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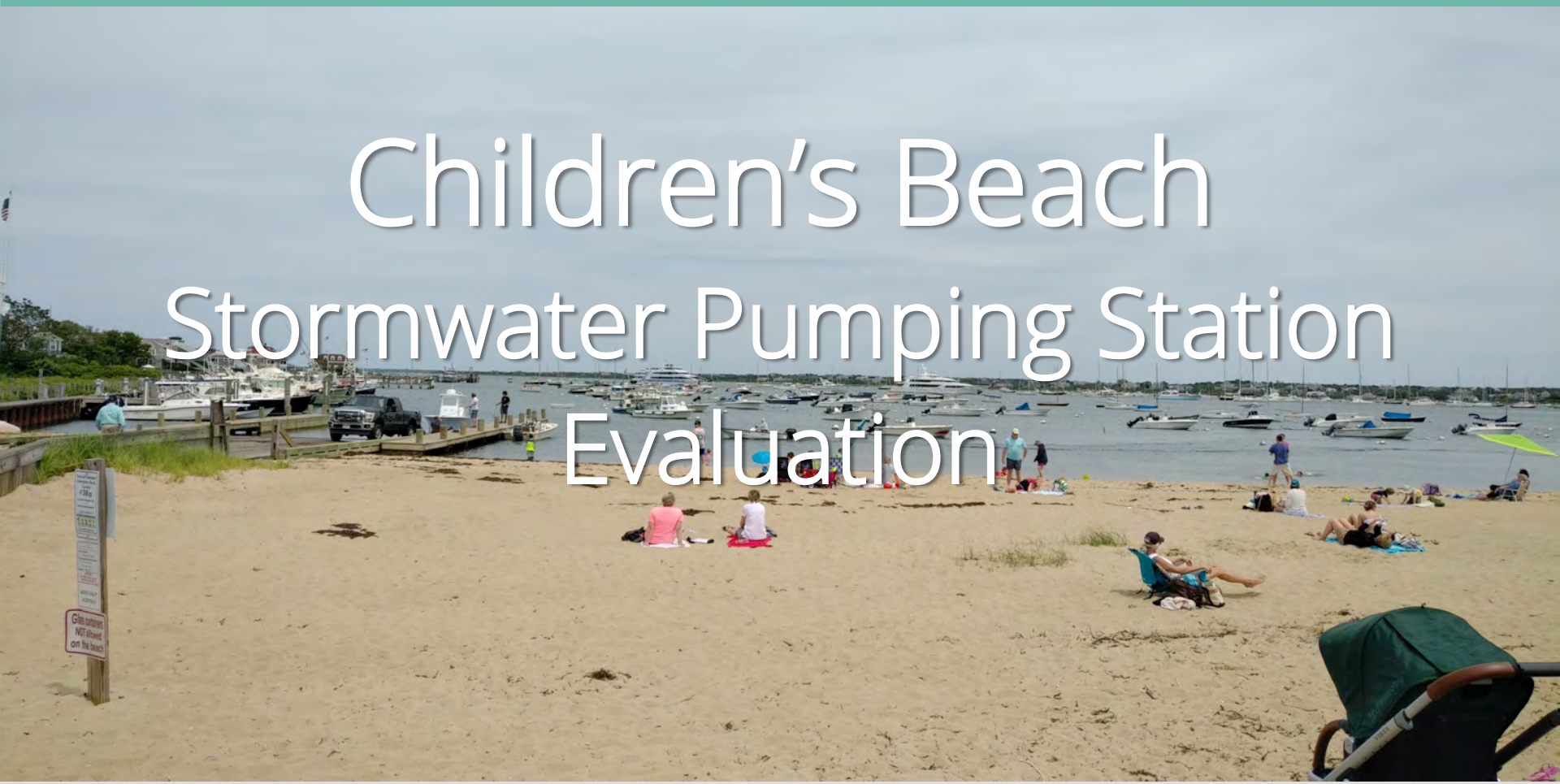


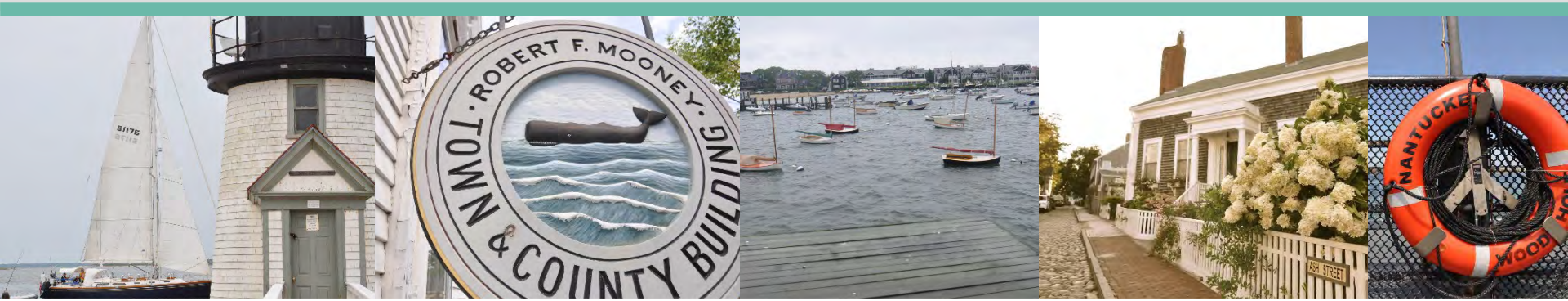
Children's Beach
Stormwater Pumping Station Evaluation

Public Meeting

Town of Nantucket

March 14, 2019

Meeting Agenda



- Background
- Existing Conditions
- Pumping Scenarios
- Forensic Study Results
- Forensics Summary
- Pumping Station Repair Alternatives
- Discussion

Background - Children's Beach Flyover

Children's Beach Tour.kmz

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Background – Initial Pumping Station Commissioning

- 2005 Children's Beach Outfall Evaluation –Improvements
  - *Brant Point SW Outfall Elimination*
  - *Brant Point SW Improvements*
  - *BMPs*
  - *Children's Beach Pumping Station*

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Background

- Pumping Station Commissioned June 2009
  - Part of Children's Beach Outfall Evaluation - 2005
  - KSB 40 Hp Amacan Axial Pumps
  - Small Wet Well
  - Small Discharge Chamber

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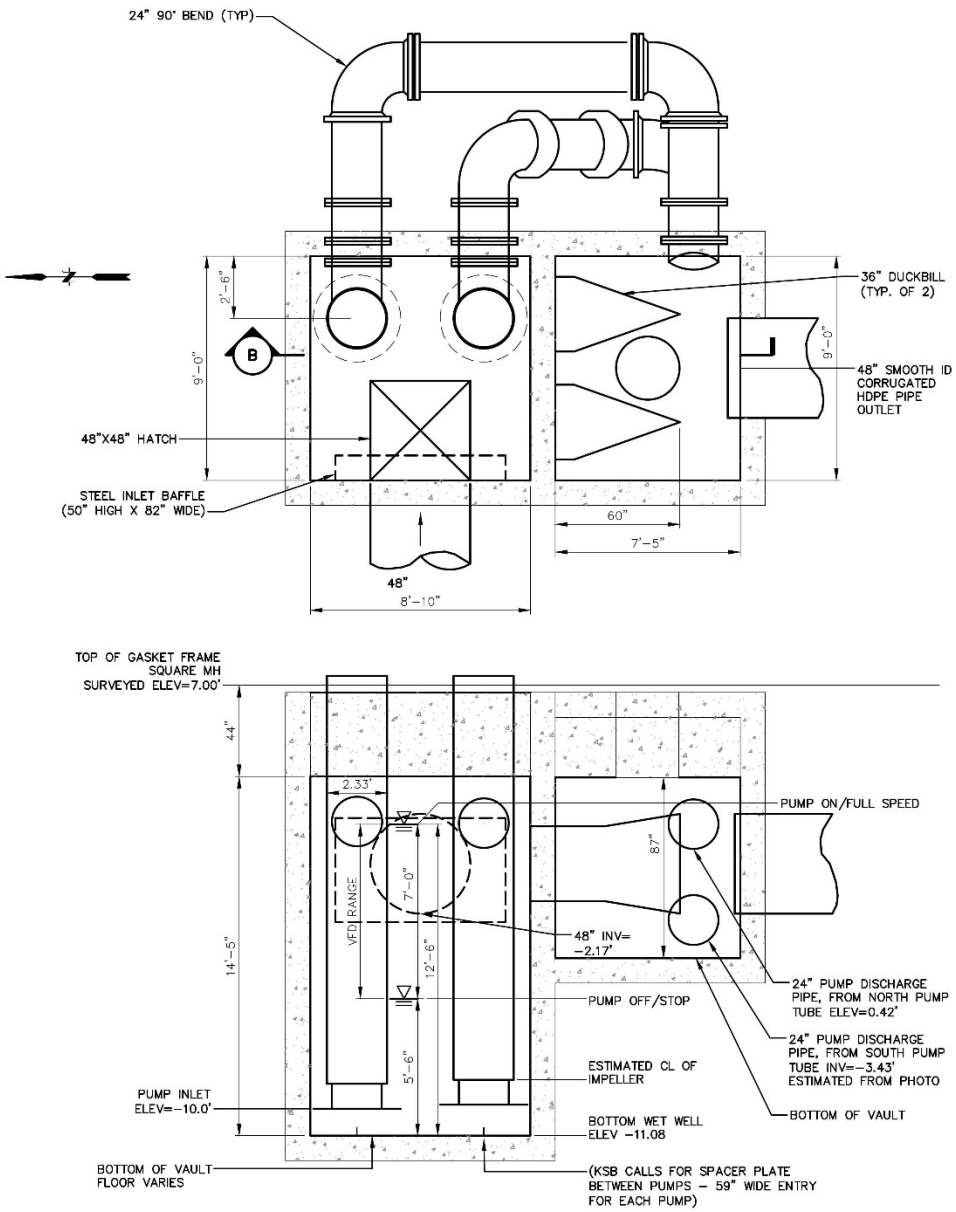
Background – Pumping Station Plan & Elevation



