

Summary of study design and data collected at Assateague National Seashore, MD

The health of maritime forests in three Mid-Atlantic National Seashores, U.S. Geological Survey. Summary Presentation of Approved Data Associated with The National Resource Protection Program

Data Sources

Monitoring Wells

The monitoring conducted for this study at wells Wo Ef 41, Wo Ef 42, and Wo Ef 43 characterized the effects of storm events on the western bay-side of Assateague Island. These wells are located adjacent to a surficial pond and in the vicinity of maritime pine trees. The wells are on a slight hill and are protected from the Atlantic coast by a taller primary dune on the east side of the island. From Lidar elevations (Figure 1) it appears that Wo Ef 41 is at a higher elevation than the interior wells. However, surveyed ground elevations show Wo Ef 41 is higher due to it being on a hill. Links to data from each of these wells can be found in Table 1.

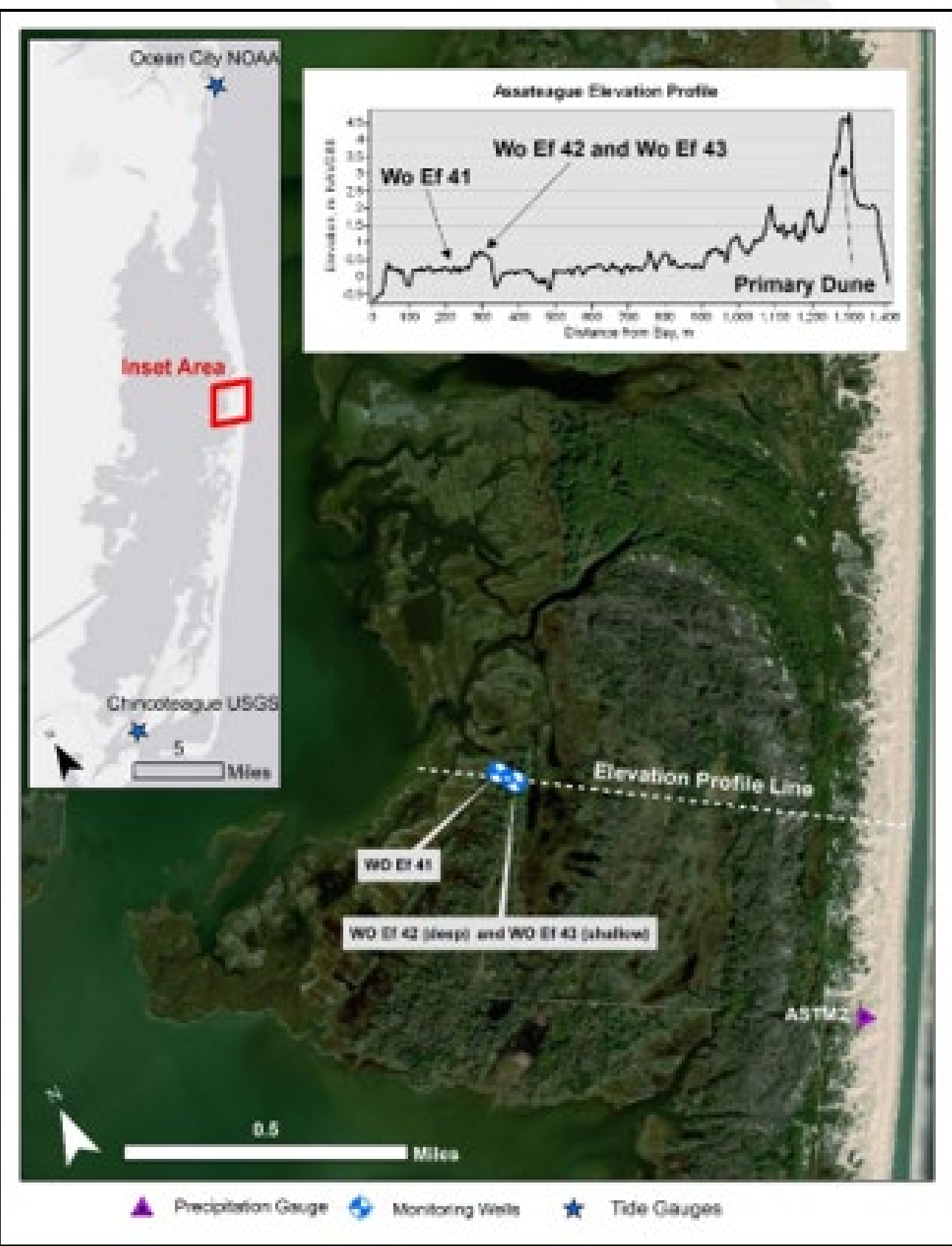


Figure 1. Location of wells in transect.

Well Name	Screened-Interval (below land surface)	Location Description	Link to Site Page
Wo Ef 41	8.75-9.5 ft bls	Located closer to the bay, on slight swale or hill	Link
Wo Ef 42	8.2-8.95 ft bls	Located in Stand of Pines, slight land surface depression	Link
Wo Ef 43	0.85-1.6 ft bls	Located in Stand of Pines, slight land surface depression	Link

Table 1. Description of wells.

Tide Data

- Chincoteague Inlet Tide Data (USGS- Site Number 01484746)
 - 6-minute elevation data
 - https://waterdata.usgs.gov/val/nwis/uv/?site_no=01484746&agency_cd=USGS
- Ocean City Inlet Tide Data (NOAA- Site Number 8570283)
