Flood Preparation and Mitigation of the Landsman Kill and Crystal Lake
Village of Rhinebeck, NY

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1. Introduction

1a. Preface

As extreme weather events increase due to climate change, municipalities in the Hudson Valley will continue to be negatively impacted. An issue that has become prevalent is an increase in flood events in the Village of Rhinebeck, New York. Through the continuation of the work done by the classes of 2019, 2020, 2021, and 2022, the objective of this project is to build upon the ability to mitigate flooding and increase the preparedness of the Village of Rhinebeck during these events. This objective was accomplished through determining a second location for a precipitation monitoring station, recommending equipment to the Village of Rhinebeck, educating homeowners on accessible flood management options, improving the ability of the previous station to obtain data, reviewing the data that has been collected in the past, and incorporating another source of precipitation data.

1b. Flooding Events and Concerns

The Village of Rhinebeck is composed of residences, local businesses, and municipal areas. While the village is at risk for extreme flooding events, the areas that are the most vulnerable are the homes that are located the closest to a manmade bottleneck created by a private bridge. This structure, in addition to the constraints created by Asher Dam, have contributed to flooding events because the Landsman Kill does not have the ability to flow freely and naturally direct itself. Human intervention in this manner has created the issue, but may also be the solution to mitigate the flooding. Another piece of infrastructure that is designed to aid in flood prevention is the valves that are connected to the dam. An obstacle for using this equipment, however, is the predictability aspect of precipitation events. The completion of these goals will ameliorate the response time to these flooding events, in addition to providing accessible options for infrastructure and landscaping improvements.

2. Equipment

2a. Tipping Bucket

The tipping bucket was previously installed at the Rhinebeck Highway Department by the Fall 2021 capping group of the Computer Science Department (Stone et. al 2022). This equipment was later removed due to freezing temperatures, then reinstalled by the capping group of 2022 once these temperatures had ceased (Stone et. al 2022). The tipping bucket was again installed on April 12, 2023. Without a de-icer, this seasonal removal is necessary.

The tipping bucket measures the volume of precipitation events. It has a sample rate of 20 minutes and a report rate of one hour. This means that the tipping bucket stores individual data points from precipitation every 20 minutes and sends the data back to the server at Marist College every hour, creating a collection rate that is not constant. The rainfall is measured in inches with a calibration constant of .01 for each "tip", or every time the bucket catches precipitation. The data is sent back to Marist College where it is stored in a server at the Hancock Center.

Figure 1. Tipping bucket.

2b. Solinst LevelVent Logger

The Solinst LevelVent Logger measures the height of the stream, and it is connected to Solinst Levelogger software where past and current data collections are able to be viewed on a database on the MySQL website, which can be accessed by Professor Algozzine (Algozzine 2023). It is also stored in the Solinst database at Hancock Center on the Marist College campus for MS Access (Algozzine 2023). Once obtained, these data files can then be exported to Excel (Algozzine 2023). This piece of equipment also measures the height of the stream as it changes.

2c. Improvements

Tipping Bucket Placement

One of the most important aspects of this project is the placement of the tipping bucket to ensure the proper collection of data. The first monitoring station is located at the Rhinebeck

Highway Department and powered by solar energy and from the Rhinebeck Highway Department.

To improve the accuracy of the data that is being collected, it was suggested to raise the tipping bucket 10 feet into the air. It was also determined that the area must be absent of vegetation to reduce the amount of leaf litter and other debris that would accumulate into the bucket.

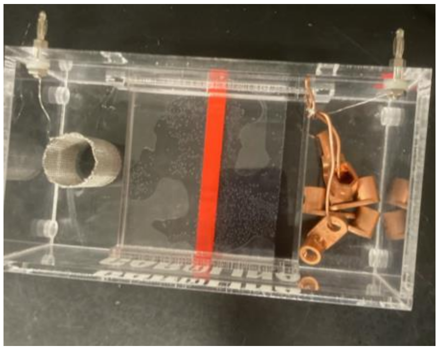
Figure 2. Platform for the tipping bucket.

Fouling of the tipping bucket

To improve the data collection abilities of the tipping bucket, the causes of fouling were examined. The causes of fouling are a green algae that was reported in June, in addition to the presence of leaf litter that was reported in November. It is unclear when the transition between each fouling type occurs, but both were accounted for in the completion of this project. To remedy the presence of debris, it was suggested to raise the tipping bucket 10 feet into the air. Next, to prevent the growth of algae, the finger mesh layer of the tipping bucket was electroplated with copper because of its antimicrobial properties.

Electroplating Process

This process was performed by Melina Serrao through the use of pure copper and a solution of copper sulfate. The pieces of equipment that were used consisted of a beaker, a telemetry box, wire, a hot plate, and a box to hold the copper sulfate solution and submerge the metal screen. First, 200 mL of distilled water was heated up and mixed with 10 grams of copper sulfate, but that did not reach equilibrium, so 12.768 grams of copper sulfate were used. Once these components were thoroughly mixed, the copper sulfate solution was transferred to the container pictured in Figure 3. Next, a wire was wrapped around the metal screen and one half of this piece was submerged into the solution, along with the pure copper, also shown in Figure 3. After charging the solution with electricity from the battery pictured below in Figure 5, copper ions were transferred to the metal screen, completely coating it. Due to antimicrobial properties that copper has, this method to prevent fouling is likely the most productive (Feldman 23).



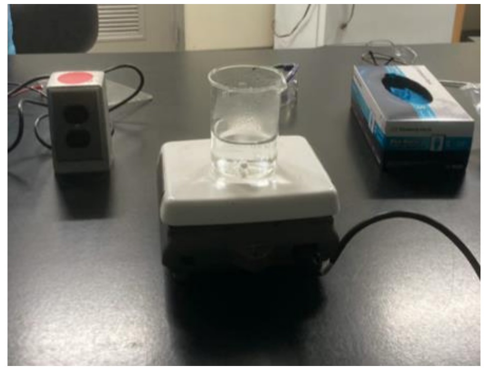


Figure 3. Metal screen layer of bucket connected to wiring and copper.

Figure 4. Hot plate and beaker with distilled water.

Figure 5. Power Source.

Figure 6. Copper-plated metal screen.

Calibration of Tipping Bucket

Another step to improve the data collection process was the calibration of the tipping bucket. To complete this process, the team consulted with Dr. Klos to discuss the process. The pieces of equipment that were used include a geopump, two graduated cylinders, and a tube (Figure 7). To begin the process, real-time data was taken from the Rhinebeck Highway Department to compare. On the slowest setting, the movement of the water from one cylinder to another was timed. Next, the flow rate from the geopump was compared to the flow rate that was shown by the tipping bucket. The procedure was repeated until the flow rates matched. It was found that the bucket was already calibrated and the process was repeated to ensure its accuracy, confirming the calibration at the completion of this process. Although this process has shown that the tipping bucket is a reliable instrument, it is recommended by the HyQuest company to send it to them for calibration (HyQuest 2023).

