Water Resources Inventory and Assessment

Montezuma National Wildlife Refuge

Seneca Falls, New York

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1 EXECUTIVE SUMMARY

Water Resources Inventory and Assessments (WRIA) are being developed by a national team of hydrologists within the U.S. Fish and Wildlife Service (Service). The purpose of these assessments is to provide reconnaissance-level information on water resources at National Wildlife Refuges and National Fish Hatcheries. The goal of every WRIA is to provide a basic understanding of the water resources that are important to the facility and assess the potential threats to those resources. Data collected in the WRIAs are being incorporated into a national database so water resources can be evaluated nationally and between regions. Information collected for the WRIAs can be used to support Comprehensive Conservation Plans (CCP), Hydro-Geomorphic Assessments, and other habitat management plans.

1.1 Findings

1. Average total precipitation for the year in the vicinity of Montezuma National Wildlife Refuge is about 36 inches. Precipitation is distributed relatively evenly throughout the year, averaging about 3 inches/month.

2. Approximately 49% of the acquisition boundary is considered wetlands using the National Wetland Inventory (NWI) classification system. 50% of the wetland area is classified by NWI as forested wetlands and 49% is in impoundments.

3. None of the streams entering the refuge are considered water quality limited on the state's 303(d) list of impaired waters.

4. USGS databases identify 6 water quality monitoring sites on or near the refuge. However, none of the sites are being actively monitored in 2013.

5. USGS databases identify 3 water quantity monitoring sites on rivers and streams near the refuge. One of these is located on Black Brook upstream of the refuge but is no longer active.

6. In 2011 the State of New York mandated water use permitting and reporting for organizations using more than 100,000 gallons per day from surface water and groundwater sources. Montezuma appears to be exempt from these requirements because use of Cayuga Lake water is permitted by the New York State Canal Corporation.

7. Long term climate records indicate air temperature near Montezuma NWR has increased approximately 2 degrees Fahrenheit (^{o}F) since 1895.

8. Long term climate records indicate annual precipitation totals have increased 3 inches since 1895.

9. Long term climate records indicate the Montezuma area was affected by the 1960s drought, the drought of record for the northeastern U.S.

10. A database of active oil and gas wells in New York identifies 3 gas wells in the White Brook watershed, upstream of the refuge.

1.2 Recommendations/Further Actions

The primary threat to water resources at Montezuma National Wildlife Refuge is water management challenges related to off-refuge infrastructure. The recommendations below outline additional steps that can be taken to help address these challenges.

1.2.1 Continue Elevation Surveys and Work to Map Refuge Water Infrastructure

The refuge is addressing some of the water management challenges by working to establish a common elevation datum for all staff gages and relating that information to Erie Canal water levels. The refuge should consider a combination of additional elevation surveys and GIS, or GPS, mapping of the water related infrastructure on the refuge. Much of this mapping has already been accomplished but additional elevation surveys can be used to develop a flow map that illustrates flow patterns in ditches and between impoundments during low water conditions and flood conditions. Such maps can be useful tools that help with water management decisions and future wetland restoration plans.

1.2.2 Continue Monitoring Water Management Activities and Evaluate Ways to Measure Water Quantity

The refuge is doing a good job keeping track of water levels and management activities in the impoundment system. This information can help inform management decisions by documenting the capability of the water control infrastructure to influence impoundment water levels. In addition, the refuge should consider incorporating monitoring steps that can help quantify the volume of water in the impoundment system. Water quantity information can be used to improve impoundment management strategies and design modifications to the impoundment system. Water quantity information should be evaluated in impoundments where there are challenges with water management; the sites where it seems difficult to get water in, or out, of the impoundment in a timely way. The refuge should consider working to quantify the volume of water it needs from off refuge water resources like Cayuga Lake, Black Brook, and other streams entering the refuge. This information will be very important in the event of a water use conflict.

2 INTRODUCTION

This Water Resource Inventory and Assessment (WRIA) Summary Report for Montezuma National Wildlife Refuge (NWR) describes current hydrologic information, provides an assessment of water resource issues of concerns, identifies water resource needs, and makes recommendations regarding refuge water resources. The information contained within this report and supporting documents will be entered into the national WRIA database.

Together, the national WRIA database and summary reports are designed to provide a reconnaissance-level inventory and assessment of water resources on National Wildlife Refuges and National Fish Hatcheries. A national team of U.S. Fish and Wildlife Service (USFWS or Service) Water Resource staff, Environmental Contaminants Biologists, and other Service employees developed the standardized content of the national WRIA database and summary reports.

The long-term goal of the National Wildlife Refuge System (NWRS) WRIA effort is to provide up-to-date data on a facility's water quantity and quality in order to protect adequate supplies of clean and fresh water. An accurate water resources inventory is essential to prioritize issues and tasks, and to take prescriptive actions that are consistent with the established purposes of the refuge. Reconnaissance-level water resource assessments evaluate water rights, water quantity, known water quality issues, water management, potential water acquisitions, threats to water supplies, and other water resource issues for each field station.

WRIAs are recognized as an important part of the NWRS Inventory and Monitoring (I&M) Program and are outlined in the I&M Draft Operational Blueprint as Task 2a. Hydrologic and water resource information compiled during the WRIA process will help facilitate the development of other key documents for each refuge including Hydrogeomorphic Analyses (HGM) and Comprehensive Conservation Plans (CCP).

Montezuma NWR WRIA

This WRIA Summary Report for Montezuma NWR incorporates hydrologic information compiled between April 2012 and February 2013. The report is intended to be a reference for ongoing water resource management and strategy development. However, the document is not meant to be exhaustive or a historical summary of activities on Montezuma NWR. This WRIA was developed in conjunction with refuge staff under a contract with Atkins North America, Inc. in 2012 and 2013.

3 FACILITY INFORMATION

Montezuma National Wildlife Refuge

Montezuma National Wildlife Refuge (NWR) is in portions of Seneca, Cayuga, and Wayne counties at the north end of Cayuga Lake in the Finger Lakes region of New York

(Figure 1). The refuge was established by Executive Order 7971 on September 12, 1938 by President Franklin D. Roosevelt to provide breeding ground for migratory birds and other wildlife. It is situated in one of the most active flight lanes in the Atlantic Flyway and is a significant stopover site for migrating shorebirds. In addition, the refuge and the surrounding forested wetlands support the second largest population of cerulean warblers in the State of New York and several other breeding birds of conservation concern.

The current boundary of the refuge encompasses 9,184 acres[1] (USFWS 2012), composed primarily of freshwater impoundments (i.e., open water, emergent marsh, mudflats) and bottomland floodplain forest, with other habitats such as cropland and grassland. The current approved acquisition boundary for the refuge is 19,510 acres; however, an additional 1,223 acres have been proposed for inclusion as part of the draft Comprehensive Conservation Plan/Environmental Assessment (CCP/EA) (USFWS 2012). The refuge is part of the 50,000-acre Montezuma Wetlands Complex (MWC) of federal, state and private lands (USFWS 2008a).

The MWC marshes have been significantly altered by the construction New York State Barge Canal during the 1800s and early 1900s. Deepening and channelization of the Seneca River and construction of canal’s lock system have had a substantial draining effect on the marshes of the Montezuma area, lowering water levels by 8 to 10 feet (USFWS 2008a). Water levels in the canal system near Montezuma are controlled by locks 30 miles downstream of the refuge, near Baldwinsville, NY. Cayuga Lake waters, upstream of the refuge, are controlled by a lock and dam at the outlet of the lake (Mud Lock C&S Canal Dam).

The U.S. Fish and Wildlife Service (Service) has built many impoundments to maintain freshwater wetland habitat for birds and other wildlife on Montezuma NWR. These impoundments are designed to restore the wetland habitat that was drained when the Barge Canal was constructed. Water for the impoundments comes from the natural runoff of small creeks entering the refuge property and directly from Cayuga Lake. Water levels in the impoundments are managed to provide habitat for species of conservation concern but are influenced by the water level management in the canal system (see Section 5.1.2).

[1] For the purposes of this report, all units are expressed in English measures, unless citing information from a primary source where the native data are presented in metric units. In those cases, the English unit conversions are also provided.

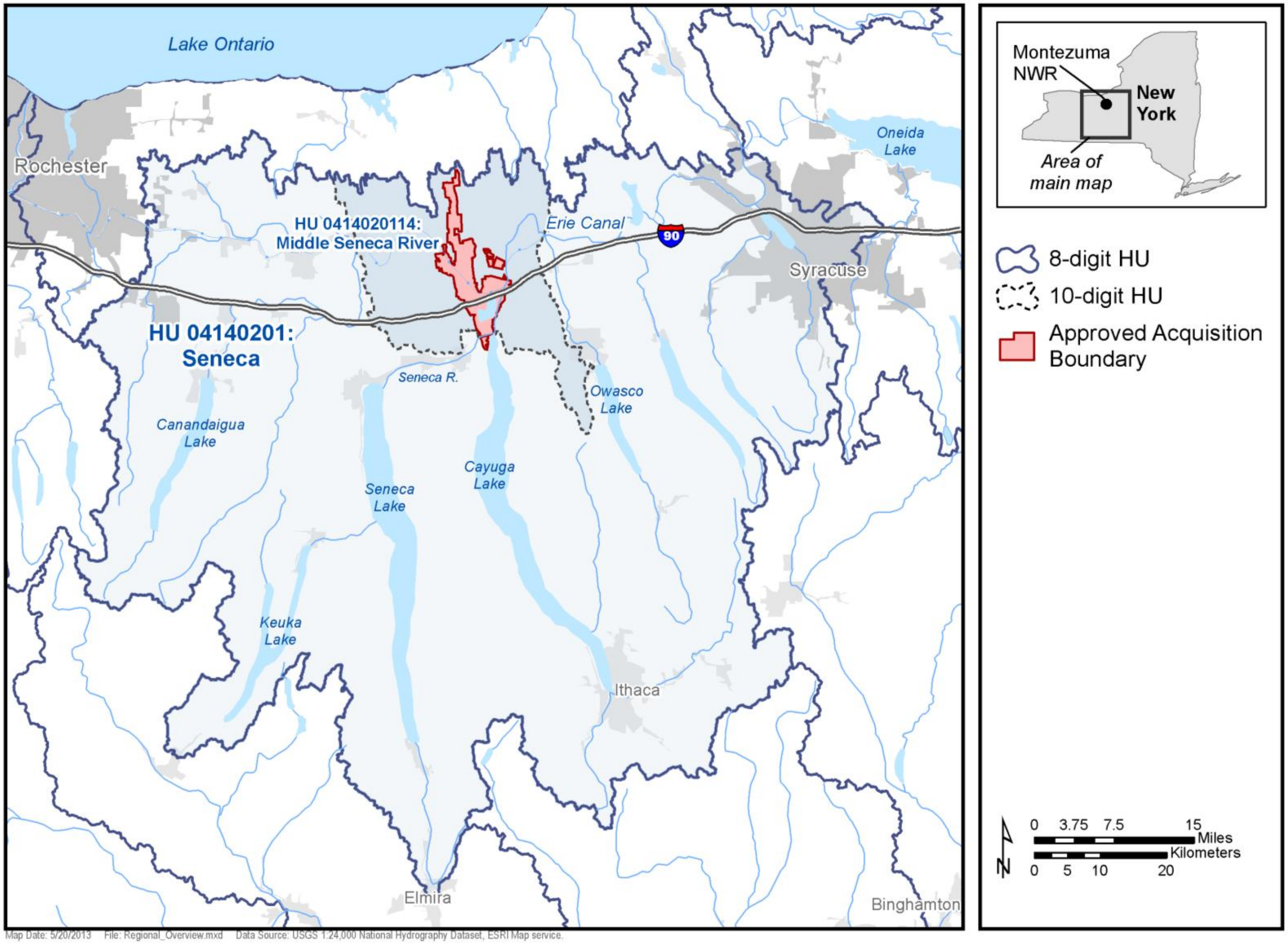


Figure 1. Location of Montezuma NWR in New York.

4 NATURAL SETTING

4.1 Topography and Landforms

The refuge lies in the Great Lakes Plain ecoregion, which is characterized by gently rolling hills and flat lake plains (DEC 2005). Broad, flat wetland basins are interspersed by 60-150 feet high drumlins left by retreating glaciers, as well as other glacial formations such as eskers, kames and kettles (USFWS 2008a).

The U.S. Geological Survey (USGS) has developed a national dataset of hydrologic units (Seaber et al. 1994). Hydrologic units are based on watershed boundaries and are assigned Hydrologic Unit Codes (HUC). Two-digit HUCs are applied to the largest areas, which are defined as regions. Regions are subdivided into 4-digit subregions, which are then further subdivided down to smaller areas. For the purposes of this WRIA, HUCs at the 8-digit (subbasin) and 10-digit (watershed) scales will be referenced. These HUCs are important because they are used by many federal and state agencies to track water monitoring and regulatory activities.

Montezuma NWR is located within the Seneca (8-digit HUC 04140201) hydrographic subbasin and the Middle Seneca River (10-digit HUC 0414020114) watershed (Figure 1).

4.2 Geology

The refuge is located near the boundary of two physiographic provinces: the Lake Ontario/Central Lowland and the Appalachian/Allegheny Plateau. The glacial valleys of Cayuga and Seneca Lakes extend from the Lake Ontario Lowland south into the Appalachian Plateau. Montezuma NWR sits in a relatively flat low-lying area at the northern end of Cayuga Lake. The surficial geology of the region is composed of a thin layer of glacial till and lacustrine sand, silt and clay, overlying bedrock consisting of limestone, shale, dolostone and evaporites (salt and gypsum) (Eckhardt et al. 2009) (Figure 2).

Geology of the area was strongly influenced by continental glaciations that ended about 12,000 years ago and the formation and disappearance of glacial Lake Iroquois. During recession of the last (Wisconsin-age) glacier, retreating ice to the north blocked water draining from the uplands to the south, creating large glacial lakes in the Great Lakes Basin (Larson and Schaetzl 2001). Lake Iroquois covered the area where Montezuma NWR is located and was about 3 times larger than present day Lake Ontario (Figure 3). As the ice sheet retreated, the lake is thought to have drained through the Hudson River Valley about 13,000 years ago (Dawicki 2005).

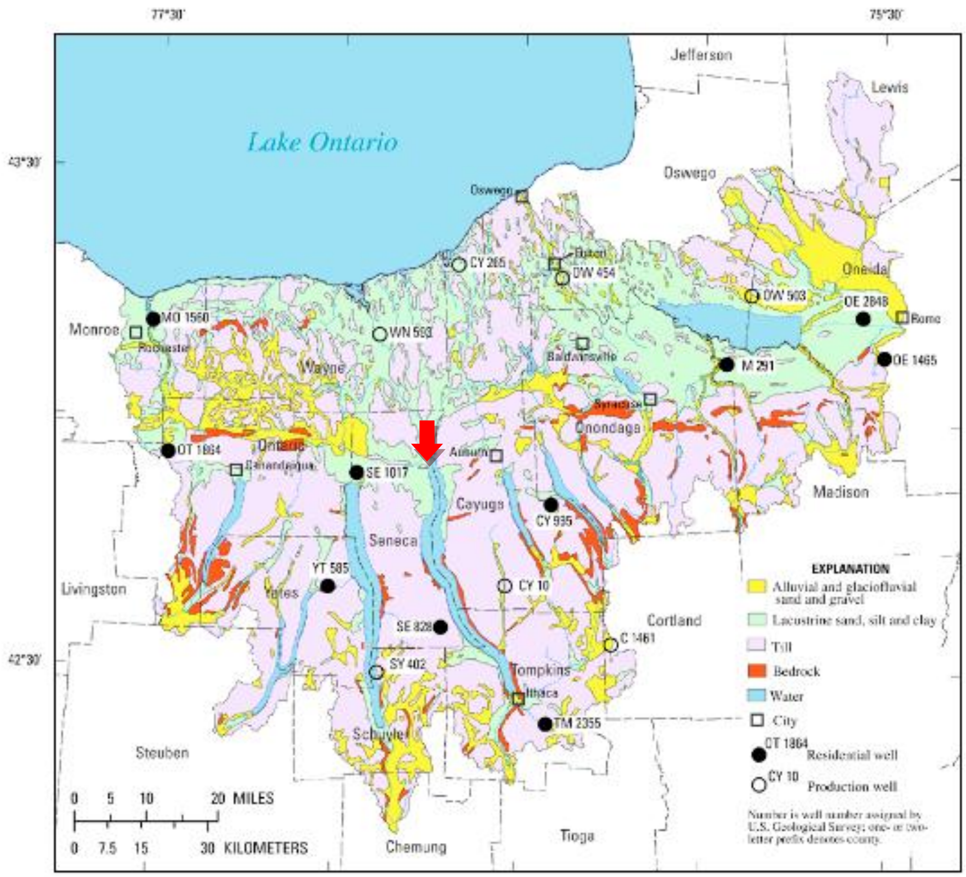


Figure 2. General surficial geology of central New York (from Eckhardt et al. 2009). Red arrow shows approximate location of Montezuma NWR.

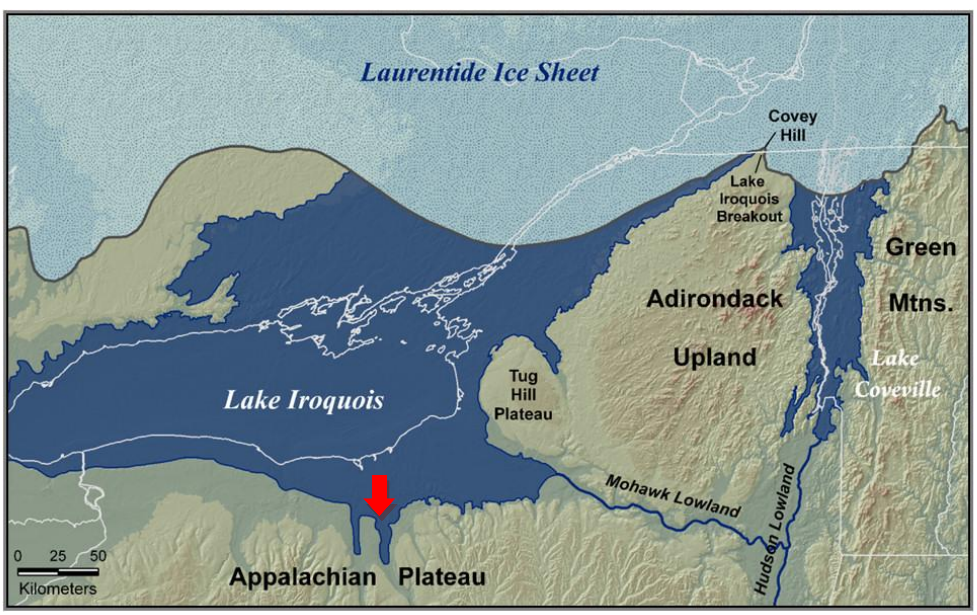


Figure 3. Maximum extent of glacial Lake Iroquois approximately 13,000 years ago (image courtesy of Dave Franzi (SUNY Plattsburg) and John Rayburn (SUNY New Paltz)). Red arrow shows approximate location of Montezuma NWR.

4.3 Soils

There are three major soil groups within the MWC. The largest is composed of various types of muck and occurs below the 380-foot contour interval. The other two groups, the Ontario soil association (drumlin zones) and the Odessa-Schoharie Fulton-Lucal association (southwest corner of MWC), occur above the 380-foot contour in better drained uplands and are composed of loams, silt loams, silty clay loams and made land (USFWS 2008a). More than 90% of soils on the refuge can be classified as hydric or partially hydric (Table 1, Figure 4).

Table 1. Acreage of hydric soils at Montezuma NWR. From NRCS Soil Data Mart (NRCS 2011).

Hydric Status	Acres on Refuge	Acres within Acquisition Boundary
All hydric	5718.2	9242.7
Not hydric	518.5	2178.3
Partially hydric	2807.8	7323.1
Unknown	139.4	765.9
Total	***9184.0***	***19510.0***

Muck soils are locally referred to as “mucklands” (Figure 4). These soils are found in former wetlands that were drained after construction of the Erie Canal. Mucklands were converted to agricultural land for growing crops like corn, soybeans, potato, and onions (USFWS 2000). Local drainage districts maintain a network of ditches, tile drains, and pumping stations to facilitate drainage and allow farming. The refuge is working to acquire mucklands that are no longer being farmed and convert them to wetland habitat.

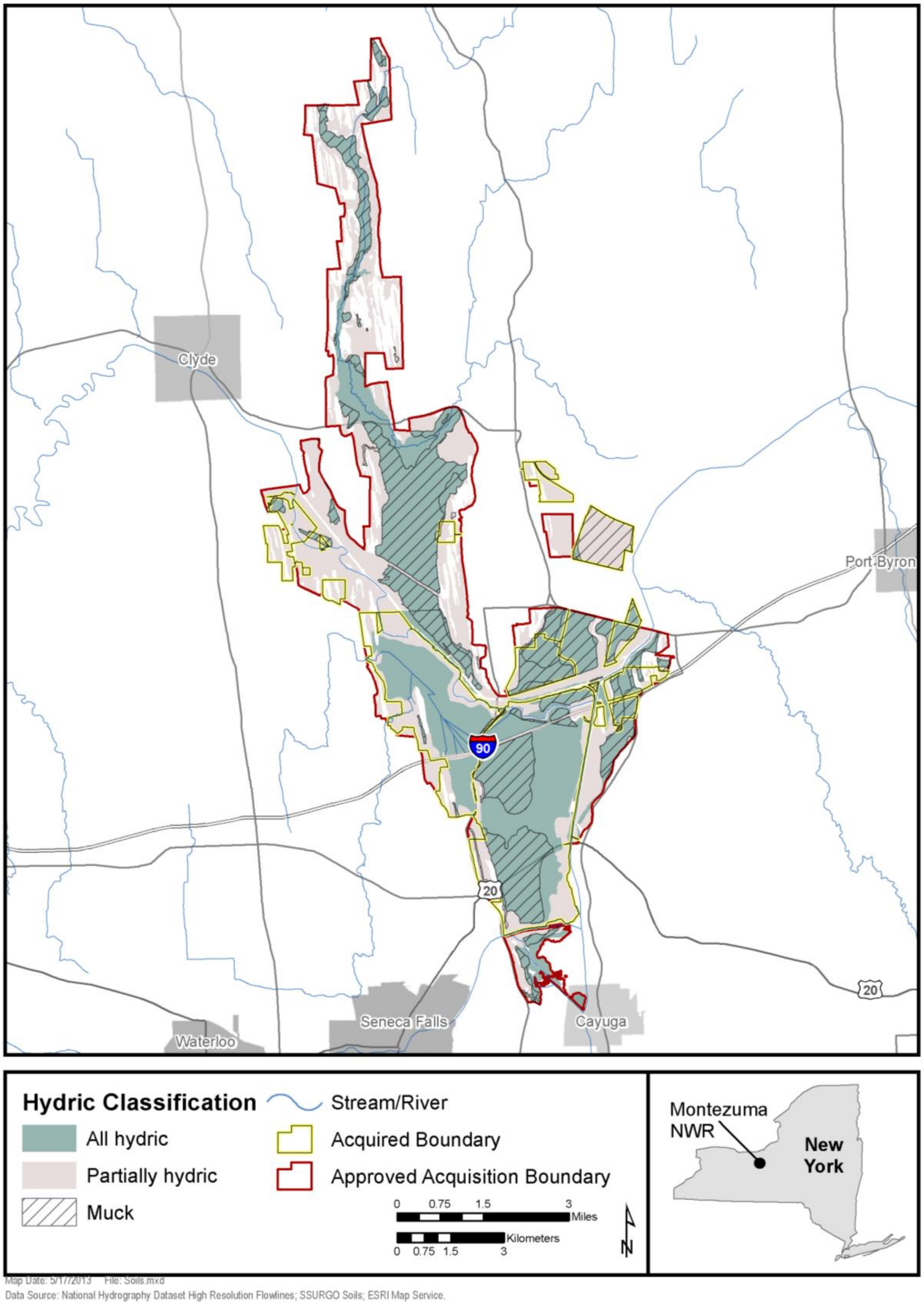


Figure 4. Hydric, partially hydric and muck soils at Montezuma NWR.

4.4 Hydro-climatic setting

The climate of the Montezuma NWR area is considered humid continental type (NY State Climatologist 2012). A variety of datasets exist that can be used to evaluate existing climate conditions and long-term climate trends at refuges in Region 5. Some of these data are included in the WRIA to provide a preliminary analysis of trends in precipitation, temperature and stream runoff.

4.4.1 Precipitation Patterns

The U.S. Department of Agriculture's (USDA) official climatological data comes from the PRISM (Parameter-elevation Regressions on Independent Slopes Model) climate mapping system, developed by the PRISM Climate Group at Oregon State University. PRISM is a unique knowledge-based system that uses point measurements of precipitation, temperature, and other climatic factors to produce continuous, digital grid estimates of monthly, yearly, and event-based climatic parameters. Data are continuously updated, and can be downloaded for a specified region, or by latitude/longitude.

The 1971-2000 PRISM data for the refuge indicate an annual average of nearly 36 inches of rain, with most precipitation occurring in summer and early fall (Table 2). Temperatures range from an average minimum of 15.3 °F in January to an average maximum of 82.2 °F in July (PRISM Climate Group 2010).

The New York State Climate Office maintains records of monthly snowfall totals for selected weather stations in the state. The nearest station to Montezuma NWR is located in Geneva, NY about 16 miles west of the refuge at the north end of Seneca Lake (Table 3).

Table 2. PRISM Monthly Normals (1971 – 2010) for -76.7521, 42.9647 (PRISM Climate Group 2010).

Month	Precipitation (in)	Max Temperature (F)	Min Temperature (F)
January	2.14	31.8	15.3
February	1.81	34.1	15.5
March	2.40	43.4	24.9
April	2.97	56.0	35.8
May	3.06	69.0	47.5
June	3.63	77.3	56.1
July	3.49	82.2	61.0
August	3.40	80.1	59.2
September	3.96	72.5	52.6
October	3.11	60.6	41.7
November	3.19	48.2	32.1
December	2.65	37.0	21.5
Total Precipitation	**35.81**		
Average Temperature		**57.7**	**38.6**

Table 3. Monthly Snowfall Normals at Geneva, NY. 1961 – 1990.

Month	Average Snowfall (in)
January	14.3
February	14.2
March	7.7
April	3.4
May	0.2
June	0.0
July	0.0
August	0.0
September	0.0
October	0.2
November	3.4
December	16.2
Total for Season	**59.6**

Average annual snowfall totals in Geneva are about 60 inches with peak snow accumulations in December, January, and February. Snow depths across the U.S. Northeast have been decreasing for the last 40 years (Hayhoe et al. 2007). Because the period of record for the data in Table 3 ends in 1990 these average snowfall totals might be higher than more recent average annual totals in central New York.

4.4.2 Streamflow Patterns

The closest USGS stream gage at Montezuma NWR was operated on Black Brook between 1985 and 1995. Black Brook enters the refuge from the west and contributes water to one of the refuge's larger impoundments, Tschache Pool. Although the USGS gage is no longer in operation data from it is valuable for understanding natural flow patterns in the small streams entering the refuge.

Runoff in Black Brook shows a strong snowmelt runoff response, with streamflow peaking in March and April of the year. Once the snow has melted the flow rate drops considerably; eventually reaching the lowest flows of the year in August and September, at the end of the growing season (Figure 5). The average annual discharge at Black Brook is approximately 20 cubic feet per second (cfs). In some years the stream can virtually dry up and flows less than 1 cfs are not uncommon between July and September.

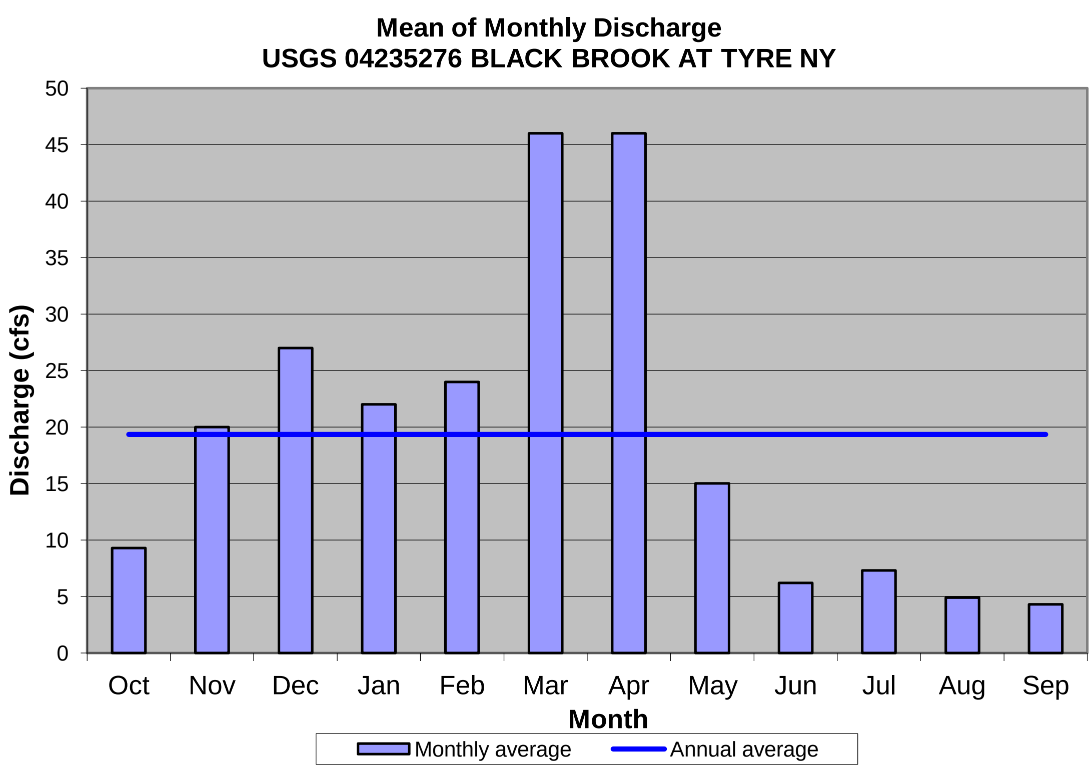


Figure 5. Average monthly discharge from Black Brook near Tyre, NY. From data collected between 1985-1995

5 INVENTORY

This section of the WRIA summarizes basic information on a refuge's water resources, water-related infrastructure, water quality, water monitoring, water rights, and climatic trends. Data from this section are incorporated into the national WRIA database. Data on waterbodies from the National Hydrography Dataset (NHD) are presented in Section 5.2. Because of the coarse scale of these data, they are not expected to be a perfect representation of stream and water body locations.

5.1 Water Resources

Surface water features include lakes, ponds, springs, reservoirs, rivers, streams, and creeks; impoundments are discussed in Section 5.2. Groundwater resources include regional and local aquifers that are important to the surface water resources of the refuge. Also included are wetlands identified in National Wetland Inventory maps that cover the refuge area.

5.1.1 Rivers / Streams / Creeks

In the absence of more specific information, the WRIA relies on the USGS 1:24,000 scale NHD to inventory streams at Montezuma NWR (Table 4, Figure 6). The focus of the preliminary analysis is on named NHD features because they tend to be the largest and, theoretically, of most interest to Service facilities.

There are many small streams that drain the uplands surrounding the refuge property. Of the streams entering the refuge, Black Brook and White Brook have the largest drainage areas; 12,580 acres and 5,760 acres, respectively (Figure 6).

Table 4. Named creeks and streams from the USGS 1:24,000 National Hydrography Dataset. Includes features on or within Montezuma NWR's approved acquisition boundary.

GNIS Name	Miles on Refuge	Miles within Acquisition Boundary
Unnamed Streams	20.9	64.0
Black Brook	7.8	7.9
Black Creek	0.0	9.7
Clyde River	5.1	9.1
Demont Creek	0.0	1.0
Seneca River	0.004	4.3
White Brook	0.3	0.3
Total	***34.0***	***96.3***

5.1.2 Lakes and Ponds

The NHD identifies one named lake, Black Lake and a small number of unnamed lakes and ponds on Montezuma NWR (Table 5, Figure 6). The lakes identified in the NHD are part of the network of impoundments managed by the Service to support migratory waterfowl. They are discussed in more detail in Section 5.2.

Cayuga Lake is an important water source for refuge wetlands and a major water resource near the refuge. However, the lake is not technically on the refuge and therefore not quantified in the Inventory section of the WRIA.

Table 5. Acreage of named ponds and swamp/marsh habitat identified in the USGS National Hydrography Dataset (NHD). Includes features within Montezuma NWR's approved acquisition boundary.

Lake/Pond Name	Acres on Refuge	Acres within Acquisition Boundary
Black Lake (Main Pool)	833.3	833.3
Unnamed Lakes/Ponds	2.1	1350.5
Total	***835.3***	***2183.8***

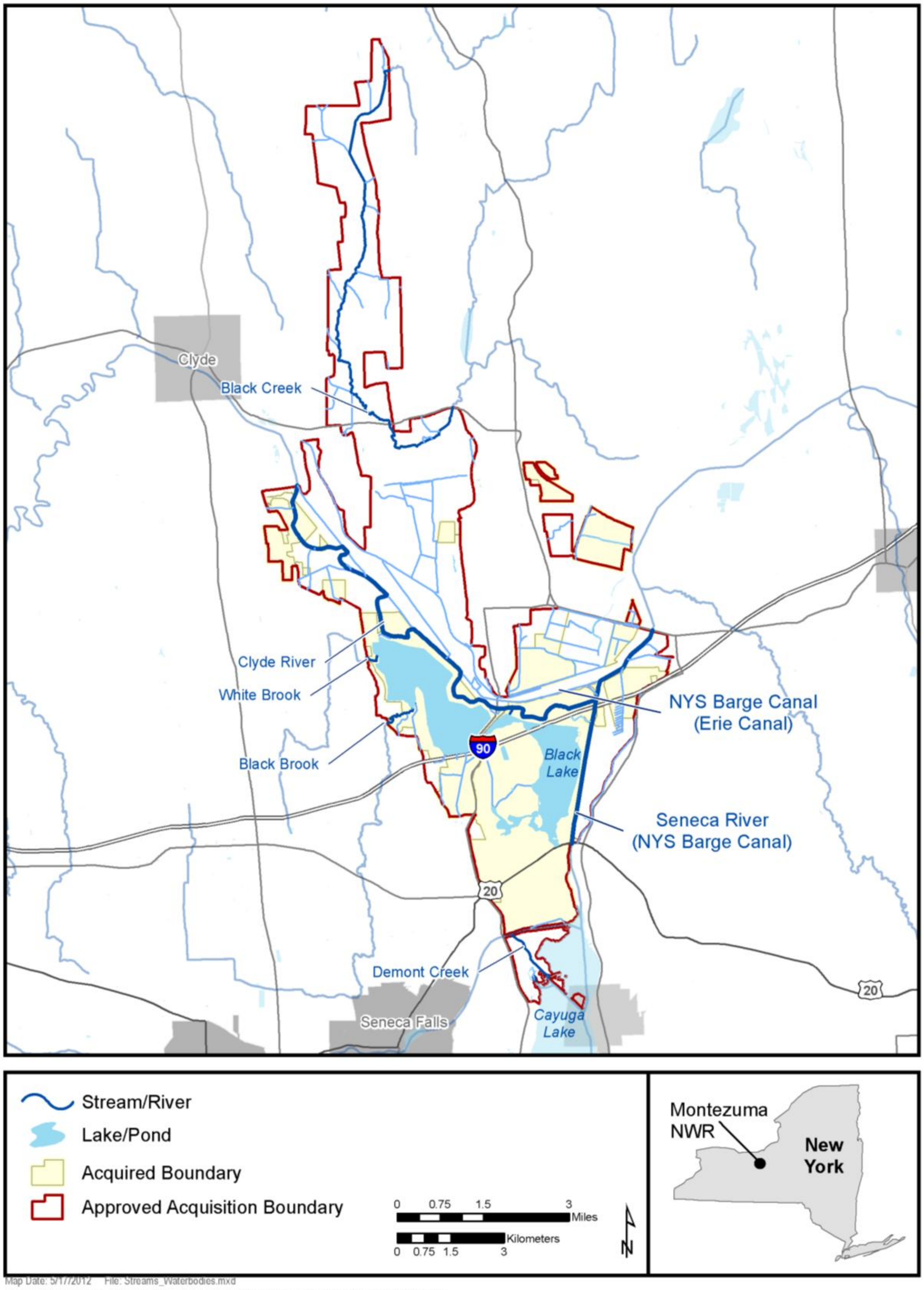


Figure 6. Named creeks, streams and waterbodies from 1:24,000 USGS National Hydrography Dataset (NHD) in the Montezuma NWR acquisition boundary.

5.1.3 Springs

According to the 2008 Habitat Management Plan, there are several springs within the refuge boundary, including a salt spring in the Main Pool (USFWS 2008a). Additionally, Esker Brook, North Spring Pool and South Spring Pool may be spring-fed (USFWS personal communication). A noticeable data gap in the inventory is more detailed information on these springs. Data on flow volumes, water chemistry, or spring locations were not found during this review. The springs are thought to be locally important and help maintain small areas of aquatic habitat during the summer months.

5.1.4 Wetlands

The National Wetland Inventory (NWI) is a branch of the Service established in 1974 to provide information on the extent of the nation's wetlands (Tiner 1984). NWI produces maps of wetland habitat as well as reports on the status and trends of the nation's wetlands. Using the *Classification of Wetlands and Deepwater Habitats of the United States* (Cowardin et al. 1979) wetlands have been inventoried and classified for approximately 90% of the conterminous United States and approximately 34% of Alaska. Cowardin's classification places all wetlands and deepwater habitats into 5 "systems": marine, estuarine, riverine, lacustrine, and palustrine. Most of the wetlands in the United States are either estuarine or palustrine (Tiner 1984). The predominant wetland class at the refuge is defined in Cowardin et al. (1979) as:

> **Palustrine**: the Palustrine System includes all nontidal wetlands dominated by trees, shrubs, persistent emergents, emergent mosses or lichens, and all such wetlands that occur in tidal areas where salinity due to ocean derived salts is below 0.5% (e.g., inland marshes, bogs, fens, and swamps)

The different systems can be broken down into subsystems, classes and hydrologic regimes based on the wetland's position in the landscape, dominant vegetation type, and hydrology.

The available NWI maps for the Montezuma area are based on aerial photographs flown in 1985. It is likely more wetland acreage would be mapped today because some of the drained agricultural land in the acquisition boundary has been converted to wetland habitat. For instance, between 1991 and 2000, 2,500 acres of mucklands were acquired by the Service for conversion to wetland habitat (USFWS 2000).

From the 1985-era mapping, approximately 49% (9,550 acres) of the land in the acquisition boundary is considered freshwater wetland using NWI's classification. Of the NWI wetland acreage, 45% is in impoundments, 50% is forested wetlands, and the remaining 5% is riverine wetlands (Table 6, Figure 7).

Table 6. Wetland habitat delineated by the National Wetland Inventory (NWI) inside the Montezuma NWR approved acquisition boundary.

Habitat Type	**Acres on Refuge**	**Percent of Total**	**Acres within Acquisition Boundary**	**Percent of Total**
Freshwater Emergent Wetland	1799	20	3014	15
Freshwater Forested/Shrub Wetland	2427	26	4813	25
Freshwater Pond	46	0	82	0
Lake	1276	14	1238	6
Riverine	105	1	404	2
Upland	3531	38	9960	51
Total	9184	100	19510	100

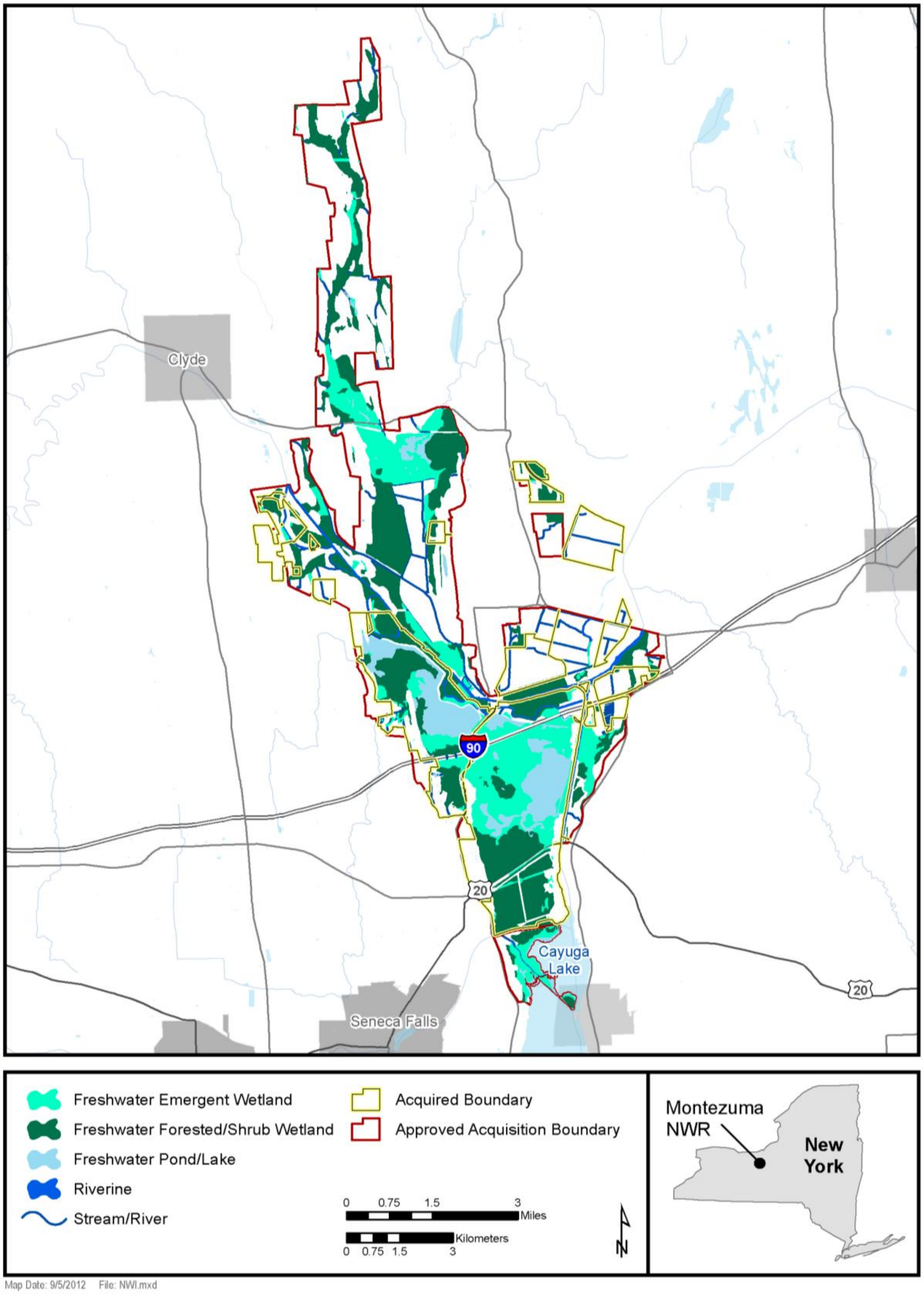


Figure 7. National Wetland Inventory wetlands in the Montezuma NWR acquisition boundary.

5.1.5 Groundwater

Montezuma NWR overlies an area of Valley-Fill Glacial Aquifers and Carbonate Rock Aquifers in central New York. These aquifer types are described generally in the USGS groundwater atlas of the United States (Trapp and Horn 1977). A more detailed review of groundwater conditions near Montezuma is found in Groundwater Quality in Central New York, 2007 (Eckhardt et al. 2009).

Miller (1988) mapped the extent of unconsolidated aquifers in central New York State. Typically, these aquifers are found in valley bottoms and consist of coarse sands and gravels deposited by streams that drained melting glacial ice (Trapp and Horn 1977). Valley-fill glacial aquifers are important because they can provide considerable water resources for municipalities, agriculture, and industry. According to Miller's map, Montezuma NWR is not located near any highly productive valley-fill glacial aquifers. Instead, the surficial geology around Montezuma consists of a thin mantle of glacial till or fine-grained glacial-lake deposits overlying bedrock (Trapp and Horn 1977, Eckhardt et al. 2009). Unlike valley-fill glacial aquifers, these deposits are relatively impermeable and do not store significant amounts of groundwater. Below the glacial till, there is groundwater in bedrock. However, these aquifers are typically not as productive as the unconsolidated aquifers identified by Miller (1988) and have poorer water quality (Eckhardt et al. 2009).

Based on the available information, groundwater resources near Montezuma appear relatively limited and, except in isolated cases, are not considered an important source of water for the stream and wetland habitat on the refuge.

5.1.6 Groundwater Well Information

The DEC operates a Water Well Program that maintains records of all water well drilling activities in the state. All activities are required by state law to be registered annually. Information on all registered wells is available online through the Water Well Program Information Wizard. Wells in this network are selectively sampled for ambient groundwater reporting (Section 5.4.2). A query of the Water Well Program information available online did not identify any large (~ 500 gallons per minute) groundwater production wells in the vicinity of Montezuma NWR.

5.2 Water-related Infrastructure

Water-related infrastructure refers to the assets at a refuge that create or support refuge water resources and objectives. Examples include impoundments for waterfowl habitat, water control structures and water supply wells used to maintain wetland habitat. Many of these types of features are accounted for in the National Wildlife Refuge System's Service Asset Maintenance Management System (SAMMS) database. One aim of the WRIA is to summarize information on a refuge's water resource infrastructure.

Montezuma NWR's water-resource related infrastructure is used primarily for managing l7 impoundments for waterbirds. Refuge wetlands are being manipulated by refuge staff using infrastructure such as dikes, water control structures, or water supply wells. Other infrastructure that affects water resources in the vicinity of the refuge is discussed below.

5.2.1 Impoundments

Over 17 miles of dikes create the network of impoundments and managed wetland/bottomland floodplain units on Montezuma NWR. These dikes create a total of 17 impoundments (Table 7, Figure 8) that are used for wetland habitat management. Water levels in the impoundments are manipulated to provide a variety of habitat types for migratory birds and resident wildlife (Table 7, Figure 8) (USFWS 2008a). Water control capabilities are considered adequate at 15 impoundments but management capability in two (Units 17 East and West) is somewhat limited.

Other than precipitation, the primary sources of water for impoundments are Cayuga Lake, Black Brook, White Brook, and Esker Brook. Water from Cayuga Lake is delivered to the Main Pool via a gravity-fed connector ditch constructed in the 1990s (USFWS personal communication). Black Brook and White Brook flow directly into Tschache Pool, the second largest impoundment on the refuge. All other impoundments are dependent on rainfall runoff from surrounding uplands or diversions from higher elevation impoundments. During flood conditions on the Erie Canal, water from the canal system can flow into refuge impoundments temporarily. During most of the year, it is more common for water from the impoundment network to drain into the canal system.

Table 7. Managed pond and wetland units at Montezuma NWR.

Name	Management Type	Acres
Main Pool	Emergent Marsh/Large Impoundment	1657
Tschache Pool	Emergent Marsh/Large Impoundment	1160
Sandhill Crane Unit	Emergent Marsh/Large Impoundment	448
Unit 17 East	Impounded Green Tree Wetland	361
Unit 17 West	Impounded Green Tree Wetland	283
Knox Marsellus Marsh	Emergent Marsh/Large Impoundment	236
Jackson	Emergent Marsh/Large Impoundment	215
May's Point Pool	Emergent Marsh/Large Impoundment	199
Puddler Marsh	Emergent Marsh/Large Impoundment	98
North Spring Pool	Emergent Marsh/Large Impoundment	91
Millennium Marsh	Emergent Marsh/Small Impoundment	69
Visitor Center Wetland	Emergent Marsh/Small Impoundment	26
Benning Marsh	Emergent Marsh/Small Impoundment	18
Shorebird Flats	Emergent Marsh/Small Impoundment	18
Box Elder Bog	Emergent Marsh/Small Impoundment	10
Lesser Yellowlegs Unit	Emergent Marsh/Small Impoundment	8
Display Pool	Emergent Marsh/Small Impoundment	2
Total		***6031***

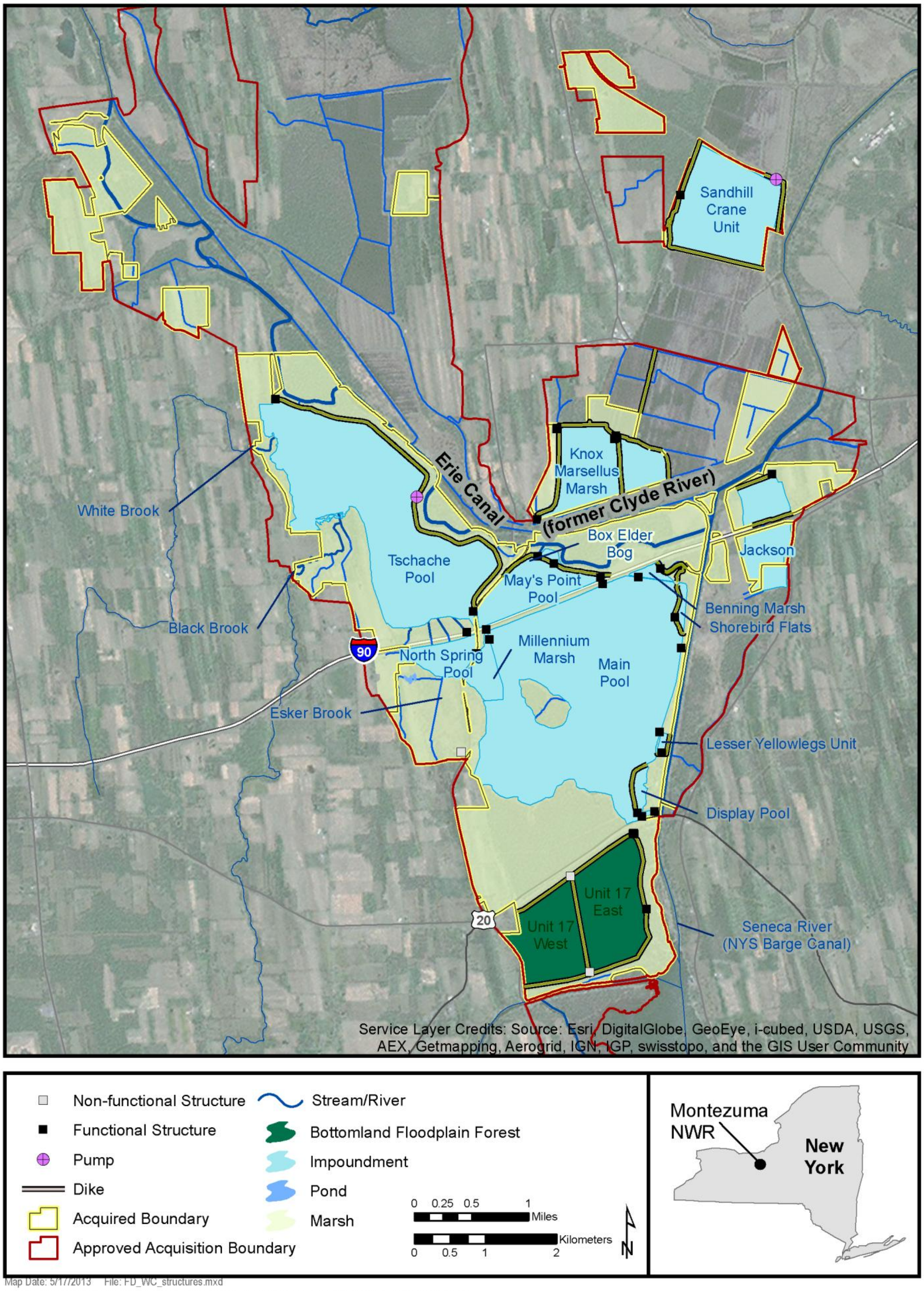


Figure 8. Management units and water control structures at Montezuma NWR.

5.2.2 Canals and Drainage Ditches

Off refuge, the Cayuga-Seneca Canal and Erie Canal are major engineering features near Montezuma NWR. The canals border and bi-sect the refuge's approved acquisition boundary and were built over a period of several decades, beginning in the early 1800s and finishing in the early 1900s. Construction of the canal system has effectively drained the historic wetlands of the Montezuma area. Additional details about water management in the canal system are discussed in Section 5.2.5.

Muckland and former agricultural land in the Montezuma NWR acquisition boundary is dissected by numerous drainage ditches and canals. Typically the Erie Canal is the low elevation terminus of these drainage networks. In some places, pump stations are necessary to pump water from the drainage ditches, across the Erie Canal dikes, and into the canal. Where the Service has purchased previously farmed lands, refuge staff install water control structures in drainage ditches to raise water levels and restore wetland habitat. Understanding the complex drainage patterns in the ditch networks is one of the challenges of designing wetland restoration plans on former agricultural land. There does not appear to be any readily available information that quantifies the extent of these ditches on the refuge or in the acquisition boundary.

5.2.3 Water-control structures

There are 40 water control structures on the refuge used to manipulate water levels in wetland impoundments (Figure 8, Table 8). Water control is accomplished by manipulating stop-logs or slide gates in the various structures. Some structures have been custom built for the individual impoundments and others are pre-fabricated and installed by refuge staff.

Table 8. Water control structures from refuge water management data (2012).

Name/Location	Status and Type	Count
Benning	Functional Water Control Structure	1
Benning – Outlet	Functional Water Control Structure	1
Box Elder Bog/May's Point Pool	Functional Water Control Structure	1
Connector and River	Functional Water Control Structure	1
Display Pool	Functional Water Control Structure	2
Jackson Property	Functional Water Control Structure	1
Knox-Marsellus/Puddler	Functional Water Control Structure	6
Lesser Yellow Leg Inlet	Functional Water Control Structure	2
Main Pool	Functional Water Control Structure	4
Main Pool/May's Point Pool	Functional Water Control Structure	4
May's Point Pool – Outlet	Functional Water Control Structure	1
Millennium Marsh	Functional Water Control Structure	1
North Spring Pool/Millenium	Functional Water Control Structure	1
Sandhill Crane Unit	Functional Water Control Structure	3
Shorebird Flats Outlet	Functional Water Control Structure	1
South Spring Pool	Non-functional Water Control Structure	1
Tschache	Functional Water Control Structure	2
Tschache/May's Point Pool	Functional Water Control Structure	1
Tschache/North Spring Pool	Functional Water Control Structure	2
Unit 17 East	Functional Water Control Structure	1
Unit 17 East and Unit 17 West	Functional Water Control Structure	1
Unit 17 West	Non-functional Water Control Structure	1
Visitor Center Wetland	Functional Water Control Structure	1

5.2.4 Off-Refuge Surface Water Diversions

Cayuga Lake and Black Brook are the two primary off-refuge sources of water for refuge impoundments. This review did not identify any major upstream water users whose diversions are capable of affecting the refuge's water supply from Black Brook or Cayuga Lake. Instead, it is more likely that water management to support navigation in the Erie Canal will affect the refuge's ability to divert surface water out of the refuge during flood events.

5.2.5 Off-Refuge Surface Water Sources: Cayuga Lake

Water levels in Cayuga Lake and the canals surrounding Montezuma are managed for navigation by the New York State Canal Corporation (NYSCC or Canal Corporation). The NYSCC has developed "rule curves" for the lakes and canals to direct water management activities during the year. When establishing rule curves, the highest priority uses are maintaining water levels to support navigation and municipal water supplies. Cayuga and Seneca lakes are drawn down during winter to prevent ice and wind damage to docks and create storage for spring snowmelt runoff. In the summer lake levels rise and are stabilized to allow for recreational uses such as boating (HWS et al. 2012).

Cayuga Lake is connected to Seneca Lake by the Cayuga-Seneca Canal. Water levels in Seneca Lake are controlled by Seneca Falls Power Corporation (SFPC), which operates hydropower plants at Waterloo and Seneca Falls. The NYSCC measures water levels in the lake at Geneva, NY and uses these levels to determine their operations and water releases downstream in accordance with the Seneca Lake rule curve. Therefore, water levels in Cayuga Lake are affected by a combination of releases from SFPC dams and management of Mud Lock, at the north end of Cayuga Lake.

Mud Lock is located near the southeast corner of Montezuma NWR and is the outlet of Cayuga Lake (Figure 9). Water released from Cayuga Lake at Mud Lock flows into the Erie Canal. At Mud Lock, there is typically a 9 ft drop in elevation between Cayuga Lake (upstream of the lock) and the canal, downstream of the lock. During periods of high spring runoff, the water surface in the canal can be higher than the lake, limiting management options and preventing lake levels from being lowered.

Water from Cayuga Lake supplements the water supply to the Main Pool impoundment. Water delivery from the lake to Main Pool is through a gravity-fed connector ditch constructed in the 1990s. The connector ditch is typically only used during the drier summer months when there is little water entering the refuge from nearby drainages like Black Brook or White Brook.

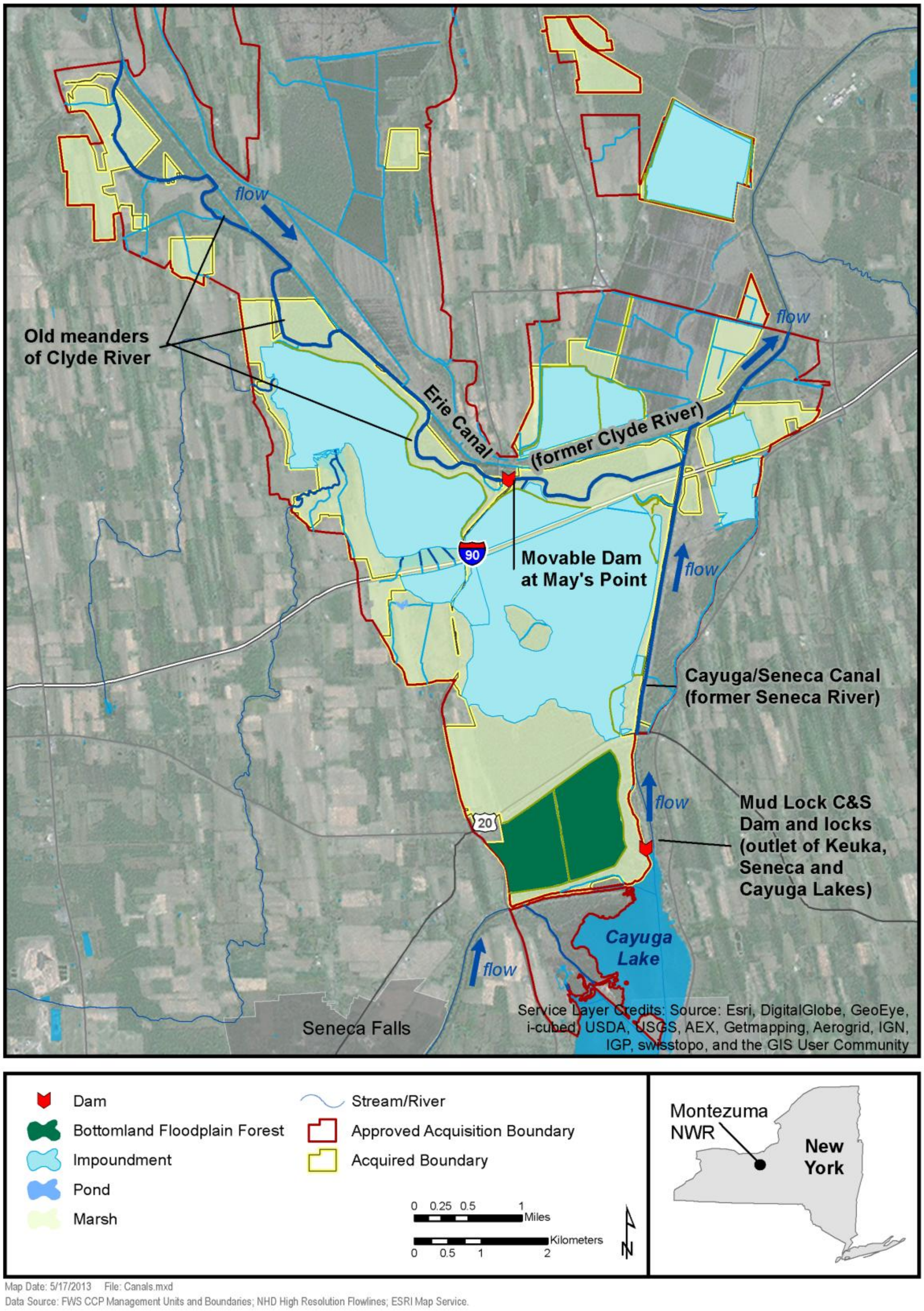


Figure 9. Off-refuge water sources, canals, and management.

5.2.6 Roads

The refuge maintains 3.5 miles of paved roads, and approximately 30 miles of unpaved roads (USFWS 2012). The New York State Thruway (I-90), highway 89, and routes 5/20 all traverse the refuge. The highways crossing the refuge create barriers to water movement and separate sections of impoundments from each other. For instance, construction of the Thruway bisected an existing marsh, creating two separate marsh units (one in northern Main Pool, the other in southern May's Point Pool). In a similar fashion, route 5/20 separates Main Pool from the wetland units at the north end of Cayuga Lake (Figure 9). A pipeline under route 5/20 allows water from the Cayuga Lake connector ditch to reach Main Pool. The smaller refuge roads are often built atop the dikes that create impoundments and are not considered significant threats to the refuge's water resources.

5.3 Water Quality

Water quality information included in the WRIA is derived from the Reach Access Database (RAD) maintained by the U.S. Environmental Protection Agency (EPA). Additional data are publically available at the EPA's "Envirofacts" website. These databases were used to collect information on listed waters and National Pollutant Discharge Elimination System (NPDES) permits in and around the refuge.

Sections 303(d) of the Clean Water Act require that each state identify water bodies where water quality standards are not met and assess the quality of the state's waters. In New York, the Department of Environmental Conservation (DEC) is responsible for generating the 303(d) list of known water quality limited rivers and lakes. These lists are updated biennially (DEC 2008). As of 2010, DEC has not identified any impaired streams or waterbodies in the Montezuma NWR acquisition boundary (Figure 10) including the two largest streams entering the refuge (Black Brook and White Brook).

Section 305(b) of the Clean Water Act requires states to periodically assess the quality of the state's waters and determine if they are fully supporting their designated uses. DEC conducts assessments of New York's waters. In 2010, 37 miles of stream inside the acquisition boundary (38% of total stream length) had been assessed by DEC, including Black Brook and White Brook (Figure 10). However, the north end of Cayuga Lake and the portion of the Erie Canal flowing through the refuge had not been assessed.

NPDES permits are issued to businesses by DEC to regulate the quality and quantity of pollutants discharged into waters of the United States. Stormwater and treated wastewater are two examples of discharges regulated under the NPDES program. There are no NPDES permits located within approximately 0.5 miles of the acquisition boundary. The absence of any nearby permits suggests there is little industrial or municipal development near the refuge and the primary surface water pathway for pollutants will be via nonpoint sources like agricultural runoff.

The findings of several reports evaluating the quality of surface water near Montezuma NWR are summarized in the paragraphs below:

- Water quality concerns at the refuge were summarized in the 2012 Contaminants Assessment Report prepared by the New York Ecological Services Field Office (Roe 2012). The report concludes that nonpoint pollution from agricultural drainage is the greatest water quality threat to the refuge. In addition, the report notes contamination risks from the Seneca Meadows landfill and hazardous waste materials that could spill on the New York State Thruway as a potential source of contamination (Roe 2012).

- Accumulation of pesticides and heavy metals in agricultural mucklands is reviewed in a USFWS guidance document on muckland management (USFWS 2000). The report found the contaminants of greatest concern in agricultural mucklands are Arsenic, Copper, Zinc, and non-polar organic byproducts of pesticide applications like Chlordane, DDT, and PCBs. In general, the effect on trust resources from these contaminants is estimated to be low to moderate, although localized “hot spots” may occur where the risks are greater. The Foster/Malone tract was identified as the area with the highest contaminant concentrations in the soil.

- DEC prepared a 30 Years Biological Trends Report for New York state streams (Bode et al. 2004). The report assessed the condition of streams and rivers based on macroinvertebrate sampling between 1972 and 2002. Four sites were located close to the refuge (i.e., Central Barge Canal at Clyde, Crane Brook, Seneca River at Seneca Falls and Yawger Creek). The Central Barge Canal was identified as being moderately impacted from organic wastes. The Seneca River was also characterized as being moderately impacted but the cause of the decline was unknown. Crane Brook, located northeast of the refuge, was found to be severely impacted in 2002 due to discharge from a potato processing plant. Finally, Yawger Creek, a tributary to Cayuga Lake, was assessed as slightly impacted due to nutrient enrichment from agricultural runoff (Bode et al. 2004).

- The Genessee/Finger Lakes Regional Planning Council (G/FLRPC) completed a Watershed Protection and Restoration Plan for Cayuga Lake (2001). The plan outlined land use conditions in the watershed and provided recommendations on how local governments can address water quality threats to the lake. The authors found the quality of Cayuga Lake water is “very good” but is threatened by land use activities that introduce excessive nutrients and sediment to the lake. Agricultural land use, stormwater runoff, and poorly maintained septic systems are the primary sources of nutrient and sediment contamination in Cayuga Lake’s watershed (G/FLRPC 2001).

- A 2007 report summarizes water quality conditions at the northern end of Cayuga Lake between 1996 and 2006 (Makarewicz et al. 2007). Over the last 100 years, the quality of Cayuga Lake water has decreased and the lake has shifted from being classified as oligotrophic to mesotrophic, or unproductive to moderately productive. In the early 1970s, concentrations of phosphorus and nitrogen peaked and water clarity decreased. Since then, the nutrient concentrations have dropped and water clarity has improved. Increased water clarity is helped by lower nutrient concentrations but major improvements were observed after zebra mussels were introduced to the lake, in the early 1990s (DEC 2008).

- The 2008 DEC assessment of Oswego River Basin waterbodies supports the conclusions of G/FLRPC (2001) and Makarewicz et al. (2007). The northern end of Cayuga Lake was identified as having no known water quality impairments. The middle section of the lake was listed as threatened but the classification was assigned to provide an extra level of protection rather than identification of a specific threat. Only the southern end of the lake, near Ithaca, is identified as impaired due to agricultural and urban runoff (DEC 2008).

Other water quality issues with specific relevance to Montezuma NWR are discussed in more detail below.

5.3.1 Seneca Meadows Landfill

The Seneca Meadows Landfill is located on Black Brook upstream of the refuge near the town of Seneca Falls. The U.S. Fish and Wildlife Service, New York Field Office (NYFO) in Cortland, NY has worked with Seneca Meadows to implement water quality monitoring on Black Brook and best management practices in their operation to minimize contaminant delivery to Black Brook (Seneca Meadows Inc. 2011). The landfill operators sample surface water and sediment in Black Brook upstream and downstream of the landfill on a quarterly basis. Collected samples are analyzed to determine if surface water and sediment downstream of the landfill exceed baseline water quality conditions in Black Brook (Seneca Meadows Inc. 2013). Quarterly reports are reviewed by Environmental Contaminants staff at the NYFO. To date, the monitoring reports submitted by Seneca Meadows have not shown any recent evidence of contamination to Black Brook from the landfill.

As part of recent landfill expansion, a portion of the Black Brook channel is being relocated. Potential water quality threats associated with the proposed project include discharges to Black Brook from dewatering of the excavation site and sediment inputs from dust and erosion.

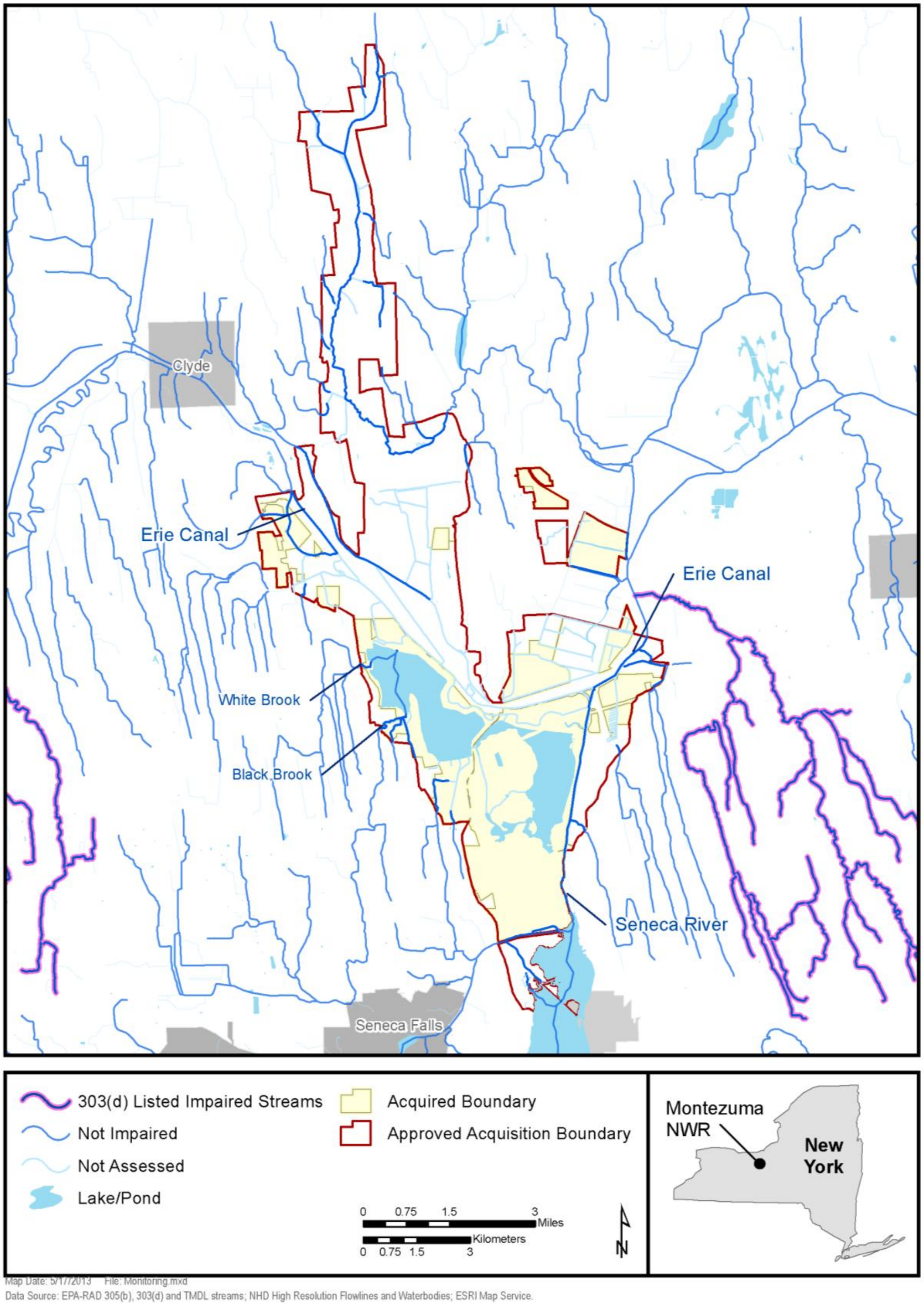


Figure 10. EPA listed waters from the EPA's RAD database in and around Montezuma NWR.

5.3.2 Erie Canal Flooding

High water levels in Cayuga Lake and the Erie Canal related to flooding and canal management are another water quality concern. During flood events, high water levels can contribute to nonpoint source pollution by eroding shorelines and stream banks, inundating septic disposal fields, and saturating soils used for agriculture (G/FLRPC 2001). Flooding can be a problem on the canal system in the spring of deep snowpack years. The Canal Corporation works to minimize these events but environmental conditions and the physical limitations of the canal infrastructure make flood events inevitable some years (Goebel personal communication)

5.3.3 Gas Wells

DEC Division of Mineral Resources regulates the development and production of oil and gas resources in New York. Hydraulic fracturing is a technique used to extract natural gas from shale deposits like the Marcellus Shale. In 1992 DEC developed a Generic Environmental Impact Statement (GEIS) to cover oil, gas, and solution mining regulations in New York. More recently DEC has prepared a draft Supplemental Generic Environmental Impact Statement (SGEIS) to evaluate the impacts of high volume (> 80,000 gpm) hydraulic fracturing. This type of drilling is being proposed for the Marcellus and Utica Shale deposits in New York and is not being permitted until the SGEIS is finalized (Collart personal communication)

Hydraulic fracturing requires large volumes of water to extract natural gas from shale deposits. Much of the water used to develop gas wells returns to the surface as "flowback" water and contains the chemicals used in the fracturing process and dissolved minerals from the shale formation. Once the well is in production water returns to the surface with the gas. This "formation" water can be more saline than seawater and poses considerable threats to aquatic biota if accidentally spilled into streams or wetlands. Additionally, water withdrawals from streams to support gas development can significantly reduce streamflow in small brooks, particularly during the summer low flow period (Soeder and Kappel 2009).

The Division of Mineral Resources maintains a database of oil, gas, and solution mining wells in New York. The database is updated regularly and contains information on almost 40,000 wells and 4,500 mines. Data on well locations were plotted in Figure 11 to determine if any active wells are located near Montezuma NWR.

Figure 11 indicates that most of the active gas wells near Montezuma NWR are located south of the refuge, east of the northern end of Cayuga Lake. Most wells are outside the watersheds of the small streams flowing into the refuge and unlikely to affect refuge water resources. There are three wells located at the headwaters of White Brook that were drilled in 2003 and 2006 (Table 9, Figure 11). These wells were installed with methods that use less than 80,000 gpm of water and extract relatively small volumes of gas (Collart personal communication). Recent well inspections indicate the wells are sound and there is no indication the wells are a threat to water quality of White Brook.

Table 9. Active gas wells in headwaters of White Brook, near Montezuma NWR.

ID in Figure 11	Well No.	Completion Date	Status	Latitude	Longitude
1	31099230420000	11/5/2003	Active	-76.84877	42.98601
2	31099230430000	2/7/2006	Active	-76.83844	42.98684
3	31099230410000	11/5/2003	Active	-76.84761	42.98134

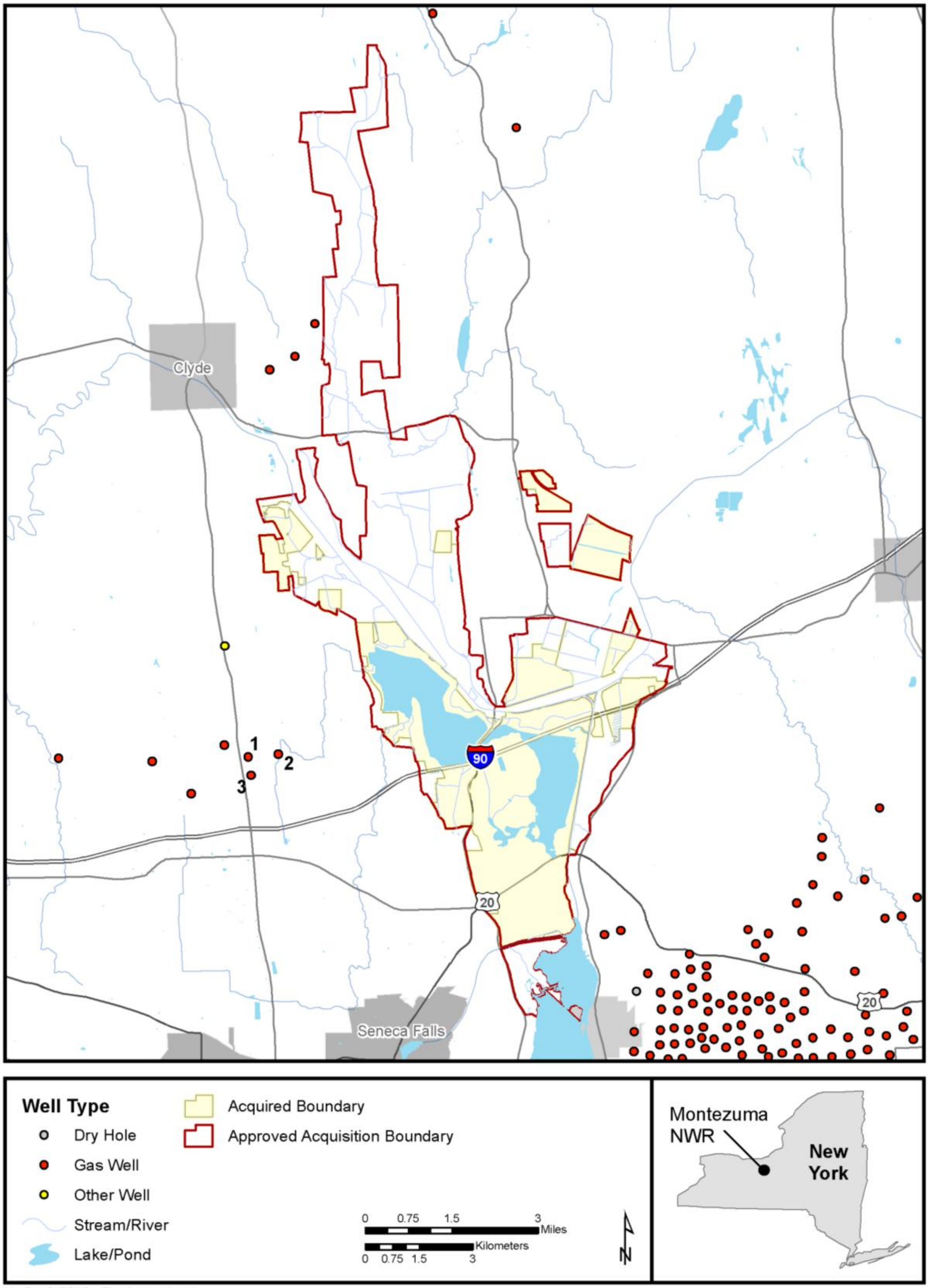


Figure 11. Location of active gas wells in the vicinity of Montezuma NWR.

5.3.4 Water Quality Overview

The available data suggest wetland habitat at Montezuma NWR does not suffer from poor water quality. Streams flowing into the refuge have been assessed relatively recently and are not considered impaired (DEC 2008). Monitoring of potential contamination sources like the gas wells near White Brook and the Seneca Meadows Landfill suggest those sources are not contaminating water quality at this time (Collart personal communication, Seneca Meadows Inc. 2013). Evaluations of Cayuga Lake indicate its water quality is good and improving (G/FLRPC 2001, Makarewicz et al. 2007, DEC 2008). However, because of the agricultural activity around the refuge and the proximity to contaminant sources like the Erie Canal, New York State Thruway, and Seneca Meadows Landfill, the potential for contamination exists. The most obvious water quality threats to refuge water resources will come from contamination in water sources like Cayuga Lake and the small streams that drain agricultural lands and terminate in the refuge impoundments (i.e., Black Brook and White Brook).

5.4 Water Monitoring

WRIAs identify water-related monitoring that is taking place on, or near, wildlife refuges and fish hatcheries. For this preliminary review, the WRIA relies heavily on information stored in the USGS National Water Information System (NWIS) database. Water monitoring can be broadly categorized as either water quality or water quantity focused. Water quality monitoring typically consists of collecting surface water or groundwater samples for chemical analyses in a laboratory or with sensors deployed in the field. Alternative protocols may use techniques such as aquatic invertebrate sampling as a proxy for water quality. Water quantity monitoring typically includes the flow rate in a stream, the water level in a groundwater aquifer, or water levels in refuge impoundments. WRIAs also consider weather stations and tide gages as other types of water-related monitoring.

5.4.1 Water Quantity Monitoring

Refuge staff record water levels in refuge impoundments using staff gages installed near water control structures. These gages are being referenced to a common elevation datum in an effort to better relate water levels between impoundments. The New York State Canal Corporation monitors water levels in Cayuga Lake and Erie Canal at Mud Lock and maintains snow survey sites at May's Point and Cayuga Lock #1. Snow depth and density information is collected as part of the New York Snow Survey and used to track the water content of state's snowpack. Additional water quantity monitoring is conducted by the USGS on the Seneca River at Seneca Falls (2005 – present) (Table 10 and Figure 12).

As described in Section 5.1.3, the Canal Corporation maintains water levels in the canal system and measures water levels at Cayuga, Oneida and Seneca lakes. Current water levels in relation to targets and data from the previous year are posted daily on the Canal

Corporation website (NYSCC 2012). It does not appear that these data are available in a real-time format like the approach used by the USGS for their stream gages.

Table 10. Water quantity monitoring sites, including type and agency. Reflects information available on USGS National Water Information System (NWIS) Mapper website (2013) and USFWS Staff Gages.

ID in Figure 12	Site Name	Category	Agency
1	04232730 - SENECA RIVER NEAR SENECA FALLS NY	Stream	USGS
2	Mud Lock Dam	Lake	NYS Canal Corp
3	Unit 17 East	Staff Gage	USFWS
4	0423406130 - SENECA RIVER AT FREE BRIDGE CORNERS NY	Stream	USGS
5	Visitor Center Wetland	Staff Gage	USFWS
6	Display Pool	Staff Gage	USFWS
7	Lesser Yellowlegs Unit	Staff Gage	USFWS
8	South Spring Pool	Staff Gage	USFWS
9	Main Pool	Staff Gage	USFWS
10	Shorebird Flats	Staff Gage	USFWS
11	North Spring Pool	Staff Gage	USFWS
12	Millennium Marsh	Staff Gage	USFWS
13	Tschache Pool	Staff Gage	USFWS
14	May's Point Pool	Staff Gage	USFWS
15	Benning Marsh	Staff Gage	USFWS
16	04235276 - BLACK BROOK AT TYRE NY	Stream	USGS
17	Box Elder Bog	Staff Gage	USFWS
18	Knox-Marsellus Marsh	Staff Gage	USFWS
19	04235274 - WHITE BROOK AT MUNSONS CORNER NY	Stream	USGS
20	Sandhill Crane Unit	Staff Gage	USFWS
21	Sandhill Crane Unit	Staff Gage	USFWS
22	04235271 - CLYDE RIVER AT LOCK 26 NR CLYDE NY	Stream	USGS
23	04235600 - SENECA RIVER (ERIE CANAL) NEAR PORT BYRON NY	Stream	USGS
24	430527076453401 - WN370	Groundwater	USGS

5.4.2 Barge Canal Datum

Water levels in the Erie Canal are referenced a vertical datum unique to the Erie Canal, known as Barge Canal Datum. At Mud Lock, Barge Canal Datum can be converted to National Geodetic Vertical Datum (NGVD) 1929 by subtracting 1.32 ft. The NYSCC does not maintain a conversion for Barge Canal Datum to North American Vertical Datum (NAVD) 88. The conversion between NGVD 29 and NAVD 88 at Mud Lock is approximately -0.58 ft using the coordinates for Mud Lock and the VERTCON website. Based on these data, convert Barge Canal Datum to NAVD 88 by subtracting 1.90 ft.

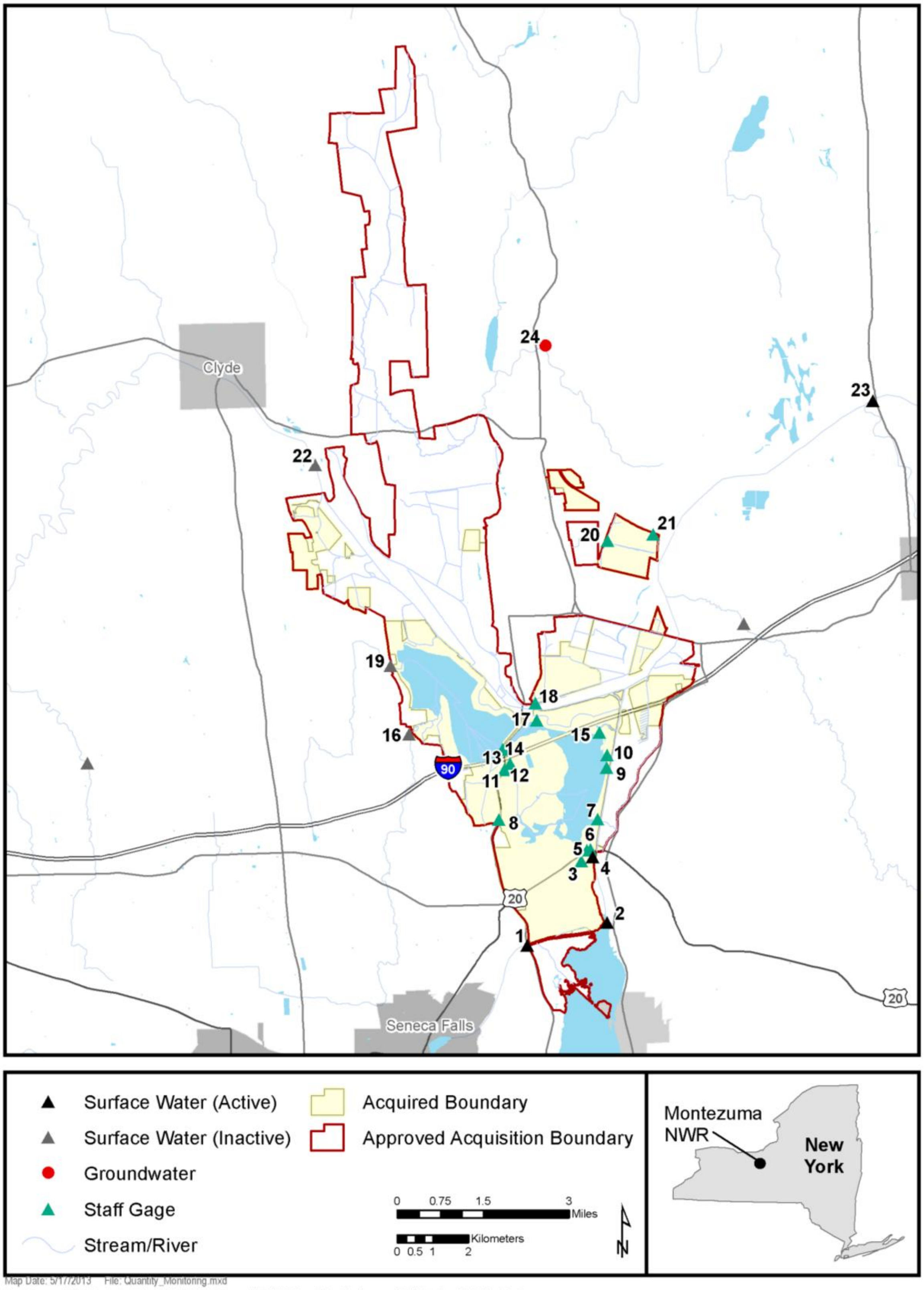


Figure 12. Water quantity monitoring site locations near Montezuma NWR.

5.4.3 Water Quality Monitoring

The USGS NWIS website does not list any active water quality monitoring sites near the refuge. Sites where the USGS has collected water quality samples in the past are listed in Table 11 and shown in Figure 13.

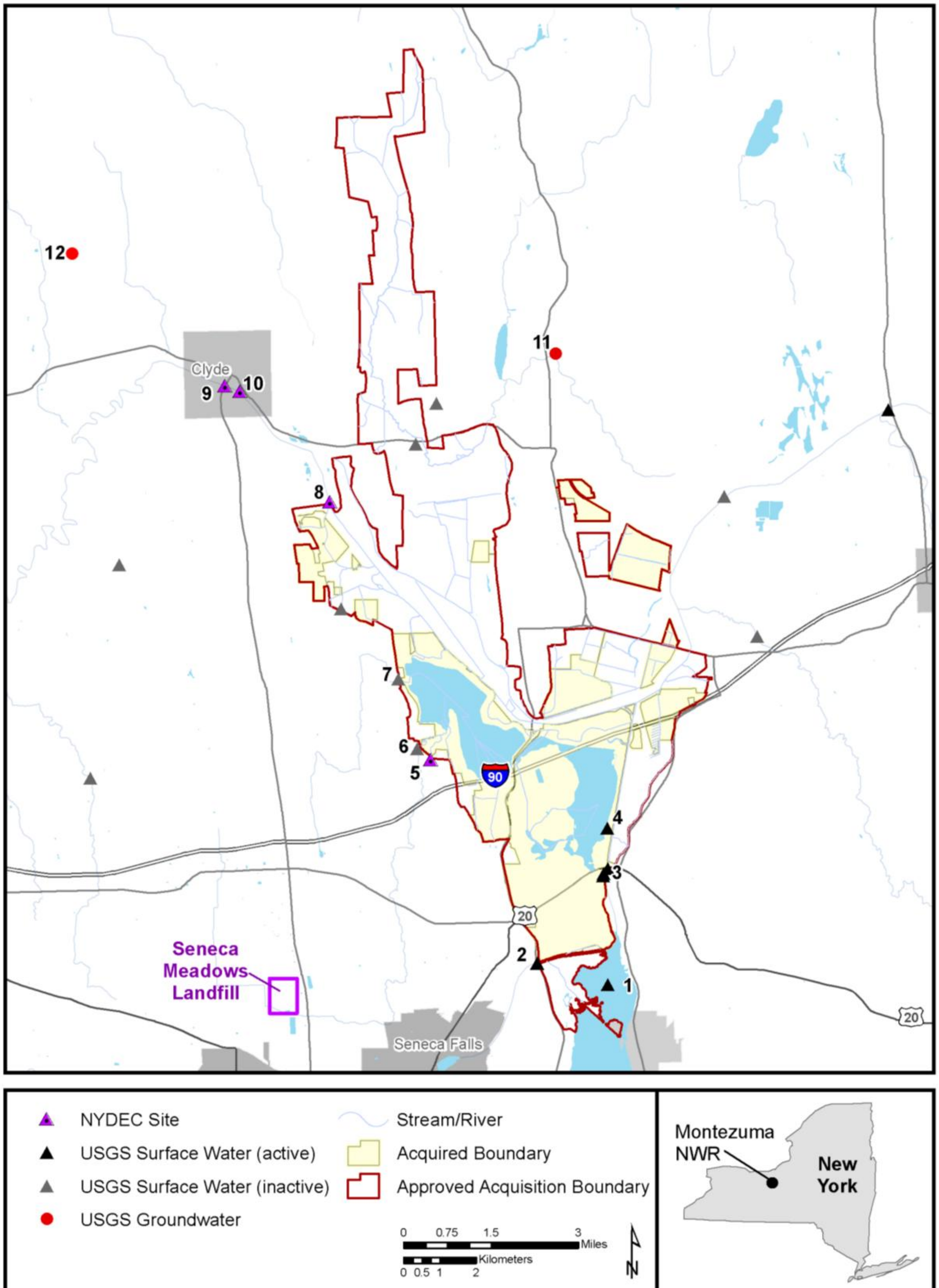
One USGS site in Table 11 (No. 4) is located on the refuge but only represents a single water quality sample collected in October 2008. The closest water quality monitoring site with more information is on Black Brook (USGS Site No. 4235276), upstream of the refuge. A total of 24 water quality samples have been collected here between 1970 and 2001 and continuous streamflow was measured from 1985 to 1995. Data collected at this site would be a good resource for evaluating incoming water quality on the largest stream entering the refuge.

In addition to the USGS monitoring, the DEC has four monitoring programs: Rotating Integrated Basin Studies (RIBS), Stream Biomonitoring Unit (SBU), Lake Assessments and a Groundwater Sampling Program. RIBS monitoring (chemical and biological) is conducted in 5-year cycles to assess surface water quality across the state, establish baselines, identify trends and support Clean Water Act reporting. There is one site near the refuge (Map ID 9 in Figure 13) in the RIBS network that was last sampled in 1995. SBU monitoring assesses water quality by collecting aquatic macroinvertebrates from streams and rivers. There are three SBU sites near the refuge (Map IDs 5, 8 and 10 in Figure 13) that were sampled in 2011, 2006 and 2007, respectively. In coordination with the USGS, the DEC also conducts an Ambient Groundwater Monitoring Program to sample basins throughout the state on a rotating basis with one basin sampled each year. The Oswego River Basin was monitored in 2007 and 2012, as part of the rotating 5-year cycle (Eckhardt et al. 2009).

Seneca Meadows, Inc., which operates the Seneca Meadows Landfill, contracts with an independent firm to conduct quarterly monitoring of Black Brook at one location upstream and two locations downstream of the landfill's stormwater outfall channels (USFWS 2008b; SWANA 2012). In addition, the Seneca Meadows Landfill conducts quarterly monitoring of over 50 groundwater wells (SWANA 2012) in and around the landfill.

Table 11. Water quality monitoring sites, including type, agency and period of record. Reflects information available on USGS National Water Information System (NWIS) and from NY DEC Monitoring.

ID in Figure 13	Station Name	Type	Agency	Begin Date	End Date
1	425602076441401 - CAYUGA LAKE CROSS SECTION C7 NEAR CAYUGA, NY	Lake	USGS	7/21/1999	7/21/1999
2	04232730 - SENECA RIVER NEAR SENECA FALLS NY	Stream	USGS	6/15/1972	7/29/1998
3	0423406130 - SENECA RIVER AT FREE BRIDGE CORNERS NY	Stream	USGS	7/29/1998	7/29/1998
4	425822076441701 - SENECA POND (MONTEZUMA NWR) NR SENECA FALLS, NY	Lake	USGS	10/28/2008	10/28/2008
5	TBLB01 - Unnamed Tributary to Black Brook	SBU	NYDEC		
6	04235276 - BLACK BROOK AT TYRE NY	Stream	USGS	7/27/1970	6/27/2001
7	04235274 - WHITE BROOK AT MUNSONS CORNER NY	Stream	USGS	8/26/1971	5/24/1972
8	CCAN11 - Central Barge Canal below Clyde	SBU	NYDEC		
9	CLYDE RIVER IN CLYDE	RIBS	NYDEC		
10	LRNC60 - Central Barge Canal at Clyde	SBU	NYDEC		
11	430527076453401 - WN 370	Ground water	USGS	8/2/1999	6/27/2000
12	430647076552901 - WN 560	Ground water	USGS	8/2/1999	1/29/2002



Map Date: 5/17/2013 File: Quality_Monitoring.mxd
Data Source: NWIS Monitoring Sites; NYDEC RIBS and SBU sites; NHD High Resolution Flowlines and Waterbodies; ESRI Map Service.

Figure 13. Water quality monitoring site locations near Montezuma, NWR.

5.4.4 Water Monitoring Data Gaps

Water quantity monitoring at the refuge is being addressed more effectively than water quality monitoring. Water levels in the refuge impoundments are well accounted for with the current distribution of staff gages. Water level observations can be correlated with existing bathymetric surveys to estimate the volume of water stored in the impoundments. Refuge staff are working to establish reference marks for existing staff gages so the gages can be re-set if damaged. Nearby monitoring of water levels in the Erie Canal and Cayuga Lake is conducted by NYSCC and available online. The refuge's work to tie all gages into NAVD 88 datum and the Barge Canal Datum is a good approach to better understand water movement between impoundments and the influence of canal management on refuge operations. Refuge staff also record water management activities at water control structures and note when water is being diverted from Cayuga Lake. Although water levels and management activities are well accounted for, there are no data currently being collected to quantify the volume of water entering the refuge from inflowing streams or diversions from Cayuga Lake. Groundwater levels are not being monitored on the refuge. However, this is considered a lower priority than surface water monitoring because groundwater is not considered a significant source of water for Montezuma NWR's water resources.

With the exception of Seneca Meadows Inc's monitoring on Black Brook, there is no active water quality monitoring of surface water entering Montezuma NWR. If funds become available, the refuge should consider monitoring that quantifies nutrient loads in incoming waters from Cayuga Lake, Black Brook and White Brook. An important first step of any monitoring plan would be a review of the USGS water quality samples collected on Black Brook and White Brook in the past.

Another data gap is quality and quantity information on the small springs that contribute water to Main Pool, North Spring Pool, and Esker Brook.

5.5 Water Rights

The laws governing water use in the State of New York are outlined in the Water Resources Law, which is Article 15 of the Environmental Conservation Law, and is summarized in the following section. Water use in New York is grounded in the common law "riparian doctrine," which allows landowners a "reasonable" use of water from adjacent water bodies (Mayland 2005). Reasonable is not defined and is typically resolved in court when disputes arise. In this context, reasonable, typically means that water use is allowed provided it does not prevent a downstream neighbor from also exercising their right to a reasonable use of the same water.

Prior to 2011, water use in New York was handled under the riparian doctrine except in certain geographic areas of the state: Long Island, Susquehanna River Basin, Delaware River Basin, and the Great Lakes Basin. In those areas, water use permits were required if use exceeded a threshold volume or were issued by an organization like the Susquehanna River Basin Commission. In 2011, the Water Resource Law was amended to require state-wide permitting of water use from groundwater or surface water sources in excess of 100,000 gallons per day (gpd). Under the new regulations, DEC issues permits to individuals, corporations, municipalities, and government agencies to use water. Water users with permits are required to report their annual water use to DEC on an annual basis.

After the 2011 regulations were signed into law, existing agricultural users had the option of "registering" their use with DEC by February 15, 2012. Registered water users do not require a water use permit but do need to report annual water use. Other users that are not registered need to apply for new water use applications under the following schedule:

- Water use exceeds 100 million gallons per day (mgd): Permit applications submitted by 6/1/2013
- Water use is between 100 mgd and 10 mgd: Permit applications submitted by 2/15/2014
- Water use is between 10 mgd and 2 mgd: Permit applications submitted by 2/15/2015
- Water use is between 2 mgd and 0.5 mgd: Permit applications submitted by 2/15/2016
- Water use is between 0.5 mgd and 0.1 mgd: Permit applications submitted by 2/15/2017

Certain parties are exempt from the 2011 permit requirements. The exemptions that may be relevant to Service facilities in New York are listed below:

- Withdrawals for agricultural purposes that have been registered or annual water use reported as of 2/15/2012
- Withdrawals that have been approved by the Delaware River Basin Commission or Susquehanna River Basin Commission
- Withdrawals from the New York State Canal System
- Long Island wells that have already been permitted by DEC
- Withdrawals used for fire suppression
- Direct withdrawals from the Atlantic Ocean or Long Island Sound
- Temporary withdrawals for construction, dewatering, hydrostatic testing, or aquifer testing if the volume withdrawn is less than an average of 100,000 gpd in a 30 day period (or less than 3 million gallons in 30 days)

It is Service policy to comply with state water laws and the 1997 National Wildlife Refuge Improvement Act clearly states that the Service shall acquire water rights under State law. The water right in this case is the permission to use waters of the state, granted by DEC through its 2011 water use permitting process. The 2011 legislation did not outline any special consideration for water use for wildlife purposes. Therefore, water use permits will be necessary at refuges in New York diverting more than 100,000 gpd from surface water or groundwater to maintain wildlife habitat.

At Montezuma NWR the channel that delivers water from Cayuga Lake to the Main Pool is the only active water diversion that might fall under the 2011 water use permit requirements. However, the refuge already holds a canal permit (No. C34036) to operate and maintain the earthen channel delivering water from the lake to Main Pool. Because the diversion was established under a permit from the Canal Corporation it falls under the exemption for canal withdrawals and does not require a DEC issued water use permit. It is not clear if DEC will require annual reporting of water use in the channel. This seems unlikely so long as a water use permit is not filed with DEC. It seems more probable that the Canal Corporation will ask the Service to quantify water use in the channel at some point in the future.

5.5.1 Water Use Conflicts

The 2011 legislation does not have a defined process for resolving water use conflicts. At present it appears conflicts will be resolved through DEC's permit review process or in court on a case by case basis. Thus, injured parties will need to make a legal case they are being harmed by another water user. Cases of this type hinge on quantification of water use which requires robust water quantity data collection practices.

Water use permit review will be handled at the local DEC offices. Montezuma falls on the boundary of DEC Regions 7 and 8 with offices in Syracuse and Avon, respectively. New water use permit applications will be listed in DEC Environmental Notice Bulletin (ENB). The ENB is published weekly and contains notices of a variety of new environmental permits being reviewed by DEC. It is expected that there will be a review period for new water use permits and during that time DEC will consider public comments on the applications. Additionally, water users with existing DEC permits will be notified of new applications to use the same water source. If the Service has concerns about new water use permits, it will be necessary to register those concerns with DEC during the permit review period.

5.6 Climate Trends

A variety of datasets exist that can be used to evaluate long-term climate trends at refuges in Region 5. Some of these data are included in the WRIA to provide a preliminary analysis of trends in precipitation, temperature, and stream runoff. Data were analyzed for trends using the nonparametric Mann-Kendall statistical test. This test can be used to determine if there is a linear trend in a dataset and whether or not that trend is statistically significant ($p < 0.05$) (Helsel and Hirsch 2002).

5.6.1 U.S. Historical Climatology Network (USHCN)

The USHCN is a network of climate monitoring sites maintained by the National Weather Service. Sites in the network are selected because their location and data quality make them well suited for evaluating long-term trends in regional climate. The closest site to the refuge is located in Geneva, NY about 16 miles west of the refuge at the northern end of Seneca Lake. Data from the site illustrates trends in precipitation and air temperature in the Finger Lakes region of New York over the last 115 years (Figures 14 – 16) (Menne et al. 2011).

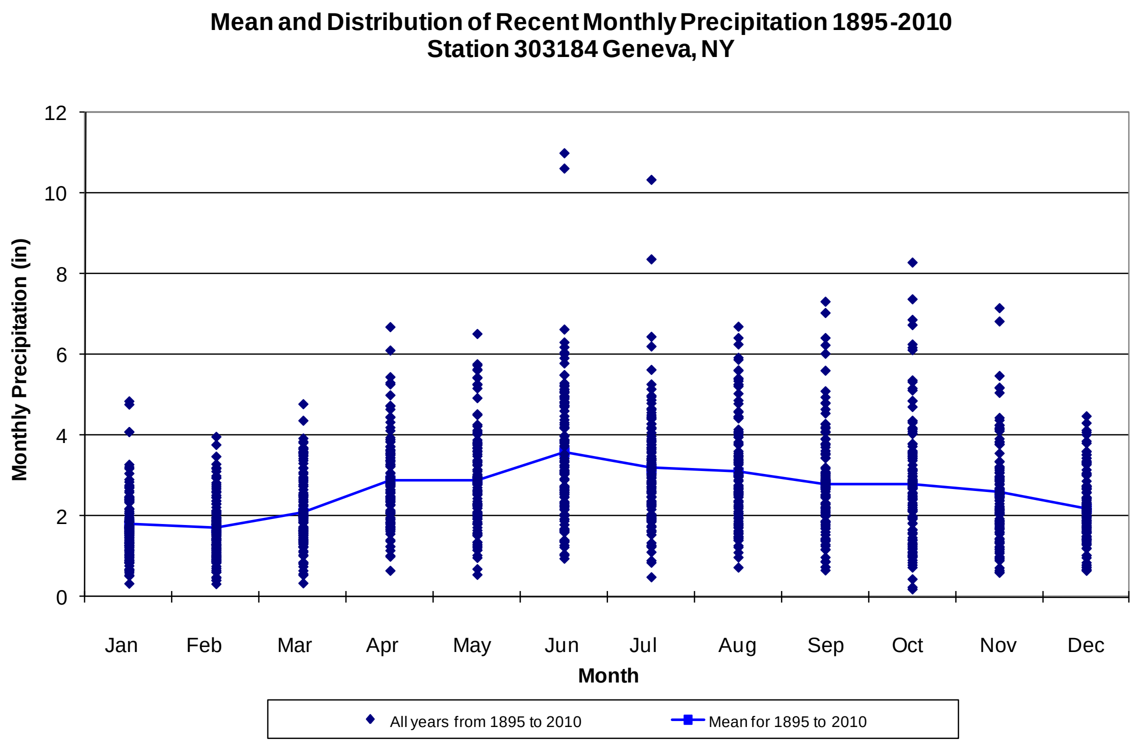


Figure 14. Distribution of total monthly precipitation at USHCN site 303184, Geneva, NY. 1895-2010.

Trends presented in Figure 14:

- Slightly higher precipitation in spring through fall seasons (April – November) than during winter.
- Average monthly precipitation is 2.64 inches.
- Average water year precipitation is 31.7 inches.

Precipitation patterns were evaluated by calculating the difference between each year's average precipitation and the average for all years. Presented as a percent, this approach can be used to identify years of above average, or below average, precipitation (Figure 15).

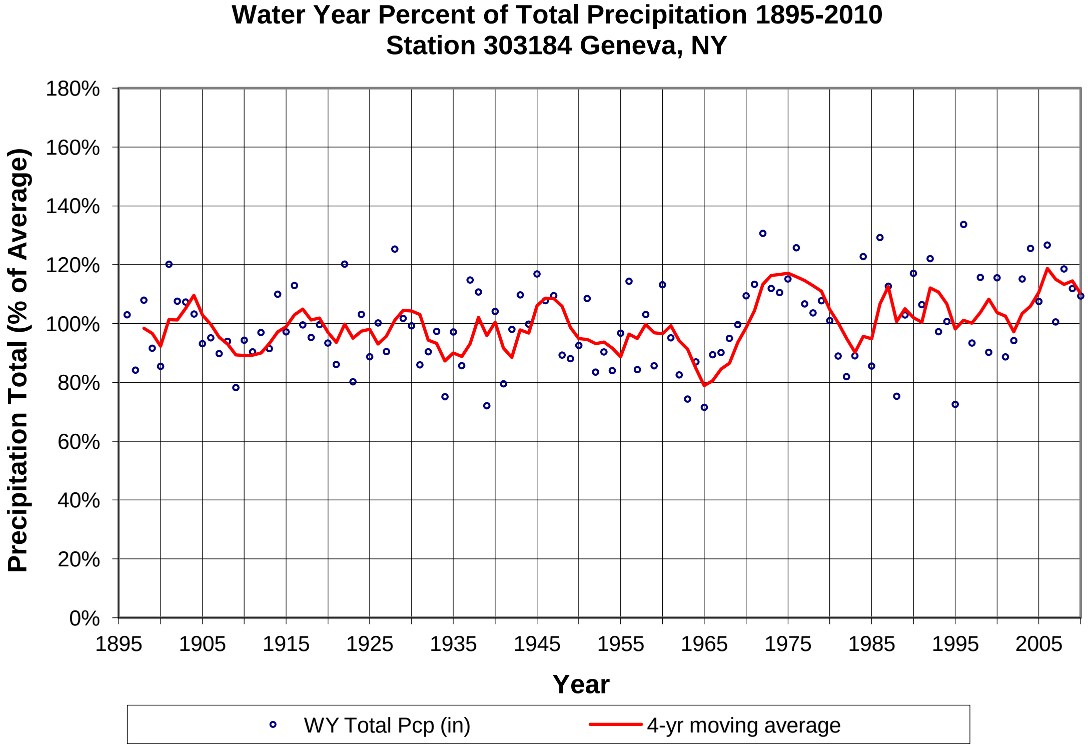


Figure 15. Percent of total Water Year precipitation at the Geneva, NY USHCN site between 1895 and 2010.

