Cleveland Division of Water with Stantec Consulting Services, Inc.

Don't "Screw Press" Around: Applying Screw Press Technology to WTP Residual Solids Dewatering

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Agenda

1. Background
2. Screw Press Technology Overview
3. Sizing the Screw Press System
4. Design Alternatives
5. Detailed Design

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Background

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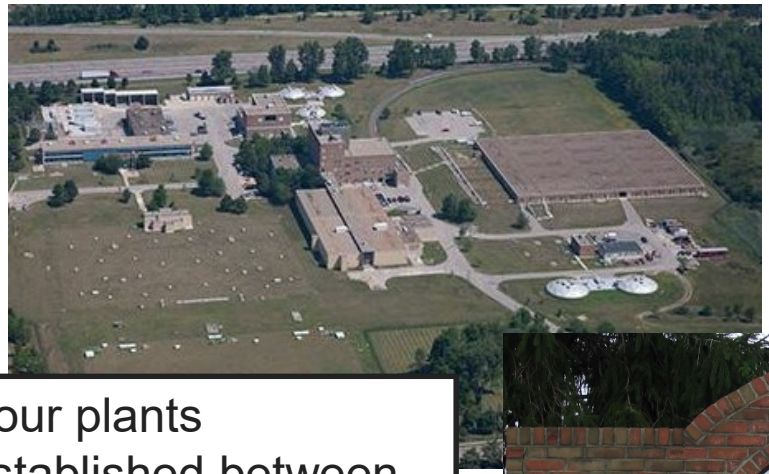
Cleveland Water Department (CWD)

Cleveland Water Department - Residuals



Four plants established between 1925 and 1958

Only Crown has On-Site Sludge Dewatering

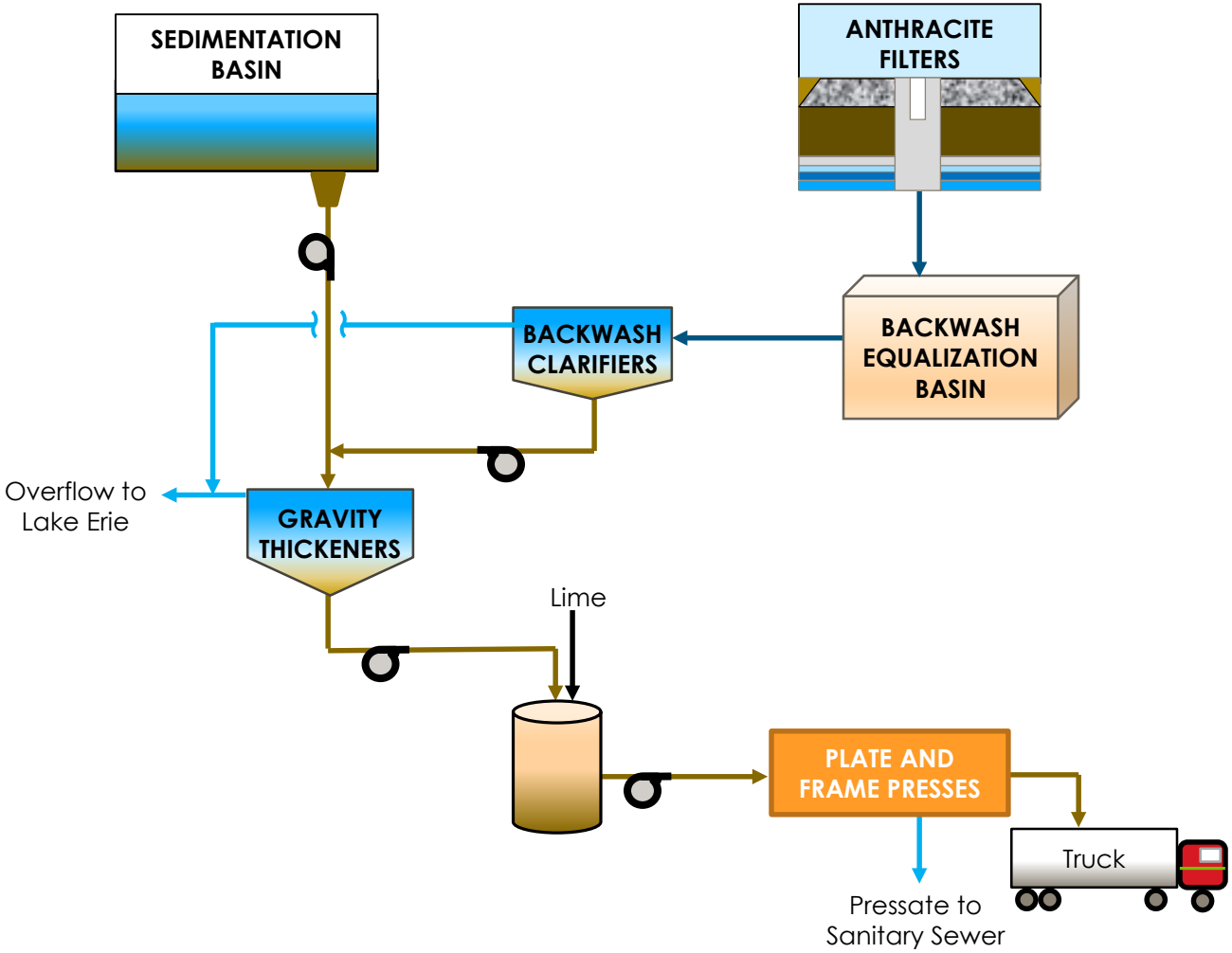
Remaining Three (3) Water Plants remove residuals from onsite sludge holding tanks to direct sewer connection

Current Crown Residuals Practices

- Crown Water
  - Avg flow through the plant: 42.1 MGD* (rated for 86.7 MGD)
  - Max flow through the plant: 63.6 MGD*(rated for 130 MGD)
- Four (4) Gravity Thickeners
- Since 1985, Crown has operated two (2) plate-and-frame presses
- Alum-polymer sludge with lime addition for dewatering

* Based on 2012-2013 data from the Residual Solids Production and Disposal Cost Report, July 2014, Stantec

Existing Residuals Process Schematic



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Existing Plate and Frame Presses

Why Replace the Plate-and-Frame Presses

- Improve solids production
- Decrease maintenance requirements
- Reduce energy consumption
- Aging equipment
- Labor intensive system

Screw Press Replacement
Schwing Bioset

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Screw Press Technology Overview

