EXECUTIVE SUMMARY

BACKGROUND

Onondaga Lake, a 4.6-square-mile lake located just northwest of the city of Syracuse in central New York State, has been the signature feature of the surrounding community for hundreds of years. Beginning in the 1600s with the production of salt extracted from formations in the area's underlying geology, Onondaga Lake has long provided a resource for industrial activity that generated the original growth of the region and the community.

However, 200 years of population growth and urban development – including industrial activity, residential development, and the sewage and stormwater runoff that result from urbanization – have impacted the lake through the introduction of nutrients, mercury, and various other substances. Nonetheless, the lake still provides a valuable natural resource to the Syracuse community, providing many recreation opportunities as well as resources for fish and wildlife.

In 1992, AlliedSignal (now known as Honeywell) entered into a consent decree with the state of New York to initiate a remedial investigation (RI) and feasibility study (FS) for Onondaga Lake. As one of several parties associated with historical discharges to the lake, Honeywell is committed to taking appropriate actions to address the environmental legacy left by more than 100 years of operations at the former AlliedSignal plants.

Onondaga Lake Looking North

The overarching goal of this FS is to evaluate a full range of potential remedial technologies and alternatives for Onondaga Lake and to develop a recommended remedy that:

- Protects human health and the environment,
- Diversifies and optimizes the habitat for wildlife,
- Can be implemented in a timely manner, and
- Remediates this valuable recreational and ecological resource for the community.

Honeywell has committed to developing a technically sound FS that recommends a remedy for the lake that meets these objectives. To prepare this FS, Honeywell was assisted by more than 100 technical experts representing more than 25 consulting firms and dozens of technical disciplines including biology, lake ecology, chemistry, toxicology, sediment dredging, sediment capping, civil and environmental engineering, habitat restoration, ecological risk assessment, geology, hydrogeology, groundwater fate and transport modeling, supernatant water treatment, and construction.

Many of the technical experts who have participated in the development of this FS are nationally recognized authorities in their respective fields. The technical opinions developed by these experts have collectively formed the basis for the conclusions and recommendations in this FS.

SECTION 1: INTRODUCTION

Allied Chemical and AlliedSignal (now Honeywell) operated chemical production facilities collectively called the Syracuse Works on the southwest side of Onondaga Lake from 1884 to 1986. The original Solvay process used the region's natural salt brines and limestone to produce soda ash and associated products. The Syracuse Works eventually included the Main Plant, the Willis Avenue and Semet Plants, and the Bridge Street Plant.

Drilling Rig and Barge on Onondaga Lake

The Onondaga Lake system was the subject of an extensive RI conducted by Honeywell from 1992 to 2000, with additional investigation by the New York State Department of Environmental Conservation (NYSDEC) in 2001. These field investigations generated thousands of data points based on sampling of lake media, including tributary water and sediment; lake water, sediment, and sediment porewater; lake biota; shoreline groundwater; sediment in four adjacent wetlands; and dredged material in the placement area located west of the mouth of Ninemile Creek.

In most cases, samples were analyzed for various potential pollutants including metals, semivolatile organic compounds (SVOCs), and volatile organic compounds (VOCs). More than 6,000 samples were collected and analyzed to identify chemical parameters of interest (CPOIs) for the lake.

Sediment, fish tissue, and water are the primary media in Onondaga Lake that, when contaminated, potentially pose a risk to humans and wildlife. Because of their importance, this FS addresses these media, which are summarized as follows:

Sediment: Sediment containing CPOIs could potentially pose a direct risk to humans, fish, and wildlife through ingestion and skin exposure, as well as indirect risks to humans, aquatic organisms, fish, and wildlife through accumulation of chemical contaminants in the food chain.

Fish Tissue: Fish whose tissue contains CPOIs pose a potential risk to humans and wildlife that may consume them. These CPOIs could also pose a potential direct risk to the fish themselves.

Surface Water: Lake water containing CPOIs potentially poses a direct risk to aquatic organisms and an indirect risk to humans and wildlife that may consume fish that accumulate some of these chemical pollutants from water. Other factors (e.g., nutrients, calcite, salinity, and reduced water transparency) may also have an adverse impact on fish, plants, and other forms of life in the lake.

Because these three media are the primary ways that potential risks can be transmitted, these media are specifically addressed in the development of the preliminary remediation goals (PRGs) in the following section.

SECTION 2: DEVELOPMENT OF PRELIMINARY REMEDIATION GOALS

Section 2 defines the sediment management units (SMUs) and the PRGs that are used to evaluate the various remedial alternatives outlined throughout the FS.

For this FS, Onondaga Lake is divided into eight SMUs, based on location, water depth, contaminant type, and other physical characteristics. The division of Onondaga Lake into SMUs allows the development and evaluation of remedial alternatives appropriate to each unique area. The remedial alternatives evaluated for each SMU are then used in combination to develop a comprehensive, lake-wide solution that can protect human health and the environment while improving habitat and recreational use of the lake.

The eight SMUs discussed through the remainder of this FS are listed below:

- SMU 1: In-Lake Waste Deposit (ILWD)
- SMU 2: Causeway
- SMU 3: Wastebeds 1 through 8
- SMU 4: Mouth of Ninemile Creek
- SMU 5: Northern Shore
- SMU 6: Ley Creek to 700 Feet South of Onondaga Creek
- SMU 7: 700 Feet South of Onondaga Creek to the ILWD

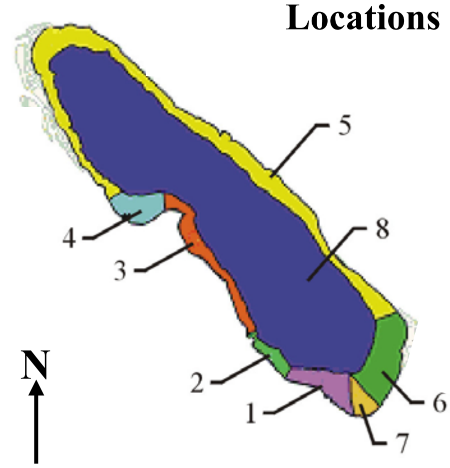
SMUs 1 through 7 cover near-shore (littoral) areas from the lakeshore to a depth of 9 meters.

- SMU 8: Profundal Area

SMU 8 encompasses the lake bottom in the deeper parts of the lake, at depths greater than 9 meters.

Adjacent wetlands SYW-6 and SYW-12 will be addressed during remediation of other upland sites.

SMU Locations



For this FS, PRGs were developed to address each of the five remedial action objectives (RAOs) identified in the RI completed by the NYSDEC. Achievement of these goals would be evaluated by a variety of quantitative measures. As described earlier, Onondaga Lake contains three primary media that have been impacted by CPOIs: sediments, fish tissue, and surface water. Therefore, three PRGs have been developed to address these impacted media.

PRG 1 (Sediments): Reduce, Contain, or Control CPOIs in Profundal and Littoral Sediments by Achieving Applicable and Appropriate SECs, to the Extent Practicable.

PRG 1 addresses the toxicity of the sediment, the bioaccumulation of mercury from sediment, and the associated release of CPOIs from sediments in the lake-bottom (profundal) and near-shore (littoral) areas. PRG 1 is quantitatively evaluated by comparison to the sediment effects concentrations (SECs), developed by NYSDEC in the baseline ecological risk assessment (BERA) to identify contaminant concentrations that may pose risk to benthic macroinvertebrates. In particular, contaminant concentrations in lake sediment are compared to individual SECs and to a single SEC index for estimating relative risks to benthic macroinvertebrates. This index, the mean probable effects concentrations quotient (PECQ) condenses complicated information from numerous chemicals into one effects-based index. In addition, PRG 1 is quantitatively evaluated by comparing average mercury concentrations in sediment to a site-specific bioaccumulation-based sediment quality value (BSQV) for mercury.

PRG 2 (Fish Tissue): Achieve CPOI Concentrations in Fish Tissue that Are Protective of Humans and Wildlife that Consume Fish, to the Extent Practicable.

PRG 2 addresses concentrations of CPOIs in fish tissue. It is quantitatively evaluated by comparing these concentrations to target fish tissue concentrations developed based on data presented in the BERA and the human health risk assessment (HHRA).

PRG 3 (Surface Water): Achieve Surface Water Quality Standards, to the Extent Practicable, Associated with CPOIs.

PRG 3, which addresses surface-water contamination, is quantitatively evaluated by comparison of CPOI concentrations in Onondaga Lake water to New York State surface water quality standards.

Since the overarching goal of the FS is to recommend a remedy that will result in the best lake-wide solution to protect human health and the environment, this FS has not been limited to the evaluation of only the quantitative goals associated with the PRGs. In addition, more qualitative goals, including enhancing the habitat for wildlife and improving conditions for recreational use of the lake, are considered when evaluating remedial alternatives.

