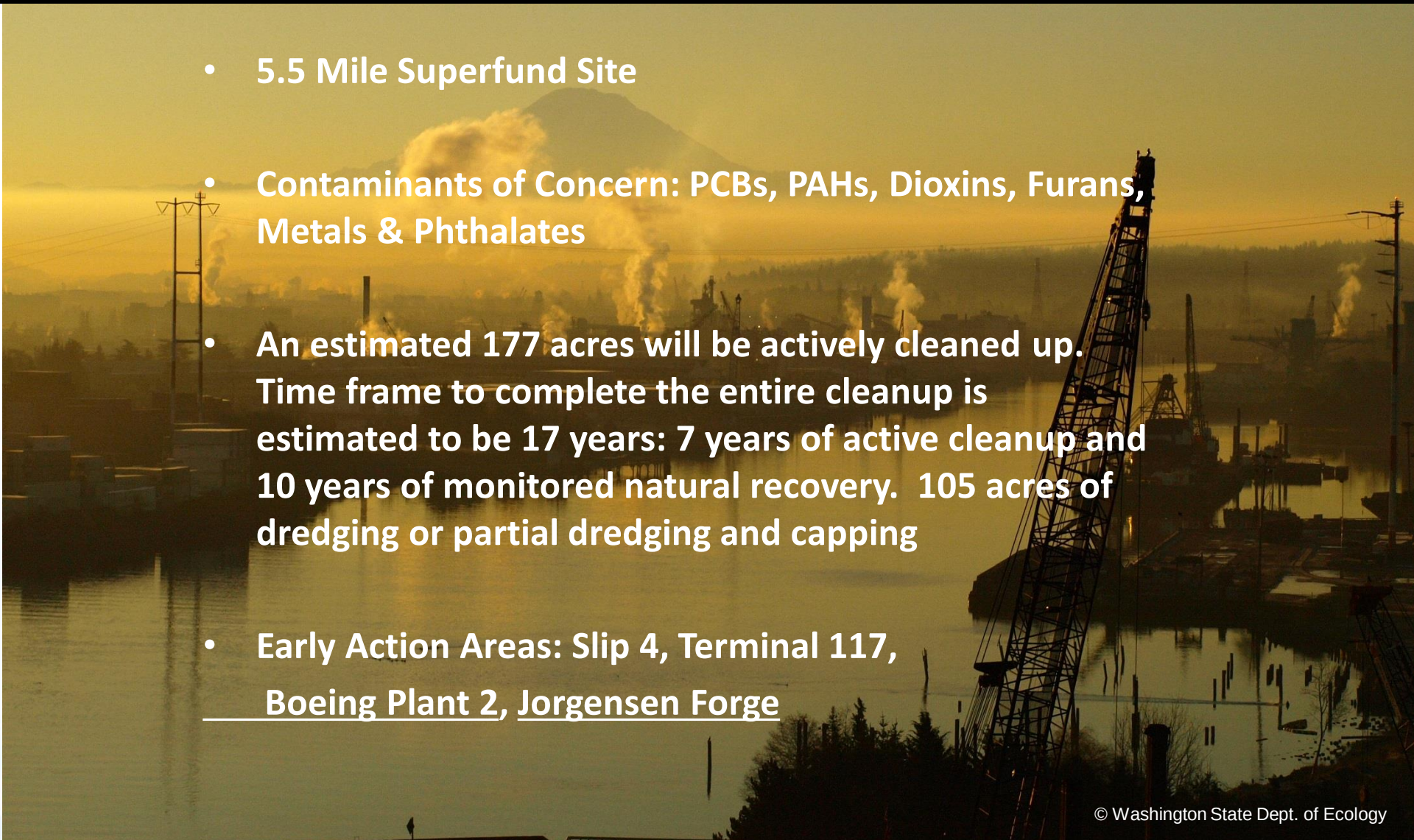
Electrocoagulation (EC) and Chitosan Enhanced Sand Filtration (CESF) Treatment Technologies For Dredge Return Water

