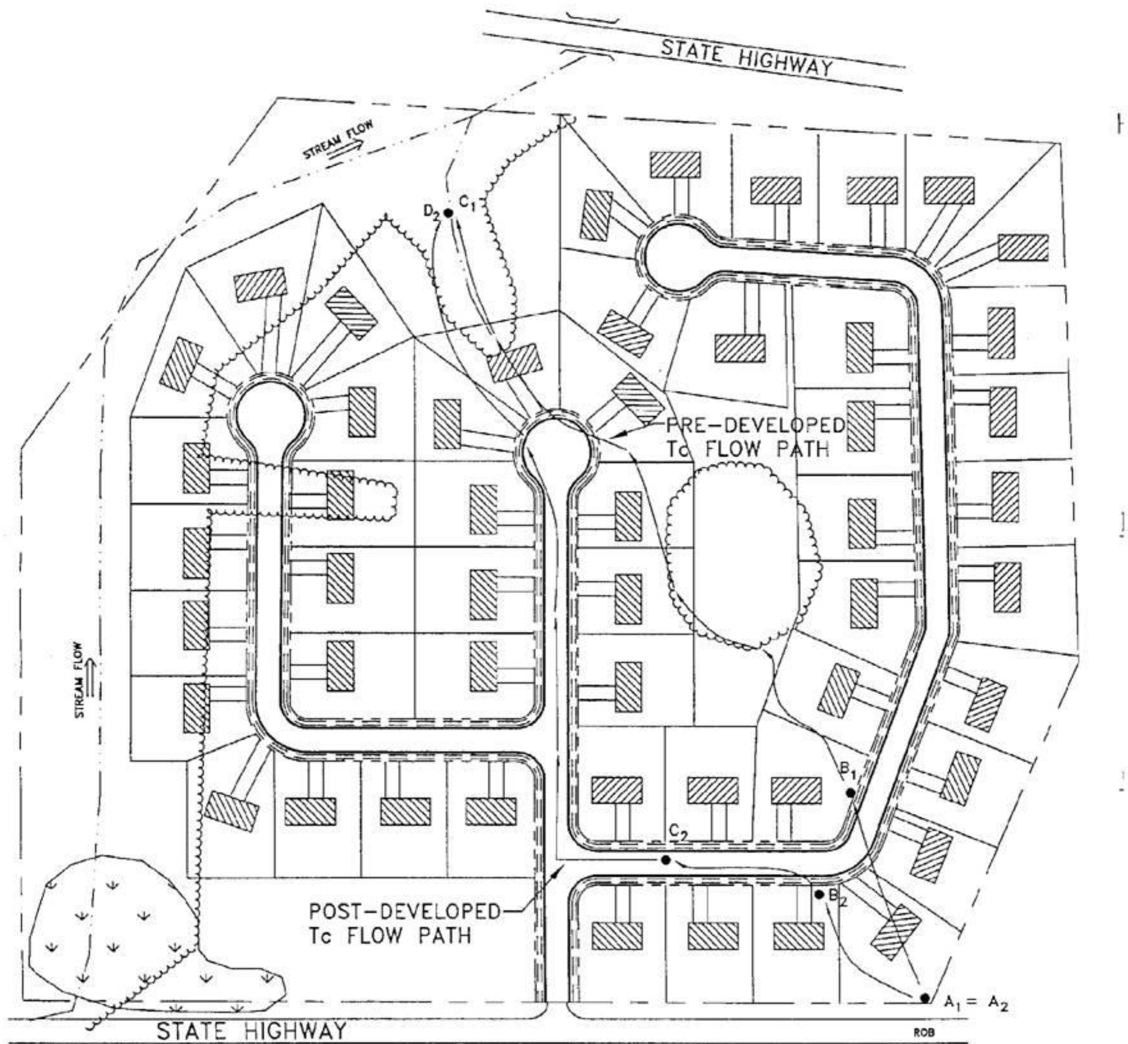
Appendix D-1

Stormwater Pond Design Example

The following design example is for a wet extended detention (ED) stormwater pond.



Base Data		Hydrologic Data	
Site Area = Total Drainage Area (A) = 38.0 ac		Pre	Post
Measured Impervious Area = 13.8 ac; or I = 13.8/38 = 36.3%	CN	65	78
Soils Types: 60% "C", 40% "B"	t_c	.32 hr	.17 hr
Zoning: Residential (½ acre lots)			

Figure 1. Peachtree Meadows Site Plan

NOTE: This real life example uses the overbank protection volume of Q_{p25}. However, Columbia County requires an overbank protection volume of Q_{p50}.

Computation of Preliminary Stormwater Storage Volumes and Peak Discharges

The layout of the Peachtree Meadows subdivision is shown on the previous page. This example assumes that the local community has adopted the unified stormwater sizing criteria requirements.

Step 1 -- Compute runoff control volumes from the Unified Stormwater Sizing Criteria

More details hydrologic calculations will be required during the design step – these numbers are preliminary.

Compute Water Quality Volume, WQ_v

- Compute Runoff Coefficient, R_v

$$R_v = 0.05 + (I)(0.009)$$
$$= 0.05 + (36.13)(0.009) = 0.38$$

- Compute WQ_v

$$WQ_v = (1.2")(R_v)(A)$$
$$= (1.2")(0.38)(38.0\ ac)(1\ ft / 12\ in)$$
$$= 1.44\ ac - ft$$

Develop Site Hydrologic and Hydrologic Input Parameters

Per Figures 2 and 3. Note that any hydrologic models using SCS procedures, such as TR-20, HEC-HMS, or HEC-1, can be used to perform preliminary hydrologic calculations.

Condition	**Area**	**CN**	**T_c**
	Ac		**Hrs**
pre-developed	38	65	0.32
post-developed	38	78	0.17

Perform Preliminary Hydrologic Calculations

Condition	**Q_{1-yr}**	**Q_{1-yr}**	**Q_{25-yr}**	**Q_{100-yr}**
Runoff	*inches*	*cfs*	*cfs*	*cfs*
pre-developed	0.7	22	101	147
post-developed	1.4	67	202	267

Compute Channel Protection Volume, (Cp_v)

For stream channel protection, provide 24 hours of extended detention for the 1-year event.

