Two Treatment Facilities in One

Direct filtration & conventional treatment at the same location (not at the same time)

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Project Background

The Green River Filtration Facility

TACOMA WATER
TACOMA PUBLIC UTILITIES

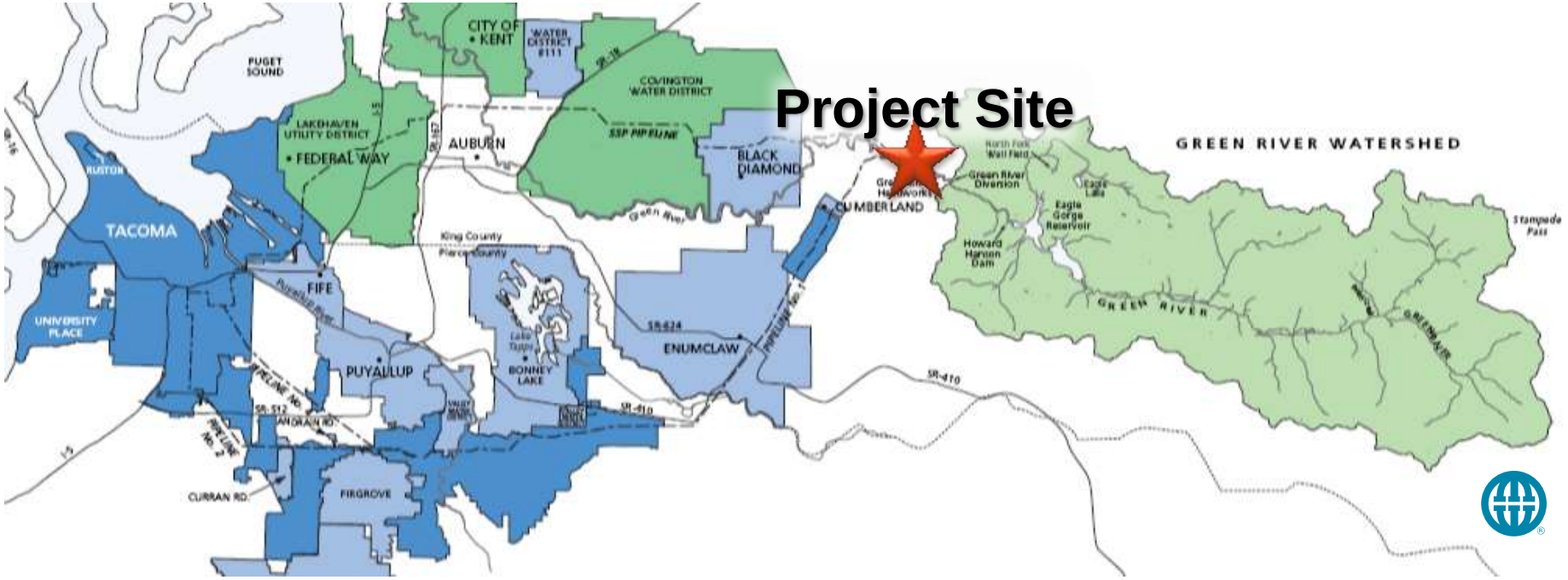
Lakehaven UTILITY DISTRICT

Covington Water District

KENT
WASHINGTON

The Green River Water Supply

- 250 sq. mile protected watershed in the Cascade Mountains
- Subject to flashy water quality conditions
- Completely unfiltered prior to December 2014
- Summer – low turbidity, consistent quality
- Winter – high turbidity, flashy



Additional treatment processes needed to comply with the Long Term 2 ESWTR

Demand Projections:

- 150 mgd peak summer demand
- 90 mgd peak winter demand
- 168 mgd ultimate capacity

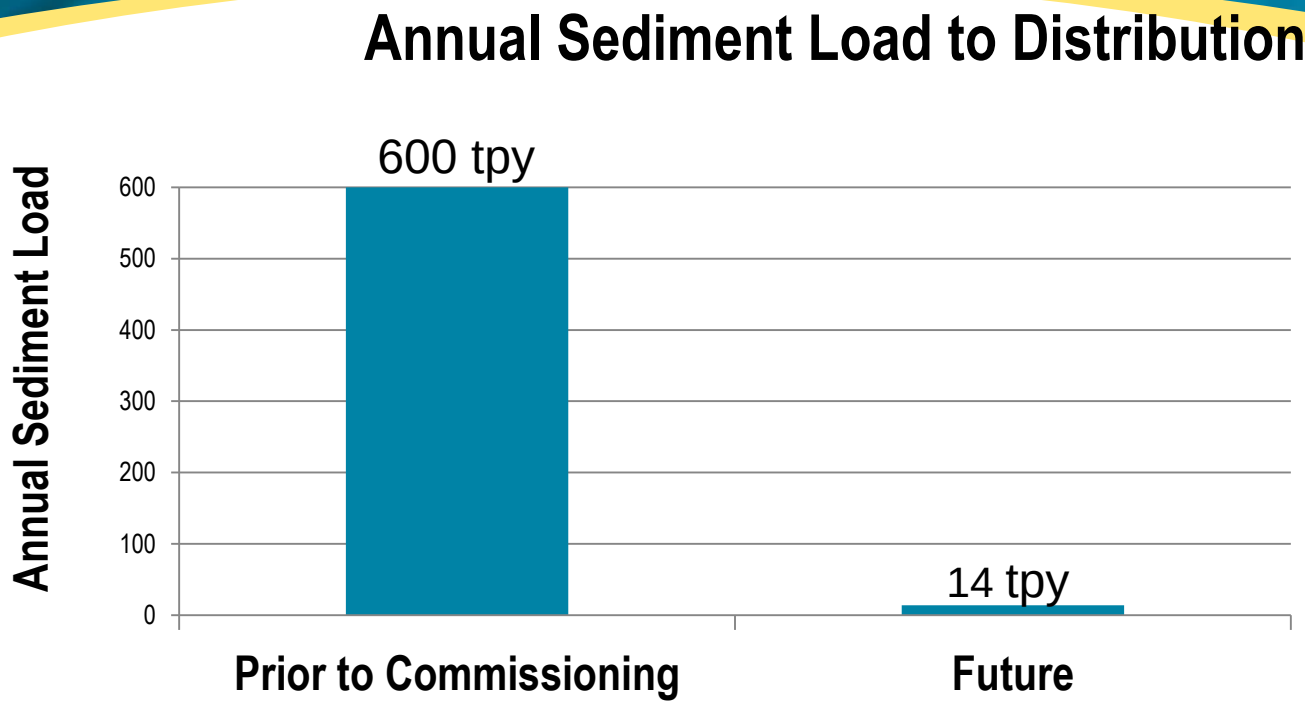
Hybrid Design selected to efficiently meet seasonal demands:

- Summer – Direct Filtration
- Winter – Conventional Treatment
- Use high-rate filtration to minimize cost & footprint

Other Goals:

