5.4.11 Shallow Groundwater Flooding

This section provides a profile and vulnerability assessment for the shallow groundwater flooding hazard.

Hazard Profile

This section provides profile information including description, location and extent, previous occurrences and losses, and the probability of future occurrences.

Description

As detailed in the flood hazard profile (Section 5.4.5), a flood is a general and temporary condition of partial or complete inundation of normally dry land areas, resulting from:

- Overflow of inland or tidal waters
- Unusual and rapid accumulation of runoff or surface waters
- Mudslides/mudflows caused by accumulation of water
- A situation in which rainfall is so intense and severe and runoff so rapid that is precludes recording and relating it to stream stages and other information in time to forecast a flood condition (New York State Disaster Preparedness Commission [NYSDPC], 2005).

According to the Federal Interagency Floodplain Management Task Force, flooding in the United States can be separated into several types (Federal Interagency Floodplain Management Task Force, 1992), including "shallow or high groundwater levels."

Per the FEMA's "Multi-Hazard Identification and Risk Assessment – The Cornerstone of the National Mitigation Strategy (1997), "high groundwater levels may be of concern and can cause problems even when there is no surface flooding. Basements are susceptible to high groundwater levels. Seasonally high groundwater is common in many areas, while in others high groundwater occurs only after long periods of above-average precipitation."

Groundwater is a crucial water resource that supplies springs, wells, and base flow to streams. When groundwater is close to the surface, it can cause chronic issues to those who experience basement flooding and compromised septic systems. Groundwater is stored and flows within the pore spaces of soil and rocks. It is present in all areas, even those that are not underlain by a major aquifer (Southern Tier Central Regional Planning & Development Board Date Unknown).

Groundwater flooding occurs when soil becomes too saturated from rainfall to absorb more water and the water table rises to the surface. For homeowners, groundwater flooding can cause many problems that may include structural damage, sewer system back-ups, and damaged appliances (North Dakota State University 2011).

According to a 2010 U.S. Geological Survey (USGS) article, record or near-record high groundwater levels are occurring across many parts of Long Island as a result of frequent and intense precipitation events. The high water table has caused widespread flooding of basements in parts of southwestern Nassau County and in central Suffolk County. Water level records from wells in these areas have shown long term upward trends that have reached record or near-record highs. More sporadic flooding has been reported in some locations near-shore and near stream channels throughout Long Island (USGS 2010).

For the purposes of this planning effort, the shallow groundwater flooding hazard has been defined as the condition of a sufficiently shallow groundwater table (saturated zone) either cyclically or persistently above the level of subsurface structures resulting in negative impacts. Impacts to subsurface structures include groundwater seepage into basements and septic system failures. In some cases, shallow groundwater breaches the land surface and floods low-lying roadways, as covered more generally under the "flooding" hazard in this Plan. The hazard definition for this planning effort does not include groundwater seepage as a result of heavy precipitation events where the actual groundwater table (saturated zone) does not impinge on subsurface structures.

Extent

The severity of a flood depends not only on the amount of water that accumulates in a period of time, but also on the land's ability to manage this water. One element is the size of rivers and streams in an area; but an equally important factor is the land's absorbency. When it rains, soil acts as a sponge. When the land is saturated or frozen, infiltration into the ground slows and any more water that accumulates must flow as runoff (Harris, 2001).

The most severe consequences of coastal floods is loss of life. Flood-related deaths are the largest cause of natural hazard-related deaths in the U.S. NOAA forecasts coastal flood conditions so communities can take action. The NWS monitors coastal flooding conditions 24 hours a day, seven days a week. The NWS issues forecasts, watches, and warnings, similar to hurricane local statements. These forecasts, watches and warnings provide details on a storm's impact to an area. NOAA's National Ocean Service monitors and distributes real-time water levels, which are used to assess storm surge conditions at stations throughout the U.S. NOAA issues website alerts on high water conditions caused by severe weather (NOAA, Date Unknown).

Location

Shallow groundwater flooding has occurred throughout the County for many years, resulting in persistent structural flood losses. These conditions in Suffolk County typically occur in low-lying areas along the coast, near surface water bodies (including wetlands, marshes and bogs) and along ancestral drainage courses. Soil permeability often exacerbates shallow groundwater problems in such areas, as in morainal areas that contain glacial till (as opposed to areas with higher permeability geologies such as outwash deposits). Further, the presence and severity of shallow groundwater conditions is a function of long-term precipitation trends in the County, particularly in the areas around the Northeast Branch of the Nissequogue River and Lake Ronkonkoma in the Town of Smithtown.

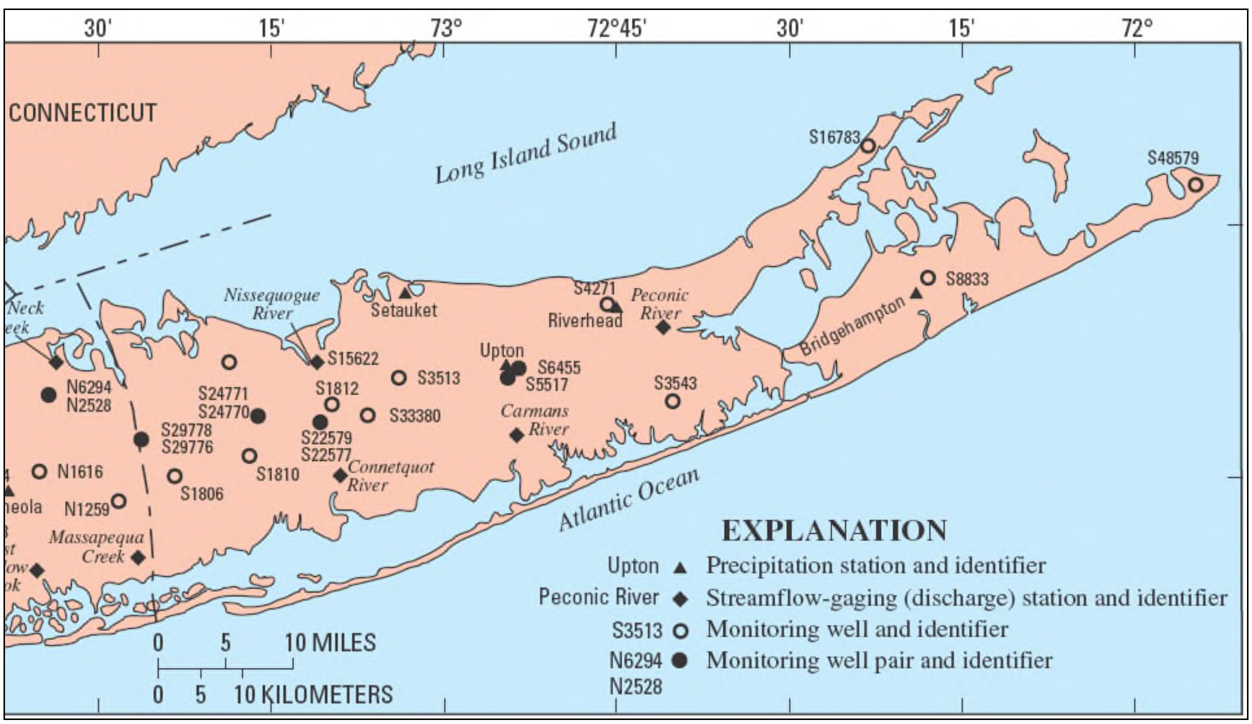
The Northeast Branch of the Nissequogue River is one of the most widely recognized areas affected by shallow groundwater flooding in Suffolk County. It is a series of ponds and streams that bring water to New Mill Pond for discharge to the Long Island Sound via the Nissequogue River. The Northeast Branch serves to drain stormwater and groundwater from its watershed. The waterway's ability to efficiently transport excess groundwater to downstream waters depends on the condition of the stream. The Northeast Branch has a recurring groundwater flooding issue. At least 268 homes are known to have experienced damages related to this flooding issue and an additional 662 homes have been identified as likely to have experienced damages relating to groundwater flooding (Schumer 2013).