Utilize SCS approach to Compute Channel Protection Storage Volume.

See Section 2.1

- Initial abstraction (Ia) for CN of 78 is 0.564: $[Ia = (200 / CN - 2)]$
- $Ia / P = (0.564) / 3.4\ inches = 0.17$
- T_c = 0.17 hours
- q_u = 800 csm/in (Type II Storm)

Knowing q_u and T (extended detention time), find q_o/q_i. For a Type II rainfall distribution,

- Peak outflow discharge/peak inflow discharge (q_o/q_i) = 0.022
- $\mathbf{Vs / Vr = 0.683 - 1.43 (q_o / q_i) + 1.64 (q_o / q_i)^2 + 0.804 (q_o / q_i)^3}$
- Where Vs equals channel protection storage (Cp_v) and Vr equals the volume of runoff in inches.
- Vs/Vr = 0.65
- Therefore, $\mathbf{Vs = Cp_v = 0.65 (1.4") (1/12) (38\ ac) = 2.9\ ac - ft\ (126{,}324\ cubic\ feet)}$

<u>Define the average CP_v-ED Release Rate</u>

- The above volume, 2.9 ac-ft, is to be released over 24 hours.
- $\mathbf{(2.9\, ac - ft * 43{,}560\, ft^2 / ac) / (24\, hrs * 3{,}600\ sec/hr) = 1.46\ cfs}$

Compute Overbank Flood Protection Volume, (Q_{p25})

- For a Q_{in} of 202 cfs, and an allowable Q_{out} of 101 cfs, and a runoff volume of 552,584 cubic feet (12.69 ac-ft) the Vs necessary for 25-year control is 3.55 ac-ft, under a developed CN of 78. Note that 6.5 inches of rain fall during this event, with approximately 4.0 inches of runoff.
- While the TR-55 short-cut method reports to incorporate multiple stage structures, experience has shown an additional 10-15% storage is required when multiple levels of extended detention are provided inclusive with the 25-year storm. So, for preliminary sizing purposes add 15% to the required volume for the 25-year storm. Q_{p25} = 3.55 × 1.15 = 4.1 ac-ft.

Analyze Safe Passage of 100 Year Design Storm (Q_f)

At final design, provide safe passage for the 100-year event, or detain it, depending on downstream conditions and local policy. Based on field observation and review of local requirements no control of the 100-year storm is necessary. If it were storage estimates would have been made similar to the Q_p Volume in the previous sub-step.

Table 1. Summary of General Storage Requirements for Peachtree Meadows

Symbol	Control Volume	Volume Required (ac-ft)	Notes
WQ_v	Water Quality	1.44	
Cp_v	Channel Protection	2.9	Average ED release rate is 1.46 cfs over 24 hours
Q_{p25}	Overbank Flood Protection	3.55	
Q_f	Extreme Flood Protection	NA	Provide safe passage for the 100-year event in final design

Step 2 -- Determine if the development site and conditions are appropriate for the use of a stormwater pond

<u>Site Specific Data</u>

The site area and drainage area to the pond is 38.0 acres. Existing ground at the pond outlet is 919 MSL. Soil boring observations reveal that the seasonally high water table is at elevation 918. The underlying soils are SC (sandy clay) and are suitable for earthen embankments and to support a wet pond without a liner. The stream invert at the adjacent stream is at elevation 916.

Other site screening aspects listed in Section 3.1 and 3.2.1 were assessed and a pond was found to be suitable.

PEAK DISCHARGE SUMMARY				
JOB:	P'TREE MEADOWS			EWB
DRAINAGE AREA NAME:	PRE-DEVELOPED CONDITIONS			3-Jan-00
COVER DESCRIPTION	**SOIL NAME**	**GROUP A, B, C or D?**	**CN FROM TABLE 2.1.5-1**	**AREA (in acres)**
meadow (good condition)		C	71	22.80
meadow (good condition)		B	58	9.20
woods (good condition)		B	55	6.00
		Area Subtotals:		38.00
Time of Concentration	**Surface Cover**	**Manning 'n'**	**Flow Length**	**Slope**
2-yr 24-hr Rainfall = 4.1 in	**Cross Section**	**Wetted Per**	**Avg Velocity**	**Tt (Hrs)**
Sheet Flow	**dense grass**	**n' = 0.24**	**150 Ft.**	**2.50%**
				0.27 Hrs.
Shallow Flow	**unpaved**		**500 Ft.**	**4.00%**
			3.23 F. P. S.	0.04 Hrs.
Channel Flow				
Total Area in Acres =	**38.00**	**Total Sheet Flow =**	**Total Shallow Flow =**	**Total Channel Flow =**
Weighted CN =	**65**			
Time of Concentration =	**0.31 Hrs**	**0.27 Hrs**	**0.04 Hrs**	**0.00 Hrs**
Pond Factor =	**1**	**RAINFALL TYPE II**		
STORM	**Precipitation (P) inches**	**Runoff (Q)**	**Qp, Peak Discharge**	**Total Storm Volumes**
1 Year	3.4 In.	0.7 In.	21.9 CFS	93,771 cu. ft.
2 Year	4.1 In.	1.1 In.	37.2 CFS	148,313 cu. ft.
5 Year	4.8 In.	1.5 In.	54 CFS	209,936 cu. ft.
10 Year	5.5 In.	2.0 In.	74 CFS	277,081 cu. ft.
25 Year	6.5 In.	2.7 In.	101 CFS	373,288 cu. ft.
50 Year	7.2 In.	3.3 In.	124 CFS	449,409 cu. ft.
100 Year	7.9 In.	3.8 In.	147 CFS	528,261 cu. ft.

