DREDGING FEASIBILITY REPORT

Chautauqua Lake

Prepared by EcoLogic LLC and
Chautauqua County Department of Planning and Economic Development for
NYS Department of State, Division of Coastal Resources
With funds provided under Title 11 of the Environmental Protection Fund
NYS Comptroller's Contract #C006814

APRIL 2013

EcoLogic

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Acronyms:

AVGWLF – ArcView Generalized Watershed Loading Function

cy – cubic yards

CCPED – Chautauqua County Planning and Economic Development

CLMC – Chautauqua Lake Management Commission

CLWMP – Chautauqua Lake Watershed Management Plan

CSLAP – Citizens Statewide Lake Assessment Program

NYSDEC – New York State Department of Environmental Conservation

PAH – Polycyclic aromatic hydrocarbons

PCB – Polychlorinated biphenyls

PWL – Priority Waterbodies List

SEQRA – New York's State Environmental Quality Review Act

TMDL – Total Maximum Daily Load

TOGS – Technical and Operational Guidance Series

Executive Summary

Sediment is carried into Chautauqua Lake by water flowing across the landscape and through the tributary streams. Erosion of stream banks and beds is a major source of the sediment that has accumulated within the lake basin. The unstable stream channels characteristic of the Chautauqua Lake watershed are a result of several natural features: glacial history—loose, unconsolidated glacial till was left after the retreat of the Wisconsin glacier approximately 10,000 years ago; watershed topography; and the weather—high annual precipitation and a substantial snowpack contribute to spring flooding events (Barton & Loguidice 2012[1]).

Over time, sediment accumulation in some nearshore areas of the Lake has become an impediment to recreational use. Sediment also provides the nutrients and substrate needed to support the growth of aquatic plants (macrophytes), which are prolific in the Lake's littoral area.

Dredging has been suggested by many stakeholders as a means to help mitigate both sedimentation and excessive plant abundance. This Dredging Feasibility Study was initiated to provide a realistic assessment of the costs, benefits, permit requirements, and associated environmental issues associated with dredging selected regions of Chautauqua Lake.

This project began in early 2012, with a compilation and review of existing data followed by design of a focused field program to identify specific regions of the Lake's nearshore zone impaired by excessive sedimentation. During the summer 2012 field program, the EcoLogic team surveyed segments of the littoral zone, tested the quality of the sediments, selected appropriate technologies for sediment removal, and developed unit cost estimates. We also reviewed the regulatory environment, documenting the necessary permits and approvals for implementing a dredging program.

The field survey confirmed that the nearshore littoral zone supports a mixture of high quality undisturbed aquatic habitat interspersed with areas affected by sediment deposition. Nearshore regions where sedimentation affects recreational access and navigational use are primarily associated with the mouths of the Lake tributaries. An on-line public opinion survey was developed to help identify priority areas where sedimentation has had the most significant adverse impact, and supplemented this effort with personal interviews. In total, there were 95 responses to the public opinion survey; these responses revealed broad agreement that excessive sedimentation affects recreational and navigational access to nearshore areas of Chautauqua Lake. In addition, most respondents reported concerns that conditions are degrading over time. When asked to identify areas of the Lake they consider to be most impaired, a majority of respondents named Burtis Bay. Overall, depositional areas at the mouths of Goose Creek, Mud Creek, Dutch Hollow Creek, and Bemus Point, in addition to the Celoron/Burtis Bay area, were considered to be the highest priority regions.

[1] Barton and Loguidice. October 2012. *Watershed and Stream Assessment: Report of Findings Goose Creek/Dutch Hollow Creek Watersheds.* Report to CCPED

Once priority areas were established, the project team completed bathymetric surveys (maps of sediment depth) in the priority areas. These data were used to estimate the volume of sediment removal needed in order to restore the impaired navigational and recreational access. Further, we collected sediment cores in the five priority areas, and submitted the sediment for laboratory analysis to determine texture (particle size distribution) and chemical quality of the deposited material. Results indicate that, with the exception of the Celoron/Burtis Bay area, deposited sediments meet the NYSDEC Class A limits for indicator chemicals. Class A sediments are considered suitable for unrestricted disposal, and pose no risk of harm to the aquatic ecosystem. Sediments collected in the Celoron/Burtis Bay area exhibited elevated levels of arsenic, and did not meet Class A standards. Sediments in this region of the Lake are considered to be "moderately contaminated", Class B. Additional safeguards would be required during the removal, dewatering, and ultimate disposal for Class B sediments. The physical data indicate that sediments are primarily fine-grained materials, silts and clay-sized particles.

As the next task, engineers and scientists estimated the volume of sediment that would need to be removed from the priority areas in order to restore the impaired uses. We made a series of assumptions regarding the target depth of overlying water to be attained, and the surface area to be dredged. These data were coupled with the results of the bathymetric survey to estimate the volume of deposited material to be removed. We estimated the minimum volume of sediment removal to restore navigational access as follows: 4,200 cubic yards (cy) from the mouth of Dutch Hollow Creek, 26,000 cy from the mouth of Goose Creek, 18,000 cy from the mouth of Mud Creek, 20,000 cy from the Bemus Creek/ Bemus Point area, and 30,000 cy from Celoron/ Burtis Bay. The Greenhurst Point deposit was estimated at approximately 28,000 cy.

One of the major challenges associated with a dredging project is the identification of areas for sediment handling, which can include dewatering, and identifying viable strategies for ultimate disposal or reuse. In collaboration with Chautauqua County Planning and Economic Development (CCPED), land parcels were identified in the vicinity of each priority site that might be suitable for sediment management activities based on size, topography, proximity, access, current land use and vegetative cover. These parcels were used to determine technical feasibility and impact on operational costs. To date, no landowners have been approached in regards to the potential utilization of identified parcels.

Preliminary cost estimates (the engineer's opinion of cost) have been developed for this feasibility study. The cost estimate considers using hydraulic dredging, with the slurry of water and sediment pumped into geotubes for dewatering, for the majority of the dredging activities. We also included a realistic contingency for mobilization and demobilization, site restoration, and treatment of water exuded from the geotubes. A second dewatering technique is the use of mechanical dewatering equipment. This approach may reduce the land area required for the dewatering operation, and would therefore improve the feasibility of selecting a sediment management area to accommodate dredging in the Bemus Creek/Bemus Point region, where the shoreline is densely developed. Mechanical dredging is also recommended for the Celoron/Burtis Bay area, in order to reduce the total volume of arsenic-contaminated soil and water that requires handling, treatment and disposal.

The total cost for sediment removal in the priority areas is estimated at ten million dollars. A significant portion of this cost is associated with dredging in the Celoron/Burtis Bay area because of the elevated arsenic levels associated with sediments in this region of southern Chautauqua Lake. These sediments will require special handling and have fewer disposal options.

A number of regulatory permits and approvals would be required before a dredging project in Chautauqua Lake could proceed. These approvals encompass federal, state and local resource management agencies. The DEC has several significant concerns that must be addressed prior to dredging Greenhurst Point. The State Environmental Quality Review Act (SEQRA) sets forth the structured requirements for data gathering and communication among stakeholders. These requirements are detailed in the Feasibility Report.

Finally, we note the connection between the many initiatives underway as the implementation phase of the Chautauqua Lake Watershed Management Plan moves forward. The most effective way to prevent sediment deposition in nearshore areas of Chautauqua Lake is to control sediment conveyance from the watershed. Concurrent with this dredging feasibility study, CCPED is directing an engineering project in two tributary subwatersheds, Goose Creek and Dutch Hollow Creek. The objective of the engineering study, which is being conducted by Barton & Loguidice P.C., is to identify, prioritize, and develop conceptual remediation designs for erosional impacts within these two tributary watersheds.

1. Introduction

1.1. Problem Statement

Chautauqua Lake is a regionally important lake in western New York, serving as the primary cultural and recreational attraction of Chautauqua County. The Lake supports renowned fisheries, most notably the cool water species muskellunge and walleye, and is a major tourist destination. The Lake has a significant positive impact on the local economy, attracting visitors and boosting local property values.

Excessive sedimentation has gradually affected the Lake ecosystem; sediment alters aquatic habitat and interferes with human recreational access. In addition to making the Lake shallower, thus expanding littoral habitat, sediment contains nutrients that support the growth of rooted aquatic vegetation. Dense macrophytes further interfere with recreational use and diminish the Lake's aesthetic value.

The CCPED and partners are working to identify sources and implement remedial measures that will reduce erosion within the Chautauqua Lake watershed. Although these remedial measures will slow the rate of future sediment deposition, they will not mitigate sediment already deposited in nearshore areas. This Dredging Feasibility Study was initiated to provide a realistic assessment of whether dredging is a feasible remedial measure for restoring impaired recreational uses of the Lake.

1.2. Purpose

The purpose of the Dredging Feasibility Study is to evaluate the technical feasibility, costs, environmental risks and benefits, and permitting issues associated with sediment dredging in selected areas of Chautauqua Lake.

1.3. Scope

The Town of Ellicot was awarded a grant from the New York Department of State, Division of Coastal Resources Local Waterfront Revitalization Program to help support a Dredging Feasibility Study for Chautauqua Lake. The feasibility study examines the costs, potential benefits, environmental considerations and permitting issues associated with removing sediment from nearshore areas of Chautauqua Lake as a means to restore impaired navigational and recreational uses. EcoLogic LLC of Cazenovia, NY was selected to work with the Chautauqua County Department of Planning & Economic Development (CCPED) and the Chautauqua Lake Management Commission (CLMC) to complete the dredging feasibility evaluation.

EcoLogic supplemented the team with specialists from two professional firms to complete the Chautauqua Lake Dredging Feasibility Study. Anchor QEA has expertise in lake sediment assessment; we used this firm to complete the sediment coring and nearshore bathymetric surveying of priority areas. In addition, we worked with Don Lake (DuLac Engineering) to identify and evaluate specific sites that might be used as sediment management areas.

The team approached the assignment by completing a series of specific tasks designed to evaluate the need for dredging, the amount and quality of material to be removed, and the potential impacts of this lake improvement project. These tasks are listed below.

- Assess the current conditions of the nearshore (littoral) zone of the Lake, focusing on aquatic habitat and areas of sediment deposition.
- Survey the public for their opinions regarding whether, to what extent, and where sediment deposition has affected their use and enjoyment of Chautauqua Lake.
- In consultation with CCPED and CLMC, identify five priority areas where excessive sedimentation is having the most severe impact on navigational and recreational access to the Lake.
- Complete bathymetric surveys (maps of sediment depth) in the five priority areas.
- Collect sediment cores in the five priority areas, and submit the sediment for laboratory analysis to determine texture (particle size distribution) and chemical quality of the deposited material.
- Estimate the volume of sediment that would need to be removed from the priority areas in order to restore the impaired uses.
- Identify sites (land parcels) in the vicinity of the priority sites that might be suitable for sediment management activities (i.e., dewatering) based on size, topography, proximity, access and existing land use.
- Estimate the costs associated with dredging.
- Compile information regarding the necessary regulatory permits and approvals needed for dredging areas of Chautauqua Lake.
- Coordinate with other work efforts underway in the Chautauqua Lake watershed to identify preventative measures (best management practices) that will reduce erosion and sedimentation in the future.

The findings of the tasks, all completed in 2012, provide the data and information used to complete this report.

1.4. Relationship to Other Chautauqua Lake Initiatives

The dredging feasibility study is one of many significant efforts underway to implement the recommendations of the Chautauqua Lake Watershed Management Plan (CLWMP)[2], finalized in September 2010. While the CLWMP includes many specific recommendations, the efforts initiated in 2012 address some of the high priority actions for work within the Lake and its watershed.

In addition to this dredging feasibility study, Barton & Loguidice is developing detailed plans for stream stabilization in two Chautauqua Lake subwatersheds, Dutch Hollow and Goose Creek. A third firm, Cedar Eden, is working on a Submerged Aquatic Vegetation Management Plan for the Lake. These three major 2012 investigations are managed and coordinated by Jeffery Diers, Chautauqua Lake Watershed Coordinator, Don McCord, CCPED Senior Planner, and Mark Geise, CCPED Deputy Director.

[2] Bergmann Associates, 2010. Chautauqua Lake Watershed Management Plan.

2. Environmental Setting

2.1. Chautauqua Lake Watershed

The Chautauqua Lake Watershed Management Plan, CLWMP (Bergmann Associates 2010) summarizes the nature of the watershed: topography and soils, hydrology, land use, vegetative cover, population and development trends, and point and nonpoint sources of nutrients and sediment affecting the Lake. The CLWMP identifies certain subwatersheds as contributing disproportionate amounts of sediment to the Lake; these subwatersheds are characterized by the presence of highly erodible soils adjacent to the stream corridor (the riparian zone). Site-specific, detailed evaluations of measures to prevent sediment loss from the landscape, and erosion of stream banks and beds, are recommended. In addition, the CLWMP recommends revisions to local zoning codes and stormwater management policies and practices. A significant focus of the watershed management plan is prevention--how to modify both the natural and built environments in ways that minimize future sediment loss.

In contrast, this dredging feasibility study is a lake restoration project. Legacy sediments—materials that have eroded from the landscape over a period of decades or centuries—have impaired the navigational and recreational uses of the Lake. The focus of this report is on appropriate methods and costs associated with sediment removal. However, prior to the discussion of dredging, we include this chapter to summarize the Lake's geologic history, current conditions, history of dredging, and economic importance to Chautauqua County.

2.2. Chautauqua Lake

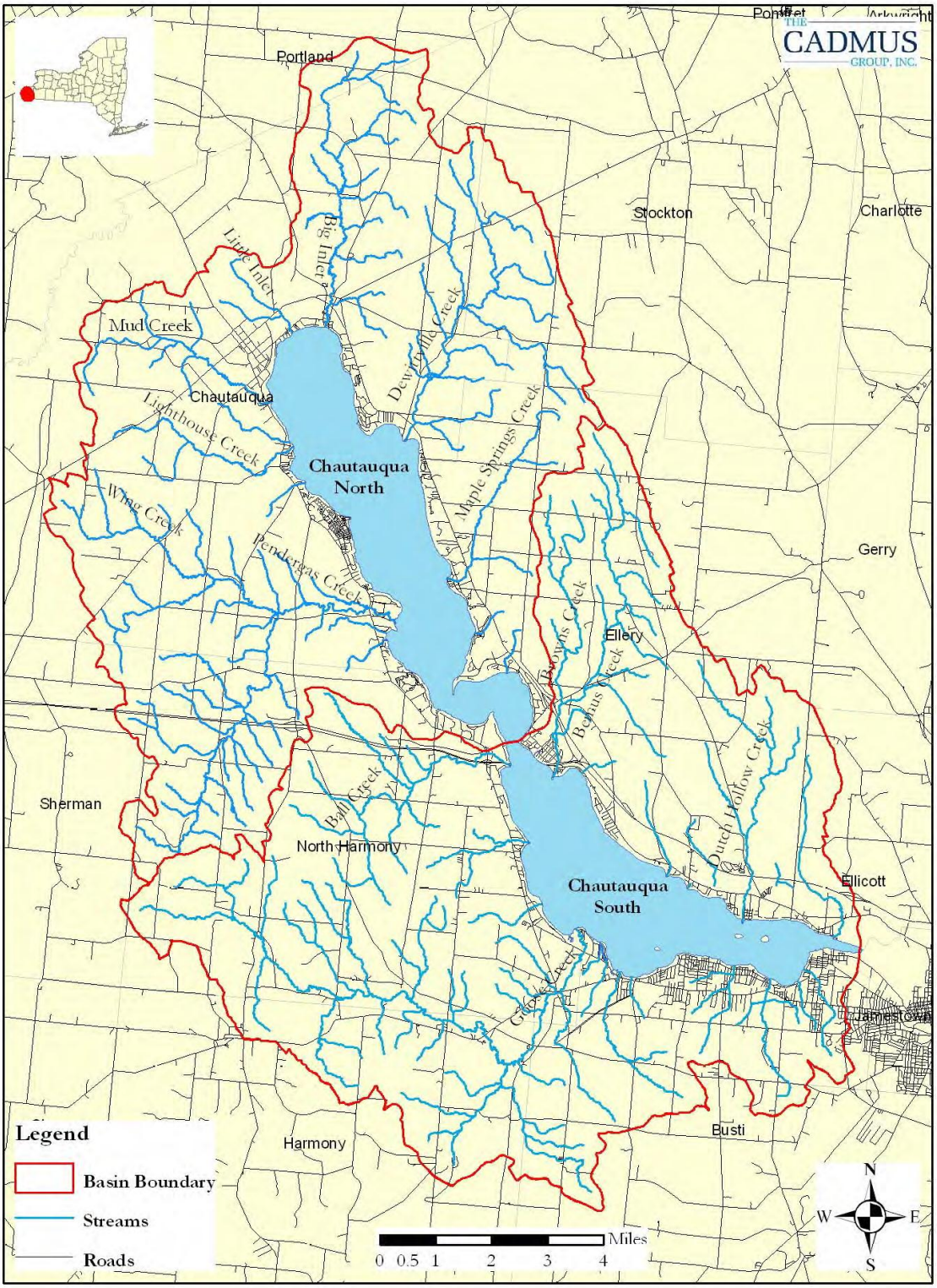
Chautauqua Lake occupies a shallow, glacially-carved valley in southwestern New York. The Lake was formed by the retreating Wisconsin glacier during the last ice age, between 10,000 and 12,000 years ago. Water was first impounded behind a deposit (moraine) near the current City of Jamestown. As the ice continued to melt, advancing the edge of the glacier northward, a second moraine was deposited in the Bemus-Stow area. Water impounded behind this deposit formed a second lake to the north as the ice continued to melt. Eventually, glacial meltwater eroded the deposit between the two basins, creating the current lake morphometry (Mayer et al. 1978).

Chautauqua Lake extends over 13,000 acres and is 17 miles long, with 42 miles of shoreline. The Lake water is classified as potable, although taste and odor may be an issue during algal blooms. According to the NYSDEC, some deeper water intakes exhibit elevated concentrations of manganese, which makes the water less desirable due to aesthetic considerations (CSLAP 2010). The Lake behaves limnologically as two distinct water bodies—a northern basin, approximately 7,000 acres in size, and a southern basin, approximately 6,000 acres in size (Table 2-1).

Table 2-1: Chautauqua Lake Morphometry

	Northern Basin	Southern Basin
Length	14.8 km (9.20 mi)	13.1 km (8.14 mi)
Width		
Maximum	3.5 km (2.2 mi)	3.2 km (2.0 mi)
Mean	2.0 km (1.2 mi)	1.9 km (1.2 mi)
Depth		
Maximum	23 m (75 ft.)	6.0 m (20 ft.)
Mean	7.8 m (26 ft.)	3.5 m (11 ft.)
Surface area	2856 ha (7071 acres)	2468 ha (6110 acres)
Volume	$2.23 * 10^8$ m^3	$0.87 * 10^8$ m^3
Length of shoreline	26.4 km	27.4 km
Water residence time	526 days	105 days
Latitude	N 42° 10´	
Longitude	W 79° 24´	
Watershed area	467.5 km^2 (180.5 mi^2)	
Elevation AMSL	399 m (1308 ft.)	

According to Mayer et al. (1978) the southern shallow basin was filled with moraine deposits during the retreat of the glaciers. Approximately 25 to 28 m of post-glacial sediments have been deposited on top of a layer of outwash gravel. The post-glacial sediments are primarily silts and clay-sized particles. The northern basin was not as extensively filled with outwash from the moraine deposits during deglaciation. There are also significant differences in the depth of post-glacial sediment deposits; Mayer et al. (1978) reported that the southern two-thirds of the Lake's northern basin exhibit only a thin layer of modern sediments.



Source: The Cadmus Group, Inc. *TMDL for Phosphorous in Chautauqua Lake*, 2012

Figure 2-1: Map of the Chautauqua Lake Watershed

2.3. History of Dredging

Dredging to improve navigational access has been completed in several regions of Chautauqua Lake, as reported by various sources. However, we were not able to locate a complete chronology of dredging activities that summarizes where, when and how dredging occurred, how much material was removed, and the ultimate fate of the dredged materials.

In 2002, Erlandson[3] reported a historical account of dredging the Chautauqua Lake outlet (Chadakoin River) to improve steamboat navigation. Contracted by New York State, some 188,000 cubic yards of material were removed from the Lake outlet to Fluvanna in the late 1880s. A clamshell excavator was used. Reportedly, the dredge spoils were placed in Burtis Bay. Periodic references to NYS legislative appropriations for dredging within the Lake appear early in the 20th century (for example, appropriations for navigational dredging were included in the NYS legislative records of 1913 and 1917). Dredging has also been completed in some of the canals adjacent to the Lake shoreline, and the most downstream areas of tributary streams. In 1998, it is reported that 11,000 cubic yards of material was removed to deepen Vukote canal to improve navigation and recreational access; dredged material was placed on Town of Busti parkland. Finally, in 2009 approximately 800 cubic yards of material was removed from the mouth of Goose Creek to improve access; dredged material was placed at the North Harmony Town Park.

[3] Erlandson, Tom. "Digging into History: Dredging the Outlet 1887-1891". The 'Shed Sheet. Summer 2002 edition.

3. Sources of Sediment

3.1. Landscape Erosion

One component of the dredging feasibility study is a review of the factors contributing to sediment loss from the landscape. In addition to natural features, such as soils and topography, land use and vegetative cover can have a significant effect on the amount of sediment eroded from the watershed. Two common land uses in the Chautauqua Lake watershed, agriculture and development, have the potential to contribute a disproportionate amount of sediment because of disturbances to the natural vegetative cover and, in the case of developed areas, increased impervious surfaces.

The subwatersheds of Chautauqua Lake vary in the percentage of land currently used for agriculture and residential development (Figure 3-1). These data are from the Chautauqua County GIS land use/property classification files, as reported in Bergmann Associates, 2010.

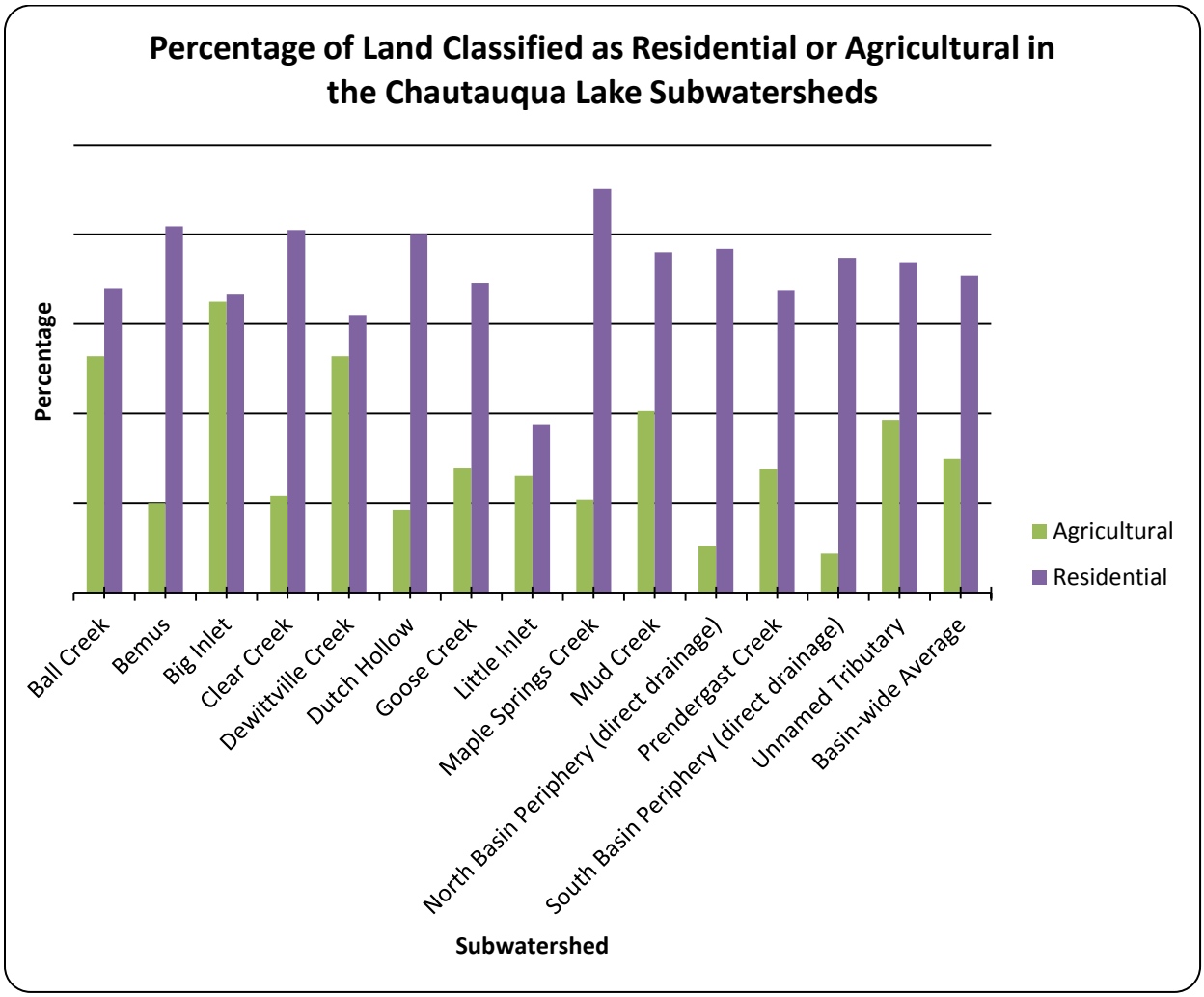


Figure 3-1: Percentage of Land Classified as Residential or Agricultural within the Chautauqua Lake subwatersheds

3.2. Priority Areas

Bergmann Associates applied a mathematical model, the ArcView Generalized Watershed Loading Function (AVGWLF), to estimate the potential export of materials (nutrients and sediment) from the 14 subwatersheds to Chautauqua Lake. As described in the Management Plan, this model integrates natural conditions such as soils, topography, and hydrology, with land use and land cover data for the 14 subwatersheds.

Within the Chautauqua Lake watershed, agriculture (crop and pasture lands), and eroding streambanks comprise the most significant sources of sediment to the Lake. The unit loss of sediment (tons per acre) is highest on transitional lands, such as construction sites. As part of the CLWMP, Bergmann Associates (2010) mapped the erodibility of soil types along a 50 ft. wide buffer of each tributary stream (Figure 3-2). The subwatersheds with the highest percentage of highly erodible soils within this riparian corridor are Big Inlet (46.6%), Mud Creek (40%), and Goose Creek and Ball Creek (27.8% each). The mouths of these subwatersheds and Dutch Hollow Creek were determined to be priority areas for the dredging study; upon input from technical stakeholders, Greenhurst Point was added as a priority area after their review of the draft report.

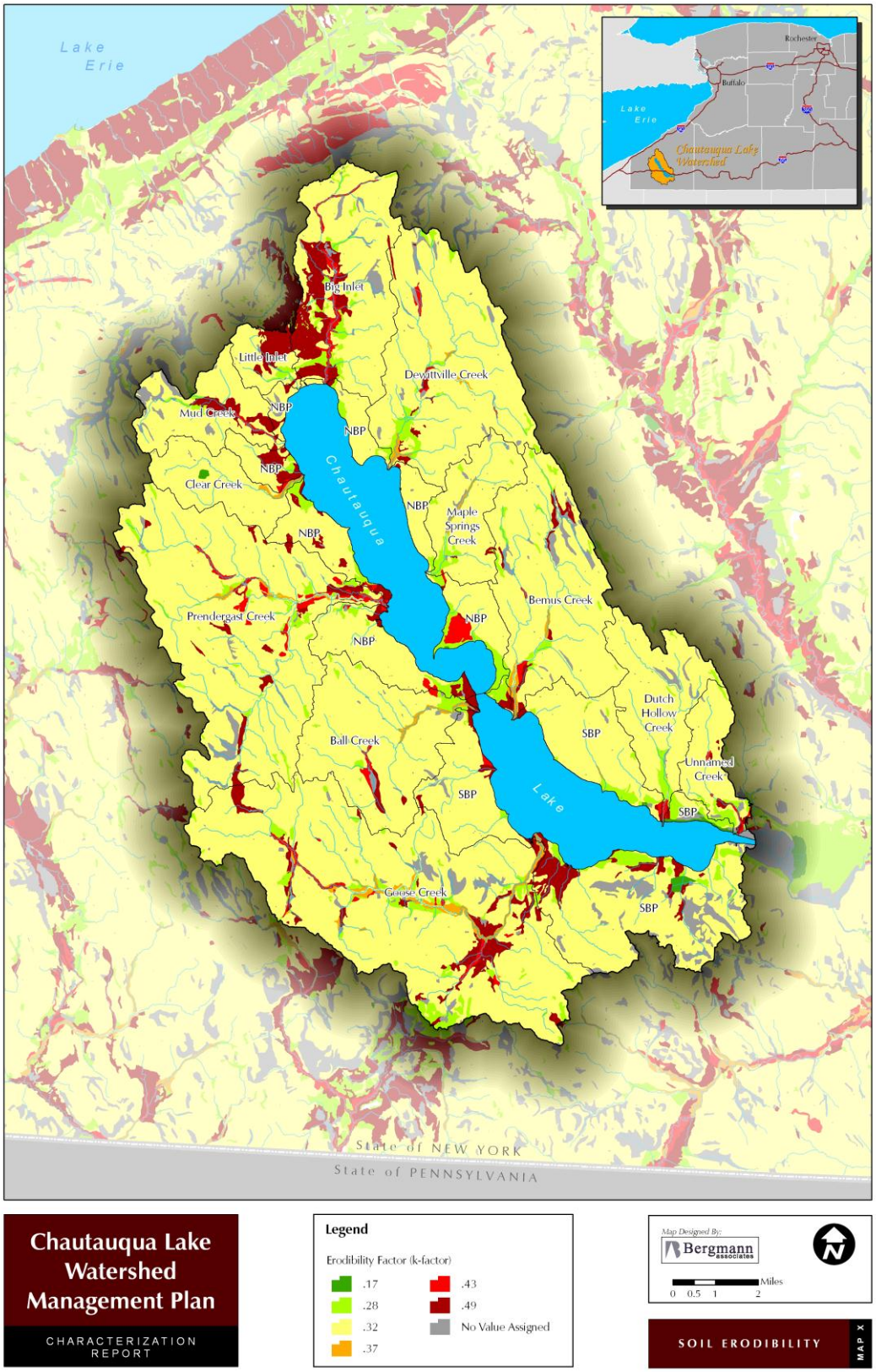


Figure 3-2: Map of Soil Erodibility in the Chautauqua Lake Watershed

4. Use impairment

4.1. Current Regulatory Status

The New York State Department of Environmental Conservation (NYSDEC) classifies waters for their designated best use. Chautauqua Lake is segmented into northern and southern lake basins; both basins are Class A. Part 701.6 of the NYCRR defines the best usages of Class A waters as:

- Source of water supply for drinking, culinary or food processing purposes;
- Primary and secondary contact recreation; and
- Fishing (the waters shall be suitable for fish, shellfish, and wildlife propagation and survival).
- Further, this classification may be given to those waters that, if subjected to approved treatment equal to coagulation, sedimentation, filtration and disinfection, with additional treatment if necessary to remove naturally present impurities, meet or will meet New York State Department of Health drinking water standards and are or will be considered safe and satisfactory for drinking water purposes.

The waters of the state are assessed to determine whether water quality and habitat conditions support the designated use. The assessment process, which gathers information from local stakeholders, results in a statewide listing of priority waterbodies (The Waterbody Inventory/Priority Waterbodies List, or PWL), where the designated uses may not be fully attained. For each of the designated uses (for example, swimming or public water supply), the extent to which the designated uses may not be met is ranked, on a scale ranging from threatened (least severe) to precluded (most severe), as illustrated in Figure 4-21. Metrics for the evaluation are summarized in Table 4-1.

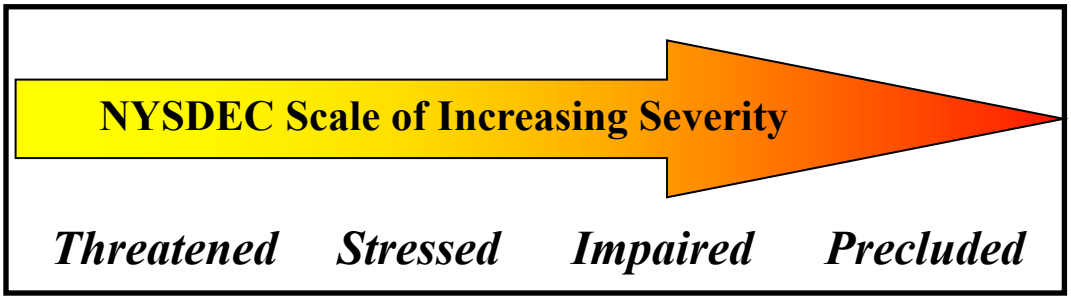


Figure 4-1: Illustration of NYSDEC scale for ranking the conditions of the state's surface waters.

