"Pretreatment of Raw water with 2000 NTU – No Problem !!"

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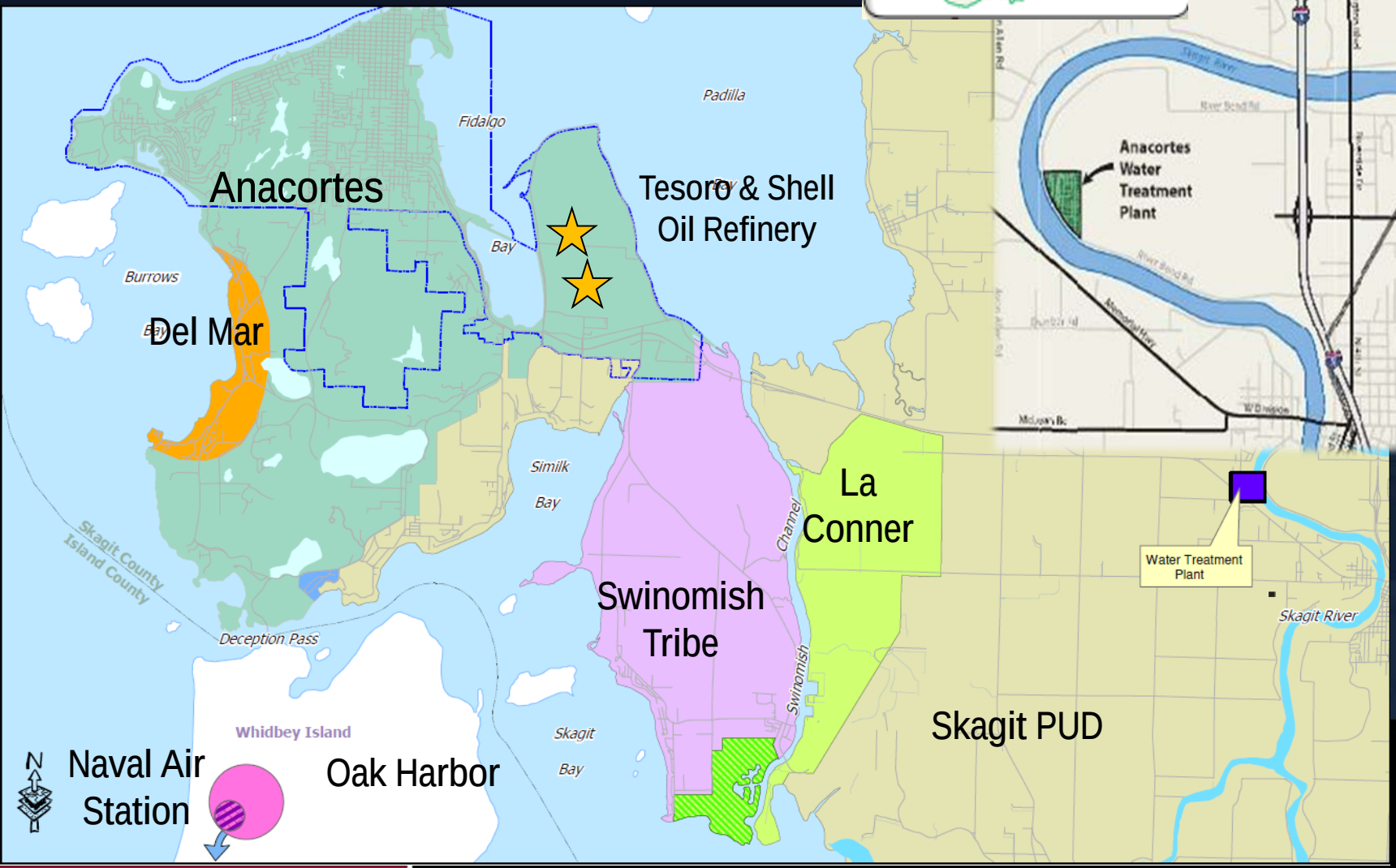
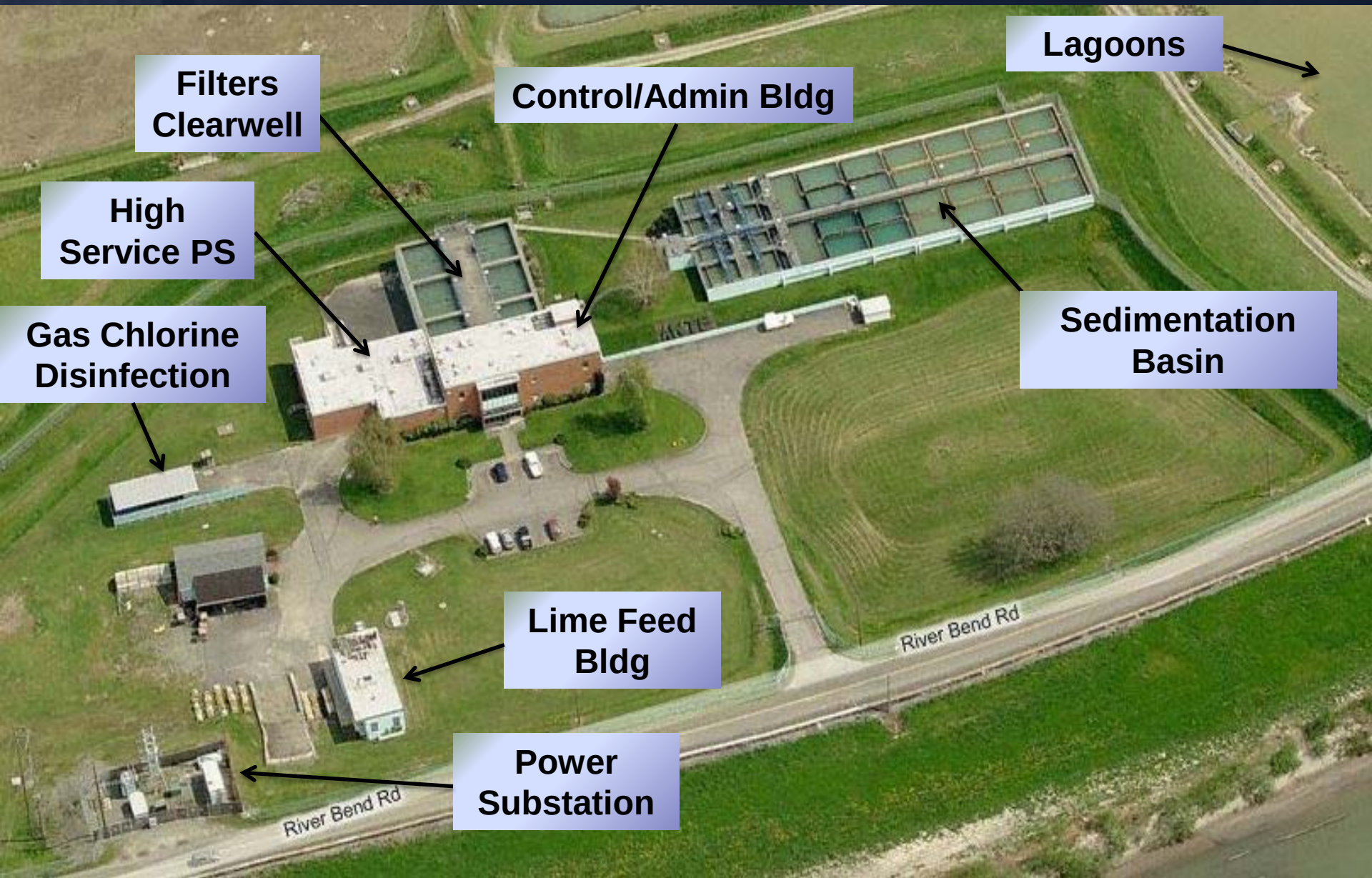
Presentation Overview

