DRAFT

Climate Vulnerability Assessment and Adaptation Strategies Plan for Western Gateway

City of Glen Cove, New York

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Prepared For:
City of Glen Cove
Glen Cove Community Development Agency

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ACRONYMS

ASCE/SEI	American Society of Civil Engineers / Structural Engineering Institute
BFE	Base Flood Elevation
CDA	Community Development Agency
CRRA	Community Risk and Resiliency Act
EPA	Environmental Protection Agency
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
GCM	Global Climate Model
GHCN	Global Historical Climate Network
HAT	Highest Astronomical Tide
HDSC	Hydrometeorological Design Studies Center
IPCC	Intergovernmental Panel on Climate Change
MHHW	Mean Higher High Water
MHW	Mean High Water
MLLW	Mean Lower Low Water
MLW	Mean Low Water
MSL	Mean Sea Level
NACCS	North Atlantic Coast Comprehensive Study
NAVD88	North American Vertical Datum of 1988
NFIP	National Flood Insurance Program
NYSDEC	New York State Department of Environmental Conservation
NYSERDA	New York State Energy Research and Development Authority
NOAA	National Oceanic and Atmospheric Administration
NOS	National Ocean Service
NYCRR	New York Codes, Rules, and Regulations
RCP	Representative Concentration Pathway
RSLC	Relative Sea Level Change
SFHA	Special Flood Hazard Areas
SEQRA	State Environmental Quality Review Act

SLR	Sea Level Rise
SMCCP	Sentinel Monitoring for Climate Change in Long Island Sound Program
USACE	United Stated Army Corps of Engineers
WRR	Waterside Recreational Redevelopment

1.0 PLAN OVERVIEW

This document is a planning tool to help the City of Glen Cove build resilience to climate change at the Western Gateway study area. The Western Gateway study area is located in the City of Glen Cove along the south side of Glen Cove Creek. The City is committed to seeing the area grow or adapt in a sustainable and responsible manner, which includes proactively assessing the area's vulnerability to climate change and focusing on the development of climate adaptation strategies to provide resilience to climate change. This plan addresses the following effects of climate change:

- Rising sea level
- Increasing storm surge
- Increasing rainfall depths
- Increasing temperatures

This plan presents comprehensive strategies and measures to guide decision makers with future resilience planning and regulation. In addition, the plan also addresses climate change mitigation by means of reducing emissions of greenhouse gases.

This plan was reviewed pursuant to the New York State Environmental Quality Review ACT (SEQRA). A summary of the review is included at the end of the plan.

1.1 TEAM

The contributors of this plan include the following:

Glen Cove Project Advisory Committee

Organization	Name
Glen Cove Community Development Agency (CDA)	Ann Fangmann, AICP Jocelyn Wenk, AICP John Probert
Mayor's Office, City of Glen Cove	Timothy Tenke Maureen Basdavanos Shannon Vulin
Glen Cove City Council	John Perrone
Glen Cove Police Department	Chris Ortiz
InterAgency Council (IAC) of Glen Cove	Spiro Tsirkas Kathie Flynn
Tiegerman Schools	Ellenmorris Tiegerman – Represented by Karen Katzman
Glen Cove Boys & Girls Club	Franca Trunzo
Glen Cove Downtown Business Improvement District (BID)	Patricia Holman
Glen Cove Yacht Yard (Brewer Yacht Yard)	Mark Friel
Glen Cove Housing Authority	Eric Wingate
Cove Animal Rescue	Janine Fakiris
RXR / Garvies Point & Village Square	John Swagerty Melanie Eitel Peter Demeropoulos
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Organization	Name
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1.2 STUDY AREA

The study area is located in the City of Glen Cove (see Figure 1). Glen Cove is located on the north shore of Long Island in Nassau County, New York. The study area includes Shore Road from Morris Avenue to Glen Cove Avenue; Glen Cove Avenue from Shore Road to Pratt Boulevard / State Route 107; all of Park Place; and all of Morris Avenue. The study area is directly southwest of downtown Glen Cove and includes approximately 0.35 miles of shoreline along Glen Cove Creek.

1.3 METHODOLOGY

Climate resilience is the ability to maintain function despite external stresses imposed by climate change. Climate resilience is achieved by evolving in a way that leaves a community better prepared for future climate change impacts. It can be achieved through a combination of 1) land use planning; 2) zoning and building codes; 3) public outreach and education; 4) emergency response preparedness; 5) strong social networks; and 6) infrastructure design, to name a few.

The preparation of the plan included the following steps:

Step 1: Characterize climate change hazards.

Step 2: Assess the vulnerability of the study area to climate change hazards.

Step 3: Gather input from the public and stakeholders.

Step 4: Review resilience strategies for climate change.

Step 5: Identify resilience strategies for study area.

Step 6: Review plan pursuant to SEQRA.

1.4 VERTICAL DATUM

Elevations in the plan are in the North American Vertical Datum of 1988 (NAVD88).

2.0 HAZARDS CHARACTERIZATION

2.1 OVERVIEW

A hazard is a threat (natural or human) that has the potential to cause loss of life, injury, property damage, socio-economic disruption, and/or environmental degradation. Hazard probability is the likelihood or chance that the hazard will occur. The hazards addressed in this plan are natural hazards resulting from climate change: sea level rise, increasing storm surge, increasing precipitation, and increasing temperatures. The hazards from sea level rise, increasing storm surge, and increasing precipitation can be grouped as flood hazards. Flood hazards are the hazard resulting from the hydrostatic and hydrodynamic loads from stillwater, currents, and wave action.

2.2 SEA LEVEL RISE AND STORM SURGE

Sea level rise and storm surge are coastal flood hazards for the study area. These hazards have been characterized using several different data sources, which are summarized below. As a participating member of FEMA's National Flood Insurance Program (NFIP), the City of Glen Cove has incorporated NFIP minimum standards, as well as higher standards, into Chapter 154 Flood Damage Prevention of the City's Administrative Legislative Code (i.e., City Code). Chapter 154 serves as the primary floodplain management requirements for the City which also includes higher standards for new construction and substantial improvements for commercial and residential structures located in the FEMA special flood hazard areas (SFHAs) located on the FEMA Flood Insurance Rate Maps (FIRMs)[1].

Pursuant to the State of New York's 2014 Coastal Risk and Resiliency Act (CRRA), the New York State Department of Environmental Conservation (NYSDEC) adopted sea level projections in 2017 for Long Island Sound. In August 2020, NYSDEC released the New York State Flood Risk Management Guidance for Implementation of the Community Risk and Resiliency Act that describe how those projections should be incorporated into project design in specified facility-siting, permitting, and funding programs[2].

2.2.1 COASTAL SETTING AND SHORELINE FEATURES: LOCATION AND TOPOGRAPHY

The flooding hazards being addressed in this plan were selected due to the location and topography of the study area. The location and topography are shown in Figure 2. Approximately 0.35 miles of the study area border Glen Cove Creek. Approximately 0.5 miles downstream of the study area, Glen Cove Creek discharges into Hempstead Bay, which is part of the Long Island Sound. At the study area, the water surface elevations in the Creek are tidal and subject to sea level rise and storm surge. The study area is relatively low-lying, with the minimum elevation at about 7 feet[3]. The study area rises to an approximate elevation of 100 feet at the southeast corner.

2.2.2 TIDES

Tides are the daily rise and fall of the Earth's waters by long-period waves that move through the ocean in response to astronomical gravitation forces, predominantly exerted by the moon and sun. A National Oceanic and Atmospheric Administration (NOAA) tide station is located at Kings Point, NY, approximately 7.3 miles southwest of Glen Cove (see Figure 3). The NOAA tide station (ID 8516945) provides a detailed record of water levels over the last 21 years (October 1998 to May 2020). Another nearby tide station, at Willets Point, NY (ID 8516990), approximately 8.6 miles southwest of Glen Cove (see Figure 3), has a record of water levels from 1931 to 2000. The tides at Glen Cove are semidiurnal which means that during each lunar day (24 hours and 50 minutes), there are two high tides and two low tides. The elevations of the high and low tides vary over the daily cycle and lunar cycle (see Figure 4).

Tidal datums are used to define tide elevations and include:

- Mean High Water (MHW) which is the average of all the high tides over the National Tidal Datum Epoch

[1] see https://ecode360.com/11768298 for more details on requirements outlined in Chapter 154.
[2] see https://www.dec.ny.gov/docs/administration_pdf/frmgpublic.pdf for more details.
[3] USGS Long Island New York Sandy LiDAR, extracted in 2014.

- Mean Low Water (MLW) which is the average of all the low tides over the National Tidal Datum Epoch
- Mean Higher High Water (MHHW) which is the average of the higher of the two high tides during each tidal day observed over the National Tidal Datum Epoch
- Mean Lower Low Water (MLLW) which is the average of the lower of the two tides over the National Tidal Datum Epoch
- Mean Sea Level (MSL) which is the arithmetic mean of all hourly heights over the National Tidal Datum Epoch
- The Mean Range of Tide which is the difference between the Mean High Water and the Mean Low Water
- Highest Astronomical Tide (HAT) which is the highest predicted astronomical tide expected to occur over the National Tidal Datum Epoch

Tidal datums are developed based on observed water level data during the current National Tidal Datum Epoch, the 19 years between 1983 and 2001. This period was adopted by the National Ocean Service (NOS) as the official time segment over which sea level observations are averaged to obtain mean values for datum definition. The tidal datums at Kings Point are indicated in Table 2-1.

Table 2-1: Tidal Datum Elevations for King Point Tide Station Relative to NAVD88 Datum

Tidal Datum	Elevation (ft); NAVD88
Highest Astronomical Tide (HAT)	5.50
Mean Higher-High Water (MHHW)	3.64
Mean High Water (MHW)	3.28
Mean Sea Level (MSL)	-0.27
Mean Low Water (MLW)	-3.9
Mean Lower-Low Water (MLLW)	-4.2

Comparing the tidal datums to the minimum study area elevation of approximately 7 feet, the study area is at least 1.5 feet above the Highest Astronomical Tide.

2.2.3 OBSERVED SEA LEVEL RISE AT TIDE GAUGE

Sea Level Rise (SLR) is the rise of global ocean waters. Relative Sea Level Change (RSLC) is the change in the difference in sea level relative to the adjacent land mass and is unique to a given geographic location. RSLC is caused by several factors, including: 1) ground settlement due to post-glacial isostatic adjustment; 2) warming of ocean waters, resulting in volume expansion; 3) increase in ocean volumes due to melting Arctic and land ice; 4) ocean density gradients due to the infusion of lower density fresh water; and 5) changes to global ocean circulation patterns (e.g., the Gulf Stream and Labrador Current).

Over the last century, sea levels along the northern East Coast have risen faster than the global mean rate. Figure 5 shows the RSLC at Kings Point since 1931. The graph uses data from both the Kings Point station and Willets Point station. As shown in Figure 5, the observed RSLC trend is 2.28 millimeters (mm) per year (2.28 mm/year = 0.09 inch/year), with a 95% confidence interval of +/- 0.20 mm per year.

2.2.4 NEW YORK STATE SEA LEVEL RISE PROJECTION

In 2011, the New York State Energy Research and Development Authority (NYSERDA) published "Responding to Climate Change in New York State: The ClimAID Integrated Assessment for Effective Climate Change Adaptation in New York State" (ClimAID), which provided the first modeling projections of sea level rise specifically along New York's coastlines and estuaries. In 2014, a ClimAID Supplement refined the sea level rise projections to take into account known (at that time) components of sea level rise, advances in physical understanding, climate modeling and computing, and new observational data that included Hurricane Irene and Hurricane Sandy.

In 2014, the Community Risk and Resiliency Act (CRRA) provisions for addressing climate resiliency in the State was enacted. The law directs NYSDEC to adopt science-based sea level rise projections and to provide guidance to help State agencies apply these projections. NYSDEC considers the ClimAID 2014 Supplement projections to be the best available data at the time for New York State planners and has adopted the sea level rise projections in 6 NYCRR Part 490, Projected Sea Level Rise, in the New York Codes, Rules, and Regulations (NYCRR). These sea level rise projections are presented in Table 2-2.

Table 2-2: NY State Projected Sea Level Change for Long Island, in feet

Year	Low Estimate (10th Percentile)	Middle Range (25th to 75th Percentile)	High Estimate (90th Percentile)
2020s	0.17	0.33 to 0.67	0.83
2050s	0.67	0.92 to 1.75	2.50
2080s	1.08	1.50 to 3.25	4.83
2100	1.25	1.75 to 3.92	6.00

Note: Projections are based on both local and global factors. The projections were developed using 24 Global Climate Models (GCMs) and two greenhouse gas concentration trajectories (called Representative Concentration Pathways – RCPs). Projections are relative to the 2000-2004 base period.

2.2.5 NOAA 2017 SEA LEVEL RISE PROJECTIONS

NOAA and USACE have developed standard ranges of RSLC for use on federal projects in the United States. NOAA's methodology is summarized in "Global and Regional Sea Level Rise Scenarios for the United States," published in 2017. The USACE's analysis is from 2013 and its projections have not been included in this plan. NOAA's analysis concluded the range in Global Mean Sea Level (GMSL) rise for 2100 is 0.3 meter to 2.5 meters. NOAA discretized the range by 0.5-meter increments and named them as six scenarios ranging from Low to Extreme. For each scenario, regional RSLC was calculated as summarized in Table 2-3.

Table 2-3: NOAA 2017 Projected Sea Level Change at Willets Point, in feet

Year	NOAA2017 VLM	NOAA2017 Low	NOAA2017 Int-Low	NOAA2017 Intermediate	NOAA2017 Int-High	NOAA2017 High	NOAA2017 Extreme
2000	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2010	0.03	0.16	0.20	0.30	0.39	0.46	0.46
2020	0.06	0.33	0.39	0.59	0.79	0.98	0.92
2030	0.09	0.46	0.59	0.92	1.25	1.51	1.61
2040	0.13	0.62	0.79	1.25	1.71	2.17	2.46
2050	0.16	0.79	0.98	1.64	2.26	2.99	3.41
2060	0.19	0.95	1.21	2.07	2.92	4.00	4.69
2070	0.22	1.12	1.41	2.56	3.67	5.02	6.00
2080	0.25	1.21	1.57	3.08	4.53	6.14	7.51
2090	0.28	1.35	1.74	3.64	5.41	7.58	9.32
2100	0.31	1.41	1.87	4.17	6.36	9.06	11.15

Note: Projections were obtained from the USACE Sea Level Change Calculator Version 2019.21. VLM is vertical land motion. Projections are relative to 2000 as base year.

The NOAA 2017 projections presented above are associated with different likelihoods of occurrence based on different emissions trajectories. Table 2-4 presents estimated exceedance probabilities associated with the six NOAA 2017 projections for several possible future emission trajectories (Representative Concentration Pathways RCP 2.6, RCP 4.5, RCP 8.5) adopted by the Intergovernmental Panel on Climate Change (IPCC) for its fifth Assessment Report (AR5).

Table 2-4: Probability of Exceeding Global Mean Sea Levels (Median Value) in 2100 for Several Representative Concentration Pathways (RCP) Scenarios

GMSL Rise Scenario	RCP2.6	RCP4.5	RCP8.5
Low (0.3 m)	94%	98%	100%
Intermediate-Low (0.5 m)	49%	73%	96%
Intermediate (1.0 m)	2%	3%	17%
Intermediate-High (1.5 m)	0.4%	0.5%	1.3%
High (2.0 m)	0.1%	0.1%	0.3%
Extreme (2.5 m)	0.05%	0.05%	0.1%

The NOAA 2017 Intermediate-Low projection has a high likelihood of occurrence (49% to 96% by 2100). The NOAA 2017 Intermediate projection has low to moderate likelihood of occurrence (2% to 17% by 2100). The NOAA 2017 Extreme GMSL scenario is a worst-case scenario with a low likelihood of occurrence.

In general, the "Intermediate" (i.e., 4.17 feet for 2100) is considered appropriate as an "analysis and planning lower bound" and the "Intermediate-High" (i.e., 6.36 feet for 2100) is appropriate as an upper bound (recommended on page 39 of the 2017 NOAA SLR Report). These estimates are slightly higher and thus more conservative than NYSDEC guidance.

2.2.6 TIDE GAUGE EXTREME WATER LEVELS

Extreme water levels recorded at Kings Point and Willets Point are plotted in Figure 6. Extreme water levels in Long Island typically result from storm surge, which is the abnormal rise of water due to the wind and pressure effects from a storm. The most recent extreme water level was during Hurricane Sandy in 2012. The maximum reported extreme water level is from 1938, from the 1938 New England Hurricane. Storm surge at Long Island result from two types of storms: Extra-tropical cyclones (nor'easters) and tropical cyclones (tropical storms and hurricanes).

Nor'easters are common on Long Island during the spring, winter and fall. They are less intense than hurricanes but have a large wind field and are long in duration (sometimes lasting several days). Nor'easters often occur in conjunction with large snowfalls, which makes emergency response and recovery more difficult.

Tropical storms and hurricanes have historically resulted in the largest storm surge flooding affecting the Glen Cove area. The most recent were Hurricane Sandy in 2012 and Hurricane Irene in 2011. The most intense hurricane of record in the vicinity of Glen Cove is the Hurricane of 1938. The approximate peak water levels at the Kings Point tide station during the Hurricane of 1938 was 12.7 feet.

Figure 6 also shows the 100-year water level (see red line), also called the 1% water level, which was computed using statistical analysis from the gauge. The red line slopes upward to account for the observed sea level rise at the gauge. The 1-year through 100-year water levels for year 2020 are summarized in Table 2-5.

Table 2-5: Kings Point / Willets Point Water Level Elevations at Long Island Coastline near Glen Cove Creek

Recurrence Interval (years)	Water Level (ft)
1	5.6
2	6.9
5	8.2
10	8.9
20	9.9
50	11.2
100	12.8

Note: Water levels were presented by NOAA in meters above MHHW. Water levels were converted to feet, NAVD88.

2.2.7 FEMA FLOOD INSURANCE RATE MAP EXTREME WATER LEVELS

Numerous water bodies in the United States have flood area mapping from the Federal Emergency Management Agency (FEMA). The study area is mapped on FEMA Flood Insurance Rate Map (FIRM) Panel 0107G for Nassau County, New York (Map Number 36059C0107G, revised September 11, 2009). The calculations for the mapping are summarized in the Flood Insurance Study (FIS) for Nassau County, New York (revised September 11, 2009).

The FIRM (Figure 7) shows the study area is in a Zone AE, which is the area (or the Special Flood Hazard Area, SFHA, as called by FEMA) subject to inundation by the 1% annual chance flood (i.e., 100-year flood, also called the Base Flood). The Base Flood Elevation (BFE) is 11 feet. The study area is also in a Zone X, which is an area subject to inundation by the 0.2% annual chance flood (i.e., 500-year flood), an area of 1% annual chance flood with average depths of less than 1 foot or drainage areas less than 1 square mile, or areas protected by levees from the 1% annual chance flood. Since the study area does not have levees and the drainage area is greater than 1 square mile, the Zone X is likely either the 0.2% annual chance flood and/or an area of 1% annual chance flood with average depths less than 1 foot.

Further west of the study area, the BFE increases. The increase in elevation is a result of wave action from Long Island Sound (see Figure 8). The study area, however, is beyond the limits of moderate wave action. Moderate wave action is defined as waves with heights between 1.5 and 3 feet. Note that the AE zone on the FIRM may have waves less than 1.5 feet high.

The FIS provides more detailed information on water levels near the study area. The water levels for FEMA FIS transect 22, the closest transect to the study area located near the outlet of Glen Cove Creek, is summarized in Table 2-6. Note that the transect has wave information, but it has not been included in this plan because the study area is beyond the limit of moderate wave action.

Table 2-6: FEMA FIS Water Level Elevations near Glen Cove Creek

Recurrence Interval (years)	Water Level (ft)
10	7.3
50	10.2
100	10.9
500	13.5

Note: The FEMA FIRM rounds the BFE to the nearest whole number (11 feet).

FEMA influences construction in existing SFHAs through its role in administering the National Flood Insurance Program (NFIP). This includes the incorporation of minimum federal floodplain management standards into state and local building codes. As an NFIP participant, the City of Glen Cove incorporated the NFIP's minimum standards into Chapter 154 Flood Damage Prevention of the City Code which include but are not limited to the following:

- Creating floodplain management regulations based on FEMA-developed data, including base flood elevations and floodway and floodplain boundaries on Flood Insurance Rate Maps (FIRM).
- Requiring permits for any development within floodplains.
- Ensuring all other federal and state permits are obtained for development within floodplains.
- Ensuring that development does not increase the flood hazard on other properties, including encroachment review for projects within regulatory floodways.

Chapter 154 serves as the primary floodplain management requirements for the City. It includes some standards that are higher than the NFIP standards for new construction and substantial improvements for non-residential and residential structures located in FEMA SFHAs located on the FEMA FIRMs. For example, for residential structures within Zones A1-A30, AE and AH and also Zone A, if BFE data are available, new construction and substantial improvements shall have the lowest floor (including basement) elevated to or above two feet above the base flood elevation. This local requirement is two feet higher than the minimum NFIP requirement.

2.2.8 USACE NORTH ATLANTIC COAST COMPREHENSIVE STUDY EXTREME WATER LEVELS

The USACE published the North Atlantic Coast Comprehensive Study (NACCS): Resilient Adaptation to Increasing Risk, in 2015. Overall, the USACE NACCS currently presents the most robust analysis of coastal flood hazards in the vicinity of Glen Cove.

The results of the USACE NACCS are available at specific model "save point" locations. Stillwater elevations and wave heights are available at each save point. Due to the updated methodology used by the USACE, the flood hazard data developed by the USACE NACCS is expected to be indicative of what future editions of the FEMA FIS and FIRMs will be for Glen Cove.

Table 2-7 presents predicted stillwater elevations for USACE NACCS save point 13962, which is located at the outlet of Glen Cove Creek. Note the 100-year flood level is slightly higher than what the FEMA FIRM presents (e.g., 12.7 feet in the NACCS versus 11 feet for the FEMA FIRM).

Table 2-7: NACCS Water Level Elevations at Long Island Coastline near Glen Cove Creek, in NAVD88

Recurrence Interval (years)	Water Level (ft)
1	6.1
2	7.3
5	8.7
10	9.6
20	10.5
50	11.7
100	12.7
200	14.1
500	16.1

2.2.9 COMBINING WATER LEVELS WITH PROJECTED SEA LEVEL CHANGE

A reasonable estimation of the effects of RSLC on tides and storm surge stillwater elevations can be developed by linear superposition of the predicted RSLC to the predicted stillwater elevation. Tables computing the sum of extreme water levels and RSLC are included in Attachment 1.

As described in the sections above, multiple sources have published sea level rise and storm surge stillwater elevations. The City will need to select which data sources to use for planning. From a regulatory standpoint, the City must use the New York State sea level rise projections and the FEMA stillwater elevations. Due to the study area's location in New York, the study area is subject to the sea level rise projections prescribed by New York State. The study area is also located in a FEMA special flood hazard area (SFHA), and thus, subject to the floodplain standard outlined in Chapter 154 Flood Damage Prevention of the City Code, which references the stillwater elevations presented by FEMA. The inundation limits for select FEMA flood levels with Intermediate New York State sea level rise projections are shown in Figure 9.

Note that in June of 2018, NYSDEC released the FINAL DRAFT New York State Flood Risk Management Guidance for implementation of the Community Risk and Resiliency Act. This guidance document did not establish any legally binding standards or criteria for any particular structure, permit or approval. Instead, it provides recommendations to State agencies regarding how to consider sea level rise and other flood risk, as required for certain programs covered by the CRRA. In addition, it is important to note that Chapter 154 of the City Code includes higher standards than the minimum NFIP standards for new construction and substantial improvement of structures. For example, for residential structures within Zones A1-A30, AE and AH and also Zone A, if BFE data are available, new construction and substantial improvements shall have the lowest floor (including basement) elevated to or above two feet above the base flood elevation. This local requirement is two feet higher than the minimum NFIP requirement.

2.2.10 NY & NJ HARBOR & TRIBUTARIES FOCUS AREA FEASIBILITY STUDY

Water levels in the study area may also be affected by a regional, large-scale project to protect the New York Metropolitan Area and six New Jersey cities from storm surge. The United States Army Corps of Engineers (USACE) evaluated 5 alternatives in a report titled “New York-New Jersey Harbor and Tributaries Coastal Storm Risk Management Interim Report,” published in March 2019. The alternatives include various combinations of shoreline-based measures (such as floodwalls, levees, and nature-based features) and storm surge gates. Two alternatives (Alternatives 2 and 3A in the USACE report) include a storm surge gate located along the East River near the Throgs Neck Bridge (Interstate 295). USACE modeling showed that these two alternatives may induce flooding outside of the barrier, such as at Glen Cove. The City of Glen Cove is about 5 miles east of the proposed gate location.

The USACE reported that this induced flooding would need to be addressed or mitigated in the alternative, and the cost of such mitigation must be considered in the cost-benefit analysis. The interim report does not include these costs. The USACE had planned to complete the study in 2021, however, in 2020 the study lost its federal funding and is, therefore, currently paused. Although it does not appear that such regional flood mitigation projects are likely to be implemented in the short-term, the City should continue to monitor the progress of the study and continue its involvement in any available USACE-sponsored public engagement processes.

2.3 INTENSE PRECIPITATION

Intense precipitation is a flood hazard for the study area. Intense precipitation is also referred to as urban flooding, or cloudburst flooding. This type of flood is a result of direct precipitation, usually high intensity and localized, upon poorly drained or impervious surfaces, and of sufficient intensity to exceed the capacity of the local storm drain network. The effect of intense precipitation depends on topography, land use, and the stormwater system. The terrain data in Figure 2 shows the study area is bordered by high ground to the south and east. Precipitation on these areas as well as on the study area can contribute to flooding. In addition, Glen Cove Creek is subject to riverine flooding resulting from precipitation on its contributing watershed. The watershed, which is approximately 14.4 square miles, is shown on Figure 10. Intense precipitation at the study area has been characterized using several different data sources, which are summarized below.

2.3.1 NOAA ATLAS 14 PRECIPITATION FREQUENCY STUDY

The most up-to-date publication on design rainfall for the study area is NOAA Atlas 14 Volume 10, published by the Hydrometeorological Design Studies Center within the Office of Water Prediction of the NOAA National Weather Service. The publication, last updated in 2019, contains precipitation depths for selected storm durations and recurrence intervals in the Northeast United States. The precipitation depths were calculated using regional frequency analysis from 7,629 climate gauges. The precipitations depths for the City of Glen Cove are presented in Table 2-8.

Table 2-8: Point Precipitation Frequency Estimates, in inches

Duration	Average Recurrence Interval (years)									
	1	2	5	10	25	50	100	200	500	1,000
10-min	0.5	0.6	0.8	0.9	1.1	1.2	1.4	1.5	1.7	1.9
15-min	0.6	0.7	0.9	1.1	1.3	1.4	1.6	1.8	2.1	2.3
30-min	0.8	1.0	1.3	1.5	1.8	2.0	2.2	2.5	2.9	3.2
1-hr	1.1	1.3	1.6	1.9	2.3	2.6	2.9	3.2	3.7	4.0
2-hr	1.4	1.7	2.1	2.5	3.0	3.3	3.7	4.1	4.7	5.2
3-hr	1.7	2.0	2.5	2.9	3.4	3.9	4.3	4.8	5.4	6.0
6-hr	2.1	2.5	3.1	3.6	4.3	4.9	5.4	6.1	7.0	7.7
12-hr	2.5	3.0	3.8	4.4	5.4	6.1	6.8	7.6	8.9	9.9
1-day	2.8	3.4	4.5	5.3	6.5	7.3	8.3	9.4	11.0	12.5
2-day	3.2	3.9	5.1	6.2	7.6	8.6	9.7	11.1	13.2	15.0
3-day	3.5	4.3	5.6	6.7	8.2	9.3	10.5	12.0	14.3	16.2

A historic rainfall event was recorded on Long Island on August 13, 2014, near Islip, NY, about 24 miles southeast of the study area. The rainfall event, which resulted in extreme flash flooding, was analyzed by the NOAA Hydrometeorological Design Studies Center (HDSC). The HDSC published a report titled "Exceedance Probability Analysis for the Islip, NY Rainfall Event, 13 August 2014" which reported the following recorded rainfall depths from the storm:

- 30-minutes: 3.2 inches
- 1-hour: 5.8 inches
- 2-hour: 9.8 inches
- 3-hour: 11.5 inches
- 6-hour: 13.0 inches
- 12-hour: 13.3 inches
- 1-day: 13.6 inches
- 2-day: 13.6 inches
- 3-day: 13.6 inches

Comparing the data to Table 2-8, the storm equaled or exceeded the 1,000-year 10-min through 1-day events. The NOAA Atlas 14 Volume 10 publication does not specify whether the 2014 rainfall event at Islip, NY, was included in NOAA's frequency analysis.

2.3.2 NATIONAL CLIMATE ASSESSMENT REPORT

Changing rainfall patterns for the United States are summarized in the Climate Science Special Report: Fourth National Climate Assessment, Volume I, published in 2017. The report is an assessment of the science of climate change, written to help assess climate-related risks and inform decision-making. NOAA was the administrative lead for the report. The report was written by scientists from various federal agencies, national laboratories, universities, and the private sector from 2016 to 2017. The report includes a discussion of both observed and projected changes in precipitation.

The scientists concluded there is suggestive evidence[4] that total annual precipitation has decreased in much of the West, Southwest, and Southeast, and increased in much of the Northern and Southern Plains, Midwest, and Northeast. Future changes are projected to vary widely by season and location. Suggestive evidence shows that for the Northeast, total seasonal precipitation is projected to continue to increase, with a more significant increase during winter and spring than summer and fall (see Figure 11).

The scientists concluded that there is moderate evidence[5] showing that heavy precipitation events in most parts of the United States have increased in both intensity and frequency. The largest increases were observed in the Northeast. Moderate evidence shows that the frequency and intensity of heavy precipitation are projected to continue to increase over the 21st century (see Figure 12). The projections show an increase in both heavy precipitation events and no-precipitation days (i.e., an increase in the extremes) (see Figure 13).

Research shows that there is strong evidence that increased water vapor resulting from higher temperatures is the primary cause of the increased precipitation.

2.3.3 RAINFALL GAUGE DATA

The closest climate gauge to the study area is at Sea Cliff, NY (GHCND:USC00307587), shown on Figure 14. The gauge has data from 1994-2005. Due to the short period of record at the gauge, data from the following, more distant gauges, was

[4] Suggestive evidence means a few sources with limited consistency, incomplete models, emerging methods, and competing schools of thought.

[5] Moderate evidence means several sources with some consistency, varying methodology, limited documentation, and medium consensus.

obtained:

- Mineola, NY (GHCND:USC00305377) (period of record: 1938 – 2010)
- Farmingdale Republic Airport, NY (GHCND:USW00054787) (period of record: 2000 – 2020)
- LaGuardia Airport, NY (GHCND:USW00014732) (period of record: 1940 – 2020)

The gauges are part of the Global Historical Climate Network (GHCN), which is comprised of climate records from numerous sources that have been integrated and subjected to a common suite of quality assurance reviews. Total annual precipitation at the Sea Cliff gauge ranged from 1 to 15 inches different than the Mineola, Farmingdale Republic Airport, and LaGuardia Airport gauges, which is a significant difference. However, precipitation trends were analyzed at the Mineola and LaGuardia Airport gauges only because these gauges had the longest period of record. The following graphs were developed using annual data:

- Total Annual Precipitation (Figure 15)
- Maximum Daily Precipitation (Figure 16)
- Number of Days with Greater Than or Equal to 0.01 inch (Figure 17)
- Number of Days with Greater Than or Equal to 0.1 inch (Figure 18)
- Number of Days with Greater Than or Equal to 1 inch (Figure 19)

A best-fit straight-line trend line was added to each graph. The gauges show that the total annual precipitation and maximum daily precipitation are increasing. The number of days with greater than or equal to 0.01 inches and 0.1 inches of precipitation are decreasing at the Mineola gauge. This aligns with the observation from the Fourth National Climate Assessment that the extremes (i.e., no rain or heavy rain) are increasing in frequency, but small and medium sized storms are decreasing in frequency. The LaGuardia Airport gauge shows the number of days with greater than or equal to 0.01 inches and 0.1 inches of precipitation is relatively constant. Both gauges show that the number of days with greater than or equal to 1 inch of precipitation is increasing, further supporting the conclusion from the NCA, considering that greater than 1 inch of rain is a heavy rainfall event.

2.3.4 RUNOFF PATTERNS AND FLOOD-PRONE AREAS

Runoff flow paths and flood-prone locations adjacent to and within the study area were evaluated using two-dimensional hydraulic modeling with the software HEC-RAS version 5.0.7. HEC-RAS uses a grid and terrain data to simulate the movement of water. A simple simulation was created using 1.1 inches of rainfall equally distributed over 1 hour, beyond the capacity of the local stormwater system (i.e., the model does not account for flows entering the stormwater system). The resultant inundation limits and flow paths are shown on Figure 20.

Observed ponding in baseball fields to north of Tiegerman School.

The results show the majority of the runoff entering the study area comes from the northeast (near Glen Cove Road) and from the southwest (near Shore Road). Some flows enter the study area from the south, southeast, and east, though to a lesser degree. The locations in the study area that exhibit the most ponding include the northeast baseball fields, Morris Avenue, and some of the industrial parcels near Glen Cove Creek. The ponding at the baseball fields and Morris Avenue drain to Glen Cove Creek via low points through the industrial parcels near the Creek.

Members of the community have noted flooding from recent storm events. Observations include:

- Flooding ("ducks and geese swimming in 2 feet of water"), high water table, and poor drainage at the baseball fields.
- Rain entering the study area from runoff along Robinson and Craft Avenues.
- Flooding at corner of Robinson and Glen Cove Avenues if drains are clogged by debris.
- Flooding and poor drainage behind the Tiegerman School.

Flooding on Shore Road resulting from runoff from Sea Cliff and high tide. The HEC-RAS model was also used to evaluate if the study area could experience flooding from Glen Cove Creek, bordering the northern side of the study area. The maximum recorded streamflow from the Creek was routed through the two-dimensional model. The Creek has a USGS streamflow gauge (ID 01302500) with data from 1939 – 2010. The peak streamflow at the gauge, located near Glen Cove Avenue, was 728 cfs, occurring on September 12, 1960. This flow was routed through the Creek from the downstream side of Glen Cove Avenue to the Long Island Sound. The water level in the Long Island Sound was set to the MHHW. The analysis shows the resultant water level in the Creek at the study area rises marginally above the MHHW elevation, demonstrating there is a low chance of the Creek overtopping the Creek's bulkheads at the study area due to intense precipitation. Note that Glen Cove Creek passes through a culvert underneath Glen Cove Avenue. Review of the terrain data shows that if Glen Cove Avenue is overtopped, the overtopping flows may reach the study area. This scenario could be evaluated further with information on the culvert beneath Glen Cove Avenue.

2.3.5 U.S. EPA STUDY

The U.S. Environmental Protection Agency (EPA) Long Island Sound Office published a study titled "Detecting Climate Change Impacts in Long Island Sound" in 2016. The study included the Mineola climate gauge, as well as 5 other gauges along Long Island. The authors found no evidence of changes in annual precipitation or in the occurrence of high rates of rainfall across the study area overall. The authors found that rainfall in coastal Connecticut and Long Island is decreasing slightly and increasing at more inland stations.

2.4 TEMPERATURE

Since the pre-industrial era (1880-1900), the global average surface temperature has increased 2 degrees. Increasing temperatures is one of the key indicators of climate change, spawning the term "global warming." The increasing temperatures at Glen Cove have been characterized using several different data sources, which are summarized below.