Table 4-1: NYSDEC Assessment of Severity of Use Impairment

Severity	Criteria
Threatened	• Water quality currently supports waterbody uses and the ecosystem exhibits no obvious signs of stress, however *existing or changing land use patterns* may result in restricted use or ecosystem disruption, or; • Monitoring *data reveal increasing contamination* or the presence of toxics below the level of concern, or; • Waterbody uses are not restricted and no water quality problems exist, but the waterbody is a *highly valued resource* deemed worthy of special protection and consideration.
Stressed	Waterbody uses are not significantly limited or restricted, but occasional water quality, or quantity, conditions and/or associated habitat degradation *periodically discourage* the use of the waterbody.
Impaired	• Occasional water quality, or quantity, conditions and/or habitat characteristics *periodically prevent* the use of the waterbody, or; • Waterbody uses are not precluded, but some aspects of the use are *limited* or *restricted*, or; • Waterbody uses are not precluded, but *frequent/persistent* water quality, or quantity, conditions and/or associated habitat degradation *discourage* the use of the waterbody, or; • Support of the waterbody use *requires additional/advanced* measures or treatment.
Precluded	*Frequent/persistent* water quality, or quantity, conditions and/or associated habitat degradation *prevents all aspects* of the waterbody use.

Source: (The New York State Consolidated Assessment and Listing Methodology - Section 305(b) Assessment Methodology., May 2009)

Chautauqua Lake was included on the Alleghany River Basin Priority Waterbodies List, a compendium of waters where the designated uses may not be fully supported. In addition to ranking the severity of the non-attainment, the list denotes the level of data available to support the designation and potential sources of pollution (Table 4-2).

Table 4-2: Chautauqua Lake -- Priority Waterbodies List Status (revised 2006)

Designated use	Attainment status	Documentation	Causal/contributing factors
Recreation	Impaired	Suspected (north) Known (south)	Algal/Weed Growth, Problem Species
Public bathing	Stressed	Suspected (north) Known (south)	Agriculture, Other Source
Habitat/hydrology	Impaired	Suspected (north) Known (south)	Invasive species (Eurasian watermilfoil)
Aesthetics	Stressed	Suspected (north) Known (south)	Nutrients, silt/sediment
Water supply	Threatened	Possible	Metals (arsenic)

In 2004, NYSDEC placed both segments of Chautauqua Lake on its List of Impaired Waterbodies, also known as the 303(d) list, in Part 1 - Individual Waterbody Segments with Impairment Requiring Total Maximum Daily Load (TMDL) Development. The 303(d) list is a compilation of lakes, streams, and coastal

areas where water quality conditions are not adequate to support a designated use. Designated uses may be human-oriented (e.g., water supply, public bathing, recreation, aesthetics) or ecologically-oriented (e.g. fish propagation, fish survival). The term TMDL refers to both the planning process and the outcome; point and nonpoint sources of pollution are identified and a coordinated strategy for reduction is defined.

New York State DEC contractor (Cadmus Group) completed the phosphorus TMDL allocation for Chautauqua Lake[4] in November, 2012. The EPA formally accepted the TMDL on January 31, 2013. As illustrated in Figure 4-2 and Figure 4-3, substantial reductions in phosphorus loading is required from both point and nonpoint sources. Agricultural phosphorus must be reduced more than 80%, and runoff from developed areas must be reduced more than 40%. The larger wastewater treatment facilities will be required to upgrade their level of treatment to provide advanced phosphorus removal.

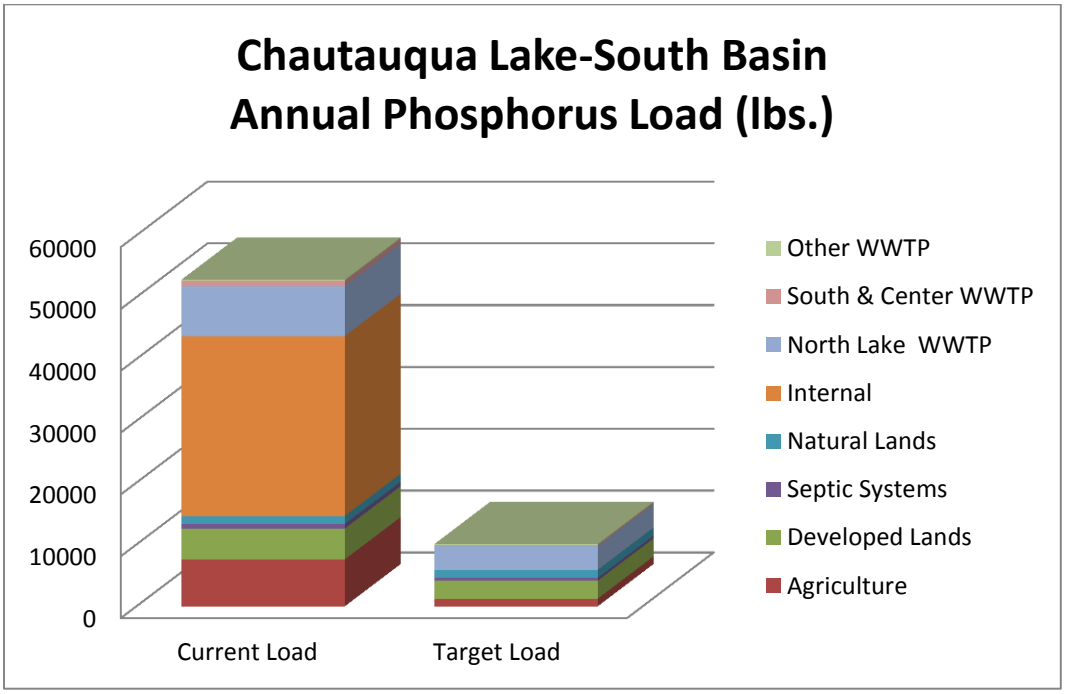


Figure 4-2: Phosphorous TMDL allocation for Chautauqua Lake, South Basin

[4] The phosphorus TMDL for Chautauqua Lake is available on-line at http://www.dec.ny.gov/docs/water_pdf/tmdlchautlk12.pdf

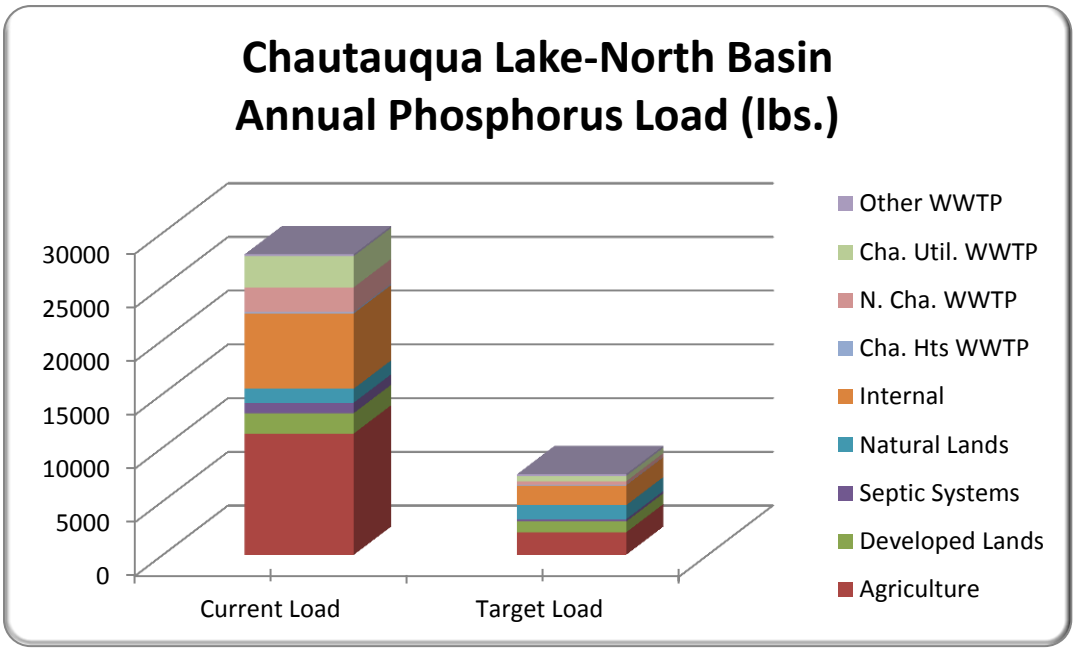


Figure 4-3: Phosphorus TMDL allocation for Chautauqua Lake, North Basin

4.2. Field Assessment

EcoLogic staff completed a field survey of the Lake's littoral zone in order to evaluate nearshore areas where excessive sediment deposition impairs the lake for navigation and recreation. A two-person field team observed the littoral zone and associated aquatic habitat during the week of July 16, 2012; the field survey was conducted from a motor boat. Seventeen segments of the Lake shoreline were selected for detailed observations, based on results of telephone and on-line public opinion surveys, review of previous investigations, and consultation with CCPED staff. We focused on the mouths of tributary streams, areas with designated public access, and commercial marinas. These are areas where sediment build up was most likely to affect the community's navigational or recreational access to the Lake.

At each site, the field crew completed standardized field forms with descriptions of substrate texture (particle size distribution), shoreline cover, percent macrophyte cover, water depth, slope of the near-shore zone, and evidence of sedimentation. A sediment probing rod was used to estimate the depth of unconsolidated material. The field team recorded their observations of fish, aquatic plant species, presence of freshwater mussel shells, and human use and impairments. In addition, we photographed each habitat area. The Lake's nearshore littoral zone supports a mixture of high quality undisturbed aquatic habitat interspersed with areas affected by sediment deposition.

The substrate, cover, width, shoreline cover type, and noted aquatic/wetland vegetation of each habitat unit are summarized in Table 4-3. Photographs of habitat types within the Lake's littoral zone are included in Appendix 1. Note the diversity of conditions evident in the different nearshore areas of the Lake. Many of the creek mouths evidenced substantial sediment deposition (Figure 4-4); some deposits were comprised of coarse particles, while others were fine-grained materials. Bold-italicized rows

indicate regions of the littoral zone that were selected for sediment coring, in order to evaluate the chemical content of the sediments. EcoLogic worked with CCPED staff to identify the five regions to be tested for chemical content and more detailed surveys for lake bathymetry, based on location (sites on both basins), degree of impairment, and public input.

Figure 4-4: Mouth of Dewittville Creek, note gravel deposit

Table 4-3: Results of Littoral Zone Habitat Survey

Habitat Area	Substrate	Cover	% Cover	Water Depth (ft.)	Shoreline cover type	Evidence of Sedimentation	Noted Fish, Wildlife, & Human Use	Photo No.
Prendergast Point	Silt/ mud – D Firm Sand- SD	Emergent & Submergent Vegetation- A Log/stump-S	>25%	2-3	Emergent wetland, hardwood forest, park	Muddy-clay around mouth of creek, 2.5 ft soft silt observed	Canada geese, mallards, minnows, longnose gar, young of year fish (fry), anglers	1, 2
Prendergast Creek/ Snug Harbor Marina	Clay- D Silt/ Mud- D Sand/gravel- SD	Submergent vegetation- P; A in some areas	10-25%	1.5-7	Marina, wetlands, hardwood forest	Apparent dredging at marina, shallow shelves on inside of creek bends	Marina, fish, mallards, Green Heron, gulls, freshwater mussel shells	3, 4
Ball Creek	Sand/ gravel- D	Submergent vegetation-P	1-10%	0.5-3	Highway; undeveloped land	1.5-4.5 sand and gravel delta around mouth of creek	Kayakers, gulls, mallards, water chestnut	5, 6
Dewittville Creek	Firm Sand- D Sand/gravel-D	Submergent vegetation-A Log/stump-P	>25%	1.3-3.5 within channel	Residential, boat docks	Gravel/sand shoal at mouth of channel	Gulls, mallards, Canada geese, Pumpkinseed & sunfish (and spawning habitat), bass, yellow perch, minnows, longnose gar, eel grass, zebra (*Dressenia polymorpha*) and freshwater mussel shells- *Lampsilis siliquodea*, Duck hunting area	7, 8
Bonita	Sand/mud- D Sand/gravel-D at mouth	Submergent vegetation- P Fallen tree- P Docks-P	10-25%	2.5-3.5	Residential, boat docks, hardwood forest	Gravel/sand at mouth of stream, deep soft sand and mud surrounding channel	Mallards, gulls, cormorants, abandoned boat docks	9, 10
Clear Creek	Sand- D Gravel- D in stream outwash	Submergent vegetation- A	10-25%	0.2-10	Wetland area, residential area, private marina, docks	2.5 ft soft sand in shallow water, gravel substrate at creek mouth	Mallards, sunfish, smallmouth bass, freshwater mussel shells- *Unionidae*, Canada geese, gulls	11, 12

Habitat Area	Substrate	Cover	% Cover	Water Depth (ft.)	Shoreline cover type	Evidence of Sedimentation	Noted Fish, Wildlife, & Human Use	Photo No.
Burtis Bay: Ready About Sailing & Holiday Harbor	***Silt/mud- D***	***Submergent vegetation- P Emergent vegetation- A***	***>25%***	***3-5***	***Marinas, residential area between marinas***	***Deep soft silt around marina, between docks, and off end of dock***	***Mallards, sailing, boating, milfoil, lily pads, Green Heron, public launch area***	***13, 14***
Mud Creek	***Clay- S Sand- D***	***Submergent vegetation- A***	***>25%***	***3-10***	***Marina, residential***	***Sand on top of 2-2.5 ft of silty clay in channel and surrounding area***	***Boating, darter, sunfish, yellow perch, sunfish- Pumpkin seed, freshwater mussel shells- Unionidae, D. polymorpha, public beach, waterfowl***	***15, 16***
Arnolds Bay: Shore Acres boatyard	Silt/mud-D Sand-D	Submergent vegetation- A	>25%	1-4	Marina, residential	Shallow water depth	Minnows, juvenile largemouth bass, milfoil, mallards (juvenile by docks), boating, floating weeds from harvesters	17, 18
Goose Creek: Ashville Bay	***Silt/mud- D***	***Emergent vegetation- P Submergent vegetation-D Log/stump- P near shore***	***>25%***	***1.5-6 0.5-7 within channel***	***Hardwood forest, residential, marina***	***Shallow water depths, >2 ft soft silty clay substrate in 3.5ft water depth***	***Minnows, fishermen, boating, mallards, gulls***	***19, 20***
Ashville Bay Marina	Silt/mud- A	Emergent vegetation-P Submergent vegetation-A	>25%	3-6	Marina, hardwood forest, residential	1 ft soft silt on top of firm sand within marina	Minnows, boating channel	21, 22
Maple Bay- Smith Boys marina to Vukote Bar	Silt/mud- D Sand-D	Emergent vegetation- P, Submergent vegetation- A, docks	>25%	3.7-4	Residential, marina	Soft silt >4 ft. deep	Boaters, swimming	23, 24

Key: D = dominant; SD = subdominant; A = abundant; P = present; S = sparse; Bold-Italic areas selected as priority

Habitat Area	Substrate	Cover	% Cover	Water Depth (ft.)	Shoreline cover type	Evidence of Sedimentation	Noted Fish, Wildlife, & Human Use	Photo No.
Big Inlet	Sand-D	Emergent vegetation- P Submergent vegetation-A Docks, boats	>25%	3-7.5	Residential, park	Soft sand bottom throughout channel	Yellow perch, log perch, sunfish, assorted freshwater mussel shells including: *Lampsilis siliquoidea, Ligumia nasuta, Pyganodon grandis*; YOY smallmouth bass, golden shiners, bullhead, brook silversides, largemouth bass, bullfrog, mallards, lily pads	25, 26
Dutch Hollow Creek	***Silt/mud- D Sand/gravel-D***	***Emergent vegetation-A Submergent vegetation-A***	***10-25% (W) >25% (E)***	***1-6***	***Residential, emergent wetland, shrub/hardwood forest***	***Sand and gravel outwash from creek; soft sand and silt around mouth***	***Two plant harvesters operation on E side, common Tern, water chestnut, lily pads***	***27, 28***
Cheney Point	Silt/mud- D Sand/gravel-D	Submergent vegetation-A	>25%	5-6	Phragmites, shrubs, grasses, residential	Sand and gravel off creek mouth	Gulls, makeshift boat launch, navigation buoys marking weedy area	29, 30
Bemus Creek	***Sandy gravel- D***	***Emergent vegetation- S***	***>25%***	***0.3 - 3***	***Residential***	***Very shallow waters around mouth***	***Mallards, gulls, kayakers, spawning carp, boating, lily pads***	***31, 32***

4.3. Public Perception of Impairment

In addition to the field observations of the Lake's littoral zone, the project team queried residents and business owners about the ways in which sedimentation affects their use of Chautauqua Lake. We developed an opinion survey, consisting of 25 questions, and used the survey in the online application, Survey Monkey. For those without access to a computer, or wanting to share their thoughts in greater detail, EcoLogic offered the opportunity to complete the survey by telephone. We conducted the survey between June 19th and August 6th 2012.

The complete survey results are presented in Appendix 2. Overall, the majority of respondents believe that excessive sedimentation has adversely affected their ability to access Chautauqua Lake (Figure 4-5).

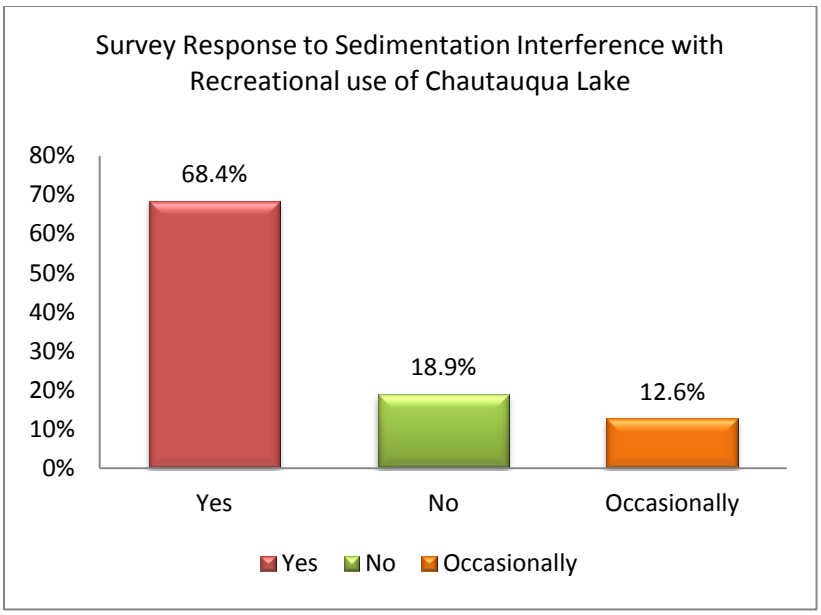


Figure 4-5: 95 Participants responded to the question: "Does sedimentation affect your ability to use Chautauqua Lake?"

We then asked respondents about specific areas of the Lake that are affected by excessive sedimentation, and had respondents rank the top three regions of the Lake that they believed to be most affected by sediment deposition. This information (Figure 4-6) was considered along with the findings of the field investigation in selecting the priority areas for nearshore bathymetric mapping and sediment testing.

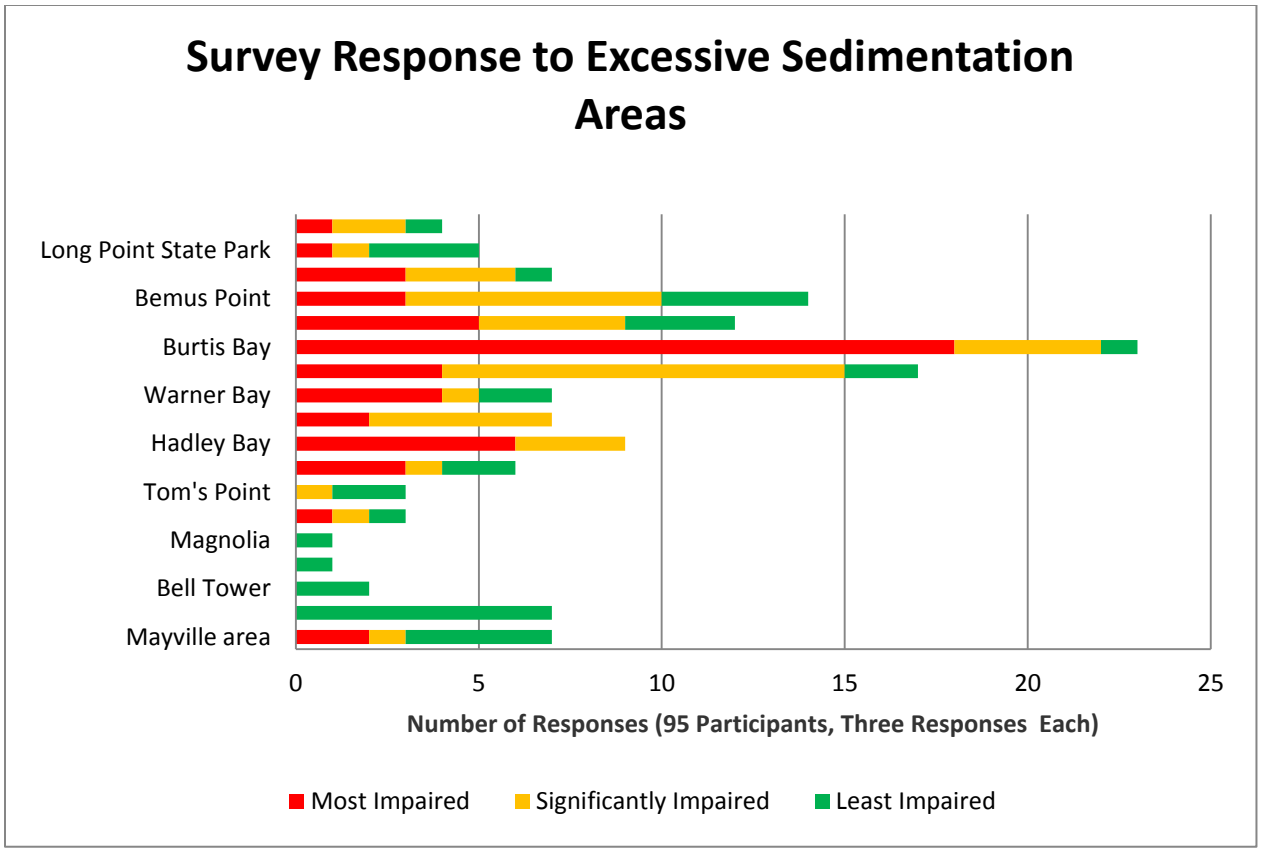


Figure 4-6: Response to "Please select and rank three areas of Chautauqua Lake where excessive sedimentation poses the greatest problems to you."

The frequency of citation is reflected in the length of the bar, and the color coding depicts the relative severity of the perceived use impairment. Burtis Bay was named most often, by a wide margin, and was called out as the most impaired site. Dutch Hollow Creek, Bemus Point, Goose Creek and Hadley Bay also received multiple responses.

EcoLogic and CCPED convened a public meeting on July 30, 2012 to review the project's objectives and gather community input regarding how sedimentation has affected access to and enjoyment of Chautauqua Lake. A group of approximately 35 residents met to learn about the dredging feasibility project and share their ideas. The PowerPoint presentation slides from the July, 2012 public meeting are included in Appendix 3.

5. Characterization of Impaired Regions

5.1. Methods

Once the survey data and comments from the public meeting were reviewed with the CCPED team, we selected five priority areas for additional investigation (Figure 5-2). There was strong agreement between the findings of the field survey of the littoral zone and the public perception of areas most impaired by sedimentation. Sites representing both the south and north basin of the Lake were selected.

The following five sites were designated as priority for additional testing.

- Celoron/Burtis Bay
- Bemus Point
- Mouth of Goose Creek
- Mouth of Dutch Hollow Creek (later expanded to include Greenhurst Point)
- Mud Creek area

The sediment testing work plan was prepared and submitted to CCPED and the Department of State, Division of Coastal Resources for review and approval. The work plan (Appendix 4) summarizes the sampling and analytical procedures and describes the regulatory basis for interpreting the data.

Sediment cores were tested for both chemical and physical parameters (Figure 5-1). The chemical content of the sediments has the potential to constrain the options for how dredged materials are handled during removal and ultimate disposal. Physical characteristics of the sediment affect the selection of equipment, design of the dewatering facilities, and capacity of the site(s) selected for dewatering and/or ultimate disposal.

Figure 5-1: The AnchorQEA sampling vessel used for collecting sediment cores in Chautauqua Lake, August 2012

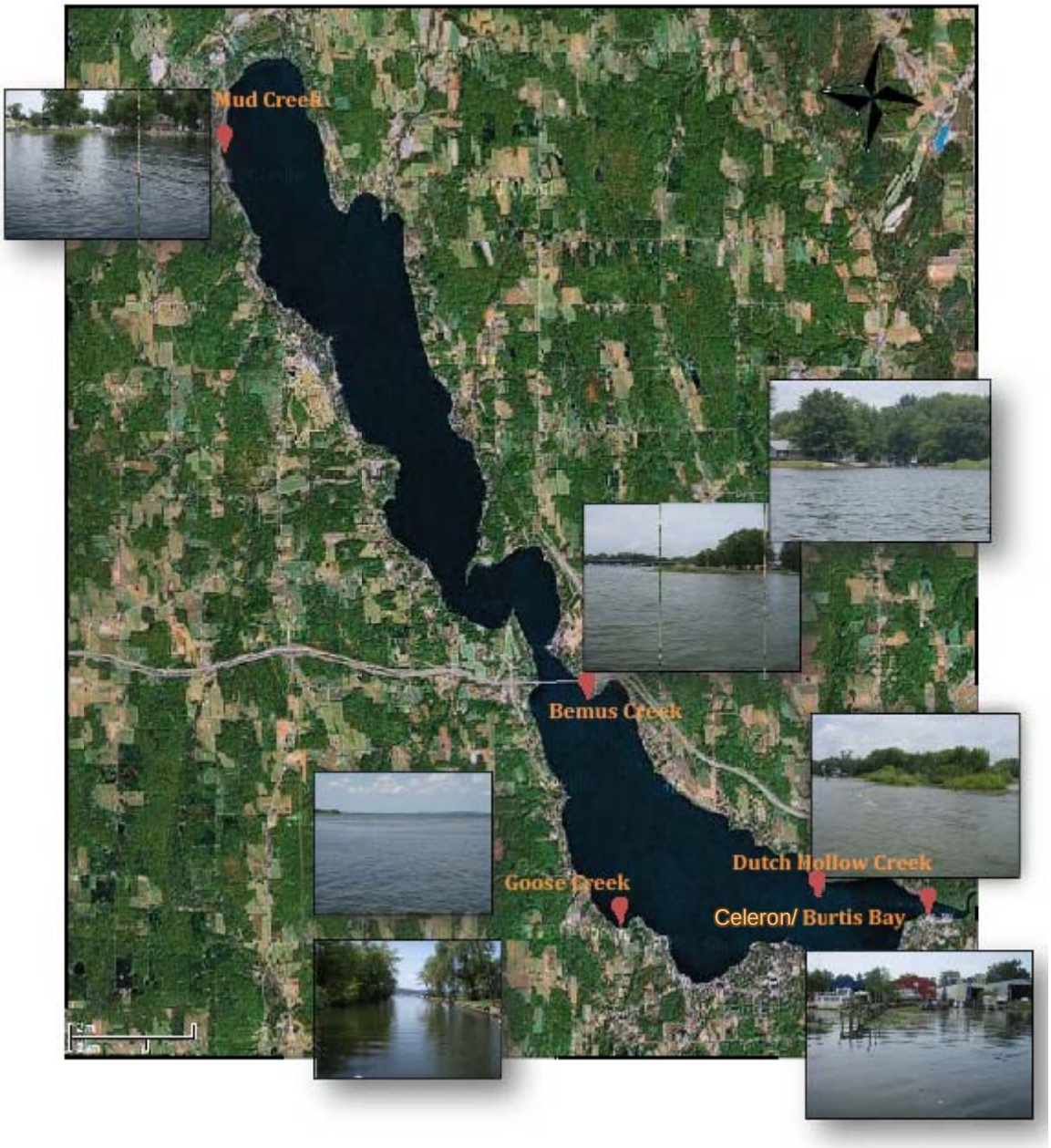


Figure 5-2: Priority areas in the Chautauqua Lake watershed

The New York State Department of Environmental Conservation (NYSDEC) has developed a statewide guidance document for use in evaluating the quality and management of dredge material. This document, *Technical and Operational Guidance Series (TOGS) 5.1.9 In-Water and Riparian Management of Sediment and Dredged Material* (NYSDEC 2004), defines upper contaminant levels to classify dredged material and constrain options for ultimate disposal.

- Class A sediments exhibit no appreciable contamination
- Class B sediments exhibit moderate levels of contamination and may be toxic to aquatic life upon long-term exposure (chronic toxicity)
- Class C sediments exhibit high levels of contamination and may be toxic to aquatic life upon short-term exposure (acute toxicity)

When Class B or C sediment is expected, NYSDEC guidance calls for evaluating the proposed future sediment surface to verify that concentrations of chemicals of concern do not exceed the pre-dredging levels. That is, sediment testing must address the potential for exposing layers of sediment with higher concentrations of contaminants. Given the watershed's history and current land uses, it was anticipated that sediments deposited in nearshore areas of Chautauqua Lake would be Class A.

NYSDEC evaluates levels of selected indicator contaminants (both organic and inorganic) to differentiate Class A, B, and C sediments. Sediments are classified based on the concentrations of benzene, certain heavy metals (arsenic, cadmium, copper, lead and mercury), pesticides (DDT compounds and dieldrin), polycyclic aromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs).

A field team, including representatives of Anchor QEA and EcoLogic, was deployed to Chautauqua Lake the week of August 6, 2012. Sediment cores were advanced in the priority areas, and characterized for sediment texture. Three cores were obtained in each of the five priority areas; sediments from the three cores were composited and submitted for laboratory analysis. The sampling and analysis were completed in accordance with the approved workplan.

This investigation conducted limited sediment sampling to assess the likely disposal options. Additional sampling and analysis in specific areas may be required if dredging is implemented in Chautauqua Lake, based on the sediment volume to be removed and the size of the area to be dredged.

5.2. Results- Sediment Composition

Results of the sediment chemical testing are summarized in (Table 5-1). The chemical content of the Lake sediments were within Class A limits, with one significant exception. Sediments deposited within the Celoron/Burtis Bay area exhibited elevated levels of arsenic, and are consequently considered Class B (moderately contaminated).

Detection of elevated arsenic levels in Burtis Bay is likely a result of the use of sodium arsenite as an herbicide to control aquatic macrophytes in Chautauqua Lake. Between 1955 and 1961, New York State regularly applied sodium arsenate to areas of the Lake ranging in size from 27 to 920 acres[5].

Stratigraphy of the sediment cores indicates that the surficial deposits of coarser-grained material are underlain by clay-sized particles. This sediment description is consistent with the results of the sieve testing of sediment samples composited from the cores. As displayed in Figure 5-3, the majority of deposited materials within all the priority areas are fine-grained, as indicated by the percent of the material passing through sieves with increasingly small openings. The sediment cores collected from the Mud Creek area are comprised of the highest percentage of fine-grained materials; those collected from Dutch Hollow Creek contain the highest percentage of coarse-grained materials. This predominance of small-grained material has a significant impact on the alternatives for removing and dewatering sediments deposited within the nearshore areas of Chautauqua Lake.

