APPENDIX B
ONONDAGA LAKE WATER QUALITY DATA SUMMARY AND INTERPRETATION

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LIST OF ACRONYMS AND ABBREVIATIONS

A(A)	aquatic (acute)
A(C)	aquatic (chronic)
BMP	best management practice
cfs	cubic feet per second
CPOI	chemical parameters of interest
H(FC)	human consumption of fish
ILWD	in-lake waste deposit
ISUS	In-Situ Ultraviolet Spectrophotometer
Metro	Metropolitan Syracuse Wastewater Treatment Plant
mg/L	milligrams per liter
mph	miles per hour
Nm	Nanometer
NTU	Nephelometric Turbidity Units
NYSDEC	New York State Department of Environmental Conservation
OCDWEP	Onondaga County Department of Water Environment
PAH	polycyclic aromatic hydrocarbon
PAR	Photosynthetically Active Radiation
PCB	polychlorinated biphenyls
PDI	Pre-Design Investigation
RI	Remedial Investigation
SMU	Sediment Management Unit
SVOC	semivolatile organic compound
SU	Syracuse University
TSS	Total Suspended Solids
UFI	Upstate Freshwater Institute
VOC	volatile organic compound
WB	Wastebeds
WQMMP	Water Quality Management and Monitoring Plan

1 INTRODUCTION

There is a long history of water quality monitoring in Onondaga Lake. In general, water quality, and particularly turbidity, within Onondaga Lake can vary significantly due to natural events such as rain storms, high winds, and other weather events. For example, the southeast portion of the Lake represents its predominantly leeward end, and as a result becomes turbid on windy and stormy days due to particulate matter that enters from the tributaries and/or wind-driven resuspension of sediments (as well as Solvay Waste in the in-lake waste deposit [ILWD] area). On calm days, water clarity can be high in shallow areas. Additionally, tributaries to the Lake (e.g., Onondaga Creek, Harbor Brook, Ley Creek, and Ninemile Creek) and outfalls (i.e., Metropolitan Syracuse Wastewater Treatment Plant [Metro]) can contribute to increased turbidity within the littoral regions of the Lake, particularly after rain storm events. Furthermore, biological processes (i.e., algal production) have an effect on water clarity and turbidity levels in the Lake. The various water quality datasets available to assess the general water quality characteristics described above are summarized in the next section.

2 OVERVIEW OF WATER QUALITY DATASETS

2.1 2010 to 2011 Water Quality Monitoring for Construction Baseline

In order to understand potential impacts on water quality from the dredging and capping operations that will begin in 2012, baseline monitoring was conducted in fall 2010 and spring, summer, and fall 2011 as part of the Water Quality Monitoring for Construction Baseline sampling program (Parsons et al. 2010 and 2011, respectively). Section 1 of this appendix summarizes the results of that baseline survey, as well as other water quality data collected as part of more historical water quality monitoring programs, and discusses trends observed.

The primary objective of the 2010 to 2011 Water Quality Monitoring for Construction Baseline sampling program was to obtain an understanding of baseline chemical and optical (i.e., turbidity/water clarity) water quality characteristics near dredging and capping areas (and where water quality monitoring will occur during those remediation activities). As part of this program, continuous turbidity monitoring was performed and surface water samples were collected during a range of conditions that can affect various components of water quality. Sampling events occurred during relatively calm conditions as well as after periods of tributary runoff, wind-driven waves, and typical lake currents, as well as under varying degrees of thermal stratification, to understand how these natural forcing conditions affect water quality within the Lake.

The information collected during this sampling program was used to: 1) establish the typical range of ambient water quality conditions expected to occur during dredging and capping activities (i.e., spring to fall construction season), as presented in Section 1 of this appendix; 2) assess the repeatability of seasonal results from 2 consecutive years (i.e., compare results between fall 2010 and fall 2011), as presented in Section 1 of this appendix; and 3) establish action levels during dredging and capping operations and provide construction managers with information to implement best management practices (BMPs) towards minimizing impacts to water quality (see Section 3 of the main Water Quality Management and Monitoring Plan [WQMMP] text).

2.2 Other Datasets

In addition to the water quality data collected during the 2010 to 2011 Water Quality Monitoring for Construction Baseline program, several other datasets were also considered in evaluating baseline conditions in the Lake. These included the following:

- Sampling during the Remedial Investigation (RI) performed by Honeywell and New York State Department of Environmental Conservation (NYSDEC) in the 1990s and 2001 (TAMS Consultants, Inc. 2002):
  - The RI datasets consisted of primarily Lake water chemistry studies conducted in 1992 and 1999. The objective of these studies was to determine representative concentrations of substances in the epilimnion and hypolimnion of the Lake. In addition, water chemistry data were collected from nearshore sites where people could be in contact with Lake water during recreation activities.
  - Additional water column sampling was conducted in 2001 to evaluate resuspension of mercury from sediments in the littoral zone in the southwest corner of the Lake.
- The Baseline (Book 1 through Book 3) Monitoring Program conducted by Honeywell (Upstate Freshwater Institute [UFI] and Syracuse University [SU] 2008), which consisted of deep basin water monitoring from 2008 to 2011 at the South Deep station and littoral water monitoring during 2008 and 2010 at several nearshore stations:
  - Objectives of the deep basin monitoring were to: 1) provide a basis to measure achievement of surface water quality standards; 2) provide a basis to measure success in controlling key processes (e.g., mercury methylation in the hypolimnion, sediment resuspension from the ILWD, and mercury release from profundal sediment); and 3) provide information on the generation of methylmercury in the hypolimnion for use in the design of nitrate addition/oxygenation pilot tests and basis to measure results.
  - Objectives of the littoral sampling were to understand the movement of mercury/methylmercury generated from the hypolimnion during and following fall turnover into the surface waters of the Lake for assessing exposure to biota. Littoral water samples were collected at four locations in the south basin and two locations in the north basin.
- The Pre-Design Investigation (PDI; e.g., Parsons 2005, 2007), which included

primarily collection of surface water samples from Sediment Management Unit (SMU) 3 (between Remediation Areas B and C) in 2005 as part of the PDI Phase 1 to identify potential impacts from Wastebeds (WB) 1-8 to the Lake. These samples were analyzed for volatile organic compounds (VOCs), phenol, and mercury. The PDI also included collection of a limited number of samples during subsequent phases of the program.

- Onondaga County Department of Water Environment Protection's Ambient Monitoring Program (e.g., OCDWEP 2009). OCDWEP has been collecting and analyzing water quality samples from various areas of the lake on a periodic basis (bi-weekly, quarterly, etc.) and after select rain storm events each year. Although OCDWEP's lake sampling is mainly focused on the profundal zone, there is also some monitoring in the littoral area of the lake, including turbidity (e.g., see Appendices F and I of the Year 2009 Onondaga Lake AMP [OCDWEP 2009]). OCDWEP provides annual updates of its monitoring results for public consideration (e.g., OCDWEP 2007).

