

Minnesota
BIOCHAR  SUMMIT
Inaugural Event June 2023

**Wednesday,
June 28, 2023
8:30am-4:30pm
Minneapolis, MN**

*Scan for
Conference
Registration
Website*



 **Stantec**

**Coon Creek
Watershed District
Biochar Filter Case
Study
Ed Matthiesen, P.E.**



• Biochar used for Stormwater Filters

“Agricultural Carbon” by National Carbon Technologies

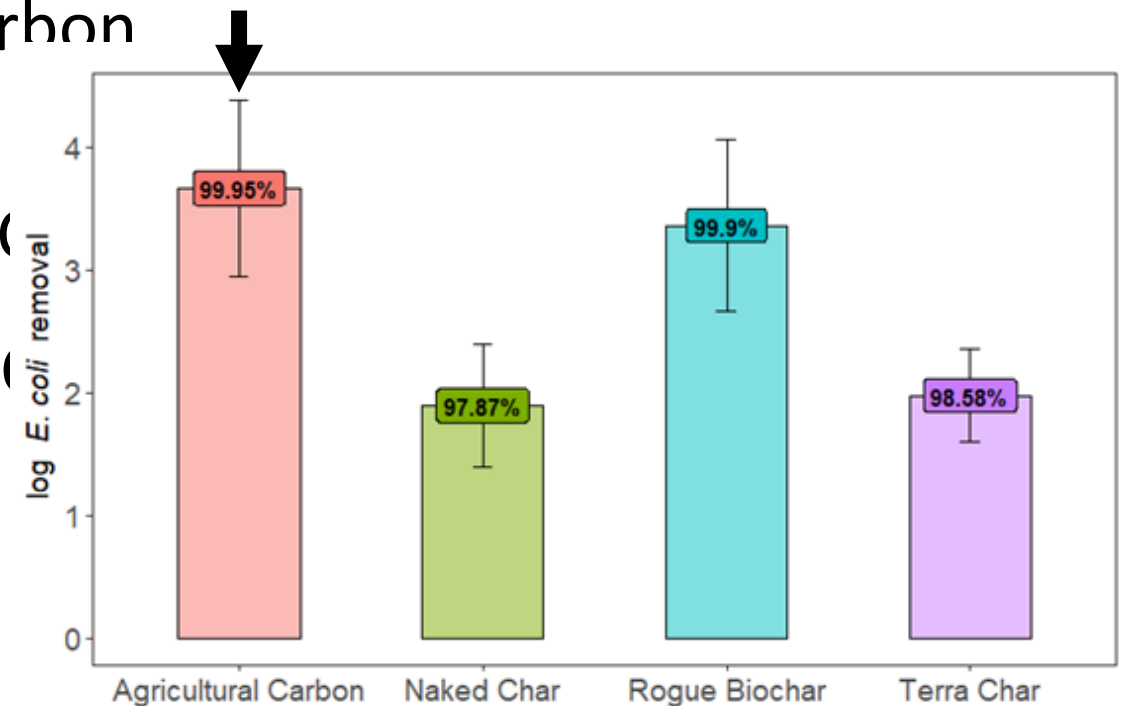
Source Material: Wood burned >550°C

Surface area: 339 m²/g ≈100 sq.mi./lb

Composition:

- 84% Fixed Carbon
- 12% Volatile matter
- 4% Ash

99.95% *E. coli* removal in lab trial



Shingle Creek Pilot Studies

- Catch-basin inserts
- In-line Stream ‘Job Box’ filters



Samueli
School of Engineering

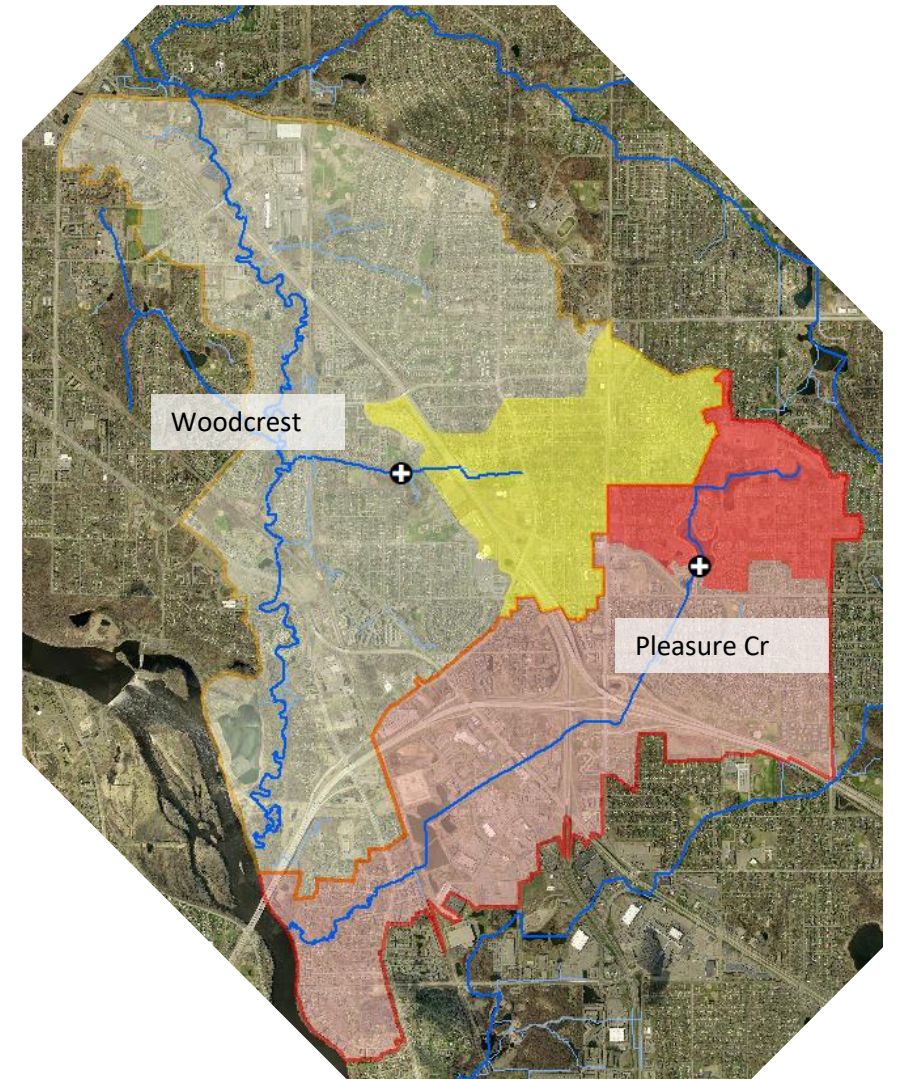
Mohanty Lab



• Large Scale Demonstration Biochar- & IESFs

Biochar- and Iron-Enhanced Sand Filters (BIESFs)

