Expansion or Optimization: What's in Your Future?

Presenter:

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Ohio Water Environment Association

Preserving & Enhancing Ohio's Water Environment

- Optimize
- Expansion?
- Issues
- If not, then what?
- Shaping of Example Projects
- Squeezing 10 into 5
- Retro-fit
- Conclusion

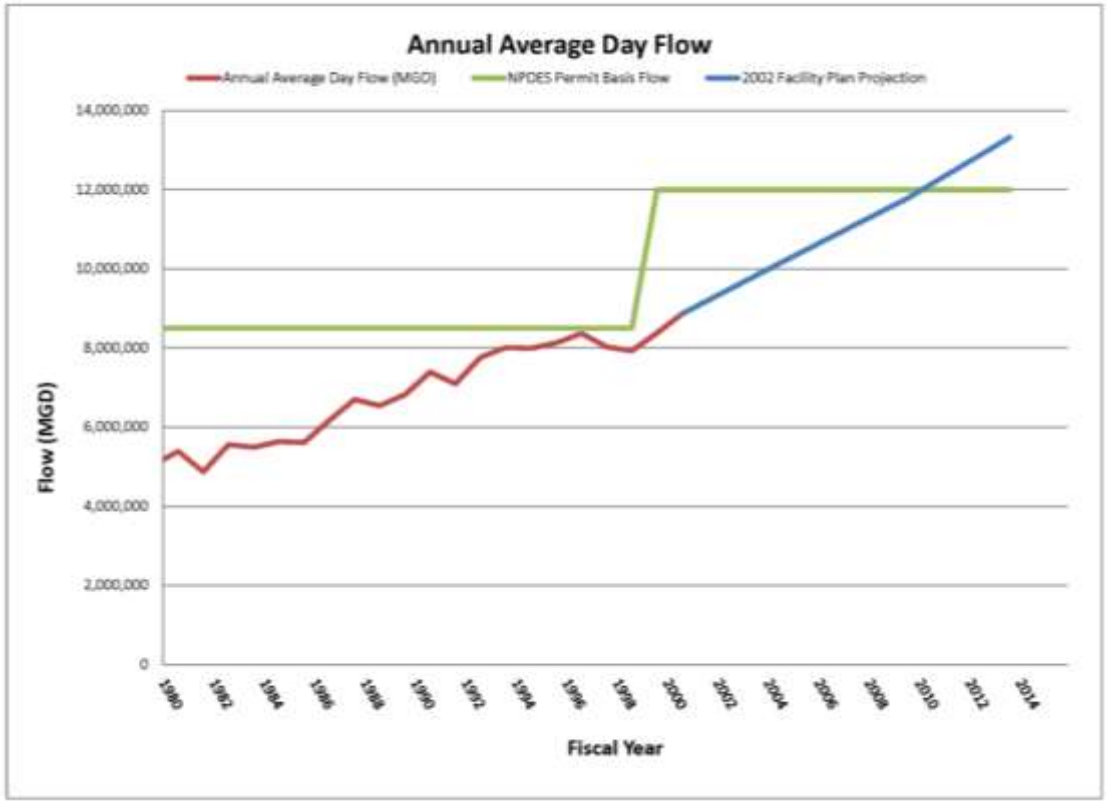
Agenda

- To Make Optimal
- To Get the Most Out Of
- Use Best
- **Modify to Achieve Maximum Efficiency in Capacity or Time or Cost**

What Does It Mean To Optimize?

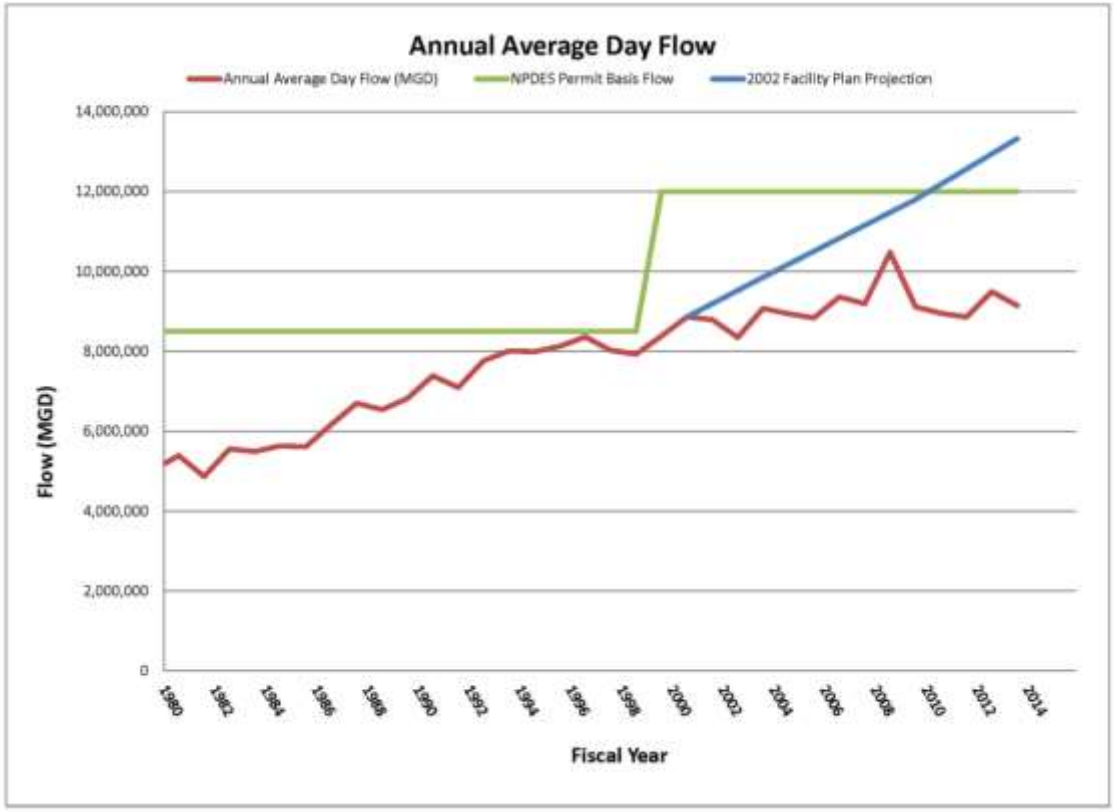
TO EXPAND OR NOT TO EXPAND,
THAT IS THE QUESTION

- 2002 Facility Plan recommended expansion to 16 Million Gallons per Day (MGD) Annual Average Day Flow (AADF) in two phases.
- 1st phase was tentatively planned to begin in 2003/04 and would have expanded facility to 14.2 MGD AADF.
- Most major equipment replacement placed on hold until expansion.



Expansion Is Imminent – Right?

- The great recession comes and greatly slows growth.
- Water conservation and efficiency efforts on the rise, reducing water usage from existing customers.
- Sewer lining and other efforts reduce infiltration and inflow (I&I) from the collection system.



What Happened to Flow Growth?

EXPANSION PLACED ON HOLD BECAUSE:

1. AADF is currently around 75% of NPDES permit basis flow. This percentage has remained relatively unchanged for approximately 15 years!
2. Increase in discharge flow above 12 MGD likely to require more stringent effluent limitations (ammonia), which in turn will require higher capital investment for the community.
3. Currently working with surrounding communities to redirect part of flow to another WWTP as part of regional planning efforts.
4. Site is currently space-constrained, making the construction of additional tankage to handle higher hydraulic flows very difficult.

Is Expansion Really Needed?