- Anacortes Water Treatment Plant
- Project Drivers and Proposed Improvements
- Skagit River Basin and Raw Water Quality Characteristics
- Ballasted Sedimentation (Actiflo®)
- Pilot Study Goals and Objectives
- Pilot Study Results & Findings
- Conclusion

Anacortes Water System Service Area



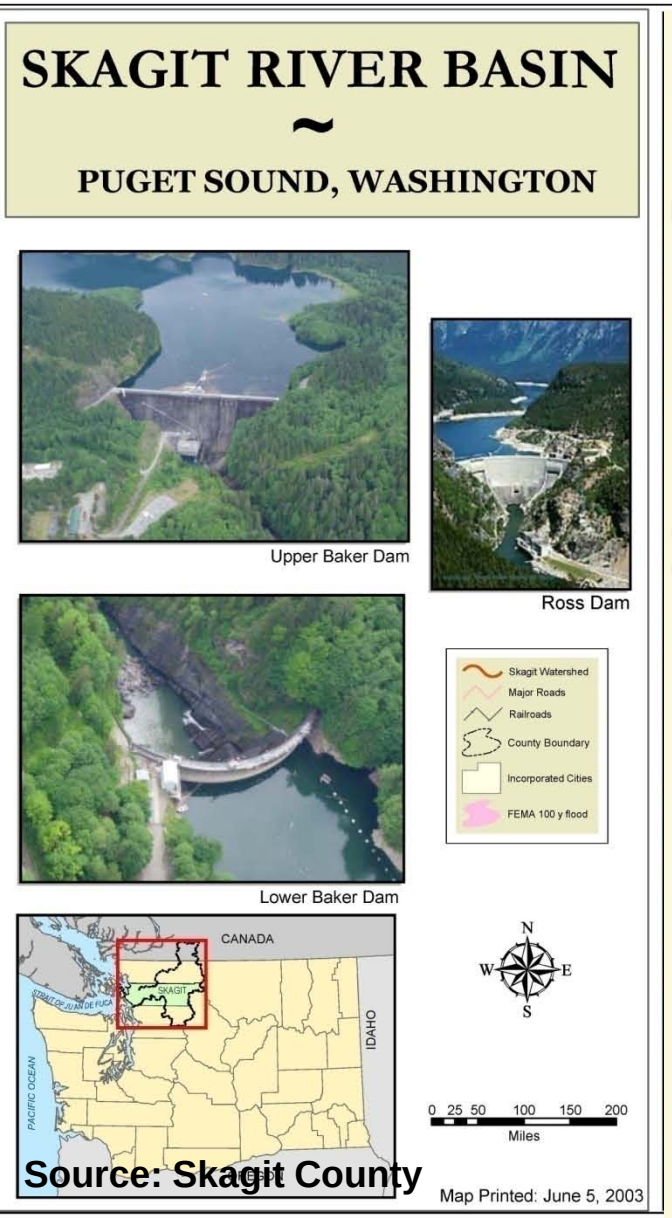
Existing Water Treatment Plant



Project Drivers – Challenges/Limitations

- Floodplain Limitations
- Challenging Raw Water Quality
  - Dramatic fluctuation of Turbidity and Color
- Ineffective Pretreatment
- Need to Expand Treatment Capacity
  - 2007 MDD: 29 MGD
  - 2030 MDD: 40.7 MGD
- Out-of-date Building Code
- Lacking Reliability and Redundancy