Two Case Studies on the Lower Duwamish Waterway Seattle, Washington

WEDA Dredging Summit & Expo – June 23, 2015

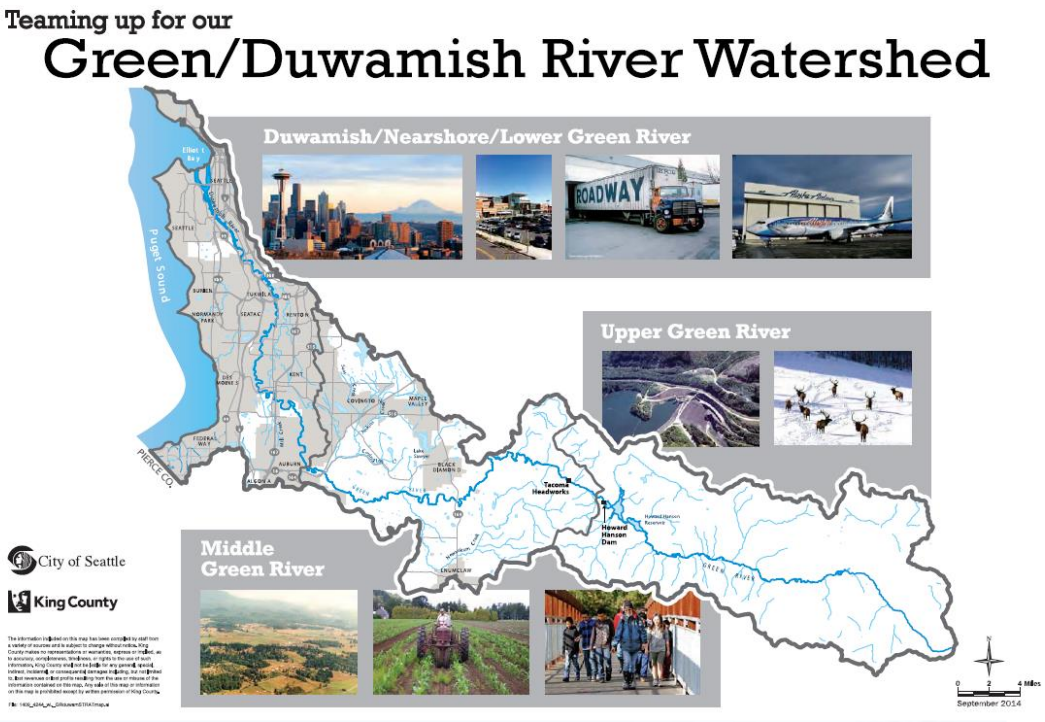
WATERTECTONICS

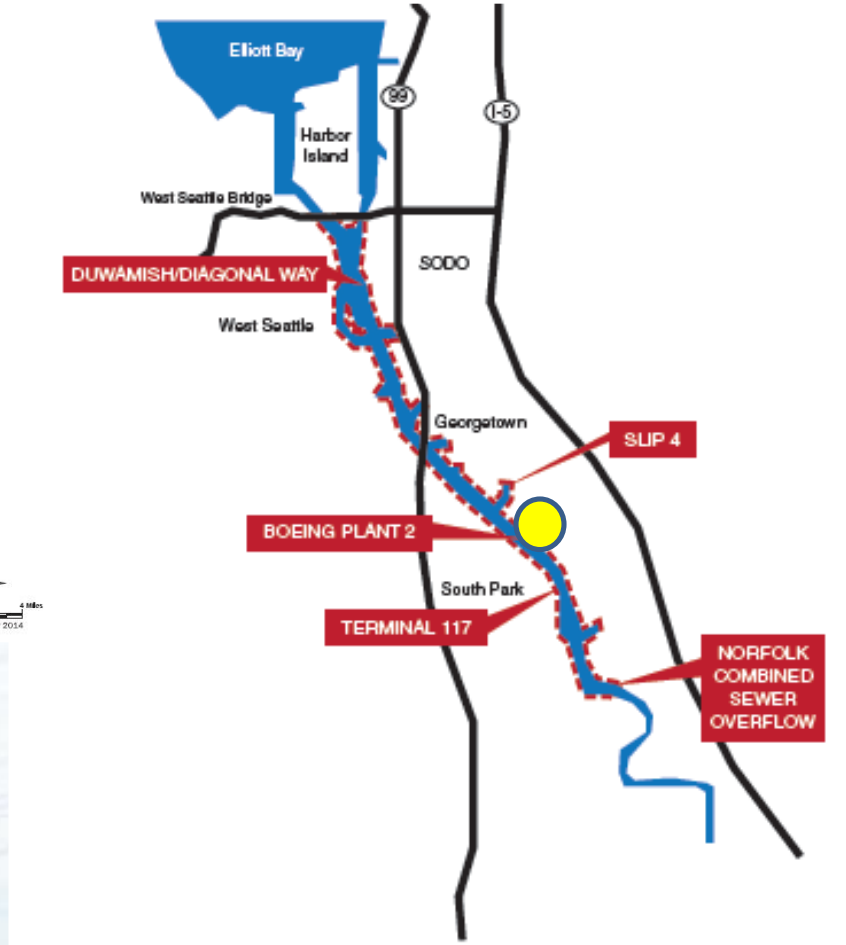
Lower Duwamish Waterway



- **5.5 Mile Superfund Site**
- **Contaminants of Concern: PCBs, PAHs, Dioxins, Furans, Metals & Phthalates**
- **An estimated 177 acres will be actively cleaned up. Time frame to complete the entire cleanup is estimated to be 17 years: 7 years of active cleanup and 10 years of monitored natural recovery. 105 acres of dredging or partial dredging and capping**
- **Early Action Areas: Slip 4, Terminal 117, Boeing Plant 2, Jorgensen Forge**