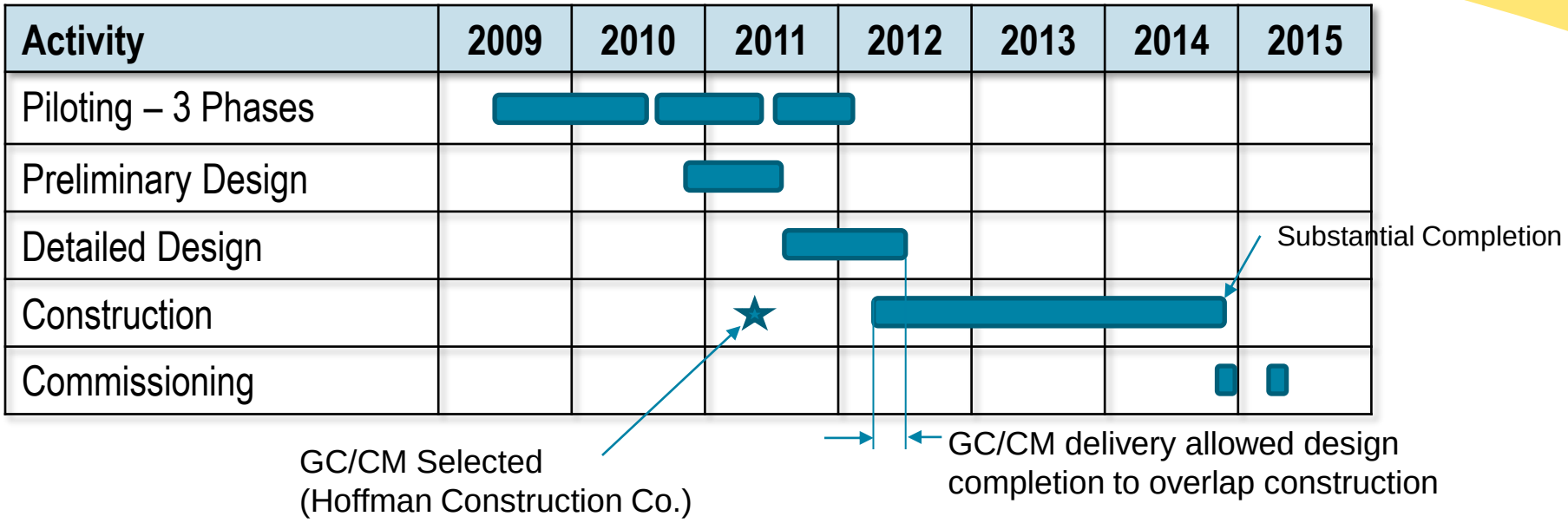
- Construct on site of existing treatment facility
- Treat all water in the River despite seasonal quality conditions
- Complete PreDesign in 7 months. Complete design in 9 months. Fully commission by Apr 2015
- Deliver within the GC/CM framework

Conversion from unfiltered to filtered supply has significant distribution system advantages



- Better use of distribution system personnel time and resources
- Less cleaning of pipelines and reservoirs
- Less flushing – greater water efficiency
- Better customer experience

Project Implementation

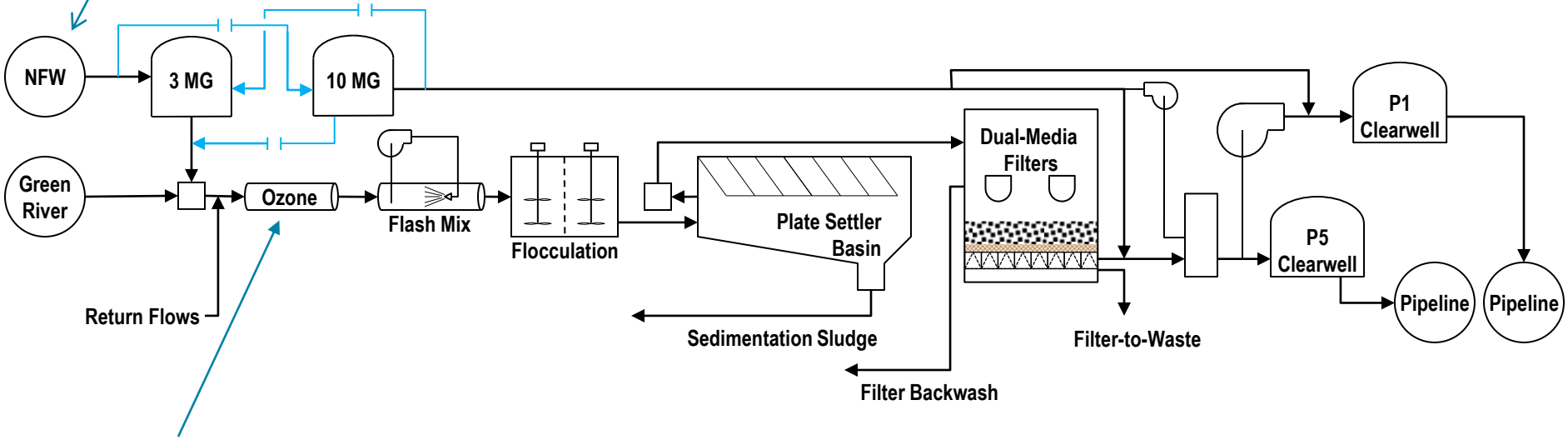


- Schedule driven by regulatory deadline for compliance with LT2 ESWTR
- Design completed during final phase 3 piloting
- Construction schedule accelerated by bidding and constructing earthwork, below ground mechanical, and yard piping prior to final design completion.

Winter – 90 mgd max.
Conventional Treatment (with Sedimentation)

Wellfield for potential blending & managing raw water quality (existing)

Conventional treatment will operate 4 to 5 months each year



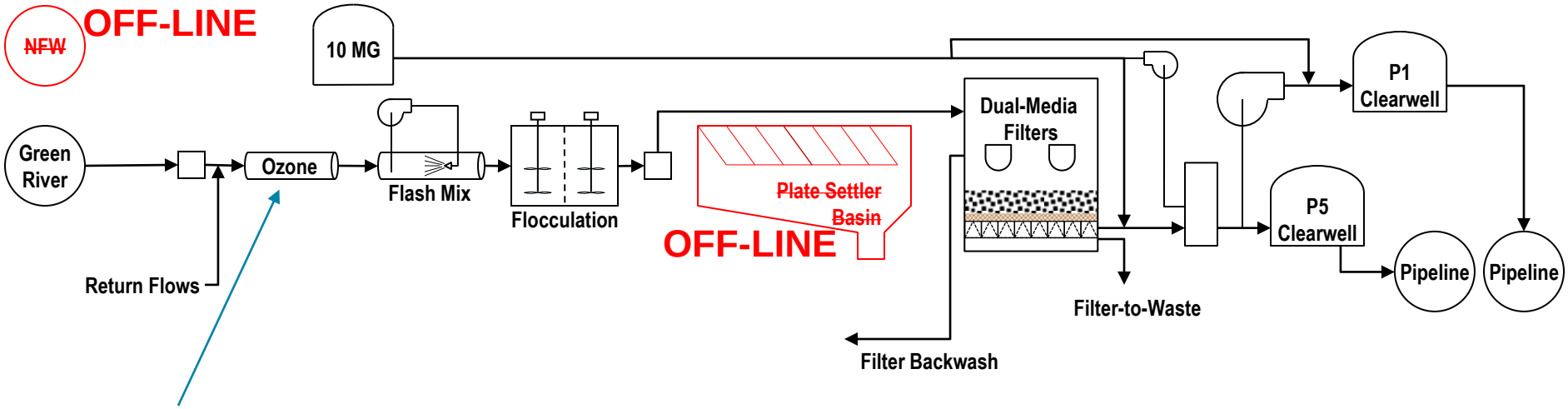
Existing pre-ozone (already in place)

New flash mix, flocculation, sedimentation, filtration, pumping, clearwells & solids handling facilities (not shown)

