Stantec

City of Elyria WTP

Proposed Improvements for Increasing Plant Capacity

Presented to OTCO

December 4, 2018

Agenda

1. Plant History
2. Plant Overview
3. Present Capacity
4. Why Increase Capacity?
5. Plant Capacity Analysis
6. High Rate Demonstration Study
7. Plant Capacity Improvements
8. Ancillary Improvements

City of Elyria WTP - Proposed Improvements for Increasing Plant Capacity

Plant History

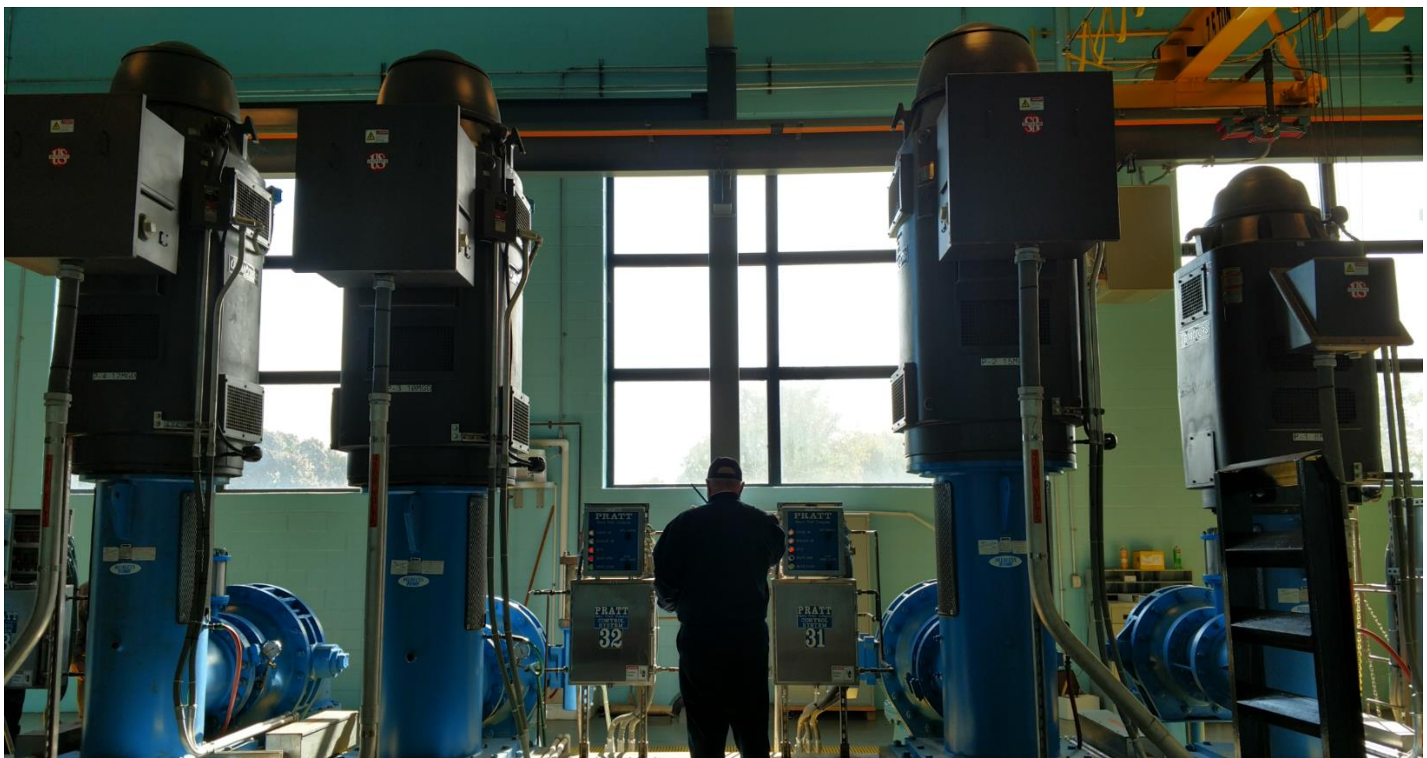
Plant History

- City of Elyria purchased property on the shore of Lake Erie in late 1800's (area now inside the city limits of Lorain)
- Original Water Works Plant on West 15th Street sold to Elyria Iron and Steel Company in 1904
- New water plant began pumping treated water from Lake Erie to Elyria in 20-inch cast iron main (still in use today)
- Believed to be the first inland City in the USA to pump treated water from the Great Lakes

Plant History

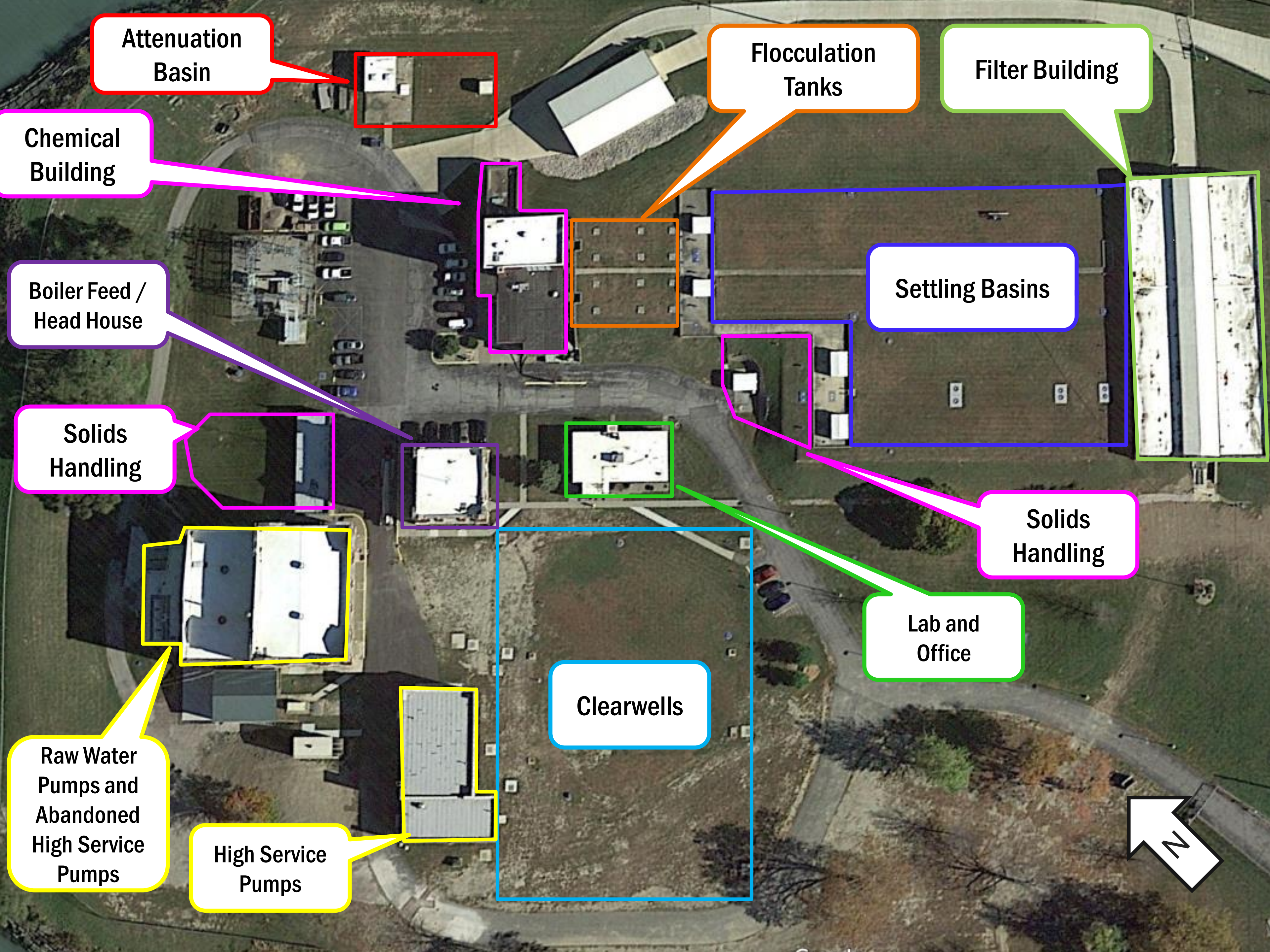
- In 1922, original plant was at capacity and a new plant replaced the old, expanding to total capacity of 8 MGD
- Over the years, various improvements and expansions have increased to current capacity of 22 MGD

- Plant supplies water to the following:
  - City of Elyria
  - City of North Ridgeville
  - City of Amherst
  - Erie Huron County Rural Water Authority
  - Several adjacent townships



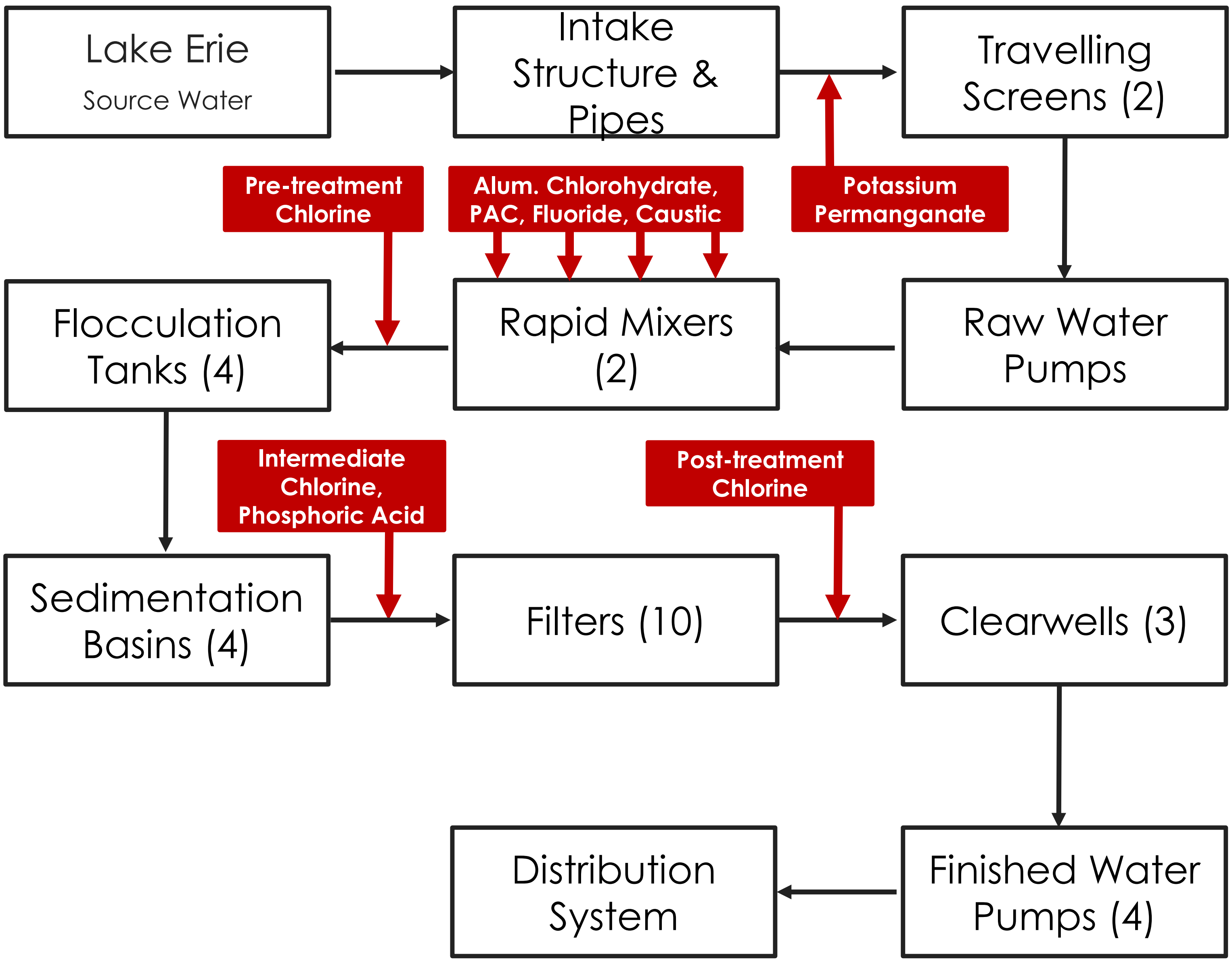
City of Elyria WTP - Proposed Improvements for Increasing Plant Capacity

