

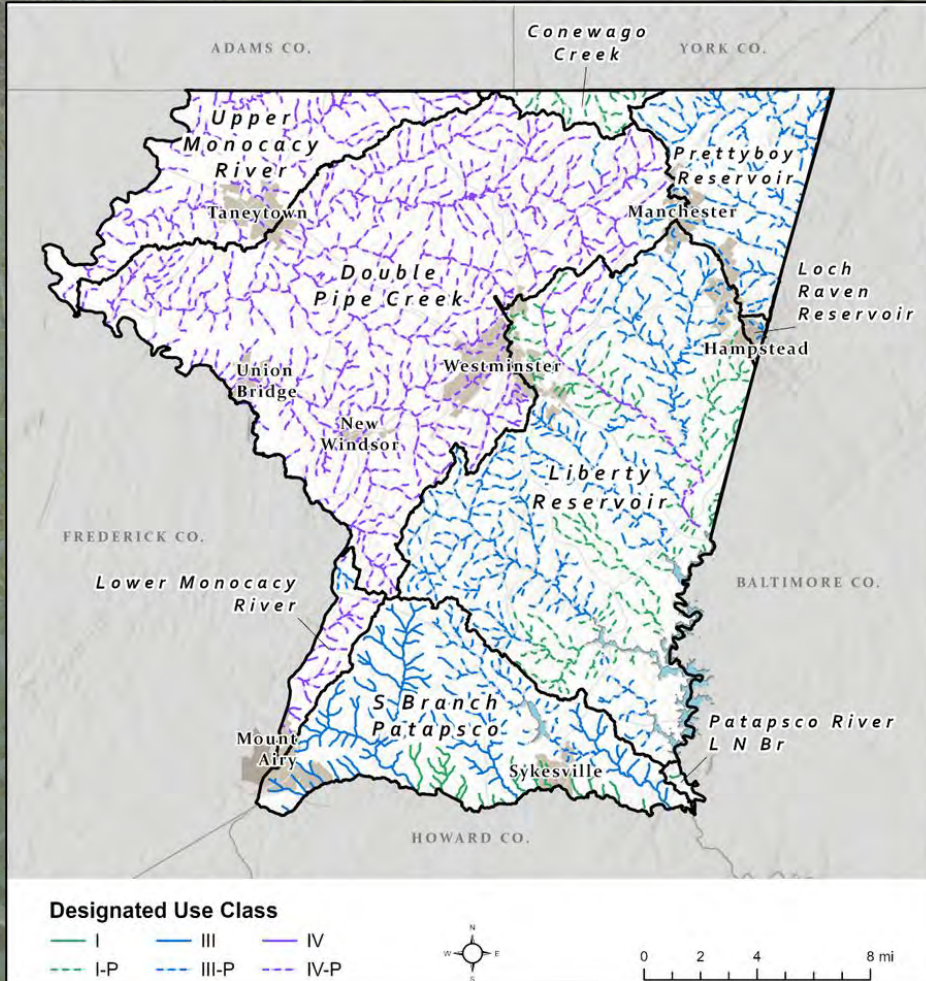


Thermal Evaluation of Wet Pond w/ Gravel Lens

**Impact of Design Modifications to Buffer Stream
Temperatures in Urbanized Watersheds**

**Byron Madigan
Water Resources Manager
Carroll County Government**

Cold and Cool-Water Resources



Patapsco Brown Trout



Prettyboy Brook Trout

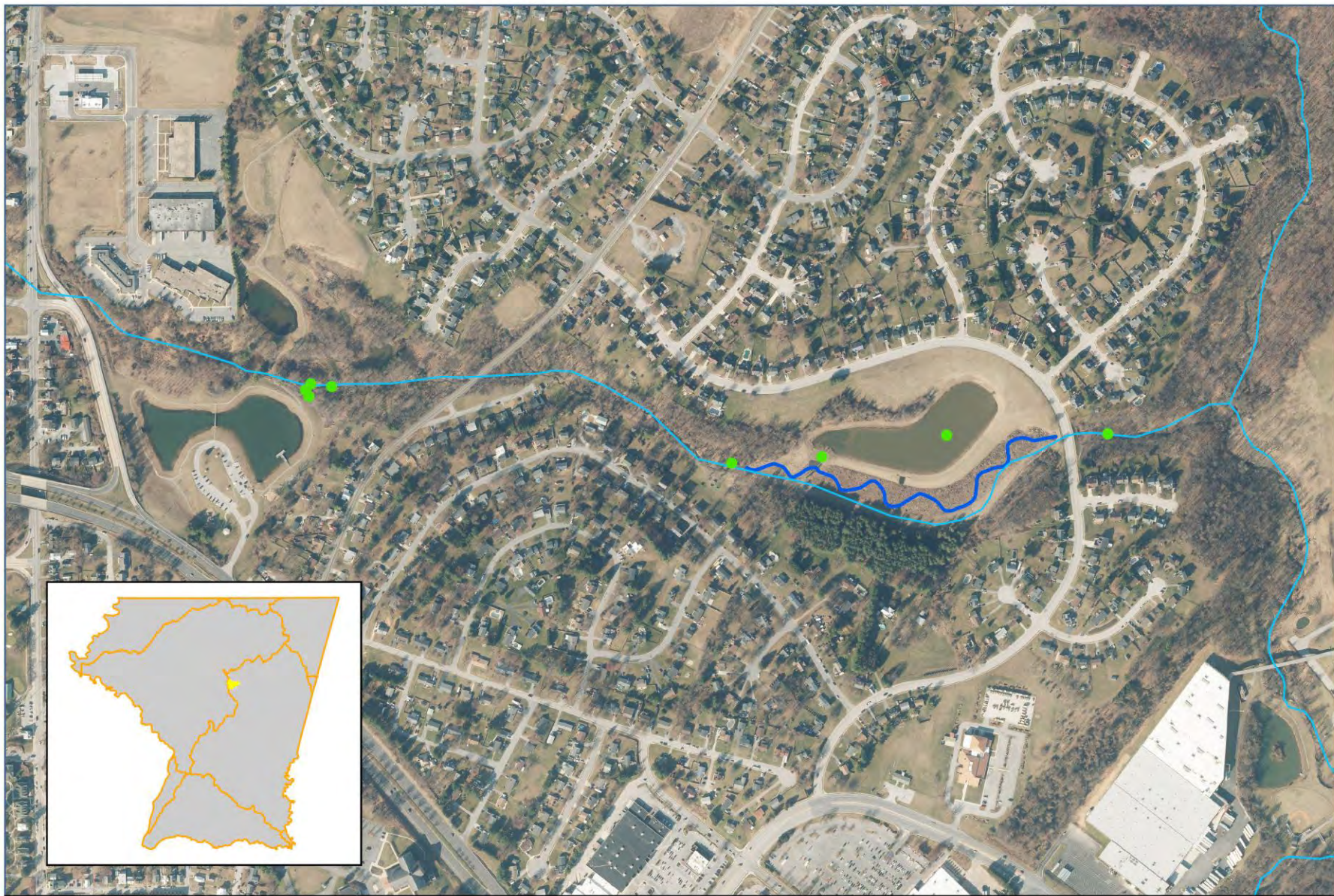


- **Control Vs. Treatment**

- **Bottom withdraw Vs. Gravel substrate (“gravel lens”)**
 - Thermal Response?
- **UNH Thermal Study (2011)**
- **Monitoring Timeframe: 2018 - Current**