Skagit River Basin



Source: Skagit County

Source: USDA Forest Service

Historic Flood Events of Skagit River

Downtown Burlington in 1921 Flood

Source:
Army Corps of Engineers
Historical Pictures

Downtown Burlington in 1917 Flood

Recent Flood Events

Sandbag Wall In Front of Water Treatment Plant

Picture taken by Nov 11, 2006

View of WTP photo taken from Intake Station, Oct 22, 2003

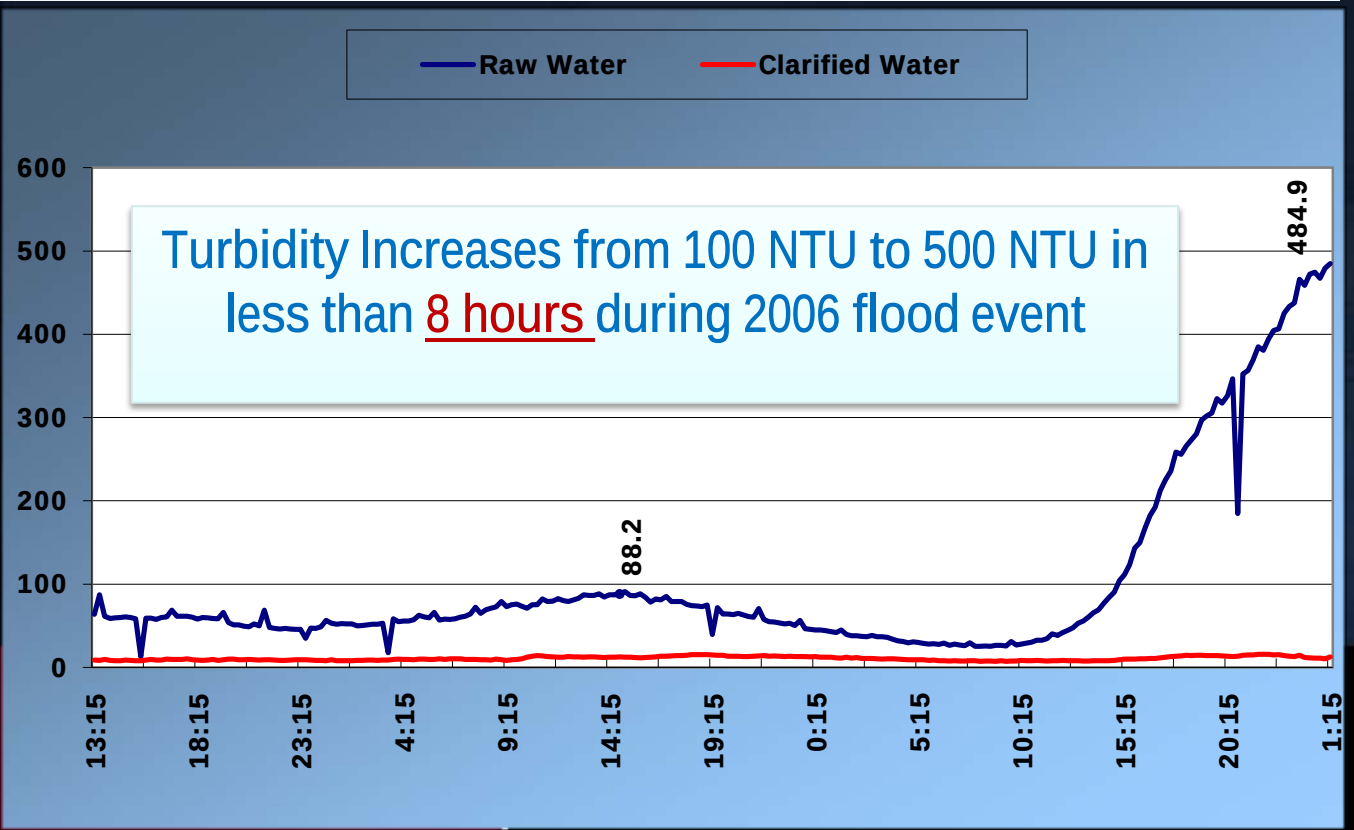
Flooded Skagit River Downtown Mount Vernon, Oct 2003

“Chocolate Creek” Event in August 1992

	Average August	1992 August
Turbidity	6 NTU	640 NTU
Color	50 ptco	7060 ptco

Water Quality Challenges

WTP Daily Average Turbidity Summary (2003 –2008)		
	Raw	Clarified
Minimum	1.4 NTU	1.1 NTU
Average	25 NTU	6.5 NTU
Maximum	2,700 NTU	32 NTU



Turbidity Increases from 100 NTU to 500 NTU in less than 8 hours during 2006 flood event

- **Ineffective Pretreatment:**

  Turbidity of clarified water exceeded -

  - 5 NTU about 50% of the time
  - 10 NTU about 20% of the time.

Selecting Ballasted Sedimentation

- Ability to treat water with high turbidity
- Rapid response times
- Compact footprint
- Perform efficiently with both low and high turbidity
- Consistent settled water for filters
- Reliable process

Ballasted Sedimentation Process

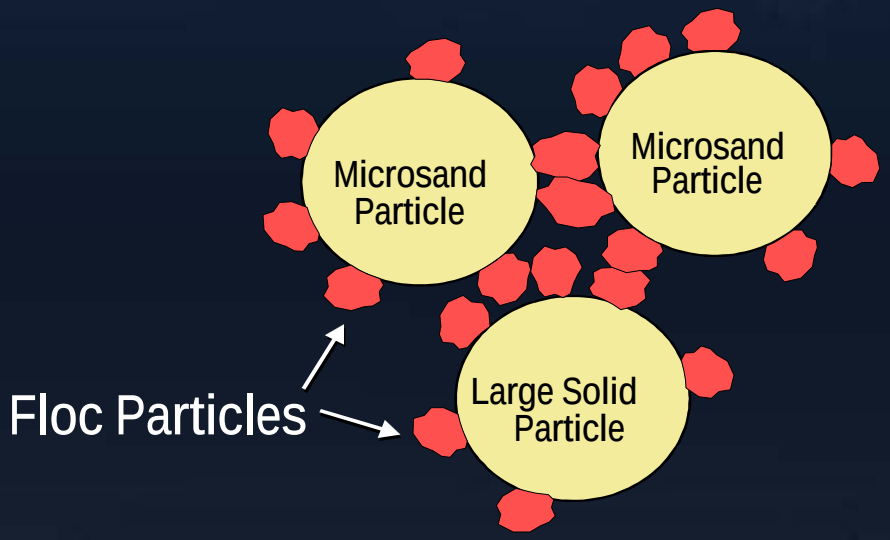
Add Coagulant to Grow Large Flocs particles

