

Water quality assessment of streams at the Stafford Technology Campus data center site

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Abstract

Shortly following the clearcutting of ~400 acres for the development of the Stafford Technology Campus, approximately 30 acres of a wetland downstream of the site declined in water storage. Weekly velocity, pH, total dissolved solids, conductivity, salinity, and temperature measurements were conducted on the three primary streams located at the Stafford Technology Campus (STC) property from March to June 2026. Neighboring streams, along with the two major creeks in the watershed, were also assessed. During the construction of an access road, ~400 feet of trees were left inside of a stream on the STC site. Water immediately downstream of the clearcutting had a pH of 6.15, and pH remained outside of the EPA's recommended threshold for four weeks. The Potomac Run Wetland decreased in volume downstream after the construction of the concrete box culvert for the roadway. Elevated levels of aluminum, cadmium, zinc, and lead were observed downstream and adjacent to tree clearing. A 13° temperature increase was experienced in a clear-cut area where water was directly exposed to solar radiation. It is evident that the waterbodies at and downstream of the STC site are affected by the encroachment into the Resource Protection Area boundary.

Introduction

In terms of water quality and land use, Virginia is distinct for two reasons: Virginia is the only state in the United States to have designated resource protection areas, and it is widely recognized as the data center capital of the world. The east coast of Virginia borders the Chesapeake Bay, a 200-mile-long estuary that provides flood control, economic benefit, and critical habitat, such as essential spawning grounds for aquatic life. In the late 1970s, it became apparent that the bay was threatened when the annual shad catch decreased from 2 million pounds to 110,000 in three years (Groom, 1993). To ensure the protection of life in the Chesapeake Bay, the Virginia General Assembly passed the Chesapeake Bay Preservation Act in 1988. The Bay Act pertains to all 89 localities in the Tidewater Region, which encompasses 29% of Virginia's land and is home to 60% of the state's population (Virginia DEQ, n.d.). The act aims to limit nonpoint source pollution, prevent erosion, and reduce stormwater runoff. This is

primarily achieved through the preservation of vegetative buffers (formally called resource protection areas or RPAs) around waterbodies that flow into the Chesapeake and limiting construction/urbanization in resource management areas, which include floodplains, areas featuring steep slopes, areas with highly erodible and highly permeable soils, and wetlands that are not covered under an RPA. A minimum 100-foot buffer of trees is required to be maintained on all sides of a waterbody that is deemed an RPA (Groom, 1993). Each locality's board of supervisors is responsible for adopting and implementing RPAs; correspondingly, it is the locality's board that accepts or denies the construction of a data center.

Virginia has the highest concentration of data centers, with most data centers clustered in the northern region of the state; however, after the recent escalation of systems utilizing Artificial Intelligence (AI), data center construction has expanded south and the rate at which counties are receiving proposals has increased exponentially. As of August 11st, Virginia has 781 approved data centers (Baxtel, 2026). The Sierra Club determined that the combined number of approved and proposed data centers is approximately 1,295 (Bennett et al., 2025). To put the immense amount of data center proposals in Virginia into perspective, the entire state of Virginia has 382 McDonalds, while Loudoun County has 199 approved and 196 additional proposals, for a potential total of 395 data centers in a single county (Bennett et al., 2025).

Being right on the border of Northern Virginia, Stafford County received 18 data center proposals in only a two year window. Of the 18 proposals, five data centers have been accepted: the Stafford Technology Campus, Potomac Church Tech Center, Centreport Gateway/Pemberton Tech Center (by-right), Vantage VA41 Data Center/Melrod (by-right), and the Cranes Corner Data Center. Two of the proposals are no longer requesting to build a data center; Garrett Development Corp. removed the request to rezone a portion of the Market at Austin Ridge's property to M-2 in its fourth submission, and Peterson Companies removed its rezoning request for Sisson North in their third submission and is now only seeking a conditional use permit to build a substation on the property. The two applicants discussed above should not be confused with the Austin Ridge Logistics Center and Sisson South, two pending data center proposals in Stafford County. Currently, Stafford County has 11 data-center applications under review, all of which contain RPAs on or adjacent to the site.

