

Post-Treatment Assessment for Aquatic Plant Control ERDC Demonstration Project Tonawanda Creek/Erie Canal, New York 2021 (Year 8)

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**United States Army Corps of Engineers
Buffalo District**



**US Army Corps
of Engineers®**

Buffalo District

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ACRONYMS AND ABBREVIATIONS

Canal Corp.	New York State Canal Corporation
CET	concentration exposure time
ERDC	Engineer Research and Development Center
GPS	global positioning system
Hydrilla	<i>Hydrilla verticillata</i>
JV	Environmental Assessment Services, LLC and Ecology and Environment, Inc. Joint Venture
ppm	parts per million
Project	Tonawanda Creek/Erie Canal Hydrilla Demonstration Project
RM	river mile
SLM	SOLitude Lake Management, LLC
USACE	U.S. Army Corps of Engineers (Buffalo District)

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1 INTRODUCTION

The Tonawanda Creek/Erie Canal Hydrilla Demonstration Project (the Project) is a field-scale demonstration of a technology developed under the U.S. Army Corps of Engineers – Buffalo District’s (USACE) Aquatic Plant Control Research Program to manage monoecious Hydrilla (*Hydrilla verticillata*; Hydrilla) in a flowing water system. This report contributes to the Year 8 post-treatment monitoring and assessment of herbicide efficacy on Hydrilla by summarizing field conditions before, during, and after treatment; summarizing herbicide treatment methodology and contact time; and identifying lessons learned to benefit future work.

1.1 Background

Hydrilla is a very aggressive, submerged aquatic plant. The U.S. Fish and Wildlife Service first discovered this invasive plant in the Tonawanda Creek section of the Erie Canal in September 2012. Hydrilla infestations have been documented from just upstream of the creek/canal’s outlet at the Niagara River, in the cities of North Tonawanda and Tonawanda, and upstream to the Lockport area, approximately 15 miles to the east. Hydrilla was identified within a total area of approximately 359 acres when initially discovered, and the USACE determined Hydrilla frequency to be at 31% in July 2014, prior to the initial large-scale herbicide application. Hydrilla beds were patchy and limited to the shallow shoreline areas outside the main navigation channel. Based on monitoring results, there was an overall reduction in Hydrilla locations from 2019 to 2020. In 2019, Hydrilla frequency was 3% at points monitored, and in 2020, that decreased to 2%. During 2019, 62 discrete points were noted as Hydrilla occurrences, compared with only 41 in 2020. In 2021, seven discrete points were noted as Hydrilla, based on September post-treatment monitoring (see Figures 1-1a through 1-1c).

There is significant concern regarding the potential spread of Hydrilla to other areas of New York State and the Great Lakes as a whole. Hydrilla could spread because fragments of Hydrilla within the creek/canal are easily transported via waterflow, the creek/canal is located directly adjacent to the Niagara River, and the canal has heavy boat traffic. These concerns provided the impetus for implementation of the Project.

In 2021, to control and eradicate Hydrilla, the USACE conducted an eighth year of treatment for the Project within an approximately 15-mile-long stretch of creek/canal that focused on application of the aquatic herbicide endothall (Aquathol® K) and spot treatment with chelated copper (Harpoon®) and endothall (Aquathol® Super K; see Figures 1-2a through 1-2c). Prior to treatment application, the USACE delineated and mapped Hydrilla populations using point intercept and hydroacoustic surveys. The 2021 endothall (Aquathol® K) treatment areas were designated as follows:

- Western block: 3.7 miles between the mouth of the Niagara River in Tonawanda and East Robinson Road in Niagara County, including Sawyer Creek and the Ellicott Creek Overflow;
- Central block: 1.4 miles between the Botanical Gardens and West Canal Launch; and
- Eastern block: 3.5 miles between Amherst Veterans Canal Park and Orbit Drive.

The areas above were treated during two separate events. The first event occurred in early July and focused only on Sawyer Creek and the Ellicott Creek Overflow. The second event occurred over two days in early August and took place in all three treatment blocks. The treatment of Sawyer Creek and the Ellicott Creek Overflow was accomplished in early July because the water temperatures in these areas warmed sooner than the temperatures in the main canal.

Additionally, spot treatment with endothall (Aquathol® K) along Sawyer Creek occurred in late August (see Figure 1-2b).

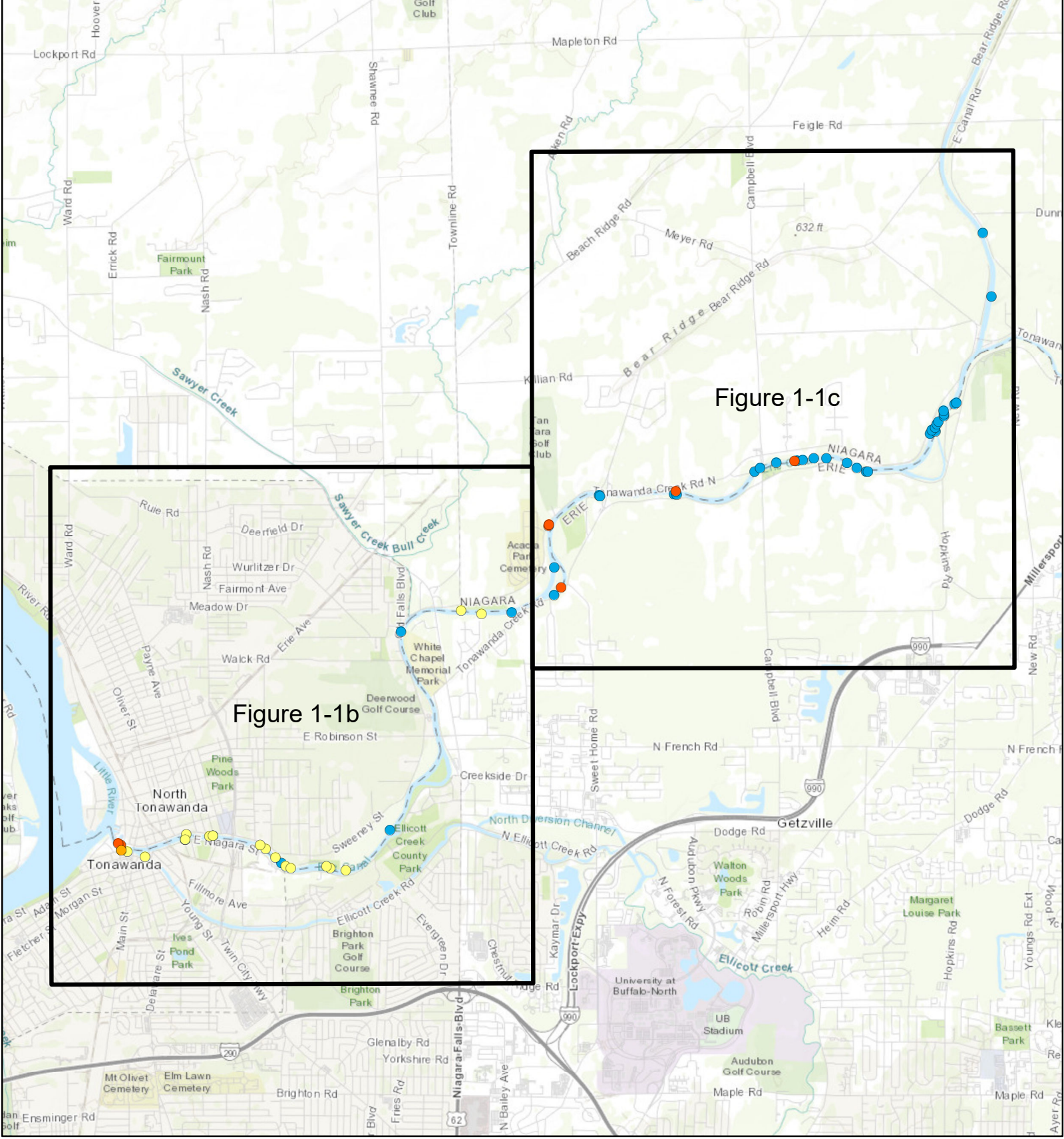
Implementation of the Project was a collaborative effort between the Engineer Research and Development Center (ERDC); the USACE; the Environmental Assessment Services, LLC and Ecology and Environment, Inc. (member of WSP) Joint Venture (JV); the New York State Canal Corporation (Canal Corp.); the New York State Department of Environmental Conservation; the U.S. Fish and Wildlife Service; and the applicator, SOLitude Lake Management, LLC (SLM). Although the USACE was not required to obtain an aquatic pesticide permit in accordance with Article 15, New York Code of Rules and Regulations Part 327 for this Project, reasonable measures were taken to meet the intent and conditions that would be associated with such a permit.

1.2 Purpose and Scope

The purpose of the Project is to perform a field-scale demonstration of a technology developed under the Aquatic Plant Control Research Program to evaluate the effectiveness of aquatic herbicides to manage monoecious Hydrilla in high water exchange environments. The USACE is also funding a separate research project titled “Improving Chemical Control in High Water Exchange Environments in Northern Waters”; this line of research has been ongoing since 2010. This method and the underlying concepts are being tested against monoecious Hydrilla at the Wells College Bay, Cayuga Lake Demonstration Project and the Stewart Park, Cayuga Lake Demonstration Project, as well as this Project.

The findings in this program will provide valuable information for developing future guidance on how to manage this invasive aquatic plant, which is expanding in high water exchange systems throughout the northeastern United States. The condition of plants was monitored by the USACE prior to and several weeks post-treatment to determine optimal timing of treatment, length of exposure, and concentration of herbicide required for effective control of Hydrilla.

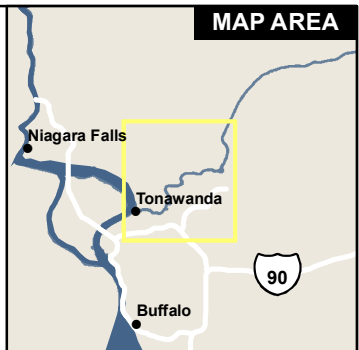
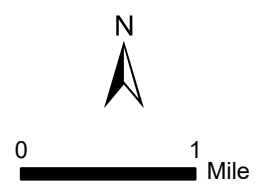
This post-treatment report includes a summary of the herbicide treatment methodology, including quantity of herbicide used and total acreage treated; a discussion of herbicide contact time and dispersion through the system; and a discussion of the monitoring that accompanied the herbicide application. Lastly, this report provides conclusions, in the form of lessons learned, to help shape future treatment projects.

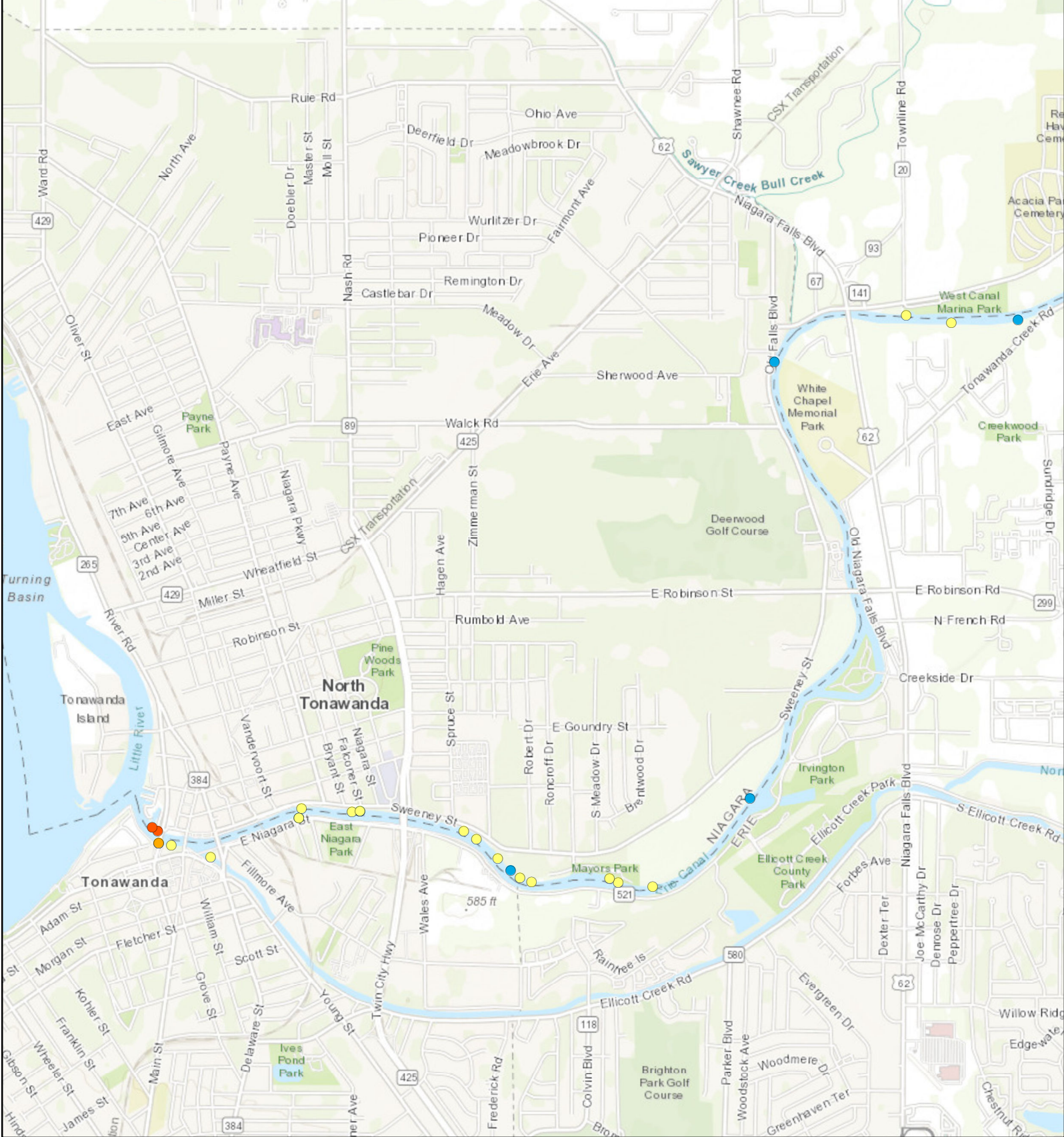


**Figure 1-1a Post Treatment Hydrilla Distribution
Tonawanda Creek/Erie Canal, Erie and Niagara Counties, New York**

Hydrilla Locations

- 2018
- 2019
- 2020
- 2021





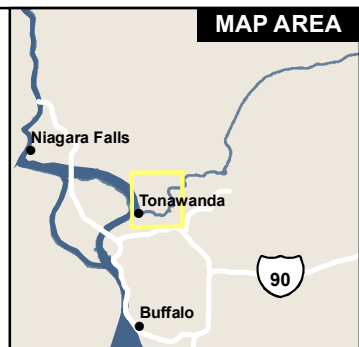
**Figure 1-1b Post Treatment Hydrilla Distribution
Tonawanda Creek/Erie Canal, Erie and Niagara Counties, New York**

