WETLAND HYDROLOGIC ENHANCEMENT THROUGH STREAM RESTORATION

CASE STUDY: BACON RIDGE BRANCH STREAM RESTORATION (ELKS CAMP BARRETT) ANNE ARUNDEL COUNTY, MARYLAND

GreenVest, LLC ("GreenVest") initiated the Bacon Ridge Branch Stream Restoration Project ("Project") in the South River Watershed to provide ecological enhancement, improve water quality, and reduce pollutant loads generated from the site and its contributing watersheds. The Project was designed and constructed to provide stream restoration for use in meeting Total Maximum Daily Load ("TMDL") reductions for the Maryland Department of Transportation - Maryland State Highway Administration's MS4 permit requirements. The primary method of stream restoration was the construction of engineered log jam structures along deeply incised channels to raise the stream water surface elevation and reconnect the disconnected floodplain. An associated goal of the restoration was to explore the potential hydrologic rehabilitation of remnant floodplain wetlands through stream restoration.

Location: The Project is located in the South River Watershed, downstream of the Bacon Ridge Natural Area in Anne Arundel County, Maryland. The entire Project area is forested. The downstream portion of the main stem is located within the Critical Area ("CA") but the majority of the Project is located outside of the CA. The Bacon Ridge Branch main stem and its main tributary were the focus of the restoration effort. Both are located within a Federal Emergency Management Agency ("FEMA") regulated floodplain.

Existing Conditions: Streams throughout the Project area were deeply incised, with vertical banks 4-10 feet deep (Photograph 1, left). Streams were actively eroding from both bed incision and cross-section/bank widening. Historic land use and stormwater runoff from upstream residential developments and roadways contributed to ongoing channel degradation. The active incision and bank erosion resulted in the reduction of floodplain function through decreased connectivity to stream flow and associated overbank events along the main stem and main tributary, as well as the drainage of groundwater (through stream bank groundwater interception) away from existing floodplain wetlands. Although remnant hydric soils were evident throughout the floodplain, relatively few areas contained hydrophytic vegetation or indicators of wetland hydrology.

Restoration Design: The stream restoration design approach called for the use of on-site materials to the maximum extent possible, particularly wood, since woody debris is the dominant material found in streams of similar geomorphic setting. To minimize the use of off-site material and grading within the floodplain to reshape channel banks, engineered log jam structures were constructed within the channel to increase the water surface elevation of the stream and hydrologically reconnect the stream to the existing floodplain (Photograph 1, right). Over time, it is anticipated that the pools between log jam structures will fill with sediment.

Photograph 1. Before (left) and After (right) Construction of Engineered Log Jam at Same Location on Tributary. Note Two American Beech on the Right Bank to Reference Location.

Effect on Groundwater: While the primary focus of the Project was stream restoration, GreenVest installed shallow groundwater monitoring wells to observe the effect of the stream restoration on the local water table throughout the system (see Attachment A). The wells were installed along three transects at intervals from the edge of the stream across the forested floodplain to the valley wall. Transects were deliberately located outside of delineated wetlands to assess the potential for stream restoration to restore lost wetland function. Hydrographs illustrating the water levels relative to the ground surface for the three transects (T1, T2, T3) are included in Attachment A. As the graphs show, groundwater levels were at or below the bottom of the monitoring wells (≥3 feet below the surface) prior to construction of the next downstream log jam structure on September 11, 2019 (T1 and T2) and October 30, 2019 (T3). Water levels in stream monitoring wells reacted immediately following the installation of log jam structures downstream, with water levels rising to the invert elevation of the structure. Groundwater levels, however, typically remained low until several rain events in mid-late October 2019 when groundwater levels increased to at, or near, the ground surface and remained at this level throughout the rest of the fall and winter at all locations. Some increase in groundwater levels is expected coincident with leaf-off and reduced evapotranspiration at the end of the growing season, however, the 2019 growing season did not end until November 13. Water levels remained elevated through winter and into the next growing season, which began on March 2, 2020. Groundwater levels during the 2020 growing season were high enough to satisfy hydrologic wetland criteria (within 12 inches of the ground surface for 14 consecutive days) as much as 300 feet from the stream channel at all but one location. Elevated groundwater levels persisted until the typical July drawdown associated with peak seasonal evapotranspiration rates. Groundwater levels increased again in August due to higher than normal rainfall.

Effects on Biology: This was only the first year following construction but the biological response to the Project is very positive. Species observed in the Project area include great blue heron, mallard and wood duck, beaver, red-tailed hawk, copperhead snake, wild turkey, snapping turtle, box turtle, bald eagle, spring peeper, wood frog, American toad, eastern ratsnake, white-tailed deer, and racoon. Habitat for several of these species was lacking prior to implementation of the Project. Of particular interest, yellow perch eggs attached to the branches of some of the log jam

structures were observed in March 2020. Spawning habitat for yellow perch was not available in the area before the restoration. Forest Interior Dwelling Species ("FIDS") such as barred owl, red-shouldered hawk, northern parula, wood thrush, and pileated woodpecker have also been observed in the Project area despite concerns by some that removal of trees would create gaps in the canopy large enough to prevent FIDS use. GreenVest anticipates continued positive changes in the vegetation and wildlife community as the site matures.

Conclusion: Preliminary results showed a significant increase in groundwater elevations across the forested floodplain after construction of the Project compared to pre-construction conditions. Prior to construction, groundwater levels throughout the floodplain were 2-4 feet or more below the ground surface and lower closer to the incised channels. After construction, groundwater levels rose to within 1 foot of the soil surface, rehydrating and restoring former floodplain wetlands, and returning wetland function throughout the system. In addition, the floral and faunal community has rapidly responded to the newly available habitat.

Please contact GreenVest with questions or requests for additional information:

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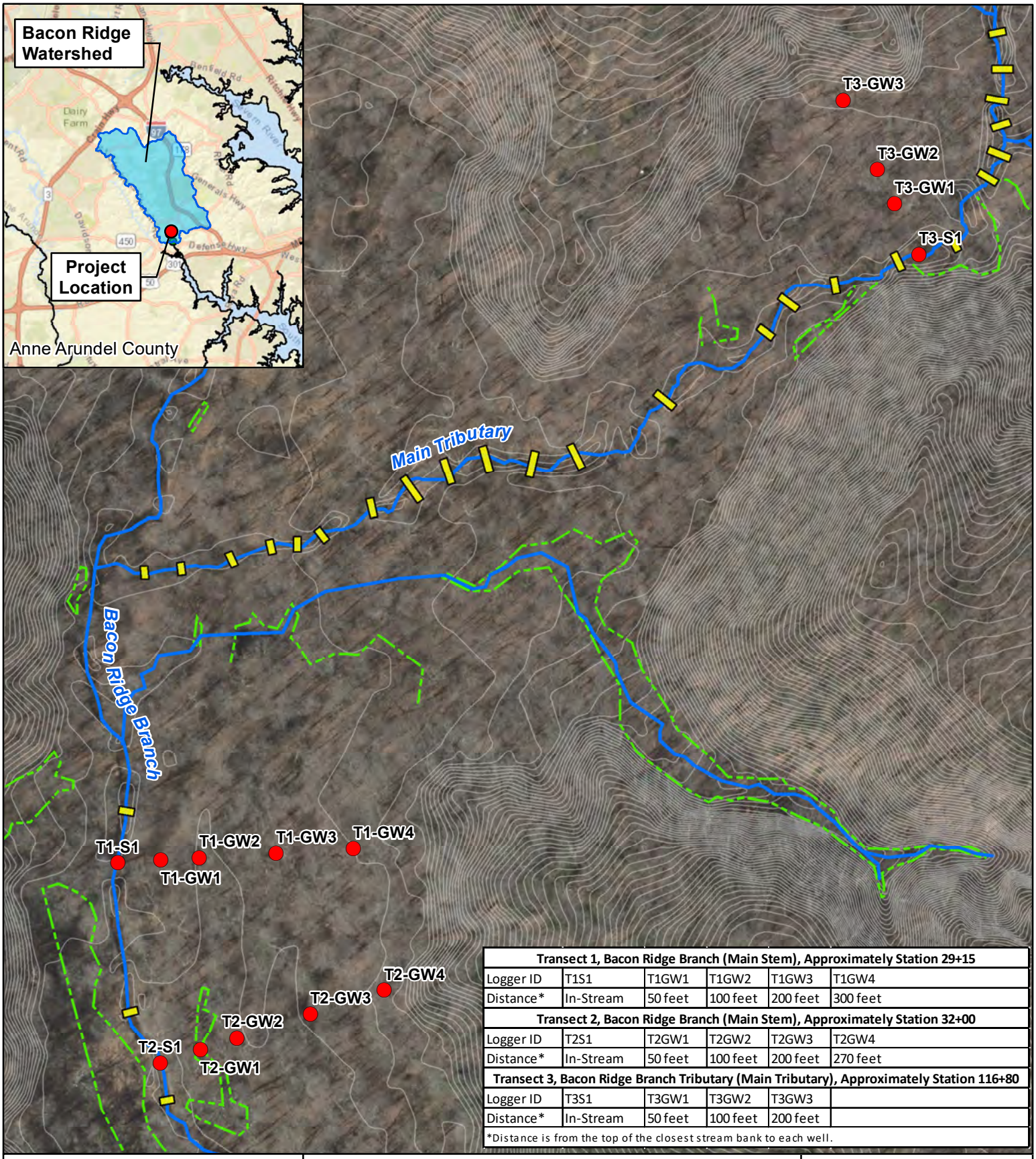
ATTACHMENT A – TRANSECT MAP AND GROUNDWATER HYDROGRAPHS



Transect 1, Bacon Ridge Branch (Main Stem), Approximately Station 29+15					
Logger ID	T1S1	T1GW1	T1GW2	T1GW3	T1GW4
Distance*	In-Stream	50 feet	100 feet	200 feet	300 feet
Transect 2, Bacon Ridge Branch (Main Stem), Approximately Station 32+00					
Logger ID	T2S1	T2GW1	T2GW2	T2GW3	T2GW4
Distance*	In-Stream	50 feet	100 feet	200 feet	270 feet
Transect 3, Bacon Ridge Branch Tributary (Main Tributary), Approximately Station 116+80					
Logger ID	T3S1	T3GW1	T3GW2	T3GW3	
Distance*	In-Stream	50 feet	100 feet	200 feet	

*Distance is from the top of the closest stream bank to each well.

