Specification & Design Considerations for Sewer Bypass

Kyle Van Fleet
March 18, 2014
Nor Cal PUG
AGENDA

- INTRODUCTION
- OVERVIEW OF RAIN FOR RENT & PROJECTS
- SPEC WRITING CONSIDERATIONS
- BYPASS PROJECT PITFALLS
- DESIGN PREFERENCE IMPACTS ON COST
- QUESTIONS
Our Goal

Helping you achieve your project objectives without having to worry about how to handle liquids.
Phoenix Bypass
145 MGD

Memphis Bypass
120 MGD
Chosen again for second phase in 2010
Sydney Tar Ponds, Nova Scotia 9

354 MGD
576 MGD Flood Control

- *Omaha, Nebraska – 2011*
- Combined sewer overflow during rain events
- Unique floating pumps capable of ~100MGD each
- DV600c’s (5), electric and hydraulic submersibles
Cooling Tower Bypass/Filter
Cooling Tower Bypass
Potable Water Emergency Pumping
SPECIFICATION WRITING

- BYPASS PROJECTS HAVE A CLEAR RISK VS COST RELATIONSHIP
- NOT ALL BYPASSES HAVE THE SAME RISK PARAMETERS
- GOAL OF THE SPEC

  - GIVE THE CONTRACTOR ENOUGH DETAIL WITH CLEAR REQUIREMENTS SO THAT THE SYSTEM INSTALLED MATCHES THE RISK COMFORT LEVELS & ESTIMATED BUDGET
COST VS RISK

A line graph showing a negative correlation between cost and risk.

- **COST** on the vertical axis.
- **RISK** on the horizontal axis.
- The line slopes downward, indicating that as cost increases, risk decreases.
WHERE IS YOUR PROJECT?
SPECIFICATION WRITING

- ACCURATE FLOW RATES
- ACCURATE PLANS & AS BUILTS
- PUMP STATION REQUIREMENTS
- PIPE/HOSE REQUIREMENTS
- SUBMITTALS
ACCURATE FLOW RATES

MODELING ACCURACY DEPENDS ON ACCURACY OF INPUTS

- DEBRIS
- GROUND WATER SEEPAGE
- LATERALS
- CORROSION/ROUGHNESS OF PIPELINE
- STORM RUN-OFF
ACCURATE FLOW RATES

- INACCURATE INPUTS → INACCURATE FLOWS → OVER/UNDER DESIGNED BYPASS SYSTEM

- IF POSSIBLE, VERIFY MODEL INPUTS & OUTPUT WITH:
  - HISTORICAL DATA
  - TV DATA OF LINE
  - FLOW METERS (NEWLY INSTALLED OR EXISTING)
HISTORICAL DRAWINGS

• MAY NOT SHOW UPGRADES, MODIFICATIONS, OR OTHER CHANGES TO THE SYSTEM
CULVERT X-SECTION AS SHOWN ON PLANS (30” CONCRETE WALLS)
THE PLAN... CONCRETE CUT LID AND PLACE FLOATING PUMP INSIDE CULVERT
ACTUAL CULVERT X-SECTION WITH WEIR WALL
PUMP STATION DESIGN

- CENTRIFUGAL VS. SUBMERSIBLE
- REDUNDANCY & PUMP WATCH
PUMP CHOICE

CENTRIFUGAL PUMPS

- THEORETICAL SUCTION LIFT OF 28FT
- REALISTIC SUCTION LIFTS OF UP TO 15 TO 20 FT
  - NPSHR IS HUGE TOWARDS FAR RIGHT OF CURVE
- SOLIDS HANDLING UP TO 3”
- OPEN OR SEMI-OPEN IMPELLER
- EASY TO SWAP OUT
- SELF PRIMING
- REQUIRES 3-5FT OF SUCTION SUBMERGENCE/SURCHARGE
SUBMERSIBLE PUMPS