Figure 2. Peachtree Meadows Pre-Development Conditions

PEAK DISCHARGE SUMMARY				
JOB:	P'TREE MEADOWS			EWB
DRAINAGE AREA NAME:	POST-DEVELOPED CONDITIONS			3-Jan-00
COVER DESCRIPTION	SOIL NAME	GROUP A, B, C or D?	CN FROM TABLE 2.1.5-1	AREA (in acres)
open space		C	74	13.00
open space		B	61	5.20
woods (good condition)		B	55	6.00
impervious area		C	98	7.90
impervious area		B	98	5.90
		Area Subtotals:		38.00
Time of Concentration	Surface Cover	Manning 'n'	Flow Length	Slope
2-yr 24-hr Rainfall = 4.1 in	Cross Section	Wetted Per	Avg Velocity	Tt (Hrs)
Sheet Flow	short grass	'n' = 0.15	100 Ft.	2.50%
				0.13 Hrs
Shallow Flow	paved		300 Ft.	2.00%
			2.87 F. P. S.	0.03 Hrs
Channel Flow		'n' = 0.013	600 Ft.	2.00%
Hydraulic Radius	X - S estimated	WP estimated	16.21 F. P. S.	0.01 Hrs
Total Area in Acres =	38.00	Total Sheet Flow = 0.13 Hrs	Total Flow = 0.03 Hrs	Total Channel Flow = 0.01 Hrs
Weighted CN =	78			
Time of Concentration =	0.17 Hrs			
Pond Factor =	1	RAINFALL TYPE		
STORM	Precipitation (P) inches	Runoff (Q)	Qp, Peak Discharge	Total Storm Volumes
1 Year	3.4 In.	1.4 In.	67.1 CFS	191,988 cu. ft.
2 Year	4.1 In.	2.0 In.	95.8 CFS	269,103 cu. ft.
5 Year	4.8 In.	2.5 In.	127 CFS	350,750 cu. ft.
10 Year	5.5 In.	3.2 In.	159 CFS	435,668 cu. ft.
25 Year	6.5 In.	4.0 In.	202 CFS	552,584 cu. ft.
50 Year	7.2 In.	4.7 In.	234 CFS	642,337 cu. ft.
100 Year	7.9 In.	5.3 In.	267 CFS	733,444 cu. ft.

Figure 3. Peachtree Meadows Post-Development Conditions

Step 3 -- Confirm local design criteria and applicability

There are no additional requirements for this site.

Step 4 -- Determine pretreatment volume

Size wet forebay to treat 0.1"/impervious acre. $\mathbf{(13.8\ ac)(0.1")(1'/12") = 0.12\ ac - ft}$ (forebay volume is included in WQ_v as part of permanent pool volume)

Step 5 -- Determine permanent pool volume (and water quality ED volume)

Size permanent pool volume to contain 50% of WQ_v:

$\mathbf{0.5 * (1.44\ ac - ft) = 0.72\ ac - ft}$ (includes 0.12 ac-ft of forebay volume)

Size ED volume to contain 50% of WQ_v:

$\mathbf{0.5 * (1.44\ ac - ft) = 0.72\ ac - ft}$

Note: This design approach assumes that all of the ED volume will be in the pond at once. While this will not be the case, since there is a discharge during the early stages of storms, this conservative approach allows for ED control over a wider range of storms, not just the target rainfall.

Step 6 -- Determine pond location and preliminary geometry. Conduct pond grading and determine storage available for permanent pool and water quality extended detention

This step involves initially grading the pond (establishing contours) and determining the elevation-storage relationship for the pond. Storage must be provided for the permanent pool (including sediment forebays), extended detention (WQ_v-ED), Cp_v-ED, and 25-year storm, plus sufficient additional storage to pass the 100-year storm with minimum freeboard. An elevation-storage table and curve is prepared using the average area method for computing volumes. See Figure 4 for pond location on site; Figure 5 grading and Figure 6 for Elevation-Storage Data.

<u>Set basic elevations for pond structures</u>

- The pond bottom is set at elevation 920.0.
- Provide gravity flow to allow for pond drain, set riser invert at 919.5
- Set barrel outlet elevation at 919.0.

<u>Set water surface and other elevations</u>

- Required permanent pool volume = 50% of WQ_v = 0.72 ac-ft. From the elevation-storage table, read elevation 924.0 (1.04 ac-ft > 0.72 ac-ft) site can accommodate it and it allows a small safety factor for fine sediment accumulation - OK
- Forebay volume provided in two pools with avg. vol. = 0.08 ac-ft each (0.16 ac-ft > 0.12 ac-ft) OK
- Required extended detention volume (WQ_v-ED) = 0.72 ac-ft. From the elevation-storage table (volume above permanent pool), read elevation 926.0 (0.73 ac-ft > 0.72 ac-ft) OK. Set ED wsel = 926.0

Note: Total storage at elevation 926.0 = 1.77 ac-ft (greater than required WQ_v of 1.44 ac-ft)

