# Tibbetts Brook Water Monitoring Program

Report of 2016 Water Quality Data

Assembled by Friends of Van Cortlandt Park staff John Butler and Alex Byrne

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*December of 2015, the Friends of Van Cortlandt Park, in partnership with Manhattan College and the NYC Department of Parks and Recreation, began to run an extensive weekly water monitoring program of Tibbetts Brook, within the boundaries of Van Cortlandt Park in the Bronx. Two locations along the Brook, three sites as it opens up into Van Cortlandt Lake, and one along a tributary to the Brook were monitored, with over 350 samples taken to Manhattan College's Department of Civil and Environmental Engineering. Detailed within this report are the parameters tested for during the first year of monitoring, some trends found in the data of water quality, and some management improvements that could be made along the waterway. The program has continued into 2017, with plans to keep this as an ongoing study.*

**Introduction**

Tibbetts Brook is a 4 mile waterway that begins just north of H.F. Redmond Park, running through the city of Yonkers and into the Borough of the Bronx, until its terminus into the sewer system within Van Cortlandt Park, connecting to New York City's combined sewer system along Broadway. A series of tributaries enter the brook both in Yonkers and the Bronx; many of which have been piped underground for significant portions.

The entering of the Brook into the sewer system allowed for development in the Kingsbridge neighborhood of the Bronx, but also adds millions of gallons of water daily to the sewer system, leading to the largest combined sewer outfall site along the Harlem River in WI-056, the largest CSO outfall site along the Harlem River and one of the largest in the city.

Tibbetts Brook was previously called Mosholu by the Leni Lenape but later named after George Tippetts. In 1699, the Van Cortlandt Family dammed a section of the Brook which is now within the boundaries of Van Cortlandt Park, to power a gristmill and sawmill. The dam created what is now Van Cortlandt Lake, even though the dam was rebuilt during the early 1900's. Environmental changes within the Tibbetts Brook watershed occurred as Yonkers and the Bronx became heavily populated. The Brook has been culverted under highways such as the Cross County and the Mosholu Parkway.

The Floodplains were taken away with the creation of such roads as the Saw Mill Parkway. Stormwater runoff from highways such as the Saw Mill and Major Deegan has negative effects on the water quality of the Brook. The Brook forms a series of ponds along its route, with one being within Redmond Park, two dammed ponds in Tibbetts Brook Park and Van Cortlandt Lake in Van Cortlandt Park.

The area surrounding Tibbetts Brook has never been a heavy industrial zones, which happens along many urban rivers larger than Tibbetts Brook. However, this does not mean that it is without its own list of concerns. The New York State Department of

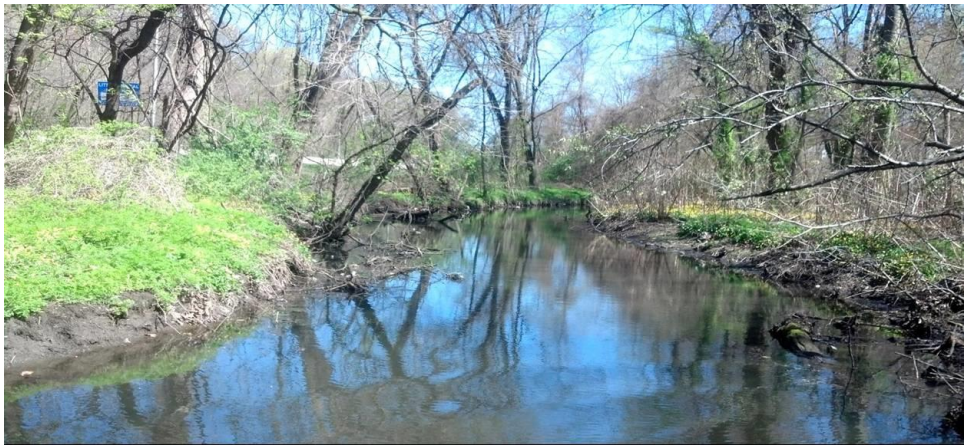
Environmental Conservation (DEC) has deemed Tibbetts Brook and its associated Van Cortlandt Lake as impaired by Phosphorous and placed on the Total Maximum Daily Load (TMDL) list. The overabundance of phosphorous has been seen as one of the major causes of eutrophication within the ponds of the Brook.

**Sampling Locations**

When putting together the details of our study, we chose 6 separate locations within the Van Cortlandt Park boundaries that would provide a view on the many aspects that affect Tibbetts Brook.

