ONONDAGA LAKE CAPPING, DREDGING, HABITAT AND PROFUNDAL ZONE (SMU 8) FINAL DESIGN

APPENDIX K – HABITAT

Prepared for:

Honeywell

301 Plainfield Road, Suite 330
Syracuse, NY 13212

Prepared by:

PARSONS

301 Plainfield Road, Suite 350
Syracuse, NY 13212

ANCHOR QEA

290 Elwood Davis Road, Suite 318
Liverpool, NY 13088

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SECTION 1

INTRODUCTION

This appendix provides details associated with the habitat restoration activities within Onondaga Lake and at the mouth of Ninemile Creek, the connected wetlands at the base of Wastebeds 1-8, the Outboard Area near the mouth of Harbor Brook, and the SMU 3 and 4 shoreline. Habitat design features like water depth and areas that will be planted are addressed in this appendix, along with a discussion of shoreline transition areas. Separate submittals describing the details of the structure and planting plans and success criteria will be provided to NYSDEC for review and approval.

SECTION 2

NINEMILE CREEK SPITS AND ADJACENT LAKE AREA

As discussed in Section 4.3.5.1 of the Final Capping, Dredging, Habitat and Profundal Zone (SMU 8) Design Report, the two small areas that extend out into Onondaga Lake at the mouth of Ninemile Creek ("the spits") have been delineated as emergent wetlands. The habitat and planting plan for this area has been integrated with the figures for the adjacent Remediation Area A to ensure a consistent design at the lake shoreline. The integrated design for this area includes removal of the emergent wetlands, which are currently dominated by *Phragmites*, and restoration of the area with an isolation cap similar to the adjacent areas in the lake. The post-remediation acreage of the spits and associated wetland will be the same as currently exists, and the elevations in this area will range from 1 ft. above water to 1 ft. deep. The restoration of these spits includes approximately 1.9 acres of emergent wetland, which will provide connectivity to the shallow littoral areas and Ninemile Creek with floating leaved and submerged vegetation. Figure K-1 illustrates the Habitat Module application and planting plan for this area.

Three vegetative zones have been established for this area of the design. The zones are consistent with the Habitat Modules described in the Draft Habitat Plan (Parsons 2009) and will include floating aquatic, non-persistent emergent wetlands, water fringe (edge of persistent emergent wetland), and interior of persistent wetlands, forested wetlands and shoreline bank area. A discrete Module 6A planting zone at the lake side edge of the module will be developed to separate it from the remainder of the persistent emergent wetland. Plants more tolerant of water energy will be selected for this fringe zone. Module 9B is designed as a deciduous forested wetland and the shoreline bank area consists primarily of wetland and conservation seed mixes.

Details of the planting program will be submitted as an addendum to the Final Design, subject to review and approval by NYSDEC.

SECTION 3

WASTEBEDS 1-8 CONNECTED WETLAND

As discussed in Section 4.3.5.2 of the Final Capping, Dredging, Habitat and Profundal Zone (SMU 8) Design Report, the Wastebed 1-8 wetland complex has both connected and inland wetlands. The designs for the inland wetlands will be provided in the Wastebed 1-8 Design Reports. The connected wetland is designed to be a 2.3-acre freshwater marsh with varied habitat characteristics that will provide high ecological value through plant and wildlife diversity.

3.1 WETLAND AND AQUATIC VEGETATIVE COMMUNITIES

Three vegetative zones have been established for this design; a deep emergent community, a shallow emergent community, and a wet meadow community. The zones are consistent with the Habitat Modules described in the Draft Habitat Plan (Parsons 2009). The deep emergent community type is planned in areas where the average growing season (May 1 to October 31; Parsons 2009) water depth does not typically drop below 24 inches, with a maximum depth of 36 inches. The deep emergent community comprises nine herbaceous species. The deep emergent design primarily includes submerged aquatic species.

The shallow emergent community type is planned in areas where the average growing season water depth ranges from 6 to 24 inches during a year with normal precipitation; however, this community may dry out during dry years (Edinger *et al.* 2002). The wet meadow community type is planned in areas where the average growing season water depth ranges from 6 inches above to 6 inches below the habitat layer surface. Figure K-2 presents the Connected Wetland Habitat Module application and the designed zonation of plant communities. Details of the planting program will be submitted as an addendum to the Final Design, subject to review and approval by NYSDEC.

3.2 HYDROLOGY

The connected wetland will be located adjacent to Onondaga Lake and directly affected by its water level variation. The design includes a main pool that will be protected from wave energy by a shoreline berm that will be constructed about 10-ft. wide, up to an elevation of 364 ft. (1.5 ft. above the typical growing season water level). Two breeches in the berm will facilitate hydrologic connection with the lake. The upper wetland border is planned at 363 ft. which will, based on historical lake water data (USGS 2010), be flooded 5 percent of the time and will be about 6 inches above the typical lake water level during the growing season. From this upper elevation, the wetland slopes gradually downward to an elevation of 359.5 ft. in the main wetland pool. This elevation will typically provide for a water depth of 30 to 36 inches during the growing season based on data for representative wet (1990) and dry (1999) years (Figures K-5 and K-6). The water depths in the design are based on USGS data from Lakeland station minus the elevation of the bottom of the wetland, or 359.5 ft. Based on this grading plan and likely lake water level variation, approximately 0.6 acres of deep emergent wetland (Habitat Modules 4A and 5A) are expected to be created as well as 1.2 acres of shallow emergent and 0.5 acres of wet meadow (Habitat Module 6A).

SECTION 4

WASTEBED B/HARBOR BROOK OUTBOARD AREA

As discussed in Section 4.3.5.3 of the Final Capping, Dredging and Habitat, Profundal Zone (SMU 8) Design Report, habitat restoration for the Wastebed B/Harbor Brook Outboard Area is designed using the seasonal inundation of areas along the shoreline to create habitat suitable for northern pike (*Esox lucius*) reproduction. The design focuses on providing the appropriate water depths at the appropriate time of year (and concomitant water temperature) for northern pike spawning in shallow (6 inches to 3.5 ft. water depth range, 362.75-359.75 ft. elevation) and deep emergent wetlands (3.5 ft. to 6.5 ft. water depth range, 359.75-356.75 ft. during spawning season). Figure K-7 provides a general cross section of this condition. Restored habitats will include the Harbor Brook channel, shallow and deep emergent wetlands, forested wetlands, and transition to upland areas (Figure K-4). Figure 4.4 in the design provides sectional and cap profile illustration that correlate to Figure K-4.

4.1 WETLAND AND AQUATIC VEGETATIVE COMMUNITIES

The free exchange of water between the lake, Harbor Brook, and the shallow and deep emergent wetlands is a key element of the design to support a robust mix of plant species to transition from upland habitat near the barrier wall to wetland habitats along the shoreline.

Figure K-4 describes the Habitat Module delineation, and areas to be planted. Module 6A is divided into three planting zones; wetland fringe, persistent emergent interior, and persistent emergent Harbor Brook. Because of the specific targeted goal to provide northern pike spawning habitat, a specific plant list was developed for Module 6A for this area that emphasizes grasses, sedges, and narrow-leaved emergents. Similar to Module 6A in Remediation Area A, there is a different planting zone for the lake ward fringe of Module 6A as well as a 25-ft. planted buffer strip lake ward of the current outboard area shoreline designed specifically to encourage a robust transition from lake to wetland. The habitat layer will be topsoil and will be planted with species appropriate to adjacent Habitat Modules 3B, 5A, and 6A (See figure 4.4). Flowering plant species are proposed in the remainder of Module 6A and module 8B.

The critical vegetative transition from upland to wetland vegetation occurs from the top of the barrier wall to an elevation of approximately 364.5 in the outboard area. This transition zone will consist of primarily scrub/shrub forest species that will be planted and seeded including native willows (*Salix* spp.), maples (*Acer* spp.), dogwoods (*Cornus* spp.), and alder (*Alnus incana* ssp. *rugosa*). Details of the planting program will be submitted as an addendum to the Final Design, subject to review and approval by NYSDEC.

The forested wetlands located at the terminus of the former East Flume in the Outboard Area will provide additional wetland diversity in this area. The design includes a variety of native woody tree and shrub species that will provide organic material and leaf litter to the adjacent emergent system, as well as wildlife habitat. Due to the limited acreage of forested wetlands adjacent to the lake, this additional forested acreage will add valuable diversity along the Wastebed B shoreline.

4.2 HARBOR BROOK CHANNEL

The Harbor Brook Channel will provide increased sinuosity and length and sufficient water depths under low flows to support fish passage. The channel banks will be sloped to maximize wetland acreage in the surrounding low lying areas and provide stability. Based on the flows and velocities in the Harbor Brook channel and the lake surface elevations, a final (i.e., to be constructed as part of the lake work) channel alignment was developed (Figure K-8). The upstream thalweg elevation is set at 360.4 ft., equal to the culvert invert elevation, with a downstream thalweg elevation of 360.4 ft. The channel slope is flat out to the lake since the hydrology in this area is driven by the lake level. The wetland areas described above will be inundated by the lake, rather than flows overtopping the channel banks, although a significant brook discharge coupled with a low lake level will also inundate the wetland areas. Design objectives, considerations and constraints, and flow hydrology for Harbor Brook are discussed in further detail below.

4.2.1 Design Objectives

The objectives for the Harbor Brook channel design include:

- Maintaining the design hydraulic capacity of Culvert #1
- Providing a channel design that is constructible with the anticipated habitat layer material
- Providing a channel that allows for maximum wetland area for northern pike spawning
- Providing an increase in channel length and sinuosity
- Allowing for periodic sediment deposition and erosion in the channel
- No increase in flooding or water surface elevation during storm events

4.2.2 Design Considerations and Constraints

A preliminary hydraulic and hydrological evaluation was completed to identify a potential final channel alignment. The following channel design considerations were used to satisfy the channel design objectives and work within the design constraints presented by the remediation design:

- In order to maintain the design discharge capacity of Culvert #1, a channel bottom width of 20 ft. was selected to match the culvert's bottom width. Using a consistent bottom width maintains the effective flow area and does not create a downstream constriction for flow through the culvert and thereby does not reduce the design discharge capacity of Culvert #1.
- The upstream channel thalweg elevation matches the proposed Culvert #1 outlet invert of 360.4 ft.
- Although a vertical bank E type channel (Rosgen 1996) has been suggested by state environmental agencies to be desirable for other stream restorations in the vicinity of

Onondaga Lake, the restoration of Lower Harbor Brook is not amenable to this channel type. The stability of the habitat fill material and the depositional setting caused by the backwater effect of Onondaga Lake, limit the ability to create an E-type channel for Lower Harbor Brook. The side slopes for the channel are 4:1, which is the slope used for all capped areas.

- The typical backwater condition in the channel caused by the lake limits flow velocities and shear stresses. These hydraulic conditions are likely to permit the deposition of finer grained material (e.g., silt, sand and gravels) in the channels that are transported into the area by Harbor Brook. A more complex channel design would further reduce velocities and shear stresses, allowing the channel to fill in with sediment over time.
- The wetland areas are designed to be inundated primarily by the lake, rather than flows overtopping the channel banks. Although a significant brook discharge coupled with a low lake level will also inundate the wetland areas.
- The upstream and downstream thalweg elevation (360.4 ft.) provides a minimum water depth of 2.1 ft. for a lake level of 362.5 ft. at a negligible channel discharge.

4.2.3 Flow Hydrology

Using the mean daily discharge data from the USGS gage 04240105 on Harbor Brook, percent exceedance discharges were calculated on a daily basis for the period of record. The minimum, mean, and maximum discharges were also calculated on a daily basis for the period of record. These daily statistics were then averaged to determine representative monthly values.

The monthly discharge exceedance probability values aggregated from the daily exceedance probability calculations are provided in Table K-1. The average value for the water year is also provided in the far right column for each exceedance probability.

The annual flow hydrology analysis indicates that a majority of the time the channel water surface elevation will be primarily determined by the lake's water surface elevation as the channel discharge will be significantly less than the channel's discharge capacity. In addition, as discussed above, the Harbor Brook channel thalweg elevation will be from 360.4 ft. As shown in Figure 3 in Attachment D to the Geddes Brook 100% Design Report (Parsons and Anchor QEA, 2011), the lake level has never been below 361 ft. (based on the period of record 1970-2009). As such, the channel will have a minimum of 7 inches, regardless of Harbor Brook flow.

4.3 WATER TEMPERATURE

Water temperature data were collected from the littoral zone in and around Harbor Brook from March through mid-May, 2011 to estimate the time period in Onondaga Lake when preferred water temperatures for spawning are available to confirm the design elevations selected for this area. The specific objective for the water temperature monitoring is to evaluate water temperatures in the shallow nearshore littoral zone in Onondaga Lake near Harbor Brook to better understand the potential timing of northern pike spawning in this system.

Water temperature was monitored at several locations in Harbor Brook and Onondaga Lake from just after ice out in early March to mid-May to determine the timing for preferred conditions for pike spawning.

4.3.1 Methods

HOBO® data loggers were placed in the lake near Harbor Brook in 1, 2, and 5 ft. of water (3 locations each), in the Harbor Brook channel, along the Harbor Brook bank, and near Ninemile Creek in 1 and 2 ft. of water. Monitors were programmed to record water temperature hourly. Data loggers were installed at each targeted water depth on March 11, 2011, in the Harbor Brook area just after the majority of ice out, and on March 23, 2011 in the Ninemile Creek area (ice out was later in this area). Loggers were attached to cinder blocks at the deep locations, and a dog stake in the shallower depths and suspended just above the substrate (i.e., approximately 6 inches). Monitors were inspected, location slightly adjusted if not within the targeted water depth, and the temperature data were downloaded on a weekly basis.

Dissolved oxygen was measured at each location using a hand held probe during each download. This data is summarized in Table K-2. Locations were not visited during May due to high water and safety concerns; loggers were removed from the lake on June 6, 2011.

4.3.2 Results

Data from the hourly temperature readings at each location from late March through mid-May are presented in Figures K-9 through K-13. One logger was not able to be downloaded following the first event on April 4 (Harbor Brook West Bank); data are not available from this location after this date. Several loggers were out of the water during downloading due to water level fluctuations and were relocated in the appropriate water depth (generally within 10-30 ft. of original location); these are noted on each figure as applicable. The preferred northern pike spawning temperature range (between 41^{o}F and 55^{o}F) is provided on each graph for comparison with the collected data.

Based on visual inspection of the figures, there is not a discernable difference in temperature among the various depths along the shoreline, all three depths appeared to reach suitable spawning temperatures approximately mid-March and extended into early May (Figures K-9, 10, 11). The Harbor Brook channel and wetland locations also followed the same general trend as the littoral locations with suitable spawning temperatures recorded between mid-March to late April (Figure K-12). The Ninemile Creek location warmed later with suitable spawning temperature recorded near the end of March and lasting into early May (Figure K-13). These results are consistent with the assumptions in the Intermediate Design with water surface elevations during March to late April used to determine the habitat layer elevation.

Dissolved oxygen measurements recorded from each location during weekly downloads ranged from 9.19 to 12.79 mg/L (Table K-2). These are consistently higher than minimum dissolved oxygen concentration (4.5 mg/L) that is suitable for embryo development (Inskip 1982). As long as eggs remain suspended on the vegetation, dissolved oxygen concentrations should be suitable for incubation and hatching in the future.

4.4 SHORELINE WAVE ATTENUATION

An evaluation was completed to determine if measures to attenuate wave energy, such as an offshore wave break, are necessary to facilitate northern pike spawning and wetland development in the WBB/HB Outboard Area. Some degree of water movement is beneficial and necessary to create suitable pike spawning habitat (Casselman and Lewis 1996, Brodeur et al. 2004). However, water movement caused by large waves (i.e., > 2 ft.) could hinder the establishment of wetland vegetation, which is also required for suitable pike spawning habitat. As discussed in Section 4.2.3, Harbor Brook channel flows are generally low, and velocities and sheer stresses are low due to the backwater effect of the lake and are unlikely to affect wetland vegetation. The potential for waves to impact the site due to the long fetch associated with this portion of the lake was evaluated based on wind data from1942 to 2009. The results of the wind analysis, presented below, demonstrate that there is only a 3 percent chance of a wave greater than 1.0 ft. reaching the shore in this area. The period of March 15th - April 7th was selected to capture the pike spawning season and the beginning of the growing season in the spring for plants that may be subjected to wave action. During this period, over 60 percent of the time there are no measurable waves that reach the shore.

Due to the limited potential for large waves to impact the site, and the desire to allow water movement to support pike spawning and vegetative growth, it is not necessary to construct permanent feature(s) above the average lake level to attenuate wave energy.