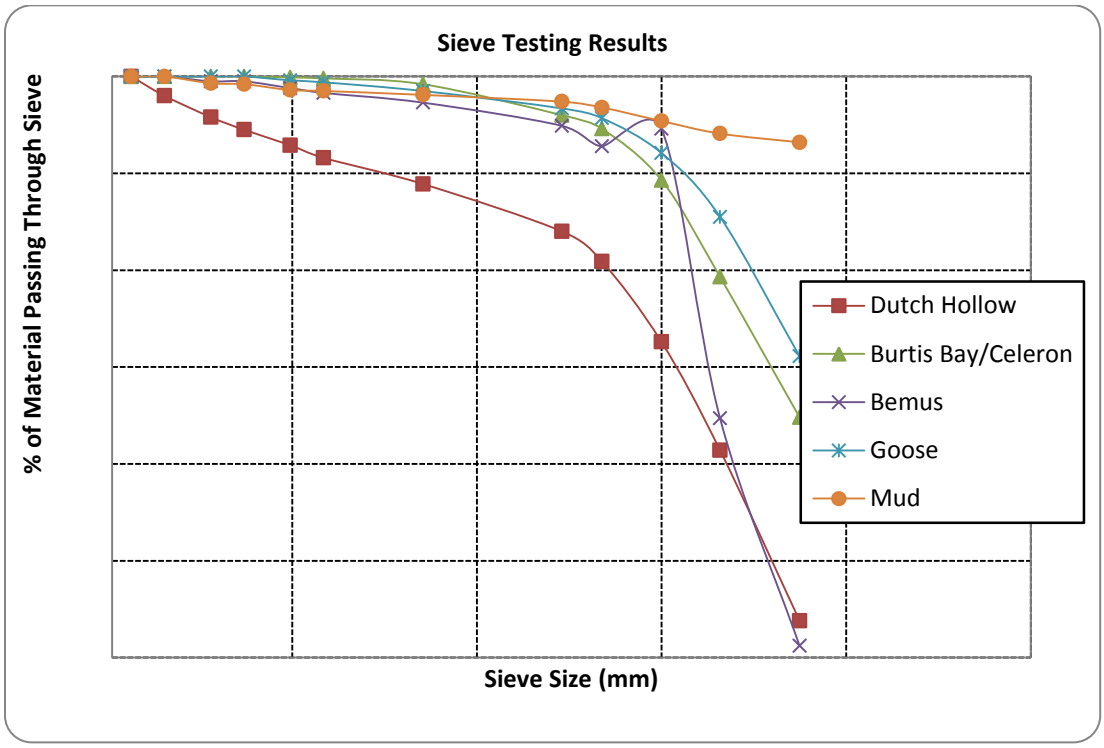


Figure 5-3: Results of sieve testing, Chautauqua Lake sediment cores from nearshore priority areas

[5] 1990 Supplemental Environmental Impact Statement: Plan for the Future Use of Aquatic Herbicides in Chautauqua Lake. CCPED, Mayville NY.

Table 5-1 : Analytical results for sediment samples from Chautauqua Lake, August 2012.

All results in mg/kg dry weight

Parameter	Analytical Method	Site 1 – Mud Creek		Site 2 – Bemus Creek		Site 3 – Goose Creek		Site 4 – D.H. Creek		Site 5 – Celoron/Burtis	
		Result	Class	Result	Class	Result	Class	Result	Class	Result	Class
Pesticides/PCBs	EPA 8081/8082	ND	A	ND	A	ND	A	ND	A	ND	A
Benzene	EPA 8260B	ND	A	ND	A	ND	A	ND	A	ND	A
Polycyclic Aromatic Hydrocarbons (PAHs)	EPA 8270	ND	A	ND	A	ND	A	ND	A	ND	A
Arsenic	EPA 6010	9.7	A	7.9	A	3.5	A	11	A	23	B
Cadmium	EPA 6010	ND	A	ND	A	ND	A	ND	A	ND	A
Copper	EPA 6010	26	A	16	A	11	A	18	A	22	A
Lead	EPA 6010	ND	A	ND	A	ND	A	ND	A	ND	A
Zinc	EPA 6010	77	--	52	--	51	--	67	--	56	--
Mercury	EPA 7471	ND	A	ND	A	ND	A	ND	A	ND	A

ND – non-detect. Analytes reported as less than the method detection limit

Threshold Classes:
Class A – No Appreciable Contamination (No Toxicity to aquatic life)
Class B – Moderate Contamination (Chronic toxicity to aquatic life)
Class C – High Contamination (Acute Toxicity to aquatic life)

The sieve analysis indicates the particle size distribution- that is, the relative contribution of sand, silt, and clay-sized particles. Sediment particles too large to pass through the #4 sieve (4.76 mm opening) are sand-sized (or larger). In contrast, the smallest sieve used--#200 (0.074 mm opening)--allows silts and clays to pass through. This information is critical to selecting appropriate dredging technology and disposal methodology. As summarized in Table 5-2, the materials to be dredged are primarily fine sands, silts and clays.

Table 5-2: Selected results of the sieve analysis of Chautauqua Lake nearshore sediment cores

Priority Area	Percent passing #4 sieve (sieve size is 4.76 mm)	Percent passing #200 sieve (sieve size is 0.074 mm)
Bemus Point	98.3 %	41.2%
Dutch Hollow Creek	91.6%	43.8%
Mud Creek	98.5%	93.2%
Goose Creek	99.4%	71.1%
Celoron/Burtis Bay	99.8%	64.8%

Results of the sieve analysis are consistent with field observations made during the coring and the habitat surveys:

- Bemus Creek: Upper 6-18 inches was gravel, sand, silt and clay. Below that was silt, sand and clay.
- Dutch Hollow Creek: These cores showed a mix of small gravel, sand, silt and organic material.
- Mud Creek: Upper 1-1.5 feet was sand and small pebble size gravel. Deeper is gray clay.
- Goose Creek: Primarily sand, silt and clay with some organic material.
- Celoron/Burtis Bay area: A mix of silt, sand and clay with some peat
- Greenhurst Point: Primarily gravel

The physical and chemical characteristics of the dredged material determine which options are feasible for sediment dewatering and ultimate disposal. The larger the particle, the faster it settles. Gravelly material will sink quickly, followed by coarse sands. Finer sands are smaller in mass and settle more slowly, particularly if there is any turbulence. Silts and clays, the smallest sized particles, settle very slowly.

While we did not collect a sample of the gravelly Greenhurst Point material for chemical analysis, we assume that this material meets Class A (uncontaminated) limits. Since most contaminants are associated with the finer-grained material, and the sample collected at the mouth of Dutch Hollow Creek met Class A limits, we are confident that the Greenhurst Point material also meets Class A limits.

5.3. Sediment and Water Depths

Additional bathymetric mapping of the priority areas was completed by AnchorQEA during the sediment coring operation in early August, 2012. Three transects were performed in the priority areas. The

sediment cores were generally sited along the transect lines. Results of the nearshore bathymetric mapping and the locations of the cores are included in Appendix 5.

These data were used to estimate the volume of sediment to be removed in order to restore impaired navigational access. Several simplifying assumptions were necessary to complete this task. First, the target depth of overlying water was estimated at 4.5 ft. This target depth would provide access to the creek mouths to motorized watercraft of various sizes. Note that this assumption is conservative, in that less depth would likely be acceptable in certain areas, such as Mud Creek, and for non-motorized watercraft.

We also had to estimate existing water depth in priority areas. The bathymetric mapping did not encompass the entire nearshore zone, so we extrapolated from existing data, supplemented by the field sheets from the July, 2012 habitat survey. These data were pooled to estimate an average depth of overlying water across the proposed dredge areas.

5.4. Estimated Volume of Sediment to be Dredged

Once the depth of the sediment profile to be removed is estimated, we coupled this information with the surface area to be dredged in order to calculate sediment volume. We focused on areas surrounding creek inlets where recreational access is impaired by excessive sediment deposition. Although many other areas of the shoreline could benefit from sediment removal, we focused on the five priority areas. The objective of the feasibility study is to develop an approach and unit costs for sediment removal. The ultimate selection of areas to be dredged, if any, rests with the larger stakeholder community.

Working with sediment volumes of 30,000 cy or less per site allowed us to focus on options for handling manageable dredge volumes. This is critical for Chautauqua Lake, given the extent of residential development and thus the limited availability of sites near the Lake that could possibly serve for sediment management (dewatering and/or ultimate disposal). Note that the dredge volumes listed in Table 5-3 are in-situ volumes, and that sediment on the Lake bottom is more compacted than sediment mixed with water in a hydraulic dredging operation. The expansion factor is approximately 1.4 for hydraulic dredging. Sediments dredged using mechanical equipment are also less compact than they are on the lake bottom, but the expansion factor is reduced.

The selected areas should be considered as examples (templates) of the costs, site selection challenges, and approval process needed to dredge selected nearshore areas. Exclusion of particular areas from this discussion does not imply that dredging would be more costly or more challenging to permit. Given the limited areas for dredge material handling and dewatering, sediment handling is likely to be the limiting factor for the volume of material to be removed from the Lake. Cost estimates are included in Section 8.

The sediment texture data, summarized in Section 5.2, indicate that most of the dredged material will be fine-grained. Given the sediment texture, hydraulic dredging is the preferable technology for most of the areas, including Mud Creek, Dutch Hollow Creek, Goose Creek and Bemus Creek. Hydraulic dredging uses the water as the carrier to remove and transport the sediment to a management facility. Based on

professional judgment and experience, the mixture of sediment and water to be drawn from the nearshore areas using the hydraulic dredge will average 10% solids and 90% water. The outcome of these assumptions regarding sediment depth, and volume for hydraulic dredging are summarized in Table 5-3.

Table 5-3: Chautauqua Lake Dredging Volumes

Priority area	Average Depth of Dredging (ft)	Area of Dredging (acres)	Sediment Volume (cubic yards)	Total Volume, using Hydraulic Dredging (million gallons)
Dutch Hollow[6]	2.5	1.05	4,200	7.7
Mud	1.5	7.5	18,000	33
Goose	2.5	6.5	26,000	47
Bemus	3.0	4.1	20,000	36
Celoron/Burtis Bay region	2.5	7.3	30,000	54
Greenhurst Point	8.0	2.2	28,000	N/A

[6] The removal of the gravel bar at Greenhurst Point, the mouth of Dutch Hollow Creek, was not included in the estimated volume of material to be removed from the mouth of Dutch Hollow Creek. This decision reflects correspondence with NYSDEC regarding the feasibility of receiving regulatory permission to remove the gravel bar. By letter to Steven Eidt of EcoLogic dated January 25, 2013, NYSDEC Region 9 Deputy Regional Permit Administrator, Charles D. Cranston, outlined NYSDEC concerns. This letter is included as Appendix 6. The cited regulatory concerns focus on habitat quality; the gravel provides important habitat for fish and birds. In addition, NYSDEC staff believes that removal of the gravel shoal will cause an increase in upstream erosion, and is concerned that removal of the gravel bar might affect erosion of the lake shoreline.

6. Dredging Technology

There are essentially two techniques used to remove sediment from lakes—mechanical dredging and hydraulic dredging. In addition to the removal of sediments, technology selection considers two other components: sediment processing (stabilization or drying) and ultimate disposal. We describe the technologies and their potential application to Chautauqua Lake, and include recommendations for approaches to dredging the five priority areas.

6.1. Mechanical Dredging

Sediment can be removed from the lake bottom through mechanical dredging, which uses a clamshell bucket, either suspended from a crane or attached to a boom. There are many configurations of bucket and crane possible, depending on water depth and access. Mechanical dredging can be carried out "in the wet"- no change in water level, or "in the dry"- following drawdown. For dredging without drawdown, cranes can be used to scoop up sediment to a distance of 30 – 40 meters from the shoreline. For areas farther offshore, mechanical dredges are typically mounted to a barge. Overall, mechanical dredges are considered to be highly maneuverable, easy to move between sites, and able to remove sediment from confined areas such as docks and marinas.

Mechanical dredging can result in an uneven bottom profile. Production rates tend to be slow and sediment may be suspended in the water column during dredging, creating turbidity. The capacity of a clamshell bucket for the Chautauqua Lake project would likely be small, no more than 2 or 3 cy. Special closed-bucket dredges can replace the clamshell bucket to reduce turbidity; these closed-bucket dredges are often specified when removing contaminated sediments. Sediment removed by a mechanical dredge must be transported for dewatering and disposal.

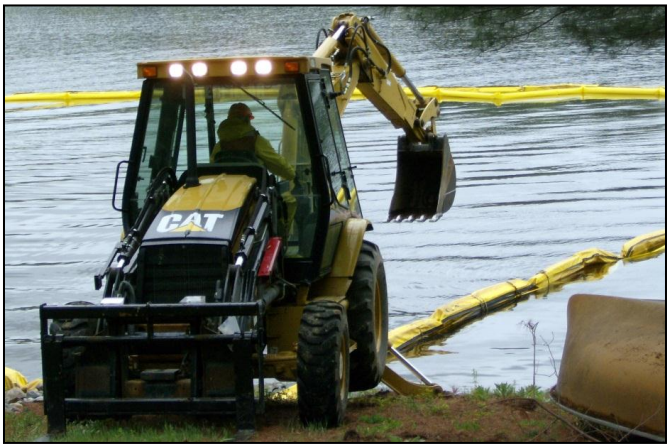


Figure 6-1: Lake Algonquin mechanical dredging (Wells, NY)

For a dredging operation with the lake at normal pool elevation, dredge material could be deposited in small scows- barges configured to hold sediment and water from the bucket excavator- and pushed to

shore for off-loading with another crane or excavator. Each scow would contain no more than 20 or 30 cy of dredged material.

In some lakes with dams to control water levels, drawdown (drawing down the water level to expose nearshore areas with significant shoaling) can allow mechanical dredging in "drier" conditions as an option. Under these "drier" conditions, sediment removal using traditional earth moving equipment such as excavators and bulldozers is possible. The results from this type of sediment removal often results in a more even bottom profile due to improved visibility conditions. In addition to this, less material is handled overall due to reduced water content.

Dredging in the dry is not a feasible option for Chautauqua Lake. The magnitude of possible drawdown is controlled by the bedrock channel in the Lake outlet. The Warner Dam in Jamestown, operated by the Board of Public Utilities (BPU), has only a limited impact on water levels in the Lake and river. Even with the dam gates fully opened, the drop in water surface elevation is not more than 1.5 ft., and low water levels are not persistent. An inch of rain within the watershed can raise the Lake water levels by one foot.

6.2. Hydraulic Dredging

Hydraulic dredges (Figure 6-2) are popular due to their speed and ability to remove large quantities of sediment. There are several types of hydraulic dredges including the suction dredge, the hopper, the dustpan, and the cutter-head dredge. The cutter head dredge is the most practical and is the one most often used. The dredging machinery is incorporated onto a floating barge. A cutter with steel blades dislodges the sediments, and a centrifugal pump draws a mixture of sediment and water (called the slurry) into a pipe, which sends the slurry to an upland basin or to geotubes staged nearshore. The water is drained off and the sediments are left to dry. Managing the return flow of water to Chautauqua Lake would require great care. Hydraulic dredges create significantly less turbidity compared to mechanical dredging without drawdown. Production rates of hydraulic dredging will vary based on sediment texture, the presence and amount of vegetation and other non-sediment materials.

Figure 6-2: Lake Algonquin hydraulic dredging (Wells, NY)

6.3. Sediment Processing

Dredged material can contain a significant amount of water, which greatly increases the volume of material to be handled and the associated costs. Several approaches and technologies can be considered for sediment dewatering, as summarized in Table 6-1.

Table 6-1: Alternative approaches to sediment processing

Technique	Description	Applicability	Advantages	Drawbacks
Geotubes	Tubes of geotextile material, receive slurry, supplemented by polymer, water drains out	Hydraulic	Smaller footprint than constructed basins and faster processing	Expense and possible need for polishing effluent
Dewatering basins	Construct containment facility, pump or load dredged material in, allow to dewater, ultimately excavate and transport	Hydraulic Mechanical	Less chemical use, can be used to restore excavated or mined areas	Requires large area (more than 10 acres) nearshore at comparable elevation (for hydraulic); as close as possible Lengthy settling time
Mobile on-site dewatering facility	Add polymer (chemicals to enhance aggregation of small particles), mechanical dewatering using filter press or similar technology	Hydraulic Mechanical	Small footprint, temporary facility Very fast processing	Expense and energy usage
Direct transfer to off-site location	Excavated material placed in lined trucks or roll-off containers, transport to ultimate destination	Mechanical	Avoids need for intermediate dewatering facility	Transport excess water, potential adverse impacts of wet material on final destination

6.3.1. Sedimentation Basins

Selection of sedimentation basin sites in a highly developed area such as nearshore Chautauqua Lake can be challenging. Since hydraulic dredging is the most likely method of sediment removal, dewatering facilities must be large enough to handle the large volume of water and sediment generated (refer to Table 5-3). These dredging operations generally require settling basins that range in size from 10 to 20 acres of diked area. As a general rule of thumb, consider that an area of about 25 acres would be required to handle between 80,000 and 100,000 cy of dredged material. The range of area requirements reflects the settling rate; smaller particles settle through the water column more slowly and thus require larger basins. The area is designed to accept the material, allow for sediment settling and have a discharge structure to return the treated water to a waterbody as approved by the regulatory authority.

The 'standard' sedimentation facility would incorporate a large diked area of several acres with a forebay to drop out heavier solids, such as sand and gravels (Figure 6-3); followed by a larger diked area for sedimentation of smaller solids such as fine sands, silts and clays. The discharge point would be a

gate or standpipe that would be variable in height allowing it to be lowered to drain the area as the sediments settled completely.

The basin area is defined by the volume of water and sediments that are being removed and the speed at which the sediments will settle. Sediments to be dredged from Chautauqua Lake are primarily sands, silts and clays, with a small amount of gravel. Clay particles settle most slowly; they are the controlling factor for design and sizing.

Figure 6-3: Sediment basin used for dewatering dredged material (Wells, NY)

6.3.2. Mechanical Dewatering

Mechanical dewatering involves the removal of the sediment through mechanical action combined with chemical addition. Most mechanical dewatering is acceptable for dredged material from a mechanical removal method since they cannot handle the high quantities of water effectively. Since hydraulic dredging is the likely alternative that would preclude the use of belt filter press dewatering.

One of the emerging technologies is the Genesis Rapid Dewatering System (Figure 6-4). This system employs several screening systems to remove particles down to the size of sand. A tertiary process involving micro screening and polymer addition is then used to remove silt and clay particles and produce an effluent that can be directly discharged back to a waterbody.

The benefits of this technology include the portability of the process equipment. The small footprint for the process (generally 150’ X 150’ or less) would allow the process to be set up in densely developed areas. The effluent is very clear, and can be returned to the water body, as the majority of sediments are Class A (with the notable exception of the Celoron/Burtis Bay area). The dewatering process is

adjusted to match the inflow from the hydraulic dredge. Drawbacks include the need to remove the cake product at the rate of production, unless there is sufficient storage area, and the costs of the operation, including fuel.

Figure 6-4: Genesis dewatering equipment

6.3.3. Dewatering with Geotubes

Geotubes (Figure 6-5) are used for dewatering various types of liquids and slurries. A relatively new technology, geotubes are accepted as a reasonable alternative for sediment dewatering. They are well suited for sediment dewatering in developed areas, where land area limits the use of sedimentation basins, or when high organic content might create unacceptable odors.

Geotubes are constructed of porous material, designed to retain small particles and allow water to pass through. The seams are welded to withstand pressure from the pumps used in hydraulic dredging. Polymers are added at the head end of the tubes to assist in settling to facilitate a faster pumping operation and increase capture of smaller solids. The tube size is selected to match the pumping rates using a piping system to distribute the dredge water to several bags at once.

There are two options for laying out the tubes. In situations with larger grained materials such as sands and small gravels, the tubes can be placed on top of the ground and the water is allowed to drain back into a stream or the dredging containment area. The materials deposited in nearshore areas of Chautauqua Lake contain a substantial amount of clay-sized particles. Clay is not easily captured in the tubes. The polymer addition will help coagulate the fine-grained materials; despite this chemical modification, it is likely that water exuded from the geotubes will require additional treatment (filtration) prior to discharge to Chautauqua Lake. The optimal type and dose of polymer will be determined in-situ. Diking the tubing area to collect the effluent will increase the project cost as well as

the overall area requirements. However, even with diking, the size of the sediment management facility is far less than that required to accommodate conventional sedimentation basins. Odors are not usually an issue since organic material in the sediments remains in the tubes. The drawbacks are the cost associated with the tubes and polymer and the probable need to remove clay particles using an advanced treatment process prior to final return of the water to the lake.

Figure 6-5: Dewatering Geotubes (Bishop Waters Technology, Inc.)

6.4. Sediment Management Facilities in Priority Areas

Once the priority areas were identified and the sediment testing and bathymetric surveys were complete, EcoLogic reviewed aerial photos and tax parcel maps to locate potential sites for sediment dewatering activities. As an initial screening, we focused on sites that are proximate to the dredge areas (within one mile), of sufficient size (at least 5 acres), and exhibit compatible land use and cover conditions. This search identified sites near Mud Creek, Goose Creek, Dutch Hollow Creek and Burtis Bay. We were unable to find an acceptable site in the Bemus Creek area.

Once candidate sites were identified from the maps and aerial photos, Steve Eidt from EcoLogic and Don Lake from DuLac Engineers completed a field reconnaissance to further evaluate the potential suitability for use as a sediment management facility. CCPED Watershed Coordinator Jeffrey Diers joined the field team as they inspected the potential sediment handling/disposal sites. The developed nature of the watershed, including much of the shoreline zone, presents a significant challenge. Changes in topography are also a critical factor, particularly for hydraulic dredging solutions.

The field team selected examples of potential areas that might be suitable for sediment dewatering operations. These sites were identified based on their size, proximity, topography, current land use and neighborhood character. Limitations such as road crossing, length of pipeline runs, costs of land acquisition or leasing are not considered. This is a preliminary feasibility study and is not meant to imply

that any particular land parcel is being considered for use in a dredging operation. Rather, we include these areas to illustrate the landscape scale of a dewatering operation. These sites are included in Appendix 7.

No site was found that could be appropriated and developed as a large sedimentation basin facility to serve all dredged areas. Consequently, dewatering options are limited to use of geotubes or mechanical dewatering. Either option could be used to dewater sediment dredged from the mouths of Mud Creek, Goose Creek or Dutch Hollow Creek. Since no potential sites appropriate to stage geotubes in the region of Bemus Point were identified, the only option to dewater sediments dredged from this area appears to be the use of mechanical dewatering.

6.5. Summary of Recommended Technologies

Hydraulic dredging and geotubes is the recommended approach for most of the dredging operations for Chautauqua Lake. There are two exceptions; mechanical dredging appears to be the preferred approach for sediment removal at Greenhurst Point and the Celoron/Burtis Bay area. An operation to remove material from Greenhurst Point, which is predominantly gravel-sized material, would likely be land-based; excavated material would be placed directly into trucks and transported up Dutch Hollow Creek to a point of egress.

Mechanical dredging is proposed for the Celoron/Burtis Bay area even though the material to be removed is fine-grained. This recommendation reflects the need to handle sediments with elevated arsenic levels, and to minimize the volume of potentially contaminated water requiring treatment prior to discharge. A feasible approach for nearshore sediments is to base operations on the shoreline and use a long-reach track hoe, depositing sediments on the shore. Since the dredging area must be surrounded by a silt curtain, NYSDEC may permit water draining from the dredged material to return to the same confined area. This approach would also be employed for dredging in off-shore areas of the Celoron/Burtis Bay area, placing the long-reach excavator on a scow. Dredged material would be deposited on a second scow, within an area surrounded by silt curtains. When the dredged material dewaters sufficiently to be removed from the scow or the lake bank, it would be placed in a confinement cell where it would continue to drain. The drainage water, which may contain elevated arsenic concentrations, must be collected and treated prior to disposal or sent to a local wastewater treatment facility for additional treatment prior to discharge.

We conferred with other engineers with specific experience in handling sediment and water with elevated arsenic levels, in order to better understand the potential regulatory, technical and cost issues. Based on this review, we estimate that the ambient arsenic levels in the water for disposal could be in the 1.0 mg/L range. Technical representatives from Tencate (the major geotube developer and manufacturer) and their engineering consultants Watersolve have advised us that in-situ testing of the Celoron/Burtis Bay area sediments and the sediment pore water is required to estimate the maximum and range of arsenic levels.

As the current regulatory limit for discharge to a waterbody is 0.05 mg/L arsenic, a treatment process would be required. One alternative is to rent a package treatment plant designed to treat and discharge

the wastewater onsite. We contacted to a chemical firm that has supplied similar systems for use on dredging and hazardous waste remediation sites. The firm recommended a treatment system that uses chemical precipitation for the suspended solids and arsenate, followed by bag filters to remove solids, and an anion exchange process to remove additional dissolved arsenic.

The wastewater may also be able to be disposed of at the Chautauqua Lake South & Center Wastewater Treatment Plant. This would require an engineering evaluation to assess the impacts on the plant's effluent and sludge, and verify that the facility could accept the water and meet its permit limits without additional treatment. The NYSDEC would also need to review whether the treatment plant could handle the water, and if there would be any allowance for dilution of elevated arsenic levels with the rest of the wastewater treated at the plant.

6.6. Ultimate Disposal

Sediment removed from Chautauqua Lake can be placed for final disposal or managed for beneficial use. Based on sediment testing completed as part of this feasibility study, and the nature of the watershed, most of the dredged material from nearshore areas will be classified as free of contamination, and suitable for reuse. The exception is sediments from the Celoron/Burtis Bay area, which exhibit levels of arsenic over the NYS guidelines for uncontrolled use and disposal.

The Burtis Bay dredge material would need to be hauled to a permitted solid waste landfill for disposal or use as cover material. This would increase costs for trucking and tipping fees at the landfill. We have confirmed that the Chautauqua County landfill would accept this material for use as daily cover material. In 2013, the standard tipping fee is $26 per ton for contaminated material. Thus, hauling and disposal of 30,000 tons of dewatered (but not dried) material dredged from the Celoron/Burtis Bay area would cost slightly more than $1 million.

Options for reuse of the dredged material from the other areas include, but are not limited to: clean fill, landfill cover material, land reclamation, streambank construction, soil aggregate, mine reclamation, landscape and garden amendment, and as a mix for creating topsoil (possibly composted with yard waste).

One factor affecting the range of potential alternatives for beneficial reuse is the sediment texture (particle size). Finer-grained materials are better suited for composting or landscape and farming applications; however, clays are less favorable for agricultural production. Coarser materials such as sand and gravel are better suited for construction projects. Based on sediment sampling for this project, sediment texture in areas proposed for dredging is variable, ranging from sand and gravel to clay, with mixtures of silt-sized particles as intermediate. Overall, the texture is predominantly fine grained.

Once dewatered, sediment removed from the Lake can be used for projects designed to restore or enhance habitat in the Chautauqua Lake watershed. The nutrient content, percent organic matter and texture (particle size distribution) will affect how the dredged material can be used. Sediment can be

used in riparian areas, along segments of tributary streams, and portions of the shoreline. Stabilizing eroding streambanks within the watershed will help reduce the overall transport of sediment and its associated nutrients. Shoreline stabilization and restoration with plantings of native species can improve riparian habitat conditions, reduce shoreline erosion, and improve the overall aesthetic quality.

Using dredged material for wetland creation is another alternative to consider. Creating wetlands is a complex endeavor, due to the need to provide a consistent hydrologic regime able to support the wetland vegetation and its associated functions. The dredged material from Chautauqua Lake is likely to be favorable for wetland creation, due to its anticipated elevated levels of nutrients and organic matter and fine particle size.

7. Permitting and Implementation

7.1. Overall Process

If the Chautauqua Lake stakeholder community decides to proceed with a dredging project, a number of steps will be required to advance the project from the feasibility stage to implementation.

- Decide who will be the lead agency, and identify affected stakeholders.
- Determine the project boundaries—dredging locations and target depths.
- Conduct a public meeting to describe the plans, and recruit other interested parties.
- Complete a more detailed bathymetric survey within the areas to be dredged to confirm volume of material to be removed.
- Identify a site (or sites) for sediment dewatering, and make arrangements with the property owner(s).
- Determine strategy for beneficial reuse or ultimate disposal of dredged material.
- Hire an engineering firm to develop preliminary and final design documents and prepare the bid package for contractors.
- Identify and pursue all opportunities for funding assistance.
- Complete the requirements of New York's State Environmental Quality Review Act (SEQRA) process, including all public participation requirements.

  Under SEQRA, proponents of the dredging project will complete a structured assessment of the project's benefits, potential environmental impacts, and measures to help mitigate adverse impacts. In addition to the applicant, several involved parties (defined as those granting a permit or approval) and interested parties (local stakeholders) will be engaged in the SEQRA process.

- Once the SEQRA process is completed, file for regulatory permits and approvals (section 7.2).
- Once the permits and permit conditions are in place, advertise bids for contractor services.
- In cooperation with project engineer, select contractor and award bid.
- Develop and execute contracts.
- Begin dredging.

7.2. Permits and Approvals

A number of regulatory permits and approvals will be required before a dredging project in Chautauqua Lake can proceed. As summarized in Table 7-1, these approvals encompass federal, state and local resource management agencies.

Table 7-1: Federal, state, and local permits and approvals, Chautauqua Lake Dredging

Type of Review/Permit	Agency	Regulatory Statute	Address	Permit/Approval
Joint application for permit	New York State Department of Environmental Conservation	Article 15, Title 5, Environmental Conservation Law 6 NYCRR Part 608	NYSDEC, Region 9 270 Michigan Ave. Buffalo NY 14203-2915	• Excavation and/or placement of fill in navigable waters • 401 Water quality certification
	United States Army Corps of Engineers (ACOE)	Title IV, Clean Water Act (Section 404) Rivers and Harbors Act (Section 10)	U.S. Army Corps of Engineers 1776 Niagara Street Buffalo, NY 14207	• Section 10 for construction in navigable waters • Section 404 disposal of dredged sediments
Stormwater	NYSDEC	Article 17, Title 8	NYSDEC, Region 9 270 Michigan Ave. Buffalo NY 14203-2915	• General permit for stormwater discharge from construction of sediment basins (hydraulic) and/or staging areas (mechanical and hydraulic)
Warner Dam Operation (if water level to be lowered)	Jamestown Board of Public Utilities	Rule curve-developed in consultation with ACOE, Chautauqua County and Jamestown Board of Public Utilities	Jamestown Board of Public Utilities 92 Steele Street Jamestown, NY 14701	• Approval for water level drawdown
Cultural Resources Survey	NYS Office of Parks, Recreation and Historic Preservation	9 NYCRR Part 428; 36 CFR Part 800	NYS Museum 3122 Cultural Education Center Albany, NY 12230	• Documentation that dredging or disposal will not affect significant historic or cultural resources

Type of Review/Permit	Agency	Regulatory Statute	Address	Permit/Approval
Navigation Aid Permit	U.S. Coast Guard	33CFR66	Ninth Coast Guard District 1240 East Ninth Street Cleveland Ohio, 44199-2060	• Private aid to Navigation Permit to mark dredge materials pipe (for hydraulic dredging)
State Environmental Quality Review Act	Multiple involved agencies and interested parties	6 NYCRR Part 617	Lead agency to be determined (possible CCPED, CLA or CLMC)	• Coordinated review • Full environmental assessment form • Public notice and comment periods
Site plan review and fill permit	Municipality	Local codes	Variable	• Potential, depends on local laws
Road opening and/or permits	Affected jurisdiction (town, County)	Local codes	Variable – depends on selected routes to convey dredged material pumped by hydraulic dredge	• Road opening or crossing

8. Cost Estimates

8.1. Basis of Cost Opinion

Cost estimates are an important component of a feasibility study. The information presented in this section is represented as an "engineer's opinion of cost"; this level of cost estimating is less precise than cost estimates associated with preliminary or final design of a project. Once the areas to be dredged are identified, sediment dewatering sites are secured, and an ultimate disposal plan is completed, these preliminary cost estimates can be refined.

As we prepared the feasibility report, an experienced engineer from EcoLogic contacted several contractors and suppliers actively involved in dredging projects in the state. These contacts included site visits (Onondaga Lake dredging project), email exchanges and lengthy teleconferences. The discussions encompassed technology selection, practical considerations, effectiveness of separating sediment from water, and costs.

Overall, we found general agreement among the contractors and suppliers on the costs associated with sediment removal. The only area of significant difference of opinion was related to the efficacy and costs associated with managing sediments that contain a large proportion of clay-sized particles. As a result, the estimates varied in price and detail. We considered the detailed cost estimate received from one contractor (Table 8-1) as representative of an upper limit with adequate built-in contingencies.

It is important to understand that the contractor submitted this estimate based on data we provided during the project's feasibility phase. Prior to submitting a firm bid price, a contractor would visit each site, calculate the actual lengths of piping to be used, estimate the need for and sizing of any auxiliary (booster) pumps, test the sediment to specify the correct polymer and dosing rate, and review the construction materials and process needed for containment structures. Without this site-specific information, contractor estimates are higher to accommodate all of these unknowns.