Plant Overview

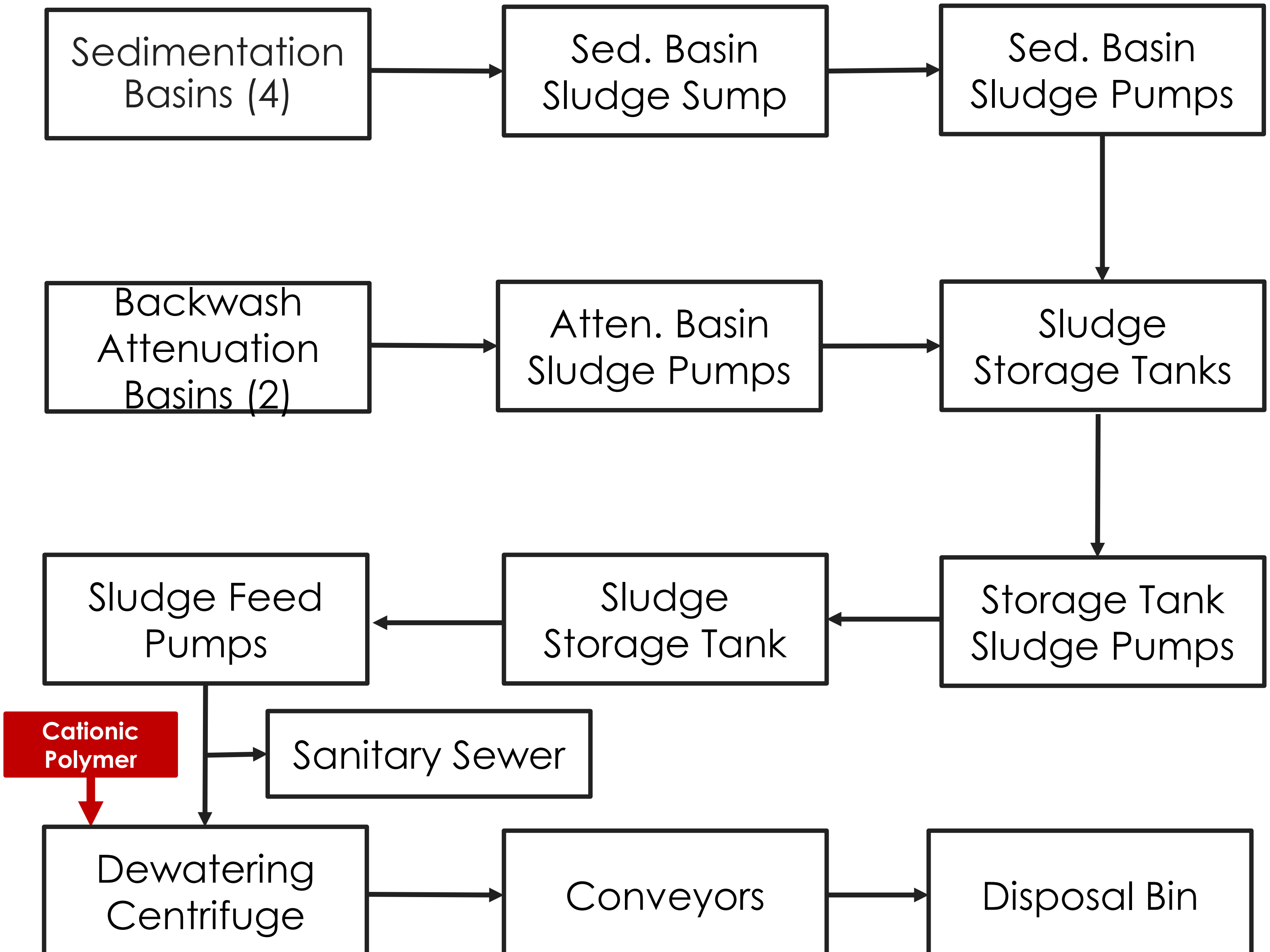


Attenuation Basin
Chemical Building
Flocculation Tanks
Filter Building
Boiler Feed / Head House
Settling Basins
Solids Handling
Solids Handling
Lab and Office
Clearwells
Raw Water Pumps and Abandoned High Service Pumps
High Service Pumps
N

Process Flow Diagram - Liquids



Process Flow Diagram - Solids



City of Elyria WTP - Proposed Improvements for Increasing Plant Capacity

Present Plant Capacity

Present Plant Capacity – 22 MGD

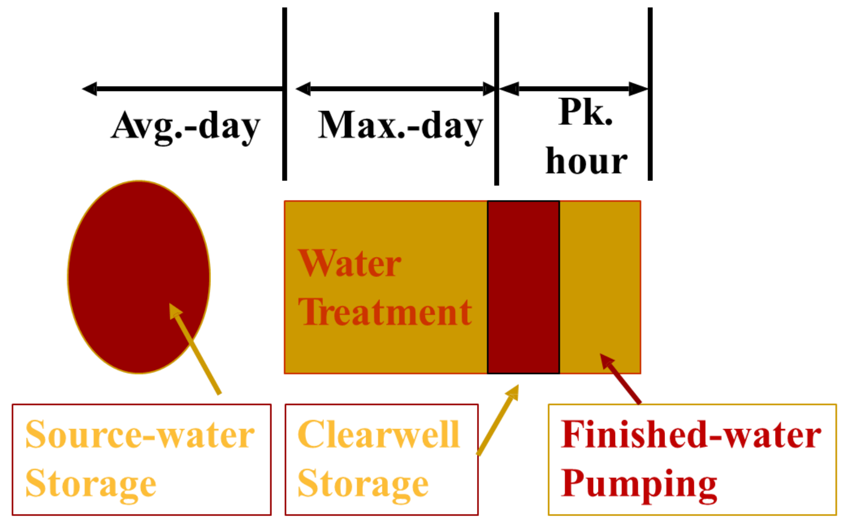
- Based on Ohio EPA assessment of the entire process
- Limited by the lowest rated component in the process
  - Water Supply Source
  - Treatment Plant
  - "Essential" Chemicals
    - Coagulant Aluminum Chlorohydrate
    - Chlorine Gas
    - Phosphoric Acid
    - Sodium Fluorosilicate
- Not impacted by "Non-essential" chemicals
    - Powder Activated Carbon
    - Potassium Permanganate
    - Caustic
    - Cationic Polymer

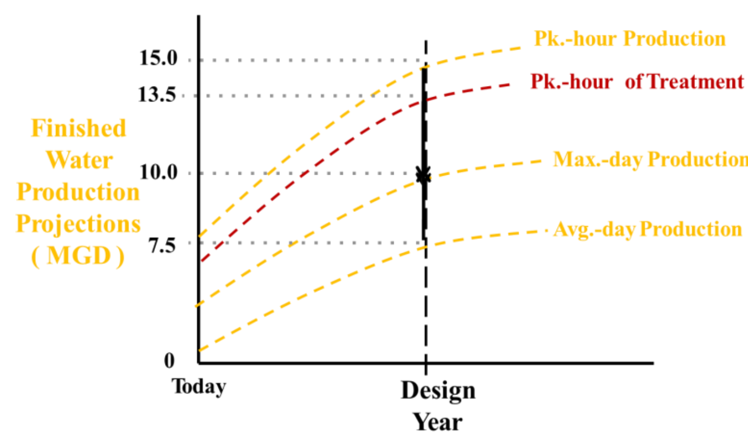
City of Elyria WTP - Proposed Improvements for Increasing Plant Capacity

Plant Capacity Analysis

Plant Capacity Analysis

- Plant specific data used to determine de-rating of process components
- Analyzed plant data from Jan 2016 to Dec 2017 to determine:
  - Average Day Production: 12.2 MGD
  - Maximum Day Production: 18.0 MGD
  - Peak-hour Treatment: 22.8 MGD
  - Peak-hour Production: 19.8 MGD
- Allows determining the following factors:
  - Max Day / Average Day = 1.5
  - Peak Hour (prod) / Max Day = 1.5 (based on individual day data, not maximums for the year)
  - Peak Hour (treatment) / Max Day = 1.3





Plant Capacity Analysis – Water Supply Source

Component	No. of Units	Existing System	Component Capacity (MGD)	Flow Basis of Component Capacity/Ratio	Equivalent Max-Day Capacity (MGD)
Source-water Supply	1	Lake Erie	∞	Avg-day 1.5	∞
Intake Structure	1	Four 66" flare openings One 24" opening Total Area = 108 sf	35	Max-day 1.0	35.0
Intake Pipe	2	One 42" pipe One 24" pipe	57.6	Max-day 1.0	57.6
Travelling Screens	2	(2) - 30 MGD	30	1.0	30
Source-water Pumps	7	LS Pump #1 - 6.5 MGD LS Pump # 2 - 7.8 MGD LS Pump #3 - 10 MGD LS Pump #4 - 7.0 MGD LS Pump #6 - 11.5 MGD LS Pump #8 - 12 MGD LS Pump #9 - 11.5 MGD	54	Max-day 1.0	54.0

Plant Capacity Analysis – Treatment Plant

Component	No. of Units	Existing System	Component Capacity (MGD)	Flow Basis of Component Capacity/Ratio	Equivalent Max-Day Capacity (MGD)
Rapid Mixers	2	10.33' x 10.33' x 17' SWD each; Total Volume = 27,140 gal G value = 300 fps/ft	73.6	Max-day 1.0	73.6
Flocculation Tanks	4	66' x 16' x 16' SWD Total Volume = 505,550 gal (2) – 30" BFV/tank	24.3	Max-day 1.0	24.3
Settling Tanks	4	(2) - 198' x 37' x 16 SWD (2) - 254' x 41.5' x 16 SWD Total Volume = 4.55 MG	15.1 10.5	Max-day 1.0	25.7
		Basins 1-2 (2) - 516' of weir Basins 3-4 (2) - 640' of weir	10.3 12.8	Max-day 1.0	23.1

Plant Capacity Analysis – Treatment Plant

Component	No. of Units	Existing System	Component Capacity (MGD)	Flow Basis of Component Capacity/Ratio	Equivalent Max-Day Capacity (MGD)
Filters	10	(4) - 726 sq ft (1921) (2) - 710 sq ft (1946) (4) - 721 sq ft (1969) Total Area = 7,208 sq ft	37.3	Max-day 1.0	37.3
Clearwells	3	CW#1: 128' x 62.5 x 14.5 Min SWD (V=837,800 gal) CW#2: 127.25' x 60.9' x 14.5 Min SWD (V=816,350 gal) CW#3: 127.5'x72 x 14.5 Min SWD (V=961,380 gal) Total Area = 25,756 sq ft Approved EVF for all 3 CWs = 0.2	25.6	Peak Hour Treatment 1.3	19.3
Finished Water Pumps	4	HS Pump #1 - 9.9 MGD HS Pump #2 - 12.4 MGD HS Pump #3 - 16.2 MGD HS Pump #4 - 13.8 MGD	36.1	Peak Hour Production 1.5	24.1

Present Plant Capacity – Essential Chemicals

Component		Existing System	Component Capacity (MGD)	Flow Basis of Component Capacity/Ratio	Equivalent Max-Day Capacity (MGD)
Coagulant Alum. Chlorohydrate	Feed	Three @ 60 gph	50.7	Max-day 1.0	50.7
	Storage	One 10,000 gal tank	22.2	Avg-day 1.5	33.3
Chlorine Gas	Feed	Three @ 1,000 lbs/day	55.0	Max-day 1.0	55.0
	Storage	Sixteen (16) - 1 ton cylinders	45.2	Avg-day 1.5	67.8
Phosphoric Acid	Feed	One @ 1.0 gph One @ 1.6 gph	20.2	Max-day 1.0	20.2
	Storage	112 - 50 lb pails	37.3	Avg-day 1.5	56.0
Sodium Fluorosilicate	Feed	One @ 60 cfh or 4,500 lbs/hr	>>>	Max-day 1.0	>>>
	Storage	112 - 50 lb bags	27.3	Avg-day 1.5	41.0

Present Plant Capacity – 22 MGD

- Key components limiting capacity:
  1. Clearwell capacity is being limited by Effective Volume Factor (EVF) of 0.2, reducing capacity to 19.3 MGD for Equivalent Max-Day Capacity
  2. Finished Water Pump capacity is limited by the firm capacity (24.1 MGD)
  3. Settling Basin capacity is limited by total weir length (23.1 MGD)
  4. Phosphoric Acid Feed Pumps can deliver chemical for 20.2 MGD

Why Increase the Capacity?