General trends in water quality associated with these data sets are discussed in Section 1 below. The sampling locations associated with NYSDEC/Honeywell datasets are presented on Figure B-1.

Water quality data were also collected during the following three activity-based sampling events, which are discussed in Section 1 of this appendix (because these are not necessarily representative of ambient/baseline conditions):

- Installation of the Willis-Semet wall
- Collection of bulk sediment for water treatment bench tests
- Capping field demonstration of activated carbon placement

3 SUMMARY OF BASELINE SURVEY AND EVALUATION OF WATER QUALITY TRENDS

An evaluation was conducted of spatial and temporal trends and patterns in the datasets noted above. Key results from this evaluation are summarized below.

Surface water data were evaluated with consideration of the following questions:

- What can be considered ambient conditions in the Lake with respect to turbidity and concentrations of chemical compounds?
- Do the following discernible trends exist across the turbidity and chemistry data collected to date?
  - Temporal (both long-term [e.g., RI to present] and seasonal)
  - Spatial (e.g., is turbidity higher near tributaries?)
  - In response to forcing conditions (e.g., wind, rainfall/runoff)
- How do chemical compound data compare to NYSDEC ambient water quality standards? Are water quality standards generally being met under current conditions?
- Can discernible trends between turbidity and Total Suspended Solids (TSS) measurements be drawn?

3.1 Turbidity Monitoring

As part of the Water Quality Monitoring for Construction Baseline program, four continuous turbidity monitoring buoys (15-minute measurements) were deployed for approximately 6 weeks during October and November 2010, and three buoys were deployed for approximately 6 months during 2011 (late May to late November). Each buoy included a data sonde (i.e., turbidity probe) and data logging equipment. A map displaying the locations of the buoys is provided as Figure B-2.[1]

[1] The 2011 locations were adjusted so that monitoring would be in areas located 300 to 600 feet outside of the silt curtain alignments anticipated during dredging and capping activities, whereas monitoring locations were closer to shore in 2010. Due to similarities in the statistical distribution of 2010 turbidity data, the two 2010 monitoring locations within Remediation Area E (locations T3 and T4) were combined into a single location near the perimeter of that area in 2011 (location E2). In 2011, the sonde (i.e., turbidity sensor) at each deployment was fixed at a depth of 10 feet, consistent with the depth used to represent the upper mixed layer of the Lake in the discrete water quality sampling (discussed below). In 2010, the sondes were fixed at mid-depth, as all three sampling events occurred post-turnover (i.e., in well-mixed waters).

During the discrete sampling events in 2010 and 2011 (as discussed below in Section 3.2), a second vessel collected spatially detailed water quality information with rapid profiling instrumentation. Vertical profiling[2] was conducted at three locations within each of four transects within the major remediation areas of the Lake (sample points designated as T1-*, T2-*, T3-*, and T4-*), and at North Deep and South Deep (see Figure B-3), for a total of 14 profiles per sampling event. Profiling was also conducted during approximately six additional occasions, such that optical/turbidity data were collected approximately bi-weekly during the program. The focus of the rapid profiling was to measure light scattering, including turbidity and the beam attenuation coefficient at 660 Nanometers (nm; cP660).

Finally, weekly profiles were also conducted using an In-Situ Ultraviolet Spectrophotometer (ISUS)[3] at ten sites (six along the longitudinal axis of the lake and four additional sites to form a lateral transect at South Deep), as part of Honeywell's Book 1 Baseline Monitoring Program (UFI and SU 2008). As part of the Water Quality Monitoring for Construction Baseline program, this Book 1 profile work was supplemented with two additional lateral transects in the south basin, one additional transect in the north basin, and one additional location outside of Remediation Area B in order to provide increased spatial resolution adjacent to the major remediation areas. The locations of the rapid turbidity profiling and ISUS monitoring are also provided on Figure B-3. A detailed interpretation of results from the rapid turbidity profiling and ISUS monitoring is presented in Attachment 1 to this Appendix.

The cumulative frequency distributions shown on Figures B-4 through B-6 illustrate the variability observed in 15-minute turbidity measurements at the continuous monitoring locations during fall 2010 (T1, T2, T3, and T4) and spring, summer, and fall 2011 (A2, D1, and E2). In general, turbidity measurements in the vicinity of Remediation Area A (Buoys T1 [2010]/A2 [2011]), Remediation Area D (Buoys T2 [2010]/D1 [2011]), and Remediation

[2] Profiling was conducted with a Sea-Bird Electronics, Inc. package of instruments, which contains: 1) Temperature, specific conductance, pressure - SBE 25 SEALOGGER CTD (Sea-Bird Electronics); 2) Chlorophyll - WETStar Fluorometer (WET Labs); 3) Beam attenuation coefficient - C-star transmissometer (WET Labs); 4) Photosynthetically Active Radiation (PAR) sensor (LI-COR Environmental); 5) Optical Backscattering (OBS) - OBS-3 (D&A Instruments; UFI calibrates for turbidity); and 6) Datalogger that stores and integrates all of the above components (Sea-Bird Electronics).

[3] The ISUS package of instruments contains: 1) Nitrate probe - Satlantic ISUS sensor (Satlantic Instruments); 2) Turbidity and chlorophyll - ECO FLNTU combination fluorometer and turbidity sensor (WET Labs); 3) Beam attenuation coefficient - C-star transmissometer (WET Labs); 4) Scalar PAR sensor (Biospherical Instruments); 5) Temperature, specific conductance, and pressure - CTD 37I sensor (Sea-Bird Electronics); and 6) Datalogger that stores and integrates all of the above components (WET Labs).

Area E (Buoy T3 [2010] and Buoys T4 [2010]/E2 [2011]) remained relatively low (e.g., less than 10 Nephelometric Turbidity Units [NTU]) throughout most of the monitoring activities, with a small percentage of measurements having higher turbidity. The sources of these variations are discussed in the sections below.

3.1.1 Temporal Variability

As illustrated on Figure B-4, during the 6-week period from mid-October to late November 2010, approximately 75% or greater of the turbidity measurements were less than 10 NTU at all stations (i.e., T1, T2, T3, and T4), with approximately 99% or greater of the measurements being less than 100 NTU.

As illustrated on Figure B-5, during the 6-month period from late May to late November 2011, approximately 90% or greater of the turbidity measurements were generally less than 10 NTU at all stations (i.e., A2, D1, and E2), with less than one tenth of one percent of measurements greater than 100 NTU at only one station (E2).