Water Level Logger Locations
Log Jam Structures
Delineated Preconstruction Wetland Boundaries
Streams
2ft Contours
N
0 80 160 Feet

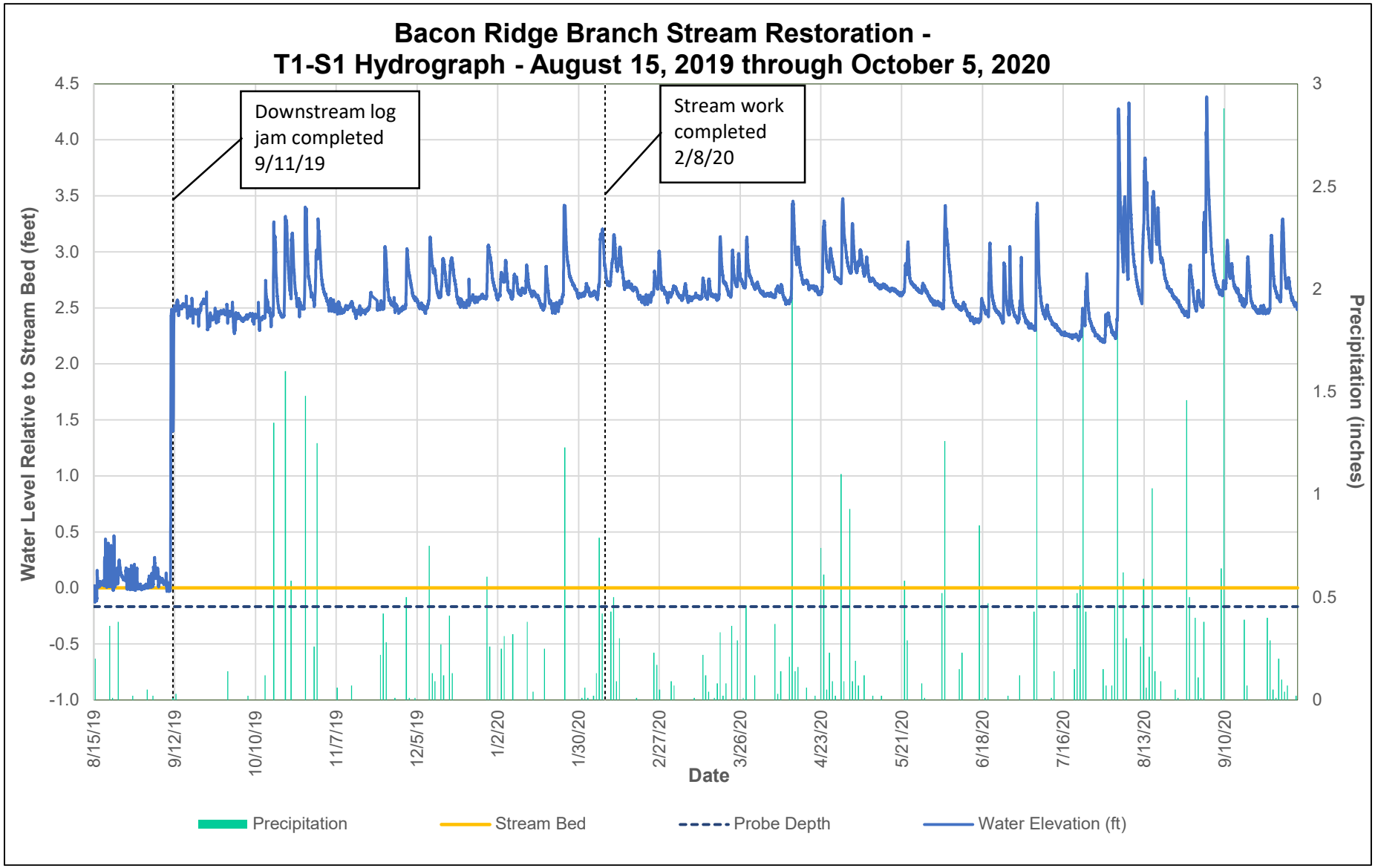
Water Level Logger Location Map
Bacon Ridge Branch (Elks Camp Barrett) Stream Restoration