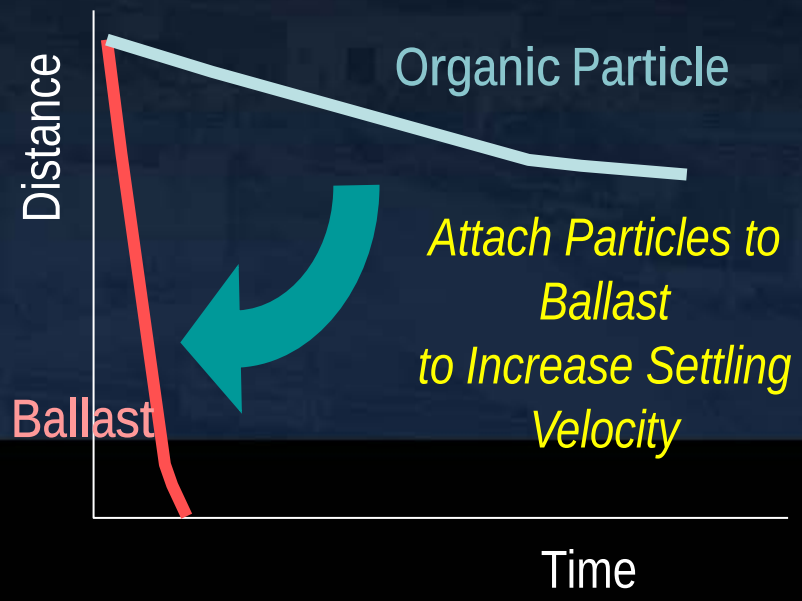
Flocculate

Add Ballast and Polymer

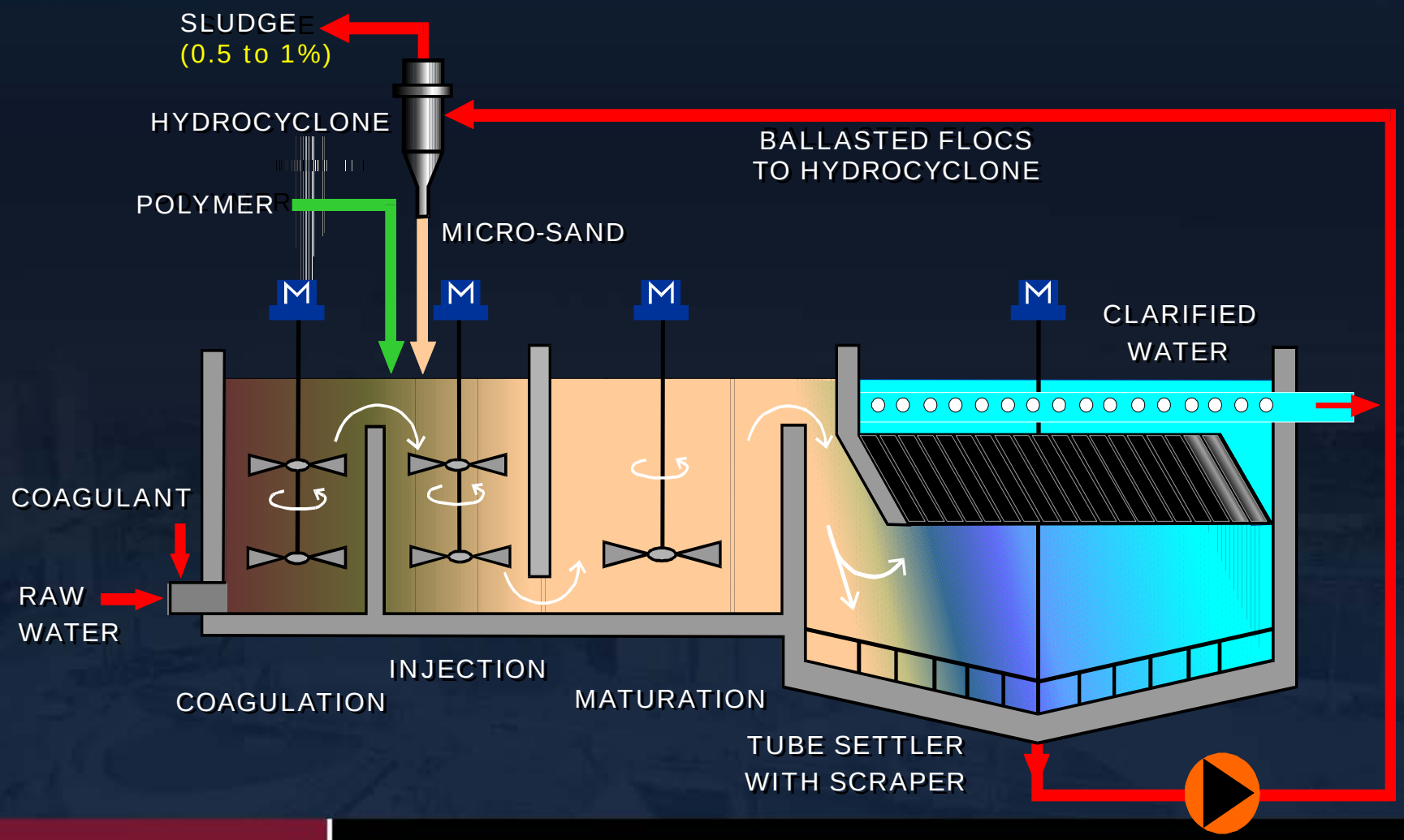
Ballasted Flocculation

Settling – use plate settlers to enhance separation



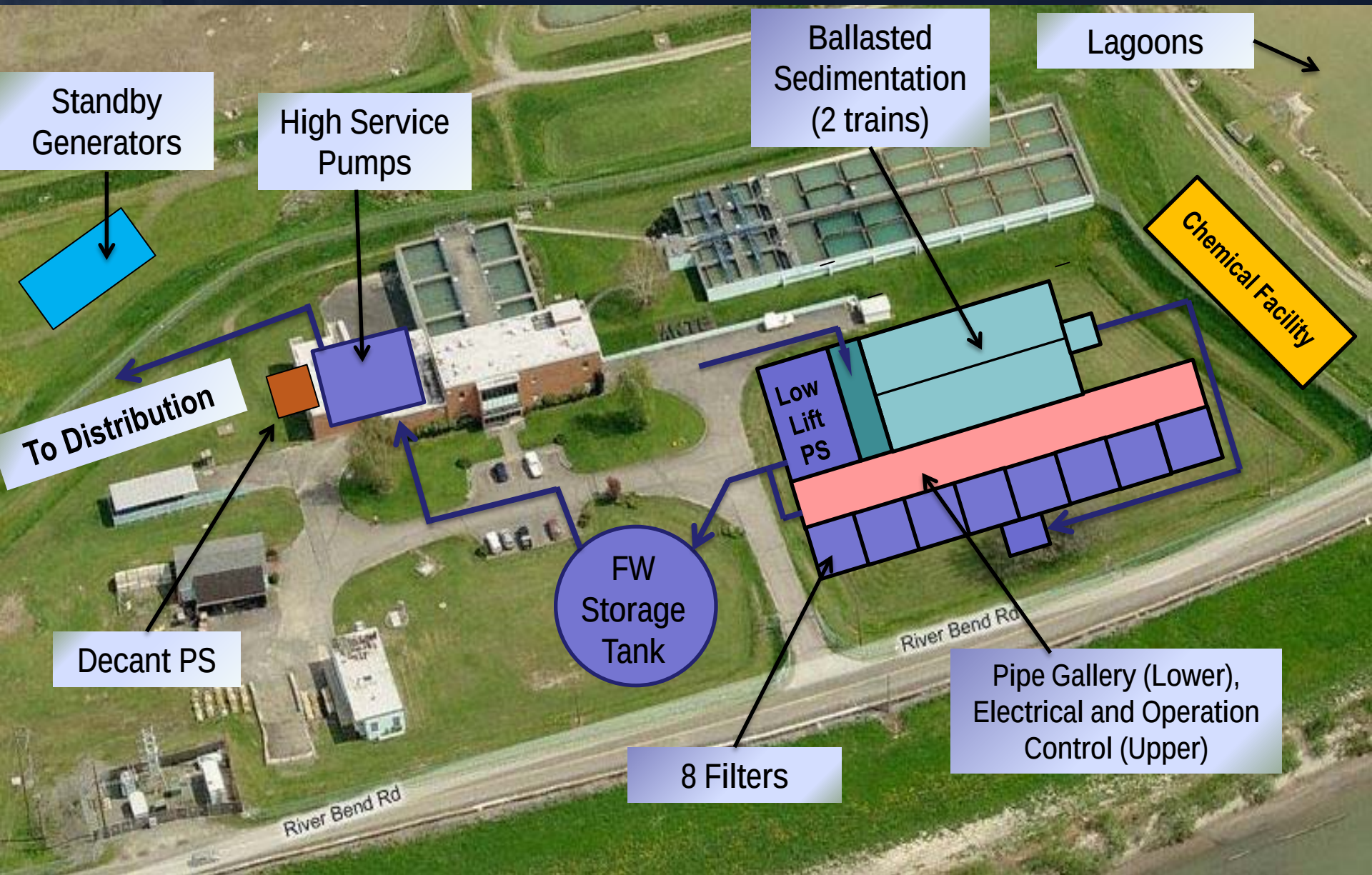


Ballasted Sedimentation - Actiflo



Vendor: Kruger

Proposed Improvements



Pilot Study Objectives

Verify Key Design Parameters
- Optimization Study

→

Demonstrate Performance
- 24-hr demonstration run

→

Simulated Turbidity Spike Test

→

Allow Plant Operators Gain Operating Experience

Test Setup and Parameters