 - Hourly elevation data
 - <https://tidesandcurrents.noaa.gov/waterlevels.html?id=8570283>

Precipitation (BLM and NPS)

- ASTM2
 - https://mesowest.utah.edu/cgi-bin/droman/meso_base_dyn.cgi?stn=ASTM2

Study Design

The monitoring period for this study was from September 2017 through June 2018. During this period, the water level and specific conductance were monitored in each well and collected at 15-minute intervals. Short-term responses to storm responses were evaluated using the timeseries of water level and specific conductance data, along with precipitation data and wind speed data collected at location ASTM2, and tidal elevations recorded from nearby tide gages at Chincoteague Inlet and Ocean City (See Fig. 1.).

Data Summary (Table 2, Figure 2)

Storm Number	Start Date	End Date	Precip. as Rain (in.)	Max. Precip as Rain (in.)	Max. Precip Date	Max. Wind Speed (mph)	Max Wind Date	Max. Height above Mean Higher High Water (NAVD88, ft)
1	9-17-2017	9-21-2017	0.28	0.13	9-19-2017	15	9-19-2017	2.802
2	10-29-2017	11-1-2017	2.04	0.31	10-29-2017	20	10-30-2017	1.752
3	1-3-2018	1-6-2018	0.07	0.04	1-3-2018	24	1-4-2018	1.97
4	1-12-2018	1-14-2018	0.69	0.36	1-13-2018	20	1-13-2018	0.676
5	3-1-2018	3-4-2018	0.24	0.05	3-1-2018	28	3-2-2018	2.411
6	3-4-2018	3-12-2018	0.75	0.16	3-7-2018	22	3-7-2018	2.677
7	3-12-2018	3-16-2018	0.53	0.13	3-12-2018	21	3-12-2018	1.92
8	3-19-2018	3-24-2018	2.12	0.18	3-20-2018	33	3-20-2018	2.346
9	4-2-2018	4-5-2018	0.03	0.02	4-2-2018	21	4-4-2018	1.233
10	4-14-2018	4-18-2018	1.63	0.65	4-16-2018	27	4-16-2018	2.122
11	5-12-2018	5-15-2018	3.46	1.69	5-13-2018	22	5-12-2018	1.473
12	5-15-2018	5-20-2018	4.14	0.8	5-18-2018	23	5-18-2018	2.08