2.4.1 TEMPERATURE GAUGE DATA

Temperature gauge data was evaluated at the Sea Cliff, Mineola, Farmingdale Republic Airport, and LaGuardia Airport gauges. Annual average temperatures at Farmingdale Republic Airport were very similar for Sea Cliff (within 0.5°F). The temperatures at Mineola were slightly higher than Sea Cliff (up to 1.7°F). The temperatures at LaGuardia Airport were the most different (up to 3.4°F warmer at LaGuardia Airport). LaGuardia Airport is located in a highly urban area (the New York City metropolitan area) and for that reason, was not evaluated further for temperature data.

Due to the short period of record at Sea Cliff, trends of temperature change were evaluated at Mineola and Farmingdale Republic Airport only. The following graphs were developed using annual data:

- Daily Maximum (Figure 21)
- Daily Minimum (Figure 22)
- Daily Average (Figure 23)
- Number of Days with Maximum Temperature Greater Than or Equal To 70°F (Figure 24)
- Number of Days with Maximum Temperature Greater Than or Equal To 90°F (Figure 25)
- Number of Days with Minimum Temperature Less Than or Equal to 32°F (Figure 26)

The data shows that temperatures are rising. The data shows the Mineola gauge has reported about a 2.3°F increase between 1940 and 2010. The trend line, which is a best-fit straight line, shows a rate of about 3° per century. The number of days above 70°F and 90°F is increasing by about 16 days and 13 days per century, respectively, at the Mineola gauge. The number of days below 32°F is decreasing by about 19 days per century.

The Mineola gauge and Farmingdale Republic Airport gauge show some differences. For example, at Mineola, the annual average maximum temperature is increasing faster than the annual average minimum temperature, while at Farmingdale Republic Airport, the annual average minimum temperature is increasing faster than the annual average maximum temperature.

2.4.2 NATIONAL CLIMATE ASSESSMENT REPORT

As discussed above, the Climate Science Special Report: Fourth National Climate Assessment, Volume I (published in 2017) is an assessment of the science of climate change, with a focus on the United States. The report was written by scientists from various federal agencies, national laboratories, universities, and the private sector from 2016 to 2017. The scientists compared the average temperatures between two time periods, 1986-2016 and 1901-2016. They reported that the annual average temperature over the contiguous United States has increased by 1.2°F for the period. Increasing temperatures for the Northeast United States are summarized in Table 2-8. The frequency of cold waves has decreased since the early 1900s, and the frequency of heat waves has increased since the mid-1960s (see Figure 27). The number of high temperature records set in the past two decades far exceeds the number of low temperature records.

Table 2-8: Observed Changes in Temperature for Northeast United States, between the Time Period 1986-2016 and 1901-1960

	Degrees Fahrenheit
Change in Annual Average Temperature	1.43
Change in Annual Average Maximum Temperature	1.16
Change in Annual Average Minimum Temperature	1.70
Change in Coldest Day of the Year	2.83
Change in Warmest Day of the Year	-0.92*

*Difference is negative due to the unprecedented summer heat of the 1930s Dust Bowl era.
Note: Changes are the difference between the average for present-day (1986-2016) and the average for the first half of the last century (1901-1960).

The scientists concluded that over the next few decades (2021-2050), annual average temperatures are expected to rise by about 2.5°F for the United States, relative to the recent past (average from 1976-2005), under all plausible future climate scenarios. The magnitude of climate change beyond the next few decades will depend primarily on the amount of greenhouse gasses (especially carbon dioxide) emitted globally. The increase in global temperatures for the various RCP scenarios is shown in Figure 28.

Future projected temperature changes for the Northeast United States are shown in Table 2-9. Note that extreme temperatures are expected to increase more than average temperatures. Cold waves are projected to become less intense while heat waves will become more intense. The number of days below freezing is projected to decline while the number of days above 90°F is expected to rise.

Table 2-9: Projected Changes in Annual Average Temperature for Northeast United States (Base Period is Near-Present – 1976-2005)

Time Period		Degrees Fahrenheit
Mid Century (2036-2065)	Change in Annual Average Temperature (RCP4.5)	4.0
	Change in Annual Average Temperature (RCP8.5)	5.1
	Change in Coldest Day of the Year (RCP8.5)	9.5
	Change in Extreme Cold Wave* (RCP8.5)	15.9

Time Period		Degrees Fahrenheit
	Change in Warmest Day of the Year (RCP8.5)	6.5
	Change in Extreme Heat Wave* (RCP8.5)	12.9
Late Century (2071-2100)	Change in Annual Average Temperature (RCP4.5)	5.3
	Change in Annual Average Temperature (RCP8.5)	9.1

* Extreme cold wave / heat wave is a 5-day 1-in-10-year event.

2.4.3 NOAA SUMMARY FOR NEW YORK STATE

In 2017, NOAA published State Climate Summaries consisting of observed and projected climate change information. For New York, the summary includes the following key takeaways:

- The warming in New York has been concentrated in the winter and spring, while summers have not warmed as much (see Figure 29a).
- Since the 1960s, the number of very hot days has been below the long-term average (1900 – 2014), however, increasing nonetheless (see Figure 29b).
- The number of warm nights was the highest on record during the most recent 5-year period (2010-2014) (see Figure 29c).
- The number of very cold nights has been below average since the 1990s (see Figure 30).

The summary discussed why extreme heat is a particular concern for urban areas due to urban heat island. The urban heat island effect is the raise in temperature resulting from heat-retaining asphalt and concrete, lack of vegetation, and man-made heat from buildings, cars, etc.

2.5 KEY TAKEWAYS

A summary of key takeaways regarding climate change at the study area are summarized below:

- With strong confidence, sea level is rising. Different studies estimate different rates of rise and the rate of rise depends on different emissions trajectories. Sea level rise results in higher tides as well as higher extreme water levels during Nor'easters, tropical storms, and hurricanes. As a result, the low-lying areas of the study area will be subject to more frequent coastal flooding. The low-lying areas of the study area are along Glen Cove Creek and the baseball fields north of the Tiegerman School.
- Storm surge stillwater elevations and sea level rise projections are available from multiple sources. From a regulatory standpoint, water levels at the study area are prescribed by the stillwater elevations provided by FEMA and the sea level rise projections provided by New York State.
- With medium confidence, heavy precipitation events are increasing in intensity and frequency. Areas that exhibit ponding now are expected to exhibit more frequent and more significant ponding in the future. Based on the terrain of the study area and surrounding area, ponding from rainfall events is most expected at the baseball fields north of the Tiegerman School and along Morris Avenue and Park Place.
- With strong confidence, air temperature is rising. This results in fewer days below freezing and more days with extreme heat. The rate of rise depends on different emission trajectories.

3.0 CLIMATE CHANGE VULNERABILITY ASSESSMENT

3.1 OVERVIEW

Vulnerability is the measure of the capacity of a person/community/system to resist or recover from the impacts of a hazard, over both the short- and long-term. Vulnerability considers the probability and the consequences of a hazard. For example, the consequences of flooding can include fatalities, injuries, property damage, infrastructure damage, damage to the environment, and interruption of business and services. Probability is the likelihood (or chance) that a hazard will occur at a specific location. Another way to view vulnerability is from a "risk-based" approach. Risk is defined as the product of probability and consequence.

An uninhabited and undeveloped area would have low vulnerability because no people or infrastructure are present which could be harmed or damaged. On the other hand, a developed area could have high vulnerability because people and/or infrastructure may be harmed. The degree of vulnerability depends on what is present in the area, the extent of the hazard (including the probability that it will occur), and how the hazard affects the area.

Section 2 characterized the coastal flood, intense precipitation, and temperature hazards within the study area, now and in the future. Section 3 evaluates these hazards in the context of the people and infrastructure located in the study area. This information allows us to understand the study area's risk and to assess the potential benefits of climate adaptation strategies, as discussed in Section 5.

3.2 WESTERN GATEWAY EXISTING CONDITIONS OVERVIEW

The first part of the vulnerability assessment is to understand the existing conditions of the study area in terms of land use, demographics, shoreline, zoning, and assessor's data.

3.2.1 LAND USE

The study area covers approximately 66 acres of the City of Glen Cove. The land uses in the study area, shown on Figure 31, include industrial, community services (e.g., schools, utilities), recreational open space, commercial offices, recreational buildings, dining, and retail. The low-lying areas in the study area, which are most likely subject to flooding, are mostly industrial, community services, and recreational open space.

Adjacent to but beyond the limits of the study area are the following: residential areas are to the south and east; downtown Glen Cove, with offices, residences, retail, and dining, is to the northeast; a large, new mixed-use development is to the north of Glen Cove Creek; and the Glen Cove Wastewater Treatment Plant and Glen Cove Marina are to the west.

3.2.2 DEMOGRAPHICS

Based on 2017[6] census data, the study area and immediate surrounding area are approximately 38% Hispanic, 34% White, 16% Black, and 12% Asian/Other (see Figure 32). Census data shows that the percent Hispanic has been generally increasing since 1970, though it dropped slightly from 2010 to 2017. The age distribution of the residents are as follows:

- under 5: 7%
- 5-17: 20%
- 18-24: 8%
- 25-34: 15%
- 35-44: 18%
- 45-54: 10%
- 55-84: 21%
- 85 and older: 2%

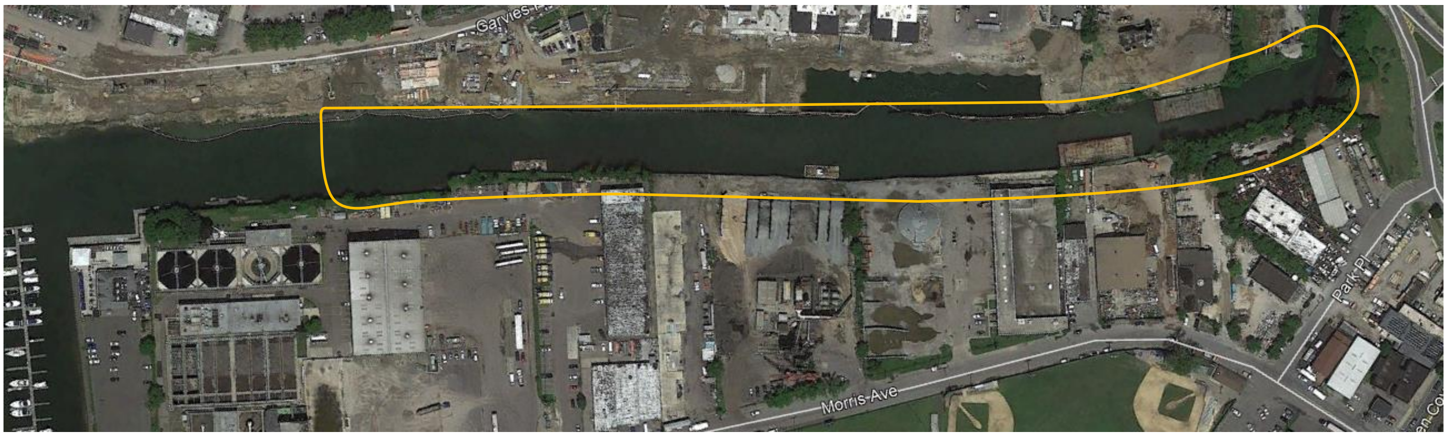
[6] Data was obtained from the Long Island Index interactive map, showing census data for Census Tract 5172 (study area) and nearby neighborhoods. 2019 census data is available for Census Tract 5172, however it is not currently presented in the Long Island Index.

The median family income is approximately $59,000 (see Figure 33), which is lower than the rest of Glen Cove and the surrounding municipalities. Approximately 28% of people over 25 years have 4 years or more of college (see Figure 34); 51% have a highest education level between 9th grade to some college; and 21% have an educational attainment less than 9th grade. Approximately 31% of the population has an income below the poverty line (see Figure 35), and this percentage has been increasing since 2000. The percentage of renter-occupied housing units is 71% and increasing (see Figure 36).

Note that since 2017, some developments have occurred in the surrounding area which may affect these demographics. Most notably, new residential developments have been constructed along the north side of Glen Cove Creek, as well as in downtown Glen Cove, at the intersection of Bridge Street, Glen Street, and School Street.

3.2.3 SHORELINE

Based on review of aerial imagery and street view images from Google Maps, as well as property descriptions from assessor's data for the waterfront parcels, the majority of the study area shoreline is a manmade vertical wall (i.e., bulkhead) that extends approximately 0.35 mile along Glen Cove Creek. The vertical wall is composed of sheet piles. In some areas, the sheet piles are adjacent to vegetation, and in other areas the sheet piles are adjacent to bare land (asphalt or soil).



Google Earth imagery (June 2019) showing study area shoreline.

Google Street View (June 2018) showing vertical bulkhead along study area shoreline.

3.2.4 ZONING

Residential (R1, R-3 and R-4), Light Industrial (I-1), Industrial (I-3), and the Glen Cove Avenue Redevelopment Incentive Overlay (RIO-CGA) District cover the zoning for the study area (see Figure 37). Per the City of Glen Cove's legislation on zoning (Chapter 280), the permitted uses for each type of zoning includes:

- R-1 One Acre Residence District: 1) Single-family dwelling with only one housekeeping unit; 2) Any municipal building or use; 3) Florist, greenhouses, farms, country estates, nurseries; and 4) Regularly organized public, parochial and private nonsectarian elementary and secondary schools per § 280-55A(4).

- R-3 Quarter-Acre Residence District: 1) Single-family dwelling with only one housekeeping unit; and 2) Regularly organized public, parochial and private nonsectarian elementary and secondary schools per § 280-55A(4).

- R-4 Seven-Thousand-Five-Hundred-Square-Foot One – and Two-Family Residence District: 1) Single-family dwelling; 2) Two-family dwelling; and 3) Any municipal buildings or uses, regularly organized public, parochial or private elementary or secondary school in accordance with requirements of § 280-55A(4) of the R-1 District.

- I-1 Light Industrial: 1) Business or professional offices, research, design and development laboratories; and 2) Manufacturing, assembling, converting, altering, finishing, cleaning or any other processing or storage of products or materials except garbage, trash, refuse, waste, sludge or the residue of any of the foregoing.

- I-3 Industrial: 1) same as I-1; 2) Coke and coal yards; 3) Lumber and building material yards and mills; 4) Contractors equipment and material storage; 5) Light and power plant; 6) Municipal garbage disposal; 7) Municipal incinerator; 8) Stone cutting and monument works; and 9) Garage, automobile repair shops.

- Glen Cove Avenue Redevelopment Incentive Overlay (RIO-CGA) District: 1) Multiple dwellings, condominium dwellings and townhouses on at least three acres of real property within the zoning district, subject to site plan approval by the Planning Board; and 2) As an accessory to multiple dwellings, condominium dwellings and townhouses, the following uses may also be authorized:

  - Real estate office for the marketing and sales of the units and signs related thereto, provided such signs comply with the City of Glen Cove Sign Ordinance.

  - Indoor and outdoor recreation facilities, including indoor swimming pools, spas, tennis courts, clubhouse, pool house, recreation and/or fitness centers, business centers and meeting spaces, provided that such facilities are planned as an integral part of the principal use and are for the use of residents of such principal use and their guests.

  - Off-street parking areas or garages.

  - Commercial uses such as convenience stores, laundry or dining facilities, or similar accessory uses, provided they are for the exclusive use of the residents and their guests.

  - Guard Booth.

  - Management Office.

3.2.5 PARCEL, BUILDING, AND ASSESSORS DATA

The study area includes 63 parcels and approximately 70 buildings (see Figure 38). Buildings take up about 14% of the study area (9 acres). The majority of the buildings are located along both sides of Glen Cove Avenue and the north side of Morris Avenue, adjacent to Glen Clove Creek.

The total assessed value for each parcel is shown on Figure 39. Assessed values range from $16,000 for a small barren strip of land to $10,308,000 for the parcel containing the Tiegerman School. Other parcels with high assessed values include the Boys and Girls Club and Glen Cove Transfer Station. The recreational fields and City's compost area (southwest corner) also have high assessed values.

3.3 FLOODING VULNERABILITY ASSESSMENT

The study area's vulnerability to coastal flooding and intense precipitation flooding was evaluated by completing an inventory of essential community facilities, infrastructure, high value assets, and natural and recreational resources in the study area and comparing their location and elevation to available flooding data. Vulnerability was qualitatively characterized as follows:

- High: indicates a high probability of occurrence and a significant consequence.
- Moderate: indicates a high probability of occurrence and a consequence of minor significance, or a moderate probability of occurrence and a moderate consequence, or a low probability of occurrence and a significant consequence.
- Low: indicates a low probability of occurrence and/or a consequence of minor significance.

3.3.1 ESSENTIAL COMMUNITY FACILITIES

Essential facilities are those facilities essential to public safety and welfare and include buildings and other structures that continue to provide services (such as emergency response and recovery) during extreme weather including flooding, wind, snow, or earthquakes.

Essential Facilities located within or in close proximity to the study area are shown on Figure 40 and summarized in Table 3-1. Approximately minimum ground elevations[7] at each facility are included in the table. The coastal flooding vulnerability of the study area's Essential Facilities was evaluated relative to the current 500-year recurrence interval coastal flood (i.e., 500-year flood) as well as the predicted 500-year flood elevations through the year 2100 (using an Intermediate sea level rise projection). Per the American Society of Civil Engineers / Structural Engineering Institute (ASCE/SEI) Standard 24-14, which provides guidelines for flood resistant design and construction, essential facilities are classified as "Flood Design Class 4." Flood Design Class 4 structures are evaluated for risk relative to the 100-year flood plus a minimum freeboard (2 or 3 feet) or the 500-year flood, whichever is higher. The vulnerability of the Essential Facilities to intense rainfall was also qualitatively evaluated relative to the runoff patterns presented in Figure 20.

Table 3-1: Flood Risk Profile of Western Gateway Essential Facilities

Facility	Approximate Minimum Ground Elevation (feet)	Coastal Flood Risk			Intense Rain Flood Risk
		Current (500-year stillwater elev. = 13.5 feet)	2050 (500-year stillwater elev. = 14.8 feet)	2100 (500-year stillwater elev. = 16.3 feet)	
Glen Cove Department of Public Works Yard at 100 Morris Avenue	8	High	High	High	Moderate
Glen Cove Transfer Station at 100 Morris Avenue	8	High	High	High	Moderate
Glen Cove Wastewater Treatment Plant	8	High	High	High	Moderate
Nassau County Public Works Facility at 12 Morris Avenue	9	High	High	High	Moderate
Cove Animal Rescue	17	Low	Low	Low	Low
Glen Cove Avenue (main access route for Police/Fire)	19	Low	Low	Low	Moderate
Fire Department at 10 Glen Cove Avenue	23	Low	Low	Low	NA[1]
Police Station at 1 Bridge Street	30	Low	Low	Low	NA[1]

1. Preliminary modeling for runoff was not modeled at the fire department or police station because these structures are not in the study area.

[7] USGS Long Island New York Sandy LiDAR, extracted in 2014.

The Glen Cove DPW Yard, Glen Cove Transfer Station, Glen Cove Wastewater Treatment Plant, and the Nassau County DPW facility are vulnerable to coastal flooding. The ground elevation at the facilities is between the current 10-year and 50-year flood elevation. The existing bulkhead that runs along the northern perimeter of the properties protects the properties from coastal flooding up to the elevation of the top of bulkhead. The facilities' vulnerability is principally due to the flood elevations exceeding the bulkhead crest elevations and flood waters entering the sites via low-lying facility entrances and egresses. For the wastewater treatment plant, coastal flooding could disable the plant by filling tanks and critical components with flood water. Untreated wastewater, as a result, may be redirected to overflow destinations or may backflow onto streets and into basements. In addition, saltwater intrusion can cause corrosive damage to the plant and can reduce the plant's treatment efficiency. In January 2021, Nassau County announced that is has approved $12.2 million for new systems and equipment for the wastewater treatment plant. A new bulkhead is also planned for the wastewater treatment plant and is discussed below in Section 3.3.2.

The Police and Fire Stations are at elevations above the projected 500-year flood level through 2100. A significant risk associated with Police and Fire is road flooding which could impact the capability of the City to provide emergency response due to impassable conditions. Glen Cove Avenue, a major access route to the Police and Fire Department, is elevated above the 500-year flood, including projected sea level rise. Other roads, such as Shore Road which provides access to the west of the study area, are at greater risk for coastal flooding. Shore Road is at approximately the 10-year flood elevation (see Table 3-3 below). During the current 500-year flood, the road would have flood depths of approximately 6.5 feet.

The Glen Cove DPW Yard and Nassau County DPW facility appear to be vulnerable to flooding from intense rainfall. Preliminary runoff modeling shows both sites are within low areas where runoff will travel through or accumulate as it drains to Glen Cove Creek. The Transfer Station and Wastewater Treatment Plant are also along runoff paths, though slightly elevated above these low points. Glen Cove Avenue is vulnerable to some flooding as rainfall along high ground to the east of the study area travels west toward the study area and toward Glen Cove Creek. The vulnerability to intense rainfall flooding is particularly applicable to future conditions when the intensity of storms is expected to be greater and may more frequently overwhelm the capacity of the local drainage network (see Section 2.3.2).

Cove Animal Rescue is located on higher ground and has low vulnerability to both coastal flooding and intense precipitation.

3.3.2 INFRASTRUCTURE

The infrastructure assessed in the study area includes coastal structures (e.g., seawalls, wharves, and bulkheads), lifeline systems (e.g., sanitary sewer, stormwater drainage systems, utilities, and gas stations), and transportation systems.

Coastal Structures

The study area shoreline is composed of a vertical sheet pile bulkhead. The purpose of a bulkhead is to prevent the sliding of the land into the water body (in this case Glen Cove Creek), and it also protects the study area from coastal flooding (including wave action) up to the bulkhead's crest elevation[8]. A bulkhead typically consists of the armor layer (which is sheet pile at the study area), filter layers (to provide drainage of the underlying soil), and toe protection (to provide stability from erosion of the bottom of the bulkhead). The presence of filter layers and toe protection at the study area's bulkhead is unknown.

Increasing water levels warrant consideration for the bulkhead's stability. Bulkhead design must consider the forces exerted on the bulkhead: static pressure from the soil and water, and dynamic forces such as wave action and seepage. These forces are important factors in overturning, especially for sheet pile bulkheads. Increasing water levels will affect the forces on the bulkhead and therefore may affect the stability of the bulkhead. The stability of the bulkhead also depends on how it is anchored to the ground. Other vulnerabilities to increasing water levels are corrosion of the sheet pile from splashing and scour at the bulkhead toe (from wave action and currents).

Increasing water levels also warrant consideration for the bulkhead's crest elevation. A bulkhead provides flood protection up to its lowest crest elevation. Based on Google Earth imagery, the bulkhead is flush with the ground elevation at some

[8] "Design of Coastal Revetments, Seawalls, and Bulkheads", Engineering Manual 1110-2-1614, U.S. Army Corps of Engineers, June 1995.

locations and elevated in other locations.

Google Earth imagery (April 2016) showing study area's bulkhead.

Using ground elevation data and imagery, it appears the lowest point in the bulkhead crest is along the west side of the study area by Glen Cove Marina or along the north side of the study area behind 10 Morris Avenue. At both locations, the ground and bulkhead crest elevation appear to be approximately 8 feet. This elevation is between the current 10-year and 50-year flood elevations. Whether the bulkhead is elevated above the ground (now or in the future) also affects the site's drainage ability. If the bulkhead is elevated, water will accumulate behind the bulkhead unless a drainage mechanism is installed. The bulkhead's crest elevation is an important consideration for the study area's adaptation to climate change.

A recent article[9] in the Glen Cove Herald Gazette stated that on August 3, 2020, Nassau County approved funding for a new bulkhead along the Glen Cove Wastewater Treatment Plant. The article stated the existing bulkhead exhibits wear and tear at locations in contact with water. The article included several quotes from locals stating the existing bulkhead is deteriorated. The County is planning to soon send out a bid for proposals to do the work. The article mentioned that the bulkhead on the north side of the Creek was already replaced as part of the newly constructed mixed-used development.

The bulkhead replacement work is depicted on construction plans and specifications prepared in January 2020 by H2M architects + engineers. The plans show the existing bulkhead top varies from elevations 8.7 feet to 9.4 feet along the Wastewater Treatment Plant. The existing bulkhead was surveyed in 2016. The bulkhead replacement, which spans about 300 feet of the canal shoreline, entails removing the top portion of the existing bulkhead and installing a new bulkhead 18-inches offset from the existing bulkhead. The top of the new bulkhead is at elevation 9.3 feet. This elevation is between the current 10-year and 50-year flood elevations. The specifications include a Subsurface and Groundwater Investigation Report by Carlin-Simpson & Associates, dated December 2016. The investigation included 6 borings along the existing bulkhead and identified the subsurface conditions as 4 soils types (from top to bottom): topsoil, existing fill, silt with organics, and sand. Some petroleum odor and soil staining were observed at one of the borings, indicating possible contamination.

The article in the Glen Cove Herald Gazette also stated that Glen Cove Creek is going to be dredged to remove existing contaminants.

Lifeline Systems

Lifeline Systems are those public and private utility facilities that are vital to maintaining or restoring normal services to flooded areas before, during, and after a flood. Lifeline systems located in the study area include:

- Sanitary Sewer System (see Figure 41, based on City of Glen Cove GIS data)

[9] "New bulkhead coming to G.C. sewage plant", Glen Cove Herald Gazette, September 3-9, 2020.

    - 8,850 feet of sewer pipes
    - 38 sewer manholes
    - 1 sewer pump station (adjacent to study area)
- Stormwater Drainage System (see Figure 42, based on City of Glen Cove GIS data)
    - 6,510 drainage pipes
    - 36 catch basins
    - 34 manholes
    - 3 outfalls
    - Some additional existing drainage structures may exist along Morris Avenue (based on plans from the Waterside Recreational Redevelopment (WRR))
    - Conceptual plans for the WRR include constructing new drainage structures near the Glen Cove Transfer Station.
- Utilities (see Figure 43, based on available City of Glen Cove GIS data)
    - Power lines (electricity, cable/internet/phone)
    - 12,300 feet of water mains
    - 38 water valves
    - Other underground utilities (gas, cables)
- Gas Stations (see Figure 44)

Google Street View imagery (June 2019) showing power lines and lighting along Morris Avenue and the adjacent baseball fields.

Table 3-2 below presents the flood risk profile for each independent lifeline system. The coastal flooding vulnerability was evaluated relative to the current FEMA FIRM BFE (11 feet) as well as the predicted 100-year flood elevations through the year 2100 (using an Intermediate sea level rise projection).

Table 3-2: Flood Risk Profile of Western Gateway Lifeline Systems

Facility	Approximate Minimum Ground Elevation (feet)	Coastal Flood Risk			Intense Rain Flood Risk
		Current (100-year stillwater elev. = 10.9 feet)	2050 (100-year stillwater elev. = 12.2 feet)	2100 (100-year stillwater elev. = 13.7 feet)	
Sanitary Sewer System	Underground	Moderate	Moderate	Moderate	Moderate
Stormwater Drainage System	Underground	High	High	High	High
Utilities: Water System	Underground	Moderate	Moderate	Moderate	Moderate
Utilities: Power Lines	7 (wires elevated, however)	Moderate	Moderate	Moderate	Low
Gas Stations	22	Low	Low	Low	Low

Note: Gas and underground cables not included because no mapping data was available.

Intense rainfall most directly impacts the stormwater drainage system because the system's purpose is to drain runoff that results from rainfall. Observations from members of the community suggest the existing stormwater drainage system may not be adequate for proper drainage of the study area, particularly at the baseball fields adjacent to Morris Avenue. Review of the stormwater drainage system shows there are no apparent catch basins along Morris Avenue. The baseball fields adjacent to Morris Avenue are reported to have a high water table, and engineers have stated they believed the area once contained a pond. From preliminary runoff modeling (see Figure 20), much of the ponding in the baseball fields appears to come from runoff east of the study area, along Glen Cove Avenue, which does have catch basins. Runoff also enters the study area from Shore Road, to the southwest, which also has catch basins. The effectiveness of these upstream catch basins is unknown. Drainage of the study area is affected by a combination of the drainage system in the study area, as well as drainage systems in areas that are uphill and contribute runoff to the study area. The WRR includes catch basins and drainage pipes at a proposed parking area near the Glen Cove Transfer Station.

Projected increased intense rainfall will most directly impact the stormwater drainage system. Increased rainfall intensity may result in more debris clogging the system and the system may reach its maximum capacity more frequently. Pipes that are undersized will surcharge (i.e., flow full and under pressure) and this will exacerbate flooding in the areas which the pipes typically drain. If pipes are not designed to handle surcharge pressures, the pipes can be damaged.

The typical design storm for stormwater drainage systems is between 5-years and 10-years per New York State Department of Transportation guidance.[10] Similarly, the City of Glen Cove General Legislation for the Subdivision of Land[11] suggests using a 10-year storm for drainage improvements. The City of Glen Cove General Legislation for Stormwater Management[12] states stormwater management be designed according to the New York State Stormwater Management Design Manual, which also suggests the 10-year storm. The Nassau County DPW drainage requirements[13] do not specify a design storm frequency for stormwater drainage systems. However, the Nassau County DPW does specify that developers are responsible for providing storage for eight inches of runoff. Providing on-site storage reduces inflows to the stormwater drainage system.

As noted in Section 2, the frequency and intensity of heavy precipitation are projected to continue to increase over the 21st century. In terms of the stormwater drainage system design, the practical consequence is that the return-period based design storm is a moving target, changing with time as formal guidance such as NOAA Atlas 14 precipitation depths are periodically updated. For example, in New York City, guidance suggests that the 5-year storm in the 2080s will approximate

[10] New York State Department of Transportation, Highway Design Manual, Chapter 8, Table 8-2, Rev. 91, May 31, 2018.
[11] Chapter 245. Subdivision of Land, Article III. General Requirements and Design Standards.
[12] Chapter 237, Stormwater Management, Article V, Performance and Design Criteria for Stormwater Management and Erosion and Sediment Control.
[13] Nassau County Department of Public Works, Drainage Requirements, undated. https://www.nassaucountyny.gov/1876/Stormwater-Management-Program.

the 50-year storm in 2020.[14] This equates to 1.6 inches in one hour today increasing to 2.6 inches in one hour in 2080. The practical consequence in terms of performance is that the stormwater drainage system will be more frequently overwhelmed by intense precipitation, leading to localized flooding and ponding.

The City's stormwater drainage system is also vulnerable to coastal flooding. The system discharges stormwater untreated into the Glen Cove Creek via outfalls. The pipe network is therefore directly connected with the Creek. Coastal flooding that reaches the elevation of the outfall will fill the drainage pipes, thereby reducing the system's capacity and possibly causing pipes to backflow. Saltwater intrusion may cause corrosive damage. It is not currently known if the outfalls have gates, flap valves, or other measures to prevent this from occurring.

The sanitary sewer system and utilities are located in the low-lying sections of the study area. The sanitary sewer system and water distribution system are vulnerable to coastal flooding via water infiltration (groundwater seeps through cracks, leaky pipe joints, or deteriorated manholes) and corrosive damage from saltwater. The water distribution system has the additional hazard of contamination of the drinking water. Sanitary sewer systems are also vulnerable via water inflow (stormwater enters through illegally connected rain leaders, basement sump pumps, or drains).

The power lines in the study area are elevated by wooden poles. However, they remain vulnerable to erosion of pole foundation from floodwaters. Gas and cable utilities were not investigated in this plan. Most likely underground cables are present, for example, for the lighting at the baseball fields. Underground cables need to be adequately protected from flooding. Underground pipes for gas are vulnerable to water infiltration, which can reduce system pressure and limit distribution capacity.

The gas stations in and adjacent to the study area are located at high ground and therefore, have low vulnerability to coastal flooding.

Transportation Systems

Transportation systems located in and adjacent to the study area include roadways, bus routes, railroads, and ferries. The roadways in the study area include Morris Avenue, Glen Cove Avenue, Shore Road, and Park Place. Traffic volumes for these roads are shown on Figure 45. Glen Cove Avenue has an average traffic volume of about 14,000 vehicles/day and Shore Road has an average traffic volume of about 1,000 vehicles per day. Members of the Tiegerman School have noted that speeding motorists along Glen Cove Avenue endanger their staff, students, and students' parents. Traffic volume is not available for Morris Avenue and Park Place, likely because these roads have volumes. The flood risk for the roads is provided in Table 3-3. The coastal flooding vulnerability was evaluated relative to the current FEMA FIRM BFE (11 feet) as well as the predicted 100-year flood elevations through the year 2100 (using an Intermediate sea level rise projection).

Table 3-3: Flood Risk Profile of Study Area Roads

Road	Approximate Minimum Ground Elevation (feet)	Coastal Flood Risk			Intense Rain Flood Risk
		Current (100-year stillwater elev. = 10.9 feet)	2050 (100-year stillwater elev. = 12.2 feet)	2100 (100-year stillwater elev. = 13.7 feet)	
Morris Avenue	6	High	High	High	High
Shore Road	7	High	High	High	High
Park Place	12	Low	Moderate	High	Moderate
Glen Cove Avenue	19	Low	Low	Low	Moderate

The minimum elevations of Morris Avenue and Shore Road is approximately equal to the current 10-year flood elevation from FEMA; therefore, the roads are at high risk for coastal flooding. The flooding of Shore Road is likely more disruptive since that road has a higher traffic volume. However, Morris Avenue provides access to some essential facilities, such as the Glen Cove DPW Yard, Nassau County Public Works Facility, Glen Cove Transfer Station, and Glen Cove Wastewater

[14] New York City, Mayor's Office of Recovery and Resiliency, Climate Resiliency Design Guidelines, version 3.0, March 2019.

Treatment Plant. Preliminary runoff modeling (see Figure 20) shows that Morris Avenue is also at high risk for flooding from intense rainfall, with maximum depths at the west end of the road. Review of the stormwater drainage system shows there are no apparent catch basins along Morris Avenue to facilitate drainage. Shore Road is also vulnerable, with maximum depths near the west end of the study area.

The minimum elevation of Park Place is approximately equal to the 100-year flood elevation projected for 2050 (with Intermediate sea level rise). The road therefore is less vulnerable than Morris Avenue and Shore Road. However, it is also vulnerable to flooding from rainfall, particularly at its intersection with Morris Avenue.

Glen Cove Avenue has the highest traffic volumes, and fortunately is also the most elevated. Its minimum elevation is approximately equal to the FEMA 500-year flood elevation in 2100 assuming a High sea level rise projection. Preliminary runoff modeling (see Figure 20) shows this road could experience some shallow flooding from runoff travelling westward, from the high grounds east of the study area to the low elevations in the study area.

The bus routes, railroad, and ferry[15] are shown on Figure 46 and each system's flood risks are summarized in Table 3-4. Note that the ferry and railroad are not located within the study area, but they are in the neighborhood and may impact access to the study area. The coastal flooding vulnerability was evaluated relative to the current FEMA FIRM BFE (11 feet) as well as the predicted 100-year flood stillwater elevations through the year 2100 (using an Intermediate sea level rise projection).

Table 3-4: Flood Risk Profile of Public Transportation at and Near the Study Area

Transportation System	Approximate Minimum Ground Elevation (feet)	Coastal Flood Risk			Intense Rain Flood Risk
		Current (100-year stillwater elev. = 10.9 feet)	2050 (100-year stillwater elev. = 12.2 feet)	2100 (100-year stillwater elev. = 13.7 feet)	
Ferry Terminal	14	Low	Low	Low	NA
Bus	19	Low	Low	Low	Moderate
Railroad	79	Low	Low	Low	NA

Note: Preliminary modeling for runoff was not modeled near the ferry or railroad because these structures are not in the study area.