- GREAT FOR DEEP VAULTS
  - NO SUCTION LIFT – ALL DISCHARGE
- QUITE AND OUT OF THE WAY
- DIFFICULT TO SWAP OUT
- REQUIRE GENERATORS OR POWER DROP
- SHOULD BE EXPLOSION PROOF
  - H₂S & METHANE GASSES
REDUNDANCY & PUMP WATCH

- CLEARLY DEFINE REDUNDANCY
  - % BACKUP FOR PUMPS
  - % BACKUP OF PIPELINES
  - % OVERSIZING OF PIPELINES

- PUMP WATCH
  - “EASIEST JOB UNTIL IT’S NOT”
  - BUDDY SYSTEM
  - HIGHLY TRAINED TROUBLE SHOOTERS & MECHANICS
  - HEPATITIS SHOTS REQUIRED FOR “DE-RAGGING”
DE-RAGGING

EVEN NON-CLOG IMPELLERS NEED CLEANING
FINAL PUMP STATION GOAL

Sydney Tar Ponds, Nova Scotia 9

354 MGD
DISCHARGE LINE

- ROAD CROSSINGS
- MATERIALS
- CONNECTIONS
- VELOCITIES
DISCHARGE ROAD CROSSINGS

- TRENCH AND PLATING IS PREFERRED METHOD
  - MUST TRENCH AND PLATE FOR PIPELINES OVER 6” IN DIAMETER

- FAILED ALTERNATIVE (SURFACE RAMPS)
  - SLOW TRAFFIC / TRAFFIC HAZARD
  - TEND TO CLOG WHEN PUMPING SEWAGE
  - UNSTABLE ON ROADS
    - CROSSINGS ARE FLAT
    - ROADS HAVE A CROWN FOR DRAINAGE
DISCHARGE MATERIAL

VARIOUS MATERIALS WITH WIDE SPECTRUM OF PROS AND CONS

• FUSED HIGH DENSITY POLYETHYLENE (HDPE)
  - LEAK PROOF/CAR PROOF/BULLET PROOF
  - READILY AVAILABLE FROM 2” TO 48”
  - HIGH INSTALLATION COSTS

• LAYFLAT HOSE
  - QUICK INSTALL
  - PRESSURES TO AT LEAST 75 PSI
  - RESTRICTED TO 6” AND BELOW
  - HOSE AND CAMLOCK CONNECTIONS PRONE TO VANDALISM
DISCHARGE MATERIAL

- VARIOUS MATERIALS WITH WIDE SPECTRUM OF PROS AND CONS

  • ALUMINUM PIPE
    - QUICK INSTALL W/LIMITED LABOR
    - HIGH PRESSURE RATING
    - AVAILABLE 12” AND SMALLER
    - HORRIBLE SUCTION RATING
    - THIN WALLED
    - HIGH SCRAP VALUE IS TEMPTING TO VANDALS

  • PVC
    - HIGH PRESSURE RATING
    - LEAK PROOF
    - BECOMES BRITTLE OVER TIME
    - EXPENSIVE (LABOR & MATERIAL) FOR LARGE DIAMETERS
DISCHARGE CONNECTIONS

VARIOUS CONNECTION TYPES

- FUSION WELDED
- FLANGED
- INDUSTRIAL GROOVE (VICTAULIC)
- GLUED
- CAM LOCK
- BAUER
DISCHARGE VELOCITIES

TYPICAL ENGINEERING DESIGN STANDARDS

- SHORT SECTIONS OF STEEL OR HDPE PIPE
  - UP TO 20 FT/SEC

- TYPICAL SEWER BYPASS MAINLINES
  - UP TO 12 FT/SEC

- DISCHARGE INTO CRITICAL OR FRAGILE STRUCTURES
  - UP TO 5 FT/SEC

- DANGERS:
  - WATER HAMMER
  - DAMAGE TO STRUCTURES

March 21, 2014

CONSIDERATIONS FOR SEWER BYPASS
SUBMITTAL REQUIREMENTS

• PE STAMPED CALCULATIONS & DRAWINGS
  – PROOF OF CONCEPT
  – ELIMINATES THE “I KNOW IT WILL WORK BECAUSE IT WORKED LAST TIME” MENTALITY
SUBMITTAL CALCULATIONS