Early Action Areas



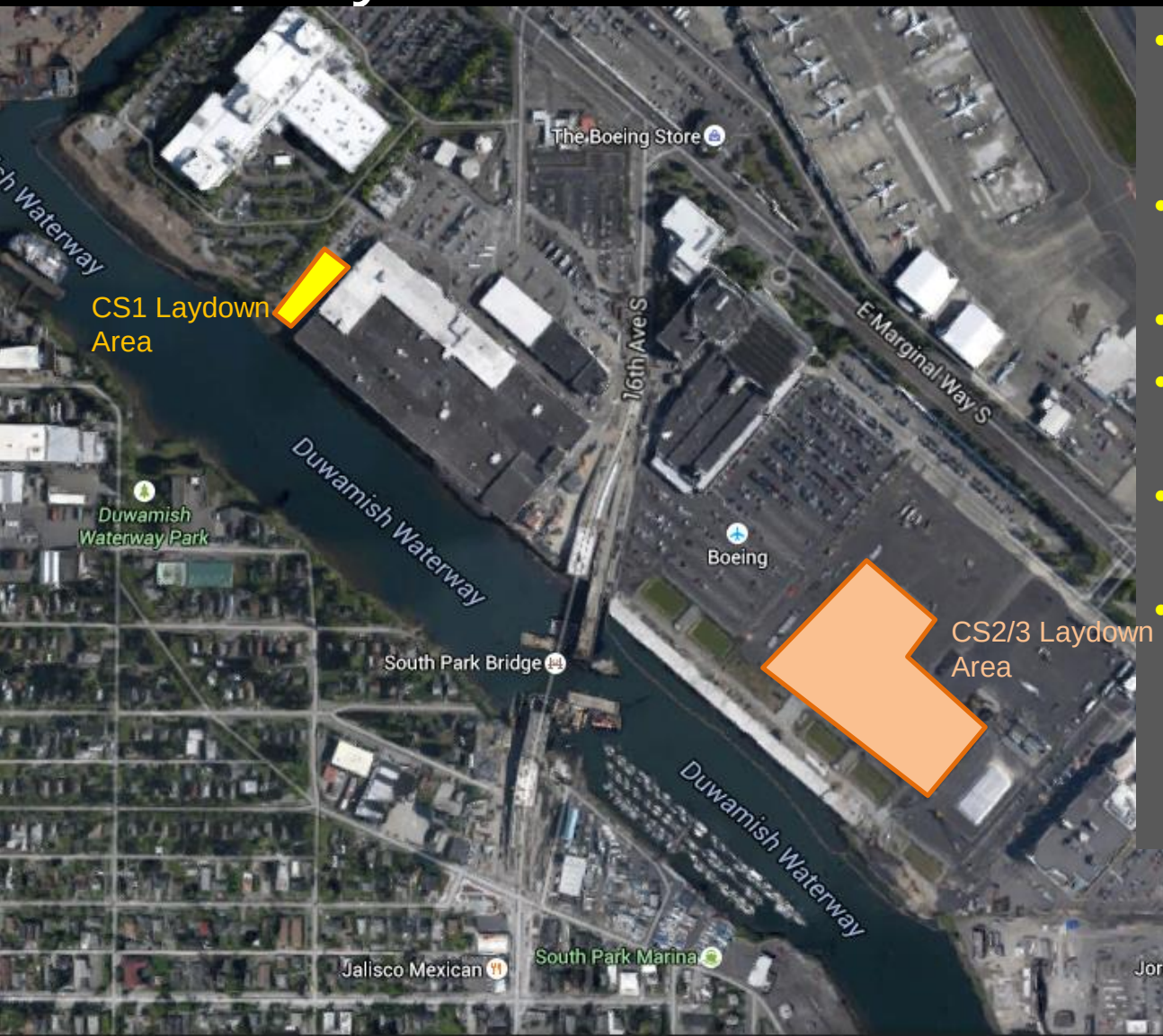


Lower Duwamish Waterway and Early Action Cleanup Areas

Boeing Plant 2 – circa WW2

Boeing Plant 2

Boeing Plant 2 – CS1 DRWT System Constraints



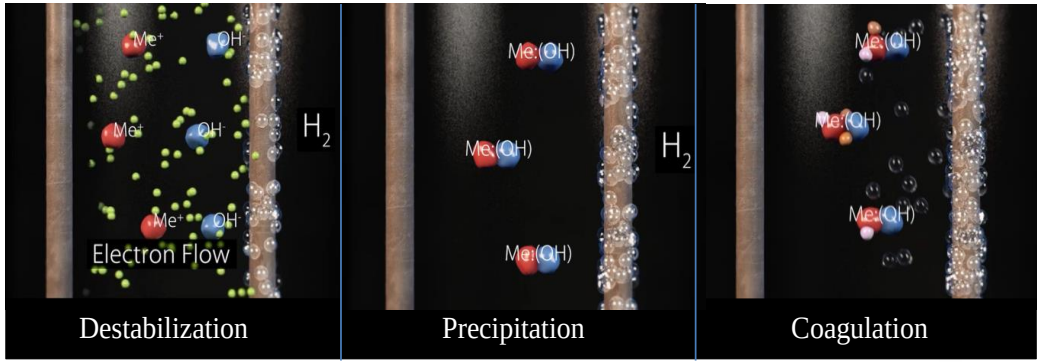
- Specified treatment approach not approved by Agencies
- Chemicals/Polymers not allowed
- Small Laydown Area
- Discharge to SS not allowed/cost prohibitive
- Considered “pilot season” for larger CS2/CS3
- WaveIonics EC technology selected as considered by Ecology as non-chemical, and carries GULD (TAPE Approval)