The cost estimate presented in Table 8.1 was developed assuming the use of hydraulic dredging to move a slurry of sediment and water from the Lake, and geotubes to separate the sediment from the water. We have concluded that this alternative represents the most feasible technology for Chautauqua Lake, given the nature of the material to be dredged and the lack of proximate lands for a sediment dewatering facility. The geotubes would be used within a containment area designed to collect and treat water exuded from the geotubes. Based on the preponderance of clay and silt-sized particles within the potential dredge areas, we have concluded that additional treatment of water exuded from the geotubes will be required to meet effluent standards for the return flow of water to Chautauqua Lake. However, polymer testing conducted during the design phase may demonstrate that the final polishing step is not necessary. This would reduce costs substantially, as chemical costs would be reduced and the need for a constructed containment area would be eliminated.

We anticipate that contractors and suppliers would submit lower cost estimates during an actual bid process, once their contingencies are reduced. Responses to recent bid requests for sediment removal

and treatment from regional lakes have resulted in cost estimates ranging from $45 to $65 per cubic yard.

Two separate equipment suppliers provided cost estimates for dewatering using their technologies; these cost estimates came in substantially lower than those provided by the contractors. One of the suppliers of geotubes quoted a price of approximately $20 per cubic yard for sediment treated with polymer and filtered through the bags.

We have also requested and reviewed cost estimates for mechanical dewatering using a proprietary process (Genesis). The dewatering cost quoted ($15 to $25 per cubic yard) is based on a turn-key operation. Since there will be substantial polymer required to remove the clay-sized particles, the $25 per cubic yard appears to be more reasonable. In addition the equipment, polymer and labor, there is a cost of $190,000 for mobilization and demobilization and approximately $50,000 for each move between areas. Given the high cost of equipment mobilization, there would be an economy of scale associated with using the equipment in several locations.

The cost estimates developed for Burtis Bay include both hydraulic and mechanical dredging. As described in Section 6.5, the recommended approach includes mechanical dredging, with dredge equipment placed on one scow, with sediments removed and placed on an adjoining scow, and ultimately transported to the dewatering site. While the site preparation costs will be consistent, the mobilization cost for the mechanical dredging equipment is higher and the polymer cost for the geotubes will likely be higher due to both a high percentage of clay and the arsenic in the dredged material. The wastewater treatment polishing may not be necessary for the other areas but would be required for the Celoron/Burtis Bay area sediments. The cost will be considerably higher to reduce the arsenic to acceptable levels prior to discharge.

Along with the costs incurred during the actual dredging process, the costs associated with permitting must be accounted for. Acquisition of the necessary permits is estimated to cost approximately $10,000 to $15,000. If more than one location is dredged in a season, the permitting cost can be shared between the locations.

Table 8-1: Estimated Cost of Dredging by Priority Area

Creek	Estimated Weighted Depth of Dredging (ft)	Estimated Area for Dredging (acres)	Estimated Sediment Volume (Cyds)	Estimated Total Volume Based on Hydraulic Dredging (MG)	Task	$/cyd	Total
Bemus	3	4.1	20,000	36	Dredging	20-25	$ 450,000
					Dewatering	20	$ 400,000
					Water Treatment	5	$ 100,000
					laydown area prep		$ 15,000
					Mob/Demob		$ 190,000
					SubTotal		**$ 1,155,000**
					20% contingency		**$ 229,000**
					Total		**$ 1,384,000**
Burtis/Celoron	2.5	7.4	30,000	54	Dredging	20-25	$ 675,000
					Dewatering	20	$ 600,000
					Polymer	5	$ 150,000
					landill tip fee*	26	$ 1,040,000
					Hauling	4.5	$ 180,000
					laydown area prep		$ 70,000
					arsenic water treat		$ 406,000
					Mob/Demob		$ 190,000
					SubTotal		**$ 3,311,000**
					20% contingency		**$ 659,000**
					Total		**$ 3,970,000**
Dutch Hollow	2.5	1.05	4,200	7.7	Dredging	20-25	$ 113,000
					Dewatering	20	$ 100,000
					Water Treatment	5	$ 25,000
					laydown area prep		$ 15,000
					Mob/Demob		$ 190,000
					SubTotal		**$ 443,000**
					20% contingency		**$ 82,000**
					Total		**$ 525,000**

*Based on 40,000 cubic yards

Creek	Estimated Weighted Depth of Dredging (ft)	Estimated Area for Dredging (acres)	Estimated Sediment Volume (Cyds)	Estimated Total Volume Based on Hydraulic Dredging (MG)	Task	$/cyd	Total
Goose	2.5	6.5	28,000	47	Dredging	20-25	$ 608,000
					Dewatering	20	$ 540,000
					Water Treatment	5	$ 135,000
					laydown area prep		$ 15,000
					Mob/Demob		$ 190,000
							$ 1,488,000
					20% contingency		**$ 289,000**
							$ 1,777,000
Mud	1.5	7.5	19,000	33	Dredging	20-25	$ 428,000
					Dewatering	20	$ 380,000
					Water Treatment	5	$ 95,000
					laydown area prep		$ 15,000
					Mob/Demob		$ 190,000
							$ 1,108,000
					20% contingency		**$ 213,000**
							$ 1,321,000

8.2. Unit Costs

Based on the responses from contractors and suppliers, EcoLogic has calculated an engineer's opinion of the unit cost estimates for sediment removal. Sediment removal is estimated to cost approximately $22.50 per cubic yard. This estimated cost is somewhat higher than reported for other NYS dredging projects. This reflects inclusion of a booster pump and more pipes, because of the distances and elevation changes to reach appropriate sediment dewatering sites. The geotube dewatering operation costs approximately $25 per cubic yard. The geotubes, polymer and effluent polishing are included in this cost. If additional treatment of the water is not necessary the cost decreases to approximately $20 per cubic yard. This does not include material removal. It anticipates either removal for a beneficial reuse of the material or removal from the tube and regrading on the site. If the material cannot be sold or removed for reuse, there would be an additional cost of approximately $10 per cubic yard for trucking and disposal.

Mobilization costs to Chautauqua Lake are anticipated to be high due to the location and the number of setups and takedowns of equipment at the various sites. As noted in Table 8-1, the costs for transporting the dredge and all other equipment to the site, setup, takedown and equipment return is $190,000. If not all sites are dredged in a single season the $190,000 cost will be incurred for each year that dredging occurs.

We were not able to obtain a detailed cost breakdown for the mechanical option using a Genesis system or similar technology. We cannot state with confidence that the $25 per cubic yard cost reflects significant power consumption and it certainly does not include the need for constant removal and trucking operations necessary during the entire operating hours each day. All of these issues need to be fully evaluated during the next step of the dredging design.

Given the imprecise cost estimates provided by the suppliers, and the conservative pricing given by the contractors, it appears that the unit costs will range from $55 to $60 per cubic yard if the sediment can be reused. The small amounts to be dredged and multiple setups and breakdowns necessary to work at the four selected creeks have a substantial impact on these costs. At this phase of the project, the confidence level in the cost estimate is low. Costs will be refined during preliminary design. The cost estimates received from the contractors appear to contain significant embedded contingencies that we accounted for where appropriate to develop reasonable estimates. Consequently, final costs may vary as much as 20% from the engineer's opinion of cost.

The cost estimates will reflect a higher level of confidence in the project's next phase, when a more detailed assessment of sediment treatability will be completed. In this next phase, sediment testing will be completed to refine the estimates of mechanical dewatering. With the conflicting information received from contractors and suppliers, the EcoLogic team is not confident that the geotubes would be able to meet anticipated effluent discharge requirements without additional treatment. Neither the supplier nor contractors were able to provide specific data from a site where geotubes were used for high clay particulate sediment removal. The costs will change substantially if additional treatment of the effluent is not required prior to discharge.

The costs for dredging, sediment treatment and disposal can be estimated on a per cubic yard basis. The cost for mobilization to and from the site, between sites and the site preparation for the geotube lay down areas are on an event basis; consequently, the number of sites dredged each year affects the total project cost. Unit costs are summarized in Table 8-2.

Note that land acquisition costs are not included in the estimate. As described in Section 6.4, potential areas for sediment handling were identified based on parcel size, proximity to the region proposed for dredging, and existing land use. Field visits to several potential sites were completed in late August, 2012.

Table 8-2: Unit costs for sediment dredging in Chautauqua Lake using hydraulic dredging and geotubes, water treatment required

Operation	Cost per cubic yd	Cost per activity
Dredging Cost per Cubic Yard	$22.50	
Geo Tube treatment	$20.00	
Water Polishing if necessary	$5.00	
Mobilization for season		$190,000
Mobilization between sites		$50,000
Site Preparation for sediment treatment per site		$15,000
Site Restoration and sediment disposal	$10	

A 20% contingency should be added to all totals developed using unit costs

Cost estimates for sediment removal from the Celoron/Burtis Bay area reflect the following assumptions (Table 8-3).

- The concentration of arsenic in the liquid phase is 1.0 mg/L. This estimate will be refined by additional sediment testing. The polymer testing required to optimize performance of the geotubes will also provide more accurate data for wastewater treatment design.
- Wastewater treatment may be affected by other chemical constituents in the water (e.g., dissolved solids).
- Two resin changes would be needed (there are insufficient data to support a more precise estimate).
- The wastewater volumes cited represent preliminary estimates for costing purposes. The duration of the wastewater treatment could last up to seven months.
- Solids disposal costs were the standard cost for disposal of contaminated materials at the Chautauqua County Landfill.
- Wastewater treatment includes tankage, utilities and waste disposal to be done by the renter/operator of the system.
- A State Pollutant Discharge Elimination System (SPDES) permit would be required from NYSDEC prior to construction or operation of a treatment facility; the SPDES application will require an engineering report and detailed plans.

- Site preparation will be more expensive for hydraulic dredging due to the need to have a more intensive containment system for the arsenic-contaminated water.

Table 8-3: Celoron/Burtis Bay Dredging Unit Costs

Operation	Hydraulic		Mechanical	
	Cost/Cyd ($)	Cost per Activity ($)	Cost/Cyd ($)	Cost per Activity ($)
Dredging	22.50		70	
GeoTube	25.00			
Water Treatment		405,250		80,500
Mobilization		190,000		500,000
Site Preparation		70,000		15,000
Site Restoration	5		5	
Silt curtain		included		75,000
Sediment Hauling	4.50		4.50	
Sediment Solidification			10	
Sediment Disposal	26		26	
Total	$83	$665,250	$115.50	$670,500

A 20% contingency should be added to the total estimated costs.

Table 8-4: Greenhurst Point Mechanical Dredging Estimates

Operation	Cost/cyd	Cost per Activity
Dredging	$25	
Hauling	$2.50	
Spoil Placement area prep		$15,000
Turbidity Curtain		$70,000
Silt Fence		$20,000
Total	$27.50	$105,000

A 20% contingency should be added to the total estimated costs.

9. Potential Funding Sources

Dredging is costly and funding is scarce. Most lake dredging projects designed to restore navigational and recreational use are ultimately funded from local sources. Outside of the Great Lakes, state and federal funds are primarily directed to restoring impaired flood control capacity or maintaining navigational access within the NYS canal system. As the Chautauqua Lake dredging project does not meet either of these criteria, competition for state and federal funding support will be intense. Most lake dredging projects to restore navigational and recreational use are ultimately funded from local sources. Potential funding sources are summarized below.

- NYS allocations of EPA funds (Clean Water Act)
    - Section 604 b money- passed through regional planning boards- typically small grants (40K)
    - Section 106 b- NYSDEC would need to advocate to EPA for fund allocation for the dredging project. There is a 50% match required. These funds are highly competitive.
- Member items requests
    - Congressional representatives
    - NYS senate and assembly representatives
- Grants from foundations, or gifts from advocates for Chautauqua Lake
- Low interest loans from NYS revolving loan fund for water and wastewater projects (NYS Environmental Facilities Corporation)
- Grant to a watershed municipality from the NY Dept. of State, Division of Coastal Resources- Local Waterfront Revitalization Program. There is a 50% match required.
- Local funds- watershed management program (funded, in part, by the Chautauqua County 2% occupancy tax)
- Municipal funds- towns, villages and county (challenged by the state's 2% property tax cap)
- Private business interests
- Revenue raised by creating a special benefit district and levying a tax

10. Preventative measures

10.1 Understanding which factors can be controlled

To build community support and gain regulatory approvals, any dredging project must consider a key issue: how can future sediment conveyance be minimized? An effective long-term strategy for minimizing the rate at which sediment enters Chautauqua Lake must understand the root causes of erosion and sedimentation, recognize the interplay of the natural and human-induced factors, identify which sources are potentially amenable to controls, and adopt strategies that will be effective.

Sediment is carried into Chautauqua Lake by water flowing across the landscape and through the tributary streams. Erosion of stream banks and beds is a major source of the sediment that has accumulated within the lake basin. The unstable stream channels characteristic of the Chautauqua Lake watershed are a result of several natural features: glacial history—loose, unconsolidated glacial till was left after the retreat of the Wisconsin glacier approximately 10,000 years ago; watershed topography; and the weather—high annual precipitation and a substantial snowpack contribute to spring flooding events.

In addition to these natural features, human-induced factors also affect the rate and amount of sediment that is conveyed from the watershed to the lake. For example, patterns of land use, impervious cover, surface drainage networks, vegetation, and many other factors affect both the potential for sediment loss and the way water moves across the landscape.

In New York State, there is a concerted effort to identify effective stormwater management strategies and transfer this knowledge to representatives of local government and other water resources management agencies. The ***New York State Stormwater Management Design Manual***, updated and revised in April, 2010, sets forth specific planning and design criteria to mitigate adverse impacts of stormwater on the state's waterways. Don Lake, DuLac Engineering was one of the primary reviewers of the NYS stormwater manual, and is a member of the project team working with CCPED. Mr. Lake and Mr. David Hanny of Barton & Loguidice P.C. provided a training session for Chautauqua County agency personnel and other water resources professionals in August 2012. The workshop agenda included reviewing structural and nonstructural measures to prevent erosion. A second workshop is planned for summer 2013.

Figure 10-1: Stormwater runoff (Don Lake)

10.2 Erosion diagnosis & mitigation engineering study

A companion project to the dredging feasibility study also began in 2012, led by Barton & Loguidice P.C. (B&L). This project focuses on identifying the root causes of sediment conveyance within two subwatersheds, Goose Creek and Dutch Hollow Creek. The project is designed to identify specific priority areas and develop conceptual designs for their remediation, and is envisioned as a pilot study that can be used to mitigate sediment transport from priority areas throughout the Chautauqua Lake watershed. The following description is summarized from the B&L report to CCPED, dated October 2012.

> *To complete this project, B&L scientists and engineers conducted a detailed physical assessment of the Dutch Hollow Creek and Goose Creek subwatersheds to evaluate land use, cover types, drainage and stormwater patterns and infrastructure, and other out-of-channel factors that potentially affect sediment transport to and by the tributary streams. The B&L team identified and mapped specific areas and factors that exacerbate erosion from the landscape and delivery of sediment to the streams. In addition, they identified areas where human-induced changes in land use or drainage patterns could indirectly increase sediment conveyance by increasing the rate and volume of runoff to the streams.* [7]

For the Goose Creek and Dutch Hollow Creek subwatersheds, B&L concluded that human contribution to sediment and erosion was small, compared with the natural factors of underlying geology and soils, topography, and precipitation patterns. The intact riparian buffers along the streams help mitigate potential for adverse impacts of agriculture and residential development.

> *"On the whole, human activities in the watershed represent minimal direct impact to the physical stability of the stream system. Identified types of direct impacts include poor roadside ditch maintenance and performance, ditching of streams and field drainage to expedite runoff,*

[7] Barton and Loguidice. October 2012. *Watershed and Stream Assessment: Report of Findings Goose Creek/Dutch Hollow Creek Watersheds.* Report to CCPED

accelerated runoff and erosion associated with sand and gravel mining, and alteration of stream channels. "[7]

The B&L erosion diagnosis & mitigation engineering study identified several priority sources of sediment and erosion within the pilot subwatershed areas, as summarized below. It is likely that these sediment sources will be significant in the other regions of the Chautauqua Lake watershed as well. The listing order for these sources does not reflect their relative contribution of sediment to Chautauqua Lake.

- Roads and roadside ditches – notably, maintenance practices that leave ditches unvegetated
- Sand and gravel mining
- Stream channel erosion

10.3 Remedial strategies

Once the most significant sources of sediment have been identified, the watershed community can focus on defining effective remedial measures. Again, the B&L engineering study provides important information gathered in the two pilot subwatersheds. Five recommended remedial strategies are summarized in this section; a detailed presentation is in Barton & Loguidice 2012.

- Stabilization of roadside ditches, using geotextile fabric and vegetative cover along the bottoms of the ditches to prevent continued erosion. Other recommended structural improvements include designing outlets, stilling basins, and check dams. Additional training of municipal highway staff is recommended as well.
- Streambank grading and thalweg control. The thalweg is the region of the stream channel that carries the most flow (usually the deepest part of the stream profile). This is a streambank restoration approach designed to stabilize eroding banks, provide additional flood flow storage, and divert high velocity stream flow away from the banks.
- Natural stable channel design (NSCD). The NSCD approach to stream restoration strives to provide long-term channel and streambank stabilization by returning an impaired reach to the physical form (cross-section, sinuosity, slope, and floodplain connectivity) needed to sustain flood hydraulics that match the water and sediment load.
- Mud sills. Construction of a mud sill allows for reconstruction of eroded portions of the streambank, restoring the stream channel to its pre-erosion position and reducing sinuosity and near bank stress while at the same time correcting the steepened condition of the eroded bank. In addition, the mud sills can enhance aquatic habitat.
- Floodplain benches. In situations where the stream would benefit from additional floodplain, but this option is constrained by high banks, nearby infrastructure, or areas that cannot be flooded, construction of a floodplain bench may be a viable option. The bench will help protect the streambanks from erosion by high flows.

10.4 Education and Outreach

Stormwater management is a major component of reducing sediment loads to receiving waters. Educating and training the general public, planning board members, elected municipal officials, design

engineers, highway department personnel, contractors, and facility owners and operators is essential for a successful program. A watershed-wide education program should be developed for all aspects of stormwater management. This program should include training and education on construction site erosion and sediment control, post construction stormwater management, illicit discharge detection and elimination, and training for local highway staff.

Figure 10-2: Industrial operations in proximity to Goose Creek (Don Lake)

The Cornell Local Roads Program is updating their training program for local highway departments; the program will be available in Fall 2013. Additional stormwater management courses have been developed within New York State and can be used to support the objectives of the Chautauqua Lake Watershed Program.

Figure 10-2: Large impervious area in upper Dutch Hollow Watershed (Don Lake)

11. Conclusions

This Dredging Feasibility Study was initiated to provide a realistic assessment of the costs, benefits, permit requirements and associated environmental issues associated with dredging selected regions of Chautauqua Lake. The EcoLogic team began working with CCPED and others in early 2012. We reviewed existing data and designed of a focused field program to identify specific regions of the Lake's nearshore zone impaired by excessive sedimentation. During the summer 2012 field program, staff surveyed segments of the littoral zone, tested the quality of the sediments, selected appropriate technologies for sediment removal, and developed unit cost estimates. We also reviewed the regulatory environment, documenting the permits and approvals needed to implement a dredging program.

We conclude that dredging sediment from nearshore areas of Chautauqua Lake is feasible, but costly. Because much of the shoreline and nearshore areas have been developed for residential and commercial uses, we were not able to identify a large land parcel in public ownership near the Lake that could serve as a sedimentation basin to dewater large amounts of dredged materials. The cost estimates presented in this report consequently reflect a decentralized approach; we recommend developing multiple smaller sediment handling facilities adjacent to the nearshore areas selected for dredging.

Following a review of dredging and dewatering technologies, we concluded that hydraulic dredging is the best approach for removing sediment from most regions of Chautauqua Lake, and that geotubes are the most suitable means of dewatering. Geotubes require a much smaller footprint for dewatering, as compared to sedimentation basins.

There is one notable exception to this overall conclusion. Mechanical dredging is recommended for the Burtis Bay/Celoron region. Analysis of sediment cores collected in this southern portion of the Lake detected elevated levels of arsenic, likely due to application of arsenic-containing herbicides between 1955 and 1961. The arsenic levels measured during the 2012 field investigations indicate that the sediments will be classified as moderately contaminated, and must be handled and disposed of with special care. In particular, the water associated with the contaminated sediments is projected to exhibit arsenic concentrations well above NYS ambient water quality standards. Water must be treated prior to discharge in order to reduce arsenic levels. Mechanical dredging generates far less water than hydraulic dredging; consequently, mechanical dredging of the arsenic-contaminated sediments would more cost effective.

The feasibility report includes an "engineer's opinion of cost", which includes a substantial contingency for uncertainty. Unit costs are calculated assuming that most of the material is removed using hydraulic dredging and pumping the dredged material into geotubes. Additional costs would be incurred for equipment, site preparation, permitting, and ultimate disposal, as described in detail in the report. For planning purposes, consider that dredging five priority regions of Chautauqua Lake, to remove a total of about 126,000 cy of deposited sediment would cost around ten million dollars (assuming $80/cy, not including any land acquisition costs). This cost estimate includes a generous contingency. Refined cost estimates produced in future phases of the project as more detailed information becomes available

would likely be somewhat below this number. There are very limited sources of funding available to assist local communities with implementing dredging projects.

Dredging will require a number of regulatory approvals and permits from various state, federal and local agencies, and will be considered a Type 1 action under the State Environmental Quality Review Act (SEQRA), triggering preparation of a Draft Environmental Impact Statement (DEIS). While one entity must assume lead agency status, the dredging project (or projects) will require a coordinated review by multiple involved agencies and interested parties.

Erosion and sedimentation from the Lake's large watershed will continue. Dredging can help mitigate past sediment deposits, but effective erosion control measures must be in place to reduce the rate of future sediment deposition. Implementation of the recently-approved phosphorus TMDL is likely to result in reduced sediment inflows to Chautauqua Lake as well, in light of the highly aggressive target reductions for runoff from agricultural and residential lands. Efforts to reduce phosphorus loading from these land uses are certain to have ancillary benefits in reducing sediment and other potential contaminants as well. A brief review of strategies for effective stormwater management is included in this dredging feasibility report. There is much additional information in the October 2012 report by Barton & Loguidice, P.C.

Most lake dredging projects designed to restore navigational and recreational use are ultimately funded from local sources. Outside of the Great Lakes, state and federal funds are primarily directed to restoring impaired flood control capacity or maintaining navigational access within the NYS canal system. As the Chautauqua Lake dredging project does not meet either of these criteria, competition for state and federal funding support will be intense.

Two issues complicate efforts to implement a large-scale dredging effort in Chautauqua Lake. The first issue is the elevated arsenic content of sediments in the Celoron/Burtis Bay area, which is the community's top priority area for dredging. The elevated arsenic levels do not preclude dredging, but they greatly increase the costs. Both the sediments removed from the Lake and the associated water content of those sediments would require special handling. Options for sediment disposal are limited, and would most likely be sent to the Chautauqua County Landfill for disposal or use as cover material. Sediment pore water would most likely required advanced treatment prior to its return to the Lake. The second issue is the lack of a suitable large site close to the Lake that could serve as a centralized sediment management facility. The Lake shoreline and watershed areas are quite developed. Sediment dewatering, consequently, would have to occur at various smaller sites proximate to dredged areas.

APPENDIX 1: LITTORAL ZONE CHARACTERIZATION: *PHOTO ATLAS*

EcoLogic

Photo 1. Prendergast Point.

Photo 2. Prendergast Point wetland area.

Photo 3. Prendergast Creek channel and Snug Harbor marina.

Photo 4. Snug Harbor Marina in Prendergast Creek.

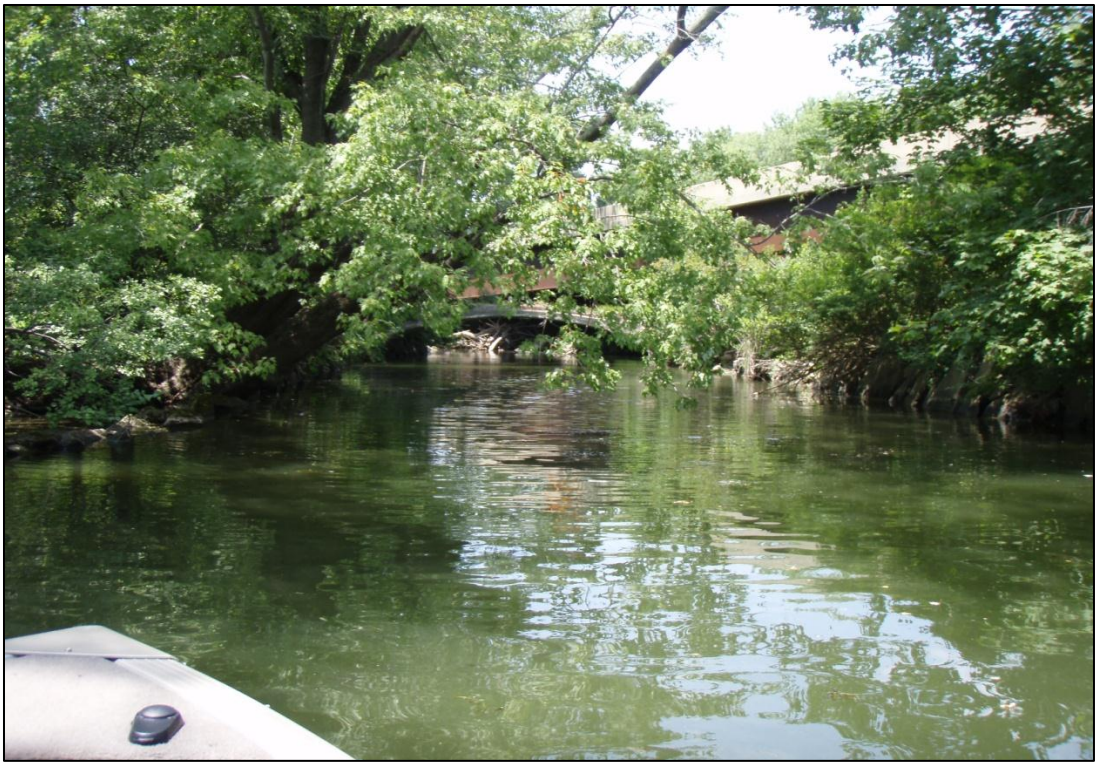


Photo 5. Ball Creek channel

Photo 6. Ball Creek mouth.

Photo 7. Dewittville Creek mouth and gravel shoal.

Photo 8. Good fish habitat South of Dewittville Creek mouth.

Photo 9. Bonita Area with abandoned boat docks.

Photo 10. Bonita area emergent vegetation.

Photo 11. Clear Creek mouth and channel

Photo 12. Clear Creek gravel and sand buildup with mallard ducks.

Photo 13. Burtis Bay, Ready About Sailing marina and emergent vegetation.

Photo 14. Burtis Bay looking southeast towards outlet.

Photo 15. Mud Creek channel.

Photo 16. *Unionidae* freshwater mussel shell found within Mud Creek channel.

Photo 17. Shore Acres Boatyard.

Photo 18. Arnolds Bay with floating weeds from plant harvesters.

Photo 19. Within Goose Creek channel, looking out towards mouth.

Photo 20. Channel into Goose Creek.

Photo 21. Ashville Bay marina.

Photo 22. Ashville Bay.

Photo 23. Maple Bay, looking south towards Smith Boys marina.

Photo 24. Smith Boys marina.

Photo 25. Big Inlet channel.

Photo 26. Big Inlet channel mouth, looking South.

Photo 27. Dutch Hollow Creek channel entrance and delta.

Photo 28. Water chestnut floret found at Dutch Hollow Creek.

Photo 29. Cheney Point

Photo 30. Cheney Point area buoys marking weedy areas.

Photo 31. Bemus Creek channel with kayakers.

Photo 31. Bemus Creek channel and delta at creek mouth.

APPENDIX 2: RESULTS OF OPINION SURVEY

Appendix 2

Results of the User Opinion Survey

Background

This dredging feasibility evaluation focuses on the potential costs, benefits, and permitting issues associated with sediment removal from selected nearshore regions of Chautauqua Lake. In order to identify priority areas, the EcoLogic team gathered input from lake users regarding how, and where, sedimentation affects their uses of the lake. We developed an opinion survey, consisting of 25 questions, and used the survey in the online application, Survey Monkey. For those without access to a computer, or wanting to share their thoughts in greater detail, EcoLogic offered the opportunity to complete the survey by telephone. This stakeholder outreach effort was conducted between June 19th and August 6th 2012.

Notice of the availability of the survey, including a request for participation, was emailed to a contact list generated by the CCPED; the list included several types of lake users (Table 1). In addition, we assisted CCPED with a press release for publication in local print and on-line media. Our objective was to gain an understanding of how sedimentation affects the ability of business owners, residents and visitors to enjoy Chautauqua Lake.

Table 1. Examples of stakeholders by interest category

Interest Category:	Examples:
Water contact (boating, fishing, swimming)	Marinas, Tourism, Commercial Mariners, Lifeguards
Water quality and aesthetics	Shoreline residents and recreational users
Economic development	Business owners, real-estate developers

The remainder of this Appendix is a presentation of the survey results. A total of 95 responses were received. Of these, 78 were submitted on line and 17 were completed during a telephone interview. The questionnaire included 19 questions requesting a quantitative response; the final six questions were open-ended. Results of the quantitative survey questions are displayed graphically. We have organized responses to the open-ended questions in categories; these results are presented in tables.

Introductory Screen (or guide for telephone survey)

"Welcome to the {online} survey to assess public opinion regarding your uses of Chautauqua Lake, and to identify areas where recreational access is impaired by sedimentation and the growth of aquatic plants. This is a joint project of Chautauqua County Department of Planning and Economic Development (CCPED), Chautauqua Lake Management Commission (CLMC), EcoLogic, and Barton & Loguidice.

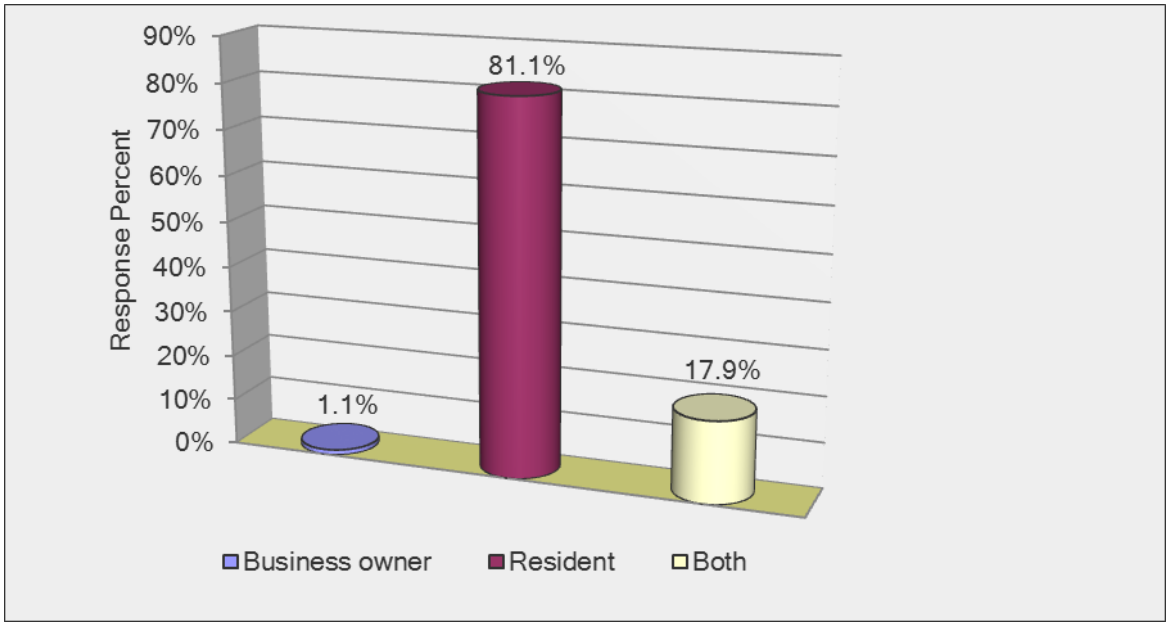
We recognize that the local community is a primary source of information regarding how the lake is used, and how sedimentation and plant growth are affecting those uses. We look forward to hearing your perspectives.