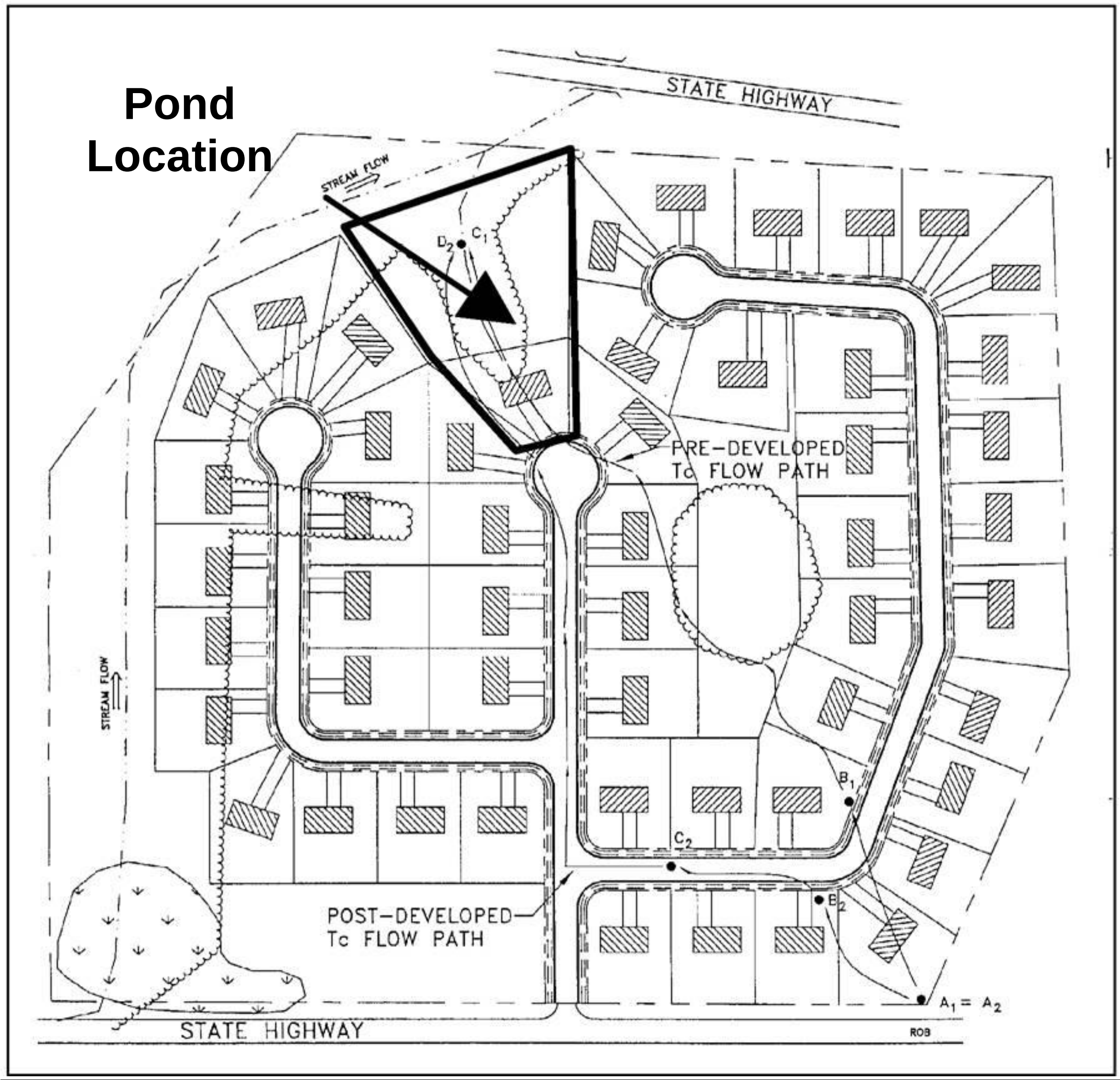


Figure 4. Pond Location on Site

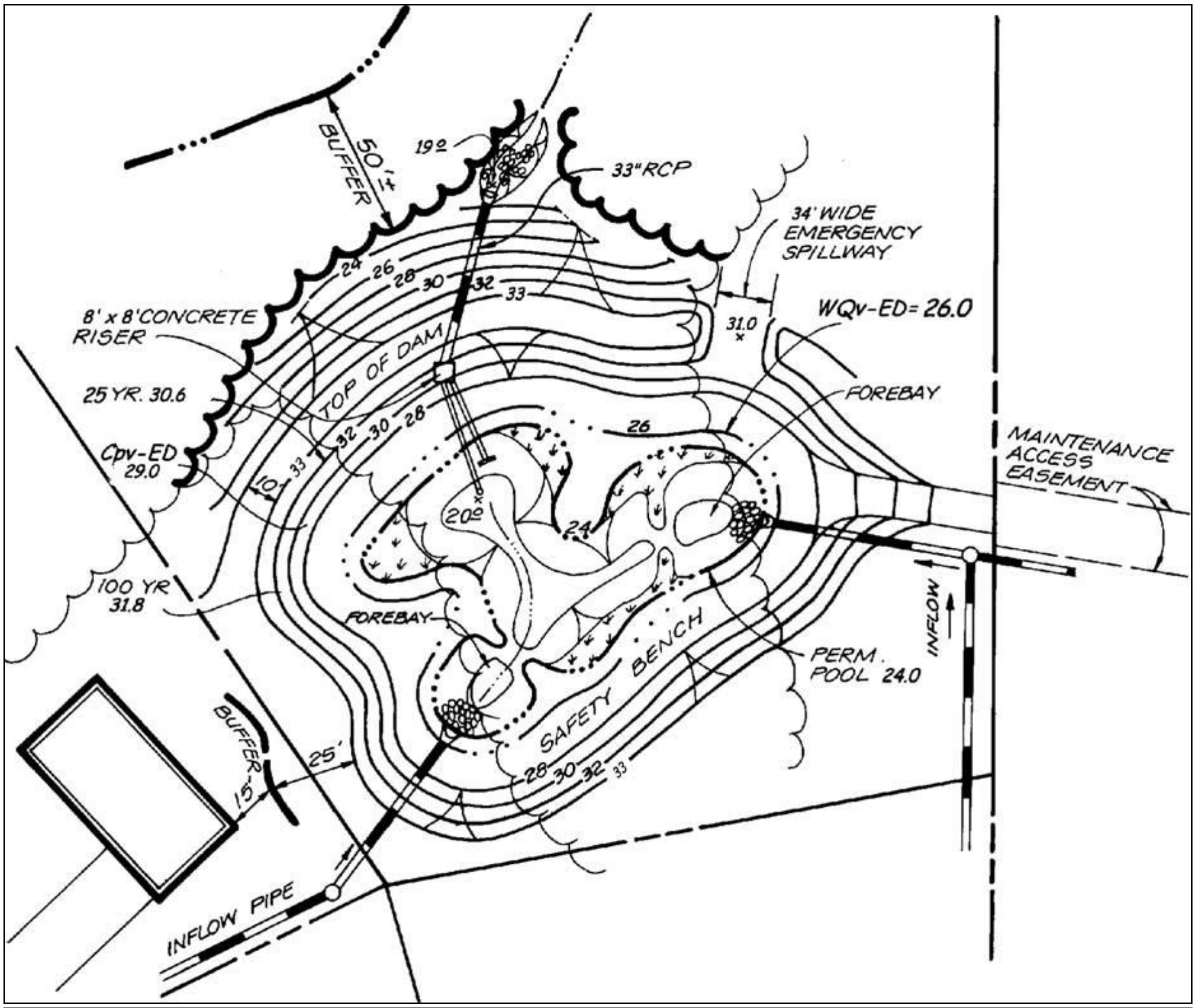


Figure 5. Plan View of Pond Grading (Not to Scale)