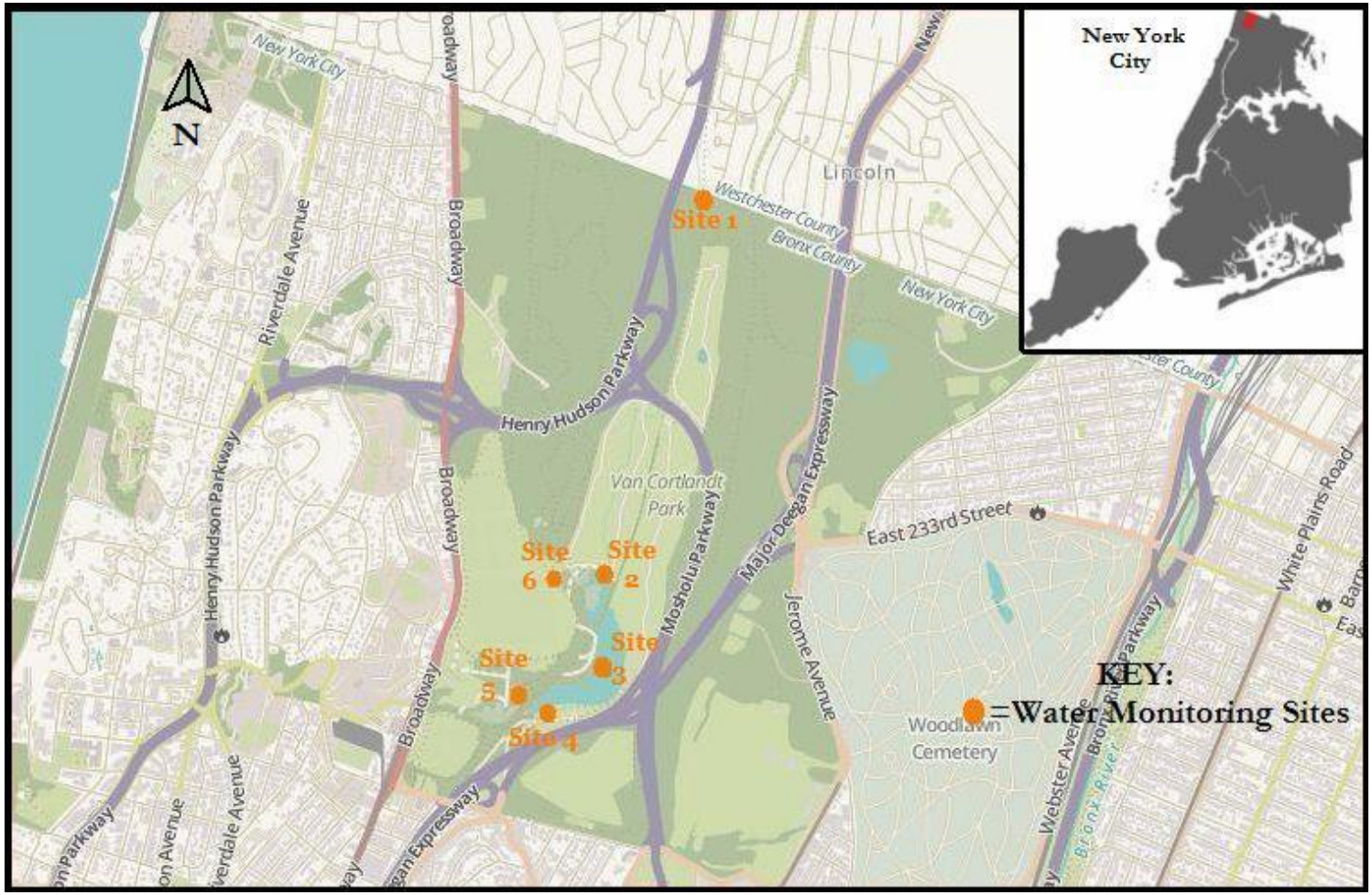
Site 1: Yonkers/Bronx Border

This site is the location where Tibbetts Brook enters Bronx County. In Yonkers, Tibbetts Brook travels through two major culverts, contains a golf course within the watershed and features a series of storm water drains that discharge directly into the Brook from primarily residential streets. At this site, cars on the Sawmill Parkway/Henry Hudson Parkway, race by 20 feet away from the Brook. Between the brook and the road is a riparian buffer zone.



Site 2: Birding Bridge

A large wooden bridge, part of the John Kieran Nature Trail, crosses over the brook at this site. Here the Brook begins to open up into a marsh habitat due to the back up of water from the dam originally built by the Van Cortlandt family. The site contains a hard rocky bottom, however if venturing into the nearby marsh this quickly turns into feet of sediment. The bridge is a popular vista point within Van Cortlandt Park to view the freshwater wetlands. North of this site, the Van Cortlandt Park Golf Course sits adjacent on either side of the brook, but maintains a buffer zone throughout. The brook is culverted under the Mosholu Parkway and Henry Hudson Parkway.




Map: The locations of all six sampling sites can be seen within the boundaries of Van Cortlandt Park

Site 3: Lake West

Located towards the middle of the lake on the western edge, the sun is plentiful at this sampling site. During the warmer months, sunfish can be found creating nests in the sediment and Yellow Pond Lily (*Nuphar luteum*) grows plentiful. This is the first of three sampling sites that are located on Van Cortlandt Lake.

Site 4: I-87 Storm Water Drain

During the early 2000's, Van Cortlandt Lake went through a restoration project where sediment was dredged from the lake floor and filters were placed into the four storm drains that enter the Lake from I-87 and Mosholu Parkway. A system to clean the filters was never set up, and suspended solids from I-87 can actively be seen flowing into the Lake from Site-4 during wet weather.

Site 5: VC Lake Sewer Outfall

At the terminus of the Lake, the water crests over a weir and into a large pipe that leads to the Broadway sewer system. During the summer months, the duckweed and filamentous green algae growth become heavily layered at this site. Access to this site is from the dam, which is now part of a walking trail.

Site 6: Western Tributary

This tributary of Tibbetts Brook has been piped underground for much of its course, only to enter above ground just north of Van Cortlandt Lake. The sampling site is located right as the water exits the underground piping. There are no plans or drawings that could be found at this time showing the details of the piping of this tributary stream. A large felled Mulberry tree can be found directly next to site. The water temperature at this site remains more constant than the other sites.