Figure B-6 presents these frequency distributions on a month-by-month basis.[4] Comparing October and November 2010 to the same period in 2011, the following variability is noted between these 2 years:

- October 2010:
  - Approximately 20% of measurements greater than 10 NTU at station T3
  - Approximately 40% of measurements greater than 10 NTU at station T4
  - At stations T1 and T2, fewer than 1% of measurements greater than 10 NTU
- November 2010:
  - Approximately 10% to 15% of measurements greater than 10 NTU at stations T2 and T4
  - Approximately 25% of measurements greater than 10 NTU at station T3

In October and November 2011, turbidity was generally only measured greater than 10 NTU at one station (E2 in November), with 5% of those measurements being greater than 10 NTU.

[4] May 2011 is not presented because less than 1 week's worth of measurements were collected.

These observed interannual differences can likely be attributed to differences in forcing conditions between these 2 years, with 2010 having somewhat higher winds and more rainfall events than 2011, as well as differences in sample locations with respect to distance from the tributaries, as discussed in Section 3.1.2.

3.1.2 Variability in Concentration Relative to Wind, Rain, Tributary Runoff

Observed short-term increases in turbidity during the 2010 and 2011 monitoring period were found to generally coincide with increases in wind, precipitation, and/or flow in nearby tributaries. Figure B-7 graphically presents turbidity measurements in conjunction with nearby tributary flow rates, wind speed/direction, and precipitation for each 2010/2011 continuous monitoring station pair (combined datasets as noted above), and for station T3 (2010). The periods of discrete water column sampling events (discussed below) are also noted on these plots. The higher turbidity measurements recorded in spring and fall generally correspond to more frequent storm/precipitation/flow events.

As illustrated in the cumulative frequency distribution plots discussed above (Figures B-4 and B-5), the vast majority of turbidity measurements were less than 10 NTU. Several periods where short-term spikes were observed above this general baseline can be seen on Figure B-7. Several noteworthy observations are as follows.

<u>Select 2010 Observations</u>

- Location T1: A noted increase up to approximately 15 NTU on October 25, 2010, was found to generally correlate with an accumulation of approximately 0.5 inches of rain on that day (Figure B-7a).
- Location T2: A period of increased and highly variable turbidity occurred between November 2 and 5, 2010, with turbidity as high as approximately 800 NTU (Figure B-7b). This period of short-term increase did not appear to correlate with any noteworthy increases in flow in Harbor Brook or Onondaga Creek, or in wind speed, although rainfall totaling approximately 0.4 inches was recorded during this period.
- Location T3:
  - A noted increase in turbidity on October 21, 2010, to approximately 60 NTU appears to coincide with a short-term increase in wind (measured wind speed up

to approximately 17 miles per hour [mph] from the west) and precipitation (approximately 0.3 inches of rainfall) on that day (Figure B-7d).

  - A noted increase in turbidity on November 8, 2010, up to approximately 140 NTU, seems to coincide with several hours of sustained winds out of the northwest (up to 14 mph) on that day, in the absence of any noted increases in precipitation or flow in Onondaga Creek (Figure B-7d).

- Location T4:
  - A noted increase in turbidity to approximately 180 NTU on October 28, 2010 (Figure B-7c) appeared following a rainfall event of approximately 0.5 inches from 3 days prior (and corresponding increases in Ley Creek flow), as well as a relative increase in wind speed on that day.
  - On November 17, 2010, a short-term increase in turbidity up to 200 NTU was recorded over a few hours following a period of approximately 8 hours of sustained winds from the west averaging 20 mph (Figure B-7c).

<u>Select 2011 Observations</u>

- Location A2:
  - A noted increase in turbidity to approximately 15 NTU on September 8, 2011, appeared following a rainfall event in which more than 2.5 inches of rain fell the day prior, and flows in Ninemile Creek increased to approximately 800 cubic feet per second (cfs) from a base flow close to 50 cfs (Figure B-7a).
  - A turbidity increase was noted again on September 29 and 30, 2011 (Figure B-7a), peaking just less than 40 NTU. This seems to coincide with increased flow of approximately 450 cfs in Ninemile Creek. Several hours of increased wind averaging approximately 12 mph from the southwest was also measured at that time.

- Location D1: Consistently low turbidity (less than 10 NTU) was measured at this station during the 6 months of 2011 monitoring (Figure B-7b). The highest measurement of approximately 25 NTU on May 28, 2011, does appear to correlate with a short-term increase in flow of approximately 680 cfs in Onondaga Creek the day prior (from a baseline flow previously of approximately 200 cfs).

- Location E2:
  - Consistently low turbidity (less than 10 NTU) was measured at this station during the 6 months of 2011 monitoring (Figure B-7c). Two noted increases (as seen on Figure B-7c) of approximately 240 NTU on July 28, 2011, and of approximately 180 NTU on September 6, 2011, were single elevated readings[5] and may be representative of a sonde error, as other readings on those days were out of range (< 0 NTU or > 1,000 NTU) and were not presented on that plot. Neither recent precipitation/elevated flow in nearby tributaries nor high winds were noted on these days.
  - Periods of variable turbidity in early to mid-June and in mid-November, where measurements generally ranged from 20 to 50 NTU, and from 10 to 30 NTU, respectively, were also noted (Figure B-7c), in absence of any specific increases in natural forcing conditions. These data may be indicative of the somewhat higher turbidity observed in this portion of the lake relative to others (see section below).

To further evaluate variations in turbidity with wind, precipitation, and flow conditions, turbidity data collected by OCDWEP from 9 littoral zone sampling locations from 2002 to 2007 were compared against yearly tributary flow and wind speed data, as shown on Figure B-8. Although sampled at a much lower frequency, the trends observed in the OCDWEP data are generally consistent with the variations in turbidity with forcing conditions observed in the 2010 to 2011 continuous monitoring data. For example, a review of 2006 turbidity results in the littoral regions of the lake indicated the turbidity levels near Ninemile Creek increased from approximately 5 NTU to over 50 NTU during a high flow event (500 to 1,000 cfs in Ninemile Creek). Similarly, 2002 turbidity results near the Metro outfall increased from approximately 10 NTU to over 40 NTU during a flow event in June (over 500 cfs in Onondaga Creek).

3.1.3 Spatial Variability

As compared to the other stations, the distribution of turbidity measurements observed in Remediation Area E (Buoys T3 and T4 [2010] and E2 [2011]) is somewhat higher than that from the other locations, as illustrated by Figures B-4 through B-7. These higher turbidity

[5] As opposed to several readings gradually increasing, reaching a maximum, and then decreasing.

measurements may be attributed to the proximity of those stations to the tributary outlets (Ley Creek and Onondaga Creek), as well as to influences from Metro and/or the increased prevalence of wind wave activity in this end of the Lake.

In addition, the data provide some evidence of variations in turbidity with proximity to shore and/or the mouths of tributaries. For instance, location E2 in 2011 was located approximately twice as far from the outlet of Ley Creek than was location T4 in 2010. Turbidity measurements were observed to be somewhat higher in October and November 2010 as compared to the same period in 2011 (Figure B-7c), under similar flows in the creek; therefore, this variability could be influenced by sediment loading in that tributary.