The fact that shallow groundwater tables are found in low-lying areas and in proximity to surface water bodies throughout Suffolk County are well recognized and understood. The upper glacial aquifer is the uppermost unit in Long Island's groundwater reservoir and contains the water table throughout the majority of the island. The upper surface of the upper glacial aquifer forms the present day land surface of most of Long Island. While in parts of Long Island, the upper glacial aquifer overlies geologies with high hydraulic conductivities, some parts of the aquifer overlay areas of limited conductivity (Gardiners clay along the much of the southern shore, and subcrops of the Raritan clay confining unit along parts of the northern shore).

As stated in U.S. Geological Survey (USGS) Water-Resources Investigations Report (WRIR) 01-4165, the upper glacial aquifer consists of till, outwash deposits, and three major glaciolacustrine and marine clay units. These include the "Smithtown clay' in north central Suffolk County, the "Manorville clay" in east-central Suffolk County, and "the "20-foot clay" in southwestern Suffolk County. These minor clay units impede the downward movement of water, and each one creates locally elevated water tables (Busciolano, 2002).

Precipitation is the sole source of all naturally occurring fresh groundwater on Long Island, and seasonal or long-term fluctuations in precipitation are reflected by the water levels in all aquifers (Busciolano, 2002). The general trends in the rise and fall of the water table follow general trends in precipitation (H2M, 1980). Long-term surface water data collection by the USGS in most parts of the Long Island began in the 1930s and 1940s (Busciolano, 2002). This report clearly demonstrates the correlation between groundwater levels and long-term precipitation trends, as determined through measurements collected at the precipitation-monitoring stations and groundwater monitoring wells shown on Figure 5.4.11-1.

Figure 5.4.11-1. Locations of Selected Precipitation and Groundwater Monitoring Stations on Long Island



Source: Busciolano, 2005.
Note: Base from USGS State base map, 1979.

Long term precipitation records at eight selected stations across Long Island were found to indicate generally similar long-term trends, with a deficit of rain in the 1960s as the major. Precipitation monitoring at the Setauket (Town of Brookhaven), Upton (Town of Brookhaven), and Riverhead stations (see Figure 5.4.11-1 and Table 5.4.11-1) indicated the following notable short- and long-term precipitation trends:

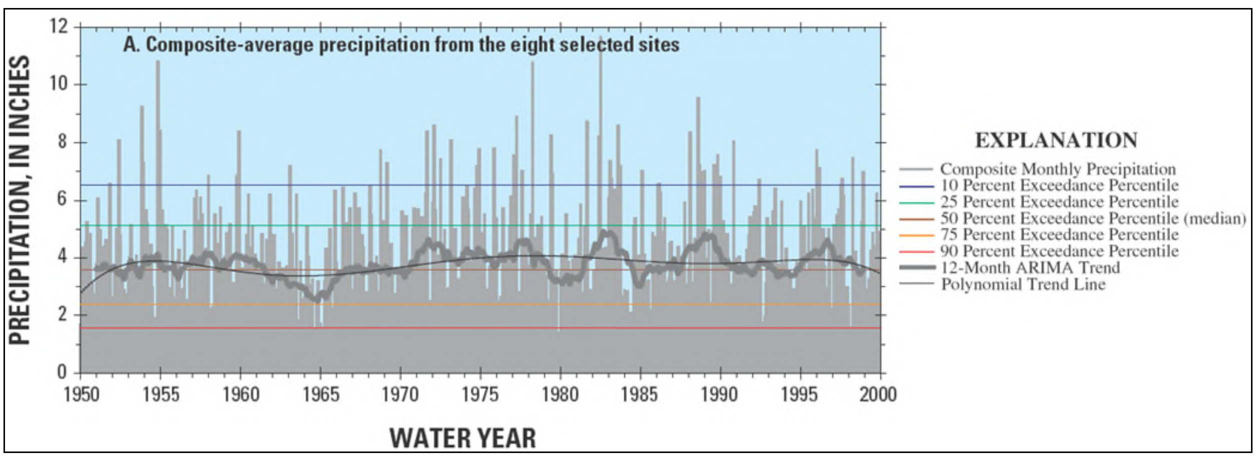
Table 5.4.11-1. Short- and Long-Term Precipitation Trends at Selected Monitoring Stations

Station	Period of record: Long or short term	Period of record: Period	Period of record: No. of years	Relation to mean: 1951-2000 mean	Relation to mean: Above or below	Cumulative value: Surplus (inches)	Cumulative value: Deficit (inches)
Setauket	Short term	1958-60	3	44.93	above	17.22	--
		1961-66	6		below	--	44.48
		1972-76	5		above	22.85	--
		1982-84	3		above	25.45	--
		1989-91	3		above	19.50	--
	Long term	1961-68	8		below	--	50.88
		1972-79	8		above	41.57	--
Upton	Short term	1962-66	5	48.85	below	--	32.19
		1982-84	3		above	27.49	--
		1985-88	4		below	--	38.16
		1989-91	3		above	26.98	--
		1992-95	4		below	--	30.61
	Long term	1972-79	8		above	25.10	--
Riverhead	Short term	1958-61	4	46.01	above	20.90	--
		1962-66	5		below	--	37.96
		1982-84	3		above	28.37	--
		1989-91	3		above	25.30	--
		1996-98	3		above	19.42	--
	Long term	1962-71	10		below	--	60.19
		1972-79	8		above	29.98	--

Source: Busciolano, 2005

Figure 5.4.11-2 shows a 50-year composite-average hydrograph of monthly precipitation for the eight monitoring stations used in the USGS report to evaluate overall precipitation trends for Nassau and Suffolk Counties.

