TPD - Ponds PRINCIPAL SPILLWAY DESIGN 9

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Types of Principal Spillways

Pipe Drop Inlet

The capacity (Q) of a drop inlet spillway must be determined by calculating the capacity of four flow control points **for a given water surface elevation:**

1. **Weir Flow at the riser inlet (Weir Control)**
2. **Orifice Flow at the riser inlet (High Orifice Control)**
3. **Orifice flow at entrance to conduit (Low Orifice Control)**
4. **Pipe flow through the conduit (Outlet Control)**

The control point with the lowest capacity at the given head is referred to as the **control condition** and establishes the flow rate of the entire drop inlet principal spillway.

The capacity of the entire principal spillway can only be increased by changing the capacity of the control condition.

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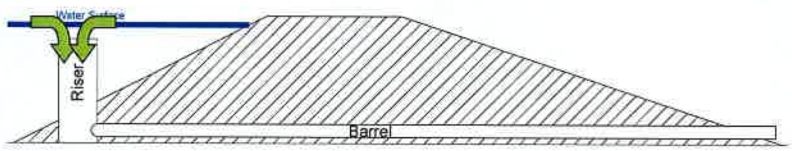
Types of Principal Spillways

Pipe Drop Inlet



1. **Weir flow at the riser inlet (Weir Control)**

(The quantity that is capable of entering the riser based on the edge length)

Use the Weir Equation: $Q = CLH^{(3/2)}$

Where C = 3.33

L = Weir Length

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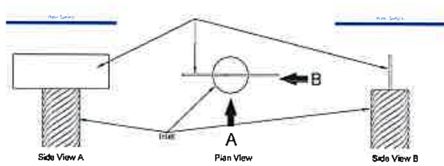
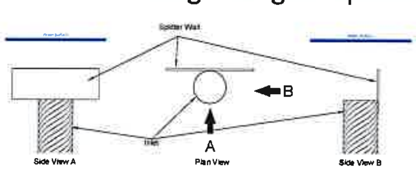
Calculating L for Circular Risers

If using a longitudinal splitter wall



$$L = 2\pi r_{inlet} = \pi d_{inlet} = 3.14 d_{inlet}$$

If using a tangent splitter wall or headwall



$$L = 2.57 d_{inlet}$$

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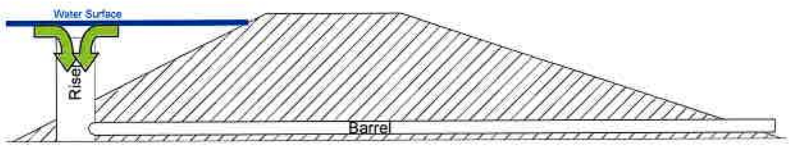
Types of Principal Spillways

Pipe Drop Inlet



2. Orifice flow at the riser inlet (High Orifice)

(The quantity that is capable of entering the riser based on its area)

Use the Orifice Equation: $Q = Ca\sqrt{2gh}$

Where C = 0.6

h = Crest of ES to Crest of Riser

a = Area of Riser

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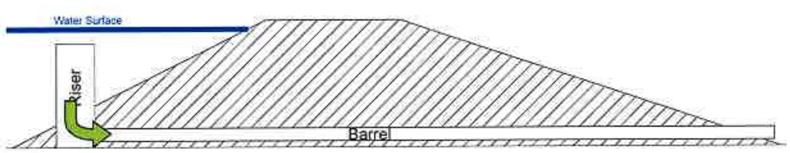
Types of Principal Spillways

Pipe Drop Inlet



3. Orifice flow at entrance to the conduit (Low Orifice)

(The quantity that is capable of entering the pipe based on its area)

Use the Orifice Equation: $Q = Ca\sqrt{2gh}$

Where C = 0.6

h = Crest of ES to CL of Barrel

a = Area of Barrel

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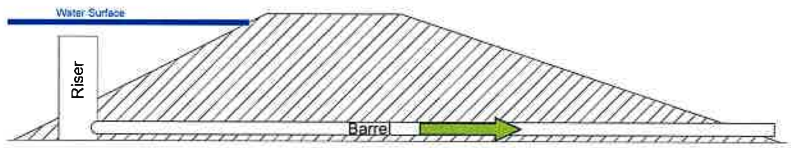
Types of Principal Spillways

Pipe Drop Inlet



4. Pipe flow through the conduit (Outlet control)

(The quantity flowing through the pipe after overcoming friction losses)

$$Q = a\sqrt{\frac{2gH}{(1+K_m+K_pL)}}$$

Use the Pipe Flow Equation:

Where H = Crest of ES to Cl of Barrel Outlet

L = Barrel Length

K_m = 1 (sudden expansion)

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K_p

Values of K_p can be found in EFH Exhibit 3-4 for pipe of various size and Manning's n.