Changing Influent Characteristics

Aging infrastructure

Limited funding

Public awareness

Asset management

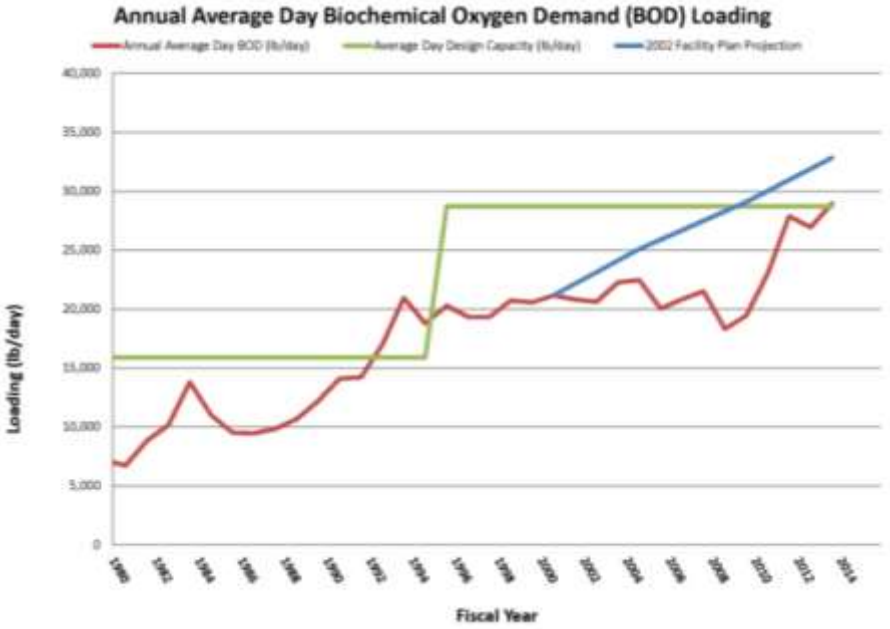
Reduced staffing

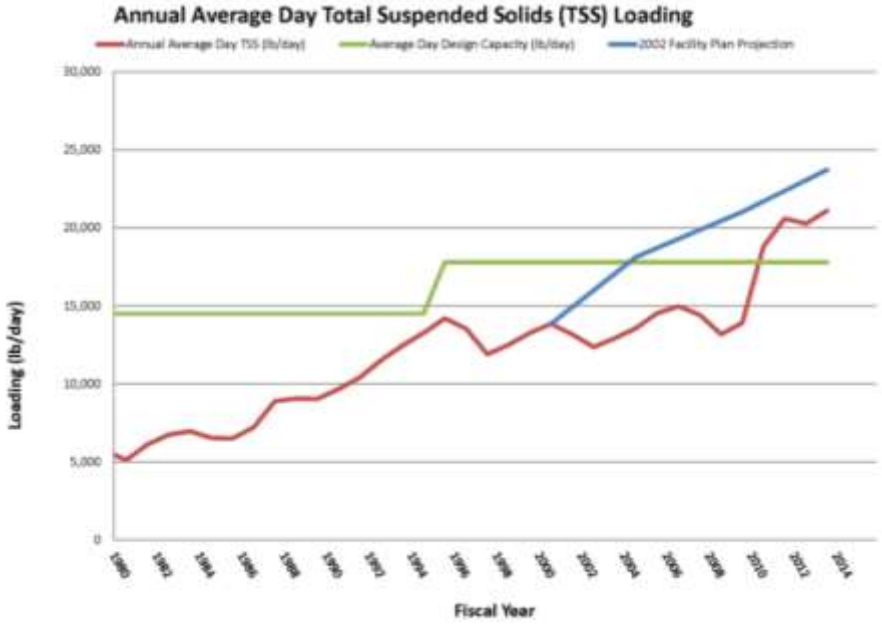
NO EXPANSION

BUT MAJOR ISSUES REMAIN……

- Notable industrial growth occurred late in the recession and beyond.
- Food processors represent large portion of growth, which in turn has led to sizeable increases in BOD and TSS loadings to WWTP.
- Loading now at/near Average Annual Day (AAD) design, and allocations are approaching Maximum Allowable Headworks Loading (MAHL).

Why Is Influent Loading Changing?





BOD/TSS Loading Trends

- Last major facility renovation was in 1995/96.
- Much of equipment previously planned for replacement, but work was placed on hold pending expansion.
  - Major equipment on conventional air activated sludge process (East Plant) >34 years old.
  - Major solids handling equipment >20 years old.

Aging Infrastructure/Asset Management

IF NOT EXPANSION, WHAT?

TIME TO OPTIMIZE

NOTABLE CHANGES BY PLANT STAFF TO IPP PROGRAM:

1. New Special Discharge Allocation Method – Plant staff replaced the old allocation system, where industries selected their allocation, with a new system that calculates allocations and assigns them. This reduced instances of overallocation.

2. Special Discharge Allocation Maximums – Plant staff formalized maximum allocations for individual industries to further encourage pretreatment and maintain allocation capacity for new and expanding industries.

NOTABLE CHANGES BY BPW STAFF TO OPERATIONS:

1. Primary Clarifiers Efficiency Improvements – Simple changes resulted in reduced chemical costs, reduced disposal costs, and 11% increase in MAHL for BOD!
2. High-Purity Oxygen Activated Sludge Efficiency Improvements – Simple changes resulted in increased reliability and decreased oxygen usage (lower chemical and power costs).
3. Dewatering Improvements – Minor process changes allowed for more efficient blending of thickened waste activated sludge (TWAS) and primary sludge on existing belt filter presses.

These items are big in the short term, but not enough to address all identified issues. As such, planning began for capital improvement projects to replace/upgrade solids handling equipment and optimize the secondary treatment process to increase BOD capacity.

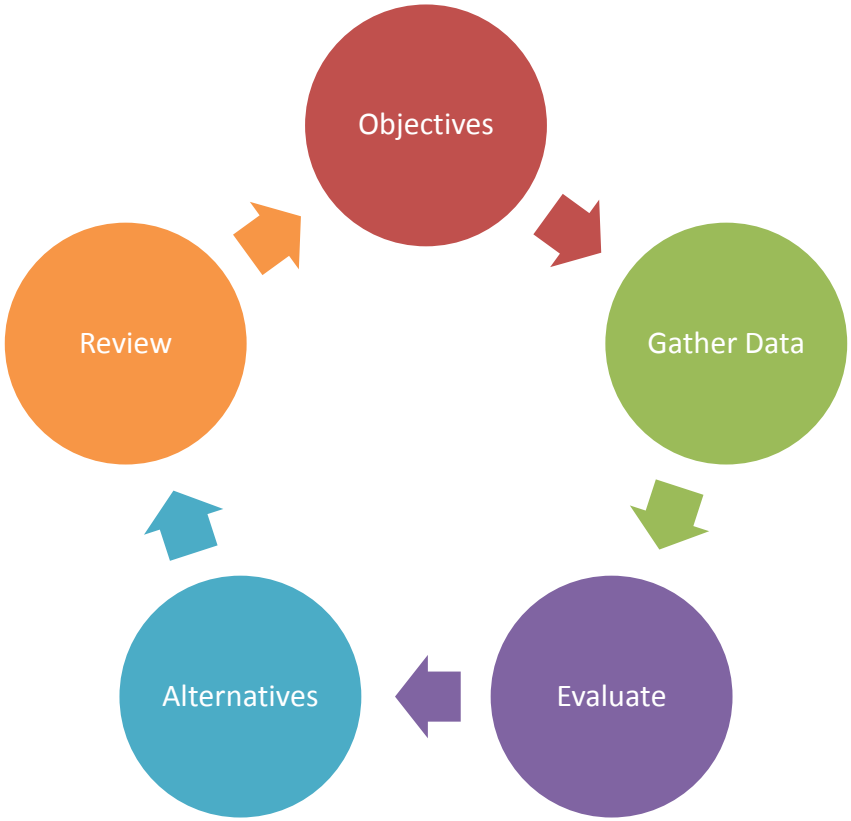
Operational Improvements/Optimization

- Increase organic and solids handling capacity
- Improve process operation/control
- Improve reliability
- Replace aging equipment
- Reduce operating costs
- Use available funds efficiently

Optimization Goals

SHAPING THE PROJECT
DEVELOPING THE OPTIMIZATION SCOPE

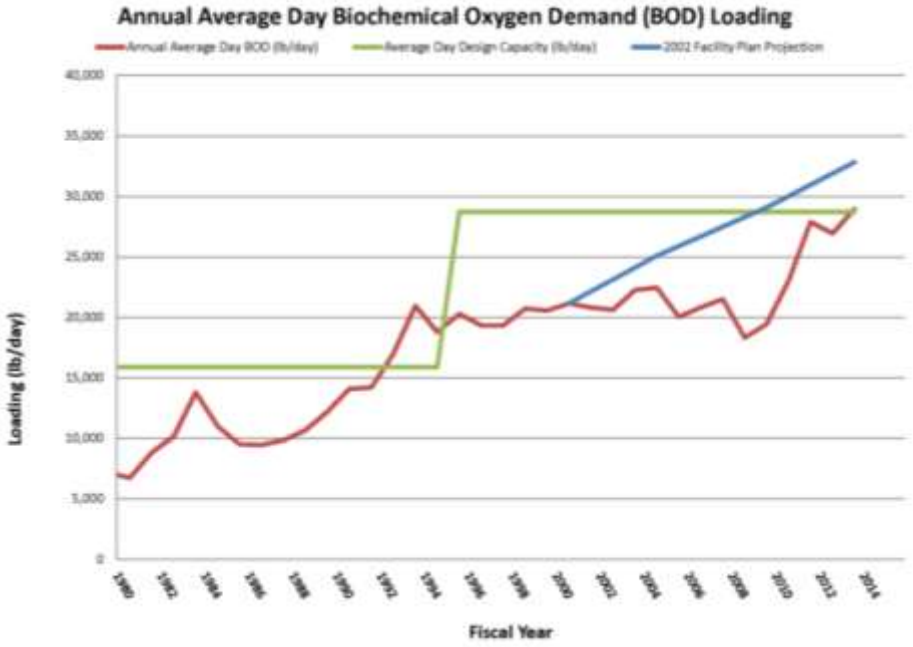
- Establish program objectives
- Evaluate the data
- Get more data
- Reclaim lost effectiveness
- Dust off the O&M manual
- Look at process changes