The Stafford Technology Campus (STC) was approved by the board of supervisors on September 17th, 2024. This 23-building data center, currently under construction, will also have

six substations onsite. The location borders Richmond Highway, with Eskimo Hill Road running through the center of the property. The 503.84-acre property was previously zoned Agricultural A-1. Stafford's Urban Services Area was expanded to cover the east half of the site and purple pipe infrastructure for reclaimed cooling water is currently being built. On May 13th, 2026, STACK Infrastructure went before the planning commission in request to rezone an additional 34.94 acres from A-1 and Light Industrial M-1 to Heavy Industrial M-2 to allow for the construction of a data center building on the parcels, with a portion of the new property proffered to the county as land to build a new fire station. The additional rezoning was approved by the board on June 16th, where a discussion around Tier 4 generators took place and was verbally accepted by STC's attorney (by Virginia law, as of July 1st, all new data center proposals are required to have Tier 4 generators or equivalent). With the acceptance of new acreage, the number of data center buildings on the property remains the same and the full buildout area cap still adheres to 5.8 million square feet.

The land where STC is being constructed was formerly part of Stafford County's last five remaining contiguous forests. According to TNT's Environmental Impact Analysis, several endangered and threatened species have inhabited the STC property, including: the Northern long-eared bat, tricolored bat, monarch butterfly, and the small whorled pogonia. Of the original 503.84-acre property, 470 acres were forested land and 72.21 acres are designated as RPAs, which comprise the three major streams that pass through the site. Notably, there are tributaries on all three streams that are not included in the RPA. The entirety of stream 3 north of Eskimo Hill Road, visually half of the stream on the site, is no longer included under the RPA and will be covered by three substations consisting of 24.80 acres (labeling for stream 3 discussed in Methods).

Trees will only be preserved on 63 of the 470 forested acres (~13.4%). The vast majority of trees were cleared from the site by May 2025. The following September, 30 acres of what is locally deemed the Potomac Run Wetland fully dried. This wetland off Potomac Run Road consists of approximately 129 acres, and is a domain for bald eagles, blue herons, wood ducks, red-winged blackbirds, turtles, and beavers. Since the decline in wetland storage, local residents have reported beavers fleeing from the wetland, an increase in the amount of beavers hit by cars, and beaver skeletons found within the habitat. By January 2026, the water level increased (although remain variable throughout the study), but beavers have not returned to the area. Two

of the streams within the STC site feed this wetland. This study aimed to monitor the quality of streams within the STC site and form a link between the construction of the data center and the Potomac Run Wetland losing ground downstream.

Methods

The streams that run through the STC site are unnamed. To locate the streams, coordinates were cross referenced using ArcGIS, the U.S. Fish & Wildlife Service Wetland Mapper, and Google Earth Pro. Comparison streams were chosen based on general vicinity to the three STC streams. The comparison streams are within 1.4 miles from the STC site, close enough to the property to analogize and far enough away to not be affected by tree removal. Streams were assigned a numerical value going chronologically from west to east. The only stream breaking this pattern is stream two, which is located at the top right of the STC site and flows into Accokeek Creek. All other streams, excluding stream 7, flow into the Potomac Run Wetland. Stream 1, 2, and 3 are on the STC property. Stream 5 and 6 are located in Granville Estates, and stream 7 is located in Potomac Run, two neighborhoods adjacent to the STC site. In addition, water quality was assessed for Potomac Creek, the major waterway that feeds the Potomac Run Wetland, the Potomac Run Wetland itself, and Accokeek Creek to create a general baseline before the potential Accokeek Center that proposes transmission lines that run down the center of the creek is built. Accokeek Center's public hearing in front of the Planning Commission is tentatively scheduled for August 26th. All seven streams flow into Potomac Creek; stream 7 connects to Potomac Creek downstream of the Potomac Run Wetland and Accokeek Creek meets Potomac Creek in the Crow's Nest Natural Area Preserve, just before both creeks flow into the Potomac River. Measurements were not taken at stream 4 because it is located behind the Stafford Detention Center. Stream 4 is referenced on the Google data sheet solely to acknowledge that there is a major stream that exists between streams 3 and 5.

Sampling Design

Measurement points were determined based on accessibility (proximity to a roadway) and uniformity of the stream channel. The measurements for stream 1 up (S1-1) were taken outside of STC property, across Richmond Highway, to achieve a baseline of water quality before water enters the site, while stream 1 down (S1-7) were taken far downstream of the STC