**Sampling Procedure**

From January 2016 through December 2016, weekly water monitoring of Tibbetts Brook was led by FVCP's Ecological Project Manager John Butler with the assistance of Environmental Educator Alex Byrne and many community members, most notably Felicity Wasser and Beni Veraz. Readings were taken at each site using probes that measured Dissolved Oxygen, Water Temperature, Conductivity and pH. Flow was measured at the stream sites using the Velocity-Area Method.

Monitors used waders to access the Brook. A quality assurance project plan (QAPP) has been developed to allow for our methods to be continued over time. A water sample was taken

at each of the six sites and brought to the Civil and Environmental Engineering lab at Manhattan College where it was tested for Nitrate, Phosphorous, Turbidity, and during the warmer months Enterococcus and Fecal Coliform.

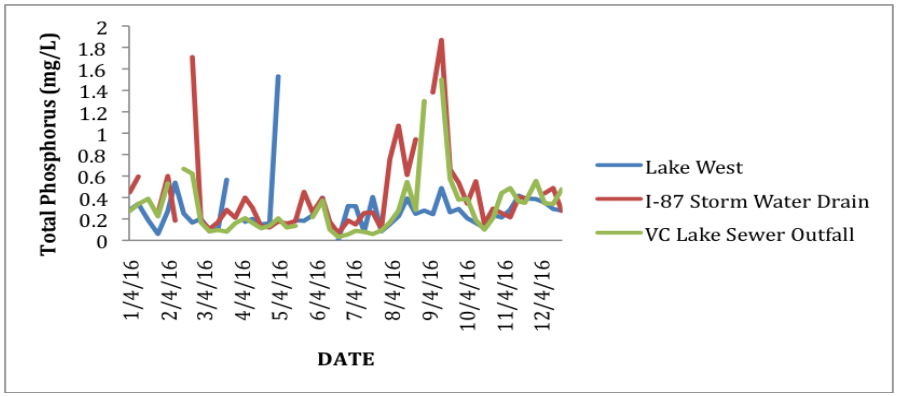
(Photo by Stan McCleave)

Monitoring was conducted in a routine fashion occurring generally on Wednesday mornings. Samples were analyzed at Manhattan College mainly on Thursday afternoons. Under the direction of Assistant Professor Jessica Wilson, engineering student and Lab Technician John Abbatangelo led the processing effort of the samples. He would frequently teach fellow students the lab techniques while processing the samples from Tibbetts Brook.

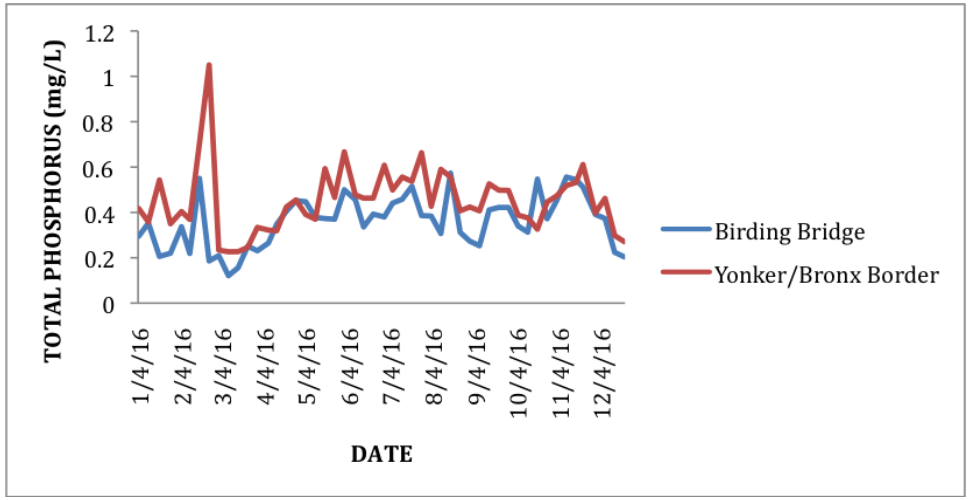
**Results**

1. Phosphorous- Natural phosphorous levels in freshwater streams tend to stay relatively low, although it is an essential nutrient for growth of aquatic plants. However, human induced land use changes such as agriculture and urban development can cause excessive amounts of phosphorous into the system, as the

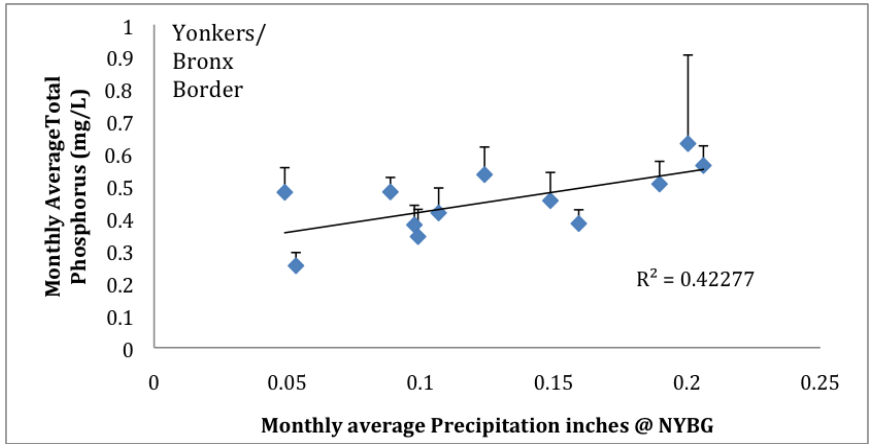
nutrient sorbs to sediment. High levels of phosphorous can lead to eutrophication of water bodies as plants and algae take advantage of the boost in phosphorous to grow. Eutrophication occurs every summer on the lakes of Tibbetts Brook. The adverse effect of this excessive growth of the aquatic plant duckweed and green algae is that this causes large swings in the amount of dissolved oxygen available in the water body. When these aquatic plants and algae begin to die during the early fall, their matter is decomposed by bacteria that use dissolved oxygen, further depleting the amount of oxygen in the water. Total phosphorous (mg/L) was measured in Tibbetts Brook.