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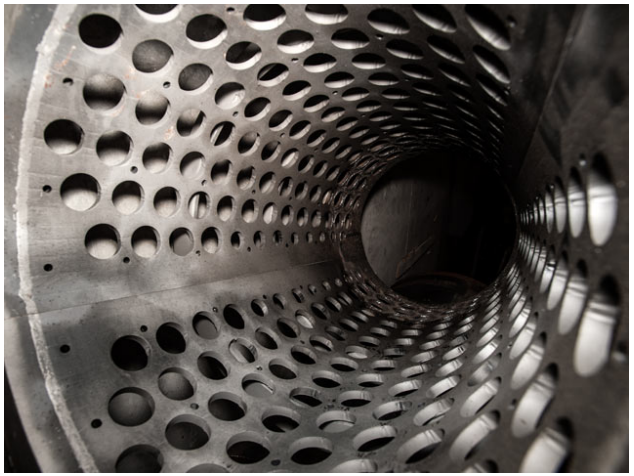
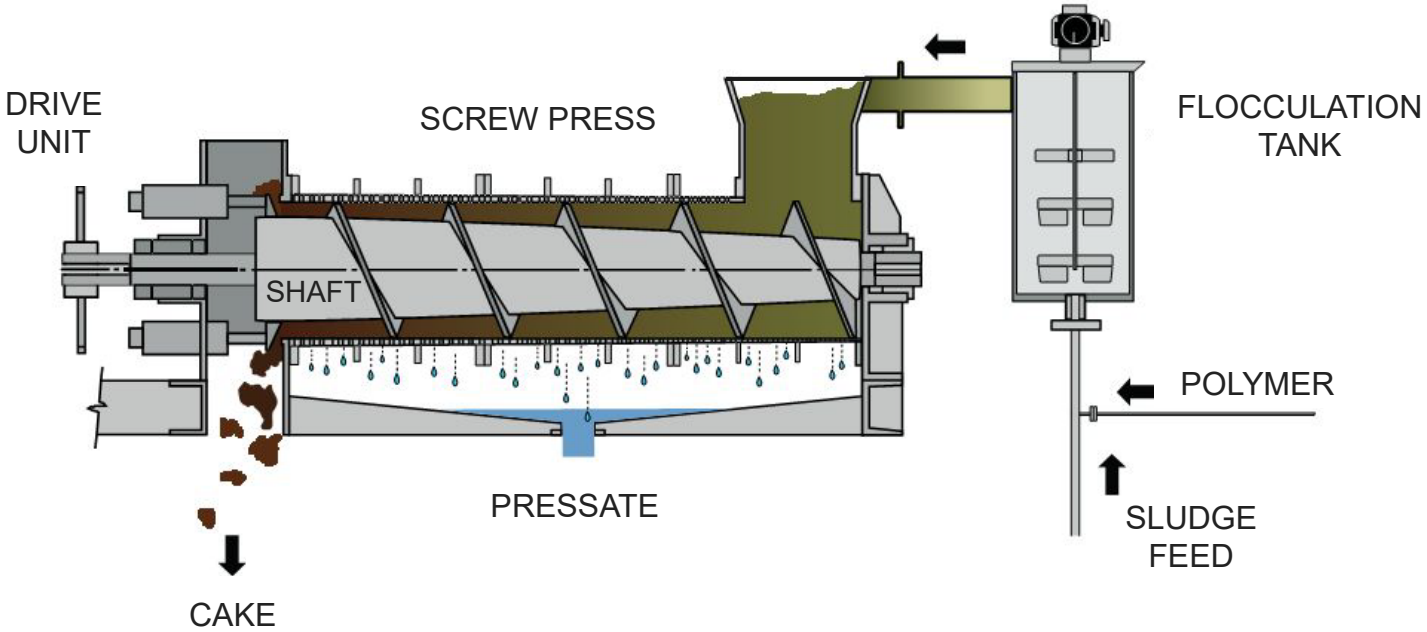
Screw Press System

- Dewater solids to achieve 15-30% solids
- Slow screw speed: 0.5-1.5 rpm





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Screw Press & Ancillary Systems

Wash Water

- To clean screw press, recommended every 2-3 hours of operation, 4-6 min

Polymer

- Added to Sludge Line at the Injection Ring for Dewatering

Screw Conveyor

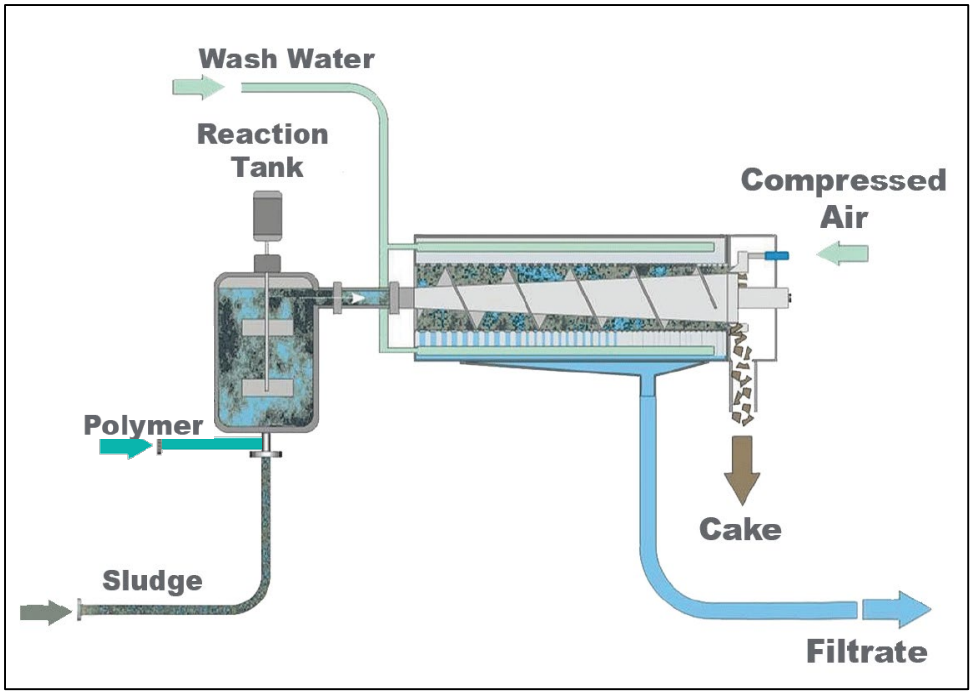
- To evenly load trucks below the screw presses (multiple gates)

Compressed Air

- To pressurize the screw press

Sludge Feed Pumps

- Including flow and density meters



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Sizing the Screw Press System

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Screw Press Sizing – Solids

Residual Solids Production Rates

- Estimated and reported residual production rate for Crown Water Works were ~172 (dry lbs/MG)

- Production Rates:
  - Avg. day – 7,278 (dry lbs/day)
  - Max day – 51,221 (dry lbs/day)

- The peaking factor (51,221/7,278) is 7
  - Must be sized to handle maximum 7-day average with redundancy

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Screw Press Sizing – Volume

Calculating Throughput Volume, V

- W_s = Weight of Dry Solids (lbs)
- ρ_ω = Density of Water (lbs/gal)
- S_{sl} = Specific Gravity of Sludge
- P_s = Percent Solids, as a decimal

$$V = \frac{W_s}{\rho_\omega * S_{sl} * P_S}$$

Throughput Volumes

- Avg day = 21,284 gal/day
- Max day = 149,795 gal/day

Assumptions

- Specific Gravity = 1.025
- Solids Concentration from Thickeners = 4%

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Screw Press Sizing – Varying Safety Factors

Ave-day[1]					
S.F.	0%	10%	15%	20%	25%
Ave-day Production (lbs/day)	7278	8006	8370	8734	9098
Ave-day Production (lbs/week)	50946	56041	58588	61135	63683
Required Dry (lbs/hr)	1698	1868	1953	2038	2123
Ave-day Volume (gal/day)	21284	23413	24477	25541	26606
Ave-day Volume (gal/week)	148991	163890	171340	178789	186239
Required Thruput (gpm)	83	91	95	99	103