property to record water quality after leaving the whole site, inside of a wetland area directly preceding where stream 1 meets Potomac Creek. Points along stream 1 were then chosen based on proximity to previous points and direct events, such as upstream and downstream of clearcutting and ponding where an access road was built (S1-3 upstream, S1-5 downstream). Measurements on stream 6 (S6) were collected in a uniform area where the stream meets a wetland to form a more direct comparison with stream 1. Measurements for stream 5 (S5), 7 (S7), Potomac and Accokeek Creek, and the Potomac Run Wetland were collected in close proximity to their adjacent roadways. Stream 2 and 3 were difficult to find because of tree cutting, land grading, and GPS inaccuracy. There is a man-made wetland border on the upper fork of stream 2 that prevents water from flowing to the other side of the transmission lines, towards Accokeek Creek (Image 1 in gallery below). Data for stream 2 was collected from this wetland boundary (S2-2) on the upper fork (close to Cartwell Drive) until the lower fork stream was found (S2-1) on March 30th. Note that this lower fork is not depicted on the U.S. Fish & Wildlife Service Wetland Mapper or Google Maps, but is shown on the STC General Development Plan (GDP) and included under an RPA. Measurements for stream 3 as depicted on the STC GDP were not taken until May 31st; until that point stream 3 was conflated with a tributary that connects to stream 3 on the east side (S3-3), south of Eskimo Hill Road. Measurements for stream 3 upstream (S3-1) were collected where grading north of Eskimo Hill Road ends in ponding that was created from the stream being cut off. Downstream measurements were taken inside of the RPA (S3-2), in the wetland border (S3-4), and in a smaller stream of runoff parallel to Eskimo Hill Road (S3-5).