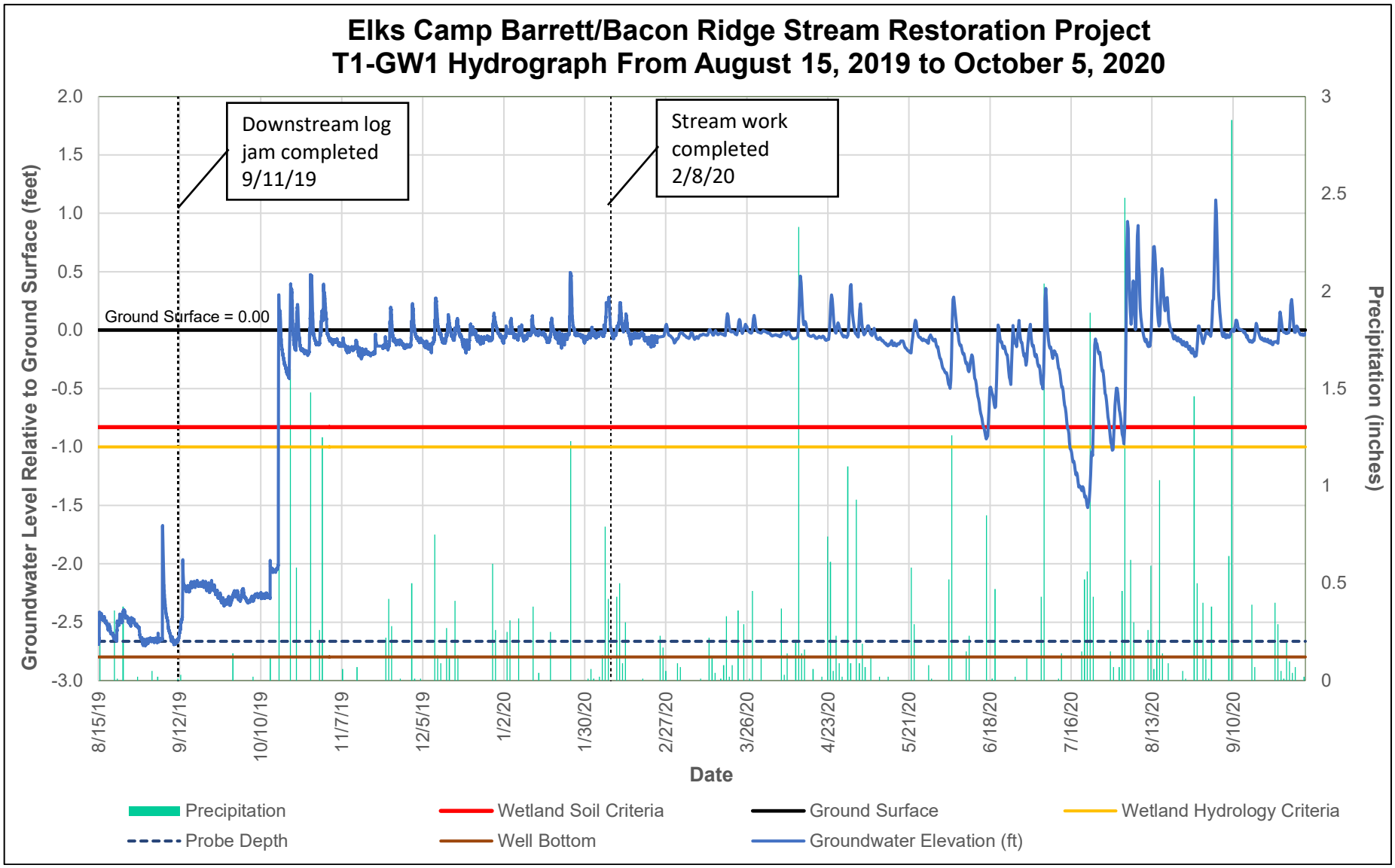
Anne Arundel County, MD

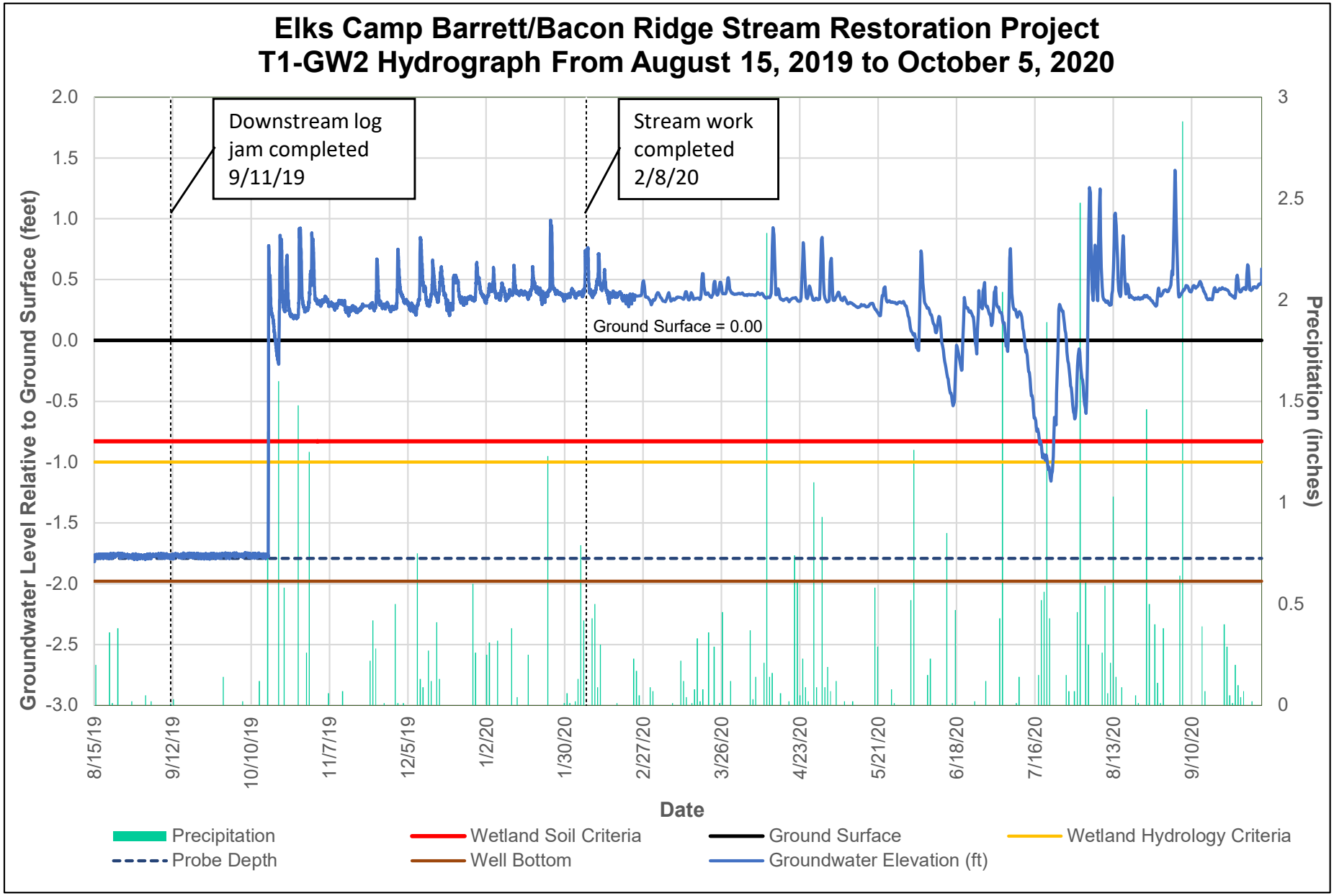
GreenVest
VISION · PERFORMANCE · RESULTS
4201 Northview Drive, Suite 202
Bowie, MD 20716 (410) 987-5500

Document Path: X:\Planning_Design\PROJECTS\SHA_Elks Club\GIS Work\Elks Water Logger Locations.mxd

Date: 10/15/2020


Bacon Ridge Branch Stream Restoration -
T1-S1 Hydrograph - August 15, 2019 through October 5, 2020
Downstream log jam completed 9/11/19
Stream work completed 2/8/20
Water Level Relative to Stream Bed (feet)
Precipitation (inches)
Date
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
3
2.5
2
1.5
1
0.5
0
8/15/19
9/12/19
10/10/19
11/7/19
12/5/19
1/2/20
1/30/20
2/27/20
3/26/20
4/23/20
5/21/20
6/18/20
7/16/20
8/13/20
9/10/20
Precipitation
Stream Bed
Probe Depth
Water Elevation (ft)


Elks Camp Barrett/Bacon Ridge Stream Restoration Project
T1-GW1 Hydrograph From August 15, 2019 to October 5, 2020
Downstream log jam completed 9/11/19
Stream work completed 2/8/20
Ground Surface = 0.00
Groundwater Level Relative to Ground Surface (feet)
Precipitation (inches)
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0
3
2.5
2
1.5
1
0.5
0
8/15/19
9/12/19
10/10/19
11/7/19
12/5/19
1/2/20
1/30/20
2/27/20
3/26/20
4/23/20
5/21/20
6/18/20
7/16/20
8/13/20
9/10/20
Date
Precipitation
Wetland Soil Criteria
Ground Surface
Wetland Hydrology Criteria
Probe Depth
Well Bottom
Groundwater Elevation (ft)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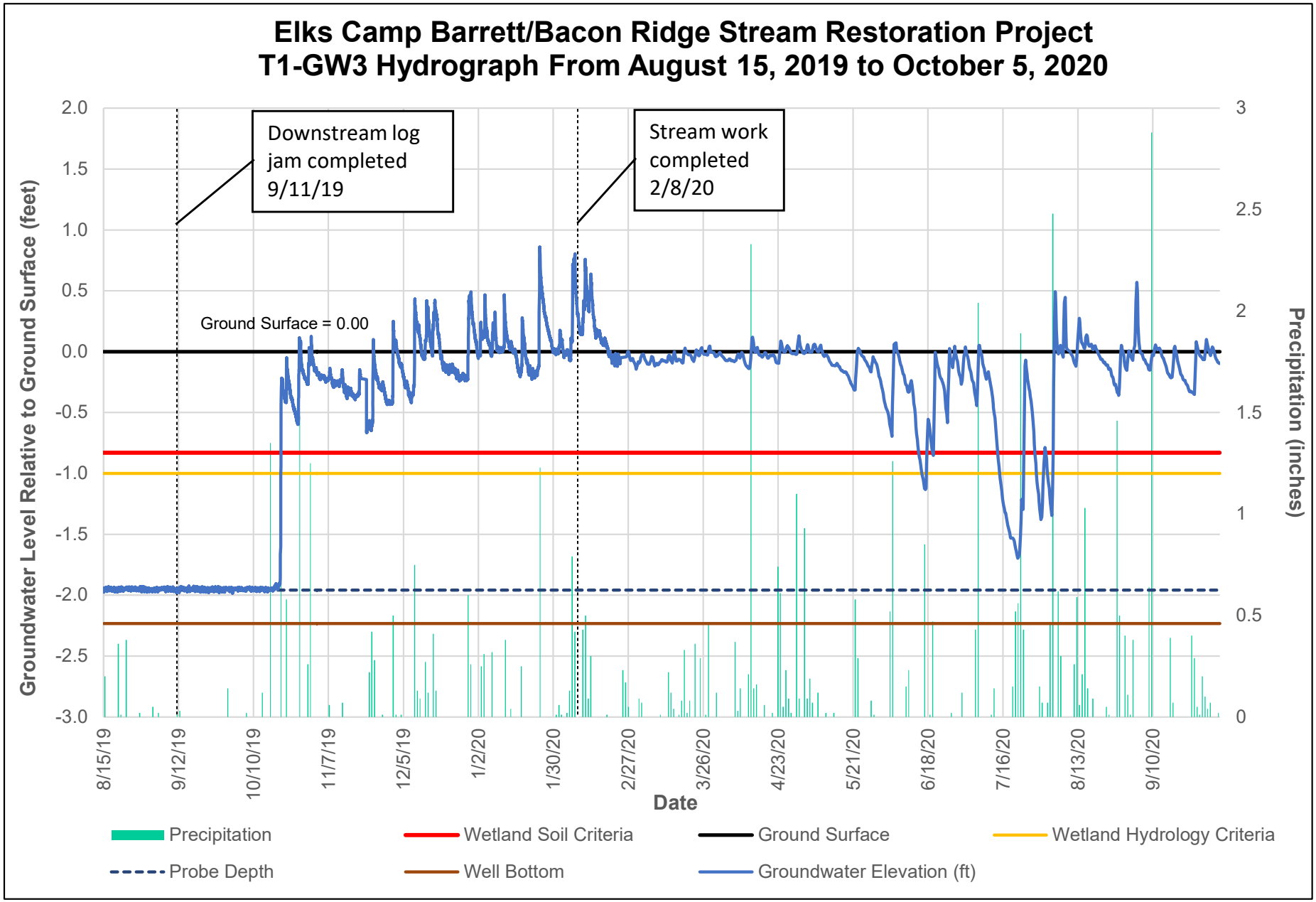
T1-GW2 Hydrograph From August 15, 2019 to October 5, 2020
Downstream log jam completed 9/11/19
Stream work completed 2/8/20
Ground Surface = 0.00
Groundwater Level Relative to Ground Surface (feet)
Precipitation (inches)
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0
3
2.5
2
1.5
1
0.5
0
8/15/19
9/12/19
10/10/19
11/7/19
12/5/19
1/2/20
1/30/20
2/27/20
3/26/20
4/23/20
5/21/20
6/18/20
7/16/20
8/13/20
9/10/20
Date
Precipitation
Wetland Soil Criteria
Ground Surface
Wetland Hydrology Criteria
Probe Depth
Well Bottom
Groundwater Elevation (ft)


