Introduction

- Typical new WI WQBEL for Impaired Waters
  - 0.075 mg/L six month seasonal limit
  - 0.225 mg/L monthly limit

- Effluent P Mainly in Solids (Chemical or Biological)

- Low P Technology used to Reach Low TSS and P
how big is big enough?
Conservative Sizing

Low-Level P Technology A Peak Flow
Right Sizing

Graph showing RWW Flow (mgd) against Percentile.

- Low-Level P Technology A
  - Peak Flow
- Low-Level P Technology A
  - Less than Peak Flow
- Technology B
  - Peak Shaving
Right Sizing

- Low-Level P Technology A: Less than Peak Flow
- Technology B: Peak Shaving
- Evaluate Multiple Design Flows

Graph with RWW Flow (mgd) on the y-axis and Percentile on the x-axis.

X: Y
Finding a Balance

Permit Compliance = Tech A + Tech B
Strike the “Right” Balance

Technology A
Low-Level P Tertiary Process
Higher Cost Alternative

Technology B
Optimized Existing Processes
Lower Cost Alternative
how low can we get?
Disc Filtration

Sun Prairie
Brookfield
Stevens Point
HOV
Beloit

Brookfield
Beloit
Sheboygan
Low P Testing

- Effluent TP (mg/L) vs. Molar Ratio (Me:P)
- < 0.075 mg/L achieved
- High chemical demand
Low P Testing

50% increase in chemical from 0.1 to 0.075 mg/L
Low P Testing: A Side Note…

Secondary effluent TP control is critical
why does this matter?
Mass Balance

Secondary Effluent
TP=0.5 mg/L

Splitter Box

Low P Technology
TP <0.075 mg/L

Meet NR 217 Requirements
Mass Balance

Secondary Effluent
TP=0.5 mg/L

Splitter Box

TP = 0.5 mg/L

Low P Technology

TP <0.075 mg/L

Meet NR 217 Requirements
Mass Balance

Secondary Effluent
TP=0.5 mg/L

Splitter Box

Low P Technology

TP <0.075 mg/L

Meet NR 217 Requirements

How often can/will this happen?

TP = 0.5 mg/L
Mass Balance

Secondary Effluent TP=0.5 mg/L

Splitter Box

Low P Technology

TP <0.075 mg/L

Meet NR 217 Requirements

How often can/will this happen?

As low TP numbers get smaller, bypass happens more frequently
Low P Technology = 0.05 mg/L

Filter size: 0.8 mgd

- Effluent P
- Monthly Limit
- 30 Day RA
- 6-Month Limit
- 180 Day RA

Effluent P Conc. (mg/L)

Low P Technology = 0.05 mg/L

- Effluent P
- Monthly Limit
- 30 Day RA
- 6-Month Limit
- 180 Day RA
- Filter size: 0.8 mgd

- Flows: historic
- Dots: daily effluent
- Effluent P
- Pink line: 6 month average
- Green line: Monthly average
- Dashed lines: permit
Low P Technology = 0.05 mg/L

Filter size: 0.8 mgd
Low P Technology = 0.07 mg/L

Effluent P Concentration (mg/L)

- Effluent P
- Monthly Limit
- 6-Month Limit
- 180 Day RA
- 30 Day RA

Filter size: 1.2 mgd

Low P Technology Impact

- **Low P Technology Capacity (mgd)**
- **Low P Technology Effluent P (mg/l)**

- Large capital increase

- %Of Year with Low P Diversion

- Large capital increase

- Low P Technology Effluent P (mg/l)

- Low P Technology Effluent P (mg/l)
Low P Technology Impact

Large capital increase
Low P Technology Impact

Large capital increase

% Of Year with Low P Diversion

6 days per year of filtration

Low P Technology Capacity (mgd)

Low P Technology Effluent P (mg/l)

Low P Technology Effluent P (mg/l)

