Washington State Department of Ecology
Water Resources Program / Dam Safety Office

# Guidance for
# Air Vents for Drop Inlet Spillways

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This guidance is offered supplement the guidance and spreadsheets for hydraulic computations for drop inlet spillways offered separately on the Dam Safety web site. This guidance focuses on the details of installing the air vent (i.e., the details to be shown on the design drawings) after the appropriate air vent diameter has been determined.

As described in the separate guidance for drop inlet spillways, at this time Dam Safety offers the following recommendations for the size of the air vent pipe:

Scenario **A**: Spillway appears vulnerable to potential flow surges and pressure drops, and/or outlet pipe hydraulics indicate inlet control would be limiting as compared to outlet control at higher flows.

> Recommend air vent pipe = **1/6** outlet pipeline diameter, with 2-inch minimum air vent diameter.

Scenario **B**: Spillway does not appear vulnerable to potential flow surges and pressure drops, and/or outlet pipe hydraulics indicate outlet control would be limiting as compared to inlet control at higher flows.

> Recommend air vent pipe = **1/12** outlet pipeline diameter, with 2-inch minimum air vent diameter.

Scenario **C**: Outlet pipe hydraulics indicate neither end of the outlet pipe is likely to become submerged, even at high flows; HW/D << 1 and TW/D << 1 for all flows. **And:** Weir flow convergence does not occur at water levels below the dam crest elevation; no potential for water seal to develop at or near the riser crest.

Air vent pipe may be omitted. Riser and outlet pipe are already open to the atmosphere during all flow scenarios.

## Air vent design

The following features are suggested for incorporating the air vent pipe into the spillway design:

- Inverted inlet (facing down), screened.
- Inlet elevation at least 1.5 ft above peak water level from dam safety inflow design flood and at least 1.0 ft above dam crest elevation, whichever is higher.
- Air vent pipe strapped to the riser for support over most of its vertical length. May be located either within or outside the riser.
- Air vent connects or opens to the spillway outlet pipe crown roughly ½ pipe diameter from the inlet to the outlet pipe, or just behind a deflector plate.
- A deflector plate at the inlet to the outlet pipe is recommended to help stabilize the flow into the outlet pipe when the pipe inlet is submerged. In most cases, a deflector plate that is $1/10^{th}$ the inlet diameter (i.e., open height = 0.90 x inlet diameter) would suffice.

For illustrative purposes, several excerpts from spillway plan sheets that were approved by Dam Safety are shown on the following pages. My thanks to Goldsmith & Associates of Bellevue and to Apex Engineering of Tacoma for permission to use their design drawings for these examples.

[end]

[MDW, 11/03/04]

# Hydraulic coefficients for deflector plates

Ref : Brater, E.F., and H.W. King. ***Handbook of Hydraulics*** , 6th Edition. McGraw-Hill. 1976.

Key definitions and equations :

$D_p$ = diameter of inlet to outlet conduit = diameter of outlet conduit (usually)
$y_f$ = relative height of opening as decimal % of inlet or conduit diameter
$d_c$ = depth of centroid below water surface as decimal % of opening diameter
$y_c$ = height of centroid above pipe invert as decimal % of opening diameter
$A_f$ = X-area factor for partial pipe flow at opening height = $y_f$
$A_p$ = X-area factor for full pipe flow = [3.1416 / 4.00] = 0.785
$A_f/A_p$ = relative X-area of opening as decimal % of full pipe X-area
$T_f$ = top width of opening = width of deflector plate, as decimal % of open diameter

$d_c$ = table value from Brater & King, Table 7-8 on page 7-37
$y_c$ = $y_f$ - $d_c$
$A_f$ = table value from Brater & King, Table 7-4 on page 7-35
$T_f$ = table value from Brater & King, Table 7-6 on page 7-36

| $y_f$ | $d_c$ | $A_f$ | $A_f/A_p$ | $T_f$ |
|---|---|---|---|---|
| 1.00 | 0.500 | 0.785 | 1.00 | 0.000 |
| 0.90 | 0.424 | 0.745 | 0.95 | 0.600 |
| 0.85 | 0.393 | 0.712 | 0.91 | 0.714 |
| 0.80 | 0.363 | 0.674 | 0.86 | 0.800 |
| 0.75 | 0.336 | 0.632 | 0.81 | 0.866 |
| 0.70 | 0.309 | 0.587 | 0.75 | 0.917 |