- Woodcrest Filter: gravity-fed pond bench filter retrofit (dark yellow)
- Pleasure Creek Filter: pump-based filter basins (dark red)
- Constructed October 2019 - June 2020
- Both filter BMPs comprised of 2 filter cells one iron-sand cell and one iron-sand cell with biochar added (30% by volume)
- “IESF” vs “BIESF” head-to-head tests





Before



After

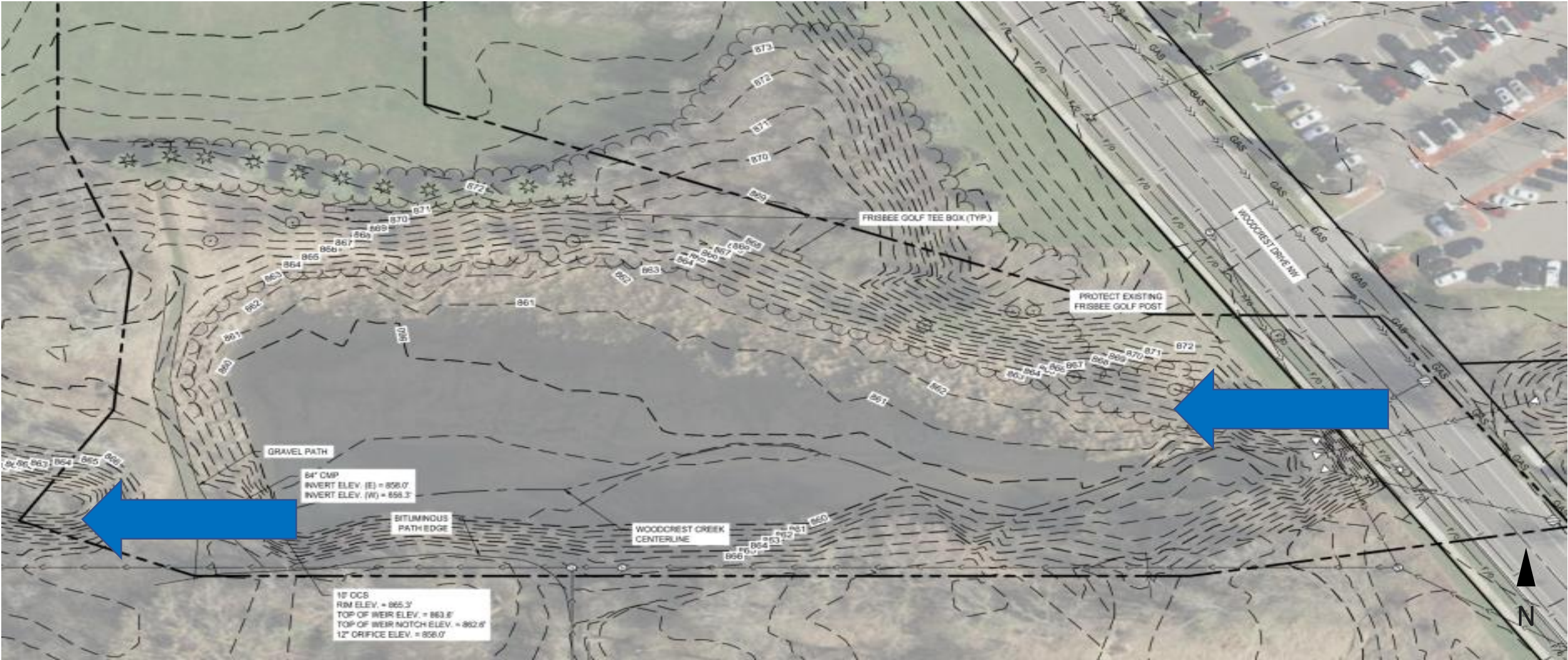
Biochar for stormwater pollutant Removal -

• Woodcrest BIESF

- Treats 0.9 sq. mi. drainage area
- 2 cfs gravity system
 - ~0.7-inch storm event
- 1/3rd Football field, in scale
- \$485,000 to construct