Boeing Plant 2 – CS1 – DRWT EC System

- WaveIonics EC system chosen as non-chemical treatment method

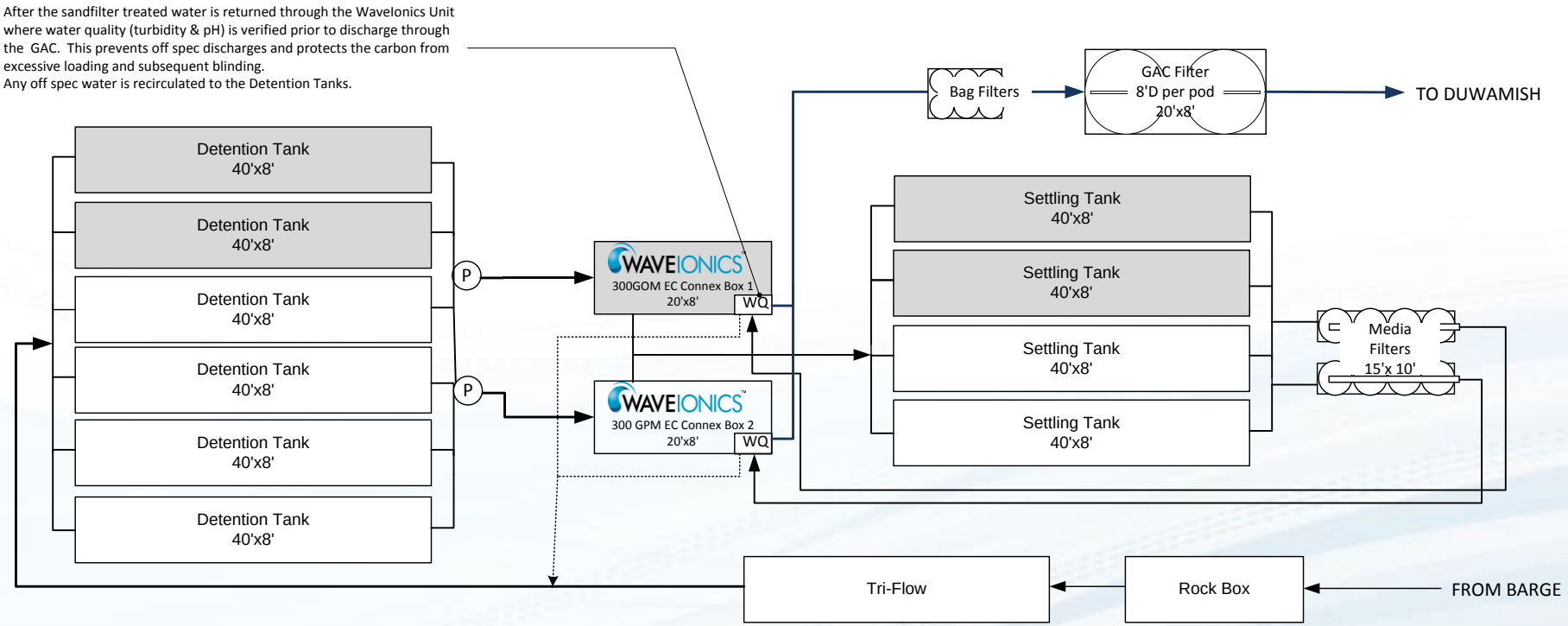
- The WaveIonics EC technology carries Washington State Department of Ecology General Use Level Designation for turbidity reduction & pH management on construction sites. Also approved by Ecology for permanent industrial stormwater treatment.
- Implementing a technology considered non-chemical with GULD approval facilitated project approval and kept timelines intact.
- So what is EC…

Electrocoagulation (EC)



- Sacrificial ion (coagulant) driven from a metal plate, cleaving of water to make OH+ (dissolved metals) and electron flow between plates (de-emulsification, bacterial membrane lysing).
- Used to remove colloidal particles (Turbidity/TSS), total and dissolved metals, emulsified oils and bacteria
- Implemented with Sand Filtration
- Wavelonics carries GULD approval from WA Dept. of Ecology

Boeing Plant 2 – CS1 – DRWT EC System

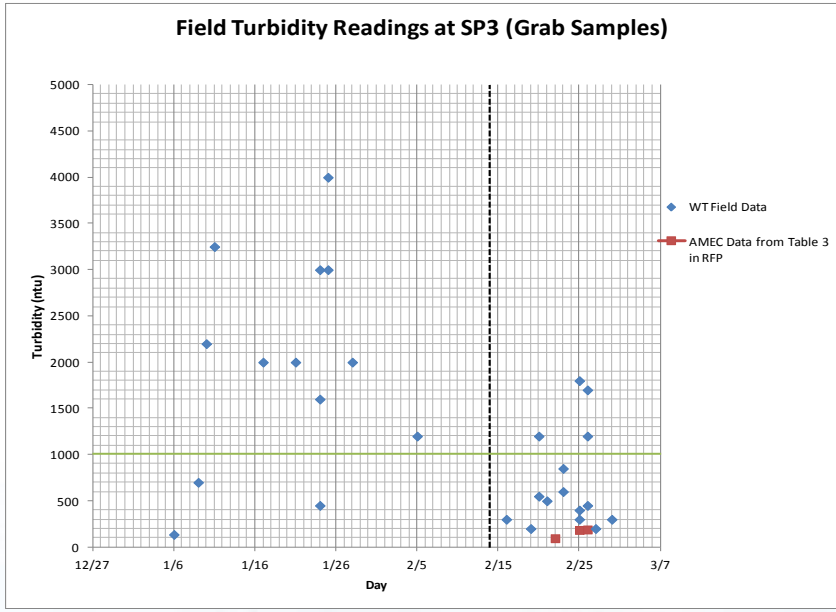


Boeing Plant 2 – CS1 – Challenges

1) HIGHLY VARIABLE INFLUENT

Over the project duration the following breakdown of turbidity was generally observed:

- 50% of the time turbidity was >1000 ntu
- 14% of the time turbidity was 500 – 1000ntu
- 26% of the time turbidity was 300 – 500 ntu
- 10% of the time turbidity was <300 ntu



Influent Sample collected 2/11/13:

TSS = 58,000mg/L (measured by ALS)

NTU = 16,200 (measured with volumetric dilutions in laboratory setting)

Wide variations in turbidity and TSS were observed on a daily and even hourly basis. Factors included both the type of cut and type of material being dredged. Lower turbidity was observed when dredging in sandy areas which occurred during the first week and last couple weeks of CS1

Boeing Plant 2 – CS1 – Challenges

2) Residual Solids Management

- Settled solids in both influent and effluent tanks required removal during operational period.
  - confined space issues
  - tanker trucks

- Sediment had to be liquefied to some extent to pump out into truck. This addition of water created increased need for soil stabilizers (cement) at the transload facility.

Boeing Plant 2 – CS1 Outcome

Accomplished:

- 36,000 cy of dredging
- Operated for 48 days
- All Chronic and Acute water quality discharge parameters met.
- 6,300,000 gallons treated and discharged back to the Duwamish Waterway

WQ Parameter	Acute Criteria	Chronic Criteria	DRWTS Effluent
Cadmium	40	8.8	0.027
Chromium	1100	50	0.22
Copper	4.8	3.1	0.44
Lead	210	8.1	0.05
Mercury	1.8	0.025	0.02
Silver	1.9	1.9	0.016
Zinc	90	81	5.78
Mercury	1.8	0.025	0.02
PCBs	10	0.03	0.010
Turbidity	5 ntu above background		≤5 ntu
pH	6.5-8.5s.u.		6.5-7.5

Boeing Plant 2 – CS1 Lessons Learned

Lessons Learned:

- Operational dewatering strategy from sediment barge to DRWTS is critical
- Having a reliable way to remove solids is also critical
- Plan for redundancy

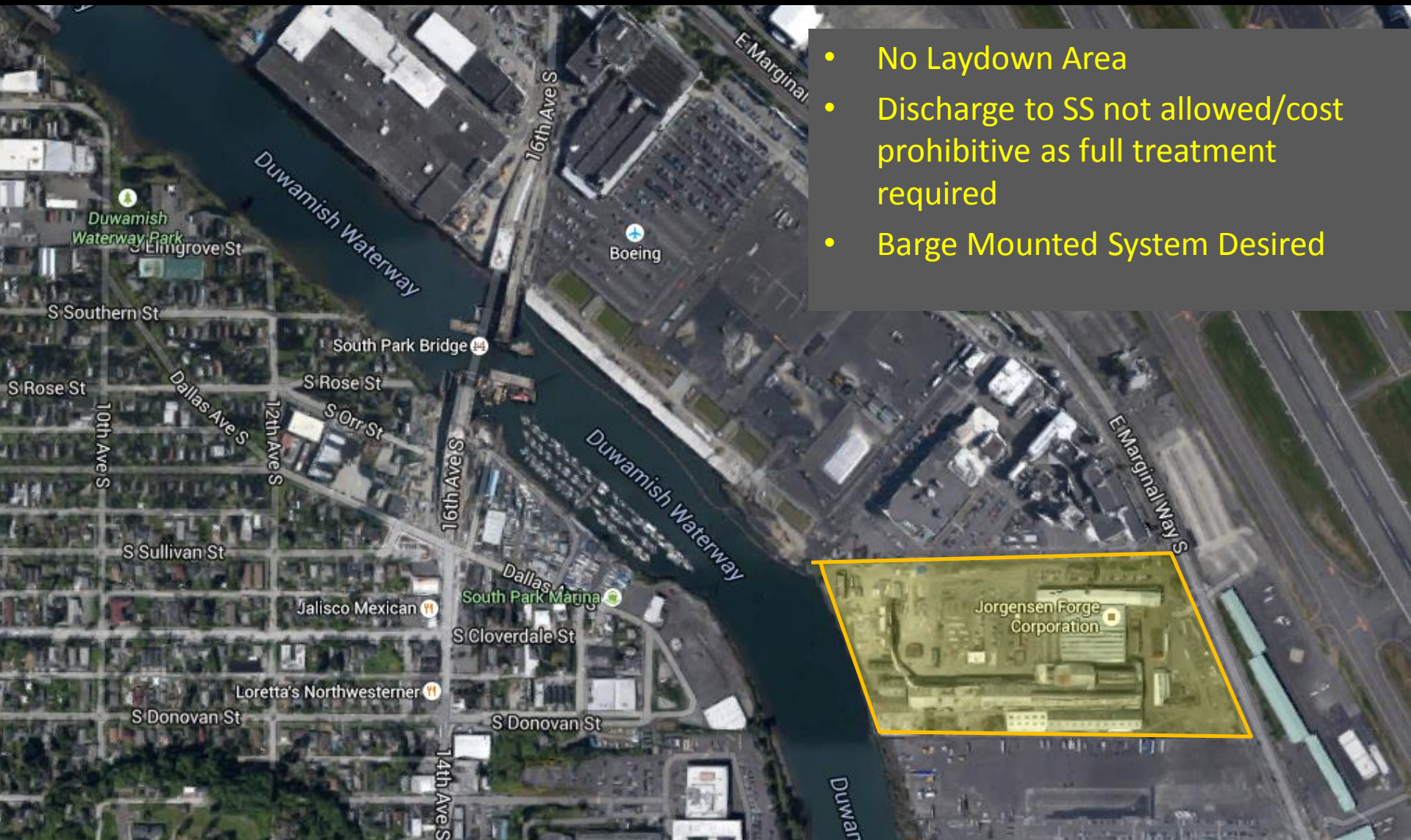
These challenges were remedied in later CS2/CS3 by replacing detention tanks with large pre settling pond (~2M gallons) and large post treatment clarifier.