SECTION 3: IDENTIFICATION AND SCREENING OF REMEDIAL TECHNOLOGIES

Section 3 uses a multi-step evaluation process to identify recommended technologies for improving the environmental condition of Onondaga Lake. State and federal guidance provide that individual remedial technologies should be screened, at first, for their ability to be implemented and for their short-term and long-term effectiveness.

The factors considered in the implementation screening include:

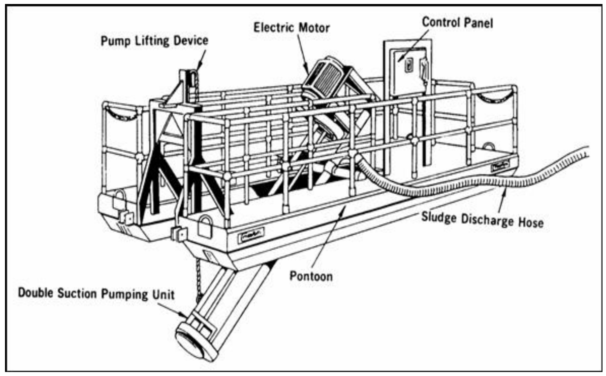
- Technical feasibility,
- Availability of the remedial technologies, and
- Administrative feasibility (e.g., work-force availability, organizational logistics).

The screening process for short-term and long-term effectiveness considers three important aspects:

- The potential for any remedial technology to have an impact on human health and/or the environment during implementation,
- The ability of each remedial technology to meet the cleanup objectives and goals (the RAOs and PRGs) over the long-term, and
- The reliability and record of performance for each remedial technology.

The above criteria are applied to a wide variety of remedial technologies that may be used for the cleanup of Onondaga Lake, including institutional controls, monitored natural recovery, reactive capping, thin-layer capping, groundwater containment, sediment dredging, dry removal, sediment consolidation or disposal, *in situ* chemical and biological treatment, phytoremediation, *in situ* solidification and/or stabilization, electrokinetic treatment, *ex situ* (off-site) sediment treatment, hypolimnion aeration (oxygenation), and habitat enhancement.

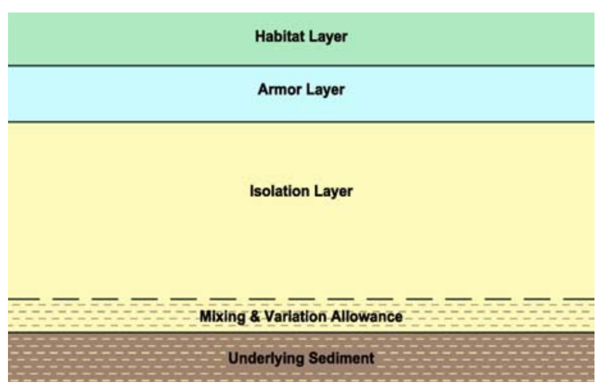
On the basis of the defined screening criteria, *in situ* and offsite treatment are eliminated from further evaluation for all SMUs. The remaining technologies are evaluated with respect to their ability to be used within each particular SMU. Remedial technologies that appear especially relevant to one or more of the lake SMUs are defined briefly in the following paragraphs.



Schematic of Hydraulic Dredge

Dredging. Dredging involves the removal of sediments and can be conducted by various methods, including mechanical devices, hydraulic systems, or pneumatic systems. Dredging is an effective remedial technology for removing sediments that affect shoreline areas inhabited by wildlife and to create new, desired water depths or habitat design features.

Isolation Capping. Isolation capping involves covering sediments with an engineered "cap" to eliminate or reduce potential exposure by humans and other living organisms that may be impacted by pollutants. Typically, isolation caps are composed of sand and/or clean sediment. Capping has proven effective at cleaning up impacted areas and can also create additional habitat for wildlife in near-shore areas.



Typical Cap Section

Monitored Natural Recovery (MNR). MNR allows natural processes to improve the concentration, mobility, bioavailability, toxicity, and/or exposure of chemicals in the environment. It is combined with a systematic monitoring program to ensure that the recovery process is proceeding appropriately. MNR can occur through a variety of processes, including the degradation of organic compounds, the burial of sediments containing chemicals by incoming clean sediments, and the conversion of chemical compounds to less toxic forms.

Much of SMU 8 appears to exhibit the types of processes (for example, the continuing deposition of sediments and the limited resuspension of pollutants) and chemical characteristics that support the progress of natural recovery.

Habitat Optimization/Enhancement. This technology focuses on creating suitable areas for aquatic plant growth and fish spawning. Habitat enhancement may include stabilizing the existing shoreline, creating additional environmental features that help support wildlife, or adding gravel or other substances suitable to encourage fish spawning. Habitat enhancement seems especially appropriate for addressing calcitic sediments in SMU 3 and oncolites in SMU 5.

View of Future Wetland

Thin-Layer Capping. A thin-layer cap is similar to an isolation cap, but with a thinner layer of capping material. Thin-layer capping provides many of the benefits of isolation capping, and the process is easier to carry out. This technology is evaluated as an alternative for SMU 8 because the physical and chemical characteristics of this SMU indicate that thin-layer capping may be appropriate, especially if implemented with another remedial technology such as MNR.

Aeration (Oxygenation). Aeration (oxygenation), which involves the addition of air or oxygen to the water column, is considered for SMU 8. Increasing the amount of oxygen in this SMU would significantly reduce conversion of mercury to methylmercury, a chemical form that is more readily accumulated in fish. Therefore, aeration (oxygenation) would also be expected to reduce mercury bioaccumulation in fish tissue, thus reducing risks to humans and wildlife that consume fish.

Deployment of Aeration (Oxygenation) Equipment

Institutional Controls. These types of controls do not involve active remediation. Instead, they are activities, documents, informational devices, or legal restrictions that minimize, limit, or prevent human exposures to CPOIs (for example, a restriction of swimming in certain areas, or fishing guidelines issued by the Department of Health). These controls are often suitable when used in combination with other, more active remedial technologies.

The remedial technologies retained after the initial screening in Section 3 (including, but not limited to, the remedial technologies described above) are carried forward and further evaluated in Section 4.

SECTION 4: DEVELOPMENT AND DETAILED EVALUATION OF REMEDIAL ALTERNATIVES

In Section 4, remedial technologies still under consideration, based on the criteria in Section 3, are assembled into various combinations to develop remedial alternatives for each SMU. These potential remedies, specific to each location, are then screened by federal criteria to identify alternatives that should be considered in a more detailed evaluation. Fully developed cleanup alternatives are then evaluated and compared for each specific SMU. They have been grouped according to two distinct areas of the lake as follows:

- The near-shore (littoral) area (SMUs 1 through 7) and
- The lake-bottom (profundal) area (SMU 8).

The remedial alternatives considered within Section 4 are measured by the federal criteria described below.

Evaluation Criteria

Consistent with federal guidelines, each cleanup alternative still under consideration at this point is evaluated for each SMU on the basis of the following federal criteria:

Threshold Criteria

- Overall protection of human health and the environment
- Compliance with applicable or relevant and appropriate requirements (ARARs)

Primary Balancing Criteria

- Short-term effectiveness
- Long-term effectiveness and permanence
- Reduction of pollutants' toxicity, mobility, or volume as a result of the proposed treatment
- Ability to be implemented
- Cost

Modifying Criteria

- Community acceptance
- Support agency acceptance

Each remedial alternative must meet the two threshold criteria to be eligible for continued consideration under the detailed analysis of remedial alternatives. If the threshold criteria are met, the primary balancing criteria are applied to provide the best overall remedy among the alternatives.

The two modifying criteria (agency and community acceptance) will be addressed as part of the upcoming proposed remedial action plan (PRAP) and record of decision (ROD) that NYSDEC will prepare. Community acceptance, assessed in the ROD, refers to the public's general response to the alternatives described in the PRAP.

Littoral Area Alternatives (SMUs 1 through 7)

Although a wide range of technologies are evaluated for the near-shore (littoral) areas of the lake, three technologies particularly applicable to these areas include dredging, capping, and habitat optimization. These technologies are combined in various ways to develop the following remedial alternatives for the littoral areas:

- Alternative 1 – No Action (required for comparison)
- Alternative 2 – Habitat Enhancement
- Alternative 3 – Isolation Capping / Habitat Optimization
- Alternative 4 – Dredging / Isolation Capping / Habitat Optimization
- Alternative 5 – Full Removal

Alternatives 3, 4, and 5 are further refined and contain subsets of alternatives. The subsets differ from one another primarily according to the specific remedial goal applied to each alternative. These goals include dredging to various SEC values, dredging to avoid loss of lake surface area, dredging to improve the cap effectiveness, dredging for contaminant mass or non-aqueous phase liquid (NAPL) removal, and/or dredging to optimize habitat and minimize erosive forces.