Summer – 150 mgd max. (168 mgd ultimate) Direct Filtration Only

Direct Filtration will operate
7 to 8 months each year

Wellfield not necessary
for summer operation



Existing pre-ozone
(already in place)

New flash mix, flocculation, ~~sedimentation~~,
filtration, pumping, clearwells &
solids handling facilities (not shown)

Pilot Findings

Tacoma Water developed and operated the pilot facility from mid-2009 to early 2012

Raw Water Turbidity – Pilot Phase

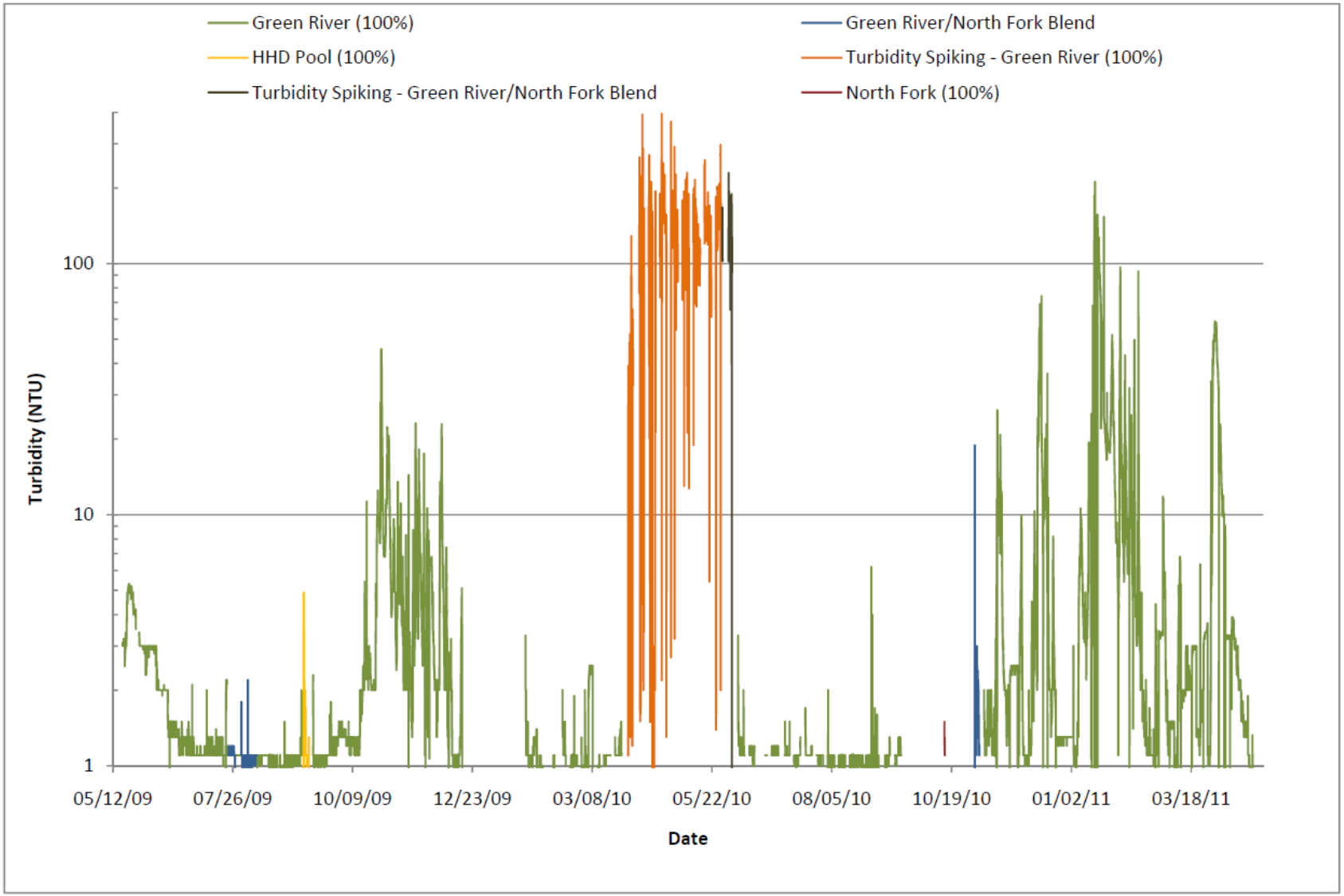


FIGURE 3-1 RAW WATER TURBIDITY THROUGHOUT PILOT STUDY

Raw Water pH – Pilot Phase

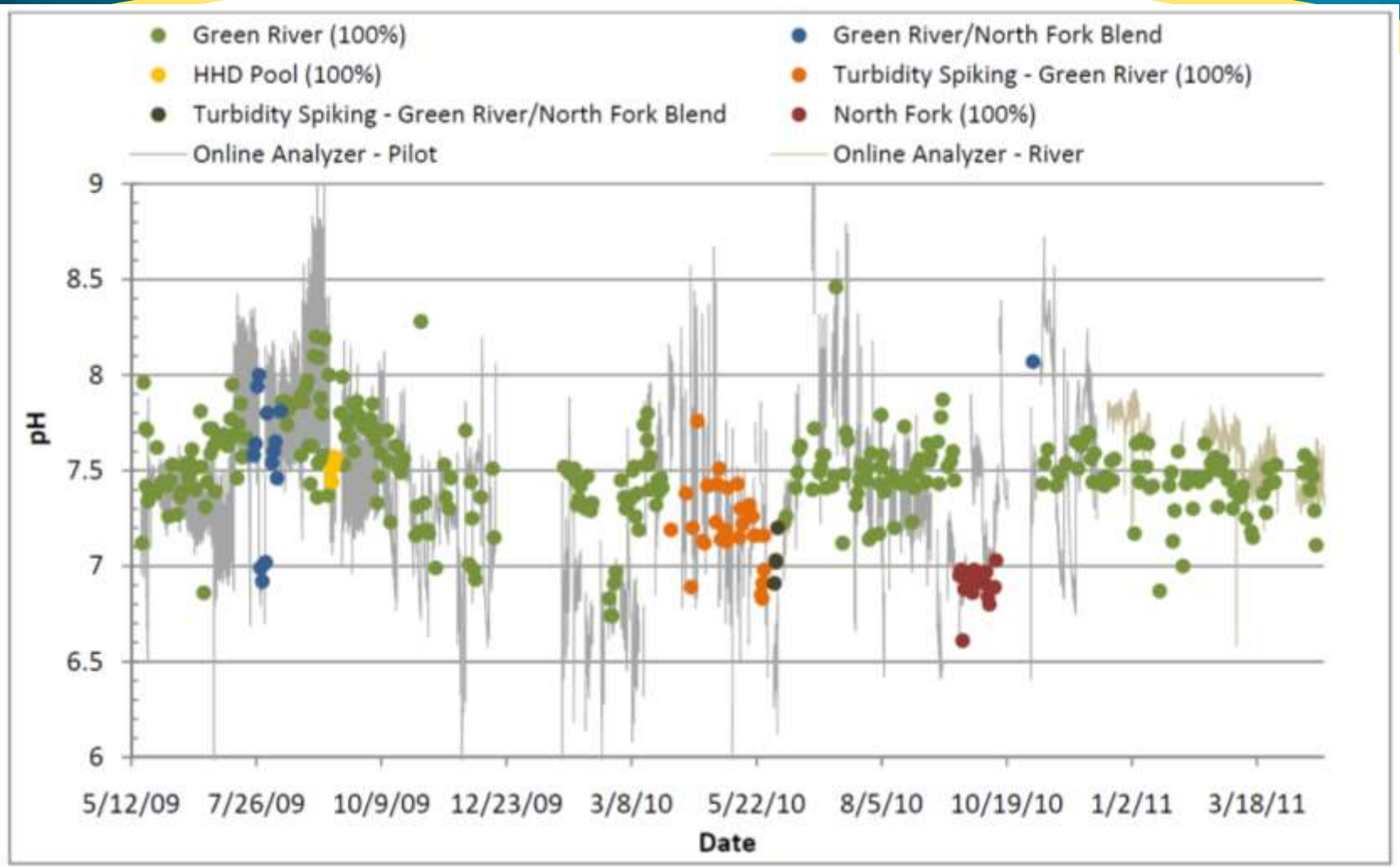


FIGURE 3-2 RAW WATER PH THROUGHOUT PILOT STUDY