**Hydraulic coefficients for deflector plate :**

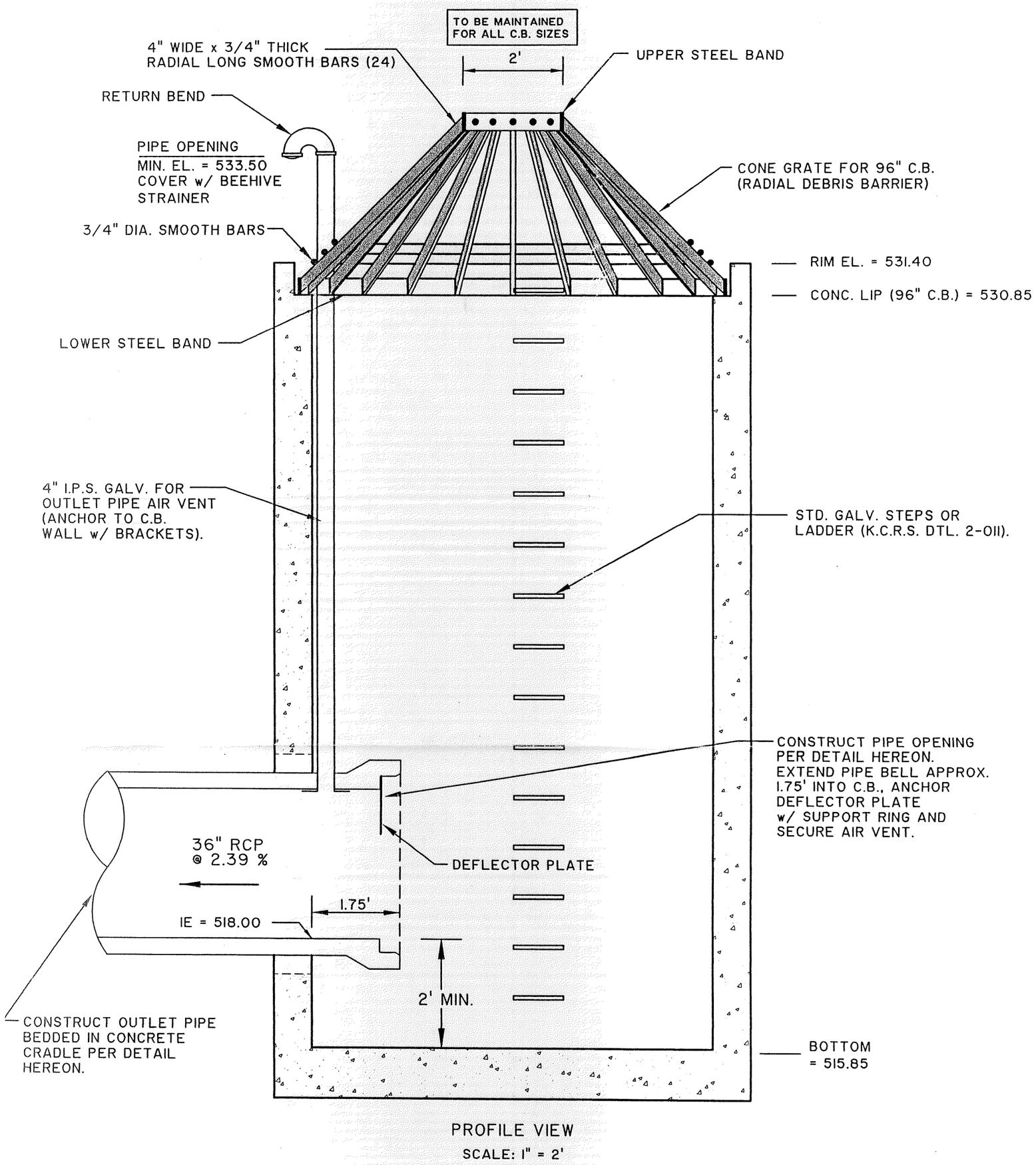
| centroid | top pipe | X-area |
|---|---|---|
| 0.50 | 1.00 | 1.00 |
| 0.48 | 0.90 | 0.95 |
| 0.46 | 0.85 | 0.91 |
| 0.44 | 0.80 | 0.86 |
| 0.41 | 0.75 | 0.81 |
| 0.39 | 0.70 | 0.75 |