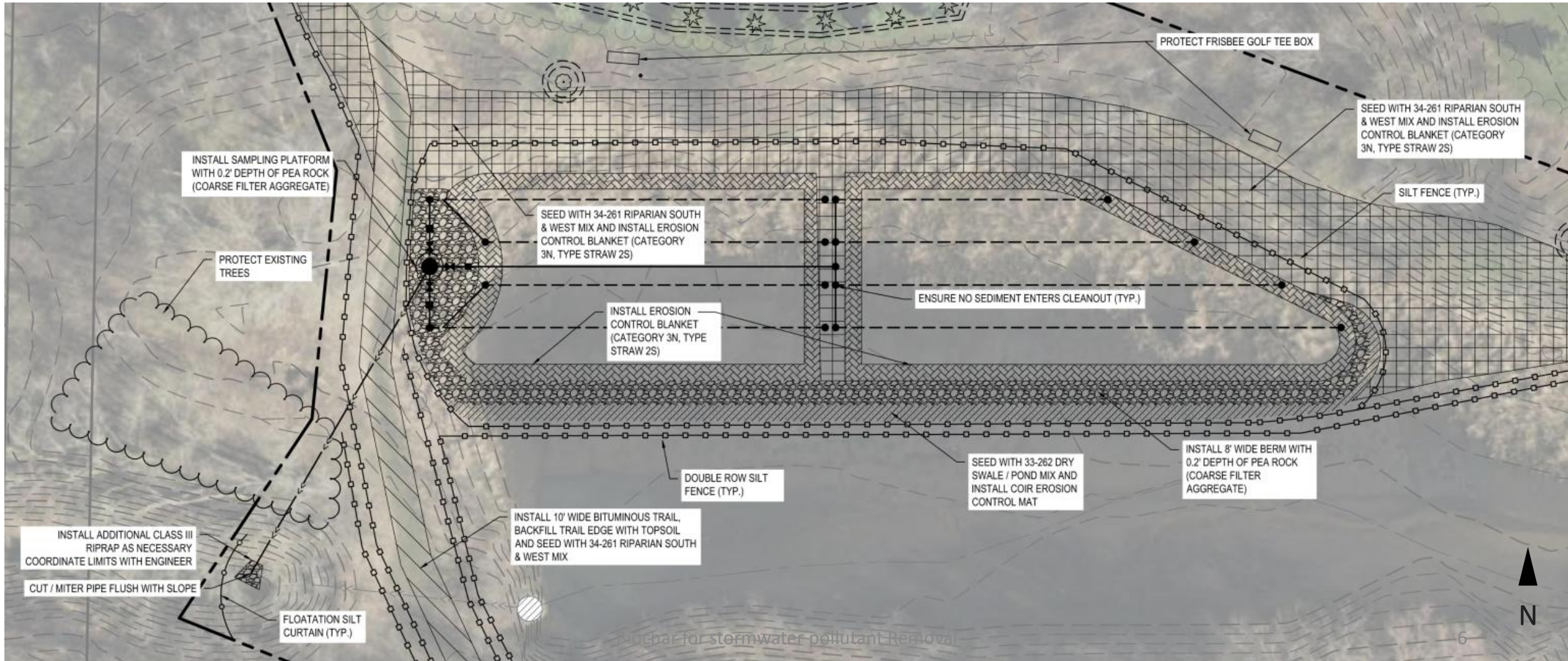


Woodcrest BIESF – existing



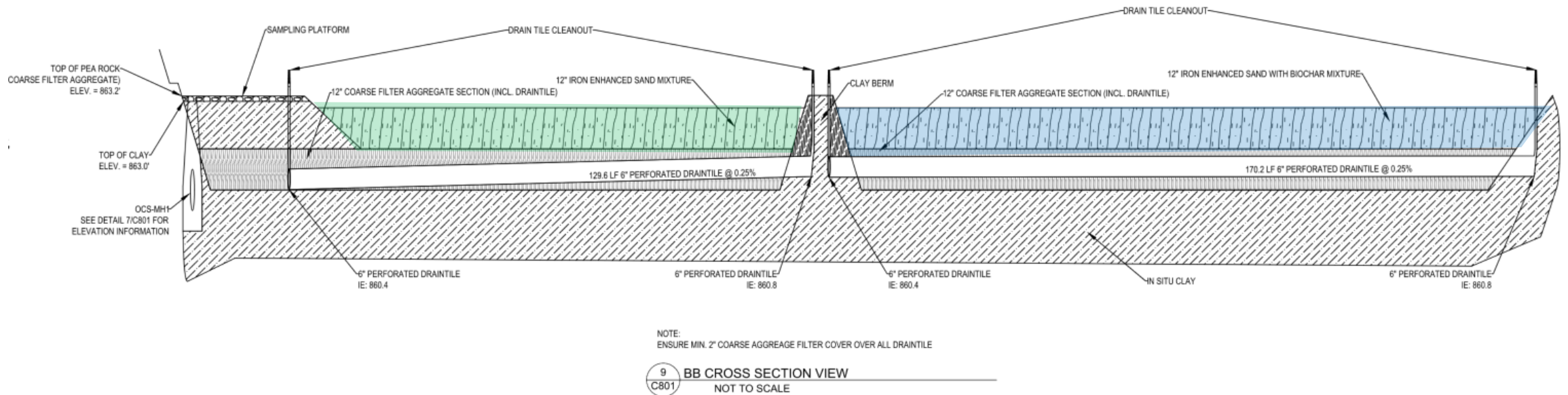
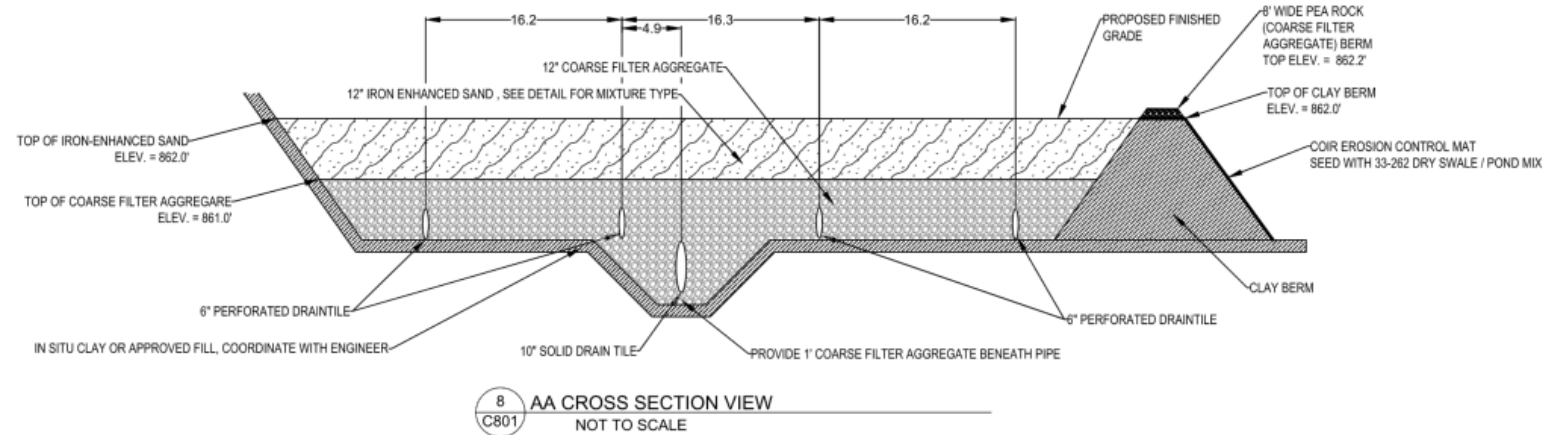