Raw Water Alkalinity – Pilot Phase

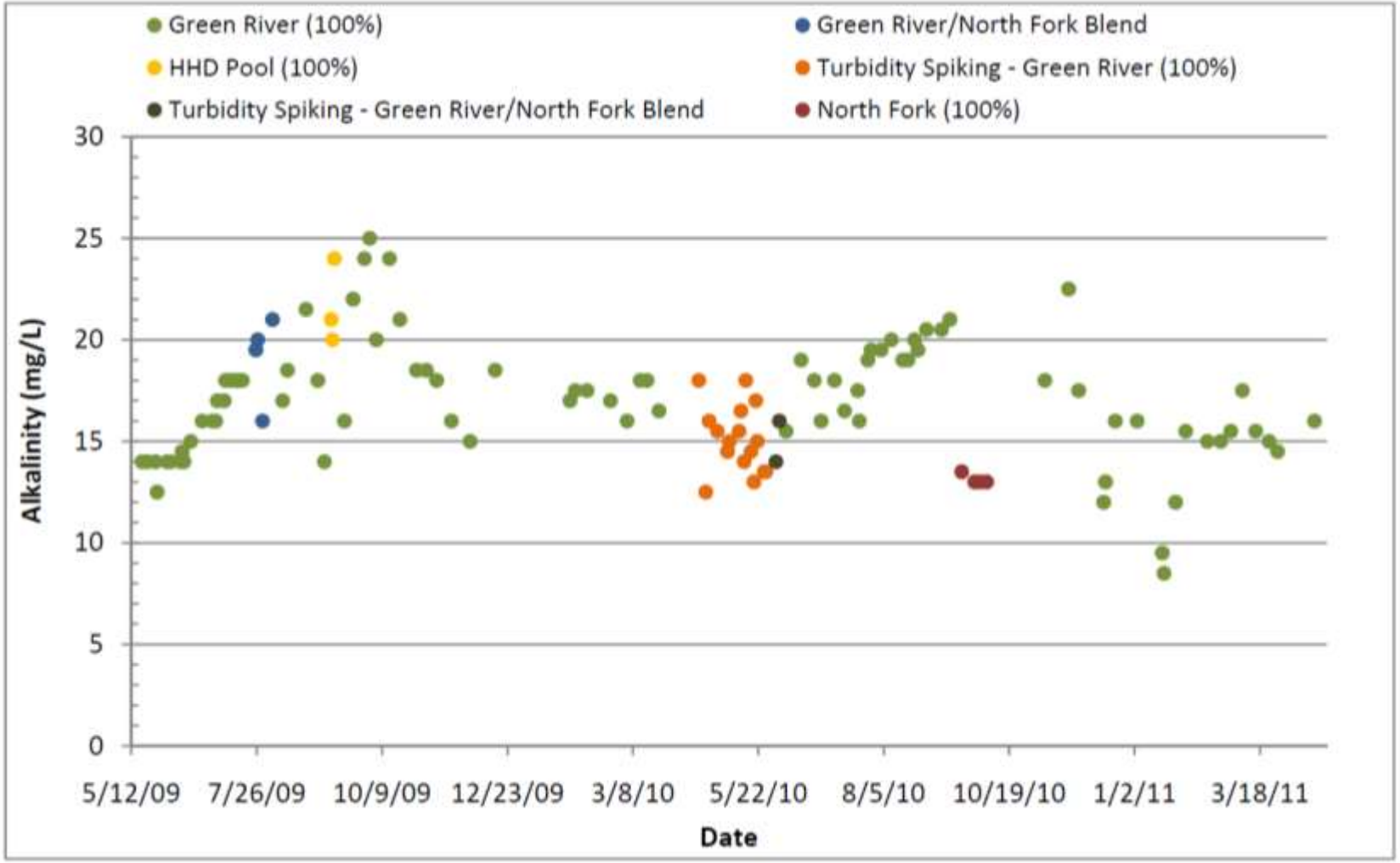


FIGURE 3-3 RAW WATER ALKALINITY THROUGHOUT PILOT STUDY

Raw Water Temperature – Pilot Phase

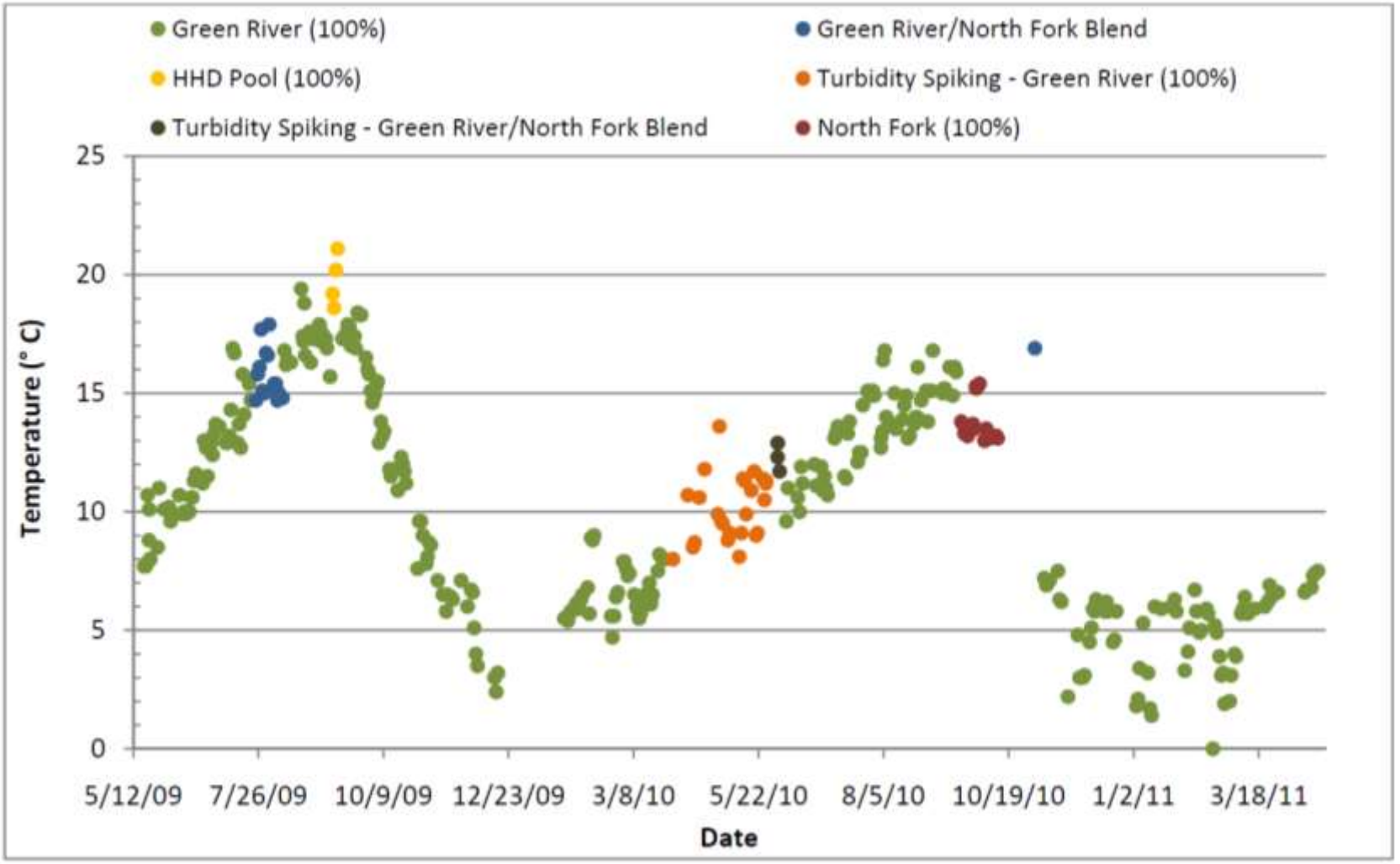


FIGURE 3-4 RAW WATER TEMPERATURE THROUGHOUT PILOT STUDY

Raw Water Total Organic Carbon – Pilot Phase

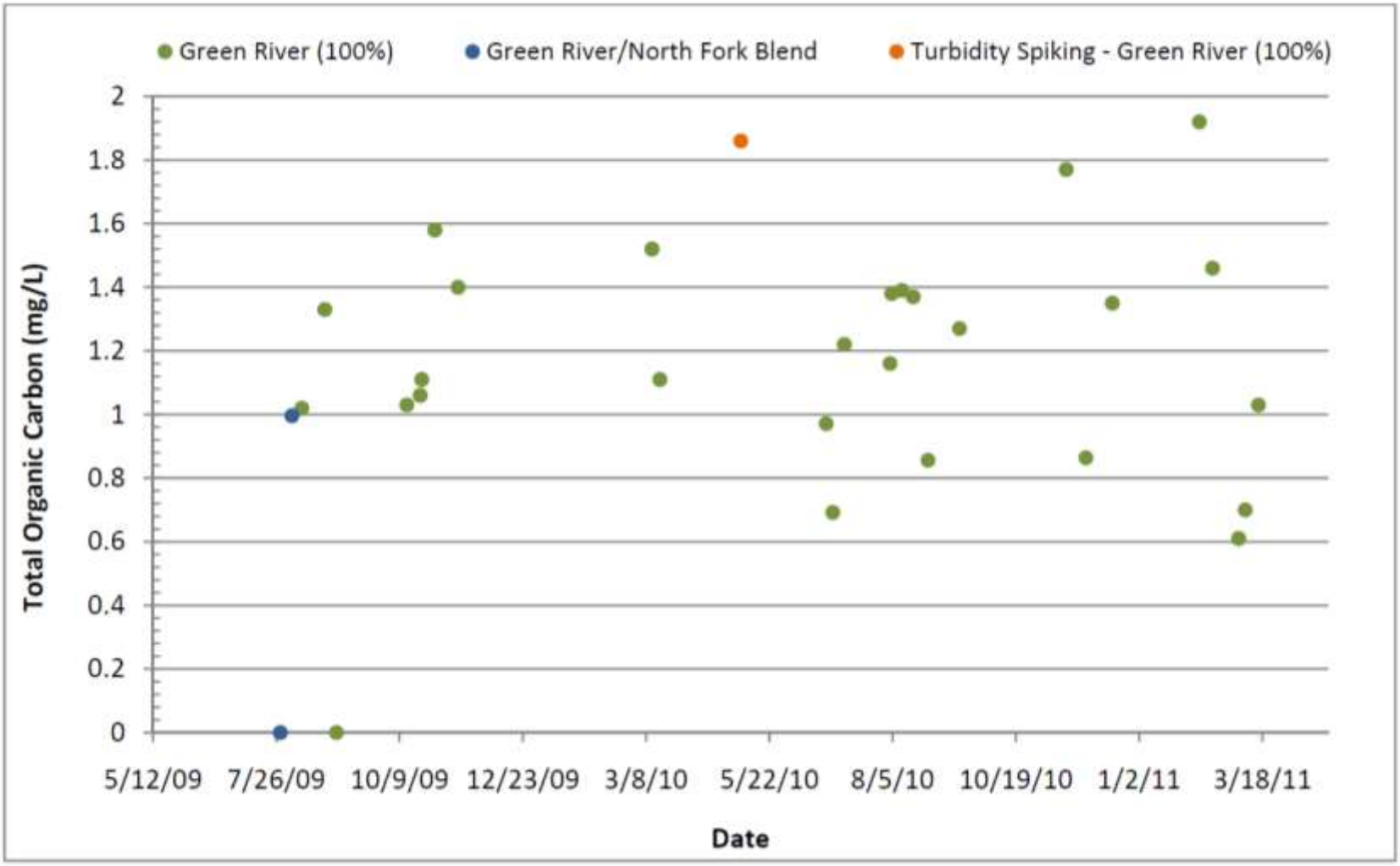


FIGURE 3-9 RAW WATER TOTAL ORGANIC CARBON THROUGHOUT PILOT STUDY

Operating modes evaluated in Tacoma Water's pilot study – Conventional Treatment

Conventional Treatment (> 10 NTU)

- PACl or ACH with Alum and Cationic Polymer found to be most suitable
  - Seek to form large heavy settlable floc
  - Moderately higher chem doses were needed, but served to consume alkalinity & affect pH
  - Alkalinity boost required
  - Combining Alum with PACl or ACH served to limit adverse effects while increasing overall coagulation effectiveness
  - Design allowed for simultaneous or staggered coagulant feed

Operating modes evaluated in Tacoma Water's pilot study – Direct Filtration

Direct Filtration (< 10 NTU)

- PACl or ACH with Cationic Polymer found to be most suitable
  - Seek to form strong pin floc
  - Low chem doses
  - Shorter flocculation HRT
  - Slightly higher speed flocculation (not tapered)
  - Minimal effect on pH & alkalinity
  - Alum worked but less effective, dewaterability concerns
  - Initial design based on PACl

