Determining WWTP Screen Capacity During Wet Weather Flows

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Screen Capacity

- Difficult to define
- Varies depending on influent wastewater
- Recently installed two new screens
- Had to evaluate existing screens
- Want to share lessons learned
Agenda

- Background
- Existing Capacity
- Design Approach
- New Screens
Background

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Screen and Grit Building

From Raw Sewage Pumps

To East Train

(4 more grit tanks)

To Central and West Train

To CEPT

To Bypass Junction Chamber

Container Room
Fine Screen Channels

From Raw Sewage Pumps

Influent Stop Logs (3)

Influent Slide Gate (4)
Influent Level Sensor (4)
Plate Screen and Press (4)
Screening Belt Conveyor

Screen Effluent Channel

Effluent Level Sensor (4)
Effluent Slide Gate (4)
Effluent Stop Logs (4)
Plate Screens
Did You Flush This?
**Structural Failure**

- Plate screens experienced structural failure shortly after installation
- SWWTP developed comprehensive retrofit to prevent future failures
- Alternate operating procedure to increase screen speed, avoid blinding
- Caused excessive wear on moving parts, high maintenance cost
- Retrofits used expensive materials like titanium bolts, increasing cost
Overall CEPT Project

- Chlorine Disinfection
- Influent Conduit
- 2 New Raw Sewage
- 2 New Fine Screens
- 2 New Primary Clarifier Chemical Feed Facilities
- 1 New Gravity Thickener
- 1 New Sludge Storage Tank
- CEPT: Preliminary Treatment
- CEPT: Clarification
- CEPT: Disinfection
Future Headworks Profile

- Six new raw sewage pumps (two open slots, 4 replace)
- Two new fine screens
- New 110 MGD CEPT train after screens
Project Goals

• Increase screen firm capacity to 440 MGD from 330 MGD
• Consider future build out capacity of 550 MGD when sizing new screens
• Meet land application regulations (5/8-inch max)
• Address existing issues
Existing Conditions

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Hydraulic Stress Test

Overflow for 3.5 min

Freeboard before Test

Overflowing Bypass Weir
Existing Screen – Previous Condition

Freeboard = 0.25"

Peak HL = 3.25'

Avg HL = 1.5'

708.00
706.25
705.18
700.00

709.50
709.75
713.00

713.00
708.00

706.43
706.70

700.67

NOTES:
1. SPECIFIED PEAK FLOW WAS 110 MGD PER SCREEN. SPECIFIED AVERAGE FLOW WAS 28.5 MGD PER SCREEN.
Existing Screen – New Conditions

Freeboard = 0.25”
Peak HL = 3.25’
Peak HL = 2.67’
Freeboard = 0.50”
Other Findings

- Influent gates lower than peak level, overflowed during test
- Grit settling in influent channel in front of screen during dry weather
- Influent stop logs too difficult to close, forces operation of screens in pairs
- Effluent slide gates lower than bypass elevation, unsafe if being maintained
Instrumentation Findings

- Influent level sensors not accurate during peak flows
- Sensor set too low within channel, inundated by flow (toilet paper)
- Affects screen speed operations
- Staff unaware of bypass events
- Programmed 3 minute delay on screen speed
Design Approach

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Capacity Analysis

- Existing screens in future = 90 MGD
- Why was tested flow ability lower than stated capacity?
- What capacity for new screens is needed?
- 550 MGD buildout firm requires four 125 MGD
- Capacity = slot velocity x effective area (Q = vA)
- Limited by available headloss, screen blinding
Screen Blinding

• Effective area = Open Area – Screen Blinding
• Screen blinding has significant impact on effective area
• Backing into blinding for existing screens from test leads to 40% blinding
• Same as the recommended assumption in BC guide specs
Slot Velocity

- Higher slot velocity creates greater headloss
- Higher slot velocity increases blinding potential
- Creates a cycle leading to backups
- WEF MOP 8 recommends maximum $v = 4$ fps
- Existing screen had 7.2 fps without blinding
Channel Velocity
Ideal Design

Maintain minimum requirements:
- Capacity > 110 MGD
- Aperture size < ¾-inch (prefer ¼)
- Slot velocity < 4 fps
- Channel velocity > 1.25 fps
Realistic Design

Maintain minimum requirements:
- Capacity > 110 MGD
- Aperture size < ¾-inch (prefer ¼)
- Slot velocity < 4 fps
- Channel velocity > 1.25 fps

What we could provide:
- Capacity > 110 MGD
- Aperture size = 3/8-inch
- Slot velocity = 4.8 fps
- Channel velocity > 1.25 fps
New Screens
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Alternative Analysis

**Perforated Plate Screen**
- **Advantages**
  - High capture efficiency
  - Open bid design
- **Disadvantages**
  - High headloss
  - Wash water demand
  - In-channel maintenance
  - Structural failure history

**Multi-Rake Bar Screen**
- **Advantages**
  - Low headloss
  - No wash water demand
  - Robust structural design
  - Open bid design
- **Disadvantages**
  - Lower capture efficiency
  - In-channel maintenance

**Flexible Multi-Rake Bar Screen**
- **Advantages**
  - Low headloss
  - Continuous removal
  - No wash water demand
  - Robust structural design
- **Disadvantages**
  - Lower capture efficiency
  - Proprietary design
Recommendations

- Shared Influent Gates (3)
- Influent Slide Gate (4)
- Influent Level Sensor (4)
- Effluent Slide Gate (4)
- Effluent Level Sensor (2)
- Extend Conveyor
- Bar Screen and Press (2)
 Specification Requirements

Don’t rely on vendors to provide your screen design

- Assume 40% screen blinding minimum
- Check with hydraulic stress test on existing screens if possible
- Define Bar Loss Coefficient = 0.84
- Provide exact flow conditions and hydraulic assumptions
- Require Ohio PE structural approval of available headloss
Screen Installation
Screen Installation
Screen Installation
Gate Installation
Operational Demonstration
Lessons Learned

• Screen capacity is difficult to define
• Influent wastewater constituency impacts capacity
• Define your requirements vs. goals
  • Screen capacity, slot velocity, channel velocity, aperture size
• Be aware of design parameters, close is better than nothing
• Incorporate operational philosophy into design
• Low maintenance is key, slow and steady wins the race
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Questions/Discussion