Elks Camp Barrett/Bacon Ridge Stream Restoration Project
T1-GW3 Hydrograph From August 15, 2019 to October 5, 2020
Downstream log jam completed 9/11/19
Stream work completed 2/8/20
Ground Surface = 0.00
Groundwater Level Relative to Ground Surface (feet)
Precipitation (inches)
Date
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0
3
2.5
2
1.5
1
0.5
0
8/15/19
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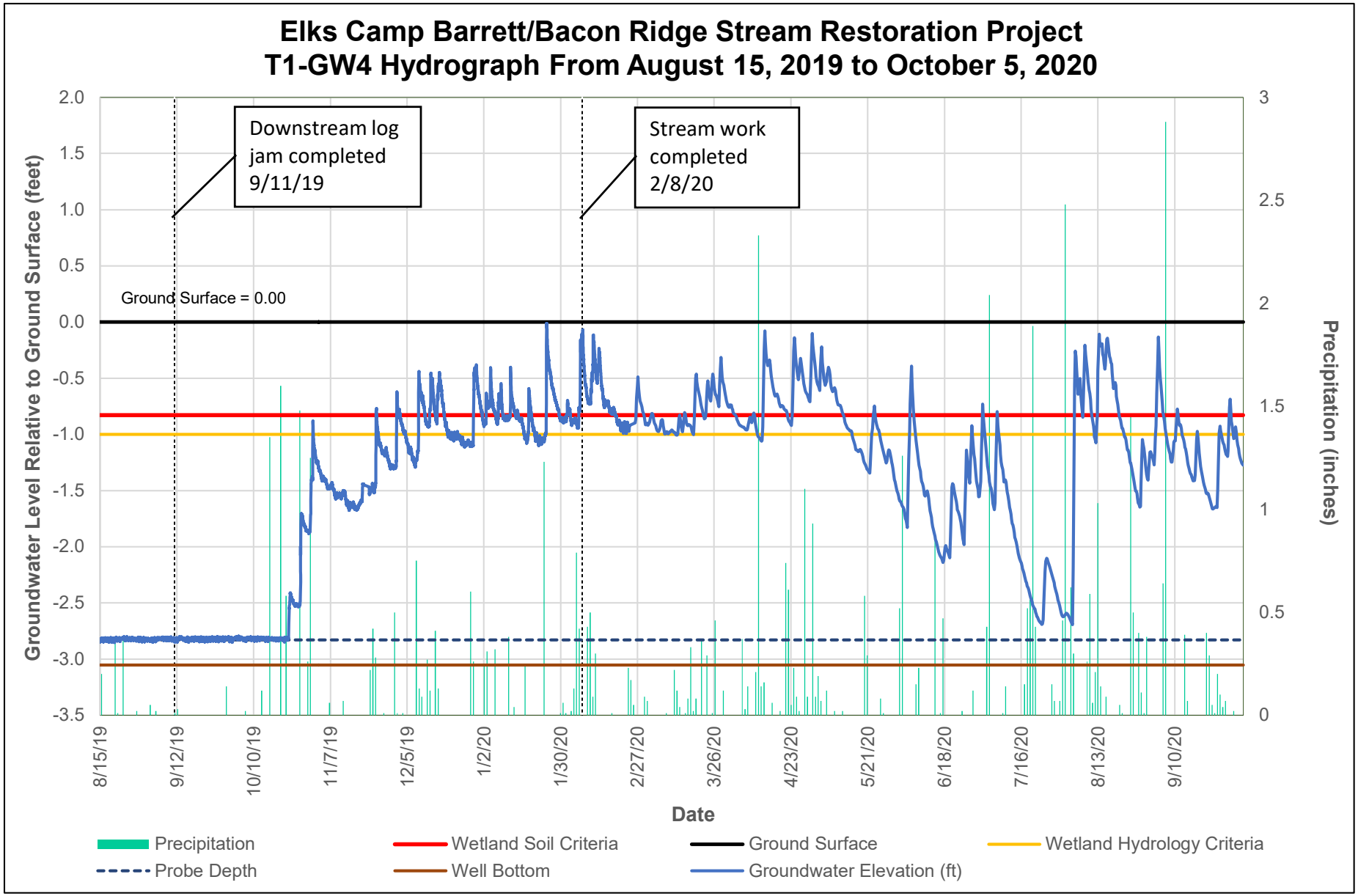
10/10/19
11/7/19
12/5/19
1/2/20
1/30/20
2/27/20
3/26/20
4/23/20
5/21/20
6/18/20
7/16/20
8/13/20
9/10/20
Precipitation
Wetland Soil Criteria
Ground Surface
Wetland Hydrology Criteria
Probe Depth
Well Bottom
Groundwater Elevation (ft)


Elks Camp Barrett/Bacon Ridge Stream Restoration Project
T1-GW4 Hydrograph From August 15, 2019 to October 5, 2020
Downstream log jam completed 9/11/19
Stream work completed 2/8/20
Ground Surface = 0.00
Groundwater Level Relative to Ground Surface (feet)
Precipitation (inches)
Date
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0
-3.5
3
2.5
2
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1
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8/15/19
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1/30/20
2/27/20
3/26/20
4/23/20
5/21/20
6/18/20
7/16/20
8/13/20
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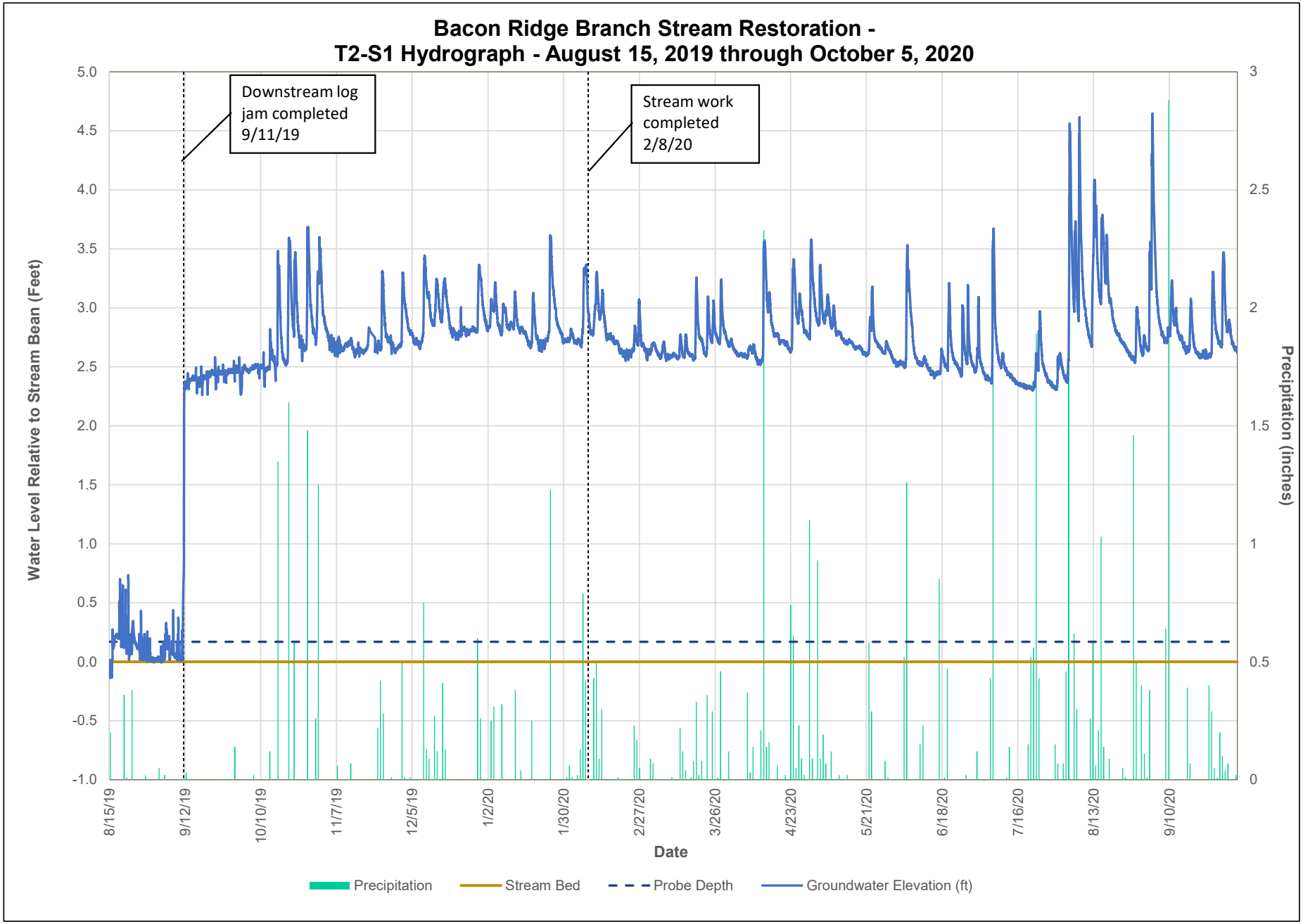
Precipitation
Wetland Soil Criteria
Ground Surface
Wetland Hydrology Criteria
Probe Depth
Well Bottom
Groundwater Elevation (ft)