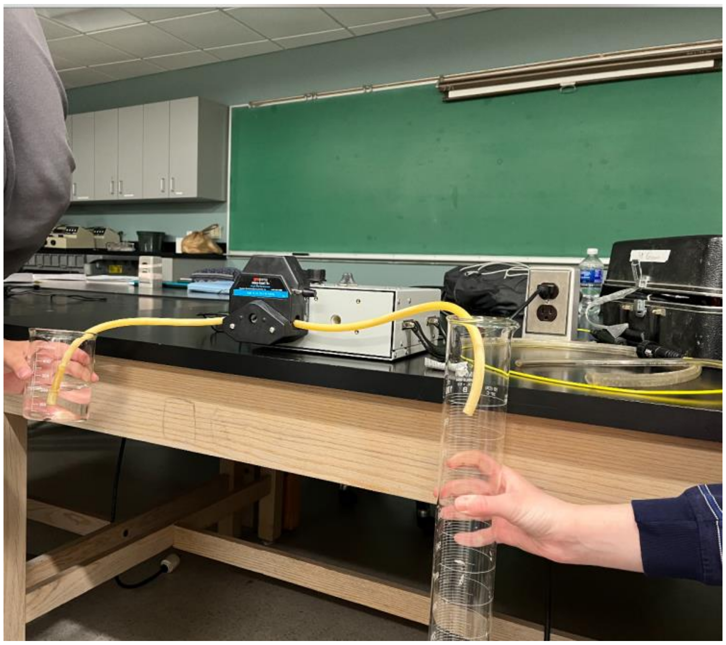


Figure 7. Geopump and beakers for calibration of tipping bucket (tipping bucket not pictured).

Installation of Tipping Bucket

To install the tipping bucket, the platform where it was previously installed was placed on top of the monitoring station. We raised it to the best of our abilities based on its location at the Village of Rhinebeck Highway Department and the equipment available. Next, the wiring for the tipping bucket was connected to the Solinst box, in addition to the bucket itself. The installed tipping bucket is pictured in Figure 8.

Figure 8. Installed Tipping Bucket and wiring setup.

Maintenance

To allow the tipping bucket to collect accurate readings for precipitation data, a cleaning plan was created. The plan consists of instructions on the disassembling of the tipping bucket to get to the metal screen and remove any debris that is blocking the entrance. Instructions on proper cleaning methods, in addition to reassembling the bucket are also included.

2d. Additions

While working on this project, the Village of Rhinebeck requested the addition of a second monitoring station without a tipping bucket. Crystal Lake was chosen as the new site because it is located on public property and it has the most direct impact on the homes that are situated on the shoreline, in addition to the Landsman Kill.

To recommend the best possible equipment to the Village of Rhinebeck, the HOBO step-by step process to create a monitoring station was consulted. Although the Solinst software has provided current data, it is not entirely accurate due to the timing of the collections being every 1-2 minutes (Algozzine 23). The first step of creating this sample order was determining that the RX3000 would be able to function as the remote monitoring station. This equipment is featured at the top of Figure 9.

The next step was choosing our region in the Hudson Valley to account for the device frequency, which is 904-924 MHz (HOBO 2023). Next, the communication type was selected. The best fit for the needs of the Village of Rhinebeck is a User-Supplied SIM, which uses logging connections that are 10 minutes long (HOBO 2023). This timing was selected to have a constant flow of data and to ensure the most accurate measurements. The power source that was selected for our station is an external DC Power Cable for the RX3000, which also comes with a battery. The fourth step of this process was the selection of a smart barometric pressure sensor to monitor this factor, in addition to the water level (HOBO 2023). An additional data source is the Water Level Sensor Module that will monitor water level, temperature, and temperature, in addition to barometric pressure (HOBO 2023).

Figure 9. RX3000 from HOBO (top) and Water level logger to measure barometric pressure and water level (bottom). HOBO 2023.

Figure 10. Location for second monitoring station (left pole).

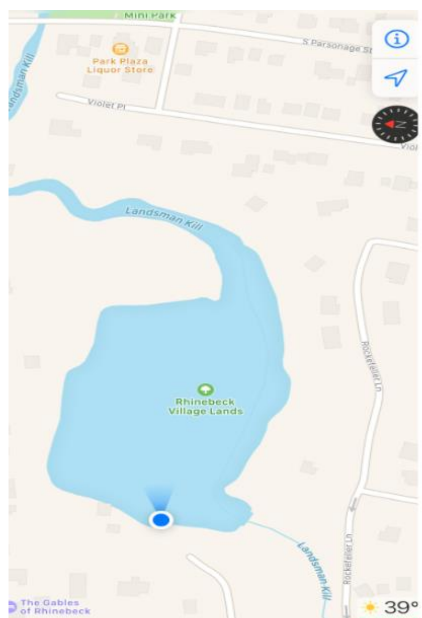


Figure 11. GPS Location of second monitoring station

Local Source of Precipitation Data

A reliable weather station will be able to aid the government officials in the Village of Rhinebeck when making decisions on when to open the valves. It will especially be important when the tipping bucket is taken out during the winter due to snow. The factors that were considered while making this choice were the distance from Crystal Lake and the availability for previously collected weather data. The station that was chosen is located at Bard College, which is 7.1 miles away from the Landsman Kill (Google Maps 2023). The distance will ensure that the past data predictions are as reliable as possible. The Red Hook Weather Station, however, will be used for predictions regarding heavy precipitation events to allow the Village of Rhinebeck to prepare for floods. This station is located 5.8 miles away from the Landsman Kill (Google Maps 2023).

The data shown in the figures below depict the relationships between the stream level and different weather conditions. The stream level data was collected near the Rhinebeck Highway Department and the data for the different weather conditions are from the Bard College Weather Station.