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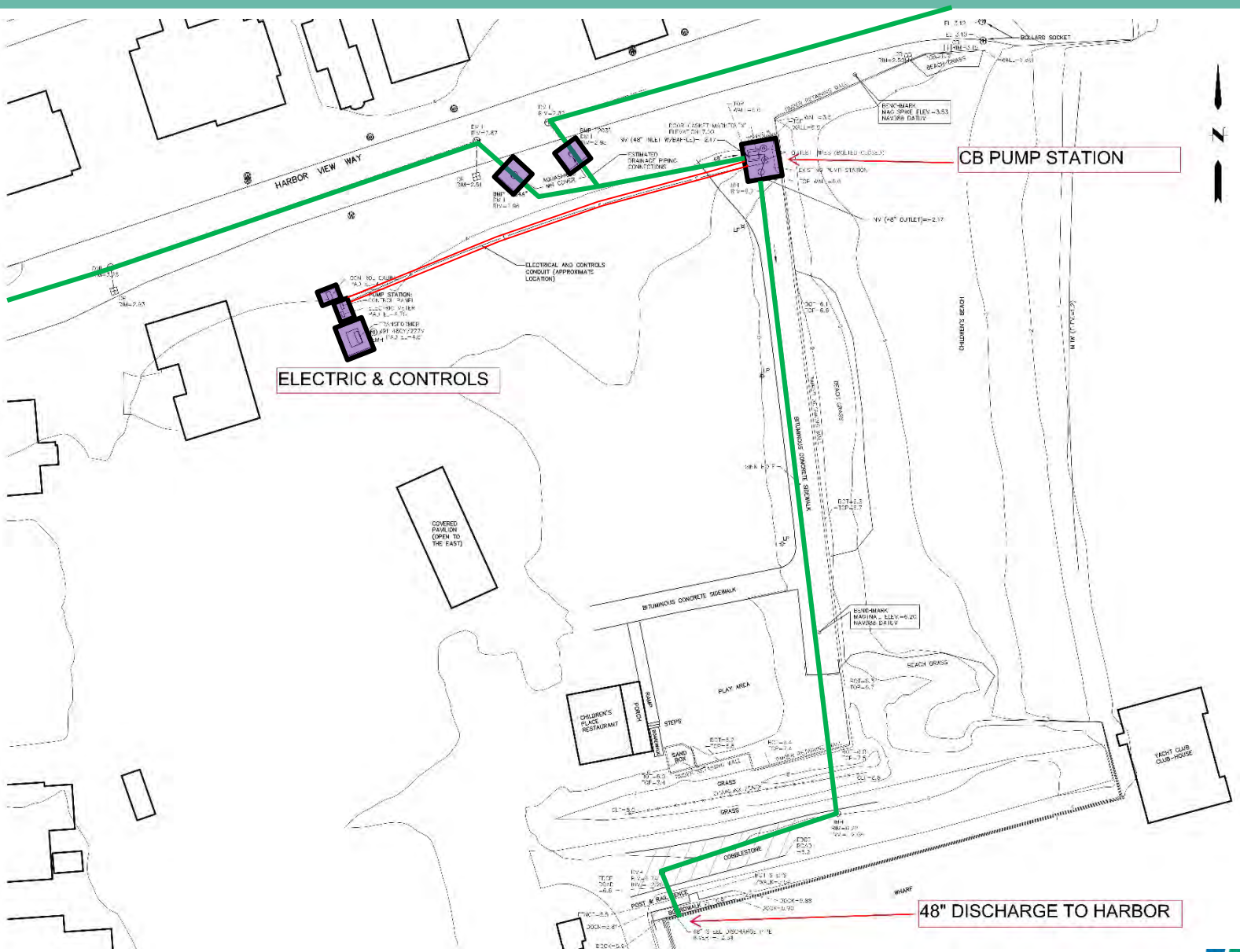
Background – Initial Pump Failure/Improvements

- Initial Failure Oct. 2009
- Hydraulic Evaluation 2011 Results
- Recommended 2011 Improvements
  - Improved Venting
  - Pump Repairs
  - VFDs

Existing Conditions – Pumping Station Area Survey



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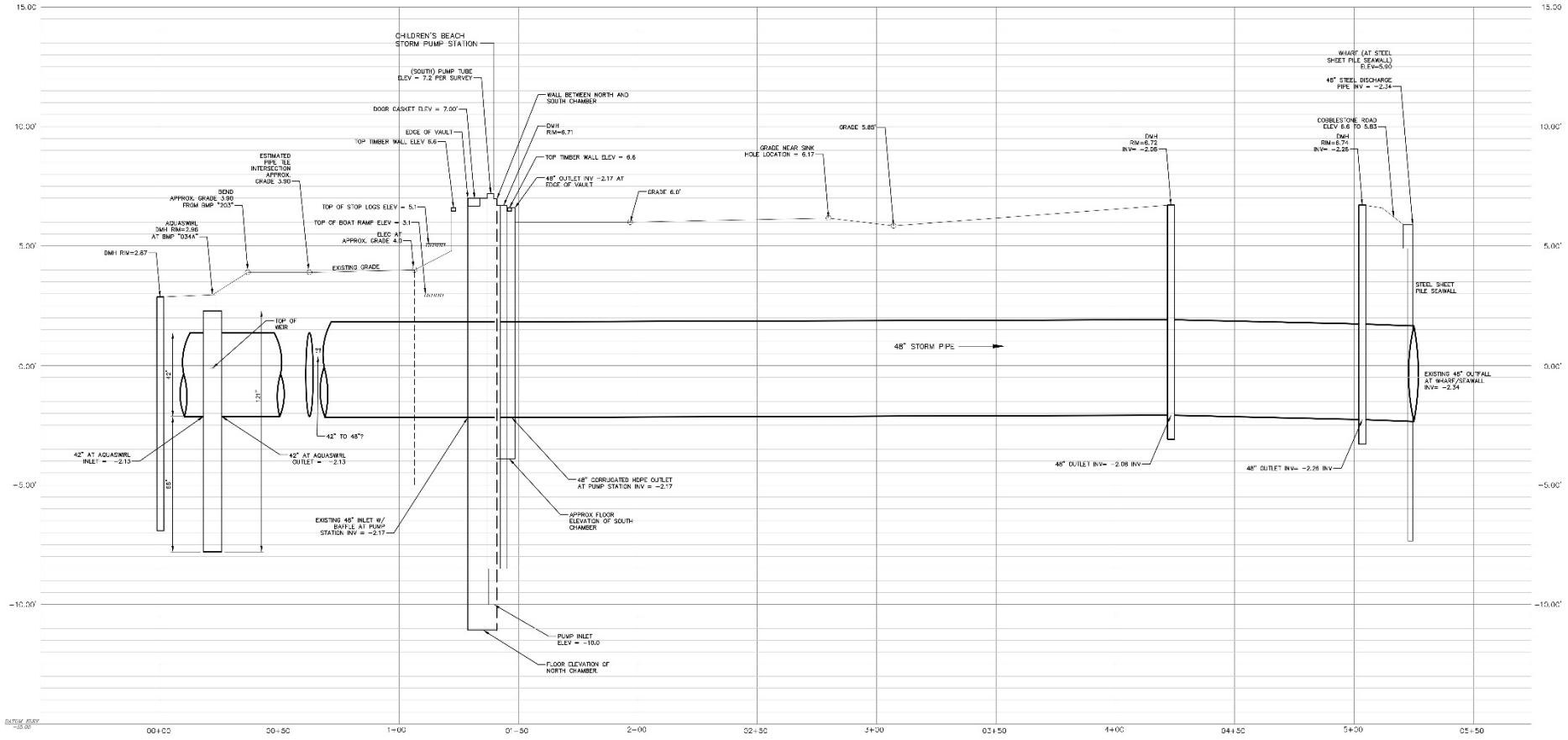
Existing Conditions – System Profile



1 BMP "SWIRL CONCENTRATOR" TO STORM PUMP STATION TO DISCHARGE AT HARBOR

HORIZONTAL SCALE: 1" = 20'
VERTICAL SCALE: ½" = 1'-0"