**Willow Pond w/ Gravel Lens
Eden Farms Stream Restoration**



— Streams 1:24K
— Restored Reach

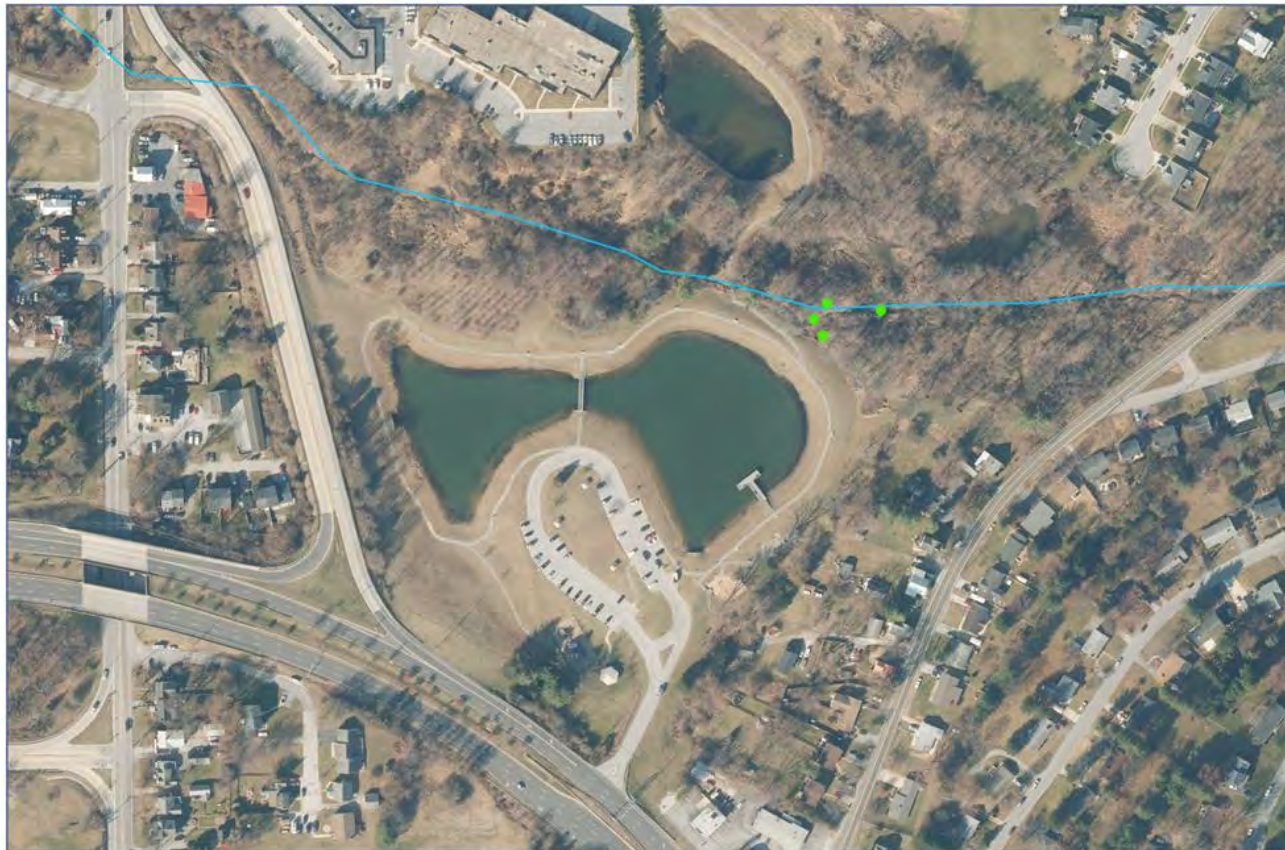
● Temp Sensor Location



0 500 1,000 Feet

Community Pond

Control Site
Retrofitted (2015)
DA: 250 Acres, 25.5% Impervious



Streams 1:24K