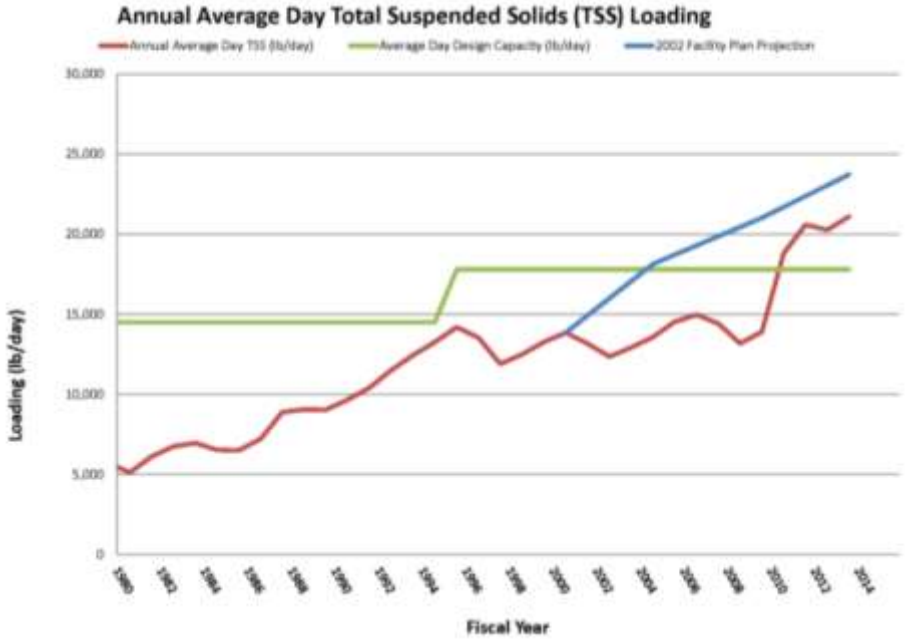


Steps to Evaluate the Decision

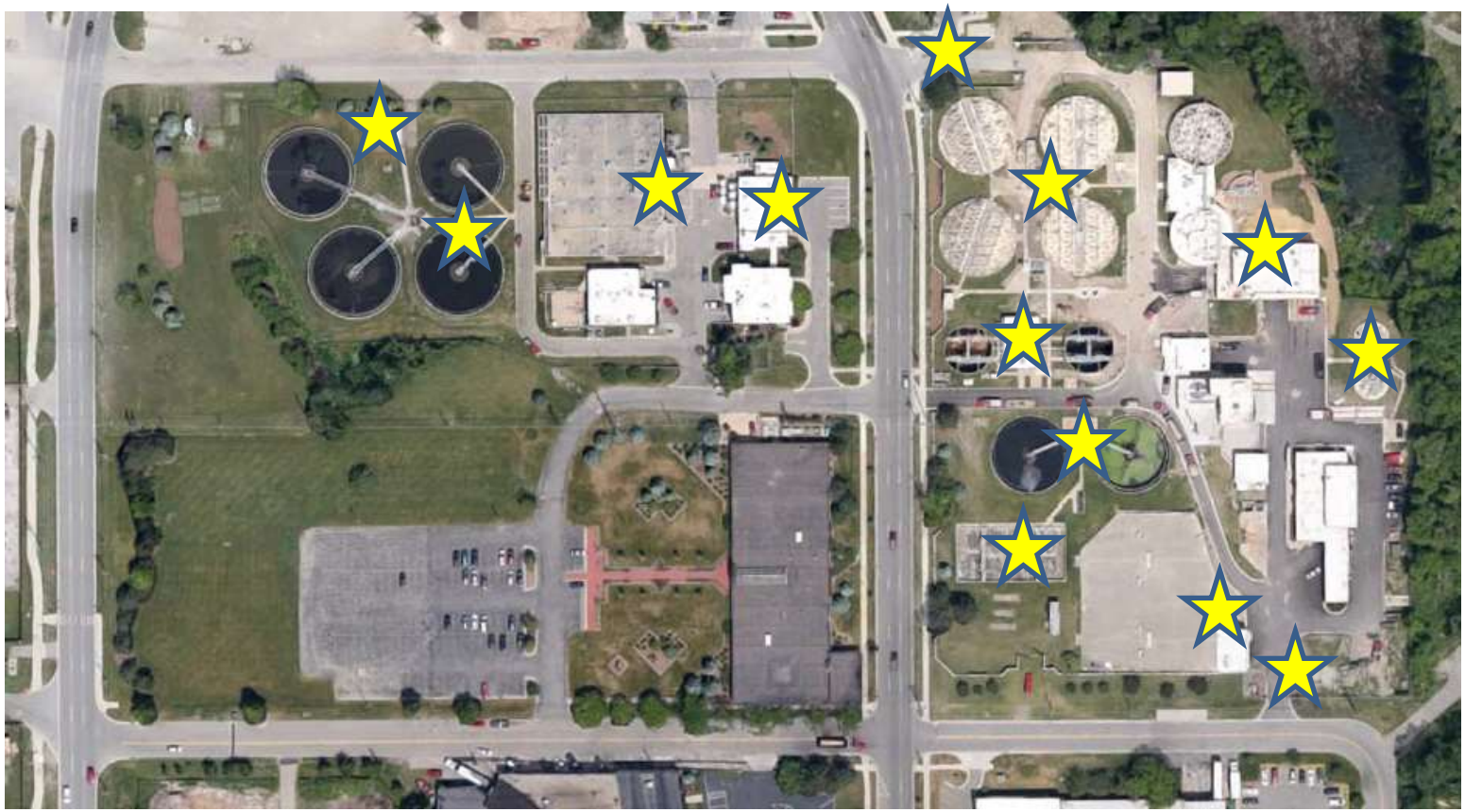
- Stress testing
- Modeling – process and/or hydraulic
- Testing the effectiveness
- Instruments and instrumentation
- Lab data
- Outside expertise