The FS initially evaluates 102 separate alternatives for the littoral areas (i.e., near-shore areas) of Onondaga Lake. A detailed analysis is then provided for 58 remedial alternatives, using the evaluation criteria listed above. These 58 alternatives were then screened down to 35 by the use of a comparative analysis. These 35 alternatives were used in Section 5 to develop lake-wide alternatives.

Profundal Area Alternatives (SMU 8)

Four technologies are potentially applicable to SMU 8, the profundal area of the lake:

MNR, capping (isolation capping and thin-layer capping), aeration (oxygenation), and dredging. These technologies are combined in various ways to develop the following remedial alternatives for the profundal area:

- Alternative 1 – No Action
- Alternative 2 – MNR
- Alternative 3 – Phased Thin-Layer Capping
- Alternative 4 – Phased Thin-Layer Capping / MNR
- Alternative 5 – Aeration (Oxygenation) / MNR
- Alternative 6 – Phased Thin-Layer Capping / Aeration (Oxygenation) / MNR
- Alternative 7 – Isolation Capping
- Alternative 8 – Full Removal

Onondaga Lake Facing North

A detailed analysis for Alternatives 1, 3, 4, 6, and 8 addresses various remedial goals; a total of 12 remedial alternatives were evaluated. After an initial screening process, three unique alternatives (i.e., to three distinct SEC values) for the profundal area of Onondaga Lake undergo an additional, detailed, comparative analysis. Thus, Alternative 6 – Phased Thin-Layer Capping / Aeration (Oxygenation) / MNR (to the three distinct SEC values: Alternatives 6A, 6B, and 6E) is retained and incorporated into all lake-wide alternatives for further evaluation in Section 5.

Detailed Analysis

Detailed and comparative analyses were performed for the screened remedial alternatives involving the littoral and profundal areas of Onondaga Lake. These alternatives cover a wide variety of remedial technologies, goals, and methods of implementation. Thirty-eight remedial alternatives (i.e., for the littoral and profundal areas) from Section 4 are being considered for further evaluation in Section 5.

SECTION 5: DEVELOPMENT AND EVALUATION OF LAKE-WIDE ALTERNATIVES

In Section 5, the SMU-specific alternatives carried over from Section 4 are used to develop lake-wide alternatives that would be protective of human health and the environment and would maximize the recreational, aesthetic, and ecological benefits of the lake for the community.

Throughout the FS, the term "lake-wide alternative" means a specific set of remedial technologies that provide a unique overall remedy for Onondaga Lake.

The lake-wide alternatives (remedies) evaluated are:

- Alternative A – No Action
- Alternative B – Capping to the Mean PECQ2 with Targeted Dredging
- Alternative C – Dredging / Capping to the Mean PECQ2 with Recreation and Habitat Diversification
- Alternative D – Dredging / Capping to the Mean PECQ2 with Minimal Armoring
- Alternative D2 – Dredging / Capping to the Mean PECQ2 with Additional Habitat Optimization
- Alternative E – Dredging to the Mean PECQ2
- Alternative F1 – Dredging / Capping to the Mean PECQ1 for Habitat Optimization and Minimization of Erosive Forces
- Alternative F2 – Dredging / Capping to the Mean PECQ1 with Removal of 25 Percent of Volume of SMU 1
- Alternative F3 – Dredging / Capping to the Mean PECQ1 with a Removal Depth of 3 Meters in SMU 1
- Alternative F4 – Dredging / Capping to the Mean PECQ1 with a Removal Depth of 4 Meters in SMU 1
- Alternative G – Dredging / Capping to the Mean PECQ1 with a Removal Depth of 5 Meters in SMU 1
- Alternative H – Dredging / Capping to the Mean PECQ1 with Full NAPL Removal in SMU 2
- Alternative I – Dredging to the Mean PECQ1
- Alternative J – Dredging to the ER-L

The attributes of each of the alternatives are shown on Table ES.1, including the capped area (in acres), estimated dredged volume (in cubic yards), duration of the dredging and capping portion of each remedy, and estimated costs.

Alternative A is a baseline for the development and evaluation of the other alternatives, as required by federal guidelines. For this alternative, no action is implemented for the lake, and no monitoring is performed to assess progress toward remedial goals.

Alternatives B through D2 and F1 through H represent a range of dredge/cap alternatives that provide different habitat and erosion control (armoring) through increased dredging and variations in cap design. The diversification needs of the aquatic and terrestrial community were considered in the development of the habitat-improvement and the cap-design portions of Alternatives B through D2, which address areas that exceed the mean PECQ2. Alternatives F1 through G address areas that exceed the mean PECQ1, a more stringent criteria for defining those areas to be remediated, and consider progressively greater removal depths and volumes in SMU 1. Alternative H considers full removal of NAPL in SMU 2. Alternatives E, I, and J provide progressively greater sediment removal through dredging.

Following development of the lake-wide alternatives, Section 5 uses a holistic approach to evaluate and compare the alternatives, using the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) criteria described in Section 4. In particular, this process considers overall protection of human health and the environment, short- and long-term effectiveness, implementation issues, community/worker exposure, volume of sediment disposal and treatment, and cost on a lake-wide basis. While all alternatives except Alternative A provide sufficient protection of human health and the environment, they differ in other aspects such as implementation risks, dredge volume, habitat diversification, and cost. Through the evaluation process, the alternative that achieves the PRGs and provides the best balance between the CERCLA evaluation criteria is recommended, as discussed in Section 6.

SECTION 6: RECOMMENDED REMEDIAL ACTION ALTERNATIVE

Section 6 recommends adopting, ***Alternative C – Dredging / Capping to the Mean PECQ2 with Recreation and Habitat Diversification,*** for Onondaga Lake and describes the remedy in detail. Section 6 also summarizes how the remedy meets the federal evaluation criteria defined in Section 4.

Selection Rationale

Alternative C is recommended because it is fully protective of human health and the environment and meets the required federal criteria. In addition, this remedy provides a high level of habitat diversification. The primary attributes of this recommended remedy are as follows:

- Achieves the RAOs and PRGs defined in this document and is compliant with ARARs, to the extent practicable, through dredging and capping;
- Protects human health and the environment;
- Provides a good balance between long-term and short-term risks;
- Diversifies the habitat for plants and wildlife in and around the lake;
- Can be implemented in a timely manner;
- Is effective in the long term; and

- Remediates a valuable recreational and ecological resource for the community.

Alternative C is preferred over Alternative A because the No Action Alternative would not be protective of human health and the environment or meet any of the other federal criteria. Alternative A is included in the analysis for baseline comparison purposes only.

Alternative B is sufficiently protective of human health and the environment and may meet the other federal criteria but does not provide as much habitat diversification as Alternative C. Therefore, Alternative C is preferred over Alternative B.

Alternative D is also sufficiently protective of human health and the environment and meets the other federal criteria. It involves dredging to an increased depth (below the ice line to minimize the stone cover required to protect the cap), but does not increase habitat diversification to the same extent as Alternative C. For example, the additional recreational / habitat buffer area in SMU 1 under Alternative C would provide more area suitable for direct contact (e.g., wading). Since the additional dredging of Alternative D has more short-term impacts, with increased cost, Alternative C is preferred over Alternative D.

Alternative D2 is sufficiently protective of human health and the environment and meets the other federal criteria. It provides additional dredging in SMUs 5, 6, and 7 to prevent a loss of lake surface area, optimize habitat, and minimize erosive forces. As a result of this additional dredging, Lake-wide Alternative D2 would provide more habitat diversification than Alternative D, comparable to Alternative C. However, since both alternatives are sufficiently protective, and Alternative D2 involves a significant increase in dredging volume and its resulting short-term impacts, and is more costly. Alternative C is preferred over Alternative D2.

Alternative E is sufficiently protective of human health and the environment and provides a high degree of sediment removal. However, Alternative E does not provide a commensurate increase in benefits compared to Alternative C because of the significant short-term impacts, implementation issues, overall quality of life impacts related to surface water contamination, transportation risks, and construction risks.

In addition, Alternative E is impractical because of the large dredging volumes, uncertainty related to dredging depths, and the long duration required for construction. Because of the significant costs, short-term impacts, and implementability issues associated with Alternative E without a significant increase in protectiveness of human health and the environment, Alternative C is preferred over Alternative E.

Alternatives F1 through F4 are also sufficiently protective of human health and the environment and meet the other federal criteria. These alternatives involve progressively increasing dredging depths in SMU 1, which result in greater sediment removal volumes. Aternative F1 provides a diversification of aquatic habitat similar to Alternative C, with Alternatives F2 through F4 providing progressively deeper and less diverse aquatic habitat. These alternatives involve significant increases in dredging volumes, short-term impacts, implementability issues, and costs. Given these considerations, and balancing the evaluation criteria, Alternative C is preferred over Alternatives F1 through F4.