Restored Reach

Temp Sensor Location



0 200 400 Feet

Willow Pond

Treatment Site
Retrofitted (2020)
DA: 349 Acres, 22.1% Impervious



Streams 1:24K
Restored Reach

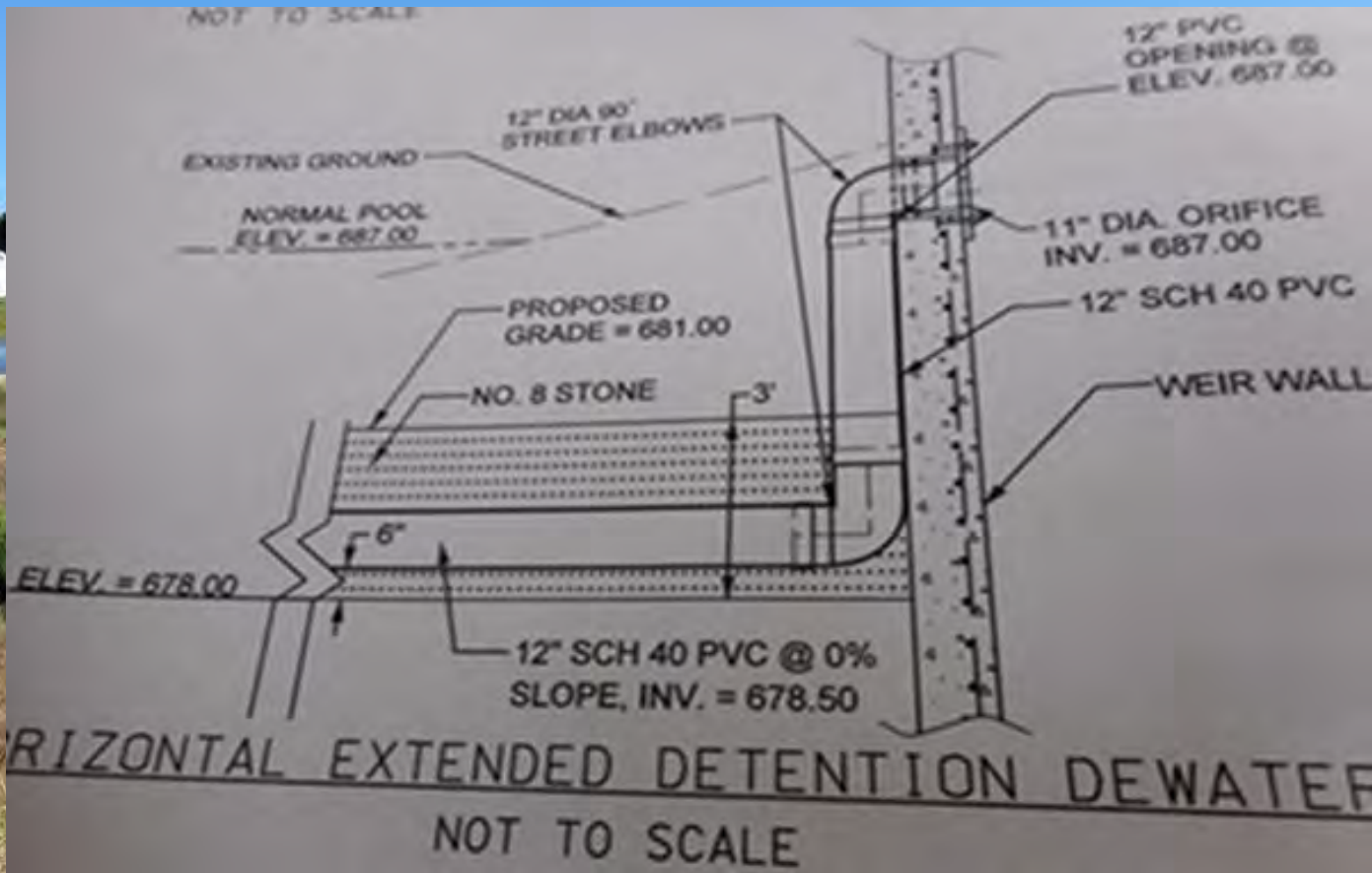
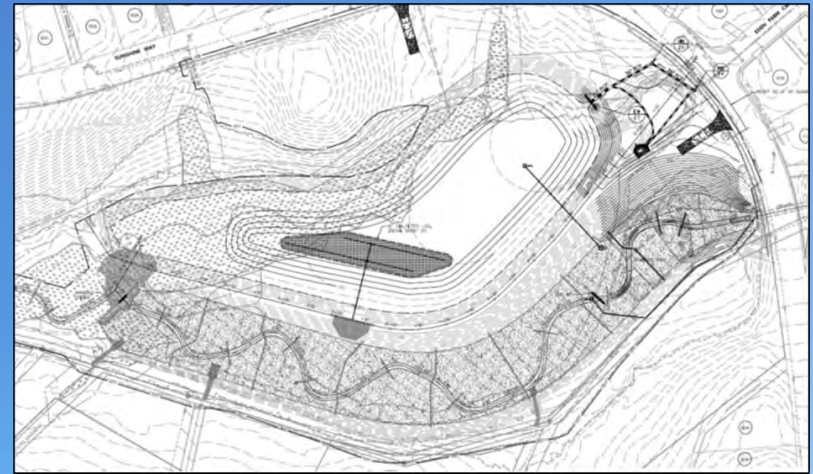
Temp Sensor Location