Table 2: List of storm events

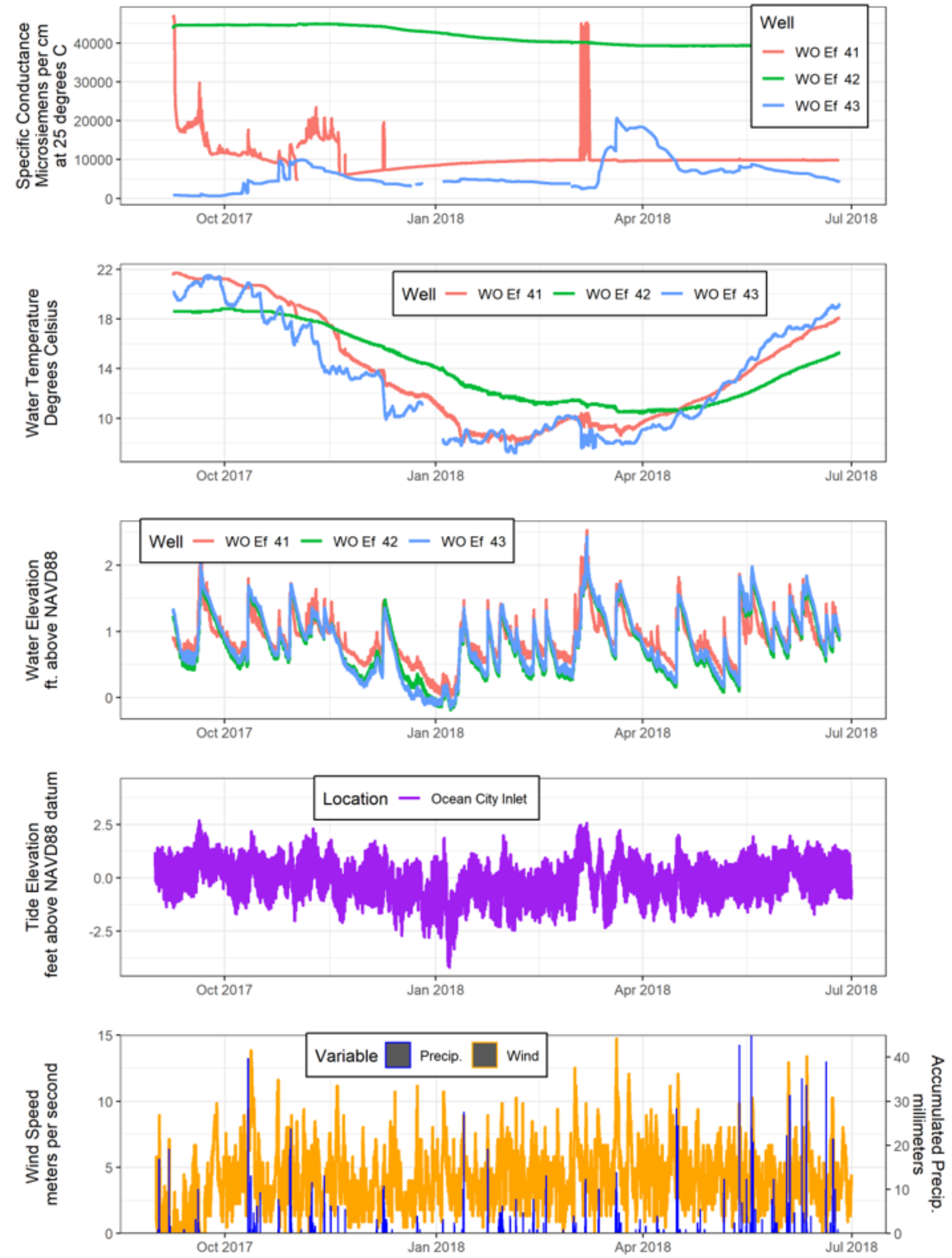


Figure 2: Assateague Monitoring Summary - Period: September 8, 2017 – June 25, 2018. Missing SC and water temperature data in Wo Ef 43 SC from December 2017 to were periods when the sensors were out of the water.