As a result, Influent turbidities prior to the EC system were very low – with the highest reading at 110ntu.

CS1: 90% of time >300

Jorgensen Forge EAA

Jorgensen Forge
DRWT System Constraints

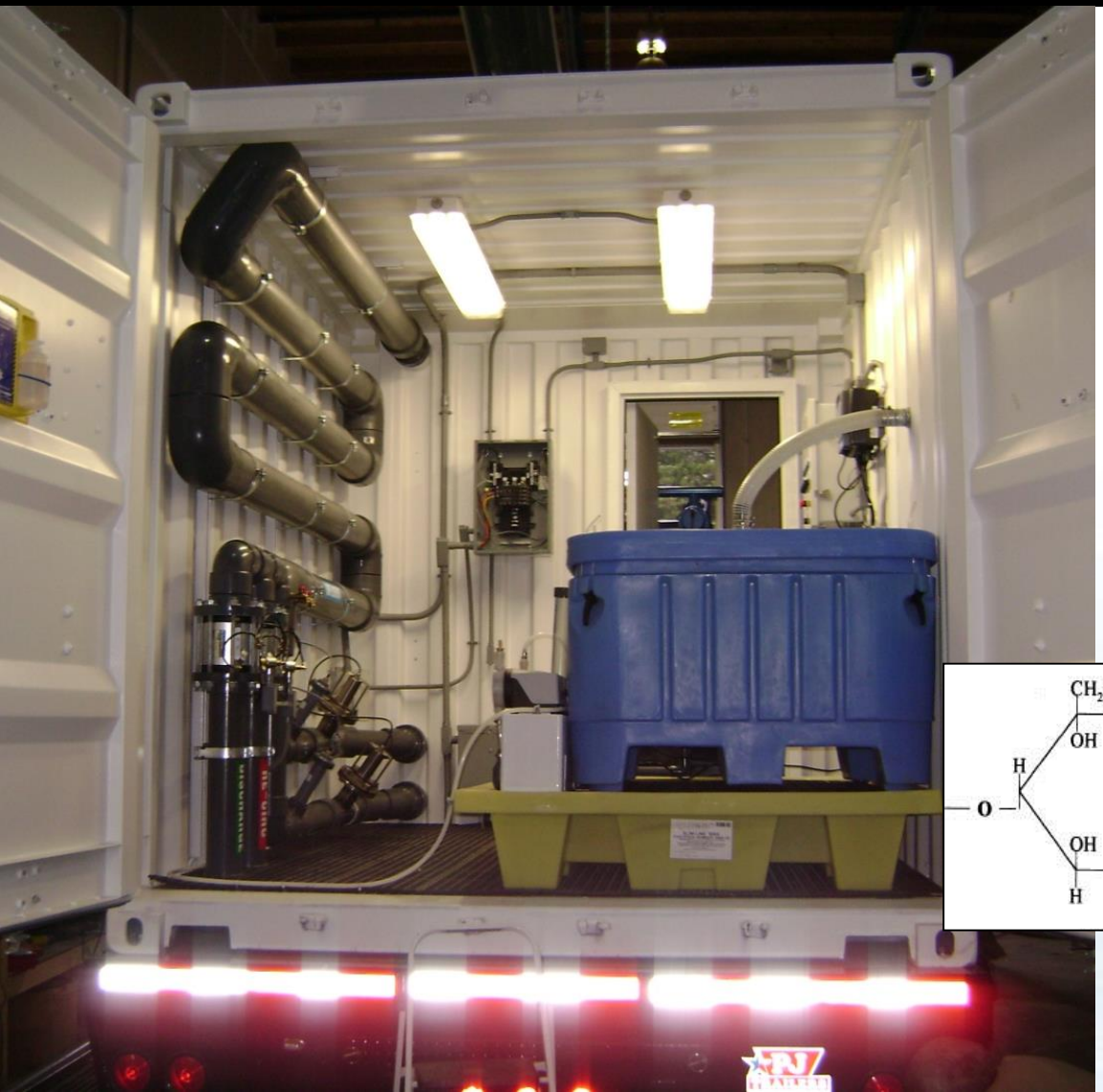


- No Laydown Area
- Discharge to SS not allowed/cost prohibitive as full treatment required
- Barge Mounted System Desired

