Seven Miles of Sludge Pipe
A Fifteen-Year Journey

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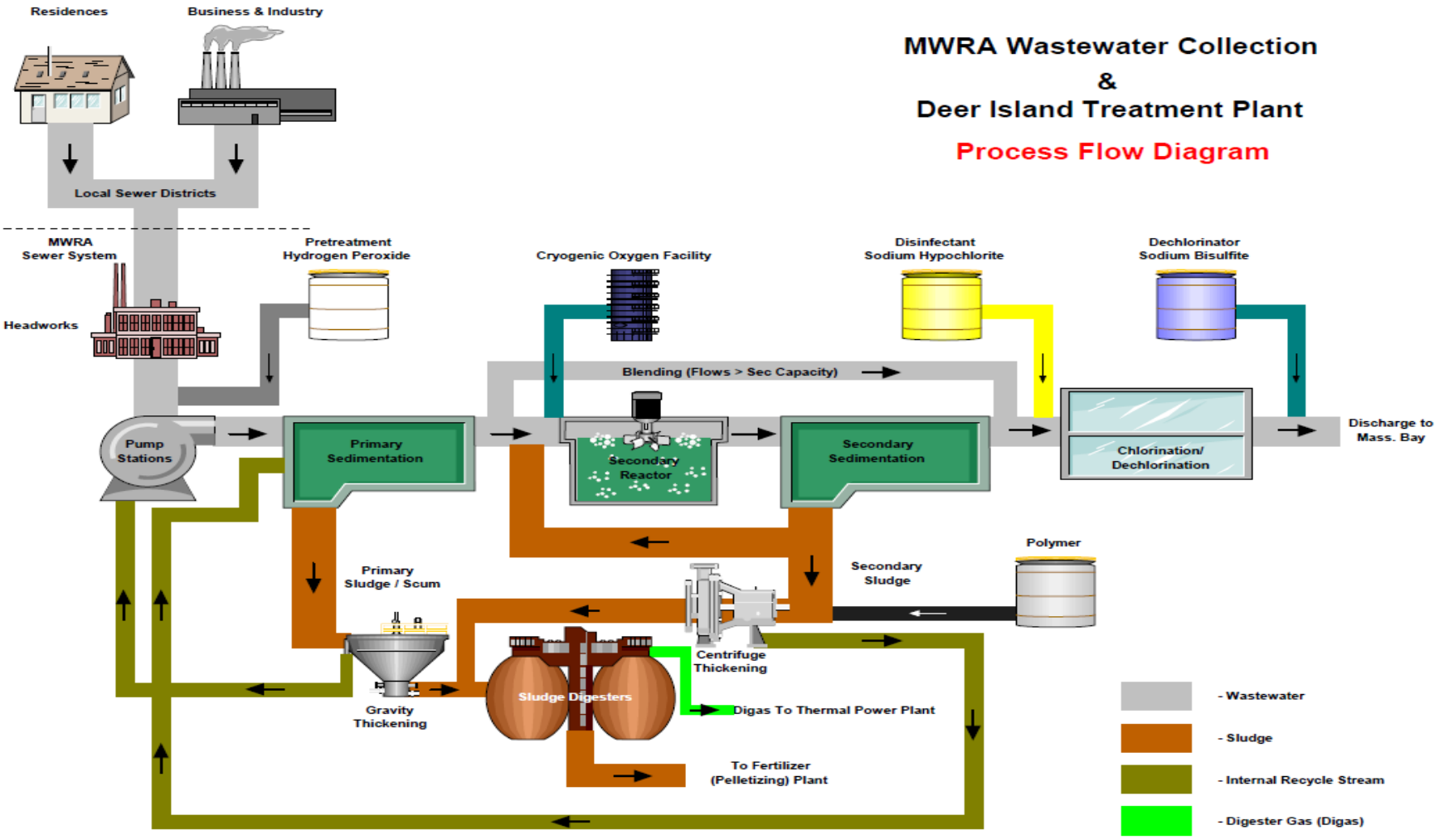
Agenda

- Deer Island Overview
- Sludge and Biosolids Processing Overview and History
- Sludge Transport History
- Sludge pumping challenges
- Sludge pump improvements
- Lesson Learned

The Deer Island Treatment Plant – an Introduction

- Constructed from 1990-2001, $3.8 billion Boston Harbor Project
- One of the largest wastewater treatment plants in the country
- Design Flow 361 million gallons/day
- Peak capacity 1.3 billion gallons/day

Process Overview



Thickening and Digestion

- Primary Sludge thickened in Gravity Thickeners
- Secondary Waste sludge thickened in Centrifuges
- Thickened sludges combined and pumped to the digesters
- Sludge digested for about 20 days in eight of twelve anaerobic digesters

Biosolids Processing Facility (BPF)