Storm Summary:

- Likely Storm overwash event occurs in March 3-9, 2017. This has large effect on conductivity in WO Ef 41, causing near-ocean conductivities (~40,000 uS/cm) during high tide. The response in well WO Ef 43 doesn't occur until March 10 to mid-April. During this period, precipitation events (March 13, March 20) were associated with a slight increase in conductivity in well WO Ef 43.
- During March overwash event, the temperature of well WO Ef 43 decreased while the temperature of WO Ef 41 increased.
 - Additionally, the temperature in well WO Ef 41 oscillates twice per day (suggesting tidal influence), while the temperature in well WO Ef 43 oscillates once per day (suggesting different source).
- High reported elevations at tide gauges seems to drive tidal oscillation in wells on September 19-20th
- Numerous storms (2, 8, 10, 11, and 12 in the table above) have significant precipitation, though the tidal elevations do not exceed the ground surface elevation for Wo Ef 41 and there is little-to-no tidal signal.

Water Level Summary:

Note: These water levels are uncorrected for variations in density. Therefore, these levels are best interpreted as freshwater head equivalents. If a well reached the density of seawater, then the true water level would be 3% lower than the freshwater head equivalent reported here

- WO Ef 41 is much more responsive to precipitation events than the two interior wells (both shallow and deep). The well hydrograph drops off much more steeply following precipitation events.
- For much of the time, all three wells are non-tidally responsive. When the reported elevations of the Ocean City and Chincoteague tide gauges approaches the elevation of the well land surface, sometimes the water level in well WO Ef 41 becomes tidally responsive.
- As an example, November 5th through 11th, the ocean surface increases above the ground surface at the Wo Ef 41 well, leading to tidal oscillations in water level (without recorded precipitation). Well Wo Ef 41 shows a tidal oscillation in conductivity as well.
 - Chincoteague Amplitude: 3.33 ft
 - Ocean City Amplitude: 1.977 ft
 - WO Ef 41 amplitude = 1.25 ft, 5-hour lag, asymmetrical shape
 - WO Ef 43 and WO Ef 42 = minimal tidal oscillation
- Looking at the cumulative distribution of water surface elevations (figure 3), the median water surface elevations for all three wells are tightly grouped. However, the WO Ef 41 well shows less variation overall than the other two wells.

Specific conductance summary:

- Shallow pine well (Wo Ef 43) is generally fresher (500 uS/cm to 10,000 uS/cm), deeper pine well (Wo Ef 42) is generally saline (>40,000 uS/cm).
 - In Wo Ef 41 well, early in the study period there is a relationship between well head and conductivity. The well appears responsive to what is happening in the ocean. Then after mid-November, it decouples. This change does not occur at a site visit and seems unrelated to the water depth. It is unclear if this is somehow related to the hydrologic regime or freshwater lens.
 - There are two periods when the Wo Ef 43 well (shallow well close to pine trees) increases above 5,000 uS/cm. The first is October 24th – November 25th, 2017, following two large precipitation events. The second is March 12th through the end of the monitoring period. The conductivity increases sharply with precipitation events and then decreases more slowly. The exact mechanism is uncertain.