Graph 1: This graph contains total phosphorous throughout the year as pertaining to the three Lake sites. Although variable through the year, the readings signify a eutrophic Lake.

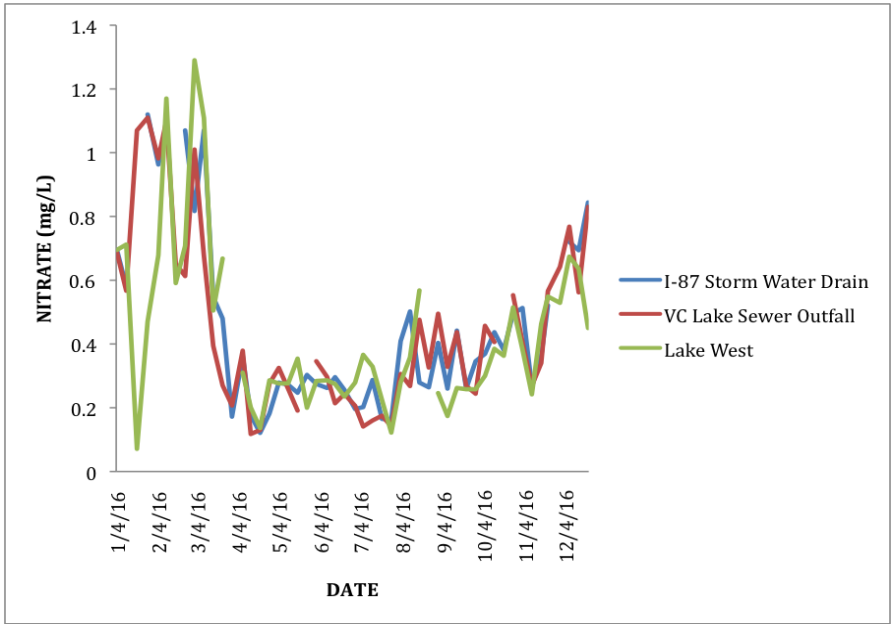



Graph 2: Total phosphorous levels at the two Brook sites tend to follow a similar pattern, with the Yonkers and Bronx border site generally a little higher than the Birding Bridge.

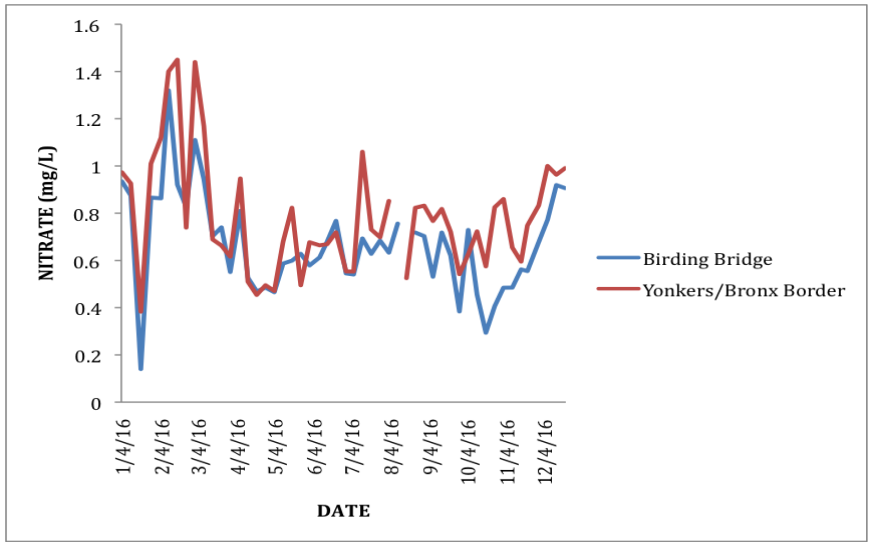



Graph 3: Total phosphorous levels at the Yonkers/ Bronx Border site show a correlation with precipitation amounts. Precipitation shows to be a driver in phosphorous levels.

2. Nitrate- Nitrogen is readily available in freshwater systems as plant matter decomposes. In 2016, nitrate was the only form of nitrogen that was monitored. Much like phosphorous, nitrogen is a nutrient needed for plant growth. Fertilizers and animal waste can raise the levels of nitrogen within water bodies, but nitrogen can also enter a water body through the atmosphere. Much of the issues with over saturation of nitrogen are similar to those of phosphorous.




Graph 4: Nitrate levels across the three Lake sites show variability throughout the year, with the winter months showing higher levels.