The survey should take about 10 minutes to complete. Your confidential and anonymous responses will be submitted when you click on the "DONE" button at the end of the survey. For more information about the project, please visit the project website at
www.ecologicllc.com/chautauqua-implementation.html

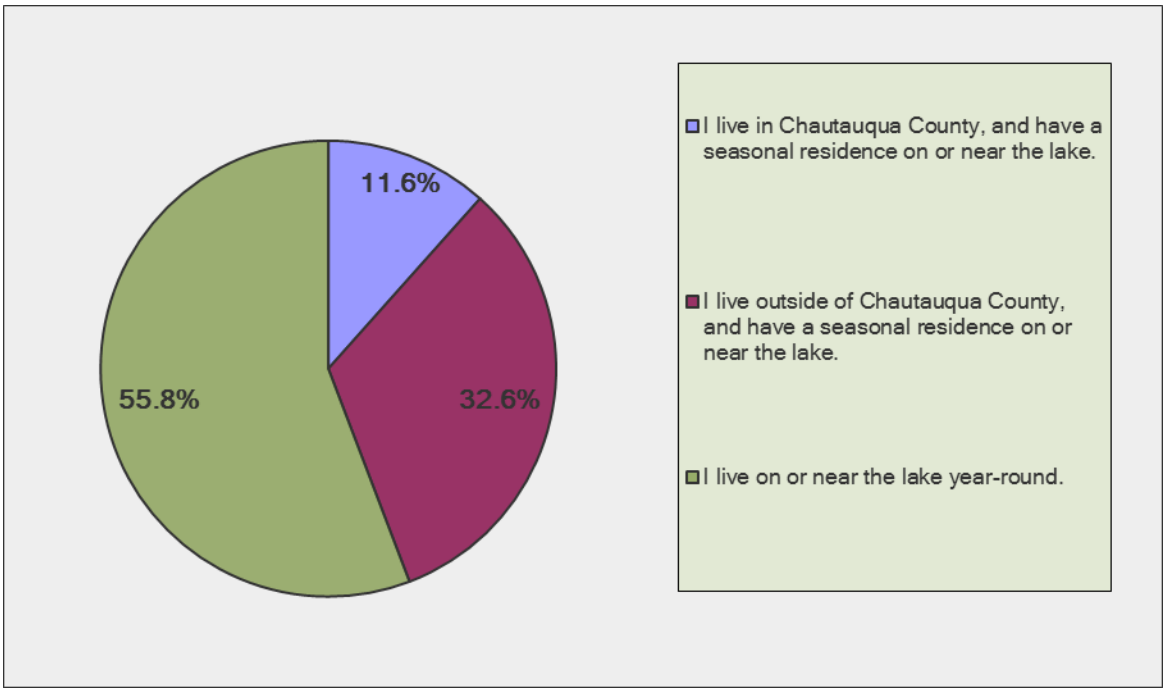
Please answer the following questions by clicking the box next to the response that most closely describes your opinion. Some questions allow for more than one response, and others ask you to rank your opinion on a scale."

Results- By Survey Question

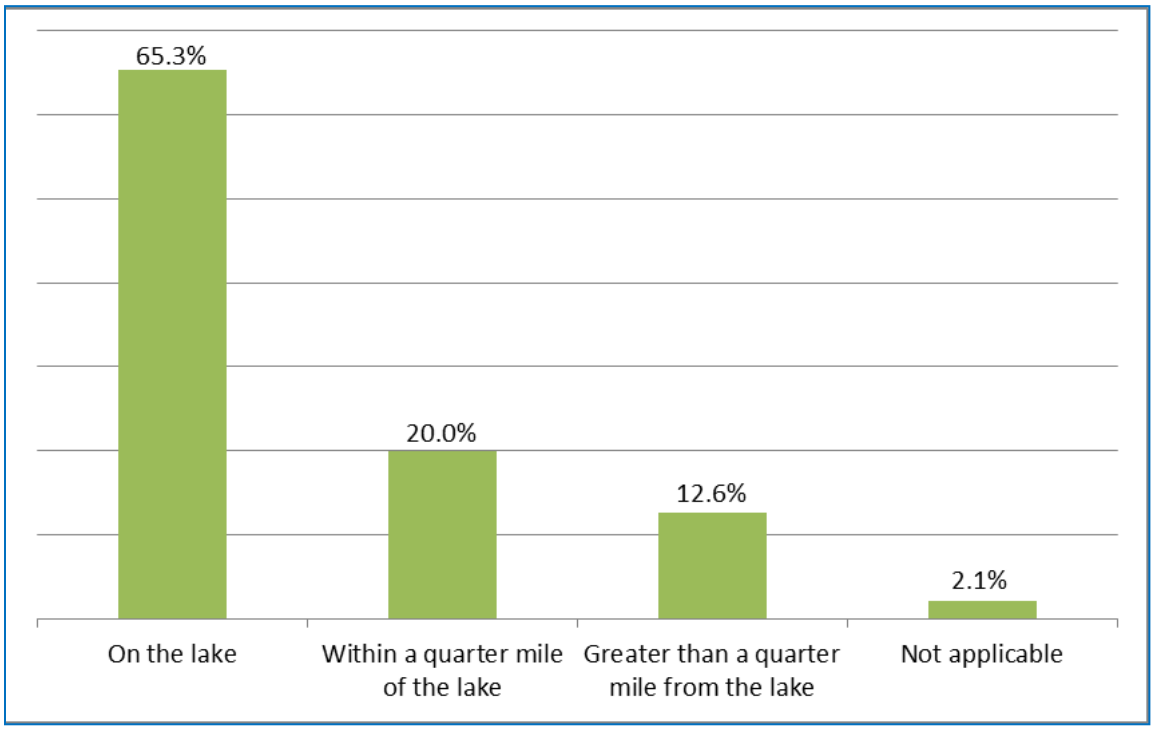
1. **Are you a business owner or resident of the Chautauqua Lake area?**



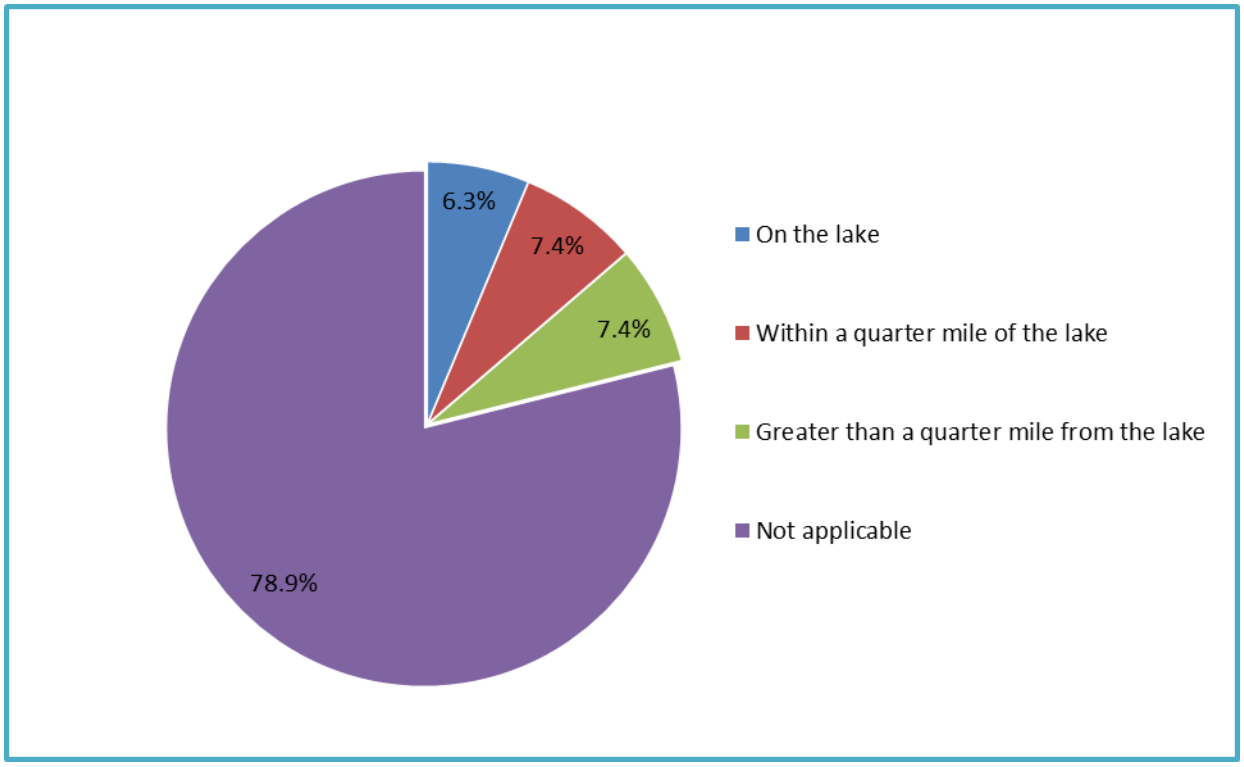
1. **Are you a seasonal or a year-round resident of the Chautauqua Lake area?**



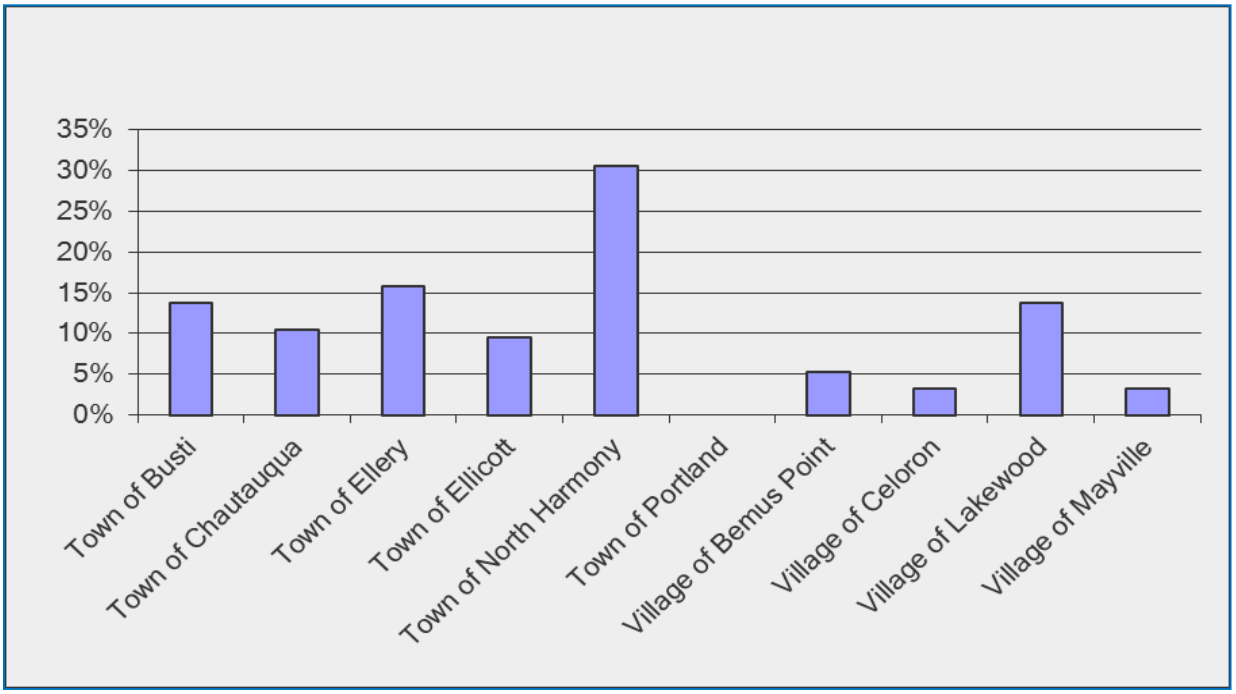
2. How close is your residence to Chautauqua Lake?



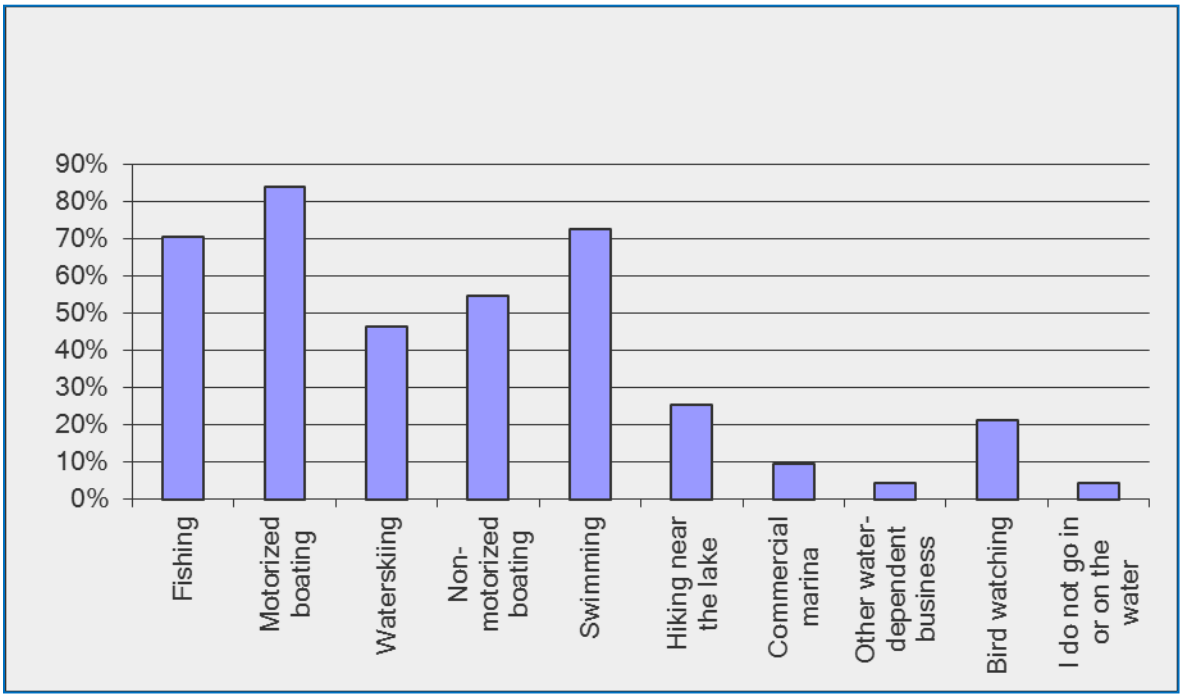
3. How close is your business to Chautauqua Lake?



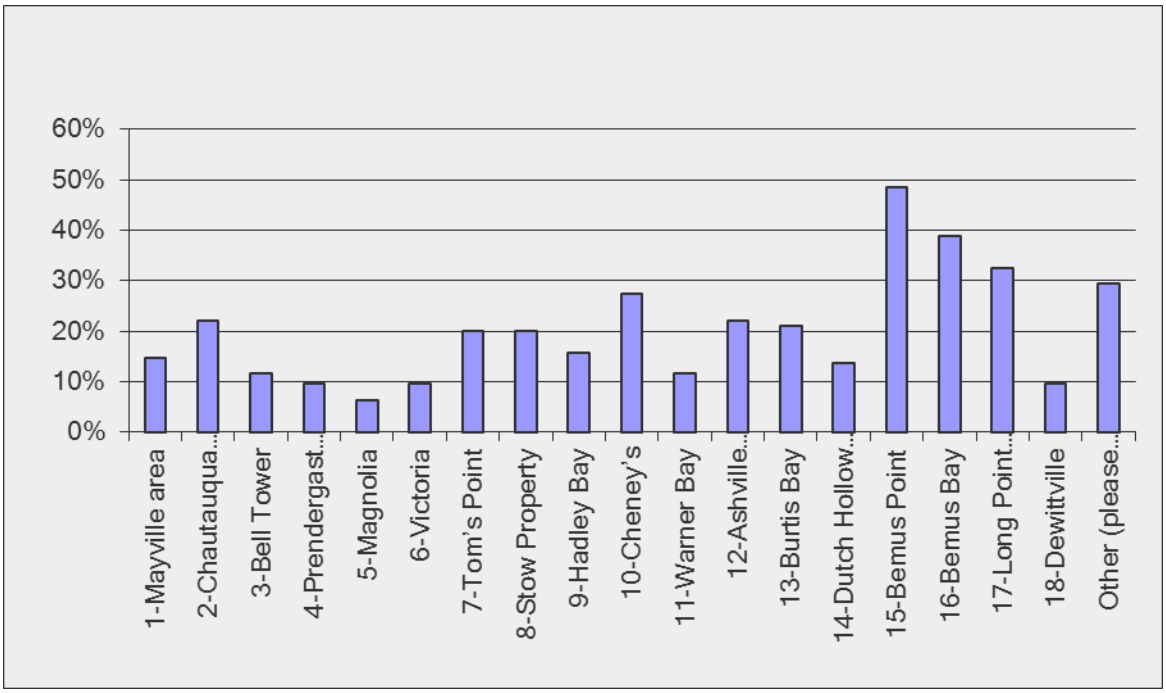
4. Please indicate the location of your residence or business



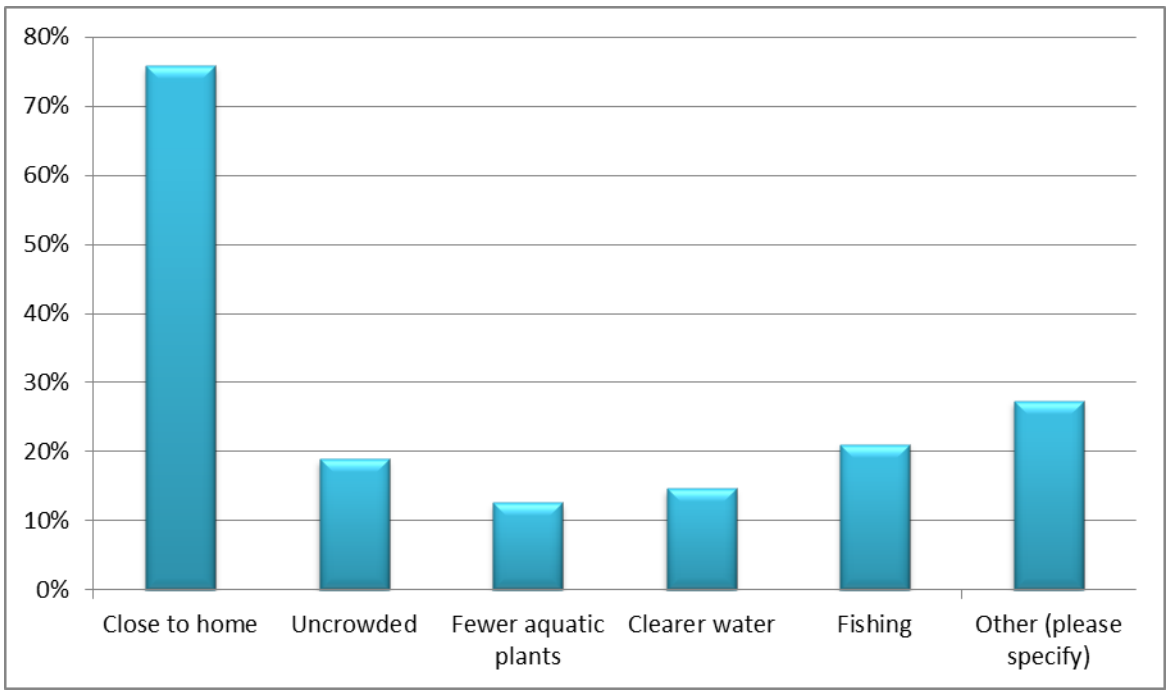
5. How do you use Chautauqua Lake? (You may select multiple responses.)



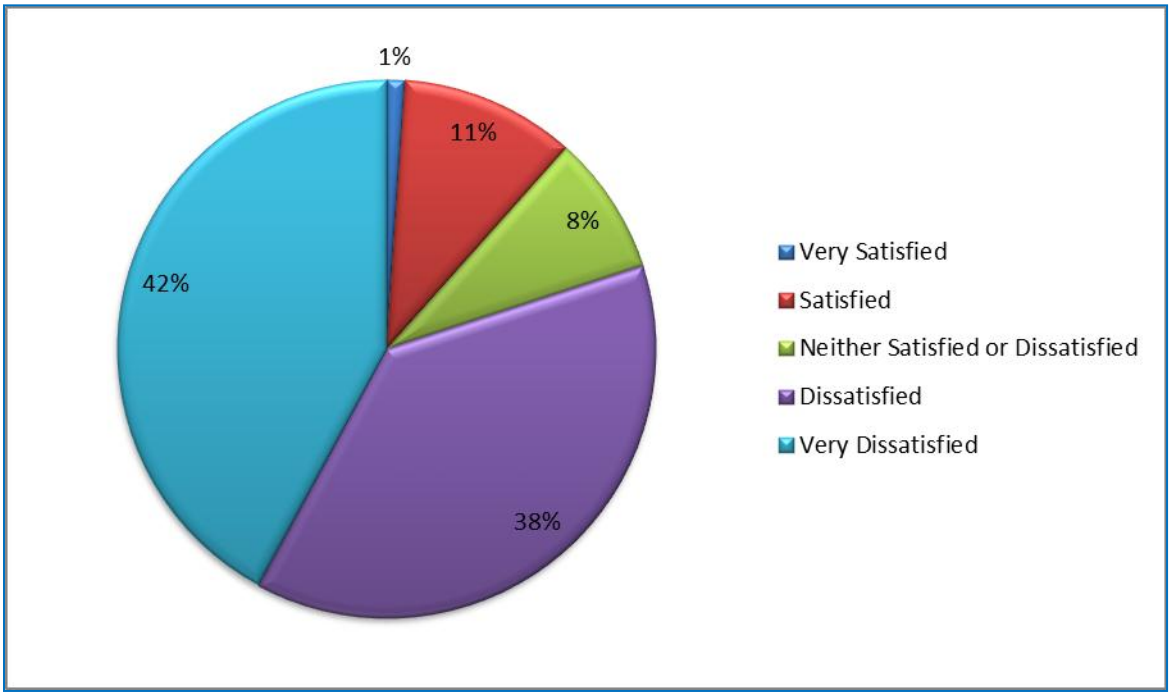
6. Which regions of Chautauqua Lake do you use most frequently?



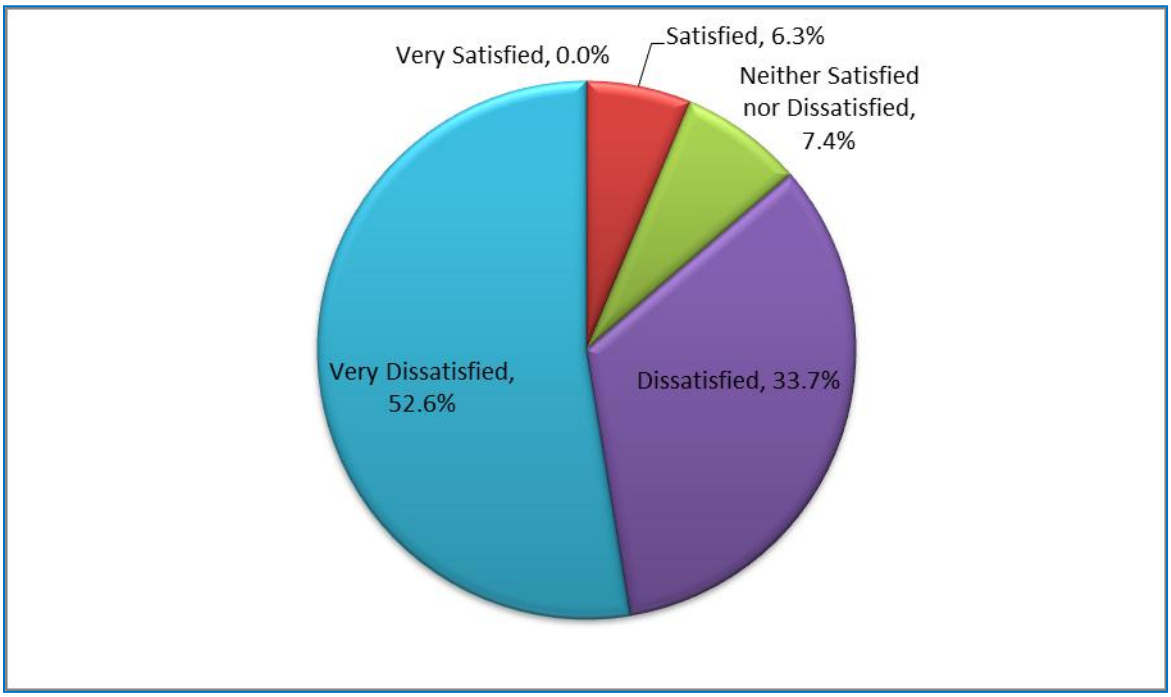
7. Why do you prefer this specific area of Chautauqua Lake? (You may choose as many options as you like from the list or enter your own.)



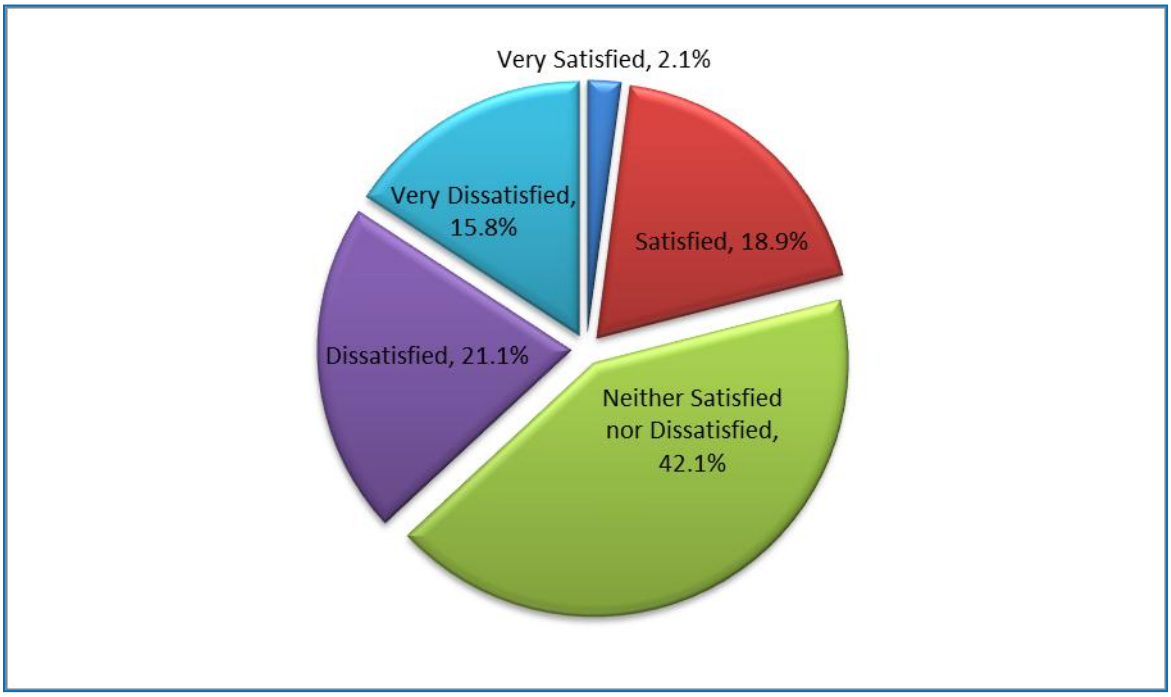
8. How satisfied are you with the overall condition of Chautauqua Lake with respect to water clarity?



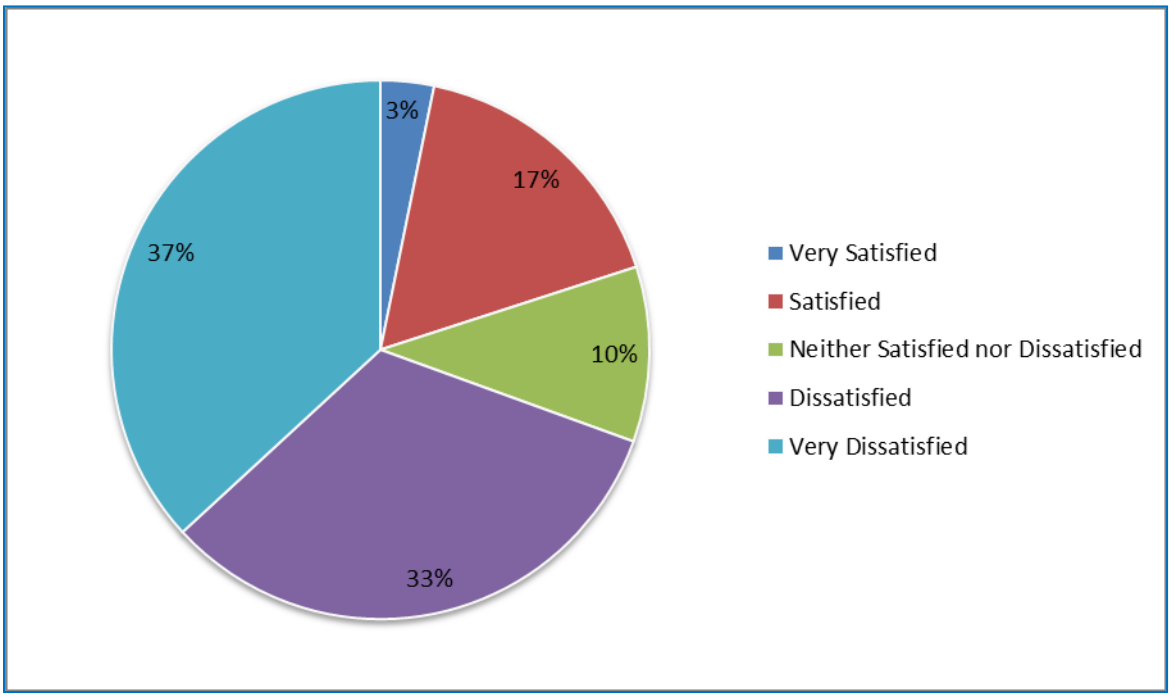
9. How satisfied are you with the overall condition of Chautauqua Lake with respect to swimming?



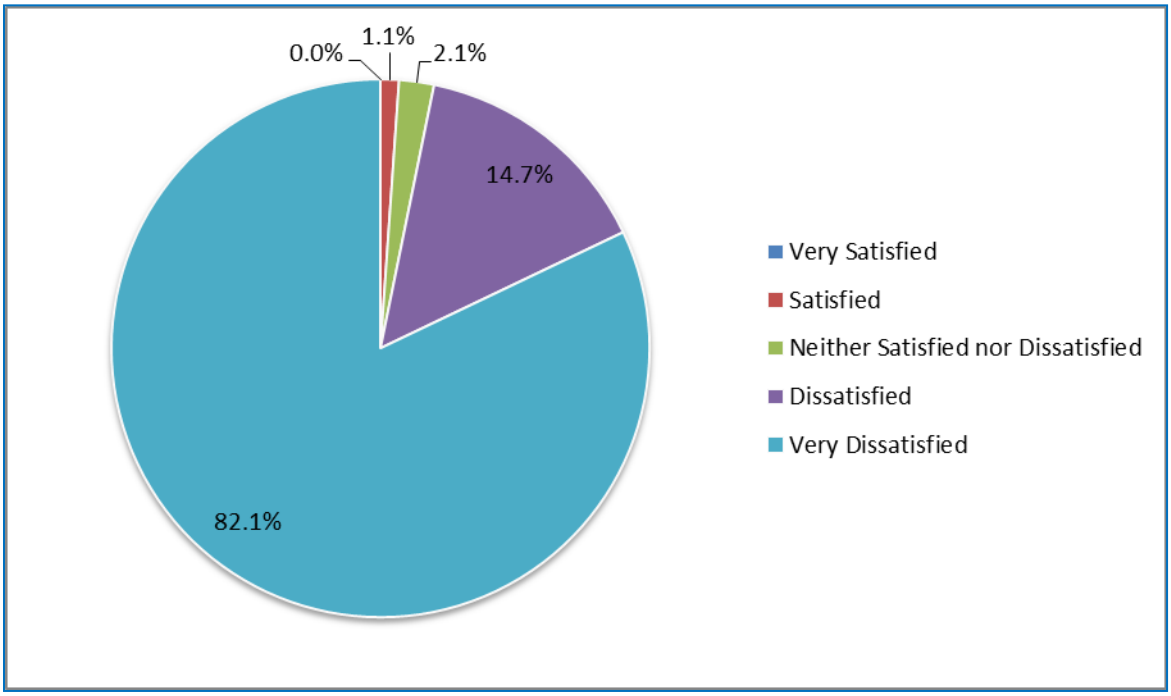
10. How satisfied are you with the overall condition of Chautauqua Lake with respect to fishing?