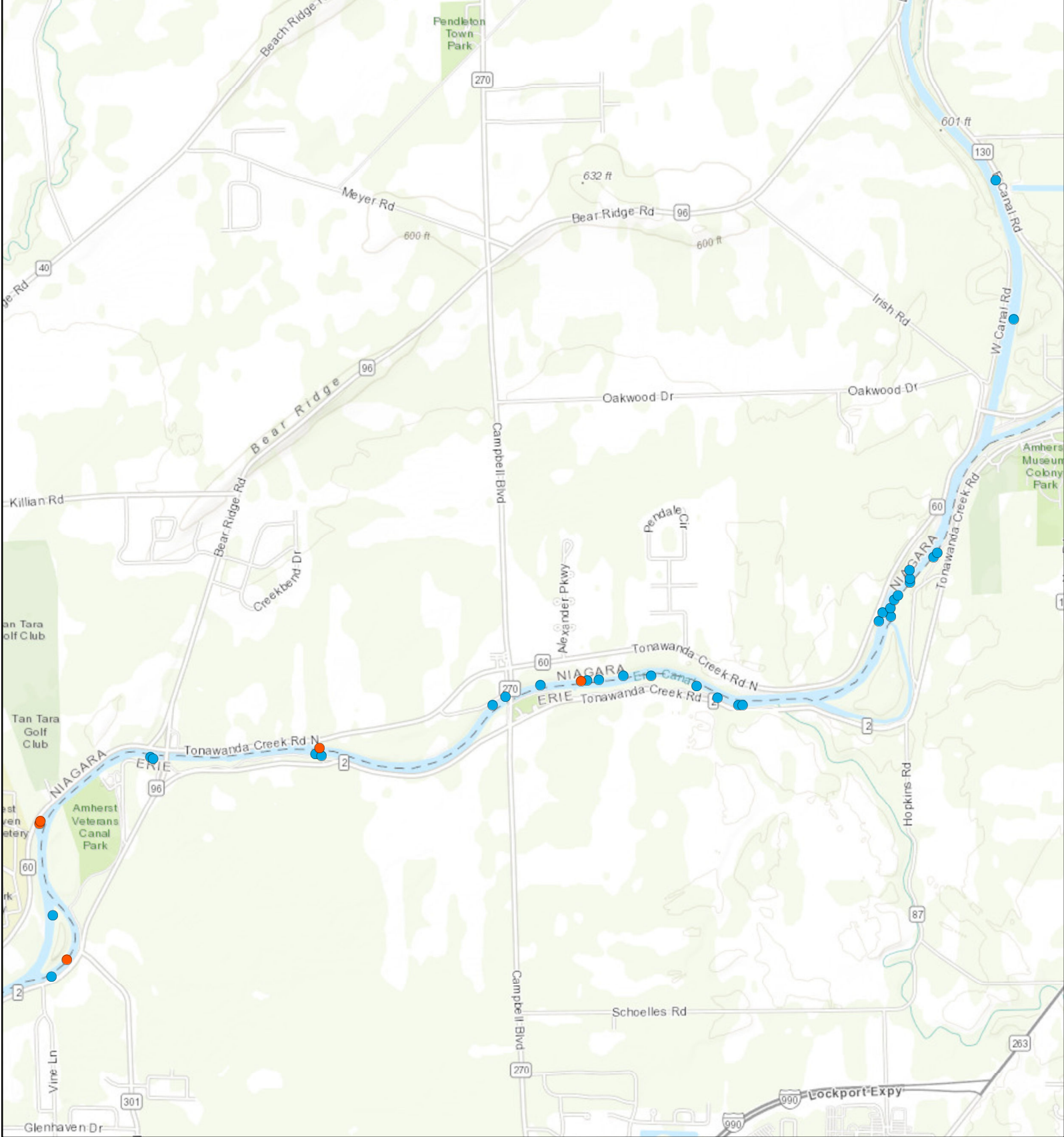
Hydrilla Locations

- 2018
- 2019
- 2020
- 2021



0 1/2 Mile

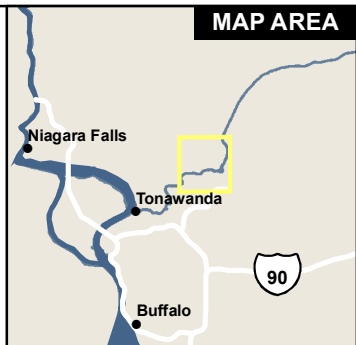
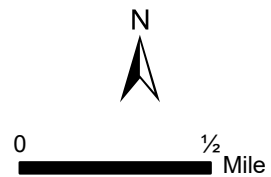


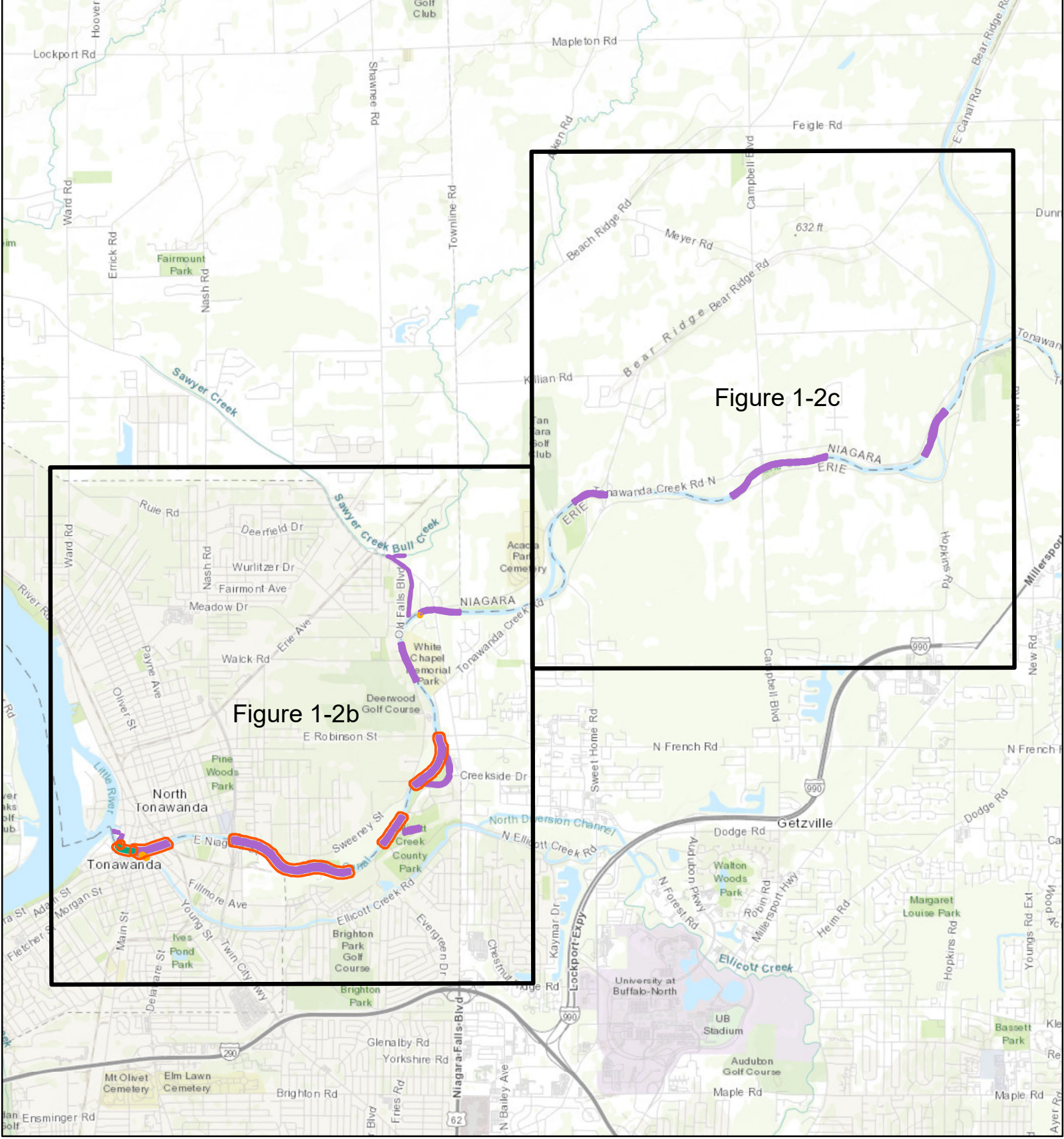


**Figure 1-1c Post Treatment Hydrilla Distribution
Tonawanda Creek/Erie Canal, Erie and Niagara Counties, New York**

Hydrilla Locations

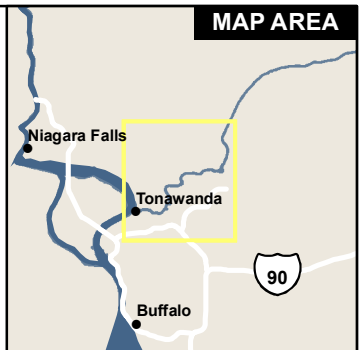
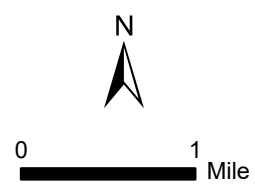
- 2018
- 2019
- 2020
- 2021

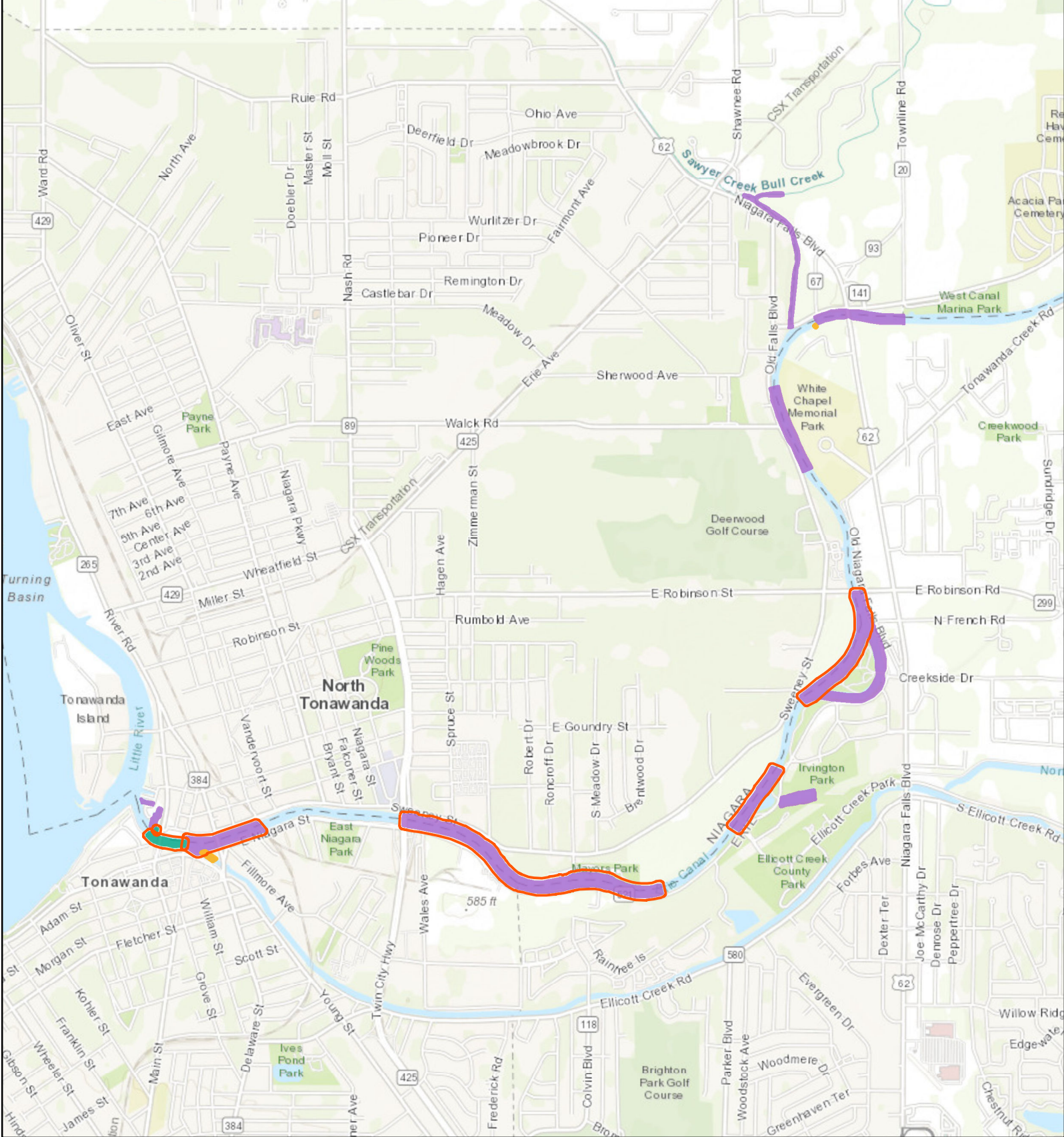




**Figure 1-2a 2021 Hydrilla Treatment Areas
Tonawanda Creek/Erie Canal, Erie and Niagara Counties, New York**

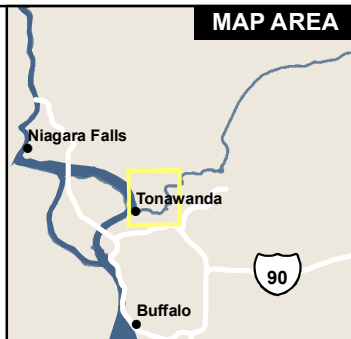
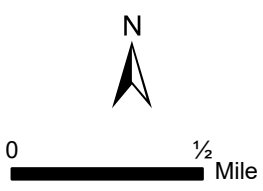
- Herbicide**
- Aquathol K
 - Super K
 - Super K/Harpoon
 - Areas with Two Treatments

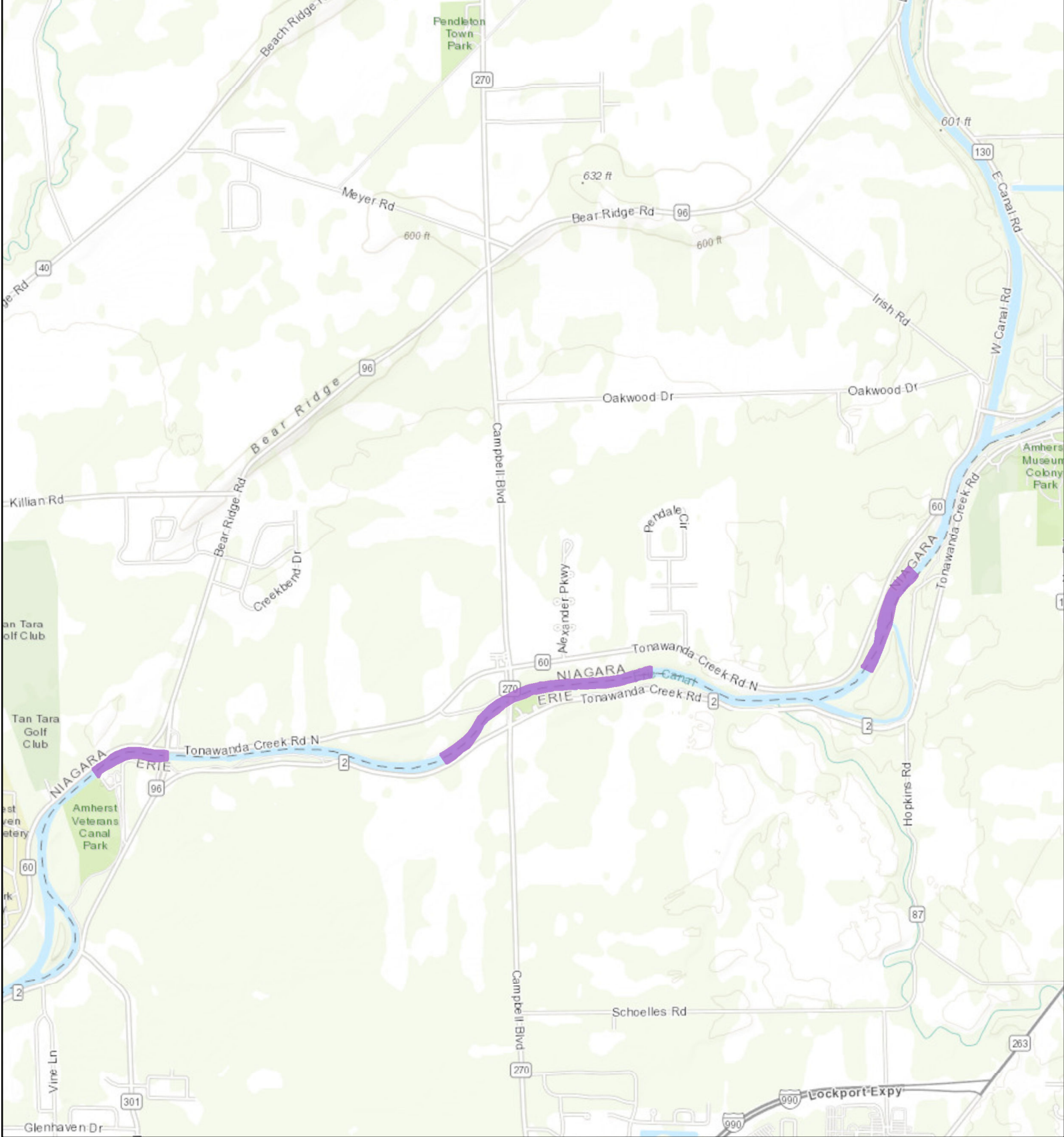




**Figure 1-2b 2021 Hydrilla Treatment Areas
Tonawanda Creek/Erie Canal, Erie and Niagara Counties, New York**

- Herbicide**
- Aquathol K
 - Super K
 - Super K/Harpoon
 - Areas with Two Treatments

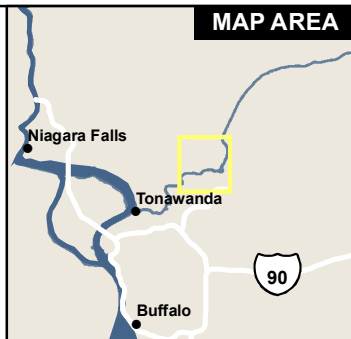




**Figure 1-2c 2021 Hydrilla Treatment Areas
Tonawanda Creek/Erie Canal, Erie and Niagara Counties, New York**

Herbicide

- Aquathol K
- Super K
- Super K/Harpoon
- Areas with Two Treatments



2 OVERVIEW OF HERBICIDE TREATMENT AND MONITORING

Treatment of Hydrilla for this Project focused on the application of the aquatic herbicides endothall and chelated copper within the creek/canal. Twenty-four hours before treatment, during treatment (48 hours), and immediately after treatment, the Canal Corp. minimized water flow in the creek/canal utilizing flow control structures on the canal in Lockport, New York. Minimizing water flow yielded greater contact time between the herbicide and Hydrilla. To minimize flow, a target flow rate of 100 cubic feet per second or less to the east (toward Lockport) was identified.