Size of deflector plate (inches, vertical dimension) for various pipe sizes :

| $D_p$, inches : | **12** | **18** | **24** | **30** | **36** | **48** | **60** |
|---|---|---|---|---|---|---|---|
| $y_f$ : 0.90 | 1.2 | 1.8 | 2.4 | 3.0 | 3.6 | 4.8 | 6.0 |
| 0.85 | 1.8 | 2.7 | 3.6 | 4.5 | 5.4 | 7.2 | 9.0 |
| 0.80 | 2.4 | 3.6 | 4.8 | 6.0 | 7.2 | 9.6 | 12.0 |
| 0.75 | 3.0 | 4.5 | 6.0 | 7.5 | 9.0 | 12.0 | 15.0 |
| 0.70 | 3.6 | 5.4 | 7.2 | 9.0 | 10.8 | 14.4 | 18.0 |

Width of deflector plate (inches, horizontal dimension) for above pipe sizes :

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| $y_f$ : 0.90 | 7.2 | 10.8 | 14.4 | 18.0 | 21.6 | 28.8 | 36.0 |
| 0.85 | 8.6 | 12.9 | 17.1 | 21.4 | 25.7 | 34.3 | 42.8 |
| 0.80 | 9.6 | 14.4 | 19.2 | 24.0 | 28.8 | 38.4 | 48.0 |
| 0.75 | 10.4 | 15.6 | 20.8 | 26.0 | 31.2 | 41.6 | 52.0 |
| 0.70 | 11.0 | 16.5 | 22.0 | 27.5 | 33.0 | 44.0 | 55.0 |




PROFILE VIEW

SCALE: 1" = 2'

# OVERFLOW STRUCTURE #MC4-1POV, CB TYPE 2 - 96" I.D.

## PRIMARY OVERFLOW

Drawing courtesy of :

**Hugh G. Goldsmith & Associates, Inc.**
**Consulting Engineers • Surveyors • Planners**

1215 114th Avenue SE
Bellevue, WA 98004
P.O. Box 3565
Bellevue, WA 98009

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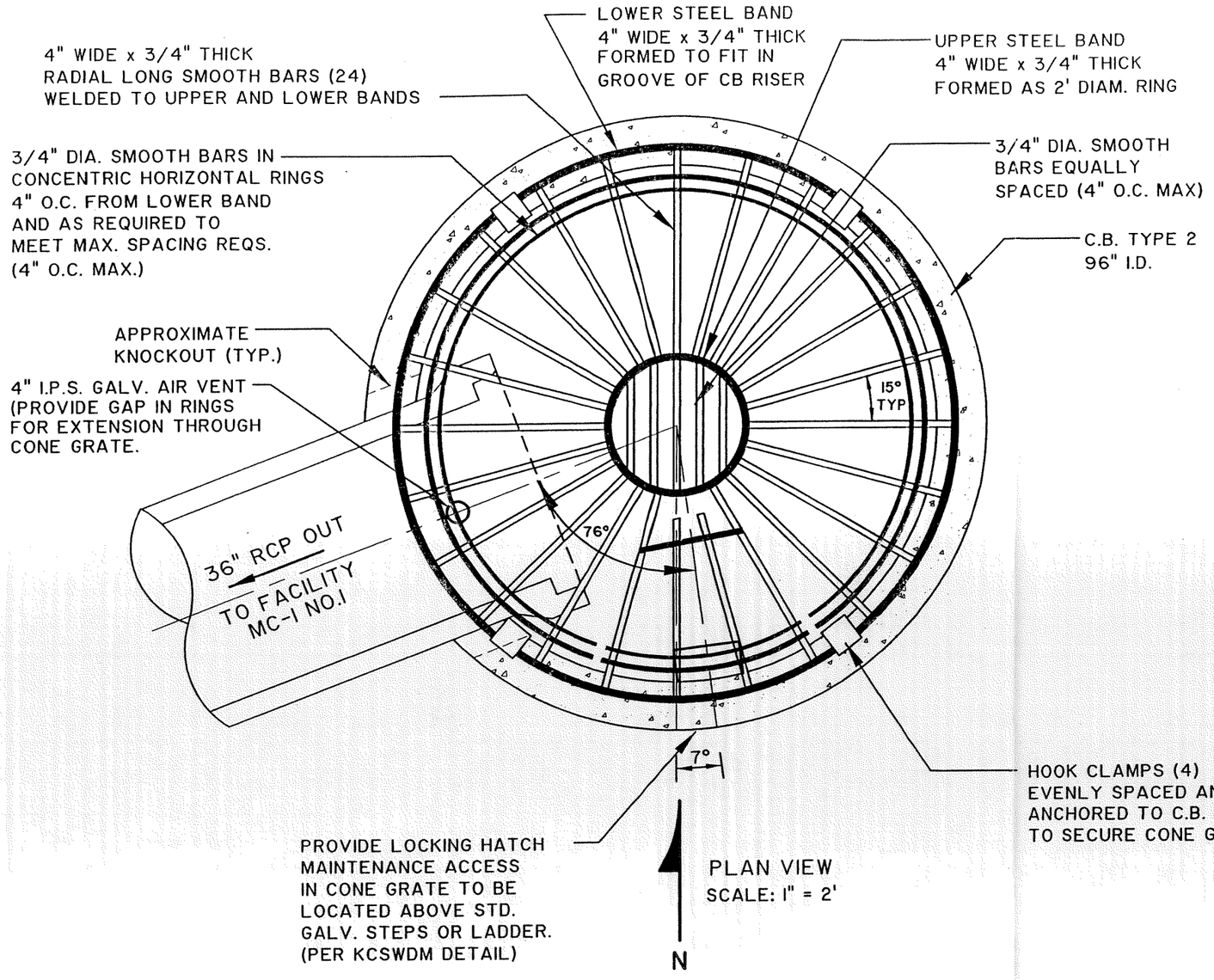