Despite these small differences in the turbidity distributions among the buoys, Figure B-9, which is based on the rapid profiling results from October and November 2010 and late May to October 2011, illustrates that, in general, the spatial distribution of turbidity in the Lake is relatively uniform, with average measurements over this time period varying by approximately only 1 NTU across the Lake. Figure B-9 also shows that the small spatial differences do indicate that turbidity is somewhat higher near Remediation Area E, which is consistent with the differences observed among the continuous monitoring buoys discussed above.

3.2 Discrete Water Column Sampling – Chemical Compounds

Discrete sampling of the water column and analysis for chemical compounds (mercury, methylmercury, VOCs/semivolatile organic compounds [SVOCs] chemical parameters of interest [CPOIs], and polychlorinated biphenyls [PCBs]) was conducted at 13 locations during three sampling events in 2010 and from 11 locations during six sampling events in 2011 (total of 105 samples plus one duplicate sample per event) as part of the Water Quality Monitoring for Construction Baseline program. A map displaying these locations is provided as Figure B-10. The results from these sampling events as well as from other programs (e.g., RI, PDI) have been evaluated, and a summary of general conclusions is presented below. A

series of box and whisker plots (one page per chemical compound) are presented as Figure B-11 and a series of temporal plots as Figure B-12.[6]

3.2.1 Temporal and Spatial Variability

Mercury concentrations appear generally consistent spatially throughout the sampled areas of the Lake, and are generally decreasing over time, exhibiting a strong seasonal pattern, both of which are well documented. These trends are supported by data from the Book 2 baseline monitoring program (e.g., Parsons, Exponent, and Anchor QEA 2009, 2011a, 2011b). VOCs/SVOCs and PCBs are generally non-detect and, when detected, trends are difficult to discern from the available data.

3.2.2 Current Concentrations in Lake Compared to NYSDEC Water Quality Criteria

Of the New York State Class B/C Surface Water Quality Standards and Guidance Values[7], the aquatic (acute) criteria would be most relevant for consideration of short-term impacts from dredging and capping activities. As such, these standards have been indicated on the plots of chemical data results presented as Figures B-11 and B-12 (for those chemical compounds that have such standards). Based on the full set of available chemistry data, dating back to the first rounds of sampling from the RI in 1992, the only observed exceedances of NYSDEC's

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[6] The box plots presented on Figure B-11 were based on the "schematic" plot as presented in Tukey (1977):

- The height of the box is equal to the "upper hinge" minus the "lower hinge," each defined as follows:
  - Lower hinge (h_L) = median of all observations less than or equal to the overall sample median.
  - Upper hinge (h_U) = median of all observations greater than or equal to the overall sample median.
- Whiskers:
  - The upper whisker extends from the top of the box to the largest observation less than h_U + (1.5 x [h_U – median])
  - The lower whisker extends from the bottom of the box to the smallest observation greater than h_L – (1.5 x [median – h_L])
- Outliers:
  - Inner Outliers are as follows:
    - [greater than h_U + (1.5 x [h_U – median]) and less than h_U + (3 x [h_U – median])] OR
    - [less than h_L – (1.5 x [median – h_L]) and greater than h_L – (3 x [median – h_L])]
  - Outer Outliers are as follows:
    - [greater than h_U + (3 x [h_U – median])] OR
    - [less than h_L – (3 x [median – h_L])]

Further information can be found in Section 2.1.4.2 and Appendix A of Helsel and Hirsch (2010).

[7] Human consumption of fish [H(FC)], fish propagation in freshwater [aquatic chronic; A(C)], fish survival in freshwater [aquatic acute; A(A)], wildlife protection [W], and aesthetic [E]

A(A) criteria were a few limited samples for one polycyclic aromatic hydrocarbon (PAH) compound (benzo(a)anthracene) collected in 2010. Therefore, as this compound has been observed to exceed the criteria under ambient conditions, sporadic exceedances of the A(A) criteria for PAHs would not be unexpected during dredging and capping activities.

4 TURBIDITY AND TOTAL SUSPENDED SOLIDS RELATIONSHIP

As discussed in Section 3 of the WQMMP, an efficient and environmentally protective program based on real-time turbidity measurements will be implemented to monitor impacts of dredging and capping on water quality. However, there is often a desire to attempt to correlate TSS and turbidity. NYSDEC suggested that such an assessment be made in its comments on the January 2011 Draft Onondaga Lake Capping, Dredging and Habitat Intermediate Design:

> *"…the parameter of interest from the perspective of ecological resource protection is TSS and not turbidity. Thus, in order to use turbidity as a guide to water quality, it would appear necessary to establish a relationship between the two parameters…"* (Parsons and Anchor QEA 2011)

Therefore, a TSS and turbidity relationship was assessed to evaluate the ability to estimate TSS based on real-time turbidity monitoring. Turbidity and TSS data collected from the Lake during 2010 and 2011 as part of the Water Quality Monitoring for Construction Baseline program, and in certain tributaries from 2009 to 2011 as part of the Baseline Book 3 program (UFI and SU 2008)[8], have been evaluated to ascertain the relative degree of correlation between these parameters and to ensure that the turbidity action levels developed for this project will also be protective of relevant TSS standards that affect ecological resources.As illustrated on Figure B-13, a relationship between these parameters appears to exist. As expected, the range of values observed in the tributaries, monitored as part of the Baseline Book 3 program, is significantly higher than those observed in the Lake as part of the Water Quality Monitoring for Construction Baseline program.

Tributary data:

- TSS ranges from approximately 1 to 700 mg/L
- Turbidity ranges from approximately 2 to 700 NTU

Lake data:

- TSS ranges from approximately 2 to 40 mg/L

[8] While other sources of historical data exist, these datasets were used as representative to evaluate the general relationship.

- Turbidity ranges from approximately 1 to 60 NTU

When considered across the full range of both datasets (Lake-focused 2010/2011 Water Quality Monitoring for Construction Baseline and tributary-focused 2009 to 2011 Baseline Book 3 program), a near direct correlation is observed. This relationship can be revised as additional data are collected during construction activities and, as necessary, could be used as a general guideline for estimating TSS levels for a given turbidity measurement.