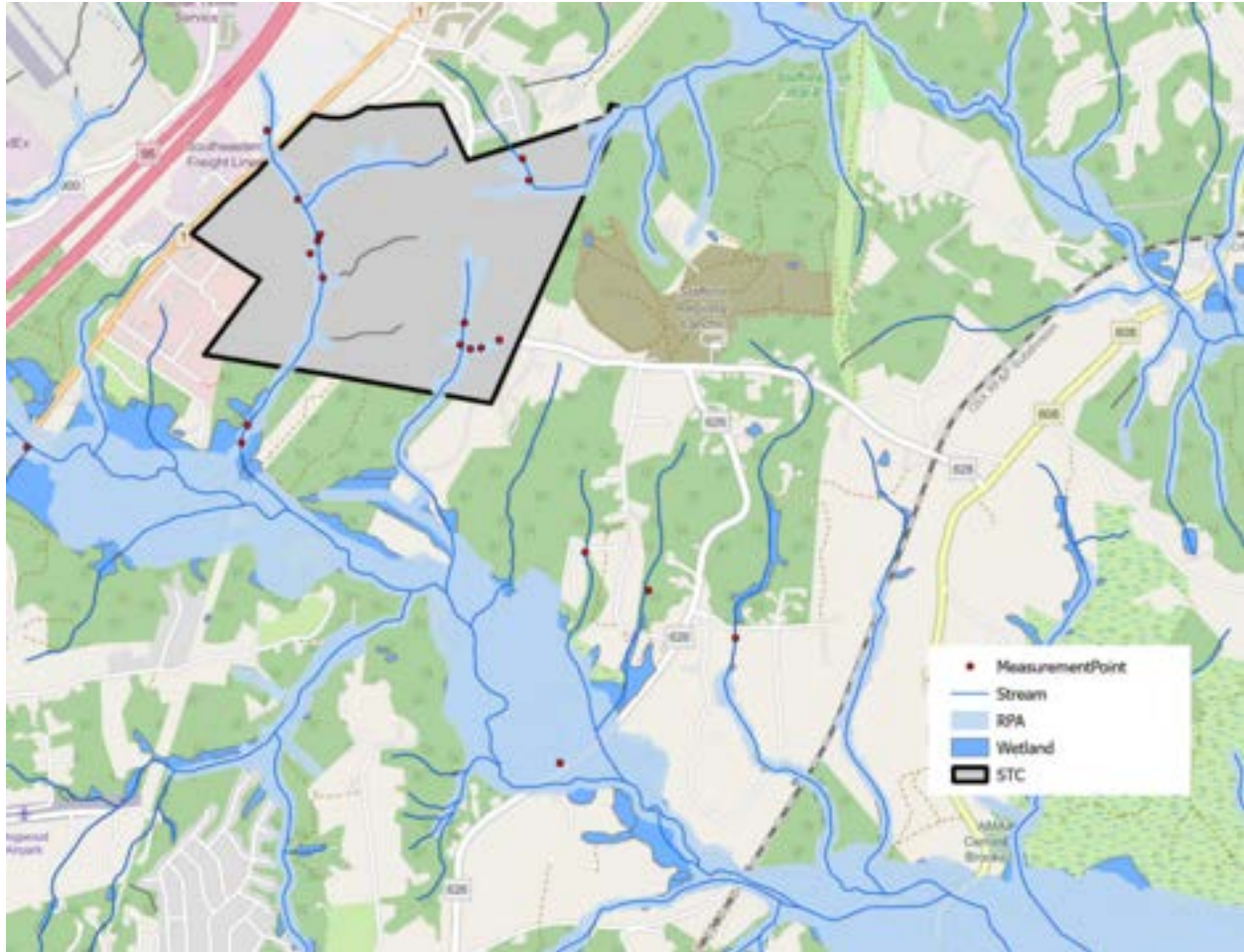


Figure 1: A Map of the primary measurement points of the study. The map is oriented north up. Measurement point for Accokeek Creek is further north and not shown. Route 1 is Richmond Highway, Route 626 is Potomac Run Road, and Route 628 is Eskimo Hill Road. Measurement points for S1 are labeled numerically from north to south. Measurement points for S3 are labeled numerically west to east, starting with S3-2 below Eskimo Hill Road. The portion of Stream 3 north of Eskimo Hill Road is no longer included as an RPA and is in the process of being graded. STC shapefile was made by Victoria Gallaway. Measurement points were pinpointed using a Garmin watch lent from Jesse Adams.

Data Collection

Discharge was calculated for S1-1, S1-7, S6, and S7 in a location on the stream that held a straight, uniform channel for several feet. A tape measure was laid across the width of the stream channel, and the channel was broken into five to eight segments depending on the width and visual changes in stream flow. A meter stick was used to record the water depth in the middle of each segment. The velocity was recorded at the same location on the stream that the depth measurement was taken using a HOJILA FM-100V10 Water Velocity Meter, a mechanical meter with a range of 0.01 to 10.00 m/s. Each segment's width was multiplied by its depth to

determine the area; each segment's area was then multiplied by its velocity to determine its discharge rate (m^3/s). The sum of the segment's discharge rates equates to the total discharge rate for that reach. Each stream's cross-sectional area (sum of segment areas), wetted perimeter (sum of height of water in contact with left bank, height of water in contact with right bank, and wetted width), hydraulic radius (cross-sectional area divided by wetted perimeter), bankfull width, floodplain width, and bed type based on grain size were recorded. Although the velocity meter was calibrated using a pre-set flow at a wastewater treatment plant, after consulting with two hydrologists, it was determined that the HOJILA meter is most likely incapable of recording an accurate velocity of the streams due to stream depth—the maximum stream depth was recorded at 0.194 meters. Discharge rate data collection concluded in March after conferring with the second hydrologist.

At each measurement point pH, total dissolved solids (TDS), conductivity, salinity, and temperature were recorded weekly using an Apera Instruments PC60 Premium Series Multiparameter meter from March to June 2026. During the last week of data collection, water samples were collected in sterilized Nalgene bottles and analyzed using inductively coupled plasma optical emission spectrometry (ICP-OES). The ICP-OES analysis was conducted by Dr. Tyler Frankel, Associate Professor- University of Mary Washington, and his research students, Garret Driscoll and Hannah Reents. In June, streams 2 and 7 were dry, and their TDS were not analyzed.

Results and Discussion

Discharge rates of S1-1, S1-7, S6, and S7 were calculated four times in March. The minimum and maximum recorded discharges of S6 and S7 were 0.000930148 and 0.0025821132 m^3/s . The recorded discharges of S1-1 and S1-7 stayed between 0.0033082992 and 0.005606034 m^3/s , but a jump to 0.0108740448 m^3/s was recorded in S1-7 on March 17th. All streams experienced an increase in discharge on March 17th, correlating to the 0.63 inches of rain received day of and 0.55 inches received the day prior (NOAA NCEI, Station: STAFFORD 6.1 WNW, VA US US1VASF0009). Due to potential inaccuracies from the velocity meter, discharge rates should not be referenced concretely.

According to the EPA, the optimum pH for the majority of aquatic life is between 6.50 and 8.00 (US EPA, 2015a). Several sites tested below this threshold throughout the duration of the study.

Measurement Point	Minimum pH	Maximum pH	Measurement Point	Minimum pH	Maximum pH
S1-1	6.30	7.00	S3-1	5.80	5.95
S1-2	6.47	6.88	S3-2	5.84	6.25
S1-3	6.43	7.00	S3-3	4.30	4.59
S1-4	6.36	6.88	S3-4	5.06	5.17
S1-5	6.15	7.21	S3-5	6.15	6.32
S1-6	6.47	7.21	S5	5.48	5.79
S1-7	6.52	6.84	S6	5.79	6.90
S1-8	5.47	6.52	S7	5.96	6.76
S2-1	5.40	5.49	Potomac Creek	6.88	7.42
S2-2	5.51	6.79	Accokeek Creek	6.38	7.06
			Potomac Run Wetland	5.95	6.41