The following subsections outline the public notification that preceded treatment; field conditions before, during, and after treatment; herbicide treatment methodology; quantity of herbicide used and total area treated; details of the flow management and monitoring; and a summary of vegetative monitoring and overall treatment efficacy.

2.1 Public Notification

Public awareness and understanding of the Project were important to its successful implementation. Although a State of New York Permit to Use a Pesticide for the Control or Elimination of Aquatic Vegetation (Article 1, Part 327) was not required for this Project, the notification requirements stipulated for the permit were adhered to (i.e., riparian owner and permitted user notification and use of warning signs). The following outreach and notification activities associated with treatment near Ithaca were conducted:

- Collaboration with stakeholders regarding the development of treatment plans for 2021 was conducted by conference call and virtual meetings.
- Riparian owners and permitted users were notified via U.S. certified mail approximately four weeks prior to the first application.
- A supplemental riparian notification letter was sent out via U.S. certified mail to owners and users along Sawyer Creek and adjacent to the Ellicott Creek Overflow to notify them that the treatment would occur later than initially planned due to later plant sprouting and forecasted rain. This notification occurred approximately seven days prior to the application.
- Yellow warning signs were posted along primary treatment areas at public access points.
- Agency notification letters were distributed by mail and email approximately three weeks prior to the first application.
- Project factsheets were distributed by boat stewards along the canal.

2.2 Field Conditions

Sawyer Creek and the Ellicott Creek overflow were treated on July 6, 2021, and designated sections of Tonawanda Creek/Erie Canal were treated on August 3 and August 4, 2021. Field conditions prior to the Sawyer Creek and main canal treatments (July 5, 2021 and August 2, 2021), during treatments (July 6, 2021 and August 3 through August 4, 2021), and immediately following treatments (July 7 through July 8, 2021 and August 5 through August 6, 2021) are summarized in Table 2-1. Approximately 1.10 inches of rain fell between July 5 and July 8, 2021. No rain fell between August 2 and August 6, 2021. Prior to the Sawyer Creek and Ellicott Creek Overflow treatment, no precipitation occurred (July 5, 2021); 0.30 inches of precipitation was recorded during treatment (July 6, 2021); and after the treatment period (July 7 through July 8, 2021), approximately 0.81 inches of precipitation was recorded. Prior to, during, and after the August treatment within Tonawanda Creek/Erie Canal, no precipitation occurred (August 2 through August 6, 2021). During the first treatment (July 6), the average wind speed was 13.4 miles per hour with

gusts up to 29 miles per hour. During the first day of the second treatment (August 3), the average wind speed was 5.8 miles per hour with gusts up to 19 miles per hour.

Table 2-1 Field Conditions Preceding, During, and Following Herbicide Application

Date	Treatment Locations	Temperature Range (degrees Fahrenheit)		Precipitation (inches)	Other
		Max:	Min:		
July 5, 2021	None	Max: 86 Min: 64		0	Clear Average wind speed 12.1 mph with gusts up to 34 mph
July 6, 2021	Sawyer Creek and Ellicott Creek Overflow	Max: 82 Min: 71		0.30	Rain Average wind speed 13.4 mph with gusts up to 29 mph
July 7, 2021	N/A	Max: 83 Min: 63		0.01	Mostly Cloudy Average wind speed 9.7 mph with gusts up to 22 mph
July 8, 2021	N/A	Max: 76 Min: 63		0.80	Thunderstorms Average wind speed 6.4 mph with gusts up to 38 mph
August 2, 2021	N/A	Max: 76 Min: 58		0	Mostly Cloudy Average wind speed 6.5 mph with gusts up to 21 mph
August 3, 2021	Tonawanda Creek/Erie Canal – multiple sites	Max: 79 Min: 56		0	Mostly Clear Average wind speed 5.8 mph with gusts up to 19 mph
August 4, 2021	Tonawanda Creek/Erie Canal – multiple sites	Max: 84 Min: 59		0	Partly Cloudy Average wind speed 4.3 mph with gusts up to 18 mph
August 5, 2021	N/A	Max: 86 Min: 62		0	Clear Average wind speed 3.9 mph with gusts up to 14 mph
August 6, 2021	N/A	Max: 86 Min: 64		0	Mostly Clear Average wind speed 7.5 mph with gusts up to 22 mph

Key:

mph = miles per hour
N/A = not applicable

2.3 Herbicide Treatment Methodology

As indicated above, the aquatic herbicide endothall (Aquathol® K) was applied to Sawyer Creek and the Ellicott Creek Overflow on July 6, 2021. On August 3 and August 4, 2021, endothall (Aquathol® K) was

applied to designated sections of Tonawanda Creek/Erie Canal and spot treatments using endothall (Aquathol® Super K) and chelated copper (Harpoon®) occurred on those same days. Additionally, spot treatment occurred on August 26, 2021, in Sawyer Creek and utilized endothall (Aquathol® K). The herbicides were applied by SLM in accordance with the *Performance Work Statement Aquatic Plant Control ERDC Demonstration Project Tonawanda Creek/Erie Canal*, dated April 2021 (USACE 2021).

2.3.1 Herbicide Transfer

An in-line herbicide injection system was used on the jon boat and airboat. The jon boat was outfitted with a 100-gallon polyethylene tank, and the airboat was also outfitted with a 100-gallon polyethylene tank. The jon boat was outfitted with adjustable granular spreaders. The liquid herbicide was pumped from 250-gallon totes in the chemical delivery box truck located onshore into the polyethylene tanks via 1.5-inch-diameter tubing by electric- and gasoline-powered transfer pumps. Liquid herbicide was also delivered in 2.5-gallon jugs, which were triple rinsed and recycled after they were emptied. The herbicide distributor took the empty totes and returned them to the manufacturer for reloading and reuse. Company work trucks carried the granular herbicide in 20-pound bags from the New York warehouse to the site. These bags were triple rinsed and then disposed of as solid waste. SLM staff and the driver from the company that delivered the herbicide and assisted with the herbicide transfer wore personal protective equipment.

2.3.2 Endothall (Aquathol® K) Treatment

For Aquathol® K, the jon boat and airboat were outfitted with a 2-inch-diameter gasoline-powered water pump. Water was drawn from the creek/canal and sprayed out beneath the water's surface through a boom and subsurface hose assembly mounted to the stern of each boat. The storage tanks and hoses were fitted with ball valves that could be closed to stop flow. Herbicide was drawn from the tanks in-line at a rate of approximately 8 gallons per minute. The tanks were filled at the designated loading areas, at Service Drive and West Canal Park. Herbicide was applied from west to east along the creek/canal. Boat passes were made parallel to the shorelines. The herbicide was applied in water less than 12 feet deep, which was generally within 50 feet of the shoreline. The quantity of herbicide needed for each section was initially determined by the total acreage of the treatment areas. Each boat had a global positioning system (GPS) navigation system, with all treatment section locations preloaded.

As stated in Section 1.1, the Project area was divided into three blocks for endothall (Aquathol® K) treatment: the western block encompassing approximately 3.7 miles between the mouth of the Niagara River in Tonawanda and East Robinson Road in Niagara County, including Sawyer Creek and the Ellicott Creek Overflow; the central block encompassing 1.4 miles between the Botanical Gardens and West Canal Launch; and the eastern block encompassing approximately 3.5 miles between Amherst Veterans Canal Park in Niagara County and Orbit Drive in Amherst. Herbicide was applied to the littoral areas and allowed to disperse across the canal to bring herbicide concentrations to target levels.

The treatment of Sawyer Creek and the Ellicott Creek Overflow was initially scheduled to occur at the end of June; however, due to later plant sprouting and forecasted rain, the application was rescheduled to occur during the week of July 5, 2021. Aquathol® K was applied to designated treatment areas in Tonawanda Creek/Erie Canal using a 10-foot jon boat outfitted with a 25-gallon portable tank and an electric trolling motor. The portable system allowed SLM staff to access the narrow channels during the treatment on August 3 and August 4, 2021. This treatment was initially scheduled to occur during the week of July 26, 2021, but was postponed by one week due to inclement weather predicted to have adversely affected the treatment.

2.3.3 Chelated Copper (Harpoon® and Aquathol® Super K) Treatment

Chelated copper (Harpoon®) and endothall (Aquathol® Super K) were applied to designated treatment areas with the use of a vortex blower from the airboat and spreaders from the jon boat during the treatment on August 3 and August 4, 2021. Boat passes were made parallel to the shoreline in water that was less than 12 feet deep. The vortex blower was calibrated by SLM before use to accurately apply the amount of product to each treatment area. These passes were generally made within 50 feet of the shoreline. The boats were outfitted with GPS, with the treatment zones preloaded on them, to ensure accuracy and to record the amount of acreage that the boats covered.

The following paragraphs summarize the 2021 treatment activities, including both endothall (Aquathol® K and Aquathol® Super K) and chelated copper (Harpoon®).

July 6, 2021: Sawyer Creek/Ellicott Creek Overflow

SLM staff arrived at an access point on Lockport Road at 1100 hours. SLM launched the jon boat at 1130 hours and moved then moved to Creekside Drive and accessed the Ellicott Creek overflow area directly. One treatment crew, consisting of a lead applicator and an assistant/technician, was sent out and completed herbicide application within Sawyer Creek and the Ellicott Creek Overflow. One 10-foot jon boat with a portable treatment system was used to apply the herbicide during 2.5 hours of treatment time.

Two areas were treated on July 6, 2021, totaling 7.9 acres (see Table 2-2 and Figure 1-2b). Both areas were treated with Aquathol® K.

August 3, 2021: Day 1

SLM staff arrived at the City of North Tonawanda boat launch at 700 Sweeney Street at 0700 hours, and the first boat was launched at 0800 hours. An afternoon launch at West Canal Park boat launch began at 1300 hours and was completed at 1900 hours for a total of 11 hours of treatment. Both an airboat and a jon boat were utilized for application during the morning and afternoon launches. Applications were completed along the edges of the creek/canal only, with a width of one boat pass.

Fifteen areas were treated on Day 1, totaling 120.89 acres (see Table 2-2 and Figures 1-2a through 1-2c). Of these 15 areas, 12 were treated with Aquathol® K, two were treated with both Aquathol® Super K and Harpoon®, and one was treated with Aquathol® Super K.

August 4, 2021: Day 2

SLM staff arrived at the City of North Tonawanda boat launch at 700 Sweeney Street at 0800 hours, and the first boat was launched at 0900 hours and crews moved to West Canal Park to complete the eastern end of the treatment zones. Similar to Day 1, both an airboat and a jon boat were utilized for application. Applications were completed along the edges of the creek/canal only, with a width of one boat pass. Treatment was completed at 1100 hours, totaling 2 hours of treatment.

Six areas were treated on Day 2, totaling 57.4 acres (see Table 2-2 and Figure 1-2b). Of these six areas, four were treated with Aquathol® K and two were treated with both Aquathol® Super K and Harpoon®.

August 26, 2021: Spot Treatment of Sawyer Creek

Due to insufficient herbicide control in Sawyer Creek as discussed in Section 2.7, a spot treatment with Aquathol® K occurred on August 26, 2021, in Sawyer Creek. Approximately 4.3 acres were spot treated (see Table 2-2 and Figure 1-2b).

2.4 Quantity of Herbicide Used and Total Area Treated

A summary of the herbicide quantities applied during the July and August 2021 treatments is provided in Table 2-2. The planned treatment areas were divided into distinct areas or plots using a geographic information system, the total amount of endothall or chelated copper to be applied to each area/plot was calculated, and the products were then applied as described in Section 2.3.

Herbicide dosing was predetermined and calculated by the USACE on the basis of the treatment area acreages and volumes. The target concentration of endothall (Aquathol® K) for Sawyer Creek and the Ellicott Creek Overflow for the July treatment was 3.0 parts per million (ppm). The target concentration of endothall (Aquathol® K) for all the treated areas in the main creek/canal channel was 1.5 milligrams per liter or ppm on Day 1 and 1.5 ppm on Day 2 of the August treatment. The target concentration of endothall (Aquathol® Super K) was 3.0 ppm on both days, and the target concentration of chelated copper (Harpoon®) was 0.75 ppm on both days. These doses were calculated on the basis of the entire water volume of the creek/canal treatment areas. For the August spot treatment of Sawyer Creek, the target concentration of endothall (Aquathol® Super K) was 3.0 ppm.

Table 2-2 Herbicide Application Summary by Treatment Area

Date	Treatment Area	Acres	Endothall (Aquathol® K) Applied (gallons)	Targeted Concentration (ppm)	Chelated Copper (Harpoon®) Applied (pounds)	Treated Concentration (ppm)	Endothall (Aquathol® Super K) Applied (pounds)	Targeted Concentration (ppm)
7/6/2021	9 - Ellicott Creek Overflow	3.6	13.7	1.5	N/A	N/A	N/A	N/A
	13 - Sawyer Creek	4.3	37.32	3	N/A	N/A	N/A	N/A
	Totals	7.9	51.02	-	-	-	-	-
8/3/2021	1 - Weatherbest Slip Road	0.33	1.93	1.5	N/A	N/A	N/A	N/A
	2 - Wardell's Marina	0.91	4.44	1.5	N/A	N/A	N/A	N/A
	3- Wardell's Boat Hoist	0.04	N/A	N/A	41.88	0.75	9.07	3
	4 - 265 Bridge	2.18	N/A	N/A	912.91	0.75	197.65	3
	5 - Main Street to Railroad Bridge	8.18	93.57	1.5	N/A	N/A	N/A	N/A
	6 - Ellicott Creek	0.4	N/A	N/A	N/A	N/A	N/A	N/A
	7 - 425 Bridge to Mayors Park	29.08	282.78	1.5	N/A	N/A	N/A	N/A
	8 - Ellicott Creek Oxbow Mainstem	5.87	67.74	1.5	N/A	N/A	N/A	N/A
	9 - Ellicott Creek Overflow	3.6	N/A	N/A	N/A	N/A	N/A	N/A
	10 - Barkpark Mainstem	12.05	115.42	1.5	N/A	N/A	N/A	N/A
	11 - Barkpark Oxbow	9.62	24.97	1.5	N/A	N/A	N/A	N/A
	12 - Walck Road	7.86	78.71	1.5	N/A	N/A	N/A	N/A
	13 - Sawyer Creek	4.3	N/A	N/A	N/A	N/A	N/A	N/A
	14 - Admiral's Boat Slip	0.01	N/A	N/A	N/A	N/A	0.4	3
	15 - West Canal	6.85	71.2	1.5	N/A	N/A	N/A	N/A
16 - Veteran's Park	6.67	63.26	1.5	N/A	N/A	N/A	N/A	
17 - Campbell Road	19.74	173.49	1.5	N/A	N/A	N/A	N/A	
18 - Orbit Drive	11.5	79.98	1.5	N/A	N/A	N/A	N/A	

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Date	Treatment Area	Acres	Endothall (Aquathol® K) Applied (gallons)	Targeted Concentration (ppm)	Chelated Copper (Harpoon®) Applied (pounds)	Treated Concentration (ppm)	Endothall (Aquathol® Super K) Applied (pounds)	Targeted Concentration (ppm)
	Totals	120.89	1057.49	-	954.79	-	207.12	-
8/4/2021	3 - Wardell's Boat Hoist	0.04	N/A	N/A	41.88	0.75	9.07	3
	4 - 265 Bridge	2.18	N/A	N/A	912.91	0.75	197.63	3
	5 - Main Street to Railroad Bridge	8.18	93.57	1.5	N/A	N/A	N/A	N/A
	7 - 425 Bridge to Mayors Park	29.08	282.78	1.5	N/A	N/A	N/A	N/A
	8 - Ellicott Creek Oxbow Mainstem	5.87	67.74	1.5	N/A	N/A	N/A	N/A
	10 - Barkpark Mainstem	12.05	115.42	1.5	N/A	N/A	N/A	N/A
	Totals	57.4	559.51	-	954.79	-	206.7	-
8/26/2021	13 - Sawyer Creek	4.3	37.32	3	N/A	N/A	N/A	N/A
	Totals	4.6	37.32	-	-	-	-	-
Total Quantities Applied			1,705.34 gallons		1,909.58 pounds		413.82 pounds	

Key:

N/A = not applicable

ppm = parts per million

2.5 Herbicide Contact Time and Dispersion for July and August Treatments

As discussed above, herbicide was applied to predetermined areas of Sawyer Creek and the Ellicott Creek Oxbow on July 6, 2021, and Tonawanda Creek/Erie Canal August 3 and August 4, 2021. The USACE conducted water sampling specific to the initial Sawyer Creek and Ellicott Creek Oxbow application on July 6 and July 7, 2021. For the main canal, the USACE and the JV performed water sampling after the August 3 and August 4, 2021, applications to determine the endothall (Aquathol® K) concentrations and dispersion of herbicide from the first day of application through August 9, 2021. The USACE performed water sampling on August 3, 4, and 5, 2021, and the JV performed sampling on August 6 and August 9, 2021. The USACE also performed water sampling of the Sawyer Creek spot treatment on August 26 and August 27, 2021. Refer to Figures 2-1a through 2-1d for water sampling locations.