Alternative G is sufficiently protective of human health and the environment and meets the other federal criteria. Alternative G would present short-term impacts and implementation issues not associated with Alternative C, but both alternatives are sufficiently protective. Therefore, balancing all of the evaluation criteria, Alternative C is preferred over Alternative G.

Alternative H is sufficiently protective of human health and the environment and meets the other federal criteria. This alternative provides additional dredging for NAPL removal in SMU 2. Similar to Alternative G, this alternative would present short-term impacts and implementation issues not associated with Alternative C, at a significantly greater cost. Therefore, balancing all of the evaluation criteria, Alternative C is preferred over Alternative H.

Alternatives I and J are sufficiently protective of human health and the environment and provide a higher degree of sediment removal than Alternatives C and E, due to more stringent removal criteria (mean PECQ1 and the ER-L.) However, Alternatives I and J pose additional short-term impacts, implementation issues, and overall quality of life impacts related to surface water contamination, transportation risks, and construction risks.

In addition, Alternatives I and J are impractical because of the large dredging volumes, uncertainty related to dredging depths, and the long duration required for construction. Because of the significant costs, short-term impacts, and implementability issues associated with Alternatives I and J, Alternative C is preferred over Alternatives I and J.

Alternative C provides the best balance among the evaluation criteria. Every alternative other than Alternative A is sufficiently protective of human health and the environment. Alternative C provides a wealth of habitat and recreational diversity, without the short-term impacts and implementation issues presented by the alternatives that involve greater sediment removal. Therefore, Alternative C – Dredging / Capping to the Mean PECQ2 with Recreation and Habitat Diversification is recommended.

The recommended remedy assumes that the upland sites adjacent to Onondaga Lake would be remediated as necessary to reduce CPOI inputs into the lake. Remedial activities involving dredging and capping in the lake would follow the substantial completion of upland site remediation to avoid recontaminating the remediated portions of the lake. These sites are being addressed under separate projects.

Recommended Remedy Description

The components of the recommended remedy, which are shown on the attached Figures ES.1 through ES.4, are summarized briefly in the following paragraphs.

Hydraulic dredging of an estimated 543,000 cubic yards (CY) of impacted sediments. In one of the largest contaminated-sediment removal projects ever conducted in the United States, the recommended remedy involves the removal of those sediments necessary to address the most contaminated shallow sediments in the lake. Significant dredging would be performed in SMUs 1, 2, 3, and 6.

Hydraulic Dredging Operation

Targeted dredging of sediments would be used to enhance the effectiveness of a sediment cap, optimize aquatic habitat, and preserve lake surface area following capping of the dredged area.

An estimated 151,000 CY of impacted sediment in SMU 1 would be dredged, so that cap placement would result in no loss of lake surface area. The removal depth required for no loss of lake surface area in SMU 1 would be carefully estimated based on the predicted settlement of sediments as a result of cap placement.

In SMUs 2 and 3, dredging would provide a post-remediation water depth that fully supports habitat enhancement. Dredging would harmoniously accomplish two goals: It would remove contaminated materials to the optimal habitat depth (meeting warm water species spawning requirements) and it would remove those materials to a depth that reduces the erosive forces on the cap. Targeted dredging in SMU 2 would be conducted to a depth of approximately four meters for NAPL removal. A total of 244,000 CY of sediments would be dredged from these two SMUs.

In SMU 6, targeted dredging of impacted sediments (148,000 CY) would ensure the effectiveness of the cap by removing the impacted sediment in near-shore areas subject to higher rates of groundwater "upwelling." Moreover, the capped areas would be engineered for habitat optimization.

This remedy can be implemented in a timely manner, and therefore would not have a significant short-term impact on the surrounding community. The dredging of sediments, as described, would not delay completing the planned walking and biking trail around the lake, and would cause no long-term restrictions on canoeing, fishing, or other recreational uses of Onondaga Lake.

Capping of an estimated 356 acres within the near-shore (littoral) zone of Onondaga Lake. The process of capping, as called for in the recommended remedy, would eliminate the potential human health and ecological exposure pathways associated with impacted sediment. This remedy would be effective in the long term with a high level of permanence.

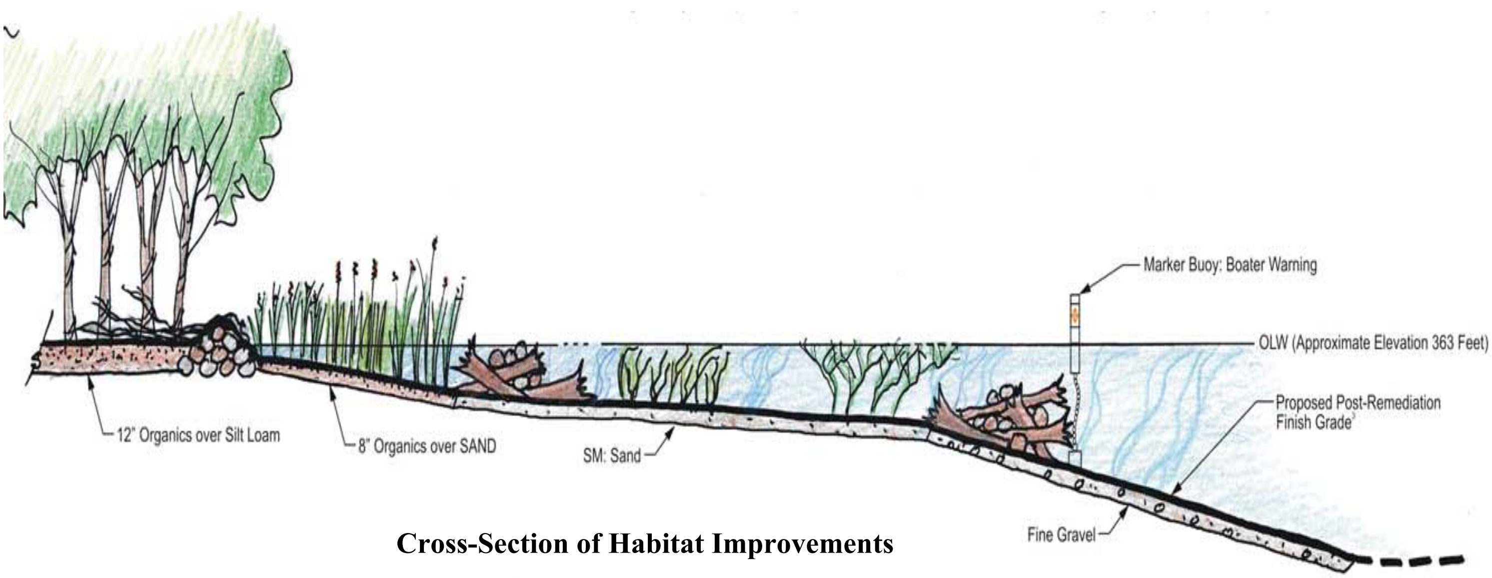
The cap would be designed and built to ensure long-term stability, using a conservative approach to reduce any concerns about potential failure. After completing the capping, a long-term monitoring program would be implemented to ensure the cap's effectiveness.

Cap Placement Using Clean Sand

Habitat improvement. The recommended remedy would enhance Onondaga Lake as a valued community resource by improving aquatic habitat throughout the lake while simultaneously achieving the RAOs and PRGs. For example, in areas of the lake where an isolation cap would be installed, the surface characteristics of the cap would be optimized to enhance growth of submerged aquatic plants, to increase fish spawning, to improve aquatic habitat, and to resist the forces of erosion.

This remedy would also improve wildlife habitat in other areas of the lake where dredging and/or capping are not necessary to protect human health and the environment. Specific habitat enhancements in the recommended remedy include:

- Approximately six acres of new upland (on-shore) habitat created in SMU 4;
- Emergent wetlands (wetland areas containing vegetation extending above the water's surface) established over approximately ten acres of isolation cap within SMU 4;
- A recreational / habitat buffer zone (a sand layer suitable for wading, to a water depth of 2 ft) established over approximately 25 acres of the isolation cap, within SMUs 1, 2, 3, 6, and 7;
- Additional habitat suitable for aquatic plants (a sand layer from a water depth of 2 to 5 ft) created over about 48 acres within SMUs 1, 2, 3, 4, 6, and 7;
- Fish spawning habitat created and enhanced with a thin gravel layer over approximately 133 acres of isolation cap within SMUs 1, 2, 3, 4, 6, and 7;



Cross-Section of Habitat Improvements

- Improved habitat for multiple bottom-dwelling species within the lake created over an area of about 114 acres within SMUs 1, 2, 3, 4, 6, and 7;
- Near-shore habitat for wildlife in SMUs 3 and 5 physically stabilized;
- Steeply sloped areas adjacent to SMU 3 would be addressed through other actions associated with the remediation of Wastebeds 1 through 8; and
- If consistent with community goals and land-use planning, a public swimming beach would be established along the northeast shoreline of the lake between the marina and the lake outlet.