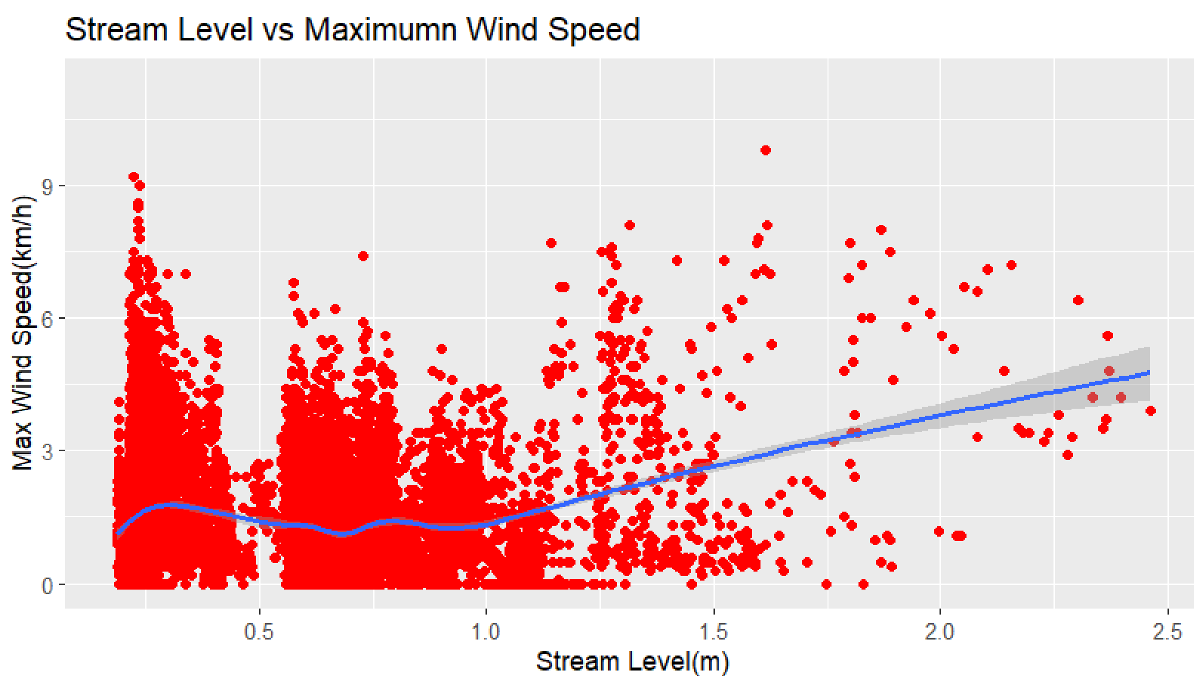


Figure 12. Stream Level vs. Maximum Wind Speed

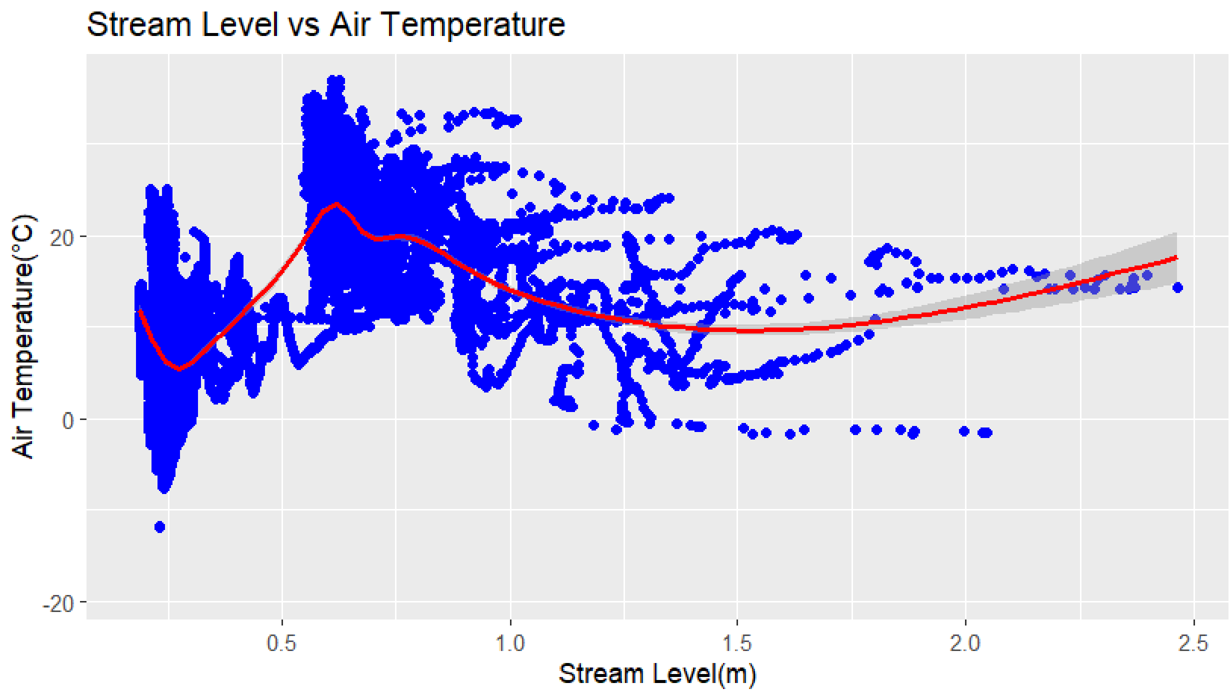


Figure 13. Stream Level vs. Air Temperature

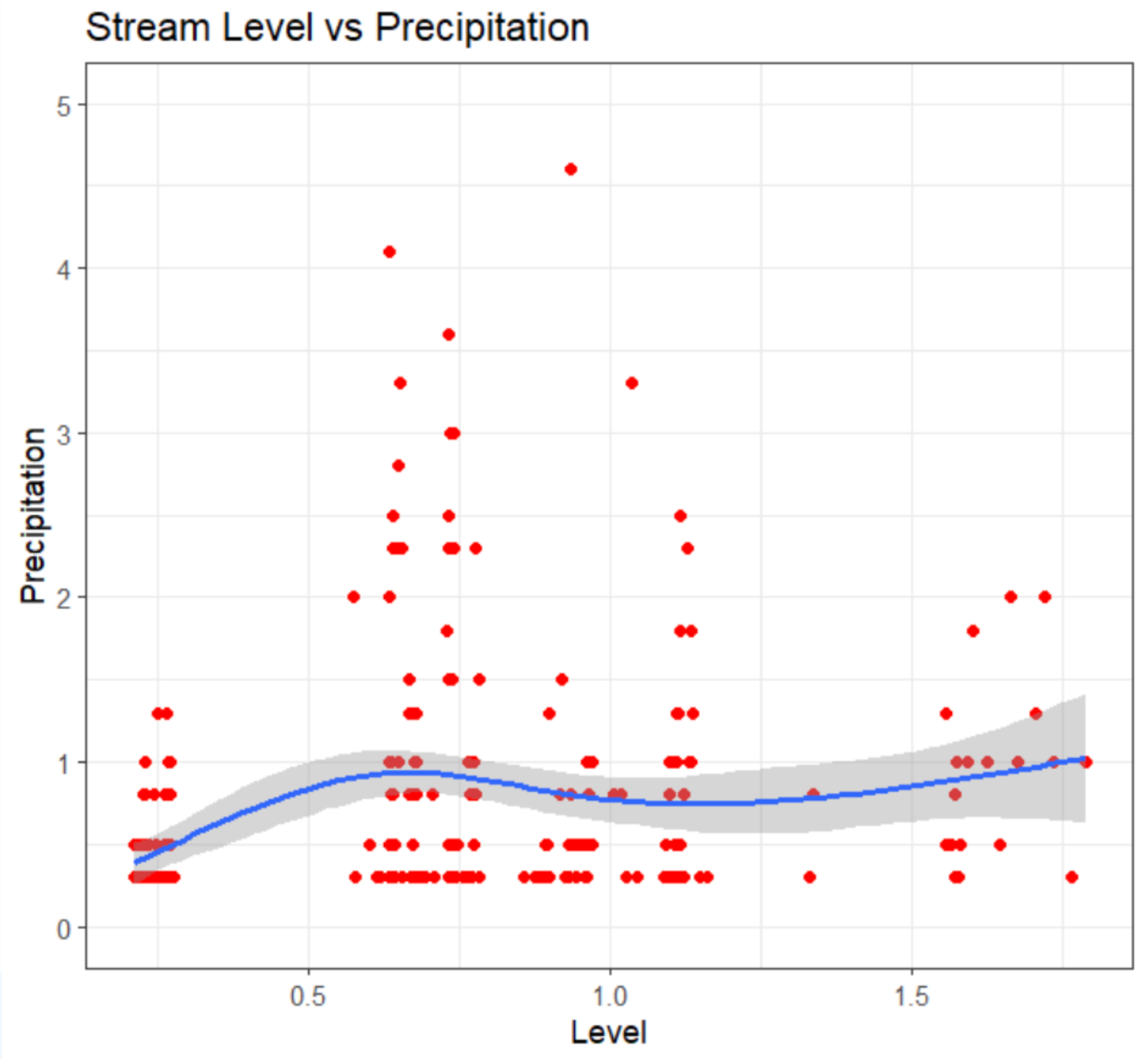


Figure 14. Stream Level vs. Precipitation

In Figure 12 and in Figure 13 there are direct relationships between both stream level and wind speed and stream level and air temperature as indicated by the upward diagonal trend line in both graphs. Figure 14 shows this trend as well; however, it is not as clear as indicated by the shallowness of the upward diagonal trend line.

3. Data Collection

3a. Hydrologic Ratings Curve

The hydrologic rating curve is used to calculate the speed and depth of the stream. The capstone group of 2022 had created the equation, $y=0.657e^{0.0476x}$ (Stone et. al 2022). An objective of the 2023 group was to collect more data to reinforce the accuracy of this calculation.

3b. Methods

Eight measurements for the hydrologic rating curve were taken at the section of the Landsman Kill at the Rhinebeck Highway Department.

To find the width of the stream, a tape measure was stretched across both banks, where the average width is 5.7 meters. Next, the depth was measured with the use of a meter stick. The average depth for the stream is 30.93 centimeters. Next, to measure the speed of the stream, the meter stick was held on top of the stream, while a leaf was dropped into the water at one end of the meter stick. Next, it was timed how quickly the leaf moved from one end of the meter stick to the other. This process was repeated three times for each collection of data and the average of the three measurements were taken. The overall average speed is 1.2 meters per second.