• Woodcrest BIESF – proposed



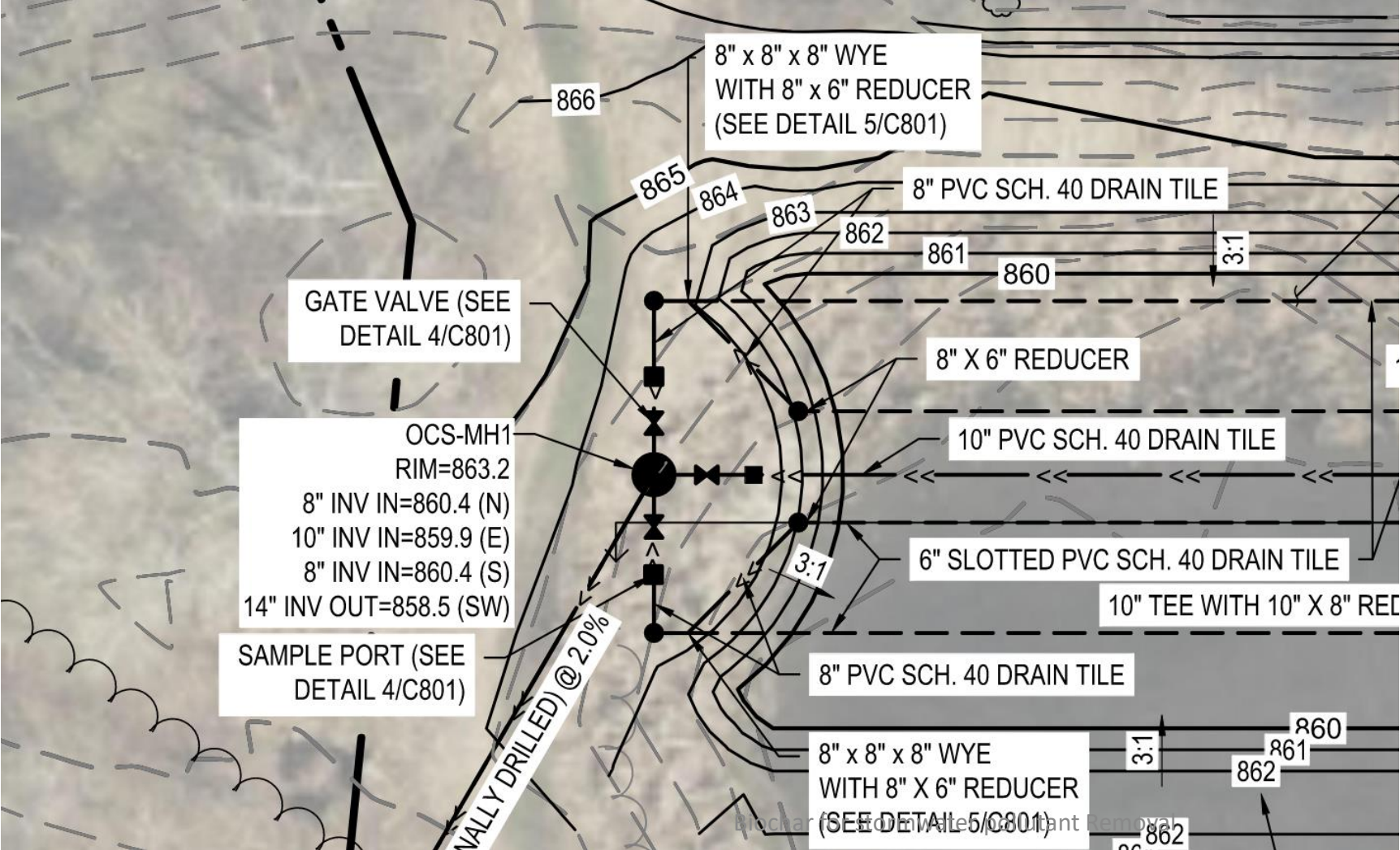


• Woodcrest BIESF – proposed X-S



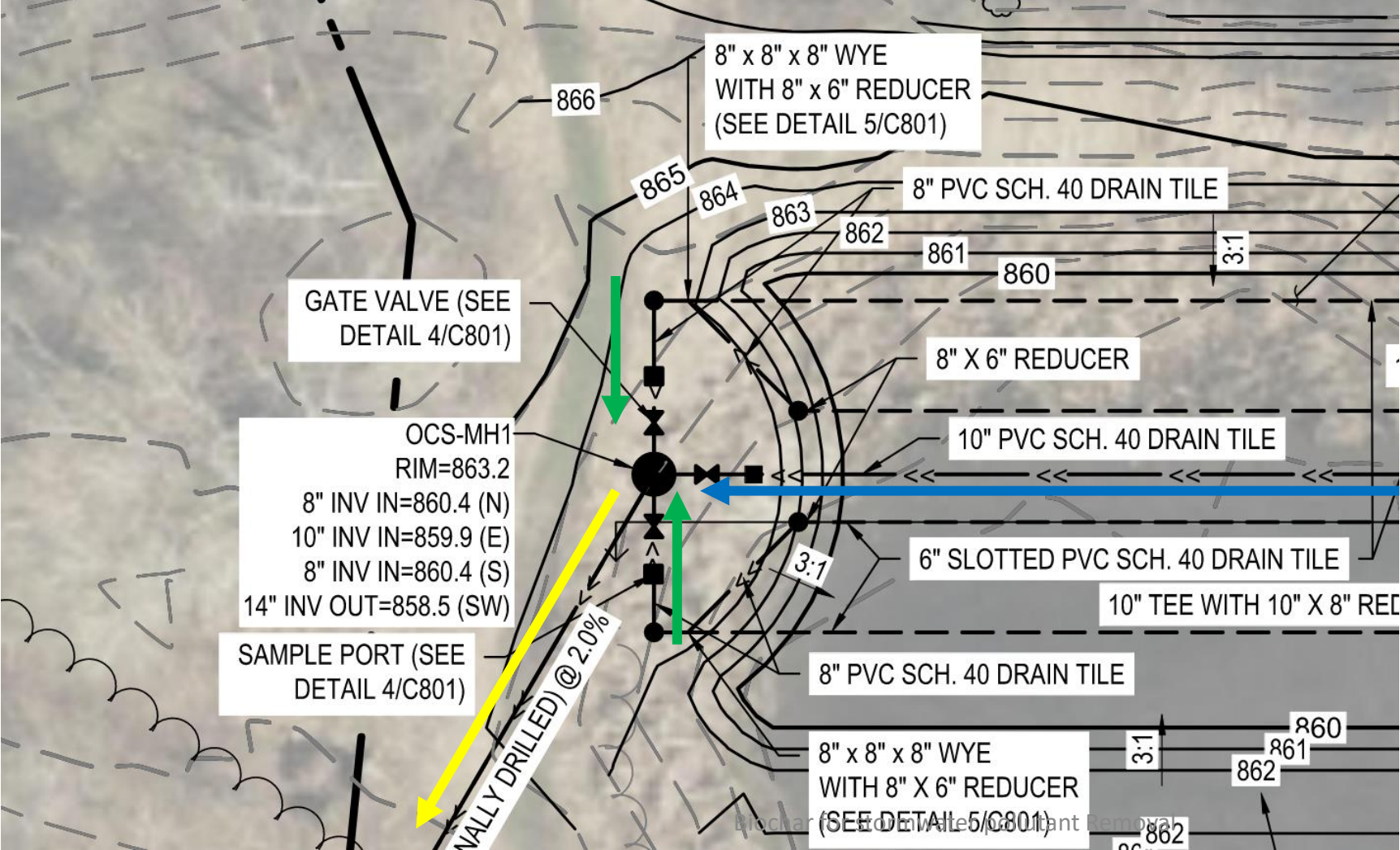


Woodcrest BIESF – sampling





Woodcrest BIESF – sampling





Woodcrest BIESF – construction