0 200 400 Feet

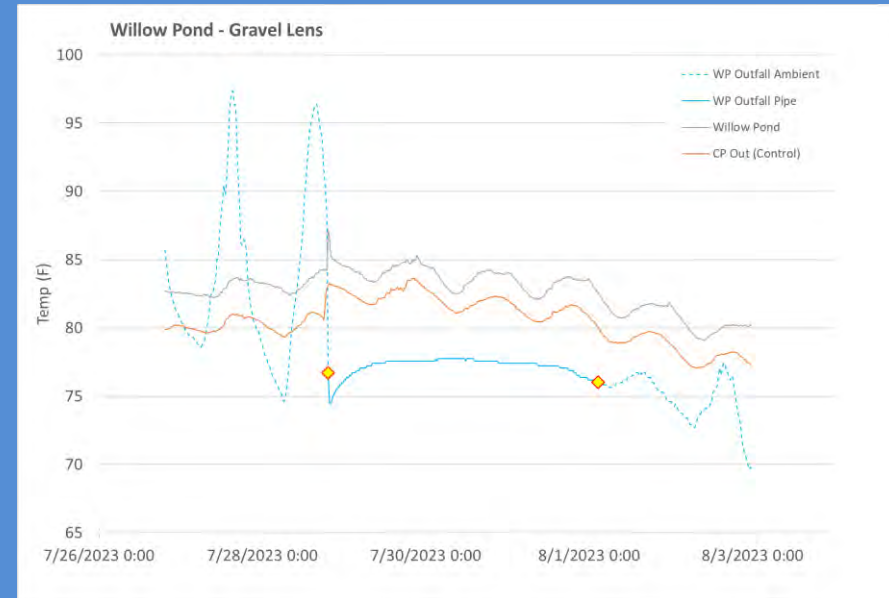
Gravel Lens Plan Details

Size: 50' x 300' x 3' Depth – No. 8 Stone
12" Dewatering Pipe



Monitoring Timeline

- 2018-2020
 - Pre Restoration Baseline
- 2020
 - Gravel Lens Retrofit
- 2021
 - Buoy Install w/ Watershed Sensors
- 2022
 - Discharge Data Recorded @ Outfall
 - Control Sensor Failure
- 2023
 - Interesting Results; 20-minute sensor readings
- 2024/2025
 - Changed Sensors to 5-minute readings