Table 1: Minimum and maximum recorded pH values of major measurement points

S1-8, S2-1, S2-2, S3-3, S3-4, and S3-5 were dry for the greater portion of the study and measurements were taken in stagnant water, most likely contributing to their low pH. These areas were also heavily impacted by intense construction. S1-8 is directly adjacent to a gravel access road that was built to expand the urban service area; sewage lines run in the area, and purple pipe is currently being constructed there for STC. S1-8's location also visually appears to be impacted by iron seepage. Power lines cut through S2, where uprooted sediment has been left. The upper reach of S3 was cut off and the land below was graded, and the lower reach was clear-cut throughout the duration of the study (Images 2, 3, 4, 5, and 6).

Being on the continental east coast, Stafford County has highly acidic soil. The STC site consists of Aura gravelly fine sandy loam (pH 4.0-4.7), Aura-Galestown-Sassafras complex (3.6-5.5), Bibb fine sandy loam (3.5-5.5), Bladen loam (3.6-5.5), Bourne fine sandy loam (3.6-6.5), Caroline fine sandy loam (3.6-5.5), Caroline-Sassafras complex (3.5-5.5), Iuka fine sandy loam (4.5-6.0), Kempsville fine sandy loam- gravelly substrate (4.5-6.0), Marr very fine sandy loam (4.5-5.5), Sassafras fine sandy loam (3.5-5.5), Sandy and clayey land- steep-

Sassafras and Carolina materials, and Alluvial land. Soil assessment was conducted using the United States Department of Agriculture's (USDA) Web Soil Survey; each soil's pH was received from the USDA Natural Resource Conservation Service. The removal of trees alters soil chemistry by reducing base cation availability, further decreasing soil pH (Zetterberg & Löfgren, 2010). Acidification is additionally increased by the erosion of metals from surrounding soils into a waterbody (Nystrand et al., 2012).

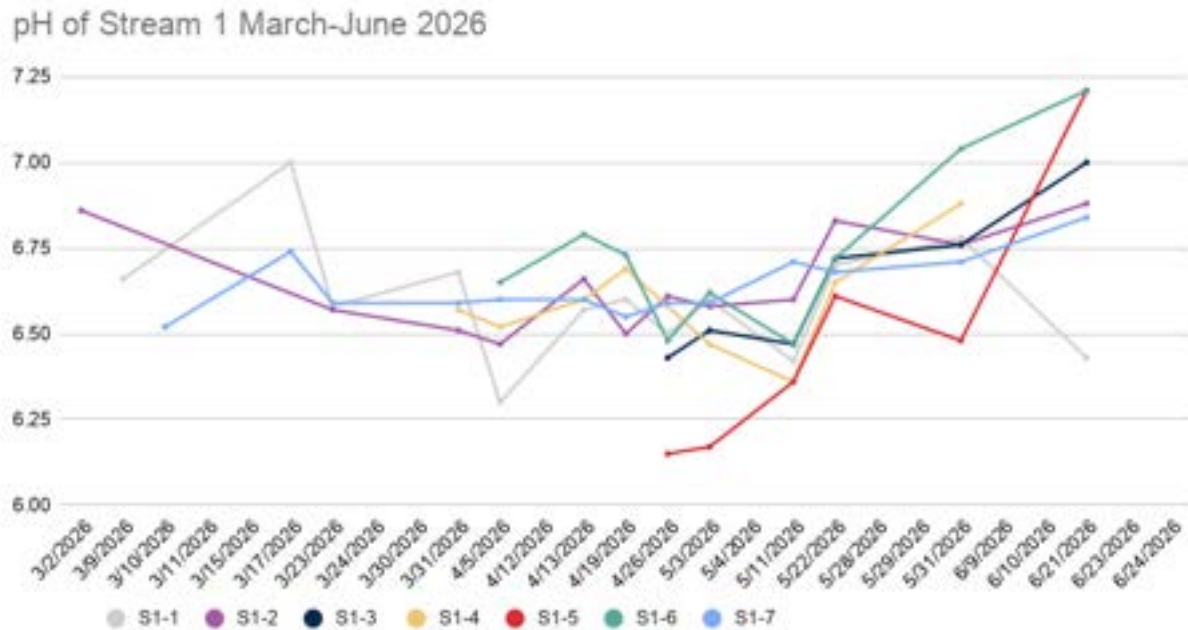


Figure 3: pH readings for the seven primary measurement points along Stream 1 from Spring and Summer 2026.