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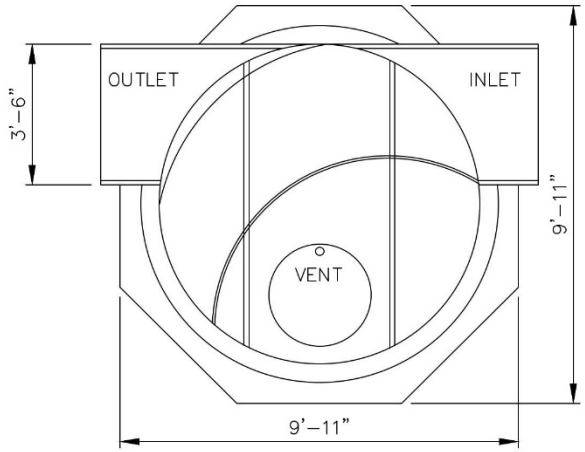
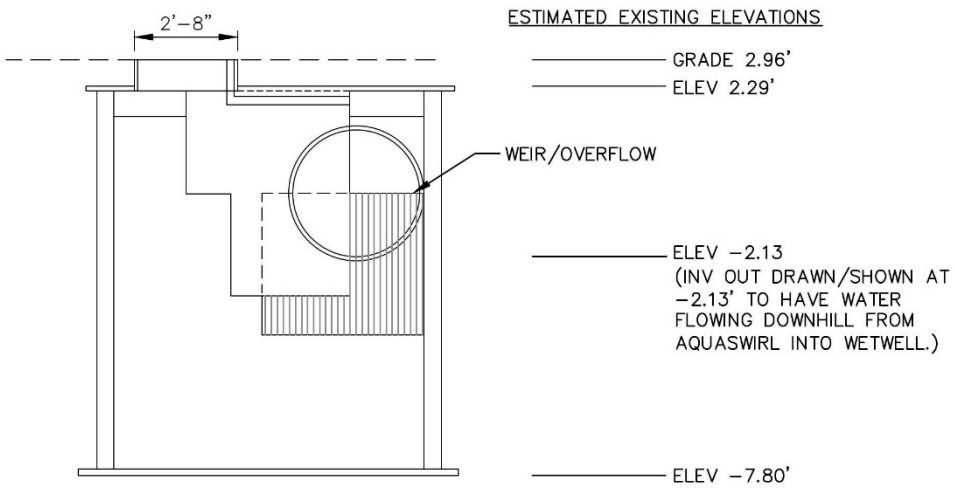
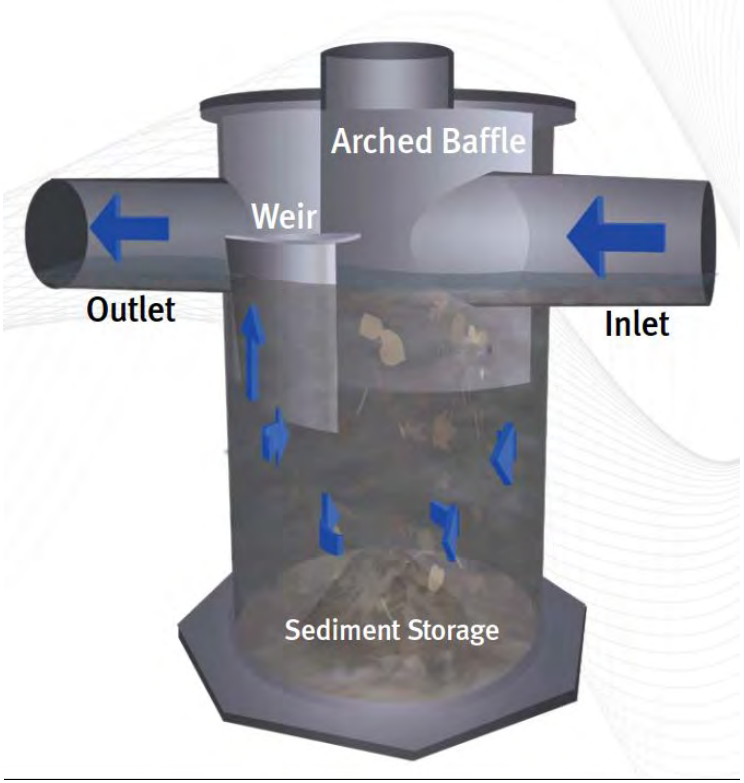
Existing Conditions – BMP Concentrator

- Aqua-Swirl Model AS-8 Units (removes solids)
  - Two Installed Upstream of Children's Beach Pumping Station







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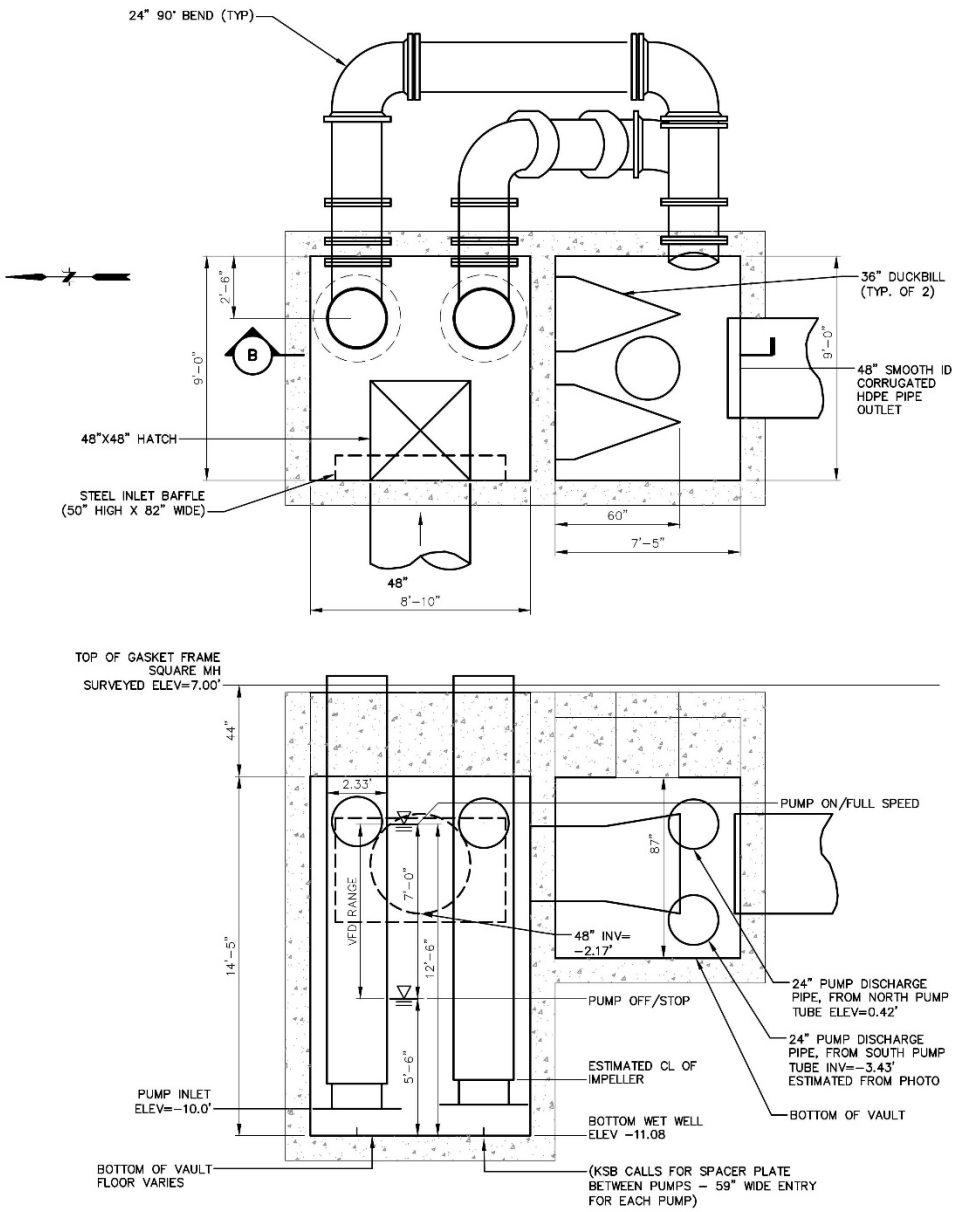
Existing Conditions - Pump Chamber



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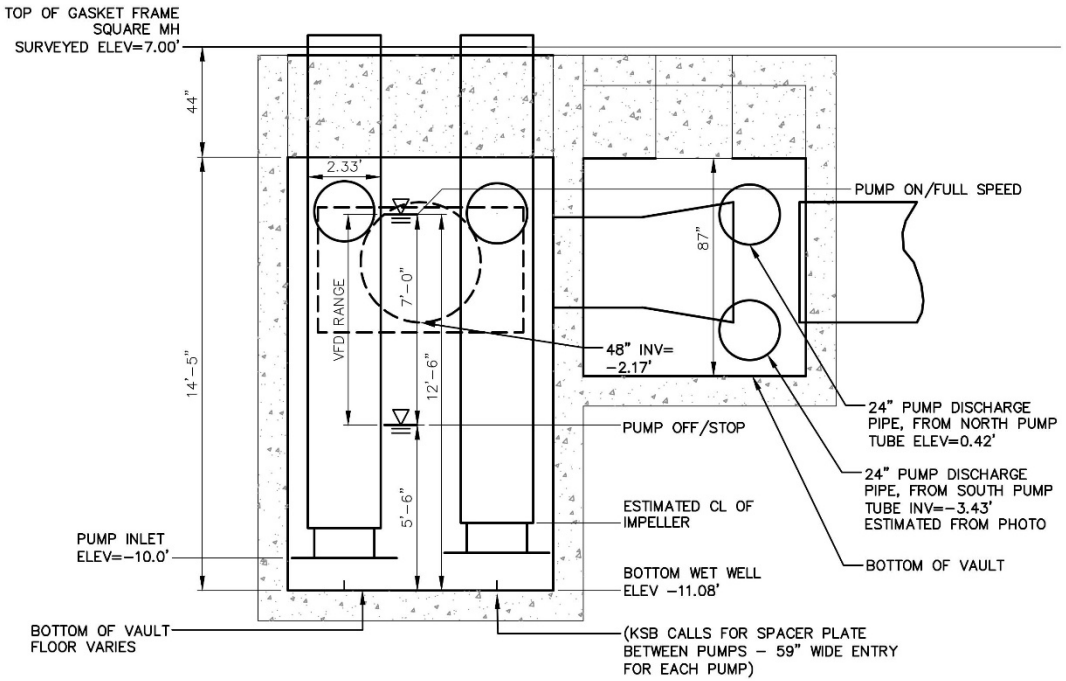
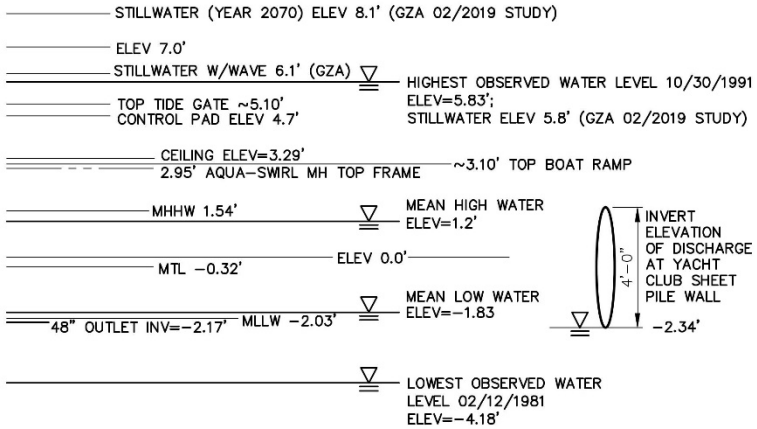
Existing Conditions - Important Elevations





