Trench Type Wet Well Designs

MINIMIZE YOUR FOOTPRINT AND YOUR MAINTENANCE HEADACHES

May 16, 2018
Presentation Objectives

• Introduction to Trench Type Wet Wells

• Introduction to Self Cleaning Operation

• Case Studies
  – Return Activated Sludge Pump Station
  – WWTP Influent Pump Station
  – WTP Pump Station
  – Lift Station

• Would the design be right for you?
Trench Type Wet Well

• Invented by D.H. Caldwell in 1964
• Improved by Dr. Robert Sanks, Ph.D., P.E.
  – 1:1 scale model of portion of trench floor
    • Result: >5 fps requirement
  – 1:3.3 scale model of the Kirkland Pump Center
    • Result: Only a small portion of the sand was ejected at pump down equilibrium.

• 1998 Breakthrough
  – 2nd Edition of Pumping Station Design
  – ANSI/HI 9.8 Pump Intake Design
1. Flow splitter and fillets may be omitted if a trench less than 1.0 m (39 in.) wide.
2. \( r_1 \geq 2.33 \times \frac{v^2}{2g} \) where \( v \) = velocity at top of ramp (2D min), \( r_2 > 1.25D \), 45° tangent between \( r_1 \) and \( r_2 \).
3. 1.2 m/s (4 ft/s) max wet pit pumps, 1.0 m/s (3 ft/s) max dry pit pumps
4. \( e \geq 45° \) smooth surface (plastic lining)
5. \( e \geq 60° \) concrete surface
6. \( S \geq (1+2.3F_0)D \)
7. See Appendix D for details and tutorials
Trench Type Wet Well

- Suitable for Design Flows > 3 MGD
- Pump Intakes, Confined in a Deep, Narrow Ditch
- Pump Intakes, Substantially Lower Than Upstream Inlet Pipe
Trench Type Wet Well

- Suitable for Different Pump Types/Arrangements
  - Wet Pit or Dry Pit/Wet Pit
  - Pumps
    - VTSH
    - Submersible
    - Non-Clog Centrifugal

- Suitable for Different Fluids
  - Clean Water
  - Activated Sludge
  - Raw Wastewater
**Trench Type Wet Well**

**Advantages**
- Superb Hydraulic Environment for Pump Intakes
- Minimum Footprint Size
- Small Floor Area (Minimum accumulation of sludge or grit)
- Ease and Quickness of Cleaning

**Disadvantages**
- Compact, Minimal Storage Capacity
- Increased Depth
- Clogging if Pumps Not Used
Section Views

- Trench
- Water Guide
- Sloping Walls
- Flow Splitter
- Fillet
Section Views

Section Cut of Flow Splitter

Flow Splitter

Concrete Fillet

VTSH Pump Bowl

1/2" Wall Anti-Rotational Baffle

1/2" Pump Anti-Rotational Baffle

Front Vane

Flow Splitter

Hydrocone and Rear Vane

Rear Vane

Hydrocone

EL 385.92

EL 385.22

EL 385.92

EL 383.67

EL 383.24

1'-10"

9'-8"

1'-10"

11" 11"

1'-10"

Typ
Illustrative Section of Trench Type Wet Well Pump Station – Normal Operation

1 fps max above trench

4 fps (wet pit)
3 fps (dry pit)
Mixes sludge and scum into a mass that is ejected by the last pump.
Cleaning Ramp

Illustrative Section of Pump Station – Cleaning Cycle (Pump Down)
Cleaning Ramp

Illustrative Section of Pump Station – Cleaning Cycle (Pump Down)
Illustrative Section of Pump Station – Cleaning Cycle (Pump Down)
Illustrative Section of Pump Station – Cleaning Cycle (Pump Down)

Cleaning Ramp
Case Study #1

- Trinity River Authority
  - CRWS Treatment Plant

- Design and Construction of Pump Station 13B

- Fluid of Interest: Return Activated Sludge (RAS)
  - Final Clarifiers – Traveling Bridge Suction Clarifiers
  - Thin Sludge

- RAS Firm Capacity – 200 MGD for WWTP
  - New PS-13B – 50 MGD (North Plant, Trains 4-6)
    - 3 pumps (200HP)
    - 30-inch diameter columns
    - 36-foot overall shaft length
  - Downrated PS-13 – 50 MGD (North Plant, Trains 1-3)
  - Uprated PS-13A – 100 MGD (South Plant, Trains 7-12)
Pump Station Evaluation

• Dry-Pit/Wet-Pit
  – Horizontal Non-Clog Centrifugal Pumps
    • PS-13 and PS-13A
  – Vertical Non-Clog Centrifugal Pumps
    • PS-6 and PS-6A

• Wet-Pit
  – Vertical Turbine Solids Handling Pumps (VTSH)
Vertical Non-Clog Centrifugal Pumps

Horizontal Non-Clog Centrifugal Pump

Pump Station 13-A
City of Phoenix, 23rd Ave. WWTP (36-inch VTSH Pumps)
Limitations at PS-13B Site

- 60-inch Final Clarifier Effluent Line
- 84-inch Primary Clarifier Effluent Line
- Electrical Duct Bank
- Caustic Soda Bank
- 2-inch to 12-inch lines
- 12-foot roadway
Relocated Caustic Soda Building

Relocated Pavement

Relocated 60-inch FCE Line

Footprint of Dry-Pit/Wet-Pit (Horizontal Non-Clog Pumps)
Footprint of Wet-Pit Wet Well (VTSH Pumps)