The City of Elyria has a goal to increase plant capacity to 30 MGD!

Why Increase the Capacity?

Increase in area demand to meet water quality and system management regulations

City of Elyria WTP - Proposed Improvements for Increasing Plant Capacity

High Rate Demonstration Study

High Rate Demonstration Study

- OPEA "Guideline for Clarifier and Granular Media Filter Ratings at Surface Water Treatment Plants" stipulates approval criteria for high-rate demonstration studies

- Two main criteria:
  1. Turbidity from High-rate filter shall:
     - Be less than 0.3 NTU for >95% of the time for 6-week period in which test is conducted
     - Be less than 1 NTU at all times
     - A surface WTP that can meet above will receive credit for 2.5 log removal of Giardia lamblia and 2.0 log removal of Cryptosporidium

  2. Total Organic Carbon (TOC) Removal Ratio
     - Bi-weekly source-water and filtered-water TOC to be averaged to determine if TOC removal ratio is >1, otherwise additional techniques

High Rate Demonstration Study

- One of the following three criteria must also be met:
  1. Average production efficiency for six-week period should be at least 90 percent (i.e. no more than 10% finished water should be used to backwash the filter)

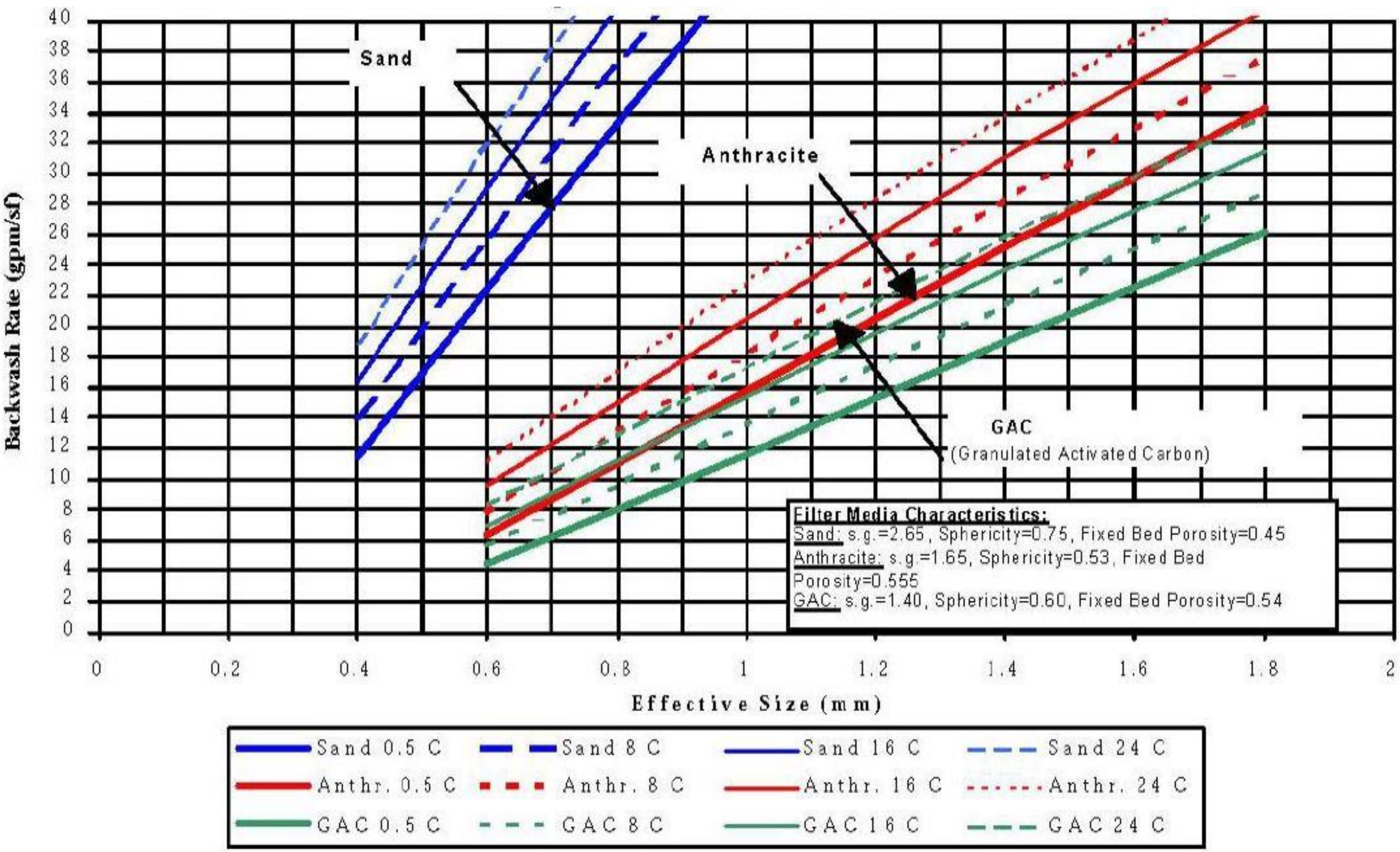
$$PE = \frac{GUFRV - UBWV}{GUFRV} \times 100$$

where PE = Production Efficiency,
GUFRV = Gross Unit Filter Run Volume
UBWV = Unit Backwash Volume

UBWV is calculated by multiplying optimum backwash rate by optimum backwash time. Optimum backwash rate is determined based on filter media characteristics and water temperature. Time is determined by:

a) Backwashing filter for at least 10 mins at optimum rate
b) Collecting a sample every 15 seconds of spend backwash water from filter trough
c) Measuring turbidity of these samples

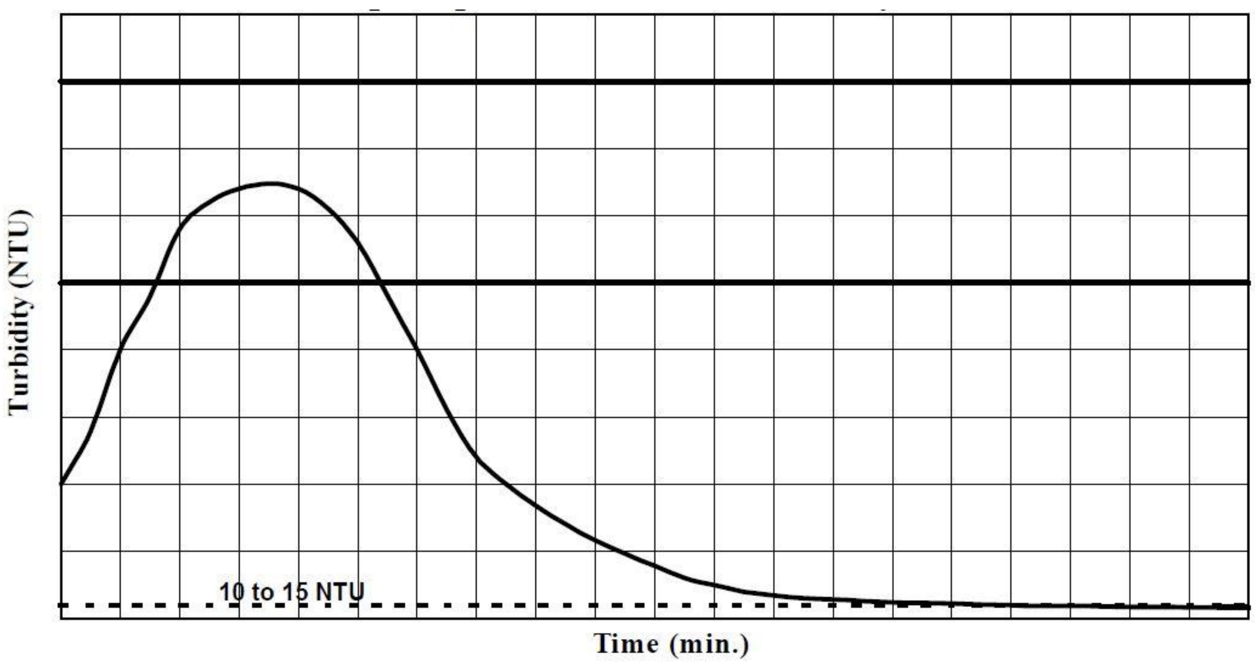
High Rate Demonstration Study



High Rate Demonstration Study

- Filter should be run to terminal head loss of 0.2 to 0.3 NTU . The turbidity values should be plotted on the Y-axis against time (X-axis).

- The optimum backwash time is defined as the time when the turbidity decreases to less than 10 to 15 NTU



High Rate Demonstration Study

- One of the following three criteria must also be met:
  2. Average value of clarified water turbidity for all runs during six week period should not exceed 2 NTU, and the 95th percentile value of clarified water turbidity data points should not exceed 5 NTU.

  3. Gross water production should be at least 5000 gal/sq. ft of filter area for each filter run. Backwashing should be initiated (or extrapolated) based on the lesser of:
     a) Reaching total head loss available for filtration at full-scale
     b) Turbidity breakthrough of 0.2 to 0.3 NTU through the filters

Criteria 3 chosen for Elyria's Demonstration Study

High Rate Demonstration Study

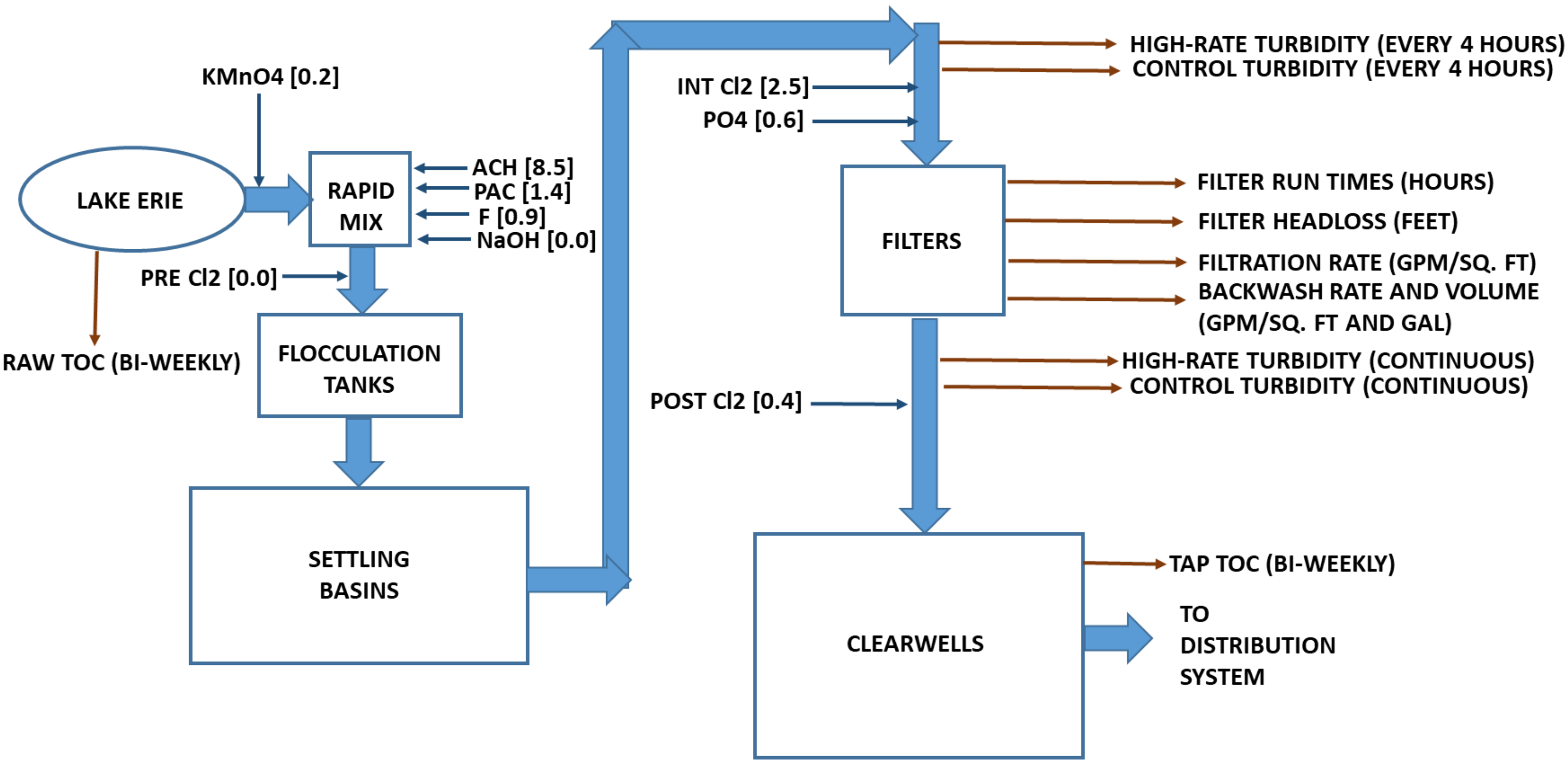
- Demonstration procedure:
  - Goal is to demonstrate successful high-rating by diverting 6 MGD of flow to Settling Basin 1. Any remaining flow will be conveyed equally to Basins 3 and 4.