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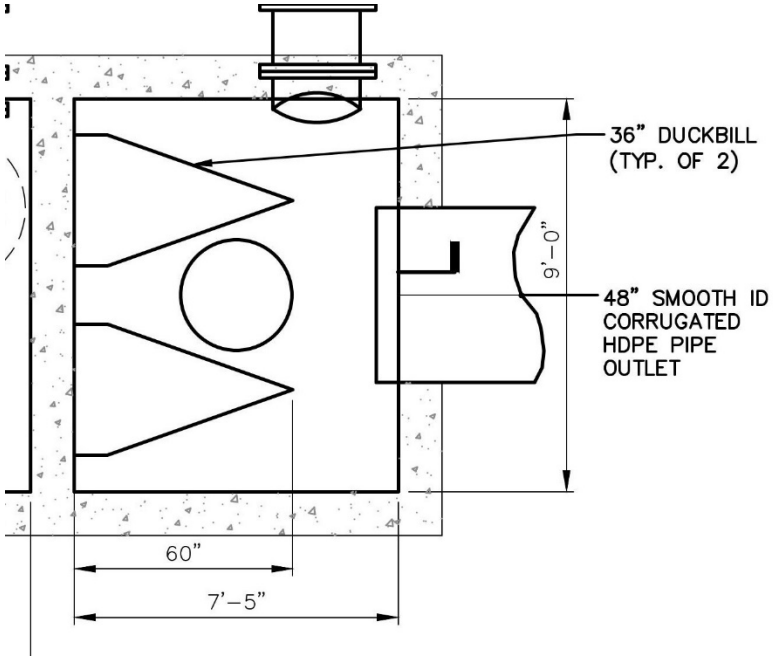
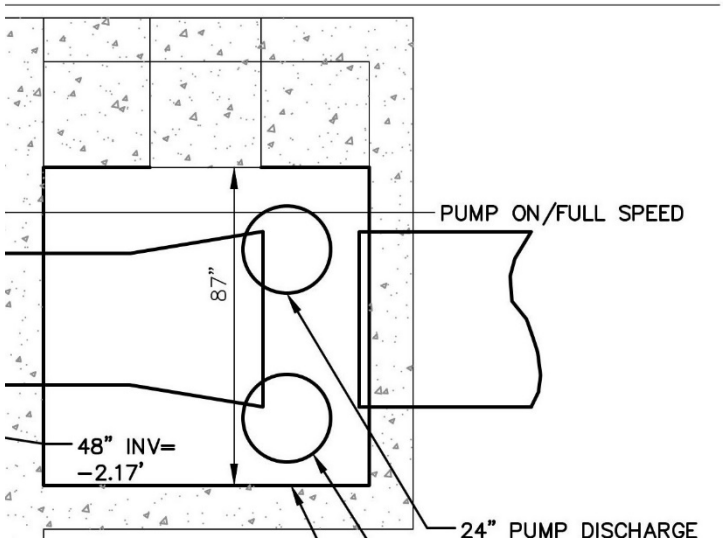
Existing Conditions - Discharge Chamber





- Congested
  - No Room for 24" Flap Valves
  - No room for 24" Duck Bill
  - Hydraulic interference

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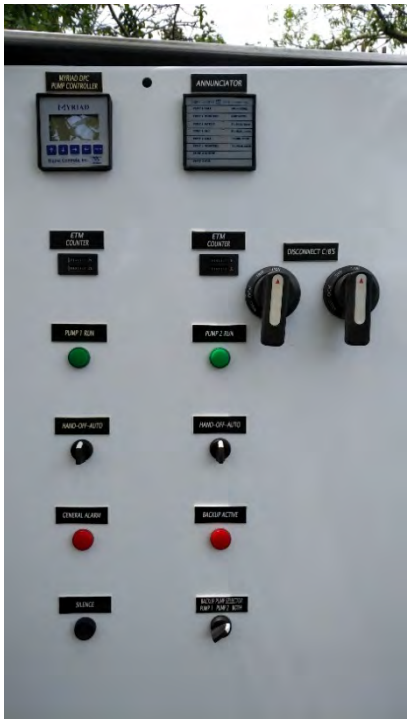
Existing Conditions - Outfall

- Note: No Outfall Check Valve

Existing Conditions – Electrical & Controls

- Electrical Panel & Controls Remote to Pump Station (~200 ft to west)
  - 480 volt, 3 phase, 200 Amp
  - YASKAWA VFDs added in 2011
  - Sigma Controls –Floats & Level Sensor
  - Low Pad Elevation – 4.70 NAVD88



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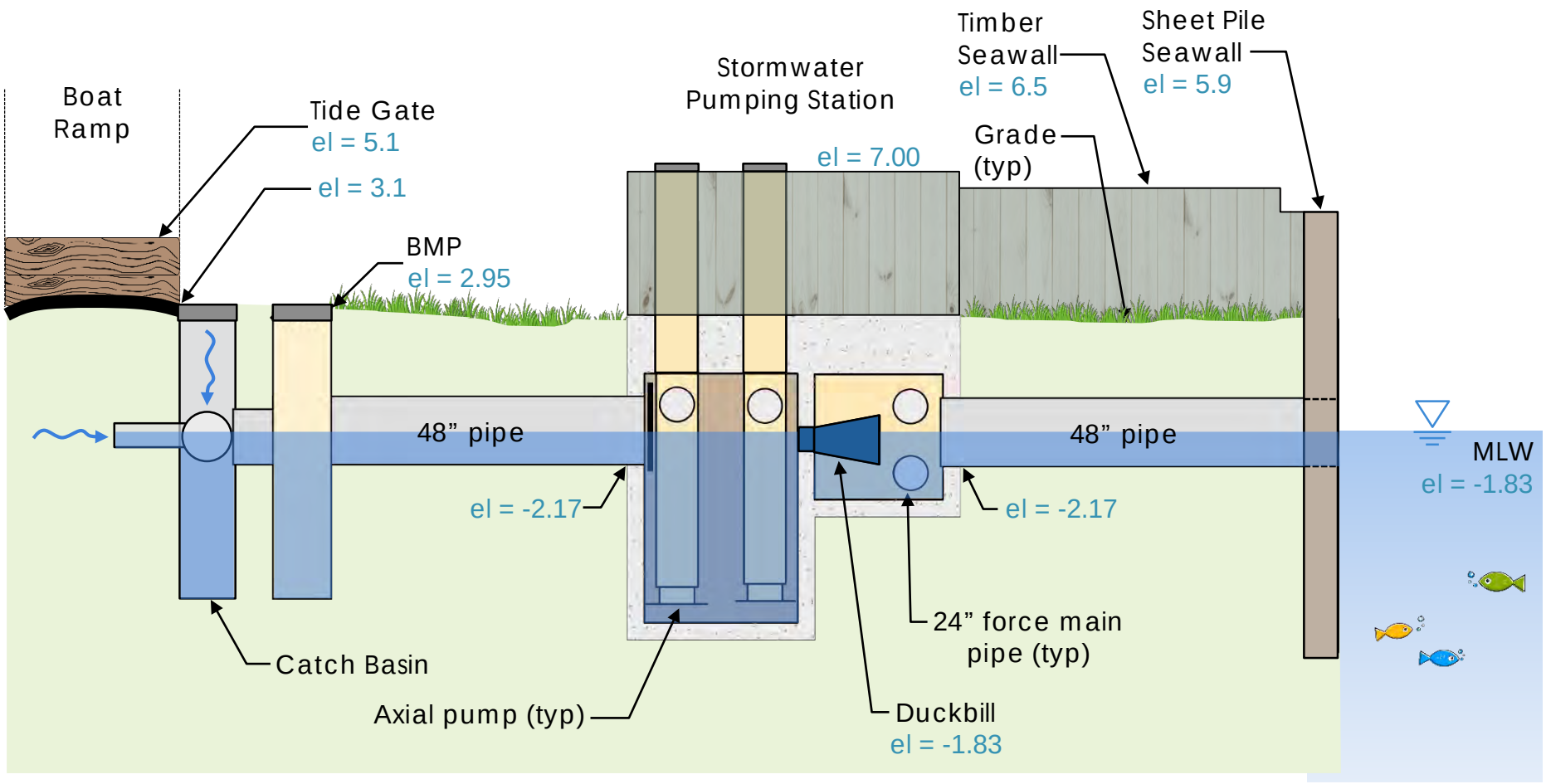
Children's Beach Stormwater Pumping Station