Aeration (oxygenation). Aeration (oxygenation) would involve the addition of air or oxygen to the water column of Onondaga Lake. This would significantly reduce the conversion of mercury to methylmercury, a chemical form that is more readily accumulated in fish. Therefore, aeration (oxygenation) would also be expected to reduce mercury bioaccumulation in fish tissue, thus reducing risks to humans and wildlife that consume fish. By adding oxygen to the lake, aeration (oxygenation) would also broaden the extent of the area within the lake that would be habitable for fish.

To better understand the impacts of aeration (oxygenation) on the sediments and on the nitrogen and phosphorus cycles in the lake, a pilot test would be performed coordinating with the Onondaga Lake Partnership, which is planning similar studies on the lake.

MNR / thin-layer capping of profundal sediments. MNR is an active, positive part of the recommended remedy for the profundal zone. It is a recognized sediment management tool that can occur through a variety of physical, chemical, and biological processes that act alone or in combination to reduce the concentrations of, exposure to, and/or mobility of chemicals.

MNR and thin-layer capping would be most effectively implemented with a phased approach. Phase I activities in the profundal zone would include full-scale implementation of an aeration (oxygenation) system if effective in pilot testing. Thin-layer capping may include portions of the profundal area that, in combination with littoral sediments, would otherwise be expected to exceed the mercury BSQV on a surface area weighted concentration basis, after an MNR period in the presence of aeration (oxygenation). Phase II would include continued MNR monitoring to assess the effectiveness of natural recovery and aeration (oxygenation). Phase III would include thin-layer capping and/or continued MNR or other contingency measures (if necessary) to achieve remedial goals, and continuation of aeration (oxygenation), if proven to be effective.

Consolidating dredged sediments in an on-site sediment consolidation area (SCA) and treatment of SCA effluent. An SCA with an impermeable liner would be constructed on Wastebed 13 in accordance with U.S. Army Corps of Engineers standards to contain the sediment removed from the lake during dredging. Wastebed 13 can accommodate the proposed volume of dredged material, provides great flexibility in SCA design, and is easily accessible by truck and pipeline. This wastebed is also relatively remote from the lake and from commercial areas, and changes in this area would create only a minimal degree of disruption to the community during its construction and operation. Moreover, this area could eventually be developed in accordance with approved reuse scenarios. The effluent water generated from sediment consolidation would be treated, preserving lake-water quality, and then released back into the dredging zone within the lake.

Costs

The recommended remedy is cost-effective, based on overall protection of human health and the environment and other federal criteria, with an anticipated cost of approximately $243,000,000. This estimate includes $210,000,000 in capital costs and a present worth value of $33,000,000 in operating and maintenance costs. Although not included in this FS, significant additional costs associated with the remediation of the upland sources are, as previously noted, necessary for the successful implementation of the lake-wide remedy, and would contribute to an overall solution for the Onondaga Lake ecosystem.

SUMMARY

More than 75,000 hours have been expended by dozens of environmental experts spanning a great variety of technical disciplines in developing an optimal remedial plan for Onondaga Lake. Given the central role played by the lake in the surrounding community, Honeywell is strongly committed to the implementation of a remedy that will help restore this important resource and enhance the overall quality of life within the community.

Taken collectively, the components of the recommended lake-wide remedy, **Dredging / Capping to the Mean PECQ2 with Recreation and Habitat Diversification**, as described in this FS, meet all of the critical objectives described at the outset of this document. Specifically, this optimal remedy:

- Achieves the RAOs and PRGs defined in this FS,
- Protects human health and the environment,
- Diversifies habitat in and around the lake,
- Can be implemented in a timely manner,
- Is effective in the long term, and
- Remediates a valuable recreational and ecological resource for the community.

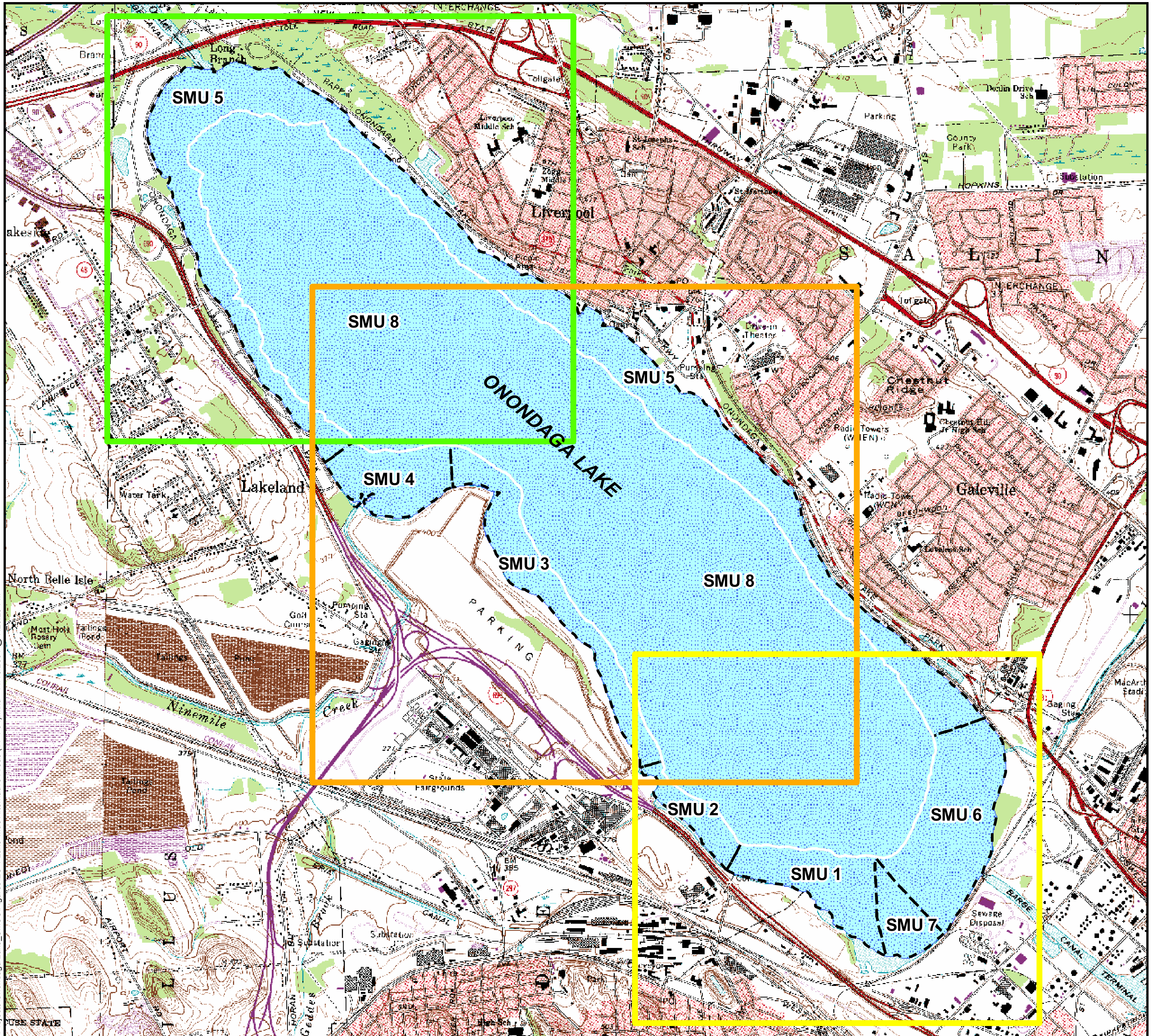
The recommended remedy would satisfy the RAOs and PRGs described in Section 2. It would also provide the most balanced way to address the federal evaluation criteria, as determined through the comparative analysis of the lake-wide alternatives. This alternative maximizes the recreational, aesthetic, and ecological benefits for the entire lake through the creation and enhancement of habitat for wildlife, the dredging and/or capping of impacted sediments, and the long-term monitoring and contingency measures to ensure the remedy's effectiveness.

Implementation of this remedy will improve the recreational use and development potential of Onondaga Lake, and will enhance the quality of life in the nearby communities for future generations.