Tools of the Trade





BOD/TSS Loading Trends



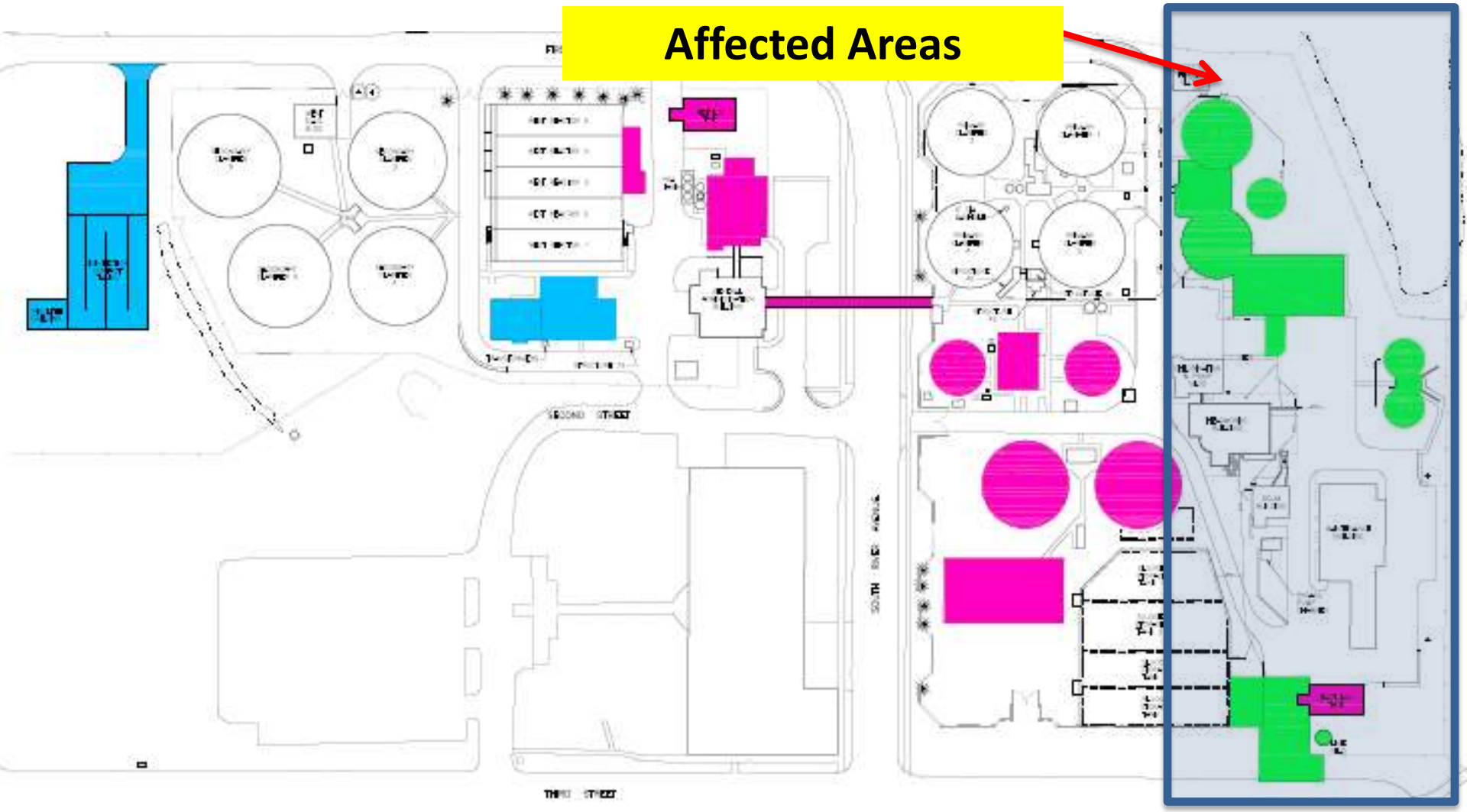
What To Examine

- Primary Treatment
- Secondary Treatment
- Solids Handling
  - ✓ Pumping
  - ✓ Thickening
  - ✓ Dewatering
  - ✓ Stabilization
  - ✓ Recycling
  - ✓ Odor Abatement
  - ✓ SCADA

Affected Processes

BIOSOLIDS OPTIMIZATION

10 YARDS OF BIOSOLIDS INTO A 5-YARD BUILDING



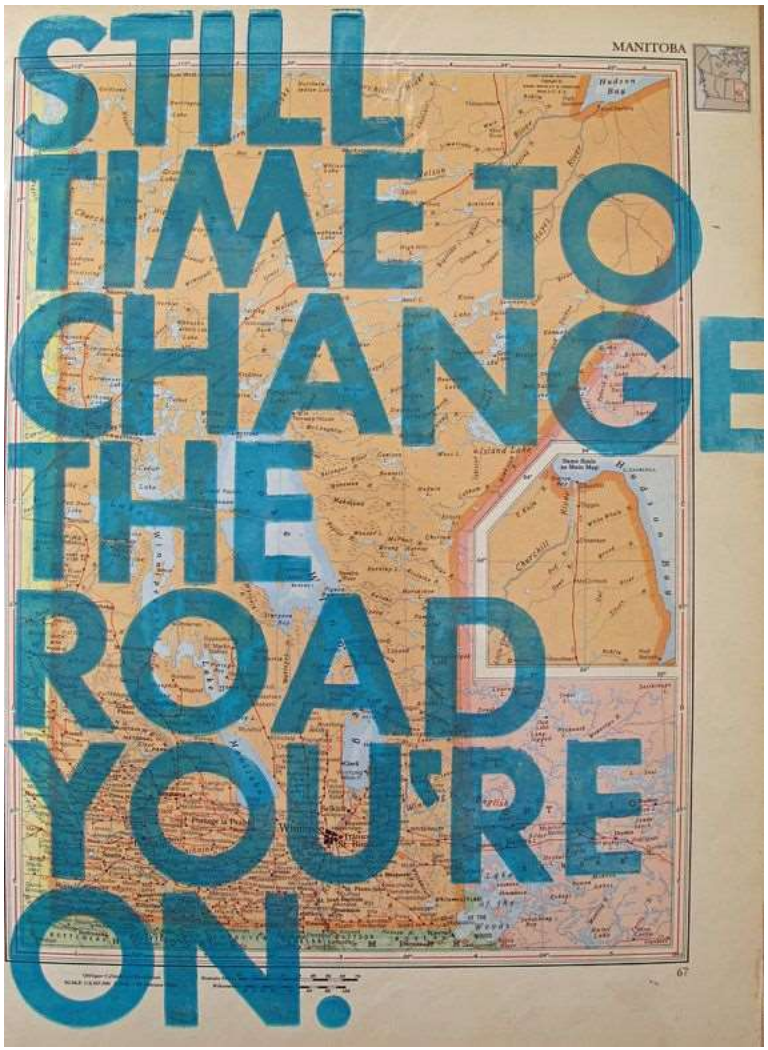
Biosolids Handling Process

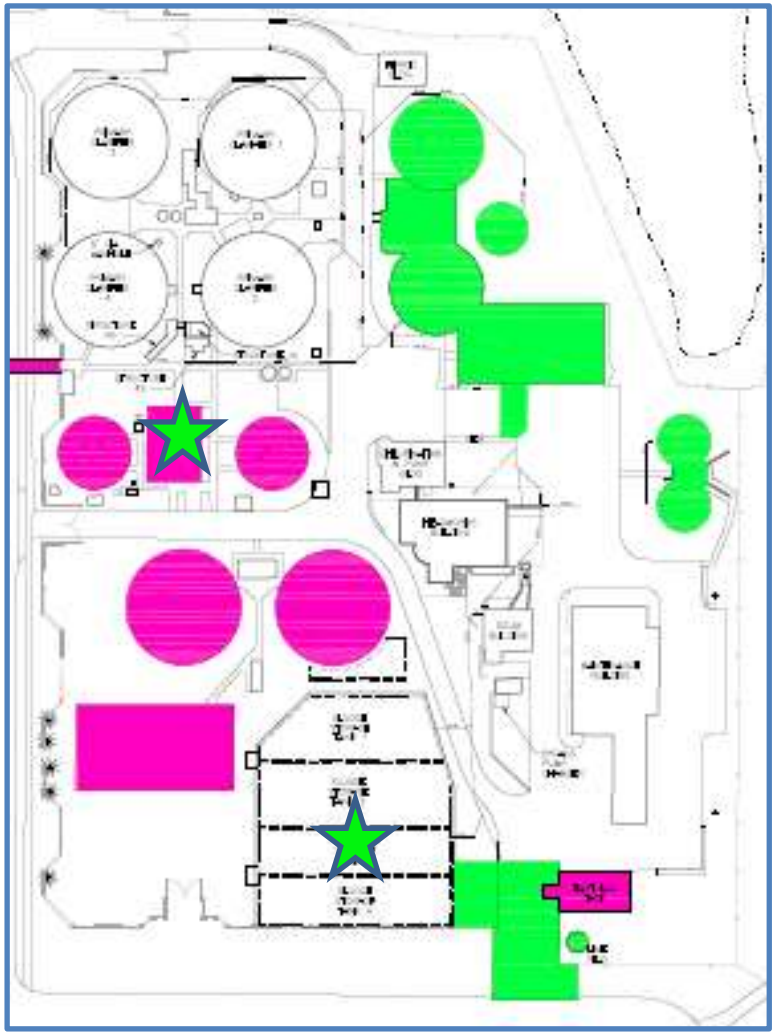
Challenges

- Improved Dewatering
- Size for the Future
- Control O&M
- Budget
- Staging
- Size Constraints
- Old Infrastructure