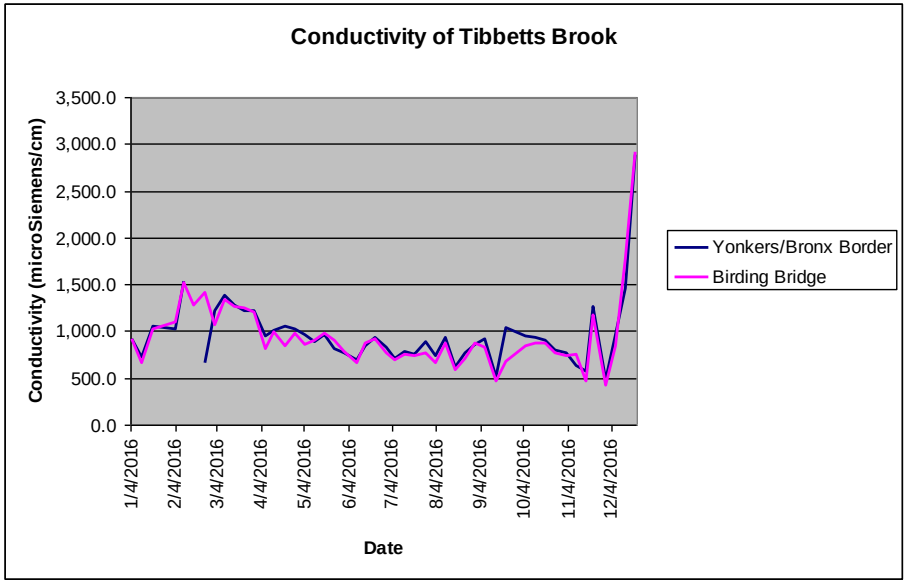



Graph 5: The same trend of higher nitrate levels during the winter months is not as apparent in the Brook sites as it is in the Lake sites.

3. Dissolved Oxygen- The amount of oxygen available in the water (DO) can tell us the viability of a waterway to host aquatic communities of fish, amphibians and macroinvertebrates. Like many other streams, the DO of Tibbetts Brook is higher during cooler months and lower during warmer months. As the temperature of the water increases, the kinetic energy increases, allowing more oxygen to escape the system. Within Van Cortlandt Lake, oversaturation of DO is also achieved during the summer due to the high density of plant life in the water giving off oxygen as a byproduct of photosynthesis during the daytime. Once these plants begin to die off, the bacteria that break them down will utilize oxygen in the water to decompose the plant

bodies. This is what is found in Van Cortlandt Lake during the early fall. As the plant growth in the Lake dies off, the dissolved oxygen levels deplete to very low levels in sections of the Lake.

4. pH- The potential for hydrogen is a numeric scale that specifies how acidic or basic a solution is. With 7 being neutral, any solution with a pH below 7 is acidic and a solution above 7 is basic. The waters of Tibbetts Brook tend to be basic, which could possibly be a result of the bedrock of the area. Although the pH within the Brook and Lake fluctuate, very rarely does it range out of "neutral". On one occasion while sampling during a wet weather event at Site 4 the I-87 Stormwater Drain, the pH rose to nearly 11 within a plume that was entering the Lake from the drain.
5. Conductivity- The water's ability to conduct electricity is measured in a metric known as Siemens, with our readings taking place in microsiemens per centimeter. As a good measure of the presence of conductive ions, one of the most prevalent dissolved solids within freshwater streams and rivers in urban areas is road salt. Spikes of conductivity readings during the winter in Tibbetts Brook positively correlate with the usage of road salt on the nearby highways. Overall, the conductivity readings fall on the higher range for a freshwater stream, showing the negative effects the highways and their stormwater drains are having on Tibbetts Brook.

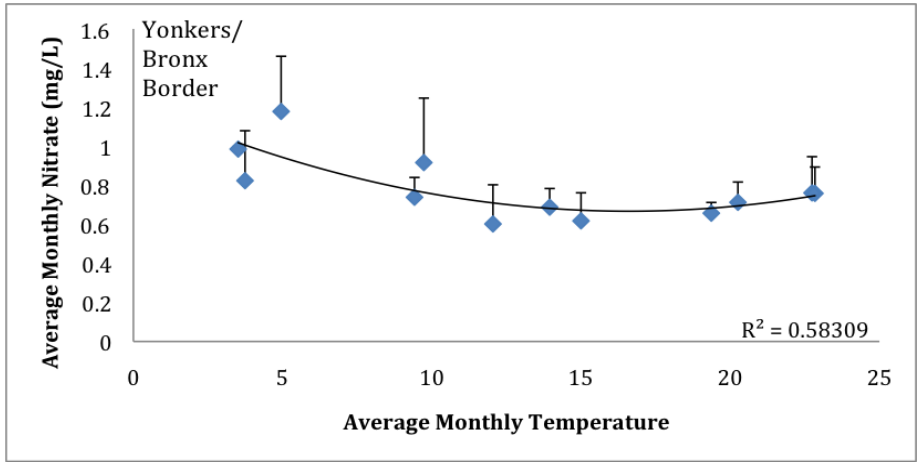



Graph 6: Conductivity readings in the Brook sites tend to be at their highest during the winter months, which could be an effect of salt runoff from the roads. The Lake sites show this same trend.

