

Post-Treatment Assessment for Aquatic Plant Control ERDC Demonstration Project Tonawanda Creek/Erie Canal, New York 2020

Prepared for:

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



**US Army Corps
of Engineers®**
Buffalo District
BUILDING STRONG®

under
Contract No. W912P4-20-0001

February 2021

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ACRONYMS AND ABBREVIATIONS

Canal Corp.	New York State Canal Corporation
CET	concentration exposure time
E & E	Ecology and Environment, Inc.
EAS E & E JV	Environmental Assessment Services, LLC and Ecology and Environment, Inc. Joint Venture
ERDC	Engineer Research and Development Center
GIS	geographic information system
GPS	Global Positioning System
Hydrilla	<i>Hydrilla verticillata</i>
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)
USFWS	U.S. Fish and Wildlife Service

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’s) Aquatic Plant Control Research Program to manage monoecious hydrilla (*Hydrilla verticillata*; Hydrilla) in a flowing water system. This report contributes to the Year 7 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 (USFWS) 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 percent in July 2014, prior to the initial large-scale herbicide application. Hydrilla beds were patchy and limited to the shallow shoreline areas outside of 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 percent at points monitored and, in 2020, decreased to 2 percent. During 2019, a total of 62 discrete points were noted as Hydrilla occurrences, compared with only 41 in 2020.

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 2020, to control and eradicate Hydrilla, the USACE conducted a seventh 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 Figure 1-1 Frames 1 through 4). Prior to treatment application, Hydrilla populations were delineated and mapped by the USACE using point-intercept and hydro-acoustic surveys. The 2020 endothall (Aquathol® K) treatment areas were designated as follows:

- Western block treatment areas: 2.8 miles between the mouth of the Niagara River in Tonawanda and the Ellicott Creek overflow. Of this area, 63.4 acres were directly treated with endothall (Aquathol® K) and the remaining areas received secondary treatment from flow in the creek/canal; and
- Eastern block treatment areas: 6 miles between Sawyer Creek in Niagara County and Orbit Drive in Amherst. Of this area, 42.9 acres were directly treated with endothall (Aquathol® K) and the remaining areas received secondary treatment from flow in the canal.

Additionally, for the third consecutive year, spot treatment with chelated copper occurred in various locations within the 15-mile stretch to control small, persistent beds of Hydrilla (see Figure 1-1 Frames 1 through 4). In addition to spot treatment with chelated copper, 2020 was the second year in which spot treatment with a granular formulation of endothall (Aquathol® Super K) was also conducted. Endothall (Aquathol® Super K) was added to the treatment plan for 2019 for evaluation of use application in smaller treatment plots.

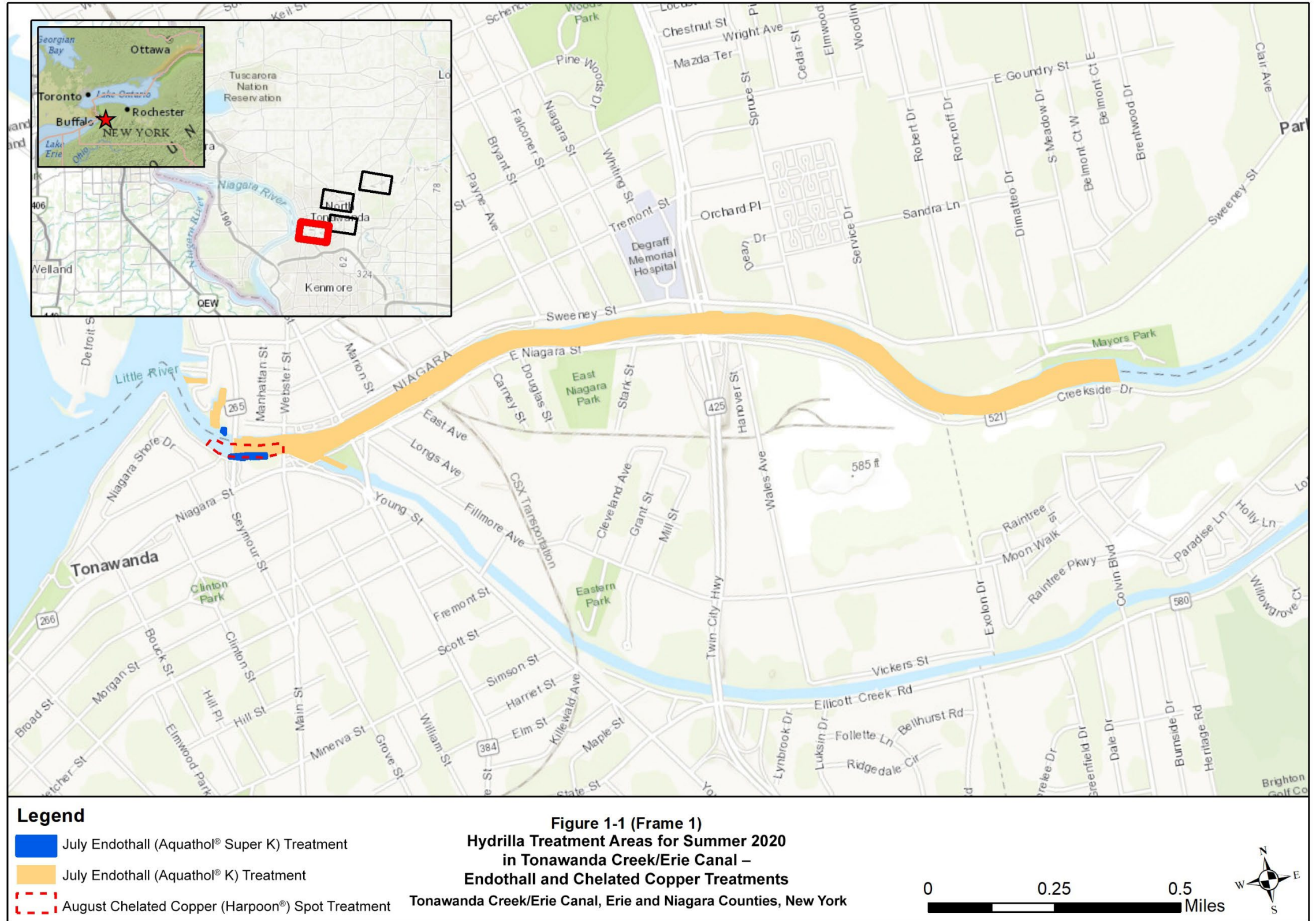
Implementation of the Project was a collaborative effort between the Engineer Research and Development Center (ERDC); USACE; Environmental Assessment Services, LLC (EAS) and Ecology and Environment, Inc. (E & E) Joint Venture (EAS E & E JV); New York State Canal Corporation (Canal Corp.); New York State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

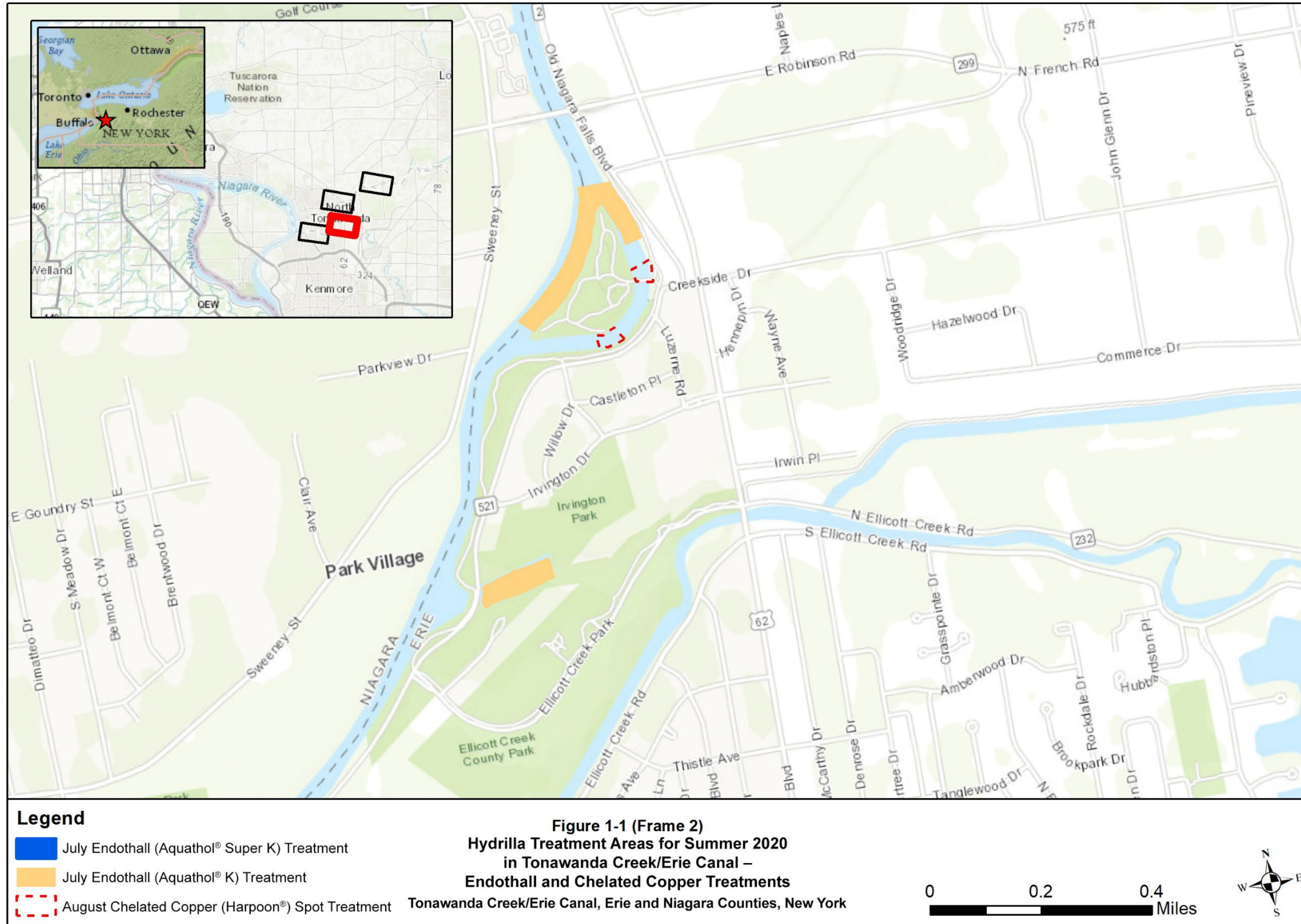
1.2. Purpose and Scope

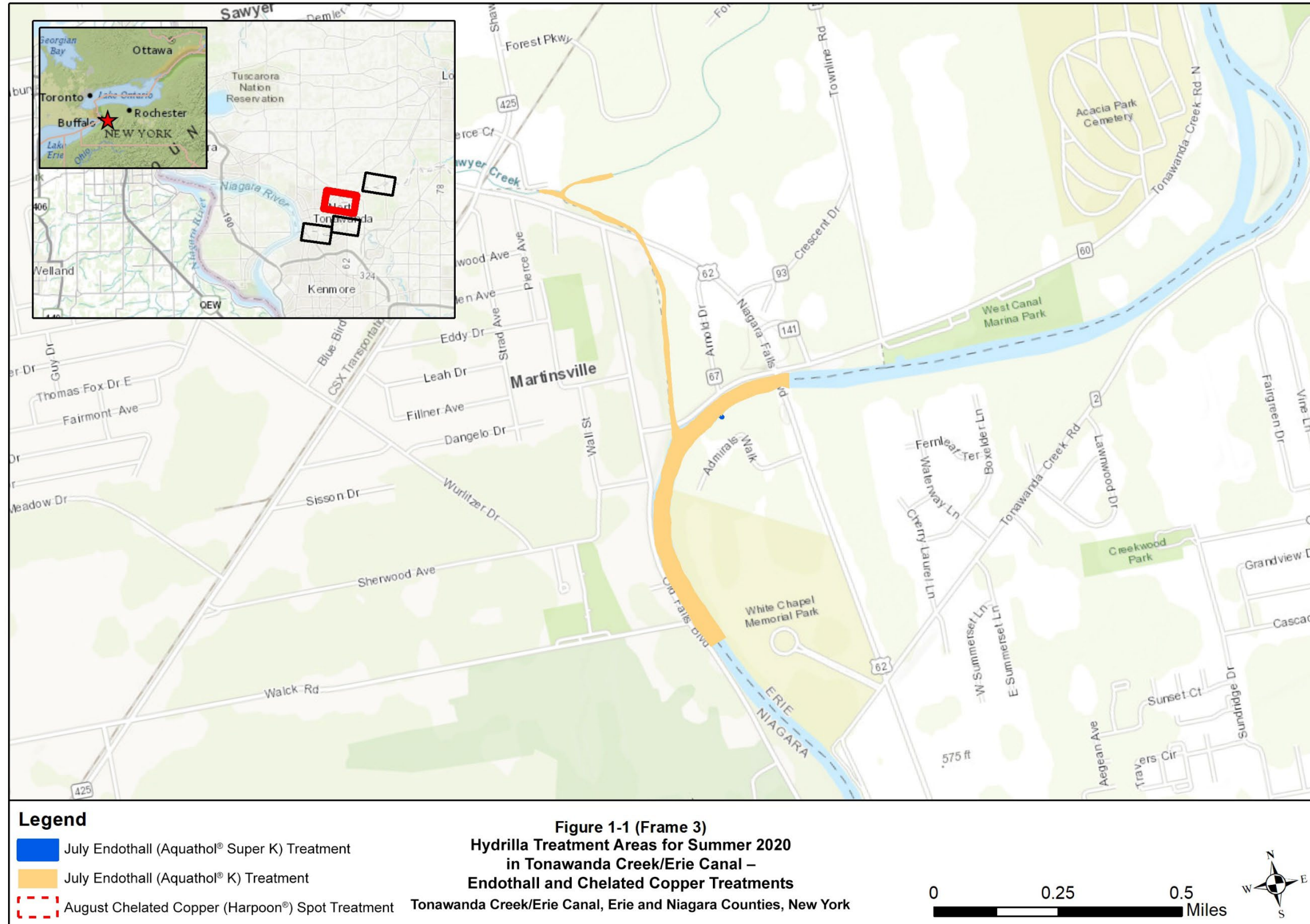
The purpose of the Project is to perform a field-scale demonstration of a technology developed under the Aquatic Plant Control Research Program to evaluate the effectiveness of aquatic herbicides to manage monoecious Hydrilla in high water exchange environments. The USACE is also funding a separate research 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.