Elevation MSL	Average Area ft ^2	Depth ft	Volume ft ^3	Cumulative Volume ft ^3	Cumulative Volume ac-ft	Volume Above Permanent Pool ac-ft
920.0						
921.0	7838	1.0	7838	7838	0.18	
923.0	11450	2.0	22900	30738	0.71	
924.0	14538	1.0	14538	45276	1.04	0.00
925.0	15075	1.0	15075	60351	1.39	0.35
925.5	16655	0.5	8328	68679	1.58	0.54
926.0	17118	0.5	8559	77238	1.77	0.73
926.5	21000	0.5	10500	87738	2.01	0.97
927.0	25000	0.5	12500	100238	2.30	1.26
927.5	30000	0.5	15000	115238	2.65	1.61
928.0	36000	0.5	18000	133238	3.06	2.02
928.5	38000	0.5	19000	152238	3.49	2.46
929.0	41000	0.5	20500	172738	3.97	2.93
929.5	43000	0.5	21500	194238	4.46	3.42
930.0	45000	0.5	22500	216738	4.98	3.94
930.5	47000	0.5	23500	240238	5.52	4.48
931.0	49000	0.5	24500	264738	6.08	5.04
931.5	52000	0.5	26000	290738	6.67	5.64
932.0	55000	0.5	27500	318238	7.31	6.27
932.5	58000	0.5	29000	347238	7.97	6.93
933.0	61000	0.5	30500	377738	8.67	7.63
933.5	65000	0.5	32500	410238	9.42	8.38
934.0	69000	0.5	34500	444738	10.21	9.17
935.0	74000	1	74000	518738	11.91	10.87

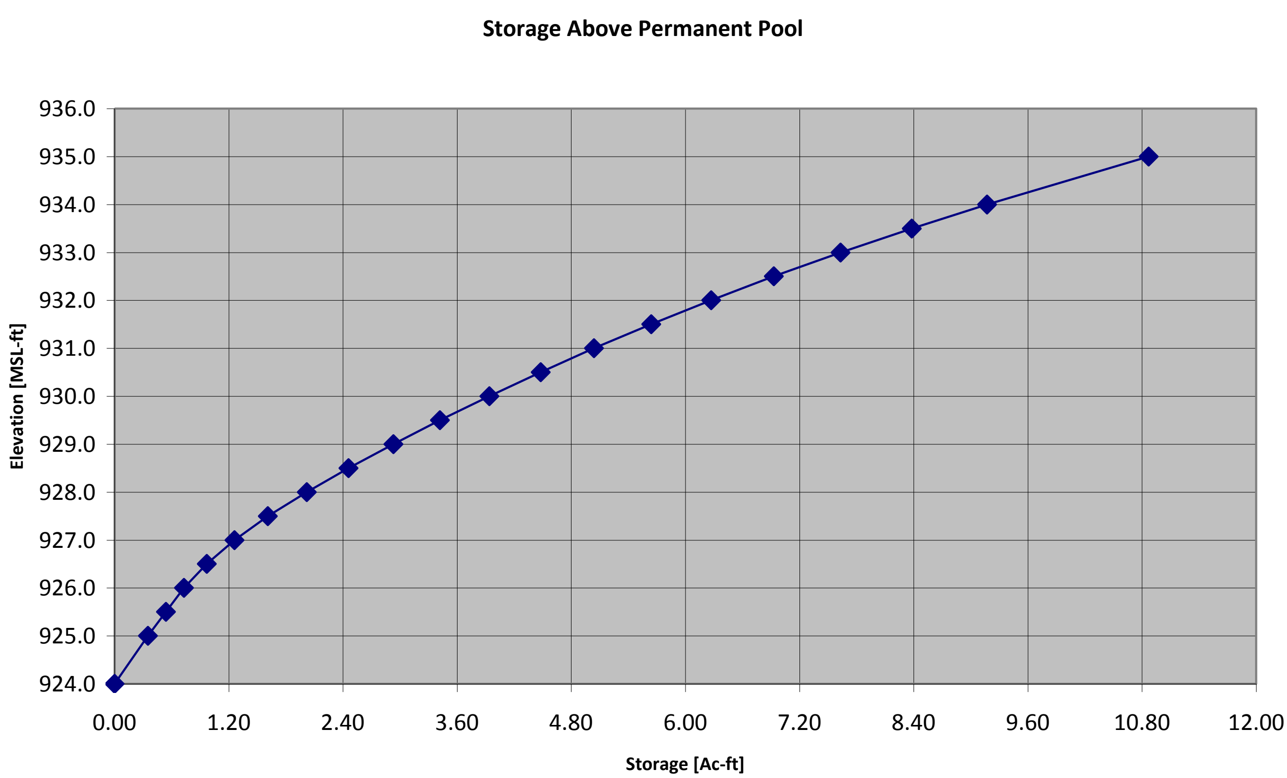


Figure 6. Storage-Elevation Table/Curve

Compute the required WQ_v-ED orifice diameter to release 0.72 ac-ft over 24 hours

- **Avg. ED release rate =** $\mathbf{(0.72\ ac\text{ - }ft)(43{,}560\ ft^2/ac)/(24\ hr)(3600\ sec/hr) = 0.36\ cfs}$
- **Average head =** $\mathbf{(926.0 - 924.0)/2 = 1.0'}$
- Use orifice equation to compute cross-sectional area and diameter
  - $\mathbf{Q = CA(2gh)^{0.5}}$, for Q=0.36 cfs; h = 1.0 ft; C = 0.6 = discharge coefficient solve for A
  - $\mathbf{A = 0.36\ cfs/[(0.6)((2)\ 32.2\ ft/s^2)(1.0\ ft))^{0.5}]}$ $\mathbf{A = 0.075\ ft^2}$, $\mathbf{A = \pi d^2/4;}$ dia. = 0.31 ft = 3.7"
  - Use 4" pipe with 4" gate valve to achieve equivalent diameter

Compute the stage-discharge equation for the 3.7" dia. WQ_v orifice

- $\mathbf{Q_{WQ_v-ED} = CA(2gh)^{0.5} = (0.6)(0.075\ ft^2)[((2)(32.2\ ft/s^2))^{0.5}](h^{0.5}),}$
- $\mathbf{Q_{WQ_v-ED} = (0.36)h^{0.5},}$ where: h = wsel - 924.16

  (Note: account for one half of orifice diameter when calculating head)