Each public transit infrastructure is elevated above the 2100 100-year flood elevation. Preliminary runoff modeling (see Figure 20) shows some vulnerability of the bus system because Glen Cove Avenue may be subject to flooding from intense rain.

Non-motorized transportation infrastructure includes sidewalks, which are present on Glen Cove Avenue and Shore Road, but not Morris Avenue or Park Place. See Table 3-3 for a discussion of each road's flood risk.

3.3.3 HIGH VALUE ASSETS

High value assets within the study area include the Boys and Girls Club and the Tiegerman School (see Figure 40). The flood risk for the facilities is provided in Table 3-5. The coastal flooding vulnerability was evaluated relative to the current FEMA FIRM BFE (11 feet) as well as the predicted 100-year flood elevations through the year 2100 (using an Intermediate sea level rise projection).

[15] Ferry terminal has been built but ferry service is not yet active.

Table 3-5: Flood Risk Profile of High Value Assets

Facility	Approximate Minimum Ground Elevation (feet)	Coastal Flood Risk			Intense Rain Flood Risk
		Current (100-year stillwater elev. = 10.9 feet)	2050 (100-year stillwater elev. = 12.2 feet)	2100 (100-year stillwater elev. = 13.7 feet)	
Tiegerman School	12	Low	Moderate	High	Low
Boys and Girls Club	33	Low	Low	Low	Moderate

The Boys and Girls Club is on high ground and coastal flood risk is low. It is located along a steep slope however, and preliminary runoff modeling shows flooding may occur around the northwest corner of the building. The Tiegerman School's approximate minimum ground elevation equals the FEMA 100-year flood elevation for 2050. The ground at the building is slightly elevated above the adjacent open fields, and preliminary runoff modeling shows intense rainfall ponding in the fields but not directly at the school building.

3.3.4 NATURAL AND RECREATIONAL RESOURCES

Recreation resources in the study area are summarized on Figure 47. The figure shows both existing and proposed resources. Recreation resources have been proposed in the study area as part of the Waterside Recreation Redevelopment (WRR) plan, last updated July 2017. The plan includes a near-term plan, which includes a multipurpose field at the existing Glen Cove compost area, and a longer-term vision, which includes a baseball field, indoor facility, play area, picnic area, esplanade along Glen Cove Creek, and residential structures. The longer-term vision is conceptual and therefore subject to change. Existing recreation resources include eight baseball fields, two playgrounds (part of the Tiegerman School), and two basketball courts.

The flood risk for the existing recreational resources is provided in Table 3-6. The coastal flooding vulnerability was evaluated relative to the current FEMA FIRM BFE (11 feet) as well as the predicted 100-year flood elevations through the year 2100 (using an Intermediate sea level rise projection). The flood risk for the proposed additions was not included in Table 3-6 because the ground elevations of the proposed structures has not been identified yet.

Table 3-6: Flood Risk Profile of Recreational Resources

Facility	Approximate Minimum Ground Elevation (feet)	Coastal Flood Risk			Intense Rain Flood Risk
		Current (100-year stillwater elev. = 10.9 feet)	2050 (100-year stillwater elev. = 12.2 feet)	2100 (100-year stillwater elev. = 13.7 feet)	
Four Baseball Fields to Northeast	10	High	High	High	High
Basketball Court Near Baseball Fields	12	Low	Low	Moderate	Low
Playgrounds	12	Low	Low	Moderate	Low
Four Baseball Fields to Southwest	18	Low	Low	Low	Low
Basketball Court at Boys and Girls Club	33	Low	Low	Low	Low

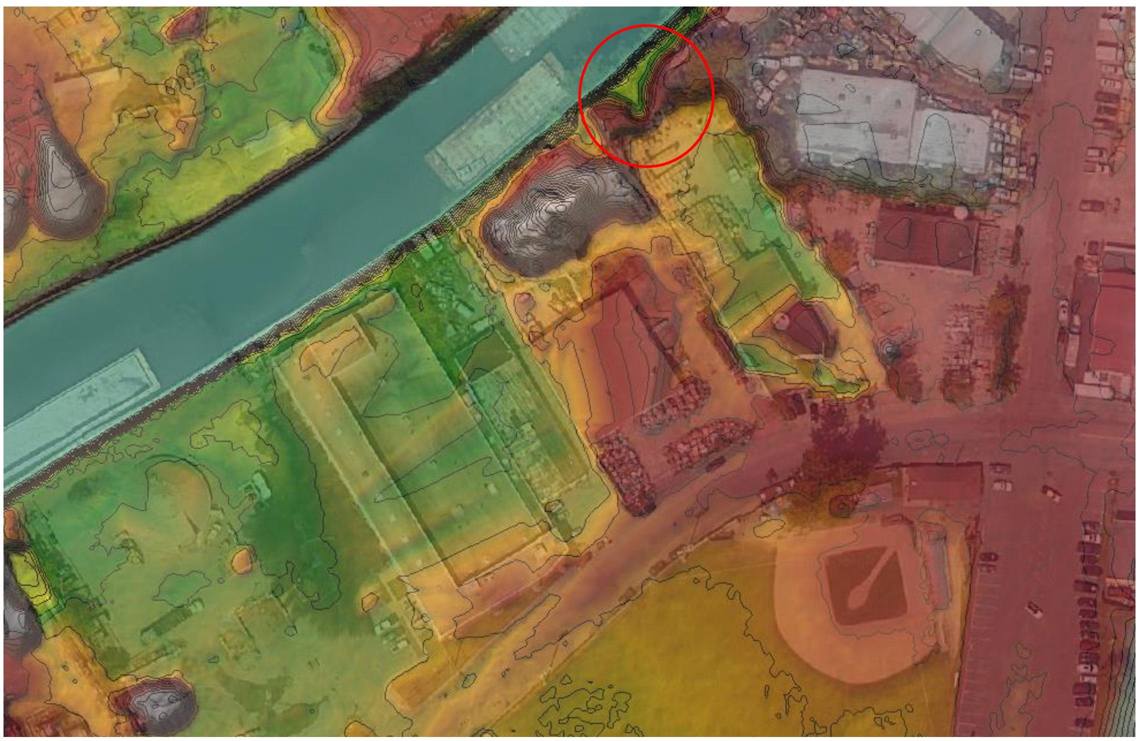
The existing baseball fields are located at two different elevations. The four fields to the northeast are lower than the four fields to the southwest. The four baseball fields to the northeast have a minimum ground elevation that is approximately equal to the existing 50-year flood elevation. The other four baseball fields are elevated and coastal flood risk is low. The four baseball fields to the northeast are also at the receiving end of incoming runoff from areas northeast, east, and southeast of the study area.

Preliminary runoff modeling, as well as historic observations from the Tiegerman School and other members of the community, suggest the fields are prone to flooding and drainage problems. Darcy A. Belyea, a member of the community, recalls that the area has a high water table and engineers believed the area once contained a pond. Ms. Belyea recalls that additional pilings had to be installed for stability during construction of the Tiegerman School extension building.

Increasing intensity and frequency of heavy precipitation in the future suggest the problems may worsen. Preliminary runoff modeling shows the four baseball fields to the southwest are less prone to flooding from runoff. The rest of the existing recreational resources have mostly low to moderate flood risks.

The proposed recreational resources are located either adjacent to Glen Cove Creek or near Glen Cove Marina. The existing ground elevations at the proposed structures range from 6 feet to 33 feet. Most of the area is low-lying, however, there is some high ground at the location of the proposed multipurpose field (currently the location of the City compost area). The proposed additional baseball field, esplanade, indoor facility, play area, and picnic area (part of the longer-term vision) will most likely have a high coastal flood risk, unless they are raised significantly higher than the existing ground elevation.

These proposed structures are also along the path of runoff draining to Glen Cove Creek. The location of the proposed picnic area shows topography that suggests runoff has eroded a small channel leading to Glen Cove Creek (see image below). Preliminary runoff modeling shows the proposed picnic area and proposed additional baseball field are particularly vulnerable to ponding. New construction in the area will have to accommodate these regional runoff patterns, in addition to direct rainfall upon the area. The vulnerability of the multipurpose field will depend on its elevation. The location of the field currently contains a hill which indicates re-grading will be required.



Terrain data shows possible erosion along Glen Cove Creek, or presence of a previous drainage channel.

Sport fields and other outdoor recreation areas are often strategically placed in flood-prone areas because flooding causes less damage to a field than to structures such as buildings. However, at a minimum, the fields will be unusable while they are flooded. The post-flood condition of the field will depend on its composition and design. Therefore, drainage is important.

The study area does not have many apparent natural resources. Clusters of trees are located at the City compost area, as well as between the boundary of the baseball fields and Glen Cove Avenue parcels. Some vegetation is along the Creek. The study area does not have any identifiable streams or water bodies.

3.4 TEMPERATURE VULNERABILITY ASSESSMENT

The study area's vulnerability to increasing temperatures was evaluated with a literature review of publications that discuss the impacts of increasing temperatures. The documents reviewed include the following:

- Heatwave Guide for Cities, by Red Cross Red Crescent Climate Center, 2019.
- U.S. Climate Resilience Toolkit, by U.S. Federal Government, 2019.
- Fourth National Climate Assessment, Volume II, U.S. Global Change Research Program, 2018.

The impacts most applicable to the study area are summarized in Table 3-7.

Table 3-7: Impacts of Increasing Temperatures and Applicability to Study Area

Impacts of Increasing Temperatures	Applicability to Study Area
During heat waves, people are more prone to dehydration, heat exhaustion, heat stroke, loss of consciousness, and other medical emergencies. People who are the most vulnerable include elderly, people working outside, infants, people with pre-existing medical conditions, and pregnant and lactating women. If people live alone, they are also more vulnerable because they may not get help. Lower income families are also more vulnerable because they may not have air conditioning in their home/car, they may have labor-intensive jobs, and they may have limited access to healthcare.	People [1,2]
Heat and sunshine can intensify ground-level pollution by mixing with nitrous oxide gases (from sources like car exhausts) to create ozone, a pollutant. People who are most vulnerable to poor air quality include young children, the elderly, and people with pre-existing medical conditions, such as asthma.	People[2]
During heat waves, high energy use may overwhelm the electricity grid which can result in blackouts.	Infrastructure; people
Heat waves can trigger water use restrictions, which have occurred in Glen Cove before.	People
Heat waves can reduce the number of hours outdoor workers can be employed safely and reduce the productivity of offices without adequate cooling.	People; economy
More warm days can expand the season for mosquitos, such as those that carry Zika and West Nile viruses, and other disease vectors.	People
More energy will be required to cool homes and businesses, and thus higher utility bills. Note that this may be offset by reduced heat costs due to milder winters.	Infrastructure; people
A longer warm season combined with nutrient pollution (i.e., fertilizer, yard waste, detergents that reach the stormwater system) can increase the risk of harmful algal blooms in water bodies.	Glen Cove Creek
Heat waves can accelerate the degradation of asphalt roads, buckle railroad and subway tracks, and cause thermal expansion of bridges.	Infrastructure

1. Demographics of the study area show 31% are below the poverty line.
2. Demographic of the study area show 7% are under age 5, 21% are age 55 – 84, and 2% are over age 85.

The major impact discussed in the publications was the health effects of heat waves. A main vision for the growth of the study area is to invite people to experience the transforming waterfront area or play sports at improved recreational facilities. Therefore, addressing heat waves is an important consideration for the study area's growth. The study area is in an urban area, and subject to urban heat island effect (increased temperatures due to asphalt, concrete, lack of vegetation, buildings, cars). The current long-term vision for the study area includes large areas for open sports fields and parking as well as residential structures. The lack of trees and the presence of asphalt may result in exacerbated high temperatures. Exposed equipment, surfaces, or seating can absorb heat and contribute to high temperature effects. For example, Crumb-Rubber Infilled Synthetic Turf Athletic Fields can have dramatically higher temperatures as compared to grass.[16] Physical exertion or lack of hydration while participating in athletics during extreme heat conditions also increases individual

[16] "Information About Crumb-Rubber Infilled Synthetic Turf Athletic Fields", New York State Department of Health, October 2018. (https://www.health.ny.gov/environmental/outdoors/synthetic_turf/crumb-rubber_infilled/fact_sheet.htm)

vulnerability.[17] Children have a higher risk of heat stroke and heat-related illness than adults.

Increasing temperatures for the study area were evaluated in Section 2.4.1 using nearby temperature gauge data. Based on the trends from the temperature gauge, the following trends are observed for the study area:

- daily maximum temperature is increasing by about 5°F per century;
- number of days with maximum temperature above 90°F is increasing by about 13 days per century; and
- number of days with maximum temperature above 70°F is increasing by about 16 days per century.

Because these trends are based on historic observations, they do not consider different emissions trajectories. Scientists concluded in the Fourth National Climate Assessment that by 2050, regardless of emissions trajectories, annual average temperatures are expected to rise 2.5°F – which is a larger rise than that predicted from the temperature gauge data near the study area. Beyond 2050, the extent of the temperature increase depends on the emissions. This suggests the trends from the temperature gauge data are a low estimate for the increasing temperatures at the study area. Table 3-7 shows that these trends are expected to result in increased illness from both heat and pollution, increased energy usage during warm seasons, longer season for disease vectors (like mosquitos), more nutrient pollution, and heat-related degradation of roads.

3.5 KEY TAKEAWAYS

A summary of key takeaways regarding the study area's vulnerabilities to climate change are summarized below:

- The Glen Cove DPW Yard, Glen Cove Transfer Station, Glen Cove Wastewater Treatment Plant, and Nassau County Public Works Facility have high vulnerability to flooding. These facilities are located at low elevations adjacent to Glen Cove Creek, which makes them prone to coastal flooding. They are also located at the receiving end of runoff from upstream areas. These facilities, especially the Wastewater Treatment Plant, provide essential services.
- The study area shoreline is composed of a vertical sheet pile bulkhead and has high vulnerability to coastal flooding. Higher water levels may affect the bulkhead's stability. In addition, higher water levels warrant a discussion about whether the shoreline should be raised to protect the study area.
- The stormwater drainage system has high vulnerability to increasing intense precipitation and coastal flooding. Increasing intense precipitation is expected to overwhelm the drainage system more frequently. Members of the community have observed that parts of the study area are not adequately drained, suggesting the existing drainage system is not adequate. Increasing intense precipitation is expected to exacerbate these problems. Coastal flooding will also affect the stormwater drainage system by filling the outfalls and drainage pipes unless tide gates/valves are installed to prevent reverse flows.
- Morris Avenue and Shore Road have high vulnerability to coastal flooding and increasing intense precipitation. Both are located at low elevations and are also at the receiving end of runoff entering the study area. Shore Road has a higher traffic volume; however, Morris Avenue provides access to essential facilities like the Wastewater Treatment Plant, Public Works facilities, and the Glen Cove Transfer Station. Park Place is projected to have high vulnerability in the future (by 2100) due to sea level rise.
- The Tiegerman School is a high value asset that is projected to change from having low flood vulnerability to having high flood vulnerability (by 2100) due to sea level rise.
- The study area's baseball fields are at two different elevations – four fields to the northeast are at a lower elevation than the four fields to the southwest. The four fields to the northeast have high vulnerability to coastal flooding. The fields are also at the receiving end of runoff entering the study area and have high vulnerability to flooding from increasing intense precipitation. The four baseball fields to the southwest have less vulnerability due to their higher ground elevation.
- The recreation features included in the proposed WRR will most likely have high vulnerability to coastal flooding and increasing intense precipitation because the ground elevation at the proposed features is at a low elevation

[17] "Heath and Athletes", Centers for Disease Control and Prevention, June 2019. (https://www.cdc.gov/disasters/extremeheat/athletes.html)

and along runoff paths towards Glen Cove Creek. The drainage system for the recreation area is still conceptual. With a robust drainage design, the area's vulnerability may be reduced.

- A main vision for the growth of the study area is to invite people to experience the transforming waterfront area or play sports at improved recreational facilities. For this reason, the study area has high vulnerability to increasing temperatures, particularly in the form of heat waves. During heat waves, people are more prone to dehydration, heat exhaustion, and other medical emergencies. Heat and sunshine can also intensify ground-level pollution. Addressing heat waves is an important consideration for the study area's growth.

4.0 PUBLIC OUTREACH AND FEEDBACK

To be written for later versions of this report.

4.1 PUBLIC MEETING NO. 1

To be written for later versions of this report.

4.2 PUBLIC MEETING NO. 2

To be written for later versions of this report.

5.0 RESILIENCE AND ADAPTATION STRATEGIES AND MEASURES

5.1 OVERVIEW

Resilience and adaptation strategies for climate change are being implemented across the United States by governments, communities, businesses, and individuals. Implementation typically includes some type of upfront investment to achieve longer-term savings and can be guided with benefit-cost analyses. Effective adaptation can also enhance social wellbeing, which can be incorporated into benefit-cost procedures. Some of these benefits include opportunity, health, equity, security, education, social connectivity, cultural resources, and environmental quality. Adaptation actions that address multiple community goals (not just climate change) are typically more effective that those that don't.[18]

5.2 COASTAL FLOOD AND INTENSE RAINFALL HAZARDS STRATEGIES, MEASURES, AND RECOMMENDATIONS

Section 5.2 provides an overview of strategies and measures for reducing vulnerability to coastal flood and intense rainfall hazards. Strategies and measures can be categorized in a number of ways. In this plan, the approach to developing the strategy is categorized in one of three ways:

1. Protect,
2. Accommodate, or
3. Retreat.

Subsequently, the means of implementation is categorized as:

A. Non-structural,
B. Structural, or
C. Nature/natural-based.

5.2.1 PROTECT, ACCOMMODATE, RETREAT

The flood resiliency and adaptation approaches are defined as follows:

Protect is a range of interventions designed to hold back flooding from inundating developed areas. Protections can be implemented on a small scale (e.g., a non-residential building can be dry floodproofed by installing temporary or permanent flood barriers at entrances and other penetrations below the design flood elevation) or a regional scale. A regional strategy of Protect is typically applied to flood hazards and implemented through a series of flood protection projects such as levees and floodwalls, which provide perimeter flood protection along and near the flood source. This strategy is or has been used in many flood-prone areas of the U.S., such as New York City and New Orleans. These flood protection projects can be integrated with public green space to provide recreation and natural resource access. The appropriate "level" of flood protection (i.e., "how high would a levee or floodwall be") is a function of technical and regulatory feasibility, compatibility with other uses, cost, prevented losses, and impact on insurance cost. Protect can also be applied to flood hazards from rainfall through the development of effective stormwater systems and drainage paths.

For the study area, an example of Protect for coastal flood hazards could involve the construction of a levee or floodwall along the study area's shoreline. To protect the study area, the levee or floodwall would need to tie into high ground at the southwest corner of the study area (near the intersection of Morris Avenue and Shore Road) and at the northeast corner of the study area. Alternatively, the levee or floodwall could extend beyond the study area, protecting additional areas. The study area coastline is currently a bulkhead. This bulkhead could alternatively be raised, which would require raising the ground elevation at the coast. The presence of a levee, floodwall, or elevated bulkhead, introduces significant hurdles – waterfront views may be obstructed by the barrier and internal drainage needs to be provided. In addition, construction of a levee, floodwall, or elevated bulkhead needs to be evaluated for worsening flood conditions nearby, for example on the

[18] Fourth National Climate Assessment, Volume II, U.S. Global Change Research Program, 2018.

north side of Glen Cove Creek. The levee/floodwall/bulkhead will not prevent backflow through storm sewers, and tide gates would be required along drainage outfalls.

Protection from rainfall hazards would involve enhancing the stormwater system, surface regrading, and possibly creating aboveground drainage channels or additional subsurface storage. Such protections would need to be supported by detailed hydrologic, hydraulic, and civil engineering studies.

Accommodate involves allowing the hazard to occur, but protecting infrastructure, property and natural resources from damage through permanent and interim measures implemented on an on-going basis. A strategy of Accommodate typically includes:

- elevation of buildings, structures and infrastructure using piles/posts/piers/columns or walls/crawlspace, frequently enforced through local, state, and federal codes and regulations (e.g., if properties east of the existing Glen Cove and Nassau County DPW properties were to be redeveloped into future residential structures along the waterfront; for buildings associated with the WRR)
- increase the site grade with fill (must be evaluated for not increasing BFE);
- wet floodproofing of buildings and structures below the BFE (parking areas, storage areas);
- emergency/flood response plans;
- operation, and maintenance of culverts and drainage paths for drainage after inundation;
- operation, and maintenance of pump stations for drainage after inundation;
- use of resilient materials in athletic fields that can resist inundation and can drain quickly;
- dredging of waterways; and
- post-storm repair and clean-up.

The Accommodate measures identified above are typically implemented at lower incremental upfront costs than the costs from Protect and Retreat and are often easier to implement. However, their long-term costs will generally be higher, and their long-term efficiency and benefits are often less.

Lastly, Retreat is managed withdrawal from coastal areas, most often characterized by a change in land use and managed relocation. A common example of Retreat is the acquisition and demolition of existing buildings within a flood hazard-prone area and transformation of the area to a public natural resource. For example, Retreat creates the opportunity to develop a Living Shoreline, which is a protected, stabilized coastal edge made of natural materials such as plants, sand, or rock, which can provide wave dissipation, flood protection, natural stormwater treatment (using green infrastructure), a healthy ecosystem, and public access to greenspace.

A common issue for Retreat-based strategies is that they often run counter to other practical, social, or economic values. For example, relocating the WRR and other vulnerable assets to outside of the study area is not a feasible alternative for the study area. There are multiple motives to locating the redeveloped sports facility within the study area: It will be close to the downtown; the land use of the study area is already established as recreational; it will provide waterfront access for visitors; it will provide recreation facilities to newly developed housing across Glen Cove Creek; and it is located near the ferry. For these and other reasons, relocating the sports facility is not desirable. On a smaller scale, Retreat could involve high value development or redevelopment of the study area's highest elevation areas first (i.e., the least flood-prone areas). For example, WRR recreational features could be prioritized to the four athletic fields to the southwest and at the location of the existing Glen Cove Compost Area, both of which are about 10 feet higher than the surrounding athletic fields and properties along Morris Avenue.

5.2.2 NON-STRUCTURAL, STRUCTURAL, AND NATURAL/NATURE-BASED SOLUTIONS

Flood resiliency measures can be further categorized as 1) Non-Structural; 2) Structural; and 3) Natural and Nature-Based measures. These classifications are consistent with federal guidance from FEMA and USACE.

Non-structural measures reduce human exposure or vulnerability to a hazard without altering the nature or extent of the hazard. Non-structural measures are consistent with the resiliency strategies of Accommodate and Retreat. Examples of non-structural measures (consistent with the USACE National Floodproofing Committee guidance) include:

- Increasing Building Elevations: Elevating existing structures to an elevation which is equal to or higher than the design flood elevation (and consistent with NFIP and building code requirements). The City of Glen Cove's General Legislation currently states new construction of any existing nonresidential structures located in areas of the special flood hazard have the lowest floor, including basement or cellar, elevated to or 2 feet above the Base Flood Elevation (BFE). The NYSDEC's "New York State Flood Risk Management Guidance for Implementation of the Community Risk and Resiliency Act" lists 2 feet freeboard above the BFE for most structures, but 3 feet for critical equipment (such as at a water treatment plant).
- Relocation: Physically moving the at-risk structure and buying the land on which the structure is located.
- Acquisition: Buying the structure and land. The structure is either demolished or sold to others and relocated. This strategy can include development sites to provide locations where displaced people can build new homes within an established community.
- Wet Floodproofing: Prevention or resistance to damage from flooding by allowing flood waters to enter and exit the structure. In accordance with NFIP and building code regulations, wet floodproofing can be performed under certain circumstances. This involves using water and corrosion resistant construction materials, finishing materials and utilities while allowing the unoccupied space to flood (e.g., unoccupied parking garages located beneath the 1% annual chance flood elevation).
- Dry Floodproofing: Waterproofing the structure to make it impermeable to floodwaters. Typically, conventionally built structures (i.e., those without structural reinforcement designed to resist hydrostatic and hydrodynamic forces) can only be dry flood-proofed up to about 3-feet depth. This measure reduces flood risk; however, it is not recognized by the NFIP for any flood insurance premium rate reduction if applied to a residential structure.
- Berms and Floodwalls: Low berms and floodwalls (generally less than 6 feet) and not accredited through the NFIP are considered non-structural measures. These nonstructural measures are intended to reduce the frequency of flooding but not eliminate floodplain management and flood insurance requirements. These measures are generally placed around a single structure or a small group of structures. Their construction cannot result in any increase of the 1% annual chance flood elevation in the adjacent areas.
- Flood Warning System: This nonstructural technique relies upon gages and hydrologic computer monitoring to determine the impacts of flooding for areas of potential flood risk. A flood-warning system, when properly installed and operated, is able to identify the amount of time available for residents and City personnel to implement emergency procedures.
- Flood Emergency Preparedness Plans: Local governments, through collaboration with FEMA and the USACE and other federal and State partners, are encouraged to prepare and maintain a Flood Emergency Preparedness Plan (FEPP) that identifies flood hazards, risks, and vulnerabilities, and identifies mitigation actions, evacuation routes, evacuation and emergency centers and post-flood recovery processes.
- Land Use Regulations: The basic principles for land use regulations are based nationally on the NFIP and implemented in Local and State building codes, which define the minimum standards of floodplain regulation. Local authorities can add additional requirements such as special Design Flood Elevations (DFEs), overlay zones, etc. through local zoning and building codes.

Structural measures are designed to alter the characteristics of the flood hazard and reduce its probability in the location of interest. These measures are consistent with a resiliency strategy of Protect. Traditional flood protection structures include levees, floodwalls, storm surge barrier gates, revetments, groins, nearshore breakwaters, dams, and channels. The purpose of levees, floodwalls, and storm surge barrier gates is to reduce flood inundation extent, where revetments, groins and breakwaters are typically intended to reduce wave action or coastal erosion. Levees, floodwalls, and barrier gates used in this context (as opposed to berms and floodwalls considered non-structural measures) refer to significant projects performed at a large scale that will often result in accreditation in FEMA Flood Insurance Rate Maps (FIRMs).

Natural measures are features that are created and evolve over time through the natural actions of physical, biological, geological, and chemical processes. Nature-Based measures are features that "mimic" natural features but are created by human design, engineering and construction to provide specific services such as coastal risk reduction. Nature-based features are acted upon by the same physical, biological, geological, and chemical process that affect natural features, and therefore will need maintenance to reliably perform. Natural and nature-based features include:

- natural and nourished beaches
- natural and constructed sand dunes, including barrier islands
- natural and constructed oyster reefs
- natural and constructed marshes and wetlands
- constructed vegetative swales
- constructed rain gardens / bioretention cells / bioretention swales / infiltration trenches
- permeable pavements
- native vegetation (to prevent erosion; to increase roughness that reduces water velocity)
- green roofs
- rain barrels/cisterns or disconnected rooftop runoff (directs runoff away from stormwater system and toward vegetated areas)
- stream daylighting (uncover previously-culverted or piped streams)

The approaches and means of implementations are summarized in Table 5-1.

Table 5-1: Summary of Example Approaches and Means of Implementation of Reducing Flood Vulnerability

3 Types of Approach		3 Types of Implementation
Protect Prevent water from reaching site or asset.		**Non-structural** With measures such as new or modified policies that do not necessarily directly alter inundation area.
Accommodate Allow water to reach site but protect site or asset from water damage.		**Structural** With structures that alter inundation area or otherwise serve as a physical barrier.
Retreat Relocate asset or move development to another site.		**Natural** With nature-based features that may alter inundation area.

5.2.3 ALTERNATIVES ANALYSIS

Table 5-2 summarizes how the flood resiliency strategies discussed above could be applied to the study area. Table 5-2 summarizes example flood resiliency strategies specifically for buildings.

Table 5-2: Potential Flood Resiliency Strategies for Alternatives Analysis by Strategy and Asset Category

#	Retreat, Protect, or Accommodate	Non-structural, Structural, or Nature Based	Description (Example)	Essential Community Facilities	Infrastructure	High Value Assets	Natural and Recreational Resources	Responsible Entity
1	Retreat	Non-structural	Prioritize development of WRR recreational facilities along higher elevations within study area (i.e., the location of the 4 southwest baseball fields and the existing Glen Cove Compost Area).	X		X	X	City
2	Protect	Structural	Dry-floodproof non-residential buildings (i.e., install temporary or permanent flood barriers at entrances and other penetrations below the design flood elevation).	X		X	X	Businesses, City
3	Protect	Structural	Install tide gates on outfalls.	X	X	X	X	City/County
4	Protect	Structural	Construct perimeter flood protection (floodwall). The floodwall could incorporate the wastewater treatment plant bulkhead replacement project.	X	X	X	X	City/County
5	Protect	Structural, Nature-Based	Enhance the stormwater system to promote drainage. Can consider nature-based features, such as streams.	X	X	X	X	City/County
6	Accommodate	Non-structural	Elevate buildings (residential or non-residential) using piles/posts/piers/columns, etc.	X		X	X	Residents, Businesses, City
7	Accommodate	Non-structural	Increase the site grade (for roads, fields, new residential/non-residential buildings, etc.).	X	X	X	X	City/County
8	Accommodate	Non-structural	Design sports fields to withstand flooding and drain quickly.				X	Owner of field (City or private)
9	Accommodate	Non-structural	Wet floodproof features below the BFE (parking garages, storage, utilities).	X	X	X	X	Residents, Businesses, City
10	Accommodate	Non-structural	Develop a flood emergency response plan.	X	X	X	X	Residents, Businesses, City
11	Accommodate	Non-structural	Develop a post-storm repair and clean-up plan.	X	X	X	X	City/County
12	Protect or Accommodate	Non-structural	Revise building/zoning regulations	X		X	X	City/County/State

Table 5-2: Example Flood Resiliency Strategies for Buildings[19]

Example Strategy	Considerations	Building Type	
		Non-Residential (Businesses, Government, etc.)	Residential (Single-Family, Multi-Family, etc.)
Build outside of flood prone areas.	For new construction, when practical.	X	X
Elevate above flood elevation using fill.	Within FEMA Zone A, outside of areas prone to wave action. For new construction.	X	X
Elevate existing buildings above flood elevation using structural measures.	Requires engineering analysis and design. Potentially cost prohibitive for larger structures.		X
Protect using perimeter protection such as levees or floodwalls.	Requires engineering analysis and design. Significant regulatory requirements. FEMA accreditation may be required.	X	X
Accommodate using wet floodproofing techniques.	Spaces subject to flooding limited to certain uses. Requires engineering analysis and design.	X	X

5.2.3.1 Essential Community Facilities

To be written for later versions of this report.

5.2.3.2 Infrastructure

To be written for later versions of this report.

5.2.3.3 High Value Assets

To be written for later versions of this report.

5.2.3.4 Natural and Recreation Resources

To be written for later versions of this report.

5.3 HEAT HAZARDS ADAPTATION STRATEGIES, MEASURES, AND RECOMMENDATIONS

Climate change-induced hazards relating to increased temperatures and extreme heat can threaten the well-being of residents and visitors to the study area, at least on a seasonal basis. The adaptation strategies and measures discussed in this section address the vulnerabilities summarized in Table 3-7 by either reducing exposure to the hazard, reducing sensitivity to the hazard, or increasing the ability to recover from the hazard. The strategies listed can be categorized as for people or for infrastructure. The following key references were used to identify these strategies:

- "Heat Islands" website by the United State Environmental Protection Agency, https://www.epa.gov/heatislands, accessed April 2021.
- "Sports for Climate Action", second issue of "Sustainability Essentials – A Series of Practical Guides for the Olympic

[19] Adapted from FEMA P-936, Floodproofing Non-Residential Buildings, July 2013 and FEMA P-312 3rd Edition, Homeowners Guide to Retrofitting, June 2014.

Movement," by the International Olympic Committee and the United National Climate Change, 2018.

5.3.1 STRATEGIES AND MEASURES FOR PEOPLE

People-based adaptation strategies achieve resiliency without the need to construct new infrastructure, which can be costly and require time for permitting, construction, etc. People-based adaptation strategies can be categorized as short-term (i.e., can be implemented in the near future) or long-term (i.e., can be implemented in the later future).

Examples of short-term, people-based strategies include the following:

- Cooling measures:
  - Provide misting fans.
  - Utilize existing buildings as cooling centers.
  - Provide access to water at recreational and group facilities.
- Heat-Health Education and Messaging:
  - Announcements to the community or at group gatherings (e.g., soccer games, athletic tournaments, etc.) when extreme heat is forecast.
  - Advertise cooling centers.
  - Provide basic information about identifying and responding to heat stress (how to avoid, symptoms of heat-related illness, when to seek treatment, etc.).
  - Connect residents/visitors to medical support in the community.
- Administrative controls:
  - Shift outdoor working hours to cooler times of the day.
  - Schedule sports and outdoor recreational activities during cooler times of the day.
  - Manage queuing times so visitors are not standing in exposed areas for long periods.
- Personal Protective Equipment (PPE):
  - Provide sunscreen.
  - Provide hats, sunglasses, handheld fans, etc.

Some strategies are considered long-term because either they take longer to implement or because the vulnerability they address is a secondary effect of increasing temperatures (for example, longer mosquito season). Examples of long-term, people-based adaptation strategies include the following:

- Education:
  - Provide information on modifying buildings to adapt to increasing temperatures.
  - Provide information and incentives for residents and business owners to implement energy efficiency measures and renewable energy to reduce stress on the electricity grid.
  - Provide basic information about avoiding bad air quality resulting from extreme heat and how to reduce air pollution.
- Community Building:
  - Encourage citizens to check on their family, friends, and neighbors (especially those who live alone and are elderly or disabled).
  - Encourage sharing resources (e.g., someone without air conditioning can visit someone with air conditioning).
- Planning:
  - Prepare a Long-Term Heat Response Plan: A coordinated plan that describes and organizes activities to prevent heat-related morbidity and mortality. A heat response plan may be a standalone plan or an annex

to an all-hazards plan.[20]

- Medical Support:
    - Facilitate access to medical care.
- Gather Data:
    - Monitor temperatures and air quality in the study area.
    - Collect feedback from residents and visitors.

5.3.2 STRATEGIES AND MEASURES FOR INFRASTRUCTURE

Infrastructure changes are another way to build resiliency in the study area. Infrastructure changes can reduce the impacts to infrastructure condition, reduce people's exposure to hazards, or otherwise help to modify people's behavior in a manner that increases overall resiliency. Examples of infrastructure changes include the following:

- Add vegetation (vegetation provides cooling effects as well as aesthetic and ecological benefits).
    - Use vegetation for shade[21].
    - Use vegetation to provide green facades on walls and roofs.
- Add infrastructure for freely available drinking water.
- Add shade-providing structures, such as awnings and canopies.
- Add splash-pads or pools.
- Add buildings that can act as a cooling center (i.e., has air conditioning).
- Add medical/first aid facilities.
- Add drainage to reduce breeding grounds for disease vectors, such as mosquitos.
- Construct with heat-resistant materials.
- Construct roofs with light-colored roofing.
- Construct with "cool" pavements, which absorb more solar energy and evaporate less water than traditional materials.
- Construct with consideration for the orientation of buildings/structures with regard to the sun.
- Reduce stress on the electricity grid by adding energy efficiency measures (i.e., natural ventilation) and renewable energy (solar, wind, coastal, geothermal).
- Avoid using gas-powered lawn and garden equipment to reduce air pollution.

5.3.3 RECOMMENDATIONS

To be written for later versions of this report.