TABLE ES.1
ONONDAGA LAKE
LAKE-WIDE ALTERNATIVES

	Lake-wide Alternative A	Lake-wide Alternative B	Lake-wide Alternative C	Lake-wide Alternative D	Lake-wide Alternative D2	Lake-wide Alternative E	Lake-wide Alternative F1	Lake-wide Alternative F2	Lake-wide Alternative F3	Lake-wide Alternative F4	Lake-wide Alternative G	Lake-wide Alternative H	Lake-wide Alternative I	Lake-wide Alternative J
	No Action	**Cap with Targeted Dredging**	**Dredge / Cap with Recreation and Habitat Diversification**	**Dredge / Cap with Minimal Armoring**	**Dredge / Cap**	**Dredge**	**Dredge / Cap**	**Dredge / Cap**	**Dredge / Cap**	**Dredge / Cap**	**Dredge / Cap**	**Dredge / Cap**	**Dredge/Cap**	**Dredge/Cap**
Criterion	**NA**	**A - Mean PECQ of 2 + Hg PEC (except SMU 5)**	**A - Mean PECQ of 2 + Hg PEC (except SMU 5)**	**A - Mean PECQ of 2 + Hg PEC (except SMU 5)**	**A - Mean PECQ of 2 + Hg PEC**	**A - Mean PECQ of 2 + Hg PEC (except SMU 5)**	**B - Mean PECQ of 1 + Hg PEC**	**B - Mean PECQ of 1 + Hg PEC**	**B - Mean PECQ of 1 + Hg PEC**	**B - Mean PECQ of 1 + Hg PEC**	**B - Mean PECQ of 1 + Hg PEC**	**B - Mean PECQ of 1 + Hg PEC**	**B - Mean PECQ of 1 + Hg PEC**	**E - ERL**
Dredging Basis	**NA**	**None in SMUs 1, 2, 4, 5, 7 and 8. NLSA, H&E and Targeted Dredging in SMU 3. Targeted Dredging in SMU 6.**	**None in SMUs 4, 5, 7 and 8. NLSA in SMU 1. NLSA, H&E and Targeted Dredging in SMUs 2 and 3. Targeted Dredging in SMU 6.**	**None in SMUs 5 , 7 and 8. NLSA and H&E in SMUs 1 and 4. NLSA, H&E and Targeted Dredging in SMUs 2 and 3. Targeted Dredging in SMU 6.**	**None in SMU 8. NLSA and H&E in SMUs 1, 4, 5, and 7. NLSA, H&E and Targeted Dredging in SMUs 2, 3, and 6.**	**None in SMUs 5 and 8. "Full removal" to the Mean PECQ2 and Hg PEC in SMUs 1, 2, 3, 4, 6, and 7.**	**None in SMU 8. NLSA and H&E in SMUs 1, 4, 5 and 7. NLSA, H&E and Targeted Dredging in SMUs 2, 3 and 6.**	**None in SMU 8. NLSA and H&E in SMUs 1, 4, 5 and 7. 25% of SMU 1. NLSA, H&E and Targeted Dredging in SMUs 2, 3 and 6.**	**None in SMU 8. NLSA and H&E in SMUs 1, 4, 5 and 7. To 3 meters in SMU 1. NLSA, H&E and Targeted Dredging in SMUs 2, 3 and 6.**	**None in SMU 8. NLSA and H&E in SMUs 1, 4, 5 and 7. To 4 meters in SMU 1. NLSA, H&E and Targeted Dredging in SMUs 2, 3 and 6.**	**None in SMU 8. NLSA and H&E in SMUs 1, 4, 5 and 7. To 5 meters in SMU 1. NLSA, H&E and Targeted Dredging in SMUs 2, 3 and 6.**	**None in SMU 8. NLSA and H&E in SMUs 1, 4, 5 and 7. To 5 meters in SMU 1. NLSA, H&E and Targeted Dredging in SMUs 2, 3, and 6. Full NAPL removal in SMU 2**	**None in SMU 8. NLSA and H&E in SMU 5. "Full removal" to the Mean PECQ1 and Hg PEC in SMUs 1, 2, 3, 4, 6, and 7.**	**None in SMU 8. NLSA and H&E in SMU 5. "Full removal" to the ERL in SMUs 1, 2, 3, 4, 6, and 7.**
SMU 1	**No Action**	**Littoral Alternative 3.A** Capping of Entire SMU / Habitat Optimization	**Littoral Alternative 4.A.2** Dredge for NLSA / Capping of Entire SMU / Habitat Optimization	**Littoral Alternative 4.A.3** Dredge for NLSA and H&E / Capping of Entire SMU / Habitat Optimization		**Littoral Alternative 5.A** Full Removal (To Mean PECQ2)	**Littoral Alternative 4.A.3** Dredge for NLSA and H&E / Capping of Entire SMU / Habitat Optimization	**Littoral Alternative 4.A.4** Dredge for Mass Removal to Remove 25% of ILWD / Cappping of Entire SMU / Habitat Optimization	**Littoral Alternative 4.A.5** Dredge for Mass Removal to 3 Meters / Cap of Entire SMU / Habitat Optimization	**Littoral Alternative 4.A.6** Dredge for Mass Removal to 4 Meters / Capping of Entire SMU / Habitat Optimization	**Littoral Alternative 4.A.7** Dredge for Mass Removal to 5 Meters / Cap of Entire SMU / Habitat Optimization		**Littoral Alternative 5.A** Full Removal (To Mean PECQ1)	**Littoral Alternative 5.A** Full Removal (To ERL)
SMU 2	**No Action**	**Littoral Alternative 3.A** Capping to Mean PECQ2 / Habitat Optimization	**Littoral Alternative 4.A.3** Dredge for NLSA and H&E and Targeted Dredging to 4 Meter Depth (For NAPL Removal) / Capping to Mean PECQ2 / Habitat Optimization			**Littoral Alternative 5.A** Full Removal (To Mean PECQ2)	**Littoral Alternative 4.A.3** Dredge for NLSA and H&E and Targeted Dredging to 4 Meter Depth (For NAPL Removal) / Capping to Mean PECQ1 / Habitat Optimization					**Littoral Alternative 4.A.4** Dredge for NLSA, H&E & Full NAPL Removal / Capping to Mean PECQ1 / Habitat Optimization	**Littoral Alternative 5.A** Full Removal (To Mean PECQ1)	**Littoral Alternative 5.D** Full Removal (To ERL)
SMU 3	**No Action**	**Littoral Alternative 2** Habitat Enhancement **Littoral Alternative 4.A.3** Dredge for NLSA and H&E and Targeted Dredging/ Capping to Mean PECQ2 / Habitat Optimization				**Littoral Alternative 5.A** Full Removal (To Mean PECQ2)	**Littoral Alternative 2** Habitat Enhancement - **Littoral Alternative 4.A.3** Dredge for NLSA and H&E and Targeted Dredging / Capping to Mean PECQ1 / Habitat Optimization						**Littoral Alternative 5.A** Full Removal (To Mean PECQ1)	**Littoral Alternative 5.E** Full Removal (To ERL)
SMU 4	**No Action**	**Littoral Alternative 3.A** Capping of Entire SMU / Habitat Optimization		**Littoral Alternative 4.A.3** Dredge for NLSA and H&E / Capping of Entire SMU / Habitat Optimization		**Littoral Alternative 5.A** Full Removal (To Mean PECQ2)	**Littoral Alternative 4.A.3** Dredge for NLSA and H&E / Capping of Entire SMU / Habitat Optimization						**Littoral Alternative 5.A** Full Removal (To Mean PECQ1)	**Littoral Alternative 5.D** Full Removal (To ERL)
SMU 5	**No Action**	**Littoral Alternative 2** Habitat Enhancement			**Littoral Alternative 2** Habitat Enhancement **Littoral Alternative 4.A.3** Dredge for NLSA and H&E / Capping to Mean PECQ2 / Habitat Optimization	**Littoral Alternative 2** Habitat Enhancement	**Littoral Alternative 2** Habitat Enhancement - **Littoral Alternative 4.B.3** Dredge for NLSA and H&E / Capping to Mean PECQ1 / Habitat Optimization							**Littoral Alternative 2/4.E.3** Habitat Enhancement/Dredge for NLSA and H&E / Capping to ERL / Habitat Optimization
SMU 6	**No Action**	**Littoral Alternative 4.A.1** Targeted Dredging / Capping to Mean PECQ2 / Habitat Optimization			**Littoral Alternative 4.A.3** Dredge for NLSA and H&E and Targeted Dredging / Capping to Mean PECQ2 / Habitat Optimization.	**Littoral Alternative 5.A** Full Removal (To Mean PECQ2)	**Littoral Alternative 4.B.3** Dredge for NLSA and H&E and Targeted Dredging / Capping to Mean PECQ1 / Habitat Optimization.						**Littoral Alternative 5.B** Full Removal (To Mean PECQ1)	**Littoral Alternative 5.D** Full Removal (To ERL)
SMU 7	**No Action**	**Littoral Alternative 3.A** Capping of Entire SMU / Habitat Optimization			**Littoral Alternative 4.A.3** Dredge for NLSA and H&E / Capping of Entire SMU / Habitat Optimization.	**Littoral Alternative 5.A** Full Removal (Mean PECQ2)	**Littoral Alternative 4.A.3** Dredge for NLSA and H&E / Capping of Entire SMU / Habitat Optimization.						**Littoral Alternative 5.A** Full Removal (To Mean PECQ1)	**Littoral Alternative 5.C** Full Removal (To ERL)
SMU 8	**No Action**	**Profundal Alternative 6.A** Phased Thin-layer Cap to Mean PECQ2, Hg PEC, and BSQV / Aeration (Oxygenation) / MNR					**Profundal Alternative 6.B** Phased Thin-layer Cap to Mean PECQ1, Hg PEC, and BSQV / Aeration (Oxygenation) / MNR							**Profundal Alternative 6.E** Thin Layer Cap to ERL and BSQV/ Aeration (Oxygenation)
Capped Acres	**0**	**356**	**356**	**356**	**392**	**20**	**579**	**579**	**579**	**579**	**579**	**579**	**214**	**2329**
Dredged Volume (CY)	**0**	**223,000**	**543,000**	**881,000**	**1,180,000**	**11,247,000 ++**	**1,207,000**	**1,868,000**	**2,419,000**	**2,947,000**	**3,490,000**	**3,724,000**	**12,184,000 ++**	**20,121,000 ++**
Cap and Dredge Duration (Years)	**0**	**3**	**3**	**3**	**3**	**9**	**4**	**4**	**4**	**4**	**4**	**4**	**10**	**17**
Total Cost ($ Millions)	**$0**	**$211**	**$243**	**$264**	**$294**	**$1,214**	**$312**	**$370**	**$429**	**$470**	**$514**	**$537**	**$1,327**	**$2,157**