Notes:	
1.	Based on 30 hrs/week (6 hour days, 5 days a week)

Same method used for Max-day calculations

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Screw Press Sizing – Schwing

Screw Press								Reaction Tank			Washwater	
Model	Capacity Aerobic 2.5% DS (dry lb/hr)	Capacity Anaerobic 3.5% DS (dry lb/hr)	Length (in)	Width (in)	Height (in)	Weight (lb)	Power (hp)	Model	Volume (gal)	Power (hp)	Washwater (gal/cycle)	Washwater Pump (gpm @ 60-90 psi)
								RT 70	225	1.5		
FSP 703	970	1300	255	57	72	11,640	5.0				70	30
FSP 1102	2430	3240	303	74	90	22,930	10	RT 110	661	3.0	130	55
FSP 1202	2760	3720	327	81	106	28,660	13	RT 120	925	5.0	155	65

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Design Alternatives

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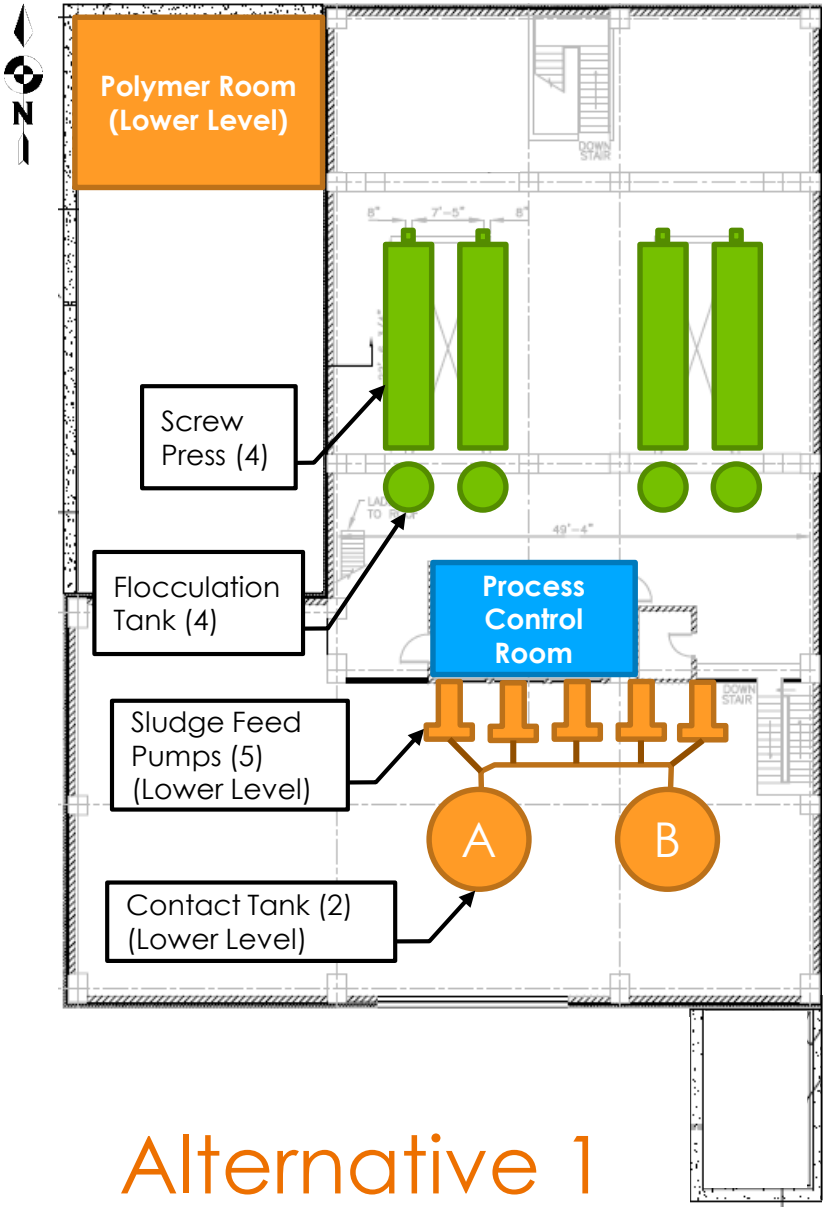
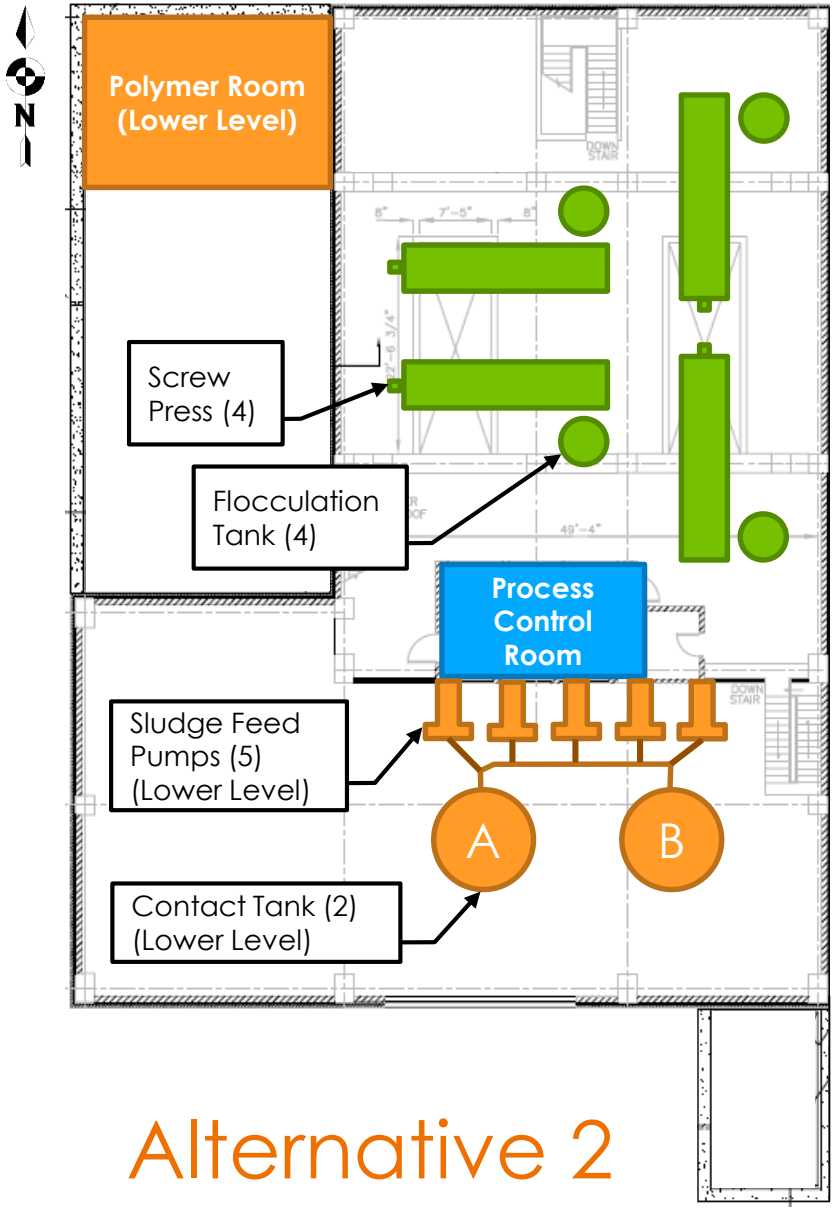