On April 26th, 2026, trees were found clearcut and left inside of stream 1, covering approximately 400 consecutive feet of the stream (Images 7, 8, and 9). Measurements were taken directly before and after where trees were discarded into the stream, (S1-3 and S1-5). Measurements for S1-4 were taken throughout the study. On April 26th the pH dropped from 6.50 at S1-1 and 6.61 at S1-2 to 6.43 at S1-3 and 6.15 at S1-5. The pH remained low at S1-6, recorded at 6.48. Measurements could not be recorded at S1-4 because it was covered by trees. April 26th was the first day that pH readings recorded below the EPA guideline of 6.50, excluding upstream measurements taken on April 5th in the rain, which naturally brings acidity. Trees were removed from the stream within the following week, but slash remained in the S1-5 section for the duration of the study (Image 10). On May 3rd pH values for this reach of S1 remained low: S1-3

6.51, S1-4 6.47, and S1-5 6.17. pH values recorded above the healthy minimum of 6.50 on May 22nd, four weeks after trees were cut and removed, but S1-5 dropped below the threshold again to 6.48 on May 31st.

Maintaining within the optimum pH range is vital for aquatic organisms and overall stream health. Living in acidic water lowers the pH of a fish's blood and kills their epithelial cells, increasing a fish's susceptibility to disease (Fritz, 1980). pH values below 6.50 prohibit female fish from properly producing eggs because of disruptions in their ability to metabolize calcium; eggs also fail to develop in these conditions due to abnormal protein deposition (Fromm, 1980). In cases where females are able to produce eggs, the resulting fish larvae develop spinal deformities. Fish with these skeletal deformities did not further reproduce (Fritz 1980). Low pH can hinder a fish's ability to breathe by causing coagulation in gill mucus and modifications to gill lamellae, often resulting in death (Fromm 1980; Fritz, 1980). Decreased pH mobilizes metals (particularly aluminum, cadmium, iron, manganese, and mercury), which also hinders respiration in addition to altering the development of fish and insects. Fish will often avoid spawning and residing in waters that have high metal concentrations, altering community structures to acid-tolerant species. The community structure is further altered at the bottom of the food chain— invertebrates shift from grazers to shredders, resulting in fluctuations of acid-tolerant species of algae (Herrmann et al., 1993).

It is against best management practices to leave trees and slash inside of streams because organic decomposition releases excess nitrogen and phosphorus into the water, causing algal blooms, which lowers the amount of dissolved oxygen necessary for aquatic life (Palviainen et al., 2015). Discarding organic matter into streams decreases velocity and blocks water and sediment from moving downstream. Clearcutting and grading acres of land increases erosion, which is apparent on the STC site (Images 11 and 12). It is the general consensus of Stafford citizens that streams were altered, and essentially choked, by the movement of sediments and trees on STC property.

Measurements on S1 were not conducted in the early weeks of June due to the construction of the public road that will go through S1 at S1-3–S1-5 and bisect the STC property, connecting to Eskimo Hill Road where the substation is placed over S3. Measurements were taken on June 21st; the concrete box culvert, which is approximately 400 feet long, was completed by this day. Intense ponding occurred upstream and downstream of the concrete

platform (Images 13, 14, 15, and 16). Water in the upstream pond, near S1-3, came slightly above my knees, approximately 2 feet deep. Considering that the uniform depth of Stream 1 is only several centimeters deep, this is an immense amount of water that has been restricted from flowing to the Potomac Run Wetland. Low water levels were seen downstream in the wetland after access road construction had begun and persisted after completion (Images 17, 18, and 19). The Stafford region is under drought conditions and S4, S5, and S6 are intermittent, adding additional strain to the wetland and making S1 a primary source of water.

Clearcutting increases the amount of dissolved organic carbon in a waterbody, which increases the mobility and toxicity of trace metals (Palviainen et al., 2015). There is not a universally agreed upon toxicity level for TDS because toxicity is highly dependent on ion concentration and individual species sensitivity. A study conducted in Loudoun County found 463 ppm and a conductivity of 654 $\mu\text{S}/\text{cm}$ to be the chronic threshold for aquatic life in Sand Branch stream (Brent et al., 2022). Only measurement points on the STC property and Accokeek Creek exceeded this limit. On March 9th S3-5 had a TDS reading of 564 ppm and a conductivity of 795 $\mu\text{S}/\text{cm}$; March 10th S1-7 651 ppm and 915 $\mu\text{S}/\text{cm}$; March 17th S1-1 539 ppm and 759 $\mu\text{S}/\text{cm}$; March 17th a minor measurement point between S1-2 and S1-3 486 ppm and 682 $\mu\text{S}/\text{cm}$; March 17th S1-7 482 ppm and 678 $\mu\text{S}/\text{cm}$. On May 22nd, Accokeek Creek had a TDS of 736 ppm and a conductivity of 1,038 $\mu\text{S}/\text{cm}$, highly deviating from the previous recorded TDS readings in the lower 200s, signaling that water was gaining pollution from an outside source.