5 ACTIVITY-BASED WATER QUALITY MONITORING

In addition to the baseline water quality monitoring activities discussed above, three activity-based sampling programs were conducted in recent years. Although the results of the activity-based sampling are not necessarily directly representative of the water quality impacts associated with hydraulic dredging or capping activities, these results provide insight into the sensitivity of the system during a physical disturbance. Water quality monitoring was conducted during two events in 2008 and during the capping demonstration project in 2011. These programs include:

- Installation of the Willis-Semet barrier wall in 2008
- Collection of bulk sediment for water treatment bench tests using a clamshell excavator in 2008
- Field demonstration of placement of sand/activated carbon capping material in 2011

5.1 Willis-Semet Barrier Wall Installation

During installation of the Willis-Semet barrier wall from August to December 2008, monitoring of TSS was conducted at three fixed stations in the Lake approximately 50 feet outboard of a silt curtain that was placed around the work area and at one background station approximately 500 feet from the work area. As the direction of the current varied over time, there were two background stations established—one station located approximately 500 feet northwest and one station located 500 feet southeast of the site. However, generally only the background station located at the upstream end of the Lake current was sampled. In general, the TSS samples remained below 5 mg/L, except for a few occasions when the background stations resulted in TSS samples of approximately 30 mg/L during easterly winds, which highlights the potential fluctuations in background levels in the Lake.

5.2 Bulk Sediment Sampling

Bulk sediment samples were collected for use in the water treatment bench tests in November 2008 using a barge-mounted excavator located within a silt-curtain-enclosed area within Remediation Area D (Parsons 2008). Continuous turbidity (readings at approximate 10-minute intervals) and water column grab samples were collected both inside and outside of the silt curtain during the collection of the bulk sediment samples. Samples were analyzed

for TSS, mercury (total and filtered), VOCs (total and filtered), SVOCs (total and filtered), methylmercury (total and filtered), and ammonia (total and filtered).

Figure B-14 presents a time-series plot of the turbidity measurements before, during, and after the bulk sediment sample collection as well as both inside and outside of the silt curtain. Continuous turbidity results showed the turbidity outside of the silt curtain remained below 5 NTU for the duration of the bulk sediment collection, while turbidity measurements within the silt curtain increased during excavation to 270 NTU, and remained variable for a short time after excavation. Similarly, TSS sample results outside of the silt curtain remained low throughout the sampling event (i.e., all below 5 mg/L) and exhibited higher levels inside of the silt curtain during and following excavation, ranging from approximately 12 to 30 mg/L. These data demonstrate a silt curtain's ability to successfully contain suspended sediments.

In comparing the chemistry results outside of the silt curtain with New York Class C Surface Water Quality Standards (6 NYCRR Part 703.5), three out of five samples met the New York Class C Surface Water Quality A(A) standards for all parameters where standards are provided. Of the remaining two samples, New York Class C Surface Water Quality A(A) standards were met for all parameters except benzo(a)anthracene (which is the same compound for which criteria exceedances were observed during 2010 to 2011 baseline sampling). These measurements yield a truly conservative estimate of sediment resuspension, as the proposed hydraulic dredging method is expected to induce much lesser sediment disturbance than the mechanical dredge/excavator.

5.3 Capping Field Demonstration

Turbidity was monitored at four locations during the fall 2011 capping field demonstration to assess water quality conditions during capping at locations similar to the full-scale program (Parsons 2011). These four turbidity monitoring locations consisted of three performance monitoring stations, or near-field stations, and one compliance monitoring station, or far-field station. The performance monitoring stations were located approximately 300 feet outside of the demarcation curtain in a radial pattern (e.g., west, northwest, and east), while the compliance monitoring station (monitoring buoy D1 used in the 2011 Water Quality

Monitoring for Construction Baseline program) was positioned approximately 500 feet northwest of the demarcation curtain. Figure B-15 presents the locations of the turbidity monitoring stations at the capping field demonstration site.

Turbidity measurements were collected from October 24 to November 18, 2011, at 15-minute intervals and averaged every 2 hours (in a running mode; Figure B-16). In general, the turbidity measurements at all four locations ranged from 2 to 5 NTU, consistent with ambient water quality measurements within the Lake, as discussed above. On four occasions (November 1, 8, 14, and 17), there were noticeable short-term increases in turbidity (10 to 30 NTU) greater than the typical background concentrations (Figure B-16). On November 1, turbidity results of approximately 5 to 15 NTU were measured at Locations 1 and 2 within 1 hour of the completion of the capping lane. The three remaining short-term increases in turbidity (e.g., November 8, 14, and 17) occurred during periods of high winds (i.e., greater than 10 mph).

In addition to the continuous turbidity monitoring described above, discrete turbidity measurements were collected within 100 to 200 feet of the capping activities, within observed turbidity plumes associated with the cap material. Turbidity measurements ranging from approximately 30 to 100 NTU were observed within these plumes, but were dissipated (i.e., turbidity returning to background conditions) within approximately 1 hour of capping.

Overall, the capping activities during the demonstration project had minimal impact on turbidity outside of the demarcation curtain, and the turbidity plumes, when observed, quickly dissipated within the demarcation curtain.

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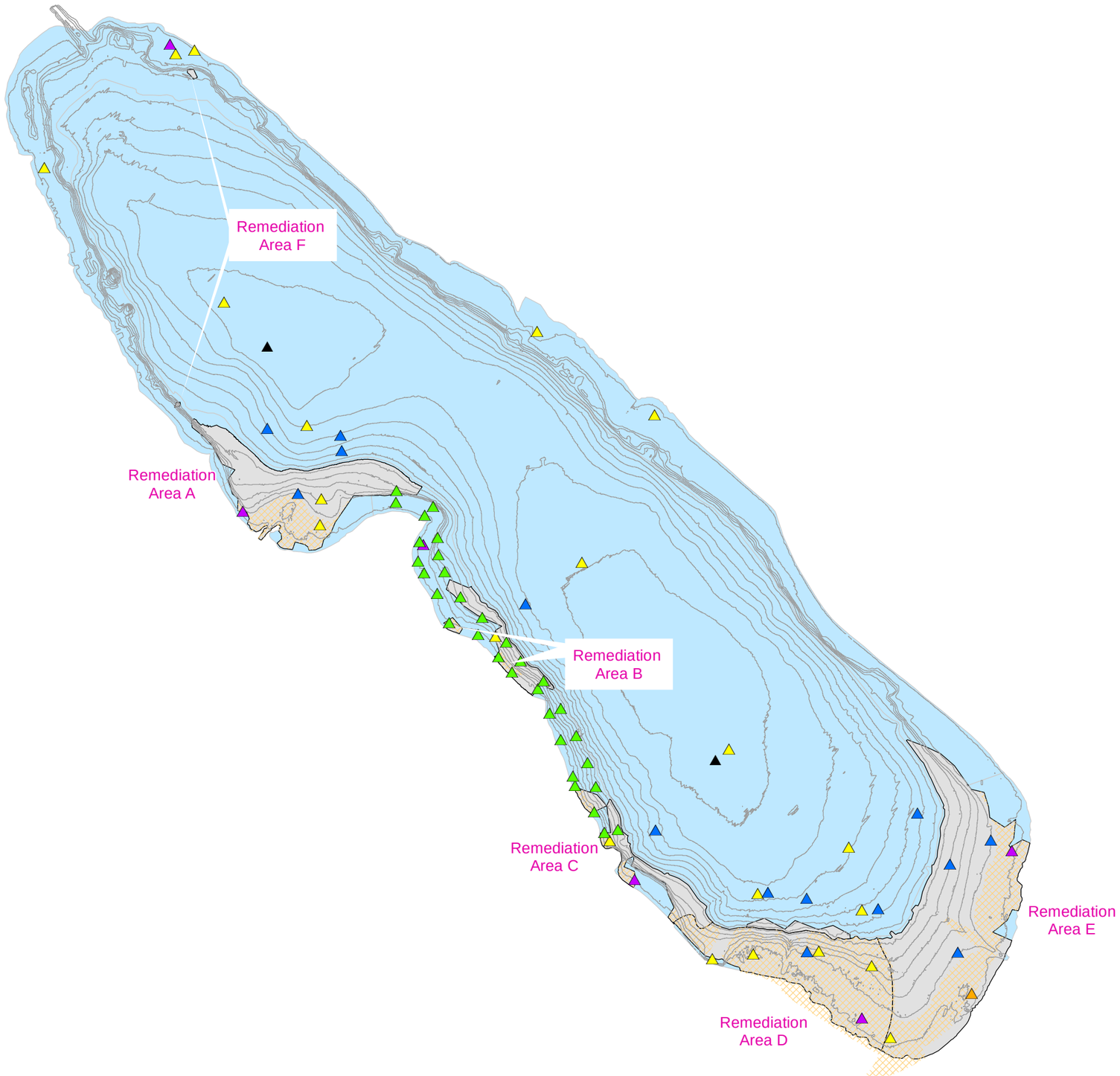
FIGURES