The samples were analyzed using an enzyme-linked immunoassay specific for endothall (Aquathol® K). The standard operating procedures for use of the RaPID Assay Endothall Test Kit were followed. The detection limit for this method is 7 micrograms per liter (or 0.007 ppm). Samples were analyzed at dilutions of 40:1, 20:1, or 10:1 with detection limits of 0.21 ppm, 0.14 ppm, or 0.07 ppm, respectively, or as non-diluted samples with a detection limit of 0.007 ppm. The sampling results analyzed and reported by the USACE indicated concentrations of dipotassium salt, the active ingredient of endothall, in each sample. For every 10 samples, duplicate analyses were performed to determine the relative percent difference of endothall between samples and to evaluate analytical precision. Each sample run incorporated the use of external standards at concentrations of 0.5 and 1 ppm.

2.5.1 July Sampling Results

The USACE performed endothall (Aquathol® K) concentration sampling along Sawyer Creek on Day 1 (July 6, 2021) of treatment and dispersion, as well as on Days 2 and 3 (July 7 and July 8, 2021) (see Table 2-3 and Appendix A, Figure A1). As indicated in Table 2-3, sample location HS14 had the highest concentrations on July 6, 2021, the day of herbicide application, and concentrations were generally maintained through the following day. On July 8, 2021, the herbicide was at nearly non-detect levels at that location. Herbicide concentration was approximately 1.5 ppm at 2 hours post-treatment on July 6, 2021, at sample location HS15 but dropped to less than 0.2 ppm 2 hours later and remained between approximately 0.3 and 0.5 ppm on July 7, 2021, before going down to nearly non-detect levels on July 8, 2021. Sample location HS20 had the lowest herbicide concentrations at less than 0.6 ppm over the two-day period of July 6 and July 7, 2021, and had a non-detect result on July 8, 2021. These results indicate that, except for in the vicinity of HS14, herbicide dispersed too quickly through the creek, which was likely due to the rain that occurred on July 6 (0.30 inch) and July 8 (0.81 inch) and higher winds as indicated in Table 2-1.

2.5.2 August Sampling Results

The USACE performed sampling between river mile (RM) 0.0 and RM 10.5 of the creek/canal area at varying spatial and temporal intervals for the treatment in August 2021. Sampling was performed on Days 1 and 2 (August 3 and August 4, 2021) of treatment and dispersion, as well as on Day 3 (August 5, 2021), and the JV performed sampling on August 6 and August 9, 2021 (see Table 2-4 and Appendix A Figures A2-1 through A2-7).

As discussed in Section 2.7, flows were managed by the Canal Corp. approximately 24 hours prior to the application period, during the 48-hour application period, and immediately after the application period. On August 2, 2021, at 0800 hours, flow gates were closed within the canal system, and flow was minimized to 100 cubic feet per second prior to herbicide application. Canal Corp. resumed flows on August 5, 2021, at approximately 1600 hours.

As indicated by the results summarized in Table 2-4 and illustrated in Appendix A Figures A2-1 through A2-7, endothall concentrations in the first 48 hours of monitoring were generally less than 1 ppm from the Niagara River upstream to approximately RM 1 in the majority of the area that was directly treated. Exceptions to this were noted upstream of Wardell's Marina (HS3) and near the Main Street Bridge (HS7A and HS7B), where concentrations were greater than 1 ppm. According to the data presented in Table 2-4, herbicide concentrations were best maintained over the course of the monitoring period at sampling locations H9A and H9B near Mayor's Park, H12A and H12B near the North Tonawanda Botanical Gardens, H13A and H13B near White Chapel Memorial Park, and at H18A and H18B, just east of Campbell Boulevard. Reasons for these trends are discussed in Section 2.7.

As stated above, following the initial sampling effort by the USACE, the JV collected grab samples of water at 1.0-mile intervals along Tonawanda Creek/Erie Canal on August 6 and August 9, 2021 (see Table 2-3 for sampling results). These sample locations are illustrated in Figures 2-1a through 2-1d and in Appendix A, Figures A2-1 through A2-7. The JV sampling locations were established along Tonawanda Creek/Erie Canal beginning at the confluence of the creek/canal at the Niagara River in Tonawanda, New York (RM 0), and ending at Lockport Road/Robinson Road in Lockport, New York, approximately 15 miles to the northeast. Sampling locations were spaced approximately 1 mile apart. In addition, samples were collected in both channels, where the flow is divided at the following four locations:

- East side of the small island along Creekside Drive at Ellicott Creek Park (RM 2.8);
- East side of Three Mile Island near Creekside Drive and Niagara Falls Boulevard (RM 3.5);
- East side of the island at Tonawanda Creek Road and Sweet Home Road (RM 6.3); and
- The side channel along Tonawanda Creek Road just west of Hopkins Road (RM 10.1).

All sampling locations are indicated in Appendix A.

The JV used a hand-operated peristaltic pump to collect grab samples from an approximate depth of 1 foot below the creek/canal surface. After each sample was collected, two drops of 31.45% hydrochloric acid were added to the bottle to preserve each sample. Each sample was labeled with a unique sample code and immediately placed into a cooler containing ice.

Google Earth was used to navigate to the predetermined sampling locations. At the time of collection, Google Earth was also used to obtain the actual sampling location coordinates. The accuracy of this unit varied depending on availability of satellites but was typically between 5 and 15 feet. All samples collected by the JV on August 6 and August 9, 2021, were shipped on ice to the University of Florida (Marc Netherland) for analysis. All samples were analyzed using an enzyme-linked specific for endothall (RaPID Assay Endothall Test Kit).

The purpose of the JV's sampling effort was to determine the movement and degradation of endothall (Aquathol® K) following the resumption of flow in the canal after the initial 48-hour application period. Sample results from August 6, 2021, indicated the presence of endothall (Aquathol® K) generally from RM 0.0 through RM 15.0. Concentrations in this area ranged from 0.1 ppm at RM 0.0 to 2.3 ppm at RM 2.0 (see Table 2-3 and Appendix A, Figures A2-1 through A2-7). On August 9, 2021, sample results indicated that endothall was present only at RM 9.0 at a concentration of 0.0 ppm. Endothall concentrations were not detected at any sampled sites with the exception of H9C (see Table 2-3 and Appendix A, Figures A2-1 through A2-7).

The canal is generally an east-west feature, but at some locations, it is actually oriented in other directions. Therefore, for the purposes of this report, flows are described as east or west. In the summer, flow conditions in the canal are primarily from west to east (away from the Niagara River). This flow pattern is

opposite of the natural flows that occur in the system during the winter when the canal is closed. It is also important to note that nightly water withdrawals from the Niagara River for hydropower operations cause flows in the canal to shift back to the west. During treatment in August 2021, the western end of the treatment area between RM 1.0 (H1A) and RM 6.34 (H6.3) displayed elevated levels of herbicide residues following the treatment compared with the eastern end of the treatment area between RM 7.0 (H7A) and RM 15 (H15C). This difference was likely due to the wind/weather conditions during and after the treatments, along with the nightly effects of hydropower operations in the Niagara River. These influences seemed to create a “sloshing effect” where the herbicide moved between H1A and H6.3. However, at the conclusion of water sampling, no herbicide was noted leaving the canal into the Niagara River. Farther to the east, starting at water sampling point H7A and ending at site H15C, we can conclude that there was an easterly movement of herbicide once the influences of the river did not affect flows within the canal.

Table 2-3 Summary of Post-Treatment Sawyer Creek USACE Water Sample Results (July 2021)

Endothall (Aquathol® K) Concentrations in ppm^a					
Sampling Dates^b					
Location ID	7/6/2021 (afternoon – 2 HAT)	7/6/2021 (afternoon – 4 HAT)	7/7/2021 (morning – 16 HAT)	7/7/2021 (early afternoon – 24 HAT)	7/8/2021 (afternoon – 42 HAT)
HS14	2.8	2.5	1.2	2.2	0.0
HS15	1.5	0.2	0.3	0.6	0.1
HS20	0.4	0.3	0.3	0.7	ND

Notes:

a Endothall results were provided by the USACE for all samples.

b Application occurred on July 6, 2021. Samples collected by the USACE occurred on July 6 through July 8, 2021.

Key:

HAT = hours after treatment

ND = non-detect

Table 2-4 Summary of Post-Treatment Canal/Creek Water Sample Results for August 2021 Main Canal

River Mile	Location ID ^c	Endothall (Aquathol [®] K) Concentrations in ppm ^a Sampling Dates ^b								
		8/3/2021 First USACE Sample (afternoon – 2 HAT)	8/3/2021 Second USACE Sample (afternoon – 4 HAT)	8/3/2021 Third USACE Sample (afternoon – 18 HAT)	8/4/2021 First USACE Sample (morning – 24 HAT)	8/4/2021 Second USACE Sample (early afternoon – 28 HAT)	8/4/2021 Third USACE Sample (afternoon – 32 HAT)	8/5/2021 First USACE Sample (afternoon – 48 HAT)	8/6/21 JV Sample (morning – 72 HAT)	8/9/21 JV Sample (morning – 140 HAT)
0	H00								0.1	ND
	HS1	ND	0.2		ND	ND	0.1	ND		
	HS2	ND	0.2		ND	0.0	ND	ND		
	HS3	HI	1.5		0.4	0.2	0.4	0.3		
	HS4	0.8	ND		ND	0.4	0.2	ND		
	HS5	ND	0.4		0.1	1.0	0.3	ND		
	HS6	0.3	0.7		ND	0.4	0.3	ND		
	H7A	0.4	0.1		ND	5.2	1.3	ND		
H7B	ND	0.1		ND	3.0	1.3	ND			
1	H1A								1.0	ND
	H8A	HI	0.7		0.9	HI	4.7	ND		
	H8B	2.6	0.5		0.8	1.0	2.9	2.8		
2	H2B								2.3/2.0*	ND/ND*
	H9A	4.5	2.9		1.1	3.5	1.6	1.7		
	H9B	2.2	2.0		1.0	1.5	0.8	1.4		
2.84	H2.8 ^d								1.2	ND
	H10A	0.7	0.8		0.4	0.8	0.7	0.1		
	H10B	0.5	0.7		0.6	2.5	0.8	0.7		
3	H3C								1.2	ND
	H11A	1.3	0.7		0.5	3.0	1.6	0.8		
	H11B	ND	0.4		0.5	0.9	1.5	0.7		
3.54	H3.5 ^d								0.9	ND
	H12A	2.7	1.3		1.0	2.3	1.6	2.0		
	H12B	1.8	1.1		0.8	2.1	2.5	1.5		

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River Mile	Location ID ^c	Endothall (Aquathol® K) Concentrations in ppm ^a Sampling Dates ^b								
		8/3/2021 First USACE Sample (afternoon – 2 HAT)	8/3/2021 Second USACE Sample (afternoon – 4 HAT)	8/3/2021 Third USACE Sample (afternoon – 18 HAT)	8/4/2021 First USACE Sample (morning – 24 HAT)	8/4/2021 Second USACE Sample (early afternoon – 28 HAT)	8/4/2021 Third USACE Sample (afternoon – 32 HAT)	8/5/2021 First USACE Sample (afternoon – 48 HAT)	8/6/21 JV Sample (morning – 72 HAT)	8/9/21 JV Sample (morning – 140 HAT)
4	H4A								0.9	ND
	H13A	1.8	1.5		1.0	0.9		1.3		
	H13B	1.3	1.2		0.9	0.8		1.9		
5	H5B								1.0	ND
	H16A	1.1	1.0		0.8	0.7		0.6		
	H16B	0.8	1.1		0.7	0.6		0.5		
6	H6C								0.9	ND
6.34	H6.3 ^d								0.6	ND
7	H7A								0.1	ND
	H17A		1.7		0.8	0.9		0.4		
	H17B		2.5		0.9	0.6		0.4		
8	H8B								0.2	ND
9.0	H9C								0.3/0.3*	ND/0.0*
	H18A		1.2		1.5	1.5		1.0		
	H18B		2.0		1.4	1.5		1.0		
10	H10A								0.2	ND
10.14	H10.1 ^d								0.4	ND
	H19A		0.2		0.4	ND		0.4		
	H19B		0.5		ND	0.2		0.5		
11	H11B								0.3	ND
12	H12C								0.2	ND
13	H13A								0.2	ND
14	H14B								0.1	ND
15	H15C								0.1	ND

Notes:

*Denotes duplicate sample taken.

- a Endothall results were provided by the USACE for all samples.
- b Application occurred on August 3 and August 4, 2021. Samples collected by the USACE occurred on August 3 through August 5, 2021. The JV collected samples on August 6 and August 9, 2021.
- c Location IDs were assigned by the USACE or the JV. Numbers indicate river mile of location and letters indicate location within creek/canal. Note: The JV sample nomenclature includes the nomenclature assigned by the USACE for consistency and ease of data presentation.
- d Side channel samples.

Key:

Blank cell = no sample collected

Bold text = samples taken within the main treatment areas

A = north/west side of creek/canal

B = south/east side of creek/canal

C = center of creek/canal

HAT = hours after treatment

ND = non-detect

2.5.3 August Spot Treatment Results

The USACE also performed water sampling for the Sawyer Creek spot treatment, which occurred on August 26, 2021; sampling was completed on August 26 and August 27, 2021, and results are summarized in Table 2-5. The results indicate that herbicide concentrations were lower than the target concentration (1 to 3 ppm) at sample location HS14 and at or above the target concentration at sample location HS15.

Table 2-5 Summary of Post Spot Treatment Sawyer Creek USACE Water Sample Results

Endothall (Aquathol® K) Concentrations in ppm^a			
Sampling Dates^b			
Location ID	8/26/2021 (afternoon – 2 HAT)	8/27/2021 (morning – 18 HAT)	8/27/2021 (afternoon – 24 HAT)
HS14	0.0	0.0	0.1
HS15	6.0	3.4	2.3

Notes:

- a Endothall results were provided by the USACE for all samples.
- b Application occurred on August 26, 2021.

Key:

HAT = hours after treatment

2.6 Flow Management

Flow monitoring using flow meters positioned at various locations in the canal was not conducted in 2021. However, flow management actions taken by Canal Corp. were an integral component of the Project again in 2021.

Water passes through Canal Corp. Locks 34/35 in three ways: (1) through the bypass tunnel, (2) through the miter gates of Locks 34/35, and (3) through the Flight of Five gates, which are associated with Old Locks 67 and 71 and located immediately north of Locks 34/35 (Manns 2014). During herbicide application, Canal Corp. closed the bypass tunnel and operations of Locks 34/35 were kept to a minimum, leaving water to be directed through the Flight of Five gates. In order for Canal Corp. to control the amount of flow through Locks 34/35, the Brookfield Power Plant was taken off-line. In addition, Canal Corp. controlled the water level between Lockport and the Genesee River by taking the Rochester Gas and Electric Power Plant at Station 26 on the Genesee River off-line.

Prior to the 48-hour treatment period on August 3 and August 4, 2021, Canal Corp. reduced flows out of Lockport by closing the bypass gate at 0800 hours on August 2, 2021. Canal Corp. minimized lock operations, which continued during the treatment period. Typically, when Locks 34/35 are filled, a short-term increase in flow rate toward the locks at the Stevens Street Bridge (east) occurs, as does a drop in water level. The bypass gate was reopened at approximately 1600 hours on August 5, 2021.