3c. Data Review

Day	Stream Width (m)	Stream Depth (in)	Area (m^2)	Speed 1 (m/s)	Speed 2 (m/s)	Speed 3 (m/s)	Average Speed (m/s)	Volumetric Discharge (m^3/s)
27-Feb	5.7	7.5	42.75	1.57	1.36	1.27	1.4	59.85
1-Mar	5.73	14.25	81.6525	0.92	1.23	0.91	1.02	83.28555
6-Mar	5.78	14.75	85.255	1.27	1.21	1.93	1.47	125.32485
24-Mar	6	15.5	93	1.25	1.31	1.25	1.27	118.11
29-Mar	5.9	13	76.7	1	1.32	0.72	1.01	77.467
1-Apr	5.73	12.5	71.625	1.23	1.21	0.95	1.13	80.93625
4-Apr	5.8	11	63.8	1.69	1.13	1.14	1.32	84.216
10-Apr	5.56	9	50.04	1.43	0.88	2.18	1.5	75.06

Figure 14. Measurements of speed and depth of the Landsman Kill.

The data presented in Figure 14 is significant because it depicts characteristics of the stream that exist as a result of precipitation events, or a lack thereof. For example, the stream width and depth are the highest from 3/24 until 4/4. These characteristics were seen after large precipitation events, whereas the smallest measurements were seen in drought periods from 2/27 to 3/1 and on 4/10. These characteristics, in addition to the average speed of the stream, are important to consider because the knowledge of these trends allow for an improved preparation for flooding events. The data collected supports the strength of the curve.

3d. Data Modeling

To further improve flooding predictions, a model was created with the aid of Duy Ngyuen, a professor of Mathematics at Marist College. The data from earlier collections were organized into spreadsheets. This data was then put into R, a programming software that can create predictive models.