- Source Water
- Classic Actiflo Set-up
  - Flow: rates up 270 gpm
  - Sand Concentration: 5-9 g/L
  - Recirculation Rate: 19 gpm (Hydrocyclone: 80/20 split)
  - Hydraulic Loading Rate: 17.9 to 42.9 gpm/sf
- Coagulant - Alum : (10-50 mg/L)
- Polymer (anionic & cationic): 0.1 – 1.0 mg/L

Treatment Goals for Ballasted Sedimentation

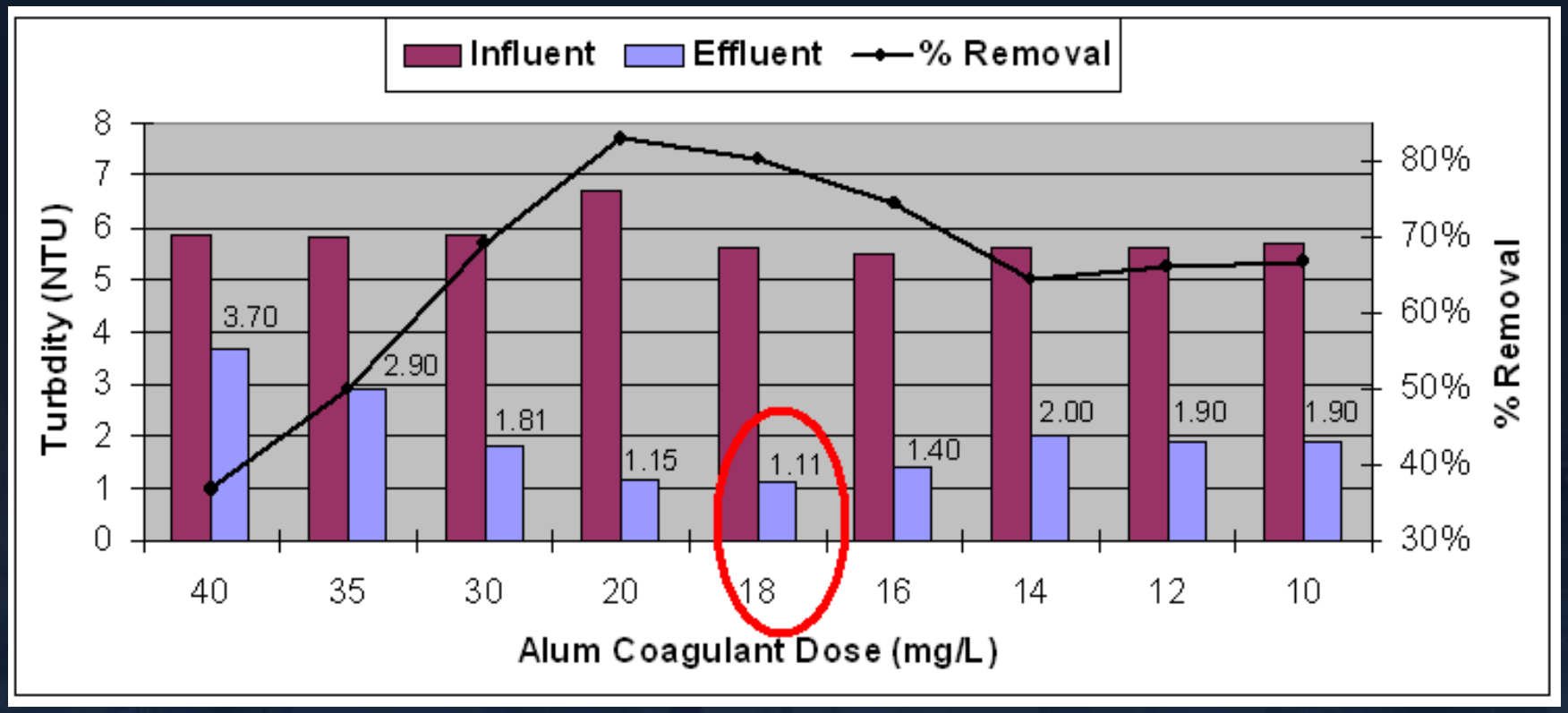
Raw Water Turbidity Range	Settled Water Turbidity
Less than or equal to 200 NTU	Less than or equal to 2 NTU
Between 201 NTU and 500 NTU	Less than or equal to 3 NTU
Greater than 500 NTU	Less than 5 NTU