Step 7 -- Compute extended detention orifice release rate(s) and size(s), and establish Cp_v elevation

Set the Cp_v pool elevation

- Required Cp_v storage = 2.9 ac-ft (see Table 1).
- From the elevation-storage table, read elevation 929 (this includes the WQ_v).
- Set Cp_v wsel = 929

Size Cp_v orifice

- Size to release average of 1.46 cfs.
  - Average WQ_v-ED orifice release rate is 0.66 cfs, based on average head of $\mathbf{3.34'(926.0 - 924.16 + (929 - 926)/2)}$
  - **Cp_v-ED orifice release =** $\mathbf{1.46 - 0.66 = 0.88\ cfs}$
- **Head =** $\mathbf{(929.0 - 926.0)/2 = 1.5'}$

Use orifice equation to compute cross-sectional area and diameter

- $\mathbf{Q = CA(2gh)^{0.5}}$, for h = 1.5'
- $\mathbf{A = 0.80\ cfs/[(0.6)((2)(32.2\ ft/s^2)(1.5'))^{0.5}]}$
- $\mathbf{A = 0.14\ ft^2}$, $\mathbf{A = \pi d^2/4;}$ dia. = 0.42 ft = 5.0"
- Use 6" pipe with 6" gate valve to achieve equivalent diameter

Compute the stage-discharge equation for the 5.0" dia. Cp_v orifice

- $\mathbf{Q_{Cp_v=ED} = CA(2gh)^{0.5} = (0.6)(0.14\ ft^2)[((2)(32.2\ ft/s^2))^{0.5}](h^{0.5}),}$
- $\mathbf{Q_{Cp_v=ED} = (0.67)(h^{0.5}),}$ where: h = wsel - 926.21

  (Note: account for one half of orifice diameter when calculating head)

Step 8 -- Calculate Q_{p25} (25-year storm) release rate and water surface elevation

In order to calculate the 25 year release rate and water surface elevation, the designer must set up a stage-storage-discharge relationship for the control structure for each of the low flow release pipes (WQ_v-ED and Cp_v-ED) plus the 25 year storm.

Develop basic data and information

- The 25 year pre-developed peak discharge = 101 cfs,
- The post developed inflow = 202 cfs, from Table 1,
- From previous estimate Q_{p-25} = 3.55 ac-ft. Adding 15% to account for ED storage yields a preliminary volume of 4.1 ac-ft.
- From elevation-storage table (Figure 6), read elevation 930.1.

Size 25 year slot to release 101 cfs at elevation 930.1.

- @ wsel 930.1:
  - WQ_v-ED orifice releases 0.88 cfs,
  - Cp_v-ED orifice releases 1.32 cfs, therefore;
  - **Allowable $Q_{p25} = 101\,\text{cfs} - (0.88 + 1.32) = 98.8$ cfs, say 99 cfs.**
- **Max head = $(930.1 - 929.0) = 1.1'$**
- Use weir equation to compute slot length
  - $Q = CLH^{3/2}$
  - $L = 99\ \text{cfs} / (3.1)(1.13/2) = 27.7\ \text{ft}$
- Use four 7ft x 1.5 ft slots for 25-year release (opening should be slightly larger than needed so as to have the barrel control before slot goes from weir flow to orifice flow).

Check orifice equation using cross-sectional area of opening

- $Q = CA(2gh)^{0.5}$, for h = 0.75' (For orifice equation, h is from midpoint of slot)
- $A = 4(7.0')(1.5') = 42.0\ \text{ft}^2$
- $Q = 0.6\,(42.0\ \text{ft}^2)[(64.4)(0.75)]^{0.5} = 175\ \text{cfs} > 99\ \text{cfs}$, so use weir equation

$$Q_{25} = (3.1)(28')\,H^{3/2}, \quad Q_{25} = (86.8)\,H^{3/2},$$ where H = wsel – 929.0

Size barrel to release approximately 101 cfs at elevation 930.1

- Check inlet condition: (use Section 4.3 culvert charts)
  - $H_w = 930.1 - 919.5 = 10.6\ \text{ft}$
  - Try 33" diameter RCP, Using Figure 4.3-1 with entrance condition 1
  - $H_w / D = 10.6 / 2.75 = 3.85$, Discharge = 88 cfs
- Check outlet condition:
  - $Q = a\,[(2gH)/(1 + km + kpL)]^{0.5}$

where:
- Q = discharge in cfs
- a = pipe cross sectional area in ft^2
- g = acceleration of gravity in ft/sec^2
- H = head differential (wsel - downstream centerline of pipe or tailwater elev.)
- k_m = coefficient of minor losses (use 1.0)
- k_p = pipe friction loss coefficient (= $5087n^2/d^{4/3}$, d in ", n is Manning's n)
- L = pipe length in ft

- $\mathbf{H = 930.1 - (919.0 + 1.38) = 9.72'}$
- **for 33" RCP, 70 feet long:**
- $\mathbf{Q = 7.1[(64.4)(9.72)/1 + 1 + (0.007)(70)]^{0.5} = 112.6\ cfs}$
- $\mathbf{88\ cfs < 112.6\ cfs,}$ so barrel is inlet controlled.

Note: pipe will control flow before high stage inlet reaches max head.

Complete stage-storage-discharge summary (Figure 7) up to preliminary 25-year wsel (930.1) and route 25 year post-developed condition inflow using computer software. Pond routing computes 25-year wsel at 930.8 with discharge = 92.4 cfs.