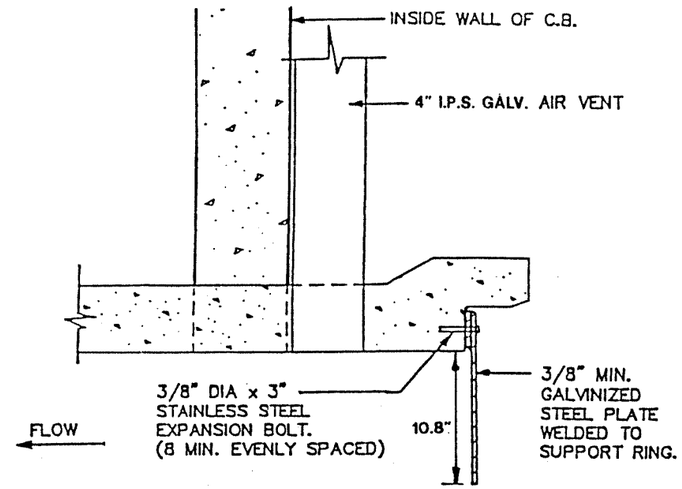


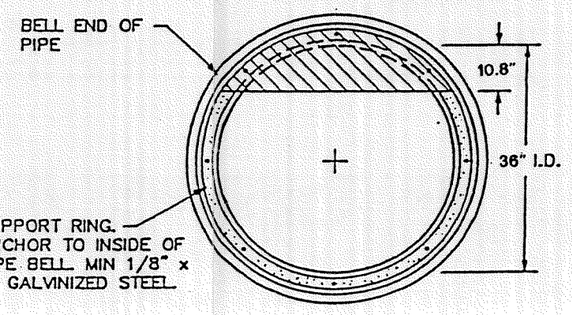


**DEFLECTOR PLATE & AIR VENT**

NOT TO SCALE

# OVERFLOW STRUCTURE #MC4-IPOV, CB TYPE 2 - 96" I.D.
# PRIMARY OVERFLOW

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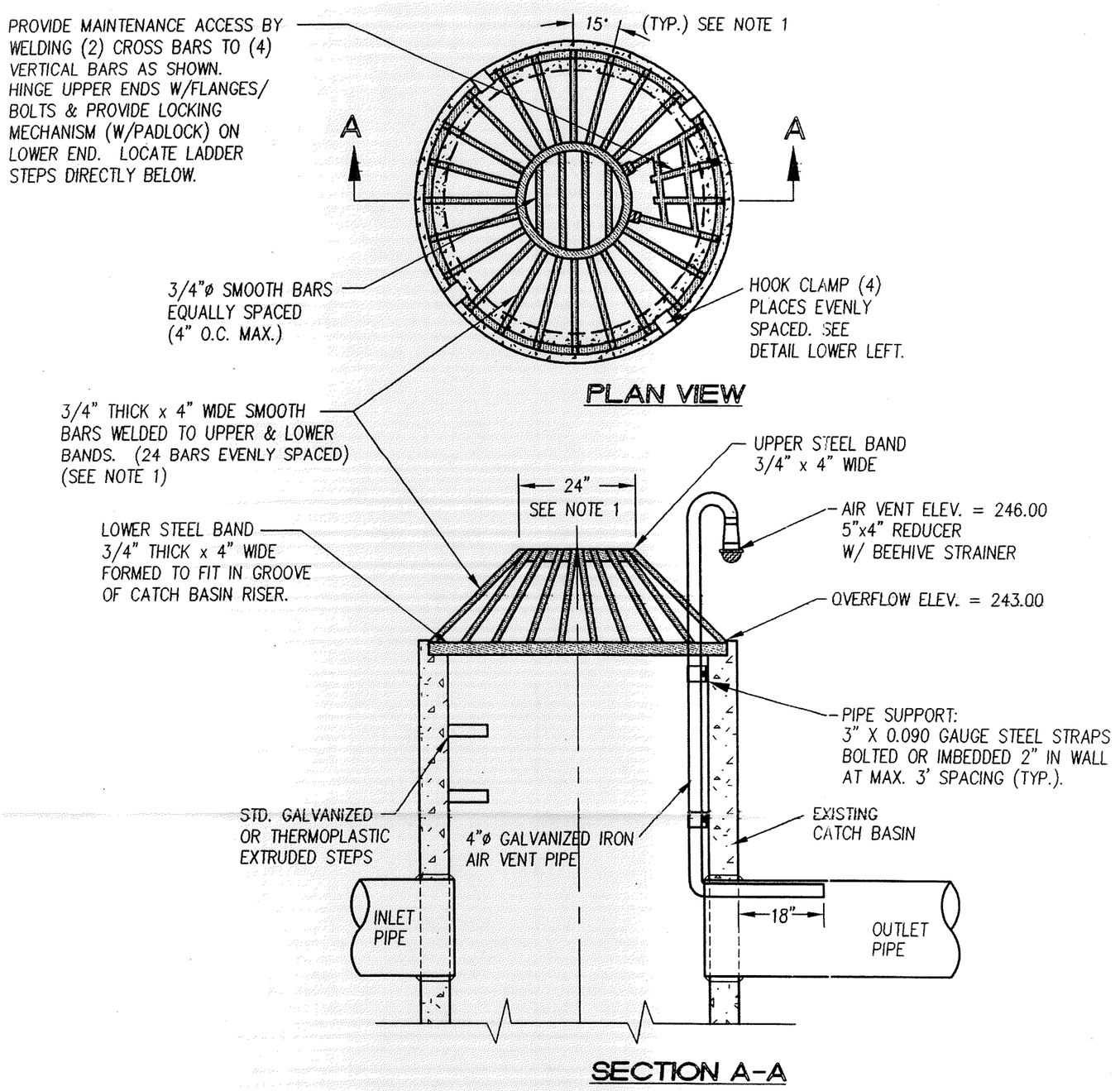



NOTES:

1. DIMENSIONS ARE FOR INSTALLATION ON 54"ø CB. FOR DIFFERENT DIA. CB'S ADJUST DIMENSIONS TO MAINTAIN 45° ANGLE ON "VERTICAL" BARS & 4" O.C. MAX. SPACING OF BARS AROUND LOWER STEEL BAND. WHEN VERTICAL BAR SPACING EXCEEDS 4" O.C., PROVIDE HORIZONTAL RINGS 4" O.C.