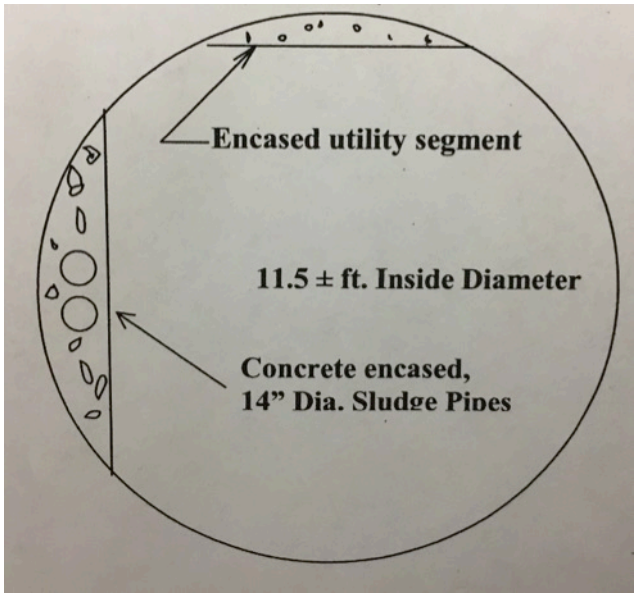
- Designed and Constructed by MWRA
- Contract Operation – Currently held by New England Fertilizer Company
- Sludge is dewatered in Centrifuges
- Dewatered cake is dried in Rotary Kiln Driers
- Dried biosolids (pellets) are distributed to farms, golf courses, and other businesses
- Marketed locally as Bay State Fertilizer

Digested Sludge Transport to BPF

- Transported via Barge from 1991 through 2005
- Barge could hold 750,000 gallons of digested sludge
- About 20 barge trips per month
- Average production 100 dry tons per day as total suspended solids
- Barge would return to Deer Island with the “filtrate” from the process
- Filtrate fed to influent of Deer Island Treatment Plant

Digested Sludge Pumping

- In April 2005 MWRA began pumping sludge to Quincy for the first time
- Pumped through one of two 14 inch lines, 39,700 feet long, most of it inside a tunnel under Boston Harbor
- Installed pumps positive displacement diaphragm piston pumps
- Manufactured by Abel GmbH of Germany
- Two 800 GPM pumps pumping
  50 hours per week



Pumping Challenges

- Membrane fail rate higher than expected
  ---covered under five-year warranty

- Pulsation Dampening a challenge

- Selection of flow rate/pumping schedule
  - Design flow rate would have been too low (encourage settling)
  - Contractor did not want to work seven days per week
  - Pumping schedule of 4-5 days per week at 1500 gpm

- Discharge pressure of pump began to increase : concerns about struvite build-up in pipe

Relationship between Flow and Pressure

- Restrictions in pipes cause energy "losses" due to "friction"
- As these losses increase, a pump must produce more pressure to maintain flow
- Positive displacement pumps always produce the same flow, but they must produce higher pressure to overcome greater restrictions
- Friction Loss Equation:

$$H_f = KV^2 / 2g$$

- Where
  - H_f = head loss due to friction in feet or meters
  - K = constant of friction (will only change if the restrictions in the pipe change)
  - V = velocity of fluid pumped
  - g = gravitational constant

Struvite Overview

- Magnesium Ammonium Phosphate –Hexahydrate

  $MgNH_4PO_46(H_2O)$

- Forms at certain conditions, especially when pH is elevated and in pressure-drop conditions

- Struvite found in digester overflow boxes and on mixers, as well as in pipes

- Iron salts used to tie up orthophosphate

Measures to Mitigate High Discharge Pressure

- Pressure gauges were placed in different locations to check for pressure changes
- Flushing program implemented with high pressure plant water
- Iron salt addition was increased
- Problem continued until 2007

High Discharge Pressure Resolution

- Disassembled pipe at Quincy side
- Used a camera to inspect the line
- Found signs of solids deposition in bottom of 200 ft riser pipe
- Jetted line in January 2008
- Weekly flushing program continued
- Discharge pressure dropped back to normal range of 80-100 psi over several weeks at full flow of 1600 gpm

Pump Discharge Pressure with 2 Abel pumps

Date	Flow, GPM	Discharge Pressure, PSI
4/12/2005	1550	67
9/5/2005	1500	103
2/10/2006	1300	140
1/30/2007	1300	166
2/5/2008	1600	137
4/30/2008	1700	96

New pumps

- Operators found that centrifugal recirculation pump could pump sludge to BPF
- Contracts issued for design and construction of new centrifugal pump to replace positive displacement pumps
- 2010 – trial centrifugal pump installed
- 2017- two permanent centrifugal pumps installed and Abel pumps removed

Pump Comparison

Pump Manufacturer/ Type	Pump Capacity, GPM	Pump Max Discharge Pressure	Pump Motor Rating (HP)	Year Installed
Abel Piston Diaphram	800	350 PSI (809 ft)	250	2005
Goulds Model 3180 Centrifugal	1600	250 ft	400	2010
Goulds Centrifugal CWX	1600	250 Ft	300	2017

Lessons Learned

- Keep an open mind when troubleshooting a problem
- Capitalize on good surprises
- Turn problems into opportunities

Acknowledgments

- Thanks to the following:
- Co-author David Duest, Director, Deer Island Treatment Plant
- Michael Hughes
- Richard Adams
- Brian Davitt
- Carl Pawlowski

Questions?