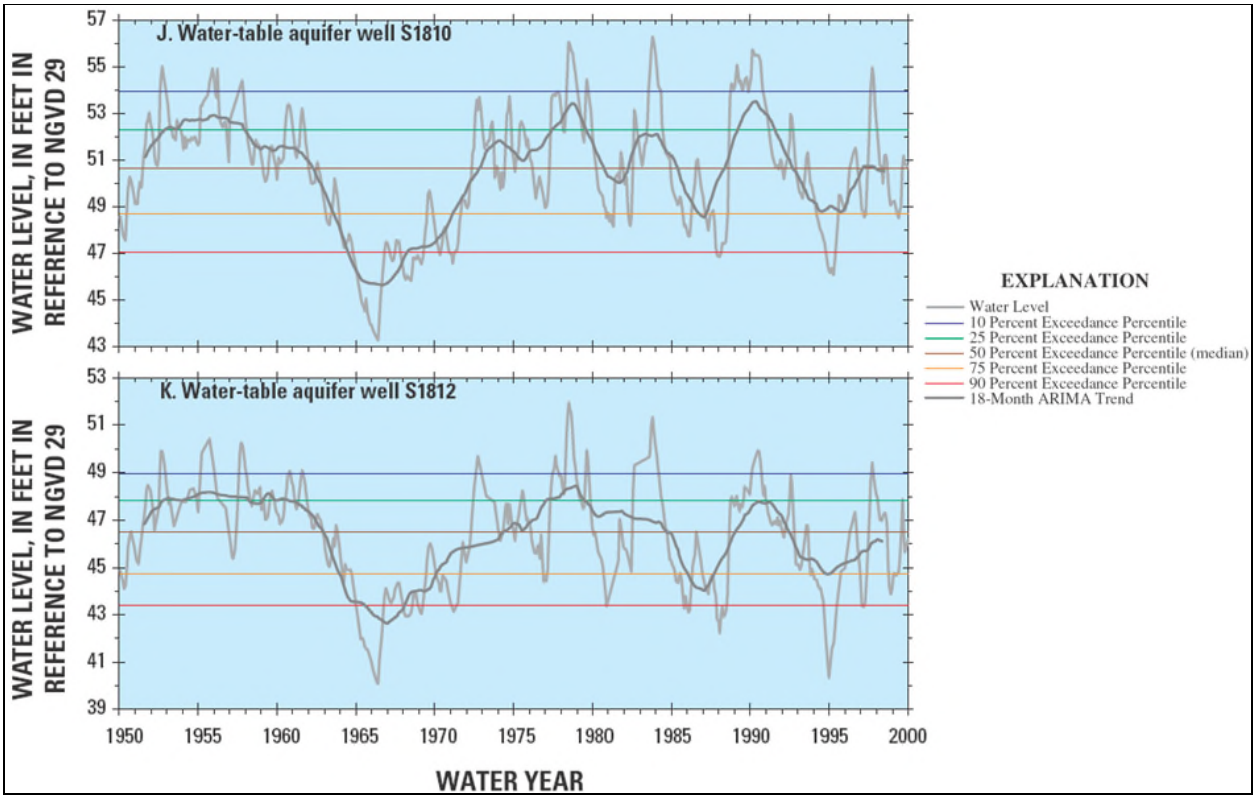
Figure 5.4.11-2. 50-Year Average Precipitation on Long Island



Source: Busciolano, 2005

Examination of groundwater level monitoring data at monitoring well S1810 (Brentwood, Town of Islip) and S1812 (Village of the Branch, Town of Smithtown) demonstrate the high degree of correlation between precipitation trends and groundwater elevations in this area, as shown in Figure 5.4.11-3.