Alternative 1



Alternative 2

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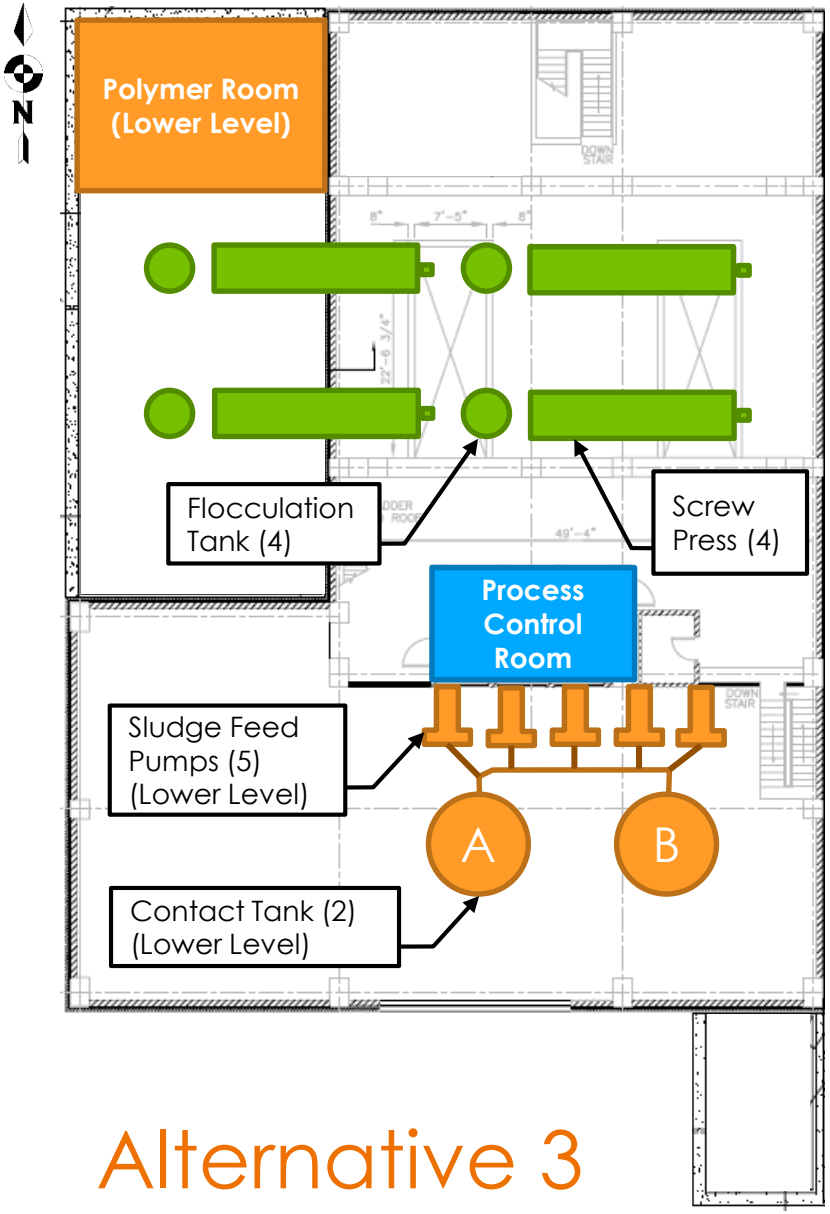
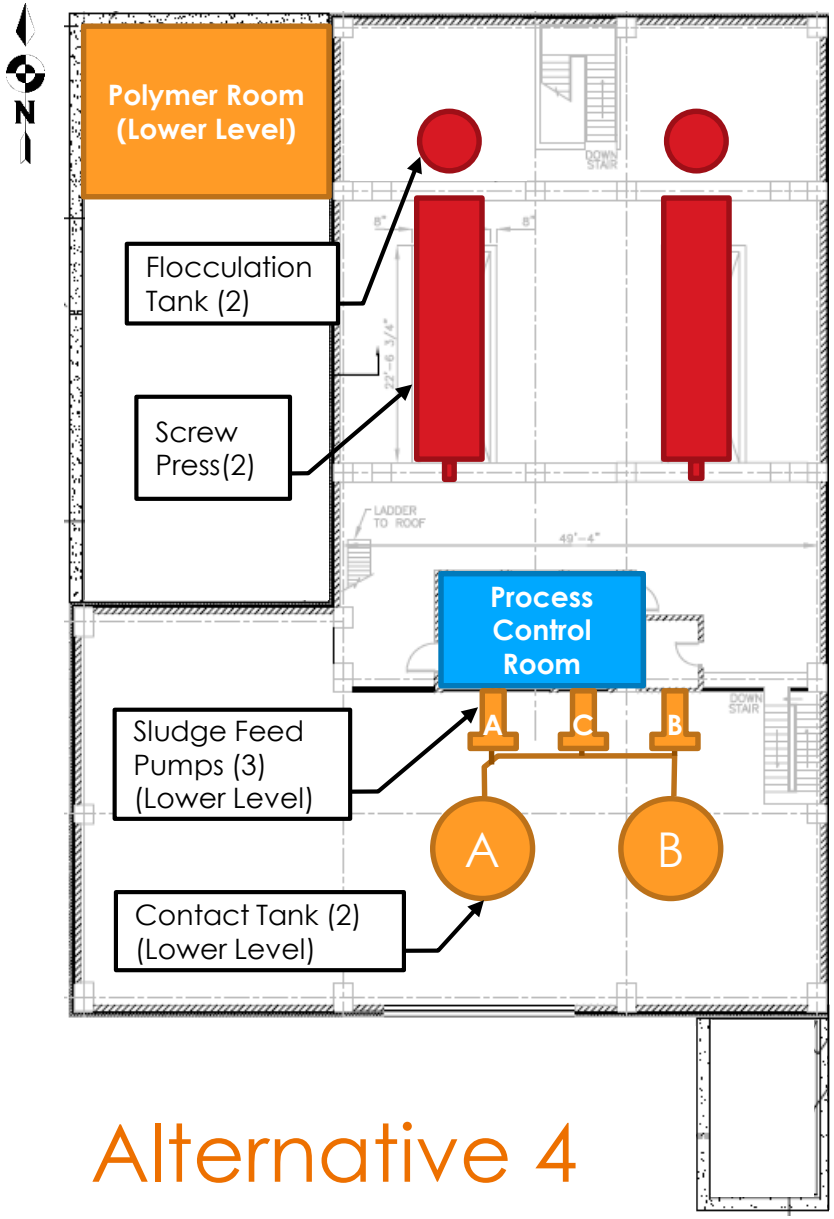


Alternative 3



Alternative 4

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Pair-wise Comparison of Alternatives