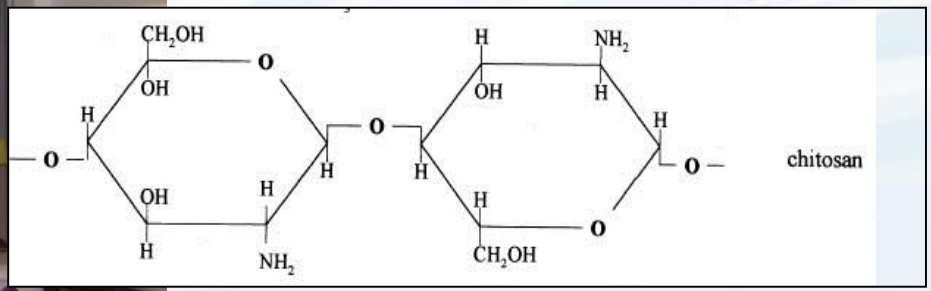
Jorgensen Forge – DRWT CESF System

- Barge Mounted Chitosan Enhanced Sand Filtration (CESF) system implemented

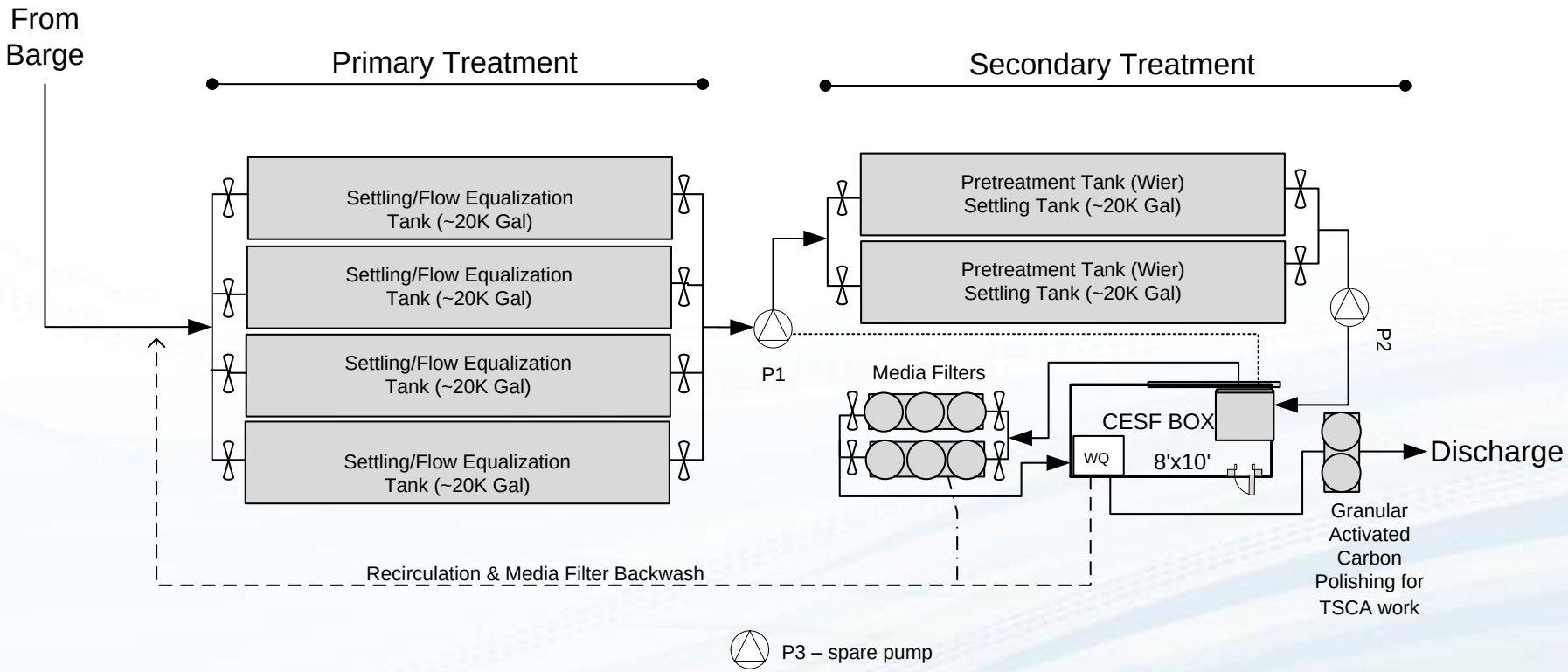
Chitosan Enhanced Sand Filtration (CESF)