5.4 NON-MOTORIZED ACTIVITY TO REDUCE GREENHOUSE GAS EMMISSIONS

The adaptation strategies listed in Sections 5.1 through 5.3 address the effects of climate change. It is important, however, to contribute to the worldwide efforts to address the causes of climate change, which inherently can reduce the effects of climate change. The U.S. EPA[22] reports that the transportation accounts for approximately 28 percent of total U.S. greenhouse gas emissions as of 2018, making it the largest contributor of U.S. greenhouse gas emissions. As the study area

[20] Centers for Disease Control and Prevention, National Center for Environmental Health, Heat Response Plans: Summary of Evidence and Strategies for Collaboration and Implementation. https://www.cdc.gov/climateandhealth/docs/HeatResponsePlans_508.pdf

[21] A 2015 study found that intercepting solar radiation (i.e., providing shade) is the most effective way to reduce heat load on people. ("Designing urban parks that ameliorate the effects of climate change", Landscape and Urban Planning Volume 138, Robert D. Brown et. al, June 2015).

[22] https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions

develops into a regional attraction due to recreational and other development, reduction in motorized transportation is one way for the area to reduce greenhouse gas emissions. Additionally, measures can be considered to reduce emissions from motorized transportation when its use is unavoidable.

5.4.1 STRATEGIES AND MEASURES

Types of non-motorized transportation which could be implemented for transportation to the study area and within the study area are pedestrian access and bicycle access. The recommendations below are elements of "Complete Streets" transportation policies, which aim to provide safe, convenient, and comfortable travel for users of all ages, abilities, and modes of transportation.

Pedestrian accessibility requires sidewalks or walking paths, and crosswalks. Currently, roads within the study area that have sidewalks are Glen Cove Avenue and Shore Road. Morris Avenue and Park Place do not currently have sidewalks. It is important for sidewalks to be provided along routes leading to the study area from locations such as the ferry terminal, train stations (Glen Street station, Glen Cove station, and Sea Cliff station), downtown, and the watercraft marinas along Shore Road. The route between the ferry terminal and the study area (an approximately 15-min walk) includes Garvies Point Road, Herb Hill Road, and Charles Street. Of these streets, only a portion of Charles Street is missing sidewalks. The three trains stations are all about a 25-min walk from the study area and have sidewalks along their routes; however, cross walks are missing in some locations. Existing sidewalks along Glen Cove Avenue provide access to the study area from the downtown. Sidewalks along Shore Road provide pedestrian access between the study area and the Shore Road marinas.

Sidewalks can be designed to be more than a simple concrete slab and they can provide more than just a means of transportation. Sidewalks can provide a place for interaction and engagement, a place to see and be seen, places of economic trade, and places to gather[23]. Sidewalk design can be broken down into the ground plane (sidewalk width, plants, lighting, pavement material/texture/pattern, waste receptables, benches, etc.), roadside plane (curb, street vendors, lighting, parked cars, bike lanes, etc.), canopy (awnings, shade, signs, building height, etc.), and the building wall plane (store/residential fronts –depends on land use, entrances, windows, building architecture, balconies, outdoor seating, etc.). One of the challenges with sidewalks is that they can involve many different parties (private property owner, City, County, etc.).

Walking paths typically course through open or greenspaces and would be a feasible feature to construct within the study area. Constructing walking paths leading to the study area, however, would be challenging because the surrounding area is heavily developed. Some greenspace is noted northwest of the Glen Street train station (along Pratt Boulevard) which could tie into Dennis Brian Murray Park, located directly west of the train station. A walking path along the north side of Glen Cove Creek is currently being constructed. This walking path could eventually tie into existing walking paths at Pratt Park and also tie into plans for Creek Park, a small park planned at the intersection of Charles Street and Glen Cove Avenue.

Pedestrian access is enhanced through wayfinding, or maps and signs that help people find their way around. Signs for the sports fields, downtown, ferry, and train station, for example, could be considered.

Bicycling is another way to provide access to the study area and promote sustainability. Bike accessibility would require the development of bike paths/lanes and bike parking at a minimum, and could include bike share programs, bike maintenance stations, and bike shops. The City is currently discussing a bike share program with Nassau County. The study area could be a good location for a bike share station, with docks and a kiosk. Due to the relatively short distance between the study area and the ferry terminal, marinas, downtown, and train station, biking is not necessarily required to provide access for those areas. However, bicycling could provide access for residents further away, such as in the neighborhoods directly north, northeast, east, southeast, and south of the study area. Bike lanes on major roads, such as Glen Cove Avenue, combined with road sharing on the smaller feeder roads could achieve this goal, though bicyclist safety and other related transportation engineering issues need to be evaluated in a detailed study. Bike paths or bike lanes could eventually connect the study area and downtown Glen Cove to other areas/attractions, such as nearby beaches or the downtown of nearby

[23] "Active Design – Shaping the Sidewalk Experience", City of New York, 2013.

communities, such as Sea Cliff, Glen Head, Roslyn, Oyster Bay, or Locust Valley.

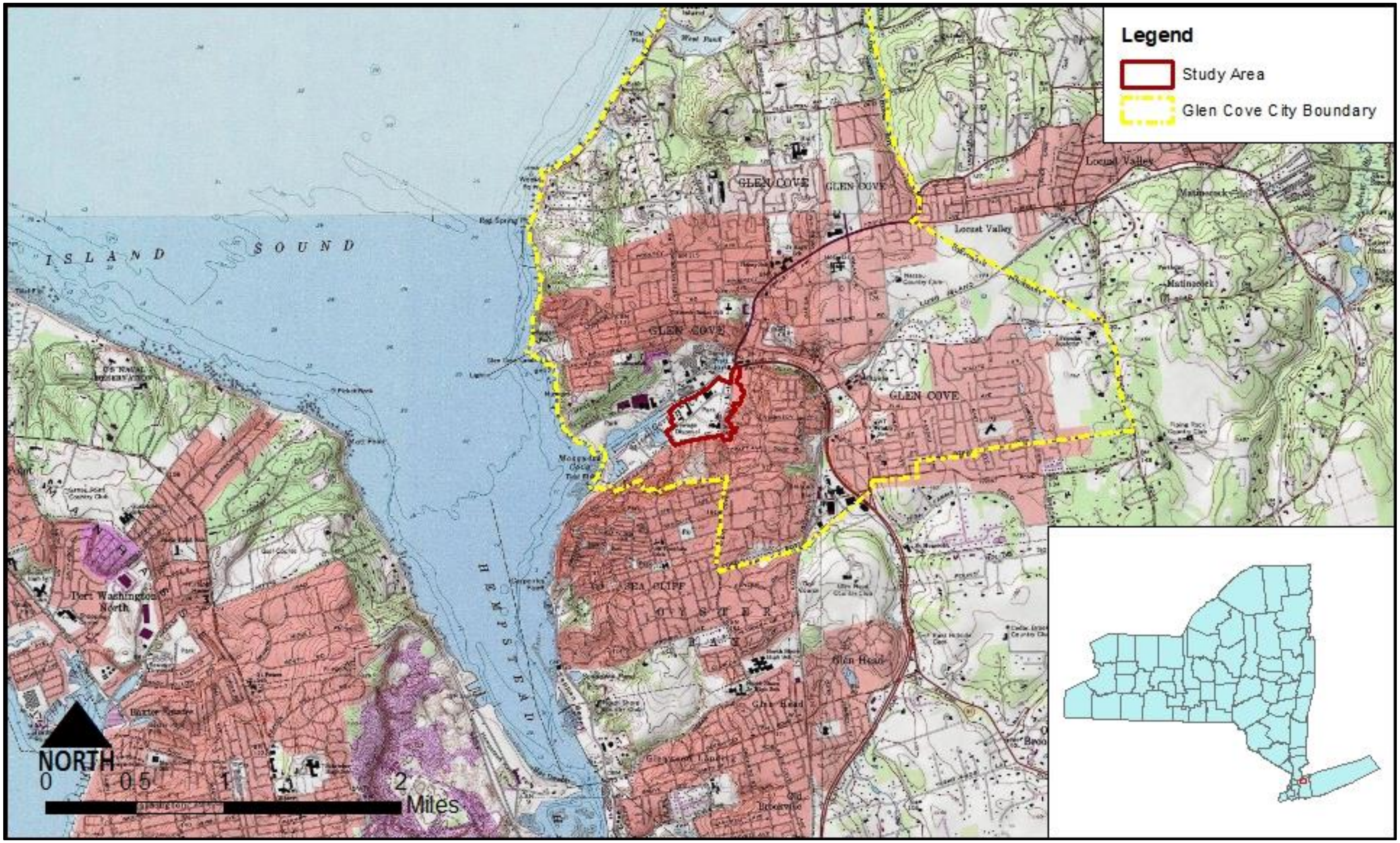
Motorized transportation to the study area is inevitable for people visiting from further away, and therefore, reducing emissions from motorized transportation is important to consider. Promoting public transportation, including the train, ferry, and bus, are ways to reduce greenhouse gas emission. It is possible that as the study area develops and draws more visitors, more frequent routes will be required. Several Nassau Inter-County Express (NICE) bus stations are located in the study area along Glen Cove Avenue. The bus routes provide access to the study area for the neighborhoods directly south and east of the study area. Bus transportation could be promoted through education and covered bus stations. NICE buses use compressed natural gas, which emits less carbon dioxide emissions than conventional fuels. The ferry service, provided by the company Hornblower, may be an opportunity to promote a fuel that results in lower greenhouse gas emissions. Other means of reducing emissions include traffic smoothing (reducing the number and intensity of acceleration/deceleration events), reducing congestion, implementing no idling policies, and plug-in charge stations for electric vehicles.

Speeding of motorized vehicles is a concern for the study area. Members of the community have expressed concern about current speeding along Glen Cove Avenue. Traffic calming measures, such as raised crosswalks, raised intersections, lane narrowing, lane removal, center medians, angled-face-out parking, and street trees / planter strips, can be considered.

5.4.2 RECOMMENDATIONS

To be written for later versions of this report.

FIGURES



Basemap: USA Topo Maps

Figure 1: Locus Map

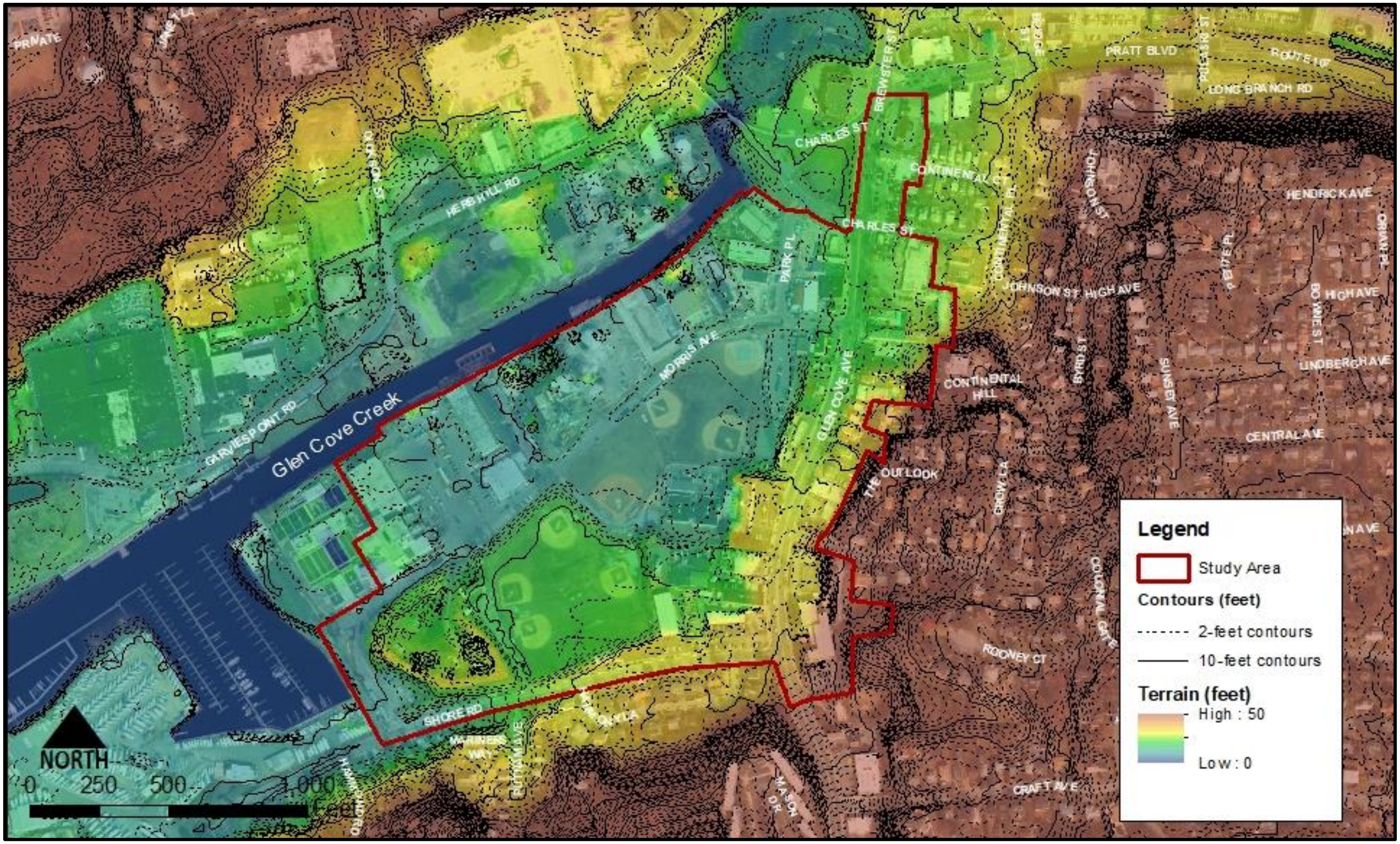


Figure 2: Study Area Topography

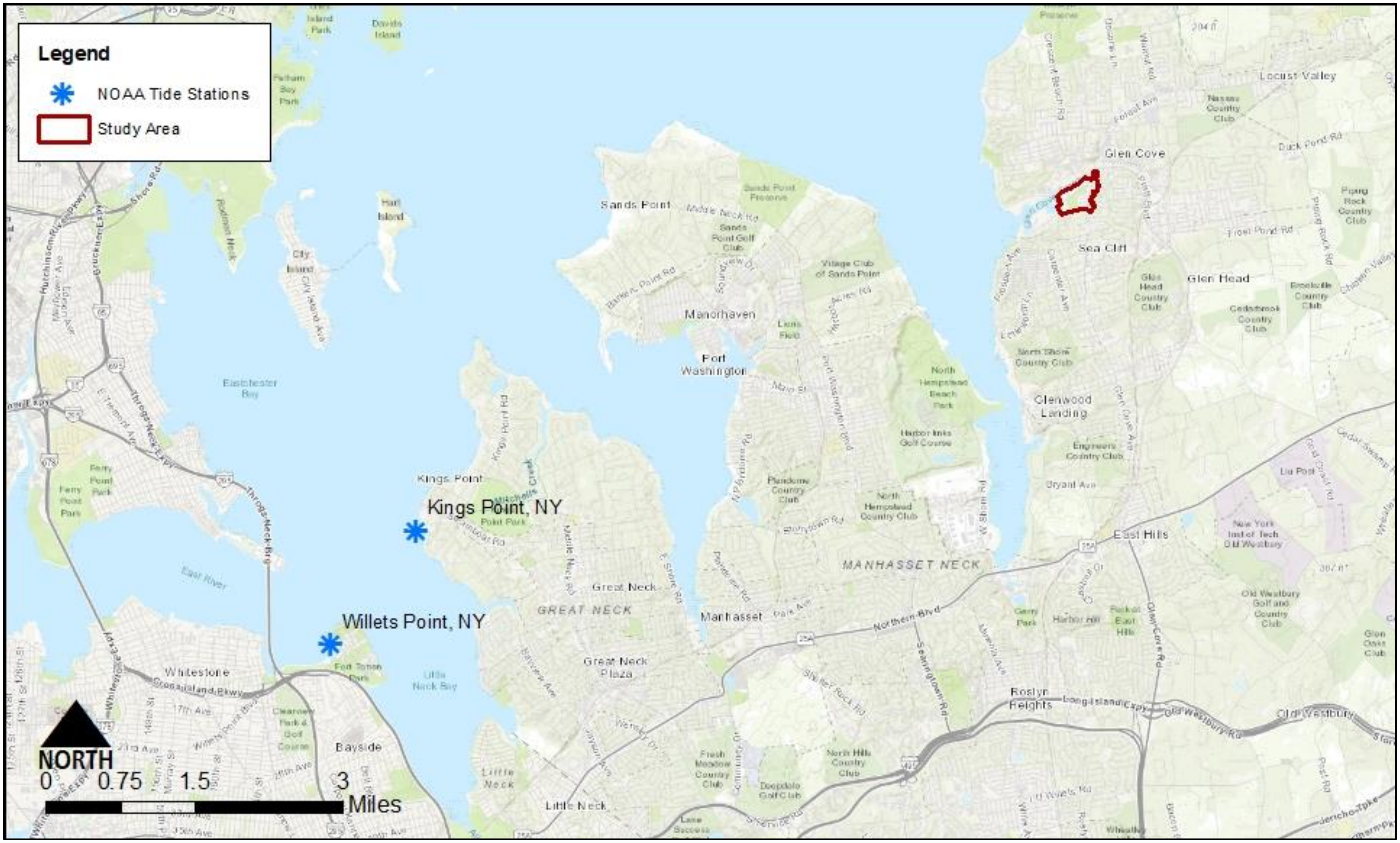


Figure 3: NOAA Tide Stations

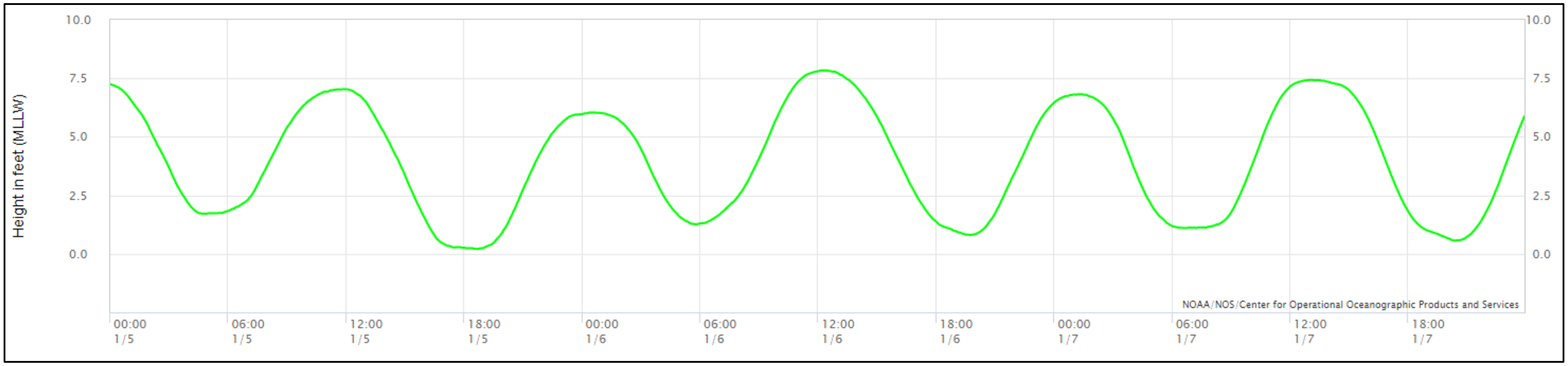
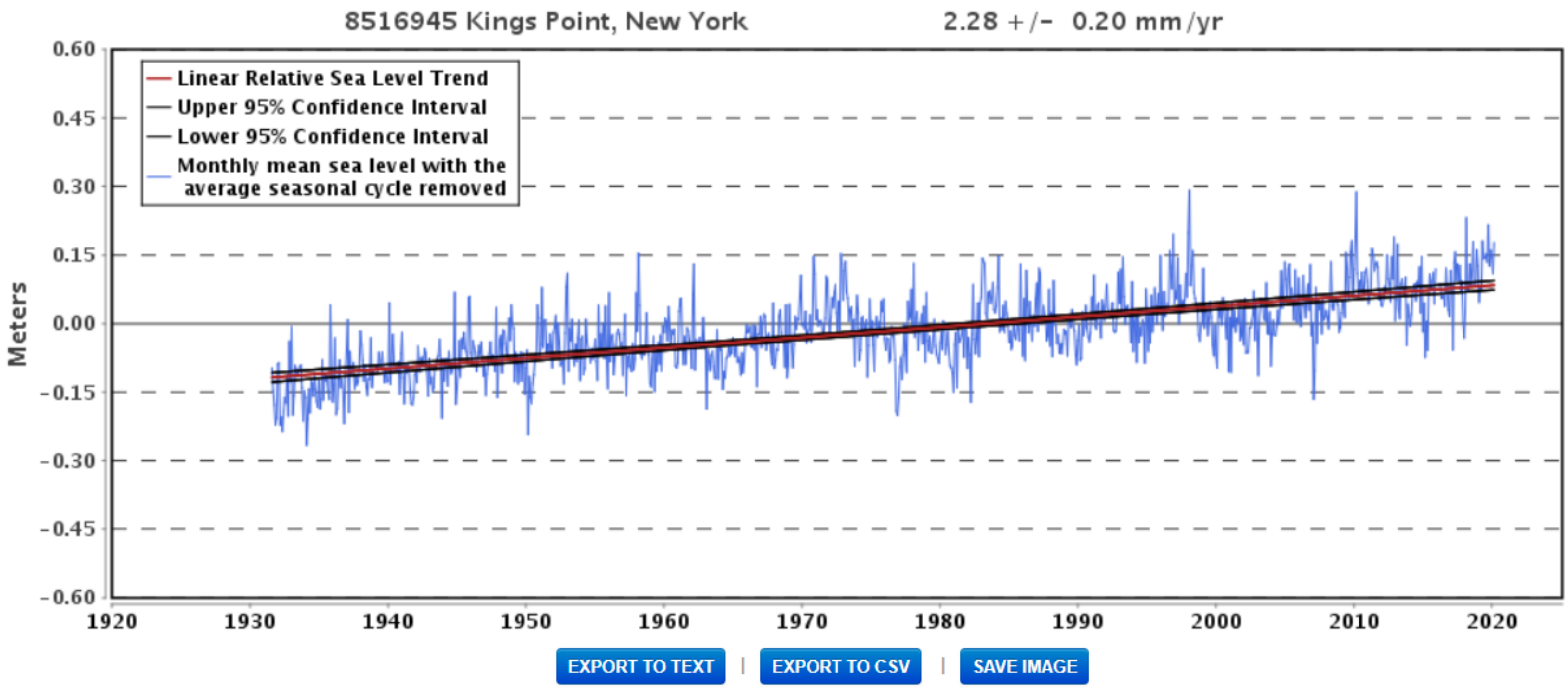


Figure 4: Tidal Elevations at Kings Point Tide Station Showing Differences in Elevations of High and Low Tides during Successive Tidal Cycles

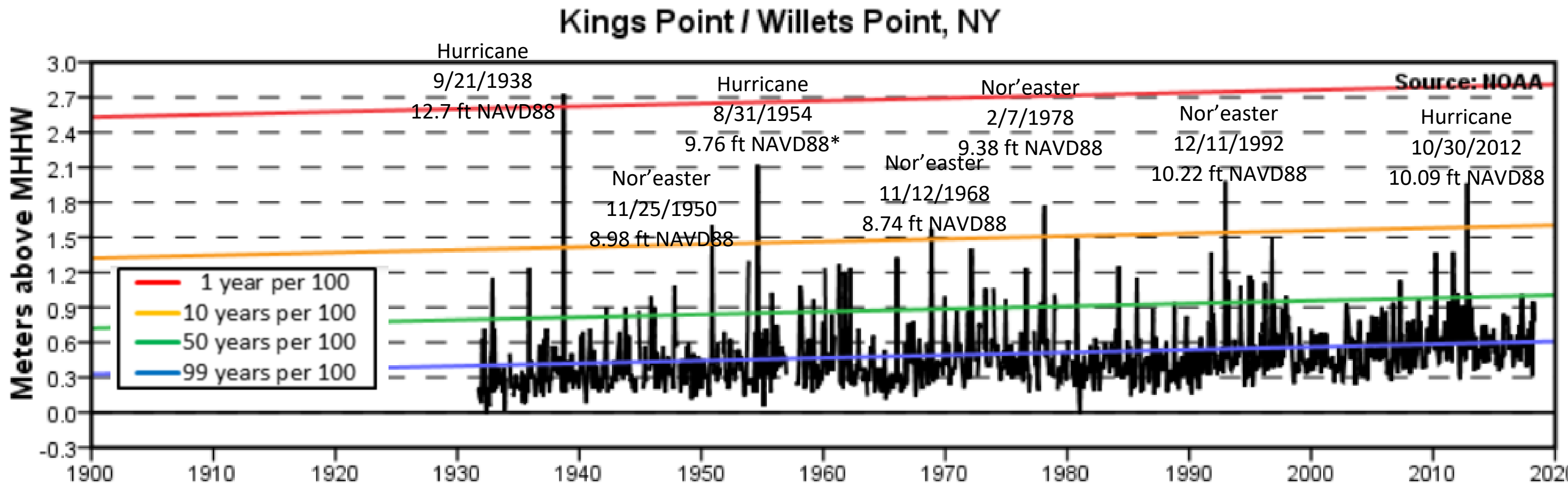
Relative Sea Level Trend
8516945 Kings Point, New York



The relative sea level trend is 2.28 millimeters/year with a 95% confidence interval of +/- 0.2 mm/yr based on monthly mean sea level data from 1931 to 2019 which is equivalent to a change of 0.75 feet in 100 years.

Earlier data stored in database as station 8516990

Figure 5: Observed Relative Sea Level Rise at Kings Point, NY since 1931



* For this hurricane, the water level reported in the graph does not match reported water level from the station's data.

Figure 6: Extreme Water Levels and Exceedance Probability Lines at Kings Point, NY

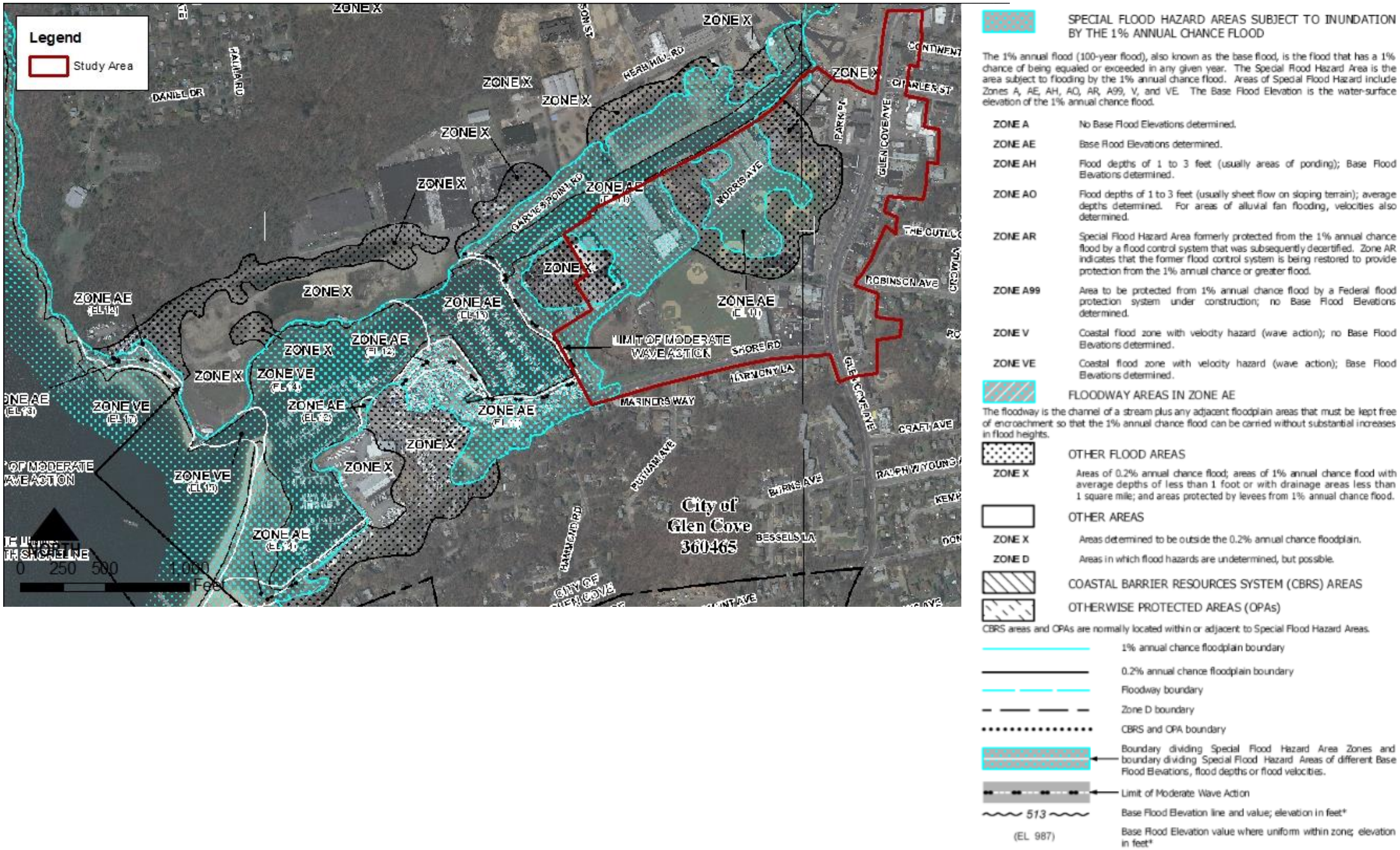


Figure 7: FEMA Flood Insurance Rate Map for Nassau County, NY Panel 0107G (revised September 11, 2009)

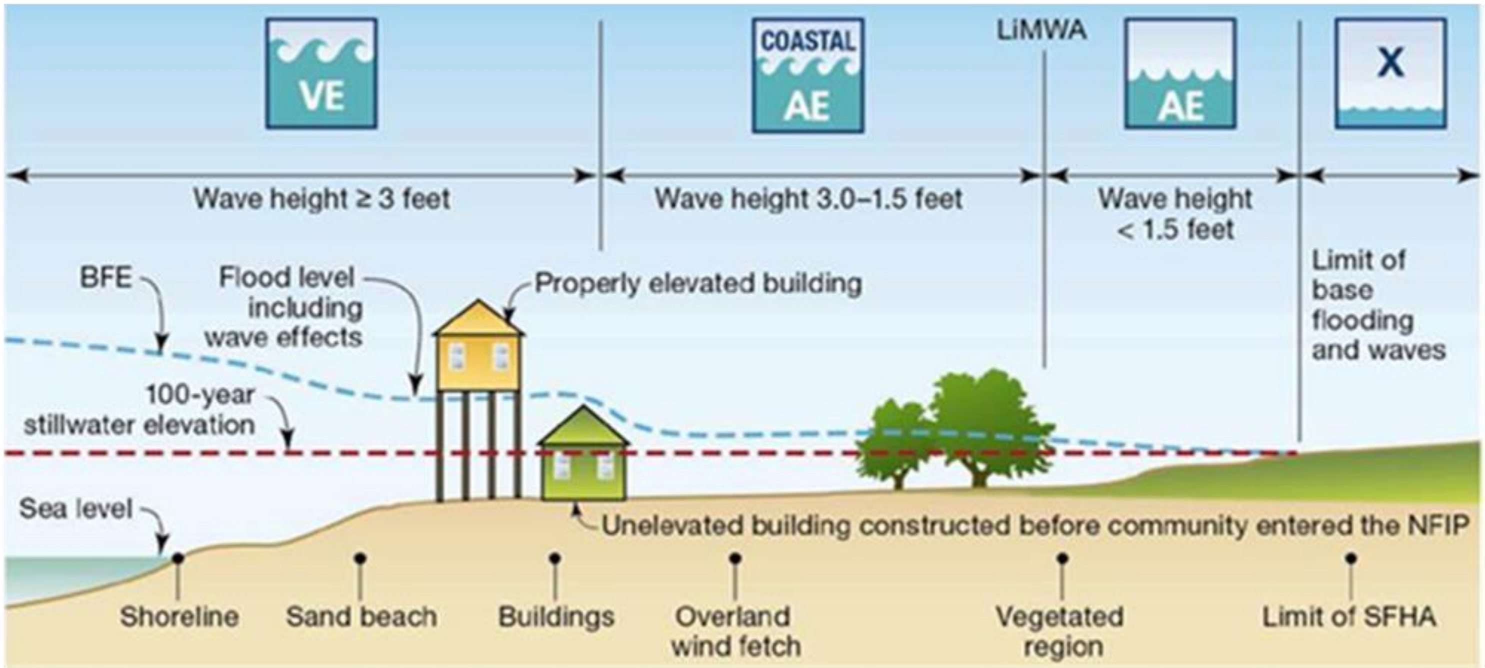


Figure 8: FEMA Coastal Flood Hazard Zone

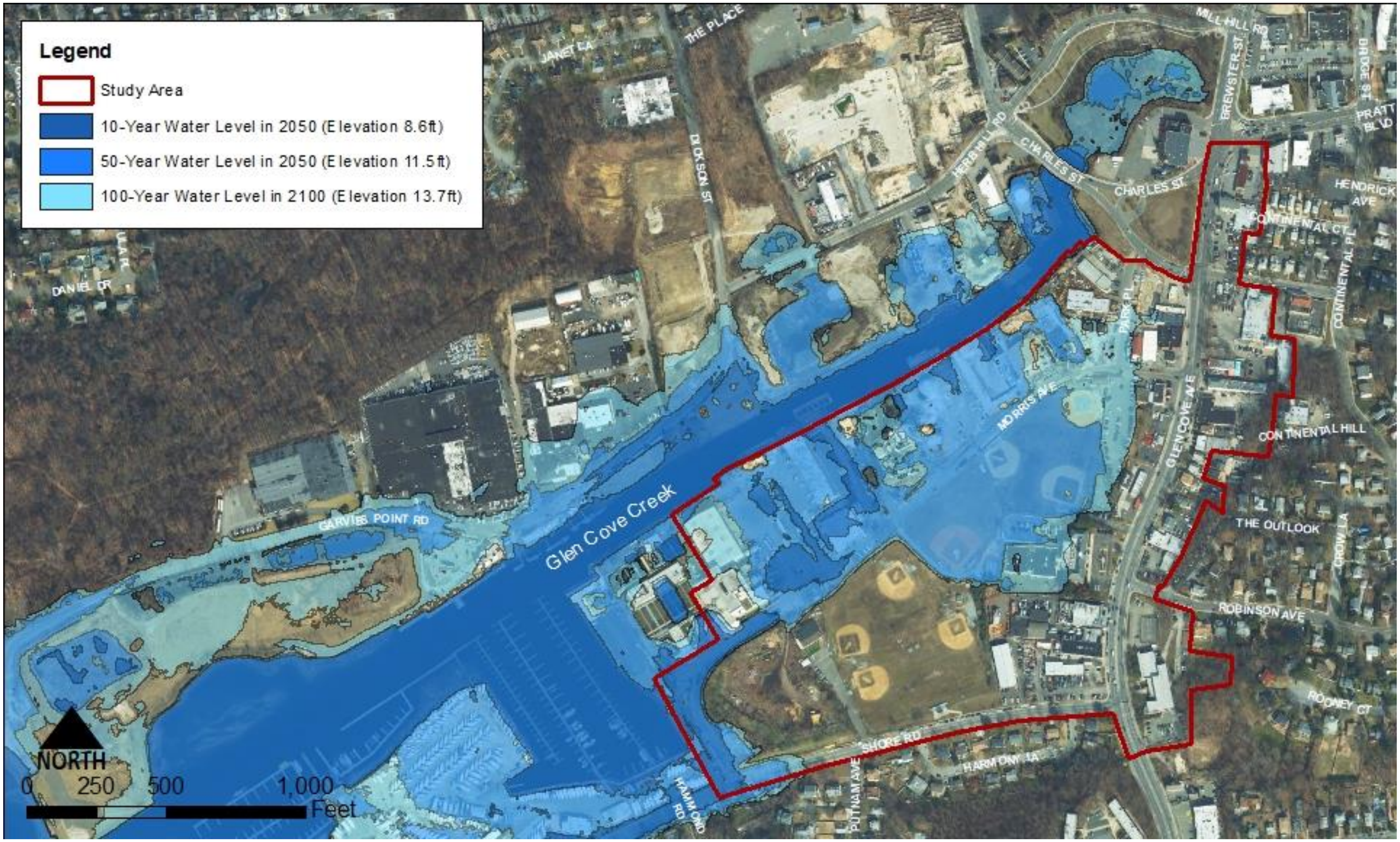


Figure 9: Inundation Mapping for FEMA Extreme Water Levels with NY State Intermediate Sea Level Rise Projections

Notes: Elevations are in vertical datum NAVD88. Inundation limits were computed using terrain data from USGS Long Island New York Sandy LiDAR, extracted in 2014. New York State published a range of sea level rise as Intermediate; the range was averaged to compute the displayed water levels.