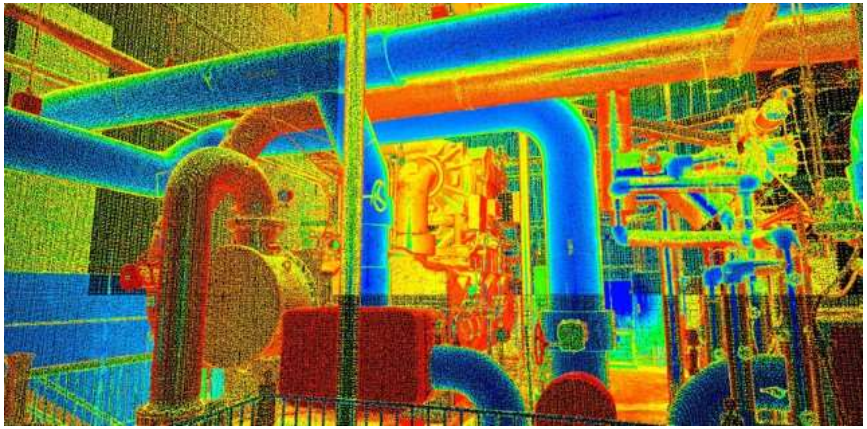
Dewatering/Thickening Equipment Comparison

- Processing volume
- % Solids
- Recycle filtrate quality
- Number of units
- Dimensions
- Warranty
- Equipment cost
- Operation cost





Biosolids Handling Process



Facing the Challenge

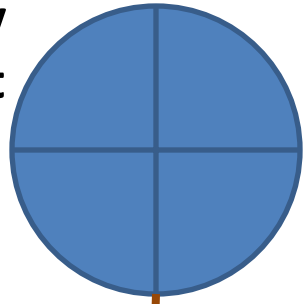
- Pilot testing
- Scanning the buildings
- Stress testing
- Code changes
- Operational changes
- Staging
- Redundancy
- Hp
- Improved blending

Dewatering Equipment Comparison

	Capacity per unit						Est. Polymer Demand, lbs/DT			
Make and Model	pph	gpm	Qty Required *	Cost per Unit	Total Cost w/ Accessories	HP per unit	Mixed Sludge	WAS	Annual Maintenance Requirements	Additional Notes
Manufacturer A	715	65	12	$425,000	$5,100,000	5	15-20	30-40	Typically every 5000-10,000hr depending on application including replacing the brush and bearing. The requirements are ~$7000 in parts and 6 man days to complete (2 people 3 days).	Price includes 316 SS construction, control panel, flow meter, progressing cavity feed pump, polymer makeup and feed system and injection ring, startup and delivery, contractor to provide floccculation pipes
Manufacturer B.1	1,660	254	3	$398,250	$1,194,750 (plus $110,000 for combined control panel)	7.5 for press, 1.0 for RST, 1.5 for floc tank	10-15	25-35	Routine lubrication and oil changes; see 10-Year Warranty (does not cover floc tank mixer)	Price includes RST, floc tank and mixer, 316 SS construction, progressive cavity feed pump, polymer makeup and feed system and injection ring, startup and delivery
Manufacturer B.2	1,225	190	4	$396,550	$1,586,200 (plus $110,000 for combined control panel)	7.5 for press, 1.5 for floc tank	10-15	25-35	Routine lubrication and oil changes; see 10-Year Warranty (does not cover floc tank mixer)	Price includes floc tank and mixer, 316 SS construction, progressive cavity feed pump, polymer makeup and feed system and injection ring, startup and delivery
Manufacturer C	1,225	190	4	$505,180	$2,020,720 (plus $36,000 for startup and freight)	13.5 total	25-30		Typically every 5000 hrs depending on application including replacing the brush, spray nozzles, and air cylinders . The requirements are ~$10,000 in parts and 6 man days to complete (2 people 3 days).	Price includes rotary drum thickener, 316 SS construction, control panel, flow meter, sludge feed and wash water pumps, polymer makeup and feed system and injection ring, startup and delivery, contractor to provide floccculation pipes

Biosolids Handling Process

Secondary Treatment



W.A.S. Pump

Gravity Belt Thickener

Thickened Sludge Pump

Sludge Storage and Lime Stabilization

Land Application

Secondary Sludge Flow Diagram

Biosolids Handling Process

Primary Treatment

Screw Press

Sludge Cake Pump

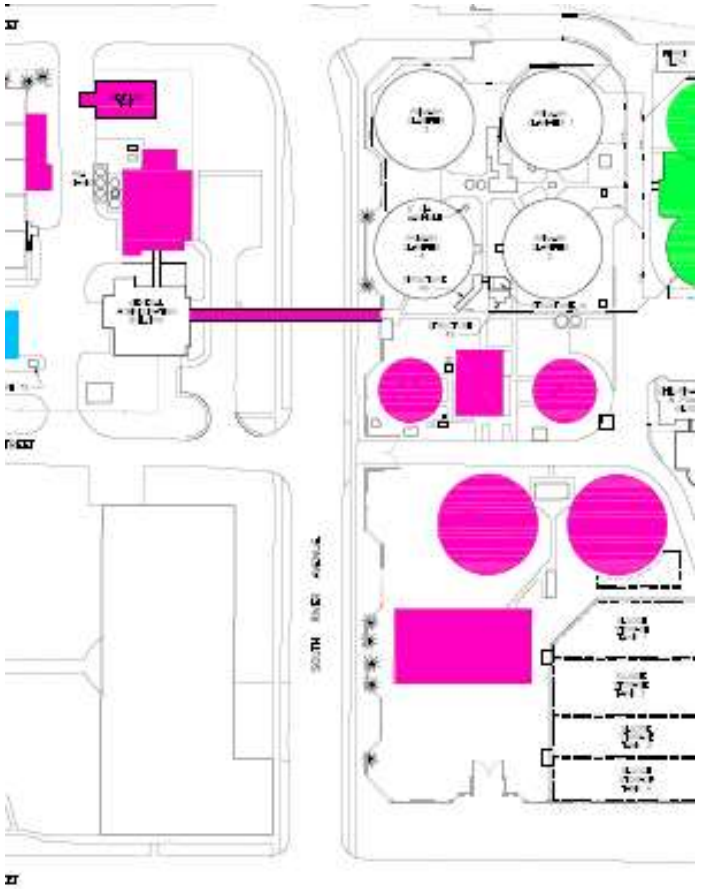
Thk. # 4

Feed Pump

Shipped to Landfill

Thickened Secondary Sludge

Primary/Secondary Sludge Flow Diagram



SECONDARY TREATMENT
RETRO-FIT

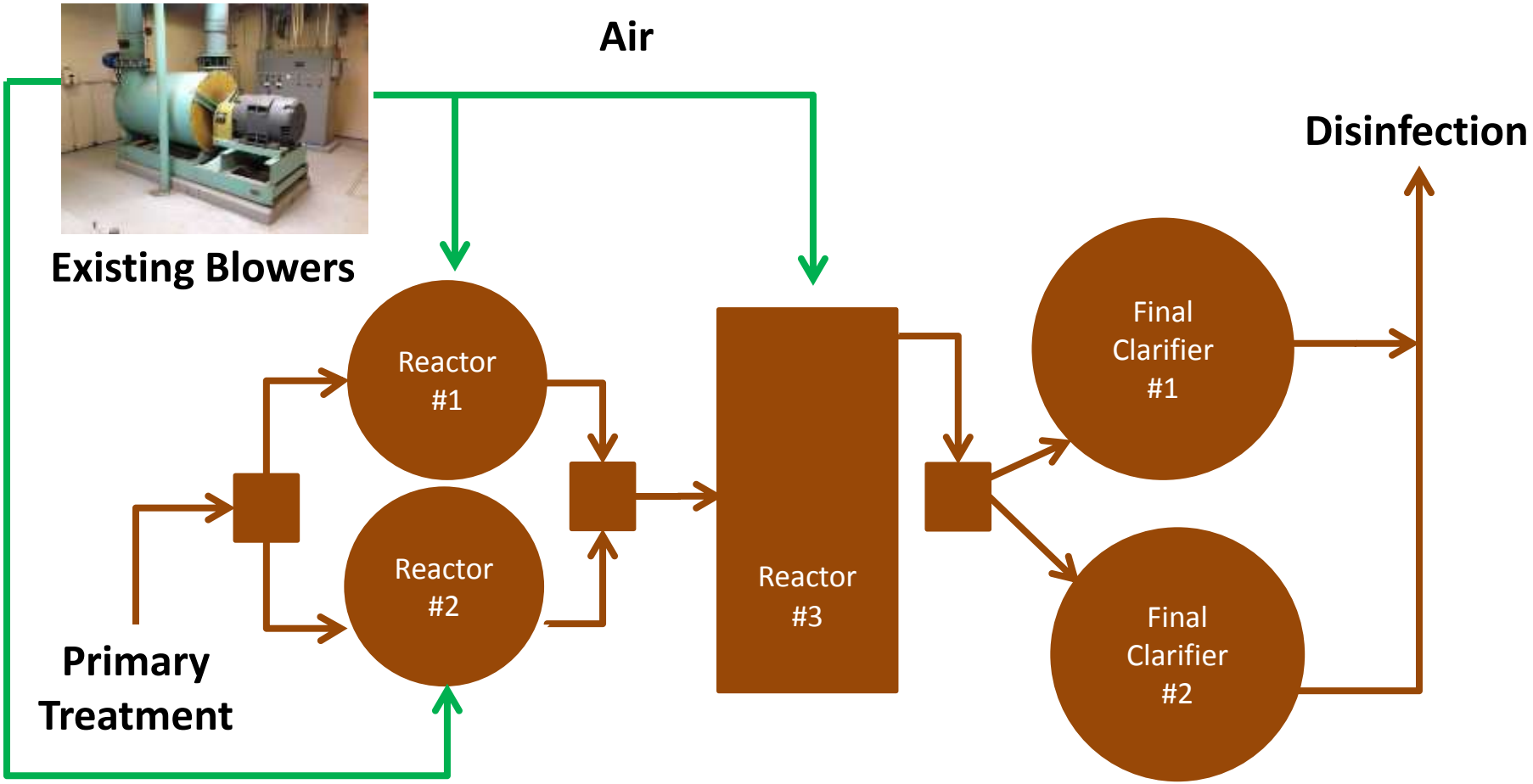
Objectives:

- Replace aging equipment
- Add 30% BOD capacity
- Reallocate maintenance labor
- Redundancy
- Budget
- Staging

Upgrades Needed:

- Secondary Treatment
  - ✓ Aeration/oxygen
  - ✓ RAS/WAS pumping
  - ✓ Reactor configuration
  - ✓ Added flexibility
  - ✓ Clarifier upgrades
  - ✓ Building /Tank Reuse

Secondary Treatment Process



Existing East Plant Flow Diagram

Optimization Alternatives Comparison

Design Average Day BOD Treatment Capacity Comparison

Alternative	East Plant Capacity (lb/day)	West Plant Capacity (lb/day)	Total WWTP Capacity (lb/day)	Increase Over Current (lb/day)	Increase Over Current (%)
Current Design	4,796	15,000	19,796	N/A	N/A
1 - Fine Bubble Aeration	8,600	15,000	23,600	3,804	19%
2a - HPOAS with VPSAs	13,300	15,000	28,300	8,504	43%
2b - HPOAS with LOX	13,300	15,000	28,300	8,504	43%
3 - IFAS	12,500	15,000	27,500	7,704	39%

Design Maximum Day BOD Treatment Capacity Comparison

Alternative	East Plant Capacity (lb/day)	West Plant Capacity (lb/day)	Total WWTP Capacity (lb/day)	Increase Over Current (lb/day)	Increase Over Current (%)
Current Design	8,340	30,000	38,340	N/A	N/A
1 - Fine Bubble Aeration	17,200	30,000	47,200	8,860	23%
2a - HPOAS with VPSAs	26,600	30,000	56,600	18,260	48%
2b - HPOAS with LOX	26,600	30,000	56,600	18,260	48%
3 - IFAS	16,600	30,000	46,600	8,260	22%

Cost of Optimization vs. Maintaining Existing

- Optimization largely replaces existing equipment approaching or past its design life.
- Cost to simply replace this equipment with current models (i.e. minimal or no capacity gain) estimated at approximately $5.3 million.

Major Equipment to be Replaced as Part of Optimization Project

Equipment	Number of Units	Year Installed	Age (Years)	Design Life (Years)
200 HP Centrifugal Blower	2	1979	34	20
75 HP Centrifugal Blower	3	1971	42	20
Waste Activated Sludge Pumps	3	1971	42	20
Clarifier Internals	2	1971	42	20
Clarifier Weirs & Baffles	2	1971	42	20
25 Hp Mixers (Aeration Basin 3)	4	1979	34	20
10 Hp Mixers (Aeration Basins 1&2)	8	1971	42	20
300 Hp Joy Compressors 1 & 2	2	1979	34	20
PSA Skid 1	1	1979	34	20
300 Hp Joy Compressor 3	1	1995	18	20
PSA Skid 2	1	1995	18	20
Liquid Oxygen Tank & Appurtenances	1	1979 (Refurbished 1995)	34	20
Cooling Tower & Pump	1	1979	34	20
Cooling Tower & Pump	1	1995	18	20

Optimization Alternatives Cost Comparison

Relative Life-Cycle Costs of Optimization Treatment Alternatives

Alternative	Cost per Pound of East Plant BOD Treatment Capacity		Cost per Pound of WWTP Net Increased BOD Treatment Capacity	
	Average Day	Maximum Day	Average Day	Maximum day
Fine Bubble Aeration with West Plant PSA Upgrades	$2,498	$1,249	$5,648	$2,425
Fine Bubble Aeration with West Plant LOX Tanks	$1,742	$871	$3,938	$1,691
HPOAS with VPSAs	$1,674	$837	$2,618	$1,219
HPOAS with LOX	$1,107	$554	$1,732	$806
IFAS with West Plant PSA Upgrades	$1,995	$1,502	$3,237	$3,019
IFAS with West Plant LOX Tanks	$1,488	$1,120	$2,414	$2,252

Secondary Treatment Process

Liquid Oxygen Bulk Storage

Oxygen

Disinfection

Reactor #1

Reactor #2

Reactor #3

Reactor #4

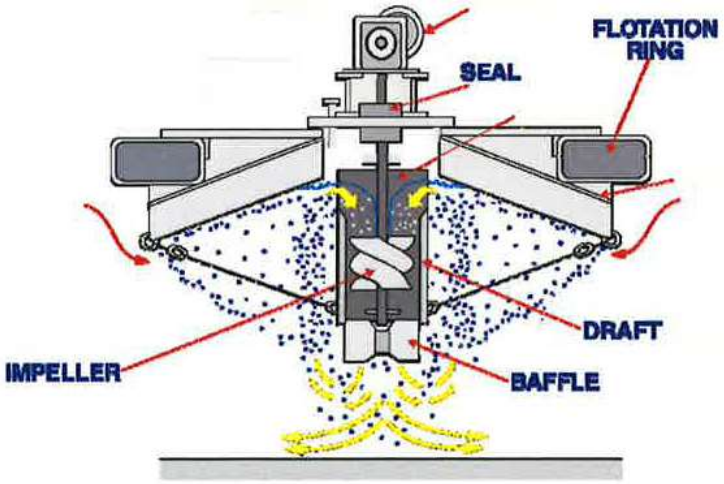
Final Clarifier #1

Final Clarifier #2

Primary Treatment

Oxygen

Proposed East Plant Flow Diagram



Floating mixer in the existing tanks

In-Situ Oxygenation System (I-SO)