Woodcrest BIESF – operation





Woodcrest BIESF – operation



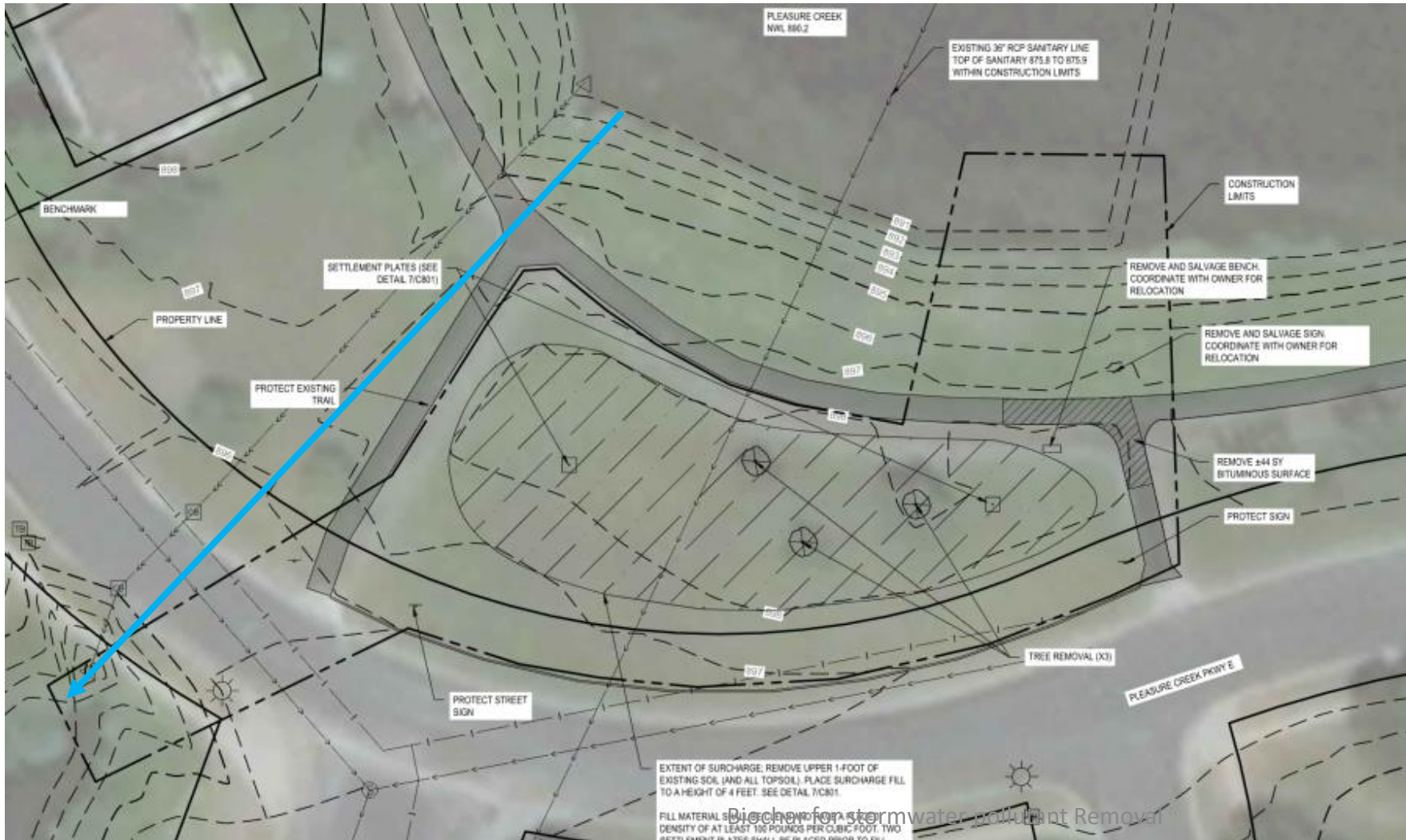


• Pleasure Creek North BIESF

- Treats 0.6 sq. mi. area
- 120-200 gpm pumped system
- Treats 200-300 af/yr
- 26-43 lbs TP/yr