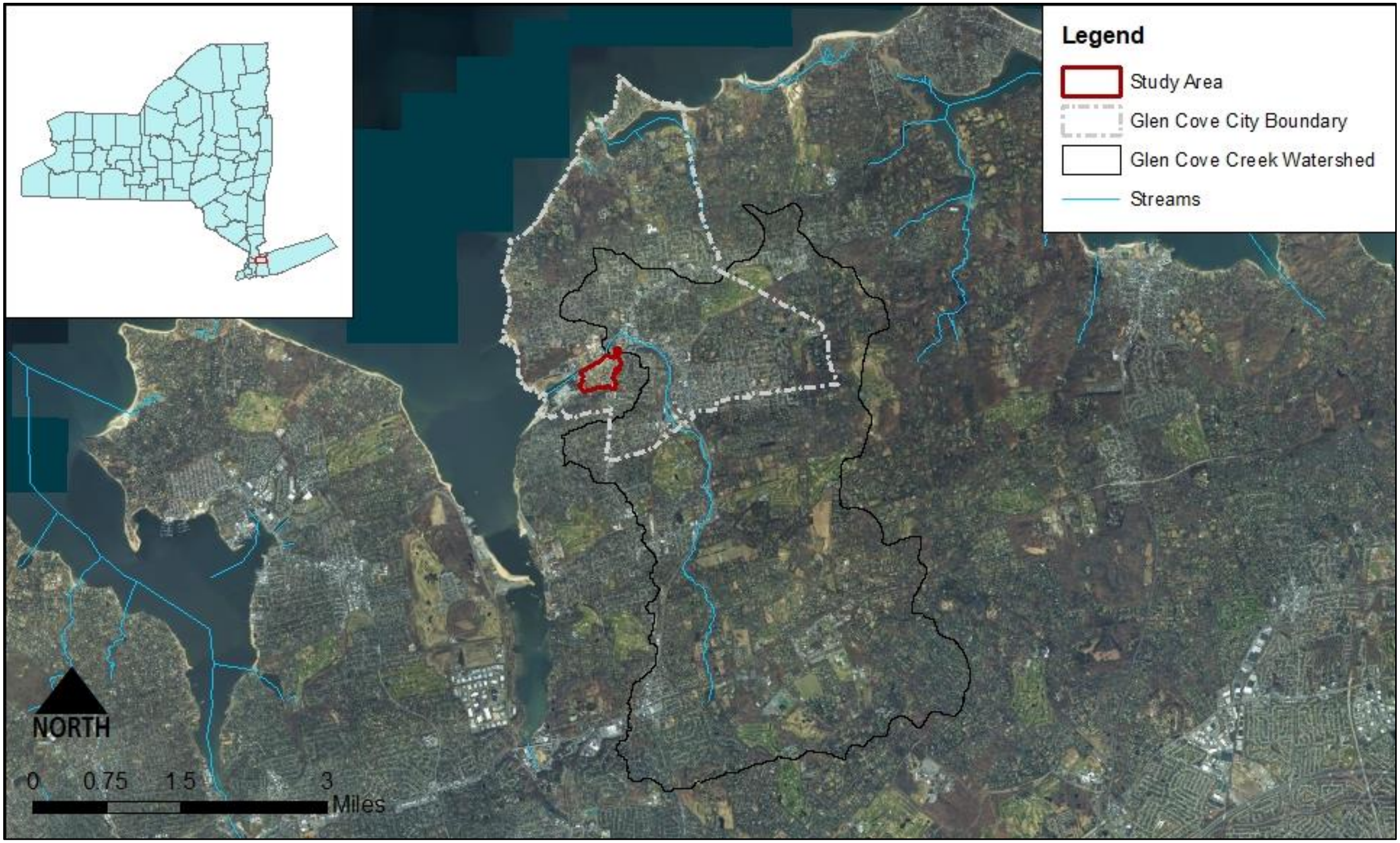


Figure 10: Glen Cove Creek Watershed Map

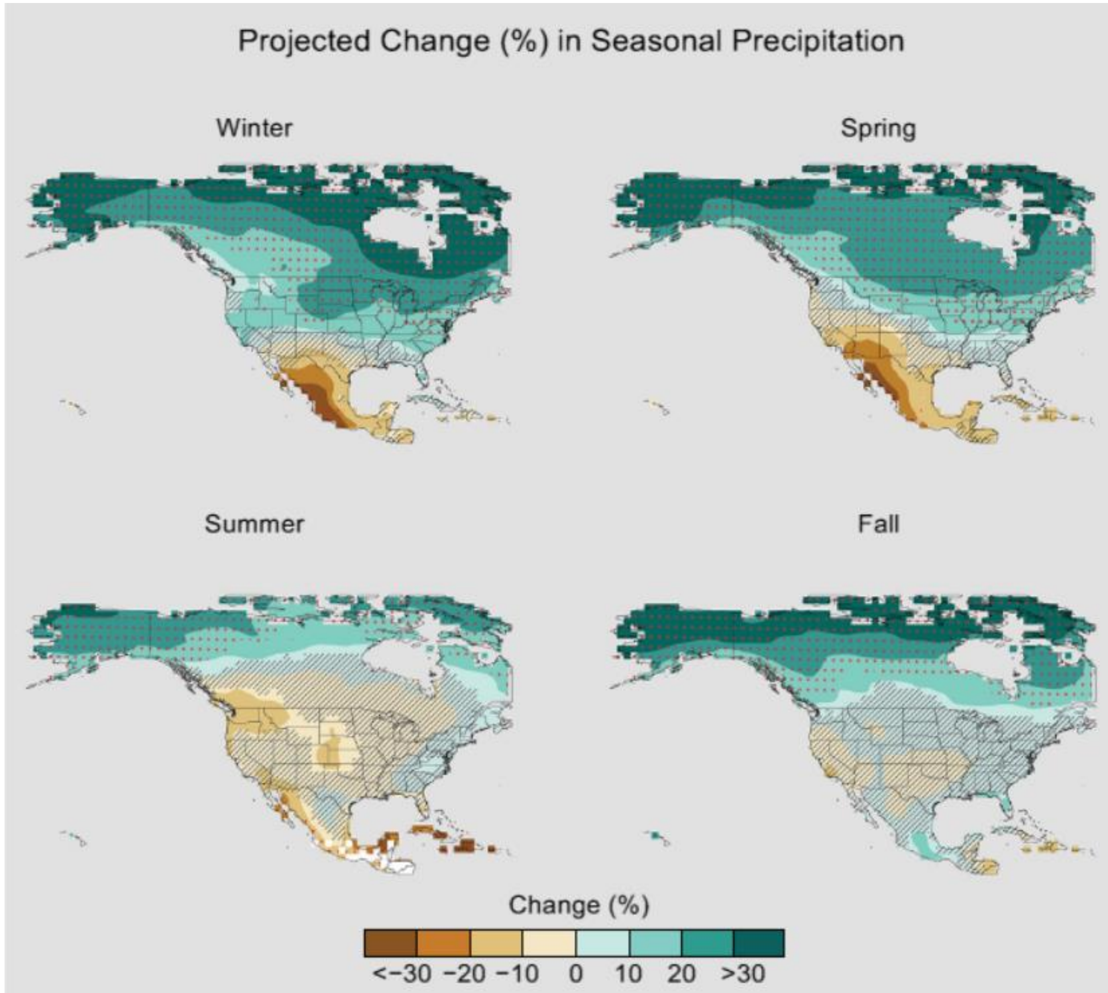


Figure 11: Projected Change (%) in Total Seasonal Precipitation for 2070-2099

Notes: Figure is from Fourth National Climate Assessment, published 2017. The values are from the CMIP5 simulations and expressed as the percent change relative to the 1976-2005 average. These results are for the RCP8.5 emissions trajectory. Stippling indicates that changes are assessed to be large compared to natural variations. Hatching indicates that changes are assessed to be small compared to natural variations. Blank regions are where projections are assessed to be inconclusive.

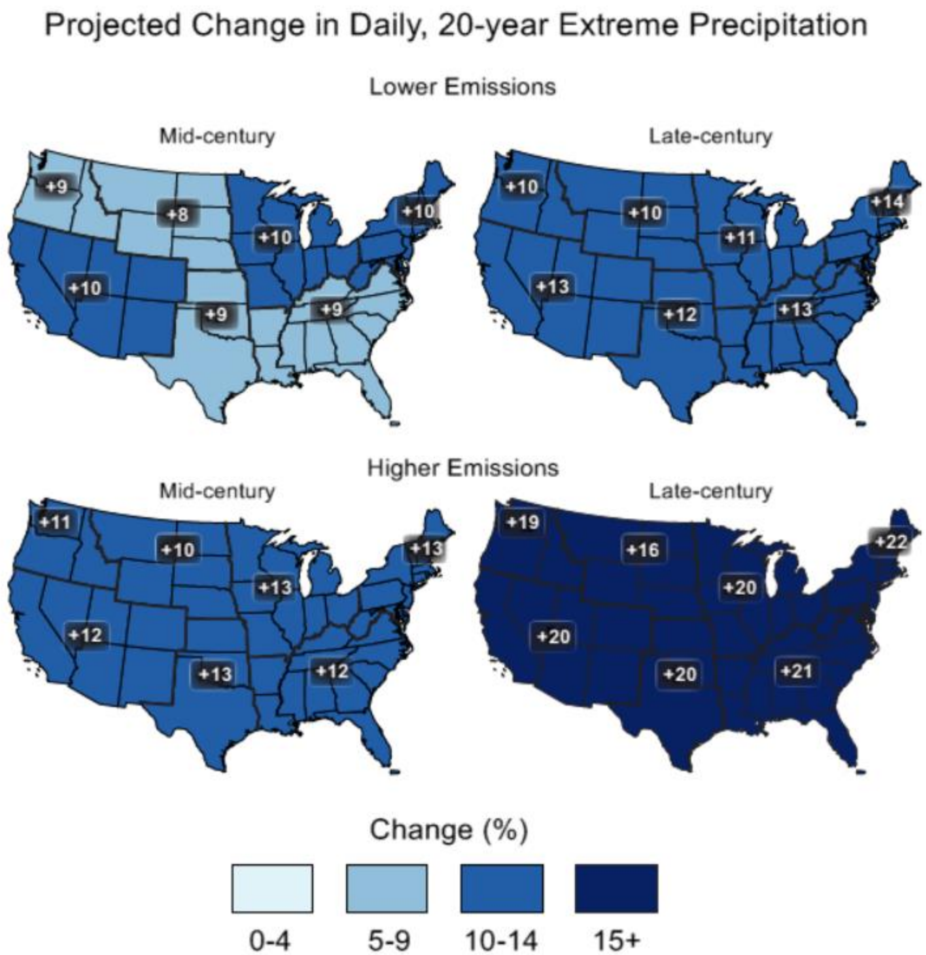


Figure 12: Projected Change in 20-year Return Period Amount for Daily Precipitation

Notes: Figure is from the Fourth National Climate Assessment, published 2017 (Figure 7.7). Results are shown for the RCP4.5 emissions trajectory (top maps) and RCP8.5 emissions trajectory (bottom maps).

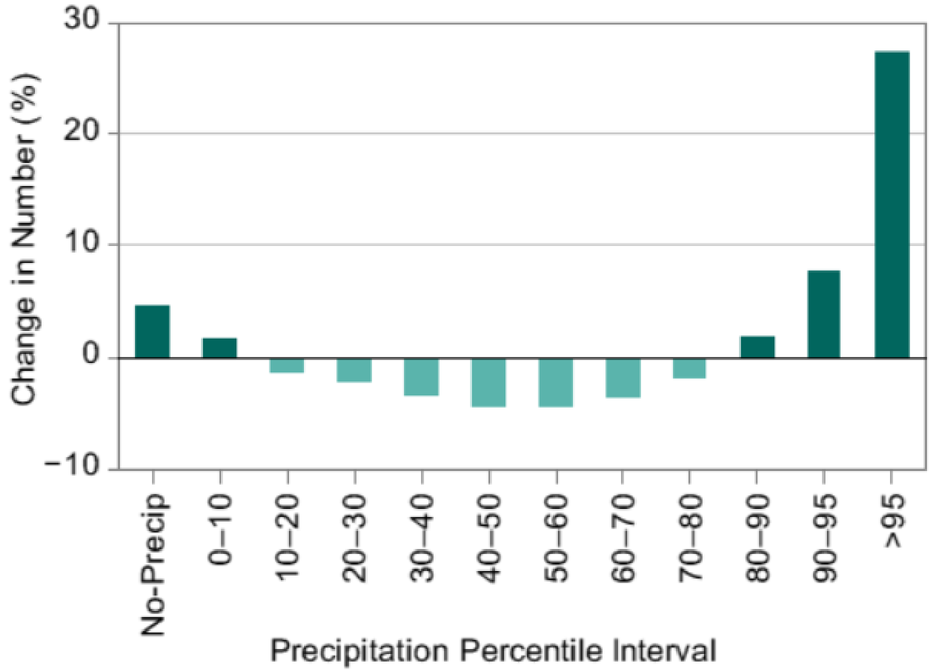


Figure 13: Projected Change in the Number of Daily Zero (“No-Precip”) and Non-Zero Precipitation Days

Notes: Figure is from the Fourth National Climate Assessment, published 2017 (Figure 7.8). Percentage Percentile Intervals (0-10, 10-20, etc.) are daily non-zero precipitation amounts from 1976-2005 that have been ranked from low to high and separated in 10% intervals. Change in number is the projected change in number of days. Graph is for late-21st century under a high emission trajectory (RCP8.5).

Figure 14: GHCN Climate Gauges

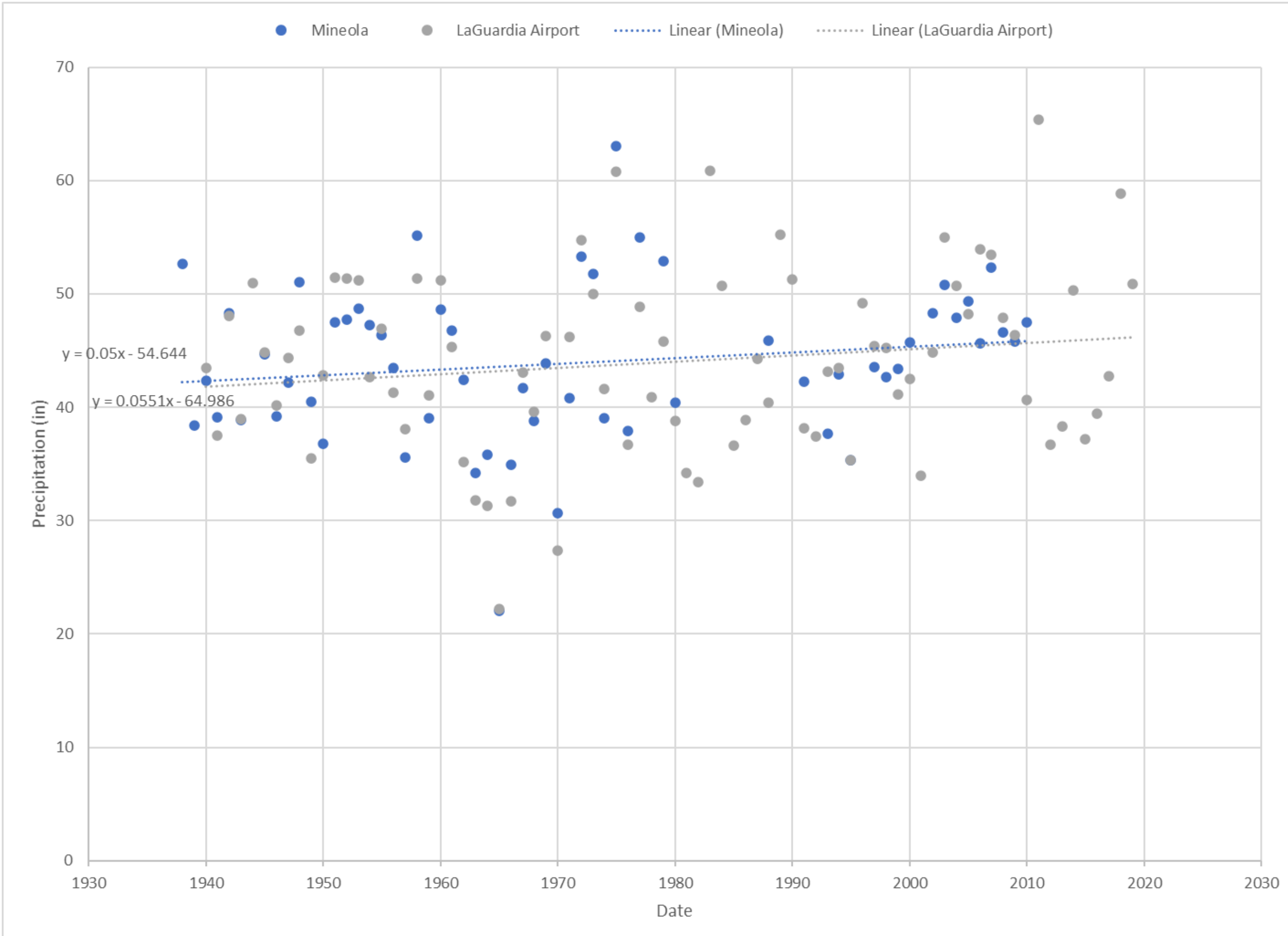


Figure 15: Annual Total Precipitation (inches)

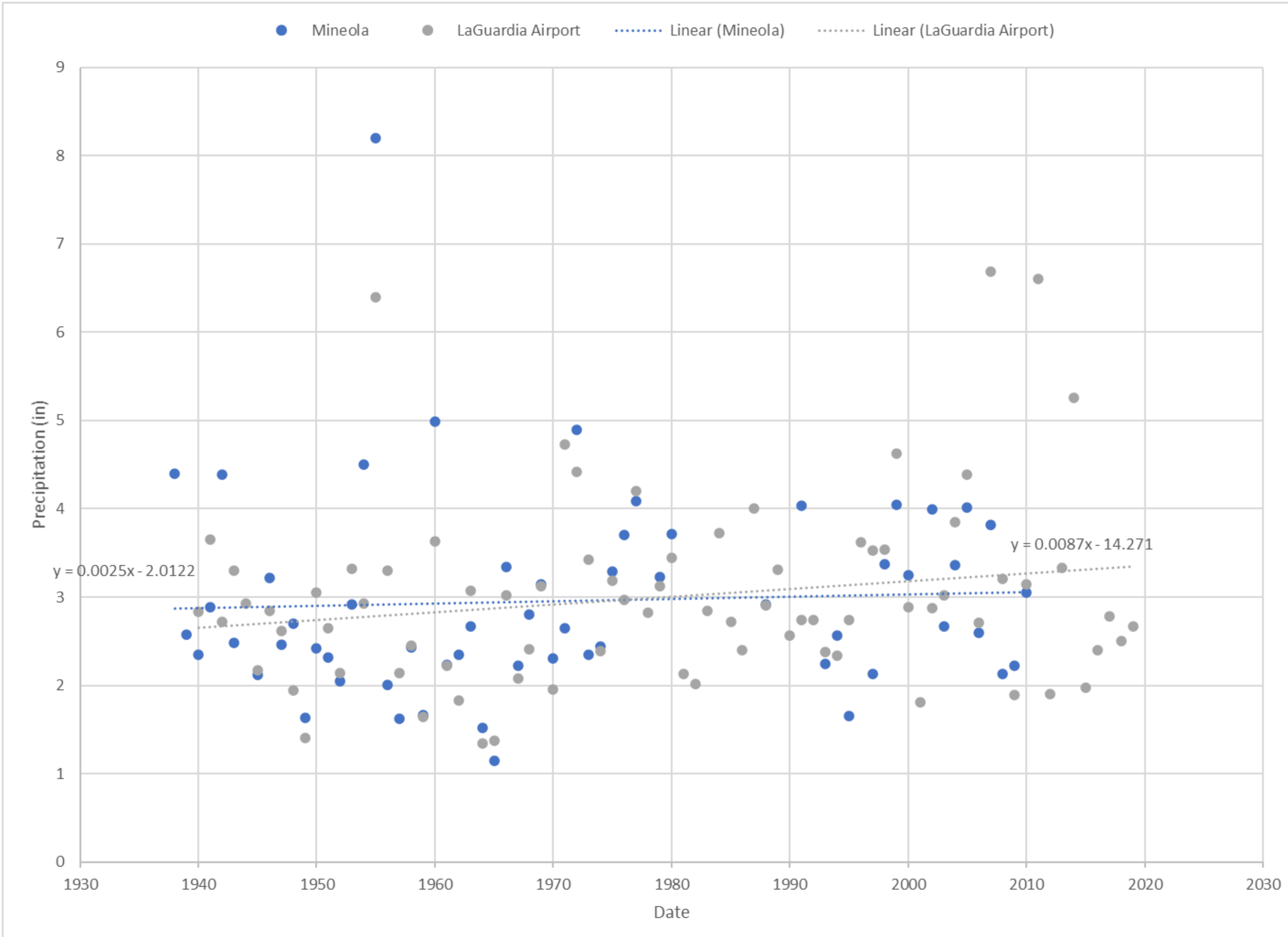


Figure 16: Maximum Daily Precipitation

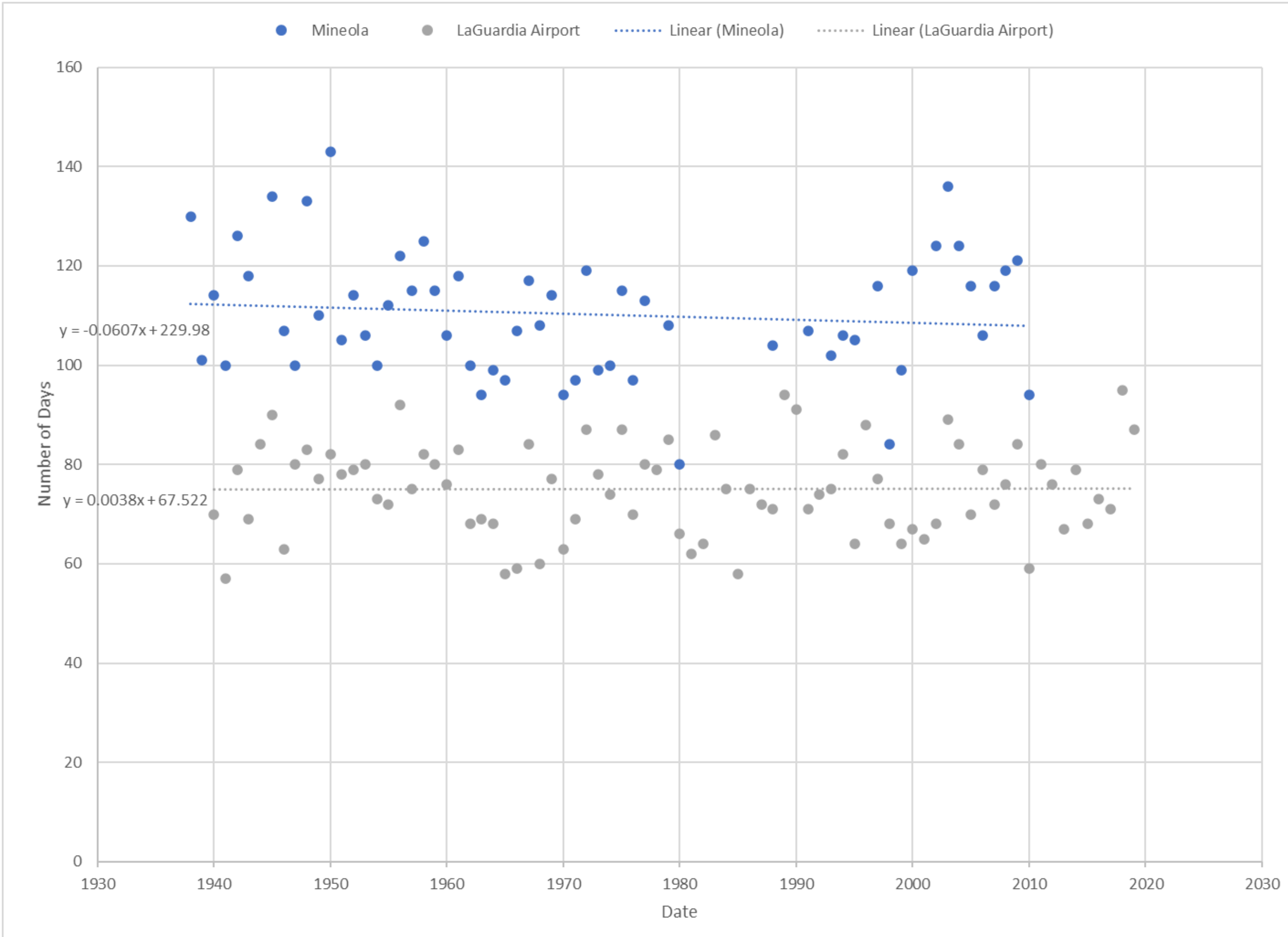


Figure 17: Number of Days with Greater Than or Equal to 0.01 inch of Precipitation

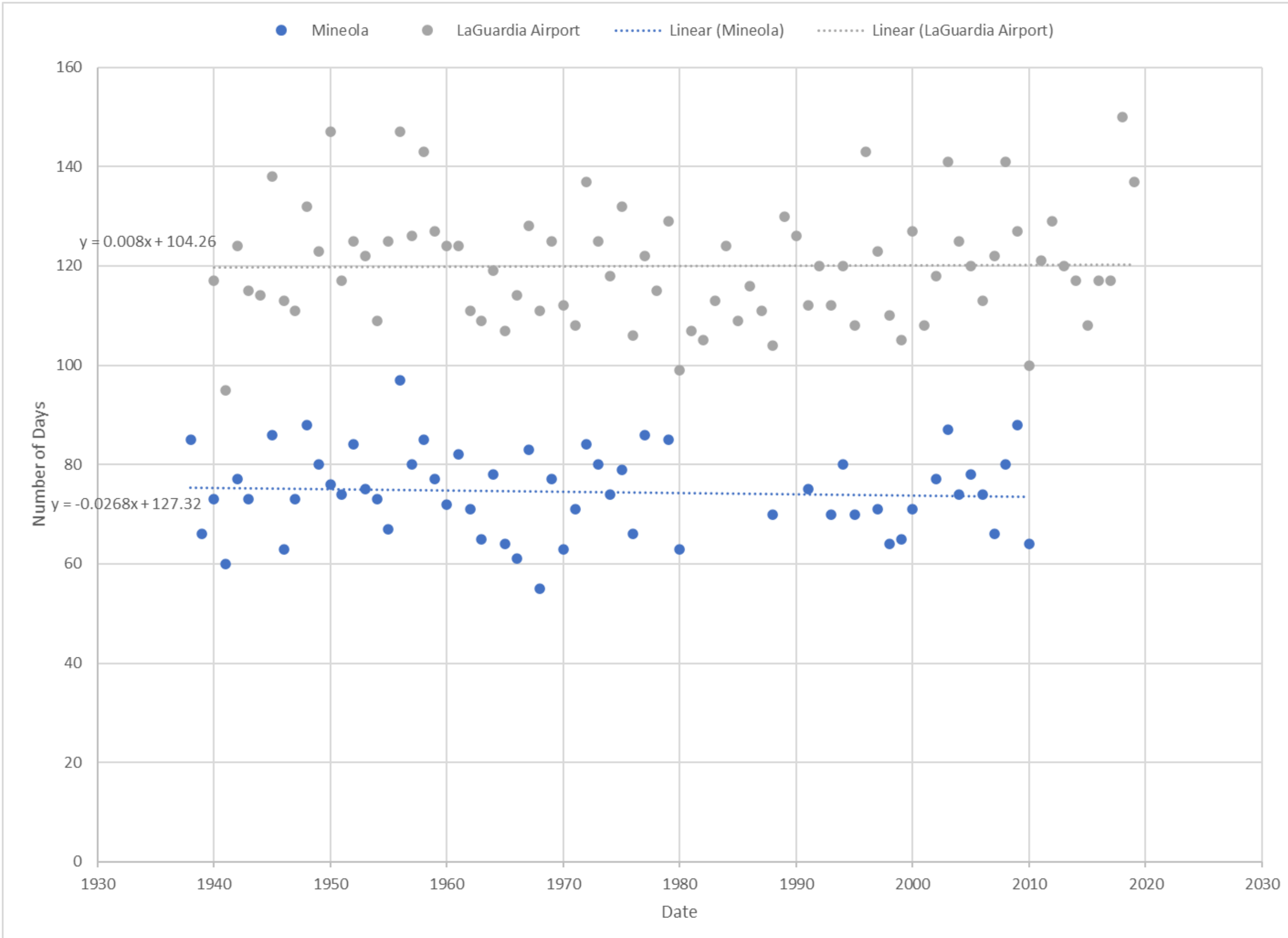


Figure 18: Number of Days with Greater Than or Equal to 0.1 inch of Precipitation