Elevation MSL	Storage ac-ft	Low Flow WQv-ED 3.7" eq dia		Riser						Barrel				Emergency Spillway		Total Discharge
				Cp_v-ED 5.0" eq dia		High Stage Slot				Inlet		Pipe				
						Orifice		Weir								
		H ft	Q cfs	H ft	Q cfs	H ft	Q cfs	H ft	Q cfs	H ft	Q cfs	H ft	Q cfs	H ft	Q cfs	Q cfs
924.0	0.00	0.0	0.0													0.00
925.0	0.35	0.8	0.33													0.33
925.5	0.54	1.3	0.42													0.42
926.0	0.73	1.8	0.49	0.0	0.00											0.49
926.5	0.97	2.3	0.55	0.3	0.36											0.91
927.0	1.26	2.8	0.61	0.8	0.60											1.20
927.5	1.61	3.3	0.57	1.3	0.76											1.42
928.0	2.02	3.8	0.71	1.8	0.90											1.60
928.5	2.46	4.3	0.75	2.3	1.01											1.76
929.0	2.93	4.8	0.79	2.8	1.12	N/A	-	0.0	0.0							1.91
929.5	3.42	5.3	0.83	3.3	1.22			0.5	30.7							32.70
930.0	3.94	5.8	0.87	3.8	1.30			1.0	86.8							89.00
930.1	4.10	5.9	0.88	3.9	1.32			1.1	100.1	10.6	88.0	9.7	112.6			90.20
930.5	4.48	6.3	0.91	4.3	1.39	0.75	175.0	1.5	159.5	11.0	90.0	10.1	114.9			92.30
931.0	5.04	-	-	-	-	-	-	-	-	11.5	92.5	10.6	117.7	0.0	0.0	92.50
931.5	5.64	-	-	-	-	-	-	-	-	12.0	95.0	11.1	120.4	0.5	24.0	119.00
932.0	6.27	-	-	-	-	-	-	-	-	12.5	97.0	11.6	123.1	1.0	79.0	176.00
932.5	6.93	-	-	-	-	-	-	-	-	13.0	100.0	12.1	125.7	1.5	154.0	253.50
933.0	7.63	-	-	-	-	-	-	-	-	13.5	101.7	12.6	128.3	2.0	252.0	353.70

Figure 7 Stage-Storage-Discharge Summary

Note: Adequate outfall protection must be provided in the form of a riprap channel, plunge pool, or combination to ensure non-erosive velocities.

Step 9 -- Design embankment(s) and spillway(s)

The 25-year wsel is at 930.8. Set the emergency spillway at elevation 931.0 and use design information and criteria Earth Spillways (not included in this manual)

- Q_{100} inflow = 267 cfs.
- Try 34' wide vegetated emergency spillway with 3:1 side slopes.
  - @ elevation 932.6, H = 1.5', Emergency spillway, Q_{ES} = 172 cfs. Primary spillway, Q_{PS}. 100 cfs
  - $\mathbf{Q_{ES} + Q_{PS} = 272\ cfs,}$ will be able to safely convey Q_f = 267. (use computer routing for exact elevations and discharges).
  - 100 year wsel = 931.7, say 932, so set top of embankment with 1 foot of freeboard at elevation 933.

Step 10 -- Investigate potential pond hazard classification

Refer to Georgia Department of Natural Resources Rules for Dam Safety in Appendix H to establish preliminary classification of embankment and whether special design criteria need to be met.

Per Chapter 391-3-8.04, Dam safety rules do not apply to artificial barriers that are:

- Classified as a Category II Dam – dams where improper operation or dam failure would not expect to result in probable loss of human life
- Not in excess of 6 feet in height regardless of storage capacity, or which has a storage capacity at maximum water storage elevation not in excess of 15 acre-feet, regardless of height.

Check pond classification: Height = 931 -919 = 12', equals assumed embankment height, Pond will remain Category II or lower.

As reported in Table 1, the preliminary maximum storage volume required is about 3.5 acre-feet, which is substantially less than the 15 acre-feet exempt limit. Therefore, for initial design considerations, no additional dam safety requirements will apply. Once final design elevations and storage volumes have been determined, a final check for dam rules exemption should be made by the designer.

Step 11 -- Design inlets, sediment forebay(s), outlet structures, maintenance access, and safety features.

Table 2 Summary of Controls Provided

Control Element	Type / Size of Control	Storage Provided	Elevation	Discharge	Remarks
Units		*Acre-feet*	*MSL*	*cfs*	
Permanent Pool		0.86	924.0	0.00	part of WQ_v
Forebay	submerged berm	0.12	924.0	0.00	included in permanent pool volume
Water Quality Extended Detention (WQ_v-ED)	4" pipe, sized to 3.7" equivalent diameter	0.72	926.0	0.36	part of WQ_v above perm. pool, discharge is average release rate over 24 hours
Channel Protection (Cp_v-ED)	6" pipe sized to 5.0" equivalent diameter	2.90	929.0	1.46	volume above perm. pool, discharge is average release rate over 24 hours
Overbank Flood Protection (Q_{p25})	Four 7' x 1.5' slots on a 8' x 8' riser, 36" barrel.	4.10	930.8	92.40	volume above perm. pool
Extreme Flood Protection (Q_{f-100})	34' wide earth spillway	6.30	931.7	141.00	volume above perm. pool

See Figure 8 for profile through principal spillway of the facility.

See Figure 9 for a schematic of the riser.

Step 12 -- Prepare Vegetation and Landscaping Plan.