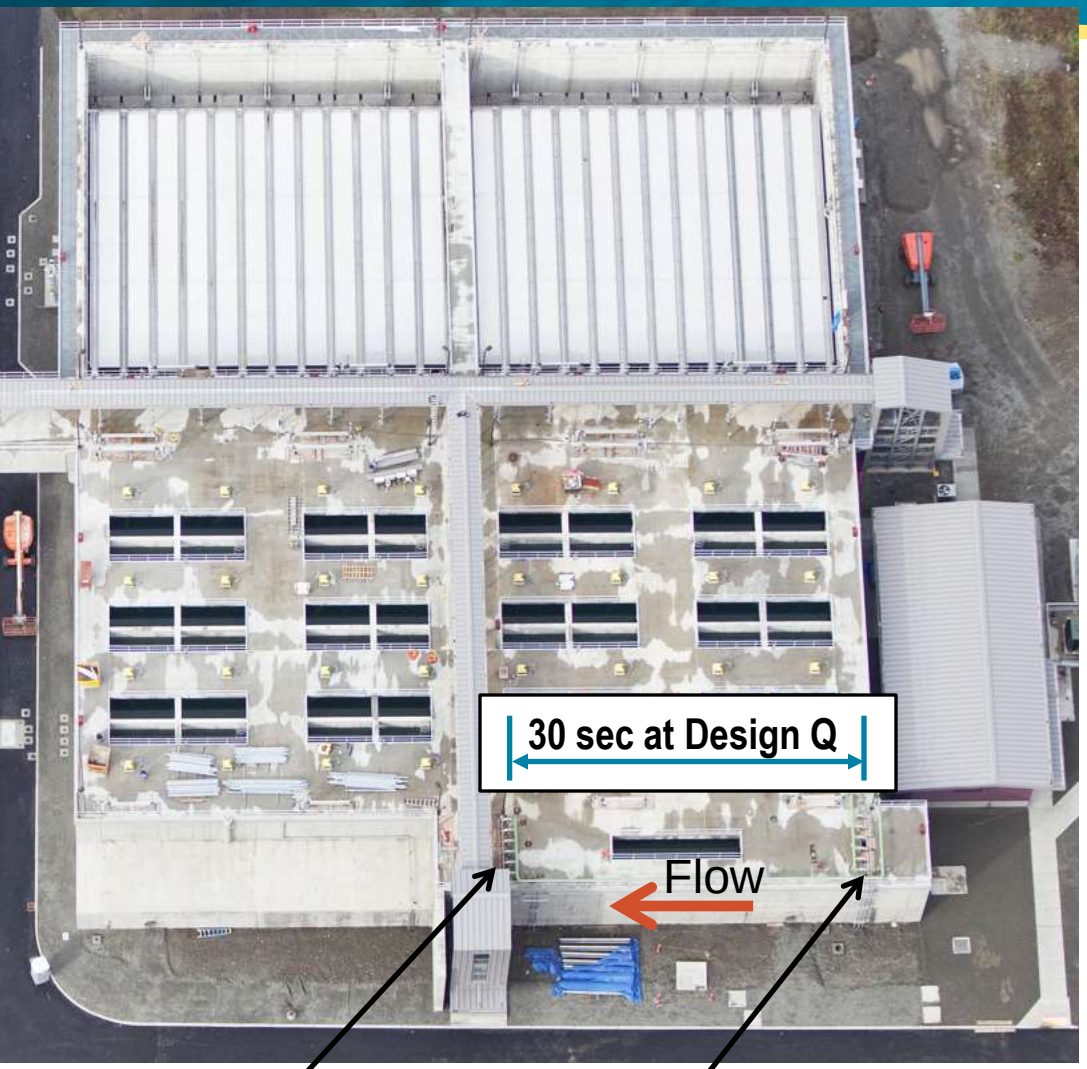
December 2014 Commissioning: Conventional Mode

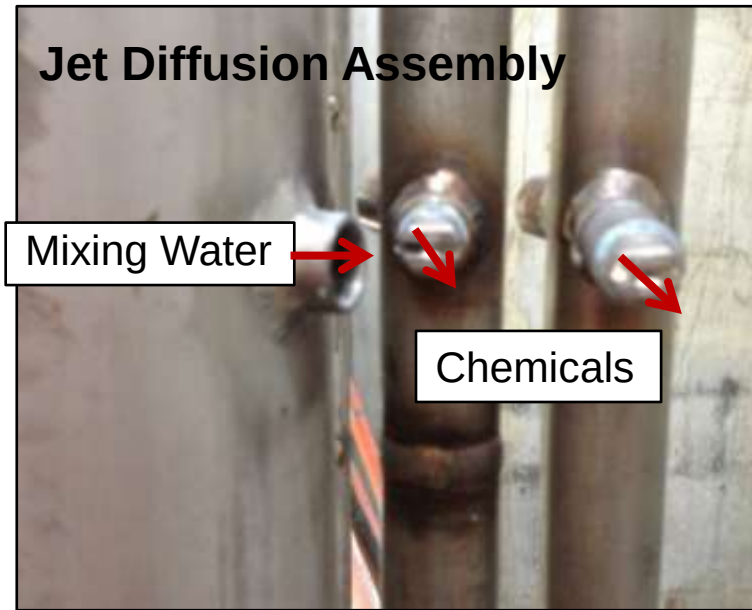
Startup - The Plan (Conventional Mode)

Activity	Dec 2014	Jan 2015	Feb 2015	Mar 2015	Apr 2015
Initial start; water only	(low flow, internal plant recycle only)				
Commissioning; 20 to 40 mgd					
Conventional (alum, PACl, cat poly)		(But not yet to all service areas)			
Filtered water produced & served					
Unfiltered supply discontinued					
Filtered water served to all areas					
Regulatory deadline - filtered water					
Transition to direct filtration				?	?

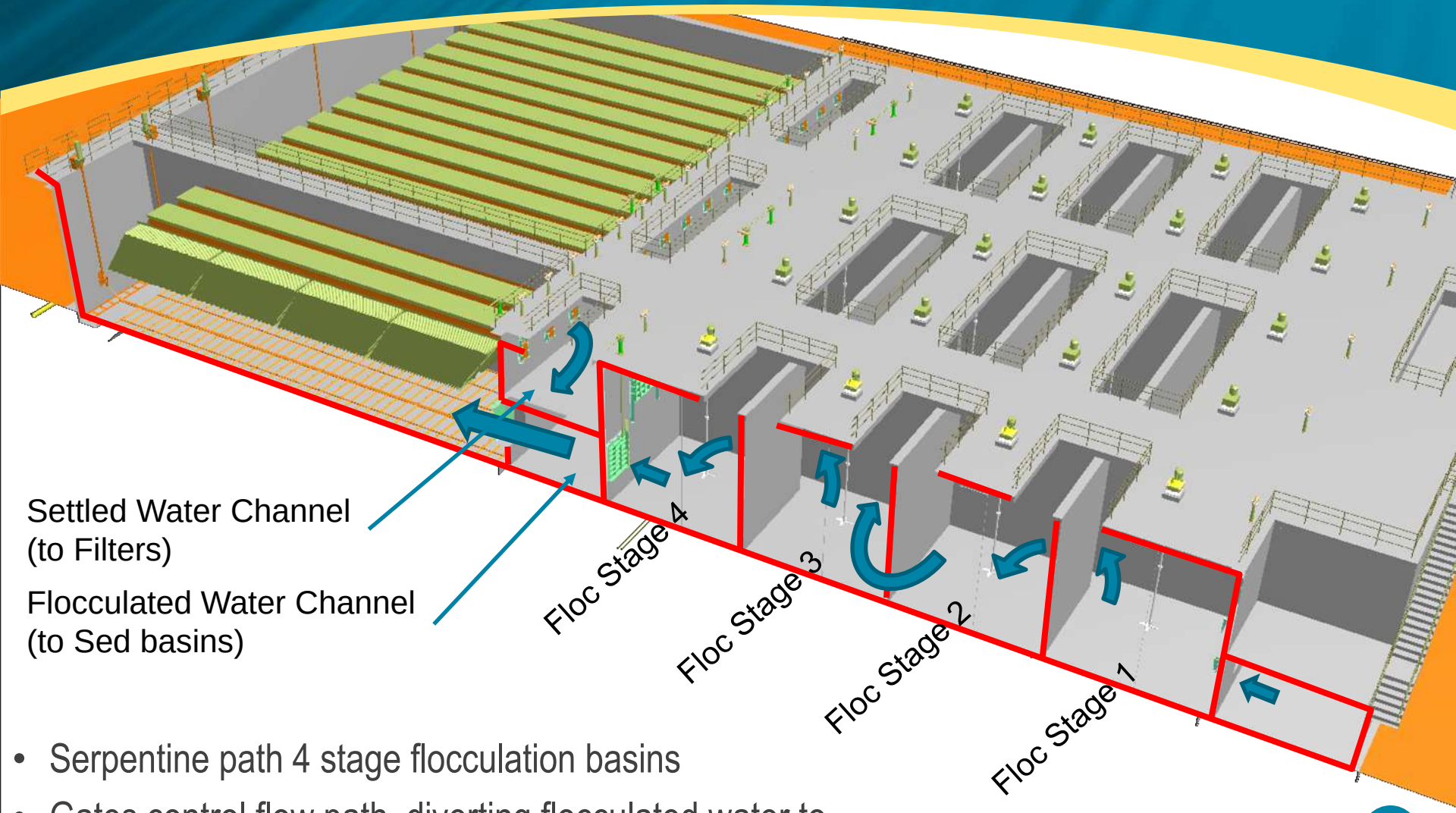
Bulk Purchase - PACl and ACH bid against other. ACH ultimately selected.