4.4.1 Historical Wave Analysis

One of the key design considerations for the habitat restoration is the amount of wave energy that reaches the Harbor Brook/Outboard shoreline. From May 18, 2005 to August 4, 2005, Upstate Freshwater Institute (UFI) measured significant wave heights in the littoral zone in vicinity of the ILWD (Owens et al, 2009). The maximum significant wave heights were measured to be approximately 2-3 ft. Long-term historical wave height measurements have not been collected in Onondaga Lake. Therefore, an analysis of wave heights at this location was performed to evaluate the frequency of various wave heights.

Historical wave heights were estimated from continuous wind measurements collected at the Hancock International Airport from 1942 to 2009 using the procedures described in Section 5 – Wind-Wave Analysis of the Armor Layer Design Appendix to the *Draft Onondaga Lake Capping and Dredge Area and Depth Initial Design Submittal*. This report was submitted to the New York Department of Environmental Conservation (NYSDEC) in December 2009. That report describes the wind-wave analysis methods and procedures in detail, provides documentation of the inputs and data used in the analysis, and presents an example calculation. The procedures used in the analysis are summarized below.

Continuous hourly wind measurements (speeds and direction) from 1942 to 2009 were obtained from Hancock International Airport. The airport is located approximately 5 miles east of Onondaga Lake. The winds were measured at the following heights above the ground:

- 1942 to 1949: 57 ft.
- 1949 to 1962: 72 ft.

- 1962 and 1963: 84 ft.
- 1963 to 2009: 21 ft.

The methodology used to estimate wind speeds for wave prediction is consistent with that described in Part II – Chapter 2 of the U.S. Army Corps of Engineers (USACE's) *Coastal Engineering Manual* (CEM; USACE 2006). In accordance with the CEM, the measured wind speeds were first converted to hourly-averaged wind speeds at heights of 32.8 ft. (10 meters) above the ground for predicting waves (USACE 2006). The hourly-averaged wind speeds were then converted to 15-minute-averaged wind speeds using procedures outlined in the CEM. In large lakes, the wave generation process tends to respond to average winds over a 15- to 30-minute interval (USACE 2006), because shorter duration gusts are generally not sufficient for significant wave generation. It is assumed that Onondaga Lake represents fetch-limited conditions and not duration-limited conditions for wave growth. Using 15-minute averages produces higher wind speeds than 30-minute averages, so the more conservative 15-minute averaging interval was used in this analysis. The methods described in the USACE *Automated Coastal Engineering System* (ACES) computer program were used to model wave growth and propagation due to winds (USACE 1992).

The wave analysis was performed using wind data collected for all months, as well as between March 15 and May 15. The period March 15 to May 15 are the critical time periods for northern pike spawning and initial plant growth. Wind directions were divided into 30-degree bins, and for each parcel, a representative fetch was estimated for each directional bin from the shoreline near the Harbor Brook confluence with Onondaga Lake. For each wind speed and direction, the corresponding significant wave height and period were calculated, and wave roses were developed for each parcel. The significant wave height and period represents the average of the largest 1/3 of all the wave heights and periods.

Figure K-14 presents the wave roses for all months and for the March 15 to May 15 period, respectively. The largest significant wave heights are from the northwest. There is a slightly higher percentage of waves in the 1-2 ft. range during the March 15 to May 15 period, compared to the average for all months. However, the cumulative frequency distribution of computed significant wave heights for all months, and for the March 15 to May 15, period shows that wave heights in excess of 1 ft. occur very infrequently, less than 3 percent of the time in either time period. (Figure K-15.)

SECTION 5

TOTAL ORGANIC MATTER CONTENT IN HABITAT LAYER

The amount of organic matter in lake sediments can vary considerably. In Onondaga Lake, areas with higher organic matter are generally associated with tributary deltas and deeper depositional areas. This pattern is understandable since in lacustrine systems, allochthonous input is generally much larger compared to internal (autochthonous) sources. Over time, the organic matter levels in the sediments placed in Onondaga Lake as part of the remedy are expected to reflect existing patterns due to continued organic matter input from the watershed and addition of organic matter is not considered to be necessary in all locations. However, in wetland locations, topsoil will be used as the habitat layer to support initial plant establishment. The amount of organic matter in the habitat layer was determined based on samples collected from wetlands adjacent to the lake in SYW-10 and Geddes Brook floodplain and review of the scientific literature (Ballantine and Schneider 2009). The sediment samples from SYW-10 and Geddes Brook flooplain had average organic matter content values of 4.7 percent and 3.1 percent, respectively, with an overall range of 1.8 percent to 15.6 percent. Based on that range and results from other studies (Bishel-Machung et al. 1996; Bruland and Richardson 2006; Campbell et al. 2002), a target range 5 percent to 15 percent and an approximate average of 7.5 percent was selected for the wetland modules that will be planted as discussed in Section 4.3.6 of the final design.

The areas currently colonized by submerged macrophytes in Onondaga Lake have organic matter values that range from 0.1 percent to 31 percent. This wide range is consistent with the range of values observed at other sites (e.g., St. Louis River Tar Site). This is also consistent with the scientific literature which shows that submerged macrophytes exist under a wide variety of environments. One aspect of the physical environment, sediment properties, has been widely studied, in particular sediment grain size, organic matter content and sediment nutrients (Van Wijck et al., 1991, Koch, 2001). Rogers et al. (1992) reported that sediments in a *Vallisneria* bed in Lake Onalaska were intrinsically infertile and plant growth was dependent on nutrient supply/renewal, most likely by way of sedimentation (Rogers et al. 1992). Other studies have shown that high levels of organic matter can inhibit growth of submerged macrophytes (Barko and Smart 1983). Since 2005, submerged macrophytes in Onondaga Lake have rapidly expanded into areas with varying sediment types and organic matter ranging from 0.17 percent to 26 percent.

Successful colonization of sediments with such a wide range of organic matter suggests that organic matter levels were not the primary factor limiting the distribution of submerged macrophytes. Rather, the increased macrophyte distribution is likely the result of increased light availability due to water quality improvements. As such, addition of organic matter to the submerged macrophyte habitat modules is not considered necessary. Natural colonization of these areas from the native seed bank is expected to occur fairly rapidly. The exceptions to this are the habitat modules adjacent to the Ninemile Creek spits, and a 25 ft. transition zone within the lake adjacent to the Outboard Area. As discussed in Sections 2 and 3, these areas will be planted, and therefore the habitat substrate in these areas will consist of topsoil with an organic content of 5 percent to 20 percent.

Benthic macroinvertebrates (BMI) also comprise an important component of secondary production in the littoral zone. The distribution and composition of the BMI community is based on a combination of factors including physical and biological habitat conditions, feeding mode and food ability (Merritt and Cummins 1988). Physical factors such as littoral slope and water depth have been shown to be the most critical factors influencing benthic community composition of lakes (Duarte and Kalf 1986; Rasmussen 1988; Stantec 2006). Sediment organic content has also been shown to be important. In lacustrine systems, BMI feed on particulate organic matter that settles to, or grows upon, the substrate (Rasmussen 1988). While the amount of particulate organic matter produced within the lake has decreased due to improvements in water quality (and concomitant reduction in primary production by algae), there is still significant particular organic matter produced within and entering the lake. Higher organic matter can reduce oxygen levels in sediments and at the sediment-water interface, and thus reduce the abundances of taxa like mayflies and caddisflies that have a higher requirement for oxygen than worms, chironomids and clams (Hilsenhoff, 1987). Therefore, addition of organic matter to the habitat layer is not considered necessary to support benthic macroinvertebrates.

SECTION 6

SHORELINE TRANSITION AREAS

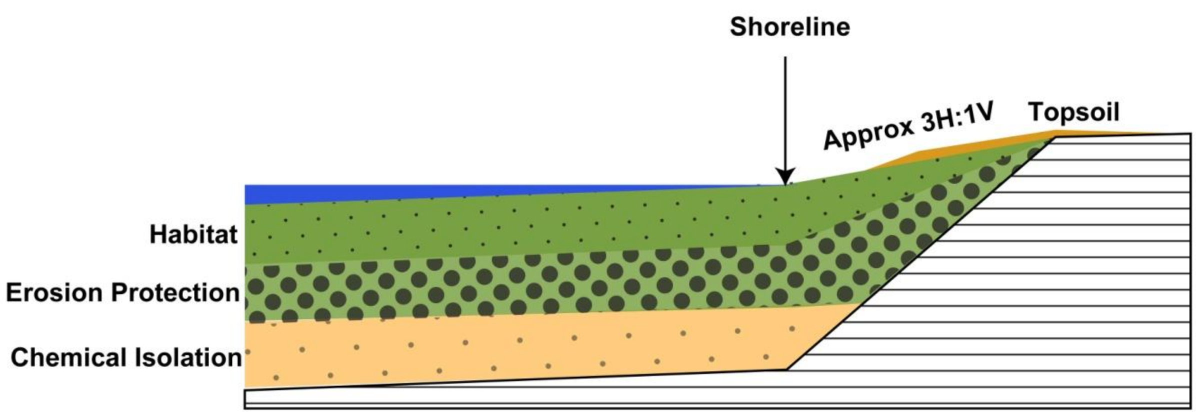
6.1 AREAS WITHOUT ADJACENT REMEDIATION

In areas where the dredge and cap design does not abut adjacent shoreline remediation, such as Remediation Areas C and E, the treatment for the shoreline areas will be the same as was used in the Willis Avenue Lakeshore Barrier Wall IRM (Site No.: 734026) Restoration/Mitigation Design Semet IRM (Parsons 2009). This restoration will include placement of top soil over the restored habitat layer above elevation 362.5 ft., and the establishment of a native plant community using upland and shoreline plantings and seeding.

Topsoil will be placed using conventional construction techniques. Once grading is completed, the upland area above elevation 362.5 ft. will be seeded with the conservation seed mix. Details of the planting/seeding program will be submitted as an addendum to the final design.

The second component of the shoreline transition includes the establishment of shrub species along the lake shoreline. The establishment of waterside vegetation will provide shade and leaf litter input that will enhance the fish and benthic macroinvertebrate habitat in the adjacent shallow water areas of Onondaga Lake that will be restored as part of the in-lake remediation work (Figure K-3.)

A typical schematic section is described below.



6.2 SHORELINE STABILIZATION ADJACENT TO REMEDIATION AREAS

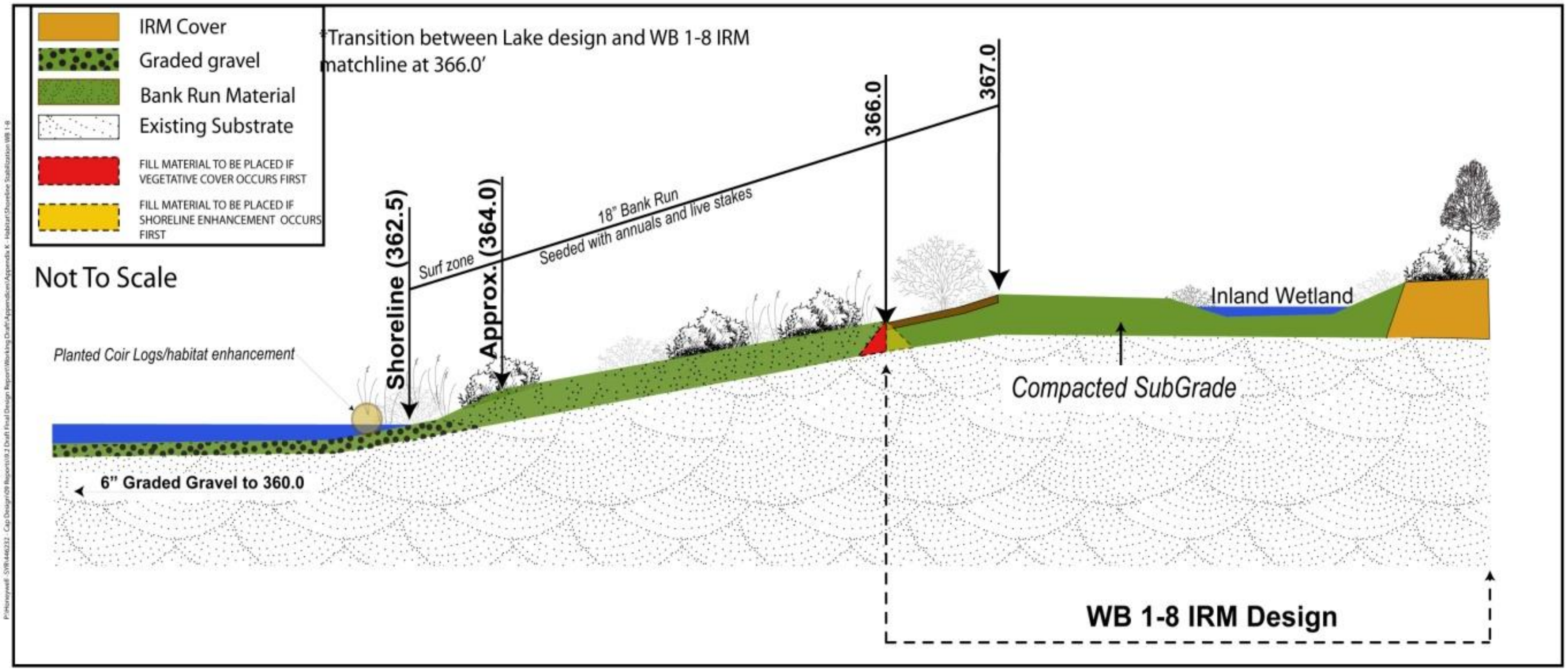
There are several areas within the lake that require remediation up to the shoreline along Wastebeds 1-8. Per the requirements outlined in the ROD, shoreline stabilization is required along the shoreline in this area. Given the sloping condition required for the dredge cut in these areas as noted on the cross section above for the isolation cap and habitat layer, the shoreline treatment will cover the adjacent upland area (362.5-365 ft.) and additional shoreline stabilization will not be required.

6.3 SHORELINE STABILIZATION IN AREAS WITHOUT ADJACENT REMEDIATION

The majority of the Wastebeds 1-8 shoreline does not require remediation for the adjacent in the lake areas. However, the shoreline stabilization requirements from the Onondaga Lake ROD identify the need to address this shoreline area. The in-lake portion of the stabilization will consist of 6 inches of graded gravel from elevation 360-362.5 ft. This elevation was determined by evaluating the surf zone for the 10-yr. storm event. The design in this area will enhance the existing shoreline with structure and planting with minimal impact on lake surface area.

In order to address resuspension of Solvay waste materials due to shoreline wave action and enhance the ecological integration of the Wastebed 1-8 IRM with the lakeshore edge, material placement and planting will be conducted from 362.5 to 365 ft. (existing conditions). A summary of the design in this area is included below along with a schematic cross section.

- 18 inches of native run-of-the-bank material will cover from the average lake shoreline (362.5 ft.) up to 366.0 ft.
- 362.5 to 366.0 ft.; this area will be planted with 2-inch plugs and seeded with native annuals and perennials in addition to placement of coir logs and larger woody debris (plant species to be consistent with predicted hydrology).
- Targeted placement of pre-vegetated, bio-degradable coir logs along the shoreline adjacent to the perched wetlands at the 362.0 elevation (locations to be shown in the design addendum). The area between and upland of coir logs will be seeded with native grasses and forbs. This approach will provide suitable area for additional sediment trapping and development of shoreline vegetation. Additionally, this enhancement will create a smooth vegetated transition to the shoreline revetment activities in the Wastebed 1-8 IRM.
- Live stakes will be installed into the 18 inches of native bank run material along SMU 3 shoreline between elevation 363 and 366 to provide vegetated buffer to invasive colonization along shoreline as well as shading for nesting birds and mammals.