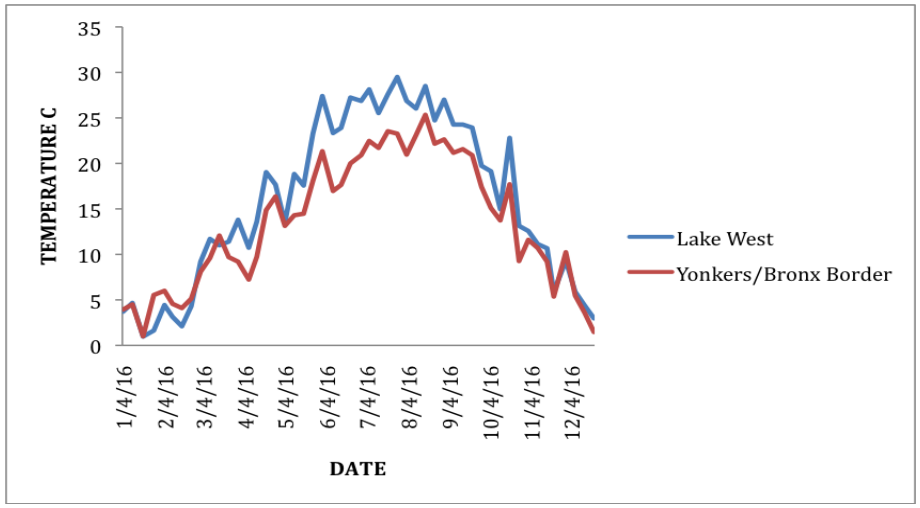
6. Enterococcus and Fecal Coliform- Enterococcus and Fecal Coliform bacteria act as indicators of harmful pathogens that are found in animal waste. FVCP sampled bacteria counts just a handful of times in 2016 to receive a baseline number during the summer months. Through this data, a stormwater outfall in Yonkers was identified as an inflow site of these bacterium.

7. Temperature- Many other parameters are driven by temperature including dissolved oxygen. Warmer

temperatures within the water assist in driving the growth of aquatic plants and algae.




Graph 7: Temperature shows a positive correlation with nitrate levels, showing its ability to be an indirect driver of nitrate levels.




Graph 8: In this graph, the difference between the Lake temperature and Brook temperature can be viewed.

## Benthic Macroinvertebrate Sampling

In addition to analyzing the chemical parameters of Tibbetts Brook, FVCP also initiated surveys for benthic macroinvertebrates to supplement water quality data, generate the first exhaustive species based list for fresh water organisms and aid in the understanding of urban freshwater biodiversity.

Benthic macroinvertebrates (BMI) include all organisms that occupy a freshwater niche that contain an exoskeleton, encompassing orders of life that include insects, mollusks, crustaceans, worms and freshwater sponges. BMI typically constitute the majority of animal biomass within freshwater

ecosystems and therefore are important components of freshwater food webs and nutrient cycling.

In addition BMI are extremely sensitive to changes in the conditions of water chemistry with many species only capable of existing within a narrow band of parameters. Conversely some species of BMI have adaptations that allow them to persist in impacted waters, typically dominating ecosystems that experience eutrophic conditions. For example as oxygen levels begin to fall as a function of elevated microbial respiration, many aquatic snail communities shift towards species that have lungs, allowing them to access oxygen from the air. This makes BMI an ideal group of organisms to couple with water quality chemical monitoring. FVCP also took part in the DEC surveying program known as Water Assessments by Volunteer Evaluators (WAVE). The following data and descriptions are from field observations from the summer of 2016 made by FVCP staff and volunteers.

**Invertebrate Fauna list**

This list represents specimens that were captured both in Van Cortlandt Lake and Tibbetts Brook at 6 different sampling locations. Methods used for capture include the use of dipnets for ~ 3 minute intervals along 3 meter linear transects. BMI were also sampled by removing downed debris within the water bodies including wood and rocks and scanning the surface of the objects, removing encountered invertebrates. All specimens were identified to the highest possible taxonomic classification with the use of *Peckarsky, Barbara Lynn. "Freshwater macroinvertebrates of northeastern North America." (1990).*

| | | | |
|---|---|---|---|
| 1 | *Psidium* | Finger nail clam | Mollusk |
| 2 | *Cipangopaldulia chinensis* | Chinese mystery snail | Mollusk |
| 3 | *Viviparus georgianus* | Banded mystery snail | Mollusk |
| 4 | *Physella* | Bladder Snails | Mollusk |
| 5 | *Enellagma* | Bluet Damselfly | Damselfly |
| 6 | *Nehalennia* | Sprites | Damselfly |
| 7 | *Ladona julia* | Chalk fronted corporal | Dragonfly |
| 8 | *Epicordulia* | Basket tails | Dragonfly |
| 9 | *Gomphaeschna* | Pygmy Darners | Dragonfly |
| 10 | *Dorocordulia* | Little emeralds | Dragonfly |
| 11 | *Tramea* | Saddlebags | Dragonfly |
| 12 | *Erythemis* | Pond Hawks | Dragonfly |
| 13 | *Notonecta* | Back Swimmers | True Bug |
| 14 | *Hydrometra* | Water Scorpion | True Bug |
| 15 | *Caenis* | Burrowing mayfly | Mayfly |
| 16 | *Cybister* | Predaceous diving beetle | Beetle |
| 17 | *Gammarus* | Scuds | Crustacean |
| 18 | *Caecidotea* | Aquatic Sow Bugs | Crustacean |
| 19 | *Orconectus limosus* | Spiny cheeked crayfish | Crustacean |