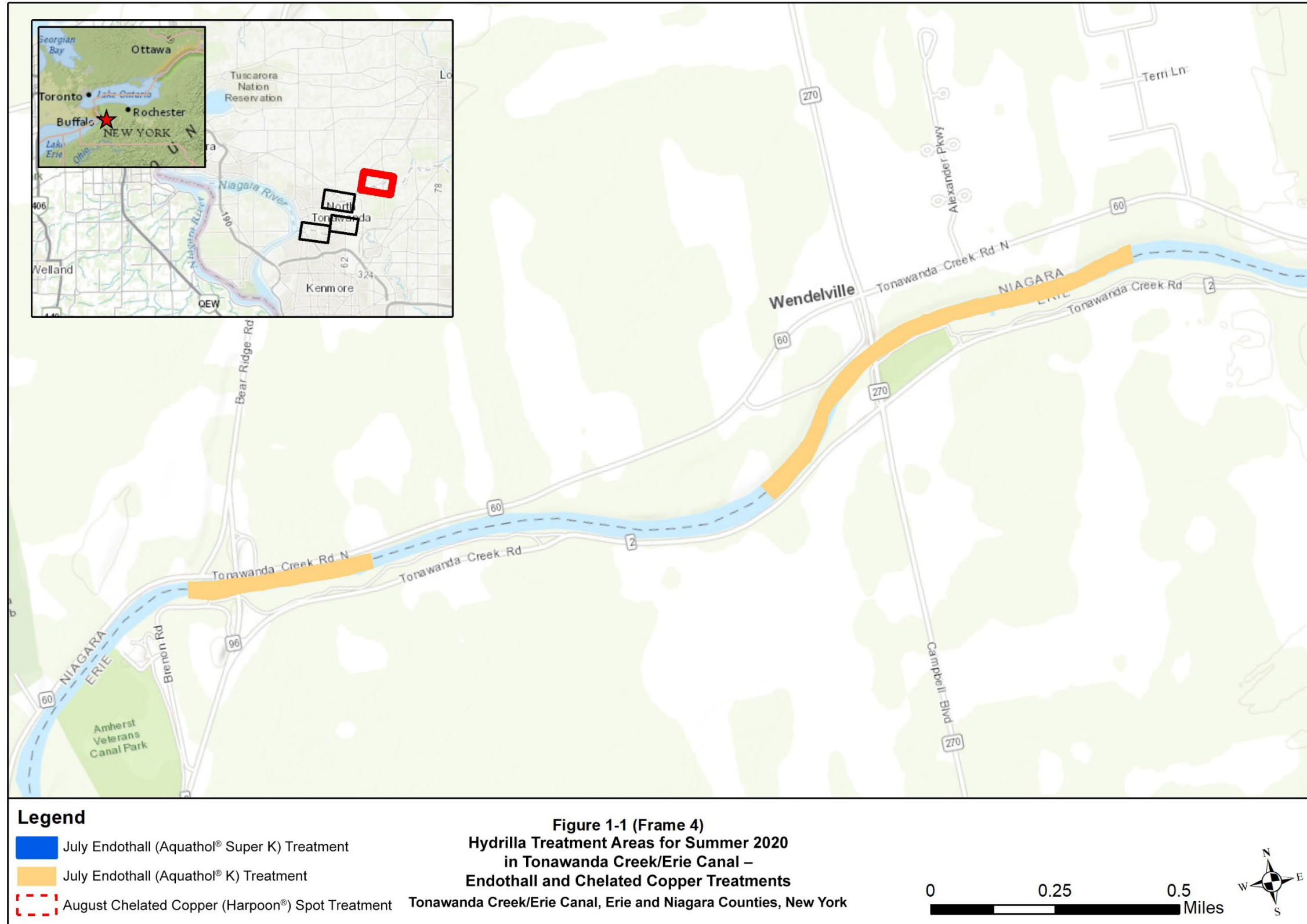
The findings in this program will provide valuable information for developing future guidance on how to manage this invasive aquatic plant that is expanding in high water exchange systems throughout the northeastern United States. The condition of plants were monitored by the USACE prior to and several 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, conclusions are provided, in the form of lessons learned, to help shape future treatment projects.









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, for a period of approximately 76 hours in order to achieve a maximum (or ideal) contact time at a target concentration. Minimizing water flow yielded greater contact time between the herbicide and Hydrilla. To minimize flow, a target flow rate of 50 cubic feet per second or less to the east 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 its dispersion; 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). Four methods of public notification were used to announce the July 28 and July 29, 2020, treatment:

- Riparian owners and permitted users were notified via U.S. certified mail approximately 21 days prior to the application;
- A supplemental riparian notification letter was sent out via U.S. certified mail to those along a supplemental treatment area within Sawyer Creek that were not previously notified. This notification occurred approximately 15 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 14 days prior to the application; and
- Project factsheets were distributed by boat stewards along the canal.

2.2. Field Conditions

Field conditions prior to treatment (July 23 through July 27, 2020), during treatment (July 28 and July 29, 2020), and immediately following treatment (July 30 through August 2, 2020) are summarized in Table 2-1. As indicated in Table 2-1, a total of approximately 0.85 inches of rain fell between July 23 and August 2, 2020. Prior to treatment approximately 0.42 inches of precipitation occurred (July 23 through July 27, 2020), during treatment (July 28 and July 29, 2020), only 0.04 inches of precipitation was recorded, and after the treatment period (July 30 through August 2, 2020), approximately 0.39 inches of precipitation was recorded. During the first day of treatment (July 28), the average wind speed was 13.13 miles per hour, with gusts up to 24 miles per hour. The wind conditions stacked up on the water, pushing the water, and by association, herbicide, as discussed in Section 2.7. Additionally, a Lake Erie seiche occurred on July 28 as a result of the strong winds.

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

Date	Temperature Range (degrees Fahrenheit)	Precipitation (inches)	Other
July 23, 2020	Max: 83 Min: 73	0.42	Mostly cloudy Average wind speed 5.78 mph with gusts up to 10 mph
July 24, 2020	Max: 85 Min: 69	0	Mostly cloudy Average wind speed 4.56 mph with
July 25, 2020	Max: 86 Min: 68	0	Partly cloudy Average wind speed 4.25 mph with gusts up to 9 mph
July 26, 2020	Max: 86 Min: 66	0	Partly cloudy Average wind speed 13.13 mph with gusts up to 24 mph
July 27, 2020	Max: 84 Min: 74	0	Partly cloudy Average wind speed 16.48 mph with gusts up to 24 mph
July 28, 2020	Max: 82 Min: 72	0.04	Fair Average wind speed 13.13 mph with gusts up to 24 mph
July 29, 2020	Max: 81 Min: 68	0	Partly cloudy Average wind speed 9.79 mph with gusts up to 24 mph
July 30, 2020	Max: 83 Min: 70	0.18	Mostly cloudy Average wind speed 4.83 mph with gusts up to 12 mph
July 31, 2020	Max: 84 Min: 65	0	Fair Average wind speed 5.08 mph with gusts up to 13 mph
August 1, 2020	Max: 87 Min: 63	0	Mostly cloudy Average wind speed 6.48 mph with gusts up to 14 mph
August 2, 2020	Max: 83 Min: 70	0.21	Mostly cloudy/light rain Average wind speed 16.58 mph with gusts up to 31 mph

2.3. Herbicide Treatment Methodology

The aquatic herbicide endothall (Aquathol® K) was applied in designated sections of Tonawanda Creek/Erie Canal and Sawyer Creek on July 28 and 29, 2020, and spot treatments using endothall (Aquathol® Super K) occurred on those same days. Additionally, spot treatments occurred on August 28, 2020, and utilized chelated copper (Harpoon®). The herbicides were applied by SLM in accordance with the *Performance Work Statement (PWS) Aquatic Plant Control ERDC Demonstration Project Tonawanda Creek/Erie Canal*, dated May 5, 2020, and the subsequent modification processed in September 2020 (USACE 2020).

2.3.1 Herbicide Transfer

An in-line herbicide injection system was used on the jon boat and skiff. The jon boat was outfitted with a 100-gallon polyethylene tank, while the skiff was outfitted with two 150-gallon polyethylene tanks. 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 empty totes were taken back by the herbicide distributor and were returned to the manufacturer for reloading and reuse. The granular herbicide was carried in company work trucks from the New York warehouse to the site in 20-pound bags. These bags were triple rinsed and then disposed of as solid waste. Personal protective equipment was worn by SLM staff and by the driver from the company that delivered the herbicide and assisted with the herbicide transfer.

2.3.2 Endothall (Aquathol® K) Treatment

The jon boat and work skiff 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 and all of the treatment section locations were preloaded.

As stated in Section 1.1, for the July 2020 treatment, the Project area was divided into two blocks for endothall (Aquathol® K) treatment: the western block encompassing approximately 2.8 miles between the mouth of the Niagara River in Tonawanda and the Ellicott Creek overflow; and the eastern block encompassing approximately 6 miles between Sawyer Creek in Niagara County and Orbit Drive in Amherst. Herbicide was applied in the littoral areas and allowed to disperse across the canal to bring herbicide concentrations to target levels.

2.3.3 Chelated Copper (Harpoon®) Treatment

Chelated copper (Harpoon®) was applied using a vortex blower during the spot treatment on August 28, 2020. Boat passes were made parallel to shore 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 systems, with the treatment zones preloaded on them, to ensure accuracy and record the amount of acreage that the boats covered.

The following paragraphs summarize the 2020 treatment activities, including both endothall (Aquathol® K and Aquathol® Super K) and chelated copper (Harpoon®).

July 28, 2020: Day 1

SLM staff arrived at the City of North Tonawanda boat launch at 700 Sweeney Street at the foot of Service Road at 0730 hours. After an on-site meeting with the USACE, SLM launched the jon boat and the skiff at 0850 hours. Two treatment crews were sent out, consisting of a lead applicator or a lead applicator and an assistant/technician, and completed herbicide application in the western block treatment areas. At 1200 hours, a second launch was initiated at West Canal Park. Two boats conducted herbicide application in the eastern block treatment areas and completed treatment at 1500 hours, resulting in a total treatment time of approximately 6 hours. Applications in the morning and afternoon were completed along the edges of the creek/canal only, with a width of one boat pass.

A total of 13 areas were treated on Day 1, totaling 110.75 acres (see Table 2-2 and Figure 2-1 Frames 1 through 4). Of these 13 areas, 10 were treated with Aquathol® K, and three were treated with Aquathol® Super K.

July 29, 2020: Day 2

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 0830 hours. Similar to Day 1, an afternoon launch at West Canal Park began at 1200 hours and was completed at 1345 hours for a total of just over 5 hours of treatment. Both boats were utilized for application during the morning and afternoon launches. Similar to Day 1, applications were completed along the edges of the creek/canal only, with a width of one boat pass.

A total of nine areas were treated on Day 2, totaling 101.2 acres (see Table 2-2 and Figure 2-1 Frames 1 through 4). Of these nine areas, six were treated with Aquathol® K and three were treated with Aquathol® Super K.