Note:
1. The Cap and Dredge duration in years assumes a seven-month construction season.
++ - The depth limit of SEC exceedances have not been defined, therefore dredge volume and cost liekly to exceed the listed value.



Detail of area shown in Figure ES.2

Detail of area shown in Figure ES.3

Detail of area shown in Figure ES.4

Open Water

NOTES

1. Profundal bathymetric boundary at 30 ft (9m) highlighted in white

2. Boundary between SMUs shown as black dashed line

0 1,500 3,000

Feet

1:26,000

FIGURE ES.1

Honeywell

Onondaga Lake
Syracuse, New York

Recommended Remedy
Dredging/Capping with
Recreation and Habitat Diversification

PARSONS

290 Elwood Davis Rd, Suite 312, Liverpool, NY 13088 Phone: (315) 451-9560

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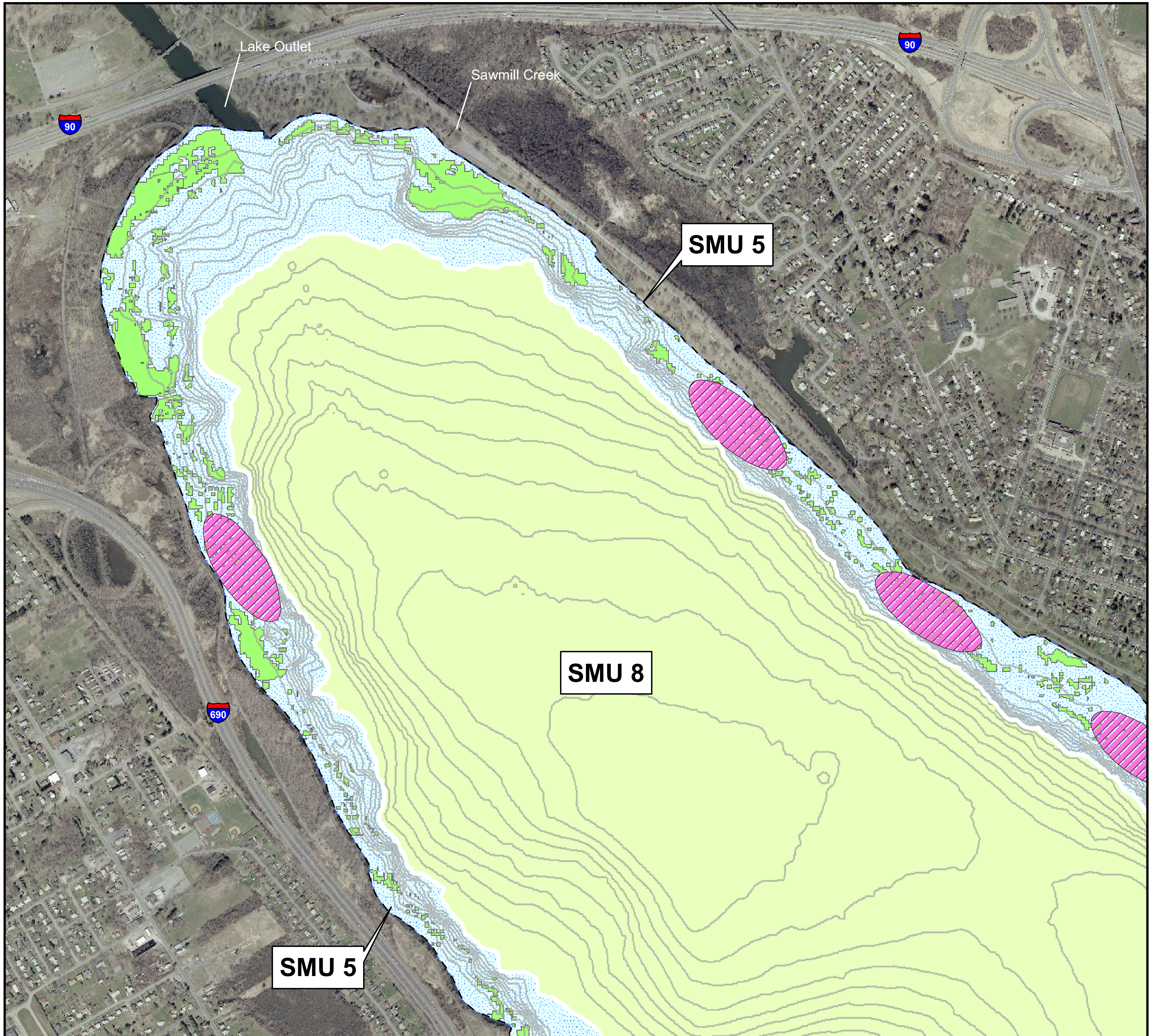

- Open Water
- Upland Area
- Emergent Wetlands
- Sand - Recreational / Habitat Buffer Area Over Isolation Cap
- Sand - Submerged Macrophyte / Benthic Area Over Isolation Cap
- Fine Gravel - Fish Spawning Habitat Over Isolation Cap
- Sand - Benthic Substrate Area Over Isolation Cap
- Sand - Thin-Layer Cap
- Thin Layer Capping / Monitored Natural Recovery, Phase I
- Thin Layer Capping / Monitored Natural Recovery, Phase III
- Profundal Area Monitored Natural Recovery and Aeration
- Area Dredged to Ensure No Loss of Lake Surface Area (All SMUs) and Enhance Habitat Value and Minimize Erosive Forces (SMUs 2 & 3)
- Area Dredged to Enhance Cap Effectiveness
- Littoral Area Testing for Submerged Macrophyte Optimization
- Current Areas of Macrophytes (2000)