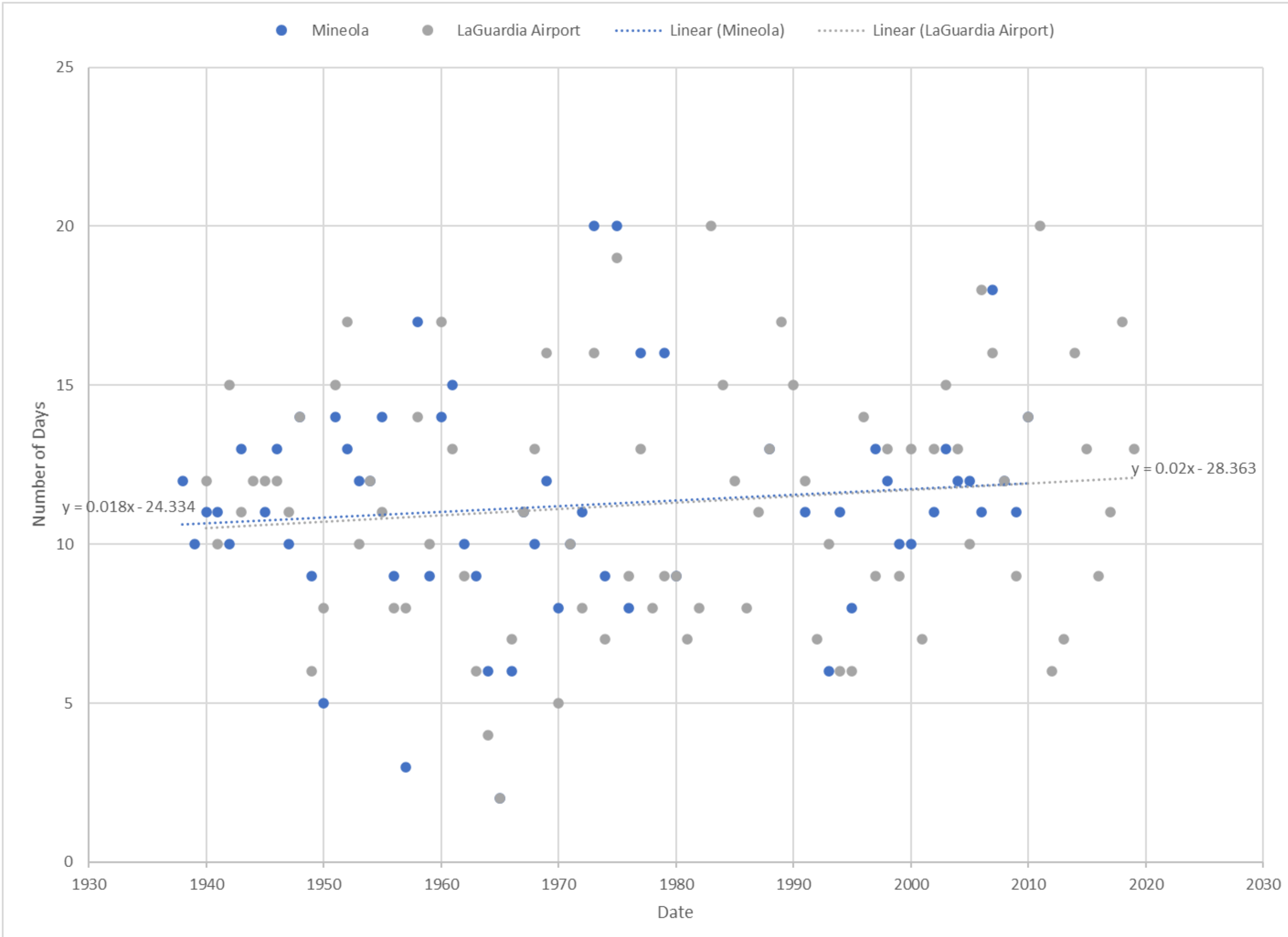


Figure 19: Number of Days with Greater Than or Equal to 1 inch of Precipitation

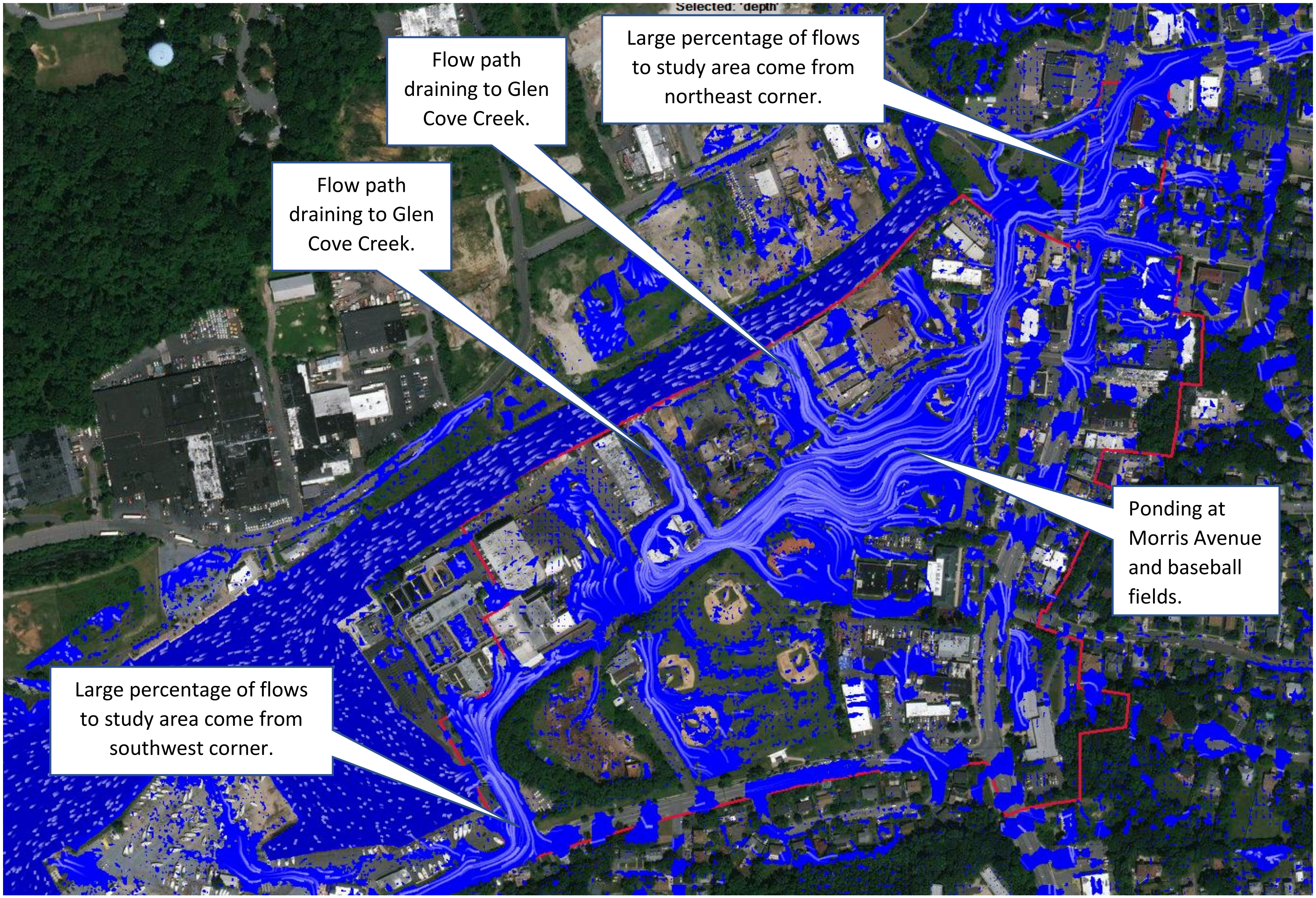


Figure 20: Runoff Flow Patterns and Ponding Areas in Study Area

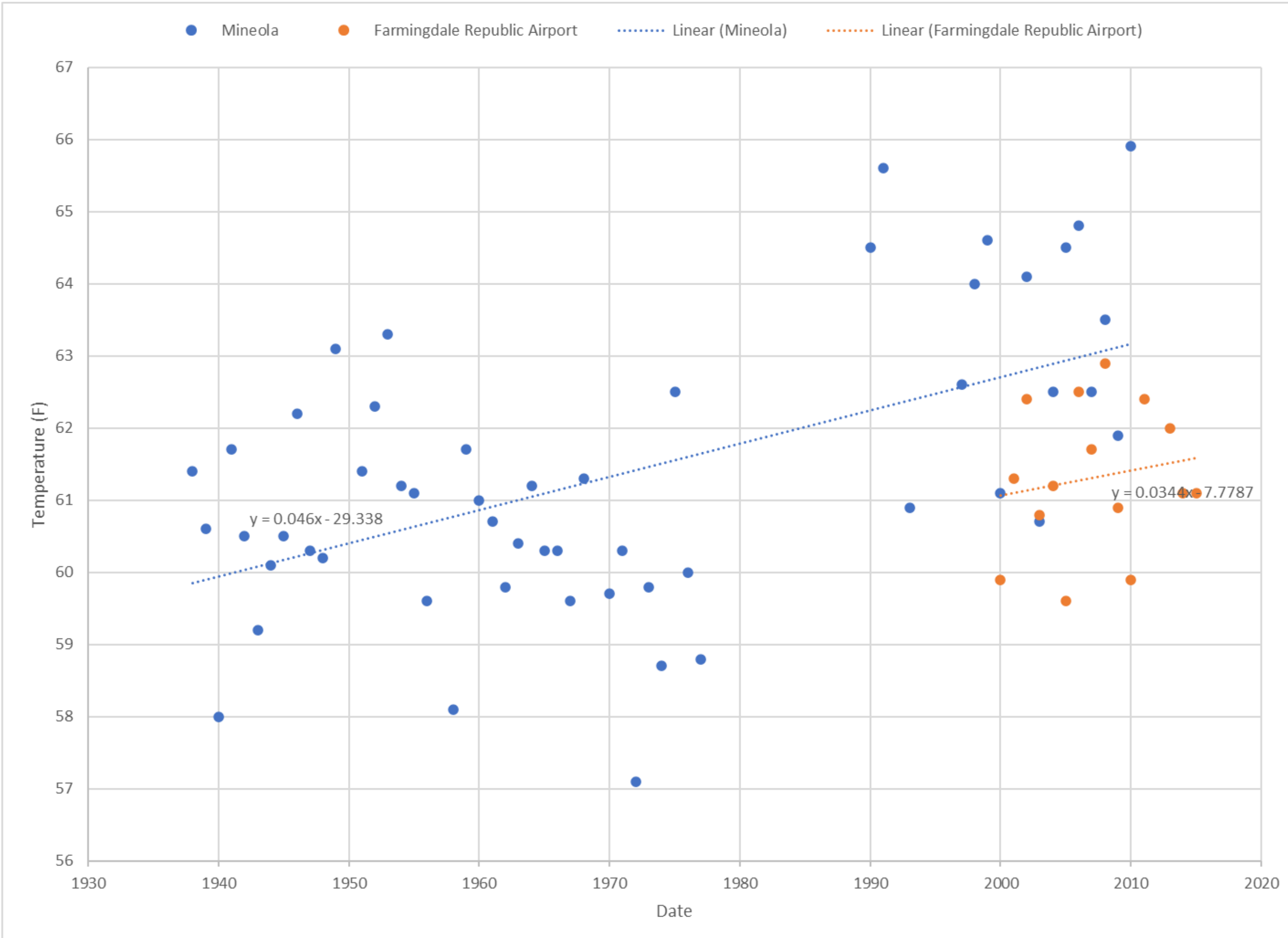


Figure 21: Annual Average of Daily Maximum Temperature at GHCN Gauges

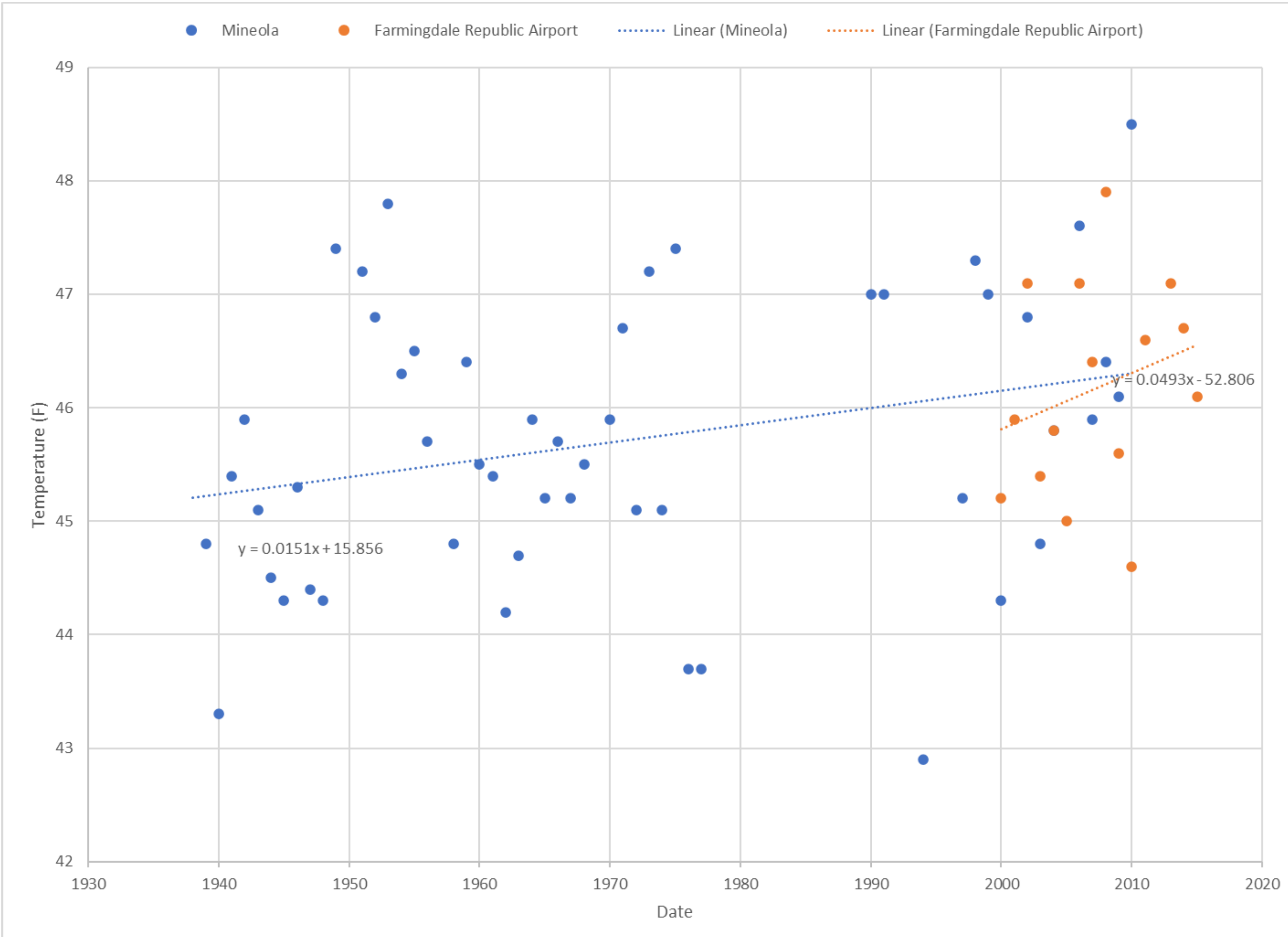


Figure 22: Annual Average of Daily Minimum Temperature at GHCN Gauges

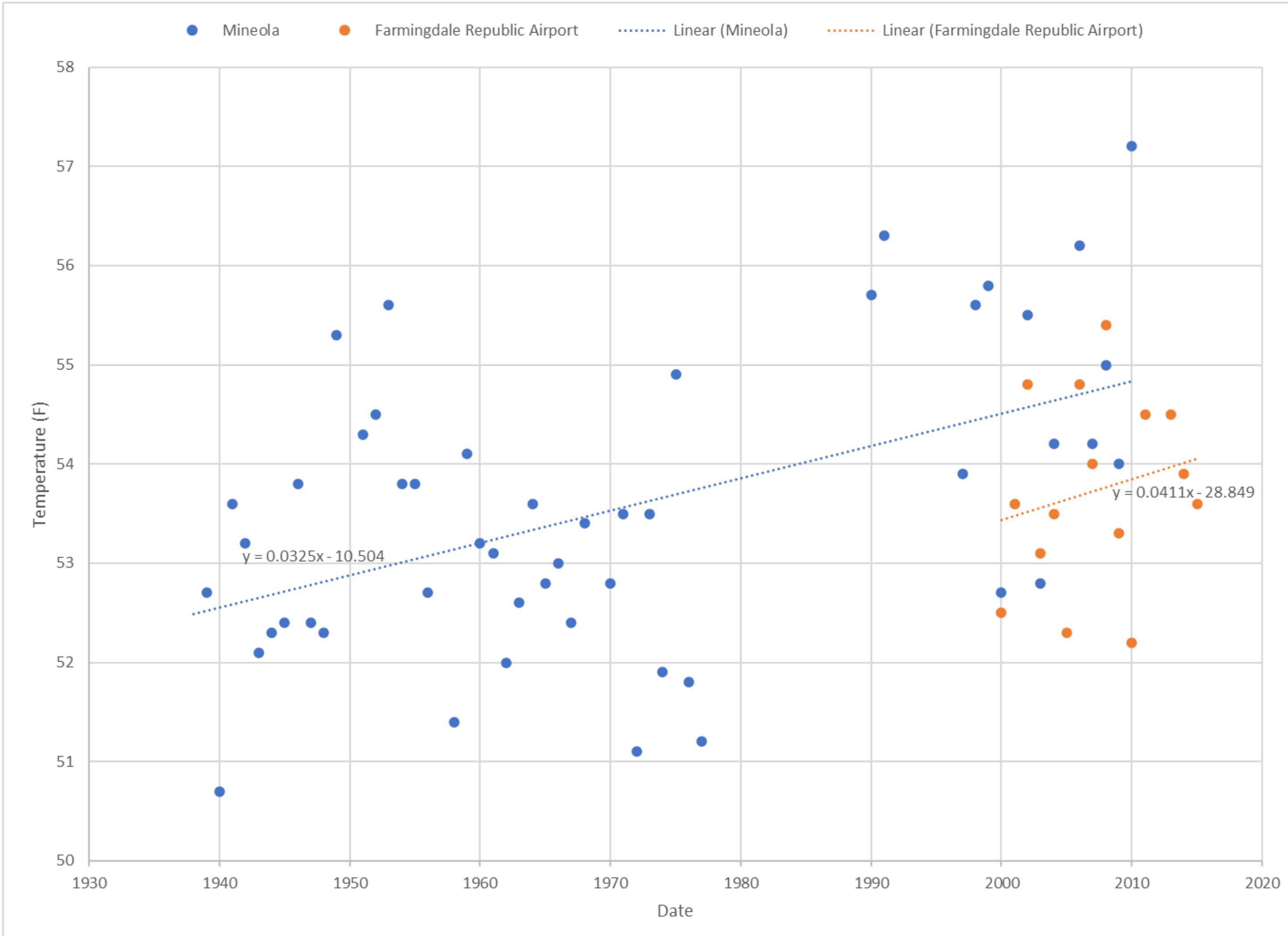


Figure 23: Annual Average Temperature at GHCN Climate Gauges

Note: Values were computed by adding average of daily maximum temperatures and average of daily minimum temperatures and dividing by 2.

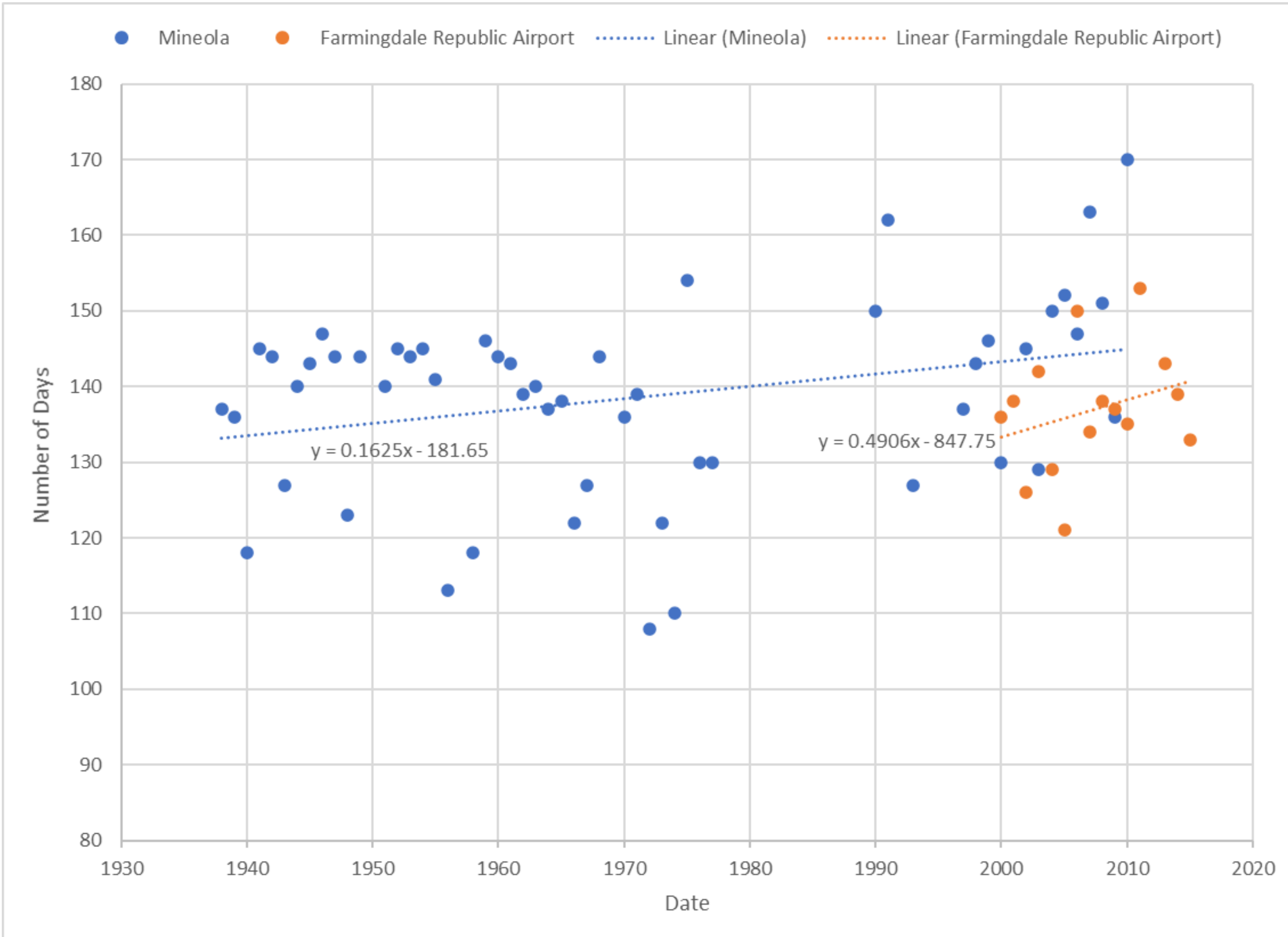


Figure 24: Number of Days with Maximum Temperature Greater Than or Equal to 70°F

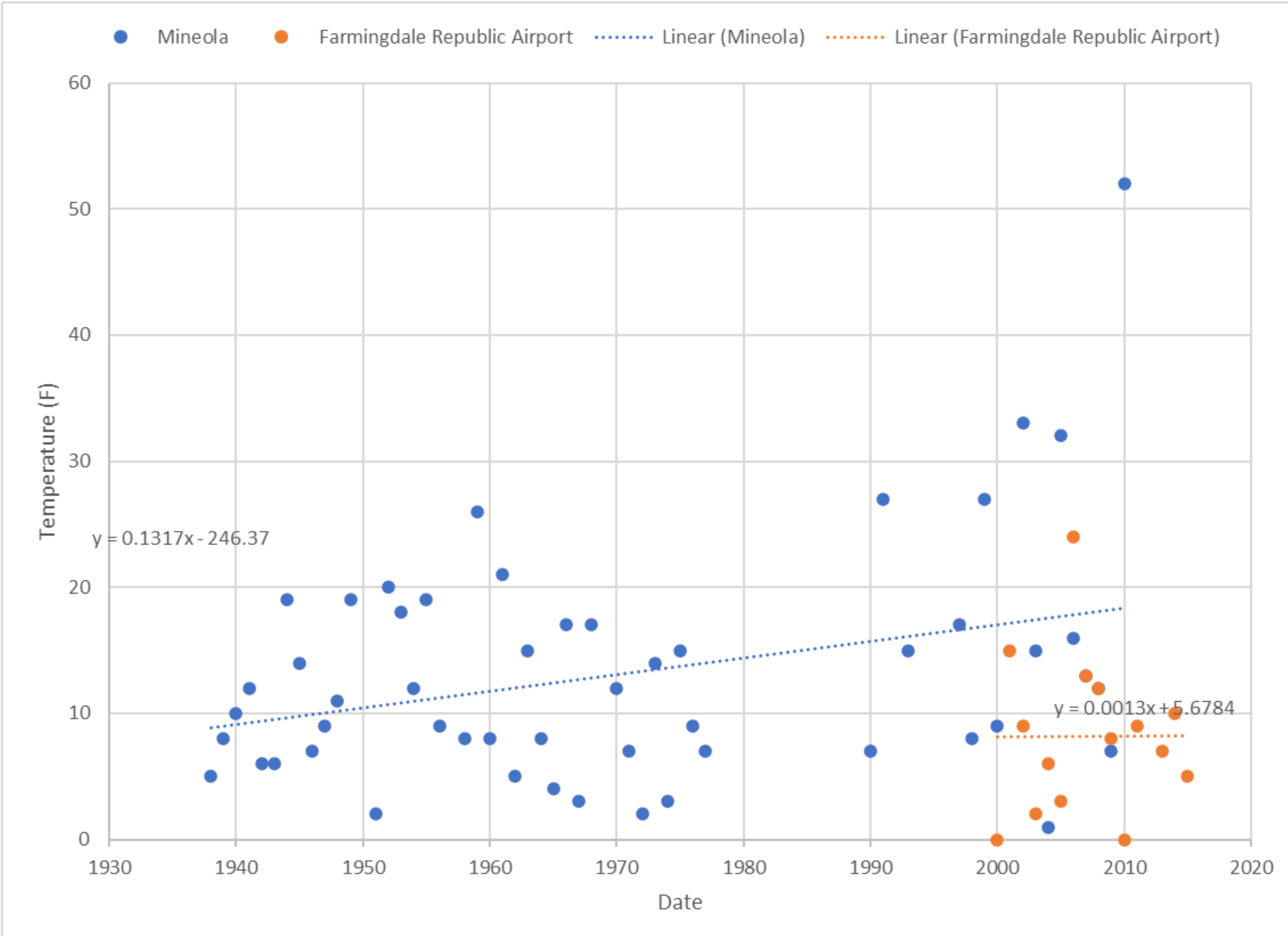


Figure 25: Number of Days with Maximum Temperature Greater Than or Equal to 90°F

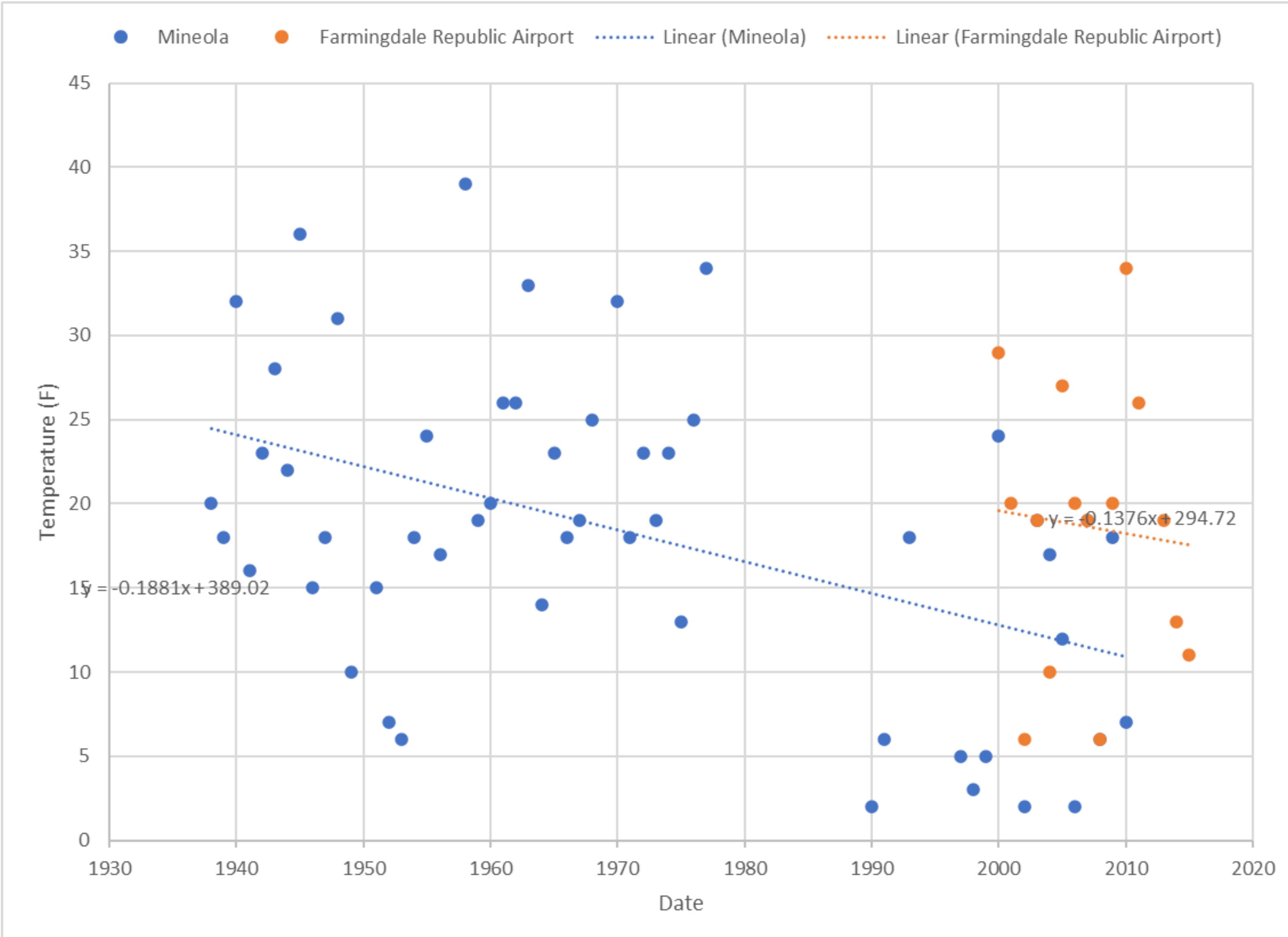


Figure 26: Number of Days with Minimum Temperature Less Than or Equal to 32°F

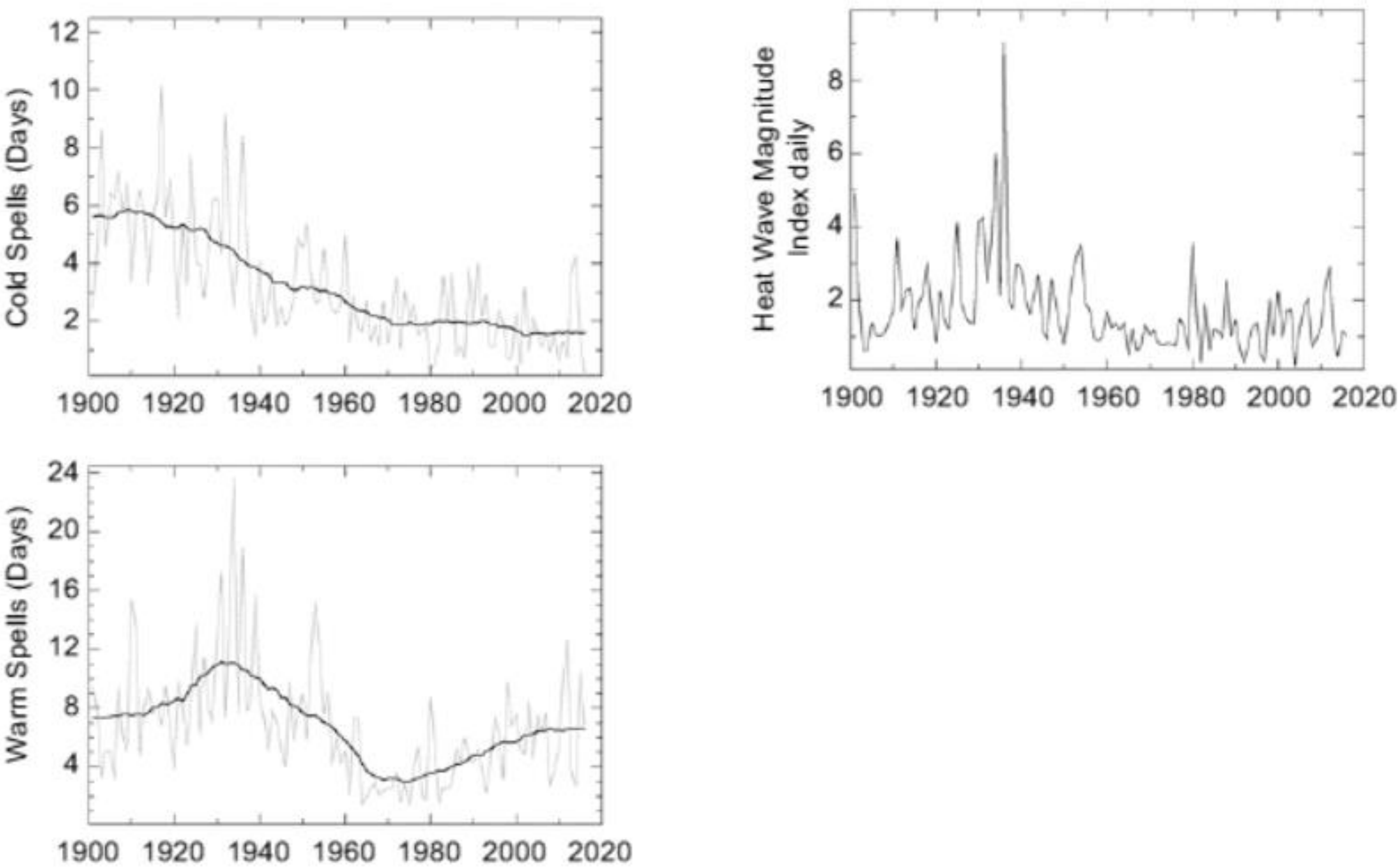


Figure 27: Observed Changes in Cold and Heat Waves in the Contiguous United States

Notes: Figure is from Fourth National Climate Assessment, Volume 1, published 2017. Estimates are derived from long-term stations with minimal missing data in the Global Historical Climatological Network – Daily dataset.

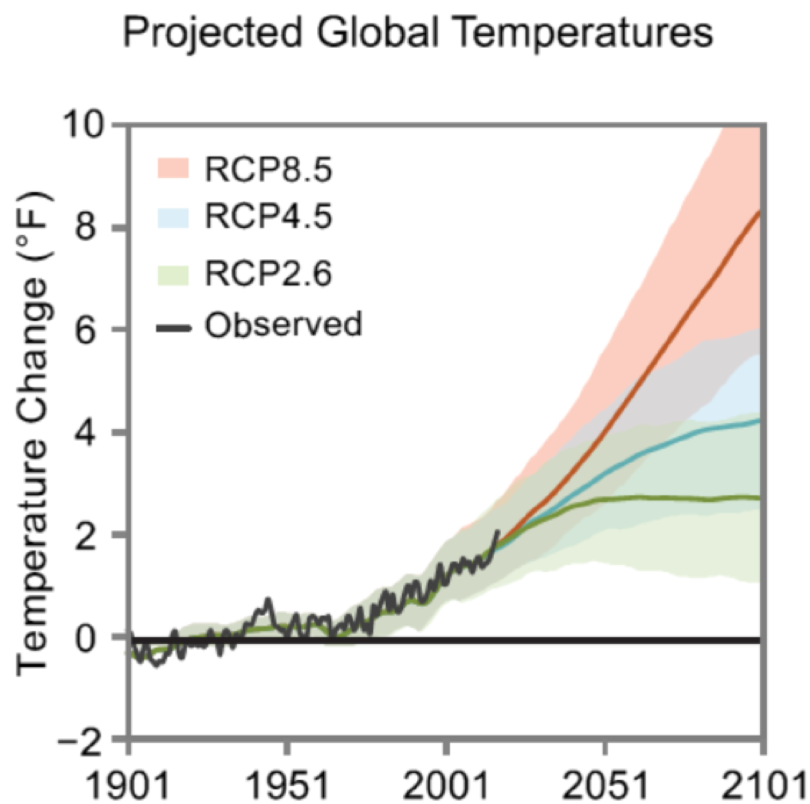


Figure 28: Projected Global Temperatures for Different Representative Concentration Pathways (RCPs)

Notes: Figure is from Fourth National Climate Assessment, Volume 1, published 2017. Multimodel simulated time series from 1900 to 2100 for the change in global annual mean surface temperature relative to 1901–1960 for a range of the Representative Concentration Pathways (RCPs). These scenarios account for the uncertainty in future emissions from human activities (as analyzed with the 20+ models from around the world). The mean (solid lines) and associated uncertainties (shading, showing ±2 standard deviations [5%–95%] across the distribution of individual models based on the average over 2081–2100) are given for all of the RCP scenarios.

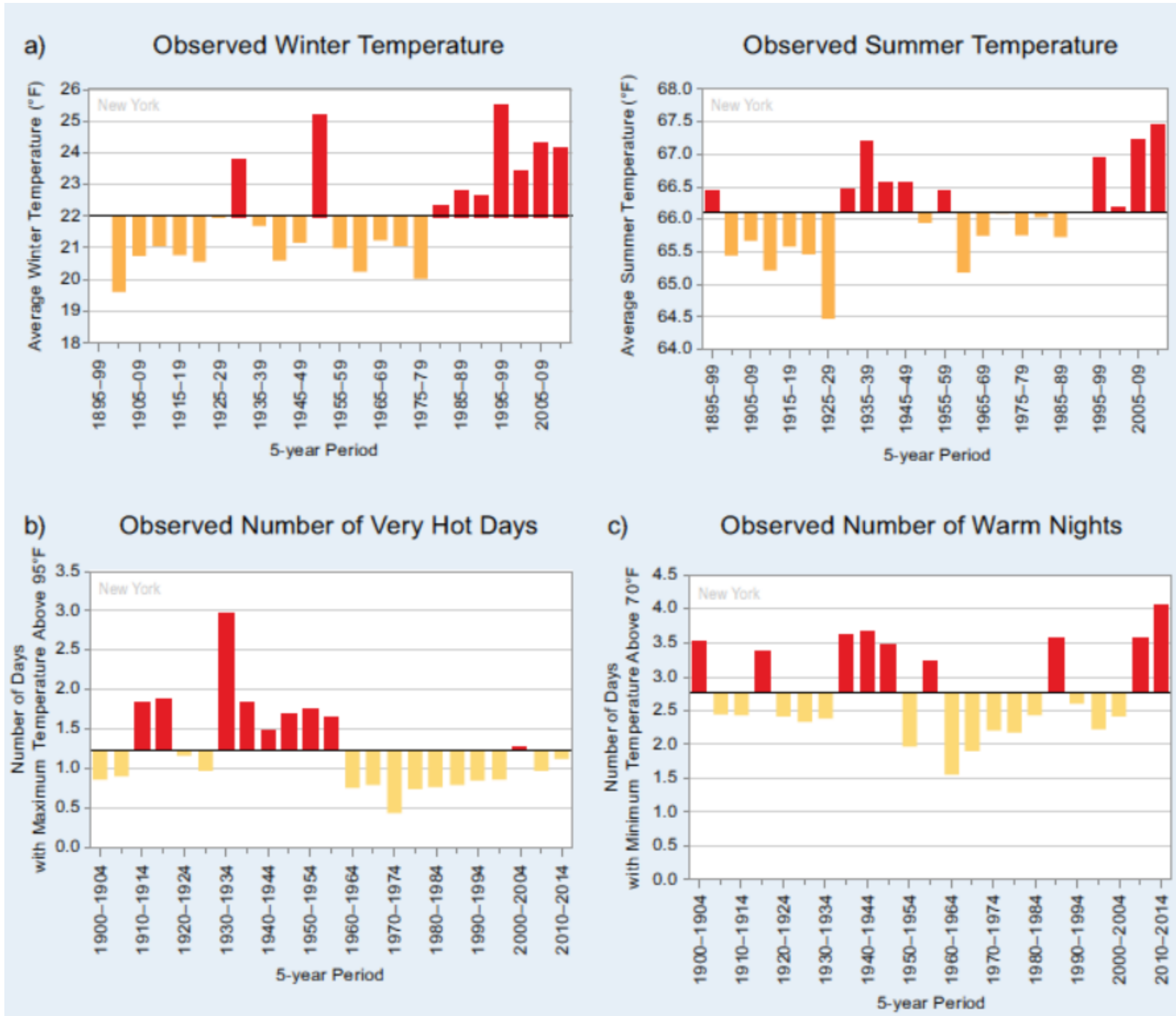


Figure 29: Temperature Data for New York State

Notes: Figure is from NOAA National Centers for Environmental Information, State Summary of New York. Values were averaged over 5-year periods. The dark horizontal line represents the long-term average.

