Evaluating Aquatic Connectivity Opportunities at Aurora Pond

Udall's Cove Park Preserve, Queens, NY

Water Quality Monitoring Report

2021

By: Forestry, Horticulture, and Natural Resources

December 31, 2021

NYC Parks

City of New York
Parks & Recreation
Bill de Blasio, Mayor
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1.0 Introduction

The Seatuck Environmental Association (Seatuck) received funding from the Long Island Sound Stewardship Fund Competitive Grants Program to evaluate the aquatic connectivity of Gabler's Creek and wildlife passage into Aurora Pond (the “Project”) in northeastern Queens. The goals of the Project are to 1) determine the extent to which, if any, river herring and/or river otters are already using parts of Gabler’s Creek, 2) conduct detailed assessments of barriers to wildlife movement, and 3) monitor water quality in the creek and pond to determine if there are any factors that would inhibit wildlife restoration.

Based on the results of these investigations, a plan will be developed for improving connectivity and restoring native wildlife populations in the creek and pond. This plan will include recommendations for addressing water quality problems and wildlife passage restrictions and a conceptual design for fish passage at Aurora Pond. The findings, recommendations, and conceptual design will be incorporated into a final report, which will set the stage for advancing the full connectivity of Aurora Pond, the restoration of river herring, river otters, and other wildlife, and the improvement of the overall ecological health of Gabler’s Creek and Udall's Cove.

To support the development of this plan, the New York City Department of Parks and Recreation (NYC Parks) Natural Resources Group (NRG) performed water quality monitoring at Aurora Pond in 2021. This water quality report provides a summary of monitoring results and recommendations for improving water quality to support wildlife, namely alewife (*Alosa pseudoharengus*).

2.0 Site Background

Gabler's Creek is a small coastal stream that originates on the northern slopes of Long Island's glacial moraine in northwest Queens, New York. Draining a narrow watershed in the community of Douglaston, it flows north through a steep wooded ravine for several thousand feet before terminating in Long Island Sound’s Little Neck Bay. Much of the creek runs through a protected corridor, including the New York State Department of Conservation’s Udall’s Cove and Ravine Natural Area. Before it reaches Long Island Sound, Gabler's Creek passes through Aurora Pond, a one-acre freshwater pond at Udall’s Cove Park Preserve. Aurora Pond and Udall’s Cove Park Preserve are city parkland under management of NYC Parks.

Directly upstream of Aurora Pond, Gabler’s Creek flows northeast along 40th Avenue before abruptly turning north and flowing through a culvert under the Long Island Rail Road tracks. After flowing under the railroad tracks and through Aurora Pond, Gabler's Creek passes through a small weir that controls the pond’s water levels, then passes through a culvert under Sandhill Road, a two-lane roadway north of the pond. The weir is not fully passable to aquatic organisms and the Sandhill Road culvert is undersized and not designed for wildlife passage; the structures combine to restrict the ability of fish and other aquatic organisms to move up or down the creek.

Current water depths of the pond range from one to four feet, with the deepest area near the weir at the northeast outlet of the pond. Within the Project site, Gabler’s Creek is a channelized, low gradient stream with low flow and a width of approximately five feet. The stone masonry walls of the stream are approximately six to eight feet tall and were constructed in 2006 as part of a NYC Parks restoration project. Gabler’s Creek is primarily driven by stormwater runoff mixed with some overland flow. There are no known city water inputs into the pond or creek. The pond and creek are bordered by several vegetated freshwater wetlands. Formalized trails provide public access through the wetlands and around the pond.

3.0 Methods

NRG performed three water quality tests at Aurora Pond on May 5, 2021, August 26, 2021, and September 30, 2021. Samples were collected at eight locations, two downstream from the pond in Gabler's Creek (DS1 and DS2), two upstream from the pond in Gabler's Creek (US1 and US2), and four along the pond shoreline (L1, L2, L3, and L4). Samples were collected consecutively in the upstream direction in the following order: DS1, DS2, L1, L2, L3, L4, US1, and US2. Maps and photos of the sampling locations are provided in Appendix A.

NRG collected measurements for eight water quality parameters including temperature, dissolved oxygen (DO), pH, conductivity, turbidity, phosphorous, and nitrates and nitrites. Oxidizing Reducing Potential (ORP) was not collected because the ORP sensor failed and could not be replaced in time for the scheduled testing dates. Salinity measurements were collected but ultimately abandoned after determining that the refractometer was not functioning properly. A summary of water quality parameters and associated sampling equipment is provided in Table 1.

Table 1. Summary of water quality parameters and sampling equipment.

Parameter	Description	Equipment
Temperature (°C)	Water temperature is one of the most important parameters for aquatic organisms, as it influences other parameters such as dissolved oxygen.	YSI 556 MPS Sonde
Dissolved Oxygen (DO) (mg/L and %)	DO levels indicate how much oxygen is available for aquatic life.	YSI 556 MPS Sonde
pH	pH indicates how basic or acidic water is.	YSI 556 MPS Sonde
Conductivity (µS/cm)	Conductivity measures how effective the water is at transferring an electrical current.	YSI 556 MPS Sonde
Salinity (ppt)	Salinity is the concentration of salt in water.	Refractometer
Turbidity (ft)	Secchi disk turbidity measures depth of visibility in the water column.	Secchi Disk
Phosphorus (ppm)	Phosphorous is a limiting nutrient for aquatic plant growth. High concentrations indicate eutrophication.	Chemetrics Chem Nutrient Test Kit
Nitrate/Nitrite (ppm)	Nitrogen is a limiting nutrient for aquatic plant growth. High concentrations of nitrate and nitrite indicate eutrophication.	Chemetrics Chem Nutrient Test Kit

Sampling equipment was calibrated before each sampling date. Sampling was conducted under dry weather conditions. Equipment calibration and sampling was performed in accordance with the applicable equipment instructions and NRG's water quality monitoring protocols. Temperature, DO, pH, and conductivity measurements were collected using a YSI 556 MPS Sonde (YSI). YSI probes were fully submerged at the sampling locations and allowed to adjust for five to ten minutes before measurements were recorded. Salinity measurements were collected using a salinity refractometer. A pipette was used to place water droplets onto the refractometer's prism. After mixing the water sample for thirty seconds, the droplet was placed upon the prism and the refractometer was held up to the light. The salinity readings were measured through the eyepiece and recorded. The refractometer was cleaned between each use. Turbidity was measured using a Secchi disk. The Secchi disk was lowered into the water until it was no longer visible and depth measurements were recorded using the measurement rope attached to the disk. Phosphate, nitrate, and nitrite measurements were recorded using bottles and Chemetrics Chem nutrient test kits. Bottles for grab sampling were rinsed three times with water from the sampling location before each sample was collected. Grab sample bottles were submerged just below the water surface at the sampling locations and allowed to fill up completely before being capped for testing on dry land using the nutrient test kits.

Temperature, DO, pH, and conductivity measurements were taken at all eight sampling locations. Nitrate, nitrite, and phosphorous measurements were taken at six sampling locations, including DS1, L1, L2, L3, L4, and US2. Turbidity measurements were only taken at L1 near the weir because this was the only sampling location where the water was deep enough to use a Secchi disk. Water quality data for each parameter were averaged by sampling area. Specifically, data collected at US1 and US2 were averaged to assess water quality in Gabler's Creek upstream of the pond, data collected at L1, L2, L3, and L4 were averaged to assess water quality in the pond, and data collected at DS1 and DS2 were averaged to assess water quality conditions in Gabler's Creek downstream of the pond. Location based averages were calculated for each sampling date as well as the average of the sampling dates. The results for each parameter were then compared to the parameter ranges preferred by alewife (Table 2). Graphs were made for each parameter outside the range preferred by alewife and for parameters that exhibited a noticeable change over time.

Table 2. Preferred water quality parameter ranges for alewife.

Parameter	Significance for Fish Habitat	Appropriate Range for Alewife
Temperature	Warmer water holds less oxygen. Fish require high oxygen concentrations to breathe. Warmer water can also make fish more vulnerable to parasites and disease.	Adult alewife prefer waters between 16°C and 20°C but can survive in temperatures between 3° to 31°C (Otto 1976), whereas young-of-year alewife have an optimum temperature preference of 26.3°C (Kellogg 1982).
Dissolved Oxygen (DO)	High DO is required for fish to breathe. Low DO can lead to fish kills.	DO preference ranges for young-of-year alewife fall within 7.6 to 10.6 mg/L (Kellogg 1982), and minimum desired concentrations are 3.6 mg/L for both juvenile and adult alewife (Dove 1995).
pH	When pH is outside of a normal range, it can cause death, damage to outer surfaces like gills, eyes, and skin, inability to dispose of metabolic wastes, and reproductive issues in fish.	In freshwater, suitable pH for alewife should not be less than 5.0 and not exceed 8.5.
Conductivity	Conductivity is affected by the temperature and the amount of dissolved solids, which impacts fish development and growth. Conductivity is often associated with salinity.	Preferred conductivity environment for juvenile alewife is ~250 µS/cm (Velotta 2018). Conductivity values for adult alewife habitat are typically less than 200 µS/cm in freshwater systems but have been recorded at 320 µS/cm which is indicative of euryhaline species' range (Jesien 1990).
Salinity	Salinity impacts fish development and growth. Certain fish species can tolerate higher levels of salinity and/or a wider range of salinity compared to others.	The eggs, larvae, juveniles and adults of alewife are tolerant of a wide range of salinities. Spawning can occur in water with a salinity range between 0-6.0 ppt, but most spawning occurs in water of salinities of less than 1.0 ppt (Dove 1995).

Parameter	Significance for Fish Habitat	Appropriate Range for Alewife
Turbidity	High turbidity has been found to have negative impacts on foraging and spawning. It can make it difficult for fish to see and catch prey, and it may bury and kill eggs laid on the bottom of lakes & ponds. Chemical reproductive cues can also be dampened by high turbidity.	High levels of suspended solids greater than 1000 mg/L increase the rates of predation, spawning disturbance and infection rates of eggs from naturally occurring fungi in sediments (Dove 1995). Suspended sediment concentrations of 100 ppm or less have been shown to have no significant effect on alewife eggs or larvae (Fay 1983).
Phosphorus	Eutrophic levels of phosphorus and/or nitrogen concentrations can lead to excess algae growth that can increase turbidity and result in Harmful Algal Blooms (HABs). HABs have the ability to produce toxins that can harm fish.	Phosphorous concentrations exceeding 0.024 mg/L (0.024ppm) is considered eutrophic in freshwater, and excessive nutrient enrichment depresses dissolved oxygen levels resulting in unsuitable and lethal habitat for alewife (Dove 1995).
Nitrate/Nitrite	See above.	Acceptable nitrate values for alewife depend on the population size and water volume but expanded range falls between 0.01 ppm and never exceeding 0.46 ppm (Brittis-Tannenbaum 2016).

4.0 Results

Average DO for the pond (7.37 mg/L), upstream area (5.26 mg/L), and downstream area (7.37 mg/L) were below the minimum preferred concentration (7.6 mg/L) for young-of-year alewife but above the minimum preferred concentration (3.6 mg/L) for juvenile and adult alewife (Table 3; Kellogg 1982 and Dove 1995). The average downstream DO concentration in May was the only average within the preferred range for young-of-year alewife for all sampling areas over time (Figure 1). Average nitrate concentrations for the pond (0.27 ppm) and upstream area (0.18 ppm) were within the preferred range (0.01 to 0.46 ppm) for alewife (Brittis-Tennenbaum 2016). Average nitrate concentrations for the downstream area (0.87 ppm) exceeded the preferred maximum concentration (0.46 ppm) for alewife (Table 3). The concentration of nitrate in the downstream area spiked in May (Figure 2). Average phosphate concentrations for the pond (0.58 ppm), downstream area (0.47 ppm), and upstream area (0.37 ppm) were greater than 0.24 ppm, indicating eutrophic conditions unsuitable to alewife (Table 2; Dove 1995). This trend was also observed for each sampling area over time (Figure 3). Average conductivity of the pond (867.67 µS/cm), downstream area (816.83 µS/cm), and upstream area (736.67 µS/cm) exceeded the preferred maximum threshold for juvenile alewife (250 µS/cm) and adult alewife (320 µS/cm) (Table 3; Jesien 1990 and Velotta 2018). This trend was also observed for each sampling area over time (Figure 4). The Secchi disk average was 1.75 feet at sampling location L1, indicating low water transparency and eutrophic conditions (Carlson 1977). Average temperature, nitrite, and pH were within the preferred ranges for alewife at each sampling area (Table 3).

Table 3. Average water quality results by pond, downstream, and upstream sampling areas. Results outside the preferred range for alewife are highlighted in grey.

Water Quality Parameter	Pond	Downstream (DS)	Upstream (US)
Secchi Average (ft)	1.75	--	--
DO %	79.08	71.05	54.72
DO mg/L	7.37	6.73	5.26
pH	6.97	6.86	7.03
Temperature (C)	18.20	17.62	16.01

Water Quality Parameter	Pond	Downstream (DS)	Upstream (US)
Conductivity (µS/cm)	867.67	816.83	736.67
Nitrite (ppm)	0.00	0.00	0.00
Nitrate (ppm)	0.27	0.87	0.18
Phosphorous (ppm)	0.58	0.47	0.37

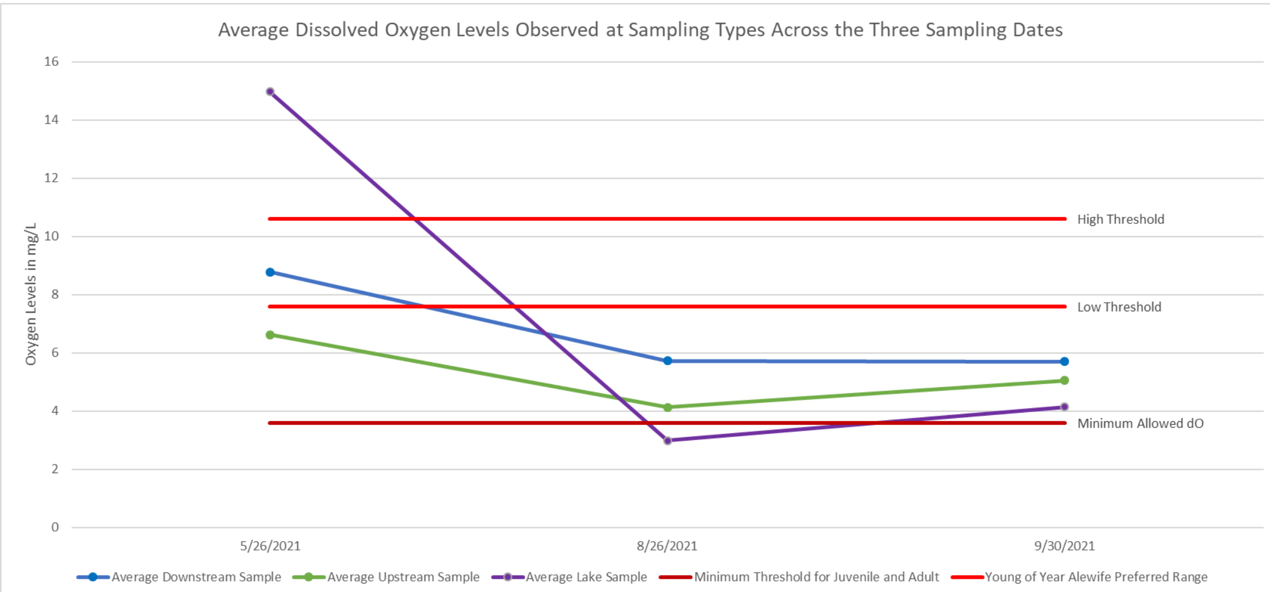

Figure 1. Average DO at each sampling area over time. The average downstream DO sample collected in May was within the preferred range for young of year alewife. The average pond DO sample collected in May exceeded the range preferred by alewife. The average DO sample collected in August was below the minimum threshold for all alewife. All other averages were below the DO range preferred by young of year alewife, but above the minimum threshold for adult and juvenile alewife.

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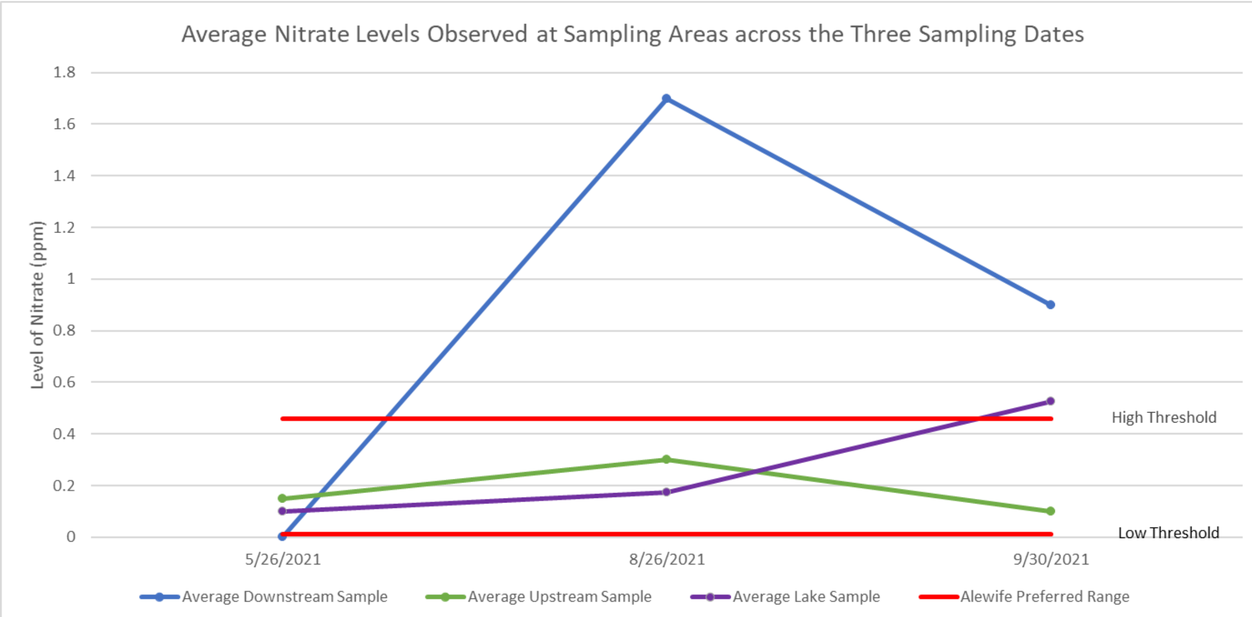

Figure 2. Average nitrate concentration at each sampling area over time. Average nitrate concentrations are generally within the range preferred by alewife except in the area downstream of the pond.

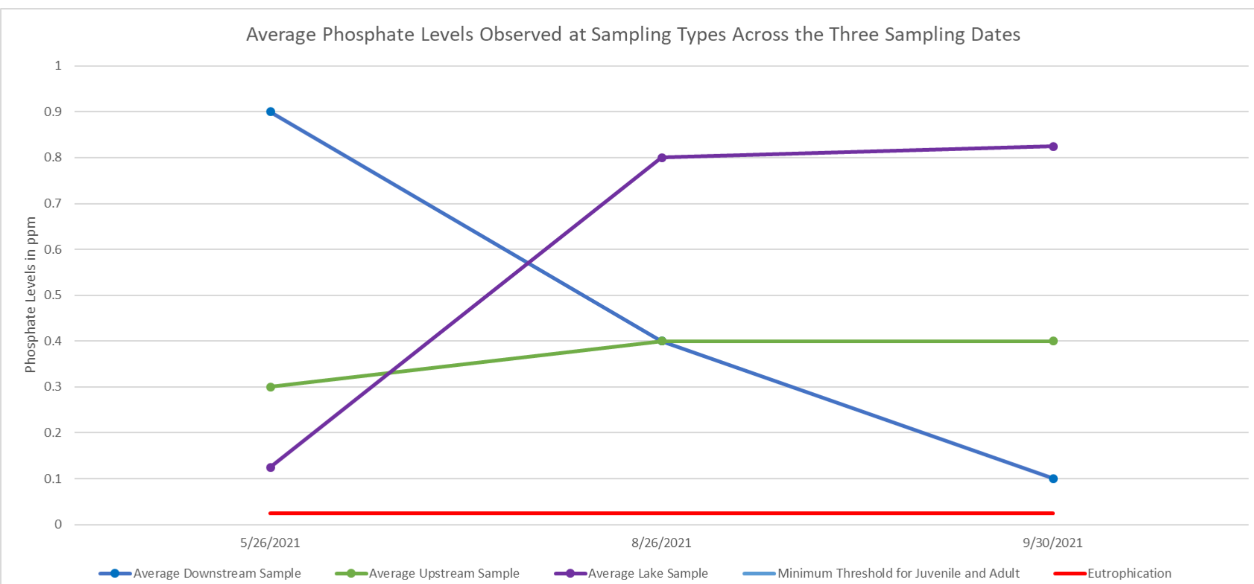

Figure 3. Average phosphate concentration at each sampling area over time. All average phosphate concentrations exceeded the preferred range for alewife and indicate eutrophication.

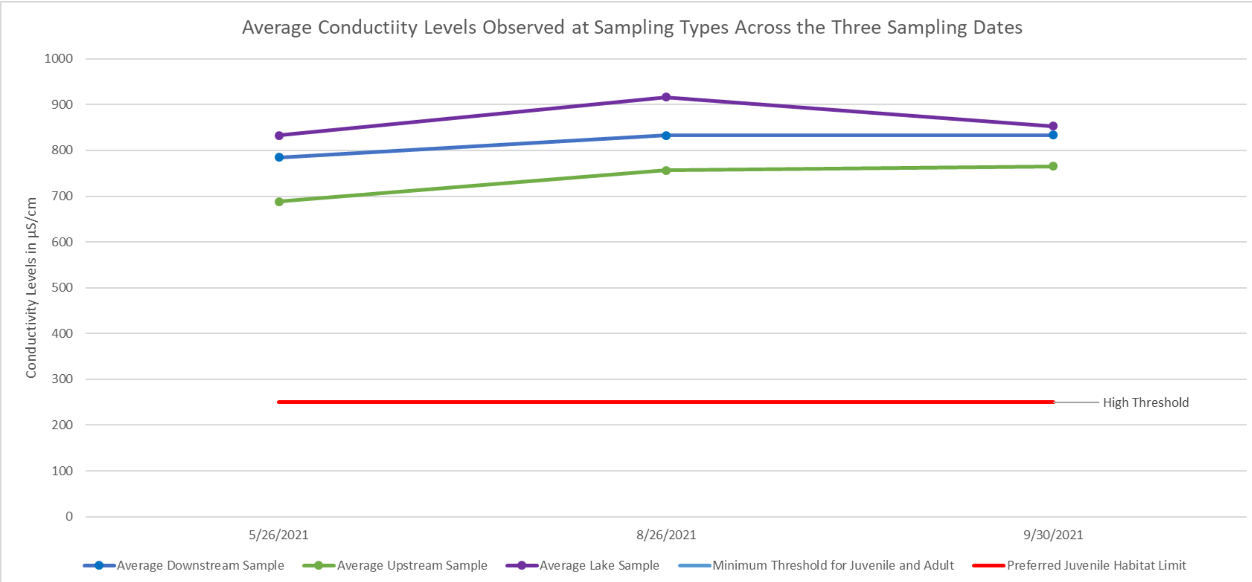

Figure 4. Average conductivity at each sampling area over time. All average conductivity measurements exceeded the preferred range for juvenile alewife.

5.0 Discussion

Overall, water quality conditions at Aurora Pond and Gabler's Creek are unlikely to support alewife. Nutrient concentrations (phosphorous and nitrogen) were too high and DO concentrations were too low. High nutrient concentrations and low DO indicate eutrophic waterbody conditions that can lead to fish mortality and overgrowth of plant material, such as harmful algae. Some algae growth was visually observed during water quality monitoring; algae were most abundant in August. Although there is no baseline for comparison at the Project site, the average Secchi disk reading (1.75 feet) showed low visibility, which is also indicative of eutrophic waterbody conditions (Carlson 1977). Dissolved oxygen and nutrient concentrations were closer to the ranges required to support alewife in May, which coincides with the river herring migration season from April to May.

Conductivity was also high and unlikely to support alewife. Conductivity is affected by several factors including temperature and dissolved solids, such as salts. Although salinity measurements were not valid because the refractometer malfunctioned, NYC Parks does not believe that the site's salinity is substantially influenced by the tide. This assumption is based on the site's inland position in the landscape and previous ecological monitoring conducted at the site. Additionally, the weir presents a barrier to flow, so the pond and upstream sampling area should not be affected by the tide. Gabler's Creek is primarily stormwater driven within a highly urbanized watershed. Therefore, high conductivity at the Project site is likely due to urban runoff polluted by elevated levels of dissolved solids, rather than seawater (Kaushal 2005; Wegner et al. 2009)

Based on visual observations made during water quality monitoring, the site appeared to have low flow during dry weather conditions. Stagnant water may be contributing to pond eutrophication and poor water quality. Restoration actions that improve base flow may improve water quality by increasing turbulence and DO. Potential restoration actions could include re-naturalizing the creek and removing or reducing barriers to flow such as the weir and culvert. During extreme wet weather conditions, the site experiences high flows and significant flooding. NYC Parks staff observed high wrack lines, sediment deposition in the pond, and erosion at the northern end of the Sandhill Road culvert following Hurricane Ida, indicating that the storm's rainfall exceeded the capacity of Aurora Pond, flooding the site and adjacent roadway. Hydrological monitoring is recommended to determine if the site's hydrology would support alewife and how the site is affected by flooding.

Based on visual observations made during sampling, the substrate of the pond and creek was mix silt, sand, and organic muck. However, no substrate samples were taken. Additional site investigations are recommended to determine if the existing substrate type is suitable for alewife and how the substrate influences water quality. Given excess nutrient levels measured in the water column, it is likely that excess nutrients are present in the pond's sediment. Any future restoration efforts to improve water quality should consider the possibly for nutrient-laden sediment. If nutrient-laden sediment is present, then dredging may decrease the site's overall nutrient levels and improve flood water storage capacity. However, dredging would disturb existing benthic habitat, and significant sediment deposition was observed in the pond following Hurricane Ida, indicating that maintenance dredging would be required following an initial dredge. For these reasons, dredging does not appear to be a feasible approach for reducing excess nutrients.

Any future restoration actions taken to improve water quality should focus on reducing nutrient levels, conductivity, and turbidity and increasing DO. Temperature and pH were within the preferred ranges for alewife. The observed water quality conditions are indicative of an urbanized watershed. A long term, watershed scale approach for reducing nutrients and managing urban runoff would improve water quality conditions at this site and other sites in Udall's Cove and the Gabler's Creek watershed. Although current water quality conditions are unlikely to support alewife, restoration actions to improve aquatic connectivity would still benefit other important species, such as American eels (*Anguilla rostrata*), and could decrease localized flooding.

5.1 Summary of Findings

- Future restoration actions to improve water quality should focus on reducing nutrients, conductivity, and turbidity and increasing DO.
- Although current water quality conditions are unlikely support alewife, restoration actions to improve aquatic connectivity would still benefit other important species, such as American eels (*Anguilla rostrata*), and could decrease localized flooding.
- Re-naturalizing Gabler's Creek and removing or reducing barriers to flow would likely improve water quality conditions and enhance aquatic connectivity but would alter the site's hydrology. Therefore, hydrological monitoring is recommended.
- Eutrophication and high conductivity are indicative of urbanized watersheds. A long term, watershed scale approach for reducing nutrients and managing urban runoff would improve water quality conditions at this site and other sites in the watershed.
- Substrate sampling is recommended to determine if the site's existing substrate would support alewife.

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6.0 References

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Appendix A
Maps and Photos

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Water Quality Sampling Locations
Aurora Pond, Udall's Cove Park

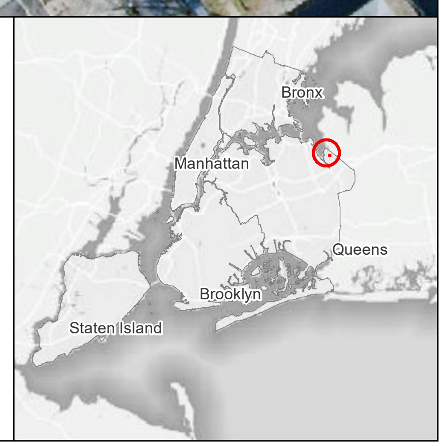
Queens, NY

N

0 100 200 Feet

Sampling Locations

Gablers Creek



Prepared by Forestry, Horticulture and Natural Resources
Data Source: NYC Parks NRG
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Photo 1: Stream sampling location DS1 north of Sandhill Road, downstream of Aurora Pond. *Facing upstream.*

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Udall's Cove Park Preserve
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Photo 2. Stream sampling location DS2 south of Sandhill Road, downstream of Aurora Pond. ***Facing upstream.***

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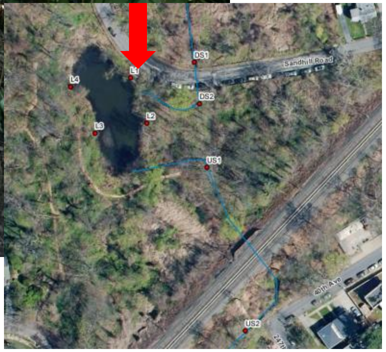

Photo 3. Sampling location L1 on the northern shore of Aurora Pond.
Facing south.

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Photo 4. Sampling location L2 on the eastern shore of Aurora Pond.
Facing west.

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Photo 5. Sampling location L3 on the southwestern shore of Aurora Pond.
Facing northwest.

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Photo 6. Sampling location L4 of the western shore of Aurora Pond.
Facing east.

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Photo 7. Stream sampling location US1 southwest and upstream of Aurora Pond. ***Facing upstream.***

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Photo 8. Stream sampling location US2 upstream of Aurora Pond south of the railroad tracks. ***Facing northeast, downstream.***

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Appendix B
Water Quality Data

Table B-1. Water quality data collected on May 5, 2021.

Air Temp (F)	Sky	Sample location	Secchi person1	Secchi Person 2	secchi average (feet)	dO%	dOmg/L	pH	temp (C)	Conductivity	Nitrate (ppm)	Nitrite (ppm)	phosphorous (ppm)
75	Sunny	L1	2.25	2.75	2.5	275	25.9	7.99	18	882	0.2	0	0.1
75	Sunny	L2	--	--	--	133.4	12.18	7.05	19.8	818	0	0	0.3
75	Sunny	L3	--	--	--	170.4	15.41	6.96	20.1	810	0.2	0	0.1
75	Sunny	L4	--	--	--	63	6.4	6.89	19.5	822	0	0	0
75	Sunny	DS1	--	--	--	90.8	8.45	6.91	18.24	786	0	0	0.9
75	Sunny	DS2	--	--	--	99.6	9.11	6.88	19.6	783	--	--	--
75	Sunny	US1	--	--	--	62.4	5.67	7.35	12	629	--	--	--
75	Sunny	US2	--	--	--	73.7	7.56	6.44	14.12	747	0.15	0	0.3

Table B-2. Water quality data collected on August 26, 2021

Air Temp (F)	Sky	Sample Name	Secchi person1	Secchi Person 2	secchi average (feet)	dO%	dOmg/L	pH	temp (C)	Conductivity	Nitrate (ppm)	Nitrite (ppm)	phosphorous (ppm)
91	Sunny	L1	1.5	1.5	1.5	8.2	0.78	6.78	18.58	862	0.3	0	0.8
91	Sunny	L2	--	--	--	21.2	1.96	6.97	19.04	1028	0.1	0	0.6
91	Sunny	L3	--	--	--	86.3	7.81	6.76	20	933	0.3	0	0.8
91	Sunny	L4	--	--	--	16.3	1.4	6.83	22.46	844	0	0	1
91	Sunny	DS1	--	--	--	43.7	4.17	6.88	18.7	825	1.7	0	0.4
91	Sunny	DS2	--	--	--	78	7.27	6.85	18.7	840	--	--	--
91	Sunny	US1	--	--	--	38.7	3.73	6.89	16.84	904	--	--	--
91	Sunny	US2	--	--	--	51.4	4.52	7.46	21.51	609	0.3	0	0.4

Table B-3. Water quality data collected on September 30, 2021.

Air Temp (F)	Sky	Sample location	Secchi person1	Secchi Person 2	secchi average (feet)	dO%	dOmg/L	pH	temp (C)	Conductivity	Nitrate (ppm)	Nitrite (ppm)	phosphorous (ppm)
65	Partly Cloudy	L1	1.5	1	1.25	46.2	4.61	6.79	15.26	850	0.9	0	0.4
65	Partly Cloudy	L2	--	--	--	31.5	3.18	6.98	14.56	953	0.6	0	0.3
65	Partly Cloudy	L3	--	--	--	76.6	6.67	6.96	15.94	794	0.6	0	0.6
65	Partly Cloudy	L4	--	--	--	20.9	2.09	6.67	15.19	816	0	0	2
65	Partly Cloudy	DS1	--	--	--	60.4	6.01	6.83	15.26	828	0.9	0	0.1
65	Partly Cloudy	DS2	--	--	--	53.8	5.38	6.81	15.24	839	--	--	--
65	Partly Cloudy	US1	--	--	--	47.5	4.75	6.78	15.5	839	--	--	--
65	Partly Cloudy	US2	--	--	--	54.6	5.34	7.25	16.1	692	0.1	0	0.4