Figure 5.4.11-3. Monthly water levels (1951-2000) at S1810 and S1812

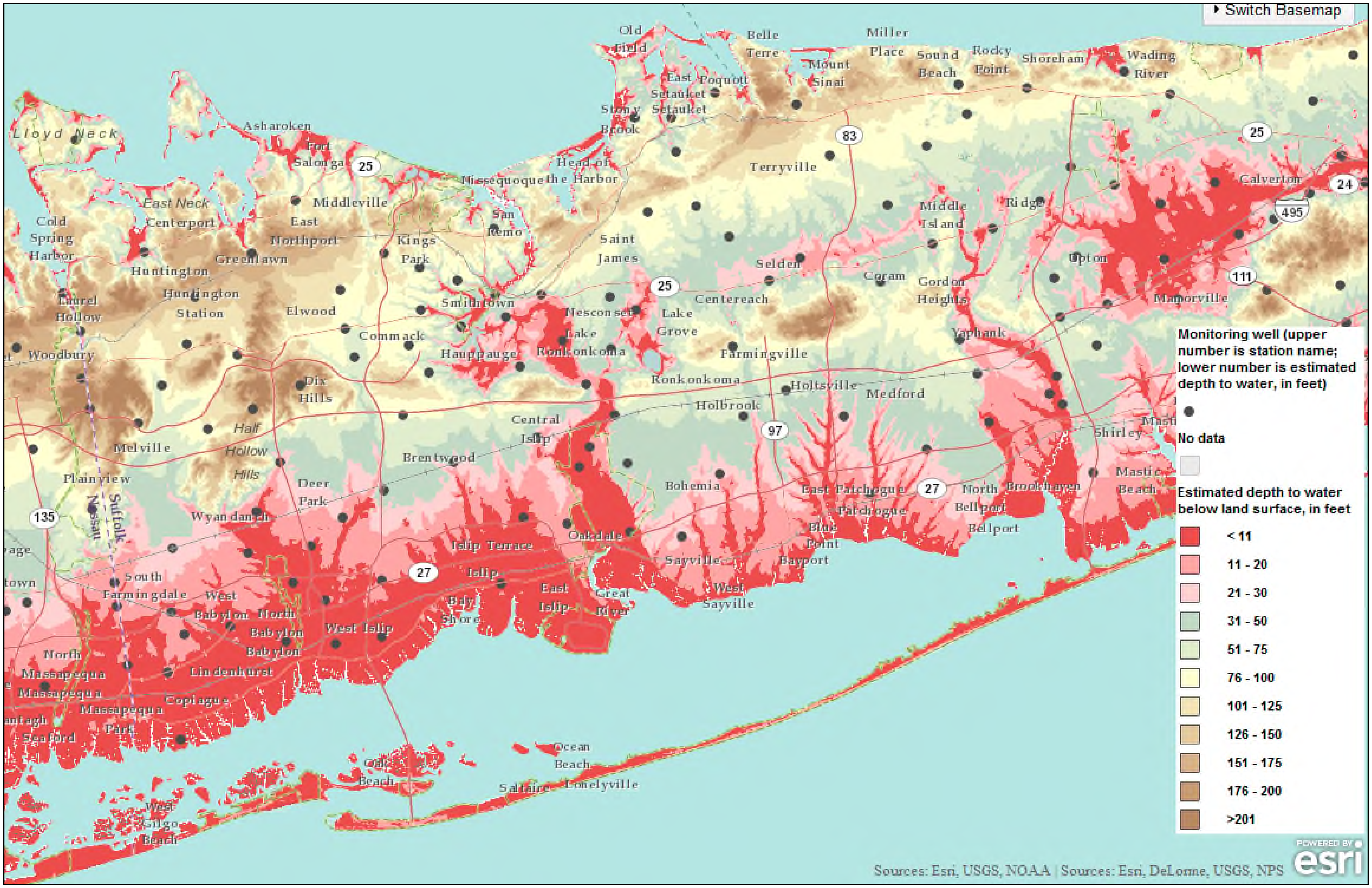


Source: Busciolano, 2005

Long Island has seen extensive growth and development over the last 100 years, due in part to its proximity to the New York Metropolitan Area, as well as the abundance of fresh groundwater resources. This growth and development has generally resulted in the drawing down of groundwater in populated areas as a result of (1) increased groundwater pumping; (2) the installation of storm and sanitary sewers; and (3) increases in impervious surfaces which limit the infiltration of precipitation into the ground (Busciolano, 2002). This effect becomes less evident as one moves from west to east across Long Island, following the trend of a decline in both population density and the level of sewering (while most of Nassau County is sewered, in Suffolk County, only the Atlantic Coast portions of the Towns of Babylon, Islip and Brookhaven have sanitary sewers). While development is known to lead to overall declines in groundwater levels, development pressures also have led to construction in areas with chronic or historically recurrent shallow groundwater conditions.

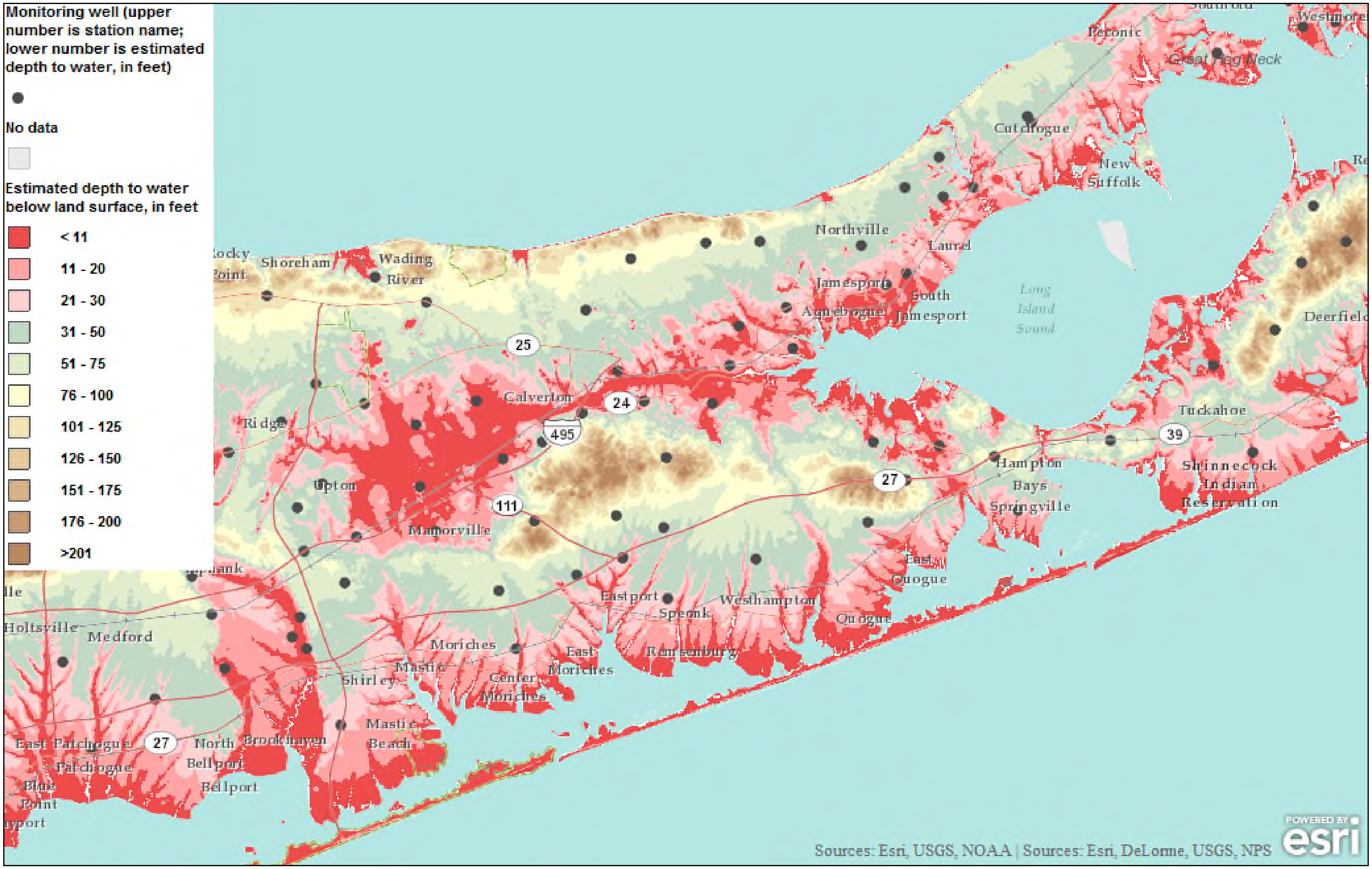
The USGS produced maps and an interactive map viewer to show depth to water on Long Island. Areas shown in red have the least depth to water and the most vulnerable to issues associated with a high water table. Figure 5.4.11-4 through Figure 5.4.11-6 shows these maps for Suffolk County.