No modifications to flow were required for the late August spot treatment.

2.7 Vegetative Monitoring and Treatment Summary

The USACE conducted full point intercept surveys on four dates, and one spot check in Sawyer Creek, throughout the growing season to determine Hydrilla distribution in the Erie Canal. Unlike previous years, there were three different treatments within the project area. The initial treatment was applied on July 6, 2021, to both Sawyer Creek and the Ellicott Creek Overflow because these areas usually warm sooner than

the areas on the Canal. The efficacy of the first treatment within Sawyer Creek on July 6, 2021, was questionable. Heavy rain the night after herbicide application may have pushed the herbicide out of the treatment area and the concentration exposure time (CET) needed for effective control was not met at sampling point HS15. The CET was met at water sampling point HS14; however, the higher concentrations at this point indicate that the herbicide was being pushed out of the treatment area and was not treating the areas where Hydrilla was present. In contrast, the treatment at the Ellicott Creek Overflow was highly effective and the CET needed for effective control within the treatment area was met.

As discussed above, the full treatment on the Erie Canal was postponed by one week; instead of occurring the week of July 26, 2021, the full treatment occurred the week of August 2, 2021. This postponement was due to inclement weather that would have negatively impacted the treatment. In the western portion of the treatment area (confluence with the Niagara River to the Botanical Gardens), water sampling points H9A, H9B, H12A, and H12B showed the greatest herbicide retention time (see Table 2-4). The residence times of the herbicide were much longer in the eastern portion of the treatment area (Botanical Gardens to the confluence of Tonawanda Creek) than in the western portion. This is a trend that has been noted over the years. The Erie Canal, away from the influences of the fluctuating water flows of the Niagara River, keeps the herbicide in place longer and provides more effective treatments. The area with the longest CET was the treatment area at West Canal Marina Park. It had slightly over 1 ppm at 72 hours post-treatment. All traces of endothall in the Erie Canal were gone by the following Monday (August 9, 2021). Although the CET for effective control was noted in only a few areas of the Erie Canal, on the whole, treatment of Hydrilla in 2021 was effective; only three treated areas experienced regrowth of Hydrilla post-treatment, and another three areas had growth in non-treated areas (see Figure 2-2b).

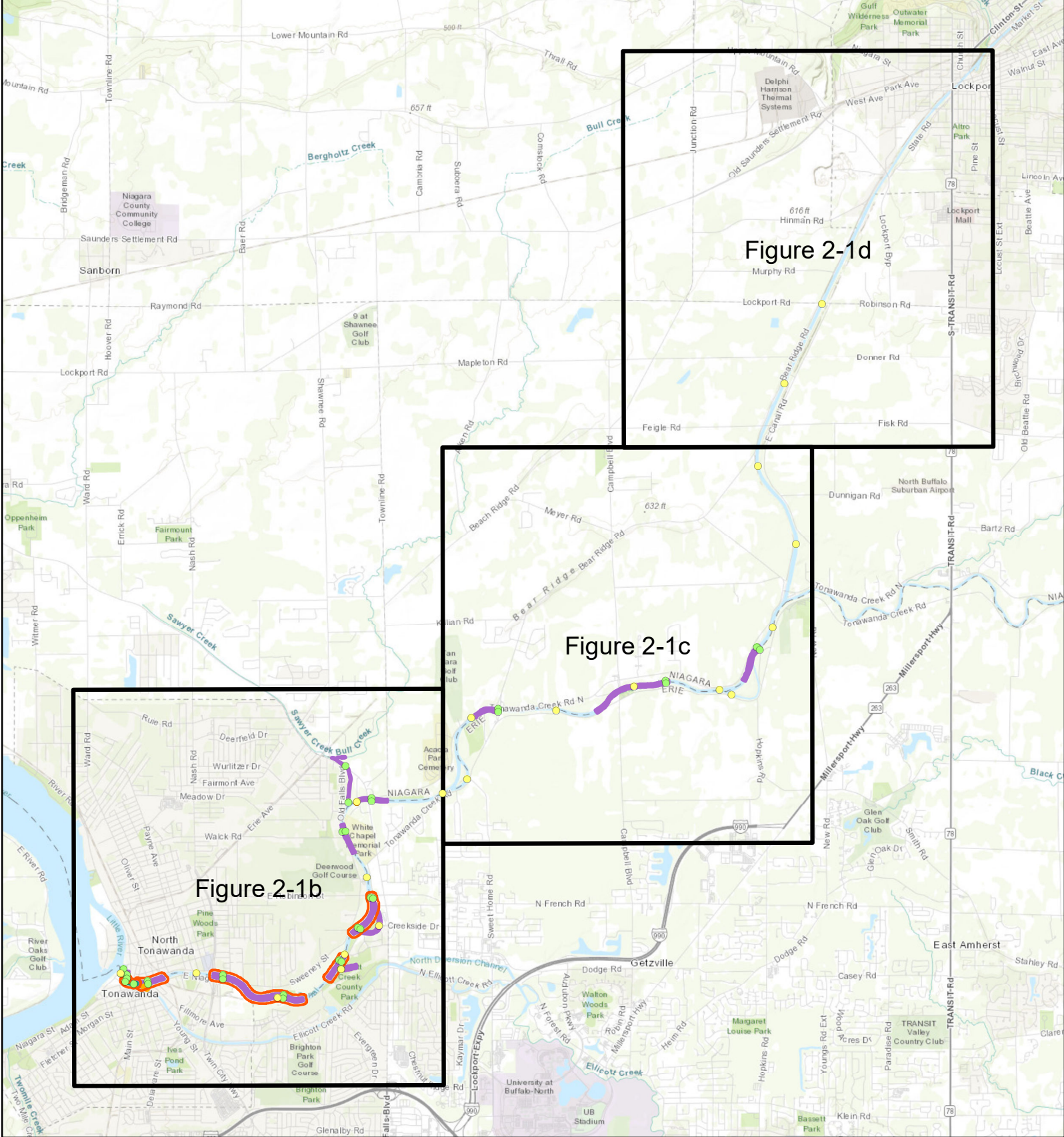
During a spot check at Sawyer Creek on August 6, 2021, 25 discrete Hydrilla locations were noted. On the basis of these findings, a second treatment within Sawyer Creek was applied on August 26, 2021. This second treatment within the creek resulted in a much longer CET than the first treatment did. The final spot check was conducted on September 15, 2021, and all the Hydrilla plants that were present had been severely damaged from the herbicide and would likely not be able to produce tubers.

Following the full August treatment, Hydrilla was found at one location, Wardell's Marina boat lift, during the post-treatment point intercept survey conducted on August 16 through August 18, 2021. During the final point intercept survey on September 13, 14, and 15, 2021, Hydrilla was found at seven locations: Wardell's Marina gas dock, Wardell's Marina boat lift, the oxbow between West Canal Marina Park and Amherst Veterans Canal Park, two points on the low shelf between the oxbow and Amherst Veterans Canal Park, one point between Bear Ridge Road and Campbell Boulevard, and one point just east of Campbell Boulevard.

Additionally, of the 14 native species identified during point intercept surveys within treatment areas in 2021, 10 demonstrated an increase in abundance, measured by percent occurrence over the previous year (see Table 2-6). Two of three additional invasive species, including Hydrilla, showed a decrease in abundance (see Table 2-6).

Table 2-6 Summary of Dominant Species Percent Occurrence in Point Intercept Surveys

Species	Native/Invasive	Percent Occurrence and Comparison to 2020
Coontail (<i>Ceratophyllum demersum</i>)	Native	2.68 (decrease)
Muskgrass (<i>Chara vulgaris</i>)	Native	0.01 (same)
Sago pondweed (<i>Stuckenia pectinata</i>)	Native	1.58 (increase)
Elodea (<i>Elodea</i> sp.)	Native	1.89 (increase)
White-stemmed pondweed (<i>Potamogeton praelongus</i>)	Native	0.09 (increase)
Eelgrass (<i>Vallisneria americana</i>)	Native	1.48 (increase)
Water stargrass (<i>Heteranthera dubia</i>)	Native	1.06 (increase)
Slender naiad (<i>Najas flexilis</i>)	Native	0.04 (decrease)
Brittle naiad (<i>Najas minor</i>)	Native	0.15 (decrease)
Spatterdock (<i>Nuphar advena</i>)	Native	0.07 (increase)
Fragrant water lily (<i>Nymphaea odorata</i>)	Native	3.97 (decrease)
Richardson's pondweed (<i>Potamogeton richardsonii</i>)	Native	0.01 (increase)
Flat-stem pondweed (<i>Potamogeton zosteriformes</i>)	Native	0.19 (increase)
Horned pondweed (<i>Zannichellia palustris</i>)	Native	0.52 (increase)
Hydrilla (<i>Hydrilla verticillata</i>)	Invasive	0.41 (decrease)
Eurasian watermilfoil (<i>Myriophyllum spicatum</i>)	Invasive	2.56 (decrease)
Curly-leaf pondweed (<i>Potamogeton crispus</i>)	Invasive	0.15 (increase)



**Figure 2-1a Water Sampling Locations & 2021 Hydrilla Treatment Areas
Tonawanda Creek/Erie Canal, Erie and Niagara Counties, New York**

Herbicide

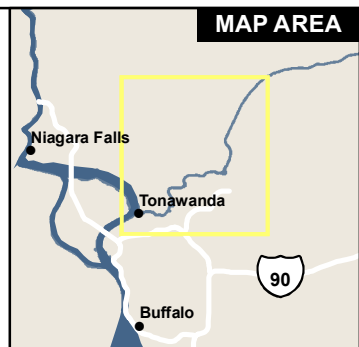
- Aquathol K
- Super K
- Super K/Harpoon
- Areas with Two Treatments

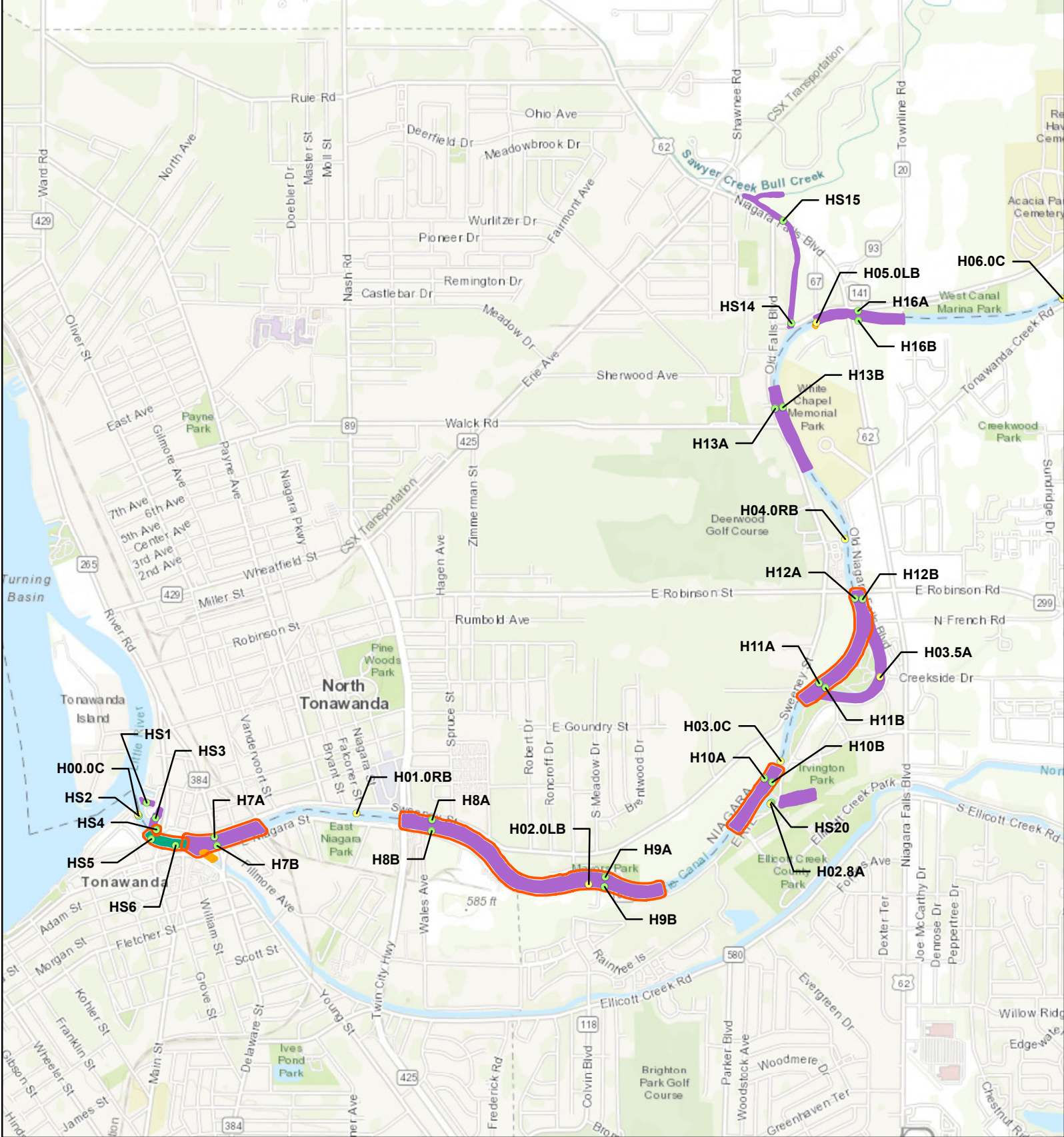
Water Sample Locations

- JV Locations
- USACE Locations



0 1 Mile





**Figure 2-1b Water Sampling Locations & 2021 Hydrilla Treatment Areas
Tonawanda Creek/Erie Canal, Erie and Niagara Counties, New York**

Herbicide

- Aquathol K
- Super K
- Super K/Harpoon
- Areas with Two Treatments

Water Sample Locations

- JV Locations
- USACE Locations



0 1/2 Mile

MAP AREA

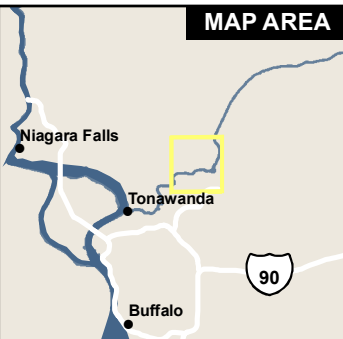
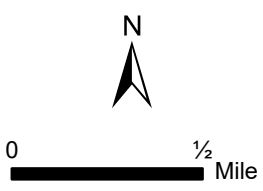