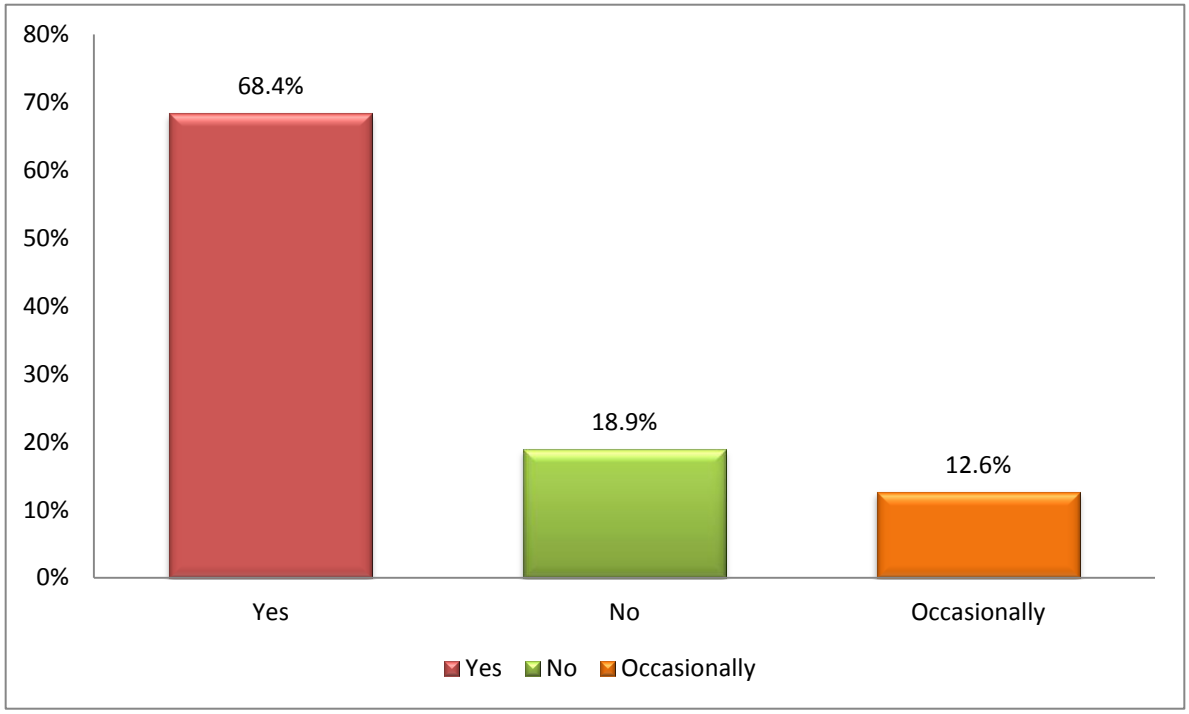
11. How satisfied are you with the overall condition of Chautauqua Lake with respect to navigation?



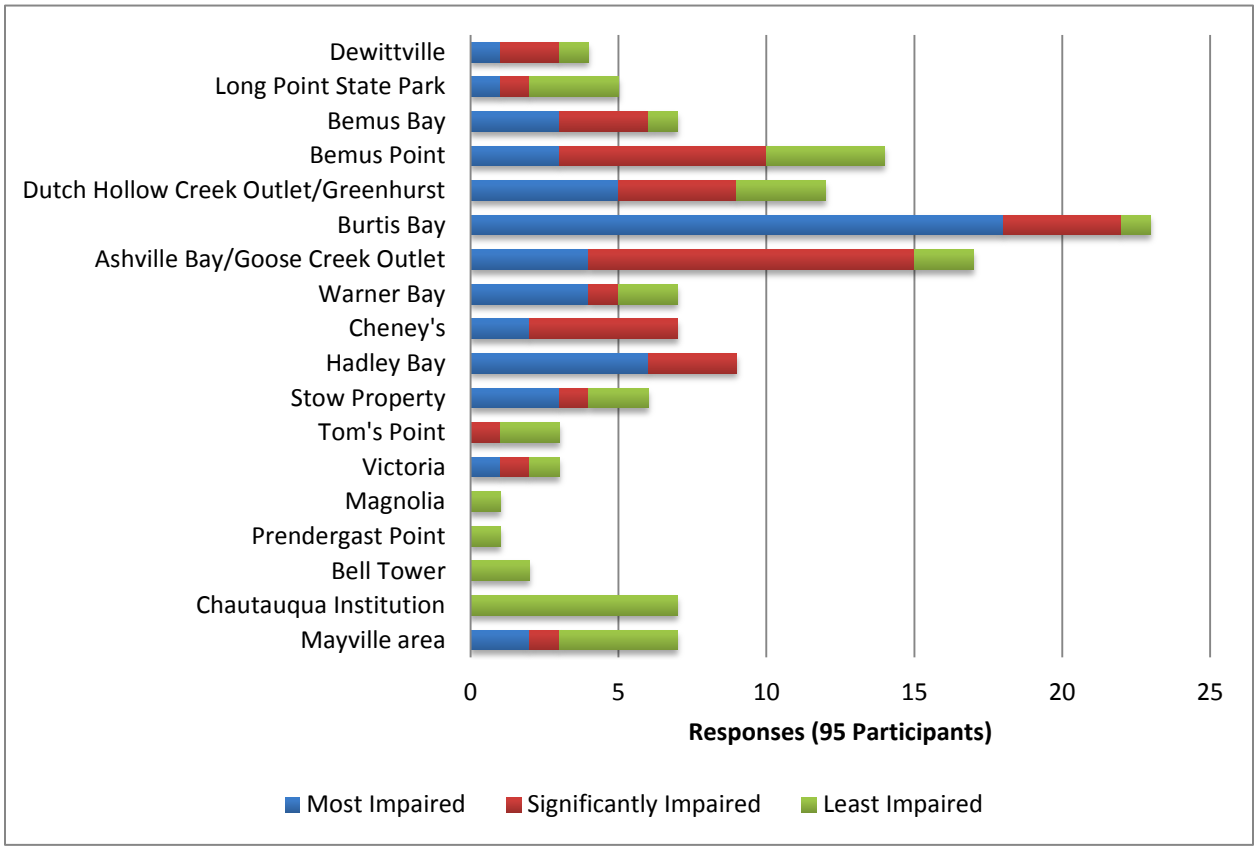
12. How satisfied are you with the overall condition of Chautauqua Lake with respect to the level of aquatic plant growth?



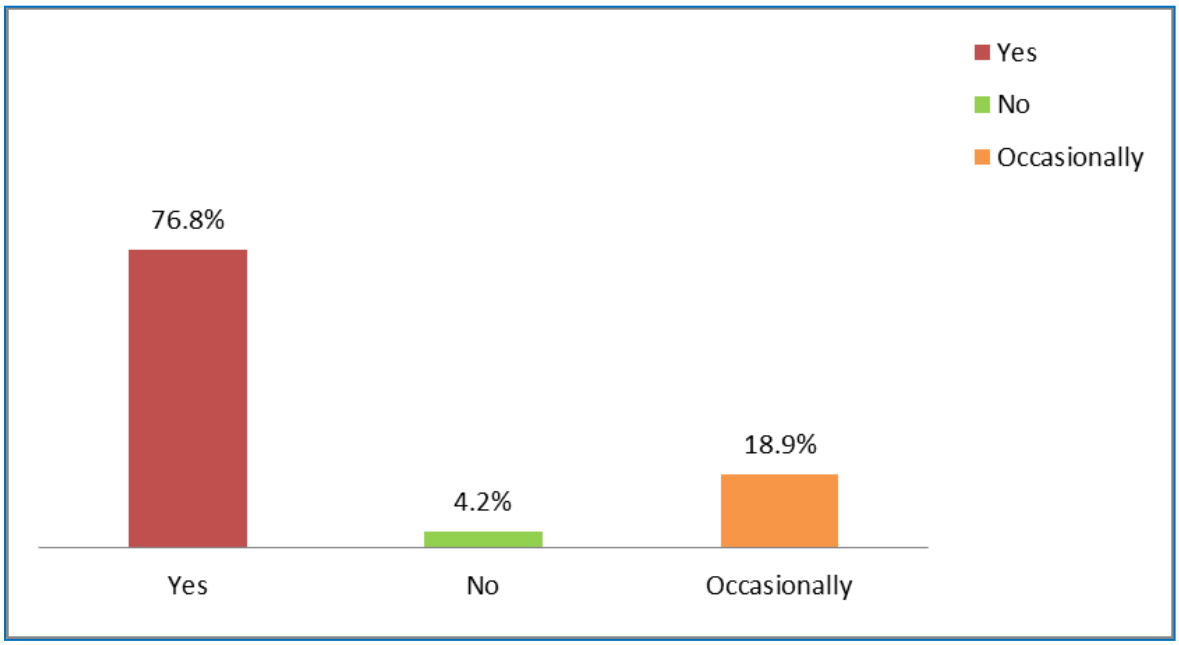
13. Does sedimentation interfere with your ability to access or use Chautauqua Lake?



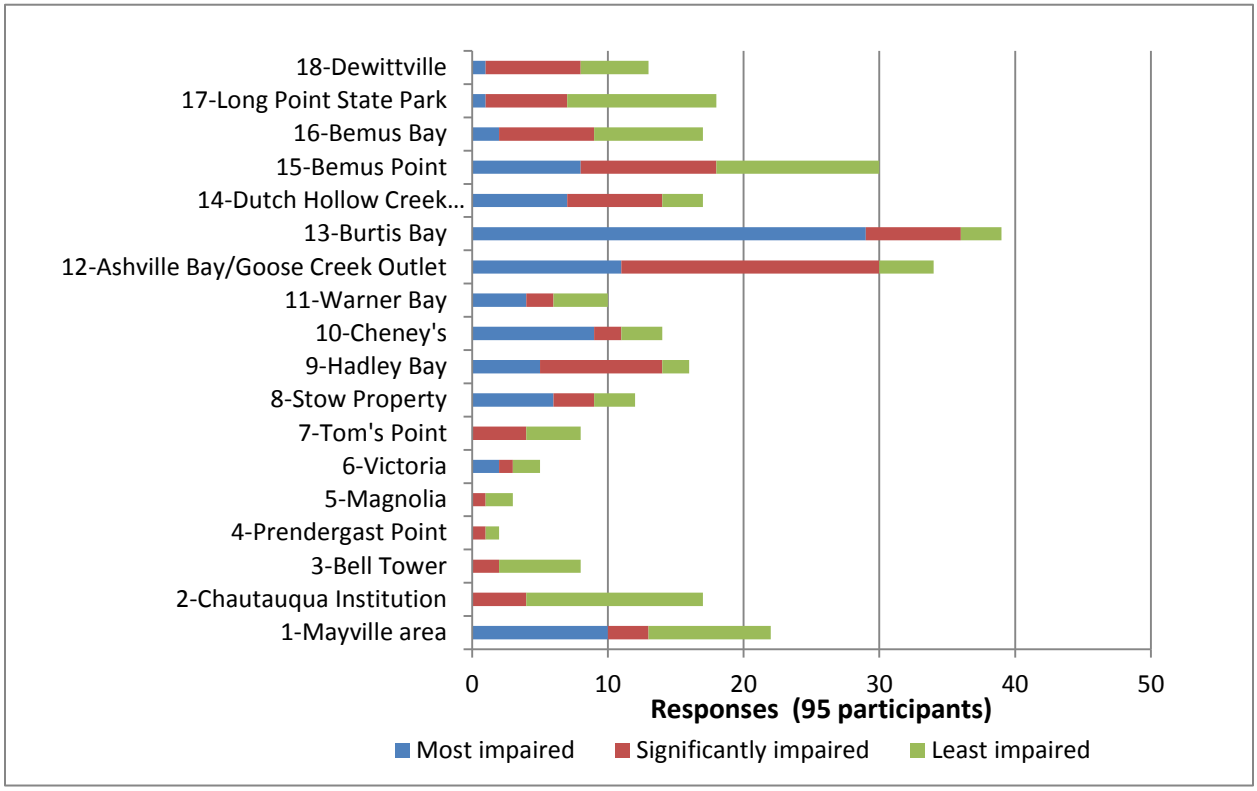
14. If you responded "yes" or "occasionally", please identify where sedimentation is causing the greatest problem for you. Please identify three areas from the list provided. A map is included depicting numbered site locations. Please rank the extent of use impairment.



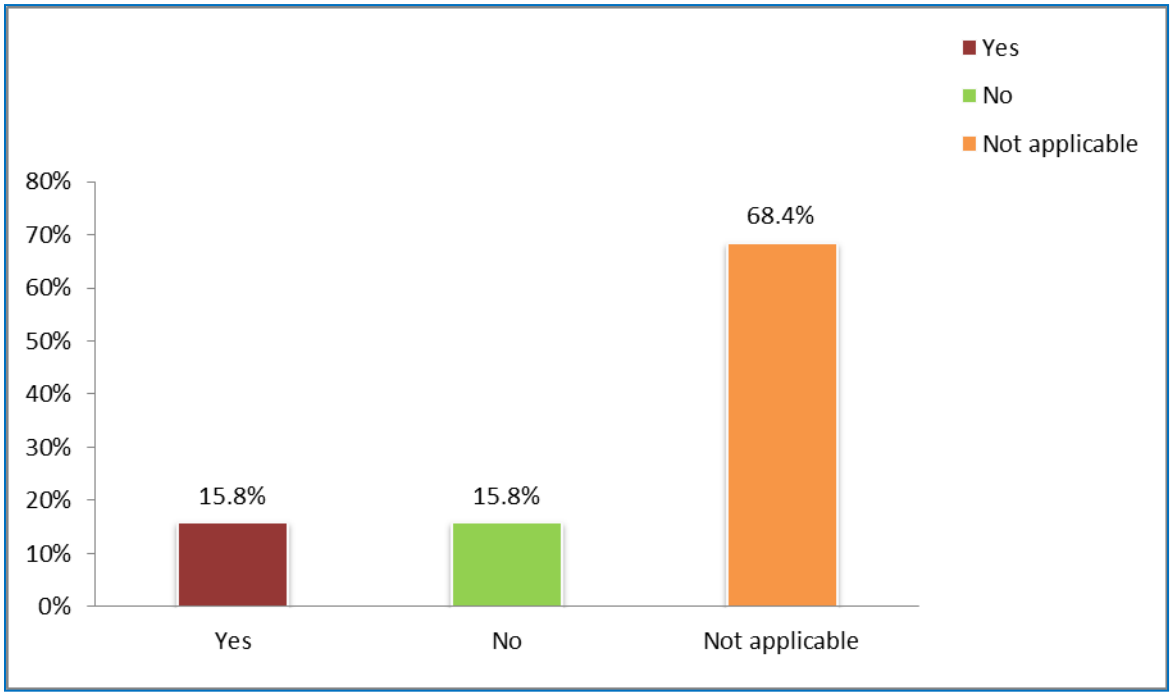
15. Does aquatic plant growth interfere with your ability to access Chautauqua Lake?



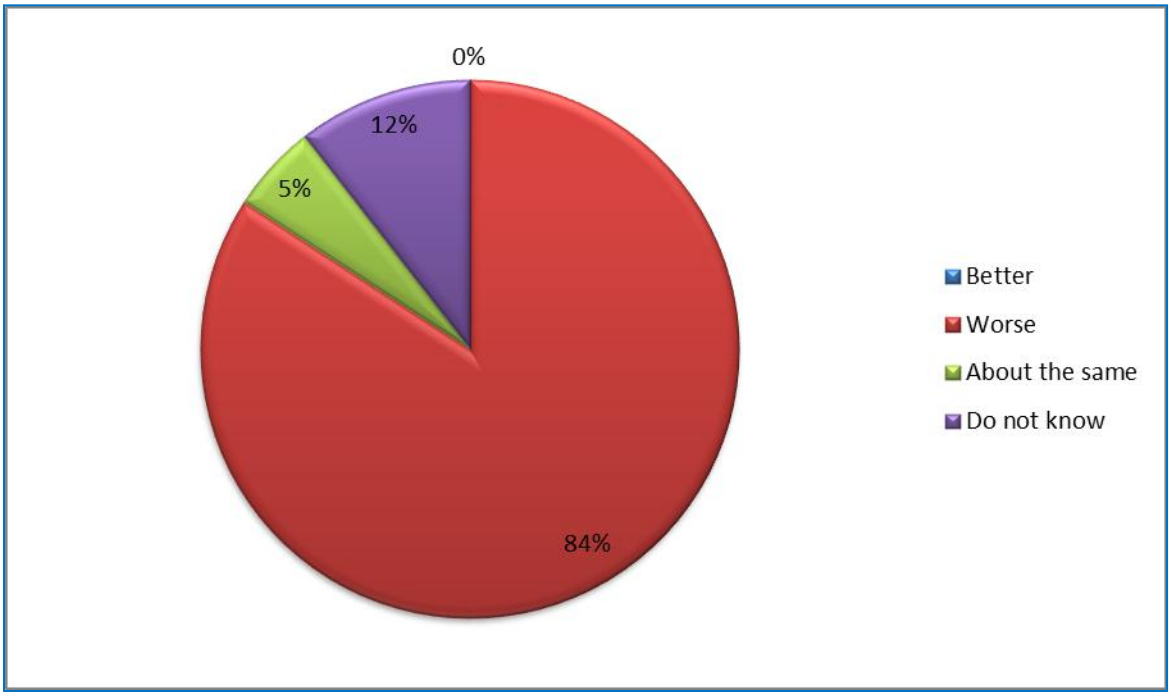
16. If you responded "yes" or "occasionally", please identify where aquatic plant growth is causing the greatest problem for you. Please identify three areas from the list provided. A map is included depicting numbered site locations. Please rank the extent of use impairment.



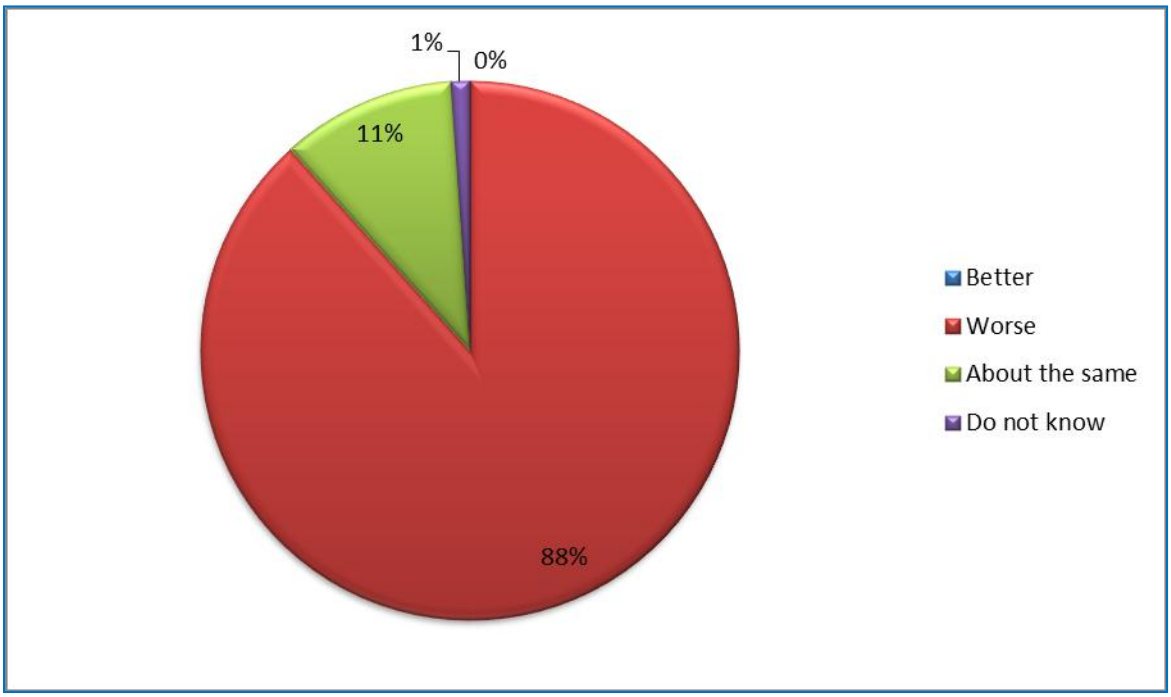
17. Does your business rely on the quality and/or depth of Chautauqua Lake?



18. Do you think the sediment levels in Chautauqua are better, worse or about the same as 5 years ago?



19. Do you think the aquatic plants in Chautauqua are better, worse or about the same as 5 years ago?



20. If certain nearshore areas of Chautauqua Lake are dredged to remove sediment, how might your uses of the lake change?

Activity	Lake Use Change
Boating/Fishing	• I would boat more. Trying to get out of the very north end along Sea Lion Drive area is terrible. When July comes there is not enough water depth to get my boat into the dock it is so shallow. And I do not have a big boat. • We could avoid having to worry about the amount of seaweed determining where we drive our boat. • I would definitely be on the lake 4-5 times a week and all weekend long. I miss boating to the restaurants on the lake. • Safer navigation and a reduction in damage to prop and lower drive unit. • I would be using the newly dredged area if able to access by boat. • I would be able to take my boat into the lake without having to get out of my boat and push it over the sediment bar at the mouth of Goose Creek. • We would definitely be on the water more knowing that we are able to navigate these areas where like to go without having to get tangled up in weeds or better yet get stuck in the sediment trying to navigate from the docks. • The quantity of times we would take out our boat would increase. • Be able to go more places with deeper water and less weeds. • Certain areas would be more accessible, creek deposits wouldn't shrink the lake size and I wouldn't have problems with running aground. • Improved access to dusk to dawn boating-fishing. • Visit more friends by boat who live on the lake • Shallow rocky bottom areas that have been covered with sediment would restore plant free smallmouth bass habitat in the 4-8' depths, making bass fishing more accessible. • Fish more parts of the lake. • Able to fish and ski in bay area closer to shore. • Better use by larger. deeper draft sailboats, which are slipped in

Activity	Lake Use Change
	Celoron at our marina • I would use it. We have stopped all activities on the lake within the last 5 years. Boating and skiing would be priorities. Also going out to dinner using the boat as transportation. • It would make it better to get the boat in and out of the lake. Also, it is almost impossible to troll while you are fishing because it is so shallow. The lake smell is so bad it is hard to live this close to it at times.
Swimming/Watersports	• I might use the lake again for swimming. As it stands, it's much too dirty to swim in most locations. • More waterskiing and swimming. • We could finally feel good about getting into the water again. • If it reduces the blue-green algal blooms, it would increase the swimming season. • It would make swimming more enjoyable. • Swimming will be better, and access to boats and docks will improve. The bottom of the lake will be less conducive to weed growth. • More water sports/skiing and more use of lake for entertainment. • I could swim in front of my property again. • We would swim throughout the season- currently we don't swim, jet ski, water ski or tube behind boat once the algae bloom. • It would provide us with a Lake we can use for swimming and water sports which are our family's most frequent Lake use. It would be nice to be able to have our grandchildren swim around our dock area which, this year, even in June is not feasible. Though we do not own a business, we do pay hefty taxes and if property values are affected by the deterioration of the Lake environment, the area and all residents will feel the impact.
Real Estate	• I would be much more likely to invest in a home on the lake in the near future with a dredging plan in place. • The delta at the mouth of Goose Creek is now 12"-18" which restricts some boats access limiting the ability to rent property which contributes to the local economy. • Will likely invite more visitors to the area to enjoy the lake, bringing tourist dollars to the area.

Activity	Lake Use Change
	• It would ultimately add to the tourism, pumping up the economy and helping our real estate market. • Visit lake more often and throughout more of summer. • It would not only increase my use but would significantly increase the use by other home owners and renters on Bemus Creek. The number of boats on the creek for lake access has decreased from more than 10 when I came here, to only mine today due to the closing of the mouth of Bemus Creek.
Aesthetics	• We will be able to resume our recreational use of the lake and shoreline. • Navigation would be enhanced. Aesthetics would be improved and long term shoaling (and loss of depth) would be reduced. • It would make areas more accessible. It would also prevent aquatic vegetation from creating unpleasant smelly murky water. It would decrease the allergens in the air and water. It would reduce the presence of Mosquitos and other types of swamp inhabitants. • Friends from out of state would be more likely to visit and use of the lake. • It would be a pleasure to bring guests to my lakefront cottage rather than an embarrassment!!!! • Dredge by the outlet and all the weeds would go flow down it. This lake should have been dredged years ago. They did it at Sturgeon Point and it is a beautiful area today.
General	• Won't change • Probably wouldn't change that much • We would use more of the lake. • Significantly greater use. • I have lived with the heavy sediment so long that it is unknown how the dredging would impact my use of the lake. Obviously I would use the lake more. • Would use/enjoy the lakefront more. • My use would more than likely improve! I have lived on the lake all of my life- 60 years. When I was a child, we would see posted signs on trees, poles, etc. advising that no swimming was allowed for a designated approximately 2 week period while the lake was being

Activity	Lake Use Change
	treated chemically. So we didn't swim for that time period, and that was the ONLY cost to us for a full summer of lake enjoyment. I am all for appropriate and responsible chemical treatment of the weeds. No other method is as productive.

21. If your business relies on Chautauqua Lake, how might dredging for sediment removal affect your business and customers? You may use the space provided to respond. If you do not own a business that relies on Chautauqua Lake, you may leave the space empty.

Category	Response
Recreation/Tourism	• I am a lifeguard on the lake. We have seen a decrease in swimmers due to sedimentation. I feel more patrons will frequent our beaches if the water appeared cleaner and deeper. • Increase in population. Increase of business. • No issues if the narrows were to remain open all season • It would increase tourism which would increase the customers visiting the Bemus Point shopping areas.
Business Owner	• Boating is restricted now because of weeds and shallow waters; several customers have said they will not come back until the lake conditions improve; currently spending an hour a day cutting, cleaning, and removing the weeds from our waterfront. • Continued or increased tourism would be good for business. • Better flow through lower basin would significantly improve water quality, thus accessibility to lake by larger sailboats, which are increasingly used by our customers.
Real Estate	• My business relies on real estate values and real estate activity. If the quality of the lake improves so does the real estate market. • I am a realtor and clients are apprehensive. • The property values and thus taxing values would stay constant or improve even with a declining value housing market. • I am a Realtor and sediment removal from some areas in Mayville and Bemus Point village will enhance the quality of the lakefront areas and correspondingly the marketability of properties.

22. If effective aquatic plant management strategies are implemented in Chautauqua Lake, how might your uses of the lake change?

Activity	Lake Use Change
Boating/Fishing	• More boating and recreational use of the lake. • Easier on watercraft, so they'd be used more. Probably less damage to personal property. • Improved motor boating, more & better fishing, swimming, water skiing much improved water clarity, no or much less shoreline stinky sludge to feed weed growth • It would be wonderful to be able to navigate the lake without the hindrance of excessive weed growth. • I would be able to boat without weeds getting tangled in my prop and overheating. Since the weeds get cut by boat propellers and end up at the north end (primarily due to all of the South winds). • I would be able to use new areas of the lake which in the past would have stopped my boat. • I will fish more often and invite more of my out of state friends to join me. • I'd start trolling more for fish. • I would have boat access to more of the lake without getting my out drive clogged with weeds. • Would be able to get into areas that are weed covered, would be able to use more of the lake • Access via canal in Bemus Point (near Shore Acres and Bemus Creek) • Increased use - we stop after July 15 or so because of the algae and weeds. they are a hazard much less unsightly • We'd boat without fear of burning out engine • More enjoyable bass fishing in formerly plant-free rocky bottom areas along Pt. Chautauqua and north east shoreline from Dewittville to Midway Park. • I would kayak, canoe, and paddleboard there more often. • Certain areas will become more accessible and enjoyable to use. Our marina is totally congested with aquatic plant life now-

Activity	Lake Use Change
	harvesting is not a solution. Dredging would significantly improve the situation. • I would definitely do more boating and not be embarrassed to be a home owner. • More boating and fishing. It was sad to see in the Post Journal an article in the back pages from 25 years ago a discussion on the weed problem and to see it even worse 25 years later. Chautauqua Lake was once the best muskie lake in the USA and now its slowly turning into a swamp full of weeds a disgrace to Chautauqua County. • I might actually consider buying a boat. The CLA does a great job with what they have but can't keep up and the harvester method cannot be used under all conditions. Herbicides are not a long-term solution either, the users and residents of the lake need to come to terms with the fact that this is a shallow, nutrient rich lake that will always have aquatic vegetation and algae. The first step should be to define what is effective plant management? Some view this as complete removal and so long as the planning department puts garbage like this out the public will think that it is possible to have complete "effective" management. John Luensman knew this 30+ years ago. • It has gotten to the point that you have to be in 10 feet of water before your prop in no longer fouled by weeds. In essence the usable acerage of the lake in the south basin is probably 1/3 of what it should be. • You can't even make one cast without weeds on your lure. • I would use it. We have stopped all activities on the lake within the last 5 years. Boating and skiing and swimming would be priorities. Also going out to dinner using the boat as transportation.
Swimming/Watersports	• Increased swimming, waterskiing, and boating frequency. • Spend more time on the lake swimming and water sports. • I would do a lot more swimming and boating. • would be able to hike, boat & swim more • better access to lake (easier navigation), more areas for swimming, canoeing • Better waterski/tubing conditions. Jet ski intakes not hampered by weeds. Better swimming conditions without the green muck, smell

Activity	Lake Use Change
	and seaweed. • I could swim from my dock and get my boat out onto the lake more easily • Youth recreation would have safer swimming conditions. • We would swim off our dock more often, especially in the late summer • Would be able to enjoy swimming right off the dock instead of having to go to the middle of the lake to swim, not to mention the safety concerns that go with that. • Would swim, ski, and sail more.
Real Estate	• I am strongly considering relocating to the Islands in Ohio if something isn't done soon, but fear that my property value will suffer because of the reputation Chautauqua now has. Everyone seems to be aware and when I tell them where I go for recreation, they say 'Weed City.' • We will continue to use the lake as we have a summer home there. We purchased our summer home there 16 years ago because of the beauty of the area and the lake. However, the past few years especially on the north end of the lake where we live (Mayville) there is a significant weed problem. We spend more time on the weekends cleaning the weeds from the shoreline instead of enjoying the lake. We would like to get back to enjoying our time up there on the water and enjoying the beauty of the lake. • New visitors and guests to the lake that currently find these conditions offensive. • Will likely invite more visitors to the area to enjoy the lake, bringing tourist dollars to the area. • Waiting to see what happens with the weeds. Otherwise, we will sell and move to a lake in Michigan. • This is needed for our lake region to prosper - for one, we would stay here and not move out - we would utilize the lake for swimming and boating more - as would more friends and tourists. • If the lake is sprayed and the weeds are less invasive I won't sell my lake house.
Aesthetics	• Increased enjoyment of the lake without smelling rotting seaweed

Activity	Lake Use Change
	buildup on the shoreline. Aesthetics would improve. • It would also eliminate much of the stench along the shore, and perhaps curtain the algae blooms'. This causes us to avoid the lake altogether in mid-to-late summer. • We pay a private individual to come and clear out the weeds because I just cannot do it or keep up with it. It is so bad that they have to come sometimes twice a week just to keep it reasonable. They accumulate and then start to rot which is a horrible smell. • Overall I would enjoy a better quality of life on the lake. • The unsightly weeds that grow to the surface along with the smell keep guest away. The first question anyone ask me about the lake is how bad are the weeds this year and how bad does it smell. The lake has gained a reputation outside of our area as being dirty with weeds and surface debris trapped in the weeds; the carp die-off didn't help these factors have greatly impacted our economy. • Mostly entertaining friends and family. You don't want to invite anyone here at this point for swimming and skiing. • We are no longer boat owners. I am here for the beauty of the lake. Stinky weeds and scum (algae) all over the top of the water does not add to the experience. • Use lake more in more areas like I remember 20 years ago. • It smells so bad we cannot sit on our deck and enjoy the water front which we pay extremely high taxes on. There were no weeds in front of our home when we built our house in 1988. The weeds have gotten worse since then. The Lake Association only picks up the weeds once a year in Warners Bay, usually late August after the summer has been ruined.
General	• I have lived with the aquatic plants so long that it unknown how it would impact my use. Obviously I would be able to use the lake more. • Would be able to get into areas that are weed covered, would be able to use more of the lake. • Weeds floating on the surface are the only nuisance. The reduce navigation and can be unsightly. Using herbicides is one time fix that will result in further damage to the lake rather than fixing the problem.

Activity	Lake Use Change
	• It would be more pleasant for users. • In 1950 we had "de-weeding" devices on our sailboats----the weeds are not new. If outlet is dredged, the "land bridge" at Greenhurst removed--we can have water flow. Oh yes-----let's get realistic and spray. Mowing is not ever going to catch up. • The natural harbors created by the numerous bays and points are a wonderful place for boaters to escape choppy water surface conditions and no matter your thing be it water skiing or picnic on your boat on a fine summer day, it is always much more pleasurable if you are not surrounded by thick weed beds that are growing so tall as to then reach many feet horizontally on the surface encapsulating decaying fish the occasional foul. • Depends on how it is implemented. • Will continue to use the lake regardless. • Get rid of the weeds and scum and I would use the lake more often. • No significant change. • Use of chemical means to reduce aquatic plants is not natural and should NOT be consider as an option. It is only a temporary fix and does not provide a return on the funds invested. A reduction in aquatic plants would reduce temporary annoyances such as navigation to and from docks.