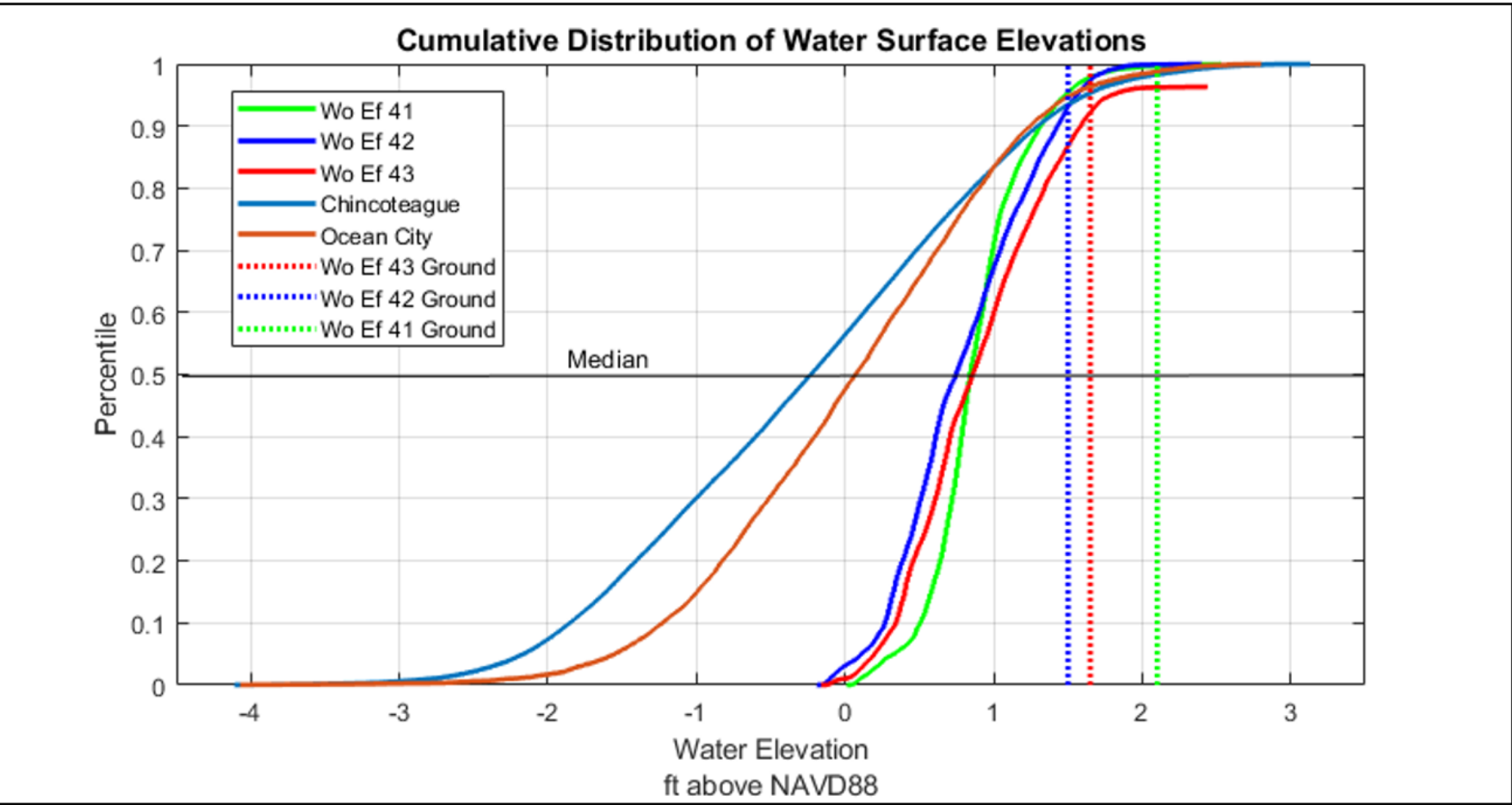


Figure 3: Cumulative Distribution of Water Surface Elevations

The water surface elevation (freshwater equivalent) exceeds the ground elevation 8% of the time for wells Wo Ef 43 and Wo Ef 42 and about 0.3% of the time for Wo Ef 41.

Narrative Summary

During the monitoring period, two primary types of responses were observed: overwash-type events, and precipitation-type events. An example of the overwash-type event occurred in early March 2018 (Figure 4). Higher-than typical tidal elevations generated by a pair of Nor'easter events from March 2-3rd and March 6th-8th, 2018 preceded increased water table elevations in the three monitoring wells on March 5th. Observed water table elevations exceeded the land surface elevation in all three wells (land surface elevation shown by dashed horizontal lines). Tidal cycling in observed water levels, and temperature increased in all three wells between March 6th and 8th. At this point in the monitoring period, the shallowest Wo Ef 43 well was consistently fresh (low conductivity) and the deeper Wo Ef 42 well was consistently saline (high conductivity) and these remained unaffected by the event. However, Wo Ef 41, which is deeper but closer to the bay and typically has a brackish water composition (medium conductivity), exhibits large tidal changes in conductivity from brackish to saline. Following the event, March 12th precipitation event and a March 20th – 22nd Nor'easter had a more muted influence on tides, water levels, and specific conductance. However, abrupt increases in conductivity in shallow well Wo Ef 43 are associated with these events.