Scenario 1: Water Flows by Gravity at Mean Low Water



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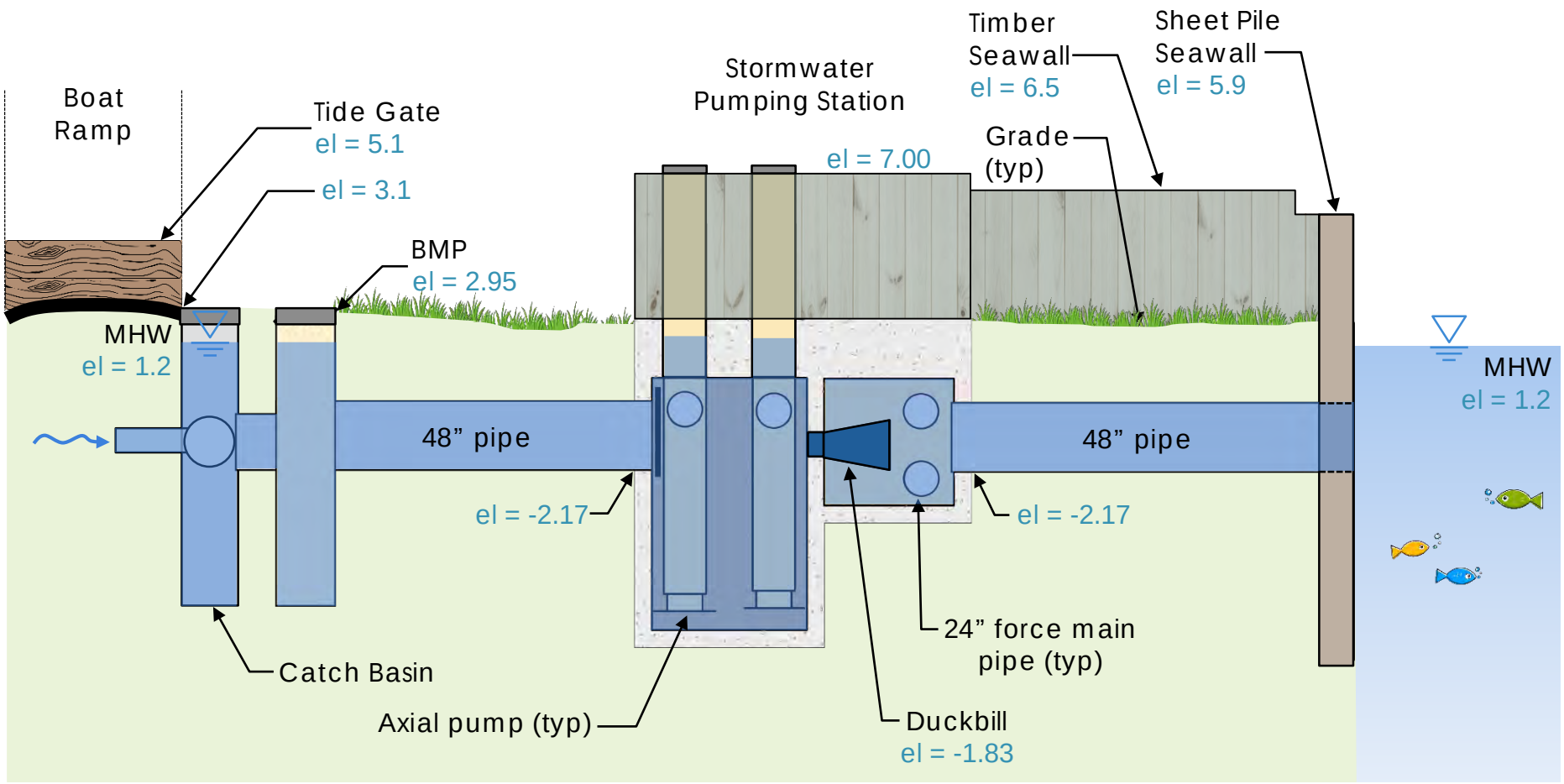
Children's Beach Stormwater Pumping Station

Scenario 2: Water Flows by Gravity at Mean High water



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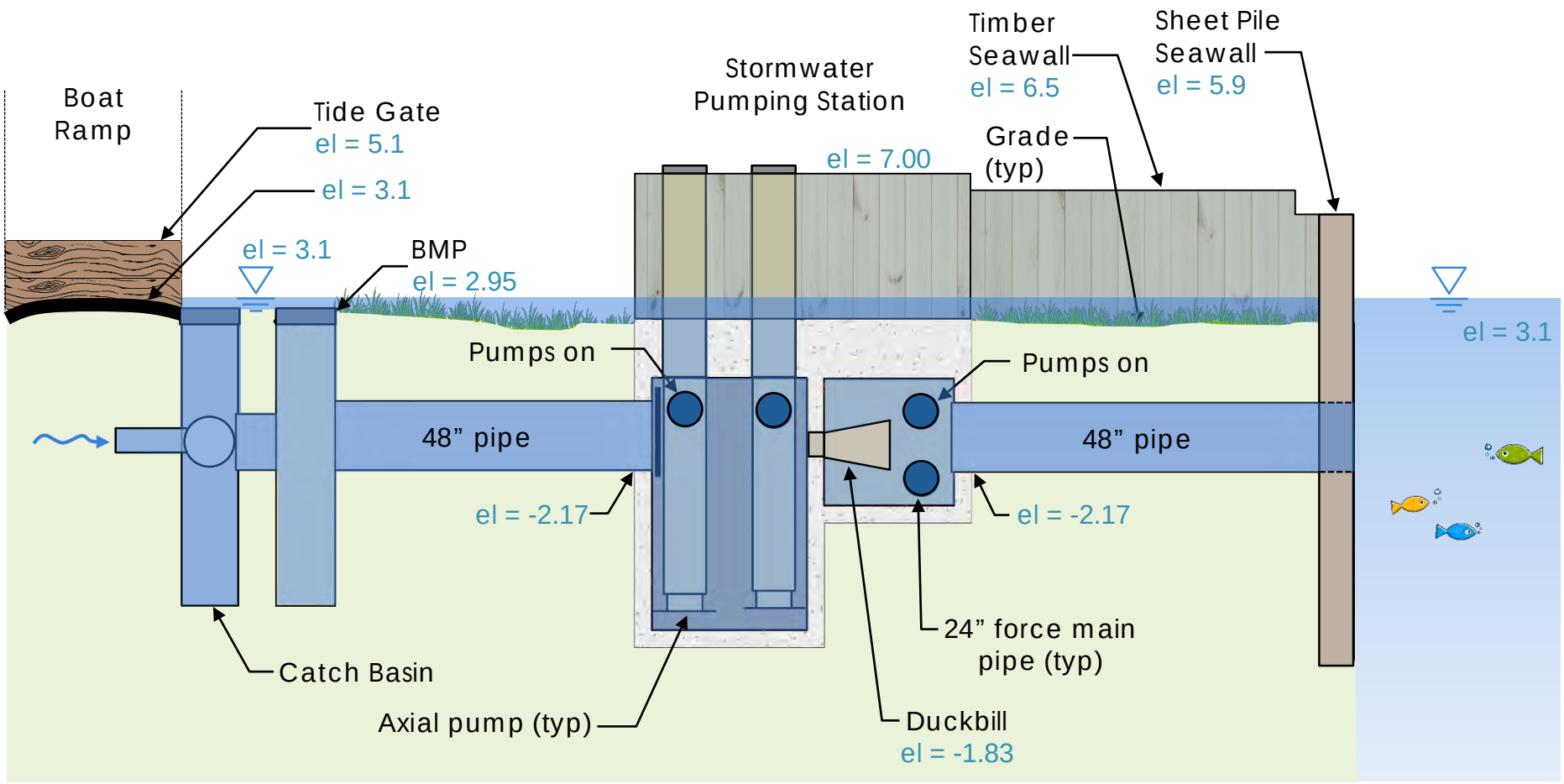
Children's Beach Stormwater Pumping Station

Scenario 3: Storm Tide – Pumps on with High Interior Drainage



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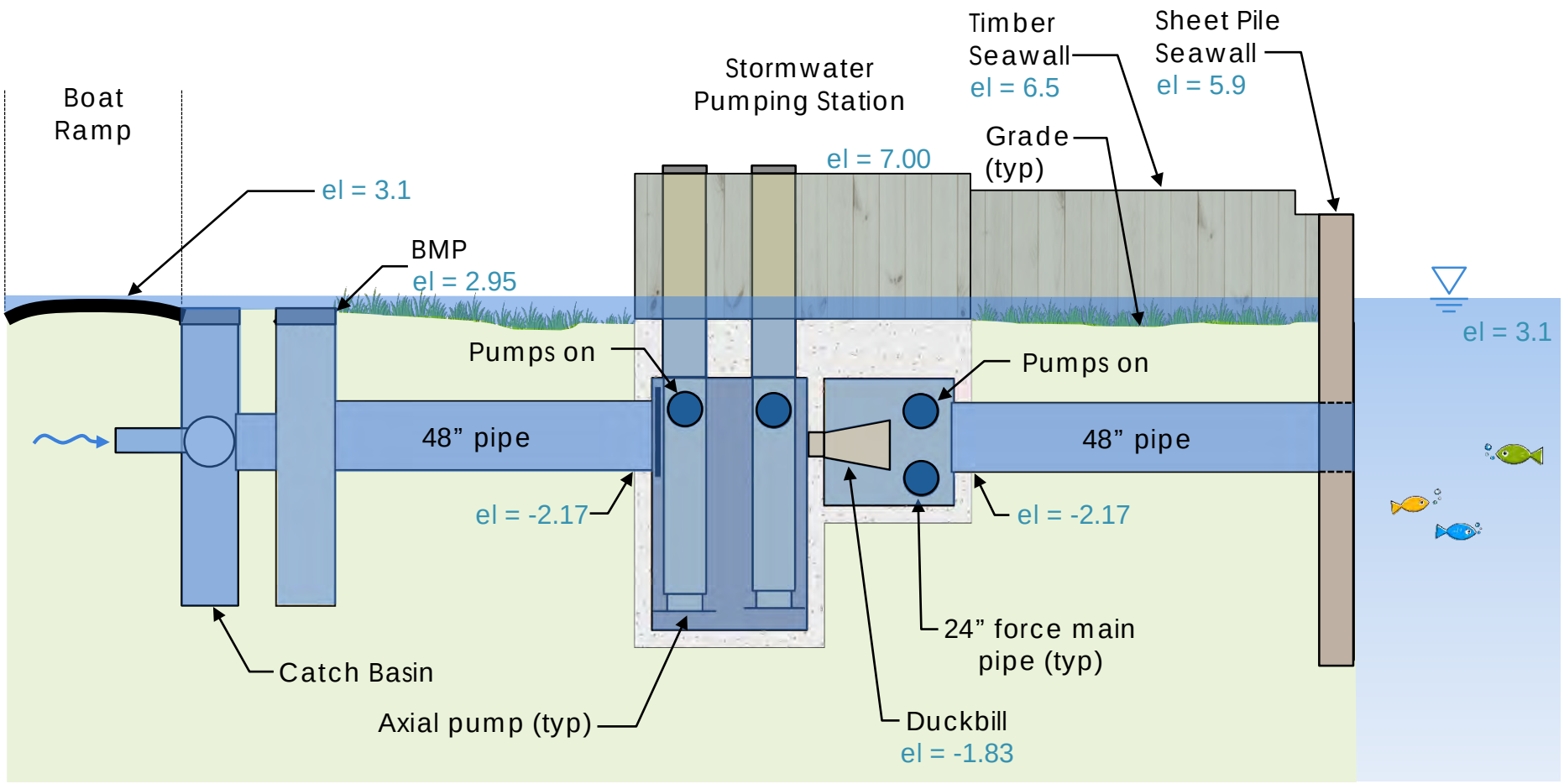
Children's Beach Stormwater Pumping Station