Existing Caustic Soda Storage Facility, 84-inch PCE Line, 60-inch FCE Line and Pavement Remains Unchanged
<table>
<thead>
<tr>
<th>Pump Station Type</th>
<th>Length/Width</th>
<th>Depth</th>
<th>Pump Cost ($)</th>
<th>OPCC ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horizontal Non-Clog Centrifugal Pump Station (Wet-Pit/Dry-Pit)</td>
<td>67’/65’</td>
<td>26’</td>
<td>$915,000</td>
<td>$10.9 million</td>
</tr>
<tr>
<td>Vertical Non-Clog Centrifugal Pump Station (Wet-Pit/Dry-Pit)</td>
<td>59’/54’</td>
<td>~35’</td>
<td>$945,000</td>
<td>$11.4 million</td>
</tr>
<tr>
<td>VTSH Pump Station (Wet Pit)</td>
<td>49’/43’</td>
<td>29’</td>
<td>$1,718,000</td>
<td>$9.5 million</td>
</tr>
</tbody>
</table>

*Total Pump Cost for Three (3) Pumps
**OPCC: Opinion of Probable Cost
# Wet Pit vs Trench Type

<table>
<thead>
<tr>
<th>Pump Station Type</th>
<th>Length/Width</th>
<th>Depth</th>
<th>Pump Cost ($)*</th>
<th>OPCC ($)**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wet-Pit Pump Station</td>
<td>49’/43’</td>
<td>29’</td>
<td>$1,718,000</td>
<td>$9.5 million</td>
</tr>
<tr>
<td>Trench Type Wet Well Pump Station</td>
<td>57’/18’</td>
<td>38’</td>
<td>$1,718,000</td>
<td>$8.5 million</td>
</tr>
</tbody>
</table>

* Total Pump Cost for 3 Pumps  
** OPCC: Opinion of Probable Construction Cost
Acknowledgements

• Trinity River Authority of Texas

• ANSI/HI (Hydraulic Institute) Pump Standards, 1998/2012

• *Pumping Station Design, 3rd Edition*
  – Editor-in-Chief: Garr M. Jones, P.E.
  – Co-Editors: Dr. Robert L. Sanks, Ph.D., P.E.
    Dr. George Tchobanoglouos, Ph.D., P.E.
    Bayand E. Bosserman II, P.E.

• *Dr. Robert L. Sanks, Ph.D., P.E. (Quality Control)*

• Dr. Joel E. Cahoon, Ph.D., P.E., Montana State University
Case Study #2

- Dallas Water Utilities
  - Central Wastewater Treatment Plant

- Design and Construction of Influent Pump Station

- Fluid of Interest: Raw Sewage
  - Coarse screens upstream (1-inch spacing)

- Firm Capacity – 335 MGD (current), 425MGD (expanded)
  - 6 pumps (2, 1000HP and 4, 800HP)
  - 42-inch diameter columns
  - 62-foot overall shaft length
  - 20-80MGD range per pump (VFDs)
Trench-Type with Dry Pump Pit

Dallas Water Utilities
Central Plant IPS Improvements

Alternate 2 - Station Section

February 2020

Scale 1/8" = 1'
Trench-Type with VTSH Pumps
Ten Years in the Making
Case Study #3

- City of Midlothian
  - Water Treatment Plant

- Design and Construction of New WTP

- Fluid of Interest: Partially Treated Water
  - Pumped water feeds membranes

- Firm Capacity – 9MGD (firm), 18MGD (ultimate)
  - 3 initial pumps (4.5MGD each)
  - 5 ultimate pumps
  - 20-foot depth
Case Study #4

- City of Fort Worth
  - Collection System

- Design of Lake Arlington Lift Station
  - Construction – November 2019
  - Completion – March 2022

- Fluid of Interest: Raw Sewage

- Firm Capacity – 40 MGD (firm), 80 MGD (ultimate)

- Trench Type Wet Well
  - Elimination of wet well reduces the size of the site
  - Self-cleaning design reduces maintenance costs
  - VFDs allow pumps to run efficiently through range of required flows
Is this the right design for you?

- **Your Conditions**
  - Limited on Space?
  - Solids/grit problem?
  - Tired of maintenance intensive cleaning?
  - Don’t prefer dry-pit/wet-pit?

- **Pre-Design Evaluation**
  - Cost Analysis (Life Cycle)
  - Benefits Analysis
  - Reference Calls
  - Site Visits
  - Comfort Level
Decision Making Examples
Case Studies #1 and #2

• Client Concerns
  – Lacking Comparable Size Installations
  – Staff Unfamiliar with Equipment

• Increasing their Comfort Level with the Equipment
  – Site Visits to Arizona and Kansas
  – Extended Warranty
  – Single Point of Responsibility
  – Witness Performance Testing
  – Contracted Maintenance (1st observe and learn)
  – Vibration Monitoring
  – Smith Pump Seminar

• Largest Driver Tipping the Risk vs. Benefit Scale
  – Significant Capital Cost Savings (Ex: DWU $16 Million over traditional design)
Contact Information
Trooper Smith
Email: tws@freese.com
Pump Station 13B Testing

Scenario 1
- 1 clarifier
- 16 MGD
- Sluice gate for proper flow rate
- Use last pump

Scenario 2A
- 2-3 clarifiers
- 32-50 MGD
- 2 pumps at full speed, let turbulence do the cleaning

Scenario 2B
- 2-3 clarifiers
- 32-50 MGD
- Sluice gate for proper flow rate
- Use last pump