The toxicity of metals is dependent on concentration, water pH, seasonal changes, species' sensitivity, and synergistic effects between other metals present within the waterbody (Gensemer & Playle, 1999). Cadmium negatively affects the growth, reproduction, immune system, endocrine system, and behavior of aquatic life; acute exposure to cadmium increases mortality rates. The EPA set the chronic criterion for freshwater at 0.25 $\mu\text{g}/\text{L}$ and acute criterion at 1.8 $\mu\text{g}/\text{L}$ standardized to a hardness of 100 mg/L CaCO_3 (US EPA, 2016). Water was sampled from S1-1, S1-6, S1-7, S3-1, S3-2, S5, S6, Potomac Creek, Accokeek Creek, and the Potomac Run Wetland. S1-7, S3-1, and S6 were the only sites that cadmium tested below 0.25 ppb. The highest level of cadmium was 6.72 ppm observed in S3-2. Aluminum is soluble when pH falls below 6.00 and restricts osmoregulation by precipitating onto fish gills, often resulting in death (Gensemer & Playle, 1999). The maximum threshold for aluminum set by the EPA is 1-4,800 $\mu\text{g}/\text{L}$ for acute exposure and 0.63-3,200 $\mu\text{g}/\text{L}$ for chronic exposure (dependent on pH, hardness,

and dissolved organic carbon). This limit is not to be exceeded more than once every three years (US EPA, 2018). S3-2 and S6 both exceeded the upper limit, with concentrations at 16,386.97 ppb and 18,066.05 ppb respectively. Lead bioaccumulates in animal tissues, causing oxidative stress and neurotoxicity (Lee et al., 2019). A study using EPA criteria to develop a biotic ligand model for lead proposes 20-1,000 $\mu\text{g/L}$ as an acute threshold and 0.3-40 $\mu\text{g/L}$ for a chronic threshold (DeForest et al., 2017). All sites tested above the chronic threshold, the highest being 121.79 ppb in S3-2 and 109.67 ppb in S6. Zinc poisoning is common in animals as zinc ions bioaccumulate, preventing natural enzymes and nucleic acids from functioning. One study put the threshold for zinc at 17.26 $\mu\text{g/L}$, 48.31 $\mu\text{g/L}$, 80.34 $\mu\text{g/L}$, and 230.6 $\mu\text{g/L}$ for pH values of 4.0, 5.0, 6.0, and 7.0 respectively (Li et al., 2018). Four sites exceeded the Zinc-pH threshold: S1-1 291.76 ppb, S3-1 243.6 ppb, S3-2 758.6 ppb, and S6 573.25 ppb. Metal toxicity and temperature are positively correlated due to temperature increasing metabolic rates (Gerhardt, 1993).

Measurements were conducted from sunup to sun down at varying time intervals, so a comparison between differing streams and temperature cannot be formed. However, it is important to consider temperature increases when building heavily industrialized infrastructure and removing trees from an RPA. On average, data centers increase surface temperature by 3.6°F. A maximum increase of 16°F has been seen. The heat island effect that data centers create can be felt within a 6.2-mile radius from the campus (Marinoni et al., 2026). Surface water temperature is highly correlated to the density of tree canopy. The abundance of invertebrates in streams decreases when water temperatures rise above 68°F during low flow conditions (Rutherford et al., 1997). In this study, every measurement point excluding S2-1, S2-2, S3-3, and S3-4 tested above 68°F at least once, some as early as March. In temperate regions, a minimum shade level of 70% is needed to keep surface water temperatures below 68°F; shade levels in native forests range between 90-96% (Rutherford et al., 1997). Drastic temperature changes between forested and clearcut areas were seen on S3 (Images 20, 21, and 22). The water temperature of S3-1, where trees were removed and water is halted, was 71.8°F on June 10th and 73.4°F on June 21st, whereas water temperature at S3-2, taken inside of a forested RPA, was 83.7°F and 86.4°F, respectively. These measurements were taken roughly ten minutes apart from each other. Fish are highly sensitive to water temperature increases. Fish eggs experience a high mortality rate when water temperatures vary 10.8°F from the temperature they were spawned in

and ovarian estrogen production is hindered in high temperatures, delaying or completely preventing reproduction (Pankhurst & Munday, 2011). The metabolic rate of fish increases with temperature, which limits the amount of dissolved oxygen available to fish (Rutherford et al., 1997). The Rappahannock River, forming the southern border of Stafford County, experienced a high amount of fish deaths this year due to low water levels and temperatures reaching above 100°F for consecutive days in July (Uphaus, 2026).