**Community ecology of Tibbetts Brook BMI**

The Brook BMI community is characterized by having considerably less diversity then the lake system and is largely limited by the homogenization of the substrate across the brook floor and the reduction of flow velocity as a result. Midgefly assemblages and beetle larvae occupy the top layers of brook sediment and silt. In addition dragonflies belonging to the family Libellulidae reside in the same silted areas of the Brook. The sediment surface community is characterized by crustaceans belonging to three different genera. The largest member of this assemblage, the Spiny Cheeked Crayfish (*Orconectus limosus),* typically occupies marginal areas of the stream, and can be found at high densities during the summer (~5/M^2). The large rocks, branches and logs that fall into the water provides habitat for a cover object assemblage composed of sponges, mollusks, crustaceans, and leeches. All of these organisms have been observed to use garbage such as glass bottles and aluminum cans as refuges and oviposition sites, mirroring the use of natural cover objects. Suggestions for future research include understanding the role of sediment oil in shaping the community structure of the brook and if canopy closure over the brook influences species richness.

**Community ecology of Van Cortlandt Lake BMI**

Unlike the Brook, the sediment and silt assemblage of the Lake benefits from a more patchy variable distribution of sediment particles where more niches are available for occupation, creating a more diverse ecosystem. The Lake BMI community is characterized by multiple assemblages that occupy several different habitat types within the Lake. Multiple species of midgefly larvae occupy the lake bottom. Burrowing mayflies are an additional component of the silt assemblage and can be found most readily on the western and eastern shore of the lake. Crustaceans belonging to the Amphipoda (Scuds and Sideswimmers) and Isopoda (Aquatic wood louse) are a dominant component of the surface sediment assemblage found at their highest densities at the lake outfall and are consistently netted along the western edge and near the outfall of the lake. Dragonfly larvae are relatively diverse in the lake, spanning multiple genera and life history traits. When considering the number of dragonflies and damselflies (Odonata) present in Van Cortlandt Lake it is possible that Lake is an important conservation space for these species in the Bronx. Aquatic vegetation also provides habitat space for another group of organisms classified as true bugs consisting of water bugs and water scorpions. Lastly on the Lake surface resides a hemipteran community of water boatman, side swimmers and water skimmers.  Future research on BMI lake assemblages should focus on the role of snails in nutrient cycling, the influence of floating wetlands on BMI diversity and establishing a species specific list of Odonate diversity.

**OTHER CONCERNS**

**Reporting Illegal Discharges**

The FVCP water monitoring team reported two occurrences during 2016 of illegal discharges into Tibbetts Brook. During June, a fish die-off of approximately twenty in number was documented at the I-87 storm water drain monitoring site. Monitoring in the past had shown that during wet weather

events, a plume of sediment would exit this outfall into Van Cortlandt Lake. FVCP staff received a pH reading upwards of 11 during a wet weather event in February at this site.

High bacteria counts at the upstream site led FVCP staff to a 48” reinforced concrete storm water outfall in Yonkers approximately a quarter of a mile north of the city border, adjacent to Lawton Street on the South County Trail. Samples from upstream and downstream of the outfall were analyzed for bacteria counts. Fecal Coliform counts were exceedingly higher downstream compared to upstream of the outfall. The Yonkers Engineering Department and the DEC were notified of the findings. Yonkers Engineering found multiple illegal connections and leaks within the pipes system and has been in the process of amending these issues.

**Water Chestnut Removal**

The invasive non-native plant known as water chestnut (*Trapa natans*) is found within Tibbetts Brook. During the summer months, the larger pond in Tibbetts Brook Park is covered with the plant that blocks sunlight from reaching the lake, both having adverse effects on native plant growth within the pond, altering the aquatic habitat for the animal life and creating a dense mat that makes fishing and boating difficult. Water chestnut contains very spiny seeds that grasp onto the sediment floor of the ponds, sprouting and reaching its way to the surface of the pond. Recently the plant has made its way to Van Cortlandt Lake, downstream of the ponds in Tibbetts Brook Park, and started to spread quickly.

FVCP staff began combating the invasive plant within Van Cortlandt Lake during the summer of 2016 by taking canoes onto the Lake and hand pulling the plant. The removed plant is then placed in the boat and brought to shore, where it is composted in the forest. The seeds need to be inundated in water in order to germinate and grow.

## MOVING FORWARD

### Creating Partnerships

Landscape and waterways improvements can only take place by creating partnerships and strengthening those relationships between governmental agencies, non-governmental groups, community members and other stakeholders. The fate of Tibbetts Brook is no different. Since the Brook travels through Yonkers and the Bronx, both Westchester County agencies and New York City agencies and their corresponding community members and groups need to be brought to the table to work towards improving the waterway. Impactful change within the Tibbetts Brook watershed will require a forward thinking political force as well as helpful push from community groups. Once partnerships are formed, the solutions can begin to flow.

### Riparian Enhancement

Riparian zones are extremely important to rivers, stream and brook systems as they act as a filter. These buffers protect waterways from excessive sedimentation, erosion and pollution from land use influences within the watershed. This makes these zones as influential in the water quality of our waterways. Riparian zones also slow the flow of water, decreasing the negative effects of floods during wet weather events. Tibbetts Brook is no different. Some sections of the Brook have what appear to be healthy riparian zones bordering the banks, whereas other sections can be improved upon.