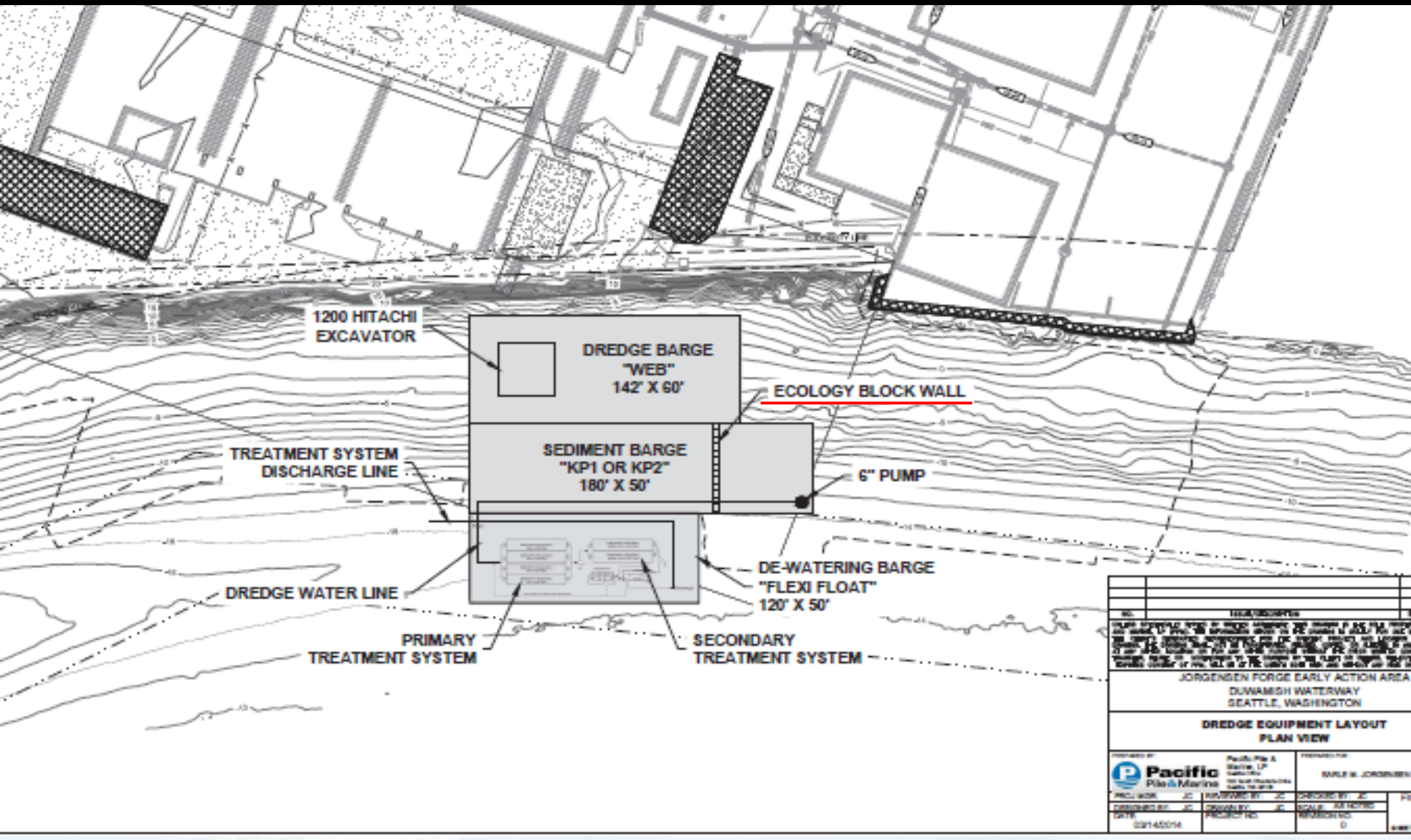
- Liquid Biopolymer (coagulant/flocculent) made form crab or shrimp shells.
- Used to remove Turbidity/TSS, Total Metals
- Implemented with Sand Filtration
- GULD approved by Ecology for marine waters in 2013.



Jorgensen Forge – DRWT CESF System



Jorgensen Forge – DRWT CESF System



Jorgensen Forge Outcome

Accomplished:

- 12,500 cy of dredging
- Operated for 45 days meeting all water quality discharge parameters – PCBs Non-Detect
- 5,183,000 gallons treated and discharged back to the Duwamish Waterway

No operational issues.

Considerations for DRWT Systems

- **Site Characteristics Impacting Design**:
  1. Schedule – what are the time constraints
  2. Has a process been approved by the Agencies.
  3. Available Laydown Area
  4. WQ Discharge Standards
  5. Contaminants of Concern
     1. Sediment Particle Size
     2. Total vs Dissolved Metals
     3. Organics
  6. Barge Off Loading Practices & Solids Management

Particle Diameter (microns)	Soil Type	Time Required to Settle 3ft
10000	Gravel	0.016 sec
2000		0.4 sec
1000		1.7 sec
600	Coarse Sand	4.6 sec
300	*Silt Fence, Ponds*	19.0 sec
200	*Bioswales*	42.0 sec
150		1.25 min
100	Fine Sand	2.8 min
60	*Passive filtration*	7.8 min
25	*Pressurized SF*	2.2 hrs
15	*Bag Filters*	6.2 hrs
10	Silt	14.0 hrs
5	*Active Treatment*	56.0 hrs
3	*CESF/EC*	155.3 hrs
1.5		26.0 days
1	Clay	58.0 days
0.1		16 yrs
0.01	Colloidal Particles	1600 yrs

Thank-you…Questions?

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