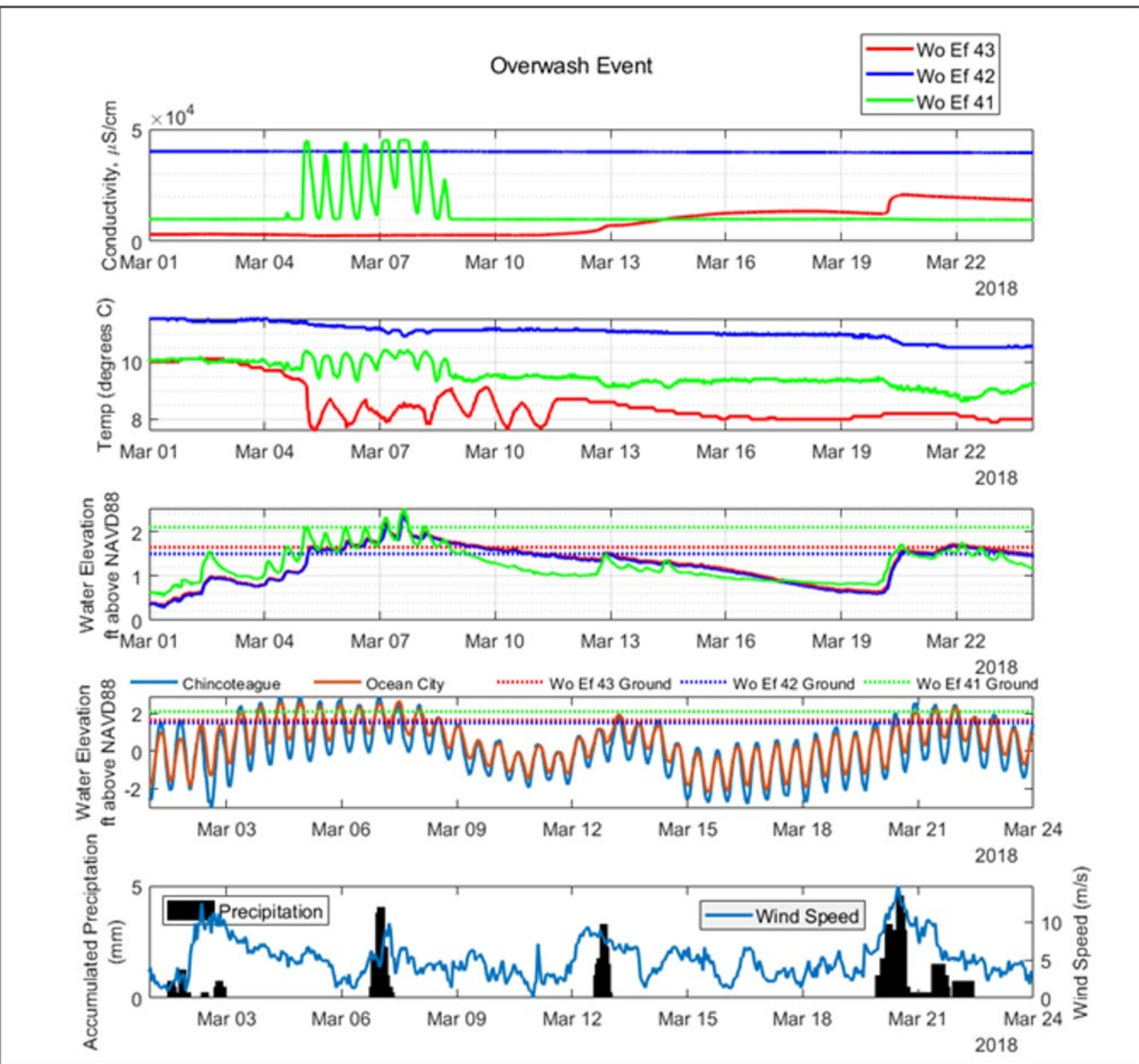


Figure 4. March 2018 overwash event.

The period of May 17th –19th, 2018 (Figure 5) is typical of a precipitation-dominated event. The characteristics of the collected timeseries data are different than the overwash-type event described above. On November 18th, precipitation exceeding 40 mm (1.5 inches) led to an increase in water level of nearly 1 foot in all three wells, causing the water level in the wells to rise above the land surface elevation. No change in the daily tidal elevations, temperature, or specific conductance is associated with the precipitation. In some precipitation-dominated events a slight flushing effect (decrease in specific conductance) is also observed.