Pair-Wise Comparison	Alt 1 - 4 Screw Presses, 2 Conveyors, No Building Additions	Alt 2 - 4 Screw Presses, 4 Conveyors, No Building Additions	Alt 3 - 4 Screw Presses, 4 Conveyors, Building Addition	Alt 4 - 2 Screw Presses, 2 Conveyors, No Building Additions
Capital Cost	3	3	5	1
Weight*	4	4	4	4
Score	12	12	20	4
Operations	3	3	3	2
Weight	2	2	2	2
Score	6	6	6	4
Maintenance	3	4	4	2
Weight	1	1	1	1
Score	3	4	4	2
Constructability	2	3	5	4
Weight	3	3	3	3
Score	6	9	15	12
Total	**27**	**31**	**45**	**22**

Categories ranked on a score of 1-5, with 1 being the best score

*Total weight of all capital cost, operations, maintenance, and constructability adds up to 10, weight per category is the same for each alternative

Alternative 4 selected because the two trains are similar operationally to existing equipment and are lower cost

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Detailed Design

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Project Scope

- Replace two (2) Plate-and-Frame Presses with Screw Presses
- Replace three (3) Sludge Feed Pumps
- Install Ancillary Screw Press Systems
- Replace GST Sludge Transfer Pumps and Drives
- Demolish Lime System
- Contact Tanks: Replace Mixers, Add Baffles and Access Hatch

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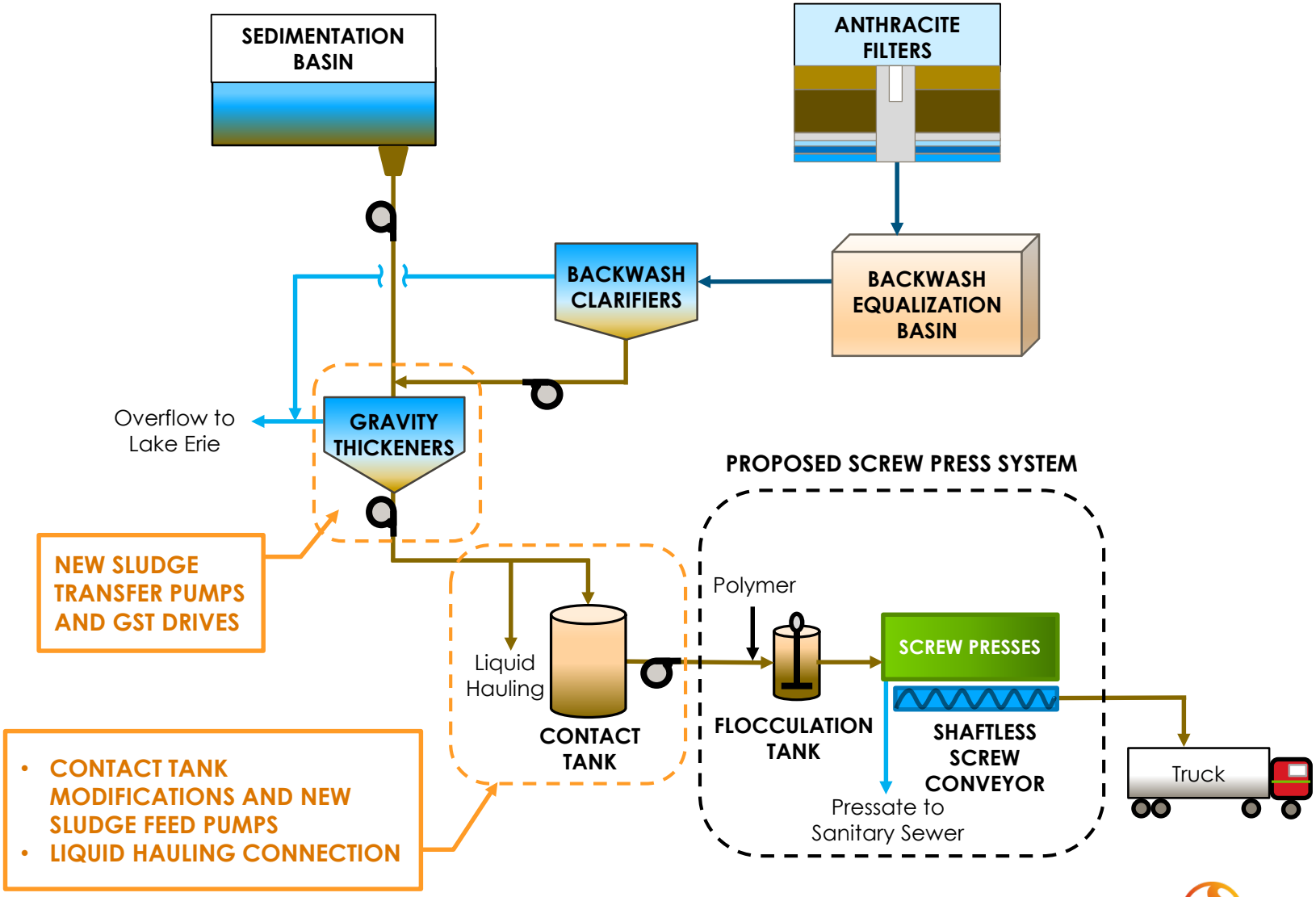
New Residuals Process Schematic



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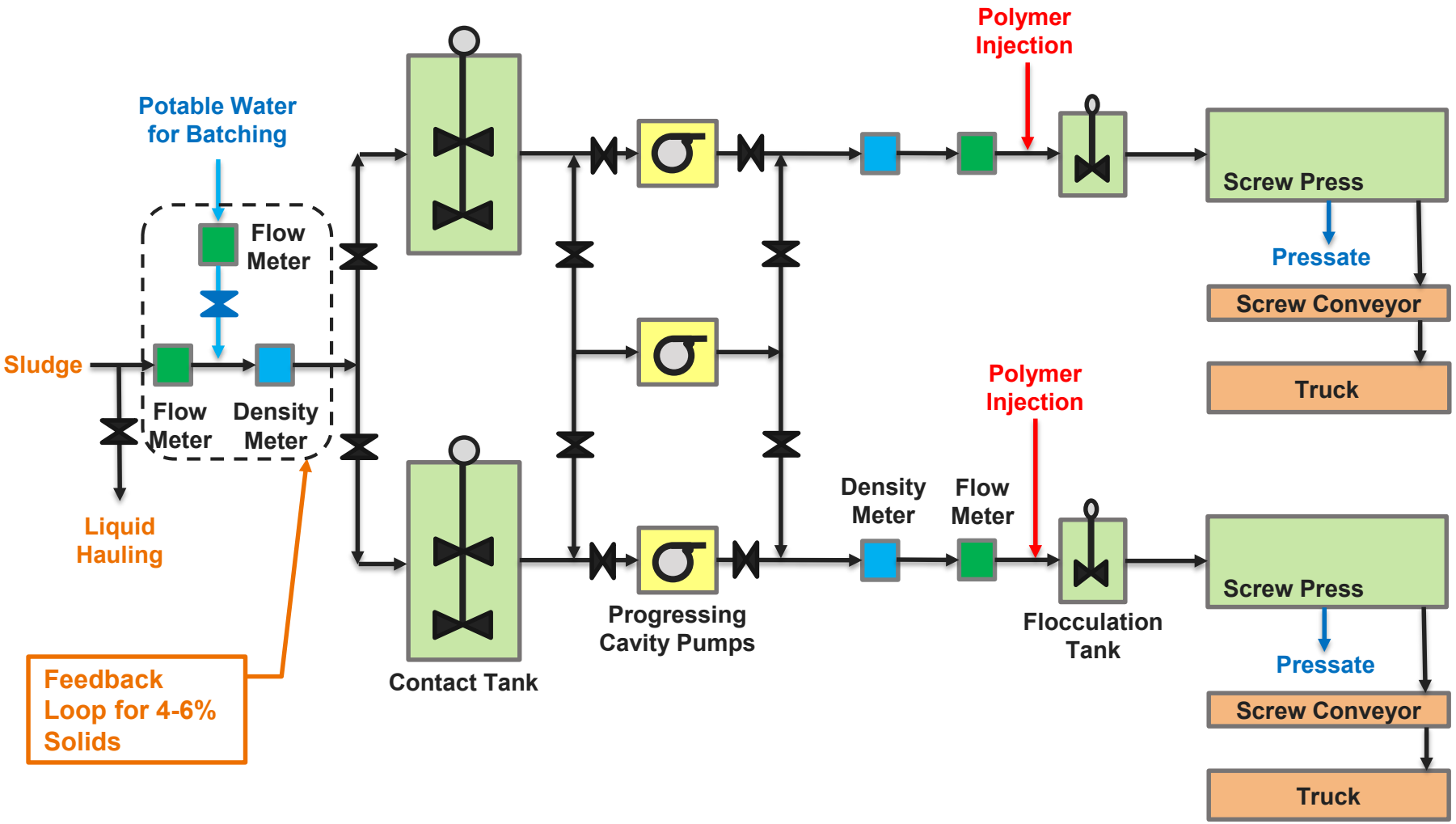
Sludge Dewatering System Schematic