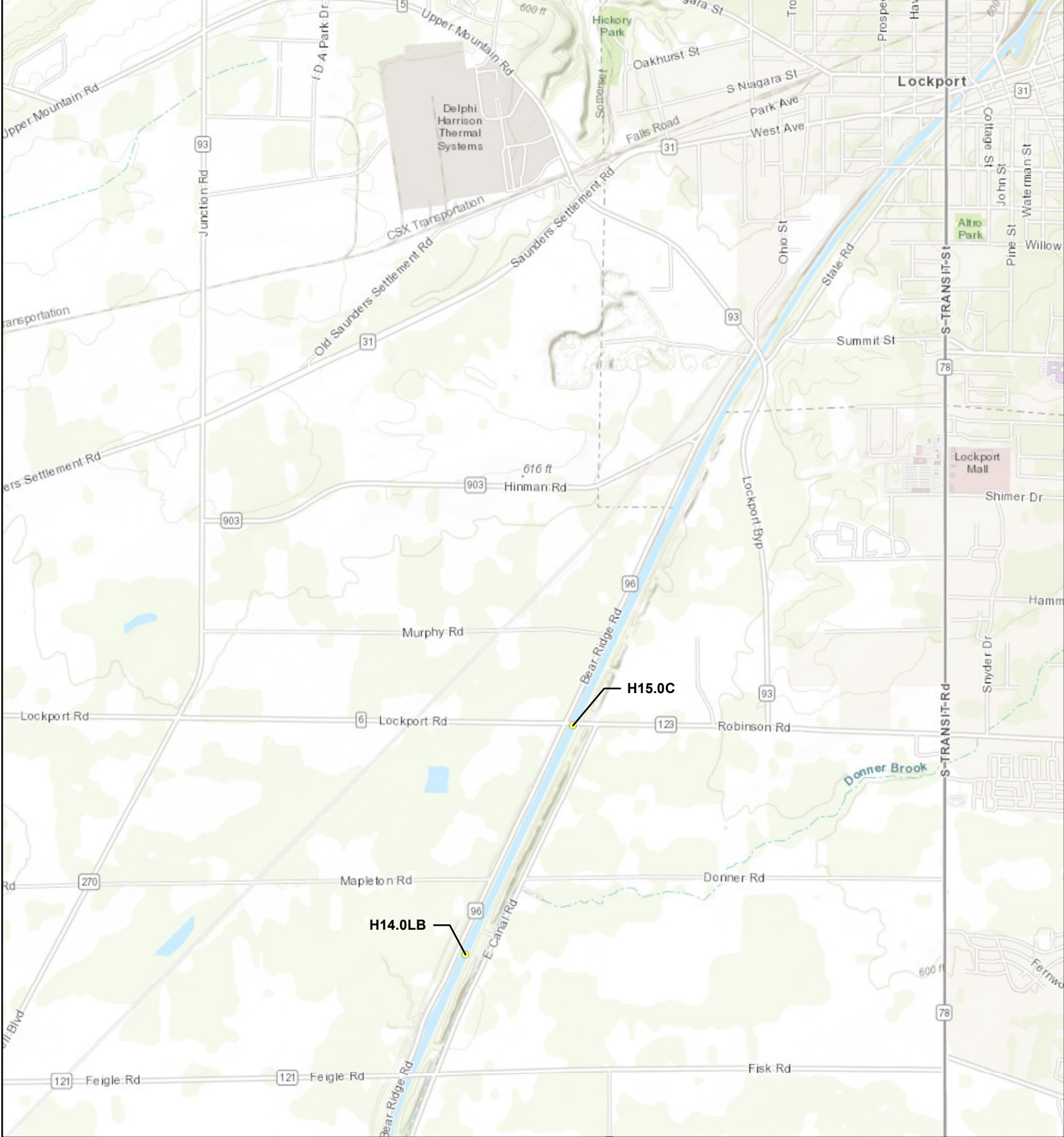


**Figure 2-1c Water Sampling Locations & 2021 Hydrilla Treatment Areas
Tonawanda Creek/Erie Canal, Erie and Niagara Counties, New York**

- Herbicide**
- Aquathol K
 - Super K
 - Super K/Harpoon
 - Areas with Two Treatments

- Water Sample Locations**
- JV Locations
 - USACE Locations

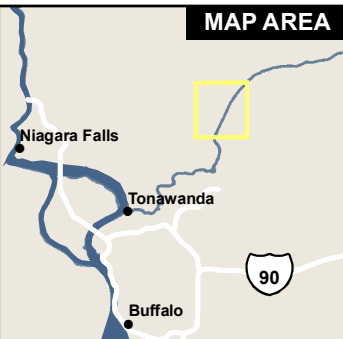
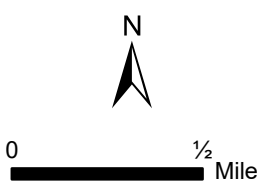


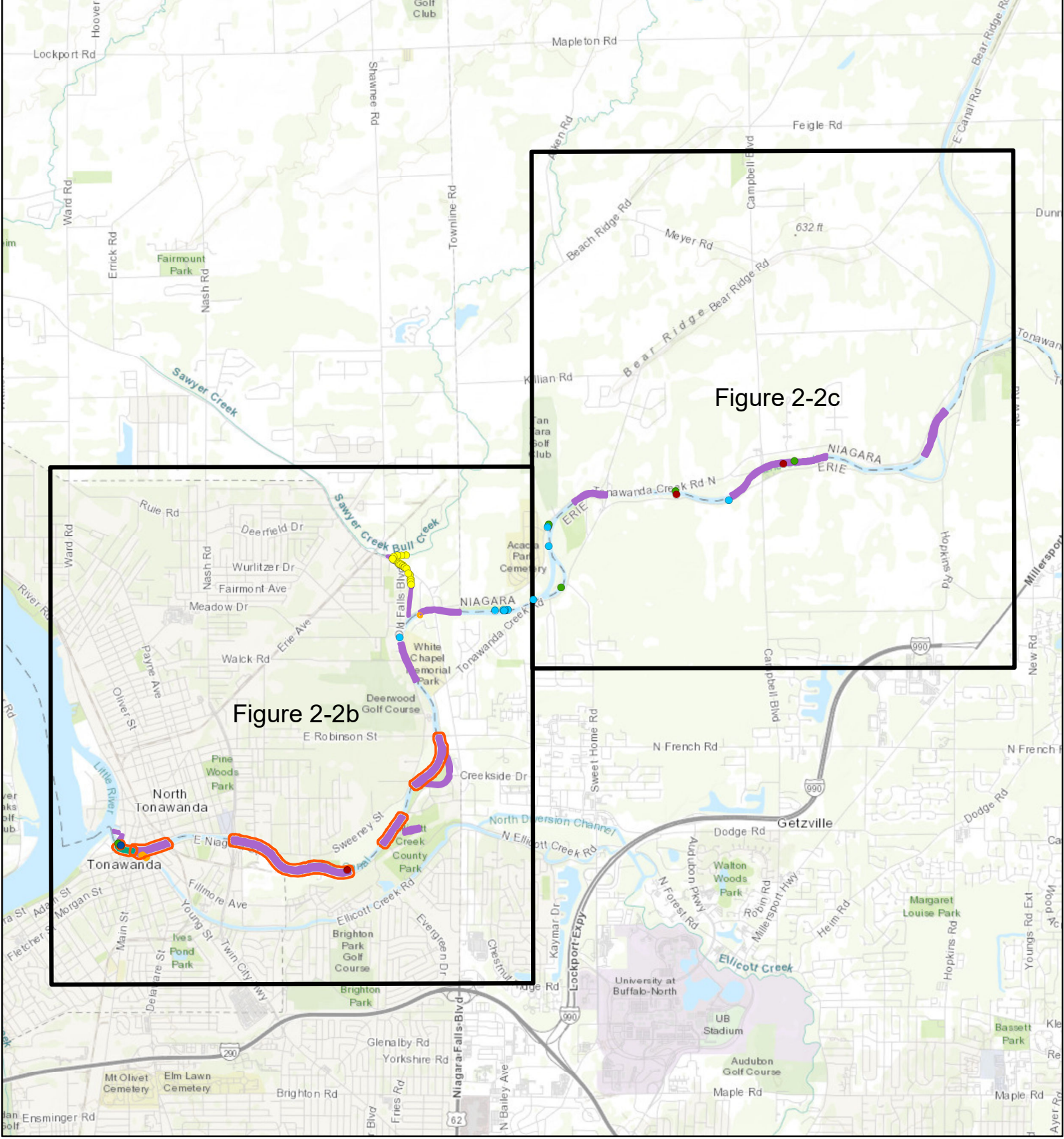


**Figure 2-1d Water Sampling Locations & 2021 Hydrilla Treatment Areas
Tonawanda Creek/Erie Canal, Erie and Niagara Counties, New York**

- Herbicide**
- Aquathol K
 - Super K
 - Super K/Harpoon
 - Areas with Two Treatments

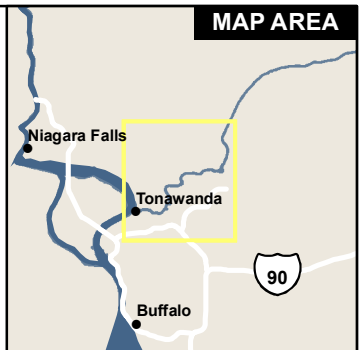
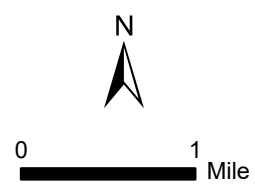
- Water Sample Locations**
- JV Locations
 - USACE Locations

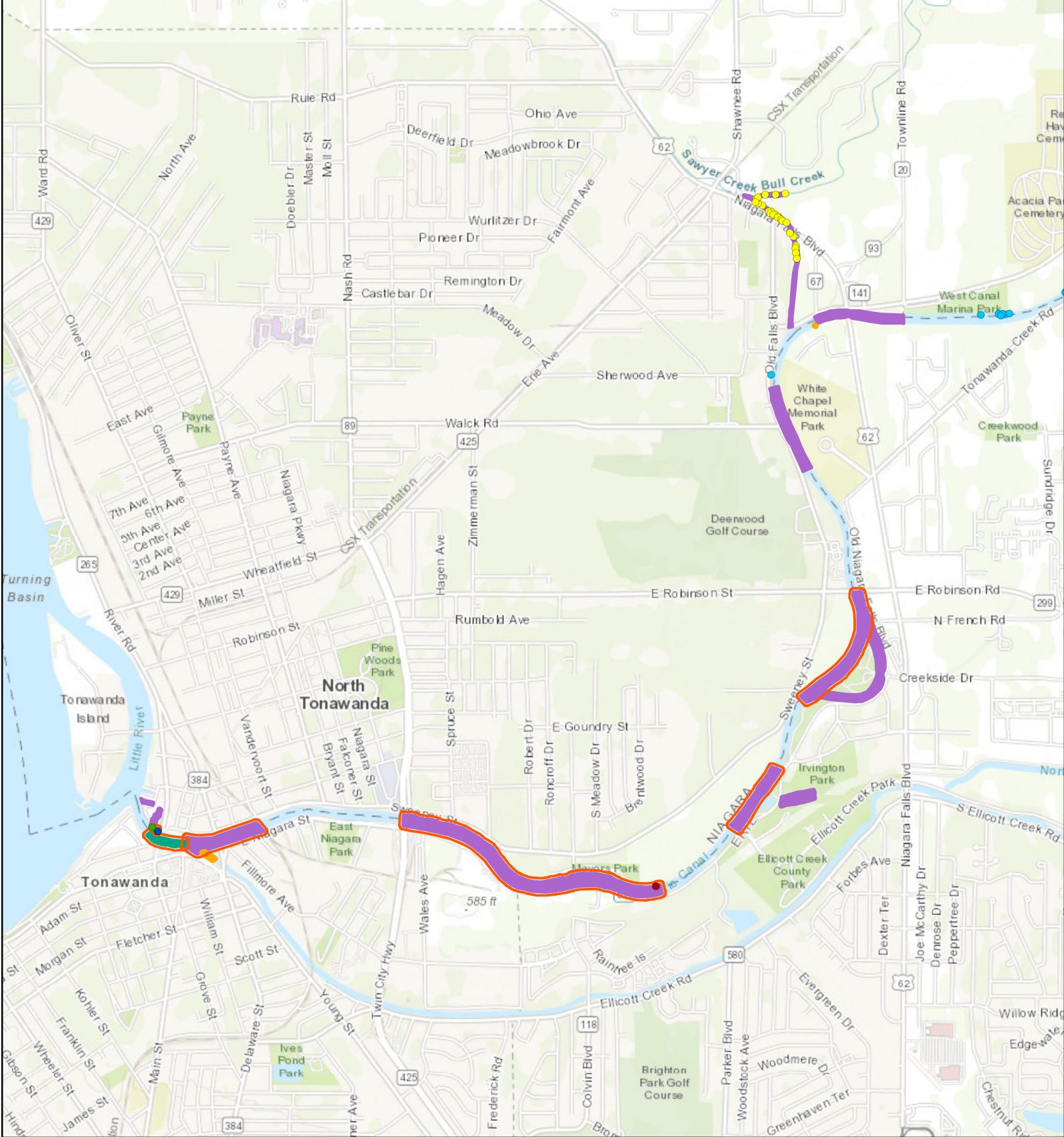




**Figure 2-2a 2021 Hydrilla Distribution
Tonawanda Creek/Erie Canal, Erie and Niagara Counties, New York**

- | 2021 Hydrilla Distribution | | Herbicide | |
|----------------------------|-----------|-------------------|-----------------------------|
| ● 7/6/21 | ● 7/19/21 | ■ Aquathol K | ■ Super K |
| ● 8/6/21 | ● 8/18/21 | ■ Super K/Harpoon | ■ Areas with Two Treatments |
| ● 9/14/21 | | | |





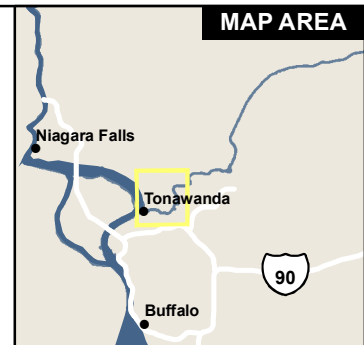
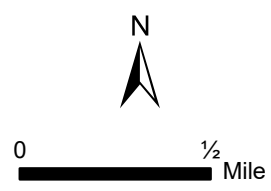
**Figure 2-2b 2021 Hydrilla Distribution
Tonawanda Creek/Erie Canal, Erie and Niagara Counties, New York**

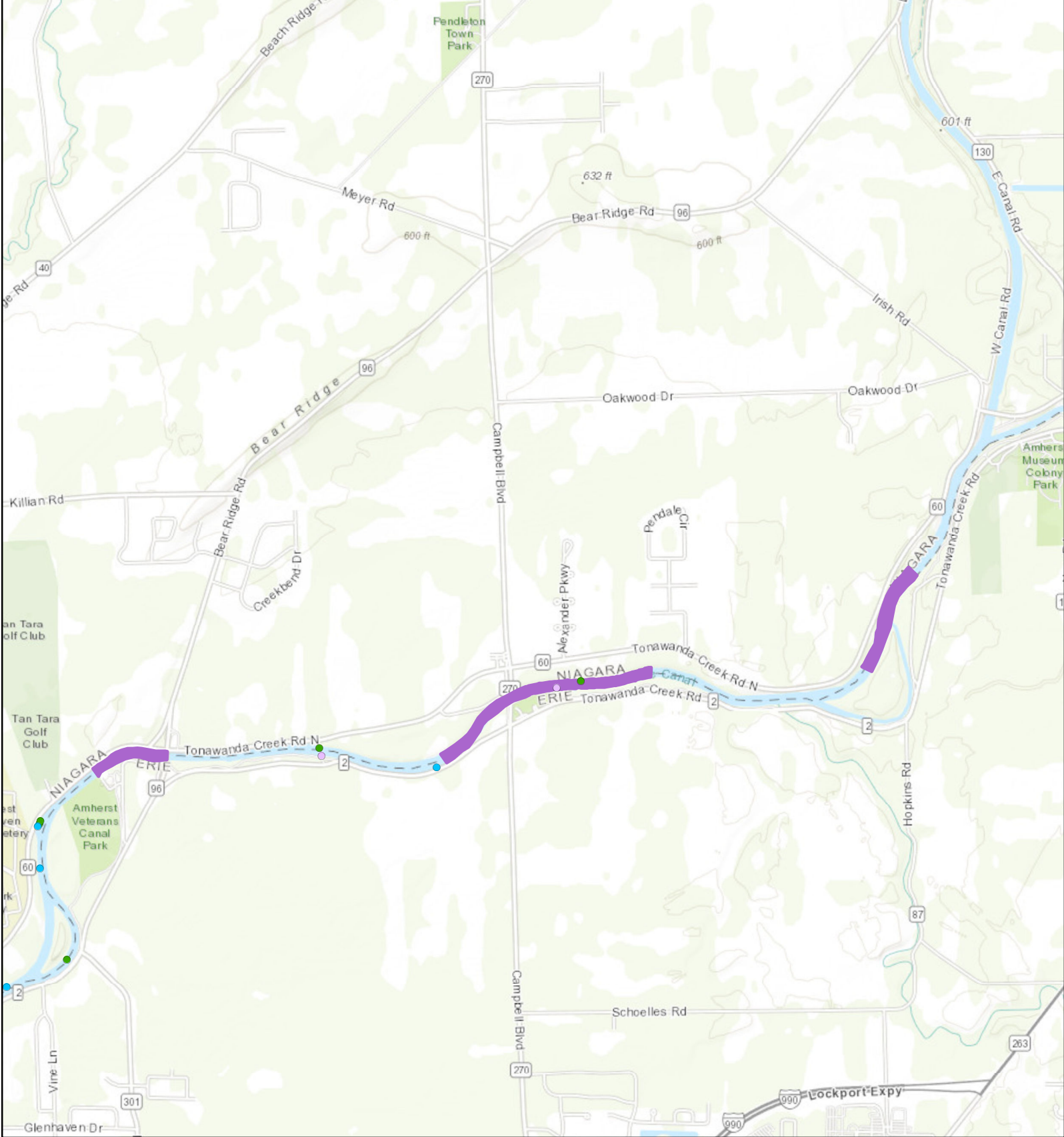
2021 Hydrilla Distribution

Herbicide

- 7/6/21
- 7/19/21
- 8/6/21
- 8/18/21
- 9/14/21

- Aquathol K
- Super K
- Super K/Harpoon
- ▭ Areas with Two Treatments

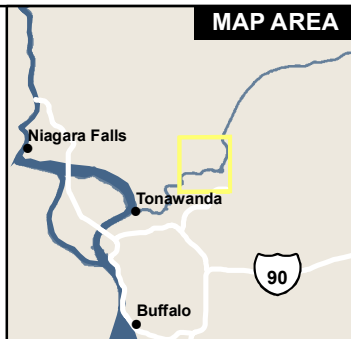
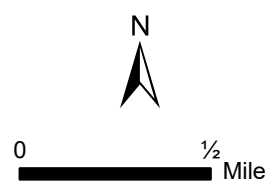




**Figure 2-2c 2021 Hydrilla Distribution
Tonawanda Creek/Erie Canal, Erie and Niagara Counties, New York**

- 2021 Hydrilla Distribution**
- 7/6/21
 - 7/19/21
 - 8/6/21
 - 8/18/21
 - 9/14/21

- Herbicide**
- Aquathol K
 - Super K
 - Super K/Harpoon
 - Areas with Two Treatments



3 STUDY IMPROVEMENTS

The study improvements were based on lessons learned from previous years of herbicide application efforts, coordination with the study partners during the 2021 treatment season, and activities conducted during the 2021 herbicide application.