IRM Cover
Graded gravel
Bank Run Material
Existing Substrate
FILL MATERIAL TO BE PLACED IF VEGETATIVE COVER OCCURS FIRST
FILL MATERIAL TO BE PLACED IF SHORELINE ENHANCEMENT OCCURS FIRST
Not To Scale
*Transition between Lake design and WB 1-8 IRM matchline at 366.0'
367.0
366.0
Shoreline (362.5)
Approx. (364.0)
Surf zone
18" Bank Run
Seeded with annuals and live stakes
Inland Wetland
Planted Coir Logs/habitat enhancement
Compacted SubGrade
6" Graded Gravel to 360.0
WB 1-8 IRM Design

SECTION 7

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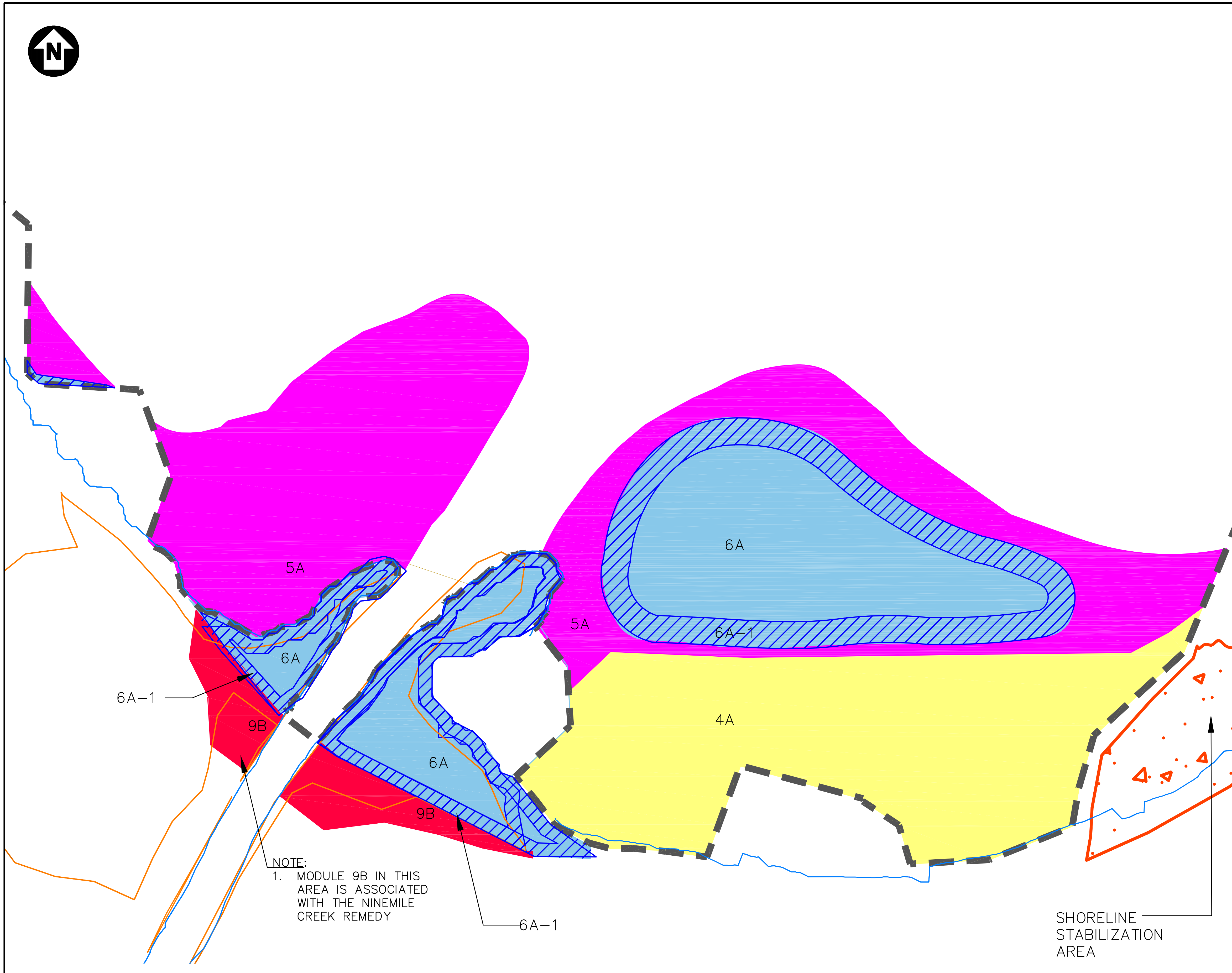
FIGURES



NOTES:
1. SEE SUBSEQUENT PLANTING ADDENDUM FOR PLANTING & SEEDING SPECIFICATIONS.
2. WHERE SHORE AND BANK DISTURBANCE OCCUR AS A RESULT OF DREDGING AND CAPPING ACTIVITIES, PLANTING WILL BE CONSISTENT WITH MODULE 8A/8B

LEGEND

- FORESTED WETLANDS (9B)
- SHORELINE UPLANDS (8A)
- FLOATING AQUATIC PLANT ZONE (4A)
- NON-PERSISTENT EMERGENT PLANT ZONE (5A)
- PERSISTENT EMERGENT WATER FRINGE PLANT ZONE (6A-1)
- PERSISTENT EMERGENT INTERIOR PLANT ZONE (6A)
- SHORELINE
- REMEDIATION AREA BOUNDARY

150 0 150 300

SCALE: 1"=150'

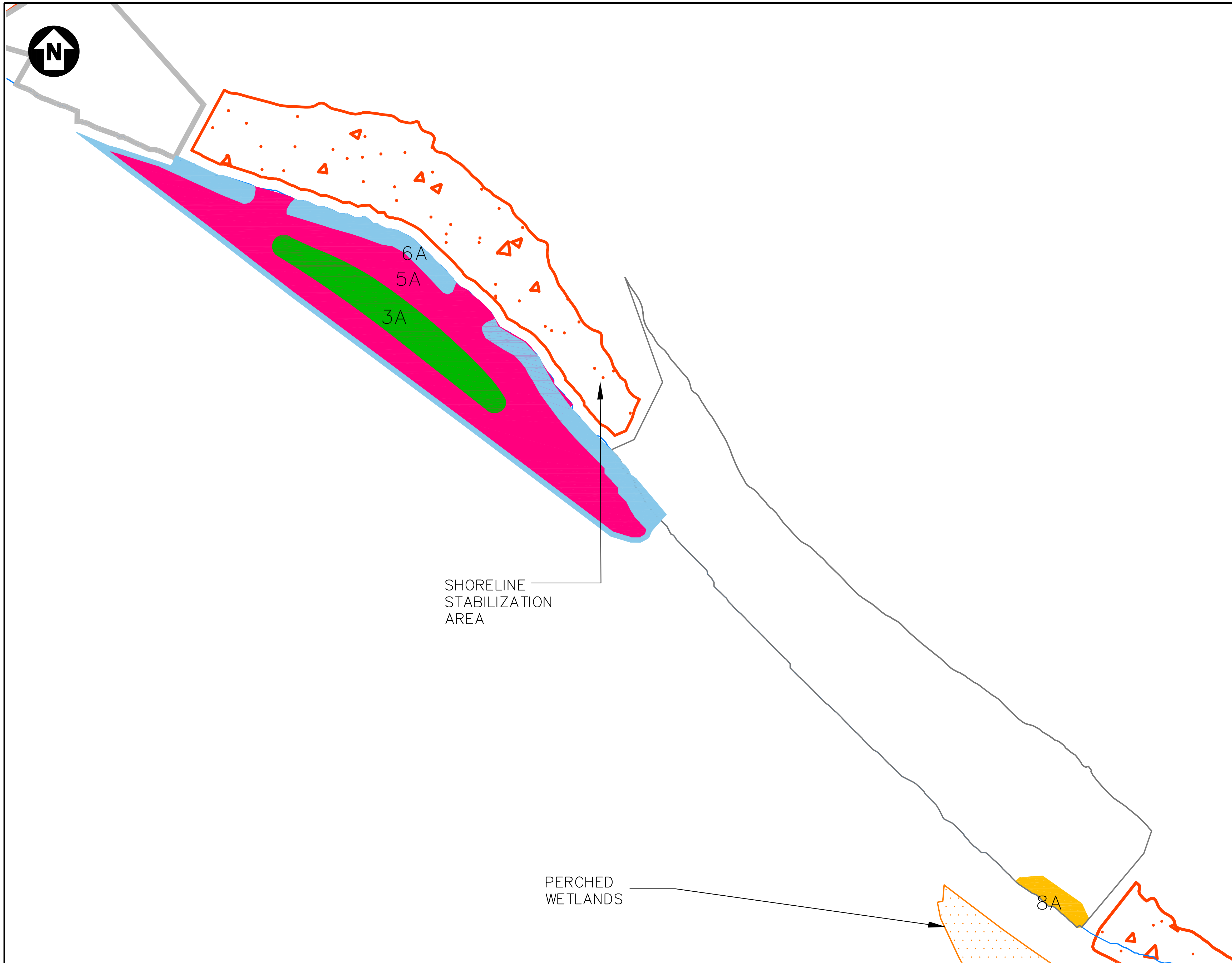
FIGURE K-1

Honeywell ONONDAGA LAKE SYRACUSE, NY

PLANTING PLAN
REMEDIATION AREA A & NINEMILE CREEK SPITS

PARSONS
301 PLAINFIELD ROAD • SUITE 350 • SYRACUSE, NY 13212 • 315/451-9560
OFFICES IN PRINCIPAL CITIES

FILE NAME: P:\HONEYWELL -SYR\446232 - CAP DESIGN\10 TECHNICAL CATEGORIES\10.1 CAD\HABITAT-DRAFT FINAL\446232-DF-PLANTS 2.24.12.DWG
PLOT DATE: 8/2/2010 1:51 PM PLOTTED BY: NEUMANN, JEREMY



NOTES:
1. SEE SUBSEQUENT PLANTING ADDENDUM FOR PLANTING & SEEDING SPECIFICATIONS.
2. WHERE SHORE AND BANK DISTURBANCE OCCUR AS A RESULT OF DREDGING AND CAPPING ACTIVITIES, PLANTING WILL BE CONSISTENT WITH MODULE 8A/8B

LEGEND

- SHALLOW WATER DEPTH, SUBMERGED AQUATIC VEGETATION (3A)
- SHORELINE UPLANDS (8A)
- NON-PERSISTENT EMERGENT PLANT ZONE (5A)
- PERSISTENT EMERGENT INTERIOR PLANT ZONE (6A)
- SHORELINE
- REMEDIATION AREA BOUNDARY

FIGURE K-2

Honeywell

ONONDAGA LAKE
SYRACUSE, NY

PLANTING PLAN
REMEDIATION AREA B & WB 1-8 CONNECTED WETLAND

PARSONS

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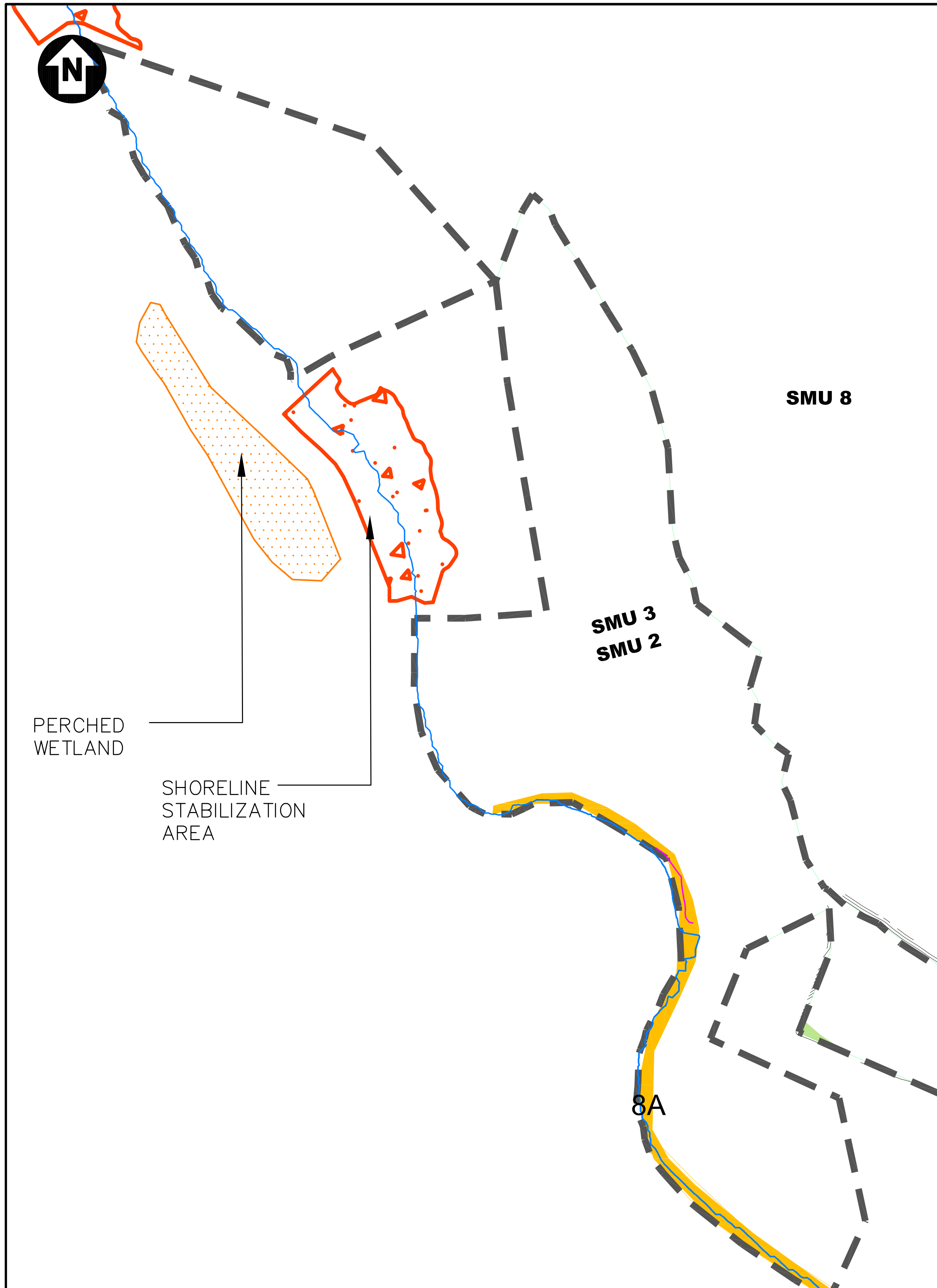
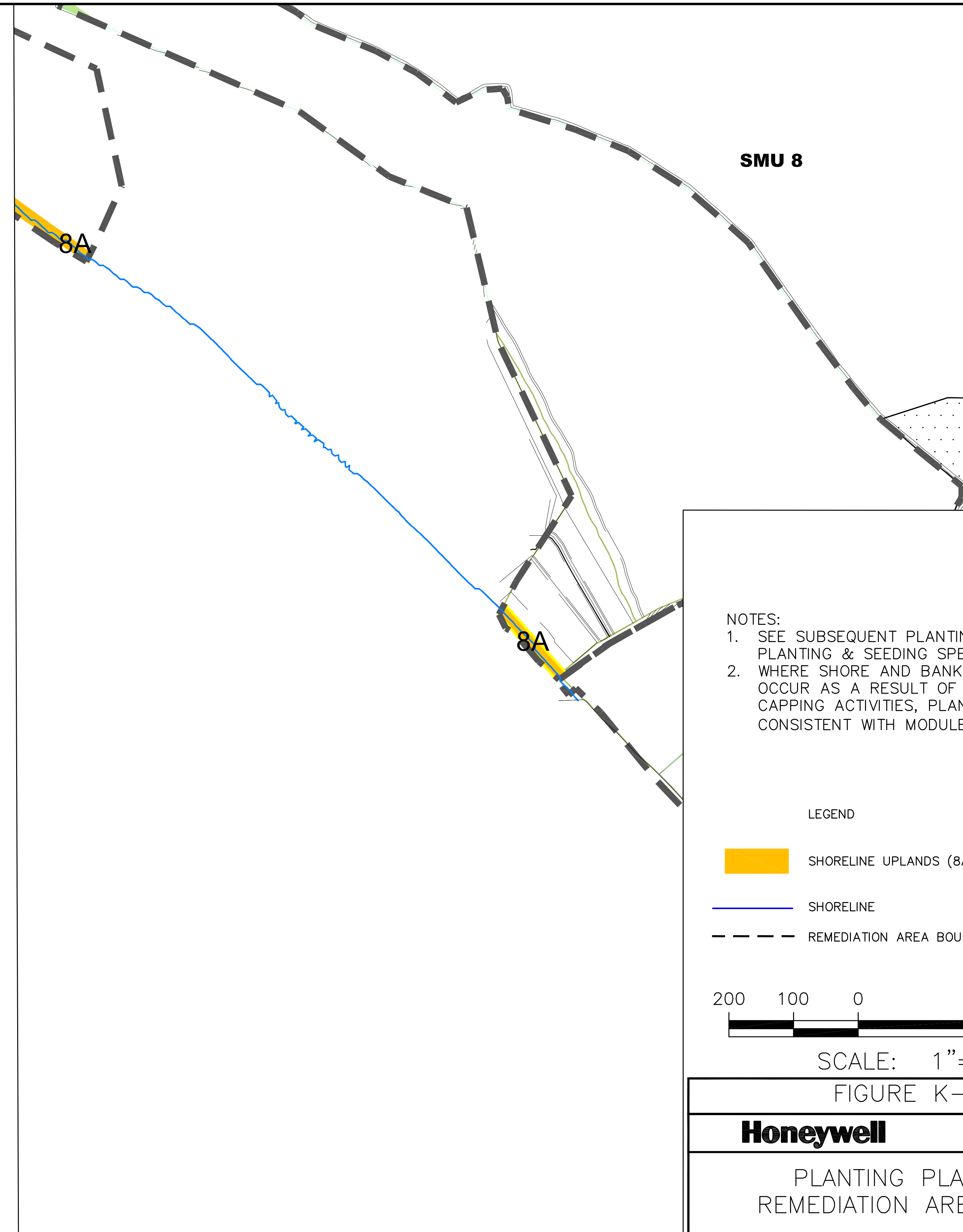
OFFICES IN PRINCIPAL CITIES