July 28, 2023 Storm

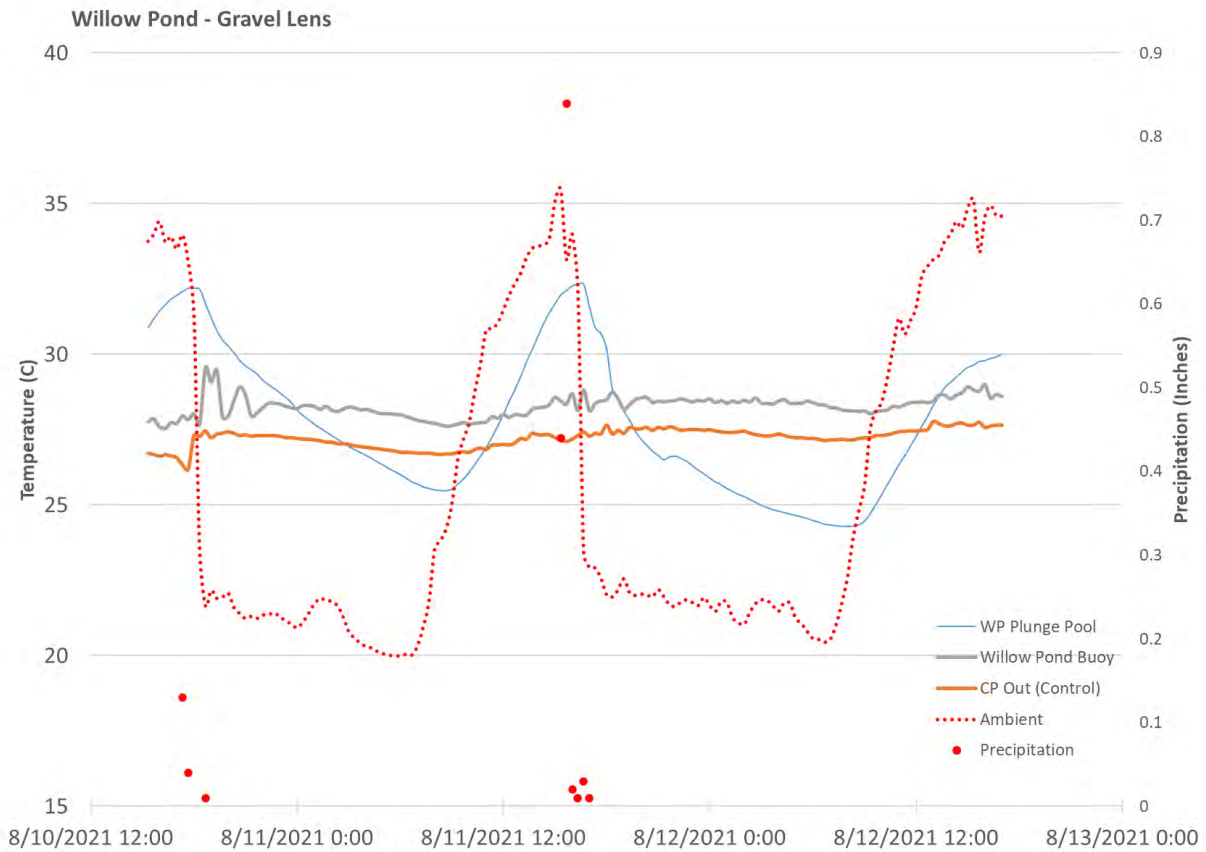
2021 Thermal Season



Buoy Launch 5/15/2021

Plunge Pool Sensor

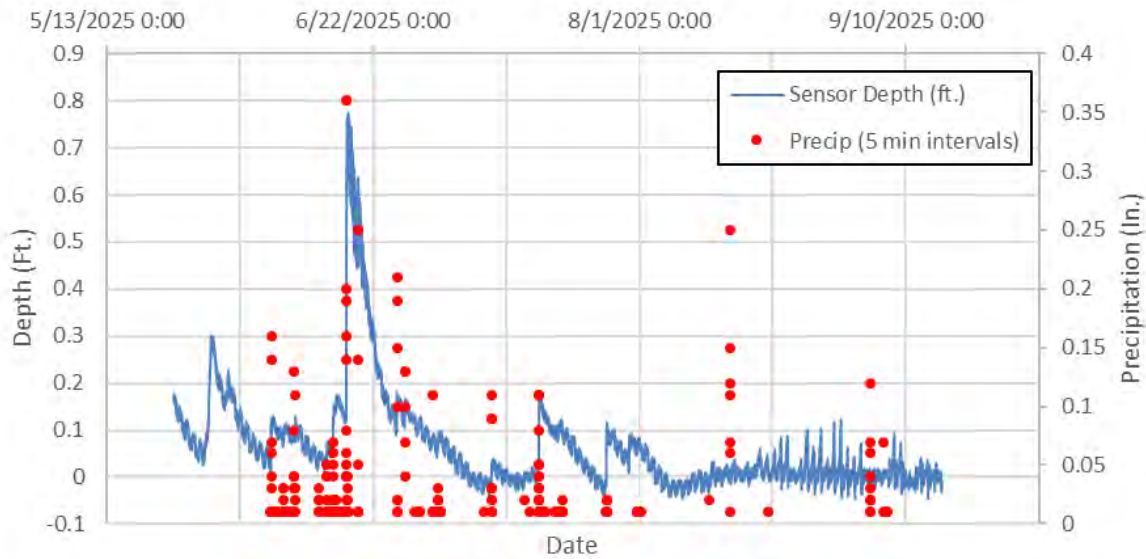




Orifice w/ U20L H0BO
 Pressure Sensor
 Installed 2022

2021 Thermal Season

Willow Pond Outfall Discharge



Gravel Lens Outfall - 2025



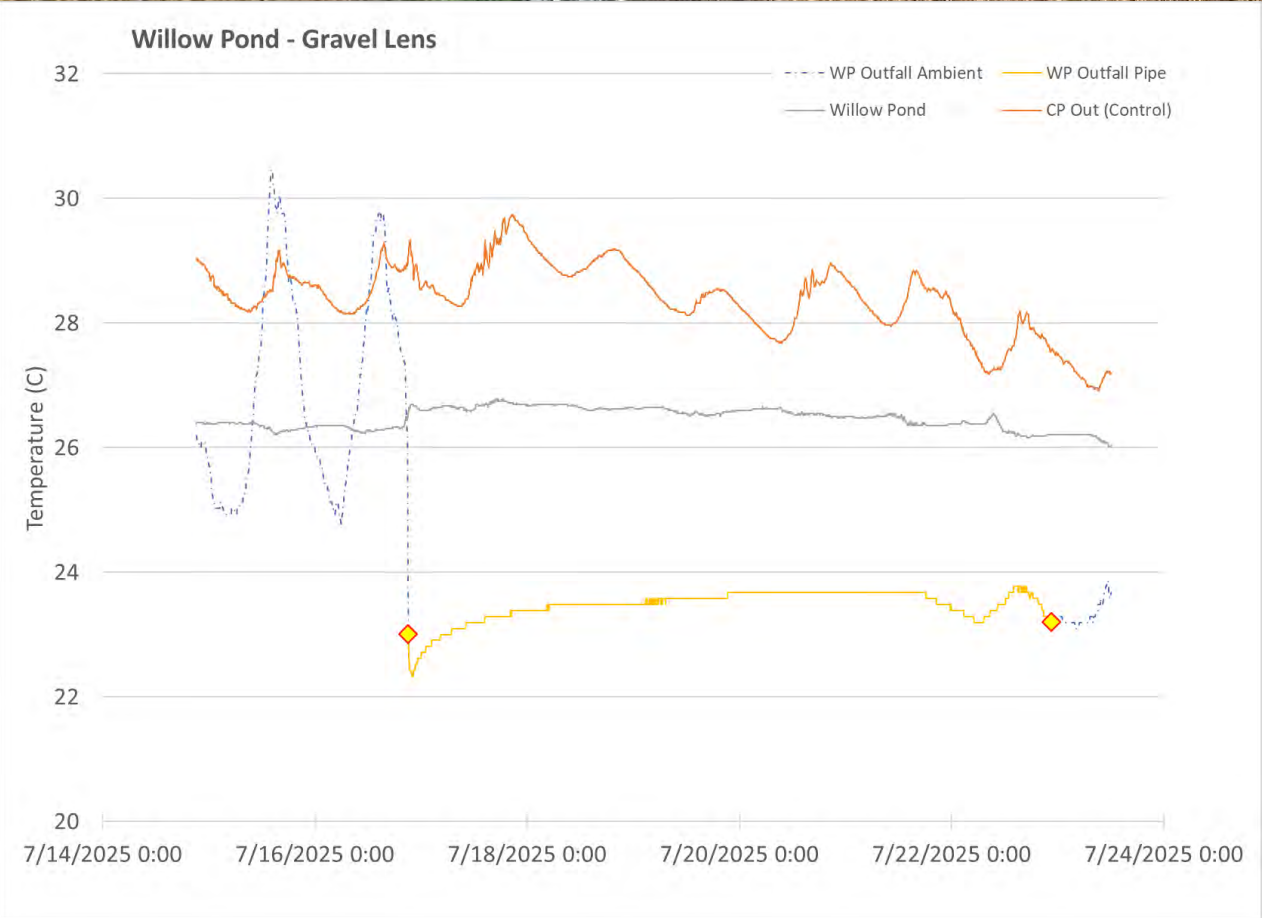