3.1 Herbicide Application and Analysis

There have been no issues with herbicide handling at the public launch areas since the Project's inception in 2014, and public access to the boat ramps continued to be uninterrupted while used by the applicators.

The immunoassays performed to determine endothall concentrations during the 2021 application were effective at detecting the herbicide and tracking its movement and degradation.

3.2 2021 Lessons Learned

Treatment Areas

Due to uncertainties tied to weather impacts and potential rescheduling of treatments, consider establishing a minimum percentage of precipitation that would require rescheduling of treatment. This minimum threshold would be mutually agreed upon by the team and could then serve as a reference point for more advanced decision-making.

Two treatment areas warrant consideration for changes to the application plan in 2022: Sawyer Creek and Wardell's Marina boat lift. The Sawyer Creek application was not successful due to higher flow the day following treatment. Treatment notification requirements make scheduling flexibility difficult, so weather impacts are somewhat unavoidable. However, when dilution problems are anticipated, and rescheduling is not an option, a rate increase or an earlier follow-up treatment may be beneficial. Historically, UPL has indicated that a factor of 48 ($4 \text{ ppm} \times 12 \text{ hours}$ or $2 \text{ ppm} \times 24 \text{ hours}$) is necessary to control Hydrilla in moving water. Expansion of the application area farther upstream from the uppermost Hydrilla occurrence may also add benefit.

Wardell's Marina boat lift exhibited post-treatment Hydrilla growth this year. Given the location and purpose of the facility, Hydrilla reintroduction from untreated areas is not surprising. It would be reasonable to apply Harpoon® granular treatments via the backpack blower from the land side at this site as a follow-up application two to three weeks after the initial treatment. This method of treatment could be accomplished at a reduced cost by using one person. The use of one person would also make scheduling easier.

Communication

Communication in 2021 was efficient and effective through the use of conference calls and email updates. No changes to frequency or methods of communication are recommended for 2022. As the Project enters its maintenance phase, it is critical to maintain one point of contact for the client, each subcontractor, and Project stakeholder for efficient communication.

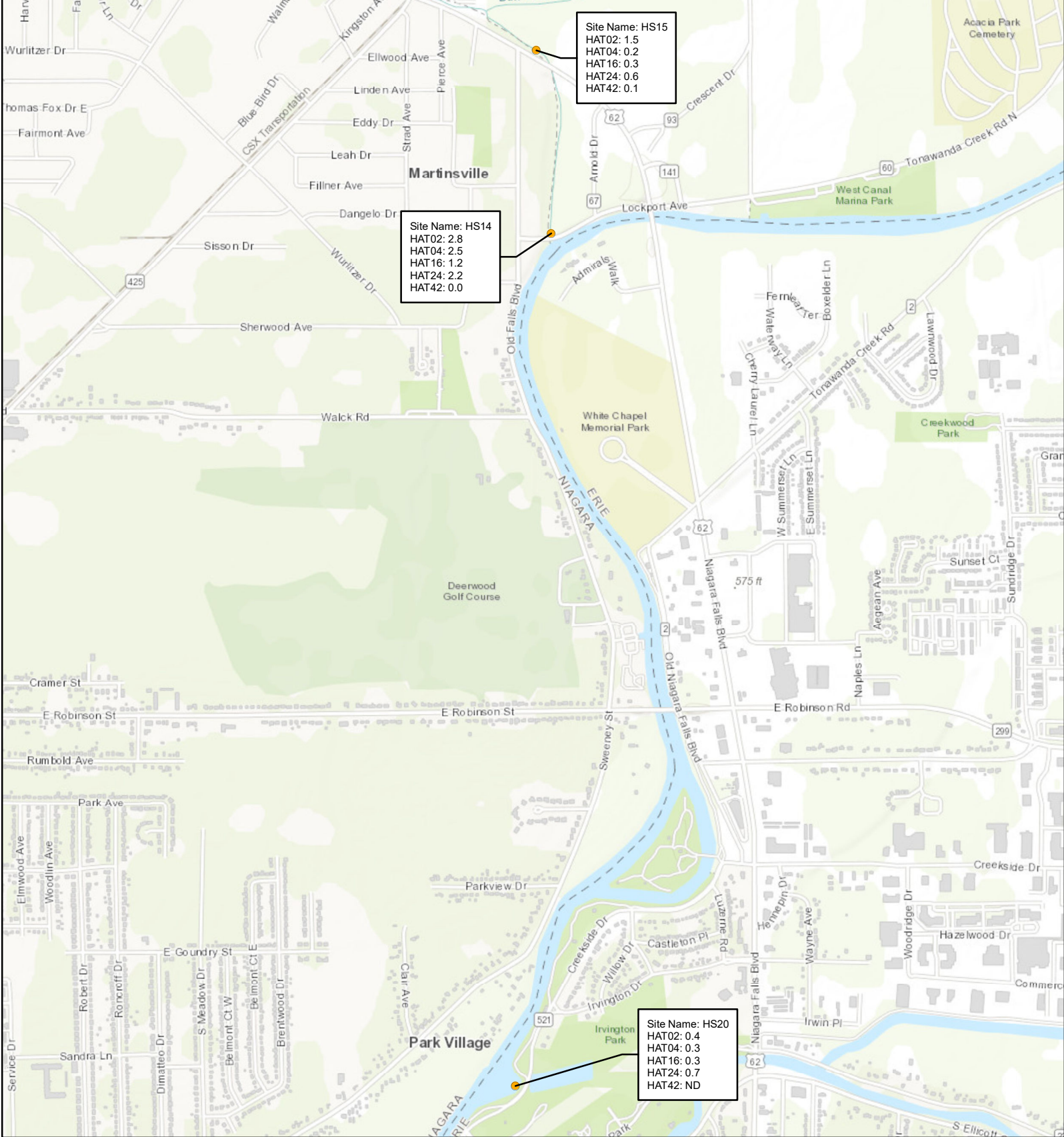
4 REFERENCES

Manns, Richard. 2014. Canal Engineering, New York State Canal Corporation. Personal communication, email correspondence with K. Dixon, Ecology and Environment, Inc. on October 15, 2014.

U.S. Army Corps of Engineers (USACE). 2021. *Performance Work Statement Aquatic Plant Control ERDC Demonstration Project Tonawanda Creek/Erie Canal, Tonawanda, NY*. April 2021.

A. WATER QUALITY SAMPLING LOCATION MAPS

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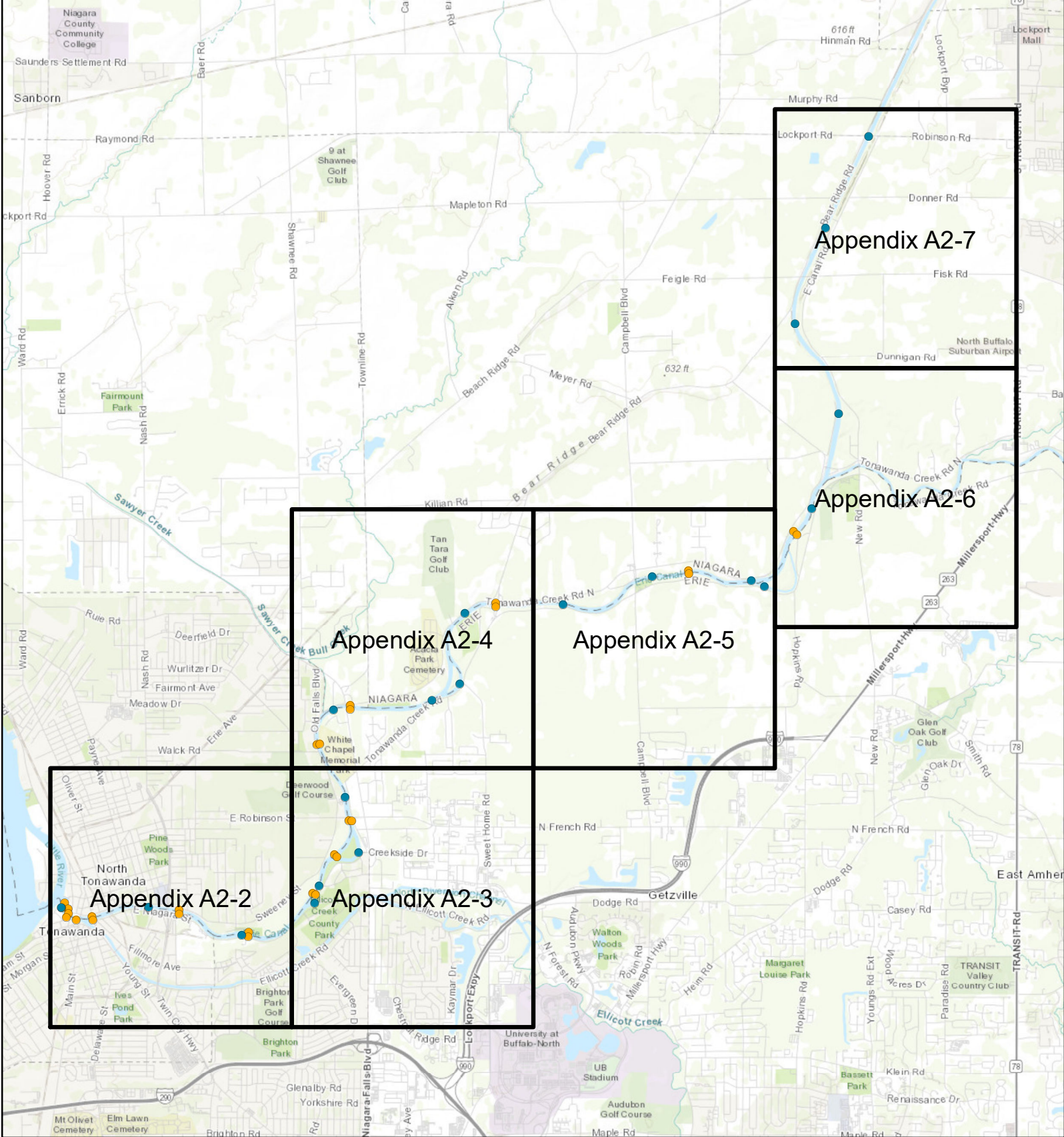
Appendix A-1 July Endothall (Aquathol K) Treatment, Sawyer Creek Tonawanda Creek/Erie Canal, Erie and Niagara Counties, New York

- USACE Sampling Locations

HAT - Hours After Treatment
 ND - Non-detect

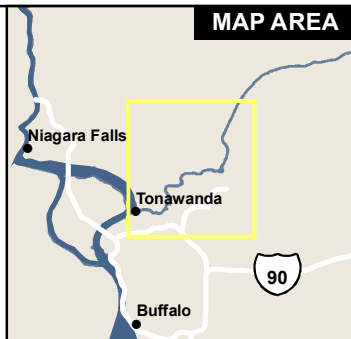
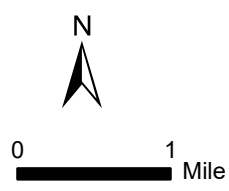
0 1,000 Feet

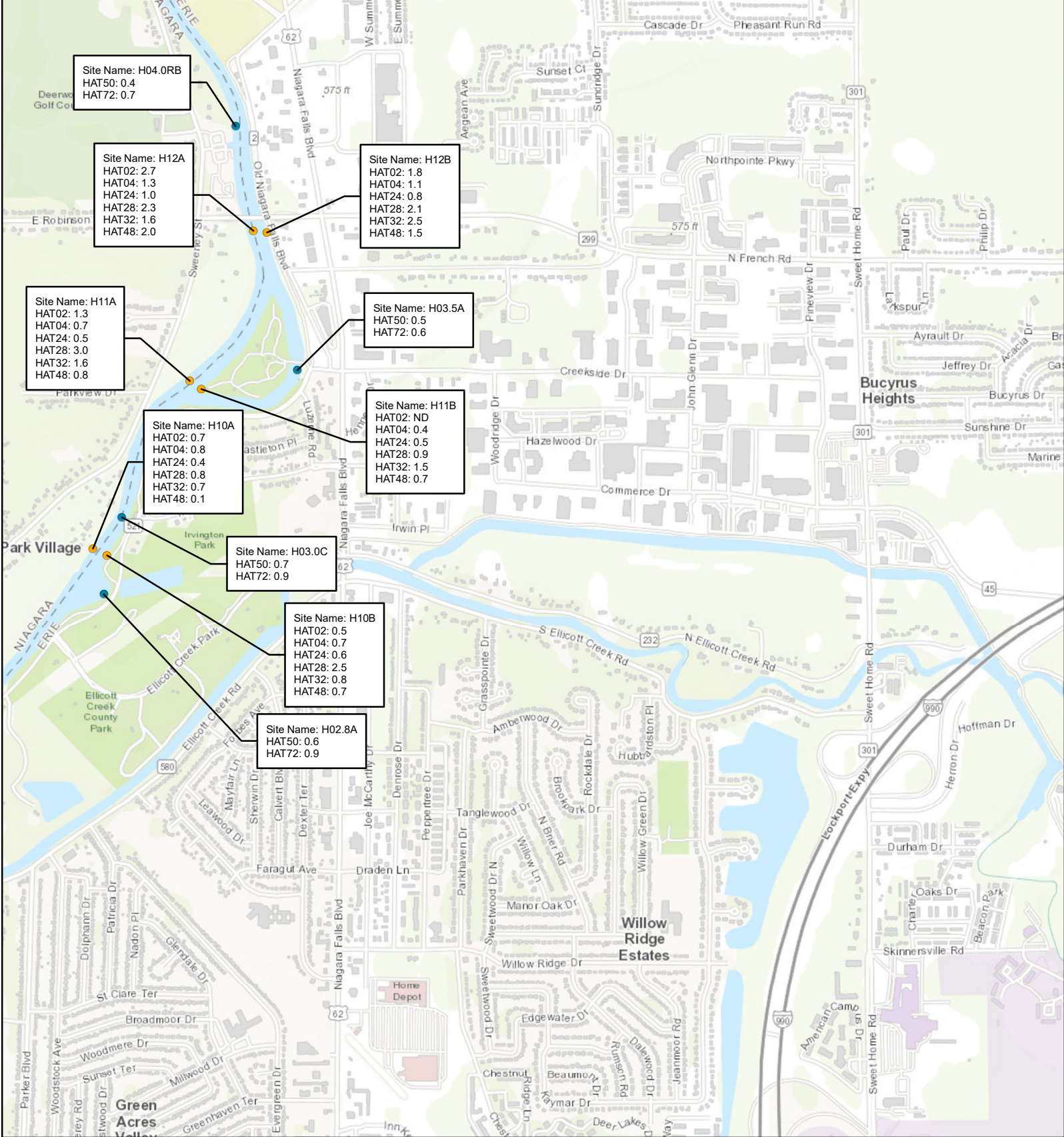
MAP AREA



**Appendix A2-1 Endothall (Aquathol K) Treatment Monitoring Locations and Results
Tonawanda Creek/Erie Canal, Erie and Niagara Counties, New York**