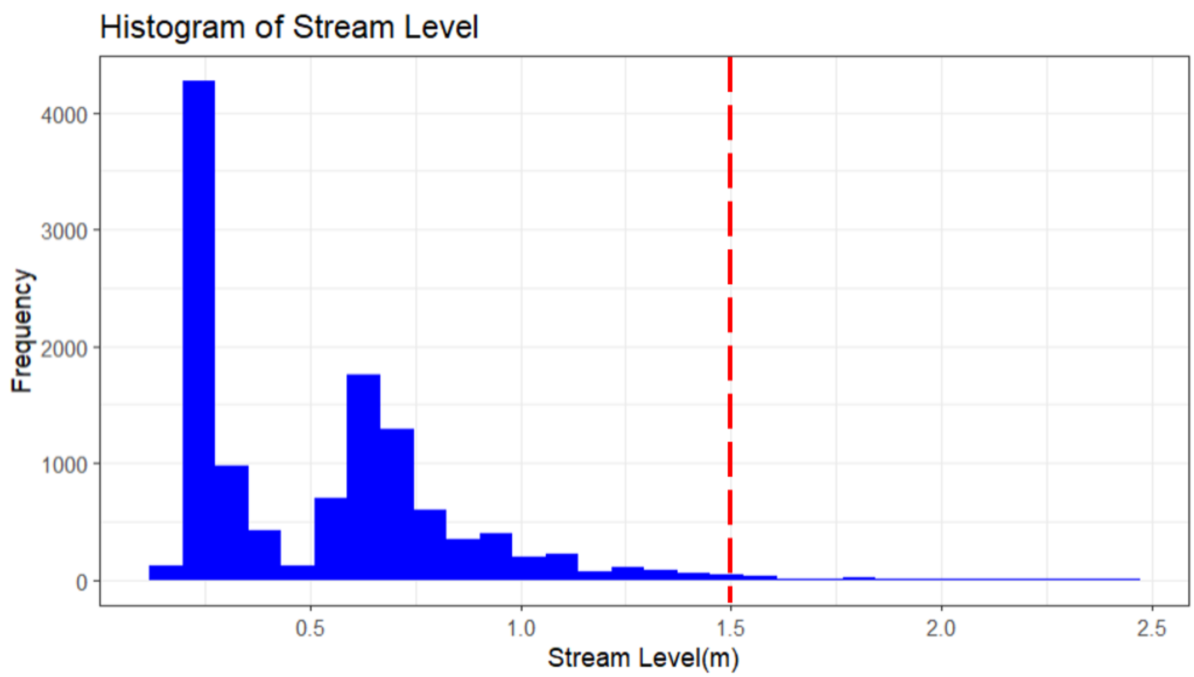


Figure 16. Predictive Model of Flooding Events at Rhinebeck Highway Department

This graph uses a predictive model of stream flooding events. Using R, a model was created to predict flooding events. During this process, it was found that significant variables are wind speed, precipitation, and stream level. Each bar on the graph represents a date that data were collected from the Rhinebeck Highway Department Monitoring Station. 1.5 meters is the threshold level for flood events at this location of the Landsman Kill.

$$\frac{e^{(\beta_0+\beta_1 x)}}{1+e^{(\beta_0+\beta_1 x)}}$$

The logarithmic regression equation was used to predict which variables had the most significance on flooding. To use this equation, obtain coefficients of each variable and multiply them by either one or zero. A one represents the theoretical presence of that variable and thus a zero represents a variable's absence.

3e. Cleaning Data

In order to conduct data analytics, data must first be clean. Clean data is free of incomplete and incorrectly formatted inputs. A good example of clean data is the weather data from the Bard College Station. Future data collections need to mimic the Bard College Stations data formatting to easily merge the two data sets. Data that was collected by Marist College did not match the formatting of the Bard College Station data, so this data was cleaned in order to merge the two sets and perform further data analytics.

3f. R code

The RStudio software is a tool that was used to create predictive models of the most significant variables on flooding. The threshold that was calculated for this location of the Landsman Kill was 1.5 meters. The equations used was to determine significant variables was:

*P(There is a Flood)= exp(Flood~Coefficient*Air.Temperature+Coefficient*Humidity+Coefficient*Barometric.Pressure+Coefficient*Wind.Speed+Coefficient*Max.Wind.Speed+Coefficient*Precipitation+Coefficient*Level+Coefficient*Temperature)/(1+exp(Flood~Coefficient*Air.Temperature+Coefficient*Humidity+Coefficient*Barometric.Pressure+Coefficient*Wind.Speed+Coefficient*Max.Wind.Speed+Coefficient*Precipitation+Coefficient*Level+Coefficient*Temperature))*

Once data was uploaded into RStudio, lines of code were used to create a predictive model of significant flood variables in RStudio. This software is extremely sensitive, thus there is a formatting standard that must be complied.

```
Data=read.csv("C:\\Users\\mserr\\Downloads\\Data220\\landsmankill\\FusedMaristandBard.csv")
Threshold=1.5
Data$Flood=NA
Data$Flood=ifelse(Data$Level>Threshold,1,0)
summary(Data)
Model1=glm(Flood~Air.Temperature+Barometric.Pressure+Wind.Speed+Max.Wind.Speed+Precipitation+Level+Temperature,data=Data)
Model1$coefficients
Model1a=exp(0.1562551770-0.0005151387*1-0.0001903384*1+0.0190996537*1-0.0015407978*1+0.0108917335*1+0.1777082848*1-0.0031632005*1)/(1+exp(0.1562551770-0.0005151387*1-0.0001903384*1+0.0190996537*1-0.0015407978*1+0.0108917335*1+0.1777082848*1-0.0031632005*1))
Model2=lm(Flood~Air.Temperature+Barometric.Pressure+Wind.Speed+Max.Wind.Speed+Precipitation+Level+Temperature,data=Data)
Model2a=0.1562551770-0.0005151387*1-0.0001903384*1+0.0190996537*1-0.0015407978*1+0.0108917335*1+0.1777082848*1-0.0031632005*1
summary(Model2)
```

From the summary of Model2, data can be interpreted to find the most significant variables when predicting flood events. Specifically, looking at this model's p-value for each variables' coefficients will indicate if a variable is significant and the model's overall p-value will indicate if the null hypothesis will be rejected or not.

Null Hypothesis (H0): There is a flood if the overall p-value less than .05
Alternative Hypothesis (H1): There is not a flood if the overall p-value is greater than .05

Variables can be eliminated by simply replacing a zero with the number one in the model's equation. This is essential to creating multiple models with different variable combinations when predicting flood events.

4. Education

4a. Flood Tolerant and Native Flora

One method to prevent extensive flood damage is planting native flora as a natural barrier. The plant species are composed of trees, flowers, shrubs, and sedges. Each plant was examined carefully to ensure that it would survive in both the wet and dry conditions that the Hudson Valley experiences. Planting riparian species will have the benefits of absorbing the runoff from flood events, in addition to filtering it (Trees for Tribs 2023). Also, the extensive root systems of the selected vegetation will enable them to remain in their place and not be overtaken by waters that are moving quickly (Audubon Society 2023).

The grass species that were selected are freshwater cordgrass *(Spartina pectinata),* sideoats grama *(Bouteloua curtipendula),* and American manna grass *(Glyceria grandis).* Each of these grasses were chosen for their ability to survive in moist, as well as well-drained soils (Audubon Society and New York Flora Association 2023). Ideally, these grass species would be planted as a replacement for turf grass because of their extensive root systems.

Figure 17. Audubon Society. Freshwater Cordgrass *(Spartina pectinata).*

Figure 18. Warner Brothers Seed Company. Sideoats Grama *(Bouteloua curtipendula).*

In addition to these species of grass, a combination of aesthetics and the function of the plants were also addressed through the incorporation of flower and shrub species that are resistant to flooding. The flower species that were chosen are Canada Anemone (*Anemone canadensis),* Canadian Lily (*Lilium canadensis)*, and Common Boneset (*Eupatorum perfoliatum*). The shrub species are Smooth Mallow Rose *(Hibiscus laevis)*, Common Buttonbush (*Cephalanthus occidentalis)* and Highbush Blueberry (*Vaccinium corymbosum*). Similar to the selected grass species, these plants were chosen for their ability to adapt to wet or moist soils and their extensive root systems (Audubon Society 2023; New York Department of Environmental Conservation 2023).