Secondary Treatment Process

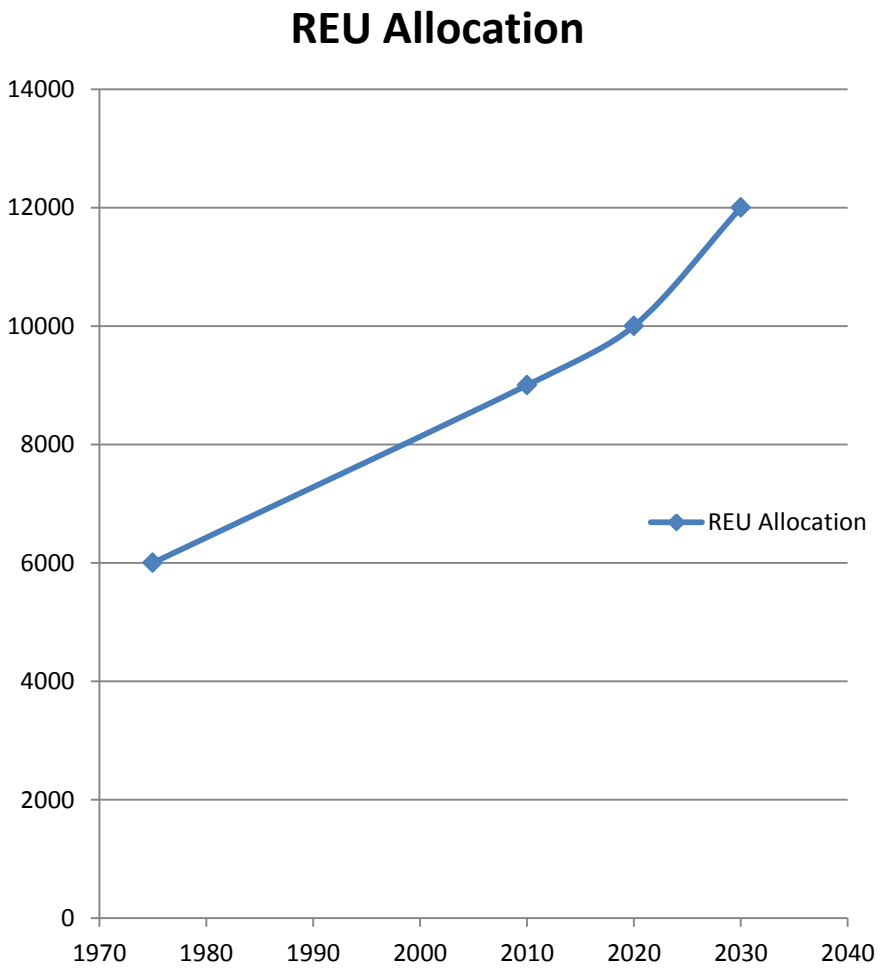
AFTER THE IMPROVEMENTS WHAT WILL THE PLANT LOOK LIKE – LIKE NOTHING HAPPENED

Case II – REU

History

- 1975 Facility constructed to Serve a Limited Service Area
- 1990 growth happens and plant expanded to handle additional REUs
- 2010 Opportunity to consolidate communities into one WWTP Service Area.

REU Expected Changes

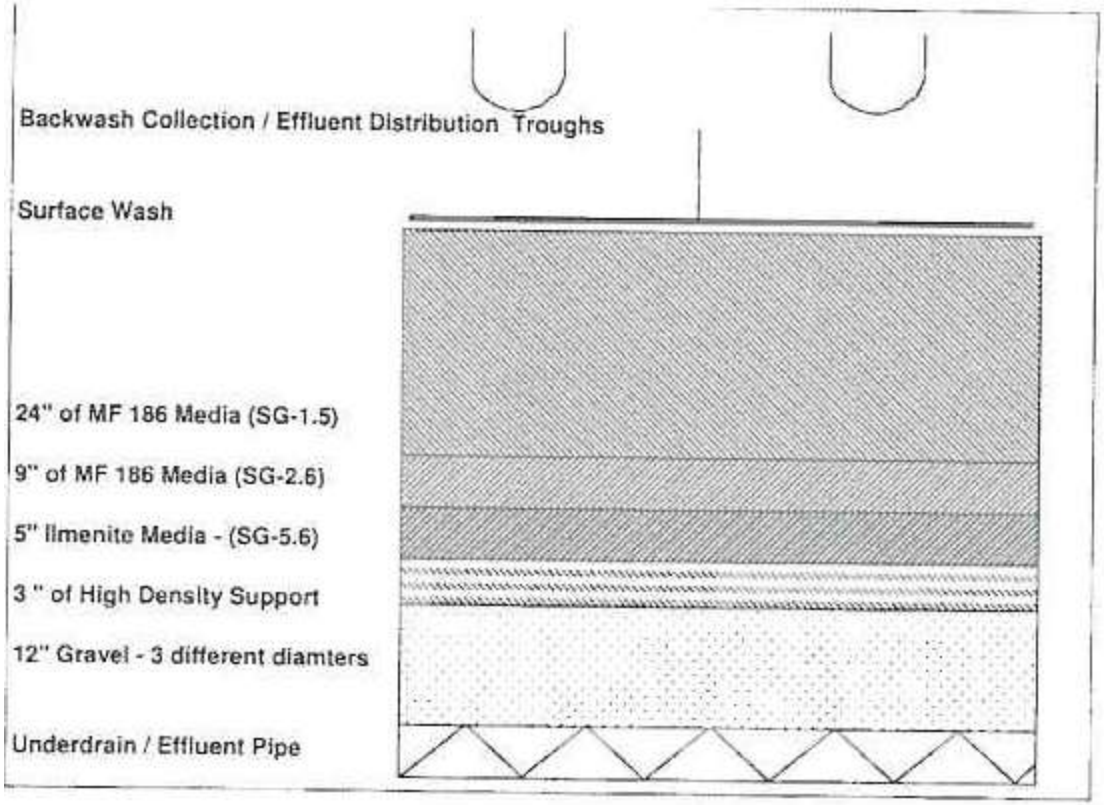


AGAIN THE QUESTION:

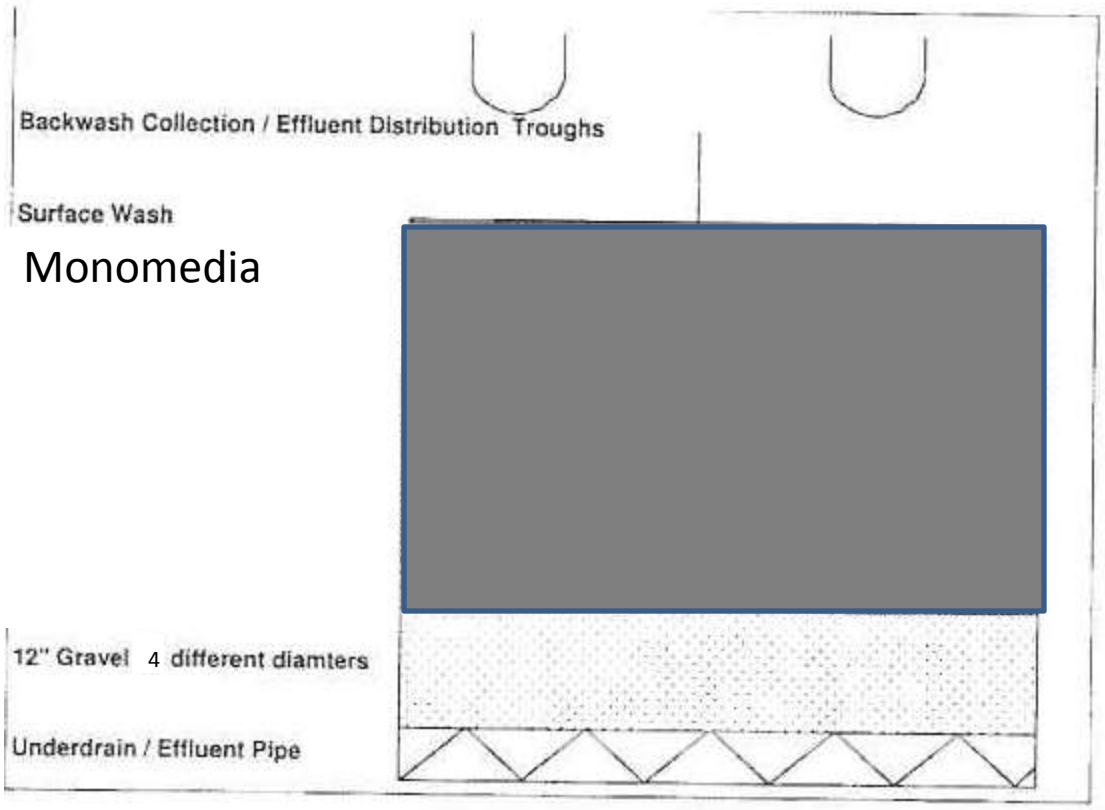
TO EXPAND OR NOT TO EXPAND?