  - Basin 3 and 4 effluent will be conveyed to Filters 6-10 through a 36-inch main with flow measured using a strap-on flowmeter.

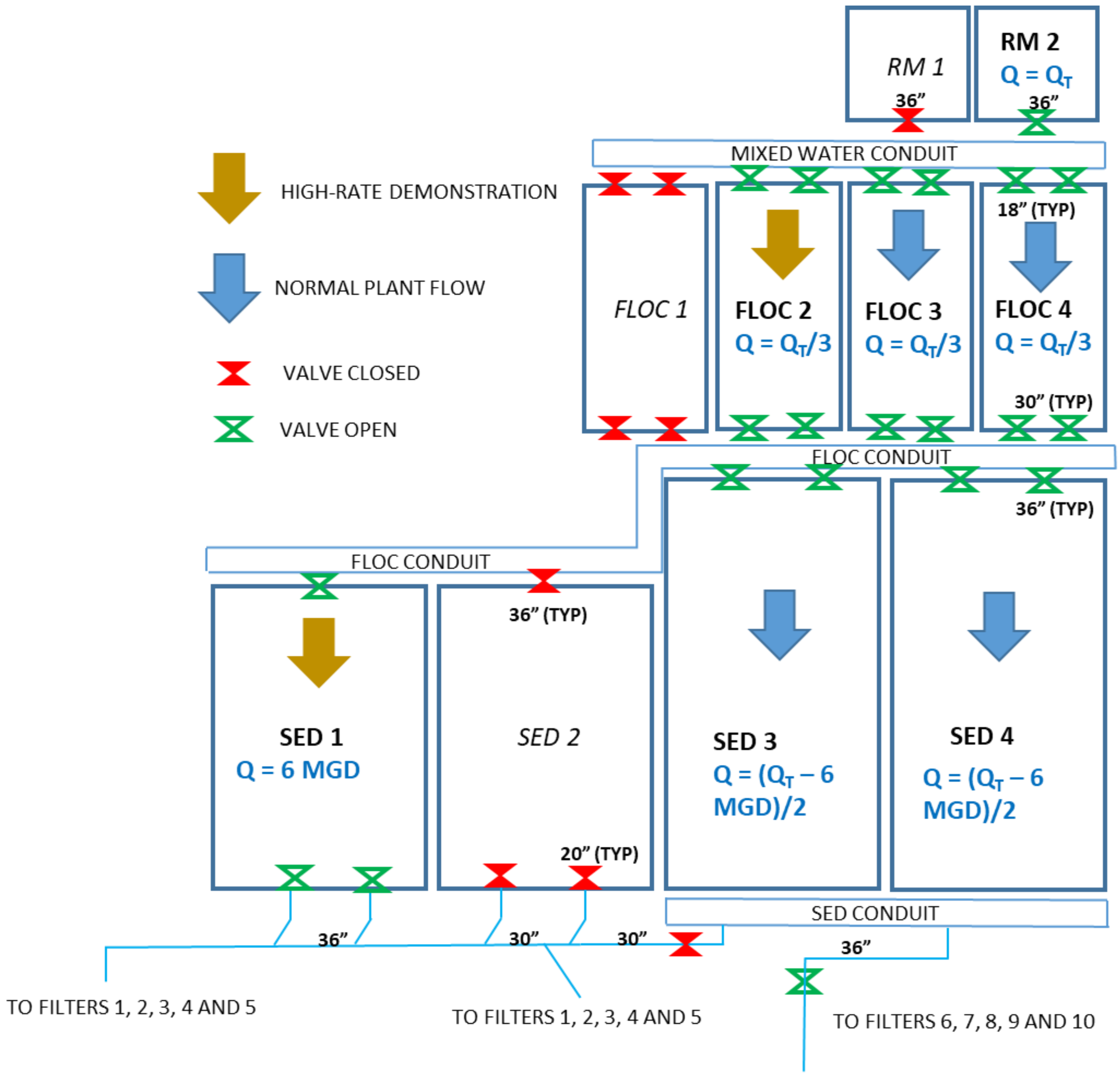
  - Filter 1 will be used as the high-rate filter (4 gpm per sq. ft or 4 MGD), as measured with a rate-of-flow controller

  - Filter 3 will be the "control filter" with remaining 2 MGD flow from Basin 1 diverted to it.

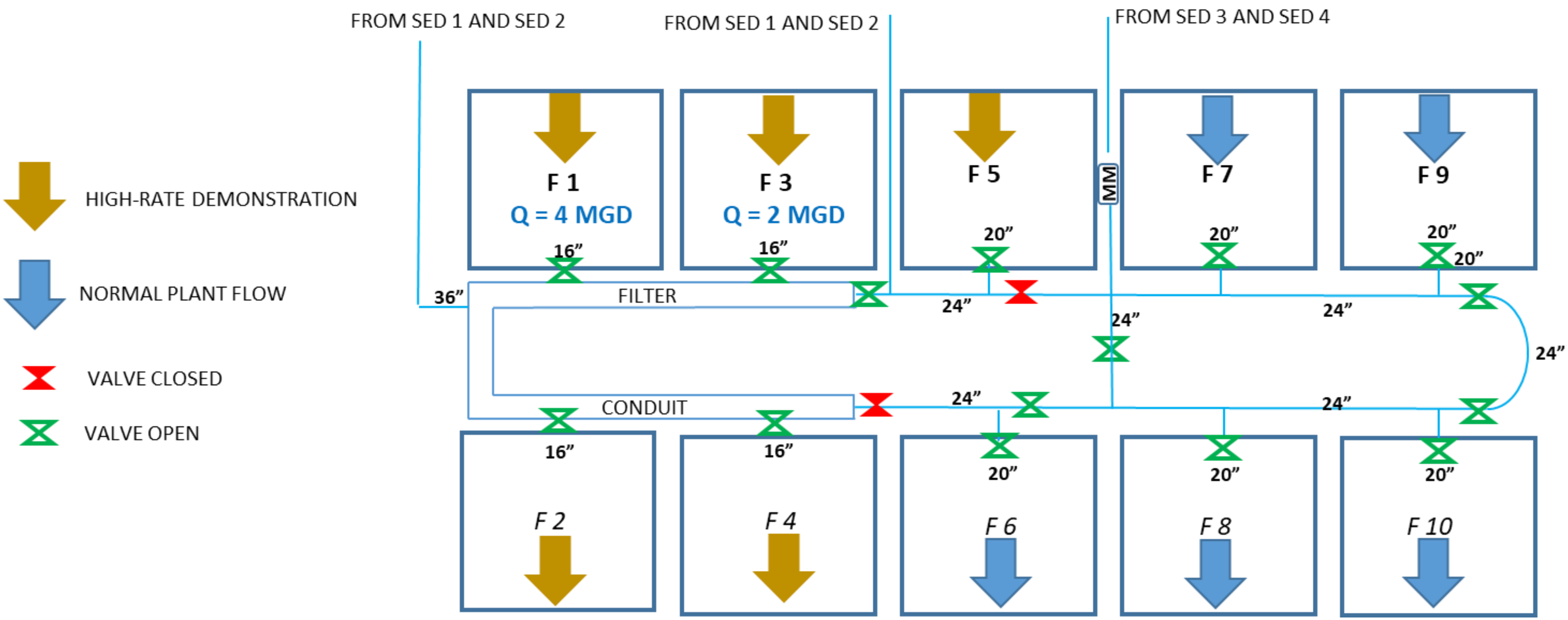
High Rate Demonstration Study



High Rate Demonstration Study



High Rate Demonstration Study



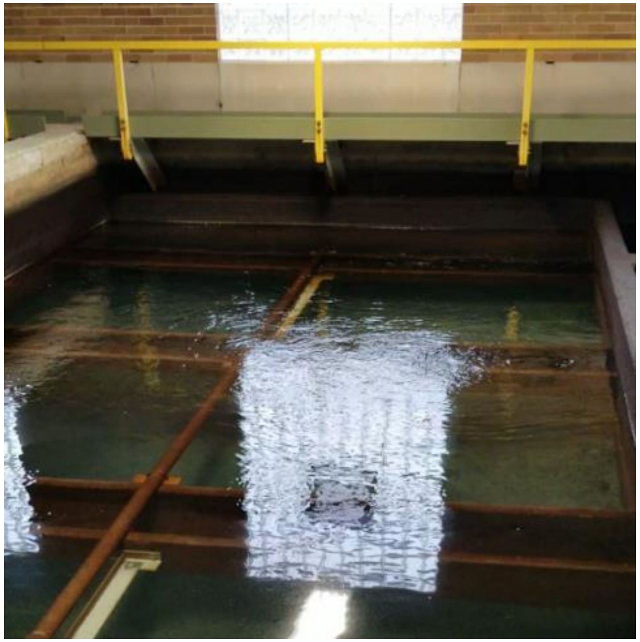
High Rate Demonstration Study

- Demonstration capacity goals:
  - Rapid Mix Tanks: total component capacity of 78.2 MGD at >30 sec detention time
  - Flocculation Tanks: total component capacity of 60 MGD at 30 min detention time
  - Settling Basins: demonstrate capacity of 30 MGD
  - Filters: total component capacity of 37.3 MGD at 4 gpm/ft^2 with largest filter out of service

High Rate Demonstration Study

Preliminary Results

- Testing underway at the Elyria WTP has revealed the following preliminary results:
  - Filter Effluent is less than 0.3 NTU 95% of the time, and always less than 1.
  - Sedimentation Basin effluent average hasn't exceeded 2 NTU and the 95th percentile hasn't exceeded 5 NTU.
  - Filters 1 and 2 capable of achieving 4 MGD each