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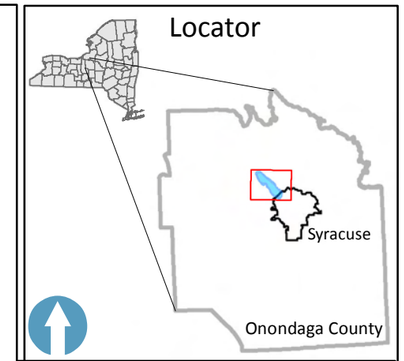


Scale

Feet

0 1,000 2,000 4,000

Legend

Onondaga Lake Monitoring Programs

- Various*
- 2005 - PDI PHASE 1
- 2007 - PDI PHASE 3
- 2008 & 2010 Baseline Book 2
- 2010/2011 Construction Baseline
- Remedial Investigation (1990's)
- 2005 Bathymetry (displayed every 5 ft)**
- Dredge Areas
- Remediation Areas

* 2008 - 2011 Baseline Book 1;
2010 - 2011 Construction Baseline;
2011 Baseline Book 3; and
2011 Nitrate Addition Program.

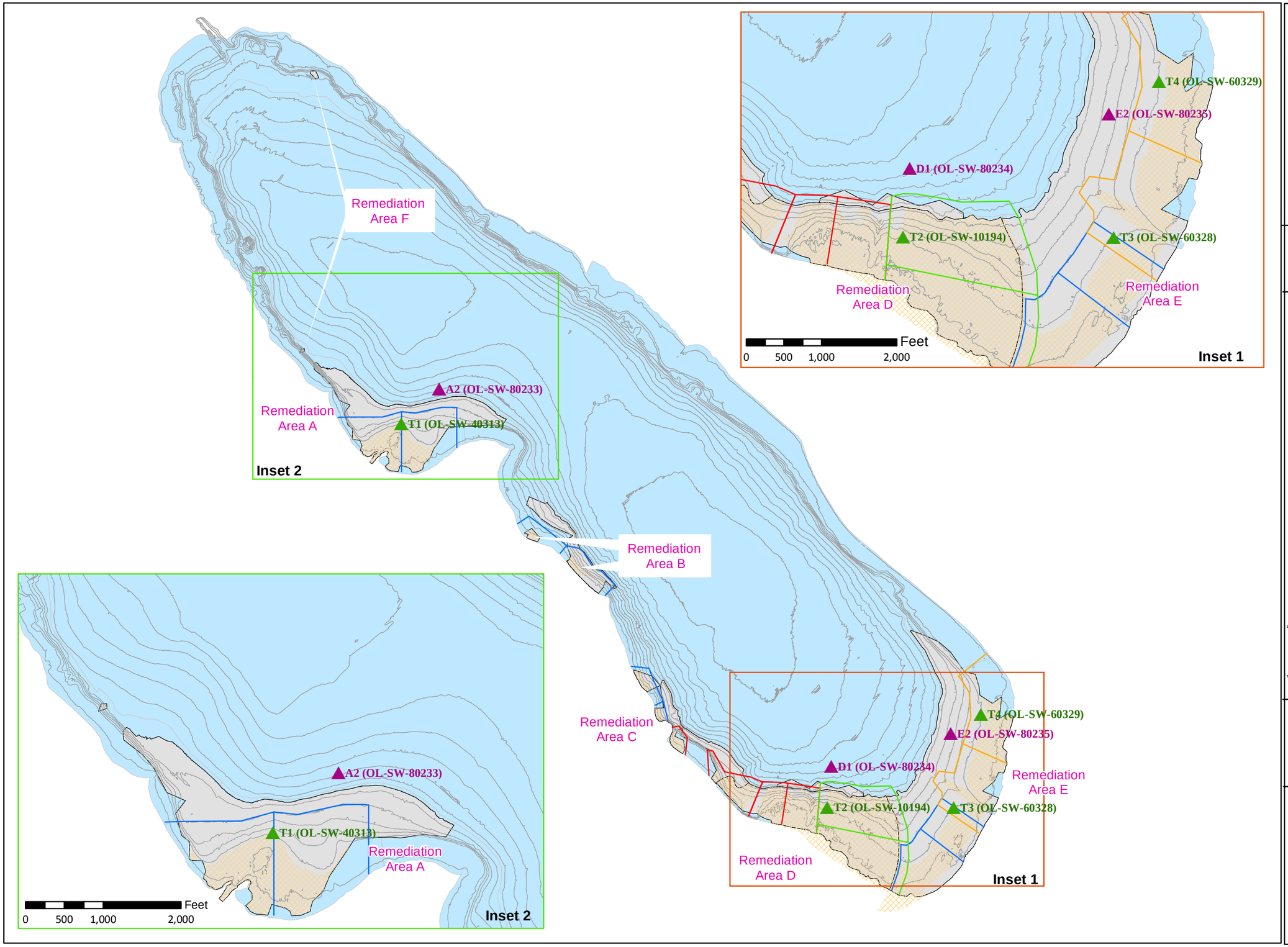
**Bathymetric survey performed by CR Environmental, Inc. for Honeywell in 2005.