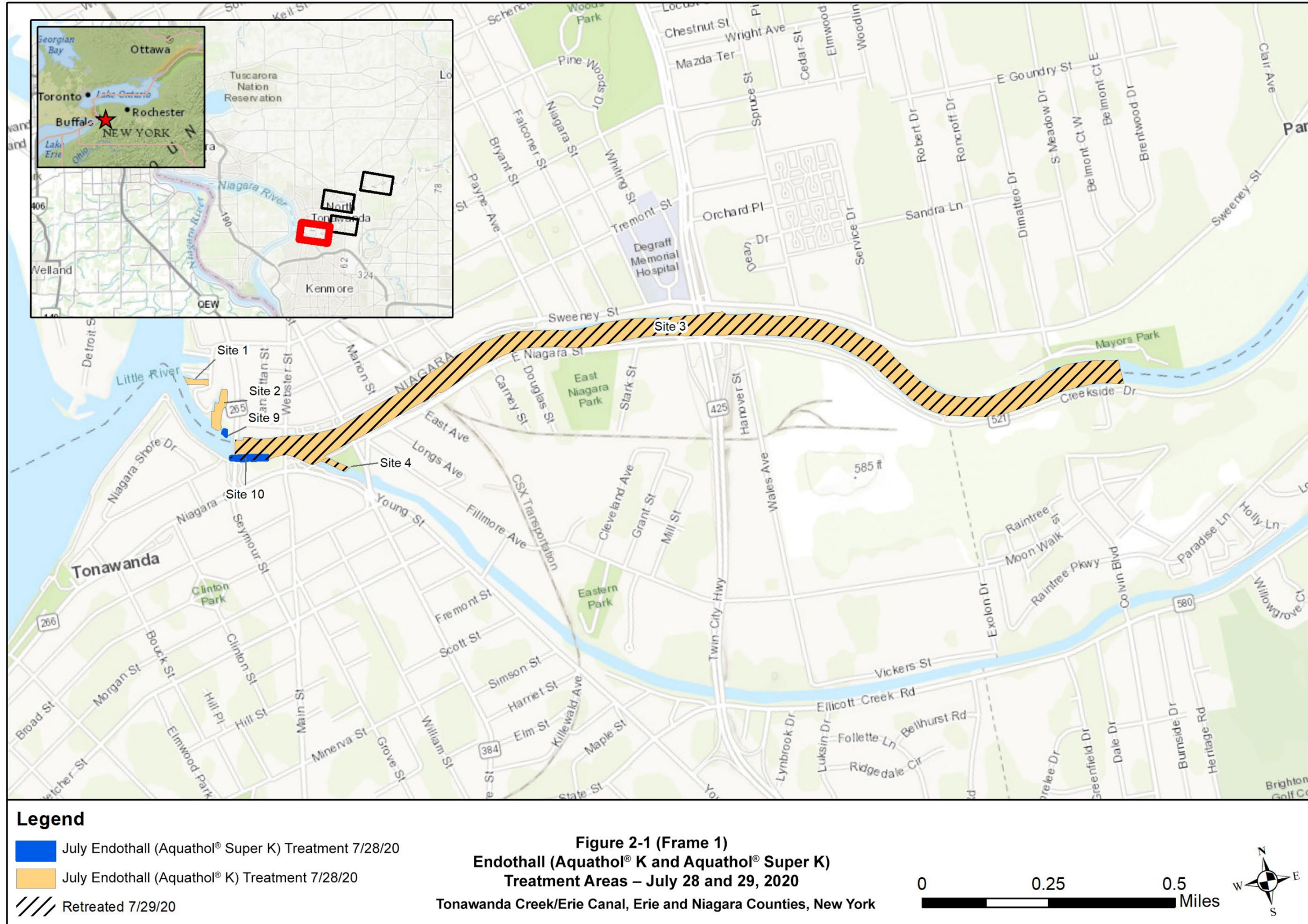
August 28, 2020: Spot Treatment

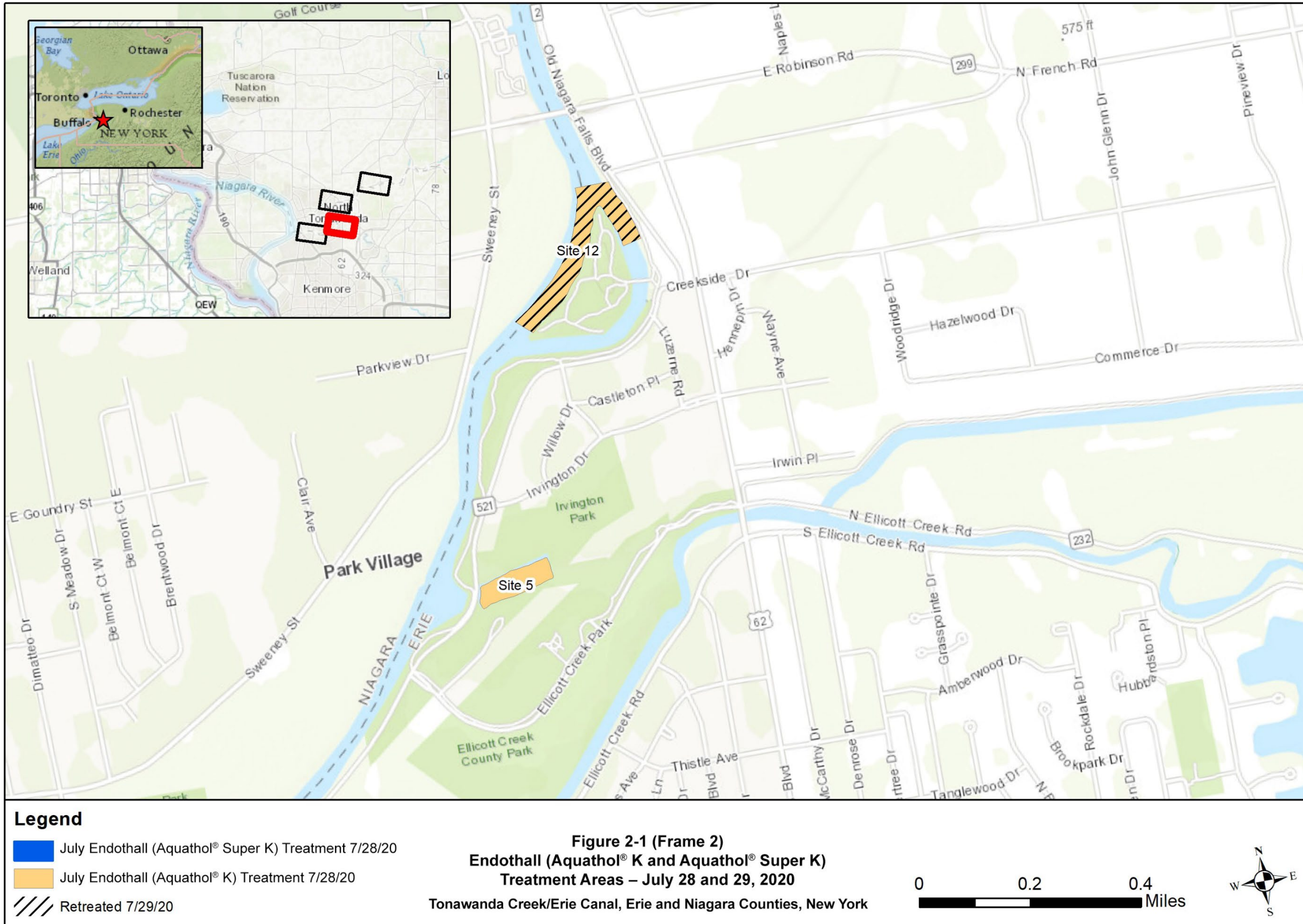
Due to insufficient herbicide control in the vicinity of the Route 265 bridge and two areas that were missed in the Ellicott Creek Dog Park (Bark Park), a spot treatment with Harpoon® occurred on August 28, 2020, in these areas. A total of approximately 3.6 acres were spot treated (see Table 2-2 and Figure 2-2 Frames 1 and 2).

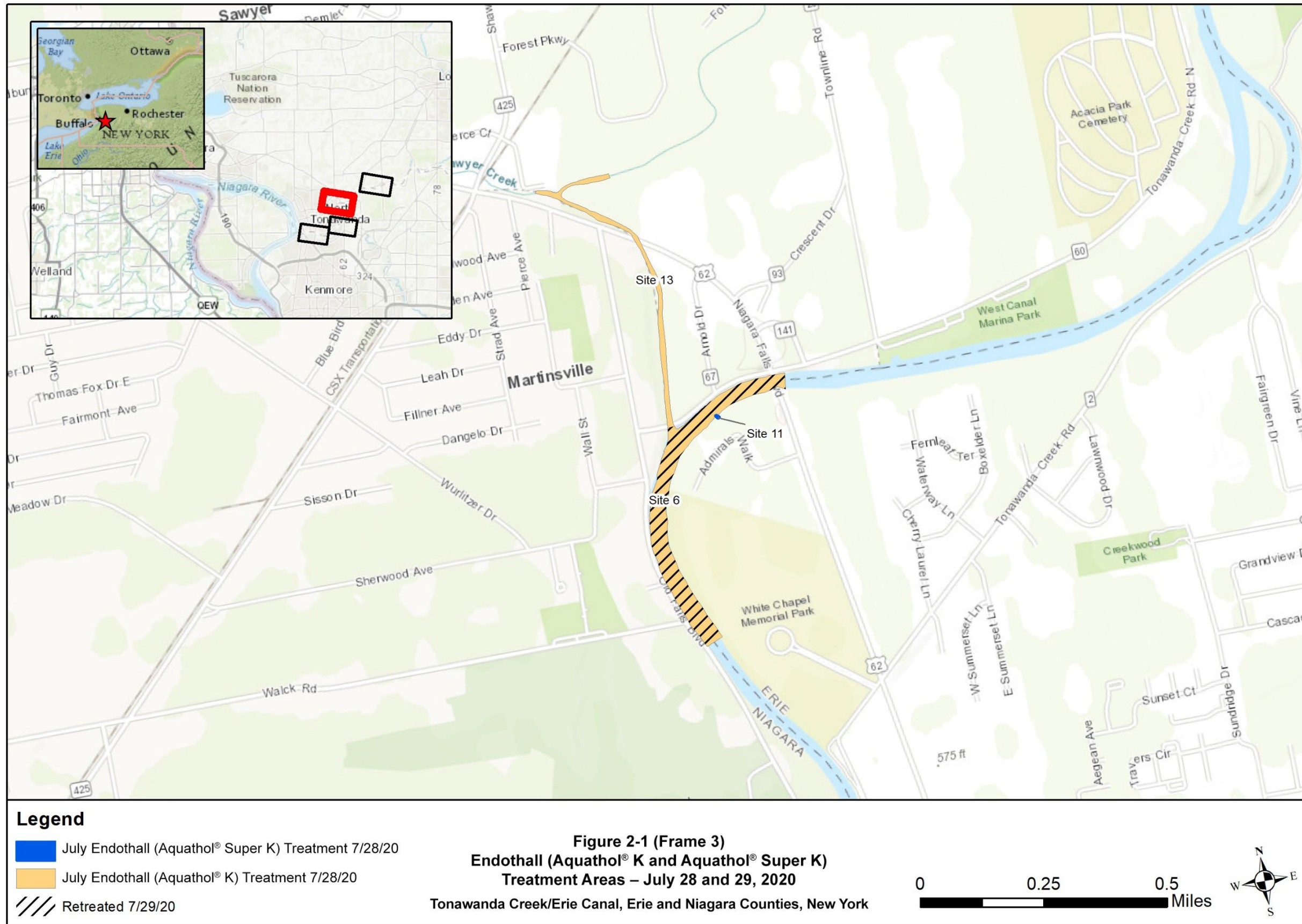
2.4. Quantity of Herbicide Used and Total Area Treated

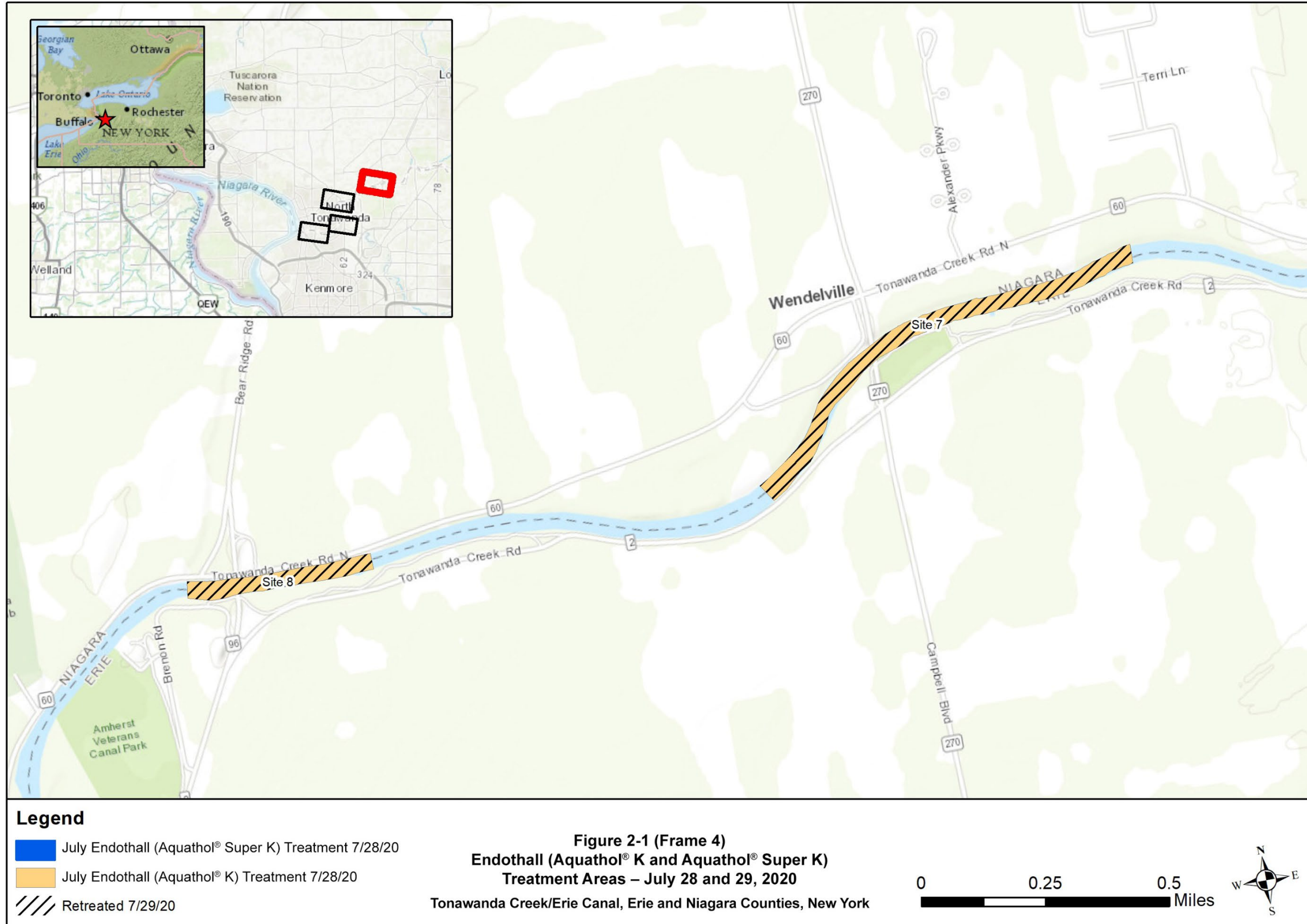
A summary of the herbicide quantities applied during the July and August 2020 treatment activities is provided in Table 2-2. The planned treatment areas were divided into distinct areas or plots using a geographic information system (GIS), the total amount of endothall or chelated copper to be applied to each area/plot was calculated, and the products were then applied as described in Section 2.3.

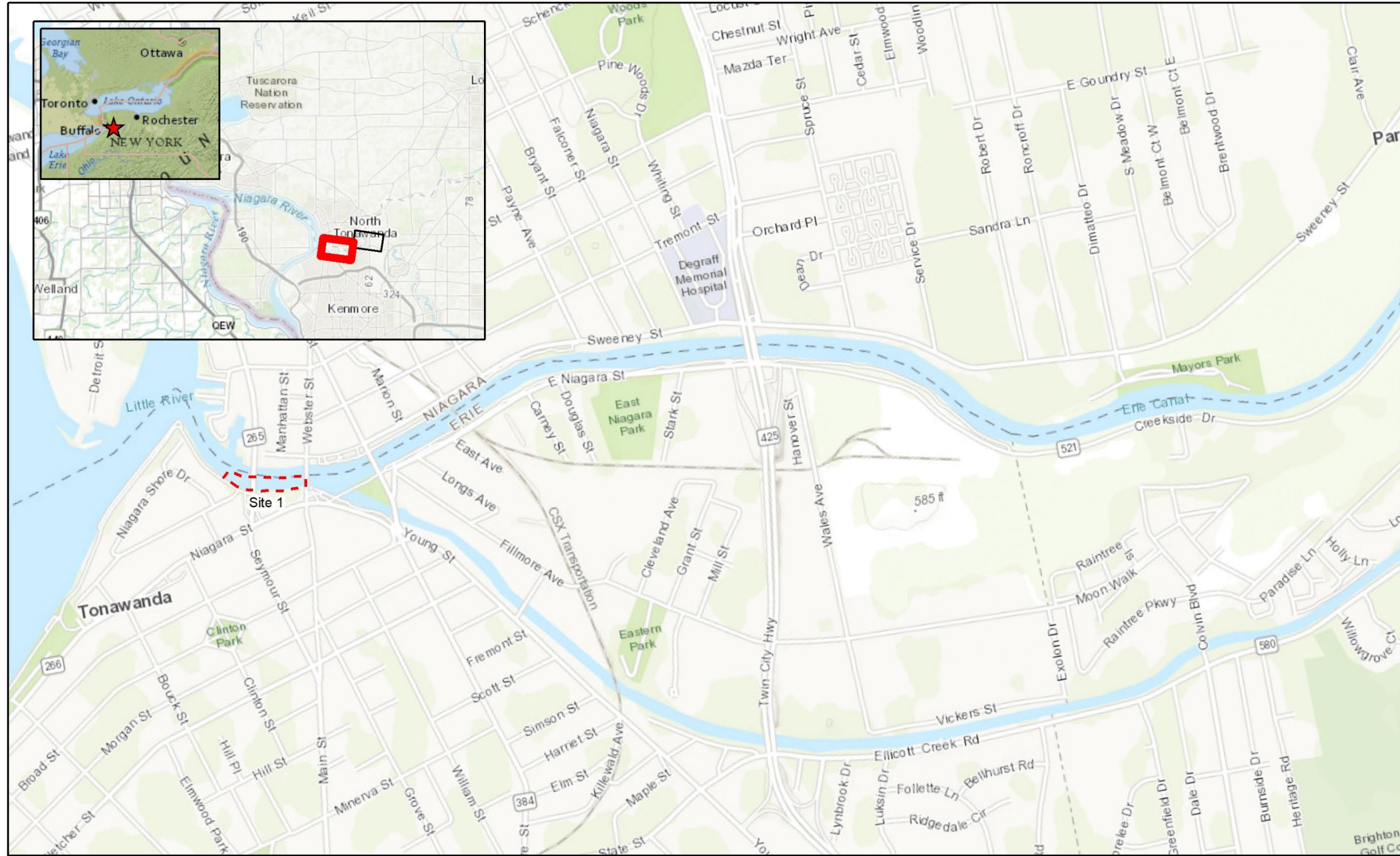
Herbicide dosing was predetermined and calculated by the USACE based on the treatment area acreages and volumes. The target concentration of endothall (Aquathol® K) for all of the treated areas in the main creek/canal channel was 1.5 milligrams per liter or parts per million (ppm) on Day 1 and 1.5 ppm on Day 2 of the July treatment. The target concentration of endothall (Aquathol® Super K) was 5.0 ppm on both days. These doses were calculated based on the entire water volume of the creek/canal treatment areas. For the August spot treatment, the target concentration of chelated copper (Harpoon®) was 1.0 ppm.