City of Elyria WTP - Proposed Improvements for Increasing Plant Capacity

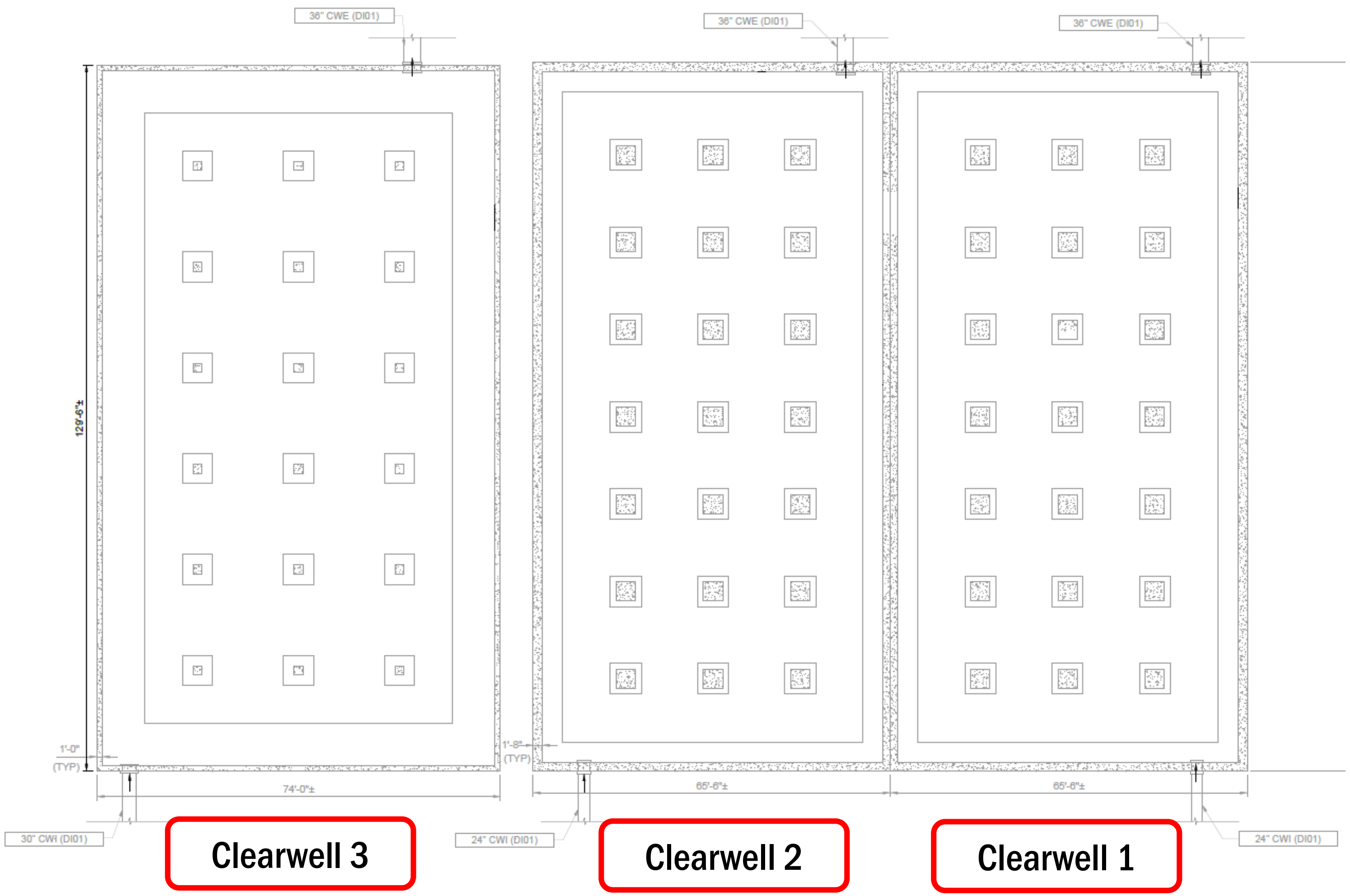
Plant Capacity Improvements

Clearwell Baffles

Plant Capacity Improvements

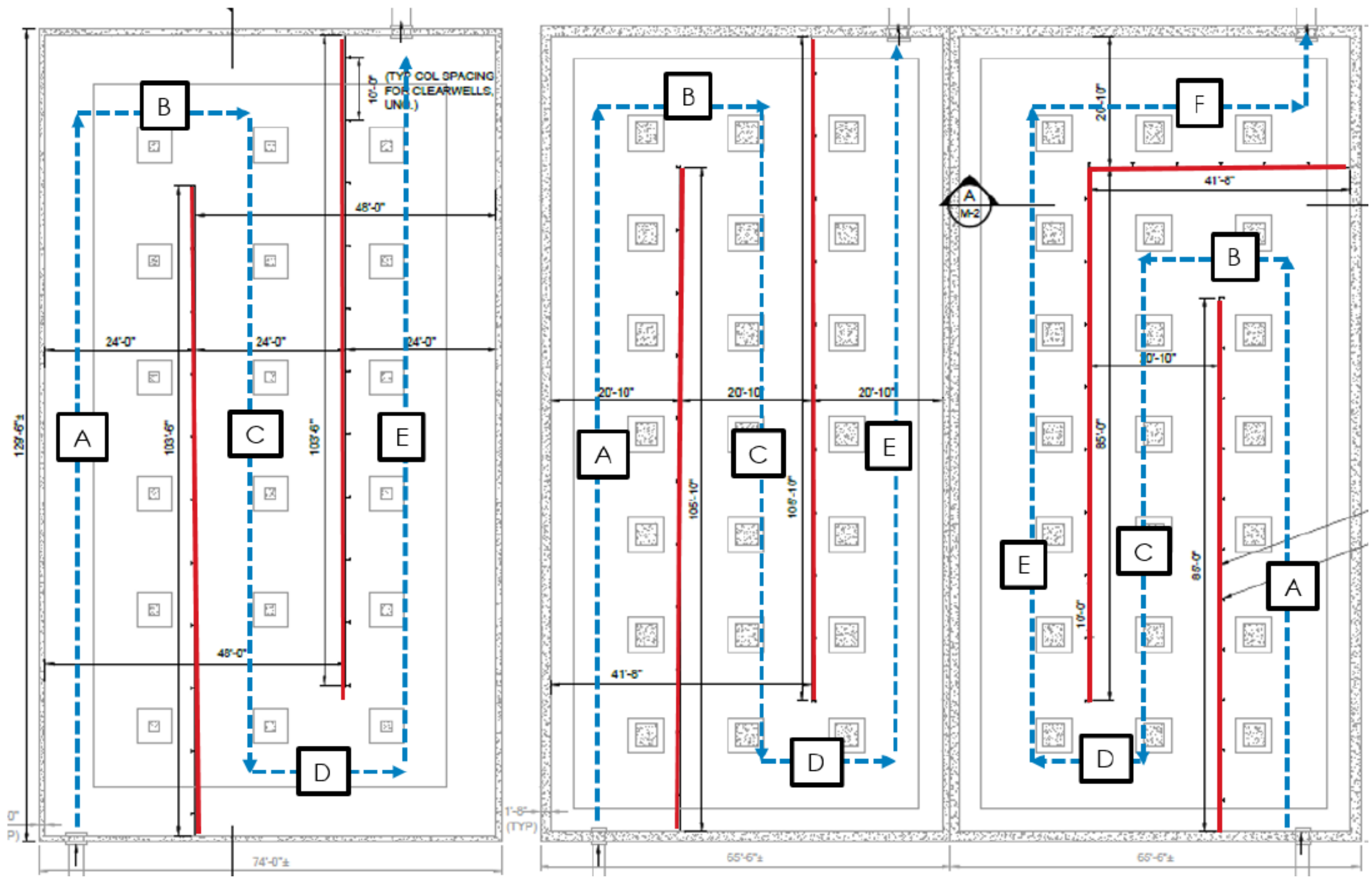
Clearwell Baffles

- Clearwell capacity is limited by Effective Volume Factor (EVF) of 0.2, reducing capacity to 19.3 MGD for Equivalent Max-Day Capacity



Plant Capacity Improvements
Clearwell Baffles

- Adding baffles (in **red**) increases clear well capacity by increasing EVF factor

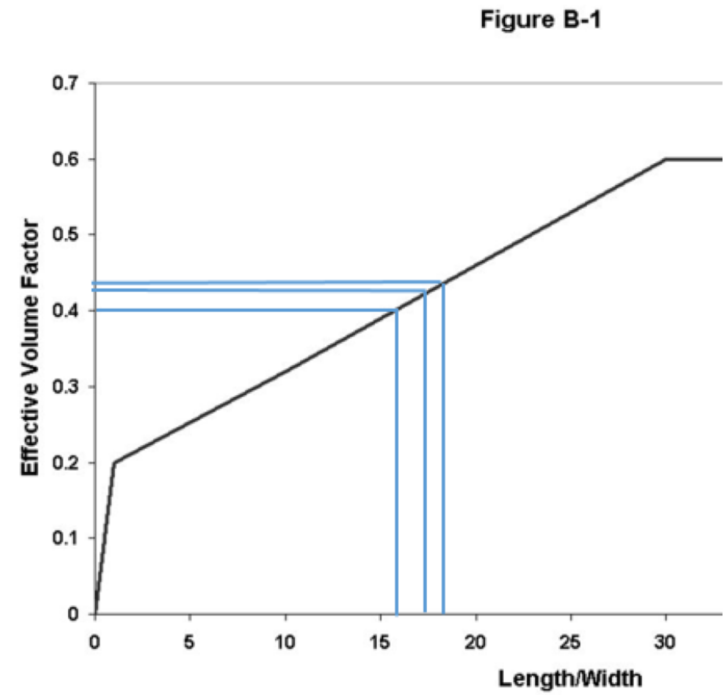


Plant Capacity Improvements
Clearwell Baffles

Plant Capacity Improvements

Clearwell Baffles

- Including baffles increases clear well capacity by increasing EVF factors:
  - New CW1 EVF → 0.43
  - New CW2 EVF → 0.44
  - New CW3 EVF → 0.4
- Clearwell component capacity increases to 54.0 MGD with Equivalent Max-Day Capacity of 41.5 MGD (peaking factor of 1.3)



Clearwell 1			
Segment	*L(ft)*	*W(ft)*	*Product*
A	95.42	20.83	1988
B	20.83	20.83	434
C	85	20.83	1771
D	20.83	20.83	434
E	105.833	20.83	2205
F	41.66	20.83	868
Total Length	369.573		
Weighted Width	20.83		
L:W Ratio	17.7		
EVF	0.43		

Clearwell 2			
Segment	*L*	*W*	*Product*
A	116.25	20.83	2421
B	20.83	20.83	434
C	105.83	20.83	2204
D	20.83	20.83	434
E	116.25	20.83	2421
Total Length	379.99		
Weighted Width	20.83		
L:W Ratio	18.2		
EVF	0.44		

Clearwell 3			
Segment	*L*	*W*	*Product*
A	115.5	24	2772
B	24	24	576
C	103.5	24	2484
D	24	24	576
E	115.5	24	2772
Total Length	382.5		
Weighted Width	24		
L:W Ratio	15.9		
EVF	0.4		

City of Elyria WTP - Proposed Improvements for Increasing Plant Capacity

Plant Capacity Improvements

Finished Water Pumps

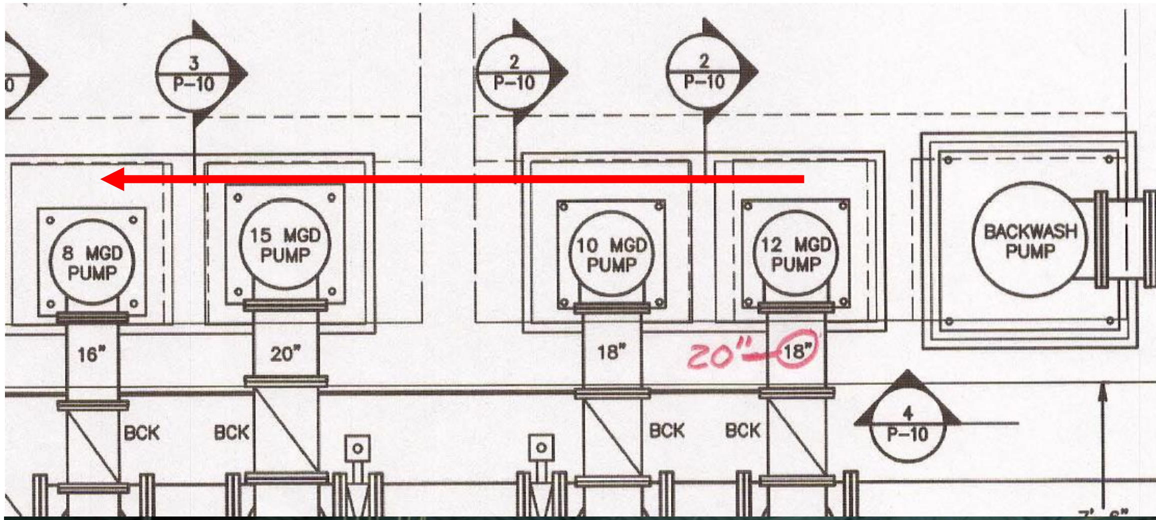
Plant Capacity Improvements

Finished Water Pumps

- Limited by firm capacity of existing pumps:
  HS Pump 1: 9.9 MGD
  ~~HS Pump 2: 16.2 MGD~~
  HS Pump 3: 12.4 MGD
  HS Pump 4: 13.8 MGD

- Increase size of smallest pump to increase overall firm capacity (without largest pump)