FILE NAME: P:\HONEYWELL -SYR\446232 - CAP DESIGN\10 TECHNICAL CATEGORIES\10.1 CAD\HABITAT-DRAFT FINAL\446232-DF-PLANTS 2.24.12.DWG
PLOT DATE: 8/2/2010 1:51 PM PLOTTED BY: NEUMANN, JEREMY





NOTES:
1. SEE SUBSEQUENT PLANTING ADDENDUM FOR PLANTING & SEEDING SPECIFICATIONS.
2. WHERE SHORE AND BANK DISTURBANCE OCCUR AS A RESULT OF DREDGING AND CAPPING ACTIVITIES, PLANTING WILL BE CONSISTENT WITH MODULE 8A/8B

LEGEND

SHORELINE UPLANDS (8A)

SHORELINE

REMEDIATION AREA BOUNDARY

200 100 0 200 400

SCALE: 1"=200'

FIGURE K–3

Honeywell

ONONDAGA LAKE
SYRACUSE, NY

PLANTING PLAN
REMEDIATION AREA C

PARSONS

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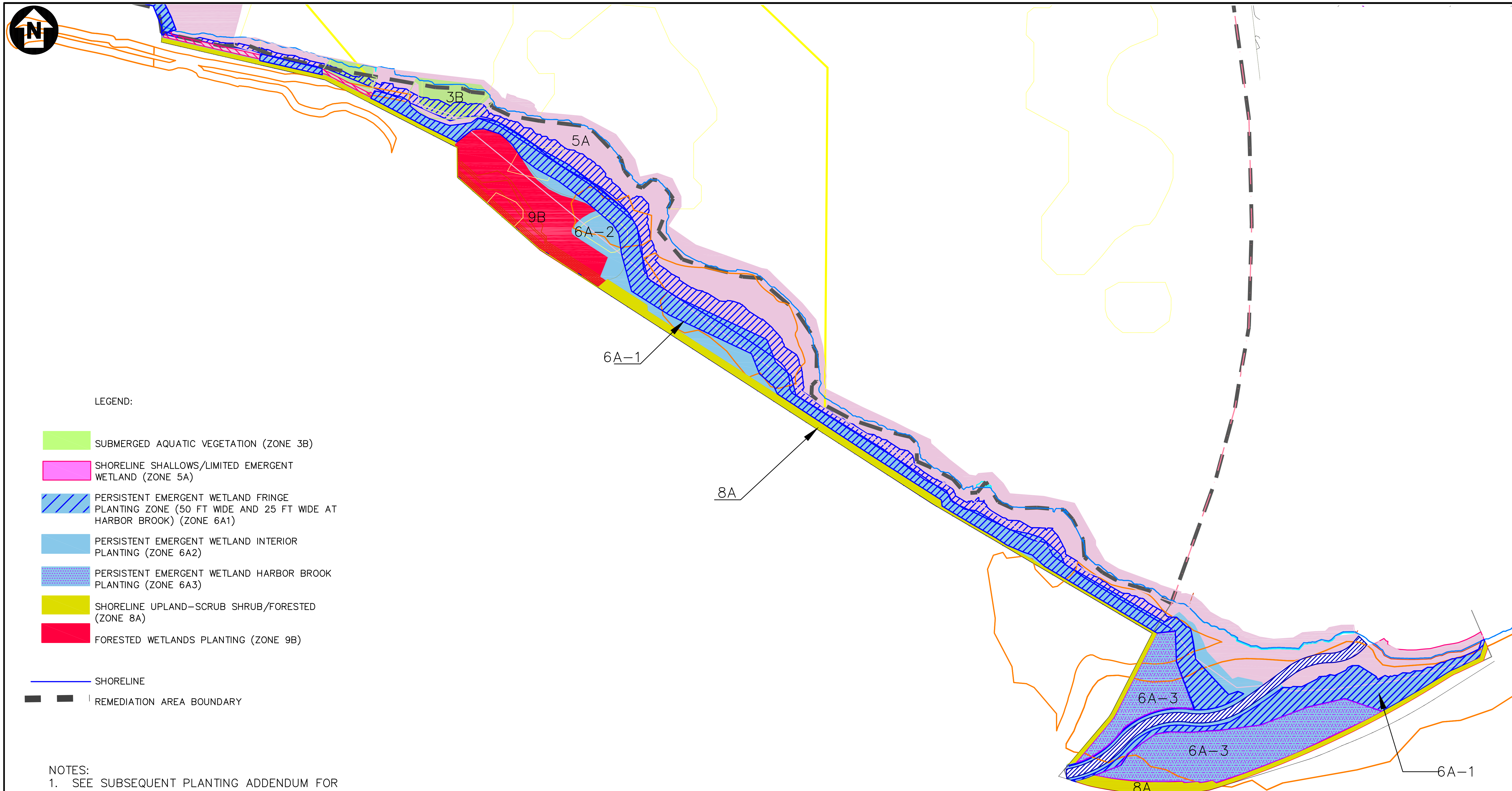
FILE NAME: P:\HONEYWELL –SYR\446232 – CAP DESIGN\10 TECHNICAL CATEGORIES\10.1 CAD\HABITAT–DRAFT FINAL\446232–DF–PLANTS 2.24.12.DWG
PLOT DATE: 8/2/2010 1:51 PM PLOTTED BY: NEUMANN, JEREMY



LEGEND:

- SUBMERGED AQUATIC VEGETATION (ZONE 3B)
- SHORELINE SHALLOWS/LIMITED EMERGENT WETLAND (ZONE 5A)
- PERSISTENT EMERGENT WETLAND FRINGE PLANTING ZONE (50 FT WIDE AND 25 FT WIDE AT HARBOR BROOK) (ZONE 6A1)
- PERSISTENT EMERGENT WETLAND INTERIOR PLANTING (ZONE 6A2)
- PERSISTENT EMERGENT WETLAND HARBOR BROOK PLANTING (ZONE 6A3)
- SHORELINE UPLAND-SCRUB SHRUB/FORESTED (ZONE 8A)
- FORESTED WETLANDS PLANTING (ZONE 9B)
- SHORELINE
- REMEDIATION AREA BOUNDARY

NOTES:
1. SEE SUBSEQUENT PLANTING ADDENDUM FOR PLANTING & SEEDING SPECIFICATIONS.
2. WHERE SHORE AND BANK DISTURBANCE OCCUR AS A RESULT OF DREDGING AND CAPPING ACTIVITIES, PLANTING WILL BE CONSISTENT WITH MODULE 8A/8B

250 0 250 500

SCALE: 1"=250'

FIGURE K-4

Honeywell

ONONDAGA LAKE
SYRACUSE, NY

PLANTING PLAN
REMEDIATION AREA D &
WASTEBED B OUTBOARD AREA

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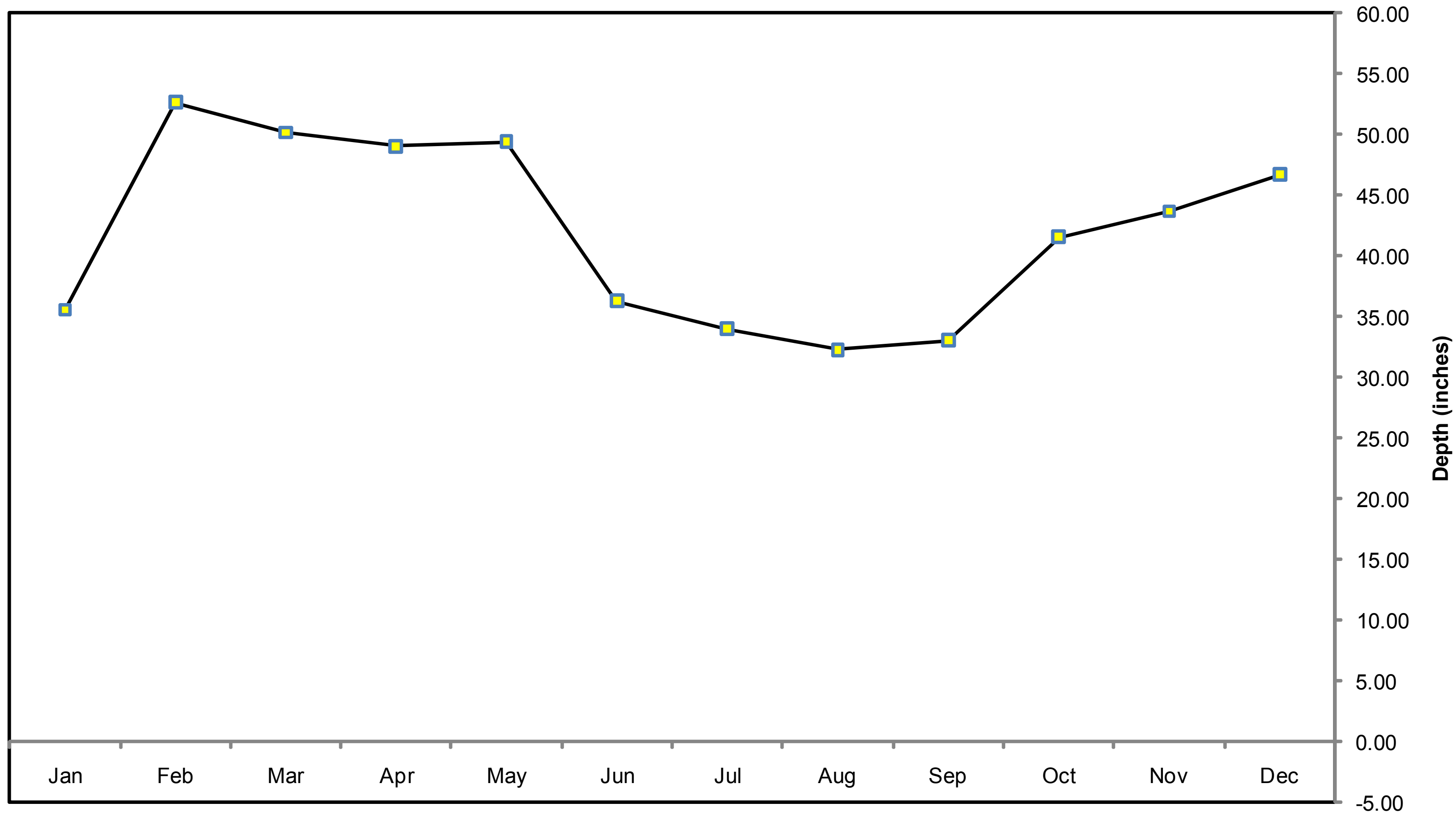
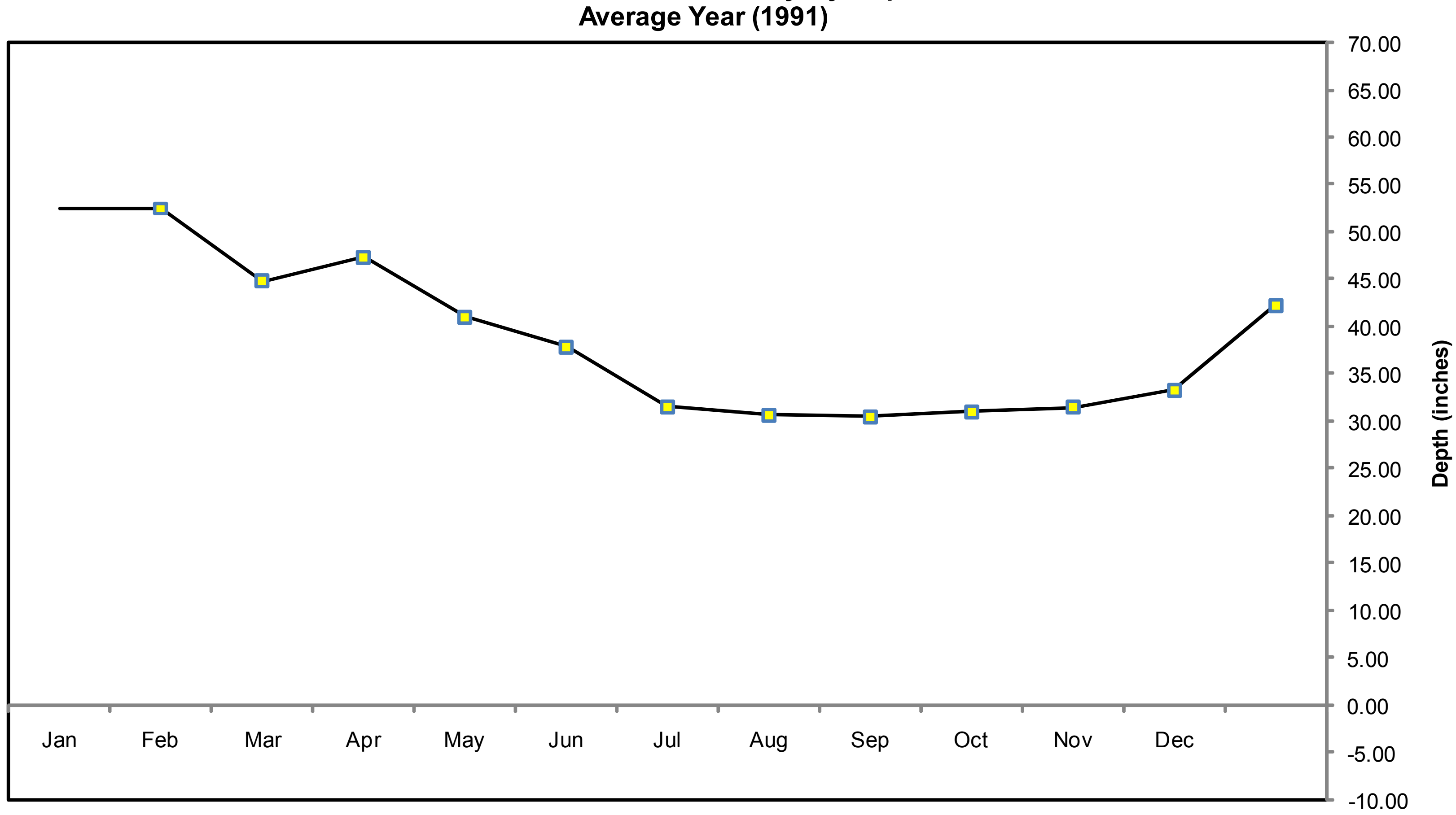
FILE NAME: P:\HONEYWELL -SYR\446232 - CAP DESIGN\10 TECHNICAL CATEGORIES\10.1 CAD\HABITAT-DRAFT FINAL\446232-DF-PLANTS 2.24.12.DWG
PLOT DATE: 8/2/2010 1:51 PM PLOTTED BY: NEUMANN, JEREMY

Connected Wetland Monthly Hydroperiod
Wet Year (1990)



Connected Wetland Monthly Hydroperiod
Average Year (1991)



Connected Wetland Monthly Hydroperiod
Dry Year (1999)