NOTES

1. Profundal bathymetric boundary at 30 ft (9m) highlighted in white
2. Boundary between SMUs shown as black dashed line

0 500 1,000
Feet

1 inch equals 900 feet

N

FIGURE ES.2

Honeywell

Onondaga Lake
Syracuse, New York

Recommended Remedy
Dredging/Capping with
Recreation and Habitat Diversification

PARSONS

290 Elwood Davis Rd, Suite 312, Liverpool, NY 13088 Phone: (315) 451-9560

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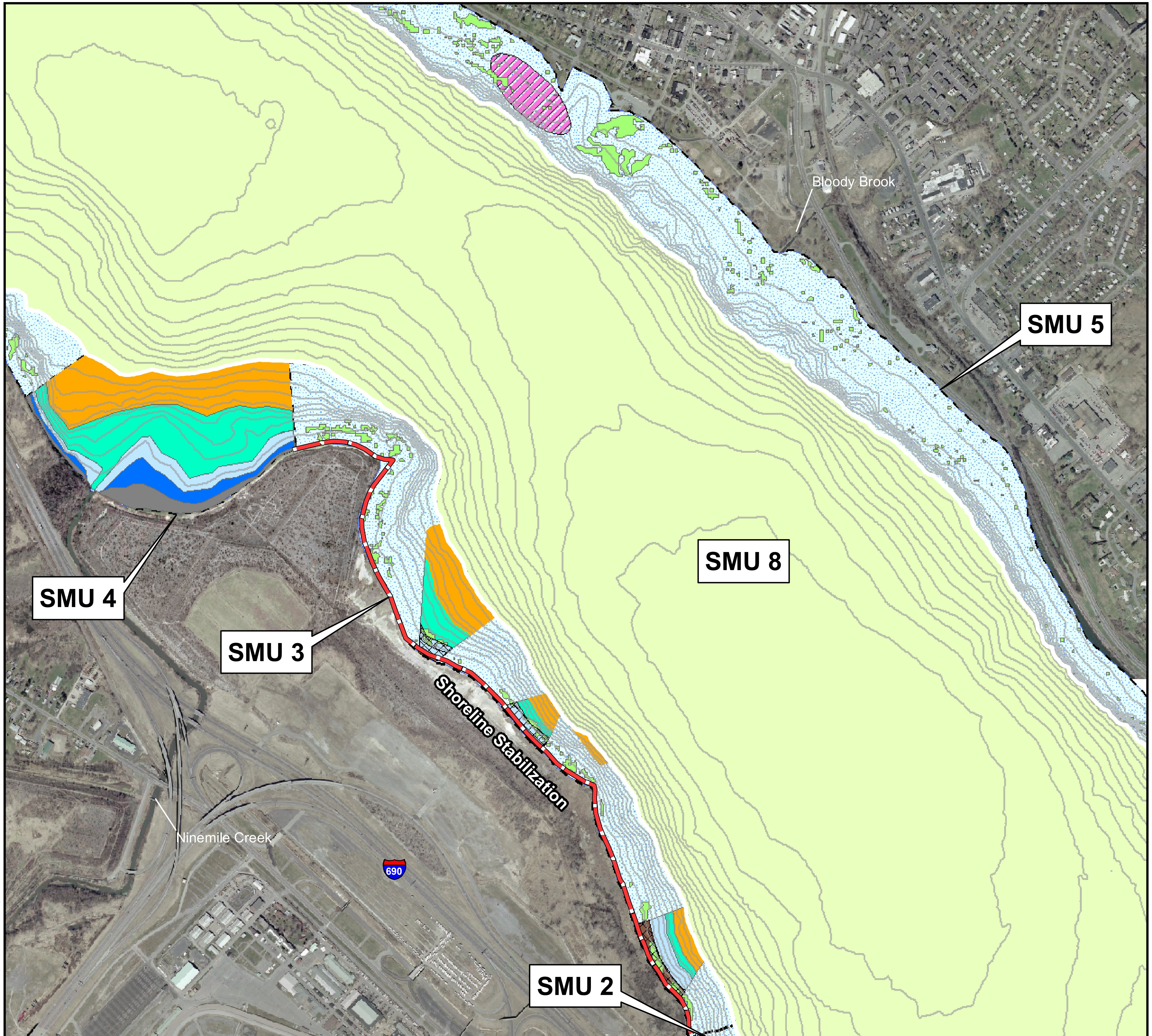

- Open Water
- Upland Area
- Emergent Wetlands
- Sand - Recreational / Habitat Buffer Area Over Isolation Cap
- Sand - Submerged Macrophyte / Benthic Area Over Isolation Cap
- Fine Gravel - Fish Spawning Habitat Over Isolation Cap
- Sand - Benthic Substrate Area Over Isolation Cap
- Thin Layer Capping / Monitored Natural Recovery, Phase I
- Thin Layer Capping / Monitored Natural Recovery, Phase III
- Profundal Area Monitored Natural Recovery and Aeration
- Area Dredged to Ensure No Loss of Lake Surface Area (All SMUs) and Enhance Habitat Value and Minimize Erosive Forces (SMUS 2 & 3)
- Area Dredged to Enhance Cap Effectiveness
- Littoral Area Testing for Submerged Macrophyte Optimization
- Current Areas of Macrophytes (2000)

NOTES

1. Profundal bathymetric boundary at 30 ft (9m) highlighted in white
2. Boundary between SMUs shown as black dashed line

0 750 1,500
Feet

1 inch equals 1,000 feet

FIGURE ES.3

Honeywell

Onondaga Lake
Syracuse, New York

Recommended Remedy
Dredging/Capping with
Recreation and Habitat Diversification

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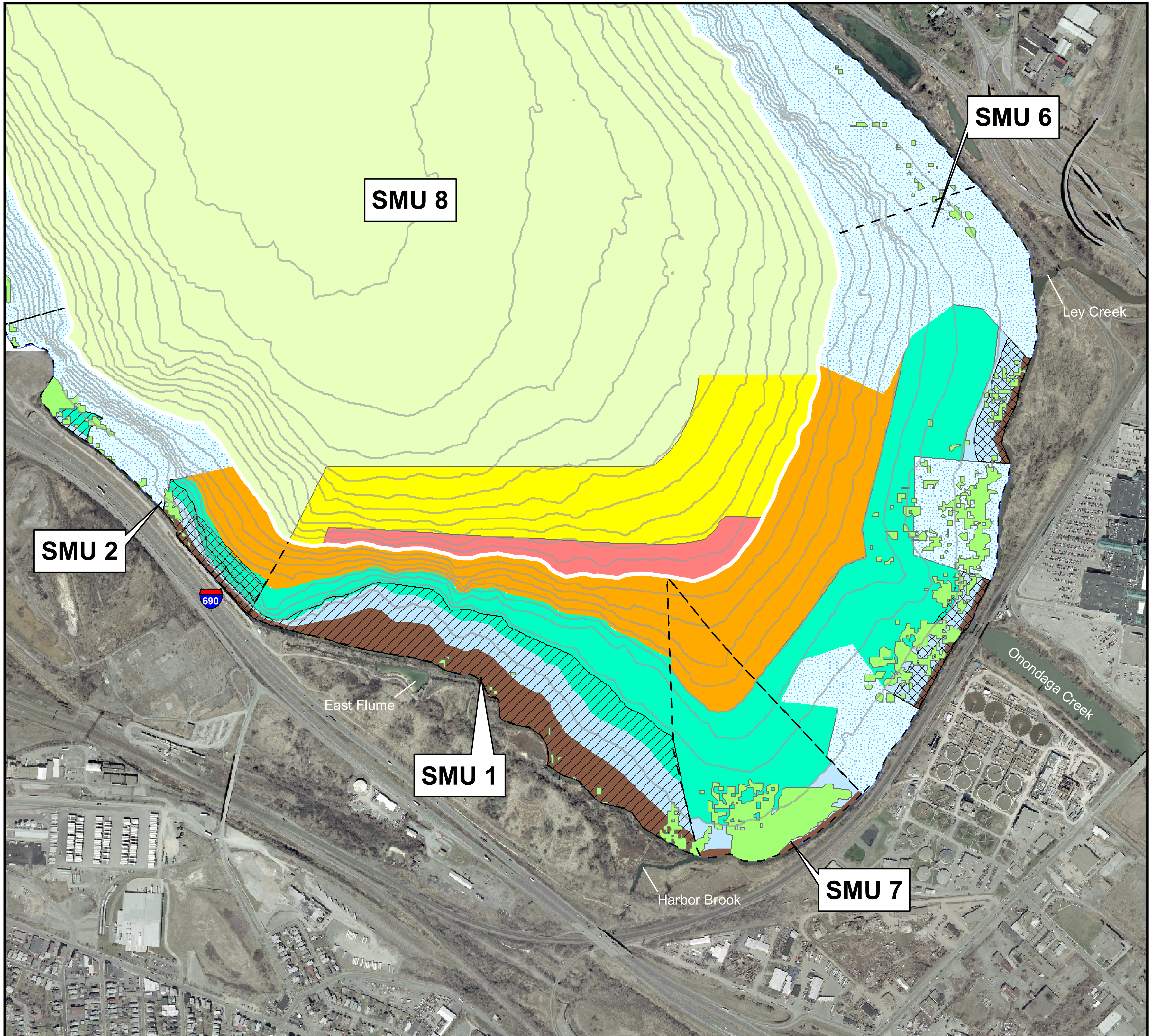

- Open Water
- Upland Area
- Emergent Wetlands
- Sand - Recreational / Habitat Buffer Area Over Isolation Cap
- Sand - Submerged Macrophyte / Benthic Area Over Isolation Cap
- Fine Gravel - Fish Spawning Habitat Over Isolation Cap
- Sand - Benthic Substrate Area Over Isolation Cap
- Thin Layer Capping / Monitored Natural Recovery, Phase I
- Thin Layer Capping / Monitored Natural Recovery, Phase III
- Profundal Area Monitored Natural Recovery Aeration
- Area Dredged to Ensure No Loss of Lake Surface Area (All SMUs) and Enhance Habitat Value and Minimize Erosive Forces (SMUs 2 & 3)
- Area Dredged to Enhance Cap Effectiveness
- Current Areas of Macrophytes (2000)

NOTES

1. Profundal bathymetric boundary at 30 ft (9m) highlighted in white
2. Boundary between SMUs shown as black dashed line

0 500 1,000
Feet

1 inch equals 800 feet

FIGURE ES.4

Honeywell

Onondaga Lake
Syracuse, New York

Recommended Remedy
Dredging/Capping with
Recreation and Habitat Diversification

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