Conclusions

Data centers are highly industrialized facilities that propose negative effects onto water bodies in the construction phase, before operations even begin. Stream 1 on the STC site experienced an intense decrease in pH where trees were clearcut for an access road and a 13° temperature difference was observed between clearcut and forested areas along Stream 3. The STC streams and Accokeek Creek were the only locations to have a TDS reading above the recommended limit of 463 ppm. Stream 3, downstream and adjacent to clearcutting, had elevated levels of aluminum, cadmium, lead, and zinc. A significant drop in water levels was observed in the Potomac Run Wetland after the construction of the roadway through Stream 1. Because of the acidic nature of Stafford County's soils, data centers should not be sited in close proximity to a waterbody. To ensure the vitality of wetlands and waterways, the Chesapeake Bay Act should be followed stringently, and RPAs cannot be viewed as a recommendation.

Images



Image 1: Man-made wetland border at the beginning of Stream 2 preventing water from forming the stream. Photo taken March 4th.



Image 2: Before view of the wetland border that stream 3's tributary crosses, south of Eskimo Hill Road. Photo taken March 5th.



Image 3: Stream 3's wetland border is in the gap on the right of the trees left standing. A very sparse number of trees were kept surrounding Stream 3's tributary, which runs (from left to right) through the center of the trees in the middle of the image. Photo taken April 26th.



Image 4: Trees removed south of Eskimo Hill Road. The entirety of Eskimo Hill Road going through the STC site is similar in appearance. Photo taken June 10th.



Image 5: Intense debris left before pipe culvert on Stream 3 north of Eskimo Hill Road. Photo taken May 31st.



Image 6: Slash left in Stream 3 south of Eskimo Hill Road and deep tire tracks create an uneven path for water. Photo taken June 21st.



Image 7: Approximately 400 feet of trees were clearcut and left inside of Stream 1 for a new road that will connect to Eskimo Hill Road. Photo taken April 26th.



Image 8: Taken close to S1-4, showing trees before they were clearcut. Photo taken March 17th (after rain).



Image 9: After clearcutting and trees were removed from the stream. Photo taken in the same location shown above on May 3rd.



Image 10: Slash left in Stream 1 at S1-5. Measurement taken after slash. Slash created intense ponding in this area. Photo taken on May 3rd.



Image 11: Sediment is found coating leaves on multiple trees near where trees were cut for the development of the access road on Stream 1. Photo taken June 21st.



Image 12: Sediment blowing onto Eskimo Hill Road from STC construction area pictured on the right. Photo taken March 23rd.



Image 13: Ponding on North side of the new access road, near S1-3. Photo taken June 21st.



Image 14: Ponding on South side of the new access road. Measurement point for S1-4 was covered by the concrete and is near the center of the concrete box covert. Photo taken June 21st.



Image 15: Additional view of riprap pond shown above. Slash pictured below is just within the border of the trees.
Photo taken June 21st.



Image 16: Additional view of slash pictured in Image 10. Measurements for S1-5 are collected in this area. Photo taken June 21st.



Image 17: Potomac Run Wetland near measurement point. The water edge was near the plastic cup shown on the right for the majority of the study and receded back during the month of June while access road construction was occurring on S1. Photo taken June 24th.



Image 18: Potomac Run Wetland near measurement point. The water edge prior to access road construction was near the grass edge on the left bank. Photo taken June 24th.



Image 19: Same area pictured above. Wetland remains receded. Photo taken on July 8th.



Image 20: S3-2, forested area with dense tree canopy. Photo taken May 31st.



Image 21: Previously forested land was graded along Eskimo Hill Road. Measurement point for S3-1 is where the orange barrier is not present on the left. Photo taken June 21st.



Image 22: Location of S3-1. No shade is provided by tree canopy in this area. Photo taken June 21st.

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Google Sheet Data Set:

https://docs.google.com/spreadsheets/d/1vb_HpHoF07apuNF7ZWjarn1j4VZkVWlVqev7SuCJWfl/edit?usp=sharing

This study is supplemented by an article published in the Sierra Club Newsletter:

https://www.sierraclub.org/sites/default/files/2026-05/spring_2026_0.pdf

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