Figure 5.4.11-4. Depth to Water – Western Suffolk County



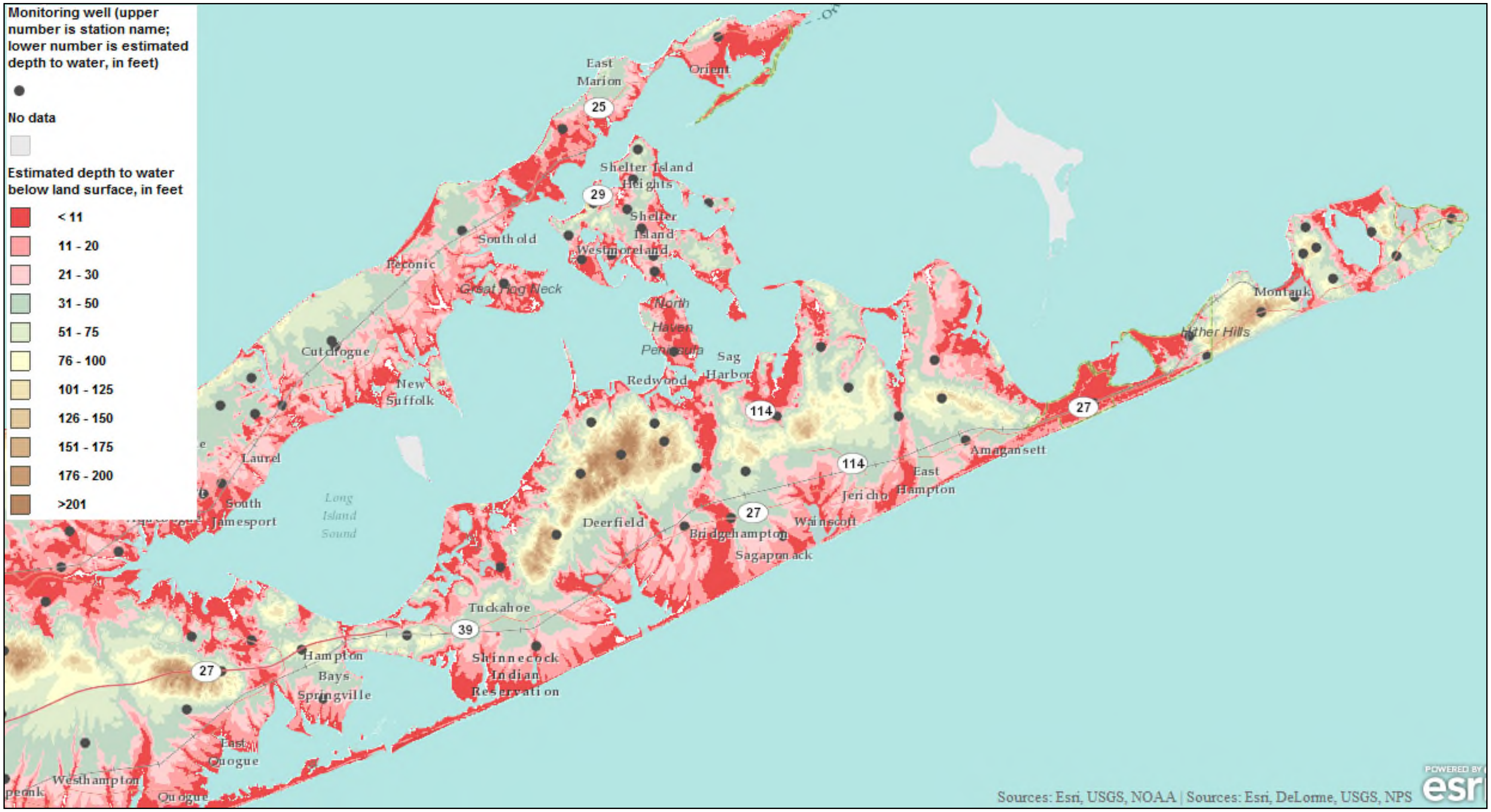
Source: *USGS Long Island Depth to Water Viewer, 2013*

Figure 5.4.11-5. Depth to Water – Central Suffolk County



Source: USGS Long Island Depth to Water Viewer, 2013

Figure 5.4.11-6. Depth to Water – Eastern Suffolk County



Source: USGS Long Island Depth to Water Viewer, 2013

Various sources estimate the number of properties and structures that may be impacted by shallow groundwater in this area. Approximately 2,791 parcels (most residentially developed) are located within the impacted areas identified.

The H2M Study summarized a number of groundwater flooding problems in the Northeast Branch of the Nissequogue River and Lake Ronkonkoma area as follows:

- As of the date of the study, groundwater levels were found to be quite high throughout the area, reflecting high amounts of precipitation over the previous five years.
- A development boom in the late 1960s took place when water levels were very low as a result of severe drought in the early to mid 1960s. This drought period, from 1960 to 1966, was the most severe drought recorded on Long Island, and groundwater levels dropped Island-side as much as 5 to 10 feet. In this area, where groundwater levels are typically among the highest on the Island, the drop in water table actually exceeded 10 feet in places.
- As recovery of groundwater levels occurred steadily from the late 1960s through the 1970s, certain areas began to experience groundwater-related flooding problems. High levels of precipitation in 1978 and 1979 resulted in hundreds of homes and many roadways being affected by groundwater- related flooding.
- While brief periods of low precipitation may make existing problems seem to subside, these problem areas remain and can be impacted when precipitation returns to normal conditions (H2M, 1980).

The "Lake Ronkonkoma Clean Lakes Study" (Suffolk County Governmet, 1986) prepared in 1986 by the Suffolk County Planning Department and Suffolk County Department of Health Services, provides further insight into the problems around Lake Ronkonkoma and corroborates the findings of the H2M study. The General Background in the study presents the following assessment of the problem:

> After World War II, many people established year-round residency, and widespread development took place. During the 1960s a severe draught caused a general five to ten foot lowering of the water table in the Lake Ronkonkoma area. At the same time, a building boom occurred resulting in the development of the woodland areas as well as sites that were unsuitable far building because they were located in wetlands, and/or normally had a high water table.
>
> [During this period] former wetland and high water table areas were filled in and subsequently developed. Certain portions of the lake were filled and developed. The northern portion of the lake was formerly located where Smithtown Boulevard (CR16) now separates the lake from the bog. This road was developed in the 1930s; the area south of CR16 and north of the lake and the Old Causeway (Lake Shore Road) was also filled in and developed. The development of Steuben Boulevard required the filling in of the shallow portion of the lake and adjacent wetlands. The western shore was also filled using dredged material from the lake.
>
> During the years following the drought, the recurrence of normal rainfall patterns led to a rise in the water table level and the flooding of numerous basements (north, west and northeast of the lake). In some instances, even the first floors of homes located north of the lake were inundated with water. The residential area north of the lake near the intersection of Nichols Road, Browns Road and Alexander Ave. has had chronic flooding problems. During the early seventies, three recharge basins serving this residential area of Smithtown were interconnected by a system of gravity piping and discharged, via a pump station and force main, about one-half mile south into the Great Bog, west of Browns Road.