Settled Water Quality Performance Requirements

Parameters	Settled Water Quality Criteria
Turbidity, NTU	Target: Not greater than 1 NTU
	95th percentile: Not greater than 2 NTU*
	98th percentile: Not greater than 5 NTU

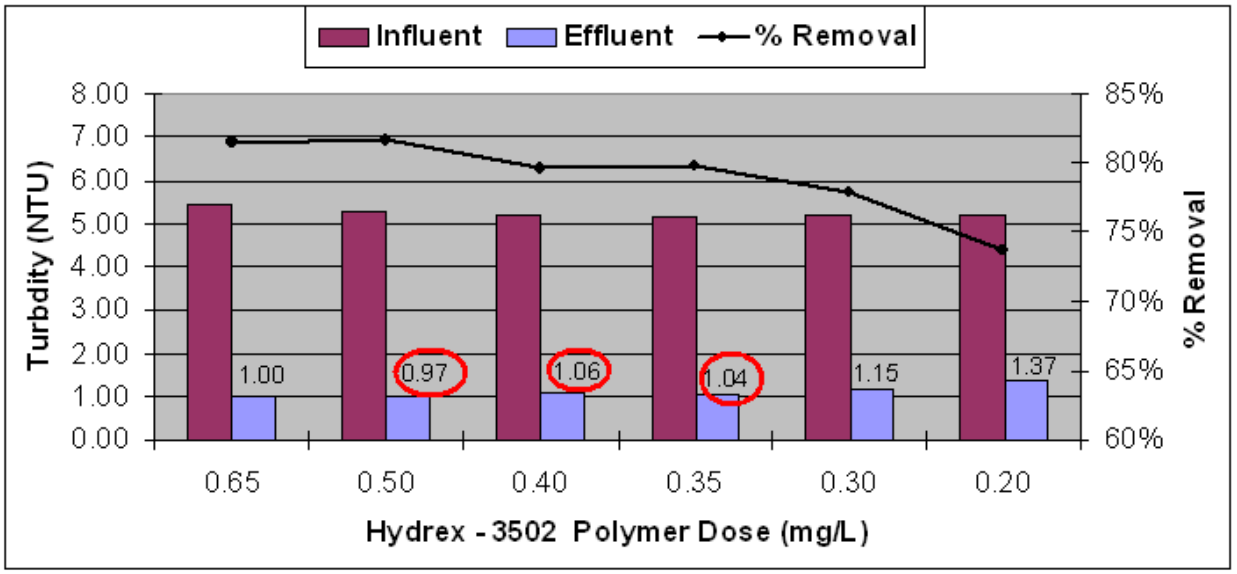
* Washington Department of Health (DOH) Treatment Optimization Program turbidity goal

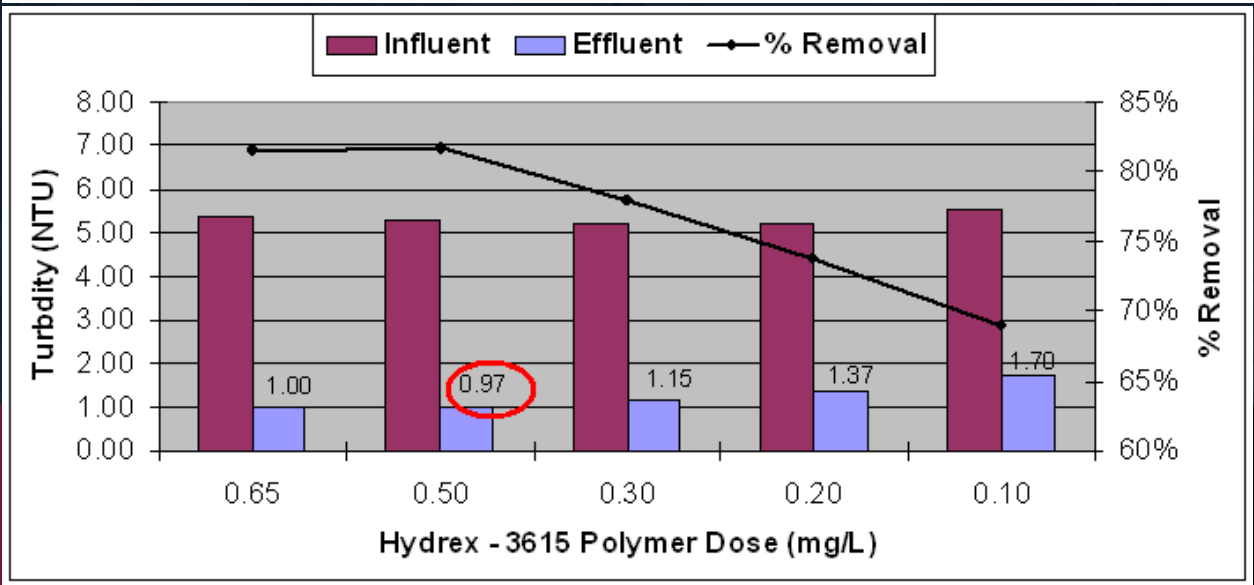
Optimization Study - Coagulant Analysis



- Alum: 10-40 mg/L Tested; Optimum Dose : 18 mg/L
- Polymer (Hydrex-3502) : 0.65 mg/L
- Flow: 160 gpm @ Hydraulic Loading Rate of 25.4 gpm/sf