Figure 19. New York Department of Environmental Conservation. Canada anemone (*Anemone canadensis).*

Figure 20. Mark Greene. North Carolina State University. Smooth Mallow Rose *(Hibiscus laevis).*

Tree species were also considered as protective vegetation. River Birch (*Betula nigra)* and Alternate-Leaf Dogwood *(Cornus alternifolia)* were the flood resistant species that were selected. These tree species are able to survive in wet or dry soils as well to ensure the protection of shorelines during each season.

Figure 21. The Arbor Day Foundation. River Birch (*Betula nigra).*

Figure 22. North Carolina State University. Alternate Leaf Dogwood.(*Cornus alternifolia).*

Finally, sedge species were examined, specifically for floodplains along the Landsman Kill. An example is a floodplain lying at the bottom of a hill where there is a large section of water from the Landsman Kill that does not dry. The presence of sedge species along the Landsman Kill will also serve as another layer of protection through their absorption of excess runoff, and their ability to survive in saturated soils, as well as those that are well drained. The sedge species that our team recommends are the Tufted hair sedge *(Bulbostylis capillaris),* Shining Flat Sedge *(Cyperus bipartitus),* and Umbrella flat sedge *(Cyperus diandrus).*

Figure 23. Native Plant Trust. Shining Flat Sedge *(Cyperus bipartitus).*

4b. Trees for Tribs

A potential resource for the homeowners who wish to use any of these riparian species is the organization Trees for Tribs. This group is a part of the New York State Department of Environmental Conservation (Trees for Tribs 2023). This resource is ideal for those who would like to rebuild a riparian ecosystem to prevent flooding through the provision of free seedlings (Trees for Tribs 2023).

5. Funding

5a. Budgeting

While creating the second monitoring station, the factors that were considered consisted of the technology that the village wanted, the equipment that would provide the most accurate readings, accessible signage, and their budget of $5000 dollars to dedicate towards new equipment. In addition to the $5000 being put towards the budget for next year, there was an additional $500 available for use. To ensure the most efficient use of funds, our team recommended that the Village of Rhinebeck put this amount towards the creation of signage to explain the purpose of the monitoring station and give the public access to the live data.

5b. Grants

An aspect of the landscape that is contributing to the flooding issue for the residents of Rhinebeck Village is a bottleneck that is privately owned. The removal of this structure is a solution, but it is an expensive process. To give the homeowner an option, however, a grant was selected.The Federal Emergency Management Agency has a grant that applies to private properties. An obstacle, however, is that both require a sponsor in a position of local government (FEMA 2023). After consulting with Mayor Bassett and Vanessa Bertozzi, it was suggested that residents consult with private construction firms to get three different quotes for the design, removal, and reconstruction of the bridge and to select the best option.

5c. GoFundMe
Another option for residents to consider is the use of GoFundMe.This website allows for the creation of private fundraisers where individuals can tell their story, share the fundraiser through emails, texts, or on social media (GoFundMe2023). In this instance, the funds would be managed by the homeowner who has created the fundraiser (GoFundMe 2023).

6. Future Projects

6a. Project Ideas
To continue the work that the 2023 capping group has accomplished, the suggested focus for future endeavors is on education, expanding upon the area of data collection and continuing the use of the predictive model and data manipulation. It is also suggested that future capstone groups maintain contact with village residents who own private bridges to see how things have progressed. No commitments to taking action have been made to reduce the threats posed by bottlenecks, but the information was reviewed to hopefully get estimates for addressing this issue.

Further Education
To educate the residents of the Village of Rhinebeck, the Little Lions Mini Park is a potential site for a third monitoring station. In addition to the public view of this data collection, creating lesson plans on the importance of flood mitigation, the use of proper equipment, and the monitoring station itself will expand on collective knowledge in regards to flooding events.

Expanding Data Collection
To expand on the collection of data, it was suggested by Dr. Zion Klos and Dr. Richard Feldman to assemble more remote monitoring stations farther upstream on the Landsman Kill, specifically near the Salzman Bridge.This endeavor would require contacting the owners of each dam and establishing new professional relationships. Additionally, the calibration of the tipping bucket will need to be checked. This can be done through completing the calibration procedure, or sending the device to the HyQuest company for this purpose.

Proposal to Reroute the Landsman Kill
Another future direction for other capping groups is to encourage the removal of debris in Landsman Kill to ensure that there will be no barriers in the stream. Additionally, if the Landsman Kill were to be rerouted, the property that could be used for this is Rhinebeck High School, as it is public property. This parcel of land is shown in Figure 24.

Figure 24. Property Map showing residential property in relation to the Rhinebeck High School for a proposed rerouting of the stream.

6b. Project Resources

Data Collection and Review

To continue this project, more data will need to be collected to reinforce the strength and accuracy of the hydrologic ratings curve. Although its accuracy is supported, it is important to continue to monitor this equation because it is a reflection of the conditions of the stream. Additionally, the variation between each season will have an effect on the measurements that are taken (Stone et. al 2022). To ensure the comprehensiveness of this equation, all seasons must be accounted for.

In addition to further data collection, the review of past and current precipitation data will be necessary to monitor the conditions of the Landsman Kill. Data collections from previous capping groups can be found with Professor Algozzine, who has provided this data to our group as well. Additionally, the data from the remote monitoring station will need to be organized and monitored. This action can be done and refined through maintaining contact with Professors Algozzine and Nguyen. Also, the first monitoring station and the Highway Department will need to be monitored as the collection of precipitation data continues. Finally, the precipitation data that is collected from the Bard College and Red Hook Weather Stations will need to be examined in relation to these sources of data.

7. Conclusion

This project is a culmination of our work, in addition to the accomplishments of previous capping groups. The 2023 capping team has found an additional local source of precipitation data, outlined suggestions for a new monitoring station through creating a budget, chosen a second monitoring site, improved the quality of existing equipment, created a predictive equation for flooding events, explored funding options, and researched information on flood resistant vegetation. We hope that the completion of these tasks will allow the Village of Rhinebeck to increase their preparedness for flooding events from the Landsman Kill, and that future capping groups will be able to expand on our work to find more solutions to this issue.