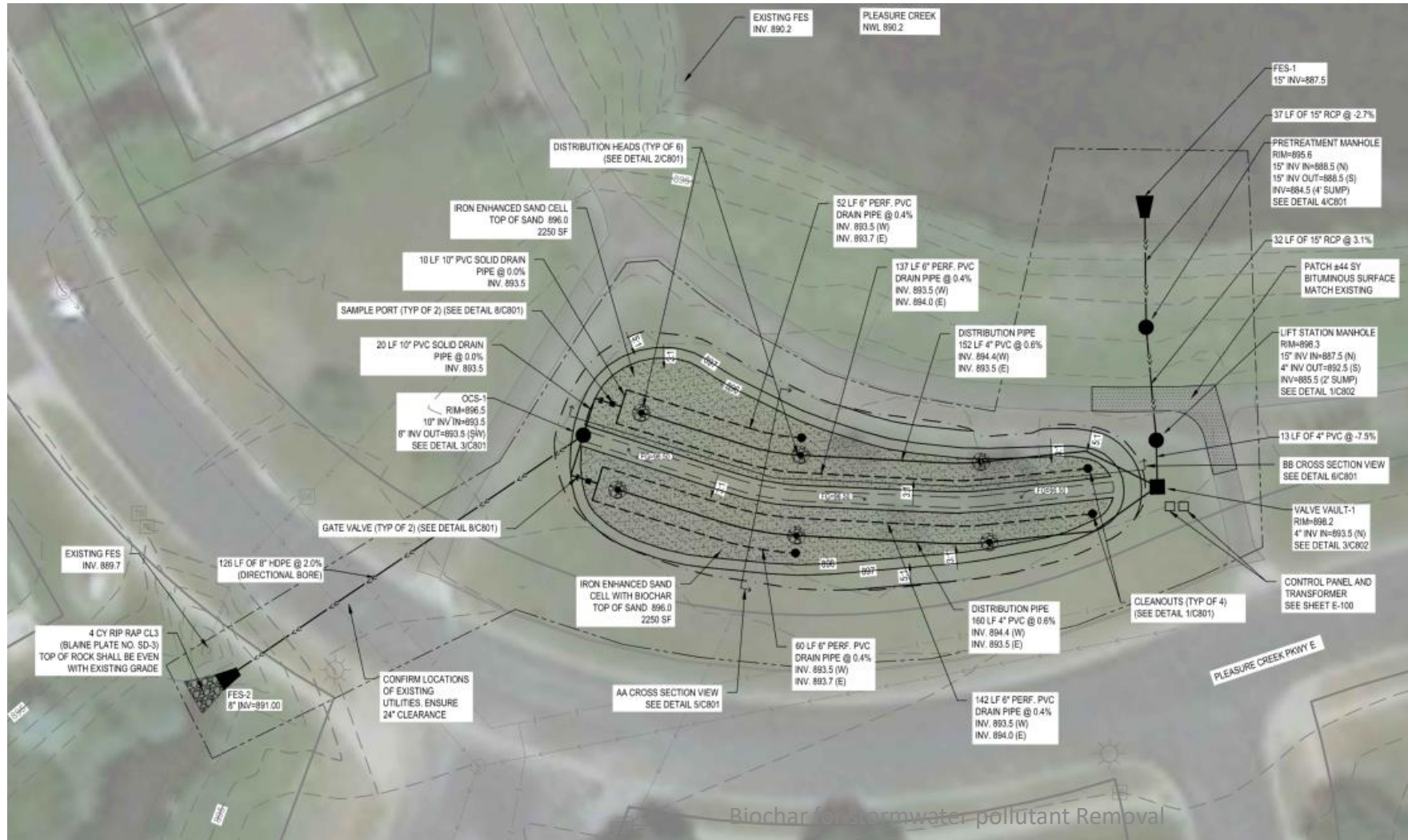


Pleasure Creek North BIESF – existing



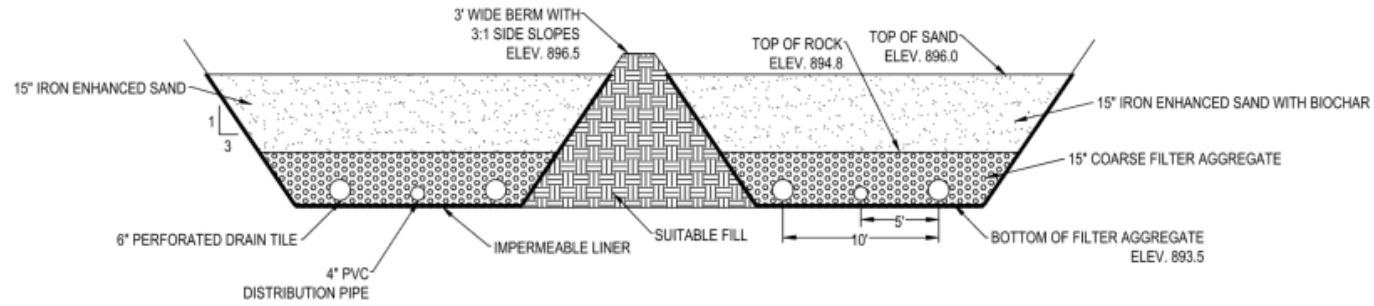


Pleasure Creek North BIESF – proposed

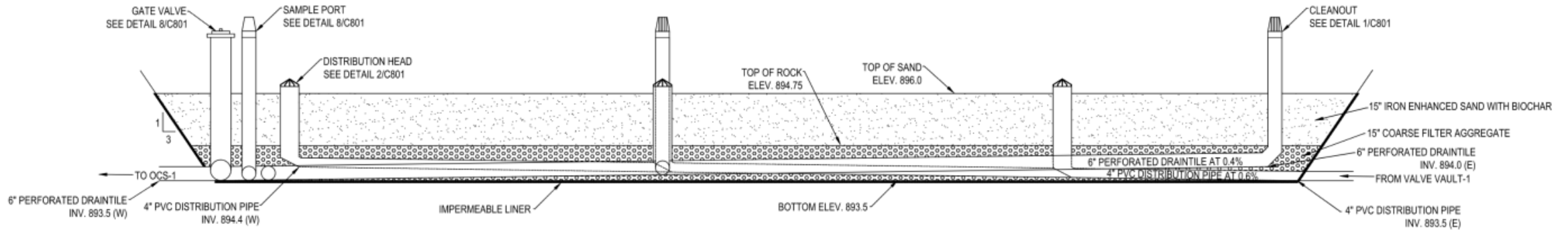




Pleasure Creek North BIESF – proposed



5 AA CROSS SECTION VIEW
C801 NOT TO SCALE



6 BB CROSS SECTION VIEW
C801 NOT TO SCALE

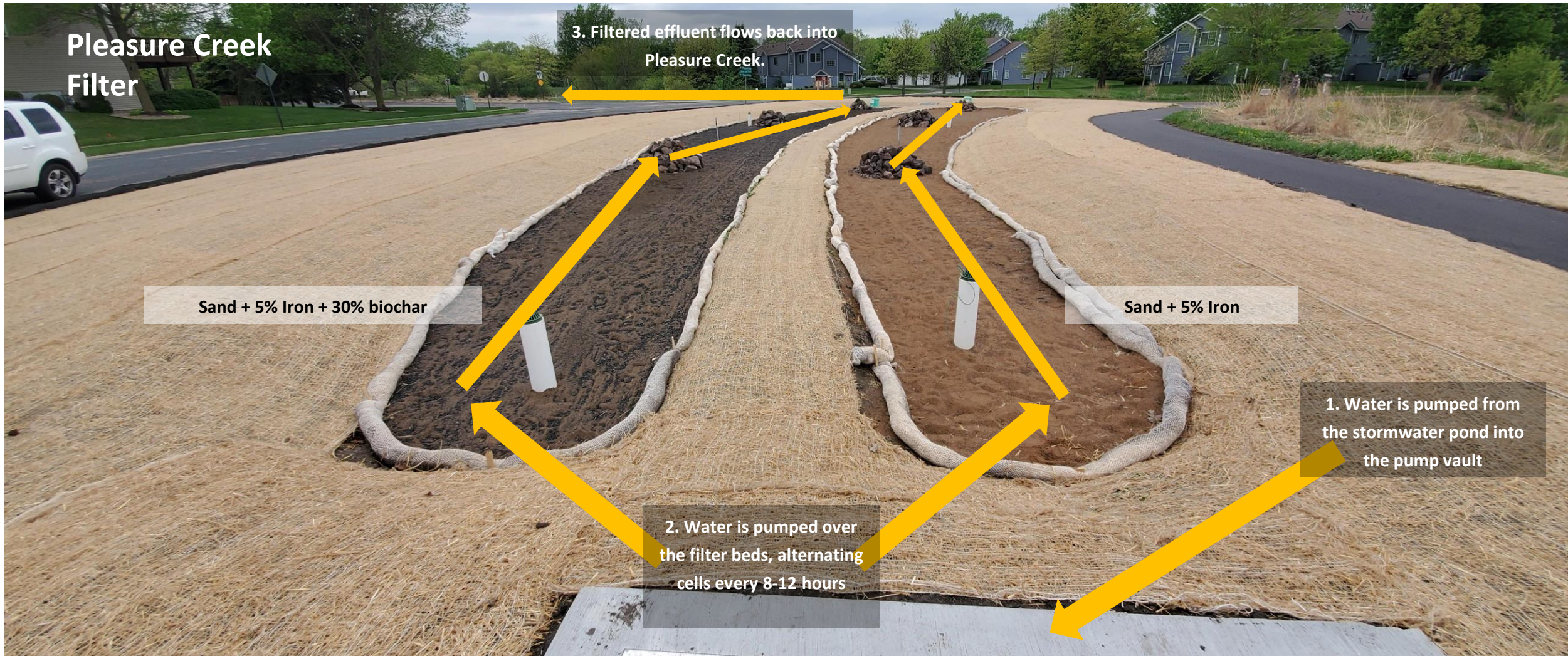


Pleasure Creek North BIESF – construction





Pleasure Creek North BIESF – operation





Pleasure Creek North BIESF – operation





- **Construction difficulties**

Woodcrest BIESF

- Disc Golf Course
- Groundwater Seepage
 - Installed clay liner
 - Installed/Constructed a bypass filter
- Biochar Supplier (both filters)

Pleasure Creek North BIESF

- ~10 feet of Peat Soil
 - Pre-Loaded (surcharged) site post-excavation with Clay
 - Added helical piles to two structures.
- Biochar Supplier (both filters)



Construction Difficulties – Peat Surcharge





• Biochar installation

Biochar Installation

- **30% Biochar by Volume**
 - Will move to 25% for future installations to reduce hydraulic restrictions (increase hydraulic capacity)
- **Mixing is ideal**
 - Peterson Companies mixed sand-iron off-site via auger
 - Avoid over-working the product
- **Layer and Till vs. Layering**
 - Propose a 1.2 ft Media:
 - 0.3' Sand – 0.15' Biochar - 0.3' Sand – 0.15' Biochar – 0.3' Sand
 - Biochar is ~1.0 specific gravity
- **Biochar products have inconsistent gradations**



• Performance monitoring

- Paired grab samples (untreated influent versus filtered effluent x2)
 - *E. coli*
 - Total Phosphorus
 - Ortho Phosphorus
 - TSS
- Sonde measurements of DO, pH, conductivity, temp
- Continuous flow measurements (AV sensors, pump rate)
- Continuous level loggers in all media beds