Bacon Ridge Branch Stream Restoration -
T2-S1 Hydrograph - August 15, 2019 through October 5, 2020
Downstream log jam completed 9/11/19
Stream work completed 2/8/20
Water Level Relative to Stream Bean (Feet)
Precipitation (inches)
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
3
2.5
2
1.5
1
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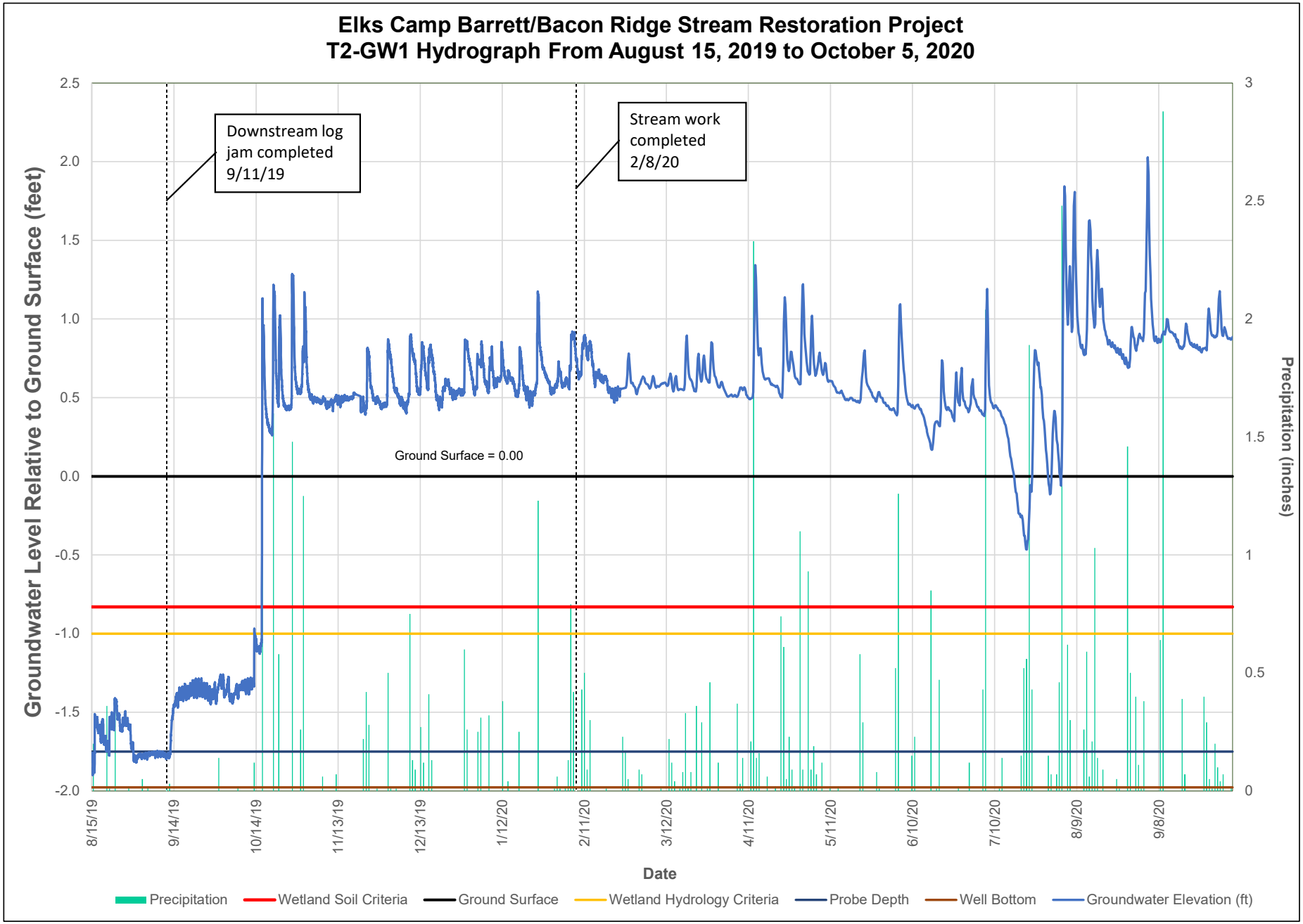
10/10/19
11/7/19
12/5/19
1/2/20
1/30/20
2/27/20
3/26/20
4/23/20
5/21/20
6/18/20
7/16/20
8/13/20
9/10/20
Date
Precipitation
Stream Bed
Probe Depth
Groundwater Elevation (ft)


Elks Camp Barrett/Bacon Ridge Stream Restoration Project
T2-GW1 Hydrograph From August 15, 2019 to October 5, 2020
Downstream log jam completed 9/11/19
Stream work completed 2/8/20
Ground Surface = 0.00
Groundwater Level Relative to Ground Surface (feet)
Precipitation (inches)
Date
2.5
2.0
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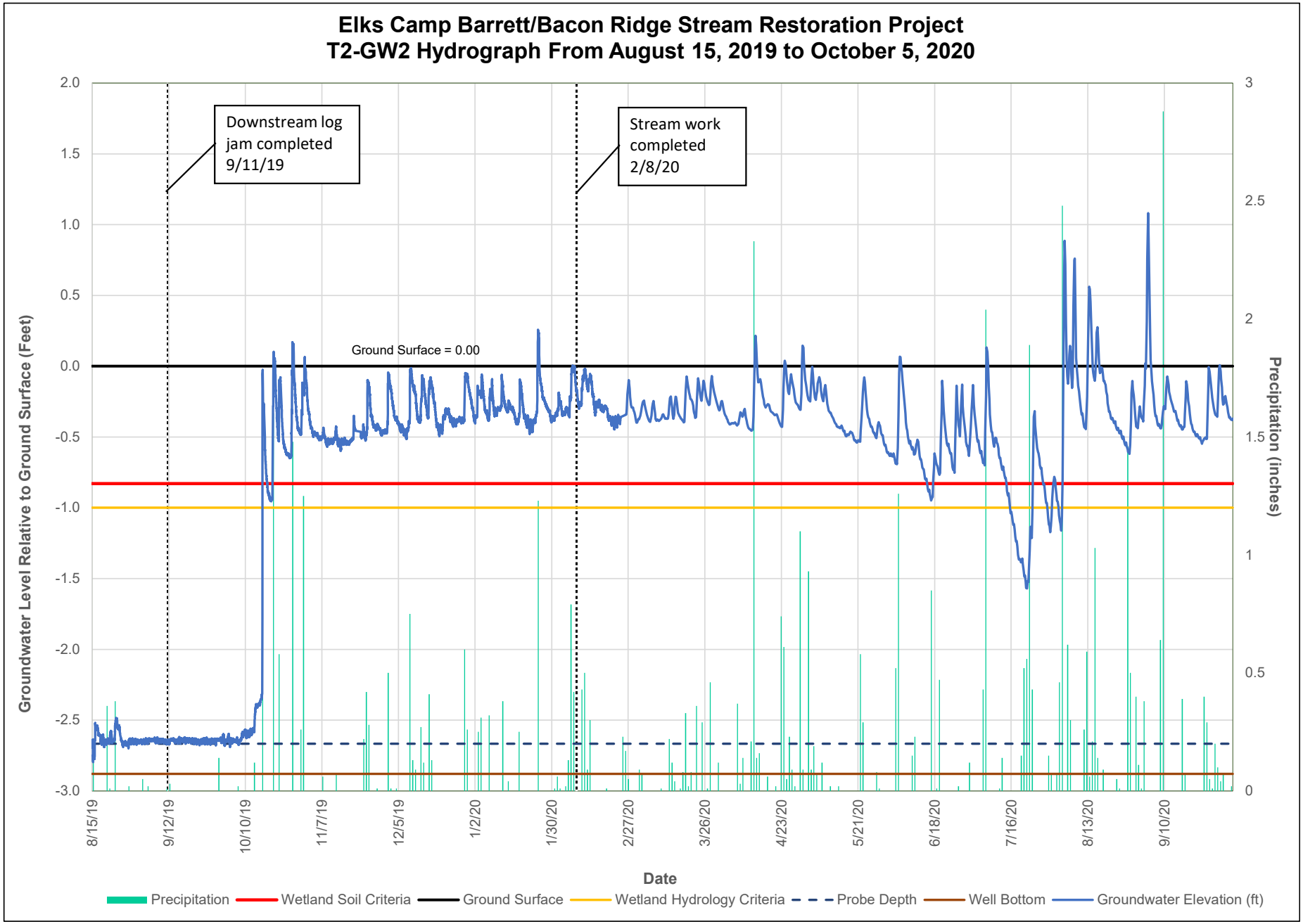
5/11/20
6/10/20
7/10/20
8/9/20
9/8/20
Precipitation
Wetland Soil Criteria
Ground Surface
Wetland Hydrology Criteria
Probe Depth
Well Bottom
Groundwater Elevation (ft)