- Relocate Pump 4 to Pump 1 and replace Pump 1

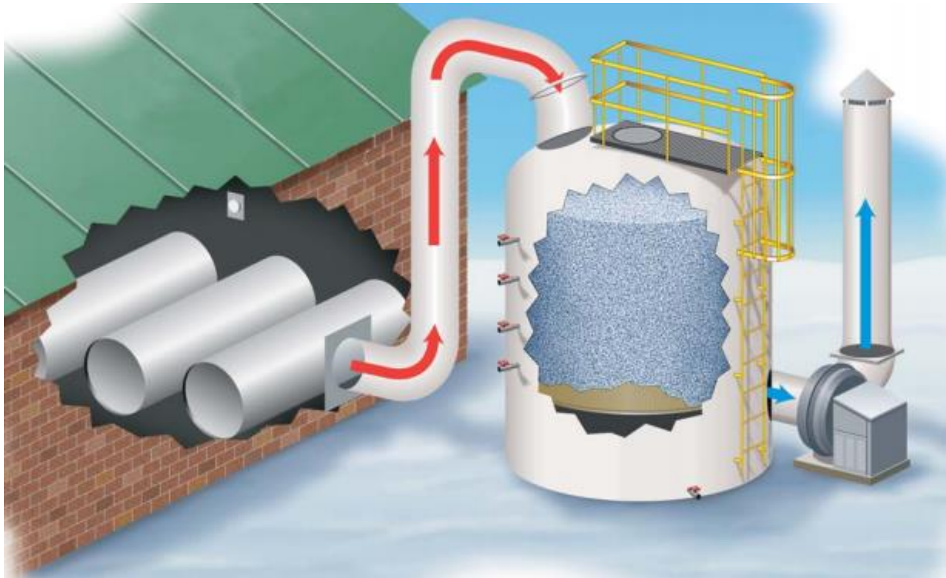


Plant Capacity Improvements

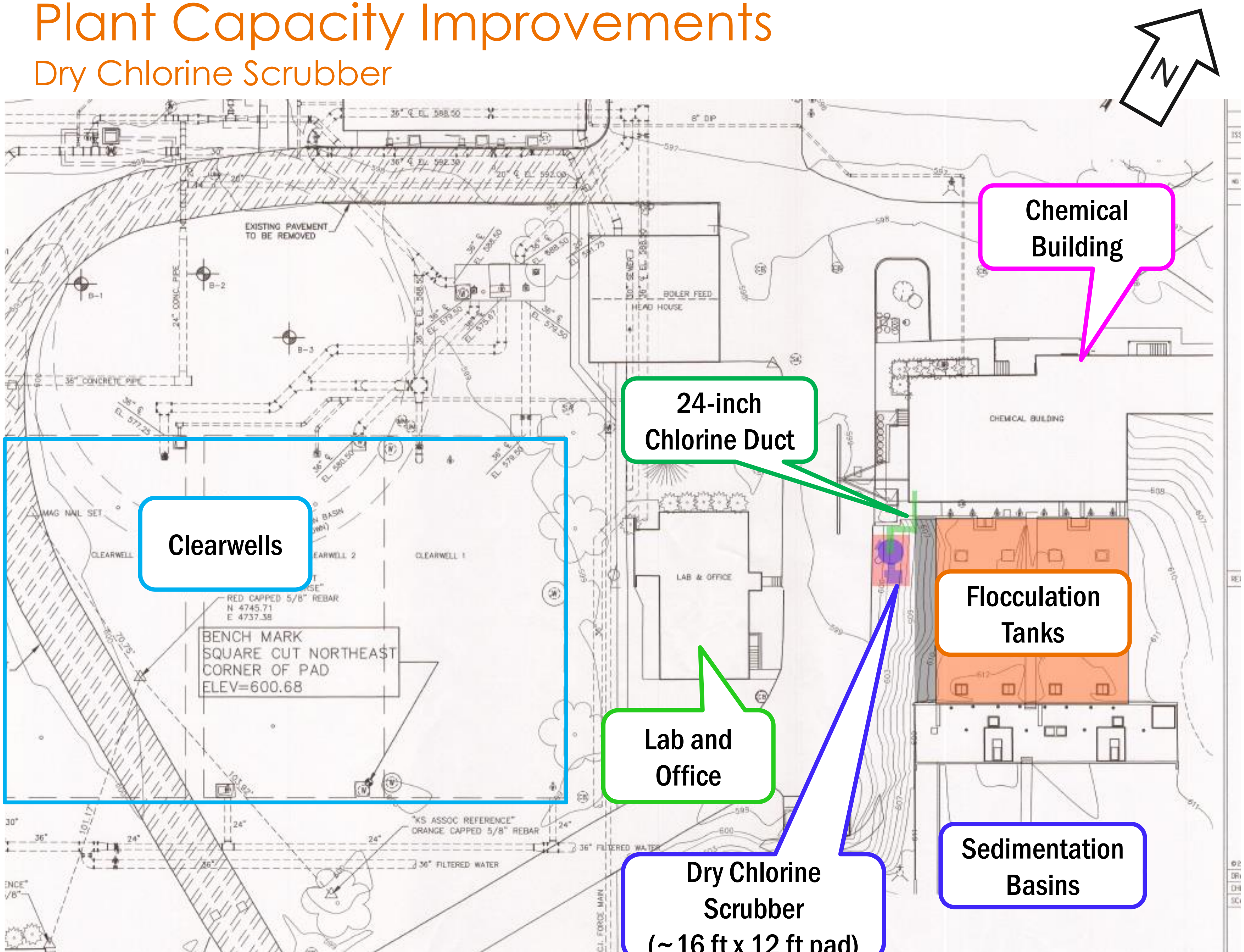
Chlorine Scrubber

Plant Capacity Improvements
Dry Chlorine Scrubber

- Chlorine Scrubber
  - Used to control gaseous chlorine emissions from Chemical Building
  - Dry media removes Cl_2/SO_2 by means of adsorption, absorption and chemical reaction
  - Cl_2/SO_2 are trapped within the pellets where an irreversible chemical reaction changes the gases into harmless solids