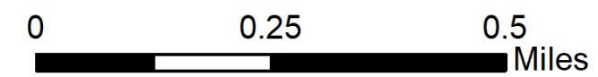




Legend

 August Chelated Copper (Harpoon®) Spot Treatment

Figure 2-2 (Frame 1)
Chelated Copper (Harpoon®) Spot Treatment –
August 8, 2020
Tonawanda Creek/Erie Canal, Erie and Niagara Counties, New York



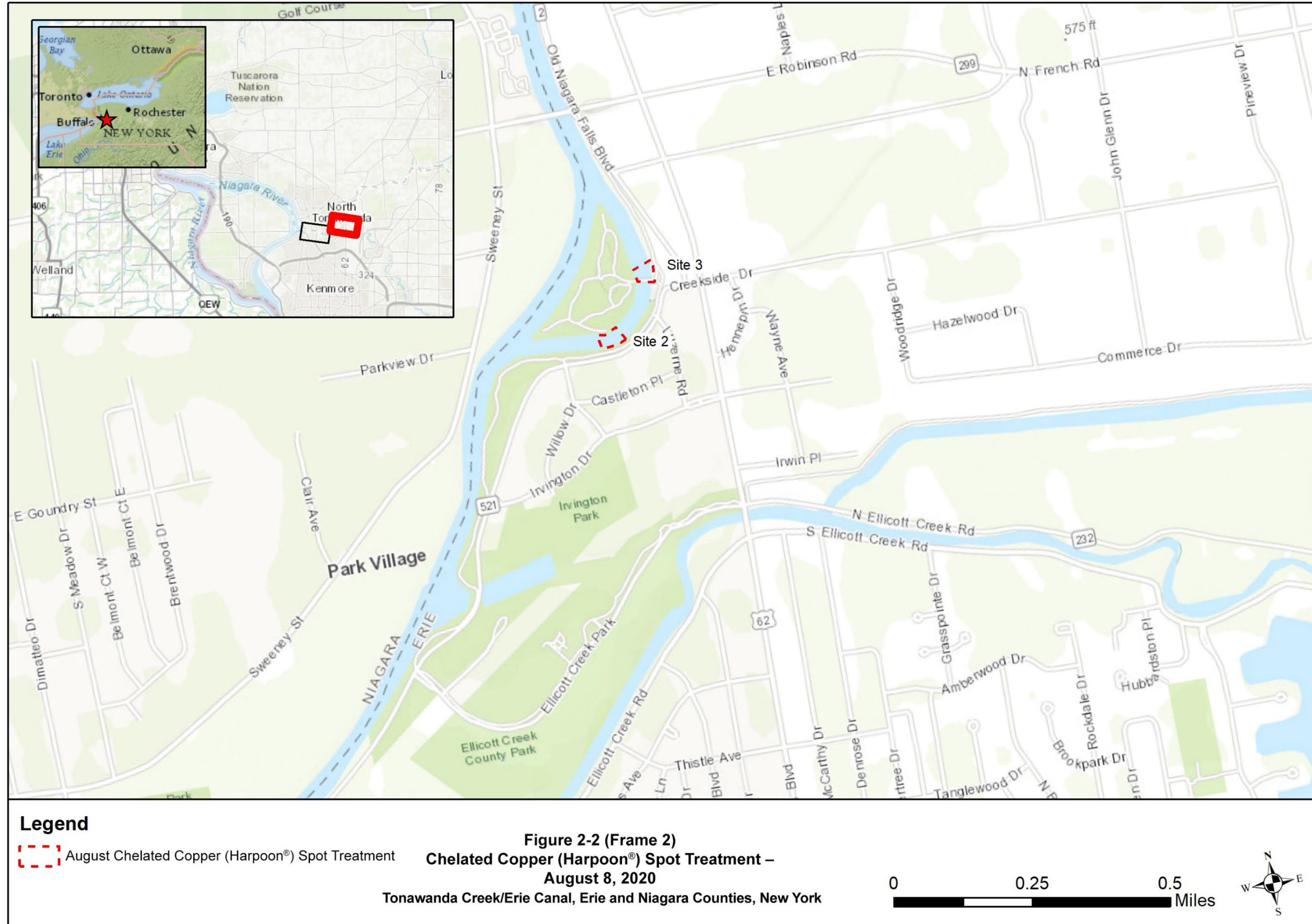


Table 2-2 Herbicide Application Summary, by Canal Treatment Area

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)
7/28/2020	1 – Weatherbest Slip	0.5	1.9	1.5	N/A	N/A	N/A	N/A
	2 – Wardell’s Marina	1.0	4.4	1.5	N/A	N/A	N/A	N/A
	3 – 265 Bridge to Mayors Park	48.9	476.16	1.3	N/A	N/A	N/A	N/A
	4 – Ellicott Creek	0.5	12	5	N/A	N/A	N/A	N/A
	5 – Ellicott Creek Overflow	3.5	10.3	1.5	N/A	N/A	N/A	N/A
	6 – Sawyer Creek to West Canal	15.3	174.65	1.5	N/A	N/A	N/A	N/A
	7 – Campbell Road	19.7	179.1	1.5	N/A	N/A	N/A	N/A
	8 – Bear Ridge Road	8.05	88.7	1.5	N/A	N/A	N/A	N/A
	9 – Wardell’s Boat Hoist	0.1	N/A	5	N/A	N/A	26	5
	10 – Rt 265 Bridge	0.5	N/A	5	N/A	N/A	60	3.5 ¹
	11 – Admirals Walk Boat Slip	0.01	N/A	5	N/A	N/A	2	5
	12 – Bark Park (Ellicott Creek Dog Park)	8.99	77.22	1.5	N/A	N/A	N/A	N/A
	13 – Sawyer Creek	4.3	37.33	3	N/A	N/A	N/A	N/A
	Total	111.35	1,061.76	-	-	-	88	-
7/29/2020	1 – Weatherbest Slip	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	2 – Wardell’s Marina	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	3 – 265 Bridge to Mayors Park	48.9	476.16	1.3	N/A	N/A	N/A	N/A
	4 – Ellicott Creek	0.5	12	5	N/A	N/A	N/A	N/A
	5 – Ellicott Creek Overflow	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	6 – Sawyer Creek to West Canal	15.3	174.	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)
	7 – Campbell Road	19.7	179.1	1.5	N/A	N/A	N/A	N/A
	8 – Bear Ridge Road	8.05	88.7	1.5	N/A	N/A	N/A	N/A
	9 – Wardell’s Boat Hoist	N/A	N/A	N/A	N/A	N/A	26	5
	10 – Rt 265 Bridge	N/A	N/A	N/A	N/A	N/A	60	3.5 ¹
	11 – Admirals Walk Boat Slip	N/A	N/A	N/A	N/A	N/A	2	5
	12 – Bark Park (Ellicott Creek Dog Park)	8.99	77.2	1.5	N/A	N/A	N/A	N/A
	13 – Sawyer Creek	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Total	101.44	1,007.81	-	-	-	88	-
8/28/20	1 – 265 Bridge	2.2	N/A	N/A	1,064.87	1.0	N/A	N/A
	2 – Bark Park Oxbow South Shore	0.7	N/A	N/A	167.51	1.0	N/A	N/A
	3 – Bark Park Oxbow Bridge	0.7	N/A	N/A	167.51	1.0	N/A	N/A
Total Quantity Applied			2,069.27 gallons		1,400 pounds		176 pounds	

Key:
 N/A = not applicable
 ppm = parts per million

Note:
¹ The concentration for Treatment Area 10 was adjusted in the field prior to application. It was originally identified for treatment at a concentration of 5 ppm for a total of 87 pounds of herbicide.

2.5. Herbicide Contact Time and Dispersion for July Treatment

As discussed above, herbicide was applied to pre-determined areas of Tonawanda Creek/Erie Canal and Sawyer Creek on July 28 and 29, 2020. The USACE and E & E performed water sampling after the July 28 and July 29, 2020, applications to determine the endothall (Aquathol® K) concentrations and dispersion of herbicide from the first day of application through July 31, 2020. The USACE performed water sampling on July 28, July 29, and July 30, 2020, and E & E also performed sampling on July 30 and performed sampling on July 31, 2020.

2.5.1. Initial Sampling Results for July – First 48 Hours

The USACE performed endothall (Aquathol® K) concentration sampling between river mile (RM) 0.0 and RM 9.4 of the creek/canal area at varying spatial and temporal intervals on Days 1 and 2 (July 28 and 29, 2020) of treatment and dispersion, as well as on Day 3 (July 30, 2020) (see Table 2-3 and Appendix A Frames 1 through 6). Additionally, two samples were taken within Sawyer Creek (see Appendix A, Frame 4).

The samples were analyzed using an enzyme-linked immunoassay procedure 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 evaluate analytical precision. Each sample run incorporated the use of external standards at concentrations of 0.5 ppm and 1 ppm.

As indicated by the results summarized in Table 2-3 and illustrated in Appendix A, endothall concentrations in the first 48 hours of monitoring were generally less than 1 ppm from the Niagara River upstream to approximately RM 2 in the majority of the area that was directly treated. Exceptions to this were noted near the Weatherbest Slip (HS1), the Route 425 bridge (HS6A), and immediately upstream of RM 2 at the eastern extent of treatment area 3 – 265 Bridge to Mayors Park (HS7A and B), where concentrations were greater than 1 ppm. Reasons for these trends are discussed in Section 2.7, Vegetative Monitoring and Treatment Summary. Monitoring results for areas that were not directly treated between RMs 2 and 3, 6 and 7, and between RMs 10 through 15 evidenced lower endothall concentrations – generally below 1 ppm.

2.5.2. Water Sampling Results Following Flow Resumption in July

As discussed in Section 2.7, flows were managed by the Canal Corp. approximately 24 hours prior to, during the 48-hour application period, and immediately after the application period. On July 27, 2020, at approximately 0830 hours, flow gates were closed within the canal system, and flow was minimized prior to herbicide application to 50 cubic feet per second. Canal Corp. resumed flows on July 30, 2020, around 1400 hours.

As stated above, following the initial sampling effort by the USACE, E & E collected grab samples of water at 1.0-mile intervals along Tonawanda Creek/Erie Canal on July 30 and 31, 2020 (see Table 2-3 for sampling results). These sample locations are illustrated in Appendix A. E & E 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 also 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 Appendix A Frames 1 through 10.

The samples obtained by E & E were collected by hand as grab samples from an approximate depth of 1 foot below the creek/canal surface using a hand-operated peristaltic pump. After each sample was collected, two drops of 31.45 percent 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, a Bad Elf GPS receiver was 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 10 feet. All samples collected by E & E on July 30 and 31, 2020, were shipped on ice to University of Florida (Marci Netherland) for analysis. All samples were analyzed using an enzyme-linked immunoassay procedure specific for endothall (RaPID Assay Endothall Test Kit).

The purpose of E & E'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 July 30, 2020, indicated the presence of endothall (Aquathol® K) generally from RM 0.0 through RM 14.0. Concentrations in this area ranged from 0.18 ppm to 2.05 ppm (see Table 2-3 and Appendix A). On July 31, 2020, sample results indicated that endothall was present from RM 1.0 through RM 15.0. Concentration ranged from 0.09 ppm at RM 15.0 up to 1.52 ppm at RM 2.0. Endothall concentrations were below 1 ppm at all sampled sites with the exceptions of H2B and H10.1 (see Table 2-3 and Appendix A).

The canal is generally an east-west feature, but in 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 July 2020, the western end of the treatment area between river mile 0 (H00) and river mile 2 (H2B) and water sampling points HS1-H7 (A and B) showed there were fluctuations in herbicide residues following the treatment. This 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 sampling points HS1-H7 (A and B). 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 H8A and H8B and ending with site H15C, it was concluded 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 Canal/Creek Water Sample Results for July 2020

River Mile	Location ID ³	Endothall (Aquathol [®] K) Concentrations in ppm ¹								
		Sampling Dates ²								
		7/28/20 First USACE Sample (afternoon - 2 HAT)	7/28/20 Second USACE Sample (afternoon - 4 HAT)	7/29/20 First USACE Sample (morning - 22 HAT)	7/29/20 Second USACE Sample (early afternoon - 25 HAT)	7/29/20 Third USACE Sample (afternoon - 27 HAT)	7/29/20 Fourth USACE Sample (afternoon - 29 HAT)	7/30/20 USACE Sample (morning - 48 HAT)	7/30/20 E & E Sample (afternoon)	7/31/20 E & E Sample (afternoon)
0	H00								0.82	ND
0.01	HS1	4.29	3.51	0.56	0.36	1.06	1.15	0.18		
0.1	HS2	ND	0.14	0.91	0.35	0.54		0.22		
0.15	HS3	1.61	0.32	0.12	ND	0.27	1.01	0.29		
0.15	HS4	ND	ND	ND	0.10	ND	0.15	0.39		
0.3	HS5A	0.97	0.55	ND	1.45	0.54	0.39	1.19		
0.3	HS5B	0.76	0.82	ND	0.92	0.31	0.54	1.02		
1	H1A								2.05	0.97
1.1	H6A	2.81	1.76	0.37	1.19	2.03	1.79	1.82		
	H6B	1.07	1.53	0.38	0.6	0.81	0.68	1.76		
2	H2B								0.66	1.52/1.35*
2.01	H7A	2.95	2.31	0.71	1.28	2.25	1.58	1.06		
	H7B	1.5	1.01	0.57	2.05	1.61	1.89	0.92		
2.8 ⁴	H2.8								0.60	0.89
2.9	H8A	0.13	0.5	0.70	0.58	0.66	0.81	0.92		
2.9	H8B	0.11	0.5	0.63	0.59	0.71	0.81	0.83		
3	H3C								0.69	0.85
3.5 ⁴	H3.5								0.50	0.62

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River Mile	Endothall (Aquathol® K) Concentrations in ppm ¹										
	Location ID ³	Sampling Dates ²								7/30/20 E & E Sample (afternoon)	7/31/20 E & E Sample (afternoon)
		7/28/20 First USACE Sample (afternoon - 2 HAT)	7/28/20 Second USACE Sample (afternoon - 4 HAT)	7/29/20 First USACE Sample (morning - 22 HAT)	7/29/20 Second USACE Sample (early afternoon - 25 HAT)	7/29/20 Third USACE Sample (afternoon - 27 HAT)	7/29/20 Fourth USACE Sample (afternoon - 29 HAT)	7/30/20 USACE Sample (morning - 48 HAT)			
3.7	H9A	1.34	0.72	0.94	2.81	2.01	1.07	0.87			
	H9B	1.47	1.41	0.19	0.94	0.98	0.64	0.80			
4	H4A								0.39	0.66	
4.6	H10A	0.84	0.48	0.12	2.13	0.47		0.78			
	H10B	0.47	0.35	0.12	0.73	0.91		0.70			
N/A – Sawyer Creek	HS11	2.63	0.5	0.5	1.58	2.02		1.21			
N/A – Sawyer Creek	HS12	4.23	hi	2.85	2.81	3.49		2.42			
5	H5B								0.79	0.63	
5.01	H13A	0.68	0.67	0.44	1.57	2.39		1.23			
	H13B	0.41	0.26	0.47	3.82	3.14		1.24			
6	H6C								0.32/0.40*	0.50	
6.3 ⁴	H6.3								0.33	0.37	
7	H7A								0.56	0.65	
7.5	H14A	0.50	0.14	ND	2.61	2.47		0.93			
	H14B	0.64	0.24	ND	3.88	1.61		0.75			
8	H8B								0.75	0.50	
9	H9C								0.51	0.37/0.32*	

Final Tonawanda Creek/Erie Canal Post-Treatment Assessment Report 2020

River Mile	Endothall (Aquathol® K) Concentrations in ppm ¹										
	Location ID ³	Sampling Dates ²								7/30/20 E & E Sample (afternoon)	7/31/20 E & E Sample (afternoon)
		7/28/20 First USACE Sample (afternoon - 2 HAT)	7/28/20 Second USACE Sample (afternoon - 4 HAT)	7/29/20 First USACE Sample (morning - 22 HAT)	7/29/20 Second USACE Sample (early afternoon - 25 HAT)	7/29/20 Third USACE Sample (afternoon - 27 HAT)	7/29/20 Fourth USACE Sample (afternoon - 29 HAT)	7/30/20 USACE Sample (morning - 48 HAT)			
9.4	H15A	1.84	0.43	0.23	3.60	3.26		1.37			
	H15B	1.48	0.87	0.17	4.30	3.48		1.18			
10	H10A								1.05	0.80	
10.1 ⁴	H10.1								0.69	1.03	
11	H11B								0.43	0.62	
12	H12C								0.57	0.54	
13	H13A								0.21	0.35	
14	H14B								0.18	0.15	
15	H15C								ND/ND*	0.09	

*Denotes duplicate sample taken.

¹ Endothall results were provided by the USACE for all samples.

² Application occurred on July 28 and 29, 2020. Samples collected by the USACE occurred on July 28 through July 30, 2020. E & E collected samples on July 30 and 31, 2020.

³ Location IDs were assigned by the USACE or E & E. Numbers indicate river mile of location and letters indicate location within creek/canal. Note: E & E sample nomenclature includes the nomenclature assigned by the USACE for consistency and ease of data presentation.

⁴ Side channel samples.

Key:

A = north/west side of creek/canal

B = south/east side of creek/canal

C = center of creek/canal

ND = non-detect

Blank cell = no sample collected

Bold text = samples taken within the main treatment areas

HAT = hours after treatment

2.6. Flow Management

Flow monitoring using flow meters positioned at various locations in the canal was not conducted in 2020. However, flow management actions taken by Canal Corp. were an integral component of the Project again in 2020.

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 (RG&E) Power Plant at Station 26 on the Genesee River off-line.

Prior to the 48-hour treatment period on July 28 and 29, 2020, Canal Corp. reduced flows out of Lockport by closing the bypass gate opening at approximately 0830 hours on July 27, 2020. Canal Corp. minimized lock operations, which continued during the treatment period. Typically, when Locks 34/35 are filled, this causes a short-term increase in flow rate towards the locks at the Stevens Street Bridge (east) and a drop in water level. The bypass gate was reopened at approximately 1400 hours on July 30, 2020.

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

2.7. Vegetative Monitoring and Treatment Summary

The USACE conducted point intercept surveys on four dates throughout the growing season to determine Hydrilla distribution. Hydrilla distribution on each of those dates is illustrated on Figure 2-3 Frames 1 through 5.

Based on that monitoring, the efficacy of the first treatment from the Niagara River to the Bark Park on July 28, 2020, was lower than anticipated. In the large treatment plot (Treatment Area 3 - 265 Bridge to Mayors Park), the only areas where the residues showed the necessary concentration exposure time (CET) for effective control (for either Aquathol® K or Super K) were sites H6A and H7 A&B. The issues noted within this treatment reach as contributing to lower efficacy were the high wind conditions on the first day of treatment and the flows from Ellicott Creek moving the herbicide around after it was applied to the treatment area. The wind direction and herbicide residues showed that the herbicide was pushed to the east faster than anticipated.

The eastern portion of the study area from approximately the Bark Park to the confluence of the Erie Canal and Tonawanda Creek were effectively treated even though the monitoring for herbicide residues does not indicate the CET for effective control was achieved for the first day of treatment (with the exception of Sawyer Creek). On the second day of treatment, the wind conditions were more optimal for an effective treatment. The water sample residue results collected after that second day of treatment showed high efficacy, likely due to the slower wind speeds and, therefore, lower flows within the canal.

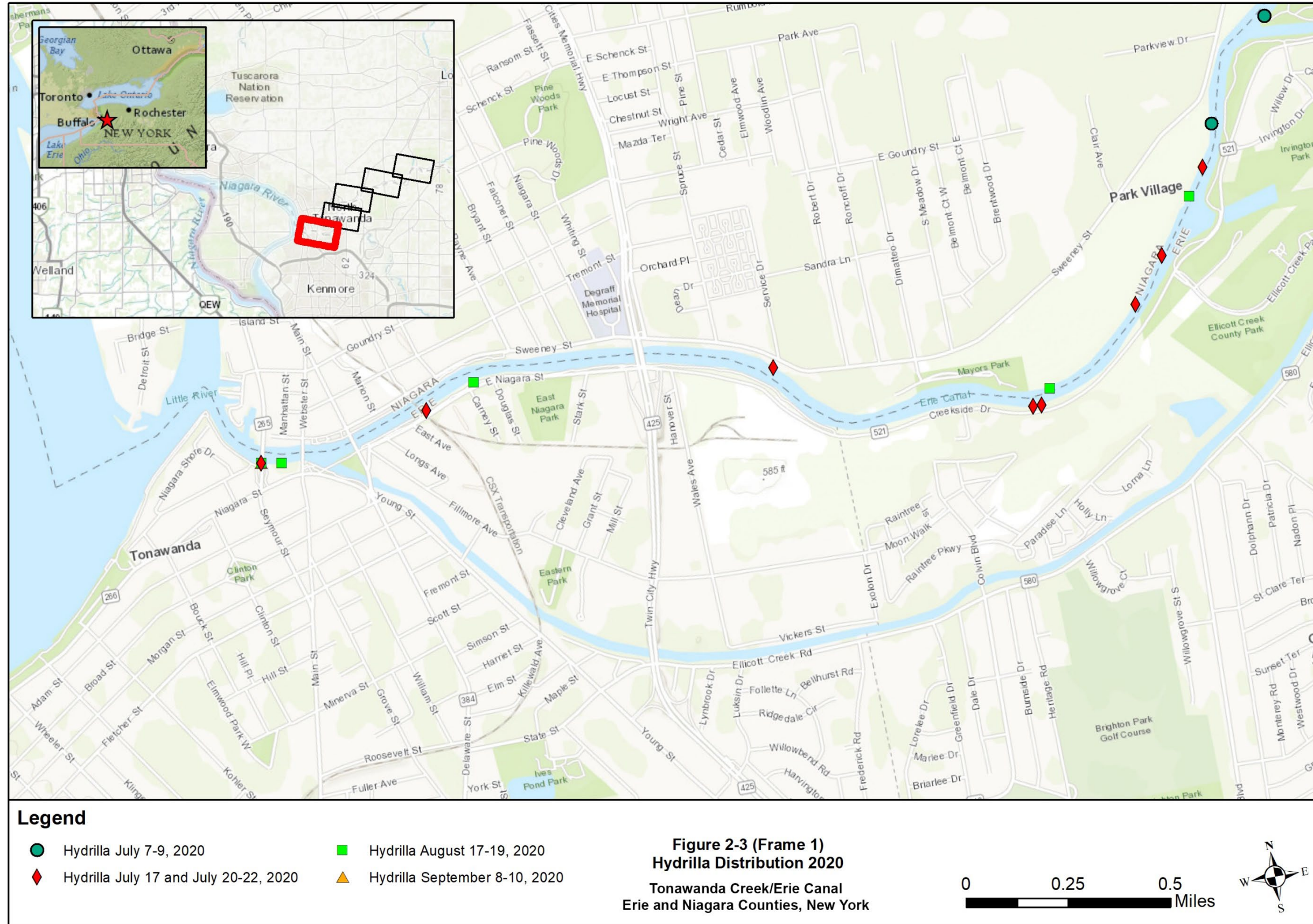
The weather conditions on the first treatment day were not ideal for the herbicide to stay in place to achieve the necessary exposure time. There was a strong west/southwest wind that began mid-morning and pushed the herbicide away from the river to the east. The sites within Sawyer Creek were the only locations that benefitted from the eastward movement of the herbicide. The wind conditions pushed the water, and by association, herbicide, up the creek and held it there for longer periods of time than the other treatment areas within the Erie Canal/Tonawanda Creek. As noted above, the second day of treatment had lower

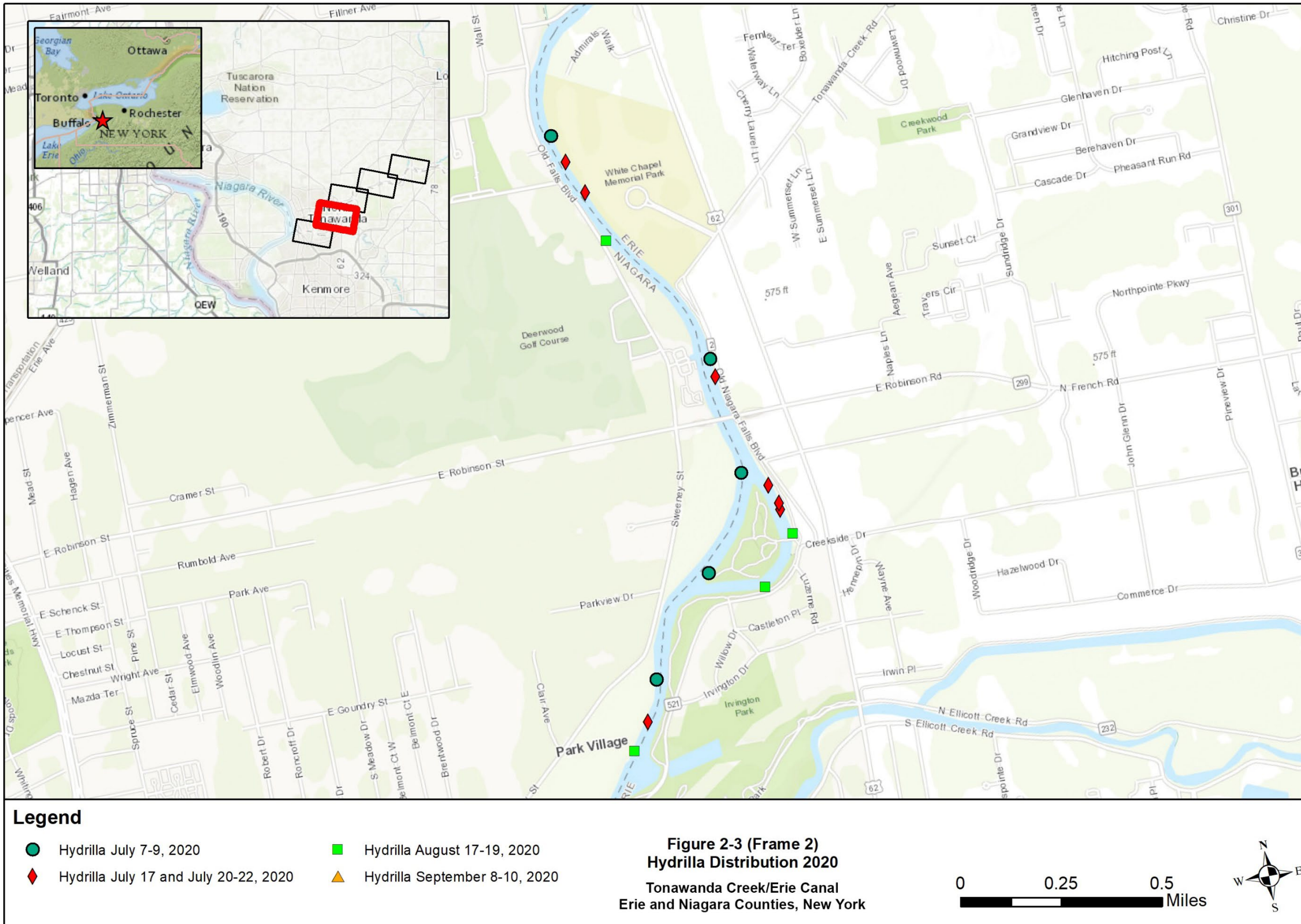
wind speeds and lower flows within the treatment areas. These conditions led to a more effective second treatment on July 29, 2020.

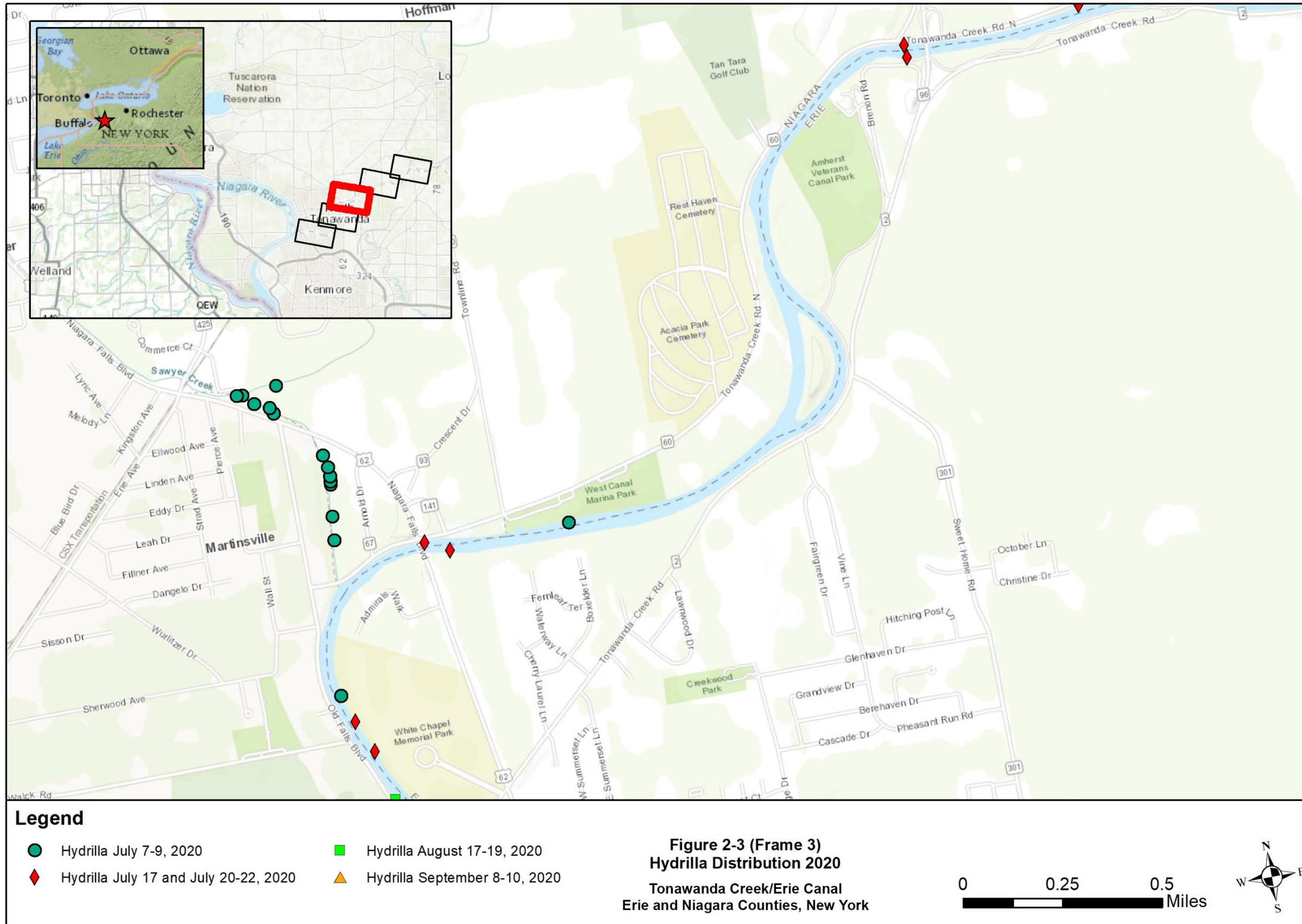
After the July treatment there were eight separate locations where Hydrilla was found during the post-treatment point intercept survey on July 17 and July 20 through 22: Wardell's Marina boat hoist, under the 265 Bridge, four sites between the 265 Bridge Bark Park, two within the Bark Park oxbow, and one halfway between Bark Park and Sawyer Creek (see Figure 2-3 Frames 1 through 3). Four of these eight locations – the two points near the 265 Bridge and the two points within the Bark Park oxbow – were spot treated with chelated copper (Harpoon®) at 1 ppm (approximately 1,400 pounds) on August 28, 2020. The other four documented Hydrilla locations that were not directly treated were in areas where there was confidence in the efficacy of the July treatment. No Hydrilla was found at these four untreated sites during the September 8 through 10, 2020, point intercept survey.

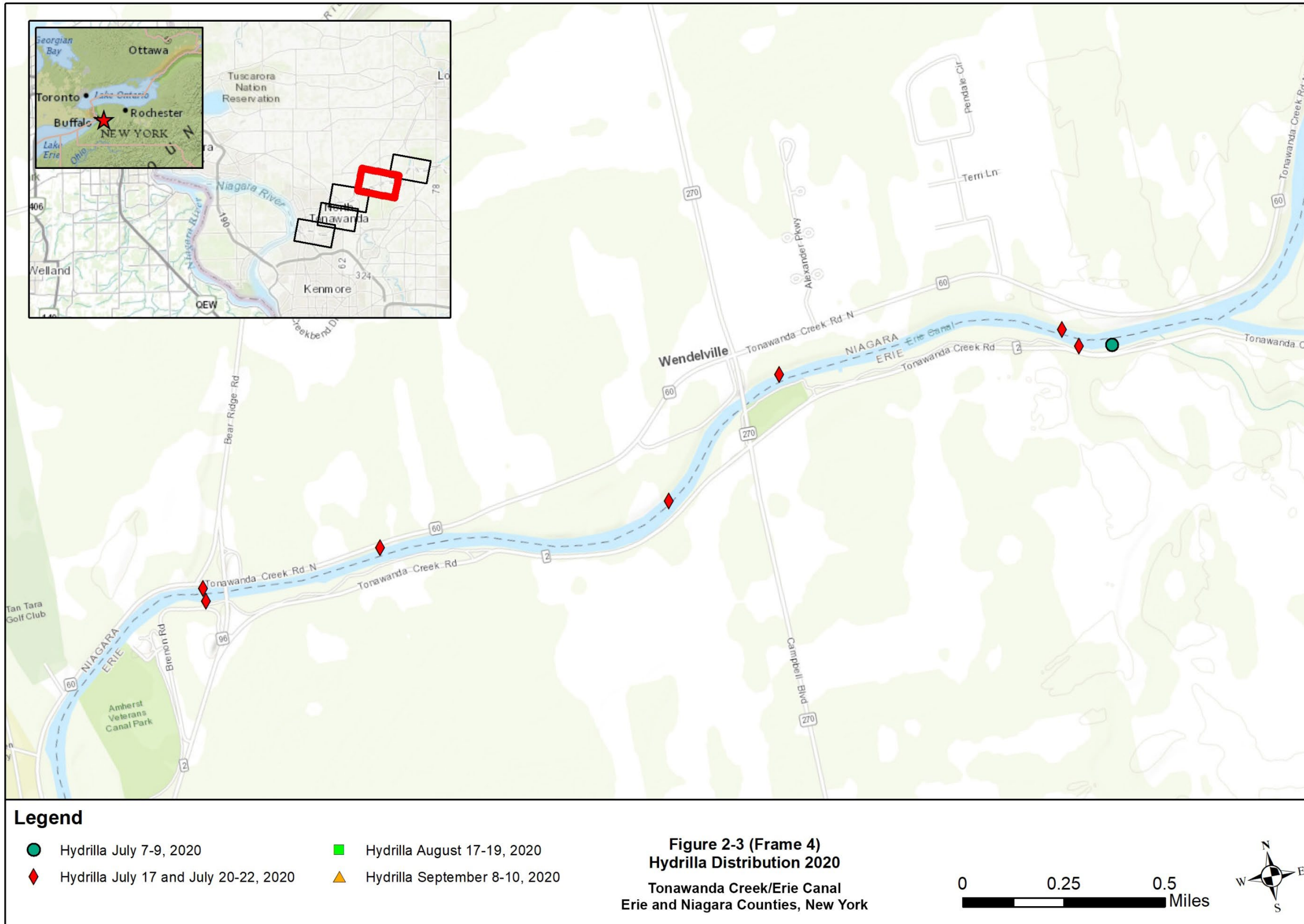
The final survey the first week of September only noted one occurrence of Hydrilla. This was the area underneath the 265 Bridge (see Figure 2-3, Frame 1). While it was noted as being moderately dense, the chelated copper spot treatment was effective and the Hydrilla plants were severely damaged from the treatment.

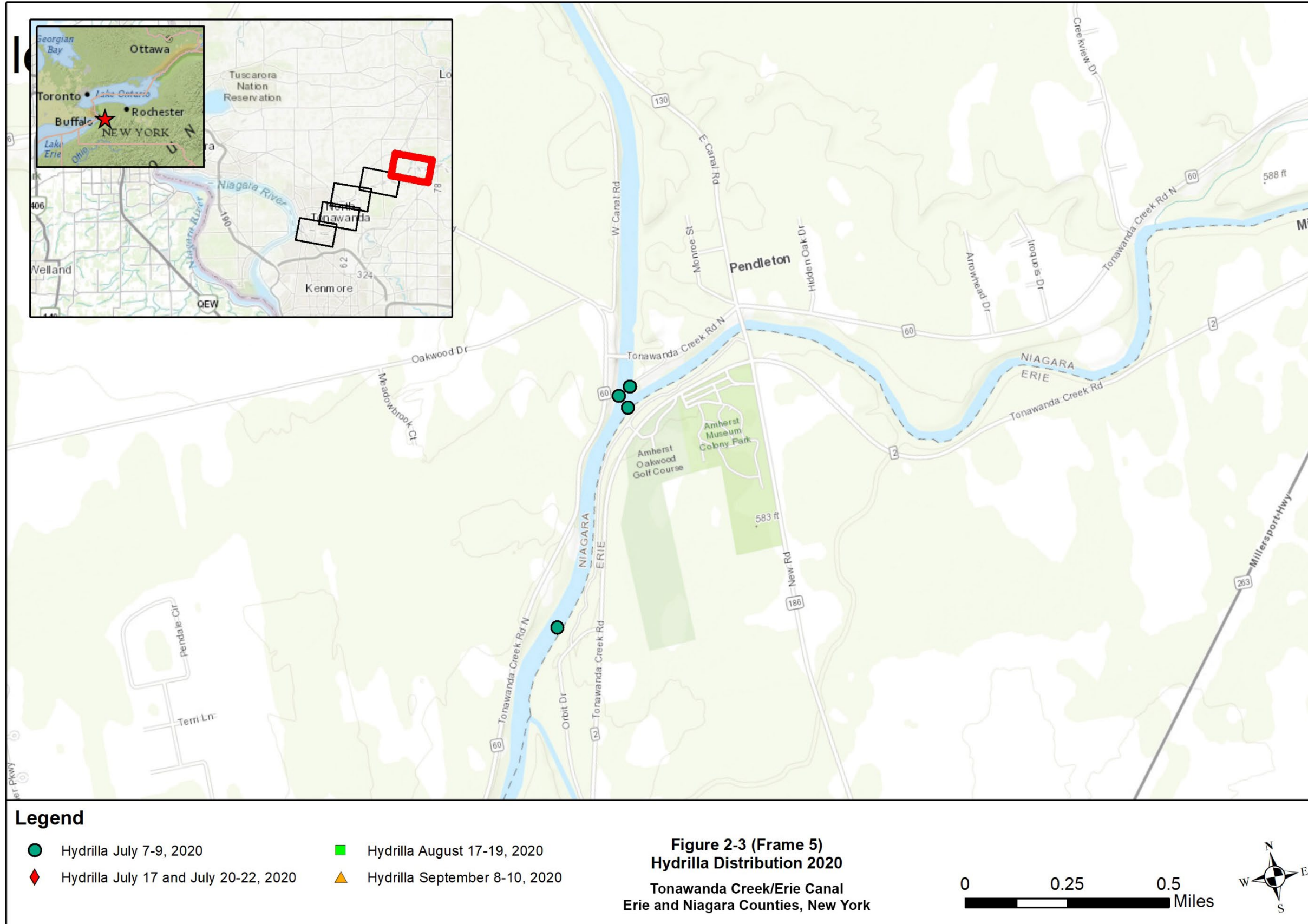
As noted above with the July treatment, the high winds and flushing coming from Ellicott Creek were likely the reason for the less effective treatment closer to the Niagara River. It is important to note that there was an overall reduction of Hydrilla locations from 2019 to 2020. During the 2019 treatment season, Hydrilla plants were noted at 62 discrete points during the four surveys. There were 13 sites that noted Hydrilla during multiple survey events. Alternatively, in 2020, only 42 discrete points were noted with an occurrence of Hydrilla, and Hydrilla was noted at only one site during multiple survey events. Note that in 2020 the survey area increased to include Sawyer Creek. Thirteen additional Hydrilla occurrence sites were identified within Sawyer Creek during the July 7 through 9, 2020, survey event; however, given the efficacy within Sawyer Creek during the treatment, no Hydrilla was noted during subsequent surveys.











3. STUDY IMPROVEMENTS

The study improvements, summarized in this section, were based on lessons learned from previous years' of herbicide application efforts, coordination with the study partners during the 2020 treatment season, and activities conducted during the 2020 herbicide application.

3.1. Herbicide Application and Analysis

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

The immunoassay tests performed to determine endothall concentrations during the 2020 application were effective at detecting the herbicide and for tracking its movement and degradation.

3.2. 2020 Lessons Learned

Treatment Areas

In the 2019 Post-Treatment Assessment Report, one recommendation was to establish a minimum treatment plot size to ensure efficacy. This recommendation was implemented in 2020, with two exceptions, the Wardell's Boat Hoist and Admirals Walk Boat Slip, where areas requiring treatment were small given their location off of the main channel.

As more spot treatment areas will likely be involved in future work, these areas are likely to be added to the treatment plan and modified according to the USACE monitoring work prior to application. Addition or modification of treatment areas should be finalized at least 48 hours in advance of application to ensure that the applicator is prepared with correct herbicide quantities and mapping to ensure accurate herbicide placement.

Communication

Communication in 2020 was efficient and effective through the use of conference calls and email updates. No changes to frequency or methods of communications are recommended for 2021. 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). 2020. *Performance Work Statement Aquatic Plant Control ERDC Demonstration Project Tonawanda Creek/Erie Canal, Tonawanda, NY*. May 5, 2020.

A. WATER QUALITY SAMPLING LOCATION MAPS

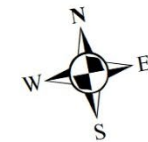
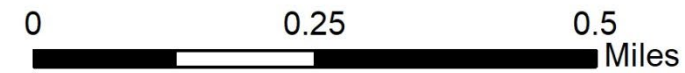


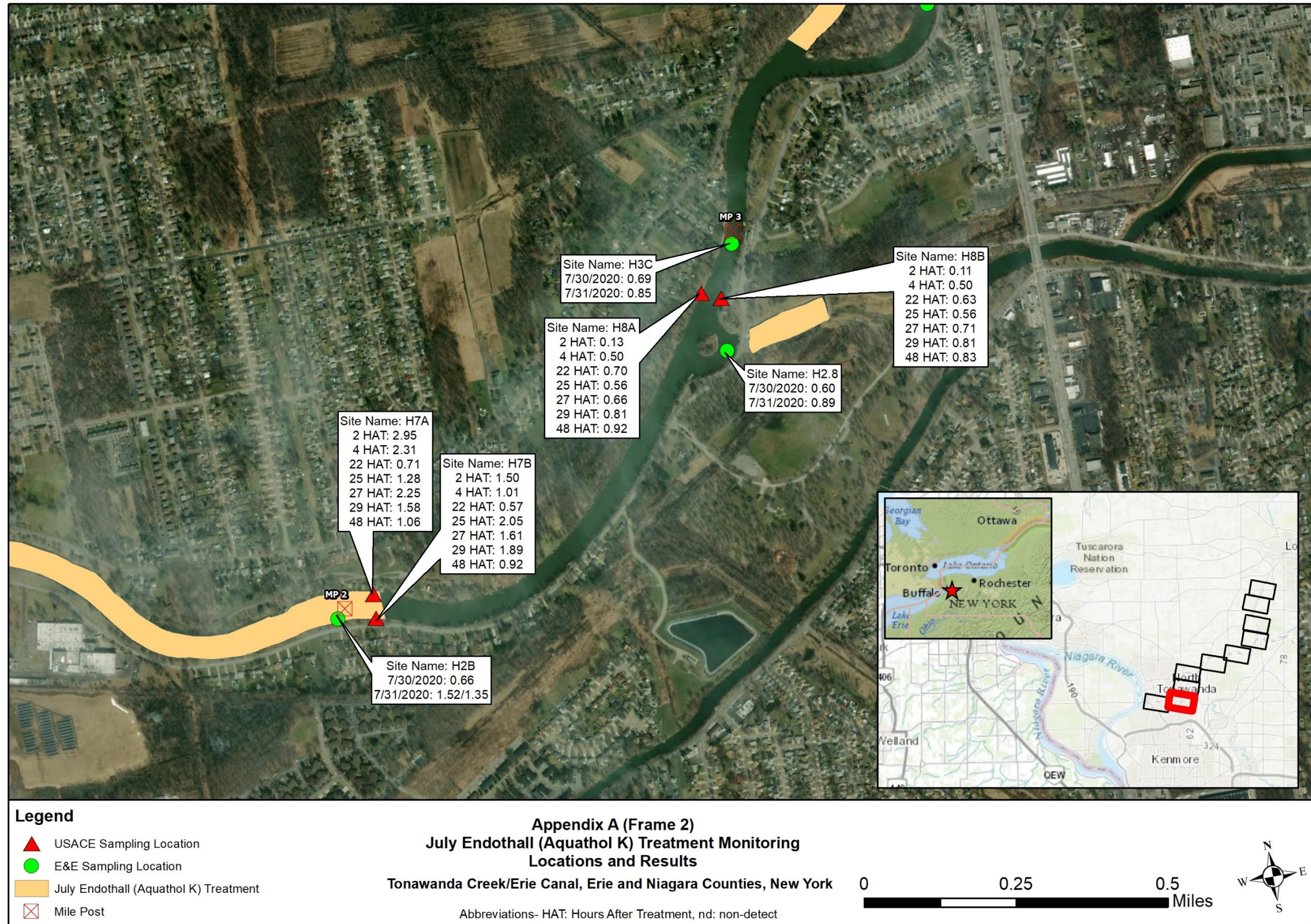
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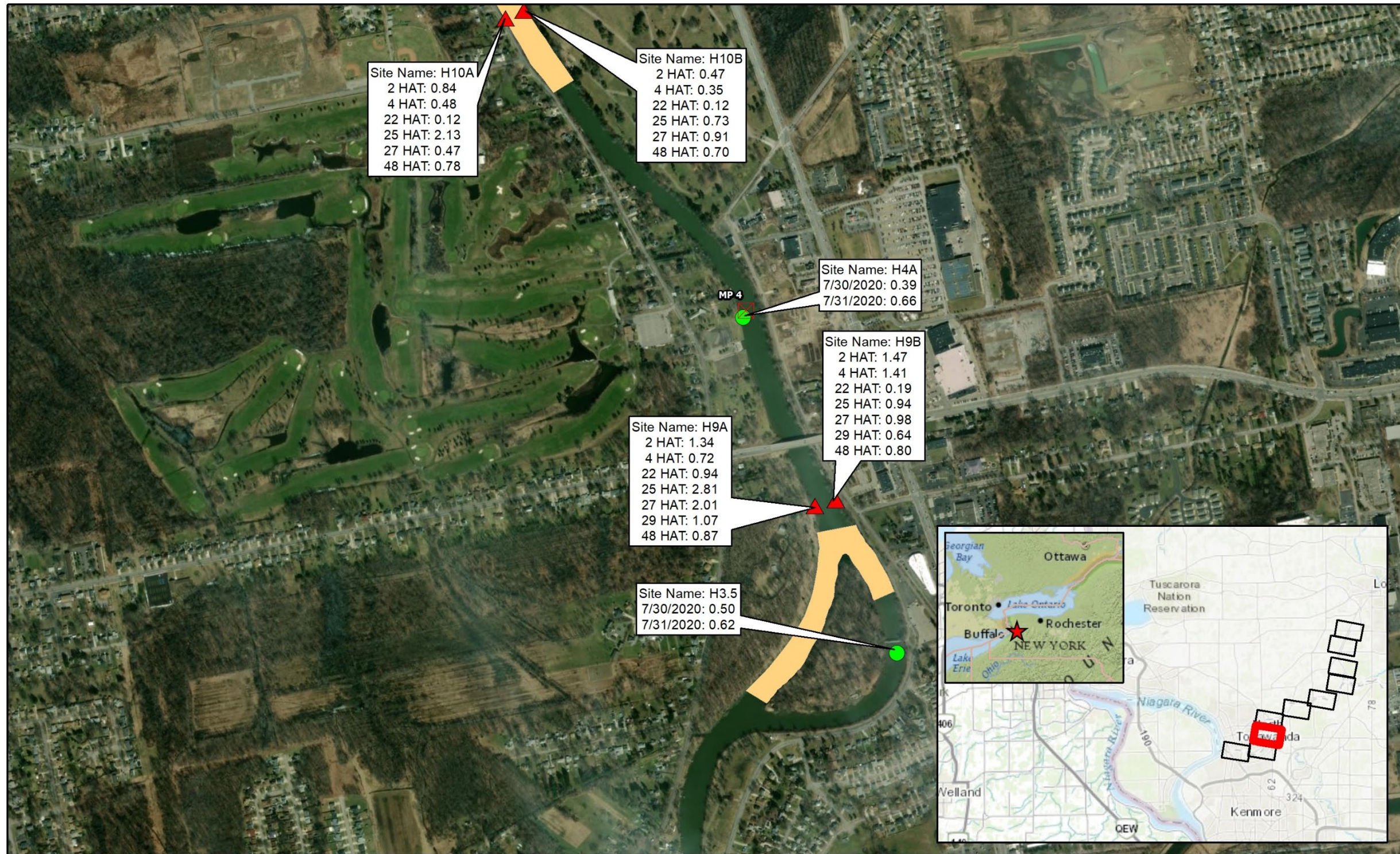
- ▲ USACE Sampling Location
- E&E Sampling Location
- July Endothall (Aquathol K) Treatment
- X Mile Post

Appendix A (Frame 1)
July Endothall (Aquathol K) Treatment Monitoring
Locations and Results
 Tonawanda Creek/Erie Canal, Erie and Niagara Counties, New York

Abbreviations- HAT: Hours After Treatment, nd: non-detect







Site Name: H10A
 2 HAT: 0.84
 4 HAT: 0.48
 22 HAT: 0.12
 25 HAT: 2.13
 27 HAT: 0.47
 48 HAT: 0.78

Site Name: H10B
 2 HAT: 0.47
 4 HAT: 0.35
 22 HAT: 0.12
 25 HAT: 0.73
 27 HAT: 0.91
 48 HAT: 0.70

Site Name: H4A
 7/30/2020: 0.39
 7/31/2020: 0.66

Site Name: H9B
 2 HAT: 1.47
 4 HAT: 1.41
 22 HAT: 0.19
 25 HAT: 0.94
 27 HAT: 0.98
 29 HAT: 0.64
 48 HAT: 0.80

Site Name: H9A
 2 HAT: 1.34
 4 HAT: 0.72
 22 HAT: 0.94
 25 HAT: 2.81
 27 HAT: 2.01
 29 HAT: 1.07
 48 HAT: 0.87

Site Name: H3.5
 7/30/2020: 0.50
 7/31/2020: 0.62

Legend

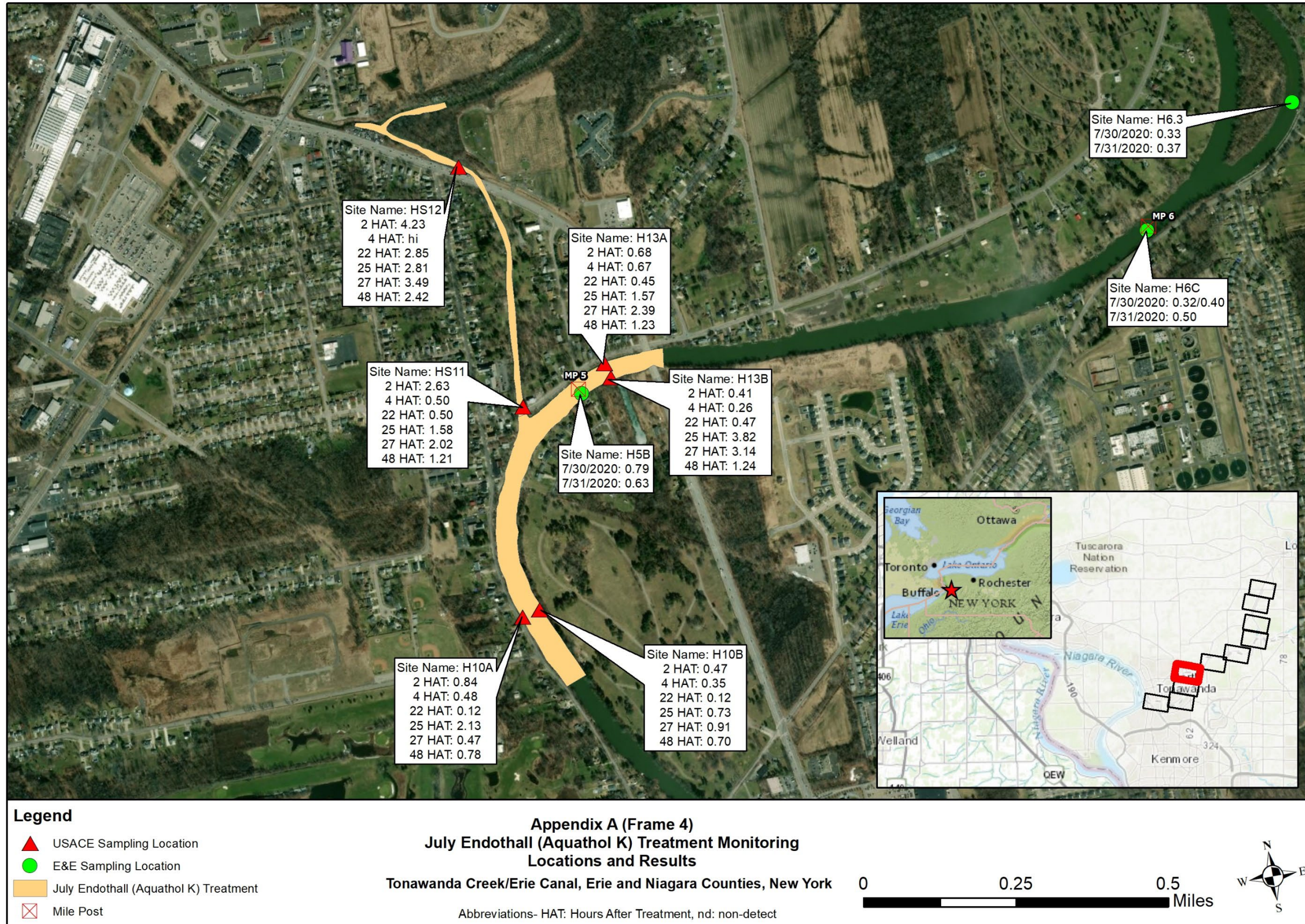
- ▲ USACE Sampling Location
- E&E Sampling Location
- July Endothall (Aquathol K) Treatment
- Mile Post

**Appendix A (Frame 3)
 July Endothall (Aquathol K) Treatment Monitoring
 Locations and Results**

Tonawanda Creek/Erie Canal, Erie and Niagara Counties, New York

Abbreviations- HAT: Hours After Treatment, nd: non-detect





Site Name: HS12
 2 HAT: 4.23
 4 HAT: hi
 22 HAT: 2.85
 25 HAT: 2.81
 27 HAT: 3.49
 48 HAT: 2.42

Site Name: H13A
 2 HAT: 0.68
 4 HAT: 0.67
 22 HAT: 0.45
 25 HAT: 1.57
 27 HAT: 2.39
 48 HAT: 1.23

Site Name: H6.3
 7/30/2020: 0.33
 7/31/2020: 0.37

Site Name: H6C
 7/30/2020: 0.32/0.40
 7/31/2020: 0.50

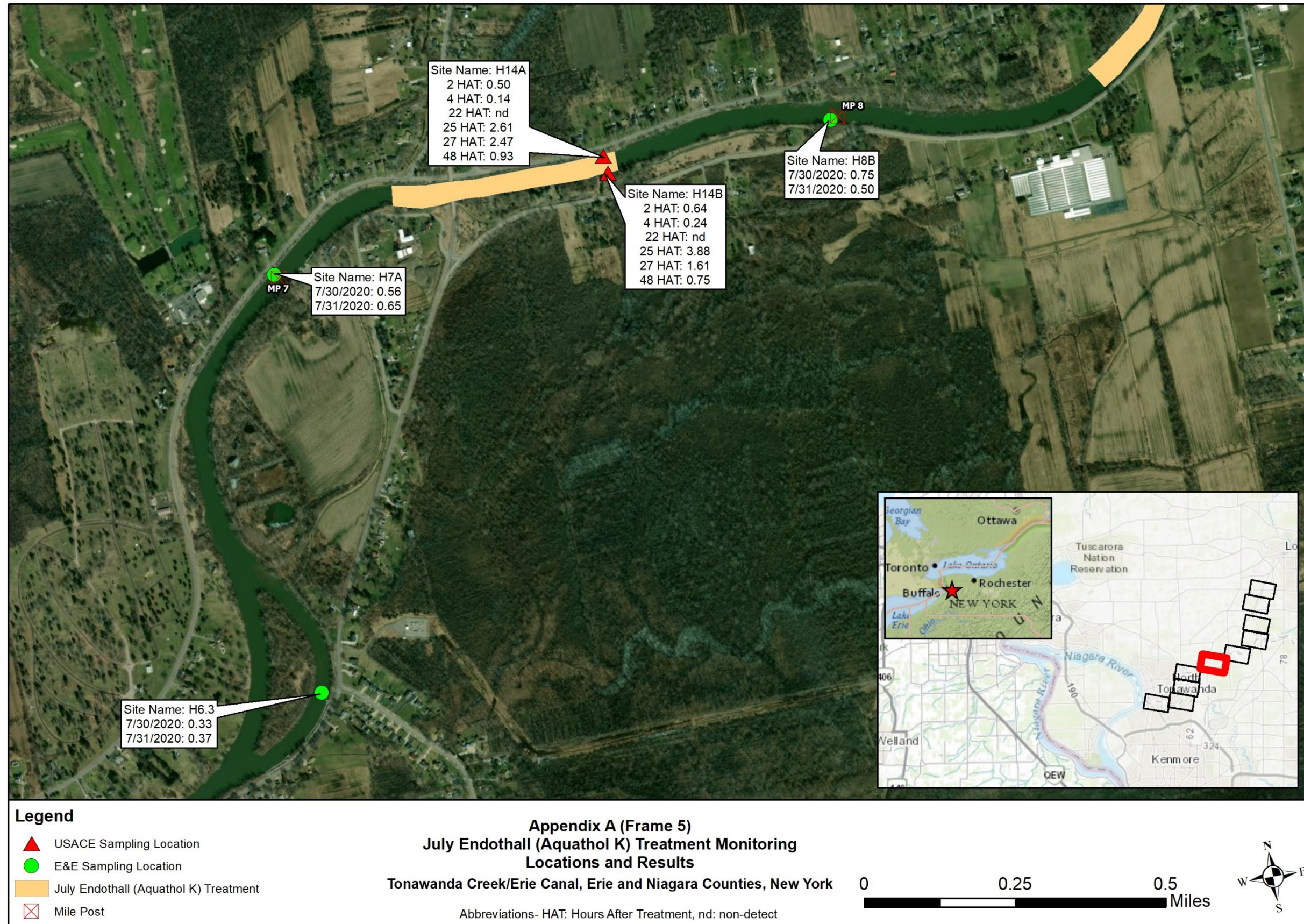
Site Name: HS11
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 4 HAT: 0.50
 22 HAT: 0.50
 25 HAT: 1.58
 27 HAT: 2.02
 48 HAT: 1.21

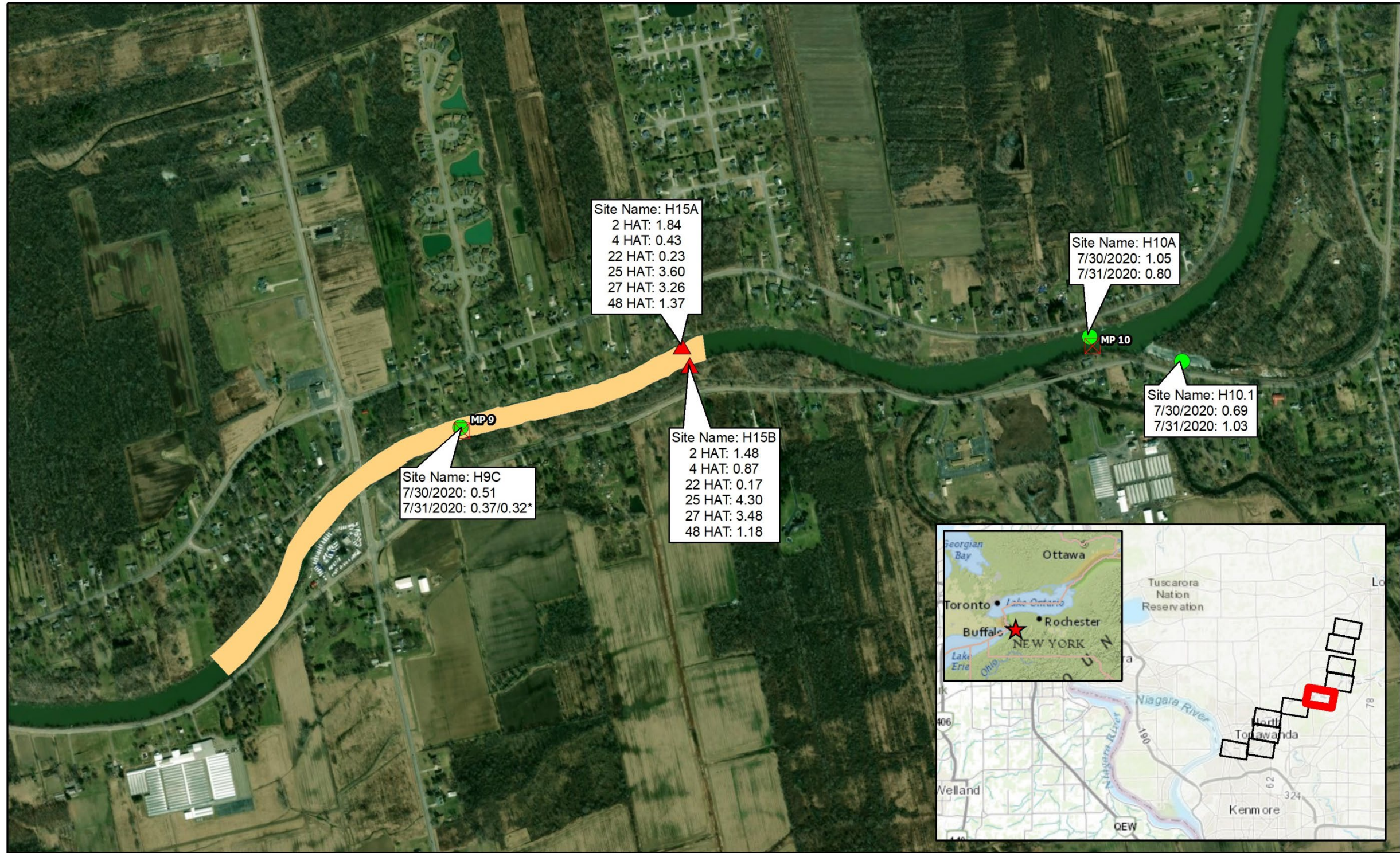
Site Name: H5B
 7/30/2020: 0.79
 7/31/2020: 0.63

Site Name: H13B
 2 HAT: 0.41
 4 HAT: 0.26
 22 HAT: 0.47
 25 HAT: 3.82
 27 HAT: 3.14
 48 HAT: 1.24

Site Name: H10A
 2 HAT: 0.84
 4 HAT: 0.48
 22 HAT: 0.12
 25 HAT: 2.13
 27 HAT: 0.47
 48 HAT: 0.78

Site Name: H10B
 2 HAT: 0.47
 4 HAT: 0.35
 22 HAT: 0.12
 25 HAT: 0.73
 27 HAT: 0.91
 48 HAT: 0.70



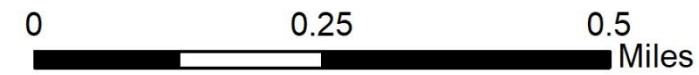


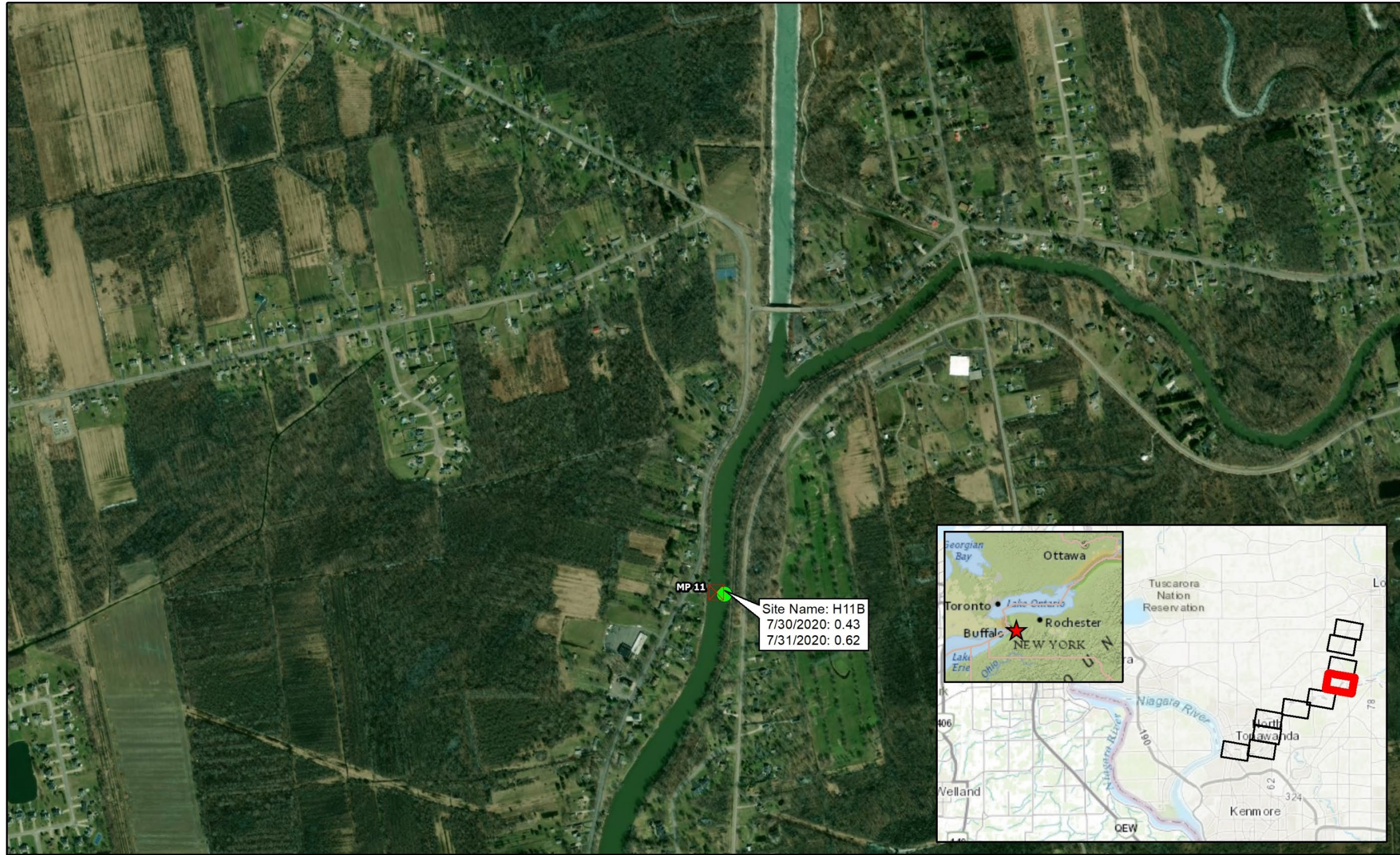
Legend

- ▲ USACE Sampling Location
- E&E Sampling Location
- July Endothall (Aquathol K) Treatment
- X Mile Post

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

Abbreviations- HAT: Hours After Treatment, nd: non-detect





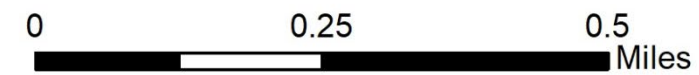
Site Name: H11B
 7/30/2020: 0.43
 7/31/2020: 0.62

Legend

- ▲ USACE Sampling Location
- E&E Sampling Location
- July Endothall (Aquathol K) Treatment
- X Mile Post

Appendix A (Frame 7)
July Endothall (Aquathol K) Treatment Monitoring
Locations and Results
 Tonawanda Creek/Erie Canal, Erie and Niagara Counties, New York

Abbreviations- HAT: Hours After Treatment, nd: non-detect



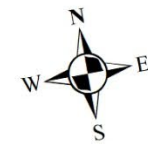
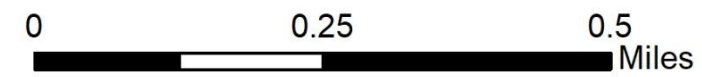


Legend

- ▲ USACE Sampling Location
- E&E Sampling Location
- July Endothall (Aquathol K) Treatment
- X Mile Post

Appendix A (Frame 8)
July Endothall (Aquathol K) Treatment Monitoring
Locations and Results
 Tonawanda Creek/Erie Canal, Erie and Niagara Counties, New York

Abbreviations- HAT: Hours After Treatment, nd: non-detect



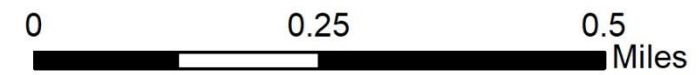


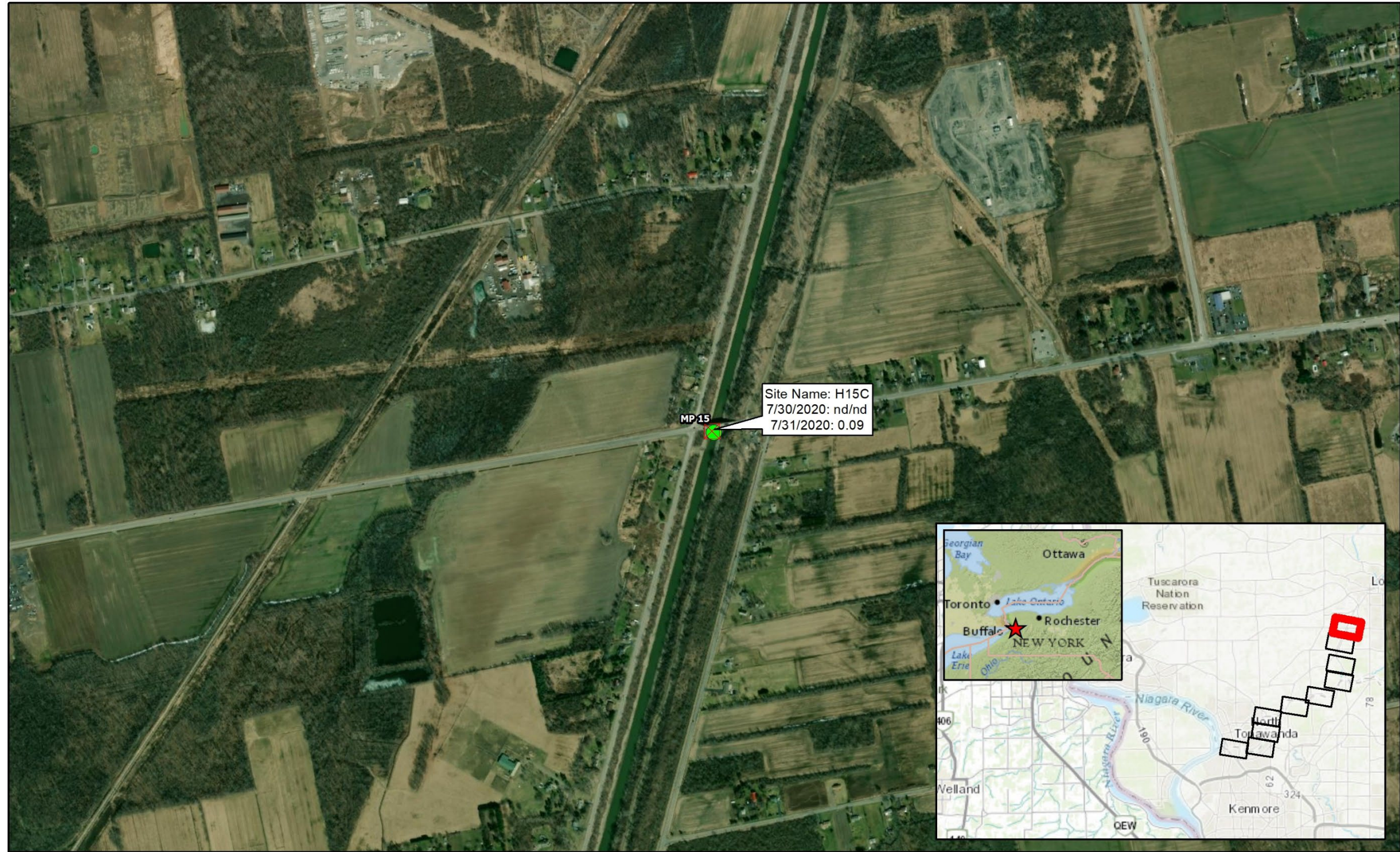
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- ▲ USACE Sampling Location
- E&E Sampling Location
- July Endothall (Aquathol K) Treatment
- X Mile Post

Appendix A (Frame 9)
July Endothall (Aquathol K) Treatment Monitoring
Locations and Results
Tonawanda Creek/Erie Canal, Erie and Niagara Counties, New York

Abbreviations- HAT: Hours After Treatment, nd: non-detect





Legend

- ▲ USACE Sampling Location
- E&E Sampling Location
- July Endothall (Aquathol K) Treatment
- X Mile Post

Appendix A (Frame 10)
July Endothall (Aquathol K) Treatment Monitoring
Locations and Results
 Tonawanda Creek/Erie Canal, Erie and Niagara Counties, New York

Abbreviations- HAT: Hours After Treatment, nd: non-detect