Elks Camp Barrett/Bacon Ridge Stream Restoration Project
T2-GW2 Hydrograph From August 15, 2019 to October 5, 2020
Downstream log jam completed 9/11/19
Stream work completed 2/8/20
Ground Surface = 0.00
Groundwater Level Relative to Ground Surface (Feet)
Precipitation (inches)
Date
2.0
1.5
1.0
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7/16/20
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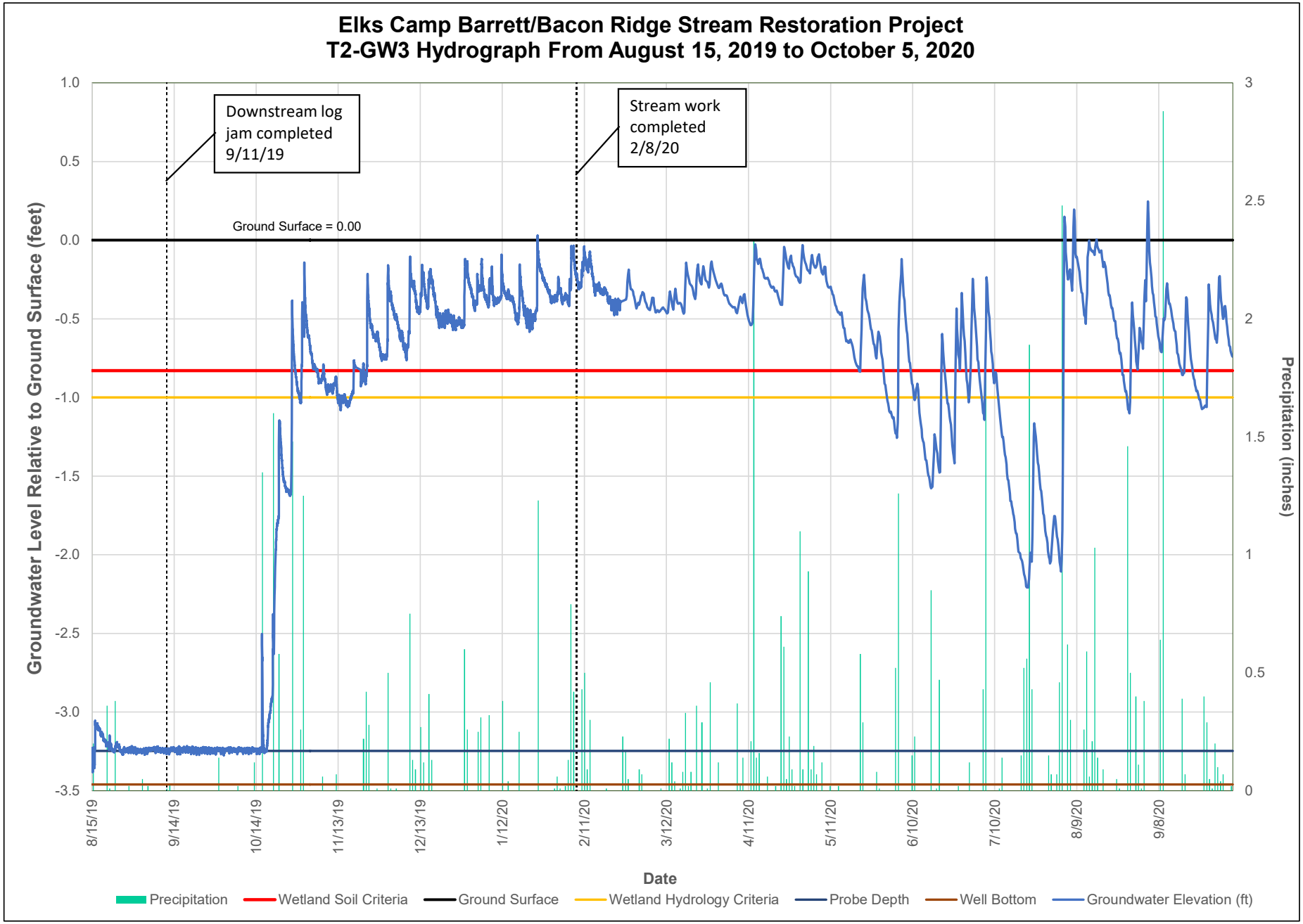
Precipitation
Wetland Soil Criteria
Ground Surface
Wetland Hydrology Criteria
Probe Depth
Well Bottom
Groundwater Elevation (ft)


Elks Camp Barrett/Bacon Ridge Stream Restoration Project
T2-GW3 Hydrograph From August 15, 2019 to October 5, 2020
Downstream log jam completed 9/11/19
Stream work completed 2/8/20
Ground Surface = 0.00
Groundwater Level Relative to Ground Surface (feet)
Precipitation (inches)
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0
-3.5
3
2.5
2
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8/15/19
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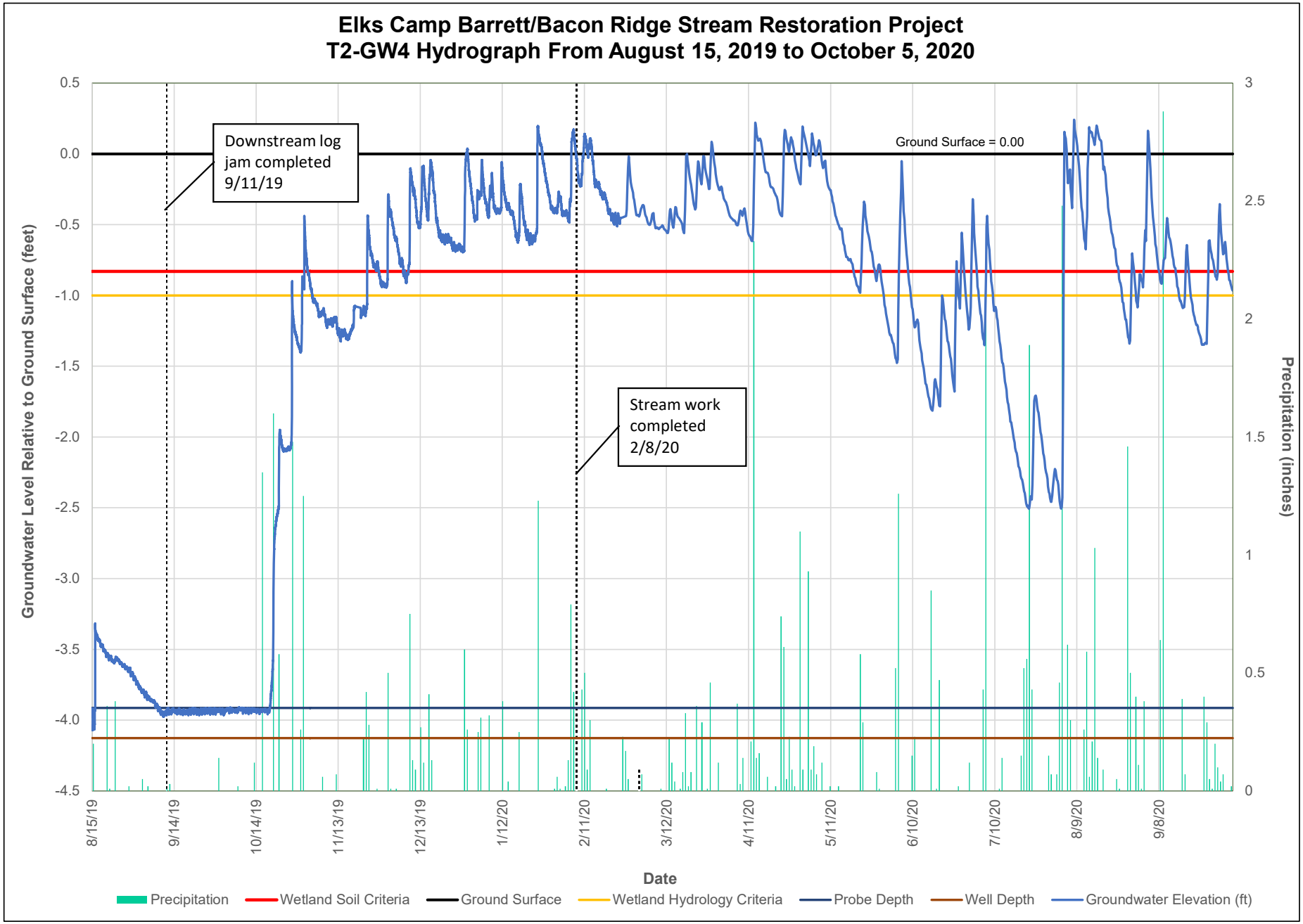
12/13/19
1/12/20
2/11/20
3/12/20
4/11/20
5/11/20
6/10/20
7/10/20
8/9/20
9/8/20
Date
Precipitation
Wetland Soil Criteria
Ground Surface
Wetland Hydrology Criteria
Probe Depth
Well Bottom
Groundwater Elevation (ft)


