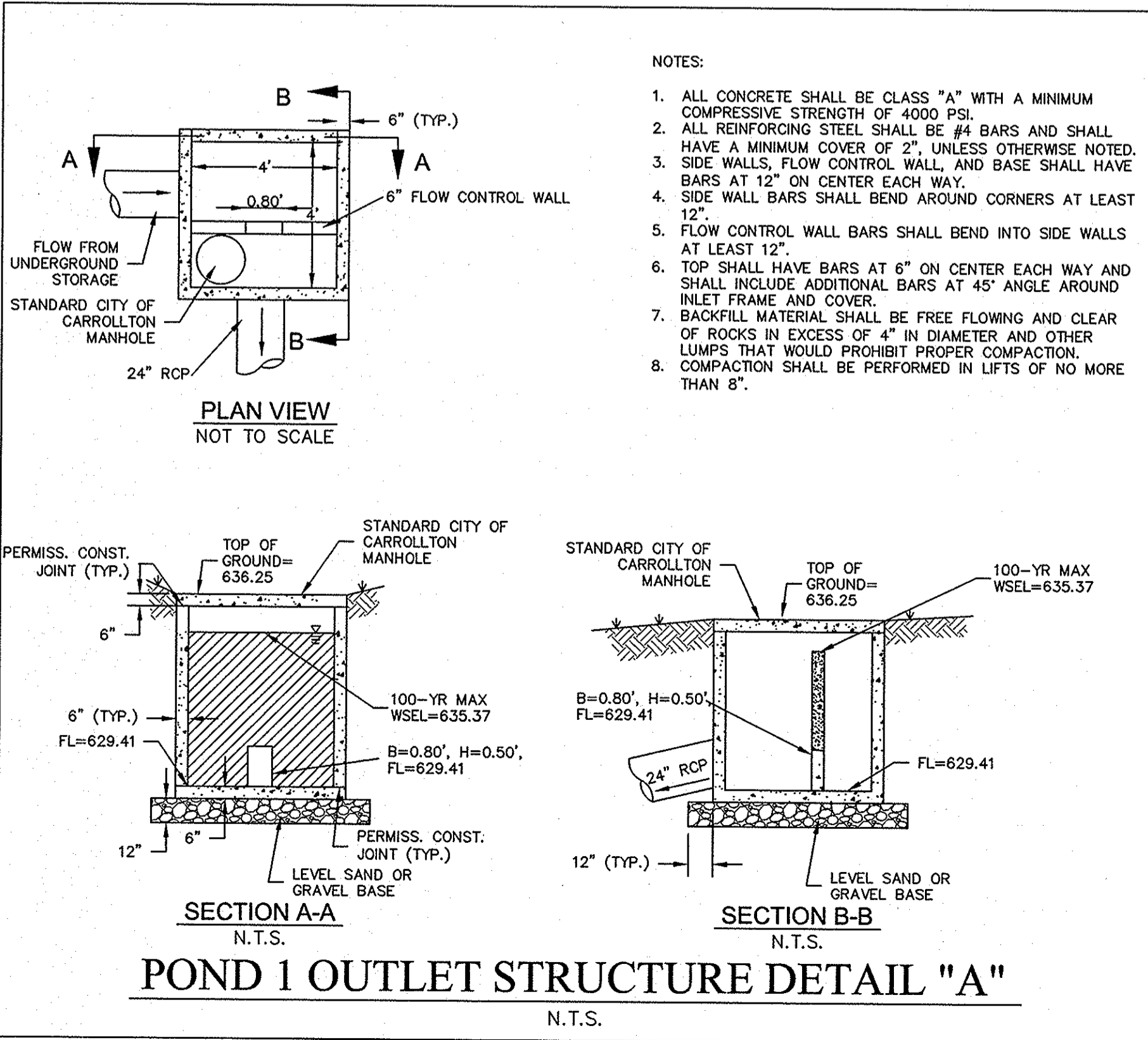
Goal: Water surface elevation based upon volume required 100-yr storm requires 0 cf of storage, which occurs at elev 631.11

Where: Use weir equation to determine flow until opening is submerged.
 $Q = C^*b^*H^{3/2}$
 $C =$ discharge coefficient = 3.33
 $b =$ weir base width
 $H =$ water level height above base of weir

Use orifice equation to determine flow once opening is submerged.
 $Q = A^*C^*(2g^*h)^{1/2}$
 $A =$ area of opening = 0.6
 $C =$ discharge coefficient = 0.6
 $h =$ water level height above center of opening

Opening 1	
b =	0.63 ft
Height =	0.65 ft
A =	0.40 SF
base elev =	627.62 ft

WSEL	H1	Q1	h1	Q1	Qtotal	Event	Q allow
627.62	0.00	0.00	0.00	0.00	0.00		
627.72	0.10	0.07	0.00	0.00	0.07		
627.82	0.20	0.19	0.00	0.00	0.19		
627.92	0.30	0.34	0.00	0.00	0.34		
628.02	0.40	0.53	0.00	0.00	0.53		
628.12	0.50	0.74	0.00	0.00	0.74		
630.12	0.00	0.00	2.18	2.87	2.87		
630.22	0.00	0.00	2.28	2.94	2.94		
630.32	0.00	0.00	2.38	3.00	3.00		
630.42	0.00	0.00	2.48	3.06	3.06		
630.52	0.00	0.00	2.58	3.13	3.13		
630.62	0.00	0.00	2.68	3.19	3.19		
630.72	0.00	0.00	2.78	3.24	3.24		
630.82	0.00	0.00	2.88	3.30	3.30		
630.92	0.00	0.00	2.98	3.36	3.36		
631.02	0.00	0.00	3.08	3.42	3.42		
631.11	0.00	0.00	3.17	3.46	3.46	100 yr	3.46



RECORD DRAWINGS
(SEPTEMBER 2010)

INFORMATION PROVIDED BY:
Rogers-O'Brien Construction Company

METHODIST HOSPITAL
FOR SURGERY
ADDISON, TEXAS
FILE NUMBER: 311T-7863

DETENTION CALCULATIONS

SHEET
C-08

App. _____

Revisions _____

No. _____ Date _____

Scale: AS SHOWN

Designed by: TNB

Drawn by: TNB

Checked by: DDK

Date: 11/03/09

Project No. 6902500

**Kimley-Horn
and Associates, Inc.**

7510 Coates Court, Suite 200
Frisco, Texas 75034
State of Texas Registration No. F-528

Tel. No. (972) 355-3580
Fax. No. (972) 355-3779