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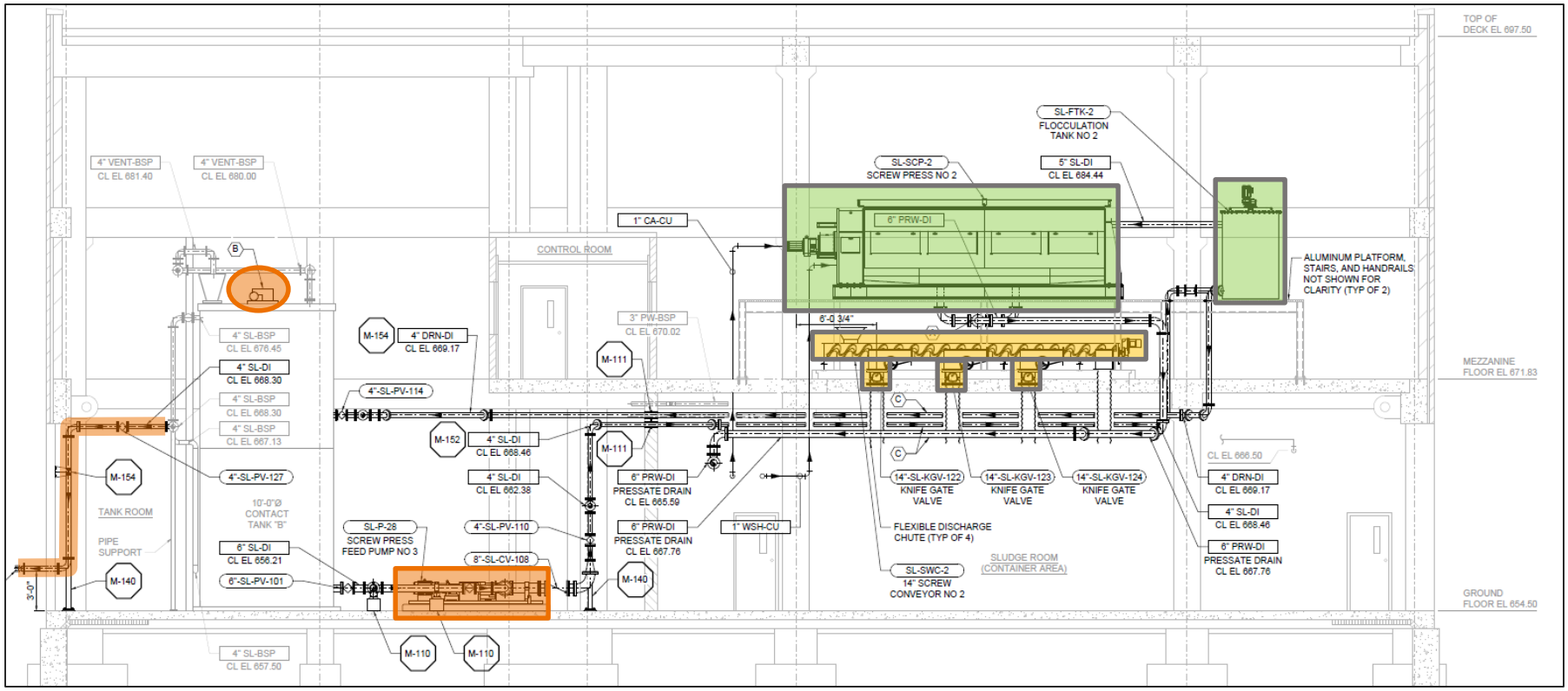
Sludge Dewatering Building Section

- Flocculation Tank raised to increase hydraulic head when draining
- Shaftless Screw Conveyor with three Knife Gate Valves
- Screw Presses will be installed through the existing floor openings
- Liquid Hauling Connection brought outside the building