Willow Pond Outfall Temperature





July 17, 2025 – 0.95” Precipitation

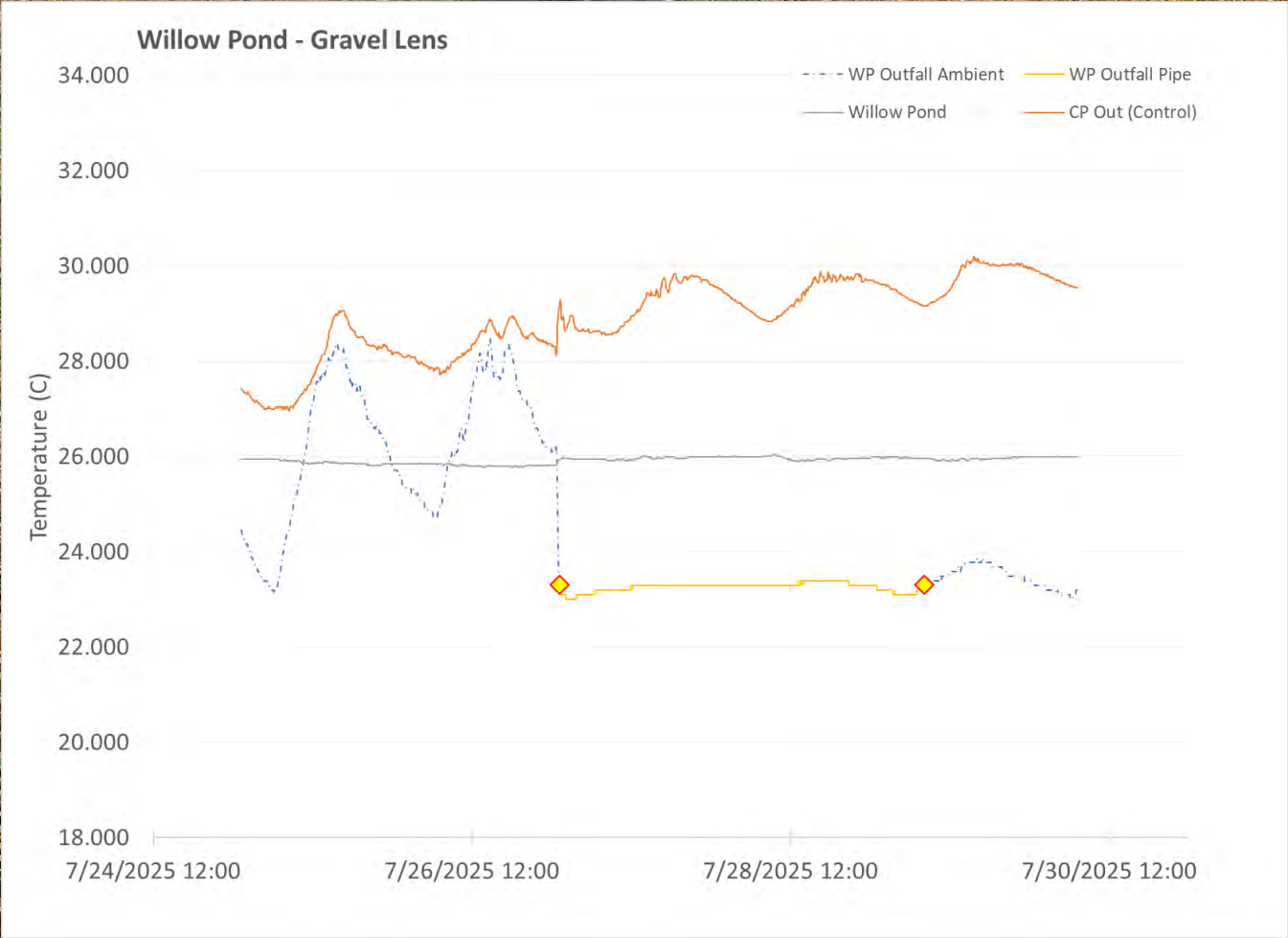
Location	Average Temp (C) During Event*	Median Temp (C) During Event*	Max Temp (C) During Event
WP Outfall (Gravel Lens)	23.464	23.484	23.677
CP Outfall (Control)	28.608	28.593	29.740
Willow Pond (Buoy)	26.606	26.622	26.793