Startup in December as a Conventional Plant (with Sedimentation)



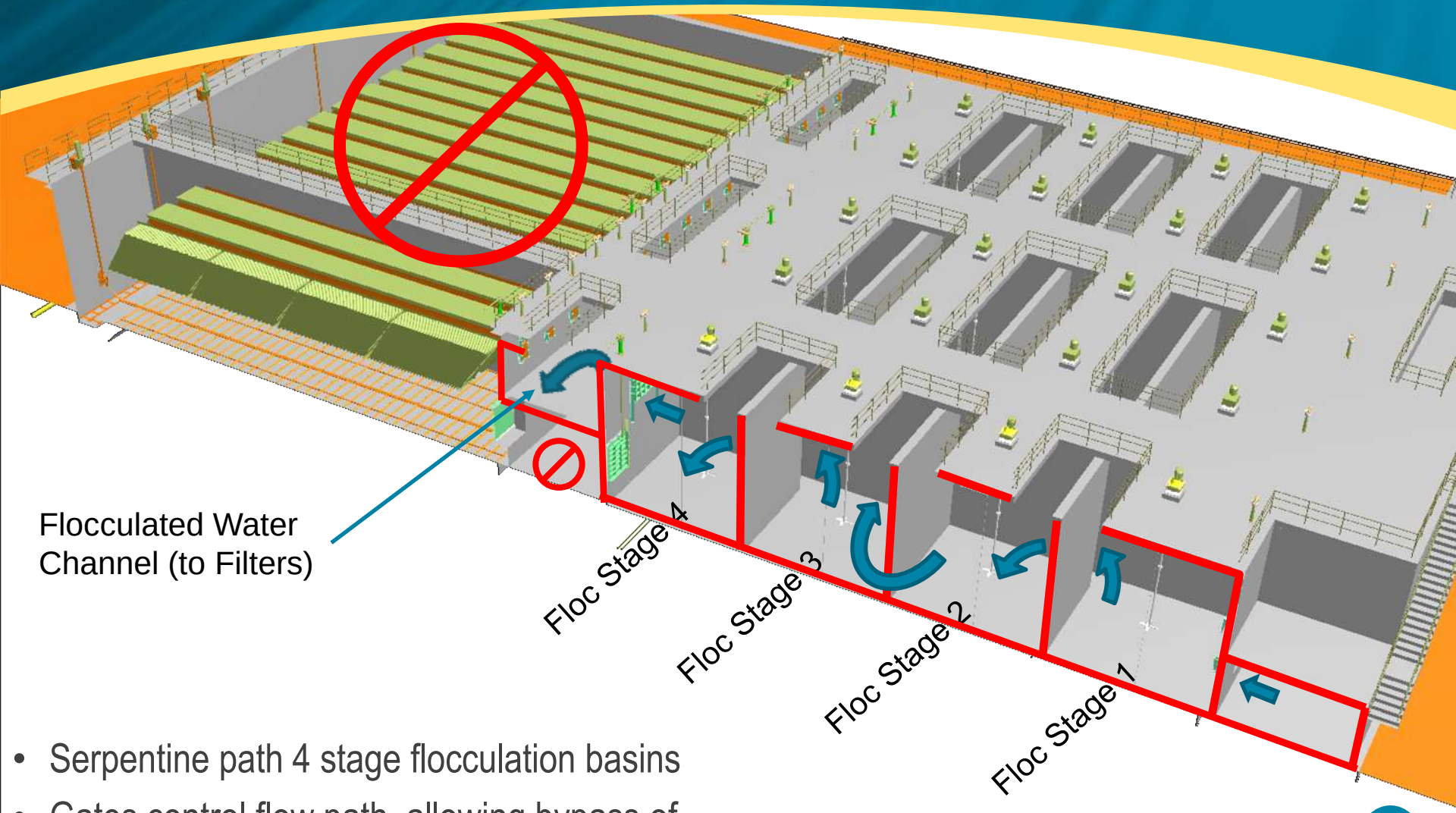


Conventional Treatment - Flocculation & Sedimentation



- Serpentine path 4 stage flocculation basins
- Gates control flow path, diverting flocculated water to sedimentation basins and eventually to filters

Direct Filtration Mode (flocculation only)



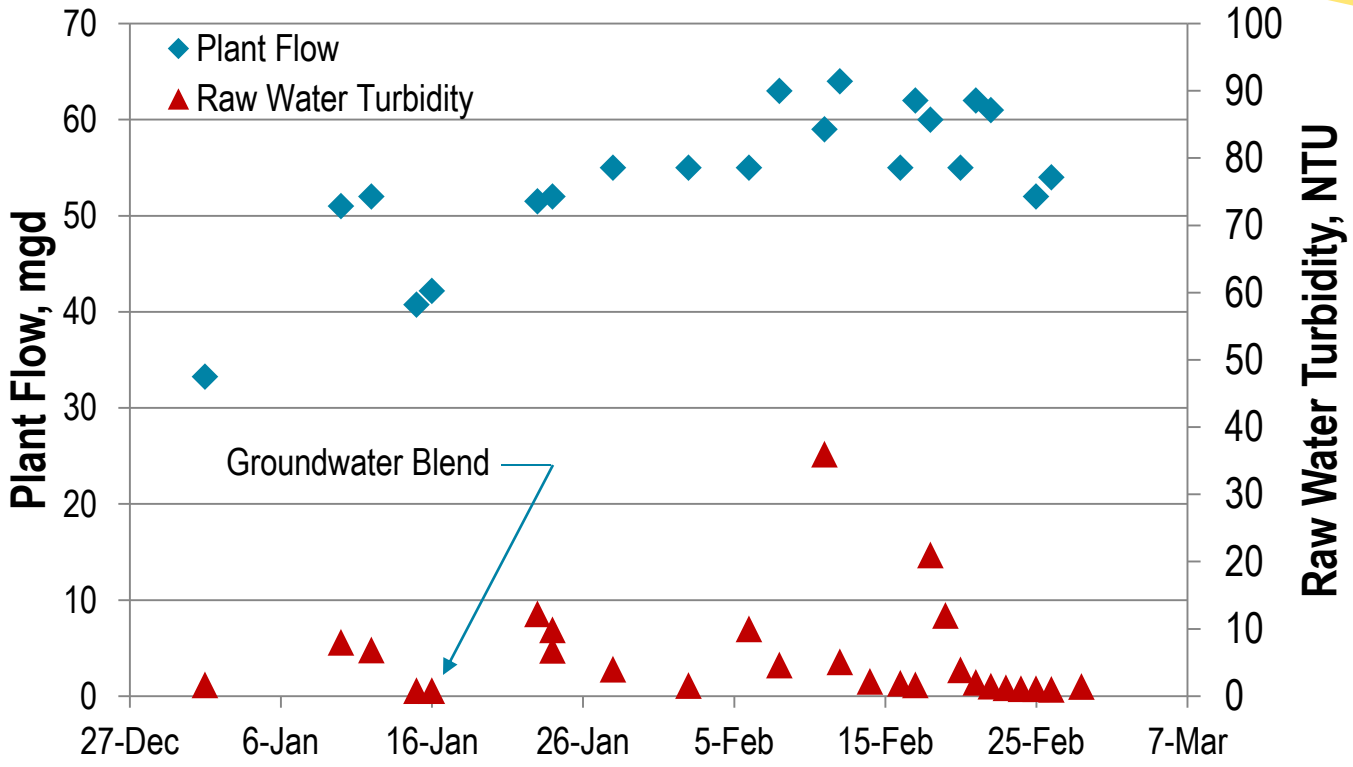
- Serpentine path 4 stage flocculation basins
- Gates control flow path, allowing bypass of flocculated water directly to filters