> Due to a rise in groundwater and lake levels in 1979, and a recurrence in 1984, the lake and the Great Bog became one body of water breached by Smithtown Boulevard, and many of the developed areas are experiencing extensive flooding problems. Today, as many as seventy homes in the general area have flooded basements, and roads near the lake are periodically flooded. There are approximately fifty additional acres adjacent to the lake that is flooded during periods when lake levels are high. Complicating the picture are homes that sat close to the water table even in dry weather. Both areas have low elevations. A former stream bed winds through neighborhoods by Millers Pond. The swampy area that abuts the damp homes on Charles Court sits at the same elevation as the surface of Lake Ronkonkoma, just across the street (Suffolk County Government, 1986).

A number of possible solutions and mitigation actions have been proposed over time, including in the H2M study, the Clean Lakes studies, and elsewhere. Mitigation actions that are currently being considered as viable, or are being initiated, are discussed in Section 9, Volume II of this Plan.
Additional town-specific data on the groundwater flooding hazard is presented below.

Town of Babylon

The Town of Babylon reports that shallow groundwater has been a problem in Babylon since initial development over a hundred years ago.

Town of Huntington

Officials from the Town of Huntington report two properties specifically impacted by shallow groundwater flooding conditions. A residence on Woodlot Lane report having to vacate the house temporarily due to its cesspool overflowing. Another residence on Radcliff Drive was also identified as having known shallow groundwater flooding issues.

Previous Occurrences and Losses

Shallow groundwater flooding hazard areas in Suffolk County include those with chronic (persistent) problems, and those areas that experience problems on a cyclical basis in response to long-term precipitation trends.

In the Northeast Branch of the Nissequogue River and Lake Ronkonkoma area, impacts from shallow groundwater have occurred cyclically in response to long-term precipitation trends. The H2M study reports that some of the older homes of that area have flooding histories dating back to 1936, with documented events during 1951 and 1952. Since the drought period in the early to mid-1960s, impacts from shallow groundwater have been reported in several general events. As groundwater levels recovered during the late 1960s through the 1970s, the basements of certain homes experienced varying degrees of seepage and certain roadways began flooding periodically. High levels of precipitation in 1978 and 1979 exacerbated the problems, with hundreds of homes and many roadways suffering impacts (H2M, 1980) In the early 1990s, part of Steuben Road was abandoned after the Town of Smithtown could no longer keep up with the repairs required due to the constant flooding (Newsday, 2007).

The shallow groundwater flooding impacts that are occurring presently began with heavy rains in October of 2005. As indicated previously, an estimated 3,002 parcels (primarily developed for residential use) are within the shallow groundwater flooding hazard areas. In addition to flooding into basements and crawlspaces, yard and street flooding is widely reported. Losses include the cost to (1) repair/retrofit basements, septic systems and cesspools, and replace basement utilities; (2) address mold abatement; (3) run pumps and dehumidifiers; and (4) address various health concerns as both direct and indirect consequences.

In 2007, at the Branch Brook Elementary School in the hamlet of Hauppauge, groundwater had been rising up into the septic system and causing raw sewage to flow into the school. The cost for the Smithtown Central School District to pump the septic tanks daily from January 2007 to December 2007 totaled over $600,000 (Hunt, 2007). The School District planned to rebuild the septic system with an estimated cost of $589,785 (Ehmann, 2007). A further discussion of vulnerability and losses is provided in the Vulnerability Assessment at the end of this profile.

Probability of Future Events

As detailed previously, Suffolk County consists of various shallow groundwater hazard areas that continue to experience chronic flood losses. Structures within areas where shallow groundwater conditions exist at all times would expect to be impacted with a 100-percent probability during times of normal precipitation.

Areas that suffer from cyclical shallow groundwater problems experience such events according to long-term precipitation trends. Since the drought period in the early to mid-1960s, impacts from shallow groundwater flooding have been experienced in three general time periods (1975-1985, peaking about 1979; 1989-1992; and 1995). Based on these records and data on long-term precipitation trends presented earlier in this profile, the probability of occurrence for shallow groundwater flooding events in those areas experiencing cyclical impacts is considered 'frequent' (hazard event that occurs more frequently than once in 10 years).

Climate Change Impacts

Climate change is beginning to affect both people and resources in New York State, and these impacts are projected to continue growing. Impacts related to increasing temperatures and sea level rise are already being felt in the State. ClimAID: the Integrated Assessment for Effective Climate Change in New York

State (ClimAID) was undertaken to provide decision-makers with information on the State's vulnerability to climate change and to facilitate the development of adaptation strategies informed by both local experience and scientific knowledge (New York State Energy Research and Development Authority [NYSERDA], 2011).

Each region in New York State, as defined by ClimAID, has attributes that will be affected by climate change. Suffolk County is part of Region 4, New York City and Long Island. Some of the issues in this region, affected by climate change, include: contains the highest population density in New York State; sea level rise and storm surge increase coastal flooding, erosion, and wetland loss; challenges for water supply and wastewater treatment; heat-related deaths increase; illnesses related to air quality increase; and higher summer energy demand stresses the energy system (NYSERDA, 2011).

Annual average precipitation is projected to increase by up to five-percent by the 2020s, up to 10-percent by the 2050s and up to 15-percent by the 2080s. During the winter months is when this additional precipitation will most likely occur, in the form of rain, and with the possibility of slightly reduced precipitation projected for the late summer and early fall. Table 5.4.11-2 displays the projected seasonal precipitation change for the New York City and Long Island ClimAID Region (NYSERDA, 2011).

Table 5.4.11-2. Projected Seasonal Precipitation Change in Region 4, 2050s (% change)

Winter	Spring	Summer	Fall
0 to +15	0 to +10	-5 to +10	-5 to +10

Source: NYSERDA, 2011

Even Though An Increase In Annual Precipitation Is Projected, Other Climate Change Factors, Such As An Extended Growing Season, Higher Temperatures, And The Possibility Of More Intense, Less Frequent Summer Rainfall, May Lead To Additional Droughts And Increased Short-Term Drought Periods (Cornell University College Of Agriculture And Life Sciences, 2011). Droughts Can Cause Deficits In Surface And Groundwater, Which Would Reduce The County's Vulnerability To Shallow Groundwater Flooding. However, According To The University Of Hawaii's School Of Ocean And Earth Science And Technology (Soest) (2012), Sea Level Rise May Pose A Significant Threat Of Groundwater Flooding. The Effect Of Climate Change On Shallow Groundwater Flooding Will Therefore Be Determined By The Balance Between Sea Level Rise And Drought.