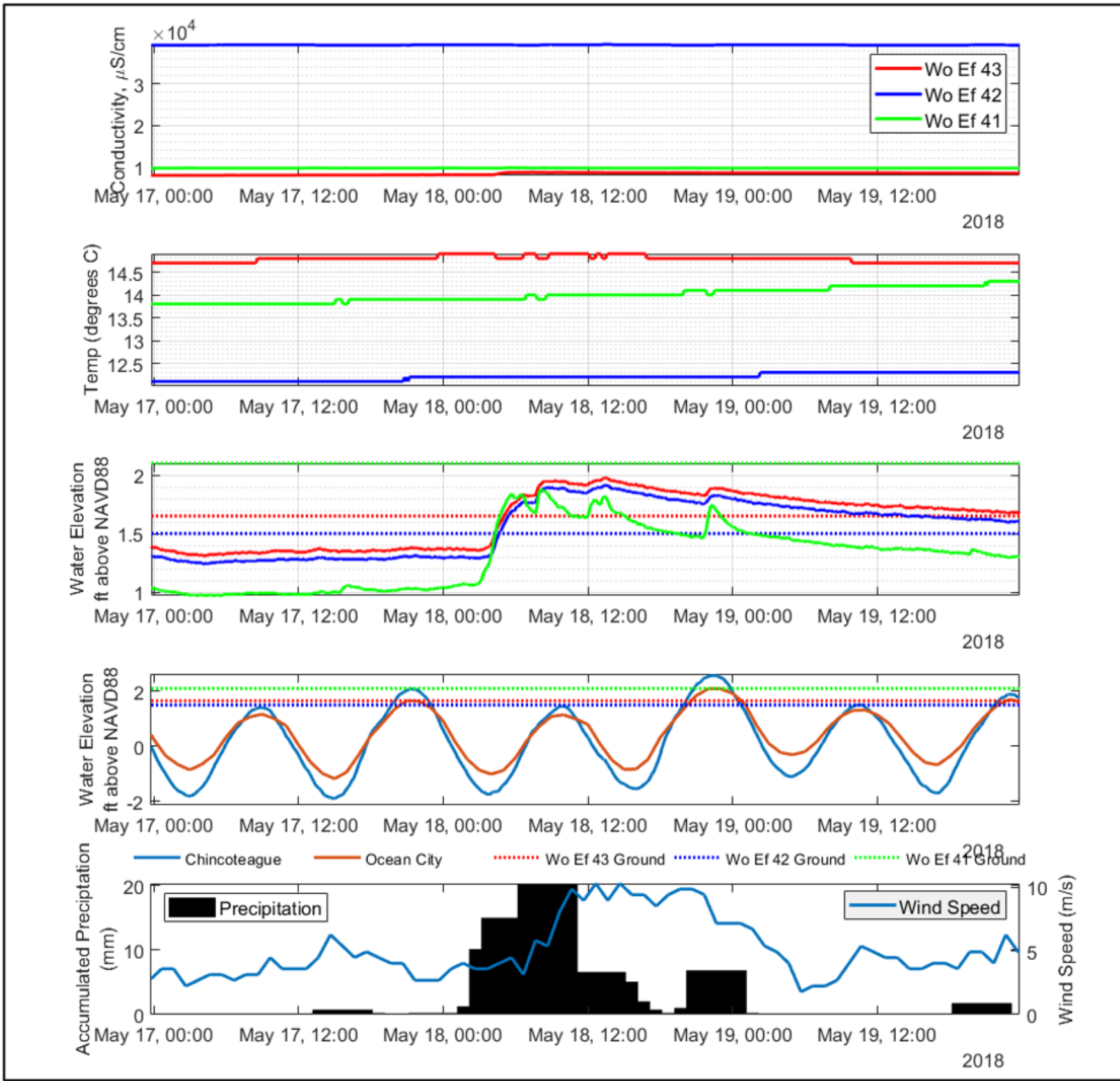


Figure 5. May 2018 precipitation-dominated event.