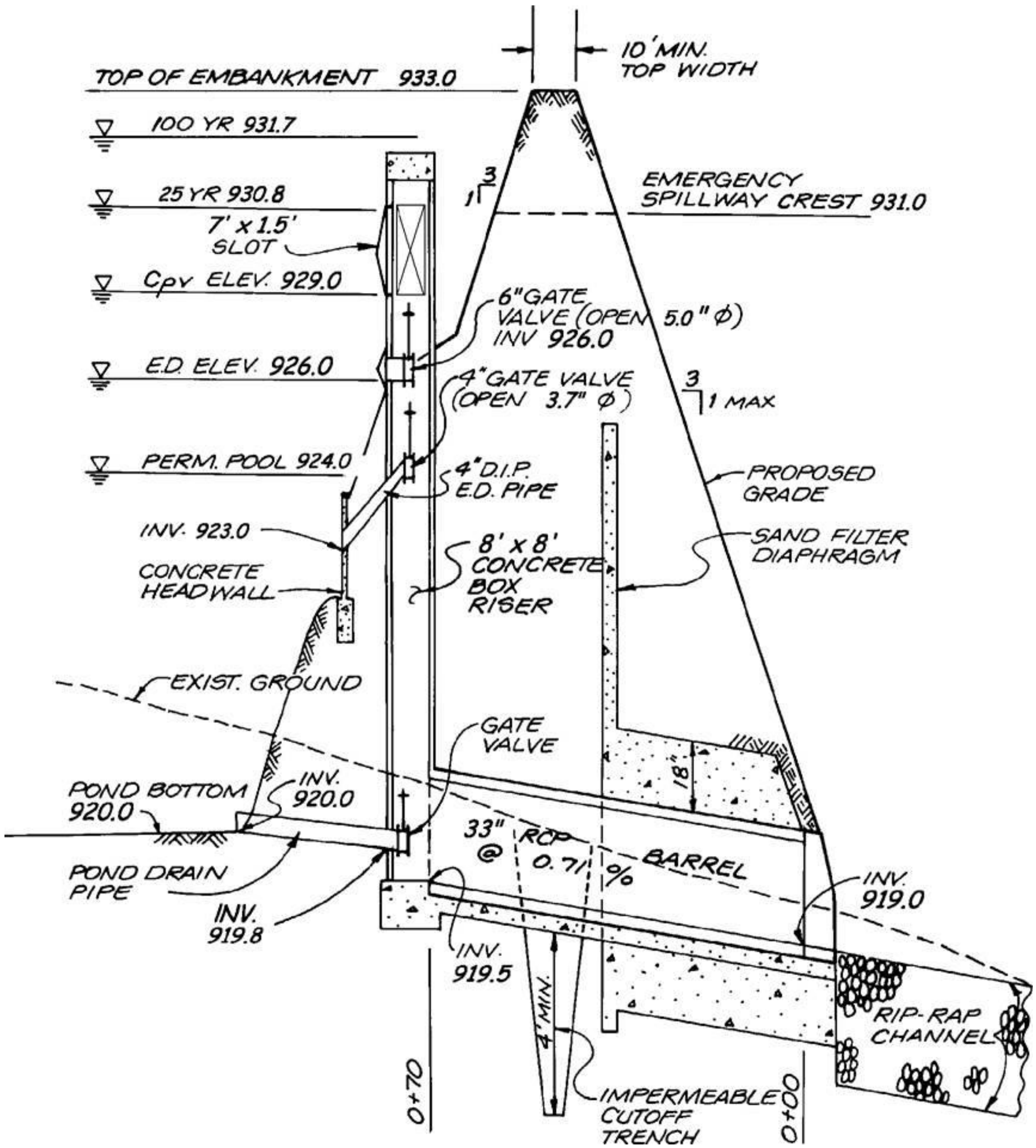


Figure 8 Profile of Principle Spillway

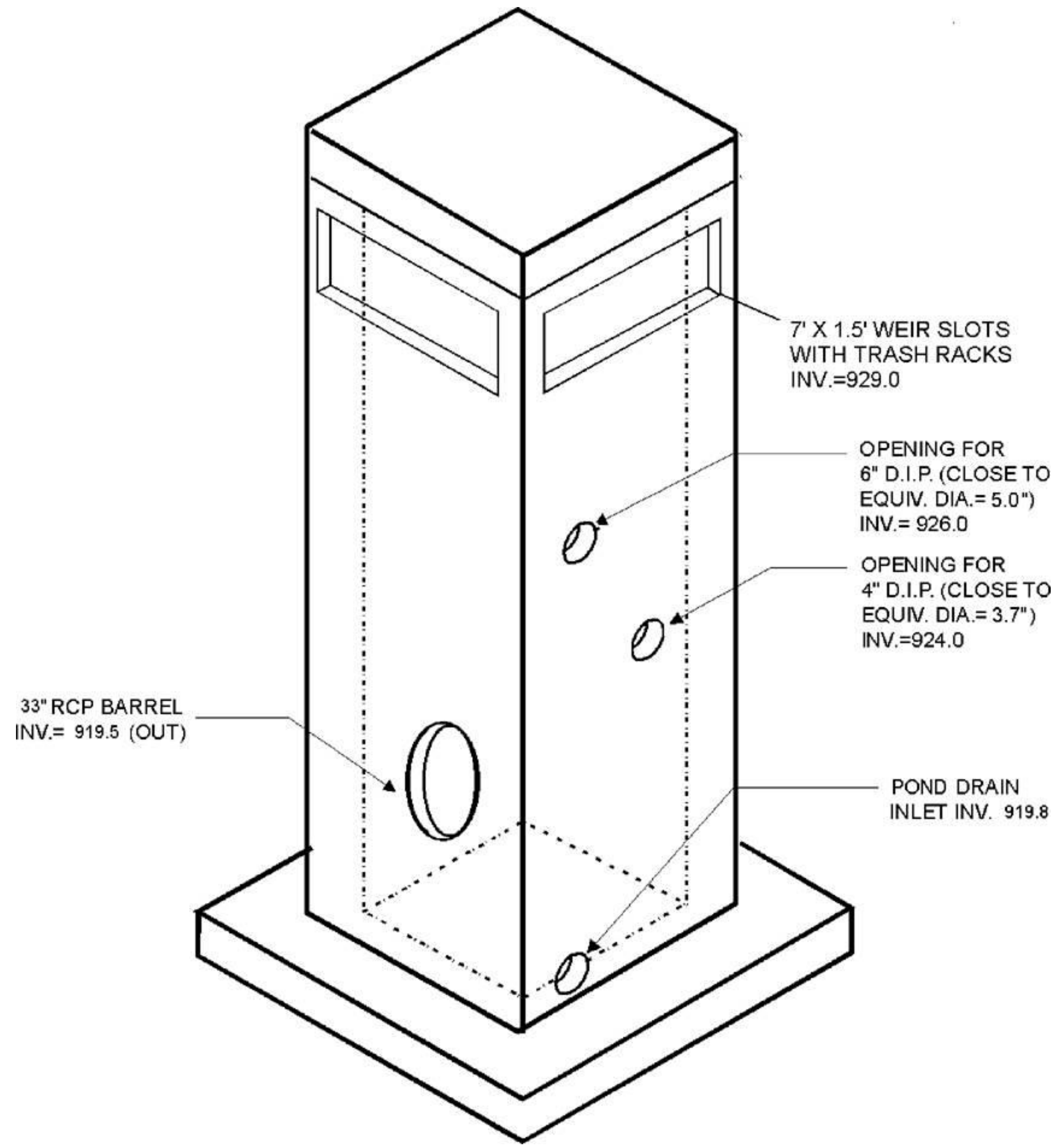


Figure 9 Schematic of Riser Detail

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