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Appendix

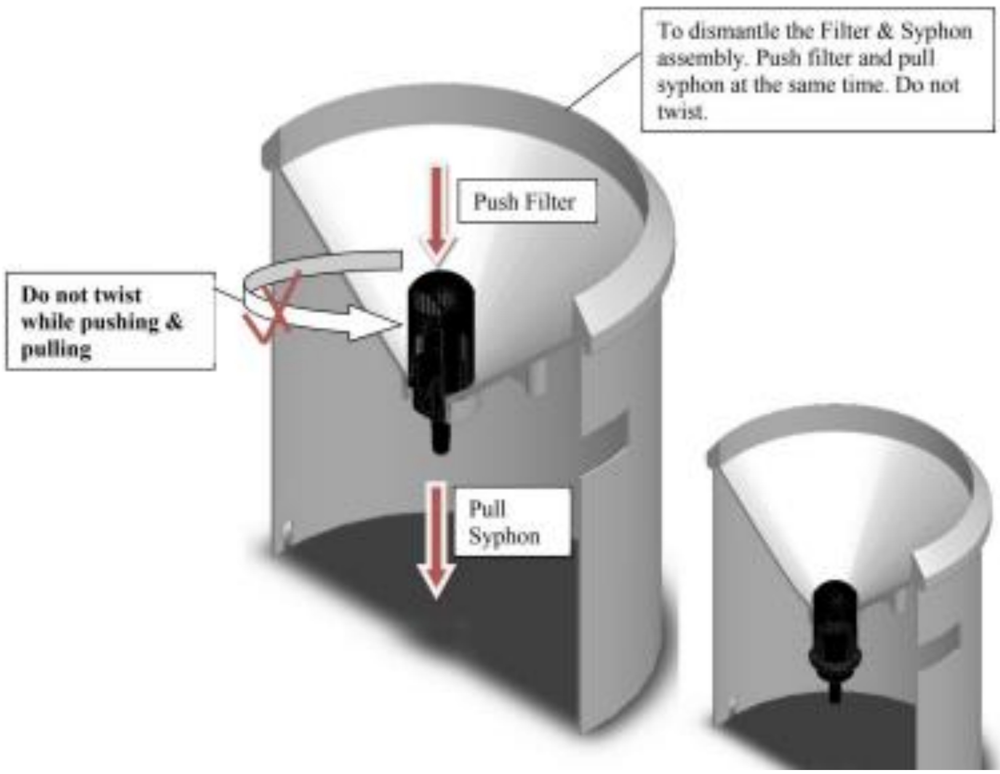
Maintenance Plan for Tipping Bucket HYQUEST: TB6/40 SERIES II

Created by Marist College Environmental Science Capping Students

Table of Contents

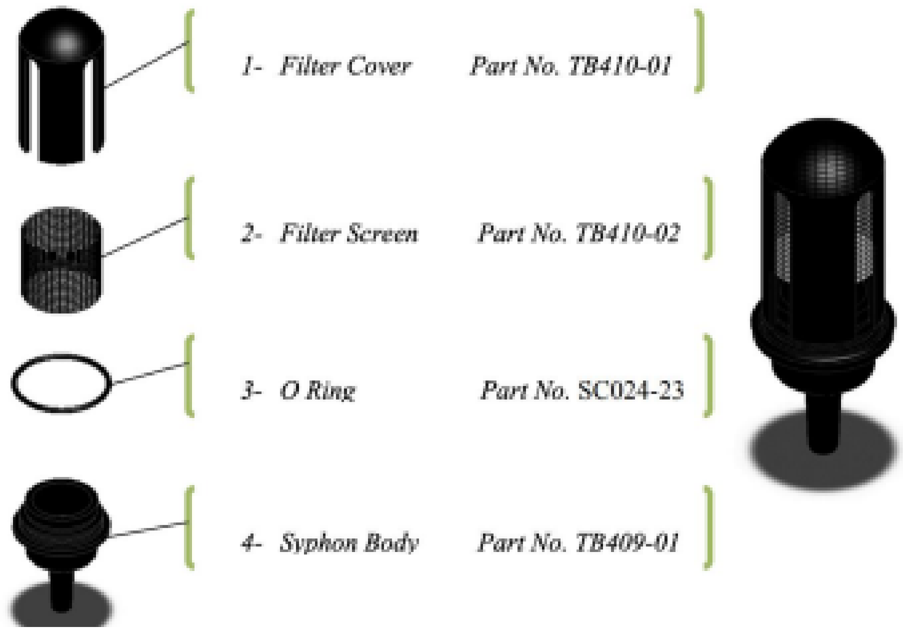
Taking the Bucket Apart

1. Start by removing the screws on the bottom of the bucket, which are attached to the plastic black base.



3

2. The mesh filter can be removed by pushing it into the funnel gently. It should slide into the funnel. **DO NOT TWIST** a. The mesh filter is composed of 4 parts
    i. Filter cover
    ii. Cooper filter screen
    iii. O Ring
    iv. Syphon body


1- Filter Cover Part No. TB410-01
2- Filter Screen Part No. TB410-02
3- O Ring Part No. SC024-23
4- Syphon Body Part No. TB409-01

Maintenance

The only routine maintenance required is cleaning.

The following items should be checked regularly for cleanliness:

- Catch filter
- Straight through syphon
- Interior of bucket
- Top surface of adjusting screws
- Enclosure locking screws
- All insect screens

1. These can be cleaned once the funnel and mesh are separated, if there is debris clean by hand or use water and a cloth. 2. Smaller debris can be removed by using a small brush.

3. Inside of bucket/funnel can be cleaned by hand.

Putting Bucket Back Together

1. To put mesh filter back into funnel, simply push the filter and syphon unit back into place with light force. DO NOT TWIST 2. Attach black plastic base to metal bucket frame.

3. Screw the screws back on to the base, joining the metal bucket to the base.

Landsman Kill Capping Group 2023
Maura McGuire
2-27-2023

Precipitation Data Evaluation

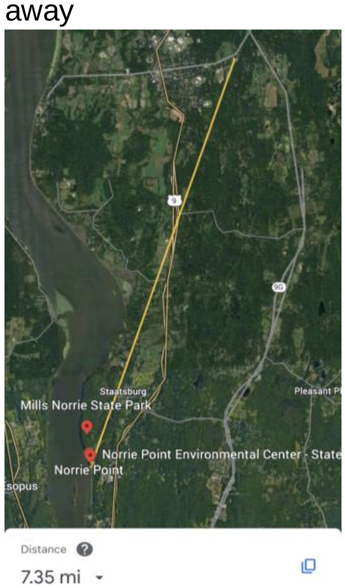
This document provides information about the various weather stations that are relevant for pulling precipitation data. This data will be compared to stream level data collected at the first monitoring site (Village Highway Department) in absence of the tipping bucket during winter months. These stations will be compared, and one will be selected based on the information provided below. Approximate proximity is determined using the measure tool on Google Earth.