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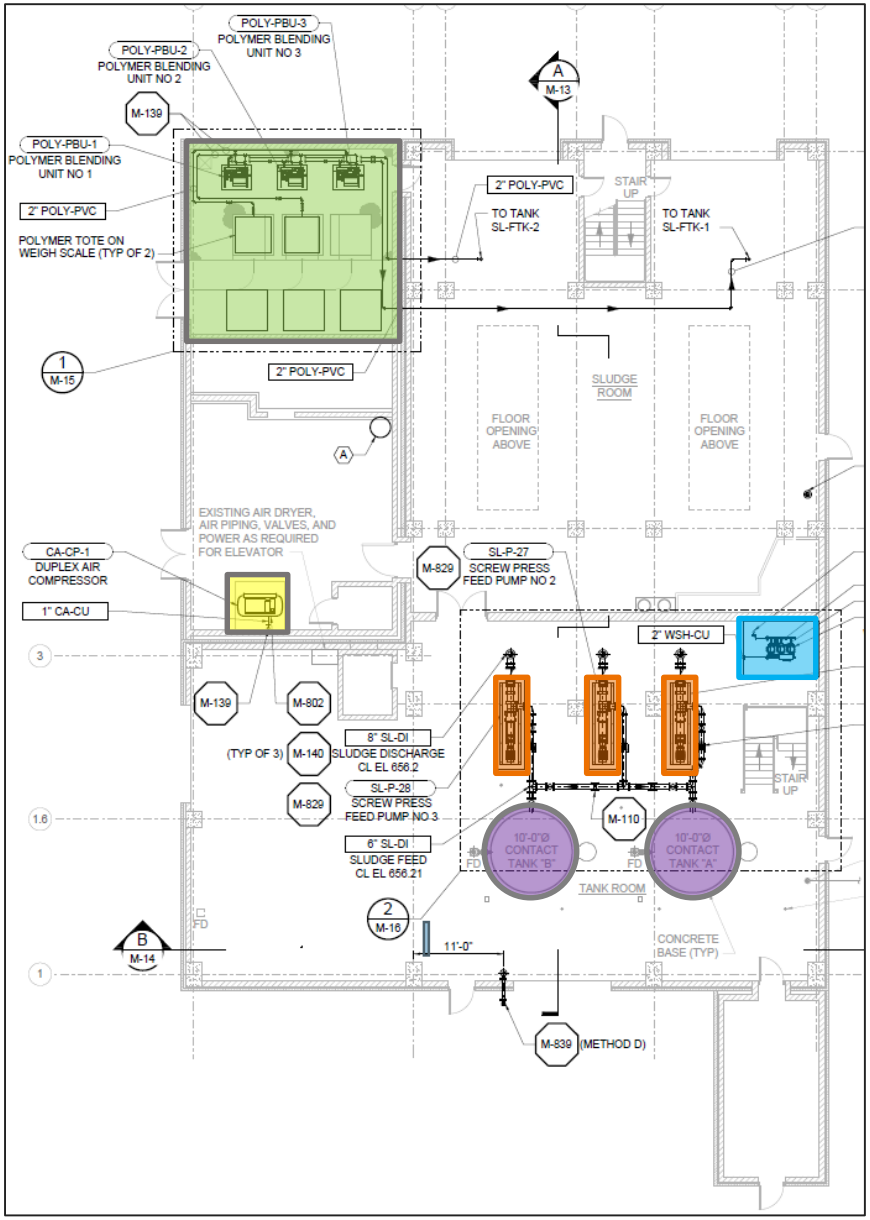
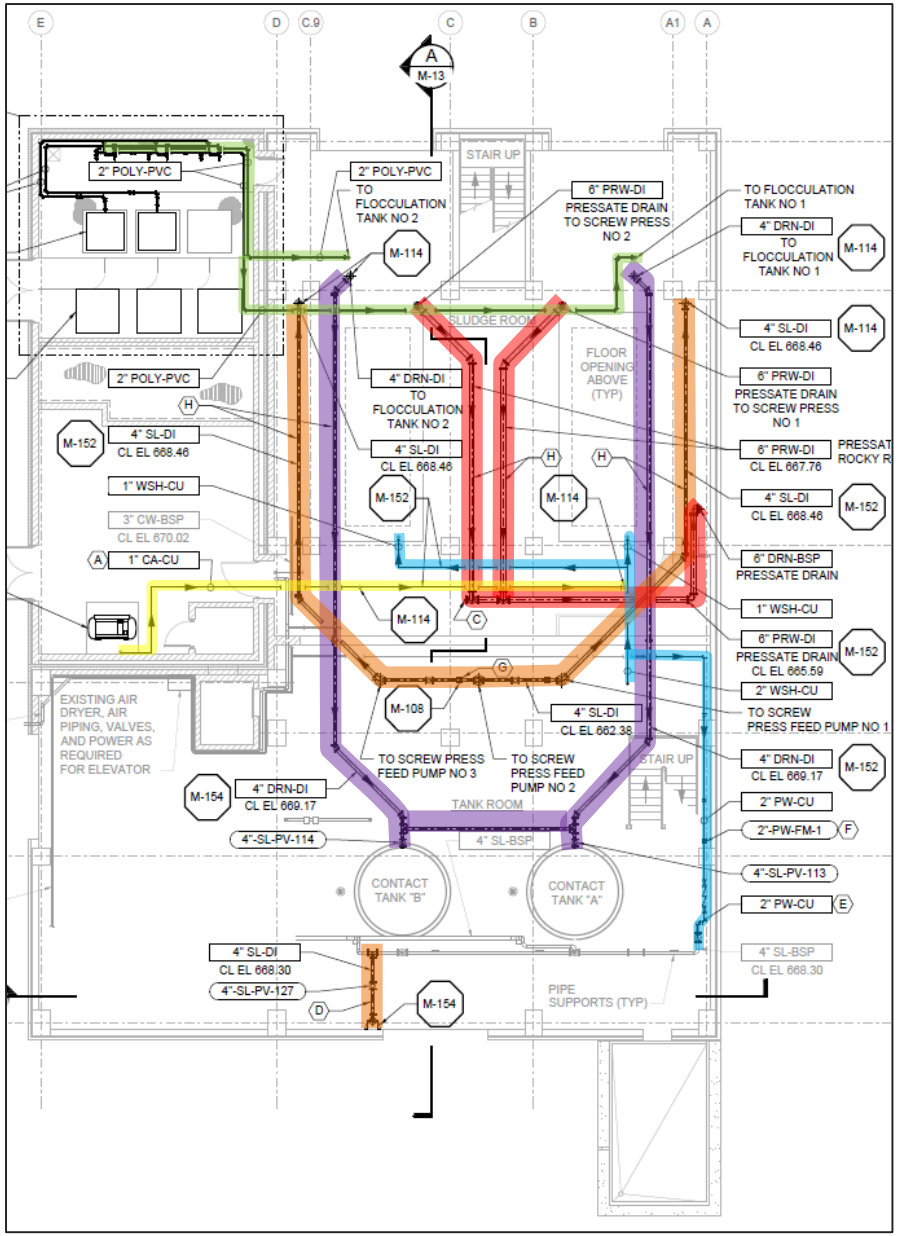
Sludge Dewatering Building Plans (Lower Level)

- New Feed Pumps (Orange)
- New Duplex Air Compressor (Yellow)
- Polymer Room in NW corner, with three Polymer Blending Units. Spill containment pallets provided for 300 gal spill containment. (Green)
- New Washwater Booster Pump Skid (Blue)
- New Contact Tank Mixer (Purple)