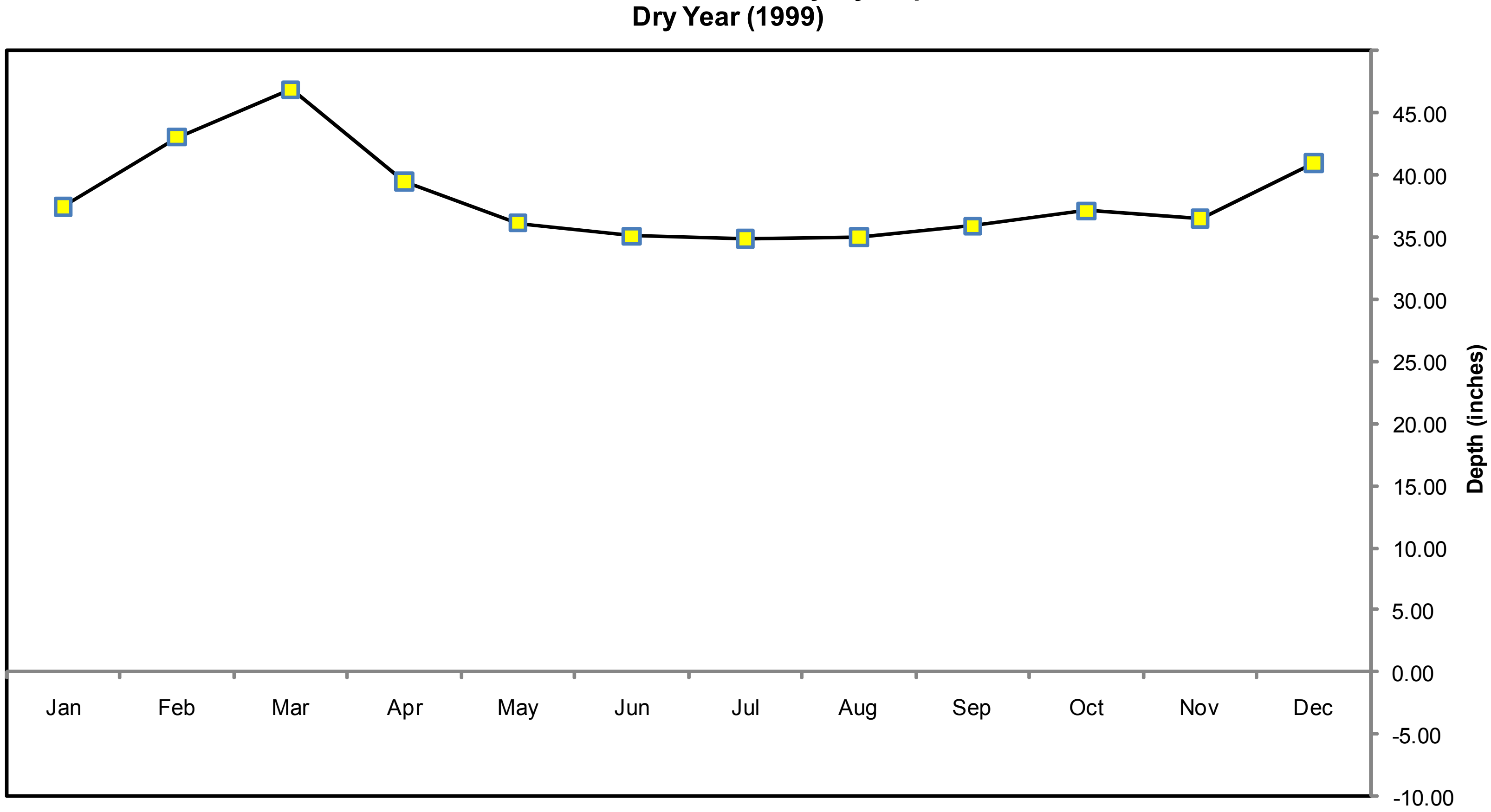


FIGURE K-5

Honeywell

Onondaga Lake
Syracuse, New York

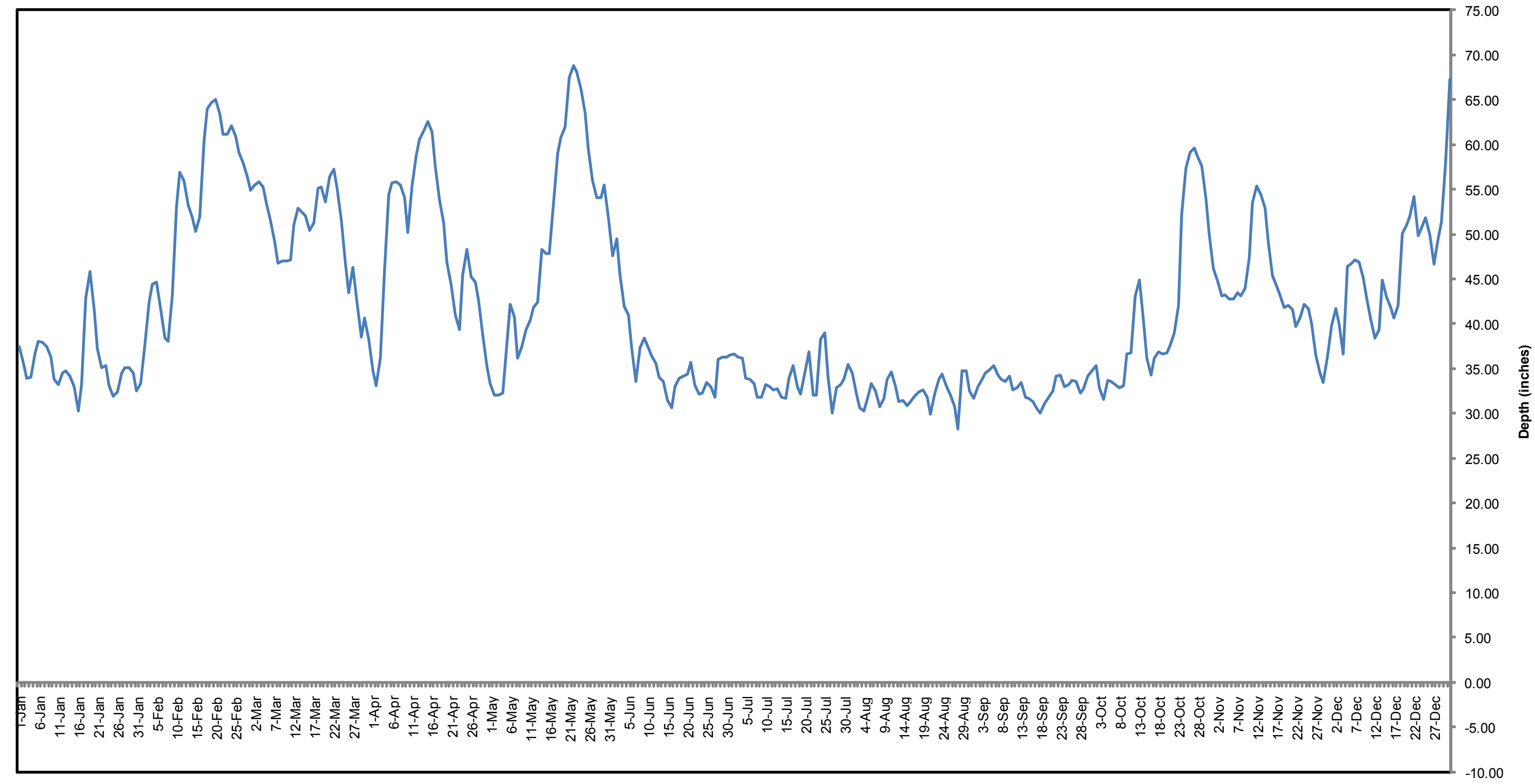
Wet, Dry, and Average
Onondaga Lake Hydroperiod by Month

PARSONS
301 Plainfield Rd, Suite 350, Syracuse, NY, 13212, Phone 315-451-9560

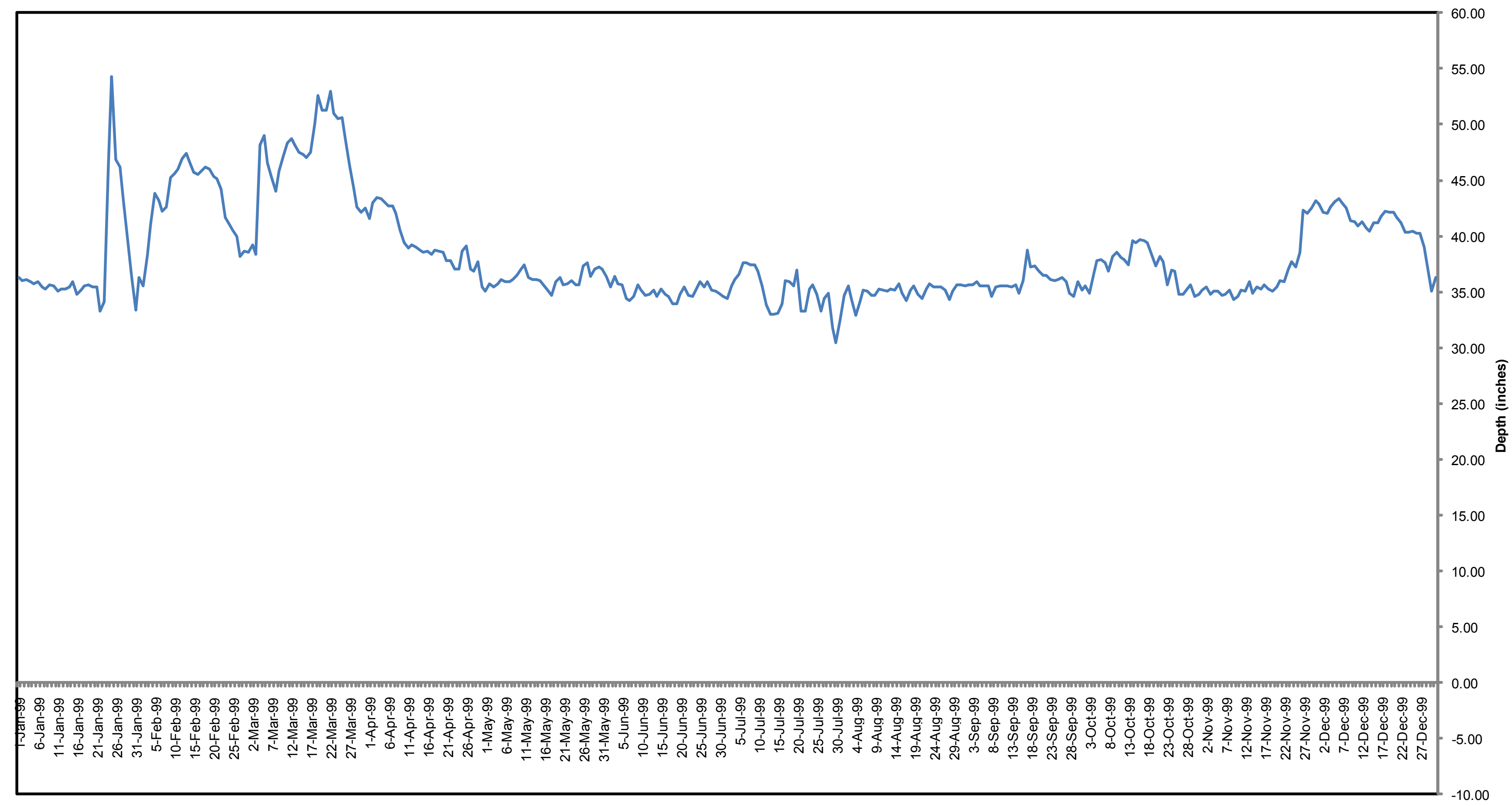
NOTE:

USGS data from Lakeland station minus elevation of bottom of wetland [359.5 ft]

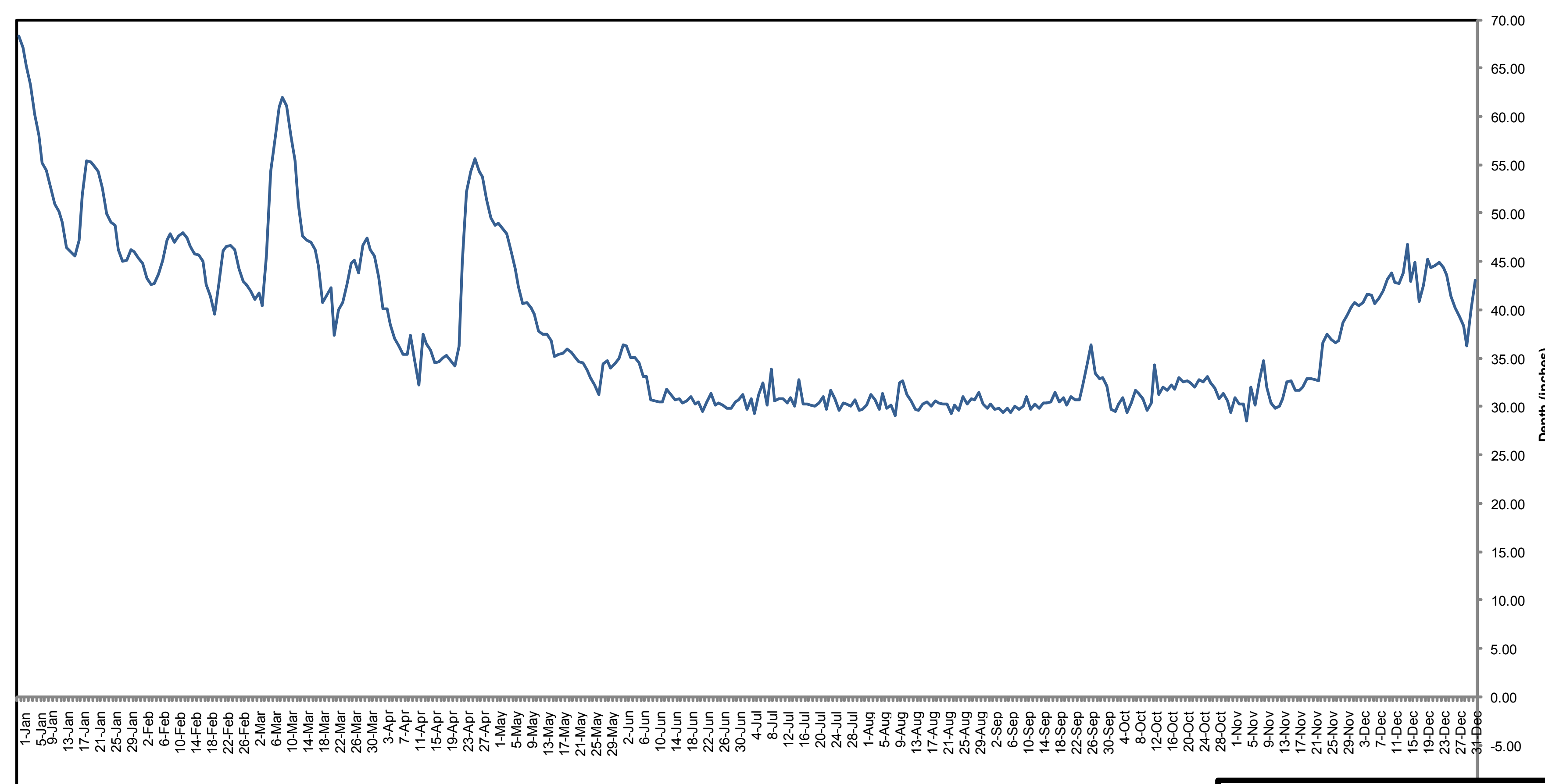
Connected Wetland Daily Hydroperiod
Wet Year (1990)



Connected Wetland Daily Hydroperiod
Dry Year (1999)



Connected Wetland Daily Hydroperiod
Average Year (1991)



NOTE:

USGS data from Lakeland station minus elevation of bottom of wetland [359.5 ft]