Elks Camp Barrett/Bacon Ridge Stream Restoration Project
T2-GW4 Hydrograph From August 15, 2019 to October 5, 2020
Downstream log jam completed 9/11/19
Stream work completed 2/8/20
Ground Surface = 0.00
Groundwater Level Relative to Ground Surface (feet)
Precipitation (inches)
0.5
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0
-3.5
-4.0
-4.5
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2.5
2
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1
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8/15/19
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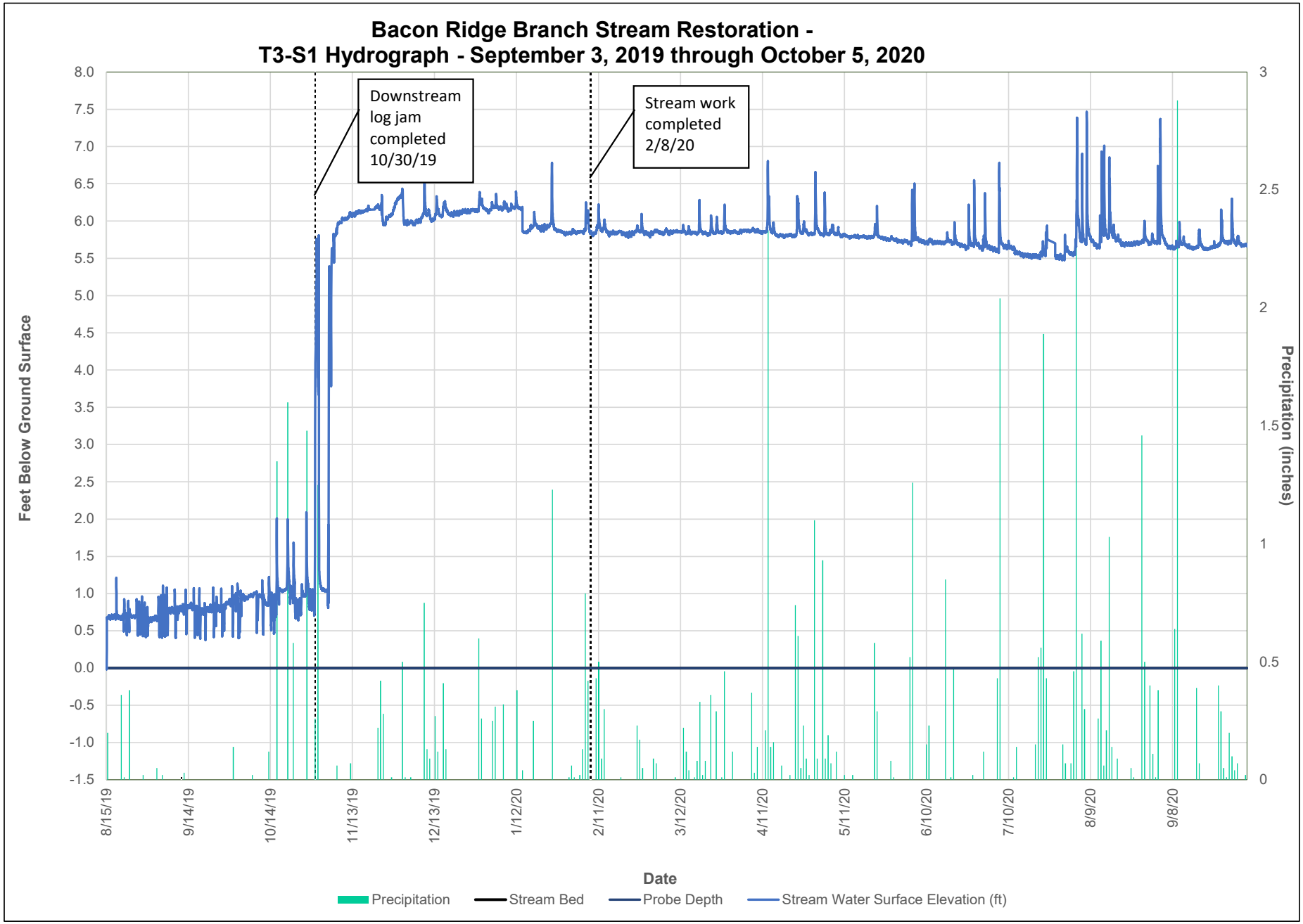
5/11/20
6/10/20
7/10/20
8/9/20
9/8/20
Date
Precipitation
Wetland Soil Criteria
Ground Surface
Wetland Hydrology Criteria
Probe Depth
Well Depth
Groundwater Elevation (ft)