Invasive plant species such as porcelain berry (*Ampelopsis brevipedunculata*) have overrun sections of the riparian zone of Tibbetts Brook, allowing for sunlight to continuously hit that

section of the stream. Shade from trees is important along the Tibbetts Brook riparian zone as it keeps the temperature of the brook lower. Higher temperatures instigate the eutrophication of the lakes along the Brook. FVCP is currently looking into the possibility of enhancing sections of the Tibbetts Brook riparian zone by targeting sections where invasive species have replaced native forest habitat, removing the invasive species and planting native tree, shrub and herbaceous riparian species.

There is a stretch of Tibbetts Brook in Yonkers that is approximately 400 feet in length and runs directly next to the Saw Mill Parkway with no riparian buffer zone. This stretch of the Brook in particular needs strategic planning to create a buffer zone that will capture storm water as it runs off of the Parkway.

**Green Infrastructure and Remediation**

Progressive solutions in the form of green infrastructure and remediation are necessary within the Tibbetts Brook watershed in order to combat the concerns with high nutrient levels. In situ solutions such as floating wetlands and constructed wetlands, utilize plant matter to remove phosphorous from water bodies. Locations to place these designs need to first be determined. The Tibbetts Brook riparian zone still houses natural habitat, however the areas of concerns are nearby the many storm water pipes, culverts and channeling of the Brook. These concerning locations are where green infrastructure tactics should take place.

Although much of the watershed of Tibbetts Brook in New York City is located in Van Cortlandt Park, the Yonkers section of the watershed houses not only Parks but residential and commercial land uses. Within this region of Yonkers, strategies such as installing rain gardens, bioswales and green roofs can assist in holding some of the runoff from wet weather that would make its way into Tibbetts Brook. This wet weather runoff gathers sediment from the landscape, carrying nutrients from roads and lawns and has negative effects of increased nutrients on water bodies like Tibbetts.

**Daylighting**

The NYC Department of Parks and Recreation (NYCDPR) is currently investigating the possibility of removing Tibbetts Brook from entering the municipal sewer system and bringing the Brook back above ground, at least partially. Currently, all of the water enters the Broadway sewer pipe after flowing through Van Cortlandt Lake. The water is then treated at Wards Island Water Treatment Plant, but on wet weather days, the millions of gallons of Tibbetts Brook water, as well as sewage from the neighborhoods of Kingsbridge, Fieldston and North Riverdale empty into the Harlem River out of the Combined Sewer Overflow (CSO) outfalls WI-056. WI-056 is one of the largest CSO outfalls in New York City, and the largest along the Harlem River. This means that this outfall discharges the most amount of sewage water on a yearly basis into the Harlem River. If removing the waters of Tibbetts Brook from the sewage system is possible, WI-056 will not overflow as often as it does allowing for a cleaner Harlem River.

NYCDPR only has access to investigate daylighting within Van Cortlandt Park, and does not have access to the land south of the Park. The area NYCDPR is looking to reroute the Brook is a small sliver of land that runs adjacent to I-87 on the western side. CSX Transportation, a railroad company, holds the rights to this stretch of land. FVCP is building support for this project through the creation of the Coalition for the Daylighting of Tibbetts Brook. This group is a collection of supporters of the plan, both groups and individuals.

**Get Involved**

FVCP's Tibbetts Brook water monitoring team is made up of staff and dedicated volunteers. The possibility is available to join this team and get your hands wet while gathering samples from the Brook or removing invasive plants such as water chestnut. Check the FVCP website at www.vancortlandt.org to sign the petition joining the Coalition for the Daylighting of Tibbetts Brook. Formally, planning meetings are held seasonally for the Harlem River alongside groups such as the Bronx Council for Environmental Quality (BCEQ). NYCDPR will also be holding information sessions on their Tibbetts Daylighting project at local Community Boards 7 and 8, and community members are welcome to attend. We hope that through growing support and partnerships for Tibbetts Brook that even more opportunities to get involved will become available.

(Photo by Stan McCleave)

**Thank You**
FVCP has many individuals and groups to thank for assisting with getting the monitoring program up and running through professional recommendations, volunteering or financially. With assistance in kickstarting the program, we thank Paul Mankiewicz and Karen Argenti from the Bronx Council on Environmental Quality (BCEQ), Dr. Kirk Barrett from Manhattan College and Shawn Fisher and Stephen Terracciano from the United States Geological Survey and a large thank you to the New York City Department of Parks and Recreation for welcoming this study. We would not have been able to monitor Tibbetts Brook without the contributions from the Hudson River Foundation, BCEQ, State Assemblyman Jeffrey Dinowitz, the National Fish and Wildlife Foundation and the Environmental Protection Agency. Benigno Veraz, Felicity Wasser, Nicholas Taussig, Diana Catz, Norma Silva and all other stewards dedicated their personal time in leading the volunteering effort of data collection and for that we are forever grateful. Last of all, FVCP would like to thank our partners in this study at the Department of Civil and Environmental Engineering at Manhattan College. Dr. Jessica Wilson has provided invaluable guidance and leadership and John Abbatangelo has been an indispensable lab technician.

All pictures were taken by FVCP staff unless otherwise noted. If using any data, pictures or information from this report, please notify Ecological Project Manager John Butler at john@vancortlandt.org before doing so. Full datasets can be accessed upon request. The views described in this report are those of the authors, and may not necessarily reflect the views of partnering organizations.