FIGURE K-6

Honeywell — Onondaga Lake, Syracuse, New York

Wet, Dry, and Average
Onondaga Lake Hydroperiod by Year

PARSONS
301 Plainfield Rd, Suite 350, Syracuse, NY, 13212, Phone 315-451-9560

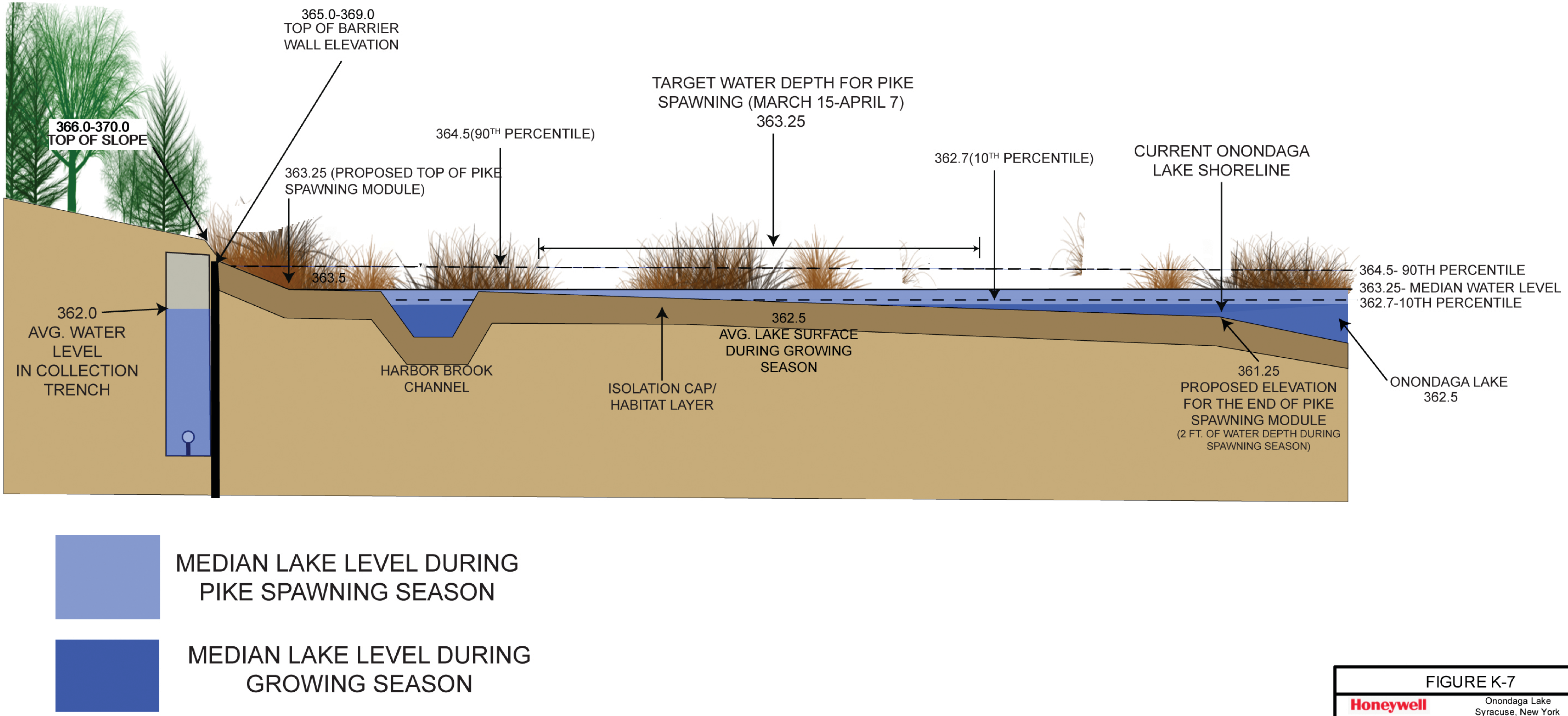


FIGURE K-7

Honeywell

Onondaga Lake
Syracuse, New York

Pike Spawning Area Section
Wastebed B/Harbor Brook
Outboard Area

PARSONS
301 Plainfield Rd, Suite 350, Syracuse, NY, 13212, Phone 315-451-9560

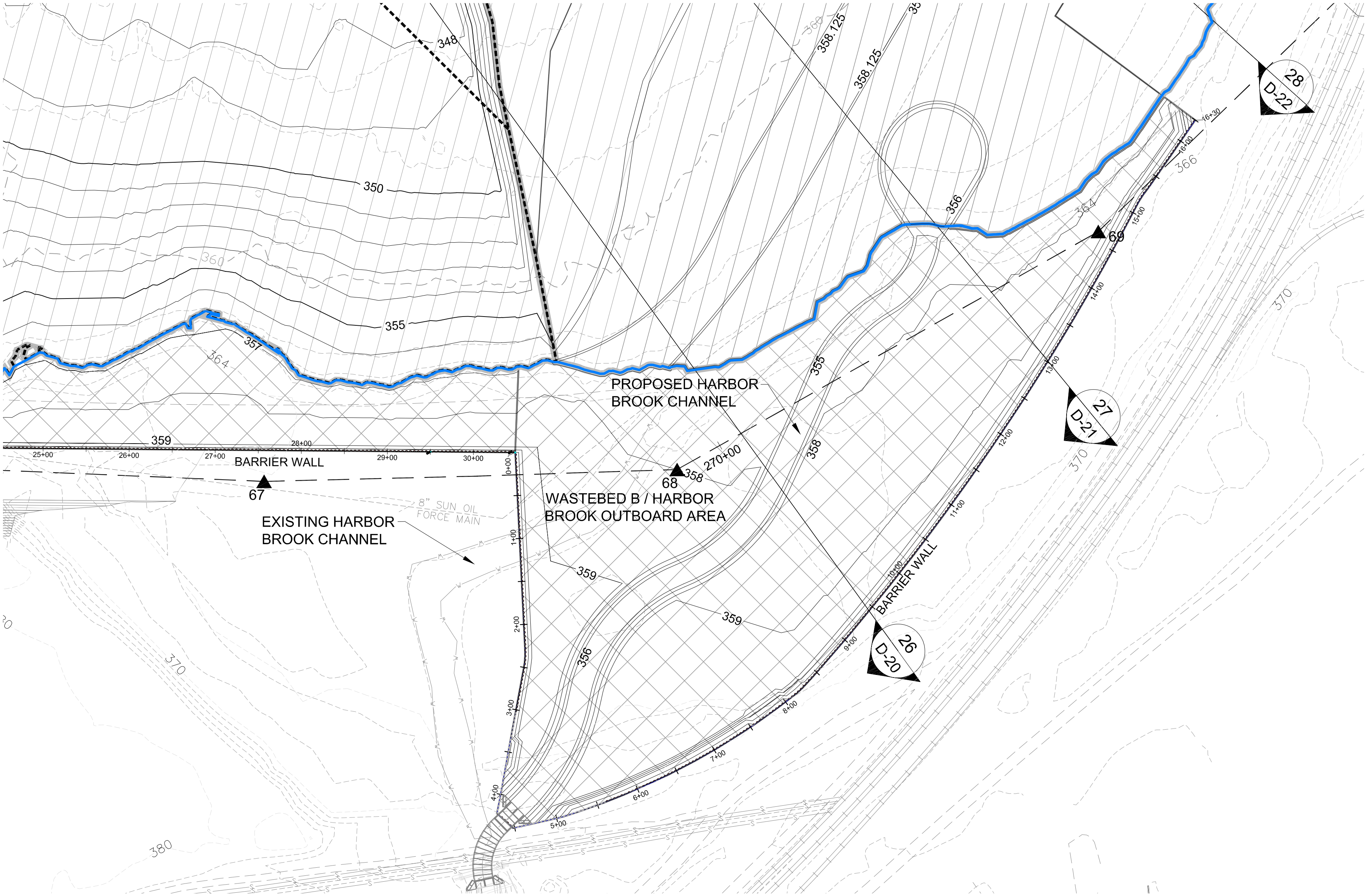


FIGURE K-8

Honeywell

Onondaga Lake
Syracuse, New York

Plan View of Outboard Area
Harbor Brook Channel

PARSONS
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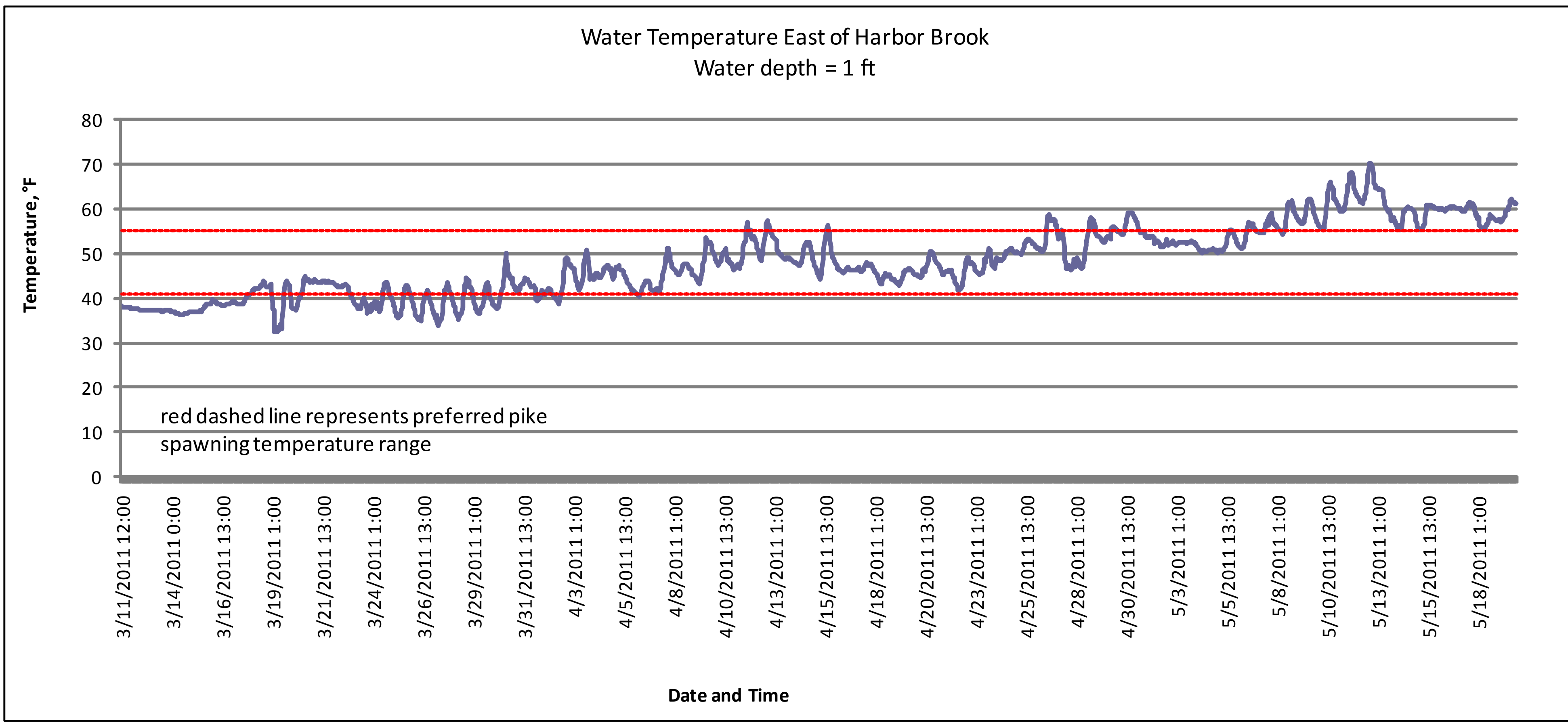