Scenario 3a: Storm Tide - Pumps on with High Interior Drainage, No Tide Gate



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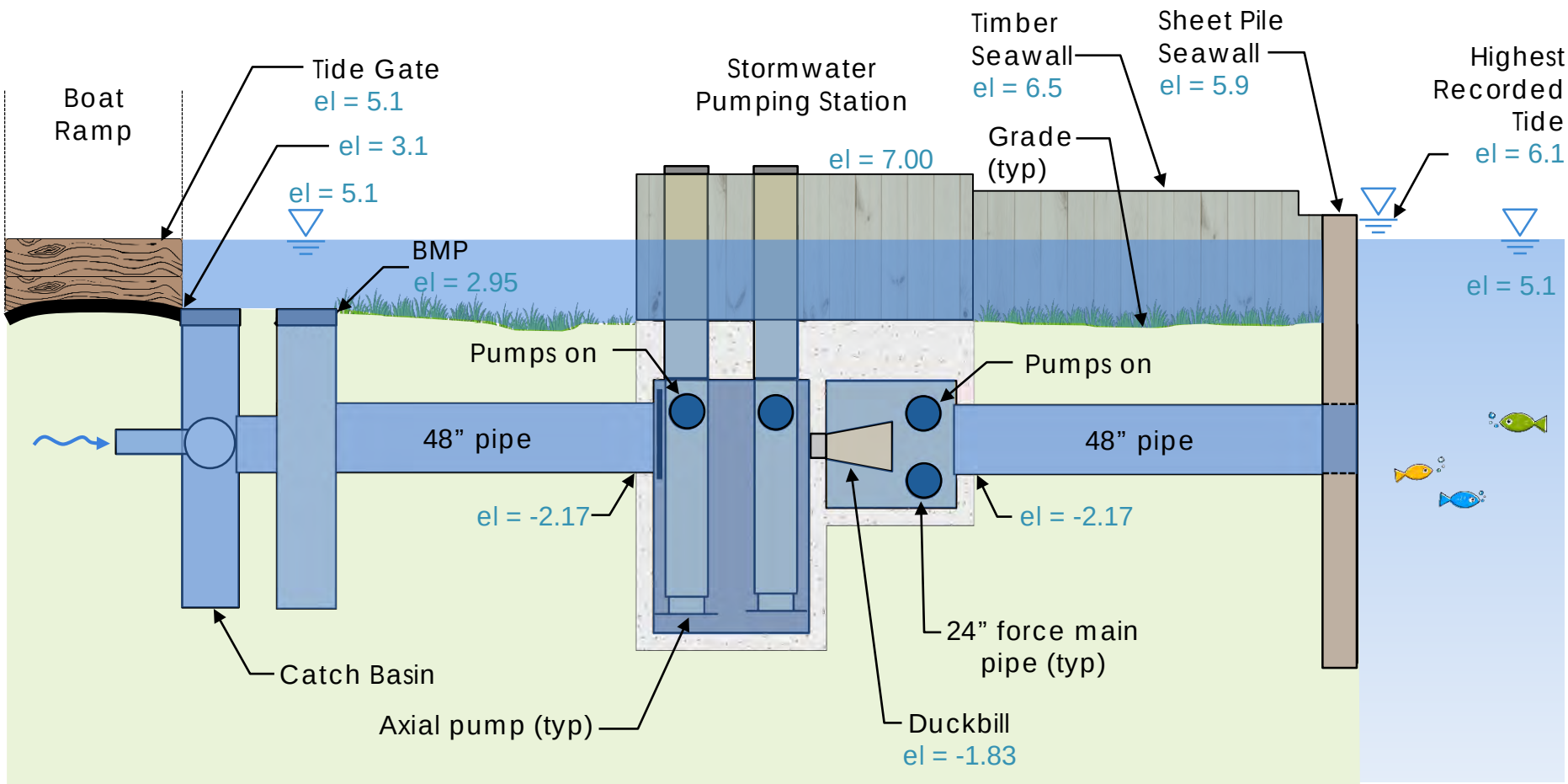
Children's Beach Stormwater Pumping Station

Scenario 4: Storm Tide - Pumps on with High Interior Drainage and Tide Gate



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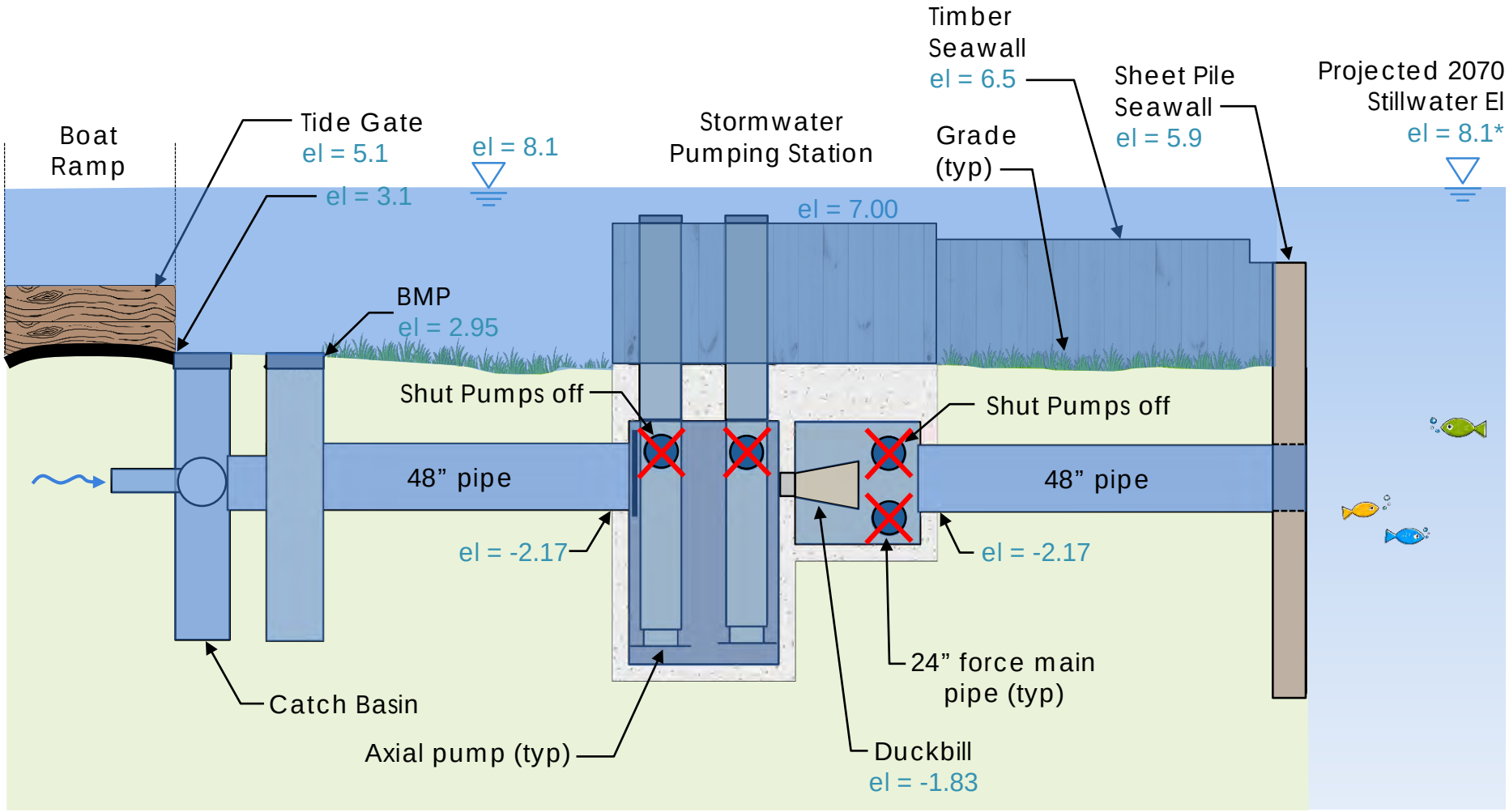
Children's Beach Stormwater Pumping Station

Scenario 5: Projected 2070 Stillwater with 2.3' Sea Level Rise



*Based upon GZA Feb. 2019 Projections with 2.3' SLR for extreme event Stillwater in 2070 at Town Pier.