HYDRAULICS: HEAD LOSS COEFFICIENTS FOR CIRCULAR AND SQUARE CONDUITS FLOWING FULL

Head Loss Coefficient, K_p, for Circular Pipe Flowing Full $K_p = \frac{5087\,n^2}{d_i^{4/3}}$

Pipe diam. inches	Flow area sq. ft.	Manning's Coefficient of Roughness "n"															
		0.010	0.011	0.012	0.013	0.014	0.015	0.016	0.017	0.018	0.019	0.020	0.021	0.022	0.023	0.024	0.025
6	0.196	0.0467	0.0545	0.0672	0.0789	0.0914	0.1050	0.1194	0.1348	0.151	0.168	0.187	0.206	.226	.247	.269	.292
8	0.349	.0318	.0385	.0458	.0537	.0623	.0715	.0814	.0919	.1030	.1148	.1272	.140	.154	.168	.183	.199
10	0.545	.0236	.0286	.0340	.0399	.0463	.0531	.0604	.0682	.0765	.0852	.0944	.1041	.1143	.1249	.136	.148
12	0.785	.0185	.0224	.0267	.0313	.0363	.0417	.0474	.0535	.0600	.0668	.0741	.0817	.0896	.0980	.1067	.1157
14	1.069	.0151	.0182	.0217	.0255	.0295	.0339	.0386	.0436	.0488	.0544	.0603	.0665	.0730	.0798	.0868	.0942
15	1.23	.0138	.0166	.0198	.0232	.0270	.0309	.0352	.0397	.0446	.0496	.0550	.0606	.0666	.0727	.0792	.0859
16	1.40	.0126	.0153	.0182	.0213	.0247	.0284	.0323	.0365	.0409	.0455	.0505	.0556	.0611	.0667	.0727	.0789
18	1.77	.01078	.0130	.0155	.0182	.0211	.0243	.0276	.0312	.0349	.0389	.0431	.0476	.0522	.0570	.0621	.0674
21	2.41	.00878	.01062	.0126	.0148	.0172	.0198	.0225	.0254	.0284	.0317	.0351	.0387	.0425	.0464	.0506	.0549
24	3.14	.00735	.00889	.01058	.0124	.0144	.0165	.0188	.0212	.0238	.0265	.0294	.0324	.0356	.0389	.0423	.0459
27	3.98	.00628	.00760	.00904	.01061	.0123	.0141	.0161	.0181	.0203	.0227	.0251	.0277	.0304	.0332	.0362	.0393
30	4.91	.00546	.00660	.00786	.00922	.01070	.01228	.0140	.0158	.0177	.0197	.0218	.0241	.0264	.0289	.0314	.0341
36	7.07	.00428	.00518	.00616	.00723	.00839	.00963	.01096	.0124	.0139	.0154	.0171	.0189	.0207	.0226	.0246	.0267
42	9.62	.00348	.00421	.00502	.00589	.00683	.00784	.00892	.01007	.0113	.0126	.0139	.0154	.0169	.0184	.0201	.0218
48	12.57	.00292	.00353	.00420	.00493	.00572	.00656	.00747	.00843	.00945	.01053	.01166	.0129	.0141	.0154	.0168	.0182
54	15.90	.00249	.00302	.00359	.00421	.00488	.00561	.00638	.00720	.00808	.00900	.00997	.01099	.0121	.0132	.0144	.0156
60	19.63	.00217	.00262	.00312	.00366	.00424	.00487	.00554	.00626	.00702	.00782	.00866	.00955	.01048	.0115	.0125	.0135

PRINCIPAL SPILLWAY DESIGN 16

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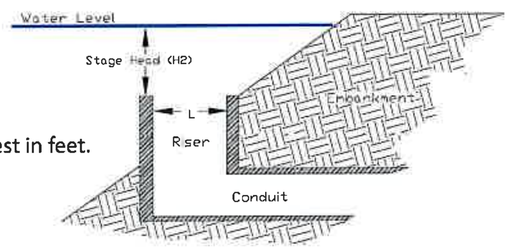
Types of Principal Spillways

Pipe Drop Inlet

The **minimum head required for positive priming** of drop inlet spillways can be determined from:

$$h_2 = \left(\frac{Q_p}{3.1L}\right)^{\frac{2}{3}}$$



H_2 = Minimum head above riser crest in feet.

Q_p = Pipe Discharge in cfs

L = Circumference of riser in feet

Vertical Pipe Must be Bigger Per Keith

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Types of Principal Spillways

Pipe Drop Inlet

Design considerations:

- The minimum cross-sectional area of the riser SHALL be 1.5 times the cross sectional area of the barrel.
- The minimum diameter of the riser SHALL be 1.25 times the diameter of the barrel.
- To prevent clogging, no barrel smaller than 6 in. should be used, nor should any riser smaller than 8 in. be used.
- When the riser is constructed of concrete, inside dimensions should not be smaller than 24" x 24".
- With the addition of a valve in the upstream end, this type of spillway can be used as a drain or water supply pipe.

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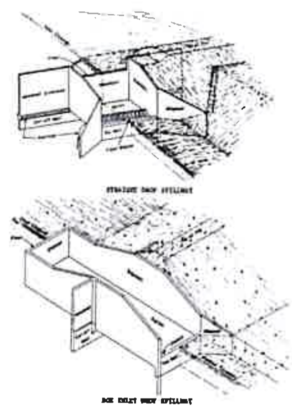
Types of Principal Spillways

4. Drop Spillway

- Efficient structure for controlling low heads, normally up to 10ft
- Weir is less likely to become clogged by debris
- A stable grade below and downstream of structure is critical
- More costly than other types for low head applications



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Types of Principal Spillways

Drop Spillway

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Types of Principal Spillways

5. Monolithic Spillway

TPD - Ponds PRINCIPAL SPILLWAY DESIGN 21

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Types of Principal Spillways

6. Chute Spillway

TPD - Ponds PRINCIPAL SPILLWAY DESIGN 22

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Principal Spillway Conduit Materials

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Conduit Materials

Acceptable pipe conduits according to CPS 378:

- Ductile Iron
- Welded Steel
- Corrugated Steel
- Corrugated Aluminum
- Reinforced Concrete (pre-cast or site-cast)
- Plastic

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