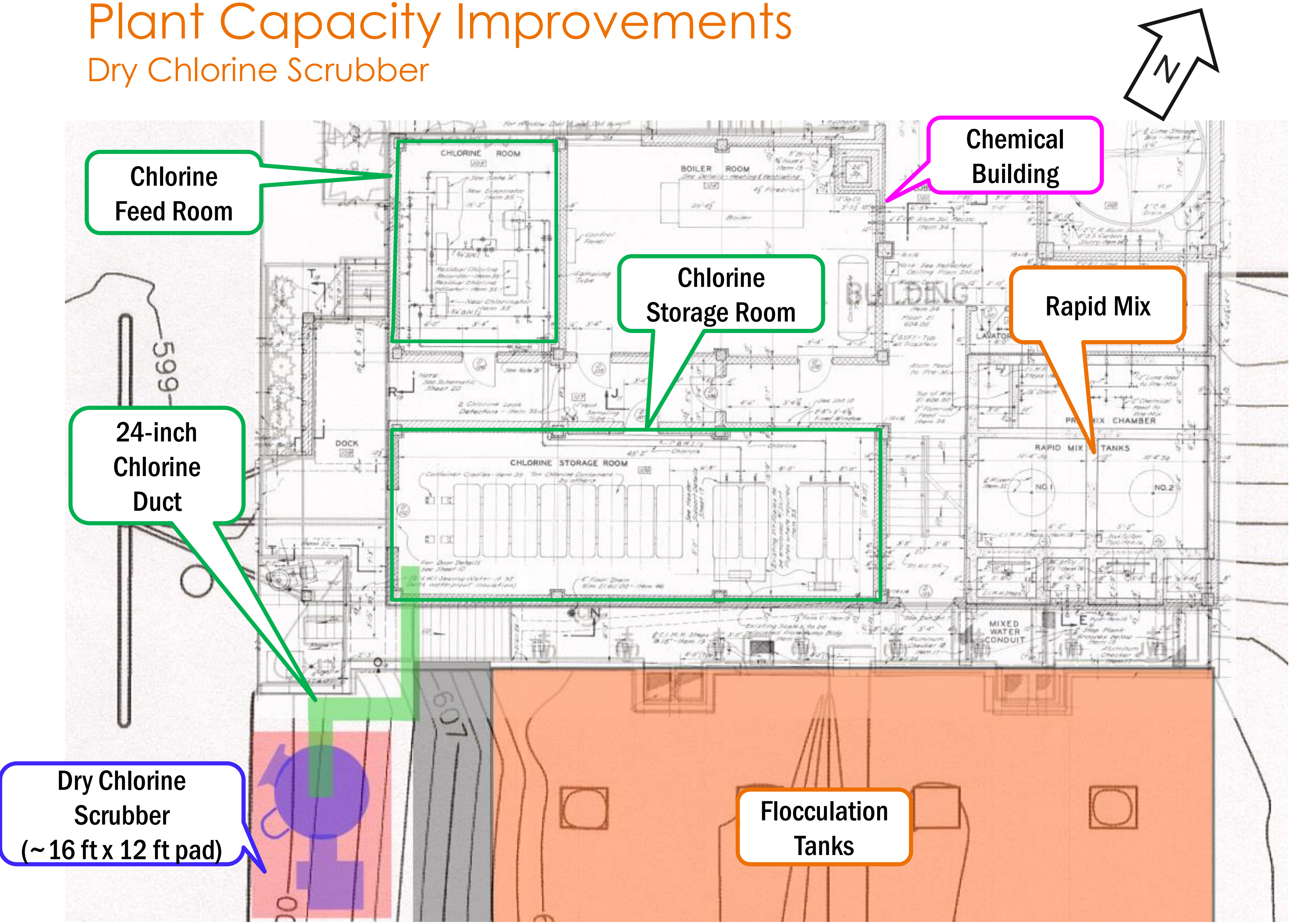


Plant Capacity Improvements
Dry Chlorine Scrubber



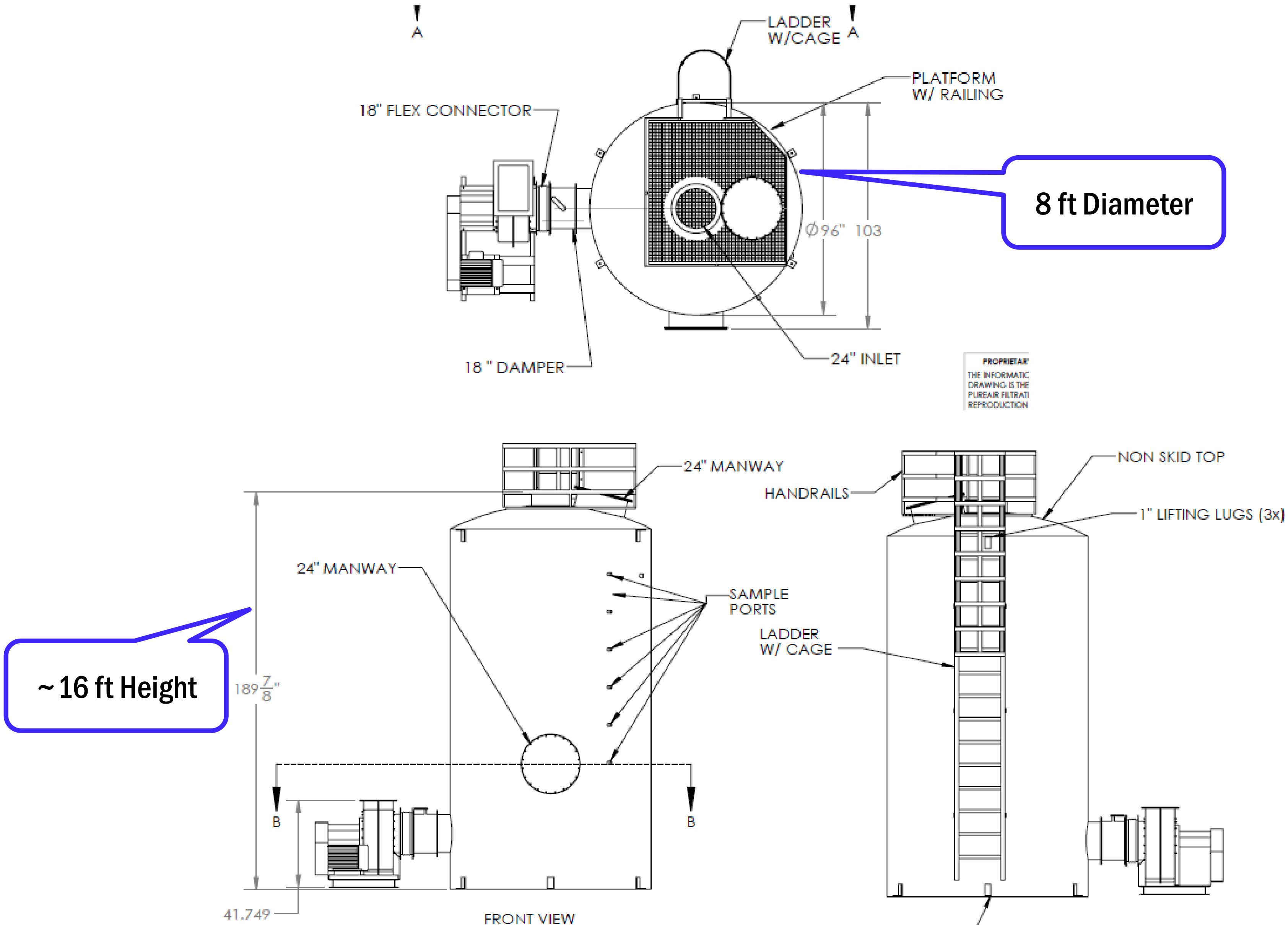
Plant Capacity Improvements

Dry Chlorine Scrubber



Plant Capacity Improvements

Dry Chlorine Scrubber



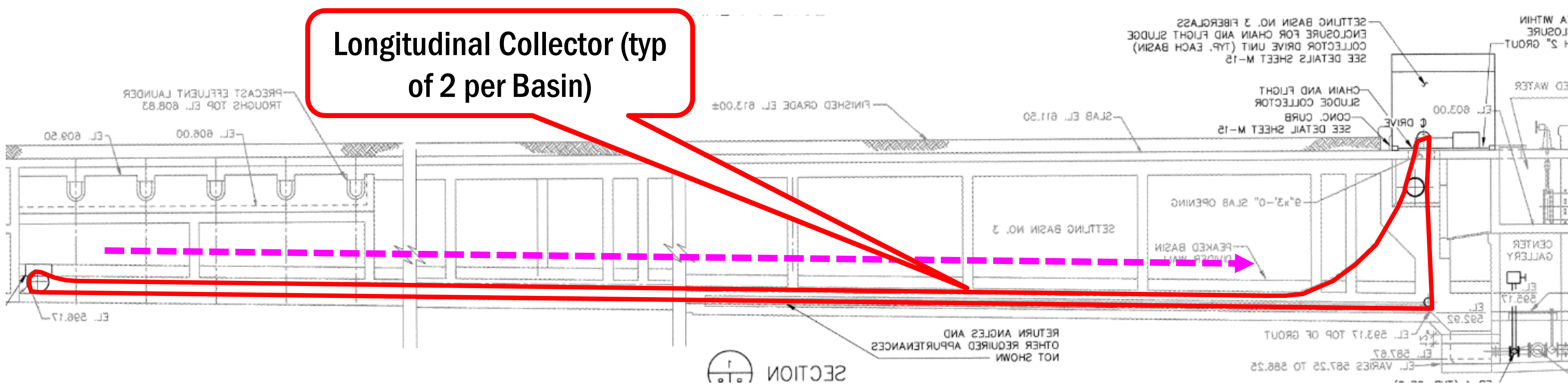
City of Elyria WTP - Proposed Improvements for Increasing Plant Capacity

Plant Capacity Improvements

Sludge Collection System

Plant Capacity Improvements
Sludge Collection System

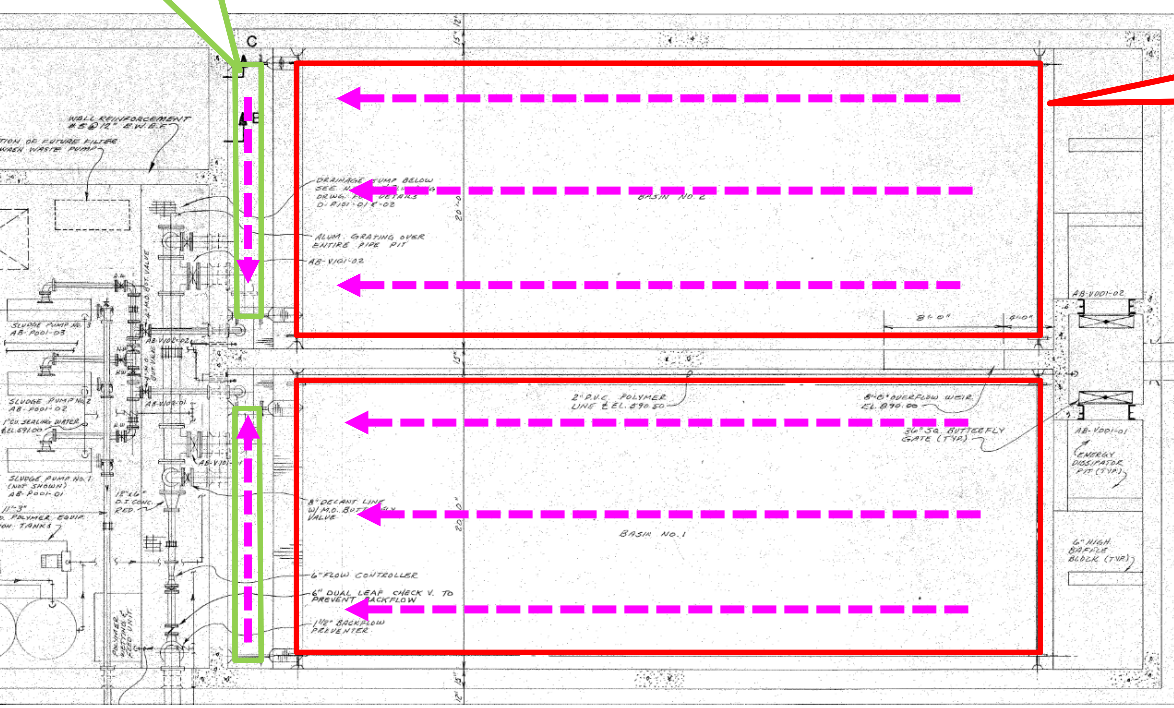
- Sedimentation Basins
  - Chain & Flight system used to remove settled solids in the Sedimentation Basins
  - Sludge conveyed to Basin sump and pumped for downstream processing
  - All 4 basins have two longitudinal collectors each, connected to the same motor

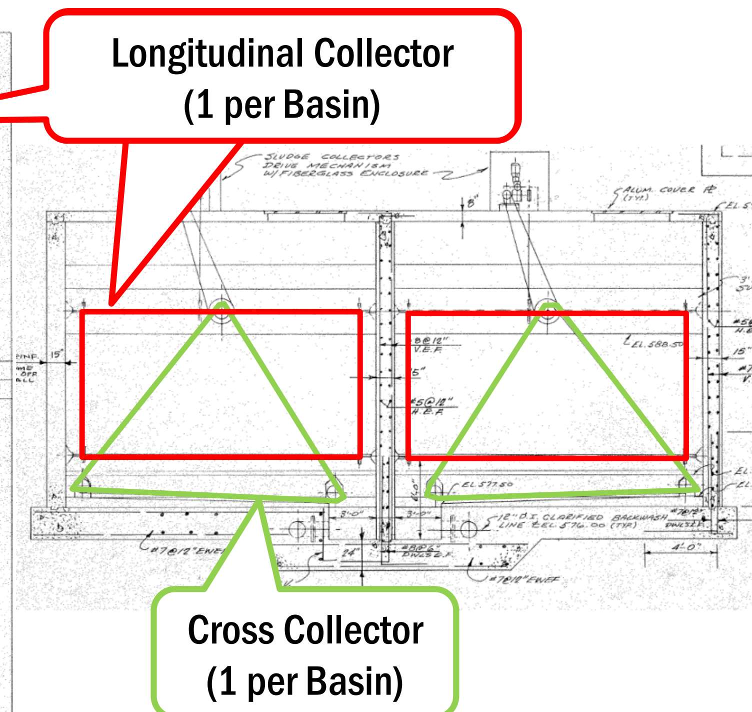


Plant Capacity Improvements

Sludge Collection System

- Attenuation Basins
  - Chain & Flight system used to remove settled solids in the Attenuation Basins, capturing solids from the filter backwash process
  - Sludge conveyed to Basin sump and pumped for downstream processing
  - Both basins have one longitudinal collector and one cross collector, connected to a dedicated motor for each basin





Plant Capacity Improvements

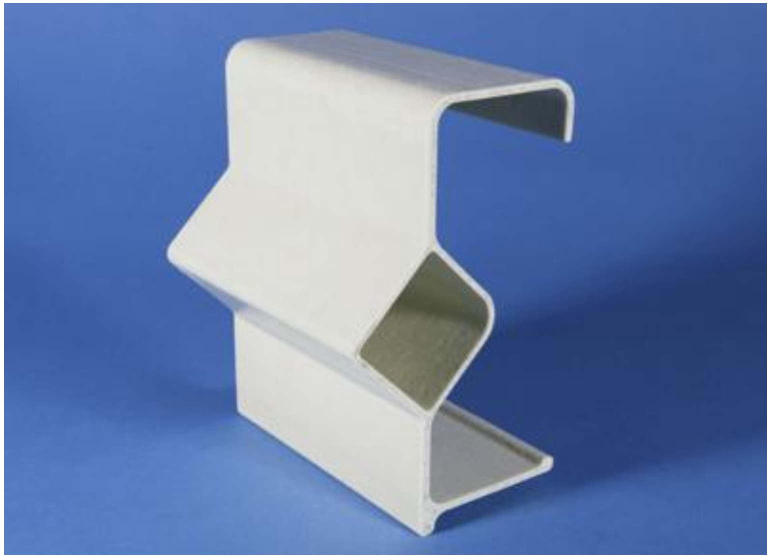
Sludge Collection System

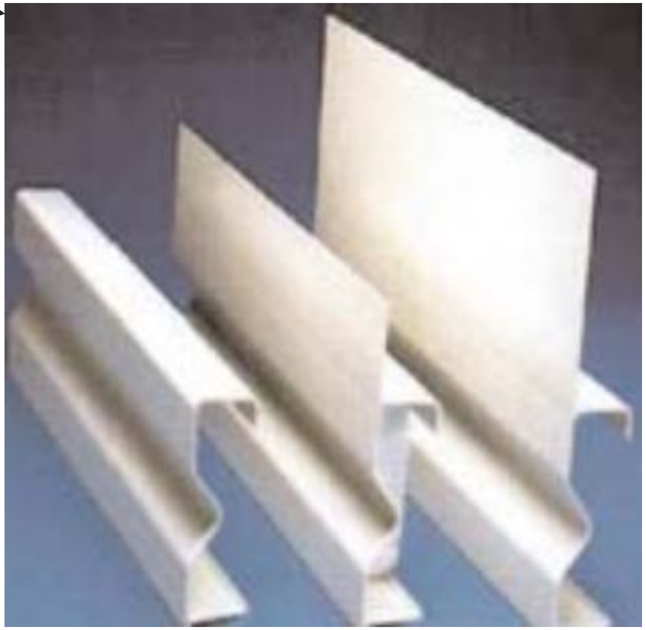
- Sludge Collection
  - Chain & Flight system comprises sprockets, bearings, guide rails, chain, flights, drive chain, drive
  - Material selection is critical
    - FRP, Stainless Steel typical, UHMW PE guide rails (yellow)

Plant Capacity Improvements

Sludge Collection System

- Sludge Collection
  - Different flight designs recommended for different applications and budgets
  - (ranked in order of quality)
    1. Diamond Flight
    2. Sigma Plus
    3. Channel Flight





Plant Capacity Improvements

Solids Dewatering Wet Well Mixing System

- Sludge Mixing System
    - Head house has two Sludge Storage Tanks with horizontal submersible mixers. Sludge pumps draw from the bottom of the tank and pump to the Sludge Storage Tank which feeds the centrifuge