- JV Sampling Locations
- USACE Sampling Locations





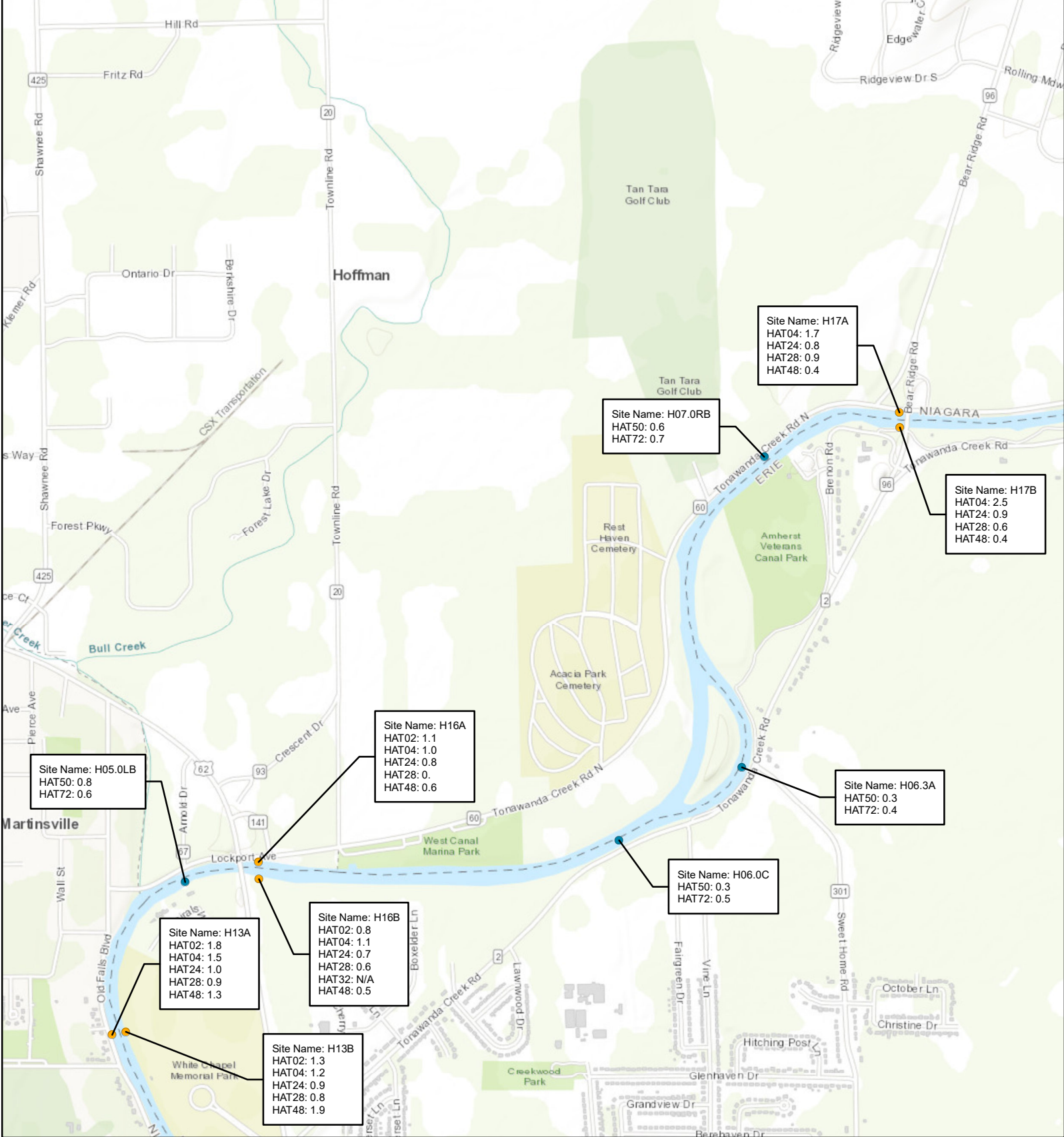
Appendix A2-3 Endothall (Aquathol K) Treatment Monitoring Locations and Results Tonawanda Creek/Erie Canal, Erie and Niagara Counties, New York

- JV Sampling Locations
- USACE Sampling Locations

HAT - Hours After Treatment
ND - Non-detect

0 1,000 Feet

MAP AREA



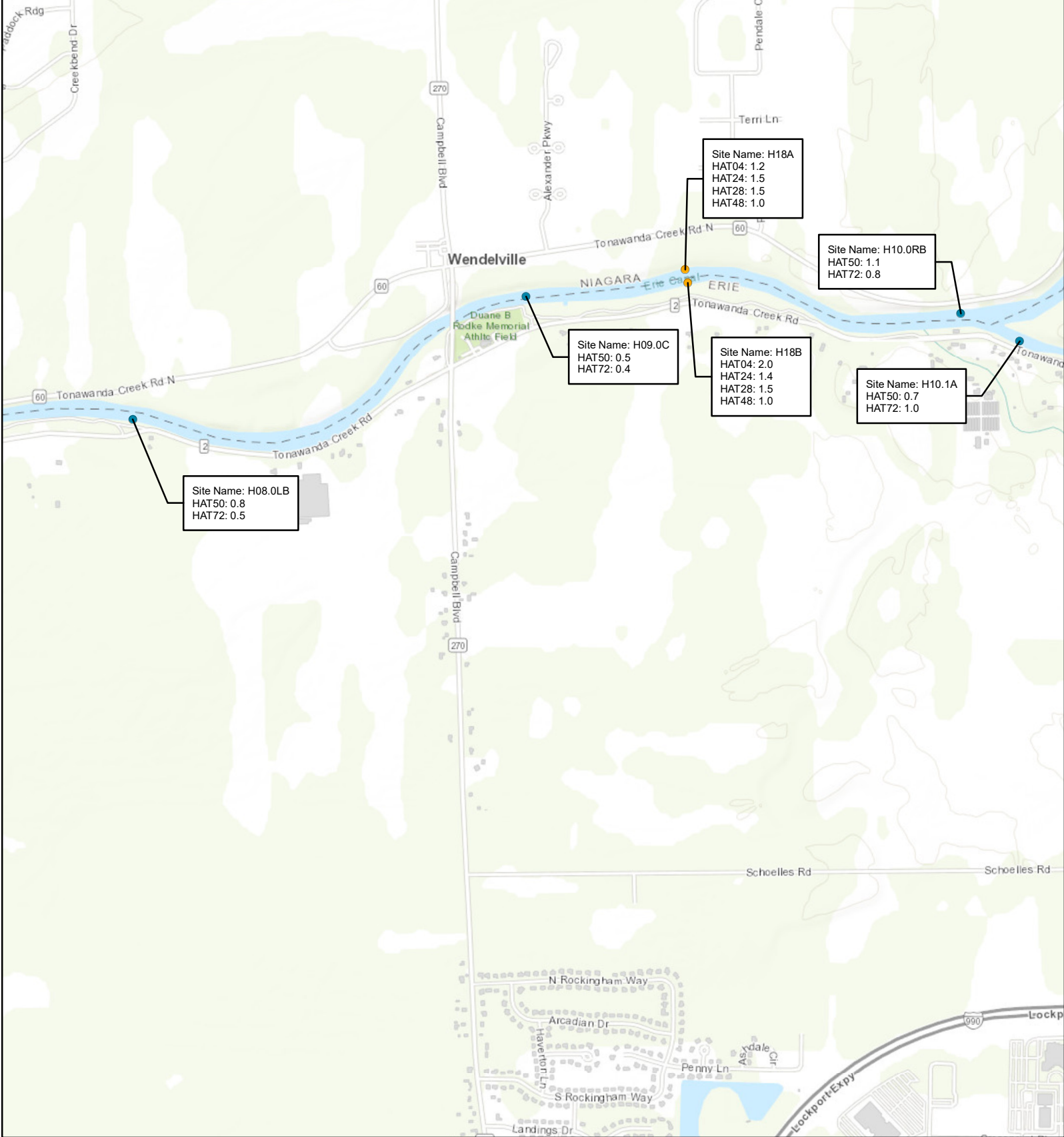
Appendix A2-4 Endothall (Aquathol K) Treatment Monitoring Locations and Results Tonawanda Creek/Erie Canal, Erie and Niagara Counties, New York

- JV Sampling Locations
- USACE Sampling Locations

HAT - Hours After Treatment
ND - Non-detect

0 1,000 Feet

MAP AREA



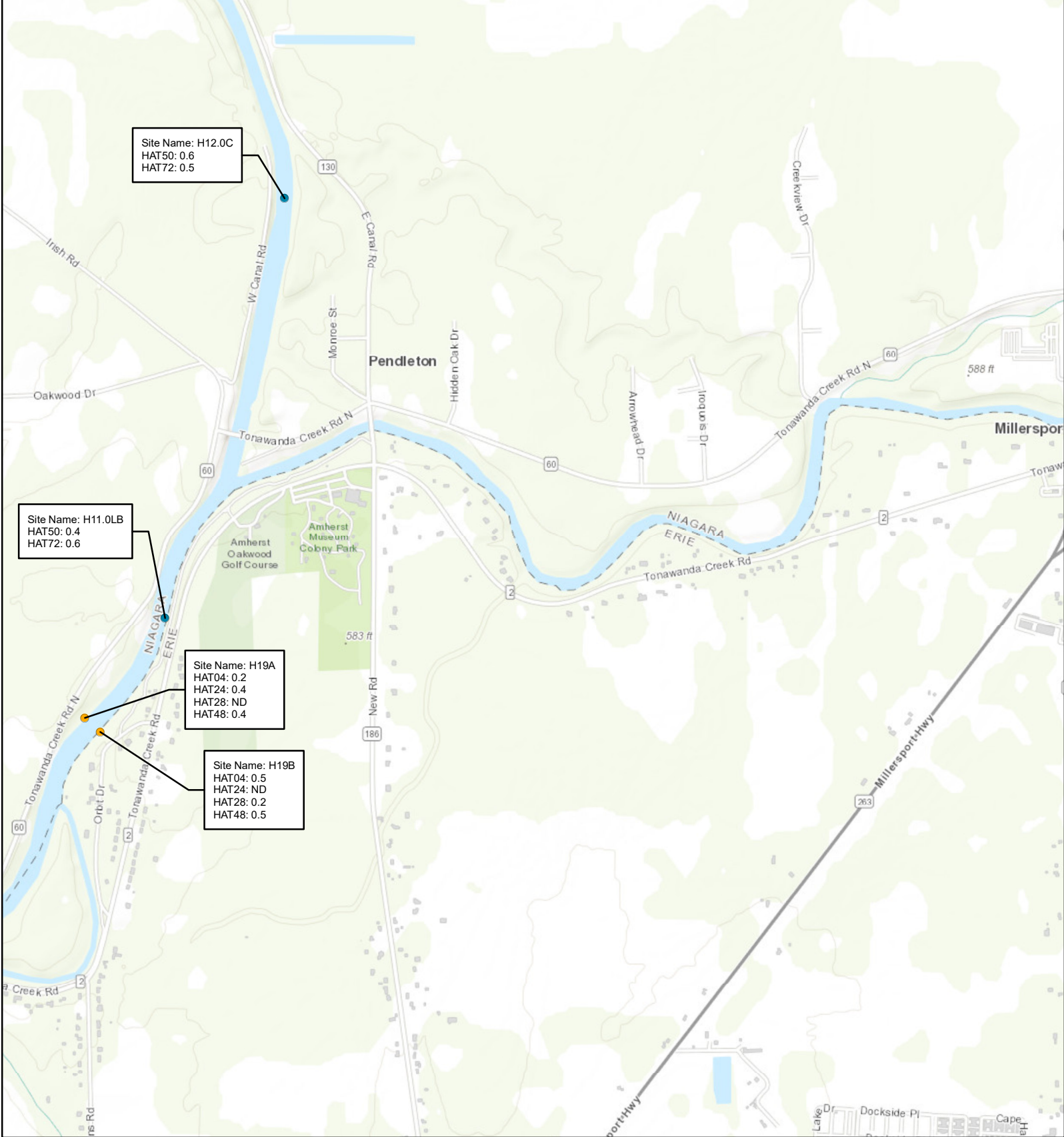
Appendix A2-5 Endothall (Aquathol K) Treatment Monitoring Locations and Results Tonawanda Creek/Erie Canal, Erie and Niagara Counties, New York

- JV Sampling Locations
- USACE Sampling Locations

HAT - Hours After Treatment
ND - Non-detect

0 1,000 Feet

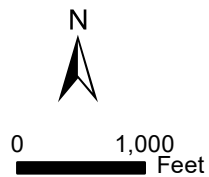
MAP AREA

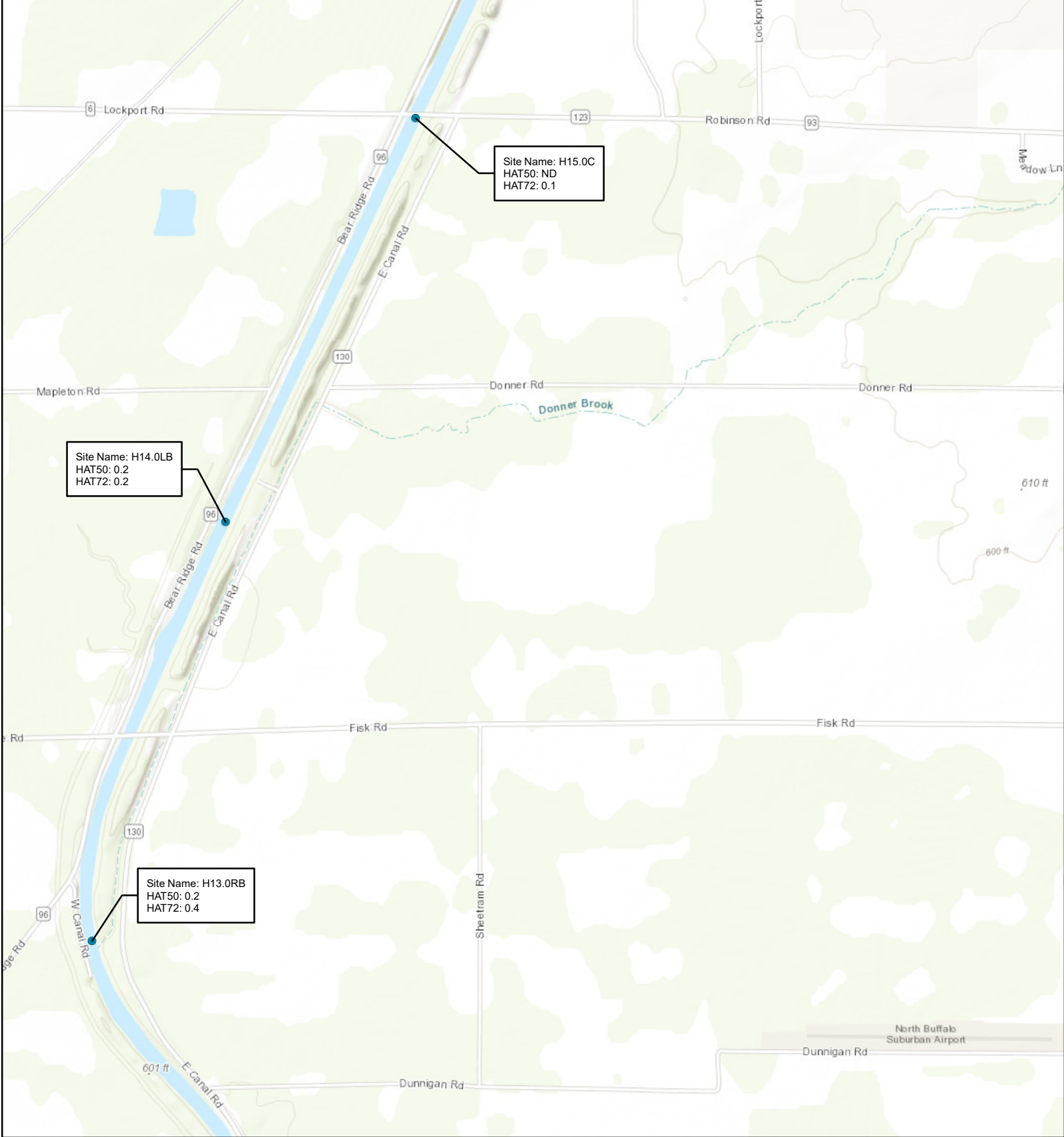


**Appendix A2-6 Endothall (Aquathol K) Treatment
Monitoring Locations and Results
Tonawanda Creek/Erie Canal, Erie and Niagara Counties, New York**

- JV Sampling Locations
- USACE Sampling Locations

HAT - Hours After Treatment
ND - Non-detect





**Appendix A2-7 Endothall (Aquathol K) Treatment
Monitoring Locations and Results
Tonawanda Creek/Erie Canal, Erie and Niagara Counties, New York**

- JV Sampling Locations
- USACE Sampling Locations

HAT - Hours After Treatment
ND - Non-detect