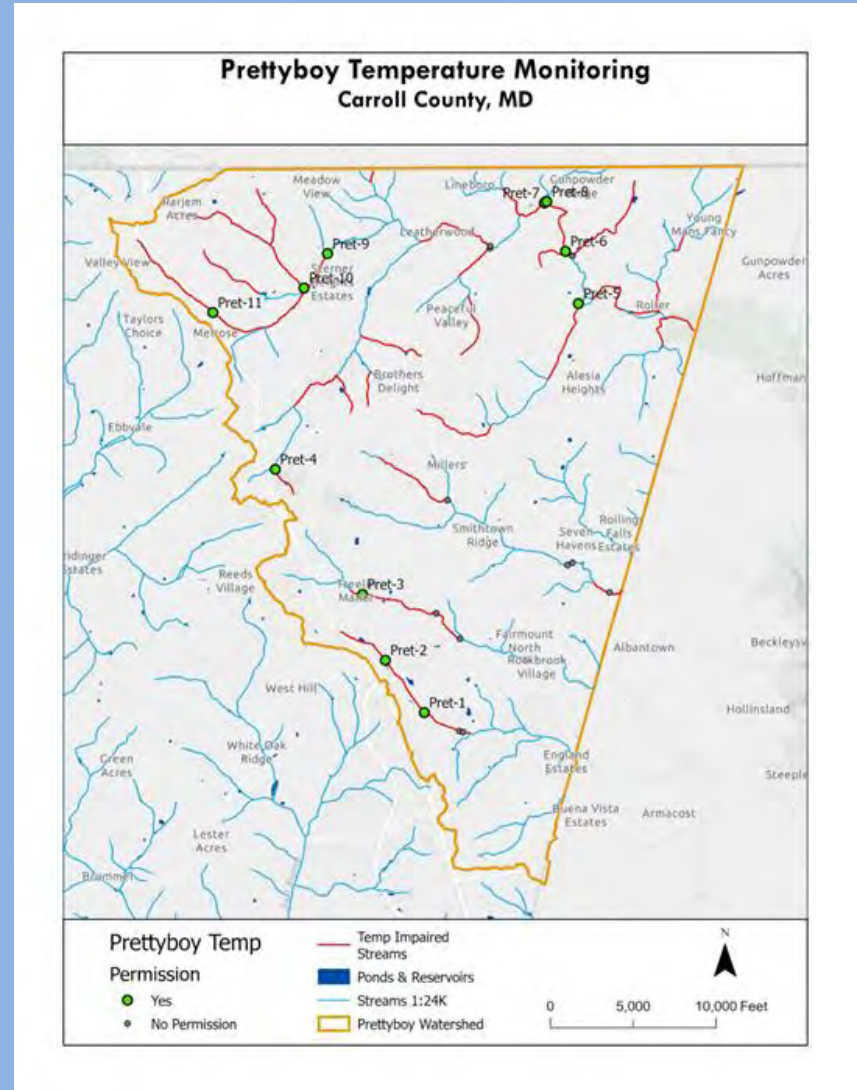
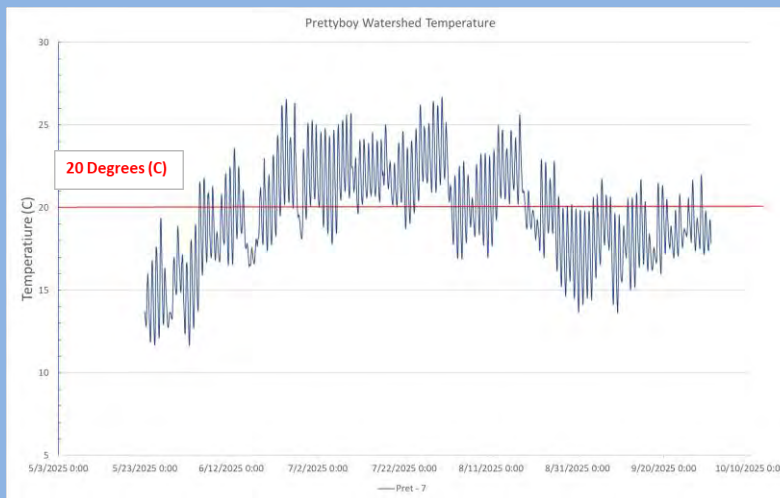
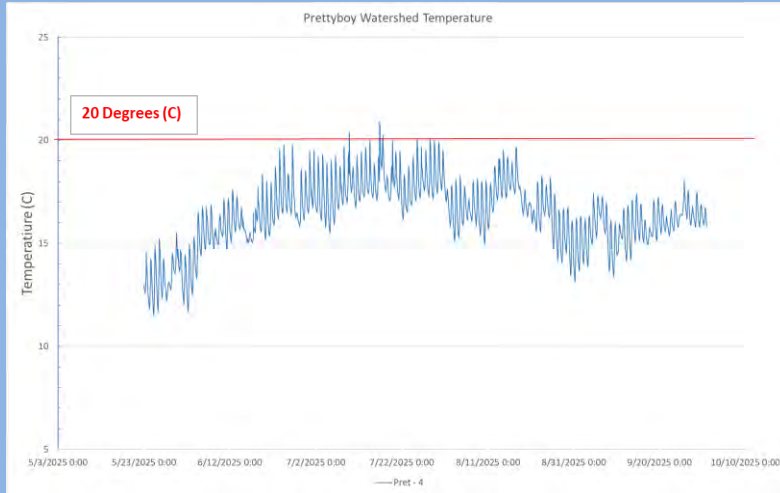


July 26, 2025 – 0.12" Precipitation (rain gauge ~1 mile away)

Location	Average Temp (C) During Event*	Median Temp (C) During Event*	Max Temp (C) During Event
WP Outfall (Gravel Lens)	23.257	23.292	23.388
CP Outfall (Control)	29.294	29.365	29.865
Willow Pond (Buoy)	25.964	25.963	26.036