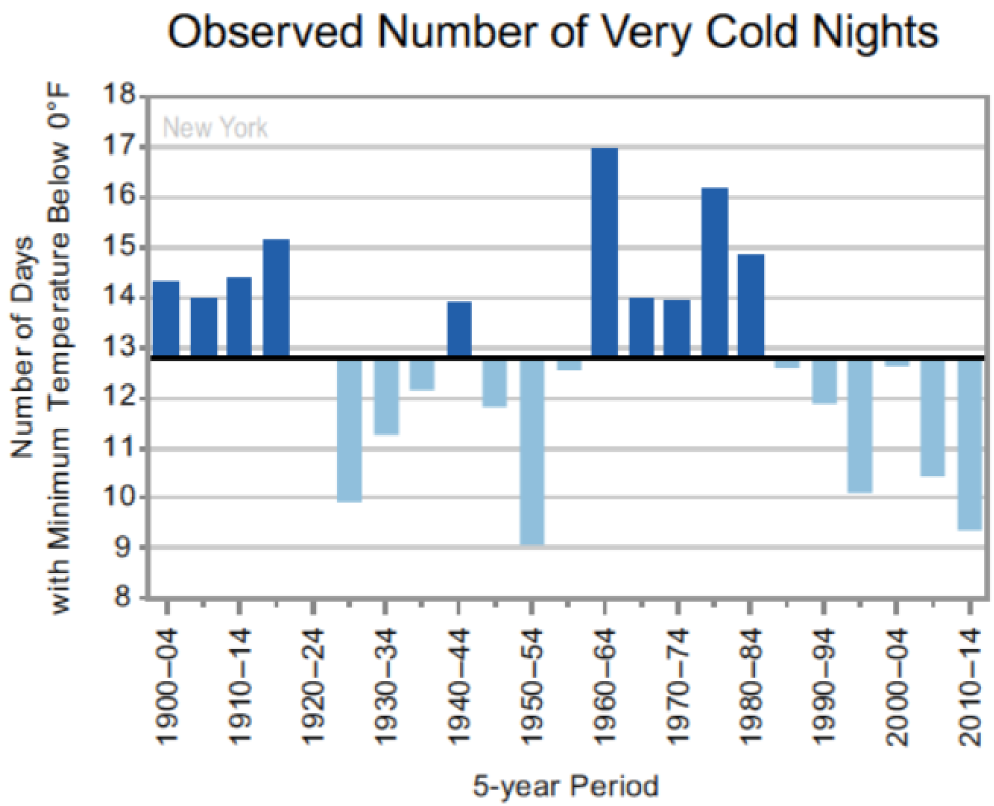


Figure 30: Temperature Data for New York

Notes: Figure is from NOAA National Centers for Environmental Information, State Summary of New York. Values were averaged over 5-year periods. The dark horizontal line represents the long-term average.

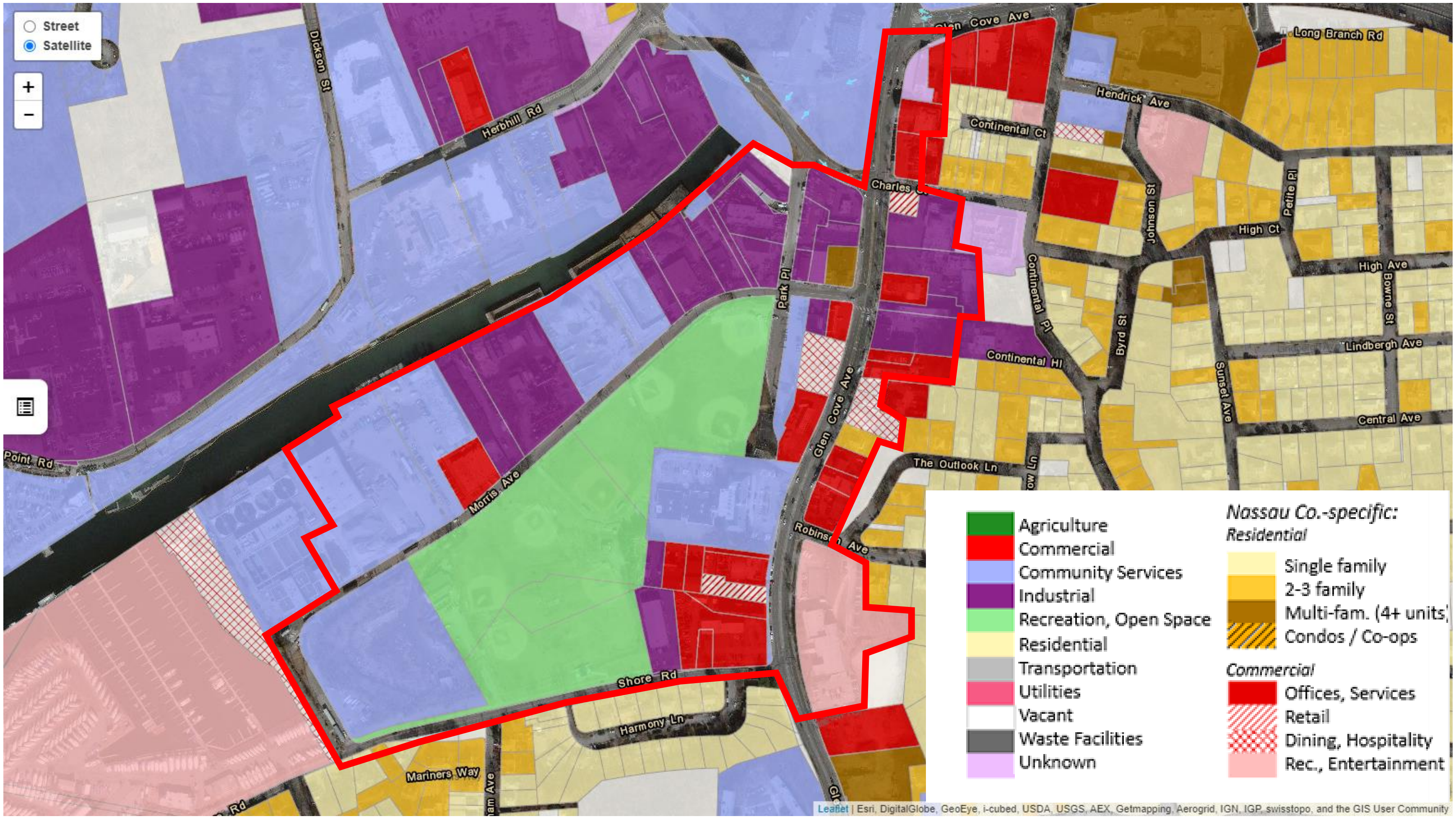


Figure 31: Land Use for Study Area

Note: Map was obtained from the Long Island Index's interactive mapping tool provided online. Land use data is from the Nassau County Planning Department and was last updated in 2013. Study area is outlined in red.

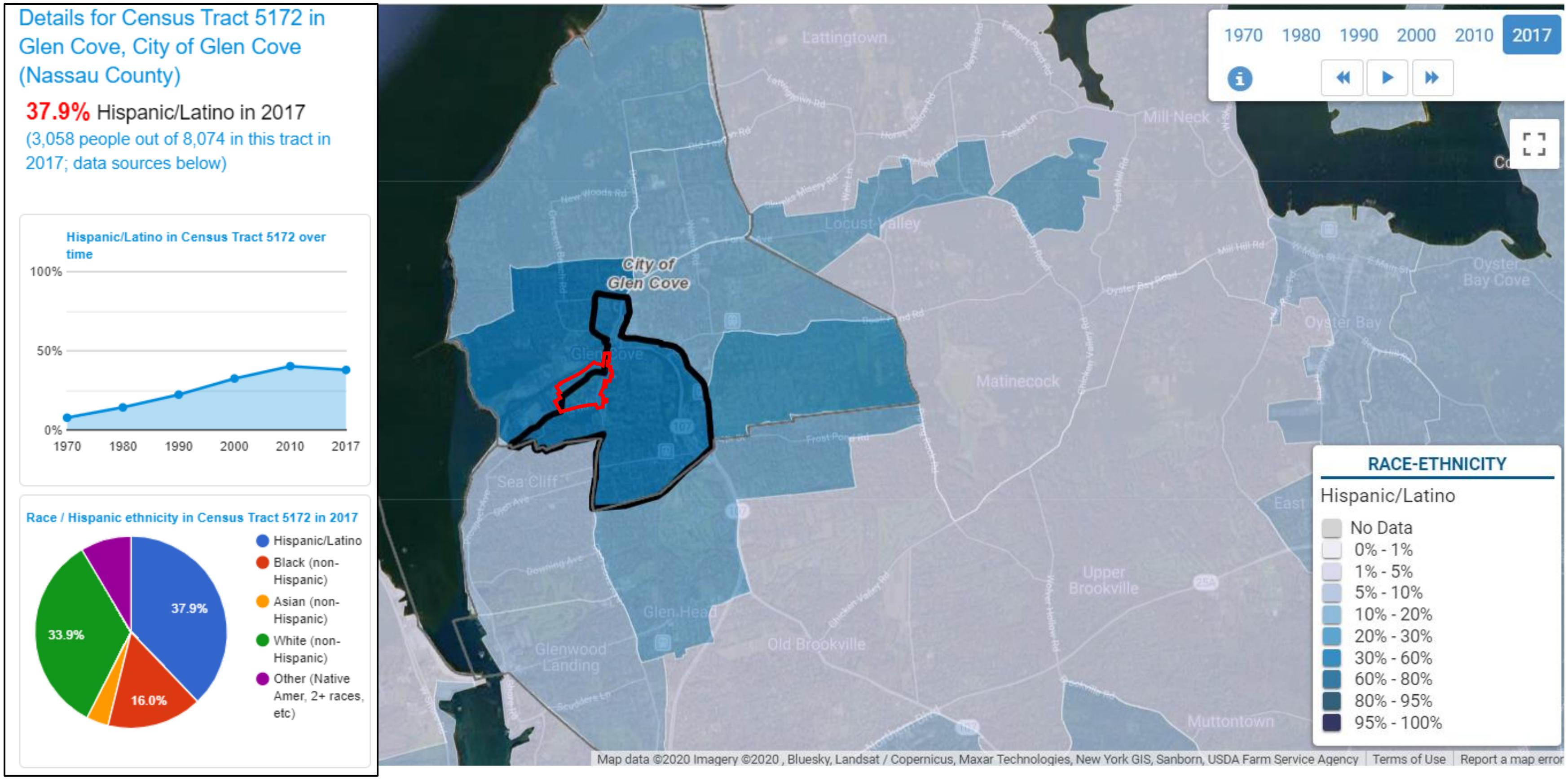


Figure 32: Reported Race-Ethnicity for City of Glen Cove in 2017

Note: Map was obtained from the Long Island Index's interactive mapping tool provided online. Map data is from the U.S. Census Bureau. Text box is information for area outlined in black. Study area is outlined in red.

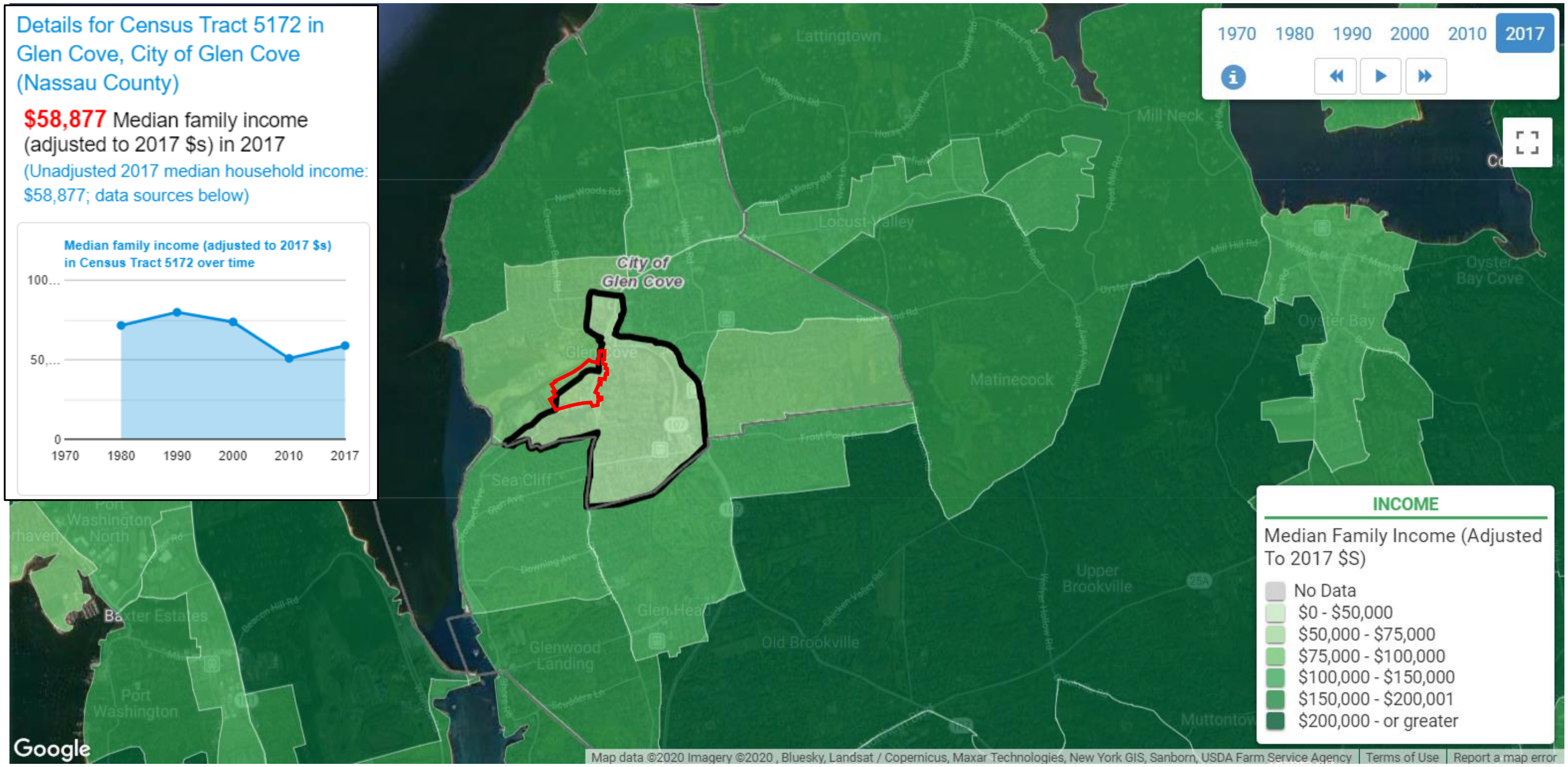


Figure 33: Median Family Income for City of Glen Cove in 2017

Note: Map was obtained from the Long Island Index's interactive mapping tool provided online. Map data is from the U.S. Census Bureau. Text box is information for area outlined in black. Study area is outlined in red.

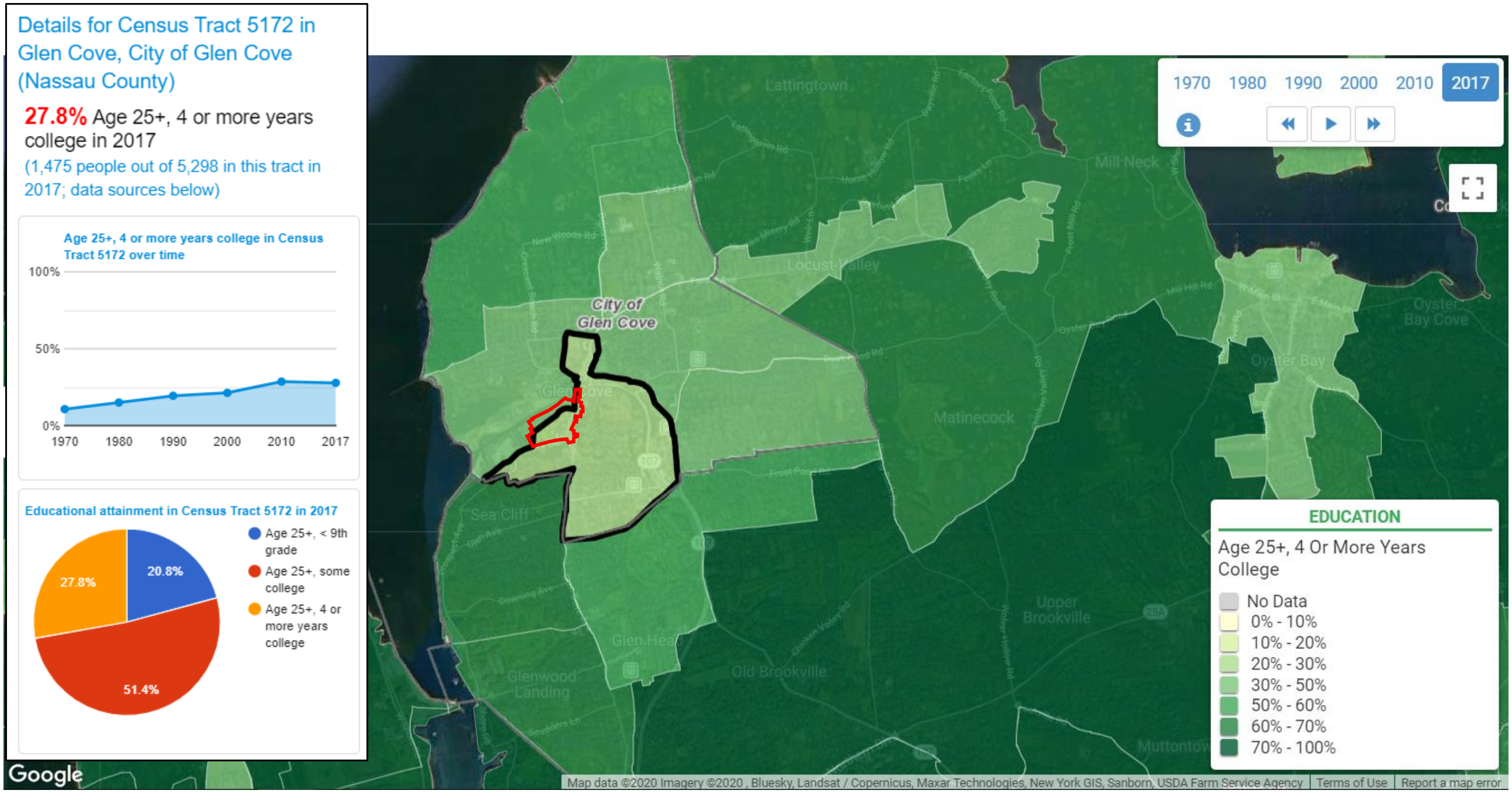


Figure 34: Percent of Population (over Age 25) with 4 of More Years of College for City of Glen Cove in 2017

Note: Map was obtained from the Long Island Index's interactive mapping tool provided online. Map data is from the U.S. Census Bureau. Text box is information for area outlined in black. Study area is outlined in red.

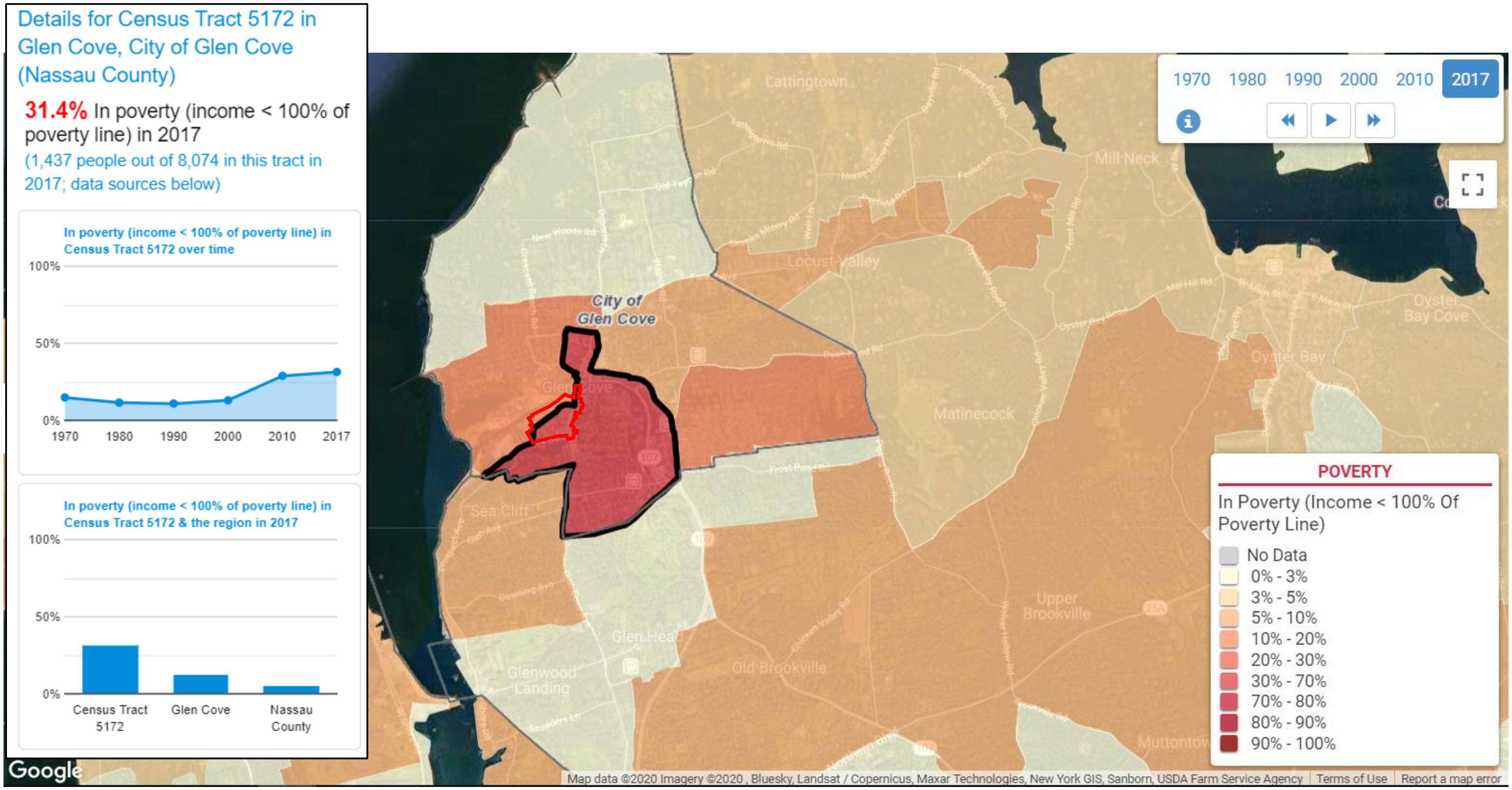


Figure 35: Percent of Population in Poverty for City of Glen Cove in 2017

Note: Map was obtained from the Long Island Index's interactive mapping tool provided online. Map data is from the U.S. Census Bureau. Text box is information for area outlined in black. Study area is outlined in red.

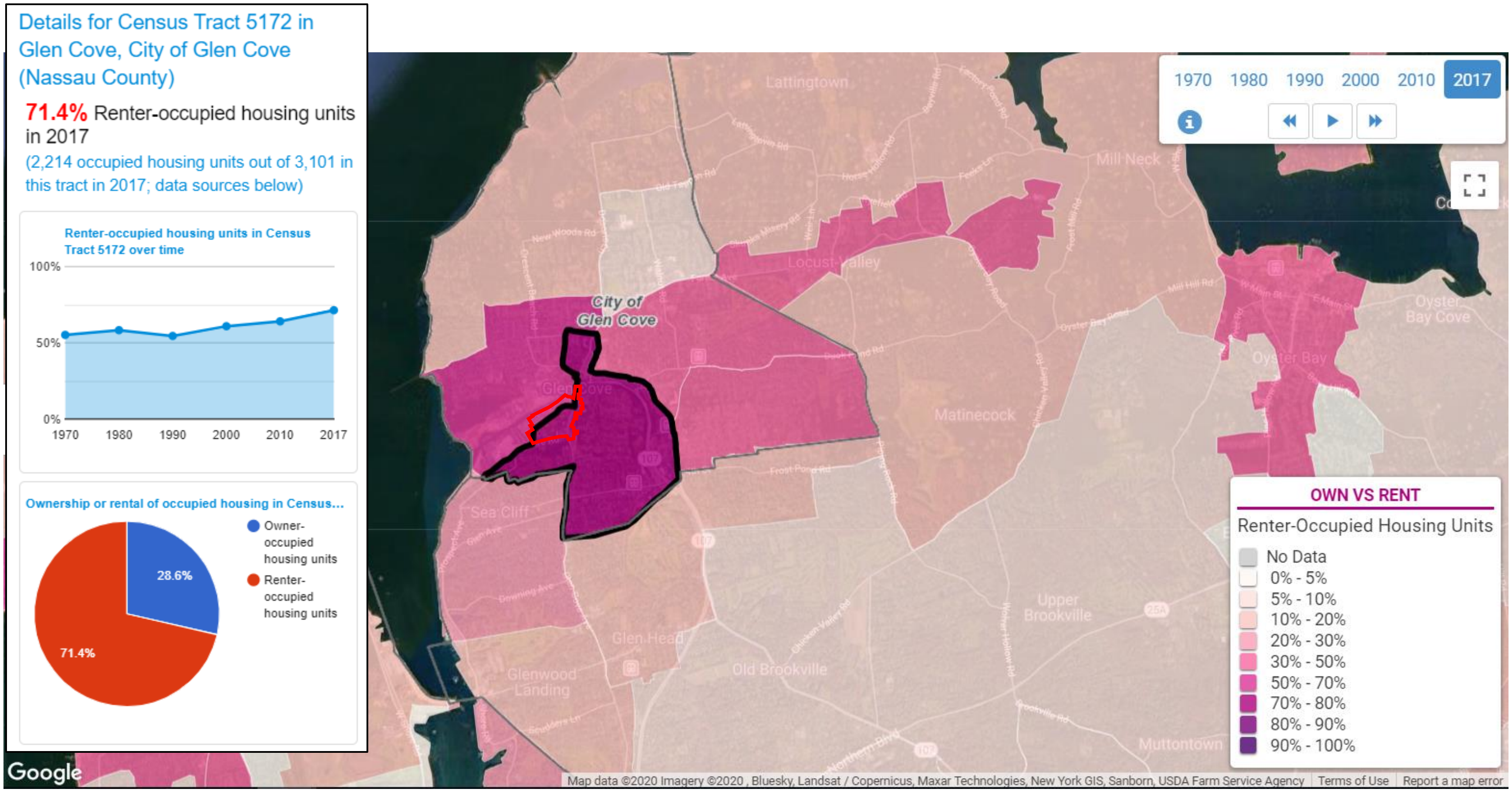


Figure 36: Percent of Renter-Occupied Housing Units for Glen Cove in 2017

Note: Map was obtained from the Long Island Index's interactive mapping tool provided online. Map data is from the U.S. Census Bureau. Text box is information for area outlined in black. Study area is outlined in red.

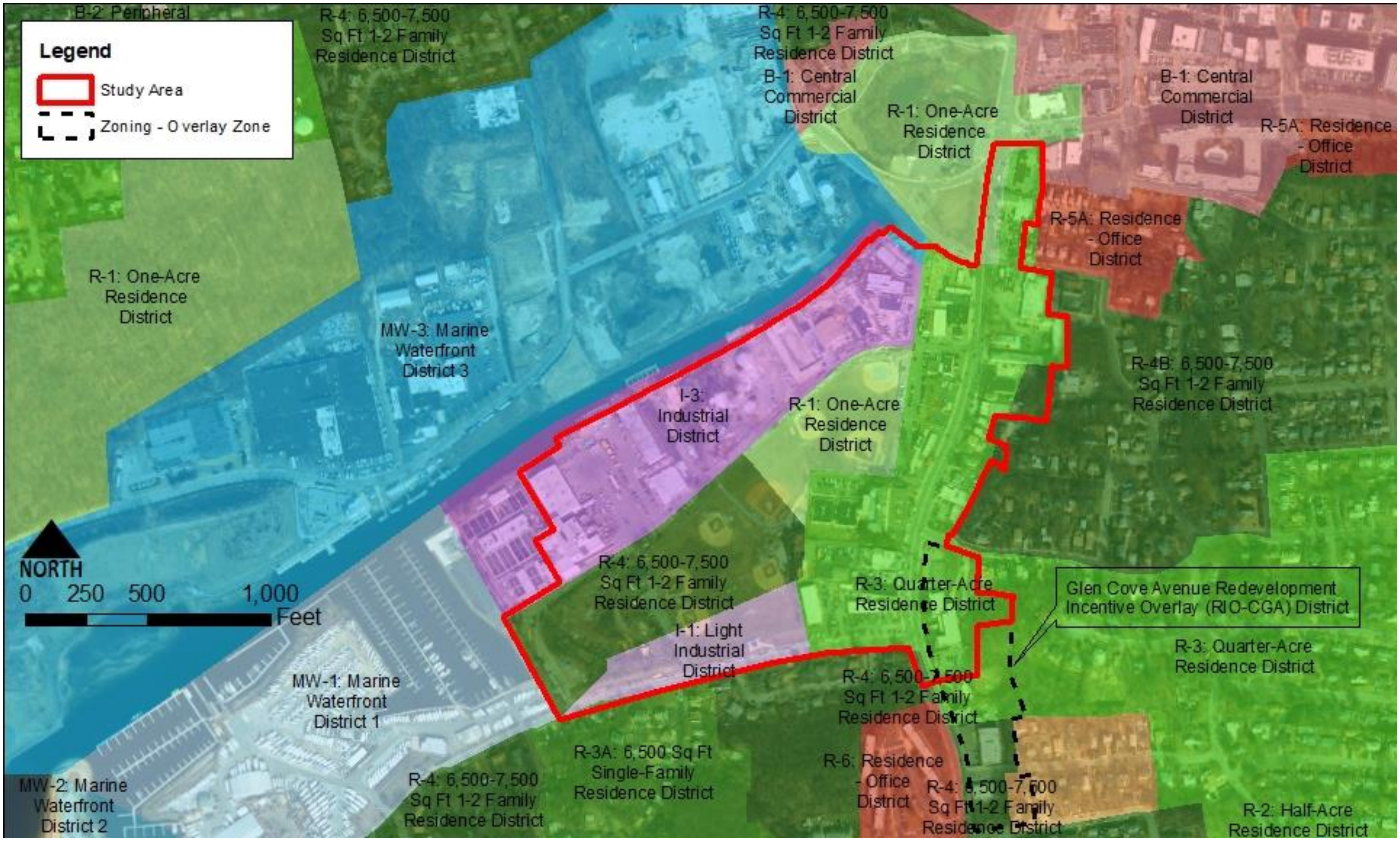


Figure 37: City of Glen Cove Zoning

Note: Zoning data provided by the City of Glen Cove, last revised February 2016.

Figure 38: Parcels and Buildings

Note: Parcels and building data provided by the City of Glen Cove.

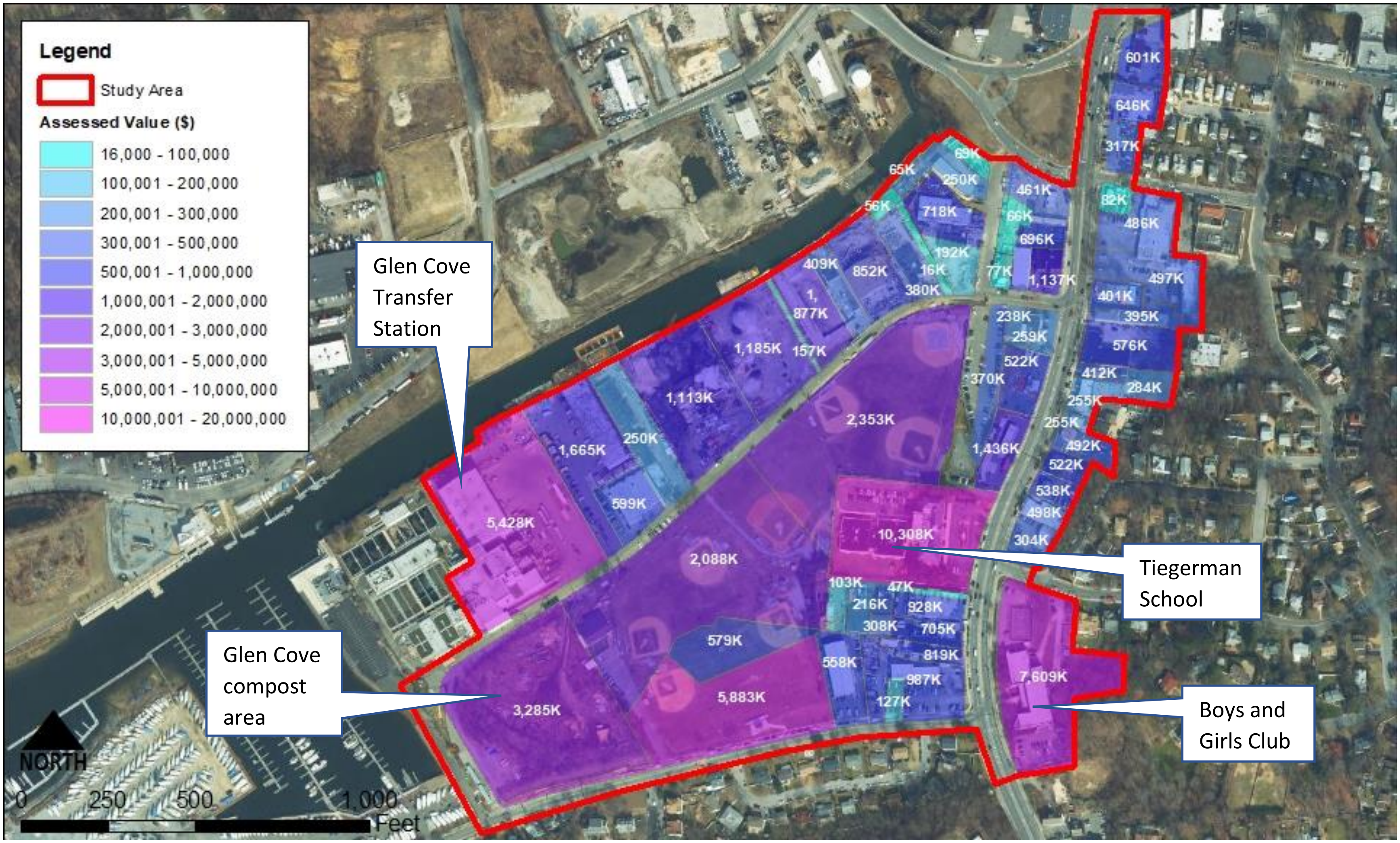


Figure 39: Assessed Total Parcel Value

Note: Assessor data is from 2019 and was provided by the City of Glen Cove. Note that assessed values differ slightly from assessed values presented in the online database provided by Nassau County.