0.050 0.055 0.060 0.065 0.070 0.075

0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5

0.0% 1.0% 2.0% 3.0% 4.0% 5.0% 6.0% 7.0%
Proposed Brookfield Flow Diagram

Preliminary Treatment → Chemical Mix/Floc → Flow Split → Primary Settling → Activated Sludge → Secondary Settling → Flow Split → Chemical Mix/Floc → Low-Level Filter

- Excess Flow Settling
  - $Q_{dbf}$
  - $P_{dbf}$ mg/L

- Disinfection
  - $Q_{ex}$
  - $P_{ex}$ mg/L
  - $Q_{llf}$
  - $P_{llf}$ mg/L

- Outfall

- Total Flow
  - $Q_{tot}$
  - $P_{tot}$ mg/L
2005-2012 Brookfield Daily Flow Distribution

RWW Flow (mgd) vs. Percent Equal or Less Than

DONOHUE
Mass Balance Approach

\[ Q_{tot} P_{tot} = Q_{ex} P_{ex} + Q_{dbf} P_{dbf} + Q_{llf} P_{llf} \]

Assign Flow Rates

- New Low-Level Filters treat flows up to 15 mgd (97.5% of daily flows)
- Existing Deep Bed Filters treat flows from 15 – 31.2 mgd (16.2 mgd capacity)
- Flows over 31.2 mgd are sent through excess flow clarifiers.

\[ Q_{tot} P_{tot} = Q_{ex} P_{ex} + Q_{dbf} P_{dbf} + Q_{llf} P_{llf} \]
Daily Mass Balance

15 mgd Disc Filters at 0.05 mg/L P
and 16.2 mgd DBF at 0.3 mg/L P
Daily Mass Balance

15 mgd Disc Filters at 0.05 mg/L P
and 16.2 mgd DBF at 0.3 mg/L P

Low Level Filters
30% of Peak Flow
Sensitivity

Effluent P with Varying Low-Level Filter Capacity

- 10 mgd LLF
- 15 mgd LLF
- 20 mgd LLF
- 30 mgd LLF
- 40 mgd LLF
- 50 mgd LLF

Estimated Effluent P Concentration (mg/L) vs. Flow (mgd)
Daily Mass Balance

15 mgd Disc Filters at 0.065 mg/L P
and 16.2 mgd DBF at 0.3 mg/L P
Daily Mass Balance

20 mgd Disc Filters at 0.065 mg/L P
and 16.2 mgd DBF at 0.3 mg/L P
Daily Mass Balance

20 mgd Disc Filters at 0.065 mg/L P and 16.2 mgd DBF at 0.3 mg/L P

Additional 5 mgd of capacity significantly reduces risk
Whitewater

First 4.0 mgd

Low Level P Technology

Flow >4.0 but <8.5 mgd

Existing Filters

> 8.5 mgd

To Disinfection
Whitewater Daily Mass Balance

4 mgd Low Level Filters at 0.06 mg/L P
Whitewater Daily Mass Balance

4 mgd Low Level Filters at 0.06 mg/L P

Low Level Filters 36% of Peak Flow
Cassville Daily Mass Balance
1.2 mgd Peak

0.6 mgd Filtered at 0.05 mg/L Effluent P
0.6 mgd Filter Bypass at 1.0 mg/L Effluent P
Cassville Daily Mass Balance
1.2 mgd Peak

0.6 mgd Filtered at 0.05 mg/L Effluent P
0.6 mgd Filter Bypass at 1.0 mg/L Effluent P

Low Level Filters
50% of Peak Flow
takeaways...
Takeaways...

- 0.075 mg/L can be achieved!
- Filtration size is critical
  - How much capacity do you really need?
  - How much is 6 extra days of filtration a year worth?
  - Risk versus capital
- Interplay of right sizing filters and adaptive management
Questions?

Leon Downing, PhD, PE
Donohue & Associates
920.889.9291
ldowning@donohue-associates.com