1. Rhinebeck Central High School
    a. **Website:** WeatherBug
    www.weatherbug.com/weather-forecast/10-day-weather/rhinebeck-ny-12572
    b. **Maintainer:** Rhinebeck Central High School (Steve Boucher)
    c. **Proximity to monitoring station:** about 4000 ft southwest
    d. **Relevant data available:** Daily rain, Monthly rain,
    e. **Past data available:** No
    f. **Data downloadable:** No
    g. **Notes:** This is what was found through a quick google search. Steve Boucher is still unresponsive. Have contacted Samantha Cassata about science teachers using data – she said they do not.
    h. 

2. KNYRHINE7
    a. **Website:** WeatherUnderground
    www.wunderground.com/dashboard/pws/KNYRHINE7/graph/2019-02-27/2019-02-27/monthly
    b. **Maintainer:** Unknown, “Personal Weather Station”
    c. **Proximity to monitoring station:** about 4000 ft northwest
    d. **Relevant data available:** Daily precip, Weekly precip, Monthly precip
    e. **Past data available:** Yes
    f. **Data downloadable:** No
    g. **Notes:** Last year’s group used this
        i. *DOWN AS OF 3/7/23
    h. 

3. NYS Mesonet Red Hook
    a. **Website:** NYS Mesonet
    www.nysmesonet.org/mesonow#network=nysm&stid=redh
    b. **Maintainer:** Red Hook Central High School, National Weather Service, University of Albany
    c. **Proximity to monitoring station:** 4.8 mi northwest
    d. **Relevant data available:** Precip amount, precip type, snow depth, snow liquid equivalent
    e. **Past data available:** No
    f. **Data downloadable:** No
    g. **Notes:** Good meteographs

h. 

4. Norrie Point
    a. **Website:** National Estuarine Research Reserve System cdmo.baruch.sc.edu/dges/
    b. **Maintainer:** Norrie Point Environmental Center
    c. **Proximity to monitoring station:** 7.3 mi southwest
    d. **Relevant data available:** Total precip, Cumulative precip
    e. **Past data available:** Yes
    f. **Data downloadable:** Yes
    g. **Notes:** Can input selections but does not have any real current data, pretty far away
    h. 

5. Bard College Field Station
    a. **Website:** National Estuarine Research Reserve System cdmo.baruch.sc.edu/dges/
    b. **Maintainer:** Bard College
    c. **Proximity to monitoring station:** 6.26 mi northwest

d. **Relevant data available:** Total precip, Cumulative precip
e. **Past data available:** Yes
f. **Data downloadable:** Yes
g. **Notes:** pretty far away
h. 

Conclusions

Bard College Field Station was chosen for data analysis regarding the correlation of stream height and precipitation. While it is farther from the first monitoring station at the Village Highway Department than we would have preferred, it is a very well maintained station and provides an abundance of data that is easily downloadable.

The NYS Mesonet Station at Red Hook High School was chosen for its predictive forecast capabilities, which are conveniently graphed for a variety of factors for the following three days. The most notable are the liquid equivalents for precipitation (including snowfall) and precipitation potential. It also graphs wind speed, wind direction, and relative humidity – factors of importance to our predictive models.

References

Algozzine C. Professional Lecturer of Information Systems. (NY). Email Message. February 10 2023.

Audubon. Cold Spring (NY): Audubon Society;[accessed 2023 March 13]. https://www.audubon.org/native-plants/search?zipcode=12601&active_tab=best_results&attribute=&attribute_tier1=12901&resource=&resource_tier1=&bird_type=&bird_type_tier1=&page=1&page_tier1=1

Bard College to Landsman Kill. Google Maps;[accessed 2023 March 14]. https://www.google.com/maps/dir/Bard+College,+30+Campus+Rd,+Annandale-On-Hudson,+NY+12504/Landsman+Kill,+Rhinebeck,+NY+12572/@41.9750552,-73.9674818,12z/data=!3m1!4b1!4m14!4m13!1m5!1m1!1s0x89dd0a6da595e9ab:0xc3ba06d142f1731e!2m2!1d-73.909314!2d42.0230728!1m5!1m1!1s0x89dd0c34dece70ab:0xd7eb74233139936c!2m2!1d-73.8942163!2d41.9284214!3e0

Cyperus bipartitus (shining flat sedge). Native Plant Trust (MA): Native Plant Trust;[accessed March 14]. https://gobotany.nativeplanttrust.org/species/cyperus/bipartitus/

How GoFundMe Works. 2010-2013. GoFundMe;[accessed 2023 March 14]. https://www.gofundme.com/c/how-it-works

Inches to Centimeters Conversion.Google;[accessed 2023 May 11]. https://support.google.com/websearch/answer/3284611?hl=en#unitconverter

Landsman Kill to Red Hook. Google Maps;[accessed 2023 March 21]. https://www.google.com/maps/dir/Landsman+Kill,+Rhinebeck,+NY+12572/Red+Hook,+New+York+12571/@41.9614899,-73.896259,13z/data=!3m1!4b1!4m14!4m13!1m5!1m1!1s0x89dd0c34dece70ab:0xd7eb74233139936c!2m2!1d-73.8942163!2d41.9284214!1m5!1m1!1s0x89dd0a84afad3bc9:0xa90c949f9619c7b0!2m2!1d-73.8754114!2d41.9950919!3e0

Native Flowers, Grasses, Shrubs, and Vines. 2018. Albany (NY): New York Department of Environmental Conservation;[updated 2018 January 29; accessed 2023 March 13]. https://www.dec.ny.gov/docs/lands_forests_pdf/factnatives.pdf

New York Flora Atlas.(NY): New York Flora Association;[updated 2023 Feb 14;accessed 2023 March 13]. https://newyork.plantatlas.usf.edu/.

North Carolina Extension Gardener Plant Toolbox. (NC): North Carolina State University;[accessed 2023 March 14].https://plants.ces.ncsu.edu/plants/cornus-alternifolia/

Property Owners and the Hazard Mitigation Grant Program. Hyattsville(MD): United States Department of Homeland Security. [accessed 2023 March and April]. https://www.fema.gov/grants/mitigation/hazard-mitigation/property-owners.

River Birch. (NE): The Arbor Day Foundation;[accessed 2023 March 14]. https://www.arborday.org/trees/treeguide/treedetail.cfm?itemID=792

Stone L, Keltchner N, and Dreyer, D. 2022. Stream Height and Precipitation Modeling for Flood Event Preparedness on the Landsman Kill. Presented at: Final Capping Class Session.

TBRG Calibration and Certification.HyQuest Solutions America. [accessed 2023 April 17]. https://www.hyquestsolutionsamerica.com/services/calibration/tbrg-calibration-and-certification#product__description

Trees for Tribs. Albany (NY): New York Department of Environmental Conservation;[accessed 2023 March 13].https://www.dec.ny.gov/animals/77710.html