Startup - The Reality

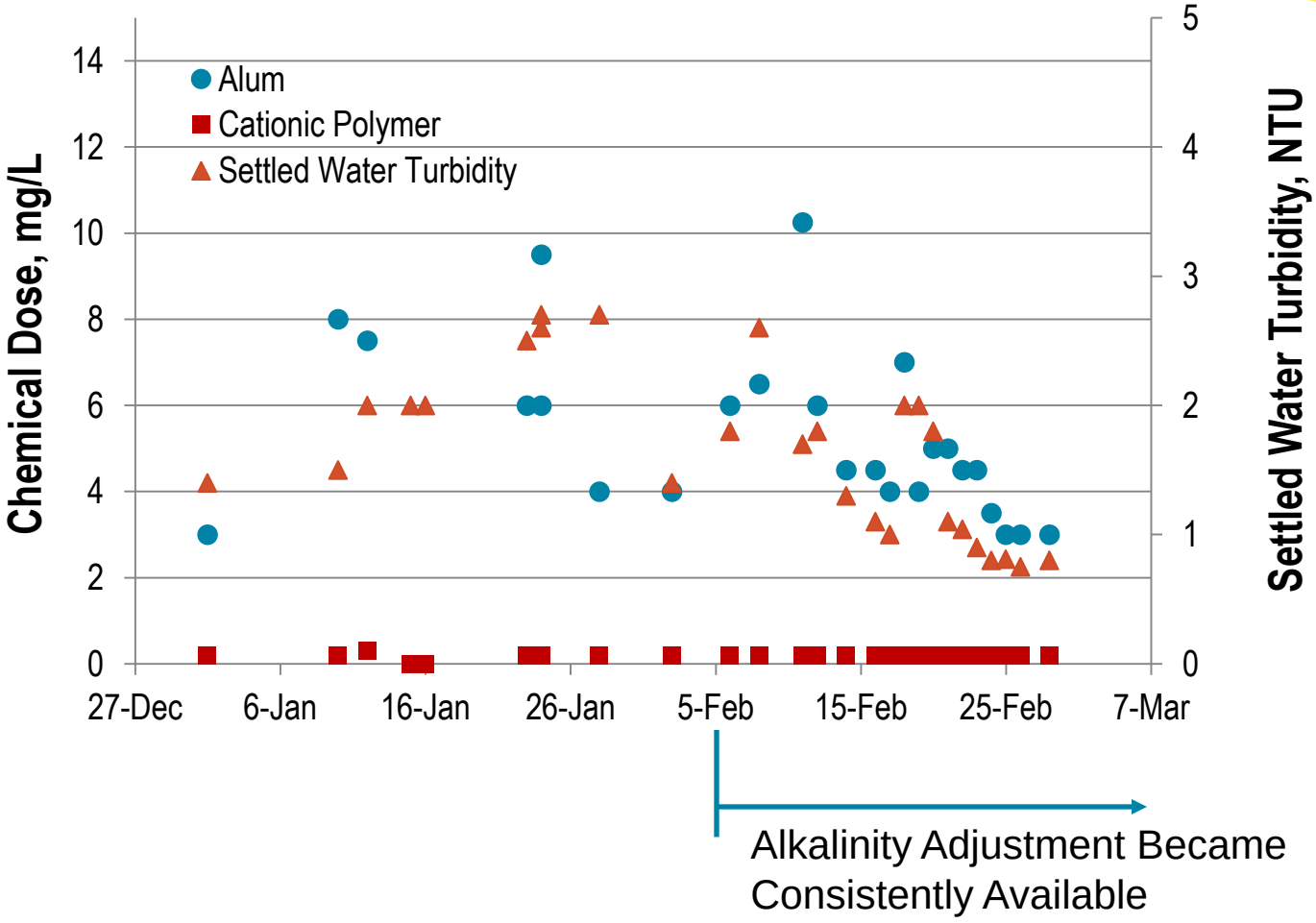
Activity	Dec 2014	Jan 2015	Feb 2015	Mar 2015	Apr 2015
Initial start; water only	***Successful***				
Commissioning; 20 to 40 mgd		***Filtered Water Goals Achieved***			
Conventional (**alum**, ~~PACl~~, cat poly)	★				
Filtered water produced & served	→	***Yes***			
Unfiltered supply discontinued		★ ***Successful***			
Filtered water served to all areas		→	→	→	***Yes***
Regulatory deadline - filtered water				***Successful*** ★	
Direct filtration – **Not Met**					

Initial Shakedown:
- Alkalinity adjustment not operational
- ACH not effective – switch to alum
- Filter aid polymer required
- Not all instruments operational

Startup – The Reality



Startup – The Reality



Recent Conversion to ACH

	February	April
Raw water turbidity	1.48	1.53 NTU
Temp	6 deg C	8 deg C
pH (at flash mix)	7.62	7.80
pH (after coagulation)	6.73	7.50
Alum	4.5 mg/L	n/a
ACH	n/a	2.5 mg/L
Cat Poly	0.2 mg/L	0.2 mg/L
Settled water turbidity	1.0 NTU	0.6 NTU

Lessons Learned and Next Steps

Prior to Commissioning:

1. Insure all tools are available before initiating full commissioning.
2. Test thoroughly all instrumentation.
3. Be certain of the primary coagulant chemical.
4. And finally, have a backup plan.

Next Steps:

1. Continue to iron out nuances, get to know the plant.
2. Transition to direct filtration and verify Standard Operating Procedures.
3. Resolve ACH poor performance in December.
4. Optimize alkalinity adjustment and use of polymers for coagulation, filtering, backwashing, and mechanical dewatering.
5. Optimize flocculation energy.
6. Optimize ACH with and without polymers.

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