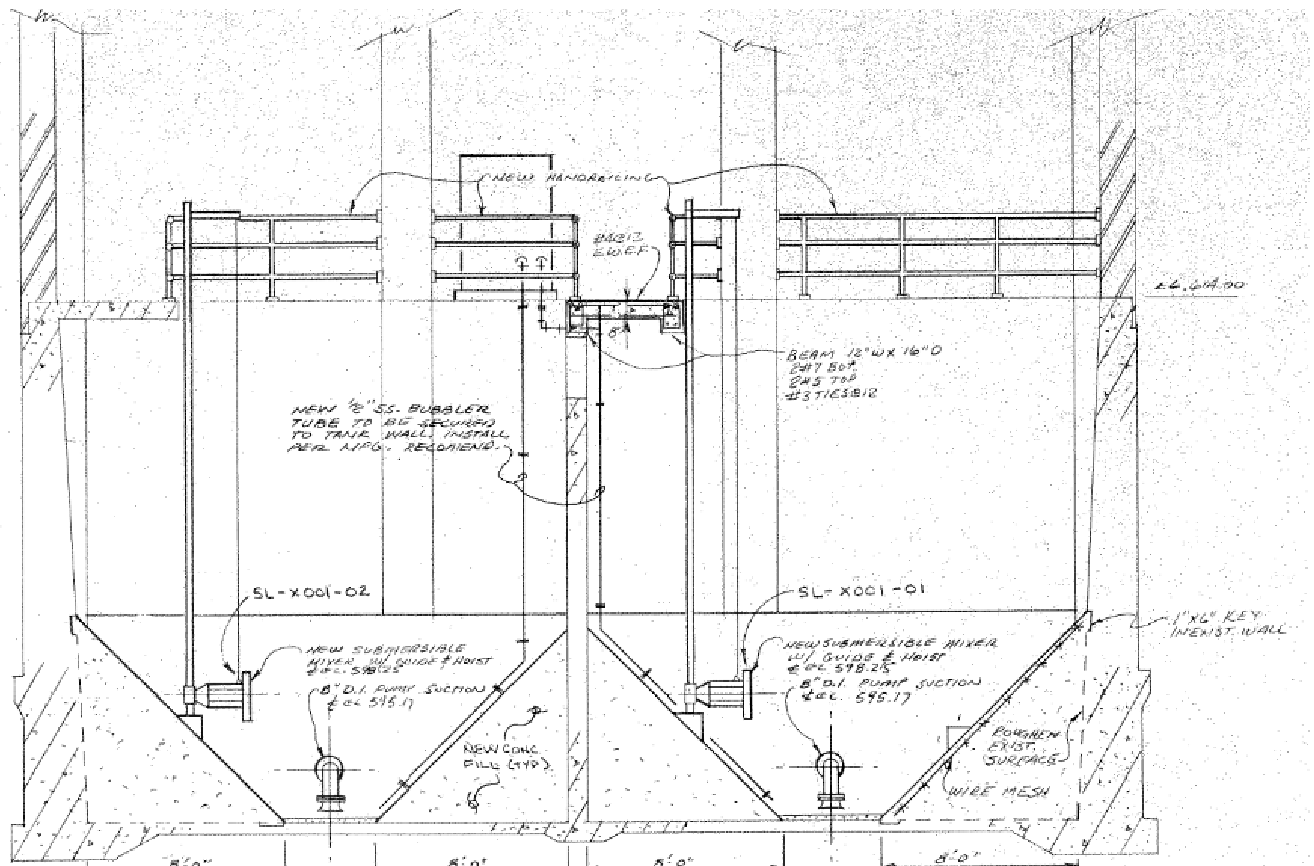
    - Sludge Storage Tank mixing system to be included.

Goal is to provide consistent homogeneous mixture to the centrifuge

Plant Capacity Improvements

Solids Dewatering Wet Well Mixing System

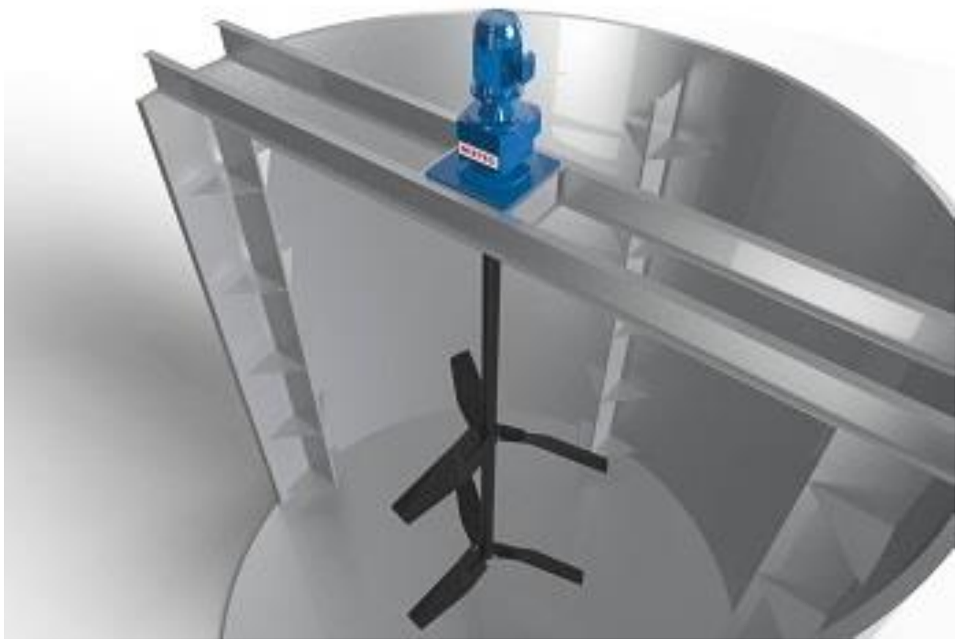
- Alternative technologies:
  - **Submersible Mixers**
  - Vertical Shaft Mixers
  - Pumped Hydraulic Mixing Systems

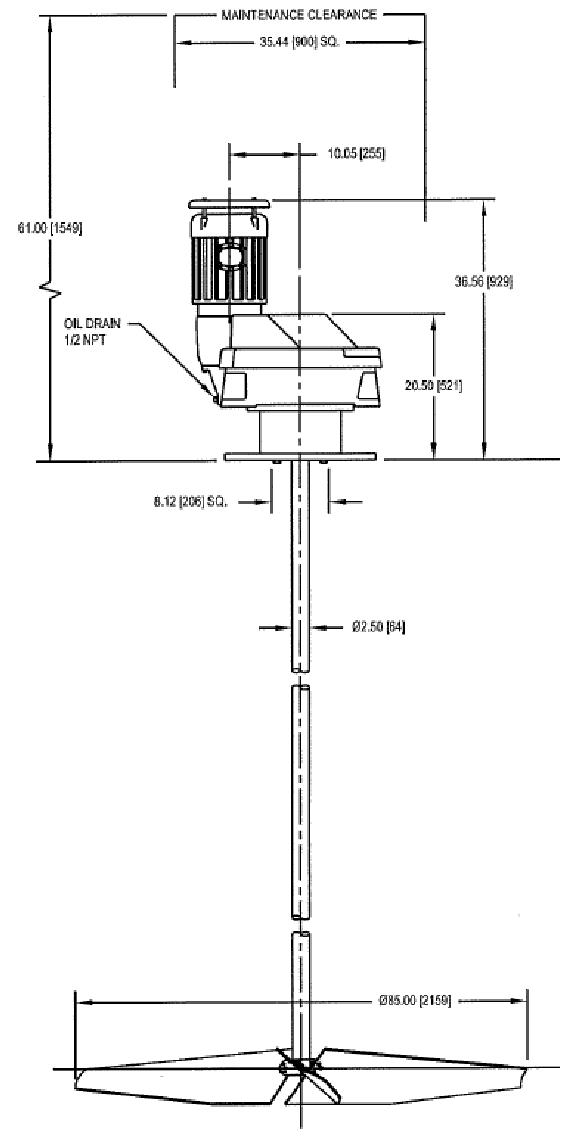


Plant Capacity Improvements

Solids Dewatering Wet Well Mixing System

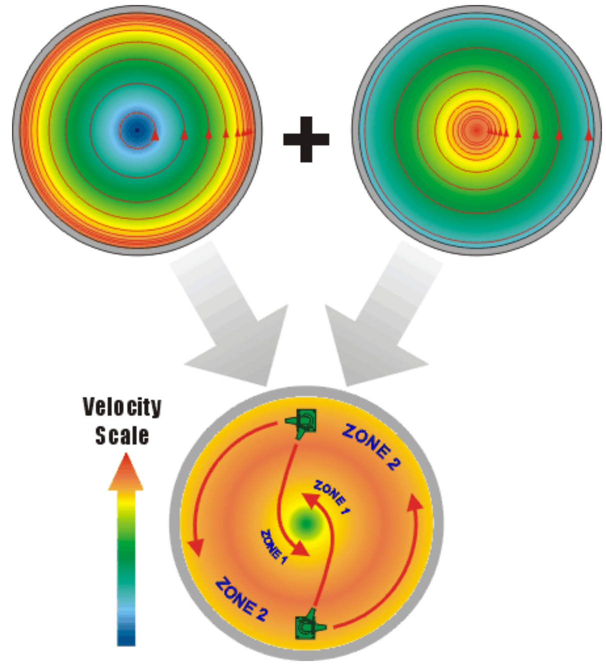
- Alternative technologies:
  - Submersible Mixers
  - **Vertical Shaft Mixers**
  - Pumped Hydraulic Mixing Systems





Plant Capacity Improvements

Solids Dewatering Wet Well Mixing System

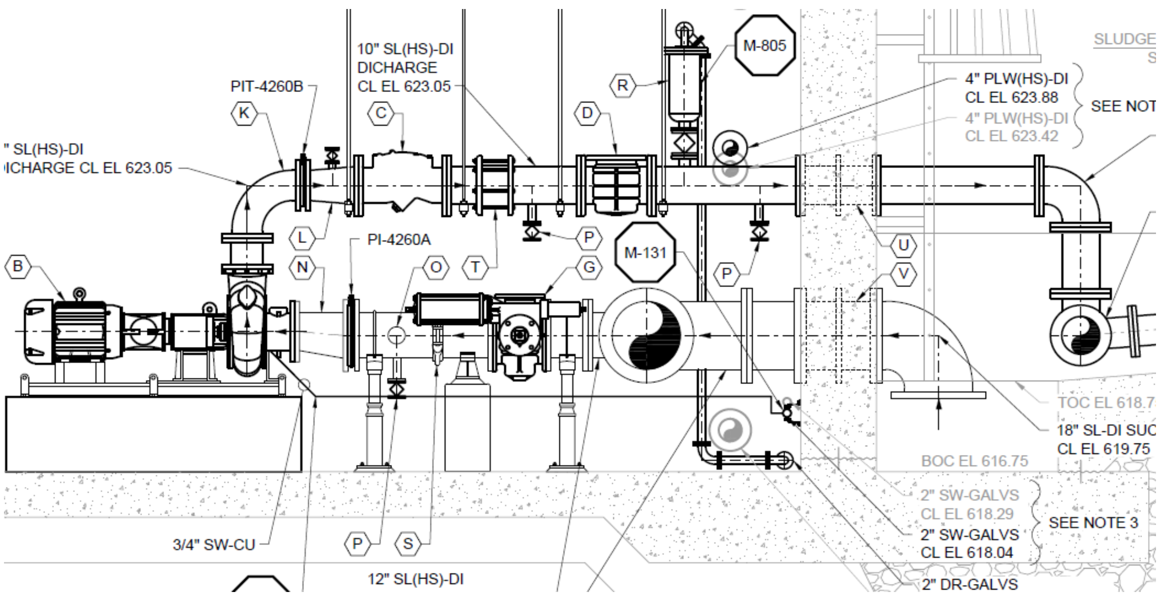


- Alternative technologies:
  - Submersible Mixers
  - Vertical Shaft Mixers
  - **Pumped Hydraulic Mixing Systems**

    e.g. Vaughan Rotamix,

    Hayward Gordon Hydromix

    Evoqua JetMix



Plant Capacity Improvements
Sludge Pump Replacement

- Sludge Holding Tank Sludge Pumps and Sedimentation Basin Sludge Pumps are in need of replacement
- Existing pumps are Moyno progressing cavity pumps with 10 or 15 HP motors
  - 15 HP for Holding Tank Pumps, 10 HP for Sed Basin pumps
- Pumps to be replaced "in-kind" (same pump)

Sedimentation Basin Sludge Pump Motors

Sludge Holding Tank Sludge Pumps

Questions