23. If your business relies on Chautauqua Lake, how might managing aquatic plant growth affect your business and customers?

Category	Response
Recreation/Tourism	• Increase in swimming patronage and less time spent managing plant growth and wash up. • I'm not a business owner but I do not use the services of some marinas because of the difficulty navigating the weeds. • Again, while I don't have a business on the lake, I should think that the conversation around the dinner table at Webb's, Casino, Italian Fisherman, Yacht Club and many others would be better based on summer fun and family rather than how terrible the lake is. This is an age-old argument to be certain however the

Category	Response
	amplitude and veracity of the argument has changed with the same proportions as the increase of the problems our lake/we are faced with. • Safer conditions for youth recreation. • Fewer weeds mean a more attractive lake area with more business.
Business Owner	• Business would improve--disgusted by the smell and sight; having trouble with boat motors and removing weeds from props • If the lake quality continues to deteriorate, business will suffer and taxes will go up • Increase business for all of Chautauqua. • We would rent and sell more kayaks, canoes, and paddleboards, and lead more outings on the lake. • Vital to our entire economy - mine relies primarily on second home owners who utilize our services • It would increase tourism which would increase the customers visiting the Bemus Point shopping areas.
Real Estate	• There would be less of the certain notoriety in real estate due to lake issues.

24. Contact Information (optional).

94% of survey participants provided contact information.

APPENDIX 3: PUBLIC PRESENTATION

Chautauqua Lake Dredging Feasibility Study

Public Information Session

July 30, 2012

EcoLogic

Funding Provided by NY Department of State Division of Coastal Resources under Title 11 of the Environmental Protection Fund NYS Comptroller Contract #C006814

Agenda

- Introductions and welcome
- Description of dredging feasibility study
- Discussion of priority areas
- Meeting summary and contact information

Project Background

- Objective: evaluate the feasibility of dredging (sediment removal) in nearshore areas of Chautauqua Lake
- Funding from NY Dept. of State, Division of Coastal Resources, awarded to Town of Ellicot
- One of three projects underway this summer
  - Dredging Feasibility
  - Pilot program stream stabilization- Goose Creek & Dutch Hollow Creek
  - Submerged Aquatic Vegetation Management Plan
- Implementation phase of the Watershed Management Plan

EcoLogic LLC

- Founded in 1997
- Environmental science and engineering, public outreach
- Clients are primarily public sector and institutional
- Major focus: lakes and watersheds




Project Partners

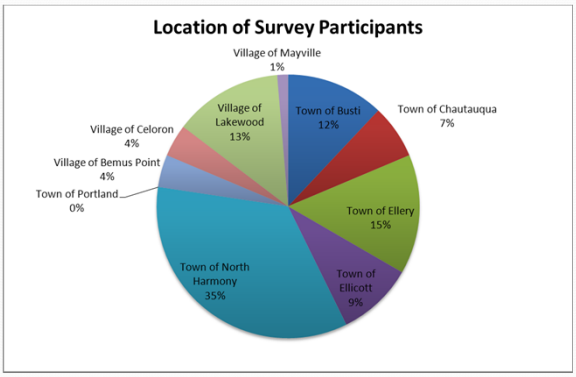
- Chautauqua County Department of Planning & Economic Development (CCDPED)
- Barton & Loguidice- stream stabilization project
- Don Lake, DuLac Engineering- storm water management specialist
- Anchor QEA- sediment coring and bathymetric survey

Dredging Feasibility Study: Task Sequence

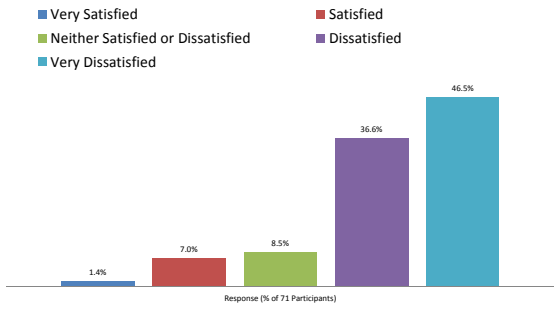
- Field survey of entire lake shoreline to assess impairment (week of 7/20/12)
- Bathymetric mapping and sediment coring in five representative areas (week of 8/6/12)
- Estimate volume of material to be removed and its quality
- Recommend appropriate dredging technology
- Outline alternatives for dewatering and disposal
- Develop unit costs
- Outline environmental review and permitting steps

Priority Area Selection

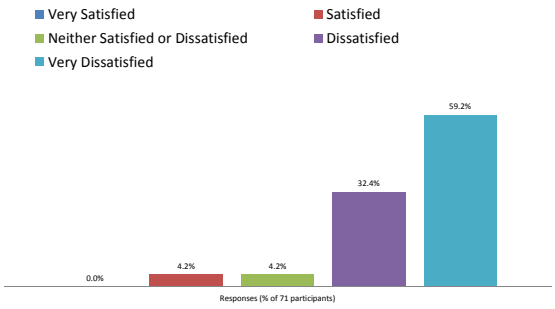
- Review data and information from multiple sources
  - On-line survey http://www.ecologicllc.com/chautauqua-implementation.html
  - Field assessment
  - Personal interviews



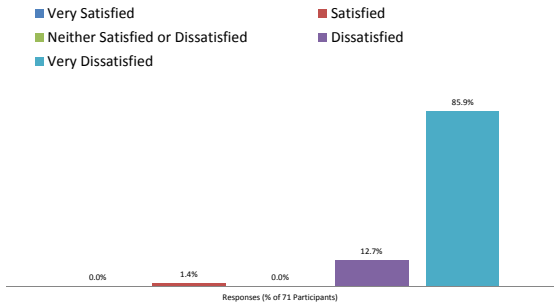
How satisfied are you with the overall condition of Chautauqua Lake with respect to water clarity?



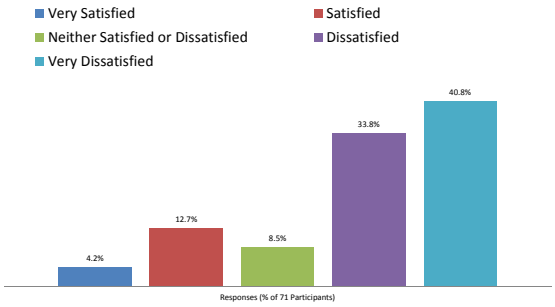
How satisfied are you with the overall condition of Chautauqua Lake with respect to swimming?



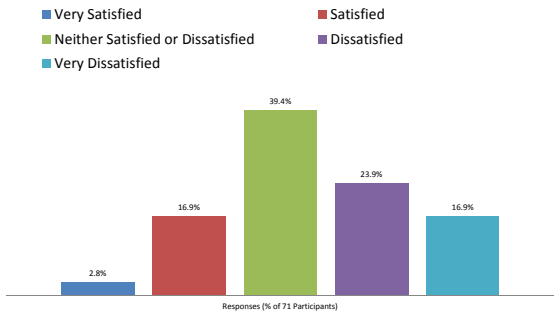
How satisfied are you with the overall condition of Chautauqua Lake with respect to the level of aquatic plant growth?



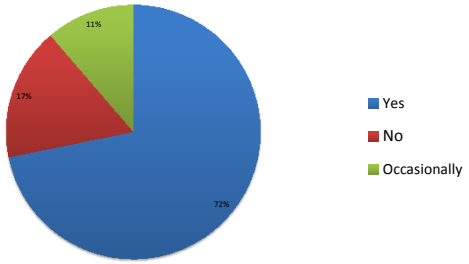
How satisfied are you with the overall condition of Chautauqua Lake with respect to navigation?



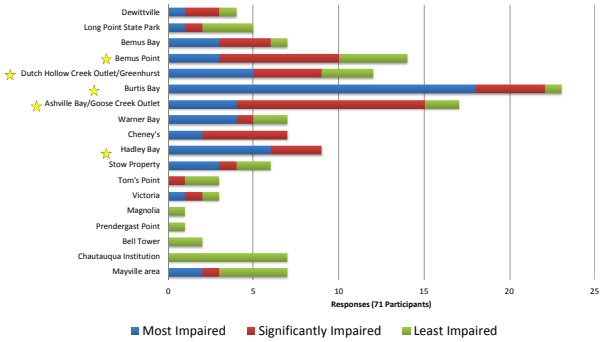
How satisfied are you with the overall condition of Chautauqua Lake with respect to fishing?



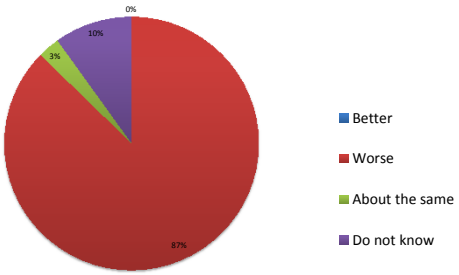
Does sedimentation interfere with your ability to access or use Chautauqua Lake?



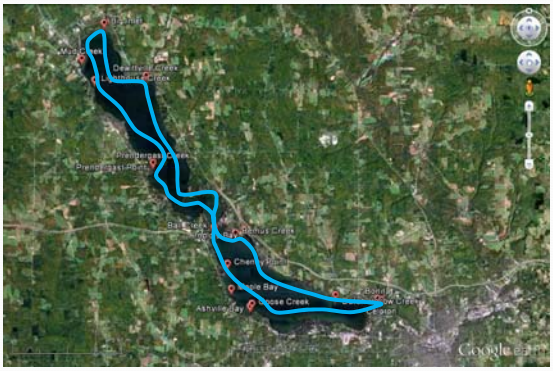
Areas where sedimentation is causing the greatest problem to survey participants



Do you think the sediment levels in Chautauqua are better, worse or about the same as 5 years ago?




Prendergast Creek
Cheney Bay
Maple Bay
Goose Creek


Prendergast Creek
Cheney Bay
Maple Bay
Goose Creek


Goose Creek


Prendergast Creek
Goose Creek

Data Collection: Lake

- Sediment volume- how much needs to be dredged?
- Sediment texture (particle size)- technology selection, dewatering time
- Sediment quality- chemical composition- any constraints on safe handling or ultimate disposal?
- Ecological conditions- habitat quality

Data Collection: Watershed

- Sediment dewatering and ultimate disposal site(s)
  - Ownership
  - Size
  - Proximity
  - Access
- Interface with erosion and sediment control measures: prevention
- Opportunities for beneficial use

Dredging Technology

Mechanical	Hydraulic
• Clamshell bucket on boom	• Faster
• Can extend 30 – 40 m. from shoreline, or barge mount	• Better suited for larger projects
• Creates turbidity	• Creates far less turbidity
• Uneven bottom profile	• Moves large volume of water
	• Better control

Hydraulic Dredging: Lake Algonquin





Mechanical Dredging: Lake Algonquin

Technology Selection: Dewatering

- Hydraulic dredging
  - Bermed sedimentation basins
  - Geotubes



Environmental Review and Permits

- SEQR process
  - Involved agencies
  - Public need and benefit
  - Evaluation of alternatives
  - Impacts and mitigation
- Permits and approvals
  - Army Corps of Engineers
  - NYSDEC
  - US Fish and Wildlife

Factors affecting Costs

- Volume of material
- Sediment texture
- Sediment quality
- Technology selection
- Distance to sediment handling facility
- Opportunities for beneficial reuse
- Complexity of environmental reviews and permits

Public Involvement

- Input on priority areas- it's not too late!
- Review materials on project web site
- Draft feasibility report – Fall, 2012
- Second public information session to summarize draft report and receive comments- October, 2012
- Sign up for email notices and links to new documents

EcoLogic, LLC
Aquatic, Terrestrial and Wetland Consultants

Planning Chautauqua
Chautauqua County Department of Planning & Economic Development

APPENDIX 4: SEDIMENT TESTING WORKPLAN

EcoLogic

CHAUTAUQUA COUNTY

DEPARTMENT OF PLANNING & ECONOMIC DEVELOPMENT

Chautauqua Lake

Dredging Feasibility Study

Sediment Testing Work Plan

Prepared by:

EcoLogic, LLC

June 28, 2012

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Chautauqua Lake Dredging Feasibility Study
Sediment Testing Work Plan

1. Introduction

This document outlines the scope of the field and laboratory effort to characterize the chemical quality and physical characteristics of sediments deposited in nearshore areas of Chautauqua Lake. Data are needed in order to complete the dredging feasibility study for the Chautauqua County Department of Planning & Economic Development (CCDPED). The chemical content of the sediments has the potential to constrain the options for how dredged materials are handled during removal and ultimate disposal. Physical characteristics of the sediment affect the selection of equipment, design of the dewatering facilities, and capacity of the site(s) selected for dewatering and/or ultimate disposal.

2. New York State guidance

The New York State Department of Environmental Conservation (NYSDEC) has developed a statewide guidance document for use in evaluating the quality and management of dredge material. This document, *Technical and Operational Guidance Series (TOGS) 5.1.9 In-Water and Riparian Management of Sediment and Dredged Material* (NYSDEC 2004), defines upper contaminant levels to classify dredged material and constrain options for ultimate disposal.

- Class A sediments exhibit no appreciable contamination
- Class B sediments exhibit moderate levels of contamination and may be toxic to aquatic life upon long-term exposure (chronic toxicity)
- Class C sediments exhibit high levels of contamination and may be toxic to aquatic life upon short-term exposure (acute toxicity)

The upper limits of the chemical content used to delineate the three classes of sediment are presented in **Exhibit A,** which summarizes relevant tables from the NYSDEC 2004 guidance document. When Class B or C sediment is expected, the NYSDEC guidance document calls for evaluating the proposed future sediment surface to verify that concentrations of chemicals of concern do not exceed the pre-dredging levels. That is, sediment testing must address the potential for exposing layers of sediment with higher concentrations of contaminants. Given the watershed's history and current land uses, it is expected that sediments deposited in nearshore areas of Chautauqua Lake will be Class A.

Both organic and inorganic chemicals are included on the NYSDEC guidance value list to differentiate Class A, B, and C sediments. Limits are identified based on the concentrations of benzene, certain heavy metals (arsenic, cadmium, copper, lead and mercury), pesticides (DDT compounds and dieldrin), polycyclic aromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs).

3. Project approach

The approach is summarized below:

- Input from the public and the project team, in addition to the findings of a littoral habitat survey planned for the week of July 9, 2012, will be used to identify five priority areas for collecting and analyzing sediment cores.
- Bathymetric mapping will be completed at 12 nearshore areas (five of these areas will be selected for sediment testing).
- A depth finder and differential global positioning system (GPS) will be used at each sampling location to document overlying water depths and the location of the sediment samples.
- Sediment cores will be advanced to an approximate depth of seven feet (adjusted for site conditions).
- Sediment samples will be analyzed for physical parameters, including moisture content, Atterberg Limits, total organic carbon (TOC), grain size distribution, specific gravity, and Unified Soil Classification System designation (**Table 1**)
- Sediment samples will be analyzed chemical parameters, per NYSDEC navigational dredging guidance: benzene, metals (arsenic, cadmium, copper, lead, zinc, and mercury), pesticides (DDT compounds, and dieldrin), PAHs, and PCBs (**Table 2**)

4. Sampling and Analysis Plan

The Sampling and Analysis Plan consists of sediment sampling and analysis, as outlined below.

4.1 Sediment Sampling Investigation

4.1.1 *Sample Locations and Analyses*

Sediment samples will be collected at five littoral locations within Chautauqua Lake, to be selected in consultation with the CCDPED project team and in consideration of stakeholder input. Sample quantities, quality control samples, containers, preservation, and analytical methods are summarized in **Table 3**.

Chemical analyses will be completed by Life Sciences Laboratory. A completed chain of custody form will accompany samples submitted for analysis.

4.1.2 *Collection Procedures*

Sediment sampling will be completed by Anchor QEA. Core samples will be collected in 3-inch tubes made of either aluminum or transparent polycarbonate. These core tubes will be advanced into the sediment using a Rossfelder P-3

vibracoring unit to a depth of approximately nine feet (providing a core sample of approximately seven feet). Three cores will be obtained at each of the five areas.

Upon collection, the sediment samples will be observed and visual descriptions of the sediment will be recorded in field logs. In particular, sediments will be observed for evidence of layering that might suggest different material types. The cores collected in each area will be combined into a single composite sample at the time of collection. Core tubes will be thoroughly cleaned with lake water between survey areas to minimize the potential for any cross-contamination.

5. Project reporting

The following results will be reported in the Dredging Feasibility Report to be completed by EcoLogic LLC.

- The physical characteristics of the dredge material provided by the results of investigation analyses.
- The chemical characteristics of the dredge material provided by results of analyses of sediment for TOGS 5.1.9 parameters
- Appropriate methods of dredging and handling based on the physical and chemical characteristics of the material.

6. Subcontractors

Several subcontractors will be utilized for the project, and will be overseen by EcoLogic LLC.

- **Anchor QEA, LLC** of Liverpool NY will complete the sediment coring.
- **Life Sciences Laboratory** in Syracuse NY, which holds ELAP certification, will analyze sediment samples for chemical parameters.
- **PW Labs Inc**. of Syracuse NY will analyze sediment samples for physical parameters associated with dredging design.

7. Project Schedule

The anticipated project schedule is presented below:

- Sediment sampling activities will be completed in August, 2012. It is anticipated that the sampling will be completed within five working days.
- Laboratory analyses will be completed approximately 30 days after sampling.
- The Draft Dredging Feasibility Study Report, including dredge material characterization, will be completed by December 2012.

Tables

Table 1. Physical tests of sediment.

Physical Test	Test Method		Description
Organic content, measured as total organic carbon (TOC)	USEPA	Lloyd Kahn	Evaluates the organic content of a soil or sediment as a predictor of the adsorptive capacity of the soil or sediment for hydrophobic compounds.
Grain size distribution	ASTM	D422/1140	Classifies soil or sediment as coarse grained or fine grained. Grain size distribution of coarse grained soil or sediment will correlate to friction angle, which is used to estimate the shear strength of the soil or sediment.

Table 2. Chemical testing- analytical methods and sample quantities

Sampling Section	Analysis	Laboratory	Analytical Method		Environ. Locations	Environ. Samples	Quality Control Dup	Quality Control MS	Quality Control MSD	Total	Unit Cost	Cost
Analytical Tests												
	Benzene	LSL	USEPA	8260	15	5	1	1	1	8	$ 80	$640
	Pesticides: Dieldrin/DDT comp.	LSL	USEPA	3550/8081	15	5	1	1	1	8	$ 75	$600
	PCBs	LSL	USEPA	3550/8082	15	5	1	1	1	8	(inc. w/ pesticides cost)	
	PAHs	LSL	USEPA	8270	15	5	1	1	1	8	$ 125	$1,000
	Metals (As, Cd, Cu, Pb, and Zn)	LSL	USEPA	3050/6010	15	5	1	1	1	8	$ 49	$392
	Mercury	LSL	USEPA	7471	15	5	1	0	0	6	$ 22	$120
	Sulfide	Test Am.-Pit	USEPA	9034	15	5	0	0	0	5	$ 20	$100
	Total Organic Carbon	Test Am.-Pit	USEPA	Lloyd Kahn	15	5	1	0	0	6	$ 20	$120
	Percent solids	LSL	ASTM	SM2540G	15	5	1	0	0	6	$ 10	$ 60
Physical Tests												
	Grain Size	PW Labs	ASTM	D422/1140	15	5	0	0	0	5	$ 160	$800
	Classification	PW Labs	ASTM	D2487	15	5	0	0	0	5	$ 5	$ 25
											TOTAL	**$ 3,857**

Notes:

Pesticides (DDT, DDD, DDE, dieldrin); PCBs = polychlorinated biphenyls; PAHs = polycyclic aromatic hydrocarbons.

Metals: As = arsenic, Cd = cadmium, Cu = copper, Pb = lead, and Zn = zinc.

USEPA = United States Environmental Protection Agency; ASTM = American Society of Testing Materials.

Laboratories: LSL = Life Science Laboratories, Inc., Syracuse, NY; Test Am-Pit = Test America, Pittsburg, PA; PW Labs = PW Labs, Inc., Syracuse, NY.

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Table 3. Analytical method, sample containers, preservation, holding times, and QC sample frequencies.

Parameter (method)	Matrix	Sample containers and volumes	Preservation	Holding times	QC sample frequency			
					Field duplicate	Trip blank	MS/MSD /Spike Duplicate**	Field/ Equipment Blank***
Benzene Medium Level* (USEPA Methods 5035/8000C/8260B)[1]	Solid	One 40-ml pre-weighed glass vials with Teflon® lined septum caps. 5 grams of sample with methanol prepared in accordance with USEPA Method 5035	4°C	14 days from collection for analysis	One per 10 samples or one per matrix (for less than 10 samples)	1 per cooler containing samples for VOCs in water	One per 20 samples or one per matrix (for less than 20 samples)	One per sampling event as required.
PAHs (USEPA Methods 3541/3550B/8000C/8270C)[1]	Solid	250-ml wide mouth glass container with Teflon® lined lid. 100 grams sample volume required.	4°C	14 days from collection to extraction; 40 days from extraction to analysis	One per 10 samples or one per matrix (for less than 10 samples)	NA	One per 20 samples or one per matrix (for less than 20 samples)	One per sampling event as required.
DDT Compounds, Dieldrin (USEPA Methods 3541/3550B/8000C/8081A)[1]	Solid	250-ml wide mouth glass container with Teflon® lined lid. 100 grams sample volume required.	4°C	14 days from collection to extraction; 40 days from extraction to analysis	One per 10 samples or one per matrix (for less than 10 samples)	NA	One per 20 samples or one per matrix (for less than 20 samples)	One per sampling event as required.

Parameter (method)	Matrix	Sample containers and volumes	Preservation	Holding times	QC sample frequency			
					Field duplicate	Trip blank	MS/MSD /Spike Duplicate**	Field/ Equipment Blank***
PCBs (USEPA Methods 3541/8000C/8082)[1]	Solid	250-ml wide mouth glass container with Teflon® lined lid. 100 grams sample volume required.	4°C	14 days from collection to extraction; 40 days from extraction to analysis	One per 10 samples or one per matrix (for less than 10 samples)	NA	One per 20 samples or one per matrix (for less than 20 samples)	One per sampling event as required.
Metals (USEPA Methods 3050B/6010B)[1]	Solid	125-ml wide mouth polyethylene or fluorocarbon (TFE or PFA) container. 100 grams sample volume required.	4°C	180 days from collection for analysis	One per 10 samples or one per matrix (for less than 10 samples)	NA	One per 20 samples or one per matrix (for less than 20 samples)	One per sampling event as required.
Mercury (USEPA Method 7471A)[1]	Solid	125-ml wide mouth polyethylene or fluorocarbon (TFE or PFA) container. 100 grams sample volume required.	4°C	28 days from collection for analysis	One per 10 samples or one per matrix (for less than 10 samples)	NA	One per 20 samples or one per matrix (for less than 20 samples)	One per sampling event as required.

Parameter (method)	Matrix	Sample containers and volumes	Preservation	Holding times	QC sample frequency			
					Field duplicate	Trip blank	MS/MSD /Spike Duplicate**	Field/ Equipment Blank***
TOC (USEPA Lloyd Kahn Method)[2]	Solid	125-ml wide mouth glass container with Teflon® lined lid. 100 grams sample volume required.	4°C	14 days from collection for analysis	One per 10 samples or one per matrix (for less than 10 samples)	NA	One per 20 samples or one per matrix (for less than 20 samples)	One per sampling event as required.
Physical Parameters:	Solid	1-gallon plastic bag, sealed.	None	NA	NA	NA	NA	NA
Grain size Distribution (ASTM D422/D1140)								

Exhibits

Exhibit A – TOGS 5.1.9 Screening Values and Sediment Management Options

Table 2 Sediment Quality Threshold Values for Dredging, Riparian or In-water Placement
Threshold values are based on known and presumed impacts on aquatic organisms/ecosystem. Where fresh water and marine threshold values differ sufficiently, the marine value is presented in parentheses. All concentrations are in mg/kg dry weight.

Compound	Class A	Class B	Class C	Derivation Code
Metals (mg/kg)				
Arsenic	< 14 (8.2)	(8.2) 14 - 53	> 53	1
Cadmium	< 1.2	1.2 - 9.5	> 9.5	1
Copper*	< 33	33 - 207 (270)	> 207 (270)	1
Lead	< 33 (47)	33 (47) - 166 (218)	> 166 (218)	1
Mercury+	< 0.17	0.17 - 1.6 (1.0)	> 1.6 (1.0)	1
PAHs and Petroleum-Related Compounds (mg/kg)				
Benzene	< 0.59	0.59 - 2.16	> 2.16	2
Total BTEX*	< 0.96	0.96 - 5.9	> 5.9	2
Total PAH1	< 4	4 - 35 (45)	> 35 (45)	1
Pesticides (mg/kg)				
Sum of DDT+DDD+DDE+	< 0.003	0.003 - 0.03	> 0.03	2
Mirex*+	< 0.0014	0.0014 - 0.014	> 0.014	2
Chlordane*+	< 0.003	0.003 -0.036	> 0.036	1
Dieldrin	< 0.11	0.11 -0. 48	> 0.48	2
Chlorinated Hydrocarbons (mg/kg)				
PCBs (sum of aroclors)2	< 0.1	0.1 - 1	> 1	3
2,3,7,8-TCDD*3 (sum of toxic equivalency)	< 0.0000045	0.0000045 - 0.00005	> 0.00005	4

+ Threshold values lower than the Method Detection Limit are superseded by the Method Detection Limit. (See Table 1) * Indicates case-specific parameter (see Chapter II, Section A) .1For Sum of PAH, see Appendix E2For the sum of the 22 PCB congeners required by the USACE NYD or EPA Region 2, the sum must be multiplied by two to determine the total PCB concentration. 3TEQ calculation as per the NATO - 1988 method (see Appendix D)

Note: The proposed list of analytes can be augmented with additional site specific parameters of concern. Any additional analytes suggested will require Division approved sediment quality threshold values for the A, B and C classifications.

Table 2.1 Derivation Codes for Chemical Threshold Values

Derivation Code	Explanation
1	Values are the geometric mean (GM) between Long & Morgan (1990) and Persaud (1992). Class A values are the GM of ER-L1 and Lowest Effect Level. Class C values are the GM of the ER-M1 and Severe Effect Levels. The resulting GMs were compared to marine water ER-L and ER-M values published by Long & Morgan (1992). When compared, the lowest of the two corresponding values was selected. When there was a large difference between a freshwater (Long & Morgan (1990) or Persuad (1992) GM) and a saltwater (Long & Morgan 1992) value, the marine value was recorded in parentheses, and is applicable to marine water dredging and management only. For total PAHs, Persaud (1992) had no toxicity values so only those of Long and Morgan (1990) were used. This approach is consistent with that described in the Technical Guidance for Screening Contaminated Sediments Document (DFW/DMR 1999). The Chlordane values were developed by NYSDEC generally following the Long and Morgan method.
2	NYSDEC water quality standards were used in conjunction with the U.S. EPA equilibrium partitioning methodology (see DFW/DMR 1993, pages 5-11) to calculate sediment quality threshold values for organic compounds assuming 2% organic carbon and equating Kow to KOC, consistent with the reality of contaminant uptake in biological organisms (Kenaga and Goring, 1980). Class A value is for the protection of benthic life from chronic toxicity. The Class C value is for the protection of benthic life from acute toxicity. If aquatic life standards were not available from 6NYCRR Part 703.5 to generate the sediment screening criterion, a guidance value was derived in accordance with 6 NYCRR Part 706.1. For total BTEX, the A and C values are the geometric means of the A and C values for benzene, xylene, ethylbenzene, and toluene. For DDT (sum of DDT, DDD, & DDE), the A value was based upon the 6 NYCRR 703.5 standard for the protection of wildlife. Because this value (0.00022 mg/l) was below the limit of analytical detection, the analytical detection limit of 0.003 mg/l was selected as a default value. The C value was the level at which significant mortality to *daphnia magna* has been documented (Long & Morgan, 1990). This approach is consistent with that described in the Technical Guidance for Screening Contaminated Sediments Document (DFW/DMR 1999).
3	Synthesis of Consensus Based Sediment Quality Assessment Values (D.D. MacDonald, et, al., Jan 2000), Marine and Estuarine Sediment Quality Values (E.R. Long, et. al., Nov 1993), PCB soil cleanup levels in NYSDEC Division of Environmental Remediation TAGM HWR-92-4046 and of sediment quality values from NYSDEC Division of Fish, Wildlife and Marine Resources Technical Guidance for Screening Contaminated Sediments, 1998.
4	A mean of the NYSDEC Fish and Wildlife bioaccumulation number, of the USEPA's low risk to mammals, the disposal of paper sludge in pasture land and the bioaccumulation protection of fish values, was calculated and rounded down to the nearest 0.5 ppt. This value is 0.0000045 ppm or 4.5 ppt. Additionally, the soil/sediment action level for 2,3,7,8 TCDD in the RCRA hazardous waste program (TAGM DHSR 3028, 1992) is 4.5 ppt. The on-land application limit of 50 ppt is used as the contaminated level from the USEPA - Paper Industry Agreement from Environment Reporter, 29 April 1994, pages 2222-3.

Table 3 RIPARIAN/IN-WATER Management Options

Activity	Class A	Class B	Class C
Dredging	Any means meeting generally accepted and approved practices	Closed bucket suggested or any means meeting environmental objectives	Closed bucket or other method minimizing loss of resuspended sediment ordinarily required
Riparian Placement	Any means meeting generally accepted and approved practices	Placement at riparian sites already containing more contaminated material. New riparian sites should be covered with Class A sediments to insure isolation of the dredged material. The depth of the cap will be determined on a site specific basis.	Riparian sites should be lined and capped with clay or other impermeable material and covered with Class A sediments to ensure long-term isolation of the dredged material from the environment. The depth of the cover material will be determined on a site specific basis.
In-water Placement	Any means meeting generally accepted and approved practices	In water placement discouraged. When applicable, sites should be capped with Class A sediment to insure isolation of the dredged material	In-water disposal ordinarily precluded.
Barge Overflow	Barge overflow may be allowed (site specific)	Usually, no barge overflow. May be allowed on site specific basis	No barge overflow
Post dredging Monitoring	May be required	See Chapter V	See Chapter V

NOTES:

1. Environmental Objectives for Dredging, Chapter IV, Section A applies to all classes.
2. Environmental Objectives for Dredged Material Management Placement at Riparian and/or In-water Sites, Chapter IV, Section B applies to all classes.
3. Riparian sites are adjacent to or within the 100-year flood plain of the surface waters in which dredging is proposed. These sites are typically diked with controlled outlets for retention of sediment and are typically regulated under Section 401 of the CWA. They do not constitute “on-land” placement.
4. Due to site specific circumstances, an applicant has full responsibility to justify all operations, including both those described above and any other selected alternatives.
5. Depending on conditions, hydraulic dredging to a confined disposal facility or excavation in the dry is the recommended method for PCB concentrations of greater than 10 ppm. Dredged material should be disposed of directly at final disposal sites. An applicant may justify another method of dredging and disposing of this material, as long as no net dumping of contaminated dredged material is proposed. If concentrations approach 50 ppm, Division of Environmental Remediation should be consulted.

APPENDIX 5: BATHYMETRIC PROFILES IN NEARSHORE PRIORITY AREAS

EcoLogic

H:\D_Drive\Projects\Chautauqua_Lake\AutoCad\20120917 Mud Creek.dwg Plan

Sep 25, 2012 1:36pm cyard

SOURCE: Survey by Anchor QEA, August 2012
HORIZONTAL DATUM: New York State Plane, West Zone, NAD83.
VERTICAL DATUM: New York State Plane, West Zone, NAD83.