Lift and TDH calculations for the pumps listed below
(4) DV-200c @ 2605 GPM / Pump Primary
(2) DV-200c @ 2605 GPM / Pump Backup

<table>
<thead>
<tr>
<th>PIPE</th>
<th>Suction</th>
<th>Discharge-1</th>
<th>Discharge-2</th>
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<tbody>
<tr>
<td>Type</td>
<td>Hose</td>
<td>Aluminum</td>
<td>HDPE</td>
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<tr>
<td>Dia (in)</td>
<td>12</td>
<td>12</td>
<td>18</td>
</tr>
<tr>
<td>Rating</td>
<td>Suction</td>
<td>Ind Grove</td>
<td>32.5</td>
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<tr>
<td>I.D. (in)</td>
<td>12</td>
<td>11.812</td>
<td>16.826</td>
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<tr>
<td>Length (ft)</td>
<td>30</td>
<td>100</td>
<td>1150</td>
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<tr>
<td>Flow (gpm)</td>
<td>2605</td>
<td>2605</td>
<td>5209</td>
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<tr>
<td>Velocity (ft/s)</td>
<td>7.391</td>
<td>7.628</td>
<td>7.517</td>
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Total Suction Lift:
- 14.60 Ft. lift, water=>ground level
- 0.35 Ft. Pipe Hf for 12" x 30" Suction Hose
- 0.88 Ft. Entrance Loss (k = 0.78)
- 0.33 Ft. (1) 12" 90° Elbow (k = 0.39)
- 1.13 Ft. 12" x 8" Priming Reducer (k = 0.64)
- 3.29 Ft. Trailer/ Skid Height

Total Lift: 20.36 Ft.

Total Dynamic Head (TDH):
- 1.62 Ft. Pipe Hf loss 12" x 100' Ind Grove Al Pipe
- 6.01 Ft. 8" Check Valve (k = 1.4)
- 1.13 Ft. 8" x 12" Enlargement (k = 0.64)
- 2.61 Ft. (8) 12" Ind Groove 90° Elbow (k = 0.36)
- 0.08 Ft. (1) 12" Gate Valve (k = 0.10)
- 2.12 Ft. (1) 12" x 18" Manifold (k = 2.5)
- 0.07 Ft. (1) 18" Gate Valve (k = 0.10)
- 9.22 Ft. Pipe Hf loss 18" x 1150' HDPE SDR 32.5
- 1.03 Ft. (3) 18" HDPE SDR 17 90° Elbow (k = 0.39)
- 15.00 Ft. Elevation Increase

Total Suction Lift: 20.36 Ft.

NPSH

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<table>
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<tr>
<td>Altitude (Ft):</td>
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<tr>
<td>Atm Pressure (Ft):</td>
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<tr>
<td>Vapor Loss @ 80°F (Ft):</td>
<td>1.20</td>
</tr>
<tr>
<td>NPSHA</td>
<td>12.32</td>
</tr>
<tr>
<td>NPSHR</td>
<td>8.00</td>
</tr>
<tr>
<td>NPSHA &gt; NPSHR</td>
<td>OK</td>
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59 Ft. Required Pump Pressure
26 PSI
PITFALLS

- CONE REMOVAL
- SURCHARING
- CLEAN WATER SOURCE
- SURGING FLOWS INTO PLANT
MANHOLE CONE REMOVAL

- TYPICAL MANHOLE COVERS ARE 22”-24”
  - ENOUGH ROOM FOR (3) 8” SUCTION HOSES
- SHOULD REMOVE CONE FOR BYPASSES ABOVE 5 MGD
- EXTRA COSTS EXCAVATING AND REHAB
- RESULT – POSSIBLE CHANGE ORDER OR
  - SYSTEM IS UNDERSIZED
  - SUCTION LINES ARE UNDERSIZED
  - COMMON SUCTIONS ARE USED
  - PUMP SYSTEM IS NOT OPTIMAL
SURCHARGING

“The More the Better...as long as it is not too much!”