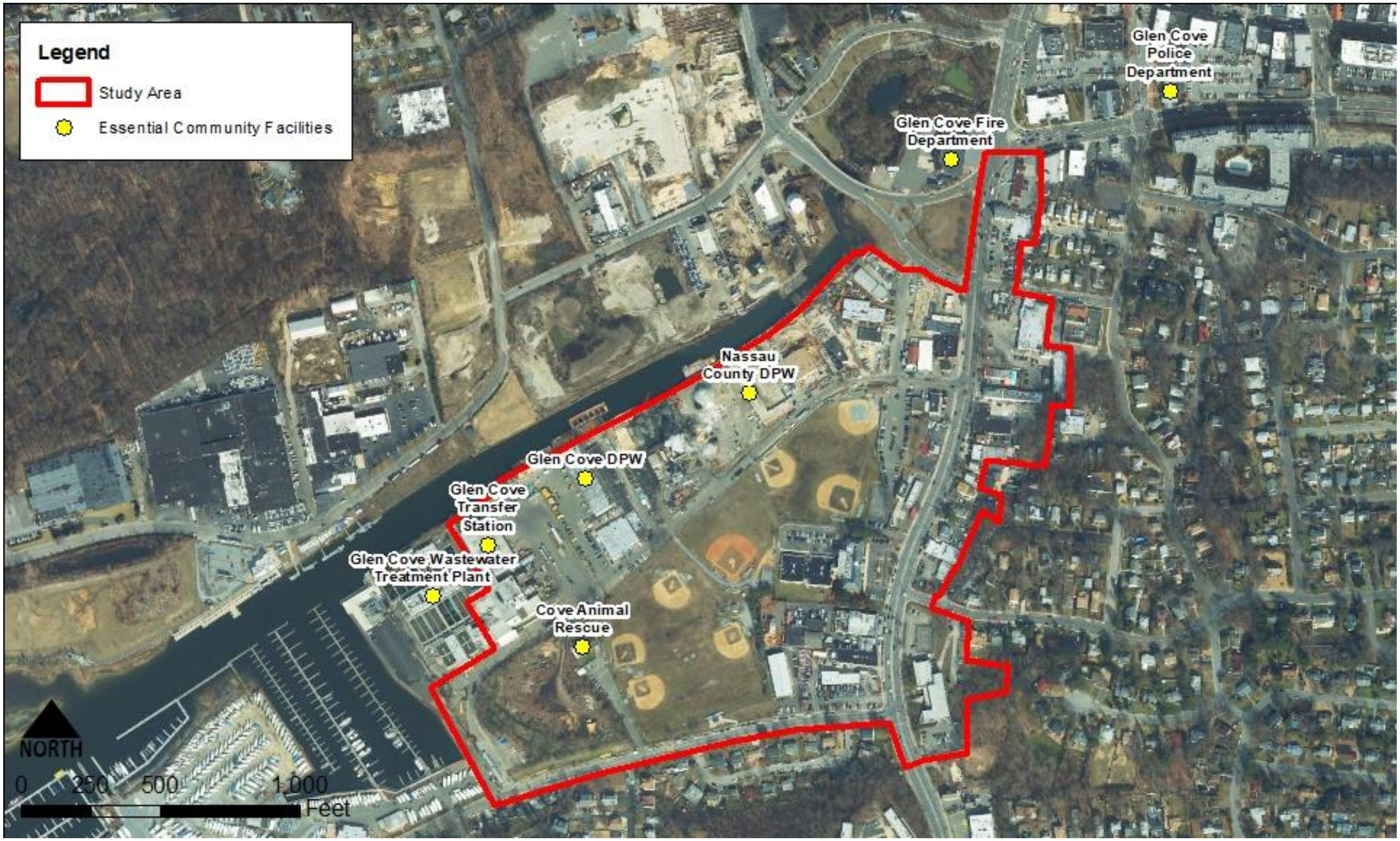


Figure 40: Essential Community Facilities

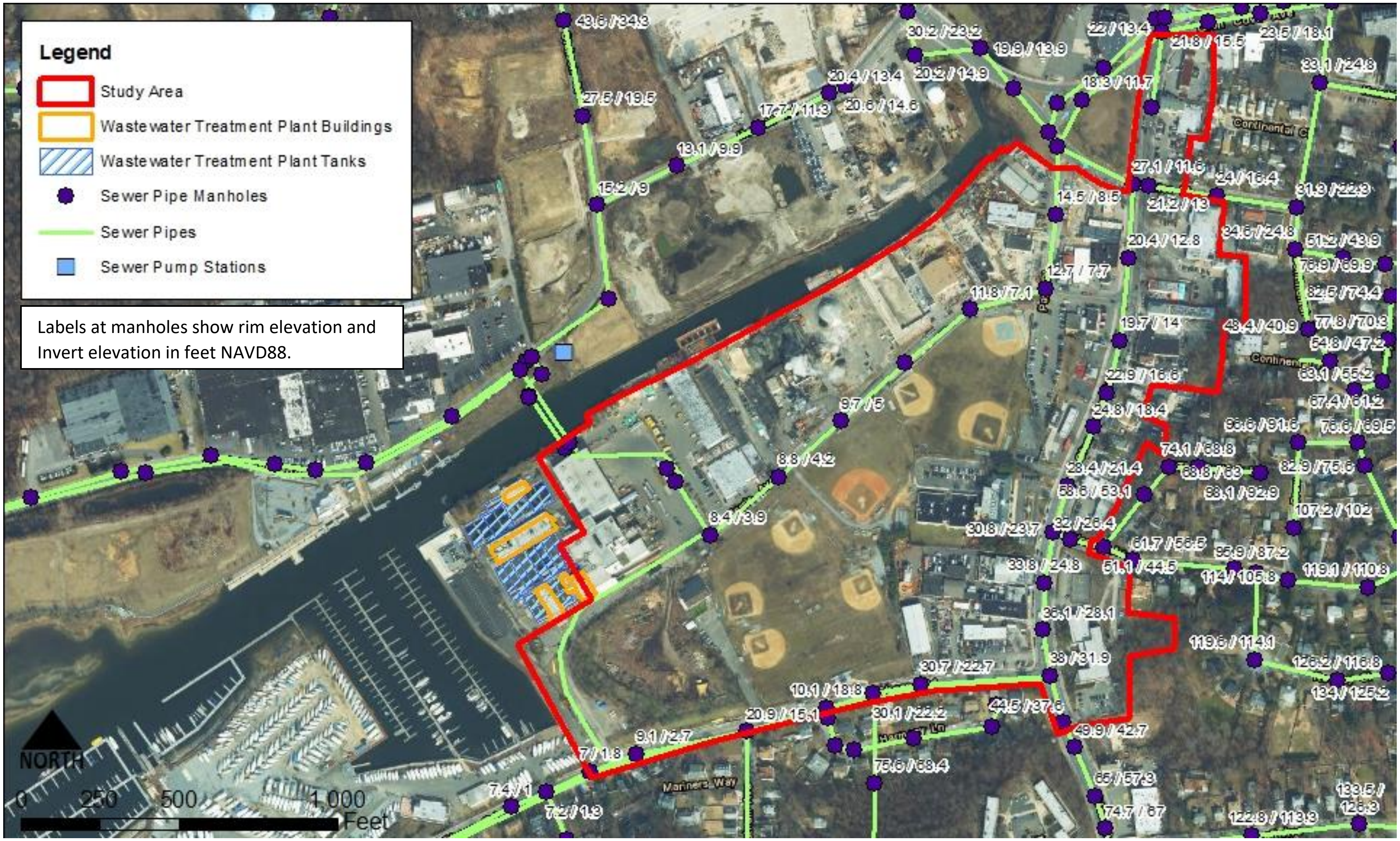


Figure 41: Glen Cove Sewer System and Wastewater Treatment Plant

Note: Wastewater treatment plant and sewer information provided by City of Glen Cove. Manhole elevations were converted from vertical datum NGVD29 to NAV88 by subtracting 1.1 feet.

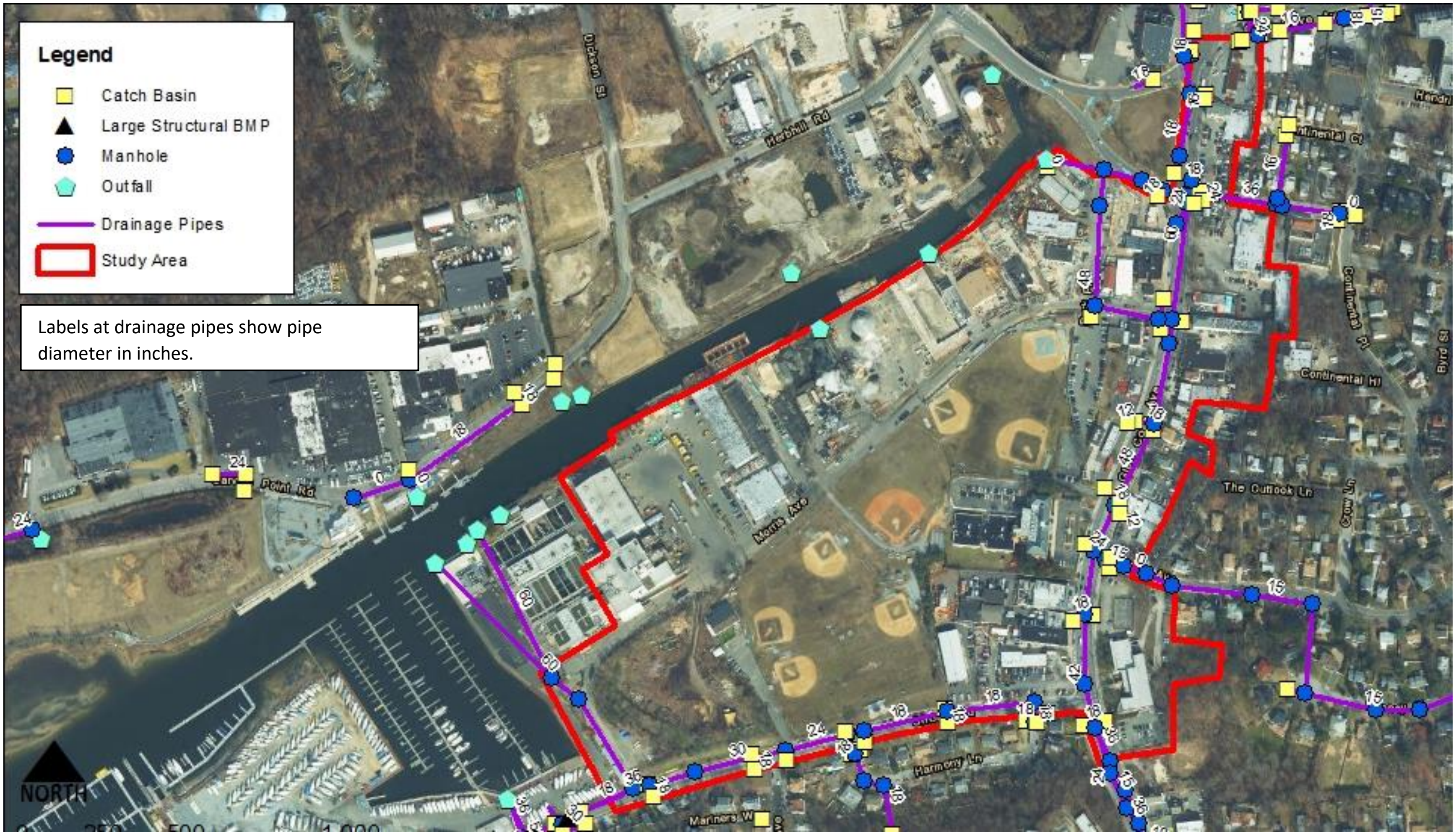


Figure 42: Glen Cove Stormwater Drainage System

Notes: Drainage structure and pipe information provided by City of Glen Cove. Data was extracted from January 2, 1975 plans. Photos and street view imagery confirms that Morris Avenue does not have catch basins. Topographic survey of the study area by B. Thayer Associates, last updated March 29, 2018, and plans from Nelson and Pope, published July 23, 2019, show catch basins and drainage pipes between the Glen Cove Transfer Station and DPW Yard. Some drainage data at parcels adjacent to Glen Cove Creek are likely missing from this figure.

Figure 43: Glen Cove Water Distribution System

Notes: Water main and valve locations provided by City of Glen Cove.

Figure 44: Glen Cove Gas Stations

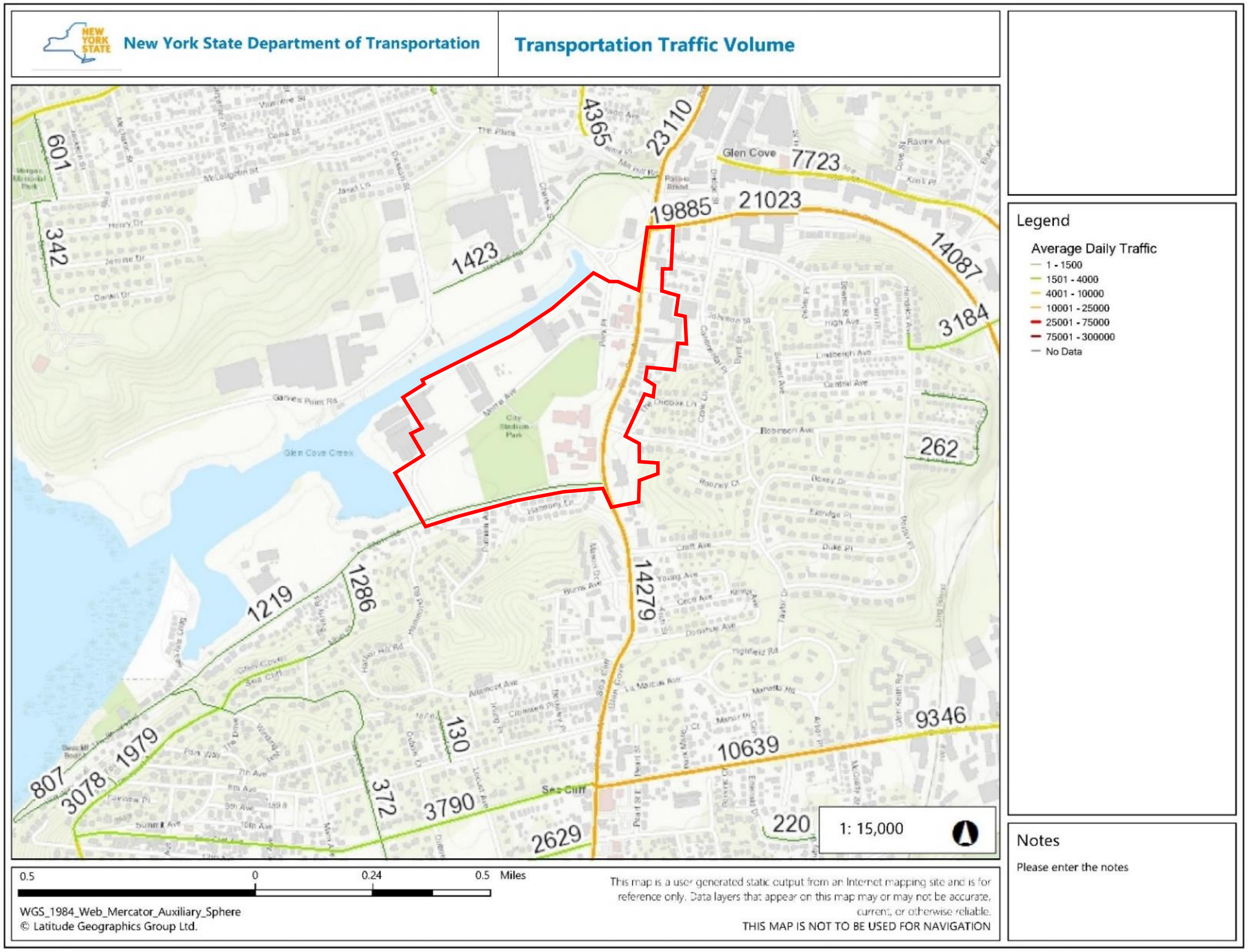


Figure 45: Transportation Traffic Volumes

Note: Map was obtained from the NYS Traffic Data Viewer, an interactive mapping tool provided online from NYSDOT. Traffic data is from 2016. Study area is outlined in red.

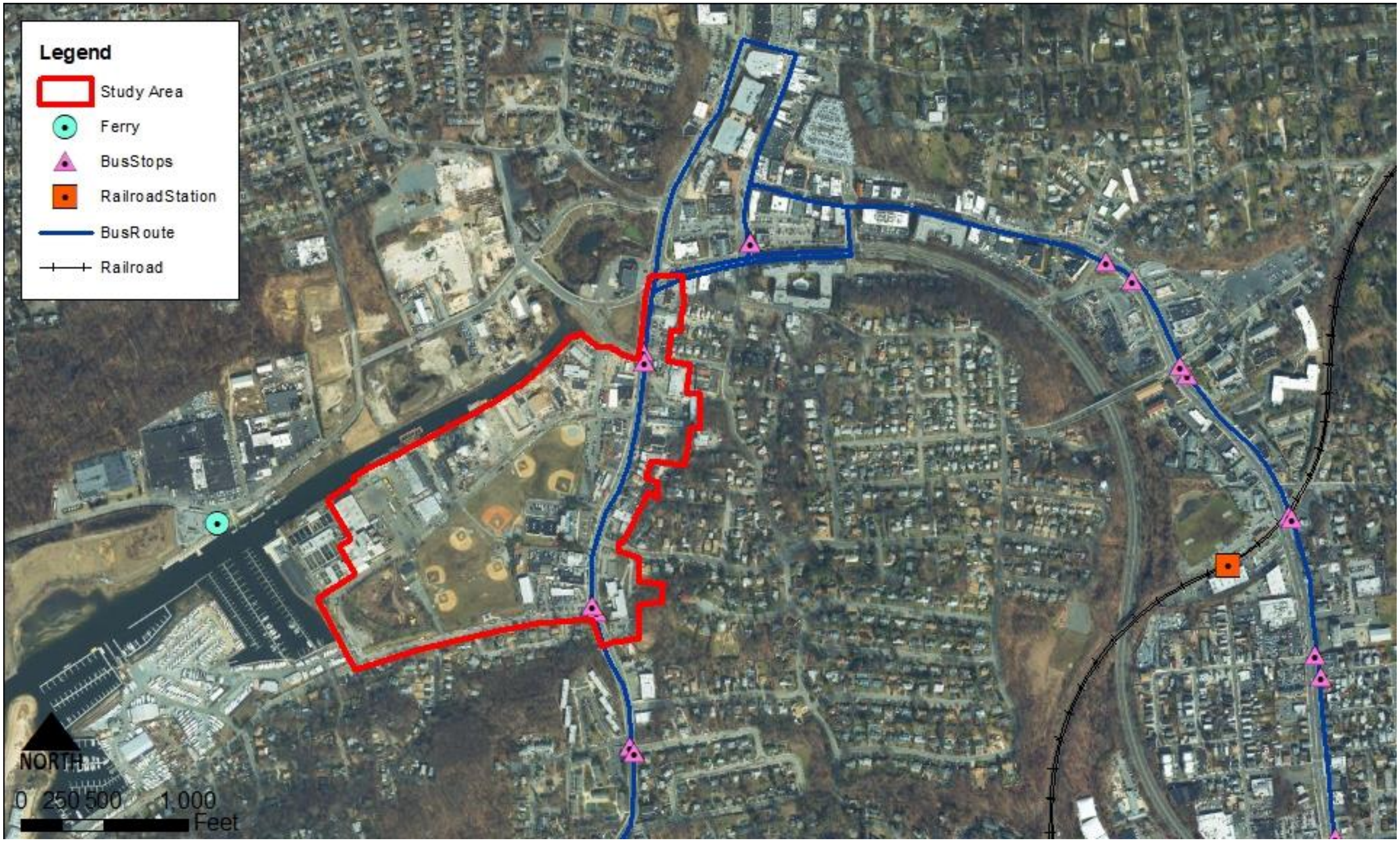


Figure 46: Public Transportation at Study Area

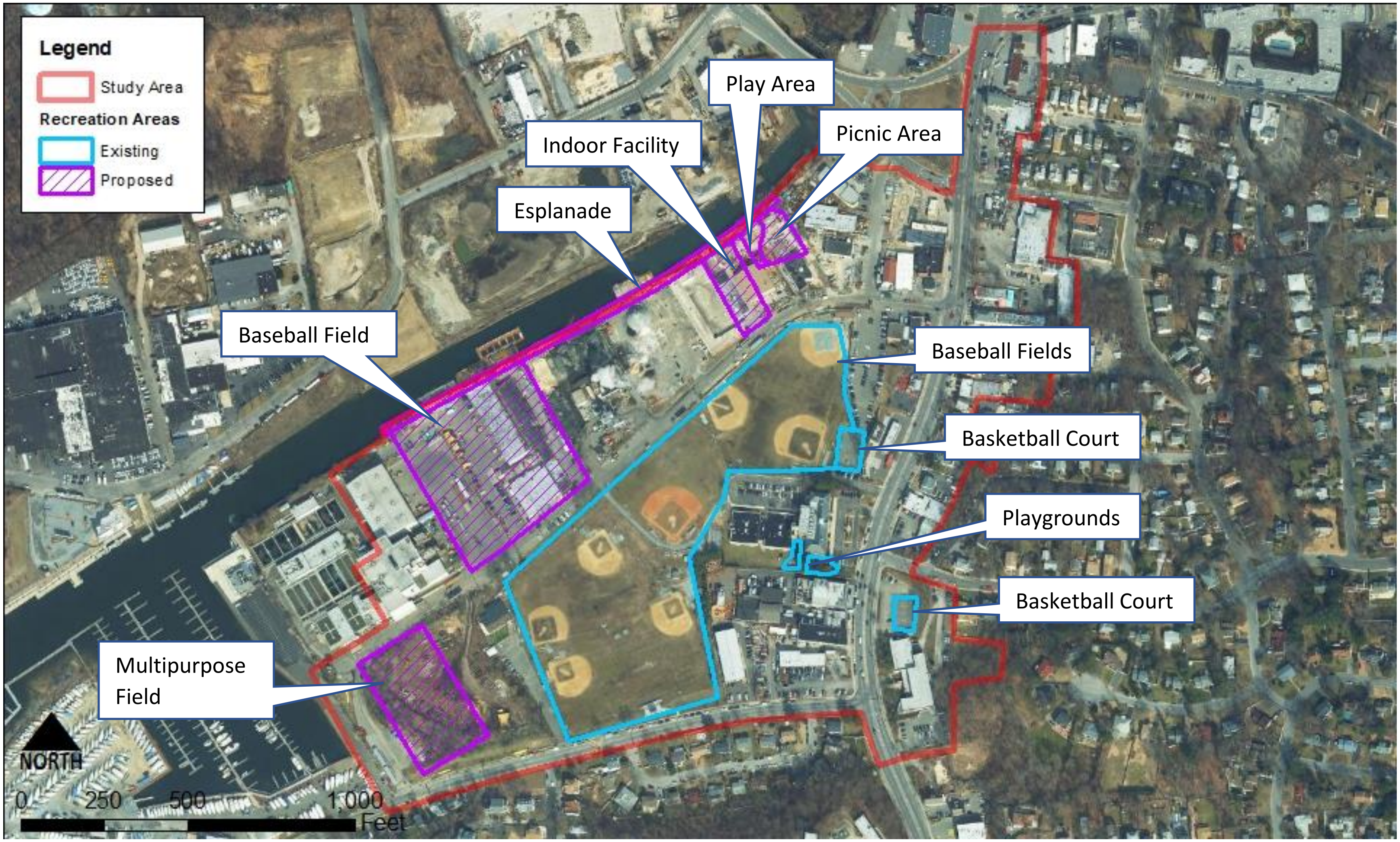


Figure 47: Existing and Proposed Recreation Resources in the Study Area

Note: Proposed recreation areas are from Waterside Recreational Redevelopment (WRR) long-term vision plan (July 2017).

ATTACHMENT 1: WATER LEVELS WITH RELATIVE SEA LEVEL RISE

Water Levels with Sea Level Rise
Low Scenario

Time Period	Water Level + Projection	Water Level for Tide / Recurrence Storm (feet, NAVD88)									
		MHHW	1-Year	2-Year	5-Year	10-Year	20-Year	50-Year	100-Year	200-Year	500-Year
Current	Tide Gauge	3.6	5.6	6.9	8.2	8.9	9.9	11.2	12.8		
	FEMA					7.3		10.2	10.9		13.5
	USACE		6.1	7.3	8.7	9.6	10.5	11.7	12.7	14.1	16.1
2050	Tide Gauge + NY State	4.3	6.3	7.6	8.9	9.6	10.6	11.9	13.5		
	Tide Gauge + NOAA	4.4	6.4	7.7	9.0	9.7	10.7	12.0	13.6		
	FEMA + NY State					8.0		10.9	11.6		14.2
	FEMA + NOAA					8.1		11.0	11.7		14.3
	USACE + NY State		6.8	8.0	9.4	10.3	11.2	12.4	13.4	14.8	16.8
	USACE + NY NOAA		6.9	8.1	9.5	10.4	11.3	12.5	13.5	14.9	16.9
2100	Tide Gauge + NY State	4.9	6.9	8.2	9.5	10.2	11.2	12.5	14.1		
	Tide Gauge + NOAA	5.1	7.0	8.3	9.6	10.3	11.3	12.6	14.2		
	FEMA + NY State					8.6		11.5	12.2		14.8
	FEMA + NOAA					8.7		11.6	12.3		14.9
	USACE + NY State		7.4	8.6	10.0	10.9	11.8	13.0	14.0	15.4	17.4
	USACE + NY NOAA		7.5	8.7	10.1	11.0	11.9	13.1	14.1	15.5	17.5

	SLR (feet)	
Data Source	2050	2100
NY State DEC (6 NYCRR Part 490)	0.7	1.3
NOAA 2017 Report	0.8	1.4

Water Levels with Sea Level Rise
Intermediate Scenario

Time Period	Water Level + Projection	Water Level for Tide / Recurrence Storm (feet, NAVD88)									
		MHHW	1-Year	2-Year	5-Year	10-Year	20-Year	50-Year	100-Year	200-Year	500-Year
Current	Tide Gauge	3.6	5.6	6.9	8.2	8.9	9.9	11.2	12.8		
	FEMA					7.3		10.2	10.9		13.5
	USACE		6.1	7.3	8.7	9.6	10.5	11.7	12.7	14.1	16.1
2050	Tide Gauge + NY State	5.0	6.9	8.2	9.5	10.2	11.2	12.5	14.1		
	Tide Gauge + NOAA	5.3	7.2	8.5	9.8	10.5	11.5	12.8	14.4		
	FEMA + NY State					8.6		11.5	12.2		14.8
	FEMA + NOAA					8.9		11.8	12.5		15.1
	USACE + NY State		7.4	8.6	10.0	10.9	11.8	13.0	14.0	15.4	17.4
	USACE + NY NOAA		7.7	8.9	10.3	11.2	12.1	13.3	14.3	15.7	17.7
2100	Tide Gauge + NY State	6.5	8.4	9.7	11.0	11.7	12.7	14.0	15.6		
	Tide Gauge + NOAA	7.8	9.8	11.1	12.4	13.1	14.1	15.4	17.0		
	FEMA + NY State					10.1		13.0	13.7		16.3
	FEMA + NOAA					11.5		14.4	15.1		17.7
	USACE + NY State		8.9	10.1	11.5	12.4	13.3	14.5	15.5	16.9	18.9
	USACE + NY NOAA		10.3	11.5	12.9	13.8	14.7	15.9	16.9	18.3	20.3

	SLR (feet)	
Data Source	2050	2100
NY State DEC (6 NYCRR Part 490)	1.3	2.8
NOAA 2017 Report	1.6	4.2

Note: NY State DEC presents the intermdedia scenario as a range (25th percentile to 75th percentile).
For this table, the 25th percentile and 75th percentile were averaged.

Water Levels with Sea Level Rise

High Scenario

Time Period	Water Level + Projection	Water Level for Tide / Recurrence Storm (feet, NAVD88)									
		MHHW	1-Year	2-Year	5-Year	10-Year	20-Year	50-Year	100-Year	200-Year	500-Year
Current	Tide Gauge	3.6	5.6	6.9	8.2	8.9	9.9	11.2	12.8		
	FEMA					7.3		10.2	10.9		13.5
	USACE		6.1	7.3	8.7	9.6	10.5	11.7	12.7	14.1	16.1
2050	Tide Gauge + NY State	6.1	8.1	9.4	10.7	11.4	12.4	13.7	15.3		
	Tide Gauge + NOAA	6.6	8.6	9.9	11.2	11.9	12.9	14.2	15.8		
	FEMA + NY State					9.8		12.7	13.4		16.0
	FEMA + NOAA					10.3		13.2	13.9		16.5
	USACE + NY State		8.6	9.8	11.2	12.1	13.0	14.2	15.2	16.6	18.6
	USACE + NY NOAA		9.1	10.3	11.7	12.6	13.5	14.7	15.7	17.1	19.1
2100	Tide Gauge + NY State	9.6	11.6	12.9	14.2	14.9	15.9	17.2	18.8		
	Tide Gauge + NOAA	12.7	14.7	16.0	17.3	18.0	19.0	20.3	21.9		
	FEMA + NY State					13.3		16.2	16.9		19.5
	FEMA + NOAA					16.4		19.3	20.0		22.6
	USACE + NY State		12.1	13.3	14.7	15.6	16.5	17.7	18.7	20.1	22.1
	USACE + NY NOAA		15.2	16.4	17.8	18.7	19.6	20.8	21.8	23.2	25.2

	SLR (feet)	
Data Source	2050	2100
NY State DEC (6 NYCRR Part 490)	2.5	6.0
NOAA 2017 Report	3.0	9.1

Water Levels with Sea Level Rise
Using Observed Rate from King Point Gauge

Time Period	Water Level + Projection	Water Level for Tide / Recurrence Storm (feet, NAVD88)									
		MHHW	1-Year	2-Year	5-Year	10-Year	20-Year	50-Year	100-Year	200-Year	500-Year
Current	Tide Gauge	3.6	5.6	6.9	8.2	8.9	9.9	11.2	12.8		
	FEMA					7.3		10.2	10.9		13.5
	USACE		6.1	7.3	8.7	9.6	10.5	11.7	12.7	14.1	16.1
2050	Tide Gauge + Observed Rate	4.0	6.0	7.3	8.6	9.3	10.3	11.6	13.2		
	FEMA + Observed Rate					7.7		10.6	11.3		
	USACE + Observed Rate		6.5	7.7	9.1	10.0	10.9	12.1	13.1	14.5	16.5
2100	Tide Gauge + Observed Rate	4.4	6.4	7.7	9.0	9.7	10.7	12.0	13.6		
	FEMA + Observed Rate					8.1		11.0	11.7		
	USACE + Observed Rate		6.9	8.1	9.5	10.4	11.3	12.5	13.5	14.9	16.9

	SLR (feet)	
Data Source	2050	2100
Observed Rate at Kings Point Tide Gauge	0.4	0.8

ATTACHMENT 2: TERMINOLOGY

Floodplain: Any land area susceptible to being inundated by water from any source as the "floodplain."

Base Flood: A flood having a 1% chance of being equaled or exceeded in any given year. The base flood is the national regulatory standard used by the National Flood Insurance Program (NFIP) and all Federal agencies for the purposes of requiring the purchase of flood insurance and regulating new development.

Base Flood Elevation: The elevation shown on the Flood Insurance Rate Map (FIRM) for Zones AE, AH, A1-30, or VE that indicates the water surface elevation resulting from a flood that has a 1% chance of occurring in any given year. In coastal areas, BFEs are calculated by taking into account: 1) the storm surge stillwater elevation, 2) the amount of wave setup, 3) the wave height above the storm surge stillwater elevation, and 4) the wave runup above the storm surge stillwater elevation (where present).

Coastal Barrier Resources Act (CBRA) Boundaries: The Coastal Barrier Resources Act (CBRA) established the John H. Chafee Coastal Barrier Resources System (CBRS), a defined set of geographic units along the Atlantic, Gulf of Mexico, Great Lakes, U.S. Virgin Islands, and Puerto Rico coasts. Most new Federal expenditures and financial assistance (including flood insurance) are prohibited within the CBRS, with some exceptions. The U.S. Fish and Wildlife Service is responsible for administering CBRA.

Community Rating System: A FEMA initiative, established under the National Flood Insurance Program (NFIP), to recognize and reward communities that have implemented floodplain management measures beyond the minimum NFIP requirements. Under the CRS, those communities that choose to participate may reduce the flood insurance premium rates in the community from 5 to 45% based on the types of activities they perform.

Flood: A condition of partial or complete inundation of normally dry land areas from: (1) the overflow of inland or tidal waters, (2) the unusual and rapid accumulation or runoff of surface waters from any source

FEMA Flood Insurance Study (FIS): The official report which usually accompanies the Flood Insurance Rate Map (FIRM), provided by FEMA that contains additional technical information on the flood hazards shown on the FIRM

Floodproofing: Any combination of structural and nonstructural additions, changes, or adjustments to structures which reduce or eliminate flood damage to real estate or improved real property, water and sanitary facilities, structures and their contents.

LiMWA: The Limit of Moderate Wave Action (LiMWA) is the demarcation between areas with waves greater and lower than 1.5 feet height.

Special Flood Hazard Areas: Flood hazard zones are lettered based on the level and type of flood risk:

> Zone V/VE: An area of high flood risk subject to inundation by the 1% annual-chance flood event with additional hazards due to storm-induced velocity wave action (a 3-foot or higher breaking wave).
>
> Zone A/AE: An area of high flood risk subject to inundation by the 1% annual-chance flood event.
>
> Zone AO: An area of high flood risk subject to inundation by 1% annual-chance shallow flooding where average depths are between one and three feet.
>
> Shaded Zone X: Areas of moderate flood risk within the 0.2% annual chance floodplain; or areas of 1% annual chance flooding where average depths are less than 1 foot, where the drainage area is less than 1 square mile, or areas protected from this flood level by a levee.
>
> Unshaded Zone X: Areas of low flood risk outside the 1%- and 0.2%-annual chance floodplains.
>
> Zone D: Areas where flood hazards are undetermined, but flooding is possible.

Coastal AE Zones: coastal areas within the 1% annual chance (base) flood, with waves between 1.5 to 3 feet height. These are areas that will be exposed to both flood, moderate wave forces and other wave effects.

Sea Level Rise: An increase in sea level caused by a change in the volume of the world's oceans due to temperature increase, deglaciation (uncovering of glaciated land because of melting of the glacier), and ice melt.

Stillwater Elevation: The projected elevation of floodwaters in the absence of waves resulting from wind or seismic effects.

In coastal areas, stillwater elevations are determined when modeling coastal storm surge; the results of overland wave modeling are used in conjunction with the stillwater elevations to develop Base Flood Elevations.

Storm Surge: Storm surge is the water, combined with normal tides, that is pushed toward the shore by strong winds during a storm. This rise in water level can cause severe flooding in coastal areas, particularly when the storm coincides with the normal high tides. The height of the storm surge is affected by many variables, including storm intensity, storm track and speed, the presence of waves, offshore depths, and shoreline configuration

Wave Set-Up: The increase in the water level caused by the onshore mass transport of water that happens due to waves breaking during a storm. Wave setup is affected by the wave height, the speed at which waves approach the shore, and the slope of the shore.

Wave Run-Up: The rush of water that extends inland when waves come ashore. Wave runup effects are computed as a part of the overland wave analysis and are added to the stillwater elevations computed from the storm surge model when developing Base Flood Elevations in coastal areas.

ATTACHMENT 3: LIMITATIONS

1. Note that the probabilities presented in this plan are approximate and uncertain. They describe future potential conditions to support planning-level decision-making. The scenarios are appropriate for use in understanding the risk of different climate change scenarios and planning. For example, applying higher amounts of sea level rise may be appropriate when considering risk mitigation for high value lifeline assets, which would merit protection against events with a low probability of occurrence.