NOTES:

LEGEND:

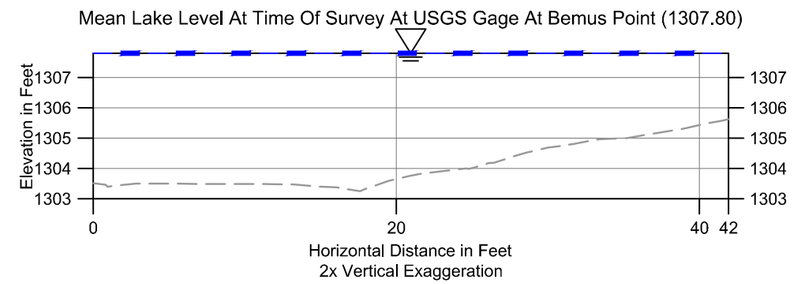
MC-C3 Core Location

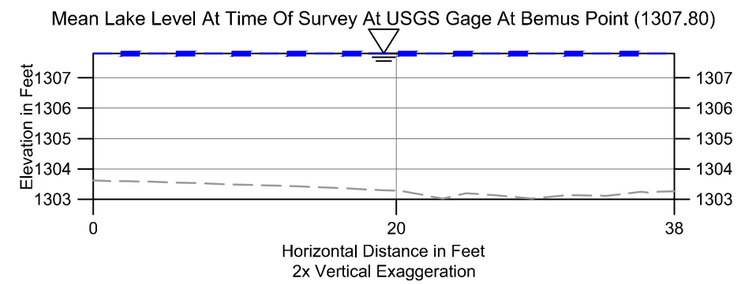
0 50
Scale in Feet

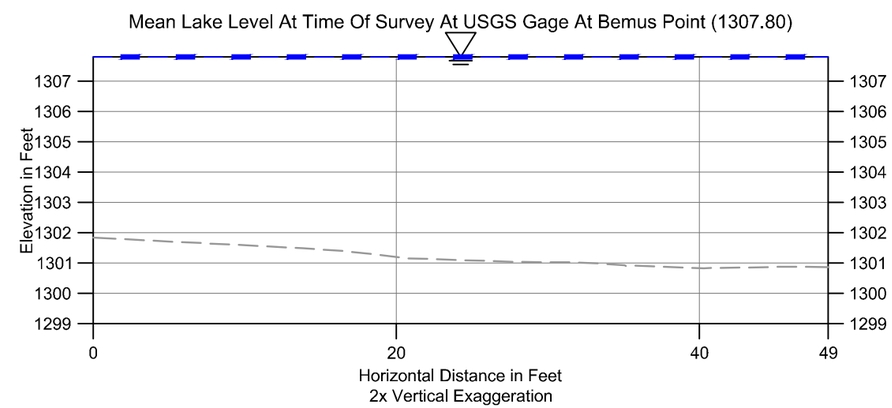
ANCHOR QEA

DRAFT

Figure 1A
Mud Creek Area
Locations For Core And Bathymetric Data Collection
Ecologic, LLC Chautauqua Lake Dredging Feasibility Study







H:\D_Drive\Projects\Chautauqua_Lake\AutoCad\20120917 Mud Creek.dwg Section

Sep 25, 2012 1:38pm cyard

SOURCE: Survey by Anchor QEA, August 2012
HORIZONTAL DATUM: New York State Plane, West Zone, NAD83.
VERTICAL DATUM: New York State Plane, West Zone, NAD83.

NOTES:

LEGEND:

Lake Level @ Bemus Point

Top Of Sediment

0 10
Scale in Feet

ANCHOR QEA

DRAFT

Figure 1B
Mud Creek Area
Bathymetric Survey Results
Ecologic, LLC Chautauqua Lake Dredging Feasibility Study

SOURCE: Survey by Anchor QEA, August 2012
HORIZONTAL DATUM: New York State Plane, West Zone, NAD83.
VERTICAL DATUM: New York State Plane, West Zone, NAD83.

NOTES:

LEGEND:

BC-C3 Core Location

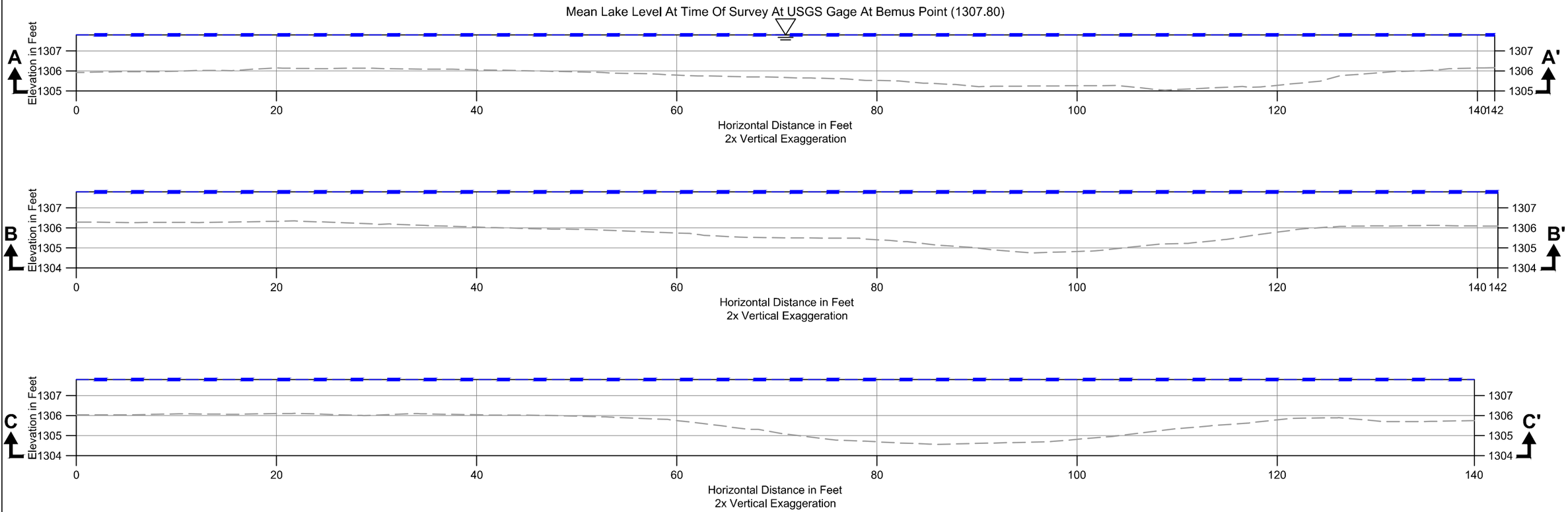
0 50
Scale in Feet

H:\D_Drive\Projects\Chautauqua_Lake\AutoCad\20120917_Bemus Creek.dwg PLAN
Sep 25, 2012 1:19pm cyard

ANCHOR QEA

DRAFT

Figure 2A
Bemus Creek Area
Locations For Core And Bathymetric Data Collection
Ecologic, LLC Chautauqua Lake Dredging Feasibility Study



SOURCE: Survey by Anchor QEA, August 2012
HORIZONTAL DATUM: New York State Plane, West Zone, NAD83.
VERTICAL DATUM: New York State Plane, West Zone, NAD83.

NOTES:

LEGEND:

Lake Level @ Bemus Point

Top Of Sediment

0 10
Scale in Feet

H:\D_Drive\Projects\Chautauqua_Lake\AutoCad\20120917_Bemus Creek.dwg SECTION

Sep 25, 2012 1:20pm cyard

ANCHOR QEA

DRAFT

Figure 2B
Bemus Creek Area
Bathymetric Survey Results
Ecologic, LLC Chautauqua Lake Dredging Feasibility Study

H:\D_Drive\Projects\Chautauqua_Lake\AutoCad\20120917_Goose Creek.dwg Plan

Sep 25, 2012 11:09am cyard

SOURCE: Survey by Anchor QEA, August 2012
HORIZONTAL DATUM: New York State Plane, West Zone, NAD83.
VERTICAL DATUM: New York State Plane, West Zone, NAD83.

NOTES:

LEGEND:

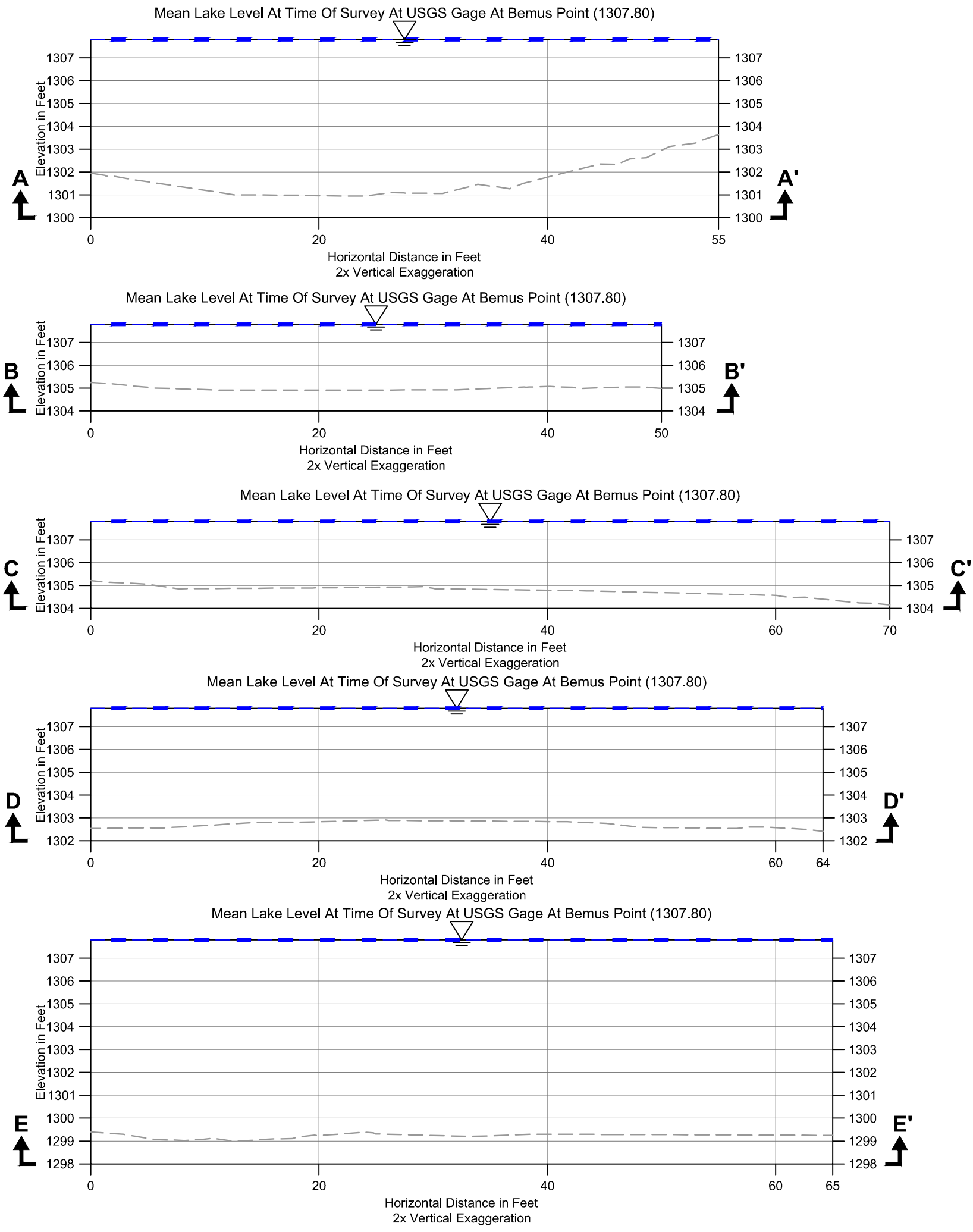
GC-C3 Core Location

0 100
Scale in Feet

ANCHOR QEA

DRAFT

Figure 3A
Goose Creek Area
Locations for Core And Bathymetric Data Collection
Ecologic, LLC Chautauqua Lake Dredging Feasibility Study



SOURCE: Survey by Anchor QEA, August 2012
HORIZONTAL DATUM: New York State Plane, West Zone, NAD83.
VERTICAL DATUM: New York State Plane, West Zone, NAD83.

NOTES:

LEGEND:

Lake Level @ Bemus Point

Top Of Sediment

0 10
Scale in Feet

H:\D_Drive\Projects\Chautauqua_Lake\AutoCad\20120917_Goose Creek.dwg SECTIONS
Sep 25, 2012 11:10am cyard

ANCHOR QEA

DRAFT

Figure 3B
Goose Creek Area
Bathymetric Survey Results
Ecologic, LLC Chautauqua Lake Dredging Feasibility Study

H:\D_Drive\Projects\Chautauqua_Lake\AutoCad\20120917_Dutch-Hollow Creek.dwg Plan

Sep 25, 2012 12:03pm cyard

SOURCE: Survey by Anchor QEA, August 2012
HORIZONTAL DATUM: New York State Plane, West Zone, NAD83.
VERTICAL DATUM: New York State Plane, West Zone, NAD83.

NOTES:

LEGEND:

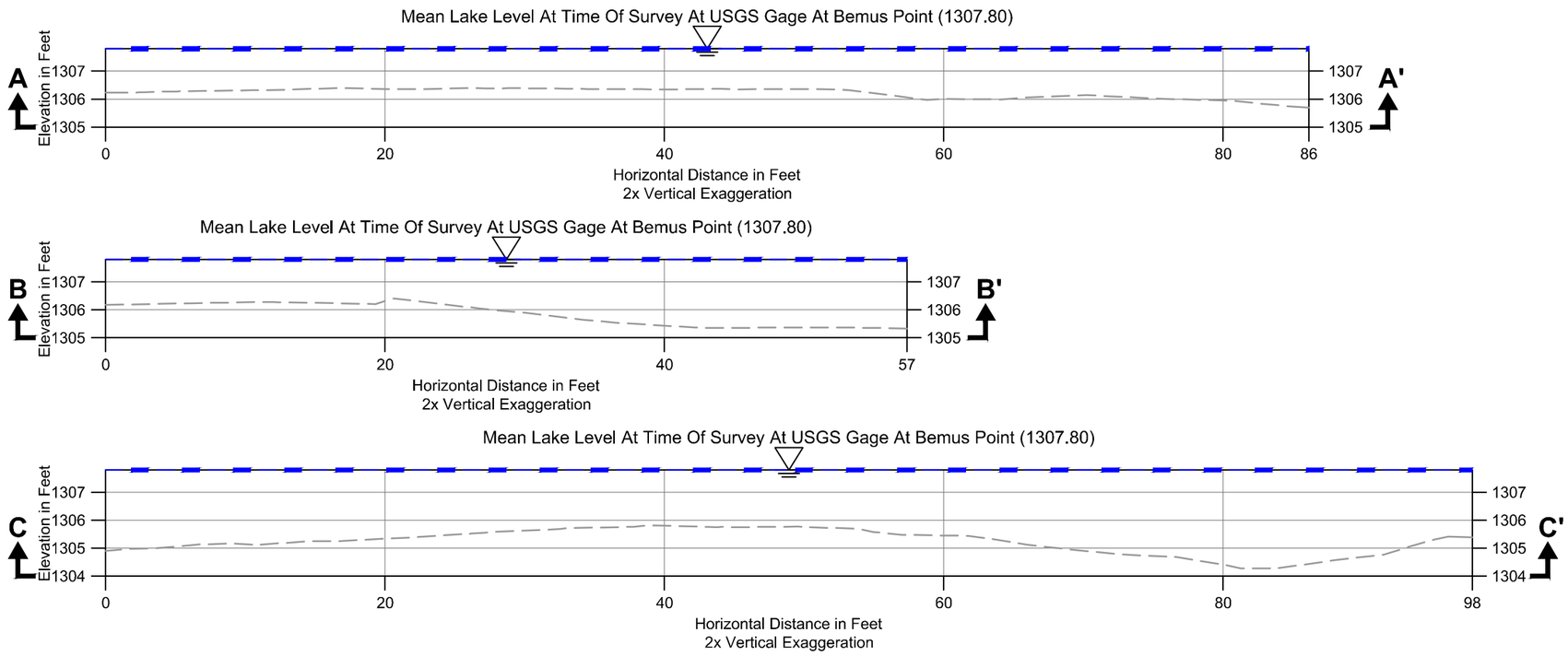
DH-C1 Core Location

0 50
Scale in Feet

ANCHOR QEA

DRAFT

Figure 4A
Dutch Hollow Creek Area
Locations For Core And Bathymetric Data Collection
Ecologic, LLC Chautauqua Lake Dredging Feasibility Study



H:\D_Drive\Projects\Chautauqua_Lake\AutoCad\20120917_Dutch-Hollow Creek.dwg SECTION

Sep 25, 2012 12:02pm cyard

SOURCE: Survey by Anchor QEA, August 2012
HORIZONTAL DATUM: New York State Plane, West Zone, NAD83.
VERTICAL DATUM: New York State Plane, West Zone, NAD83.

NOTES:

LEGEND:

Lake Level @ Bemus Point

Top Of Sediment

0 10
Scale in Feet

ANCHOR QEA

DRAFT

Figure 4B
Dutch Hollow Creek Area
Bathymetric Survey Results
Ecologic, LLC Chautauqua Lake Dredging Feasibility Study

APPENDIX 6: LETTER FROM DEC REGARDING REMOVAL OF DUTCH HOLLOW CREEK GRAVEL SAND BAR IN CHAUTAUQUA LAKE

EcoLogic

New York State Department of Environmental Conservation
Division of Environmental Permits, Region 9
182 E. Union, Suite 3, Allegany, New York 14706-1328
Phone: (716) 372-0645 • **Fax:** (716) 372-2113
Website: www.dec.ny.gov

Joe Martens
Commissioner

January 25, 2013

Mr. Steve Eidt
EcoLogic LLC
5 Ledyard Avenue
Cazenovia, NY 13035

Removal of Dutch Hollow Creek Gravel Bar In Chautauqua Lake
Town of Ellery, Chautauqua County

Dear Mr. Eidt:

This letter is in response to your telephone inquiry for department comments on the above referenced project. Department staff have reviewed the proposal and offer the following comments:

1. What is the purpose of the proposed gravel bar dredging? A department permit pursuant to Article 15, Title 5 of the Environmental Conservation Law/6NYCRR Part 608 will be necessary. As part of the permitting process and pursuant to the standards in Part 608, the applicant will be required to demonstrate that the proposal is: a) reasonable and necessary; b) the proposal will not endanger the health, safety or welfare of the people of the State of New York; and c) the proposal will not cause unreasonable, uncontrolled or unnecessary damage to the natural resources of the state, including soil, forests, water, fish, shellfish, crustaceans and aquatic and land-related environment.

2. The gravel at the mouth of this stream is important habitat to numerous species, both aquatic (centrarchid species for spawning) and terrestrial (shorebirds and waterfowl for resting and feeding).

3. Has there been a stream survey to determine the location(s) of the most actively eroding and unstable reaches upstream of the gravel bar? What is being done in the Dutch Hollow watershed to prevent the current erosion problem and subsequent deposition into the lake? Department staff recommend that a detailed geomorphic study should also be required to show that such gravel removal would not increase erosion upstream of the excavation site, including property damage along the riparian corridor.

   Department staff believe that the removal of this large gravel bar will cause an increase in gravel and sediment erosion upstream of this gravel bar with subsequent deposition into the lake, causing long term adverse affects to the stream corridor. An increase in nutrients and turbidity into the lake would also likely occur. With removal of the gravel bar, the upstream erosion would be a perpetual problem requiring continued removal of the gravel bar to maintain the altered condition in the lake. Therefore, the gravel bar removal would only be a treatment of the symptom, and not the solution to the problem. Department staff believe this type of "treatment" is inconsistent with the goals, strategies, and recommendations of the Chautauqua Lake Management Plan.

4. Any proposal for dredging should be done in accordance with the Department's Division of Water Technical & Operation Guidance titled In-Water and Riparian Management of Sediment and Dredged Material.

5. The New York Natural Heritage Program should be contacted to determine if there are any rare, threatened or endangered species that are likely to occur and/or be impacted by the proposed project.

6. How would the removal of the gravel bar effect erosion patterns caused by wind and waves to the remaining lake shoreline?

If you have any questions, please contact me at the above telephone number.

Respectfully,

Charles D. Cranston

Charles D. Cranston
Deputy Regional Permit Administrator

cc: Mr. Michael Clancy, NYSDEC Region 9 Division of Fish & Wildlife

APPENDIX 7: SCHEMATIC REPRESENTATIONS OF POTENTIAL SEDIMENT DEWATERING SITES

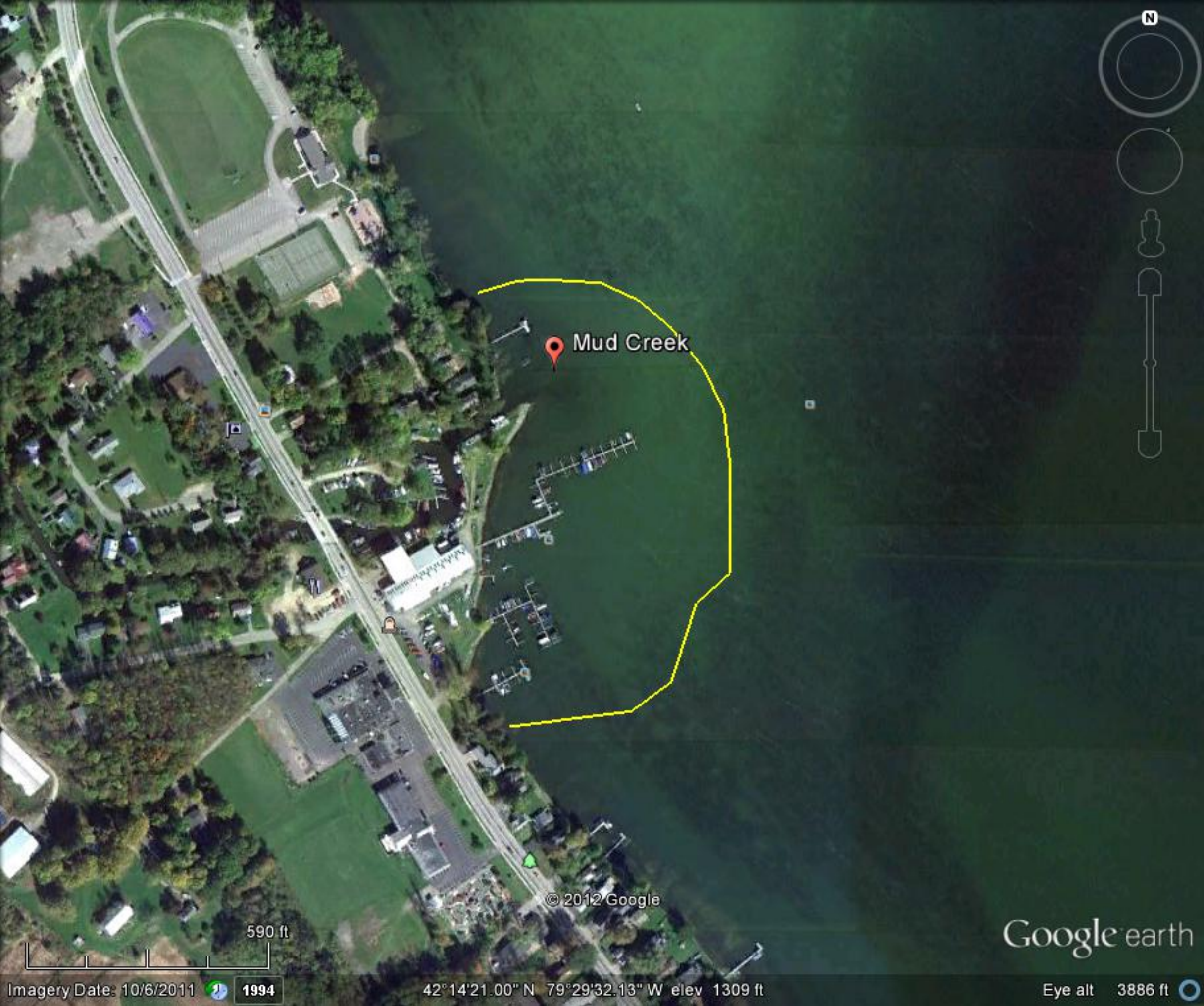
APPENDIX 6: SCHEMATIC REPRESENTATIONS OF POTENTIAL SEDIMENT DEWATERING SITES

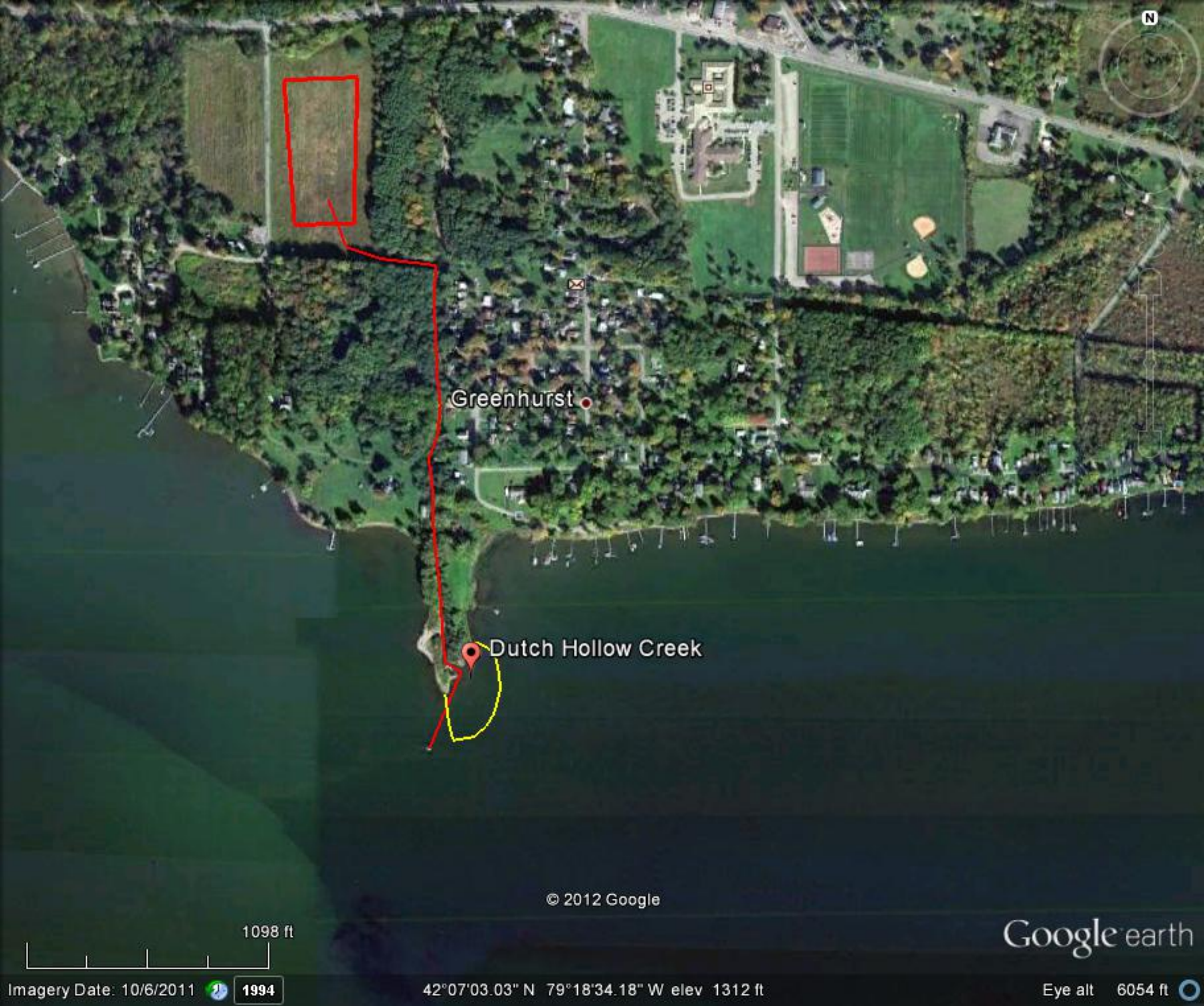
EcoLogic


N
Bemus Creek
© 2012 Google
538 ft
Google earth
Imagery Date: 10/6/2011
1994
42°08'55.04" N 79°22'59.26" W elev 1309 ft
Eye alt 3635 ft

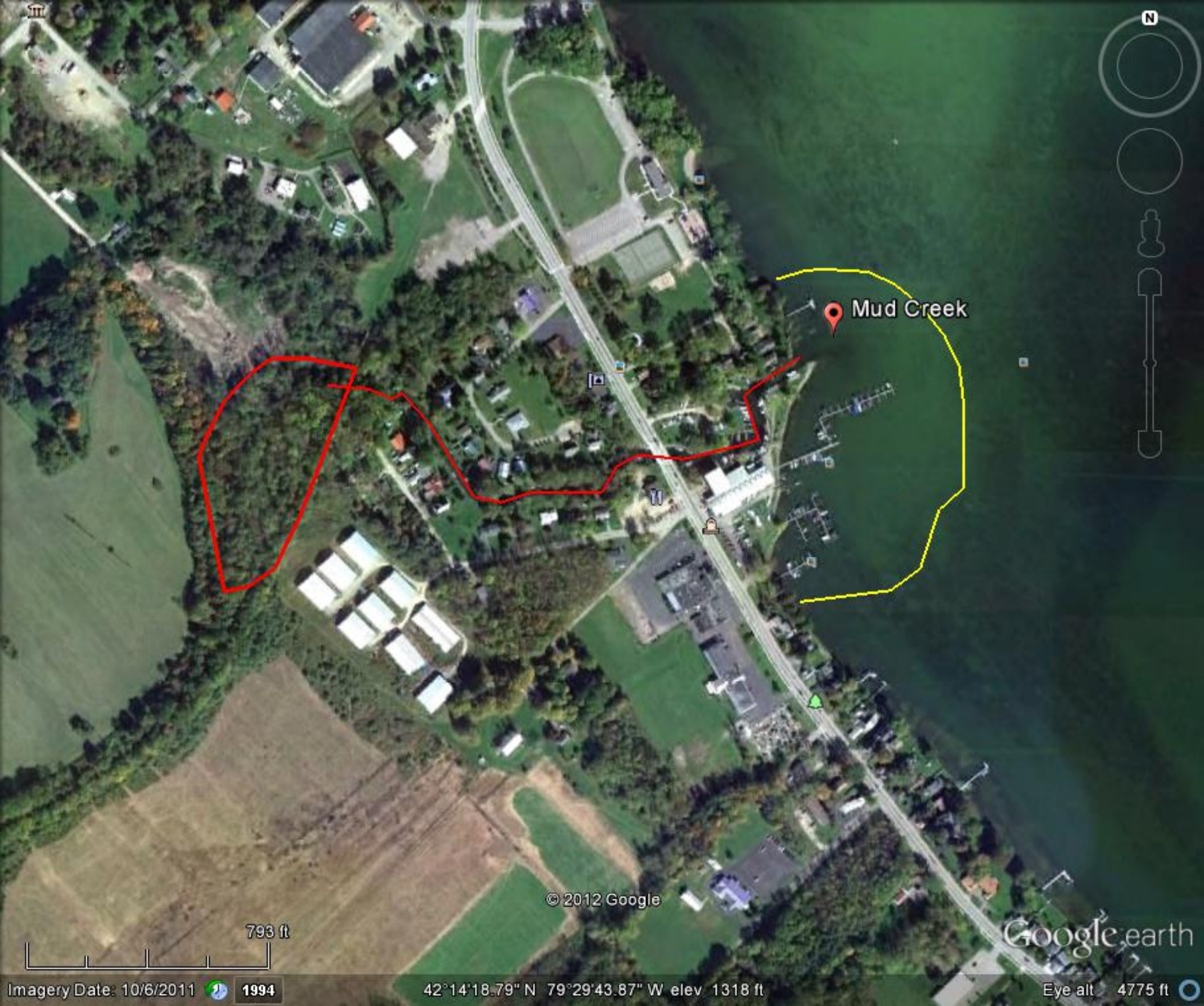

Dutch Hollow Creek
© 2012 Google
270 ft
Google earth
Imagery Date: 10/6/2011
1994
42°06'55.12" N 79°18'41.90" W elev 1309 ft
Eye alt 2478 ft


Goose Creek
Ashville Bay
© 2012 Google
450 ft
Google earth
Imagery Date: 10/6/2011
1994
42°06'37.18" N 79°22'13.08" W elev 1312 ft
Eye alt 3342 ft


Mud Creek
© 2012 Google
590 ft
Google earth
Imagery Date: 10/6/2011
1994
42°14'21.00" N 79°29'32.13" W elev 1309 ft
Eye alt 3886 ft


Greenhurst
Dutch Hollow Creek
© 2012 Google
1098 ft
Google earth
Imagery Date: 10/6/2011
1994
42°07'03.03" N 79°18'34.18" W elev 1312 ft
Eye alt 6054 ft


Goose Creek
Ashville Bay
Ashville Bay
© 2012 Google
891 ft
Google earth
Imagery Date: 10/6/2011
1994
42°06'27.34" N 79°22'09.38" W elev 1314 ft
Eye alt 5436 ft


Mud Creek
© 2012 Google
793 ft
Google earth
Imagery Date: 10/6/2011
1994
42°14'18.79" N 79°29'43.87" W elev 1318 ft
Eye alt 4775 ft