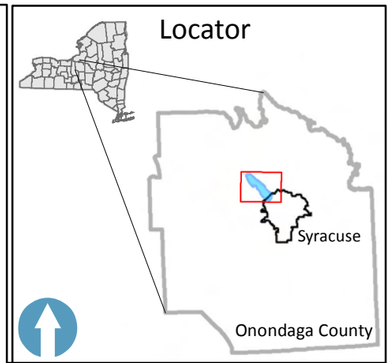
Figure B-1
Sample Locations of Data Evaluated as Part of Baseline Survey
Onondaga Lake

Honeywell
PARSONS
ANCHOR QEA

120139-01.01 MAY 2012

H:\Honeywell\Onondaga_Lake_Remediation(090139-01)\WQMMP\GIS - Figure B-1 - spatial extent of historic datasets.mxd; B.Solomon; 11JAN2011





Scale

0 1,000 2,000 4,000 Feet

Legend

- 2011 Continuous Turbidity Monitoring Station
- 2010 Continuous Turbidity Monitoring Station

Turbidity Curtain Locations (by year)*

- 2012
- 2013
- 2014
- 2015
- Dredge Areas
- 2005 Bathymetry (displayed every 5 ft)**
- Remediation Areas

* Turbidity curtain alignments presented herein are conceptual and will be updated in the field as necessary and placed with DEC concurrence.

** Bathymetric survey performed by CR Environmental, Inc. for Honeywell in 2005.

Figure B-2
2010/2011 Water Quality Monitoring for Construction Baseline Turbidity Monitoring Locations Onondaga Lake

Honeywell
PARSONS
ANCHOR QEA

120139-01.01 MAY 2012

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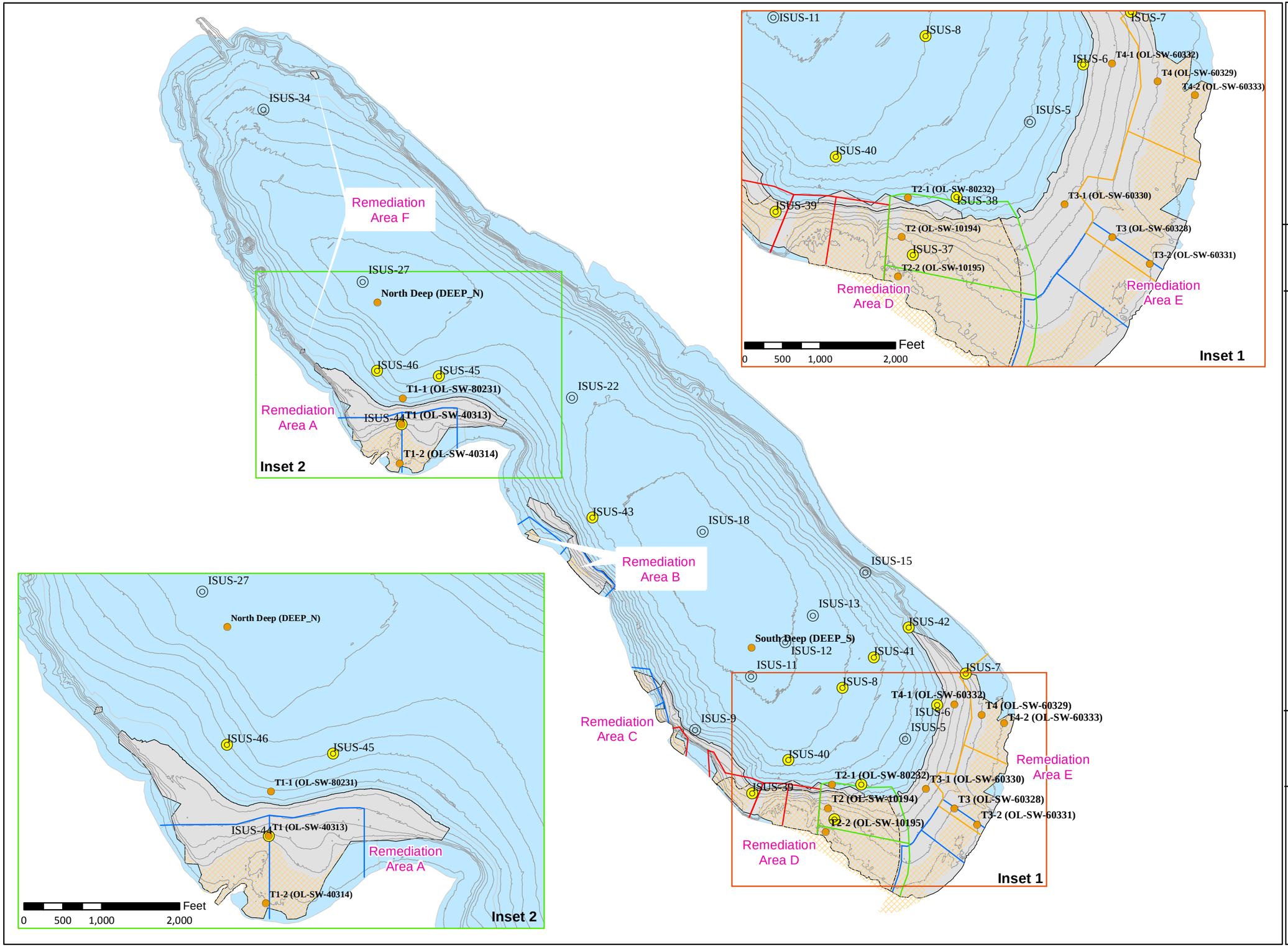

Figure B-3
2010/2011 Rapid Turbidity Profiling and ISUS Sampling Locations
Onondaga Lake