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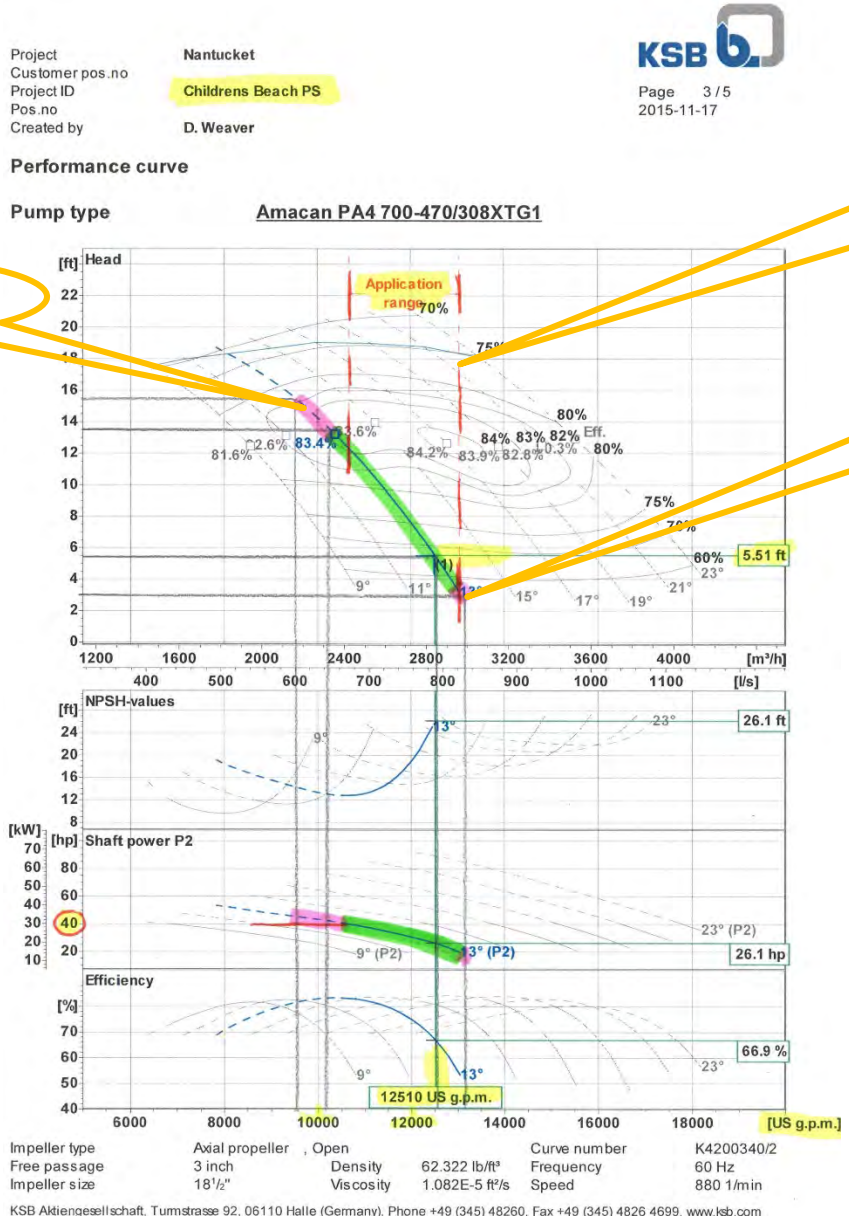
Forensic Results - Flow Dynamics & Controls

- Flow Dynamics in Pump Station
  - Wet Well Volume 3,700 gallons –
    - *One pump - 18 seconds of storage*
  - Storage - Wet Well & 48" Pipe from AquaSwirl 13,100 gallons.
    - *One pump - 1.05 minutes of storage*
  - Control System has to respond rapidly
    - *"Short Cycling" of Pumps Reported – Frequent Starts Damage Motor*
  - Water Feed Issues
  - Venting is Important –
    - *Wet Well Vents undersized - Causes Pressure +/- Several Feet of Water*
    - *No vent on discharge chamber*
    - *Can cause overload of pump motor*

Forensic Results – Pump Hydraulic Issues



Motor Overload

Small Application Range

Excess Pump Loading

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Forensic Results - Pump Motor Problems

- Motors suffered damage due to overheating
  - Pumps called on to operate outside of the "Application Range"
    - *Left Side of Curve – Where Shaft Power Increases Above 40 HP*
  - 40 HP Motor size too small
    - *KSB recommends increasing motor size after determining hydraulic operating points*
      - Increase by 4 HP without VFD
      - Increase by additional 6 HP with VFD
      - For CBPS – Motor should be 50 HP

Forensic Results – Hydraulic Issues Cont'd

Open intake chambers with suction umbrella

If a check of the minimum water level in the pump sump establishes that this is insufficient, another chamber variant without corner fillets in combination with a suction umbrella fitted at the discharge tube's inlet may provide sufficient submergence to prevent air-entraining vortices. This allows the pump to operate at a lower suction-side minimum water level t_1 with the same pump size and the same operating point.

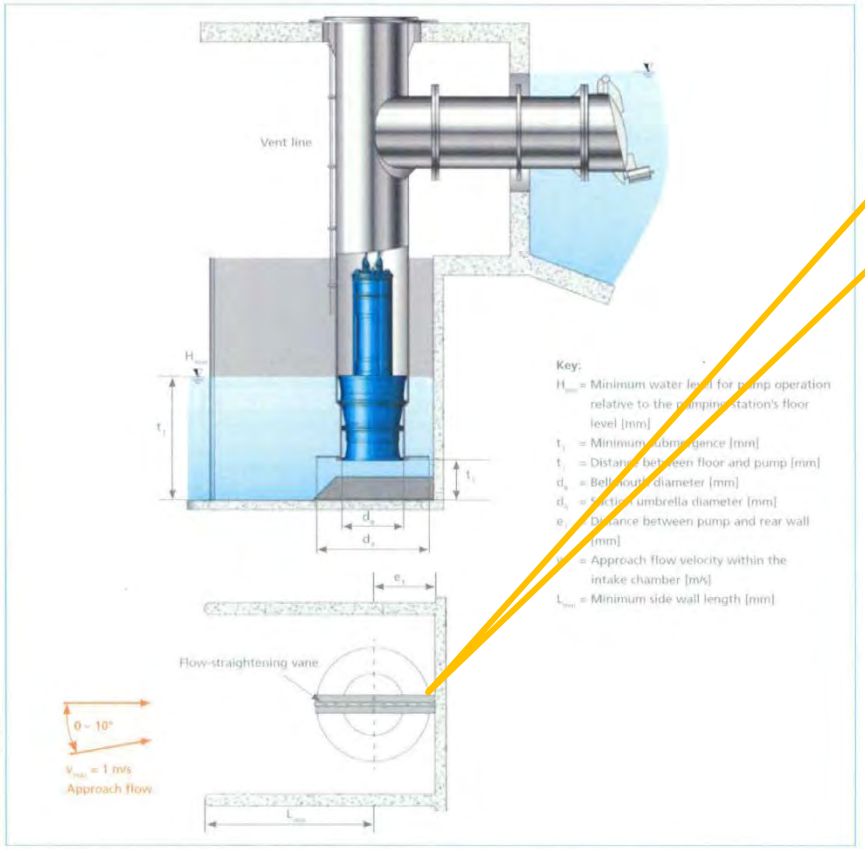

Fig. 23: Open intake chamber with suction umbrella (see the type series booklet or selection software for the actual dimensions)

Flow Straightening Vane

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Forensic Results – Hydraulic Issues Cont'd

Covered intake chambers

A special type of chamber is the covered intake chamber. It allows the lowest minimum water levels without the occurrence of air-entraining surface vortices and can accommodate flows approaching at an angle of 0 to 90 degrees at 1 m/s max.

However, this variant involves higher construction costs than the chamber types previously described. This type of chamber has more than proved its worth under unfavourable approach flow conditions and low water levels.

Formed Inlet

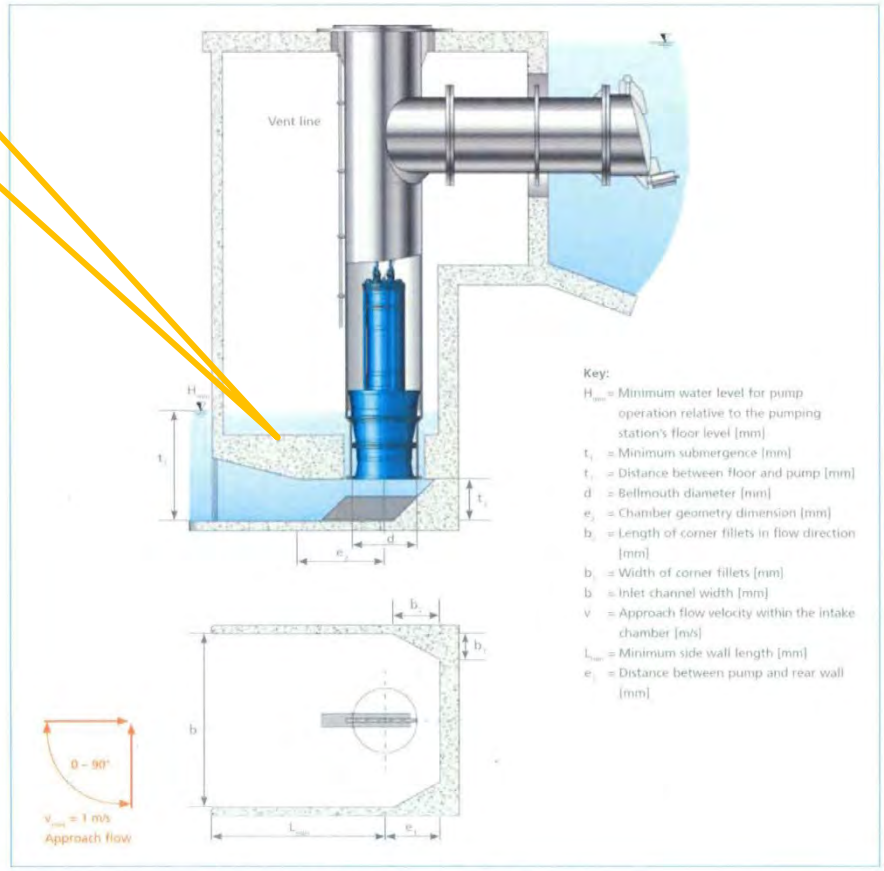

Fig. 24: Covered intake chamber (see the type series booklet or selection software for the actual dimensions)