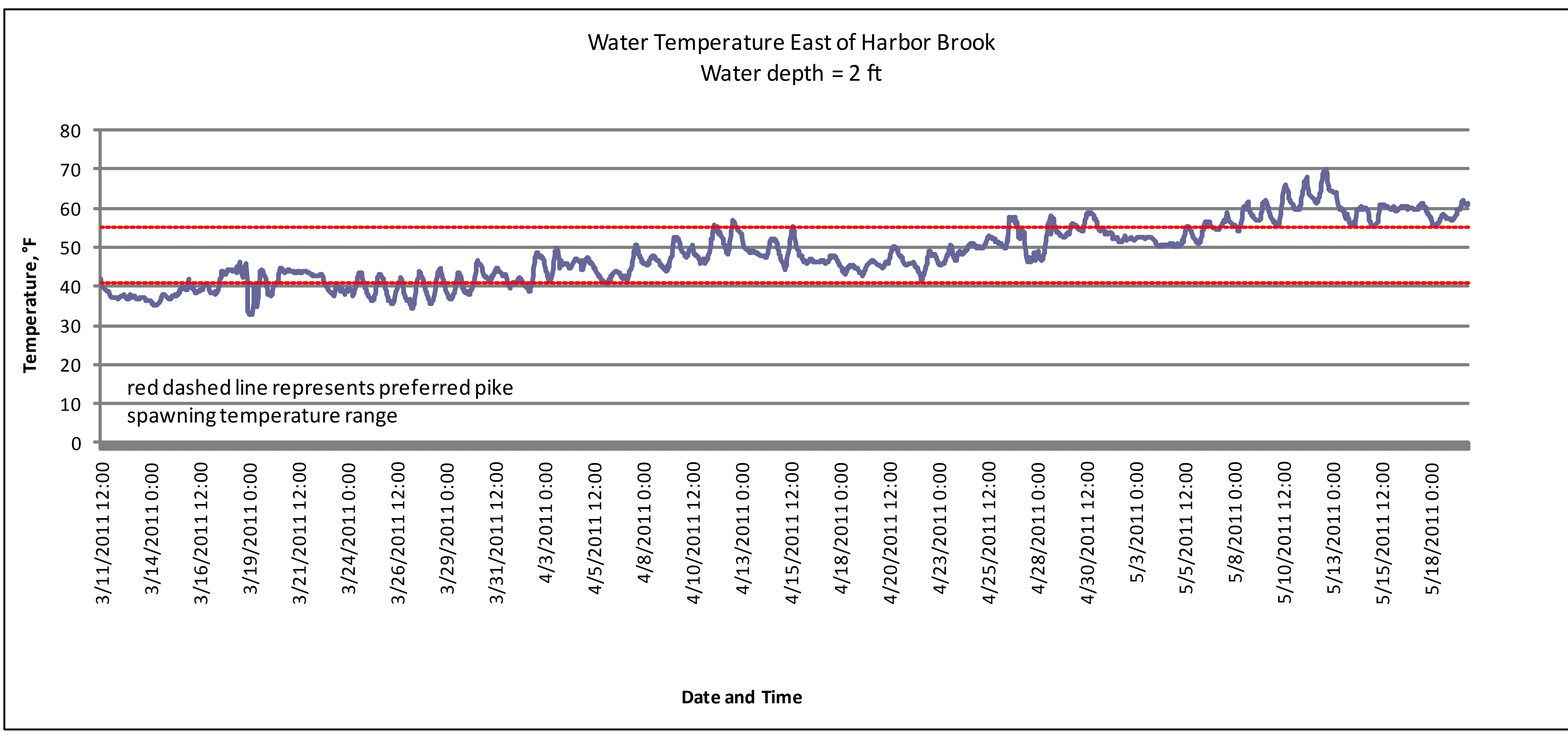

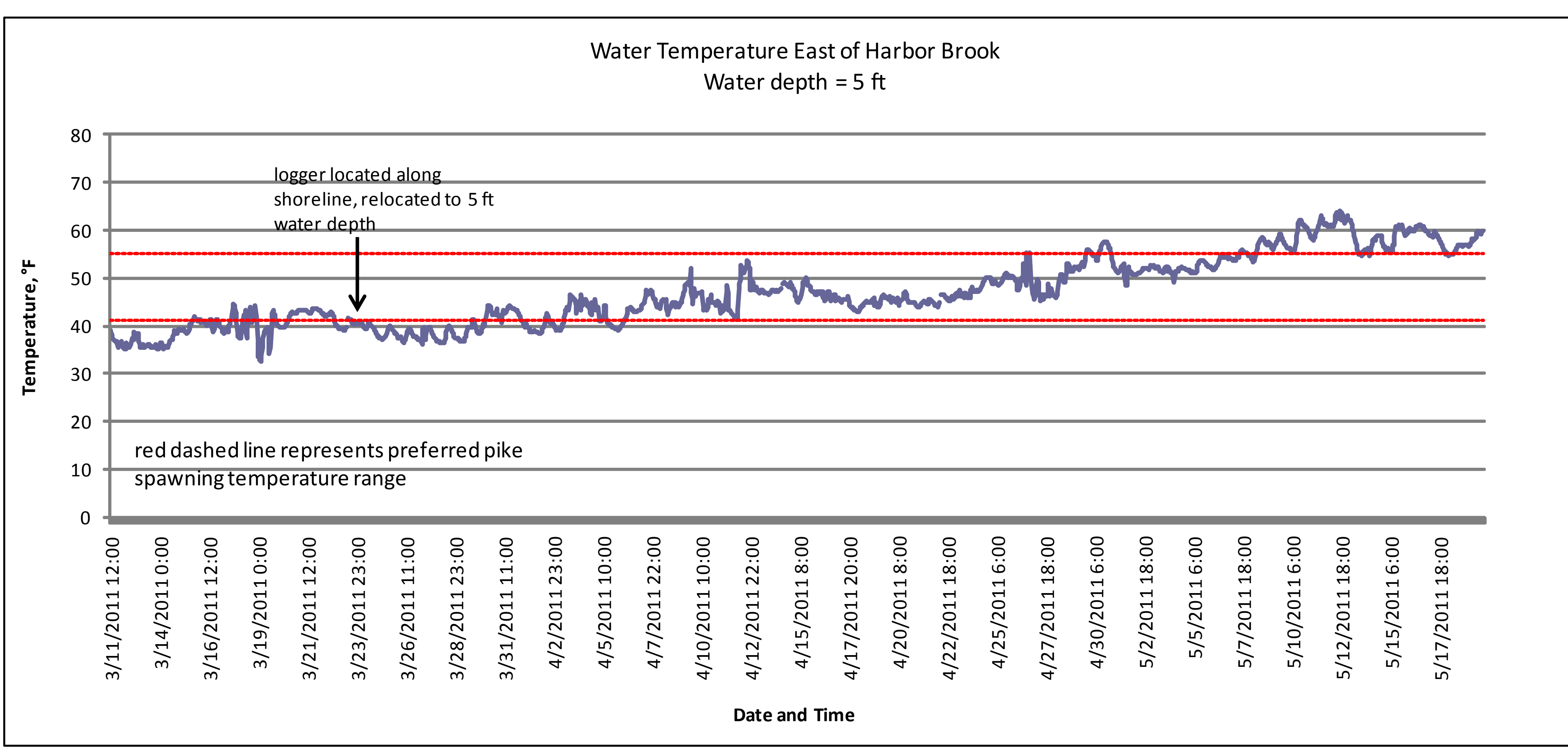

FIGURE K-9

Honeywell

Onondaga Lake
Syracuse, New York

Water Temperature in Littoral Zone
East of Harbor Brook

PARSONS
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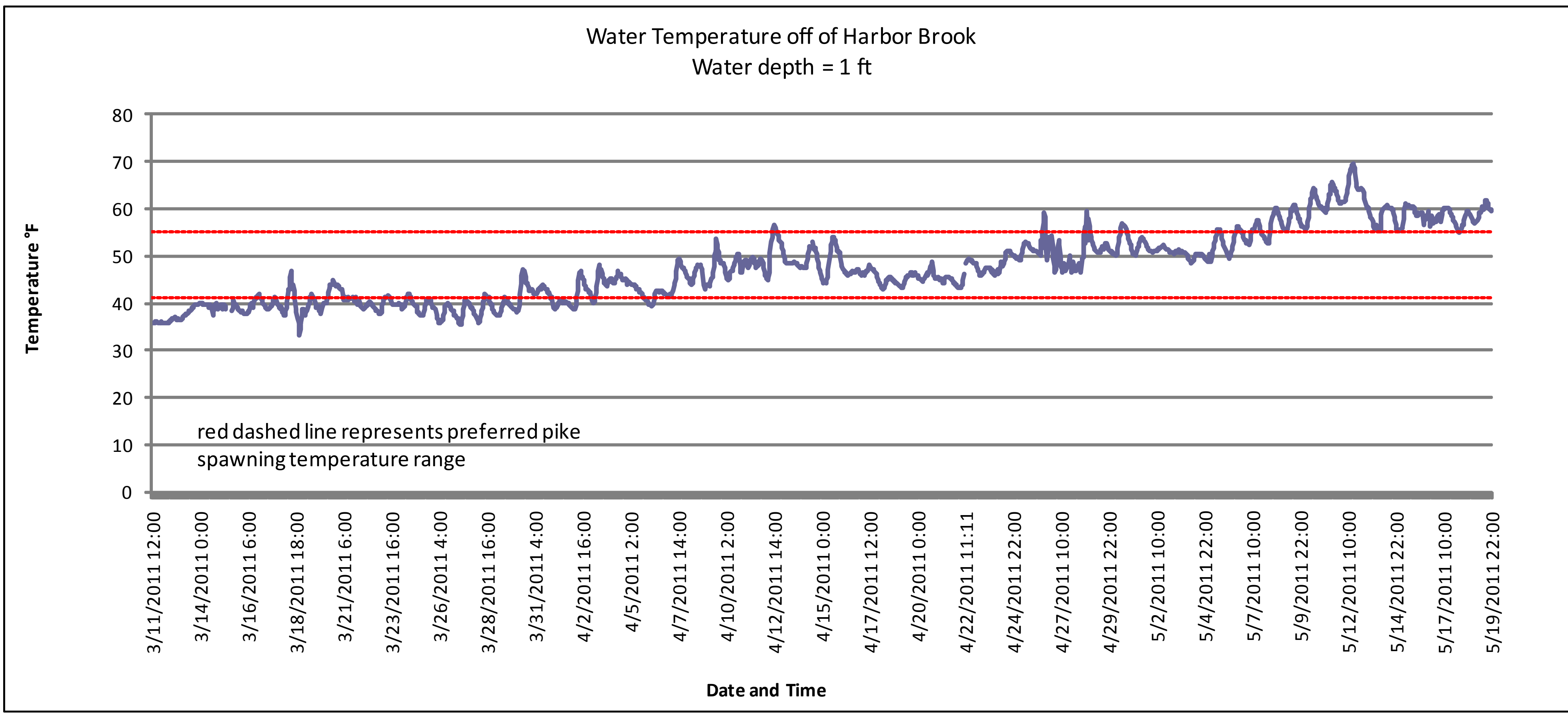

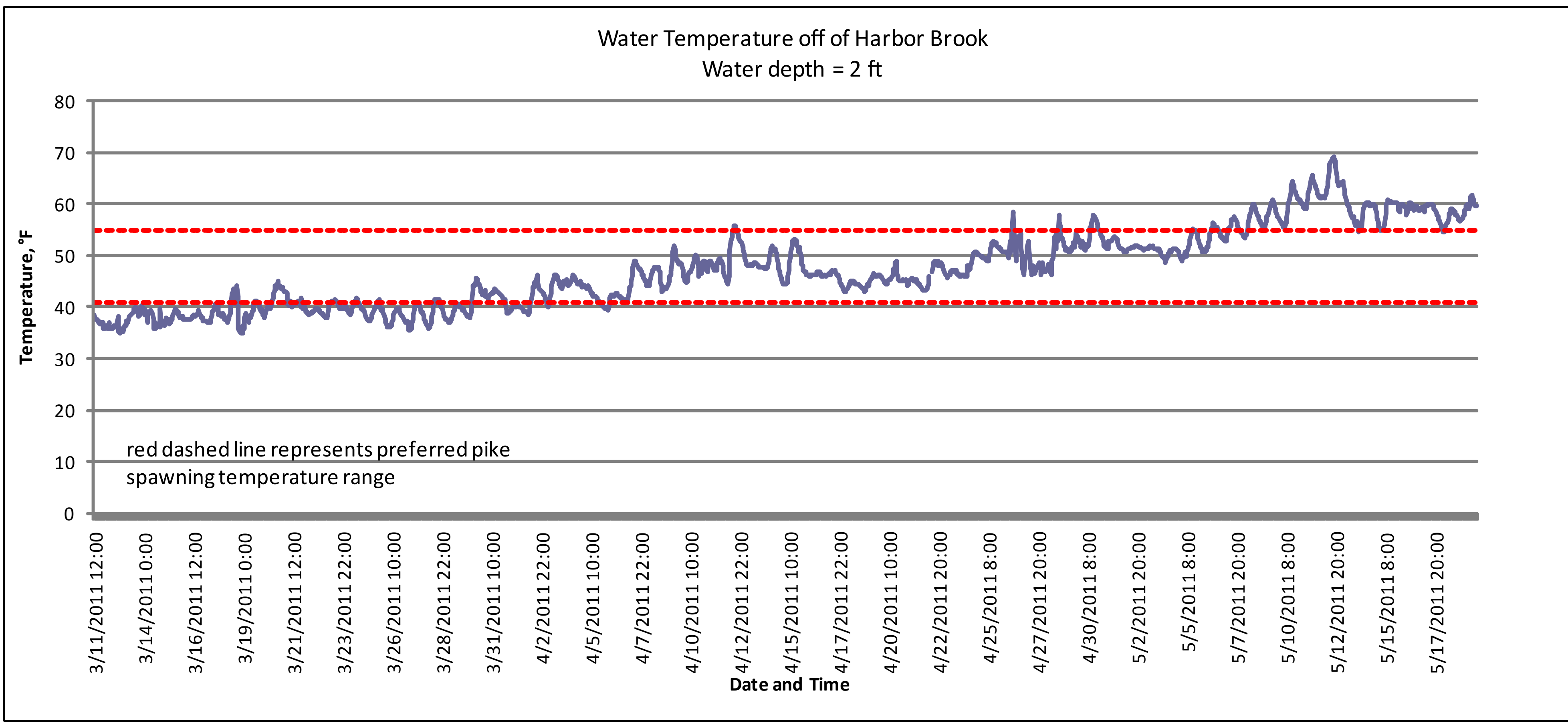

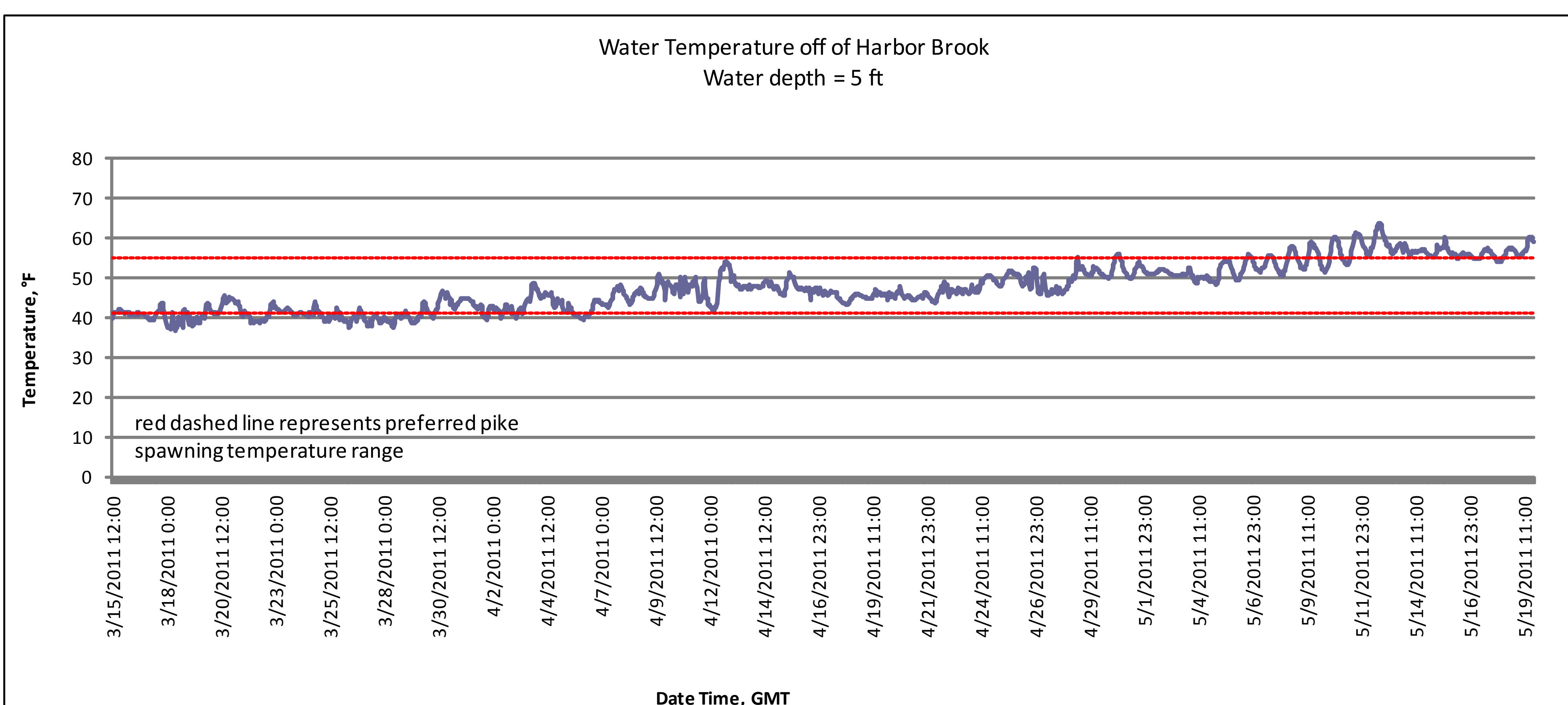

FIGURE K-10

Honeywell

Onondaga Lake
Syracuse, New York

Water Temperature in Littoral Zone
Off Harbor Brook

PARSONS
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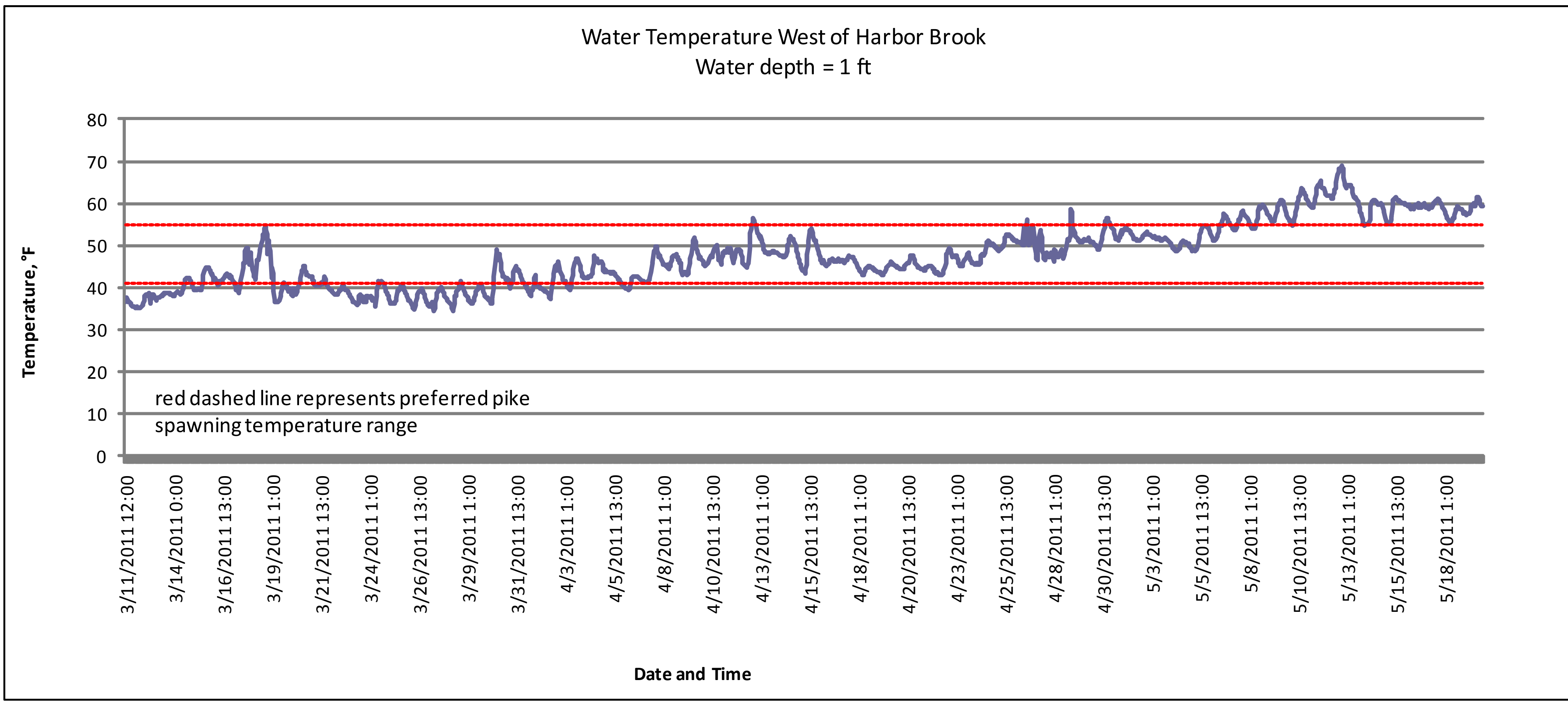
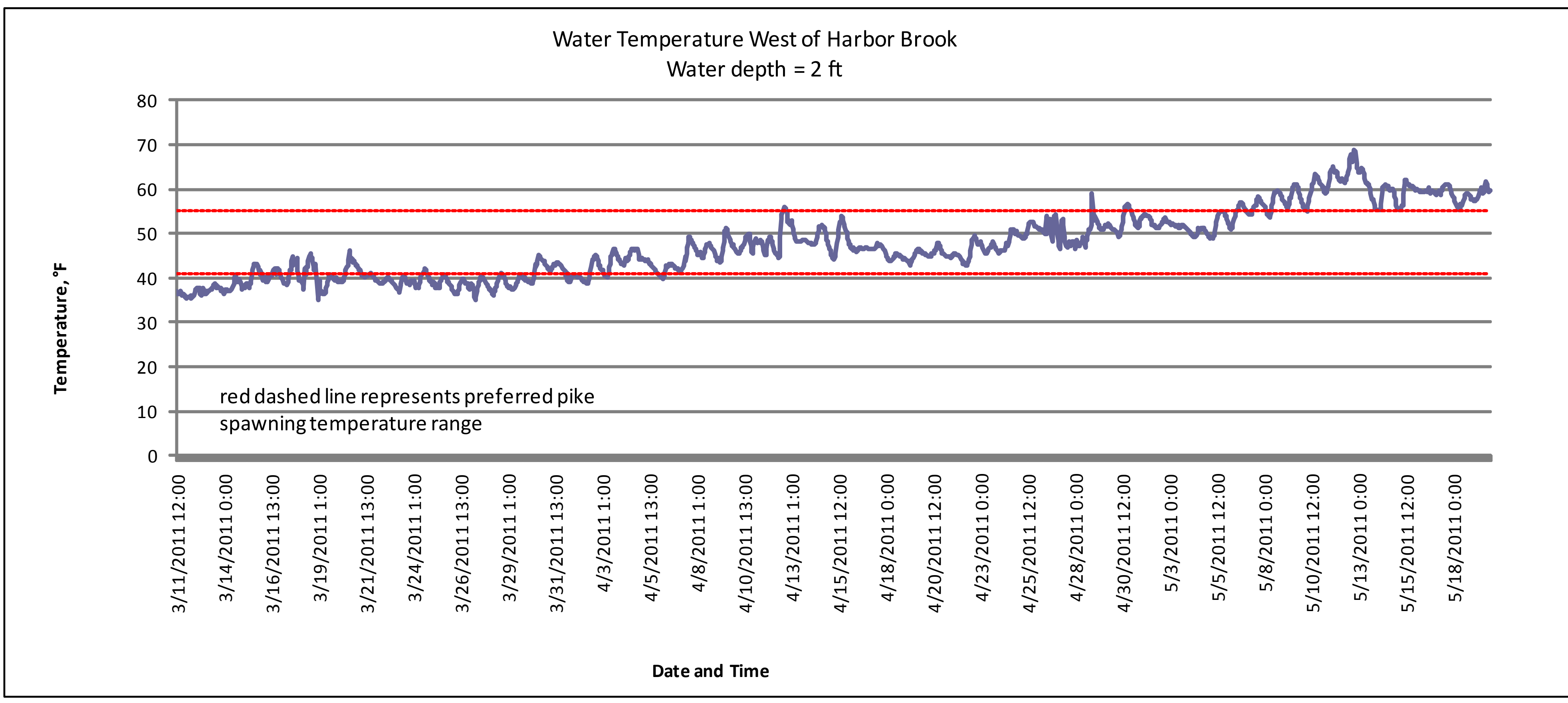