• 2020 Cumulative Pollutant Load Reductions

Filter Cell	Overall % Load Reduction		
	<i>E. coli</i>	TP	OP
Woodcrest BIESF	89%	78%	74%
Woodcrest IESF	72%	83%	89%
Pleasure Cr BIESF	87%	56%	-10%
Pleasure Cr IESF	84%	43%	-41%

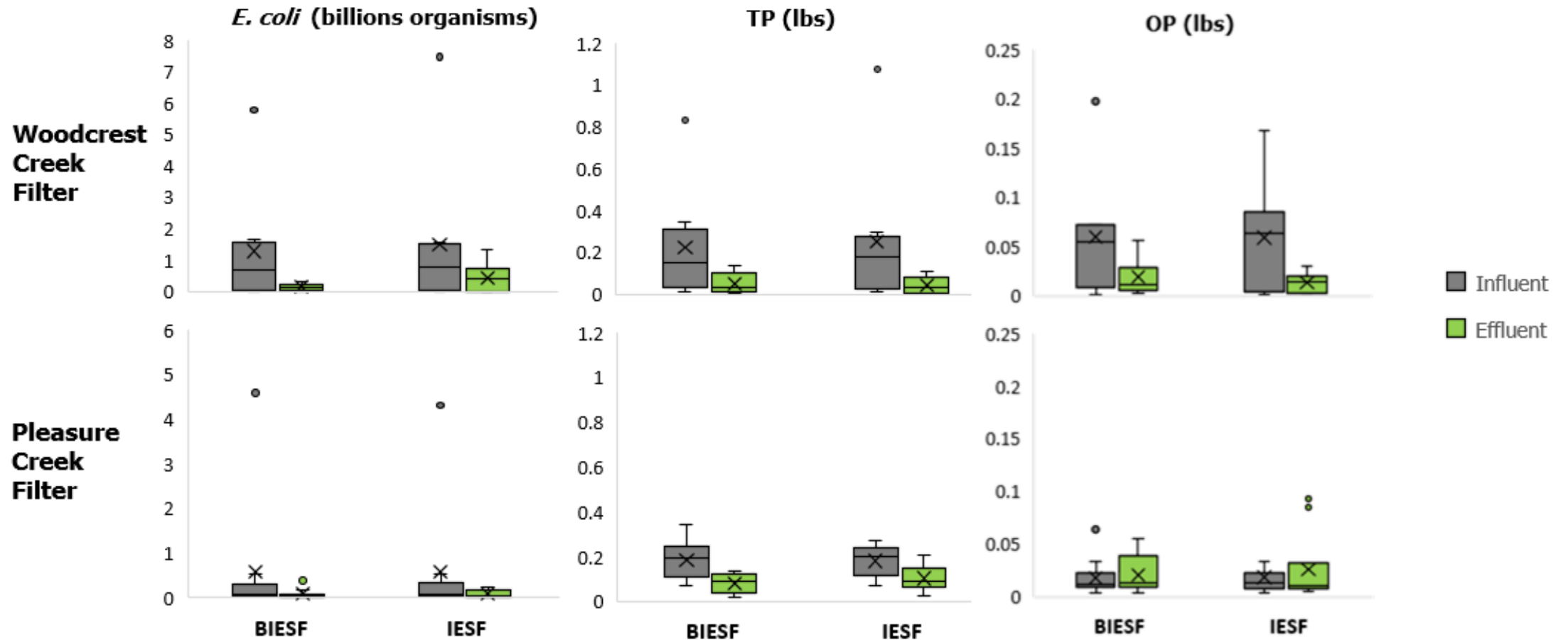
9.9 billion orgs captured

3.64 lbs captured

0.02 lbs export
0.08 lbs export



• 2020 Influent vs Effluent Pollutant Event Loads





• Summary of 2020 results

- All filter cells reduced *E. coli* and TP concentrations & loads
- At Woodcrest Filter, the biochar cell removed 17% more *E. coli* than IESF cell (89% v 72% cumulative load reduction)
- At Pleasure Creek, both filter cells performed similarly at removing *E. coli* (87% vs 84% cumulative load reduction)
- TP load removals were comparable between media types; IESF outperformed BIESF at Woodcrest by 5%, but BIESF > IESF at Pleasure Creek by 13%
- For OP, IESF outperformed BIESF by 15% at Woodcrest. At Pleasure Creek, insignificant amounts of leaching were observed from both media types, but slightly more export from IESF cell.

- Removal efficiencies were variable across individual events; all cells



• 2021 preliminary findings

- Drought impacted operation and sampling of both filters
- At Woodcrest Filter, BIESF cell removed 11% more *E. coli* than IESF cell
 - 69% v 58% cumulative load reduction (89% v 72% in 2020)
 - Unlike in 2020, export was observed during some small events
- At Pleasure Creek, only 1 of 11 samples had influent *E. coli* >126 cfu/100 ml. For this event, *E. coli* was reduced 98% by BIESF and 99.8% by IESF.
- TP continued to be consistently removed at both filters and both media types
- Insignificant leaching of OP was observed at Pleasure Creek (0.3 lbs/yr; influent OP was below detection in half of samples)

Filter BMP/ Media	Cumulative load reduction	
	TP	OP
Woodcrest BIESF	85%	68%
Woodcrest IESF	84%	64%
Pleasure BIESF	59%	-108%
Pleasure IESF	47%	13%



• Conclusions & Future Work

- Biochar amendments to sand filters may increase *E. coli* removal by 5-20%, especially when influent concentrations are high
- Adding biochar to IESFs does not significantly impact phosphorus removal
- Biochar is a low cost, low risk media amendment with potential to increase removal of bacteria
 - BIESF cells ~6% more expensive than IESF cells
 - Assuming Biochar is 30% by volume
 - Biochar [installed] Average Unit Price: \$330/CY
 - Iron-Enhanced Sand [installed] Average Unit Price: \$273/CY
- Biochar may also reduce other pollutants of concerns (pesticides, heavy metals, PAHs) and support plant growth in bioengineering practices



- Project partners

Project funde





• Thank you

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Special thanks to: