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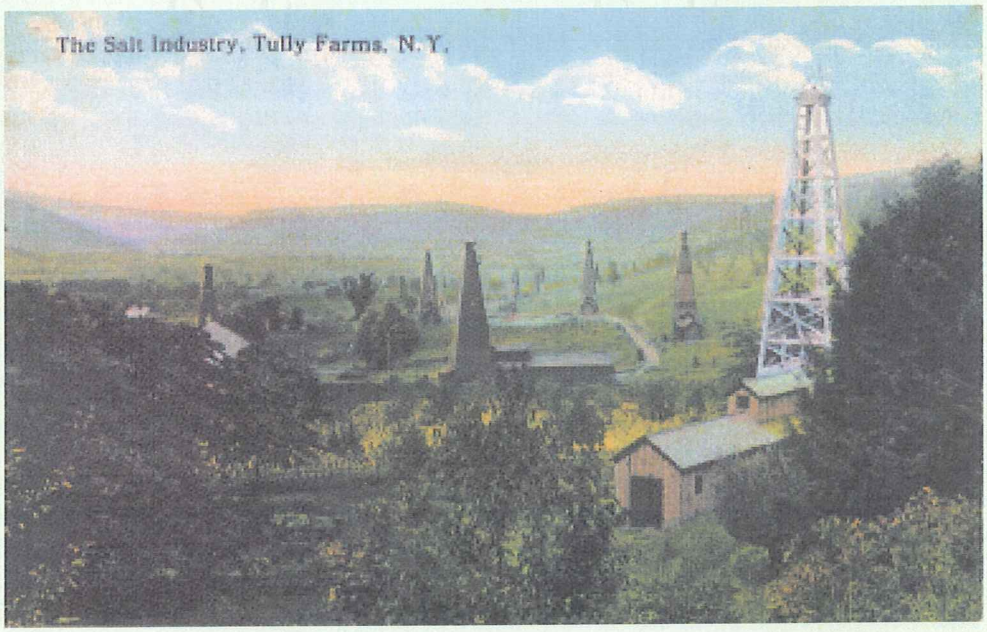
Prepared in cooperation with Onondaga Lake Cleanup Corporation, U.S. Environmental Protection Agency-Region 2, New York State Department of Environmental Conservation

Salt Production in Syracuse, New York ("The Salt City") and the Hydrogeology of the Onondaga Creek Valley



Brine from springs in and around the southern end of Onondaga Lake, from former brine wells dug or drilled at the lakes' edge, and from wells that tapped halite (common salt) beds near Tully, N.Y., 15 miles south of Syracuse, were used commercially from the late 1700's through the early 1900's for salt production. The rapid development of this industry in the 18th and 19th centuries led to the nicknaming of Syracuse as "The Salt City."

The brine originates from halite beds of the Salina Group shales of central New York. The dissolution of halite by ground water creates a brine that moves through an unconsolidated basal aquifer northward to the springs near Syracuse. This report briefly presents the history of salt production in the Syracuse area, explains the origin of the halite deposits and the ground-water flow paths from the halite beds to Onondaga Lake, and discusses the need to understand the hydrogeology of the Onondaga Valley and potential changes in water quality (specifically salt water) in relation to current remediation of Onondaga Lake and other contaminated sites in the Onondaga Creek watershed.

Department of the Interior
U.S. Geological Survey

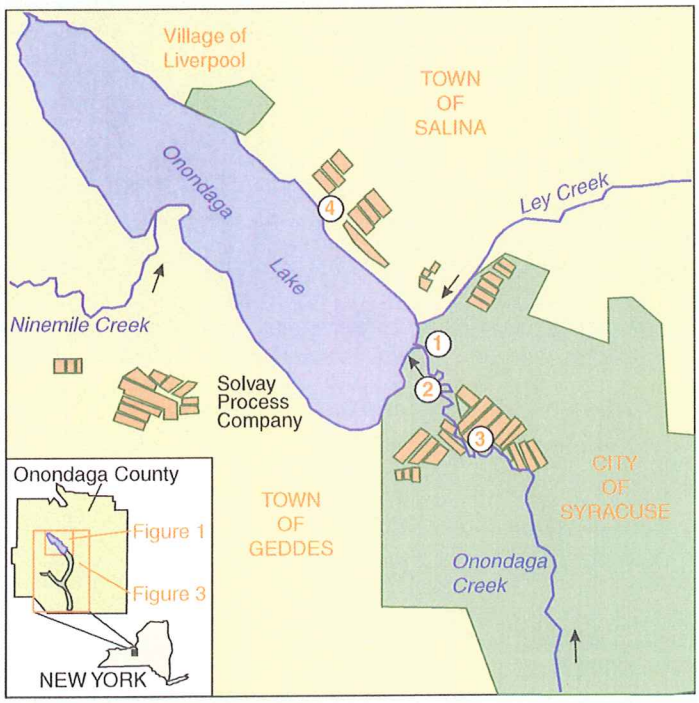
Fact Sheet FS 139-00
November 2000

HISTORY OF SYRACUSE SALT

Jesuit missionaries visited what is now the Syracuse region in the mid-17th century and reported salt (brine) springs around the southern end of "Salt Lake," known today as Onondaga Lake (fig. 1). Their observations are reported in Beck's 1826 account of salt springs and in Merrill's 1893 study of the salt and gypsum industries of New York State.

The brine springs were reported to have extended around much of the lake from "the Towns of Salina through Geddes and from Liverpool to near the mouth of Ninemile Creek—a distance of nearly 9 miles" (Beck, 1826). The Onondaga Indians of the mid-18th century, as well as European traders, produced salt by the boiling process. In 1788, the Treaty of Fort Stanwix transferred lands around the lake from the Onondaga Nation to local salt producers with the stipulation that the land would be used to produce salt for the common use of everyone.

Figure 2. Early 1900's postcard showing solar-evaporation salt sheds at Syracuse, N.Y. (Hugh G. Leighton Co., Portland, Me, no date.)



Base from USGS, 1898, 1:48,000

EXPLANATION

SALT SHEDS

DIRECTION OF STREAMFLOW

(1) BRINE WELL GROUP LOCATION

Figure 1. Pertinent geographic features of salt-production area, Syracuse, N.Y., and location of the brine well groups: 1-Salina Group; 2-Geddes Group; 3-Syracuse Group; 4-Liverpool Group. Solvay Process salt sheds received much of their brine from the Tully Valley.

The systematic production of salt began in 1797, when the State legislature designated a 1-mile-wide strip of land around the southern half of the lake as the Onondaga Salt Springs Reservation. Laws were passed to regulate the methods of production (boiling or solar evaporation), storage, and sale of the salt, as well as the collection of a duty for every bushel of salt produced from the Reservation.

The increasing production of salt by evaporation "solar salt" (fig. 2) in the early 1800's required brine of a higher concentration than was available from the springs; therefore, shallow dug wells were constructed in an attempt to find a more concentrated brine. Beginning in 1838, the State authorized the drilling of deep wells at several locations around the lake to locate the source of the brine. None of these wells encountered the source.

From 1797 through 1917, the Onondaga Salt Reservation produced more than 11.5 million tons of finished salt (Phalen, 1919). This amount would have filled a volume equal to four times that of the Carrier Dome (an enclosed athletic-field complex at Syracuse University, which has a volume of about 38 million cubic feet). In 1888, the Solvay Process Company established a chemical plant along the southern shore of Onondaga Lake

(fig. 1) to manufacture soda ash from the halite and limestone resources found within the local bedrock. The concentration of brine from the springs and wells in the Salt Reservation was diminishing, however, and this forced the company to seek additional sources of brine.

The Solvay Process Company drilled several deep test holes in the area south of Syracuse and eventually encountered halite deposits at a depth of 1,216 feet below land surface in the southern end of Tully Valley (fig. 3), about 15 miles south of Syracuse. More than 120 wells were drilled into four halite beds on the east and west flanks of the southern part of the valley from 1890 through 1986 (Kappel and others, 1996). The withdrawal of brine from the Tully Valley brinefield area over this 96-year period resulted in the removal of more than 96.2 million tons of salt, equivalent to the volume of nearly 35 Carrier Domes.

Many non-salt-producing companies also became established in the Onondaga Creek valley within the city of Syracuse from the mid-1800's through the early 1900's. Several of these businesses dug or drilled wells into the underlying sand and gravel aquifers to obtain water for cooling purposes, such as in the production of dairy products and beer, storage of perishable goods, and temperature regulation in office and storage buildings. The water obtained from these wells had a nearly constant temperature of 50° to 52° F and ranged in chemical character from saline to brine (Higgins, 1951). Once used, the water was discharged to nearby streams that drained to Onondaga Lake. Although this process did not utilize the salt resource, it took saline water from the ground-water system and discharged it to streams and, ultimately, Onondaga Lake, thereby increasing the salinity of the surface-water system.

The use of ground water for cooling purposes in the Syracuse area declined and eventually ceased with the advent of air conditioning. Neither the amount of salt removed, nor the amount of water withdrawn from the aquifer system during this period, can be accurately estimated, nor can the well locations, the number of wells, or their present condition (properly sealed or left open) be ascertained. The presence of these wells is of concern, however, in that the old and decaying well casings could provide a hydraulic connection between the brine-bearing sand and gravel aquifers and the surface-water system.

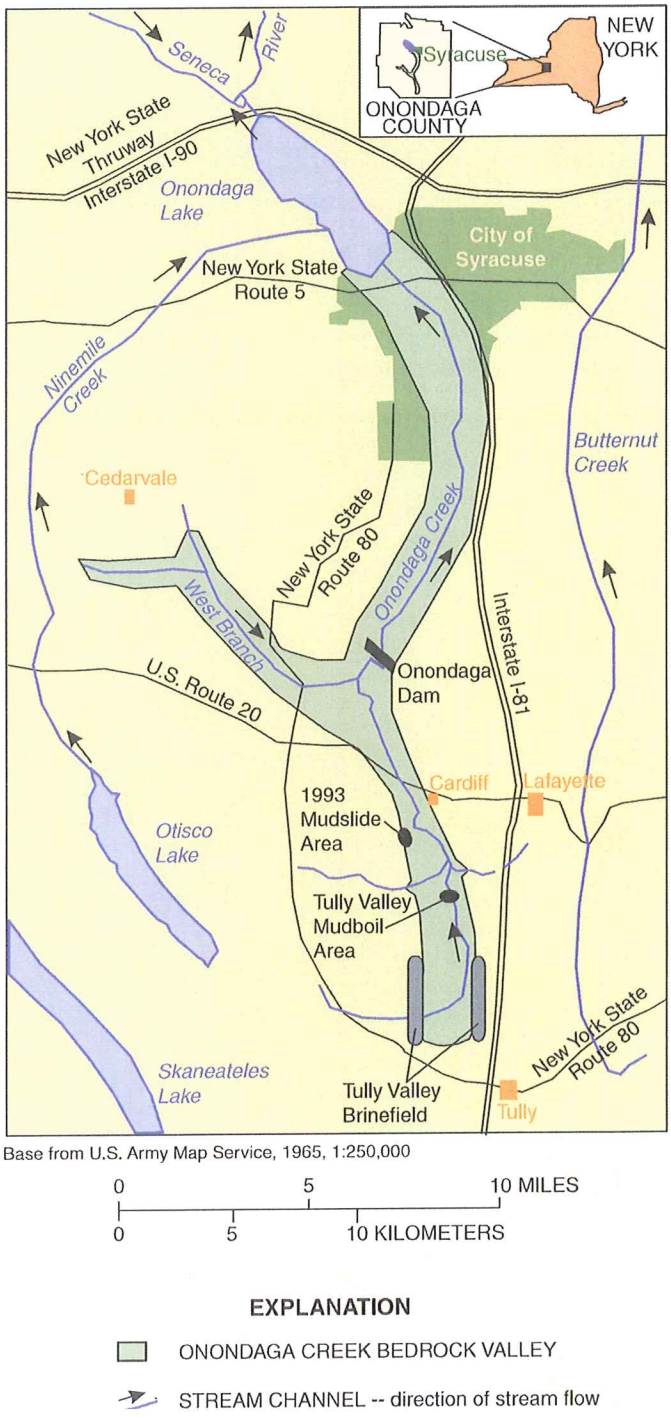


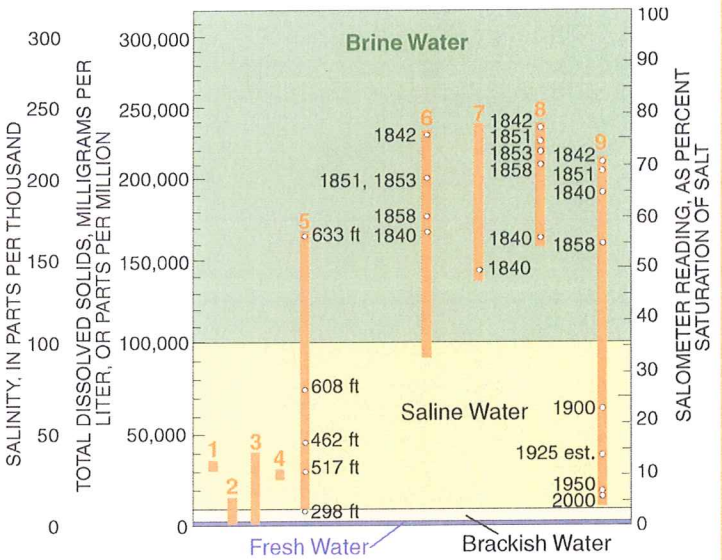
Figure 3. Location of Onondaga Creek valley and the Tully Valley brine fields, mudboils, and mudslides in relation to Syracuse, N.Y.

HOW SALTY IS THE WATER?

The salt concentration of water can be measured in several ways. The most common method is to measure the total dissolved solids (TDS) content by evaporating a sample of the water, then weighing the residue (salts, minerals and other solids). The TDS content of potable freshwater is generally less than 1,000 milligrams per liter (mg/L). Brackish water is not potable and has a TDS content of 1,000 to 10,000 mg/L. The TDS of saline water, which encompasses the average sea-water value of 35,000 mg/L, ranges from 10,000 to 100,000 mg/L. Brine has a TDS value greater than 100,000 mg/L.

An electronic water-quality meter can measure water-quality properties, including salinity. Salinity is a measure of all mineral salts in the water, such as calcium sulfate (gypsum) and calcium carbonate (calcite), as well as sodium chloride (halite or common salt). Salinity is measured in parts per thousand, rather than milligrams per liter or parts per million.

Salt producers from the 1800's through the present day use a salometer, which indicates the percent saturation of salt in a brine solution. For example, a reading of 0°S (zero degrees saturation) indicates pure water, and a reading of 70°S indicates water that is 70 percent saturated with salt. The average salometer reading of brine processed during the 19th century at the Onondaga Salt Springs Reservation was between 74° and 78°S (Bell, 1998). Past and current salt concentrations of ground water throughout the Onondaga Creek Valley are indicated in the adjacent diagram which allows comparison among values for fresh, brackish, saline, and brine waters in the Onondaga Valley by each measurement technique described above.



1 Average seawater value

2 Tully Valley mudboil discharge (1992-2000). Data from USGS.

3 Springs within 1993 Tully Valley mudslide (1993-2000). Data from Curran (1999), and USGS.

4 Discharge water from "cooling plant" wells in downtown Syracuse, N.Y., July 1991. Data from New York State Department of Environmental Conservation.

5 Water samples from mudboil-area drillhole - 1994. 298-foot sample from unconsolidated sand and gravel; deeper samples from bedrock. Data from Kappel and others, (1996).

6 Salina Group wells in Onondaga Salt Reservation. Depth ranges from 132 to 312 feet. Data from Higgins (1951), and Geddes (1859).

7 Geddes Group wells in Onondaga Salt Reservation. Average well depth 338 feet. Data from Higgins (1951), and Geddes (1859).

8 Syracuse Group wells in Onondaga Salt Reservation. Well depths 237 to 360 feet. Data from Higgins (1951), and Geddes (1859).

9 Liverpool Group wells in Onondaga Salt Reservation, depth of wells unknown. Data from Higgins (1951), and Geddes (1859). Data for year 2000 collected at Gale Spring near Liverpool by USGS, July 2000.

Range of total dissolved-solids concentration, salinity, and salometer readings from several sites, dates, and depths in the Onondaga Creek valley, in relation to ranges that define freshwater, brackish water, saline water, and brine. (Locations shown in figures 1 and 3).

GEOLOGIC AND GLACIAL HISTORY OF THE ONONDAGA CREEK VALLEY AND SYRACUSE REGION

Between 500 million and 300 million years ago, a mountain range as high as the present-day Himalayas formed along what is now the East Coast of North America as result of the collision of two landmasses that are now the European and North American continents. As the mountain range gradually rose, a large, shallow depression to the west became inundated to form an inland sea. Precipitation and runoff over millions of years slowly eroded the mountain range and deposited thousands of feet of sediment into the inland sea. Much of this sediment was in the form of mud and later became consolidated into the thick layers of shale that are found beneath the Syracuse area. Layers of limestone and sandstone also formed, and evaporation from the shallowest areas left layers of evaporites (salts) such as calcium sulfate (gypsum), calcium carbonate (calcite), and sodium chloride (halite or common salt) within the muddy sediments. The northern shore of the inland sea during the period of mineral-salt formation was about 5 miles south of today's city of Syracuse. The salt beds were subsequently buried by sediments produced through the continued erosion of the mountain range. These sediments eventually filled the inland sea, mostly with mudlike material that would become the shales found in the Syracuse region today.

The Salina Group Shales (first described in Salina, N.Y.; figs. 1, 3) consist of layers of shale interbedded with remnant salt-crystal casts. The beds of halite (rock salt) within the Salina Group begin near Cedarvale (fig. 3) and thicken southward (fig. 4). The composite salt thickness in the Tully area is about 150 feet, and the salt lies at a depth of about 1,300 feet below land surface. Further south, near the Pennsylvania border, the total salt thickness is more than 500 feet, and the salt lies at a depth of more than 2,000 feet below land surface (Rickard, 1969).

The halite beds that supply the brine springs at Onondaga Lake are south of Syracuse at depths greater than 1,000 feet. The northward movement of brine to the southern shore of Onondaga Lake results from artesian pressure, driven by elevational differences between the southern Tully Valley and Onondaga Lake. The unconsolidated glacial materials above the bedrock in the Onondaga Creek valley provide a the hydraulic connection between the halite deposits and the springs, as explained in the following section.

Beginning about 1.6 million years ago, massive ice sheets flowed southward (several times) across the North American continent (Isachsen and others, 1991). The last period of glaciation, known as the Wisconsin period, began about 100,000 years ago and ended about 14,000 years ago. The weight and force of the 1-mile-thick, southward-moving ice sheet eroded hilltops and widened and deepened river valleys. These valleys in central New York are now known as the Finger Lake valleys—one of which is the Tully Valley (fig. 3). Glacial scouring in the northern part of the Tully Valley exposed the halite-bearing Salina Group Shales to ground water in the base of the bedrock valley, near U.S. Route 20 and along the flanks of the West Branch valley of Onondaga Creek (figs. 3, 4).

The last major advance of the Wisconsin-aged glacier, about 20,000 years ago, also created large end moraines (mounds of glacial debris) at the southern end of the Finger Lake valleys. These moraines blocked the southward drainage of these valleys, and, as a result, the vast amounts of meltwater from the melting glacier formed proglacial lakes between the ice front to the north, the moraine to the south, and the east and west valley walls. The sediment discharged from the glacier formed deposits several hundred feet thick in each of the Finger Lake valleys. The coarse sediment particles (gravel and sand) were deposited close to the melting ice where the meltwater streams entered the lakes. The finer particles (silt and clay) were transported farther into the lakes, where they settled and capped the coarser deposits. Therefore, each Finger Lake valley's bedrock floor is overlain by coarse gravel and sand deposits and are overlain in many places by varying thicknesses of silt and clay.

This sediment sequence was confirmed by Mullens and others (1991), who studied the valley-fill sediments of eight Finger Lakes through marine-seismic-survey techniques. They found gravelly deposits overlying the bedrock floor, capped by mixed, finer grained deposits of clay, silt, and sand. The basal gravelly deposits appeared to be nearly continuous, to meander along the north-south axis of each valley and to form a basal, confined aquifer that is a conduit for water (or brine) movement.

After the glacier had retreated northward out of the Onondaga Valley, it began to discharge water and sediment onto the Lake Ontario Plain north of Syracuse (fig. 4). Glacial deposits on the Lake Ontario Plain differ from those in the Finger Lake valleys in that they are poorly sorted and are much thinner than those found in the narrow Finger Lake valleys.

Soil borings from construction projects around Onondaga Lake indicate that the glacial deposits around the lake range from fine to coarse but at the southeastern end of the lake, near the mouth of the Onondaga Creek valley, these deposits contain a high percentage of sand

and fine gravel, whereas the deposits at the northwestern end of the lake contain a high percentage of silt, clay, and marl. Thus, the deposits near the southeastern end of the lake transmit water more readily than those at the northwestern end; this difference in sediment type explains the presence of brine springs around and in the southern end of the lake and their absence along the northern end.

The movement of brine from deep sediments to land surface results from the northward decrease in elevation along the Onondaga Creek valley. The unconsolidated basal aquifer in the southern part of the Tully Valley is about 200 feet above sea level, but near Onondaga Lake the basal aquifer is at or below sea level. This elevation gradient allows ground water to move northward and upward through the sediments toward points of discharge at the springs around the southeastern end of Onondaga Lake.

GROUND-WATER FLOW SYSTEMS IN THE ONONDAGA CREEK VALLEY

The Onondaga Creek valley contains several ground-water-flow systems. The one within the bedrock and the overlying unconsolidated basal aquifer contains slowly moving water that ranges from saline to briny, and the overlying middle and upper glacial valley-fill deposits contain several aquifers, which have more rapidly moving freshwater, and a much lower mineral content. Water within the deep flow system has become enriched with minerals through the dissolution of halite, calcite, and gypsum, and, the only outlet for this water, until the advent of brine mining, was the springs near the southeastern shore of Onondaga Lake (fig. 1). During the 14,000 years since deglaciation, the salt concentration in the basal aquifer increased to nearly saturated conditions because the amount of water discharged from the springs was small in relation to the amount of water stored in the aquifer.

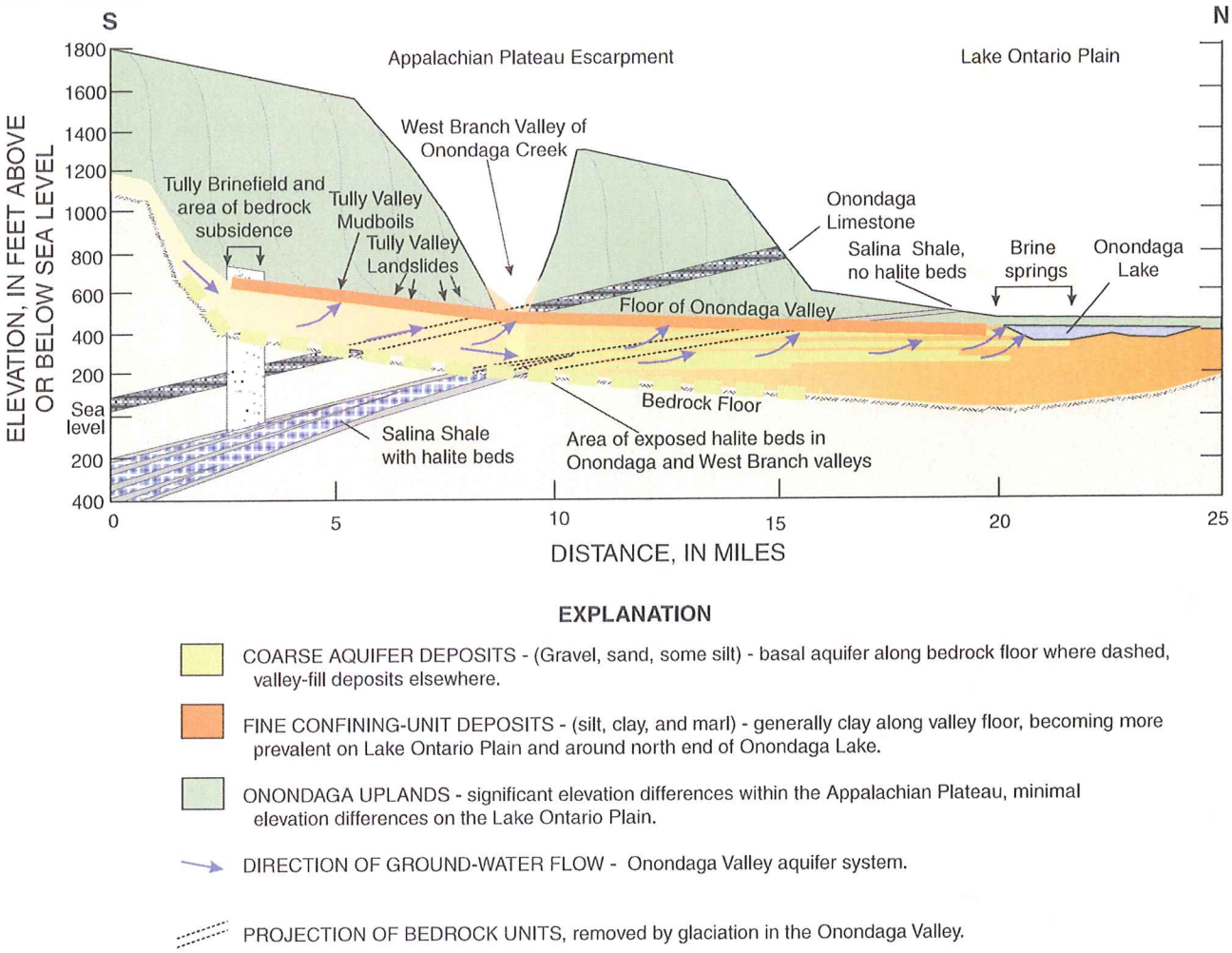


Figure 4. Idealized geologic section along Onondaga Creek Valley, Onondaga County, N.Y., showing locations of halite beds, Tully Valley brinefield, mudboils, and landslides, and Onondaga Lake brine springs.

The pumping of brine to the surface for salt production in the early 1800's, increased the amounts of brine leaving the deep ground-water flow system. The lowering of the outlet of Onondaga Lake at the Seneca River in 1822, lowered the water table around the lake and caused the brine springs to flow at higher rates than before. Subsequent increases in the rate of brine withdrawal from deep wells drilled near the lake in the mid-1800's allowed freshwater from the valley walls and the middle and upper aquifers throughout the Onondaga Creek Valley to recharge the deeper aquifer system and dilute the brine at depth. The resulting dilution caused the salt industry in Syracuse to decline by the late 1800's because the less concentrated brine required more time for evaporation, and yielded less salt than a more highly concentrated brine. At the same time, hard-rock mining of salt in other parts of the state and nation had become more productive and quickly eclipsed the importance of the Onondaga Salt Springs Reservation.

FUTURE IMPLICATIONS OF BRINE SPRINGS FOR ONONDAGA LAKE AND SYRACUSE

The closing of the Onondaga Salt Springs Reservation in the early 1900's, and the cessation of brine mining in the southern part of Tully Valley in the late 1900's, ended the final chapter of salt mining in the Syracuse region, but ground-water flowpaths along the southeastern shore of Onondaga Lake in Syracuse still allow salty water to migrate from the deep flow system to the springs in and around the lake. In the Tully Valley, however, bedrock subsidence and fracturing that resulted from nearly 100 years of halite removal have altered the local ground-water-flow system. The massive bedrock units that separate the Salina Group halite layers from the overlying bedrock units in the southern part of the valley became highly fractured as a consequence of the subsidence of the mined halite layers. The entire overlying bedrock sequence that extends upward from the mined-out halite zones to land surface has become fractured and provides hydraulic connections between bedrock aquifers (which were previously not connected), and to the adjacent valley-fill aquifers (Yanosky and Kappel, 1997). Thus, the bedrock and the unconsolidated aquifers in the southern end of the Tully Valley are now hydraulically connected and allow the migration of salty water to the valley-fill aquifer.

This hydraulic connection in the Tully Valley could increase the quantity, and diminish the quality, of water that flows through the rest of the Onondaga Creek valley aquifer system. No industries are known to be tapping the valley-fill aquifer near Syracuse, but water whose quality may vary from saline to a weak brine continues to discharge from the old springs around and beneath the lake. The old cooling-plant wells, if they were not sealed after they were abandoned, also could provide migration pathways for saline to brine-laden water, as could other manmade flowpaths between aquifers, such as construction borings, deep pilings, or other excavations. If more highly concentrated salt water is now entering the basal aquifer in the Tully Valley, it could, in time, discharge from the springs or along old well casings near Onondaga Lake and warrant consideration in any long-term plans for water-quality remediation in and around the Lake.

SUMMARY AND CONCLUSIONS

The deep and shallow aquifer systems in the Onondaga Creek Valley provided the brine that built "The Salt City." The processes of glaciation and deglaciation eroded and modified the bedrock foundation of shale, limestone, and evaporite deposits, and the deposition of glacial deposits within the valley created the aquifers that provide a hydraulic connection between the halite deposits south of the city and the salt springs that discharge along and beneath the southeastern end of Onondaga Lake. The water-quality changes brought about by man's activities in the Onondaga Valley aquifer system over the past 200 years are unknown and cannot be reliably estimated. The compilation of available hydrogeologic information, the collection of new data, and the construction of a ground-water flow model could provide information on the changes in the quantity and quality of water discharged from the aquifer system over the last 200 years, and would allow simulation of the effects of future remediation efforts on the water quality of Onondaga Lake and the ground-water flowing to it.

by William M. Kappel

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CHARACTERIZATION OF THE ONONDAGA VALLEY AQUIFER SYSTEM

The aquifer system in the Onondaga Creek valley is affected by the geology of the entire valley; thus, the planning and implementation of ground-water-mitigation projects for the cleanup of Onondaga Lake and other contaminated sites in the Onondaga Creek basin require extensive hydrogeologic data. Such data will help to define the interaction between ground water and surface water and the relation between human activities that affect a given part of the aquifer and the results of those actions elsewhere.

A detailed characterization of the aquifer system would require the construction of conceptual models of the geology and hydrology of the valley; this endeavor would require geologic and hydrologic data, as well as several other types of information:

Geologic data: Test-hole drilling data for construction activities (buildings, roads, bridges) are available but need to be compiled and plotted to indicate the depth to bedrock, the stratigraphy of the overlying glacial sediments, and the extent and water-bearing capability of each stratum.

Hydrologic data: Test-hole information, well records, and water-level data on the various aquifers in the valley would need to be compiled and plotted to indicate the rate of ground-water flow within each aquifer and any connections between these aquifers.

Other information: Analysis of the above data would indicate the locations from which further information is needed. Test holes in those areas would provide the additional data needed to complete the conceptual models of the aquifer system.

Once the conceptual geologic and hydrologic models are developed, a mathematical model of the ground-water-flow system can be constructed. The model can then be calibrated against data collected before and during model development and can then be used to predict future ground-water flow patterns and water-quality conditions throughout the aquifer system; it also could be used to simulate the interactions between aquifers and Onondaga Lake. If enough data are available, the model might also be used to simulate historical aquifer conditions to indicate how they may have been altered by man's activities.

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METROPOLITAN DESK

Tribe Seeks Syracuse, but a Clean Lake May Do

By KIRK SEMPLE; MICHELLE YORK CONTRIBUTED REPORTING FROM THE ONONDAGA INDIAN RESERVATION FOR THIS ARTICLE. (NYT) 1044 words

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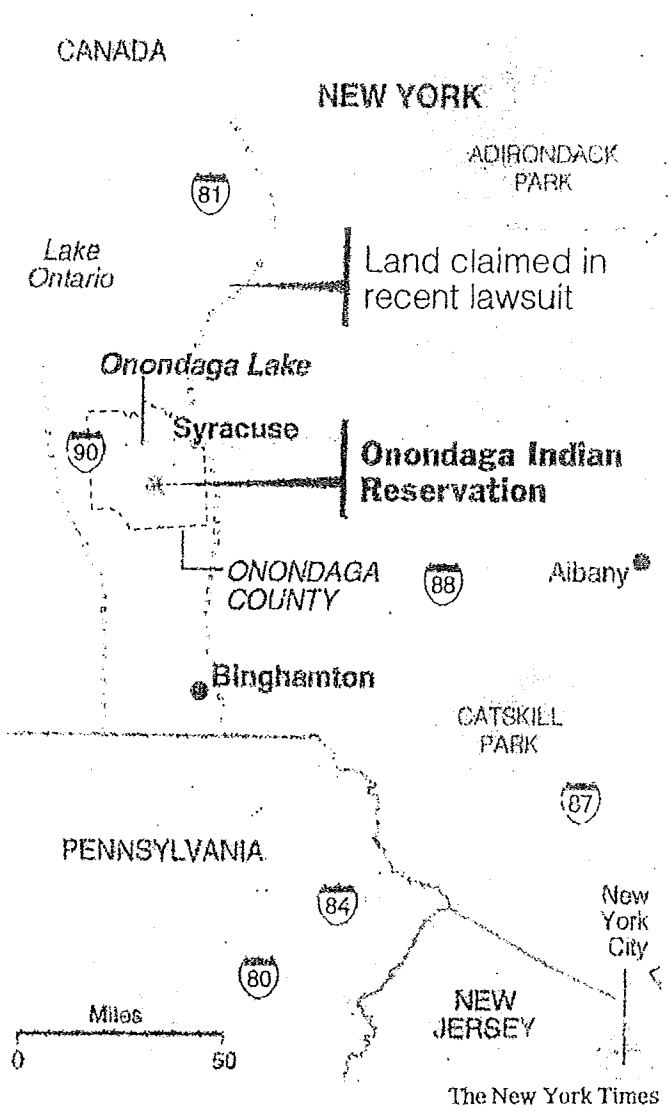


The Onondaga Indian Reservation is an 11-square-mile parcel.

The Onondaga Nation, an Indian tribe based in upstate New York, filed a lawsuit yesterday claiming that it owns 3,100 square miles of land stretching from the St. Lawrence Seaway to the Pennsylvania border and including Syracuse.

The tribe contends that the State of New York illegally acquired the land in a series of treaties between 1788 and 1822 and has asked the Federal District Court in Syracuse to declare that it still holds title to the land, which is now home to hundreds of thousands of people and includes all or part of 11 counties.

It is the largest Indian land claim ever filed in the state. The tribe said that it does not want all of that land, however, but that its principal intent is to gain leverage to clean up polluted sites in the land claim area.

The lawsuit names as defendants the State of New York, the City of Syracuse and Onondaga County, as well as five corporations that, the nation contends, have damaged the environment in the claim area.

Todd Alhart, a spokesman for Gov. George E. Pataki, said late yesterday that the governor's office had not yet received a copy of the claim. "We will take whatever steps

may be necessary to protect the interests of property owners and taxpayers in central New York, the Southern Tier and the northern New York region," Mr. Alhart said.

Unlike other Indian tribes that have filed land claims against the state, the Onondaga Nation, which has about 1,500 members, is not seeking monetary damages or the right to operate casinos in New York. Instead, tribal representatives said, the Onondagas want a declaratory judgment saying the land, which they consider ancestral territory, was taken illegally.

They then hope to use such a ruling to force the cleanup of sites in the claim area, particularly Onondaga Lake, a federal Superfund site and one of the most contaminated bodies of water in the nation.

The Onondaga Nation has made the cleanup of the lake, which is 4.5 miles long and one mile wide, one of its priorities. The tribe has lived near the lake for centuries and regards it as sacred land.

Tribal representatives said yesterday that the nation would not sue individual property owners or try to evict them.

"The nation has said flat-out that individuals have nothing to worry about," said Dan Klotz, a spokesman for the nation. The Onondagas, he said, "will not waver from that."

Other pending Indian land claims in New York have not interfered with property transactions, experts on Indian law said.

"They don't plan to press for eviction as a remedy and I don't think there's ever been a court that has seriously considered eviction," said John Dossett, general counsel for the National Congress of American Indians, a Washington, D.C.-based advocacy group for tribal governments. "I think that homeowners can rest easy."

At the same time, however, tribal authorities said they were in the market for more land. The nation's reservation is an 11-square-mile parcel south of Syracuse. Joseph J. Heath, an attorney who represents the Onondaga Nation, said if the court rules in the tribe's favor, he expected that settlement talks with the state to follow, including discussions about expanding the nation's reservation and protecting ancestral burial grounds threatened by development.

Mr. Heath said the tribe would try to buy land only from "willing sellers" and the government.

Still, Mr. Heath and other tribal representatives emphasized that the tribe's main intent was to gain more influence over state environmental policy and push for environmental cleanups in their region. "They're sick of being ignored on environmental issues," Mr. Heath said.

The tribe's elders have discussed filing suit for more than 50 years, they said in interviews yesterday. But as the pollution in the lake increased -- and their own population expanded -- they felt compelled to take legal action.

Decades of industrial dumping left a layer of toxic sludge on the lake bottom and drove the federal government to place it on the Superfund list of toxic waste sites in 1994. Last November, state regulators announced a plan to require Honeywell International to conduct a $448 million cleanup of the lake, including extensive dredging of the lake bottom to remove much of the 165,000 pounds of mercury and other toxins that have collected there.

Honeywell is one of five companies named in the Onondaga lawsuit. It is responsible for the cleanup because in 1999 it merged with Allied Chemical, which owned a plant that was accused of being one of the lake's main polluters.

The Onondagas have called the cleanup plan inadequate and say the state was legally obligated to consult with the tribe's chiefs but did not.

Mr. Alhart, the governor's spokesman, rejected the nation's assertion that the state was being lax on the cleanup of Lake Onondaga or that it had ignored the nation.

The lawsuit also names four other companies that operate a gravel mine, limestone quarry and coal-burning power plant in the region. In the lawsuit, the Onondagas also named Clark Concrete Company and a subsidiary, Valley Realty Development, which own a gravel mine in Tully, N.Y.

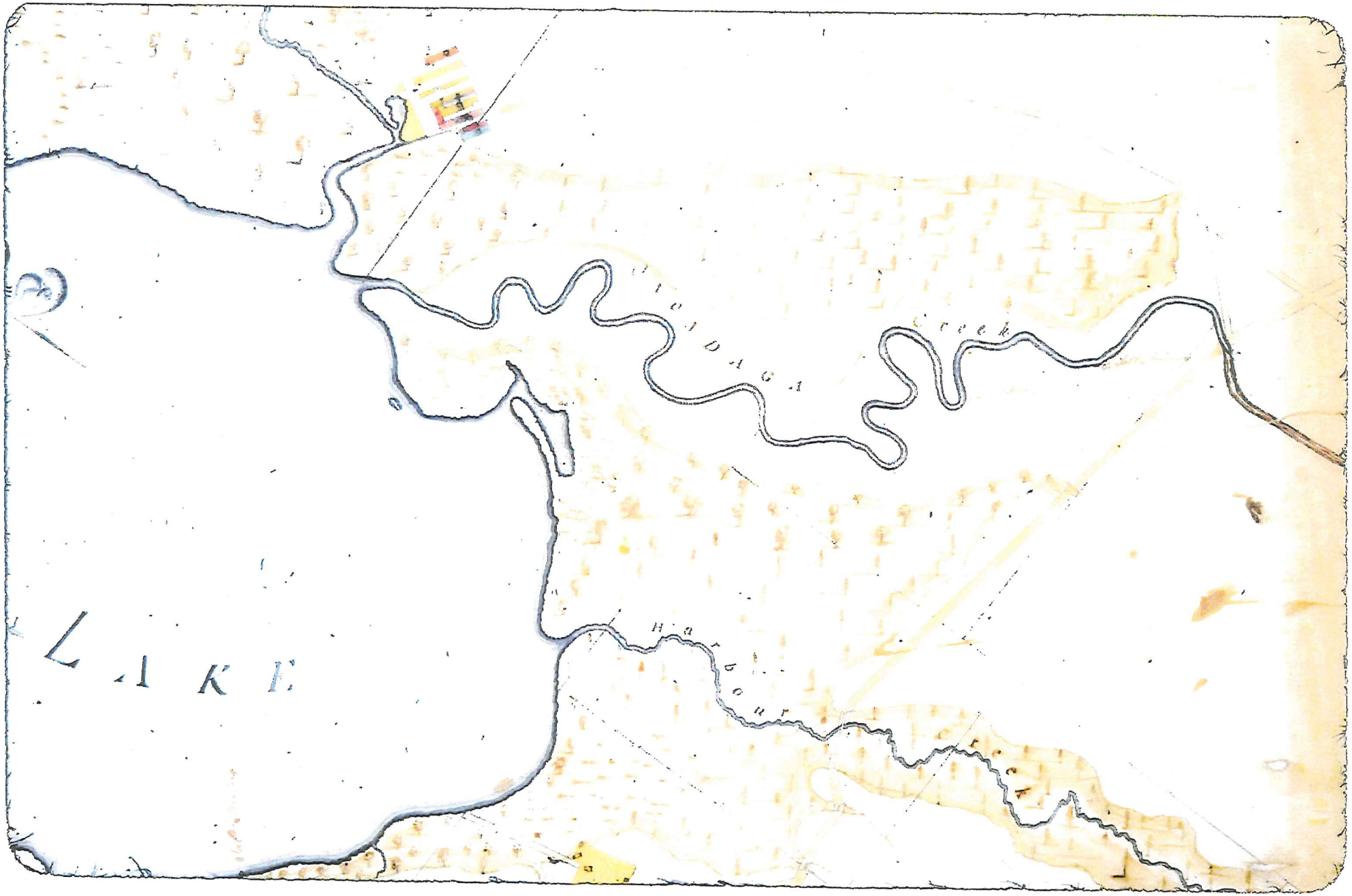
The nation has accused the mine of polluting the Onondaga Creek, which runs into the lake. The nation also named Hanson Aggregates North America, the owners of a limestone quarry in DeWitt, and Trigen Syracuse Energy Corporation, a coal-burning power plant in Geddes.

Attempts made late yesterday to reach officials with those companies were unsuccessful.

Tribal representatives said yesterday that they were not seeking a casino as part of a settlement of the claim. Casinos are a central component of five Indian land claim settlement agreements that Gov. George Pataki announced in recent months.

Photo: The Onondaga tribe says that New York illegally acquired land that includes Syracuse; it wants a court to declare that it still holds title to the land. (Photo by Michael J. Okoniewski for The New York Times)(pg. B4)

Map of New York State highlighting Onondaga Indian Reservation and land claimed in recent lawsuit: The Onondaga Indian Reservation is an 11-square-mile parcel. (pg. B1)


LAKE
Onondaga
Creek
Harbour

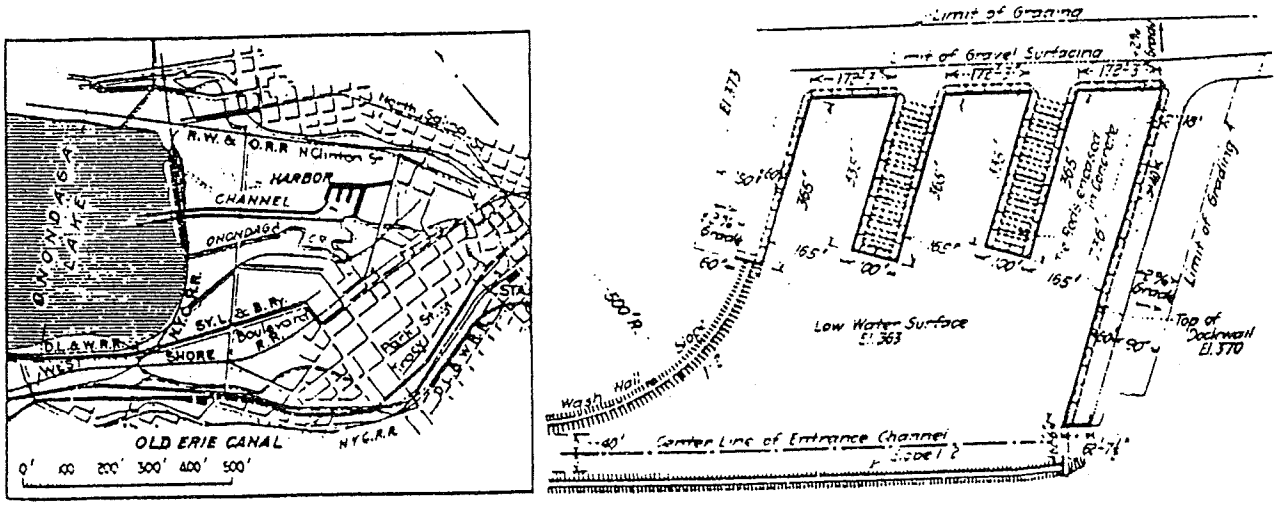
Syracuse Canal Terminal Built Over Old Salt Works

Two Piers with Slips and Turning Basins on Low Ground Used for Many Years for Salt-Drying Tables

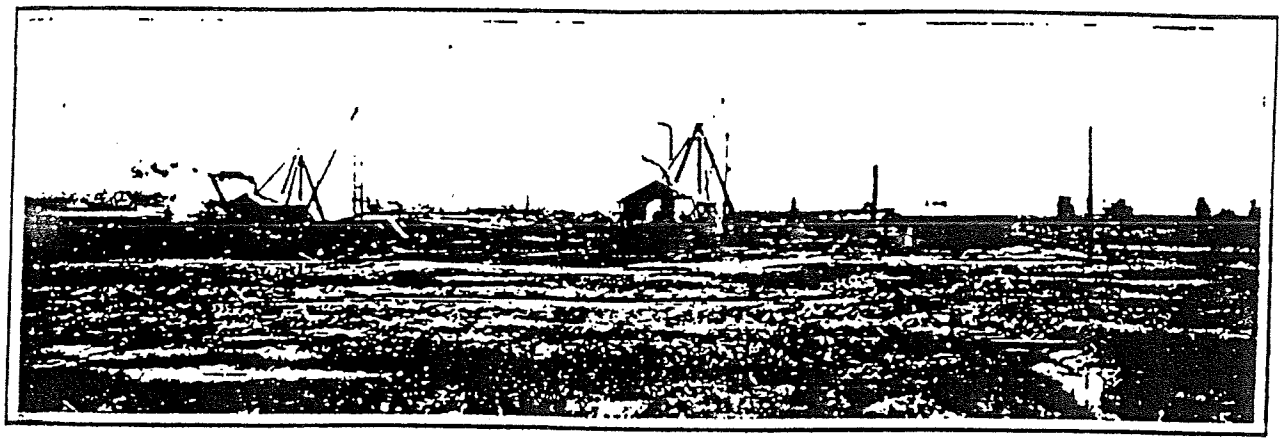
THE TERMINAL piers for the New York State Barge Canal at Syracuse, N. Y., are now being built at the head of Onondaga Lake in the midst of flats which for many years were the site of the long timber sheds where brine pumped from wells was evaporated out into the salt which was one of the city's principal products. These flats were in some previous geological period a part of a lake bed, but low water had let them dry—a large area quite near the city's busiest district given over entirely to the land-wasting brine sheds. Here the new terminal is being dug out of the ground. The lake is being brought, by dredging, up to the dock wall, which will be connected by railway and highway to the rest of the city. It is hoped that in time the whole district will be reclaimed for manufacturing and shipping purposes.

Pier Type of Terminal Here

In the New York State Barge Canal there are two types of terminals. One is a marginal dock wall in a slightly widened waterway section, the other a pier construction where lake or large river area is available. In Syracuse the latter type is being built. The old Erie



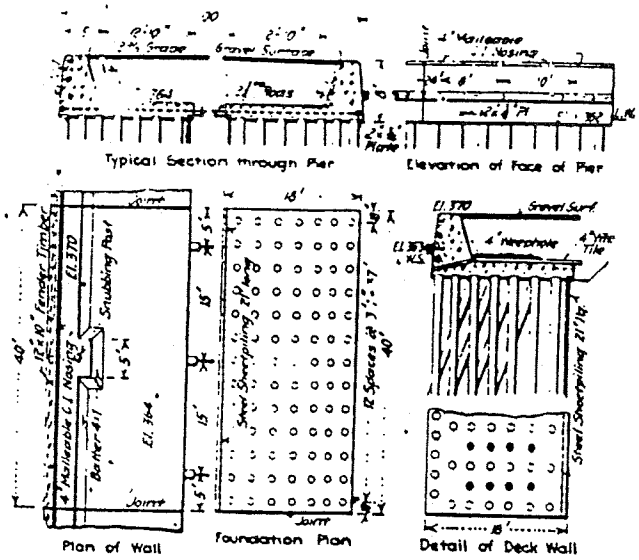
BARGE-CANAL TERMINAL AT SYRACUSE LOCATED NEARLY MILE FROM LAKE



FIRST EXCAVATION WAS MADE ON OLD SALT FLATS

Canal passed through the City of Syracuse. The new Barge Canal main line is several miles north of Syracuse but connection to that city is had through Onondaga Lake to the new terminal being built at its southern end. Here on the flat lands between the various railroads entering the city the terminal channel 80 ft. wide is being excavated for a distance of about 3600 ft. up to the turning basin, which is about a square—800 ft. on the side with a dockwall around three sides from one of which protrudes two piers 350 ft. long, forming in the whole area three 165 x 350-ft. slips and a large basin.

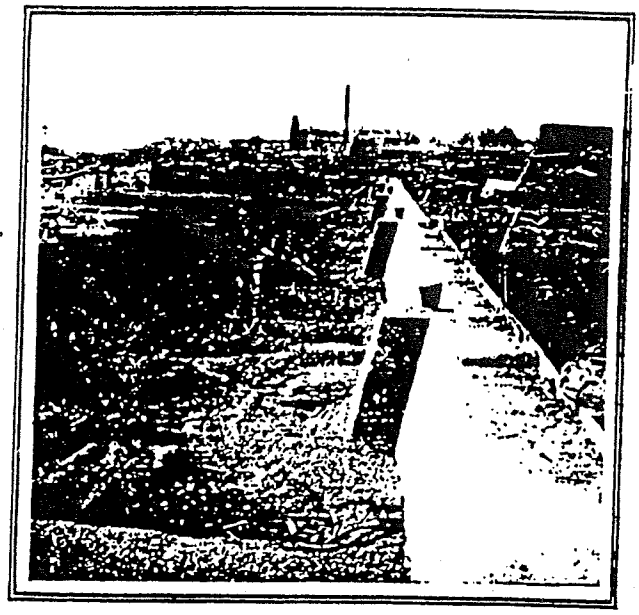
The standard wall construction for dock wall and pier is a gravity section of concrete 3 ft. thick at the top with an outside slope of 12 on 1, and an inside slope of 4 on 1, extending down 8 ft. to a foundation of timber piles, with a backfill up to the level of the wall and a gravel surfacing clear across the pier and for a distance of 60 ft. back of the wall. These walls rest on a concrete floor base 2 ft. thick and 18 ft. wide, which is integral with the wall, and under which the concrete piles are placed. The pier walls, which are 100 ft.



GRAVITY WALLS FOR PIER AND DOCK WALLS

apart throughout, are tied together every 15 ft. by two 1-in. rods with heavy washers at the wall end and turnbuckles for tightening in the middle. The middle section between the floor concrete has been incased in concrete a foot square.

Both the dock and pier walls are in 40-ft. lengths with a straight joint for expansion. Centered in each block, is a snubbing post with a counterfort extension in the concrete wall. The dock wall has a similar design to the pier walls, except that there is no tie rod and



GRAVITY WALL COMPLETE BEFORE SLIP WAS EXCAVATED

there are, in addition, three batter piles to help take the inclined thrust.

There is on the inner face of the wall flooring a continuous line of steel sheet-piles 21 ft. long, which were used in making the wall floor excavation but which are left in place cut off so that they extend a short way into the concrete floor. The piers and the ground for 60 ft. back from the dock wall are floored with gravel surfacing 6 in. thick. From there back a distance of 90 ft. the natural surface is to be graded off to a 2% grade to El. 373, which is 10 ft. above low-water surface, the top of the dock and pier wall being at El. 370. The channel, as in all the Barge Canal, is 12 ft. deep.

When the contractor entered the site it was covered with dilapidated salt-drying sheds founded on a solid

and dry formation which was, nevertheless, filled with roots and trees and presented every indication of having been a marsh before drying out. As shown on the general map this was nearly a mile from the lake shore. The pier and dock walls were first excavated between rows of steel sheet-piling limiting the outer and inner faces of the wall floors. Ordinary Lackawanna steel sheet-piling was first used for this, but it was found to be insufficient to stand the earth pressure when excavated so the arch web type of the same sheet-piling was substituted with very satisfactory results. These piles were driven on the 18-ft. spacing clear around the limits of the wall, and excavation made with clamshell to grade, the clamshell operating on a simple derrick mounted on tracks, which were moved across the site as needed. One view shows the site at the early part of the work, and the other is taken looking along one of the completed walls after the stone had been placed just behind the wall.

This wall construction was completed this spring, and the gravel fill for the flooring is now being placed. At the same time a hydraulic dredge was brought up Onondaga Lake and is proceeding to dig a channel across the flats to the basin. It will be noticed that these flats are the original bed of Onondaga Creek, which will now empty into the turning basin and thence through the channel to the lake. There will be about 1,000,000 cu.yd. of excavation in the whole job.

The terminal was designed and is being built under the direction of the New York State Engineer, Frank M. Williams, with T. B. LaDu, Special Deputy State Engineer, in charge of terminal work. The contract is being carried out under the direction of Guy Moulton, Division Engineer, by the Walsh Construction Co.

0 0.5 1 km

Orthoimagery taken in 2003

Integrating Complex Site Conditions into Remedial Design: Onondaga Lake and Upland Sites

As part of the ongoing effort to clean up and restore Onondaga Lake, a feasibility study (FS) was completed by Parsons for Honeywell to evaluate the various alternatives for remediating the Lake. The FS was an extensive scientific evaluation involving many technical consultants and national experts. The result was a three volume document consisting of six sections and 14 appendices that addressed each of the technical concerns related to the Lake. In order to account for the variability of site conditions throughout the Lake, eight sediment management units (SMUs) were established based on a variety of physical and chemical parameters (Figure 1). The SMUs were utilized as a framework to develop the lake remedy based on the site conditions and concerns in each SMU.

The technical details related to issues such as sediment stability, resuspension, consolidation, erosion, and groundwater migration were integrated into each of the applicable FS evaluations. Unique local conditions, such as the presence of natural halite brine beneath the Lake, provided another level of complexity to the FS process. The nature of the local site conditions in the Onondaga Lake area made this an extensive and complex task that required a large team several years to complete.

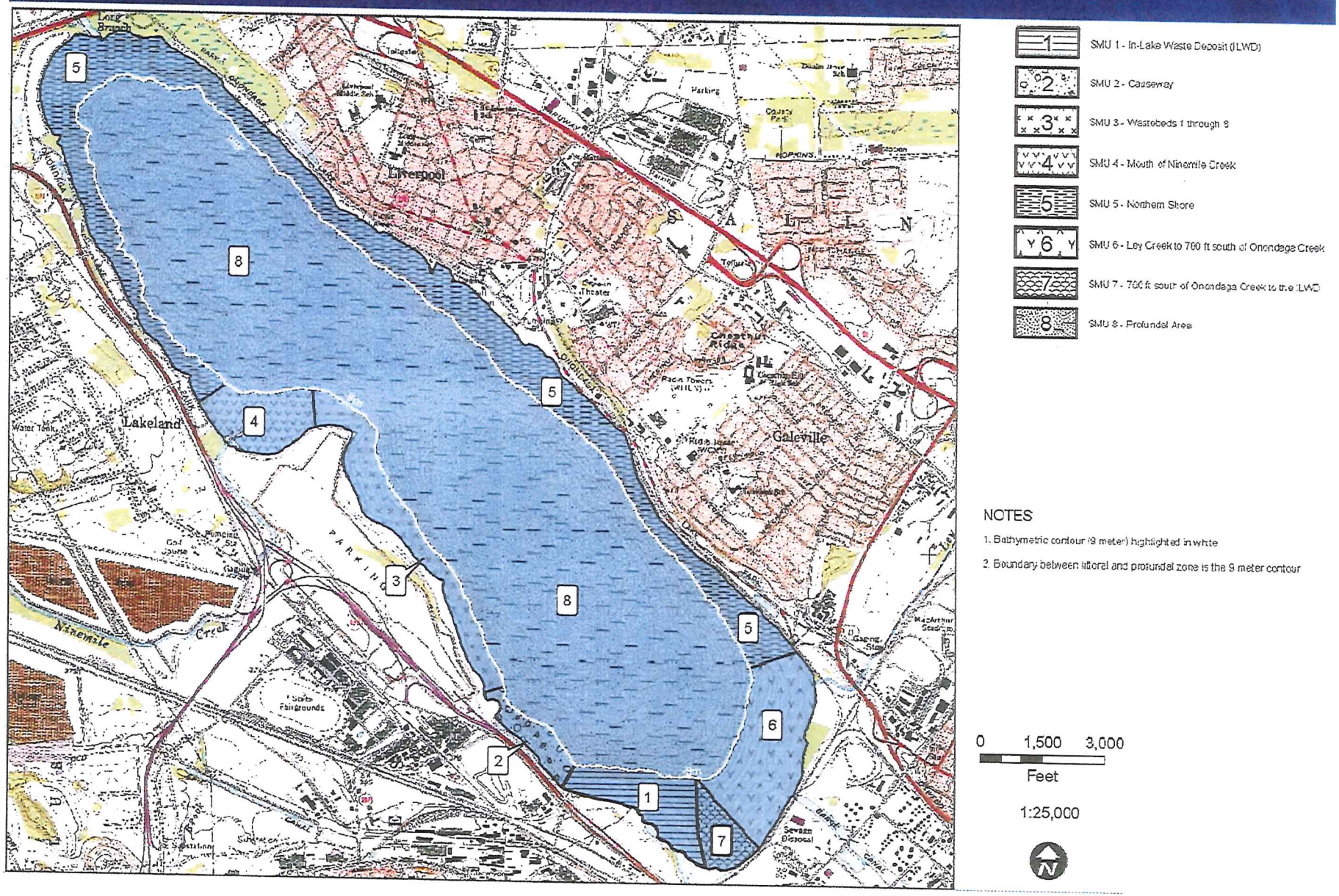
The FS was submitted to the New York State Department of Environmental Conservation (NYSDEC) in November 2004. Following receipt of the FS, the NYSDEC released their Proposed Plan (PP) for cleaning up the Lake to the public for review and comment. The main components of the remedy include dredging and capping of impacted sediments, hydraulic containment systems along portions of the shoreline, monitored natural recovery, aeration/oxygenation of deep portions of the lake, and habitat optimization. The proposed locations of remedial activities are outlined on Figure 2. The public comment period for the PP is complete and a Record of Decision (ROD) is expected from the agencies in July 2005.

In order to facilitate an effective remedy in Onondaga Lake, several of the upland sites adjacent to the lake must be addressed prior to any lake remediation. For example, the Willis Avenue site, which is located adjacent to SMU 2, contains impacted groundwater and dense non-aqueous phase liquid (DNAPL) beneath the ground surface.

An Interim Remedial Measure (IRM) is currently being designed for this site and will include a hydraulic containment system near the shoreline of the lake to contain DNAPL and impacted groundwater. The containment system consists of a barrier wall and drain in the shallow/intermediate zone (~50 ft) and groundwater extraction wells in the deep zone (~90 ft). Figure 3 displays a cross section of the geology in this area and details of the hydraulic containment system.

The important formations to note on this figure are the silt and clay unit and the deep sand and gravel unit. The presence of silt and clay allows for the barrier wall to be keyed into a low hydraulic conductivity layer to ensure groundwater is not moving into the Lake. The sand and gravel layer is a highly permeable unit, but displays a small amount of flow due to the hydraulic conditions in the area. However, deep extraction from this unit will be required in order to contain the impacted groundwater at depth. The presence and distribution of these glacial deposits plays an intricate role in the design of remedial activities in and adjacent to Onondaga Lake.

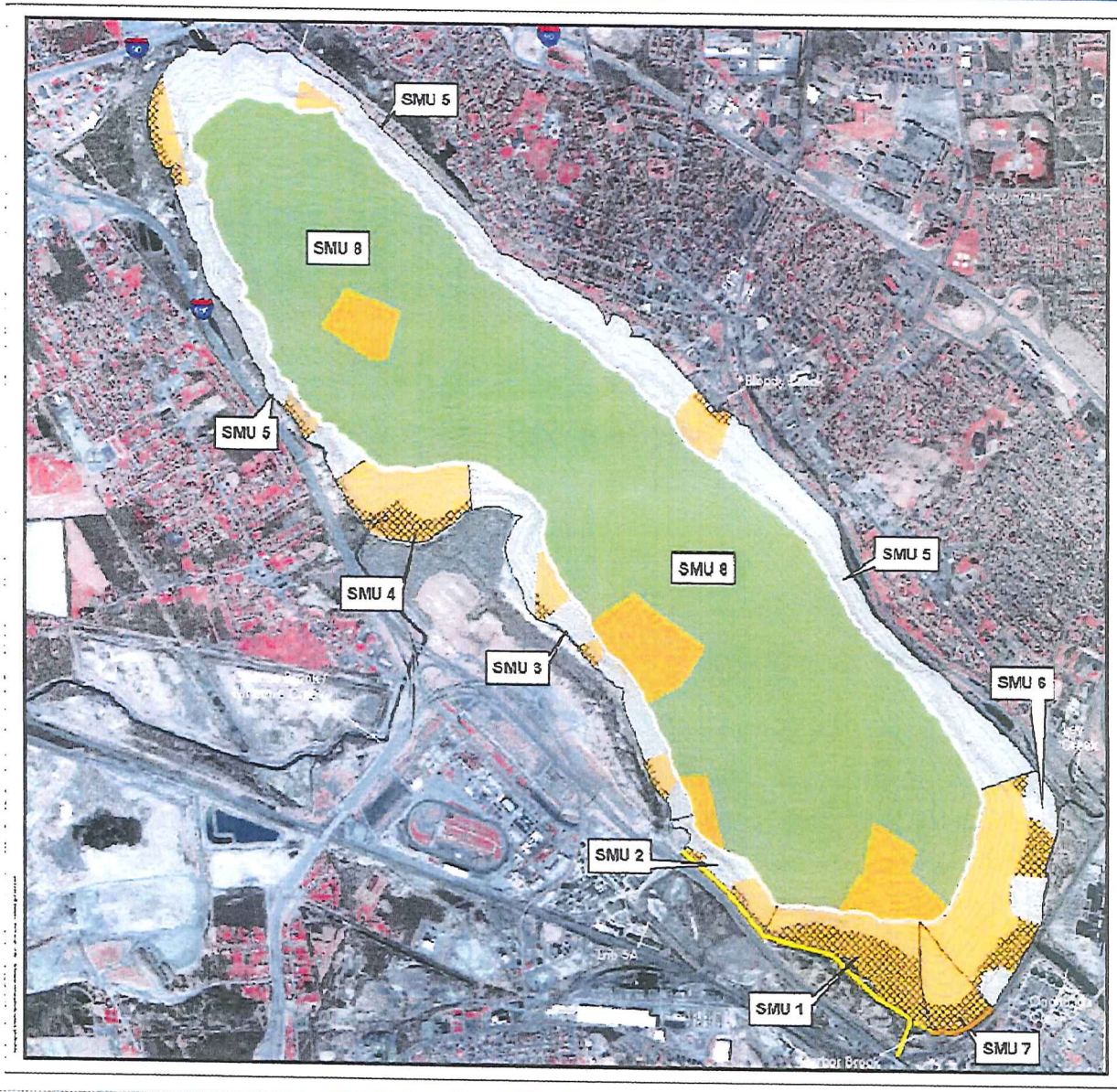
Figure 1: Sediment Management Units (SMUs)



NOTES

1. Bathymetric contour (9 meter) highlighted in white
2. Boundary between littoral and profundal zone is the 9 meter contour

Figure 2: Proposed Plan



Littoral Areas Not Requiring Remediation

Isolation Capping

Thin Layer Capping

Areas to be Dredged

Profundal Area Monitored Natural Recovery and Aeration

SMU 7 Barrier Wall (Location is Conceptual)

Willis/Semel-Wastebed B/Harbor Brook Barrier Wall (Part of Interim Remedial Measure, Location is Conceptual. Dashed Section to be determined as part of design.)

NOTES

1. Profundal bathymetric boundary at 30 ft (9m) highlighted in white
2. Boundary between SMUs shown as black line
3. Bathymetric contours are at 1-meter intervals based on current bathymetry
4. SMU = Sediment Management Unit

N

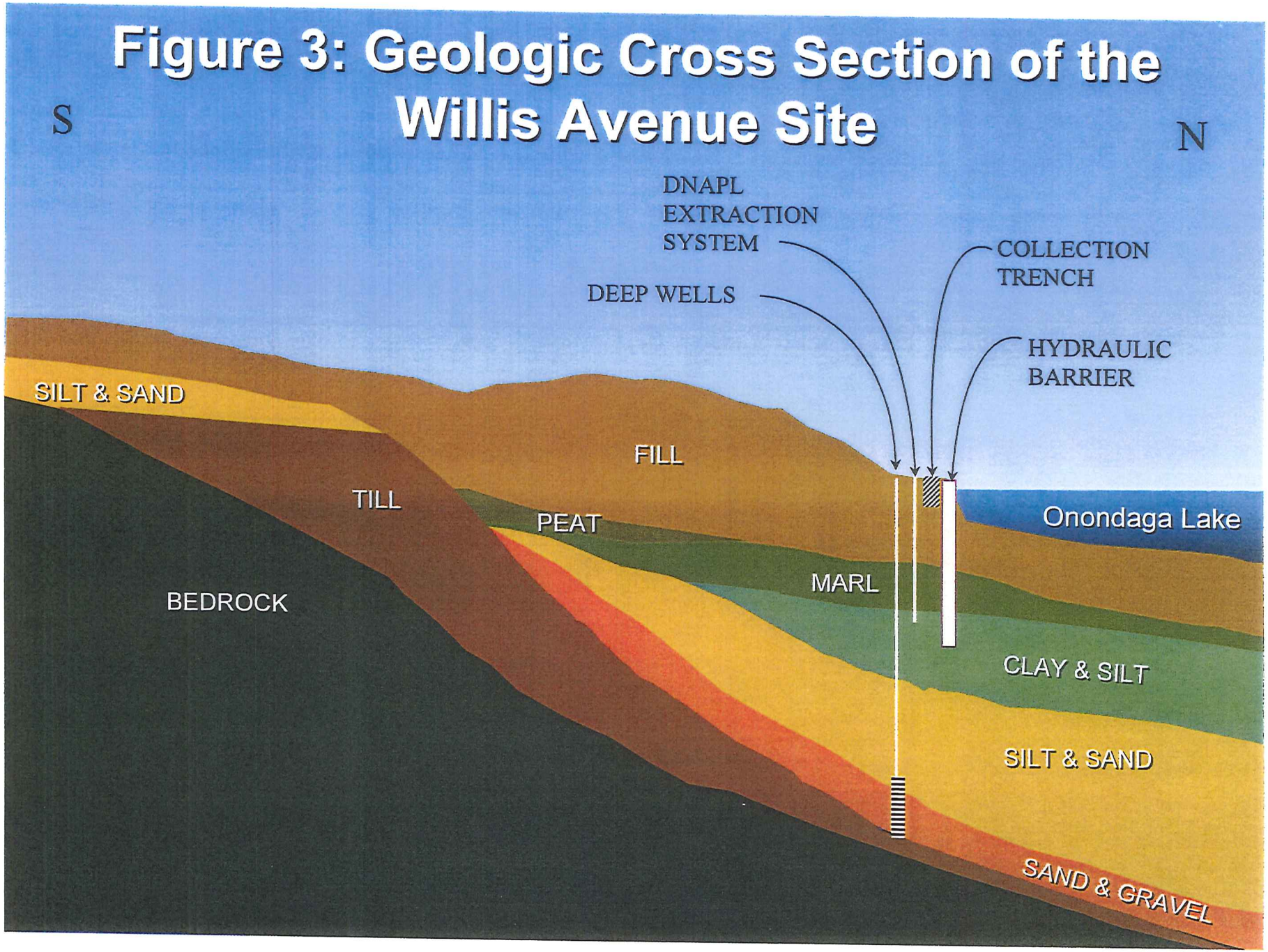
2,700 1,350 0 2,700

Feet

NYSDEC Preferred Remedy

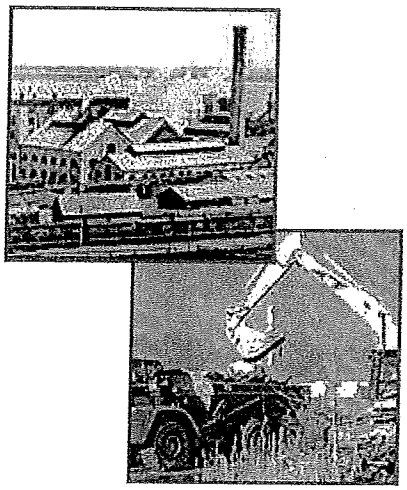
Onondaga Lake
Syracuse, New York

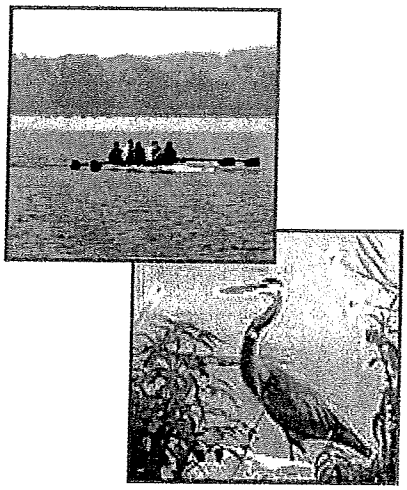
Figure 3: Geologic Cross Section of the Willis Avenue Site



SYRACUSE AREA REMEDIATION PROGRESS

Honeywell





Click here to learn how Honeywell is removing a debris dam from Nine Mile Creek to improve access to Onondaga Lake for canoes and kayaks. April 26, 2005

On November 29, 2004 the New York State Department of Environmental Conservation (DEC) released its proposed plan for the cleanup of Onondaga Lake. The public has had the opportunity to learn more about the specifics of the plan and submit comments during DEC's public comment period, which ended March 1, 2005. For a look at the plan in its entirety, visit **www.dec.state.ny.us/website/der/projects/ondlake/** .

Honeywell and DEC share the same goal - to implement a cleanup that protects human health and the environment. The United States Environmental Protection Agency's (EPA) National Remedy Review Board (NRRB) has reviewed the proposed plan and will soon provide its comments and recommendations. The NRRB is an EPA peer review group that reviews Superfund cleanup plans. According to the DEC, a Record of Decision (ROD) will be issued on April 1, 2005.

DEC's current proposed plan is based in part on a three-volume study called a Feasibility Study (or FS) that Honeywell submitted in May 2004 in response to the agency's request and resubmitted with additional information in November 2004. DEC's plan calls for a combined dredging/capping remedy generally in line with the approach recommended in the FS. The primary difference between the DEC plan and the FS is the volume of sediment that would be removed from the southern shoreline of the lake. The DEC plan calls for the removal of up to 2.65 million cubic yards of sediment, while the FS plan calls for the removal of more than 500,000 cubic yards of sediment.

The FS reflects more than 12 years of scientific analysis and engineering studies that evaluated a wide range of cleanup options. Deciding on an environmentally sound course of action required more than 90,000 hours of analysis by more than 100 national and local experts.

The cleanup plan in the FS is a comprehensive remedy designed to:

- protect human health and the environment,
- meet the performance criteria established by EPA,
- improve the habitat for fish and wildlife,
- improve recreational opportunities and expand public access to the lake,
- and create the conditions allowing, over time, for the lake's natural recovery.

We remain committed to working with the state to finalize an approach and implement an appropriate remedy.

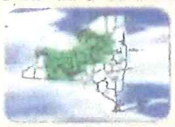
Click Here to view a summary Fact Sheet (2 pages) of the highlights of the FS.

Click Here to view the full Executive Summary of the FS (17 pages).

http://www.onondaga-lake-initiatives.com/

USGS
science for a changing world

FL-LOWPA



Finger Lakes - Lake Ontario Watershed Protection Alliance

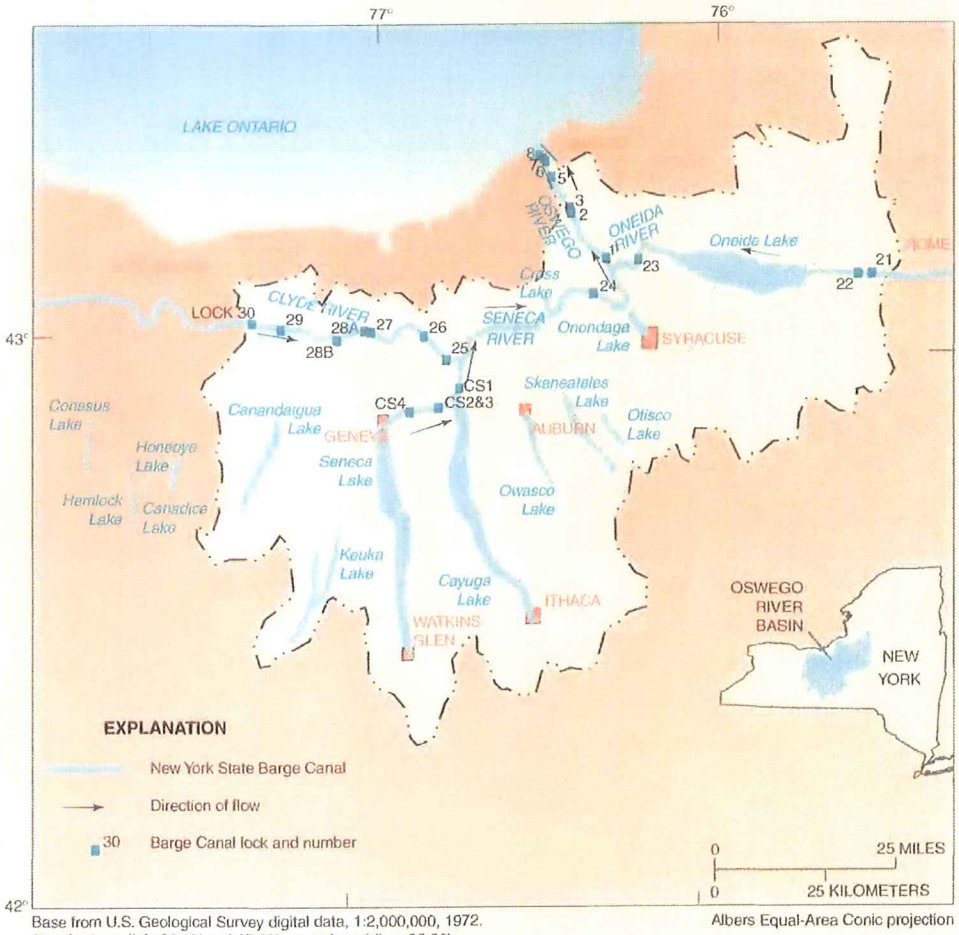
Managing the Water Resources of the Oswego River Basin in Central New York

INTRODUCTION

The Oswego River Basin in central New York State contains a diverse system of streams, lakes, and canals. Water flows from upland streams to the Finger Lakes, then to low-gradient rivers, which are part of the New York State Barge Canal, and ultimately to Lake Ontario (fig. 1). Although natural and man-made components of this hydrologic system are known, how the system functions and how the components interact are not completely understood. This Fact Sheet is a result of a shared interest on the part of U.S. Geological Survey (USGS) and Finger Lakes-Lake Ontario Watershed Protection Alliance (FL-LOWPA) in facilitating public understanding and discussion of the complex Oswego River Basin and its water-resource-management issues.

PHYSIOGRAPHY OF THE OSWEGO RIVER BASIN

The Oswego River Basin has an area of 5,100 square miles and encompasses three physiographic provinces — the Appalachian Plateau, the Tug Hill Plateau, and the Lake Ontario Plain (fig. 2). One additional geographic area that plays a vital role in the flow regime of the Basin is the Clyde/Seneca River-Oneida Lake Trough, a belt of lowlands running west-to-east through which the Barge Canal flows. The trough is key to understanding the Oswego River Basin flow system — its natural and human-altered "plumbing".



Base from U.S. Geological Survey digital data, 1:2,000,000, 1972. Standard parallels 29 30' and 45 30', central meridian -96 00'.

Albers Equal-Area Conic projection

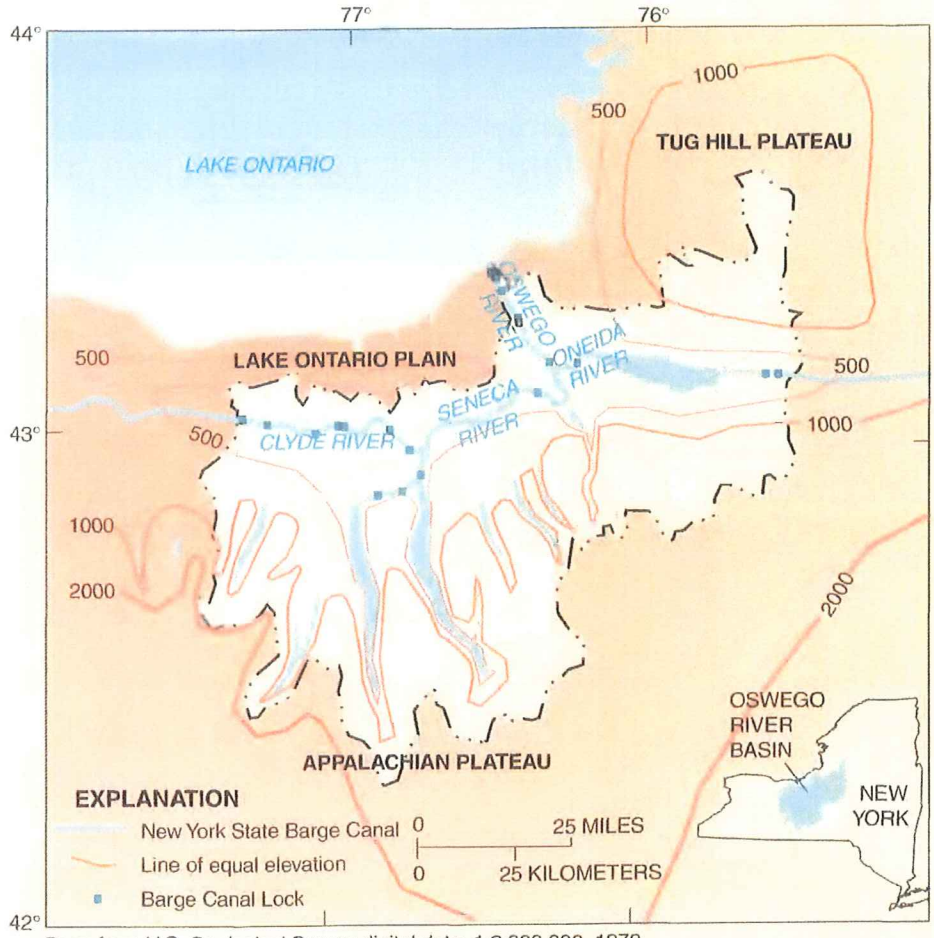
Figure 1. Location of major lakes and rivers, New York State Barge Canal, and major cities within the Oswego River Basin in Central New York

U.S. Department of the Interior
U.S. Geological Survey

Fact Sheet FS 180-99
March 2000

Clyde/Seneca River-Oneida Lake Trough

The trough is a product of regional geology and glaciation. During and after the last Ice Age (ending about 14,000 years ago), glaciers carved-out erodible shales that lie between the Lockport Dolomite bedrock "ridge" to the north of the trough and Onondaga Limestone bedrock "ridge" that forms the northern edge of the Appalachian Plateau to the south. The trough was subsequently filled with mixtures of clay, silt, sand, and gravel from the receding glacier. The result was a flat, low-lying area with many square miles of wetlands, some of which are now farmed as muckland. The New York State Barge Canal was constructed within the trough because the gradient is exceptionally low. The Canal's surface elevation drops only 23 feet in 60 miles along the main stem between Locks 27 and 24. Before construction of the canal in the early 1800's, the gradient averaged about 0.4 feet per mile; with the canal, the water-surface elevation changes in steps at each of the locks. The low gradient poses a challenge to water-resources management because the natural and man-made gradient inhibits the rapid movement of large volumes of water.



Base from U.S. Geological Survey digital data, 1:2,000,000, 1972.
Standard parallels 29 30' and 45 30', central meridian -96 00'.

Figure 2. Physiographic provinces of the Oswego River Basin and generalized land-surface elevation

Effect of the Trough on Basin Drainage

Surface water and ground water in the Oswego River Basin flows from upland watersheds to rivers and lakes and then to the trough containing the main stem of the New York State Barge Canal. As illustrated in figure 3, water flows from the outlet of Keuka Lake to Seneca Lake, with a change in elevation of about 270 feet, and from Seneca Lake to Cayuga Lake with an elevation change of about 60 feet, then from Cayuga Lake to the Barge Canal through the Mudlock gate-structure where the fall is only 9 feet. During some major storm-runoff periods, the water-surface elevation in the Barge Canal near Montezuma (just downstream from the Cayuga Lake outlet) has exceeded the water-surface elevation in Cayuga Lake; and if the Mudlock gates had been open, water would have flowed from the Barge Canal into Cayuga Lake.

The area near Montezuma receives about 48 percent of the runoff from the Oswego River Basin's 5,100 square miles. Further downstream (to the east), the canal receives additional water from the Owasco, Skaneateles, and Otisco Lake watersheds, which, like Canandaigua Lake to the west, are at higher elevations and drain readily to the trough. Similarly, the uplands around Oneida Lake drain to the eastern end of the trough from the surrounding watershed, and the additive contribution of these lake outflows to the Barge Canal results in a "bottleneck" at Three Rivers junction (the confluence of the Seneca, Oneida, and Oswego Rivers). This junction receives water from 96 percent of the Oswego River Basin but is within the flattest, slowest-moving reach of the Barge Canal and the Oswego River Basin. At times, inflow to the trough exceeds the channel capacity and causes flooding within Seneca, Cayuga, and Oneida Lakes and along the Seneca and Oneida Rivers. The gradient in the Oswego River, downstream of Fulton, increases markedly to 118 feet in 29 miles (4 feet per mile), and allows the water to flow more readily toward Lake Ontario.

NOT A FLOODPLAIN PROBLEM, BUT A WATERSHED CONSIDERATION

The amount of water that enters any Finger Lake from a storm depends on local watershed conditions. For example, when soils are saturated or frozen in the Cayuga Lake watershed, for every inch of water that falls on the watershed and runs off to the lake, the lake level increases by one foot within 1 to 2 days, but once in the lake, this amount of water can take a week or more to fully drain to the Barge Canal because the lake level can be lowered by only a tenth of a foot per day due to the low gradient of the Seneca River/Barge Canal and the difference in elevation between the River and Cayuga Lake. The natural drainage within this basin, with its cumulative, rapidly flowing upland discharges and a slowly draining outflow, poses difficulties for water-level management. The New York State Barge Canal Corporation uses "control points" within the Oswego Basin to monitor and manage water levels. The management strategies of this system have been controversial for nearly a century because the users desire differing water-level-management results. Reaching resolution is not simple, nor is any decision favorable to all.

Most water-resource problems within the Oswego River Basin (or any other basin) tend to be looked upon as local water-level issues, property issues, water-quality issues or single-use issues. The first responsibility and challenge to water-resource managers and users is to view all issues within the context of basin-wide management. Only when the focus is on the entire system will the basin residents be able to define reasonable goals and work toward them.

Thus, water level, water-quantity, or water-quality problems within the Basin need to be considered on a watershed basis, rather than as isolated problems along a particular stretch of river or lake. As an example, an upland farmer might install drain tile to remove water from his fields so that he can work the fields earlier in the season. This common practice can cause more water to flow into a nearby roadside ditch, and prompt the town highway department to deepen the ditch. The increased flow from the ditch now could increase erosion and possibly cause a downstream culvert to clog and cause localized flooding. The town replaces the culvert with a larger one, allowing more water to move through more quickly. This in turn could erode denuded road banks, and carry enlarged sediment loads to a river or lake where the sediment is deposited as an alluvial fan that clogs the mouth of the stream and may cause flooding of nearby property. The town then excavates this sediment and removes more than was deposited to avoid the need to reexcavate in the near future. This over excavation can begin a process of stream erosion that may spread upstream into the watershed, causing further erosion of streambed and the streambanks. In this hypothetical example, each individual action benefits the local situation, but the cumulative effect alters stream conditions in the watershed, and can cause a natural process of erosion and(or) deposition, which may be viewed in a detrimental way from some perspectives. Whenever a stream is disturbed locally, it needs time to restore its gradient and streambank conditions, and if the disturbance (natural or man-made) is large enough, the watershed can be affected well beyond the initially-affected area, and can take a decade or more to reach a new equilibrium.

LIMITATIONS IN WEATHER FORECASTING AND UNDERSTANDING CLIMATE VARIABILITY

Today's forecasting "skill" or accuracy in predicting a precipitation amount is accurate to only about 2 days into the future. The accuracy of extended forecasts (beyond 2 days) diminishes sharply thereafter; only the probability of precipitation (as a percent) is given and the amount is not predicted. Seasonal (3- to 4-month) forecasts are highly generalized, and are given only in terms of wetter (or drier) or hotter (or cooler) than the long-term norm or average condition. Management of a region's water resources, especially those within a complex system such as the Oswego River Basin, is difficult with only a 2-day lead time for specific weather information.

Longer term weather and climate conditions, incorporating the concepts of global warming and climatic variability, must rely on long-term records of the earth's climate; but systematic records only extend to 100 years ago or less. One means of extending the record farther back in time is through dendrochronology (the study of tree rings). Studies in forests in the northeastern United States indicate that precipitation and air temperature variability followed a generally calm, cyclic pattern between 1890 and 1960, with relatively few departures from the norm, but have departed from this cycle in the form of droughts, floods, and periods of extremely cold or extremely warm temperatures more frequently since the 1960's. The mid-1960's were characterized by drought, whereas 1993 and 1996 were extremely wet with heavy seasonal precipitation and rapid snowmelt. The recent, more erratic weather might be an aberration, but tree-ring data for the 1700's and 1800's indicate many departures from the norms of the 1890-1960 period.

WATER-QUALITY CONSIDERATIONS

The seemingly erratic weather patterns of recent decades may, in fact, be more typical for the Oswego River Basin than the period of relative calm between 1890 and 1960. One implication of this possibility is that watershed systems will be more difficult to manage in the near future than before 1960. Our relatively short record of local rainfall and runoff conditions, therefore, is not a reliable indicator of future weather, nor of the resultant lake levels, or river-flow conditions.

Water quality in the Finger Lakes is suitable for most uses with minimal treatment, but it cannot be assumed to remain so indefinitely. The introduction of zebra mussels (a non-native species) has led to an increase in the clarity of the water, but increased clarity does not necessarily imply diminished pollution. About 20 cities, towns, and villages within the Oswego River Basin use the Finger Lakes as a drinking-water source, and nearly the same number use the lakes for disposal of treated wastewater. Nutrients and pesticides have been detected in all of the Finger Lakes, although at concentrations below current drinking-water standards. The quality of water entering and moving through the Oswego River Basin is adversely affected by other human activities as well, and the resulting contamination can diminish the suitability of these water resources for certain uses. The phrase "we all live downstream" is a reminder to all that our actions can affect others.

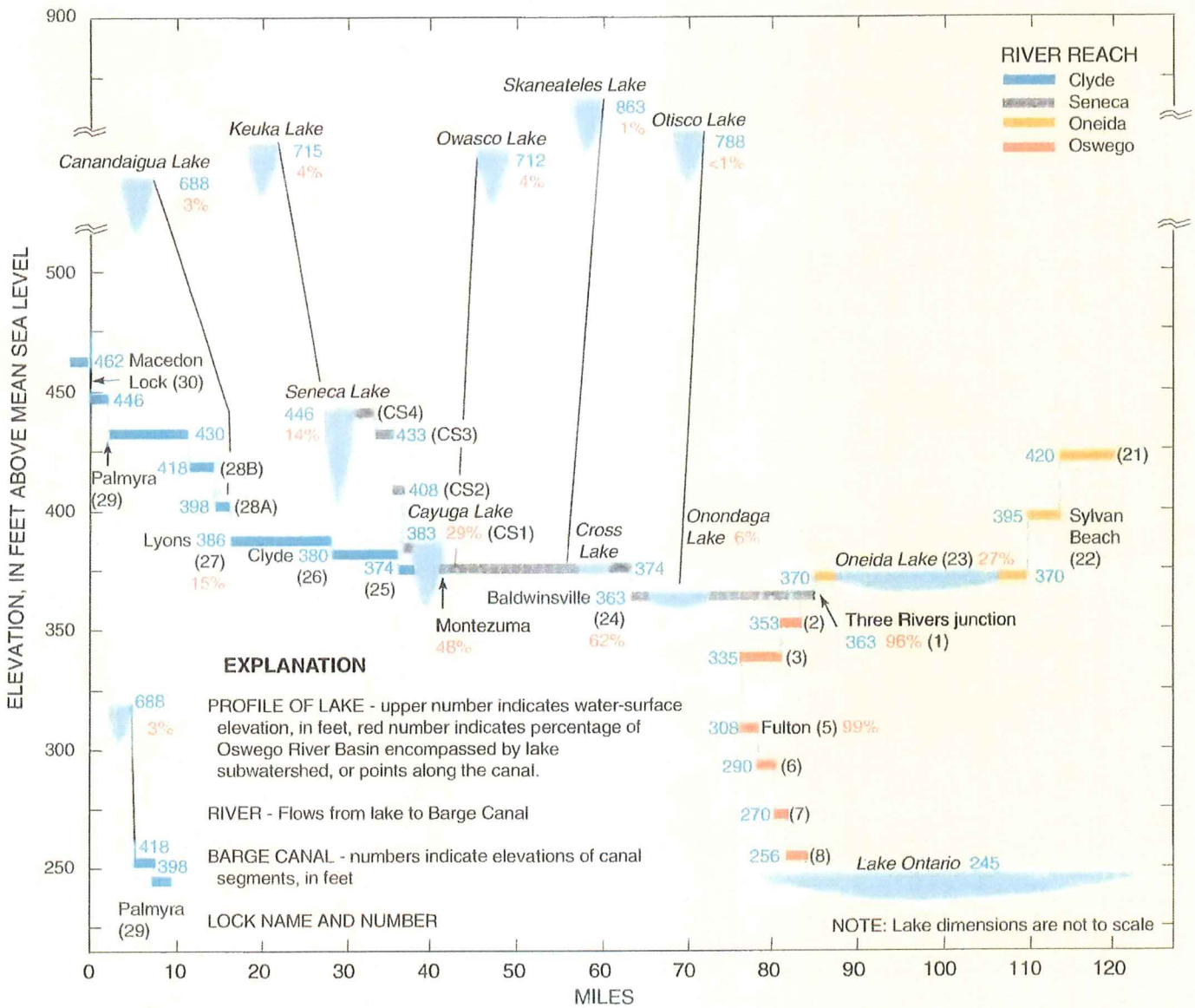


Figure 3. Relative lake and lock positions, water-surface elevations, and percentage of Oswego River Basin occcupied by selected lake and canal watersheds. (Locations shown in fig. 1).

Q & A

WHAT CAN BE DONE TO IMPROVE WATER RESOURCES?

Managing the water resources of the Oswego River Basin is a daunting task, but some steps that can be taken to improve these resources are:

1. UNDERSTAND THE CONCEPT OF WATERSHED PROCESS -

Everyone, from the upland farmer to the lakeside landowner, lives in a watershed. Thus, everyone's actions affect the quality and quantity of the water resource. The adverse effects of human activities can be minimized within the watershed, but only with resolve to meet clearly-defined watershed goals. Conditions within the natural system are in a state of perpetual change, and man has only a limited ability to alter them. Although the effects of some extreme-weather conditions may be reduced, they cannot be eliminated.

2. INVOLVE THE PUBLIC -

Educate the public in the watershed process, and involve the residents of the basin (stakeholders) in planning, management, and goal setting. Encourage individuals to plan and manage their properties as part of a larger watershed system.

3. ENSURE THAT LOCAL ACTIONS CONFORM TO BASINWIDE WATER-MANAGEMENT OBJECTIVES -

Set basinwide water-management goals before imposing local objectives or solutions. Address local problems within the context of total watershed management.

4. DEVELOP GOALS THAT ARE CONSISTENT WITH THE "REAL WORLD" -

Explore whether the proposed goals are realistic and consistent with the basin's hydrologic characteristics, climate and precipitation variability, and canal hydraulics.

5. REALIZE THE POTENTIAL AND LIMITATIONS OF WATERSHED MANAGEMENT -

Watershed hydrology and canal hydraulics can be simulated by computer models that, when calibrated and verified with sufficient data, can be used to develop and refine water-management strategies and to define our limitations in manipulating our water resources.

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FACING CHALLENGES IN THE OSWEGO RIVER BASIN

Establishing Goals and Priorities in Water-Resource Management

The Finger Lakes - Lake Ontario Watershed Protection Alliance (FL-LOWPA) sponsored a policy dialogue forum on water-level management in the Oswego River Basin on September 16, 1997. Stakeholders, including representatives from Federal, State, and County agencies, municipalities, businesses, and citizen associations, were invited to participate. The goals for the forum were intentionally modest: (1) to identify and clarify stakeholder interests in the management of water levels in the Oswego River Basin; (2) to reach agreement on a set of key issues; and (3) to reach consensus on the primary steps to address key issues.

Forty-four participants represented an even balance among various stakeholders and perspectives. Several presentations provided an overview of the hydrology of the Oswego River Basin, the current management scenario, and an administrative model (Susquehanna River Basin Commission) for river-basin management and conflict resolution. Seven key issues or needs were identified through facilitated discussions and small work groups. These included enhancing:

1. Public education (about hydrology and human effects on a watershed).
2. Data gathering, sharing, and synthesis (Information is commonly inadequate and dispersed).
3. Coordination of watershed-management goals and activities.
4. Flood mitigation through land-use planning.
5. Trust among stakeholders (The need to use credible sources of information and structured processes to facilitate discussion).
6. Emergency response to flooding (through monitoring, media involvement, duplicating procedures that have been successful in the past, and coordination among agencies and sharing responsibilities).
7. Natural-resource and water-quality protection (by assessing the current status of these resources, setting priorities, and securing financial support to maintain and protect these resources).

Participants identified initial steps toward resolving some key issues. Together, the steps suggested a useful approach, while realizing that no single step or group can attain the objectives alone. Participants agreed that a continuous, constructive dialogue on the issues is needed.

Co-sponsors for this Fact Sheet include: The Soil and Water Conservation Districts of Oneida, Seneca, Steuben, Tompkins, and Yates Counties; the Water Quality Co-ordinating Committees of Chemung, Oswego, and Schuyler Counties; the Cayuga County Water Quality Management Agency; the Ontario County Water Resources Council; and the Madison County Planning Department.

68th Annual Reunion of the Northeastern Friends of the Pleistocene
May 20 – May 22
Syracuse, New York

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