Optimization Study – Polymer Analysis





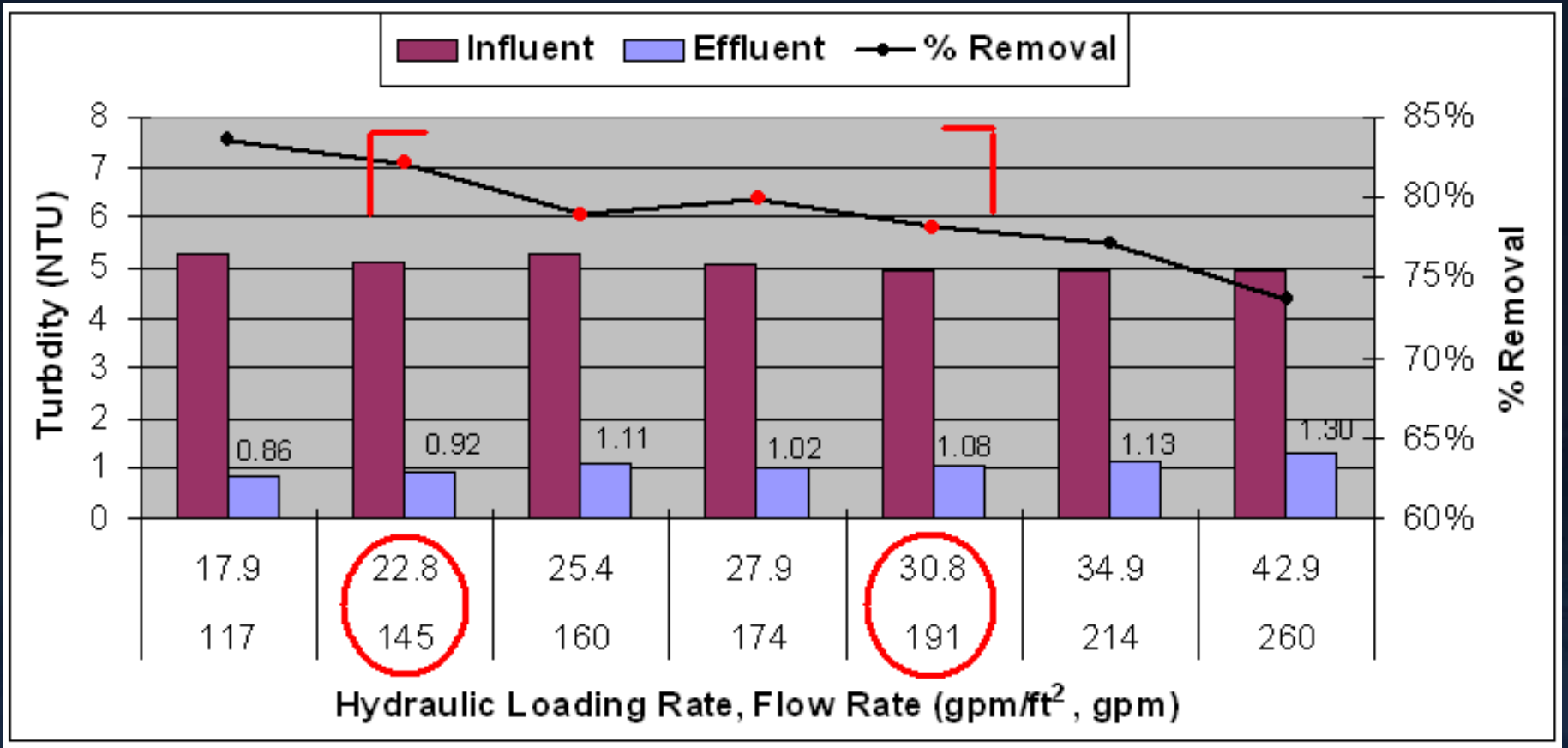
- Anionic
- Cationic

- Both performed well at dose 0.30-0.65 mg/L

0.40 mg/L Anionic Polymer Selected as Optimum

@ 18 mg/L Alum Dose

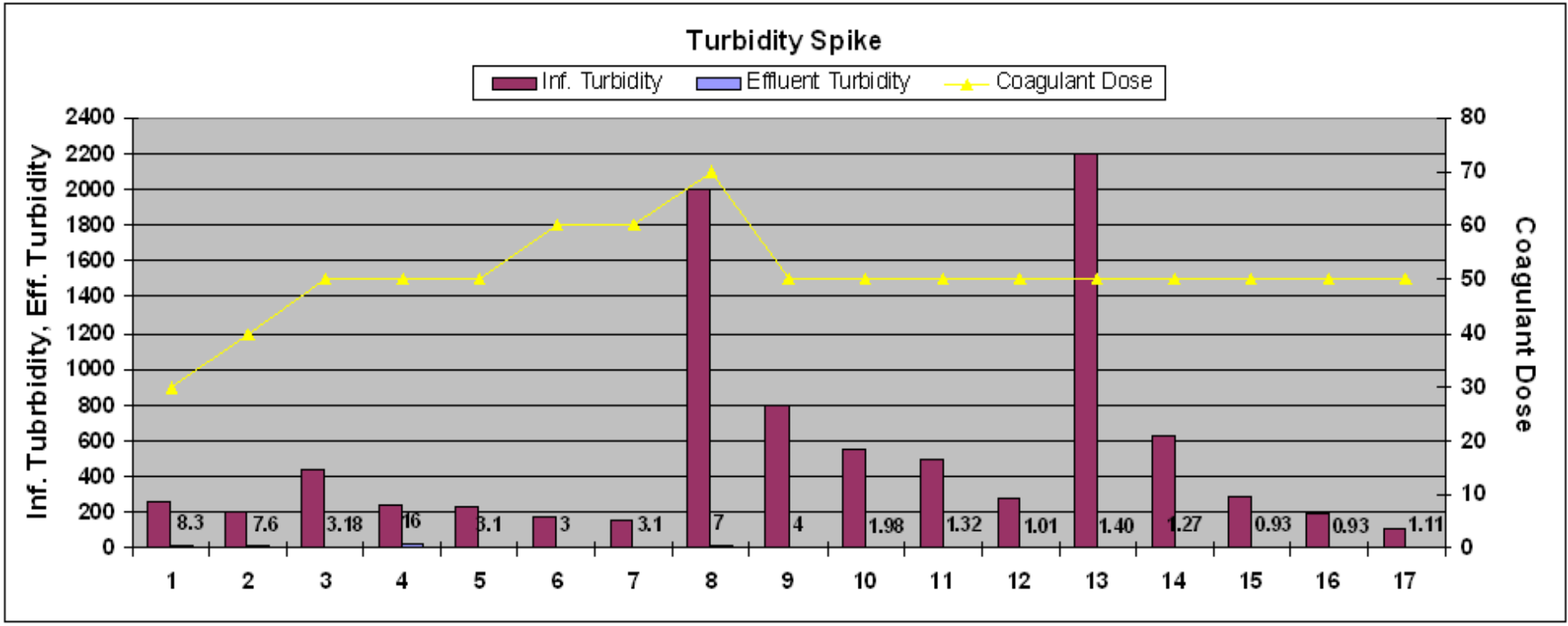
Hydraulic Loading Rate (HLR) Analysis



- Alum: 18 mg/L
- Polymer: 0.40 mg/L

Optimum Operating Range: 22.8 to 30.8 gpm/sf

Simulated Turbidity Spike



- Alum: 30 -70 mg/L (Added lime for pH adjustment)
- Polymer: 0.40 mg/L (data 1-12) & 0.50 mg/L (data 13-17)
- Raw Water Turbidity: 200 NTU consistent, as high as 3000 NTU