Process/ Component	Operating Condition	Hydraulic Capacity (mgd)	Processing Capacity (mgd)
Influent Pumping	5 of 6 pumps running	8.8	8.8
Screening	1 unit on line	9.5	9.5
Grit Removal	1 unit on line	5.68	9.5
Secondary Treatment	4 units on-line	5.68	6.48
Tertiary Filtration	4 units on-line	5.0	**7.0**
UV Disinfection	2 banks on-line	9	8.14

Bottlenecks = Capacity Restraint



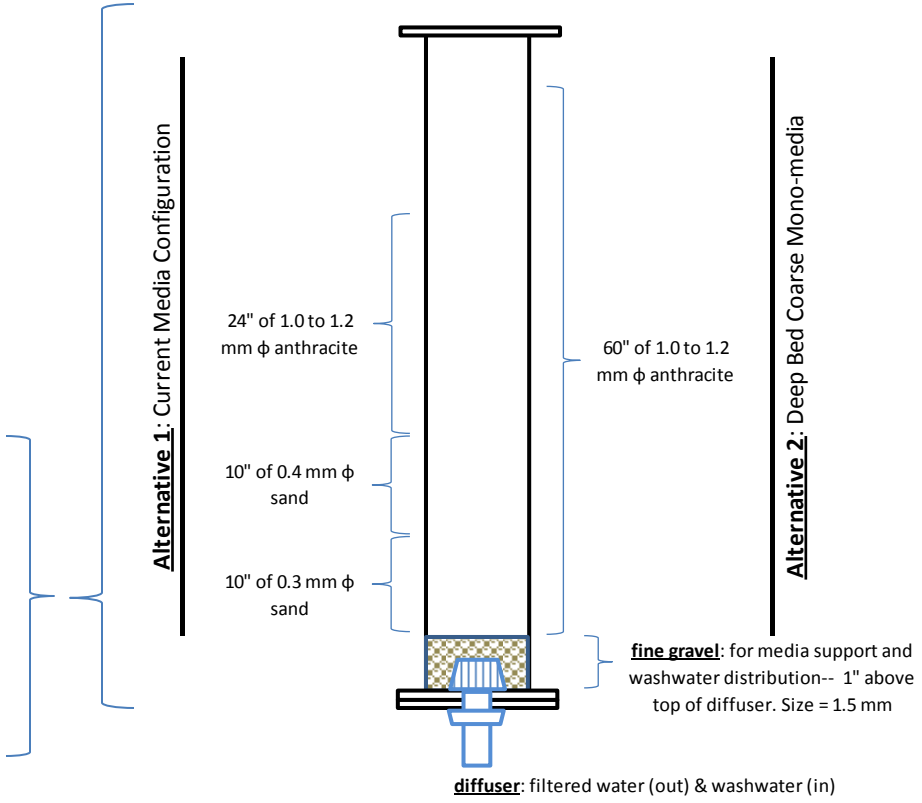
Filtration Options –Mixed media



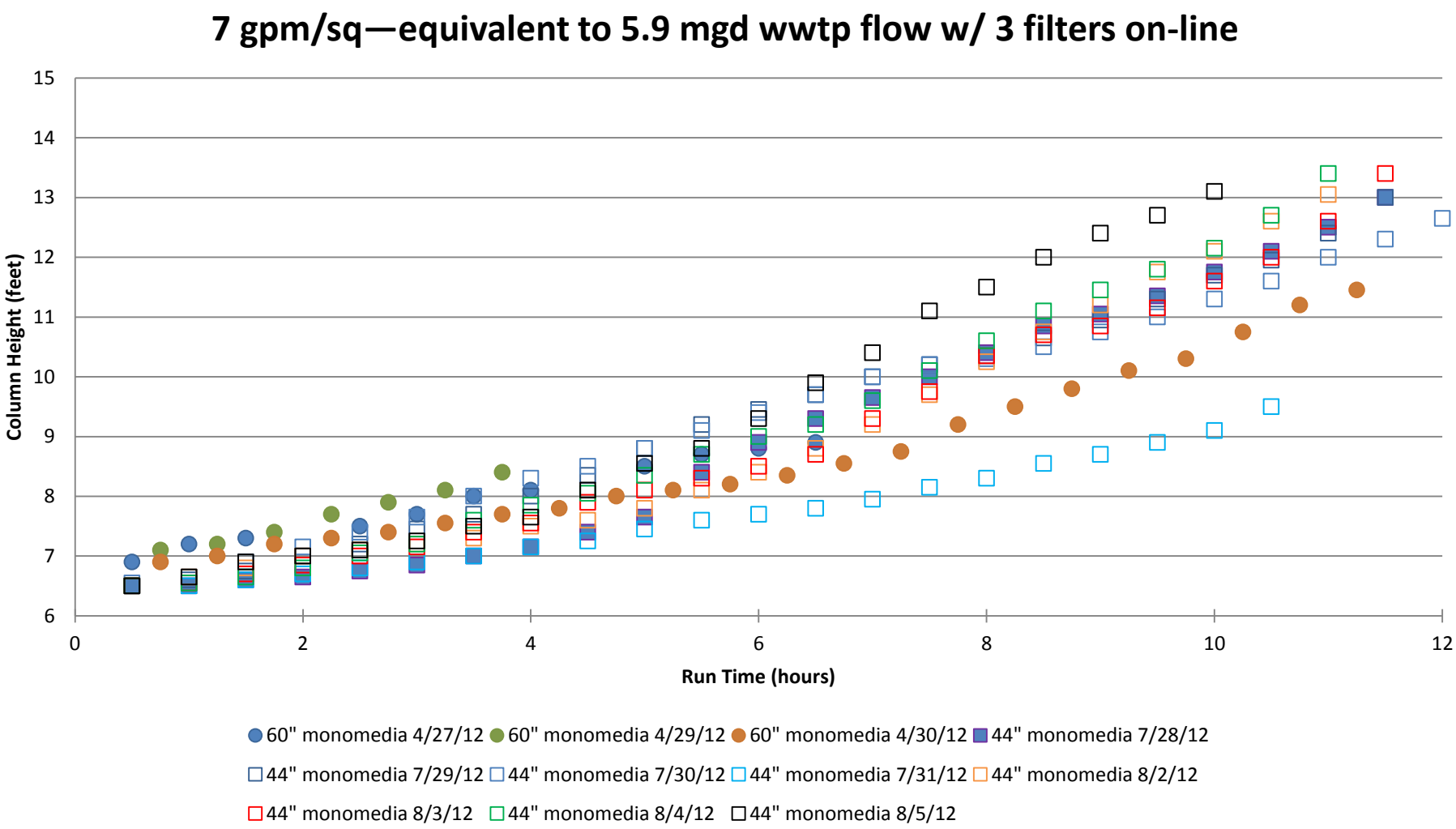
Filtration Options –Monomedia

- Proven at other US installations (6 – 8 gpm/sf)
- Regulators required test
- Side-by-side
- Acclimate the media
- Time frame:

  5-days



Monomedia Pilot Test



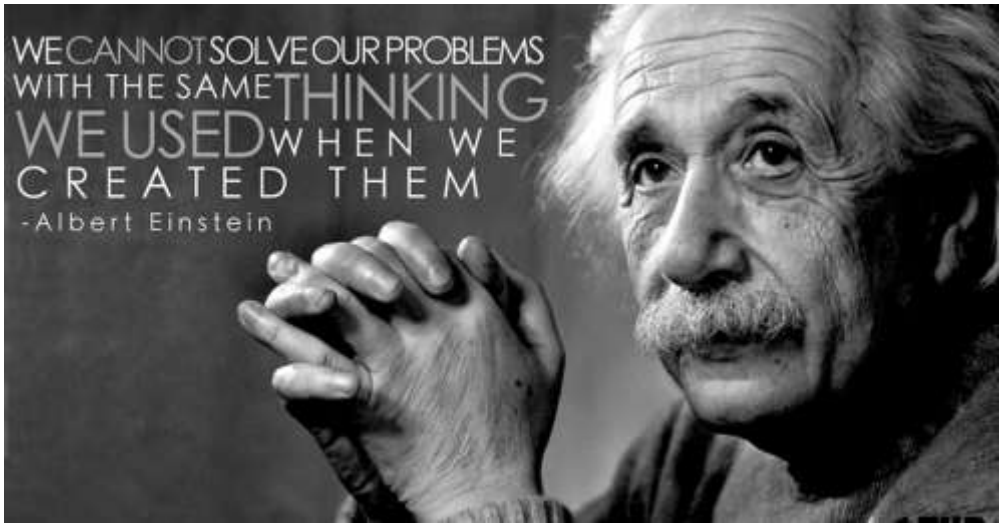
Monomedia Headloss and Run-time:

- Different Technology
  - Not cost competitive (not pursued)
- Same Multi-media stratification, with:
  - More filters (~$2.3 million), OR
  - Additional retention (~$1.8 million)
  - Media replacement, regardless (~$300,000)
- Monomedia
  - $40,000 investment (for pilot study)
  - ~ 30% potential reduction of retention volume

Project Optimization Results

In Conclusion:

- What Does Optimization Mean?
- It’s all in the Data
- Get in Shape
- Understand the Real Problems
- Be Open Minded
- Simplify Your Life
- Get a Bigger Box
- Look at the full picture



Questions?