Vulnerability Assessment

To understand risk, a community must evaluate what assets are exposed or vulnerable in the identified hazard area. For the shallow groundwater flooding hazard, areas identified as hazard areas include specific land areas identified by previous studies, citizen input, and town knowledge. The following text evaluates and estimates the potential impact of groundwater flooding hazard on Suffolk County, including:

- Overview of vulnerability
- Data and methodology used for the evaluation
- Impact on: (1) life, health and safety of residents, (2) general building stock, (3) critical facilities, (4) economy, and (5) future growth and development
- Effect of climate change on vulnerability
- Change of vulnerability as compared to that presented in the 2008 Suffolk County Hazard Mitigation Plan
- Further data collections that will assist understanding this hazard over time

Overview of Vulnerability

Shallow groundwater flooding is a significant concern in many parts of Suffolk County, particularly those identified in this hazard profile. To assess vulnerability, potential losses and impacts have been estimated. The shallow groundwater flooding hazard exposure and loss estimate analysis is presented below.

Data and Methodology

Input data collected and reviewed for the shallow groundwater flooding hazard includes local damage data and estimates from historic and current events, Suffolk County Real Property Tax Service parcel data, and an updated building stock inventory developed using the Suffolk County Planning Department and the Suffolk County Real Property Tax Service spatial files. To date only affected areas in the Lake Ronkonkoma/North Branch parts of the Towns of Smithtown, Islip, and Shelter Island have been identified with shallow groundwater hazard areas at a level of detail to support the identification of potentially affected parcels, structures, and populations. To support the analysis of this hazard, parcel centroids were used as provided from Suffolk County Real Property Tax Service. The Planning Committee provided critical facilities and infrastructure lifelines data.

It is noted that when analyzing Census blocks against the identified shallow groundwater flooding hazard areas, many blocks fall only partly within the hazard delineations. For this purposes of this assessment, the population/demographic data presented include only those blocks whose geometric centers fall within the identified hazard areas. Therefore, the assessment is likely to underestimate the total population exposed. With current limited information regarding the severity of past impacts on specific properties, there is currently insufficient information to determine the severity of impact on population and structures exposed to the shallow groundwater flooding hazard. Impacts to life, health, and safety and structures are discussed below.

Impact on Life, Health and Safety

Shallow groundwater flooding can be an issue in developed areas where drainage systems (swales, ditches, storm sewers, stormwater ponds, etc.) are overloaded by large storm events. Shallow groundwater flooding is not generally considered to pose an immediate danger to life; however, there are a number of health and safety concerns associated with the hazard. Health concerns are related to exposure to mold and groundwater contaminated by fecal coliform and hazardous materials, as well as stress. Safety concerns also include slips, trips and falls, both while addressing basement flooding problems, and when walking or driving on ice-covered surfaces in cold weather.

Table 5.4.11-3 summarizes the number of people, including vulnerable populations, living in the identified shallow groundwater flooding hazard areas.

Table 5.4.11-3. Population Exposed to Shallow Groundwater Flooding

Jurisdiction	2010 U.S. Census Population Exposed	2000 U.S. Census Elderly Population Exposed	2000 U.S. Census Low-Income Population Exposed
Islip (T)	116	8	1
Smithtown (T)	5,794	761	231
Village of the Branch (V)	623	97	4
Suffolk County	**6,533**	**866**	**236**

Sources: 2010 U.S. Census, 2000 U.S. Census

Exposure represents the population living within the shallow groundwater flooding hazard areas that may suffer the health and safety concerns associated with the hazard. As previously noted, this estimate likely underestimates the number of people exposed.

Further it is noted that the Branch Brook Elementary School at 15 Ridgley Road in Hauppauge is impacted by shallow groundwater flooding, with groundwater rising up in to the septic system and incidents of raw sewage entering the school. Per the New York State School Report Card Comprehensive Information Report (March 2006), Branch Brook Elementary School had a 2005-05 enrollment of 452 students, and a staff of 32.

Impact on General Building Stock

Table 5.4.11-4 presents the number of properties (parcels) and structures exposed to the shallow groundwater flooding hazard as estimated using both parcel centroid data provided by Suffolk County Real Property and the updated structure-level building inventory. The table also provides a calculation of the total replacement cost value of the buildings exposed to the hazard based on the Suffolk County Planning Department and the Suffolk County Real Property Tax Services data.

Table 5.4.11-4. Parcels and Structures Exposed to Shallow Groundwater Flooding

Jurisdiction	Parcels Exposed	Structures Exposed			Total RCV
		Residential	Commercial	Total	
Islip (T)	124	126	30	158	$260,538,884
Smithtown (T)	2,425	2,213	30	2,251	$2,294,275,522
Village of the Branch (V)	240	236	0	236	$279,095,218
Suffolk County	**2,789**	**2,575**	**60**	**2,645**	**$2,833,909,624**

Sources: Suffolk County Planning Department, 2014; Suffolk County Real Property Tax Service, 2014
Notes: RCV = Total replacement cost value (structure and contents)

Exposure represents the number of parcels and structures located within the shallow groundwater flooding hazard areas that may be impacted. As previously noted, this estimate likely underestimates the numbers of structures exposed; the degree of impact to each parcel cannot be estimated with available data. Further data collection and evaluation could support estimates of costs per year or per event that may be associated with these events.

Properties and structures exposed to the shallow groundwater flooding hazard can experience impacts and losses in the following general categories:

- Repair and retrofit of basements, installation of dewatering systems (e.g., French drains, sumps)
- Repair and retrofit of foundations
- Septic System/Cesspool Repair or Replacement
- Mold Abatement
- Utilities to run sump pumps, dehumidifiers

Various sources have provided the following estimates range of costs that can be associated with groundwater flooding:

- Cesspool and Septic System Replacement: $ 15,000 - $25,000 (mounded septic systems)
- Mold Abatement: $8,000 - $14,000 per household
- Carpet Replacement: $2,200 according to one resident located at 17 Village Way in Smithtown (Dodge, 2007).
- Annual Utilities: One household on Florence Avenue estimates $4,800. Other specific costs were not provided; however, the low end would being one sump pump running 1 hour per day and one dehumidifier run continuously; the high end representing two sump pumps and one dehumidifier running continuously.

These data shows that an individual homeowner could be severely impacted by financial impacts associated with this hazard.