Optimum Performance: 1.4 NTU Settled Water Turbidity
@ 50 mg/L Alum and 0.5 mg/L Polymer Dose

TOC Results

HLR (gpm/sf)	Coagulant Dose (mg/L)	Raw Water TOC (mg/L)	Settled Water TOC (mg/L)	% Removed
25.5	18	1.87	1.51	19%
40	18	1.87	1.45	22%
40	25	1.87	1.17	37%
40	25	1.87	1.19	36%
36	25	1.75	1.22	30%
22	18	1.16	0.97	17%

Higher coagulant doses resulted in lower settled water TOC

Summary Findings

Demonstrated ability to meet all settled water quality goals

Achieved effluent turbidity less than 1.5 NTU at hydraulic loading rates from 18 to 43 gpm/sf

Demonstrated ability to handle high turbidity events

Achieved effluent turbidity level of 1.4 NTU with 2200 NTU raw water turbidity

Demonstrated quick response

Treatment restored within 1 HRT following simulated failure of coagulant pump

Key Operating Guidelines for Full Scale Operation

Raw Turbidity (NTU)	Coagulant Dose (mg/L)	Polymer Dose (mg/L)	Target Settled Water pH with Lime Dose	Mixing Speed (Hz)	Hydraulic Loading Rate (HLR) (gpm/ft^2)
Low (< 15)	18	0.4	Not Required	90	18 - 43
High (up to 2200)	50*	0.5	7.55	90	18 - 43

Acknowledgement

- City of Anacortes
  - Jamie LeBlanc (Plant Manager)
  - George Atkinson (Plant Supervisor)
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  - Richard Stratton, P.E.(Senior Project Manager, HDR Folsom Office)

Questions?

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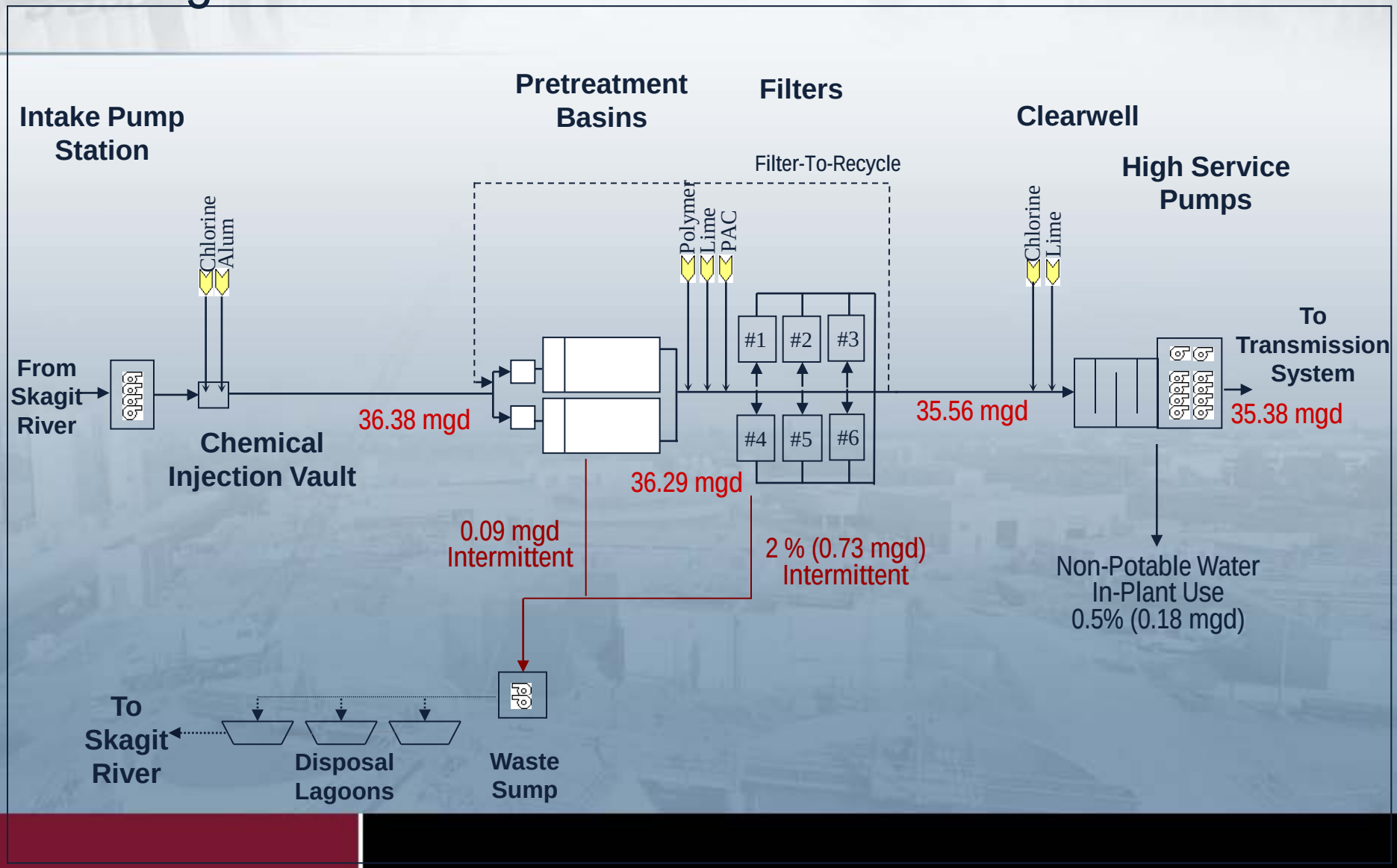
Raw Water Quality (2003-2008)

- Turbidity
  - Average: 28 NTU
  - 95th-%: 81 NTU
  - 98th-%: 164 NTU
  - Maximum: 5475 NTU
- Color: 1 – 4872 Pt Co
- pH: 6.5 - 7.8
- Alkalinity: 16-38 mg/L
- TOC 0.5 to 3.0 mg/L

Existing WTP Facilities