- All pumps require submergence to operate properly
- Surcharging reduces suction lift and increases performance
- Caution:
  - Upstream conditions
  - Suction manhole/wet well conditions
TOO MUCH SURCHARGE
ON-SITE WATER

- HYDRO-TEST PRIOR TO SYSTEM STARTUP
- FLUSH PRIOR TO SYSTEM REMOVAL
- CLEAN WATER IS REQUIRED FOR BOTH OPERATIONS
  - IF NOT ONSITE AND AVAILABLE, CONTRACTOR WILL NEED TO TRUCK IN WATER
  - RESULT IS POSSIBLE CHANGE ORDER OR SYSTEM IS NOT HYDRO-TESTED AND FLUSHED PROPERLY
SURGING PLANT FLOW

☐ BYPASS FLOWS SHOULD MIMIC NATURAL DAILY INCOMING FLOWS

☐ BYPASS SYSTEMS WITH ON/OFF MECHANICAL FLOATS CAN CAUSE SURGES INTO THE PLANT

☐ RESULT:
  • DAMAGE TO EXISTING INFRASTRUCTURE
  • INACCURATE PLANT FLOW MEASUREMENT
  • DAMAGE TO DIGESTER OR RAS BACTERIA

☐ SOLUTION
  • PRECISION LEVEL HOLDING TELEMETRY
DESIGN IMPACTS ON COST

- OVER ESTIMATE OF FLOWS
- ALUMINUM VS HDPE
- LEVEL CONTROL AUTOMATION
- PUMP WATCH
OVER ESTIMATE OF FLOWS

- PUMP COST TEND TO BE LINEAR TO FLOW RATES
  - 40 MGD PUMP IS TWICE THE COST OF 20 MGD PUMP

- INSTALL LABOR & PIPELINE COSTS ARE NOT LINEAR
  - LARGER SYSTEMS REQUIRE:
    - FORKLIFTS
    - CRANES
    - GENERATORS
    - HIGHER MATERIAL COSTS
    - SLOWER INSTALL TIMES
    - CONE REMOVAL
40 MGD VS 20 MGD

40 MGD

- LABOR COSTS: $115K
- MONTHLY RENTAL COSTS: $60K
- TOTAL = $175K

20 MGD

- LABOR COSTS: $45K
- MONTHLY RENTAL COSTS: $25K
- TOTAL = $70K

2X FLOW = 2.5X COST
ALUMINUM VS HDPE

- **400FT 12” ALUMINUM**
  - INSTALL COSTS = $2K

- **400FT 12” FUSED HDPE**
  - INSTALL COSTS = $7K

**REASONS:**
- FORKLIFT, FUSION MACHINE, FUEL, HEATING & COOLING TIMES
LEVEL CONTROL

MECHANICAL ON/OFF FLOATS

- HOLD LEVEL TO WITHIN 5FT
- COST OF INSTALL = $300
- MONTHLY RENTAL COST = $50

PRESSURE TRANSDUCER W/VFD

- HOLD LEVEL TO WITHIN 1”-2”
- COST OF INSTALL = $2K
- MONTHLY RENTAL COST = $2K
PUMP WATCH

- RECOMMENDED ON HIGH PROFILE PROJECTS
- ENSURES ONSITE PERSONNEL IS TRAINED TO MANAGE ANY PROBLEMS IMMEDIATELY
- EXPENSIVE

TYPICAL DAILY COST FOR 2-MAN CREW
- $5K PER DAY
- (2) 2-PERSON CREWS ON 12-HR SHIFTS
CONCLUSION

- A CLEAR SPEC AND SCOPE WILL ALLOW THE BYPASS CONTRACTOR TO PROVIDE THE CUSTOMER WITH A SYSTEM THAT ADHERES TO THEIR RISK VS COST COMFORT LEVEL.
  - OWNER SAVE MONEY ON CHANGE ORDERS, FINES, FEES, SPILLS
  - LEVEL PLAYING FIELD FOR BYPASS CONTRACTORS
THANK YOU...ANY QUESTIONS?