Note: "Water Year" runs from October 1 through September 31. It is commonly used to track hydrologic data.

Trends presented in Figure 15:

- The 1960s drought that affected central New York and the U.S. Northeast (Seager et al. 2012) shows up clearly in this record.

- Precipitation totals have regularly been above average, since the 1960s drought which agrees with observations at other weather stations in New York (Seager et al. 2012).

- Water year precipitation totals have increased approximately 3.4 inches over the period of record (1896 – 2010). The increasing trend is statistically significant using the nonparametric Mann-Kendall test.

Monthly temperatures at the Geneva, NY USHCN site were also reviewed to identify any patterns in air temperature since 1895 (Figure 16).

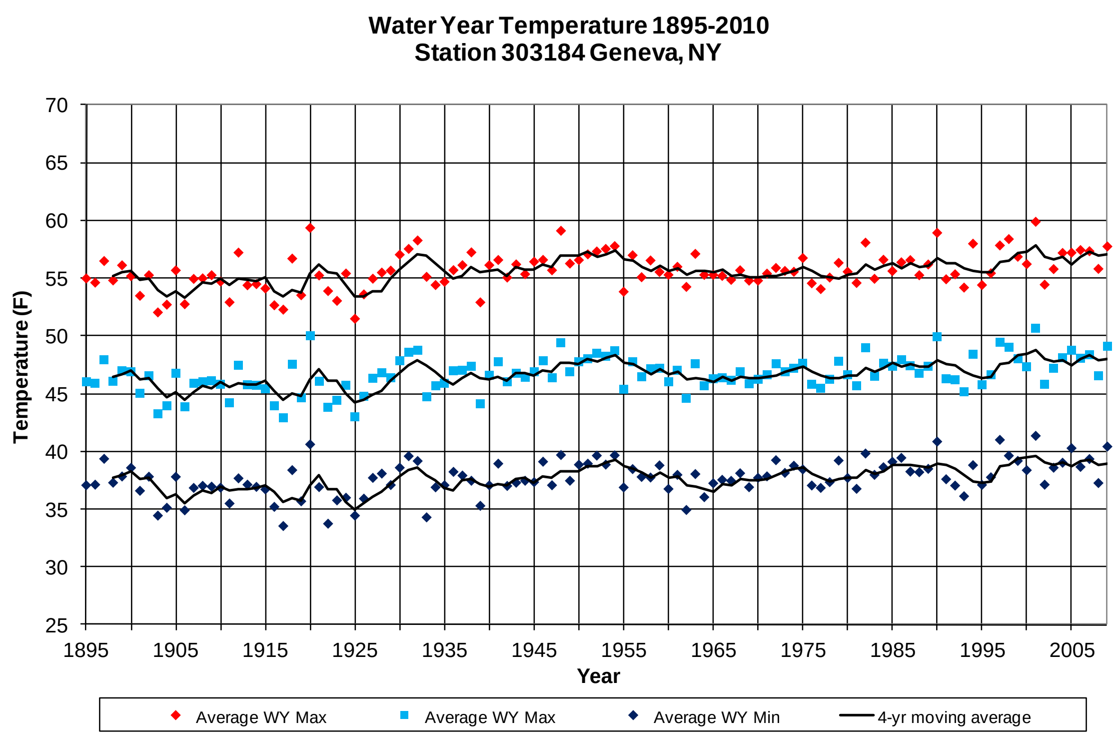


Figure 16. Average temperatures for the Water Year: 1895-2009 at the USHCN station in Geneva, NY. The Water Year extends from 10/1 – 9/30 of a year.

Trends presented in Figure 16:

- Average water year maximum temperature has increased approximately 2.05 ^{o}F over the period of record (1895-2010). This is a statistically significant trend.

- Average water year mean temperature has increased approximately 2.17 ^{o}F over the period of record. This is a statistically significant trend.

- Average water year minimum temperature has increased approximately 2.25 ^{o}F over the period of record. This is a statistically significant trend.

Maximum, mean, and minimum water year temperatures measured at the Geneva, NY USHCN station have all increased significantly since 1895. These increases agree with studies showing global temperatures are rising (Bates et al. 2008) and regional studies showing increasing air temperatures in the northeastern U.S. (Hayhoe et al. 2007).

5.6.2 USGS Hydro-Climate Data Network (HCDN)

The HCDN is a network of U.S. Geological Survey (USGS) stream gaging stations that are considered well suited for evaluating trends in stream flow conditions (Slack et al. 1992). Sites in the network have periods of record that exceed 20 years and are located in watersheds that are relatively undisturbed by surface water diversions, urban development, or dams.

The closest HCDN stream flow gage near the refuge is located on Fall Creek near Ithaca, NY, about 40 miles south of the refuge at the south end of Cayuga Lake. The station has a period of record from 1925 to 2012.

Flow patterns were evaluated to by calculating each year's average discharge difference from the average for all years. Presented as a percent, this approach can be used to identify years of above average or below average runoff (Figure 17).

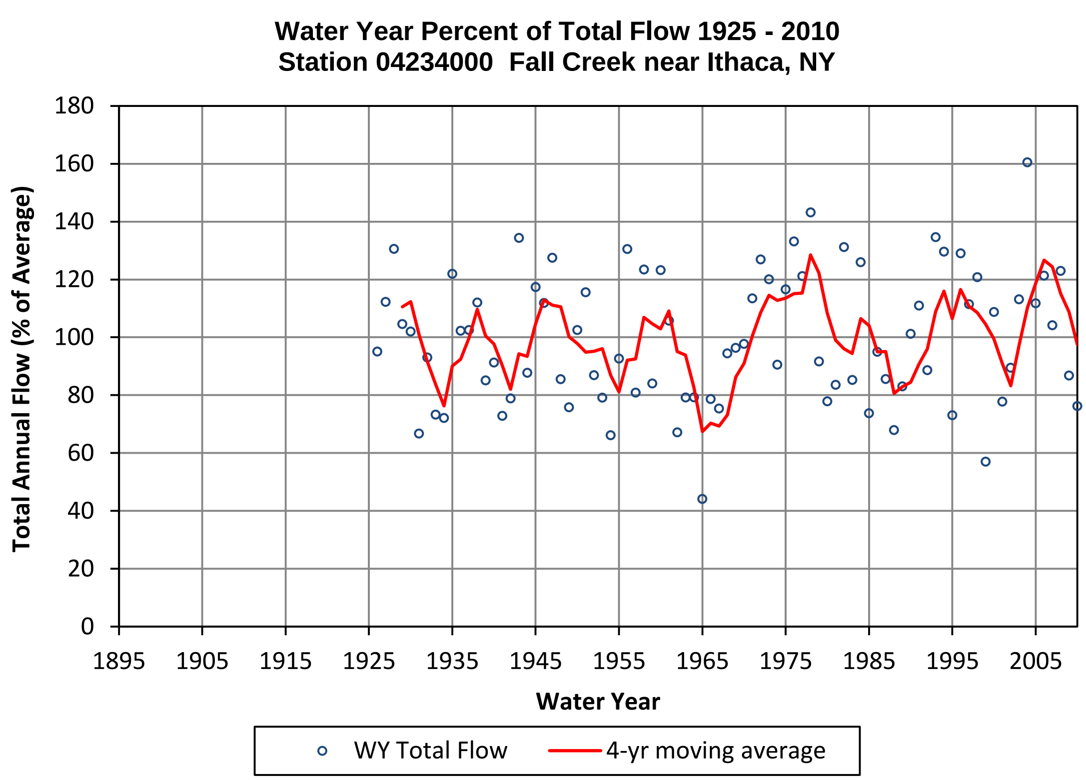


Figure 17. Percent of the average annual flow at USGS Station 04234000, Fall Creek near Ithaca, NY: 1925-2010.

Trends presented in Figure 17:

- The 1960s drought dramatically affected flow in Fall Creek and remains the most pronounced period of below average flow.
- The average annual flow from the period of record is 189 cubic feet per second (cfs).
- The highest average annual flow was in 2004 (304 cfs).
- The lowest average annual flow was in 1965 (84 cfs)

The long-term record presented in Figure 17 is expected to reflect conditions in other watersheds near Montezuma NWR. Streamflow patterns in Fall Creek at Ithaca roughly correspond to total precipitation data presented in Figure 15. The strong response to drought conditions in the 1960s is similar to the response observed in many watersheds throughout the Northeast. This drought is considered the "drought of record" for the northeastern U.S. and droughts of similar magnitude and duration have not been observed before or since (Hayhoe et al. 2007, Seager et al. 2012).

5.6.3 Future Climate Predictions

The Intergovernmental Panel on Climate Change (IPCC) predicts the U.S. Northeast will experience earlier spring snowmelt and reduced summer runoff as the global climate warms in response to human emissions of greenhouse gasses (Bates et al. 2008, Mack 2008). Hayhoe et al. (2007) review historic climate data and climate change models to evaluate the Northeast's response to global climate change. Results of their analyses are summarized below:

Temperature

Air temperature records in the Northeast show consistent signs of warming since the 1970s with the greatest increases occurring during the winter months. Warming trends are expected to continue and rates of warming increase under different climate modeling scenarios. As temperatures warm the frequency of extreme warm temperatures will increase also.

Precipitation

Precipitation records in the Northeast show a consistent increase in annual precipitation totals over the last century. Under different climate modeling scenarios, winter precipitation is expected to increase while summer precipitation is expected to remain unchanged or decrease. Heavy, intense precipitation events are expected to become more common.

Snowpack

The amount of snow cover has decreased across the Northeast in the last 30 years. This trend is expected to continue with less precipitation falling as snow in the winter months.

Streamflow Patterns

Since 1970, peak snowmelt runoff has occurred earlier in the year and the peak runoff values have been rising in winter and early spring. These patterns are expected to continue as wetter winters and warmer temperatures decrease winter snowpacks. The response to seasonal snowmelt will become less pronounced as more winter precipitation falls as rain. Peak flows are expected to be concentrated in the winter and early spring months and minimum streamflow will continue to be concentrated in the summer months. Minimum flows will be lower than the recent past and the duration of the summer low flow period is expected to increase.

Drought

Modeling scenarios predict that the frequency of severe, persistent drought (> 6 months) will remain at rates observed in the recent past. However, hotter drier summers and periodic precipitation deficits are expected to increase the frequency of short- (1-3 month) and medium-term (3-6 month) droughts. Periods of drought will be most pronounced at the end of the growing season in the late summer and early fall.

The climate trends discussed in Section 5.6 mirror the trends observed throughout the Northeast (Hayhoe et al. 2007). At Montezuma, management challenges that will be exacerbated by a warming climate include increased flooding and increased short-term droughts. It seems possible that the frequency of flood events in the Erie Canal system will increase as runoff patterns shift and heavy precipitation events become more common. Consequently refuge lands will be flooded by the Erie Canal more frequently than they have in the past. Hotter, drier summers are expected to create the opposite problem during the summer months. Increases in short-term droughts will keep water levels low in impoundments that are dependent on precipitation and natural runoff for their water supply. At times, summer water levels may be lower than they have been in the recent past which could compromise wetland habitat management. The refuge's small springs and the ability to divert water from Cayuga Lake will take on greater significance in drier summers because they may be the only reliable water supply for the refuge.

6 ASSESSMENT

6.1 Water Resource Issues of Concern

This section discusses some of the challenges facing the refuge's water resources. For the purposes of this initial review, the primary water resources of interest are the wetlands and impoundments inside the acquisition boundary of the refuge.

6.1.1 Impacts of Off-Refuge Infrastructure

The impoundment system at Montezuma NWR was designed to re-create wetland habitat that was lost when the Erie Canal was built at the north end of Cayuga Lake. The network of water-related infrastructure surrounding the refuge complicates the Service's ability to manage the impoundment system in several ways: (1) refuge wetlands are isolated from the historic water supplies of the Seneca and Clyde Rivers; (2) water in refuge impoundments needs to be kept low to avoid flooding neighboring farms or the roads crossing the refuge; (3) some refuge wetlands are isolated from the Cayuga Lake or Black Brook water supplies by roads crossing the refuge; and (4) drainage ditches and tile drains installed for agriculture limit the ability to flood the landscape and maintain suitable wetland habitat conditions.

6.1.2 Water Supply for Refuge Wetlands

Construction of the Erie Canal and its associated infrastructure has lowered the elevation of the Seneca River and drained the extensive wetland system that once covered the Montezuma area. Montezuma NWR wetlands are effectively isolated from the historic water supplies of the Seneca and Clyde Rivers and are dependent on precipitation, runoff from small drainages, and diversions from Cayuga Lake for their water supply. In drier summers it is likely these supplies will not be sufficient to maintain adequate wetland habitat conditions in all of the impoundments. It is possible future refuge managers will want to consider infrastructure upgrades or management actions that improve the availability of water for impoundments during the summer months. These might include infrastructure that allows additional diversions from the Canal, internal water delivery systems that improve connections between impoundments, or drilling wells to take advantage of groundwater resources.

6.1.3 Water Quality of Streams, Cayuga Lake, and Erie Canal

The available data indicate wetland habitat at Montezuma NWR does not suffer from poor water quality. However, the risk of contamination still exists due to land use around the refuge. The CAP report suggests that one of the primary water quality concerns at Montezuma is nonpoint source pollution from adjacent agricultural fields. Application of fertilizers, pesticides, and farming practices are expected to contribute contaminants, nutrients and sediments to refuge wetlands through the small streams entering the refuge and diversions from Cayuga Lake. Seneca Meadows landfill is located adjacent to Black Brook and is a potential upstream source of contamination for Tschache Pool. Additionally, periodic flooding in the Erie Canal is expected to deliver excess sediment and nutrients to refuge wetlands.

6.2 Needs and Recommendations

The primary threat to water resources at Montezuma National Wildlife Refuge is water management challenges related to off-refuge infrastructure. The recommendations below outline additional steps that can be taken to help address these challenges.

6.2.1 Continue Elevation Surveys and Work to Map Refuge Water Infrastructure

The refuge is addressing some of the water management challenges by working to establish a common elevation datum for all staff gages and relating that information to Erie Canal water levels. The refuge should consider a combination of additional elevation surveys and GIS, or GPS, mapping of the water related infrastructure on the refuge. Much of this mapping has already been accomplished but additional elevation surveys can be used to develop a flow map that illustrates flow patterns in ditches and between impoundments during low water conditions and flood conditions. Such maps can be useful tools that help with water management decisions and future wetland restoration plans.

6.2.2 Continue Monitoring Water Management Activities and Evaluate Ways to Measure Water Quantity

The refuge is doing a good job keeping track of water levels and management activities in the impoundment system. This information can help inform management decisions by documenting the capability of the water control infrastructure to influence impoundment water levels. In addition, the refuge should consider incorporating monitoring steps that can help quantify the volume of water in the impoundment system. Water quantity information can be used to improve impoundment management strategies and design modifications to the impoundment system. Water quantity information should be evaluated in impoundments where there are challenges with water management; the sites where it seems difficult to get water in, or out, of the impoundment in a timely way. The refuge should consider working to quantify the volume of water it needs from off refuge water resources like Cayuga Lake, Black Brook, and other streams entering the refuge. This information will be very important in the event of a water use conflict.

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