Prettyboy Reservoir Watershed Pending Temperature TMDL



Prettyboy Watershed

Site 10

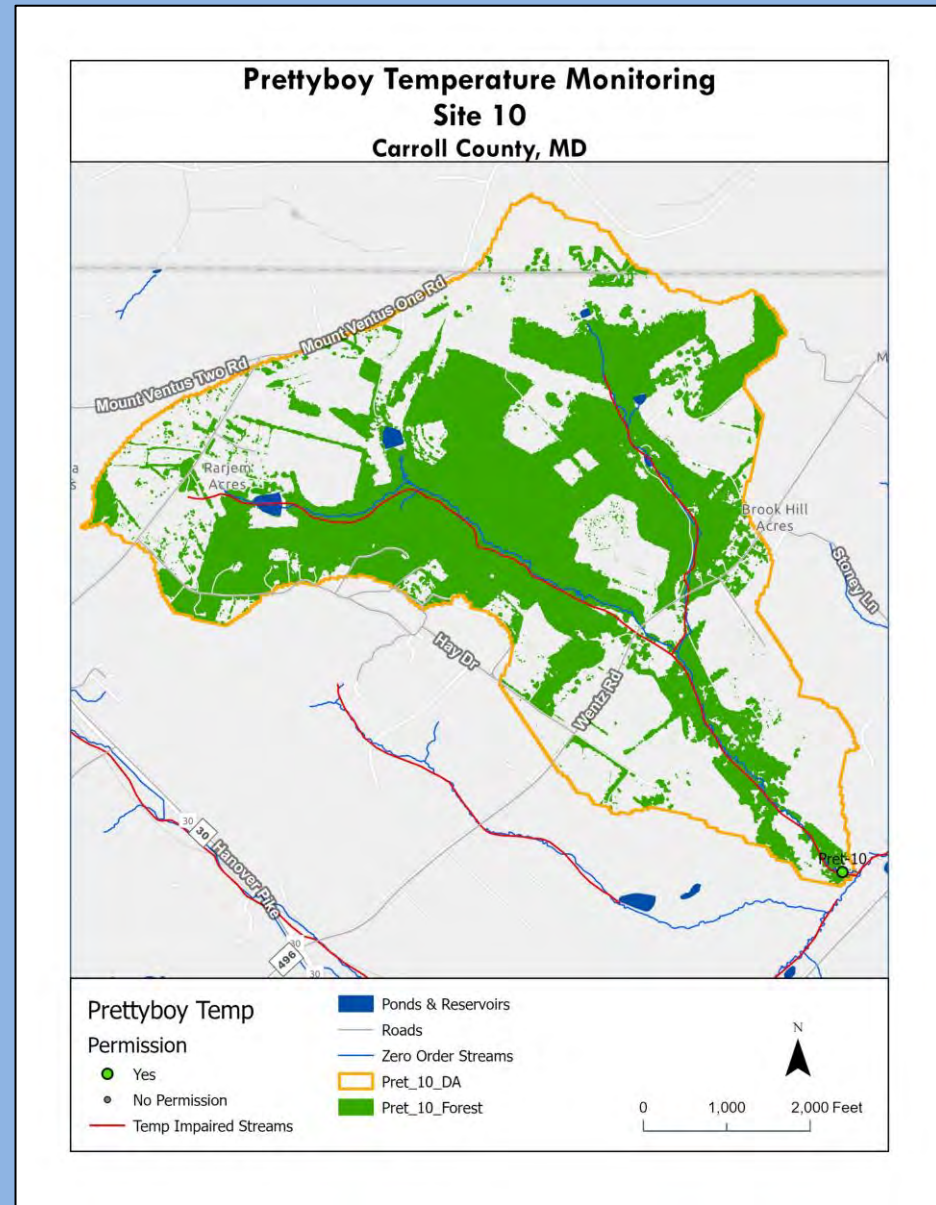
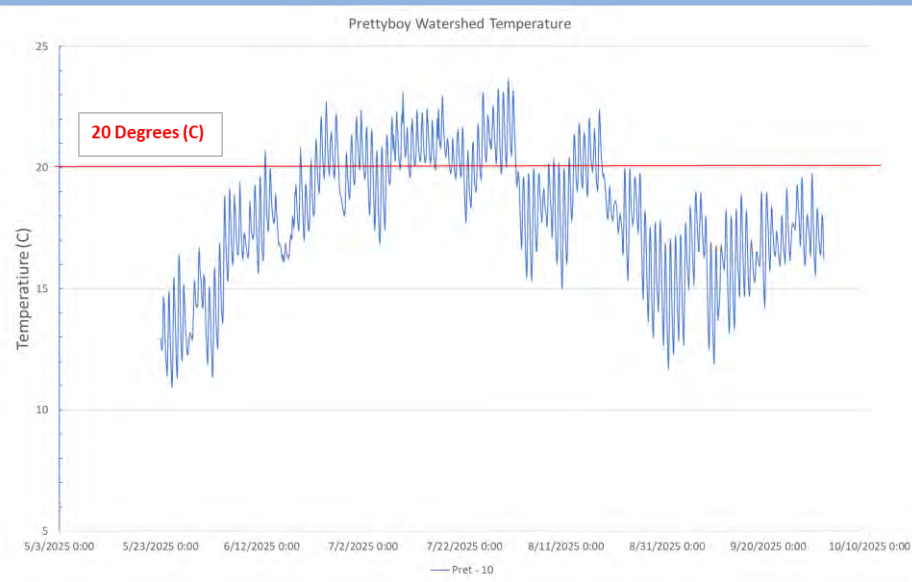
Drainage Area: 836 Acres

Forest Cover: 393 Acres (47%)

Riparian Forest Cover: 62 Acres (83%)

Headwater Ponds: 5

- 3.94 Acre Combined Surface Area



% of Time above 20° C	June	July	August	Sept.	Overall
Pret-10	17%	75%	14%	0%	27%

Byron Madigan

Carroll County Government

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Thank You!!

Willow Stream Restoration/Gravel
Lens Wet Pond