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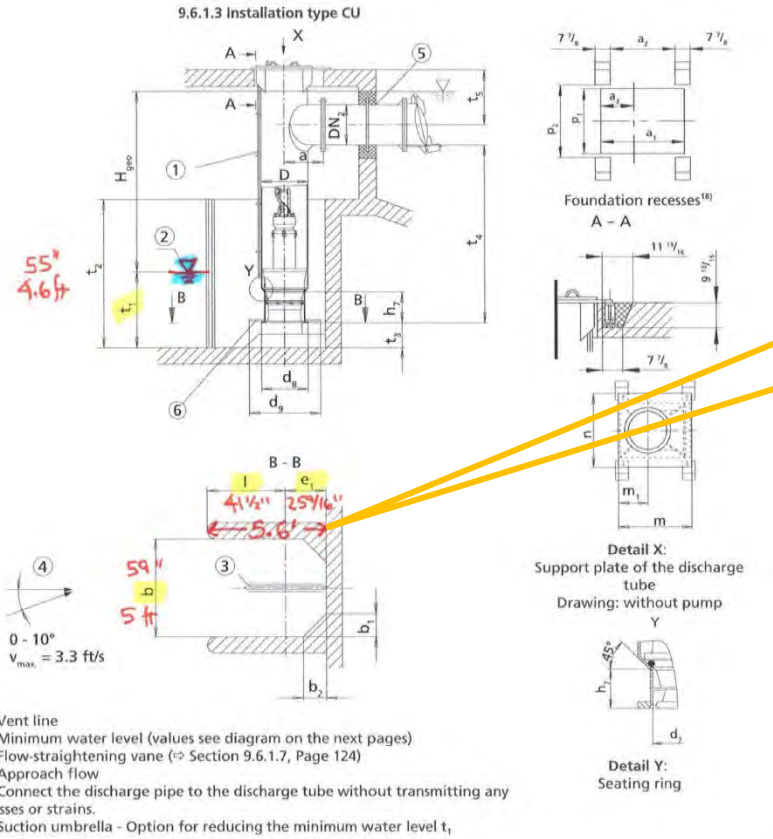
Forensic Results – Hydraulic Issues Cont'd



①: Vent line
②: Minimum water level (values see diagram on the next pages)
③: Flow-straightening vane (⇨ Section 9.6.1.7, Page 124)
④: Approach flow
⑤: Connect the discharge pipe to the discharge tube without transmitting any stresses or strains.
⑥: Suction umbrella - Option for reducing the minimum water level t_1

Table 56: Dimensions [inch]

Pump size	$DN_{2\,min.}$	$DN_{2\,max.}$	D	a	a_1	a_2	a_3	b	b_1		b_2	
									Without suction umbrella d_8	With suction umbrella d_9	Without suction umbrella d_8	With suction umbrella d_9
700 - 470	15 ¾	27 ⁹⁄₁₆	28	25 ⁹⁄₁₆	44 ⅛	34 ¼	16 ¹⁵⁄₁₆	59 ¹⁄₁₆	11 ¹³⁄₁₆	–	11 ¹³⁄₁₆	–
800 - 540	19 ¹¹⁄₁₆	31 ½	32	27 ⁹⁄₁₆	48 ⅛	38 ⅛	18 ⅞	70 ⅞	14 ⅜	–	14 ⅜	–
900 - 540	23 ⅝	35 ⅞	36	29 ¹⁵⁄₁₆	51 ¹⁵⁄₁₆	42 ⅛	20 ⅞	70 ⅞	14 ⅜	–	14 ⅜	–
1000 - 700	27 ⁵⁄₁₆	39 ⅜	40	31 ⅞	56 ⅝	45 ¹¹⁄₁₆	22 ¹³⁄₁₆	90 ⁹⁄₁₆	18 ⅛	–	18 ⅛	–
1200 - 870	35 ⁵⁄₁₆	47 ¼	48 ¹⁄₁₆	35 ¹³⁄₁₆	64 ⅜	53 ⁹⁄₁₆	26 ¾	110 ¼	22 ⅛	–	22 ⅛	–
1500-1060	47 ¼	59 ⁹⁄₁₆	60	41 ¾	77 ⅜	66 ⁹⁄₁₆	33 ⅞	137 ¹³⁄₁₆	27 ⁹⁄₁₆	–	27 ⁹⁄₁₆	–
1600-1060	51 ⅜	63	64	43 ¹³⁄₁₆	81 ¼	71 ¼	36 ¼	137 ¹³⁄₁₆	27 ⁹⁄₁₆	–	27 ⁹⁄₁₆	–

18) All dimensions for foundation recesses apply to discharge tube design without intermediate flange.

Minimum Dimensions for Children's Beach PS*

*** Dimensions presented are part of the required design parameters but not the only requirements**

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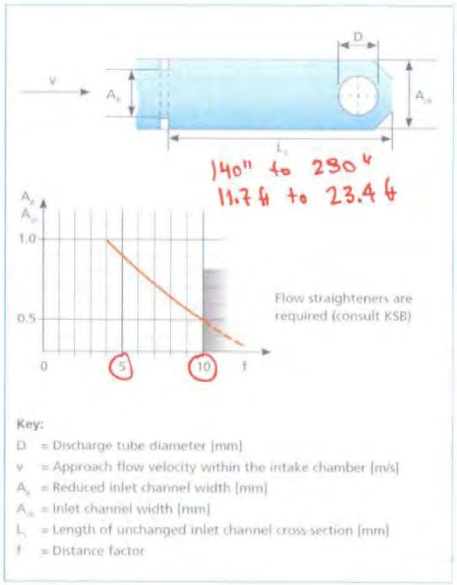
Forensic Results – Hydraulic Issues Cont'd



Key:
D = Discharge tube diameter [mm]
v = Approach flow velocity within the intake chamber [m/s]
A_k = Reduced inlet channel width [mm]
A_{ch} = Inlet channel width [mm]
L_s = Length of unchanged inlet channel cross-section [mm]
f = Distance factor

Fig. 27: Influence of cross-sectional constriction

If these mounting devices constrict the free flow cross-section, the distance between the pump and this point of flow disturbance must be checked and increased where necessary (Fig. 27).

28"

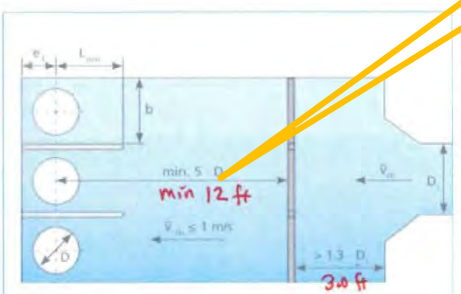
$$L_s = D \cdot f \quad [mm]$$ Formula (6)

5 to 10

Key:
L_s = Length of unchanged inlet channel cross-section downstream of flow disturbance [mm]
D = Discharge tube diameter [mm]
f = Distance factor (see Fig. 27)

The intake chamber surfaces as well as the wall around the pump sump should have rough concrete surfaces. If the areas in contact with the fluid handled are too smooth or even provided with a paint coat, this may lead to the reduction of the wall shearing stress – and thus increase the risk of vortex formation (submerged vortices, and possibly surface vortices).
The roughness of surfaces in contact with the fluid should range from 1 to 3 mm.

Minimum Wet Well Length Approx.18 FT for Children's Beach PS*



Key:
e_1 = Distance between pump and rear wall [mm]
L_{min} = Minimum length of lateral walls [mm]
b = Intake chamber width [mm]
$\bar{v}_{ch}$ = Mean flow velocity in inlet channel [m/s]
D_1 = Inlet diameter [mm]
D = Discharge tube diameter [mm]

Fig. 39: Solution, Variant 4.2

Solution:
Each pump is to be provided with a complete intake chamber sized to match the respective pump (see the type series booklet or selection software). The intake chambers are installed facing the inlet in the opposite sump wall. A curtain wall with openings near the floor should be installed across the entire width of the pump sump upstream of the intake chambers. This prevents the pumps from influencing each other during pumping and ensures an even approach flow.

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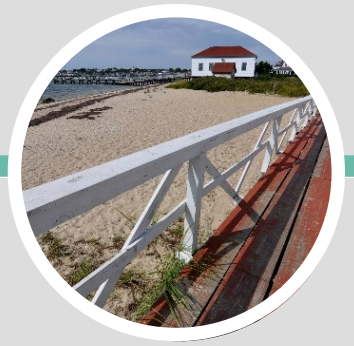
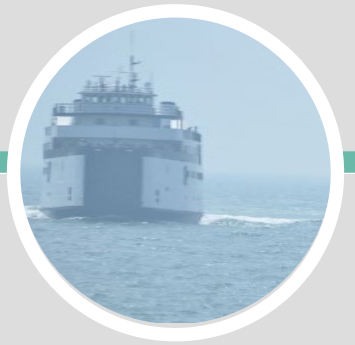
Forensic Summary - Revitalizing Children's Beach Pump Station

- Issues Have Been Identified
- DPW and F&O Working with Town Manager & Local Stakeholders
  - Put "Short-Term"/ Temporary Improvements in Place
    - *Ex. Short Term Pumping*
  - Goal is a "Permanent" Solution
    - *What Does "Long-Term" Really Mean? (see next slide)*
    - *Understand Sea-Level Rise Time Horizon*
    - *Define/List Permanent Improvements*

Forensic Summary - What Does "Long-Term" Really Mean?

- GZA February 2019 Report Results
  - Current:
    - *Stillwater Elevation (current condition) = 5.8*
    - *Total Water Level (stillwater with wave setup) = 6.3*
    - *For Reference:*
      - Top of Boat Ramp 3.1
      - Top of Tide Gate 5.1
      - Top of Pump Station 7.0
  - 2070:
    - *Stillwater Elevation (w/2.3 feet sea level rise yr. 2070) = 8.1*
    - *Total Water Level (stillwater w/ wave setup & 2.3ft 2070) = 8.6*






Questions & Discussion

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