Impact on Critical Facilities

There are identified critical facilities exposed to the groundwater flooding hazard as listed in Table 5.4.11-5. These facilities are summarized by facility type.

Table 5.4.11-5. Critical Facilities in the Groundwater Flooding Hazard Area

Jurisdiction	Facility Types		
	Potable	School	Wastewater
Islip (T)	0	0	2
Smithtown (T)	2	1	5
Village of the Branch (V)	3	0	0
Total	**5**	**1**	**7**

Source: Planning Committee 2014

The Branch Brook Elementary School at 15 Ridgley Road in Hauppauge is impacted by shallow groundwater flooding, with groundwater rising into the septic system and incidents of raw sewage flowing into the school. The Smithtown Central School District began pumping the septic tanks daily with estimated costs ranging from $500 to $2,000. From January 2007 to August 2007, pumping and septic system costs for Branch Book Elementary School totaled $40,511. The Smithtown Central School District is planning to rebuild the septic system for an estimated cost of $589,785 (Ehmann, 2007; Smithtown News; 2007).

In certain areas, flooding has extended above the ground surface and impacted yards and roads throughout the hazard areas. The following impacts to roads have been identified:

- In the early 1990s, part of Steuben Road was abandoned after the town could no longer keep up with repairs from constant flooding. (Newsday; March 12, 2007).
- Roads along Smithtown Boulevard, and the parking lot of the Bavarian Inn, periodically flooded. (Newsday; July 10, 2007).
- Adrian Lane, Schoolhouse Road (reported at 2007 Smithtown meeting).
- Periodic flooding on South Shore Road in Northville – during the summer months, fecal contamination was evident in the culvert system most likely attributed to shallow groundwater, surface water runoff, and animal waste (Suffolk Times, 2013)

Impact on Economy

Sufficient information was not available to perform a detailed assessment of estimated losses to the economy associated with this hazard. Potential impacts include closed businesses or schools if impacted by flooding, lost days of work if homeowners miss work to address home flooding, disruption of transportation if roads are flooded, and potential costs for illnesses and injuries that could be associated with the hazard.

Future Growth and Development

As discussed in Sections 4 and 9, areas targeted for future growth and development have been identified across the County. Any areas of growth could be potentially impacted by shallow groundwater flooding if located within in the identified hazard area. Areas targeted for potential future growth and development in the next five (5) years have been identified across the County at the municipal level. Refer to the jurisdictional annexes in Volume II of this HMP.

Effect of Climate Change on Vulnerability

According to the 2014 New York State HMP update, as the climate changes and sea level rises, more flooding events will occur. Flooding events will become more frequent throughout New York State (NYS DHSES 2013). Climate change is beginning to affect both people and resources in New York State, and these impacts are projected to continue growing. Impacts related to increasing temperatures and sea level rise are already being felt in the State. ClimAID: the Integrated Assessment for Effective Climate Change in New York State (ClimAID) was undertaken to provide decision-makers with information on the State's vulnerability to climate change and to facilitate the development of adaptation strategies informed by both local experience and scientific knowledge (New York State Energy Research and Development Authority [NYSERDA], 2011).

Each region in New York State, as defined by ClimAID, has attributes that will be affected by climate change. Suffolk County is part of Region 4, New York City and Long Island. Some of the issues in this region, affected by climate change, include: the area contains the highest population density in the State; sea level rise and storm surge increase coastal flooding, erosion, and wetland loss; challenges for water supply and wastewater treatment; increase in heat-related deaths; illnesses related to air quality increase; and higher summer energy demand stresses the energy system (NYSERDA, 2011).

Temperatures and precipitation amounts are expected to increase throughout the State, as well as in Region 4. It is anticipated that by the 2020s, the State's temperature will rise between 1.5 and 3ºF; 3 to 5.5ºF by the 2050s; and 4 to 9ºF by the 2080s. The lower ends of these ranges are for lower greenhouse gas emissions scenarios and the higher ends for higher emission scenarios (NYSERDA, 2011).

In Region 4, it is estimated that temperatures will increase by 3ºF to 5ºF by the 2050s and 4ºF to 7.5ºF by the 2080s (baseline of 53ºF). Precipitation totals will increase between 0 and 10% by the 2050s and 5 to 10% by the 2080s (baseline of 43 inches). Table 5.4.11-6 displays the projected seasonal precipitation change for the New York City and Long Island ClimAID Region (NYSERDA, 2011).

Table 5.4.11-6. Projected Seasonal Precipitation Change in Region 4, 2050s (% change)

Winter	Spring	Summer	Fall
0 to +15	0 to +10	-5 to +10	-5 to +10

Source: NYSERDA, 2011

Even though an increase in annual precipitation is projected, other climate change factors, such as an extended growing season, higher temperatures, and the possibility of more intense, less frequent summer rainfall, may lead to additional droughts and increased short-term drought periods (Cornell University College of Agriculture and Life Sciences, 2011). Droughts can cause deficits in surface and groundwater, which would reduce the County's vulnerability to shallow groundwater flooding. However, according to the University of Hawaii's School of Ocean and Earth Science and Technology (SOEST) (2012), sea level rise may pose a significant threat of groundwater flooding. The effect of climate change on shallow groundwater flooding will therefore be determined by the balance between sea level rise and drought.

Change of Vulnerability

Suffolk County and its municipalities continue to be vulnerable to the groundwater flooding hazard. However, there are several differences between the exposure estimates between this plan update to the results reported in the original 2008 HMP. Their differences are due to the new and updated population (U.S. Census 2010 now available) and building inventories used.

For example, the 2008 HMP building inventory used the default HAZUS-MH general building stock. For this plan update, the exposure analysis was conducted at the structure level using building footprint locations.

Overall, this vulnerability assessment uses a more accurate and updated building inventory which provides more accurate exposure estimates for Suffolk County.

Additional Data and Next Steps

The assessment above identifies vulnerable populations and economic losses associated with this hazard of concern. Historic data on structural losses to general building stock are not adequate to predict specific losses to this inventory; therefore, the percent of damage assumption methodology was applied. This methodology is based on FEMA's How to Series (FEMA 386-2), Understanding Your Risks, Identifying and Estimating Losses (FEMA, 2001) and FEMA's Using HAZUS-MH for Risk Assessment (FEMA 433) (FEMA, 2004).

Over time, Suffolk County and participating jurisdictions will work together to learn more about the shallow groundwater flooding hazard, and support further mitigation efforts as discussed in Sections 6 and 9 to reduce the losses within these areas. Comprehensive identification of shallow groundwater flooding hazard areas and associated impacts and losses also will support future planning efforts.