Bacon Ridge Branch Stream Restoration -
T3-S1 Hydrograph - September 3, 2019 through October 5, 2020
Downstream log jam completed 10/30/19
Stream work completed 2/8/20
Feet Below Ground Surface
Precipitation (inches)
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
3
2.5
2
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0
8/15/19
9/14/19
10/14/19
11/13/19
12/13/19
1/12/20
2/11/20
3/12/20
4/11/20
5/11/20
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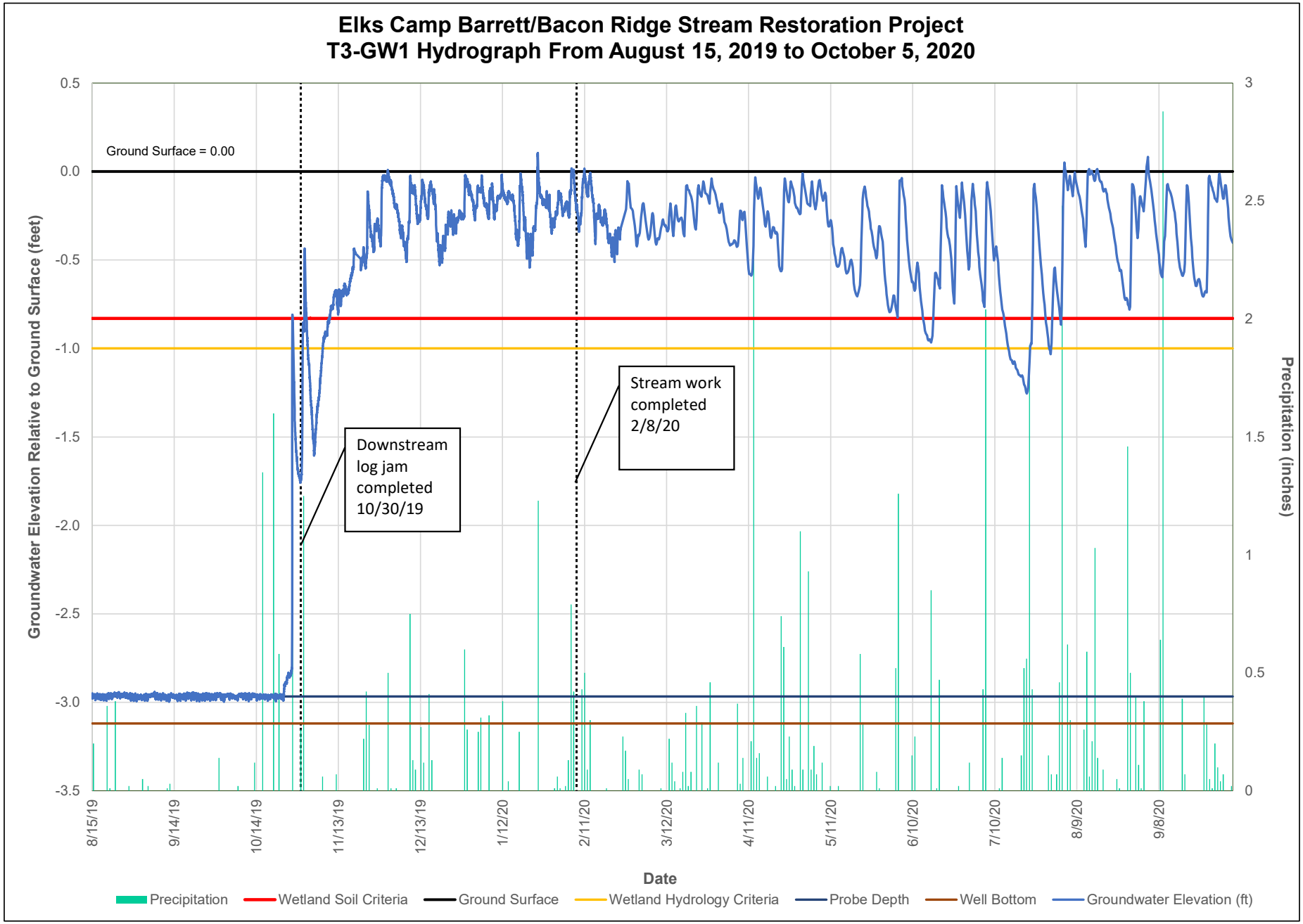
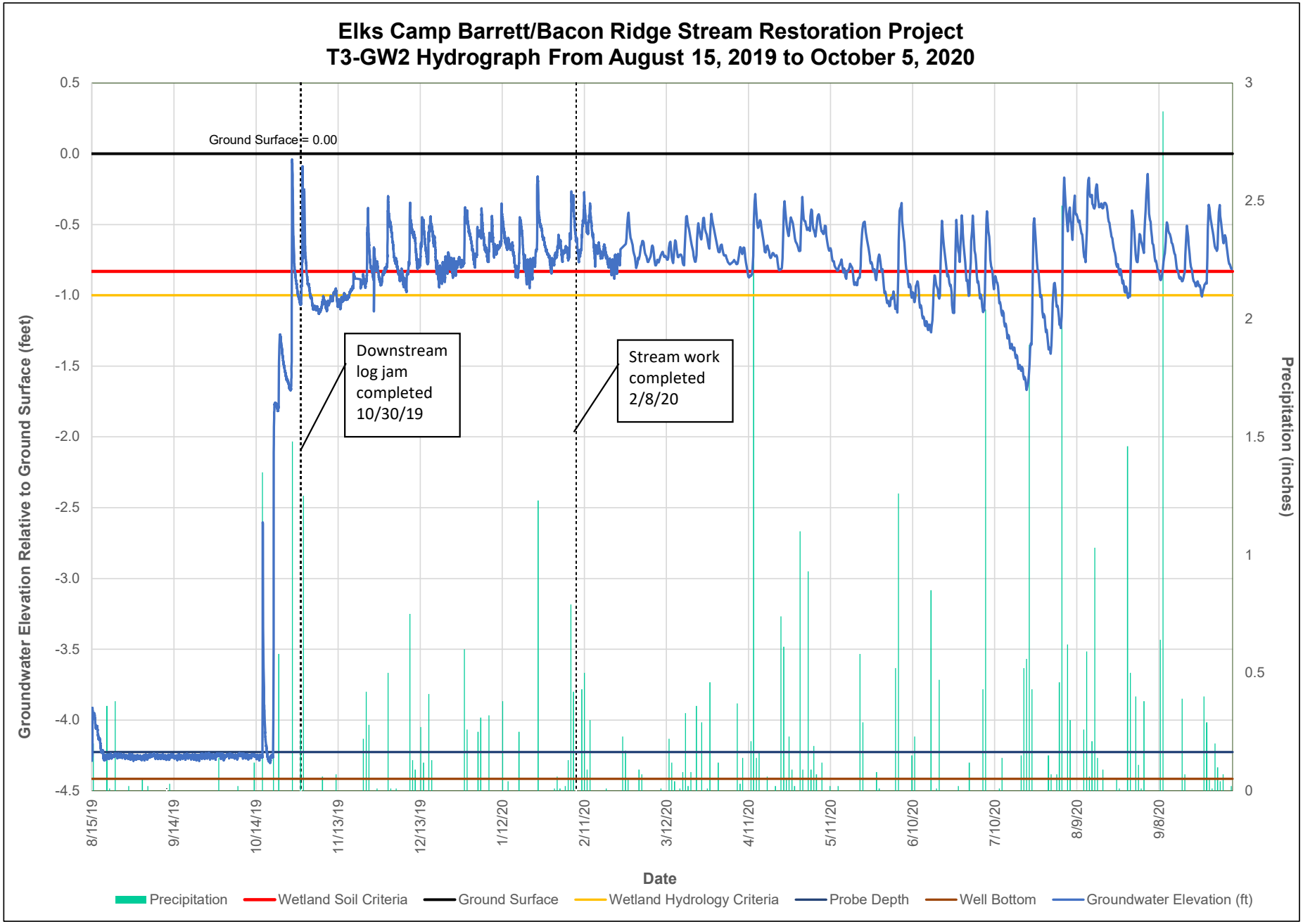
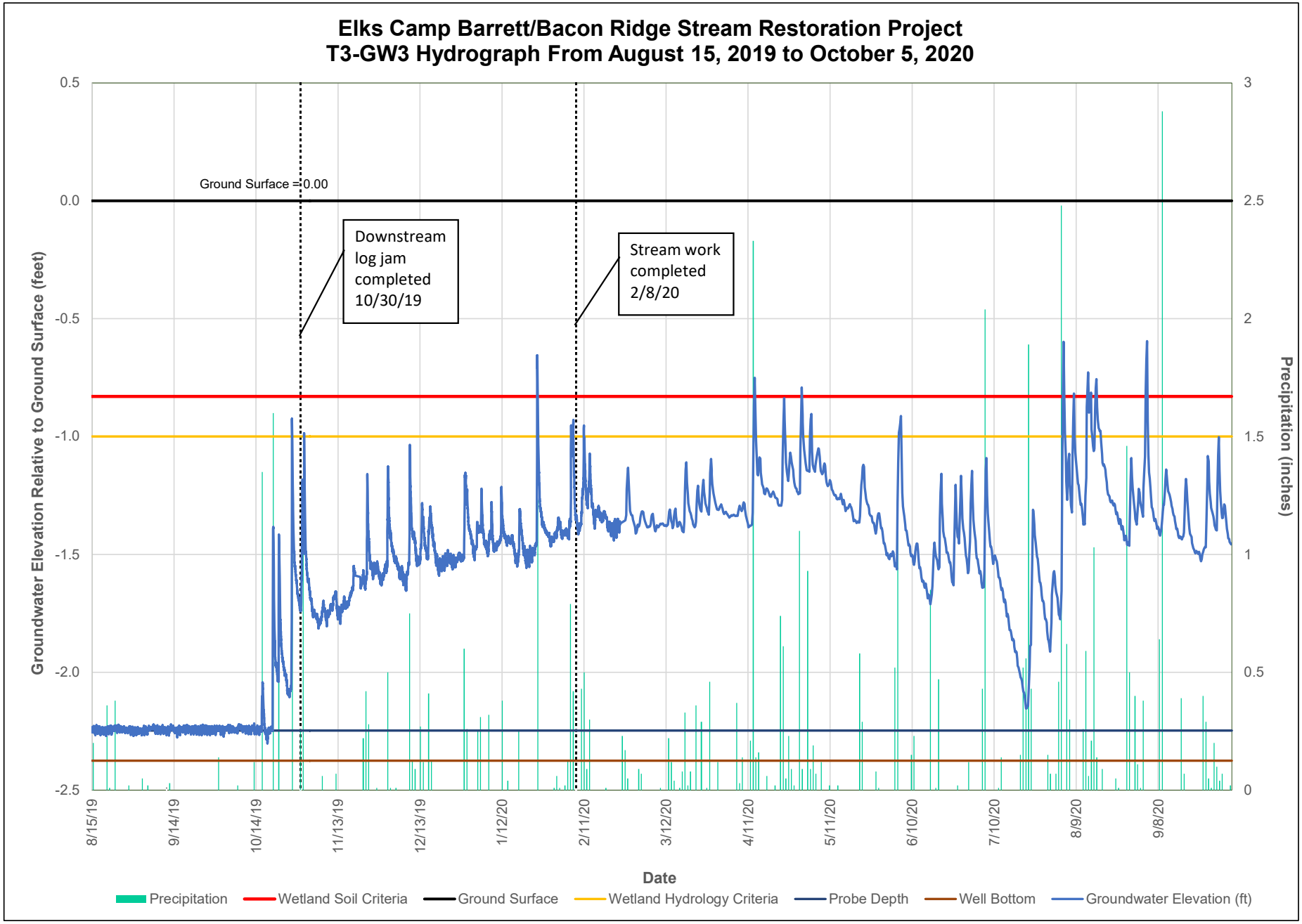
Date
Precipitation
Stream Bed
Probe Depth
Stream Water Surface Elevation (ft)


Elks Camp Barrett/Bacon Ridge Stream Restoration Project
T3-GW1 Hydrograph From August 15, 2019 to October 5, 2020
Ground Surface = 0.00
Downstream log jam completed 10/30/19
Stream work completed 2/8/20
Groundwater Elevation Relative to Ground Surface (feet)
Precipitation (inches)
0.5
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0
-3.5
3
2.5
2
1.5
1
0.5
0
8/15/19
9/14/19
10/14/19
11/13/19
12/13/19
1/12/20
2/11/20
3/12/20
4/11/20
5/11/20
6/10/20
7/10/20
8/9/20
9/8/20
Date
Precipitation
Wetland Soil Criteria
Ground Surface
Wetland Hydrology Criteria
Probe Depth
Well Bottom
Groundwater Elevation (ft)


Elks Camp Barrett/Bacon Ridge Stream Restoration Project
T3-GW2 Hydrograph From August 15, 2019 to October 5, 2020
Ground Surface = 0.00
Downstream log jam completed 10/30/19
Stream work completed 2/8/20
Groundwater Elevation Relative to Ground Surface (feet)
Precipitation (inches)
Date
0.5
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0
-3.5
-4.0
-4.5
3
2.5
2
1.5
1
0.5
0
8/15/19
9/14/19
10/14/19
11/13/19
12/13/19
1/12/20
2/11/20
3/12/20
4/11/20
5/11/20
6/10/20
7/10/20
8/9/20
9/8/20
Precipitation
Wetland Soil Criteria
Ground Surface
Wetland Hydrology Criteria
Probe Depth
Well Bottom
Groundwater Elevation (ft)


Elks Camp Barrett/Bacon Ridge Stream Restoration Project
T3-GW3 Hydrograph From August 15, 2019 to October 5, 2020
Ground Surface = 0.00
Downstream log jam completed 10/30/19
Stream work completed 2/8/20
Groundwater Elevation Relative to Ground Surface (feet)
Precipitation (inches)
0.5
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
3
2.5
2
1.5
1
0.5
0
8/15/19
9/14/19
10/14/19
11/13/19
12/13/19
1/12/20
2/11/20
3/12/20
4/11/20
5/11/20
6/10/20
7/10/20
8/9/20
9/8/20
Date
Precipitation
Wetland Soil Criteria
Ground Surface
Wetland Hydrology Criteria
Probe Depth
Well Bottom
Groundwater Elevation (ft)