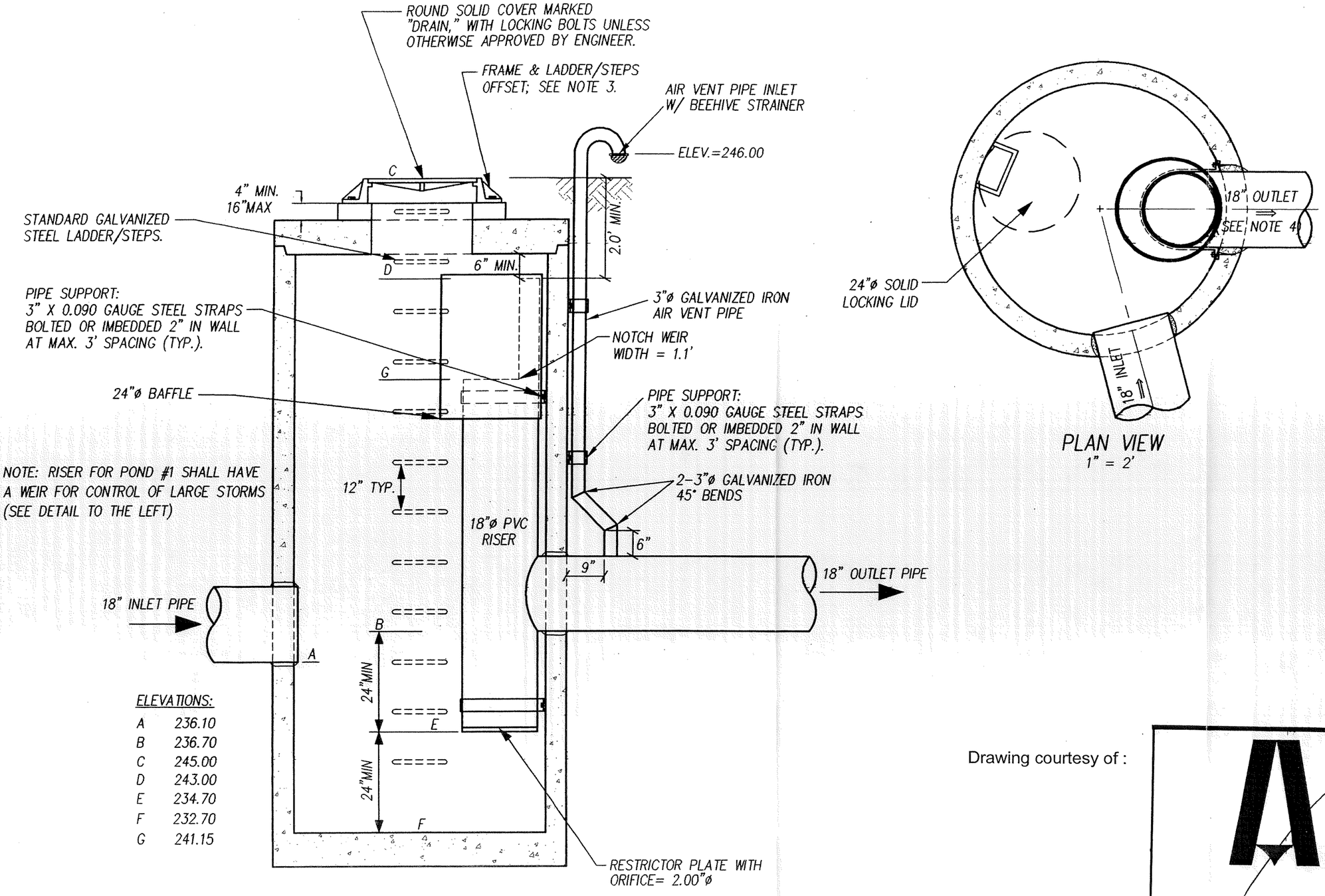
2. METAL PARTS: CORROSION RESISTANT. (STEEL PARTS GALVANIZED OR STAINLESS STEEL)

# OVERFLOW STRUCTURE DETAIL

N.T.S.

Drawing courtesy of :

Apex Engineering PLLC
2601 South 35th, Suite 200
Tacoma, Washington 98409-7479
(253) 473-4494 FAX: (253) 473-0599




PLAN VIEW
1" = 2'

# TYPE 2, 60"ø FLOW CONTROL STRUCTURE

FLOW RESTRICTOR / OIL POLLUTION CONTROL DEVICE

1" = 2'

Drawing courtesy of :

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