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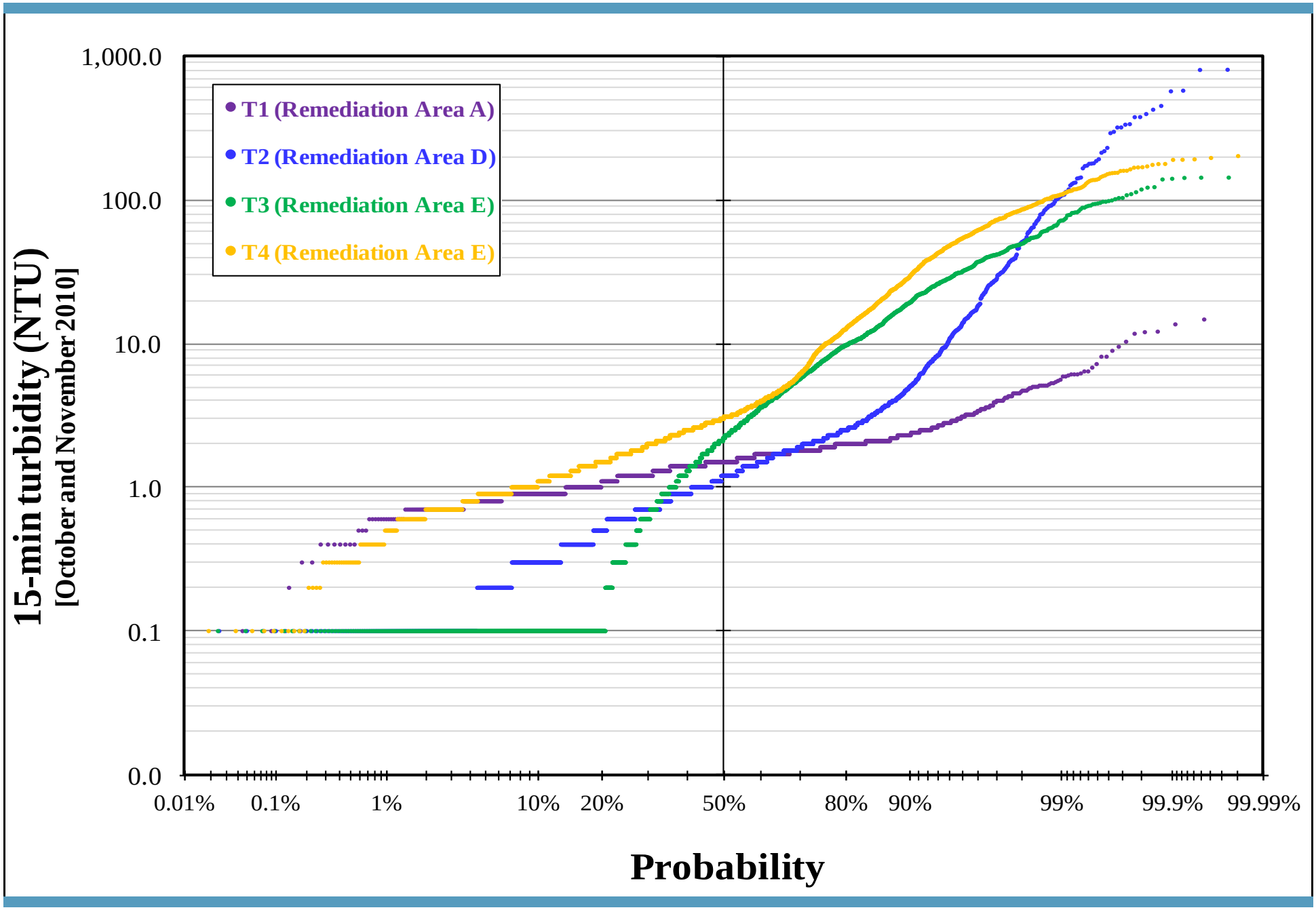

Figure B-4
2010 Continuous Turbidity Monitoring Data – Probability Distribution
Water Quality Management and Monitoring Plan
Onondaga Lake

ANCHOR QEA

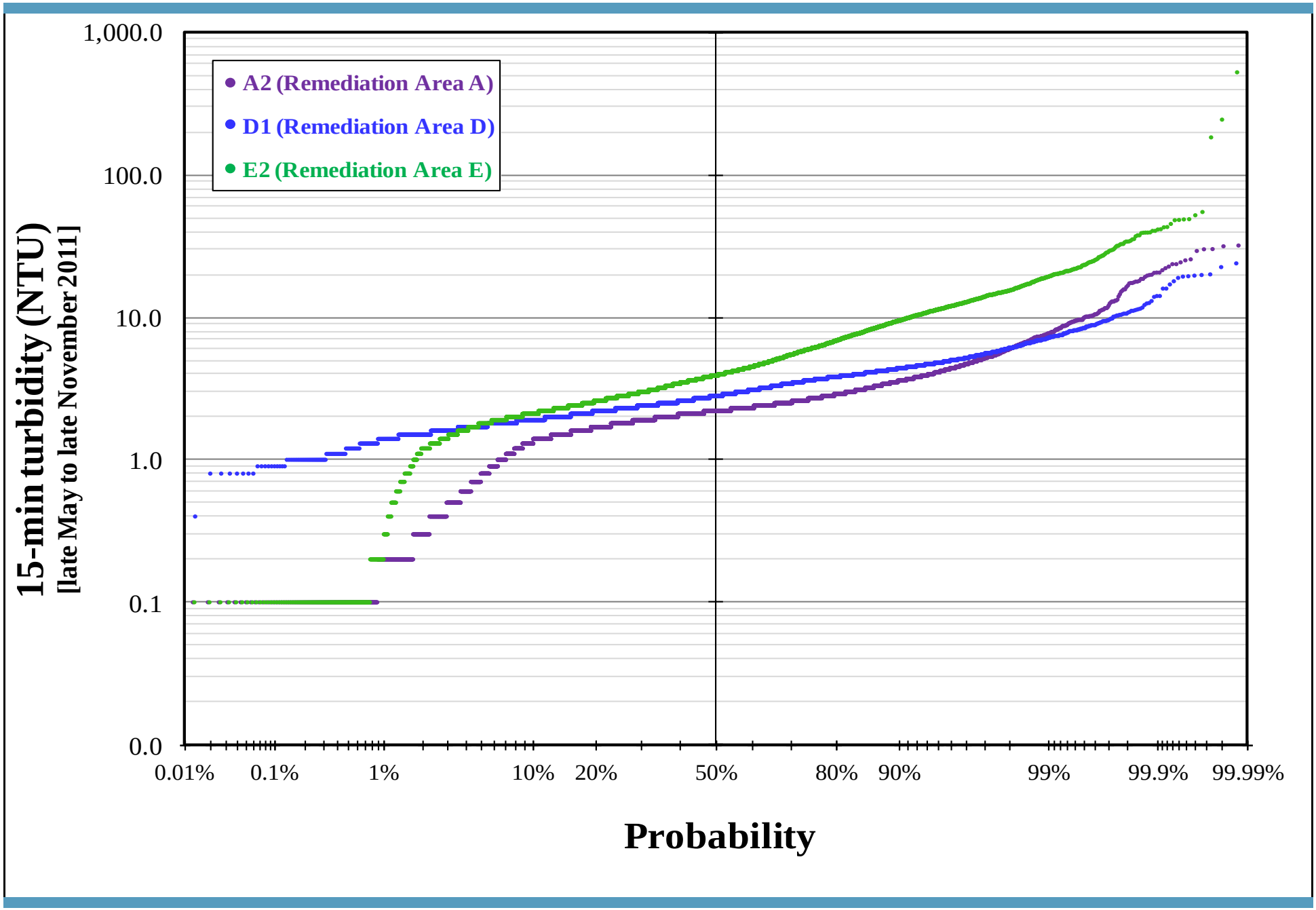

Figure B-5
2011 Continuous Turbidity Monitoring Data – Probability Distribution
Water Quality Management and Monitoring Plan
Onondaga Lake

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