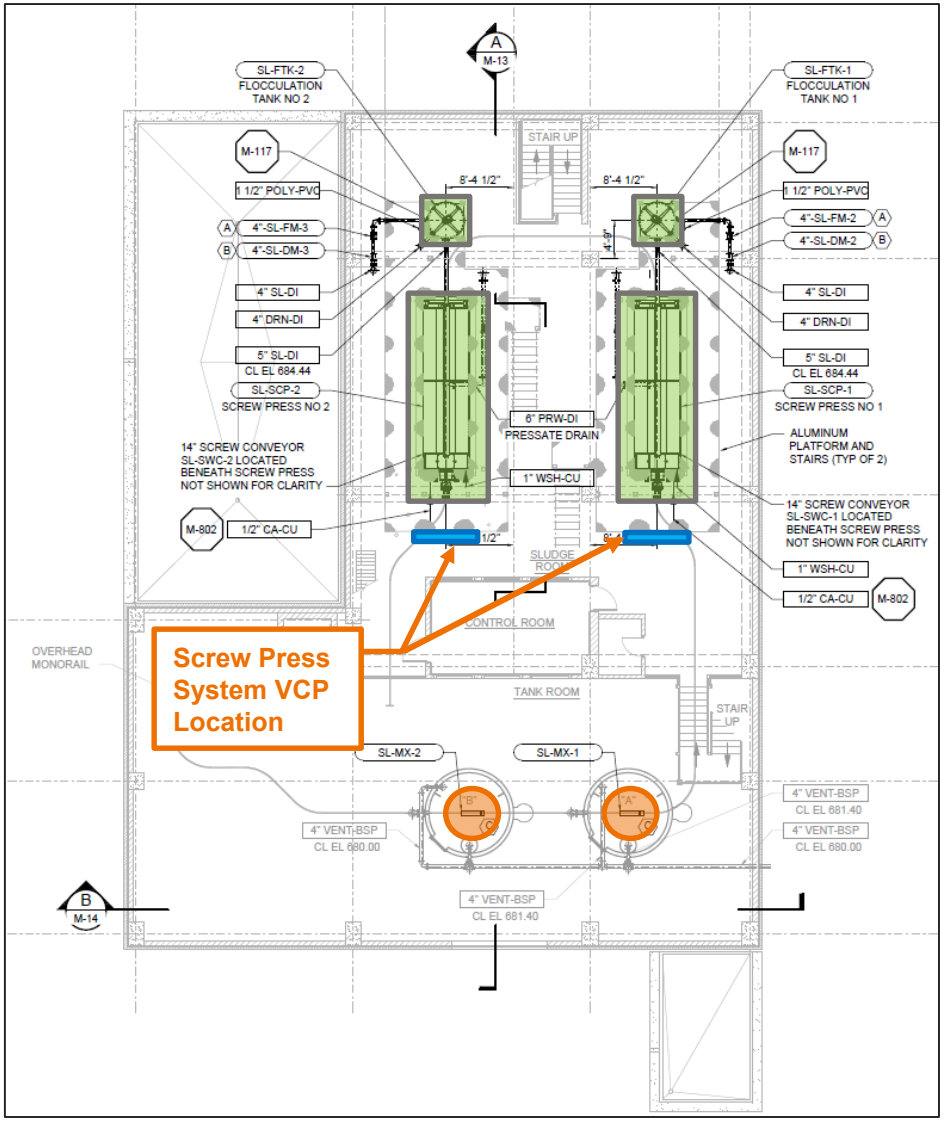
Sludge Dewatering Building Plans (Intermediate)

- Lime System Removed
- Screw Press Drain lines to Rocky River WWTP (Red)
- Piping from Contact Tanks to Flocculation Tanks and Liquid Hauling (Orange)
- Air Compressor piping (Yellow)
- Polymer Piping (Green)
- Washwater Piping (Blue)
- Flocculation Tank Drain Lines (Purple)



Sludge Dewatering Building Plans (Upper Level)

- Two Screw Presses with Flocculation Tanks in place of existing Plate and Frame Presses
- Lime System Removed
- Platform to be built after Screw Press Delivery and Placement on 2nd Floor
- Break room removed and Control Room Rehabilitation



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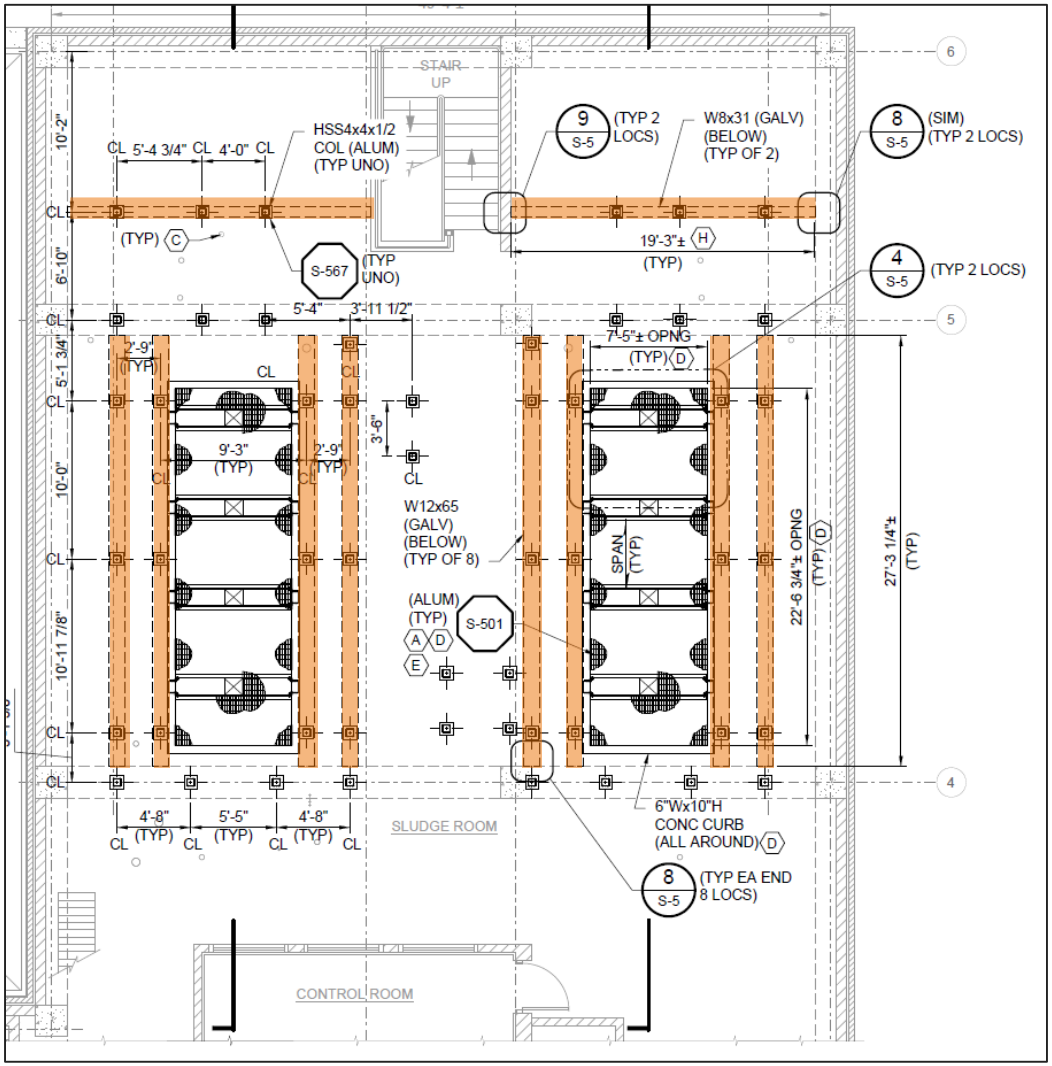
Sludge Dewatering Building Structural Modifications

- Additional intermediate beams added under 2nd Story
- Needed to support the screw presses, floc tanks, and screw conveyors
- Lightweight steel I-beams with simple installation
- Plate-and-Frame Presses spanned column lines 4 - 5 with no intermediate beams



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Future Crown Residuals Operations

- Density meters and flow meters will determine contact tank batching and polymer dosing.

- Normal operation: 1 Screw Press, 4-6 hours/day, 5 days/week
- Maximum operation: 1 Screw Press, 24 hours, 7 days/week or
  2 Screw Presses, 12 hours/day, 7 days/week

Cleaning Cycle:

- Washwater booster pumps will be turned on for 4-6 min every 2-3 hours of operation.

- At the end of each day, the flocculation tank should be drained by gravity back to the Contact Tanks

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Conclusion

- **Advantages to Screw Presses**
  - Completely Enclosed Machines
  - Less energy consumption and manpower
  - Entire system automated with centralized control through SCADA
  - Dewatered sludge can be used for beneficial re-use

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Questions?

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Thank you

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