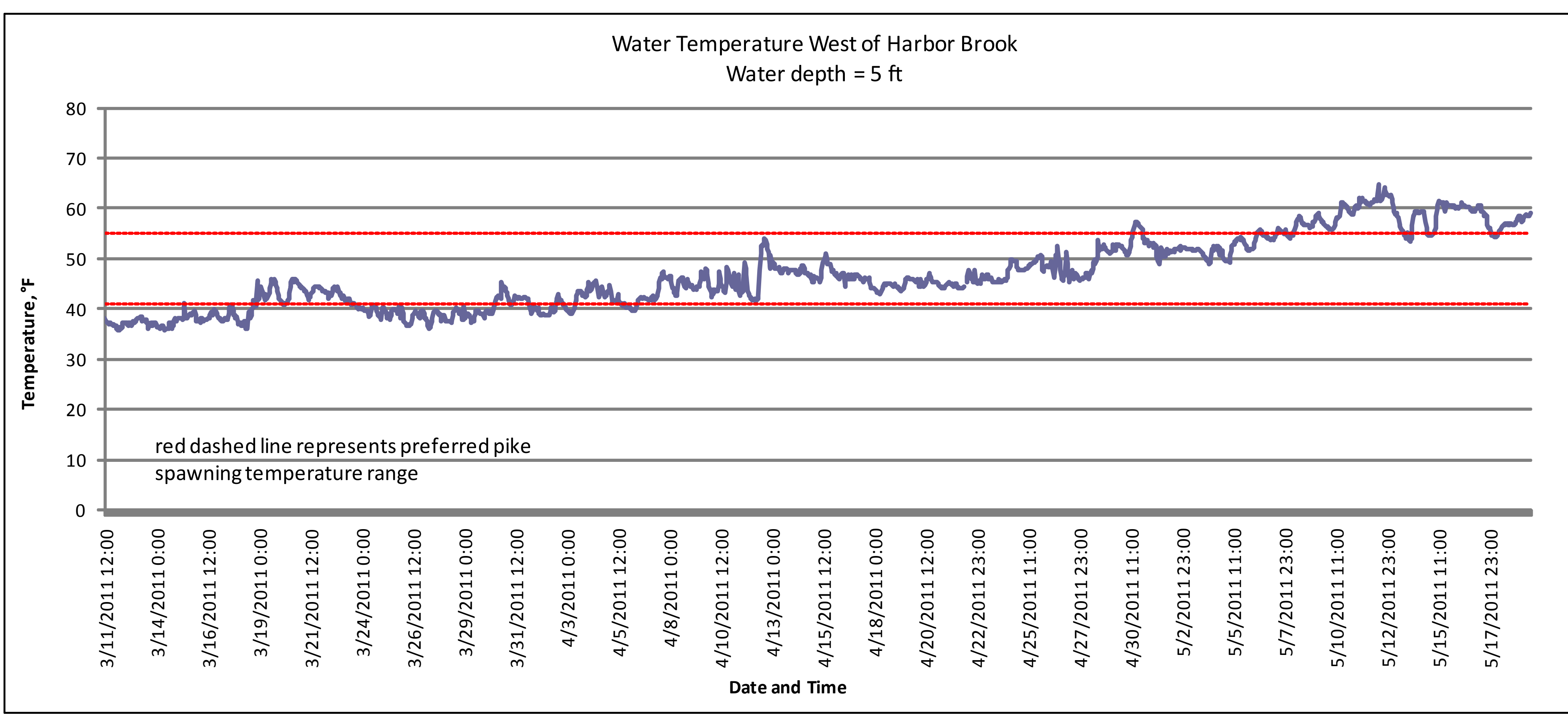
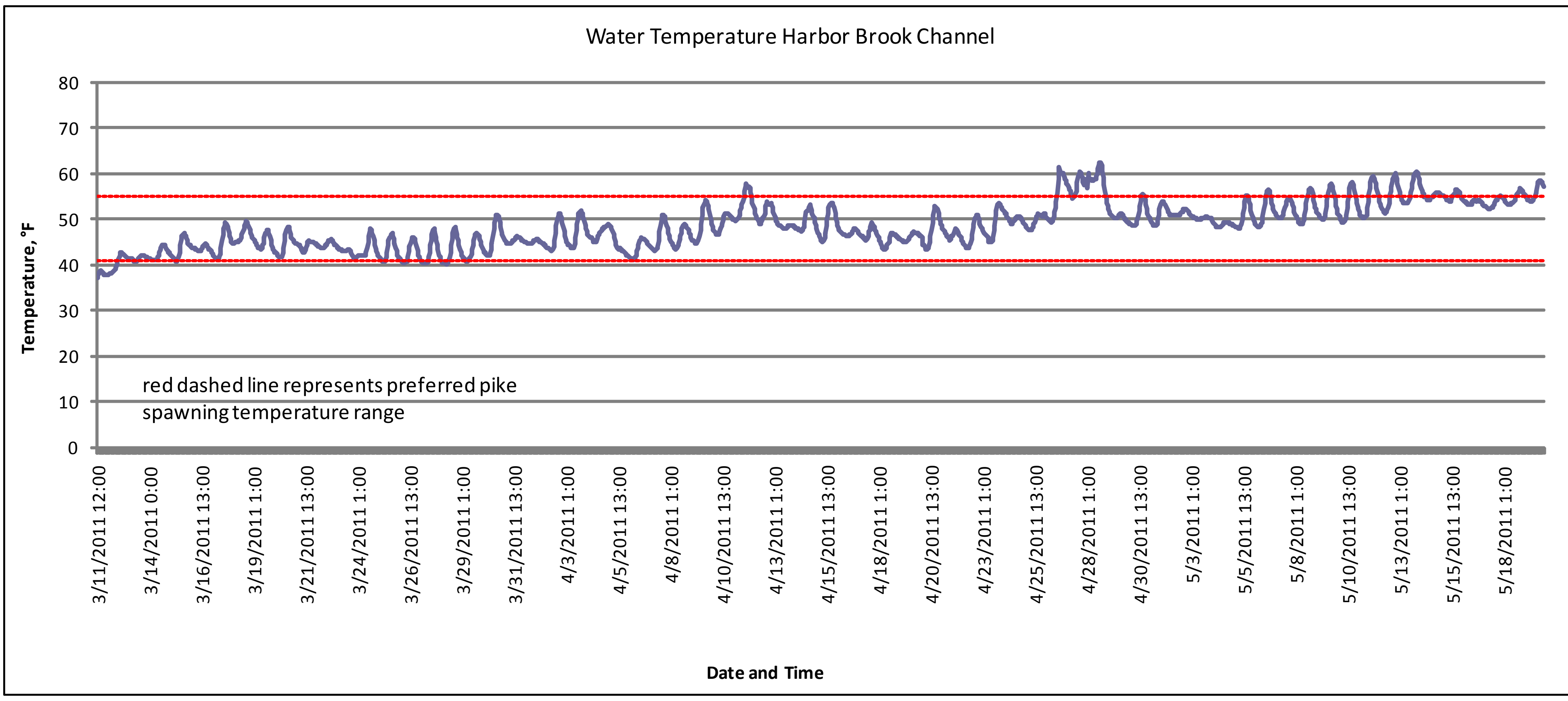


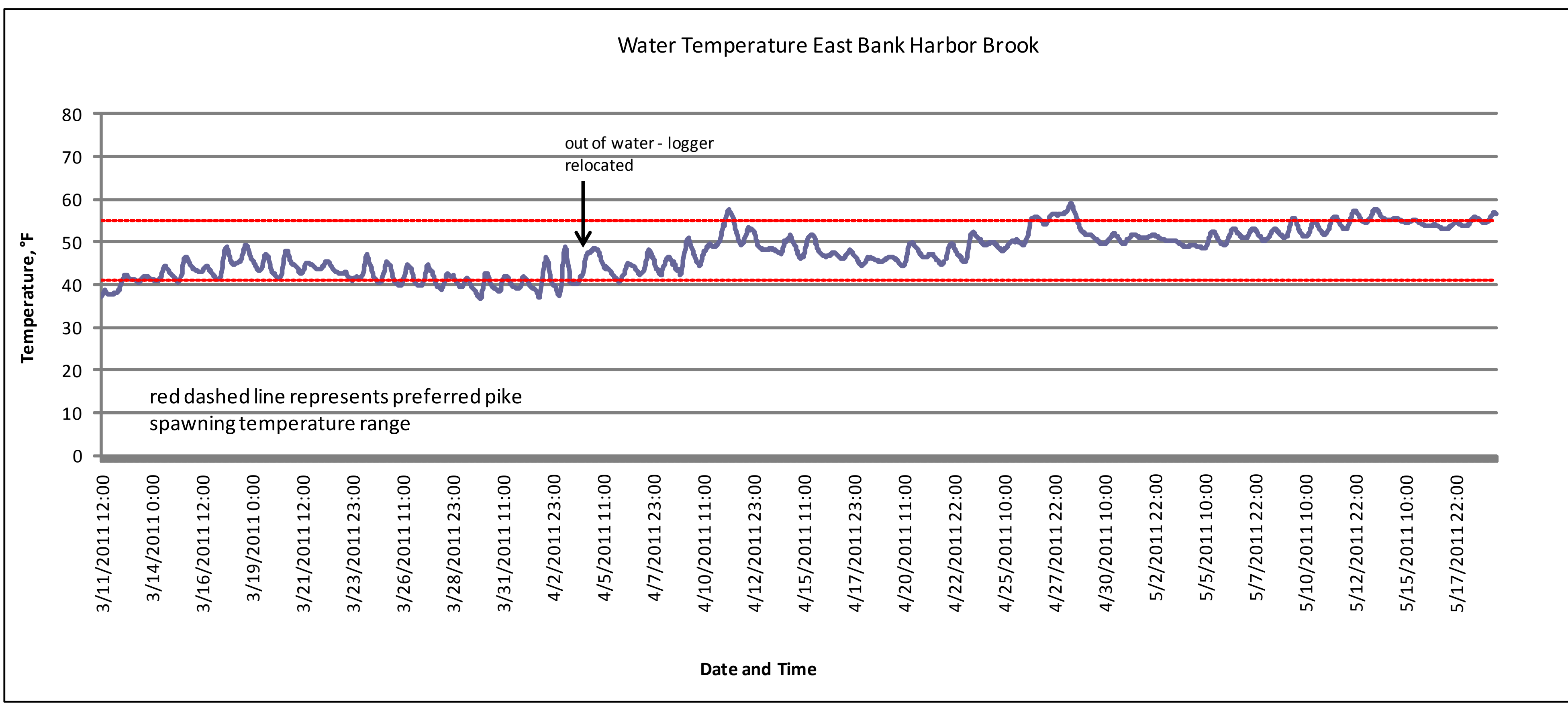
FIGURE K-11

Honeywell | Onondaga Lake Syracuse, New York

Water Temperature in Littoral Zone West of Harbor Brook

PARSONS
301 Plainfield Rd, Suite 350, Syracuse, NY, 13212, Phone 315-451-9560





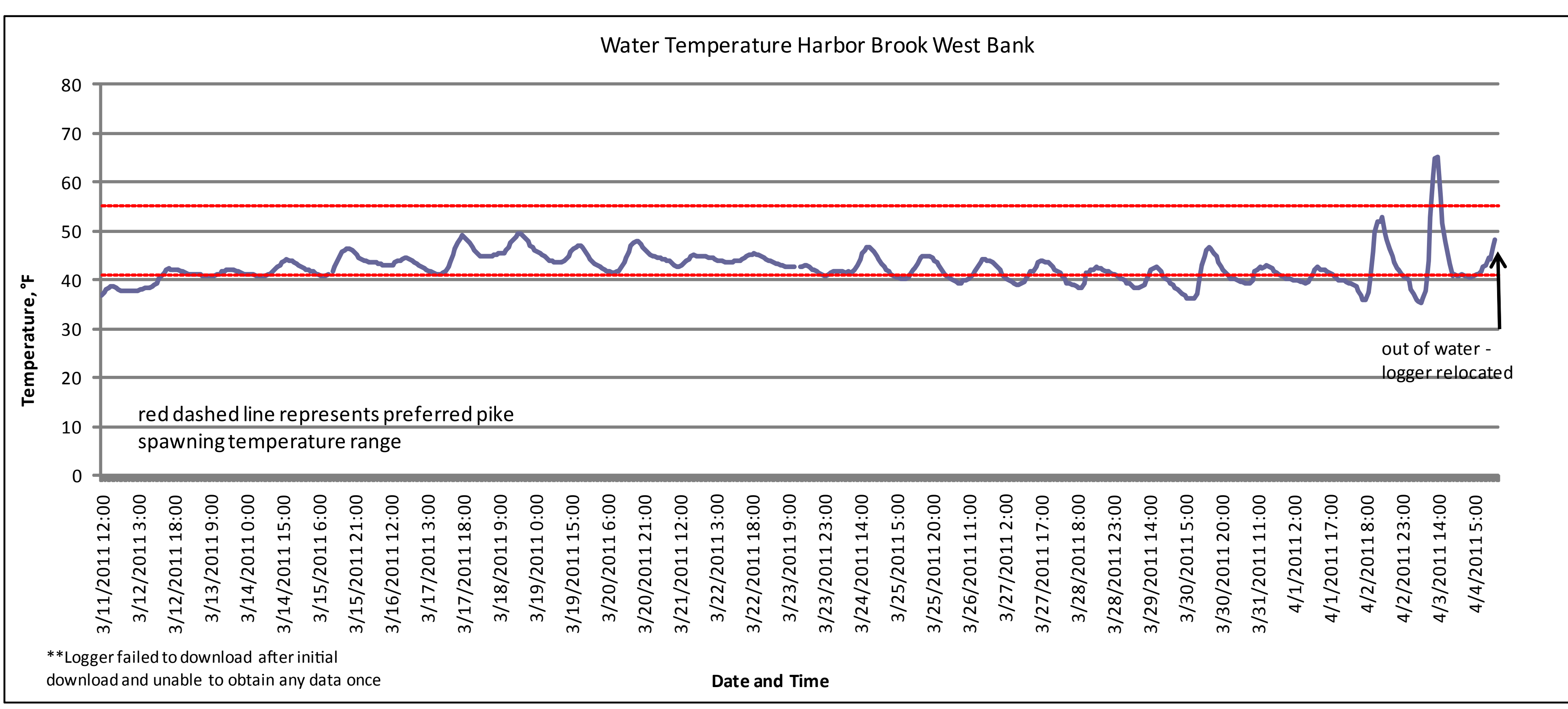


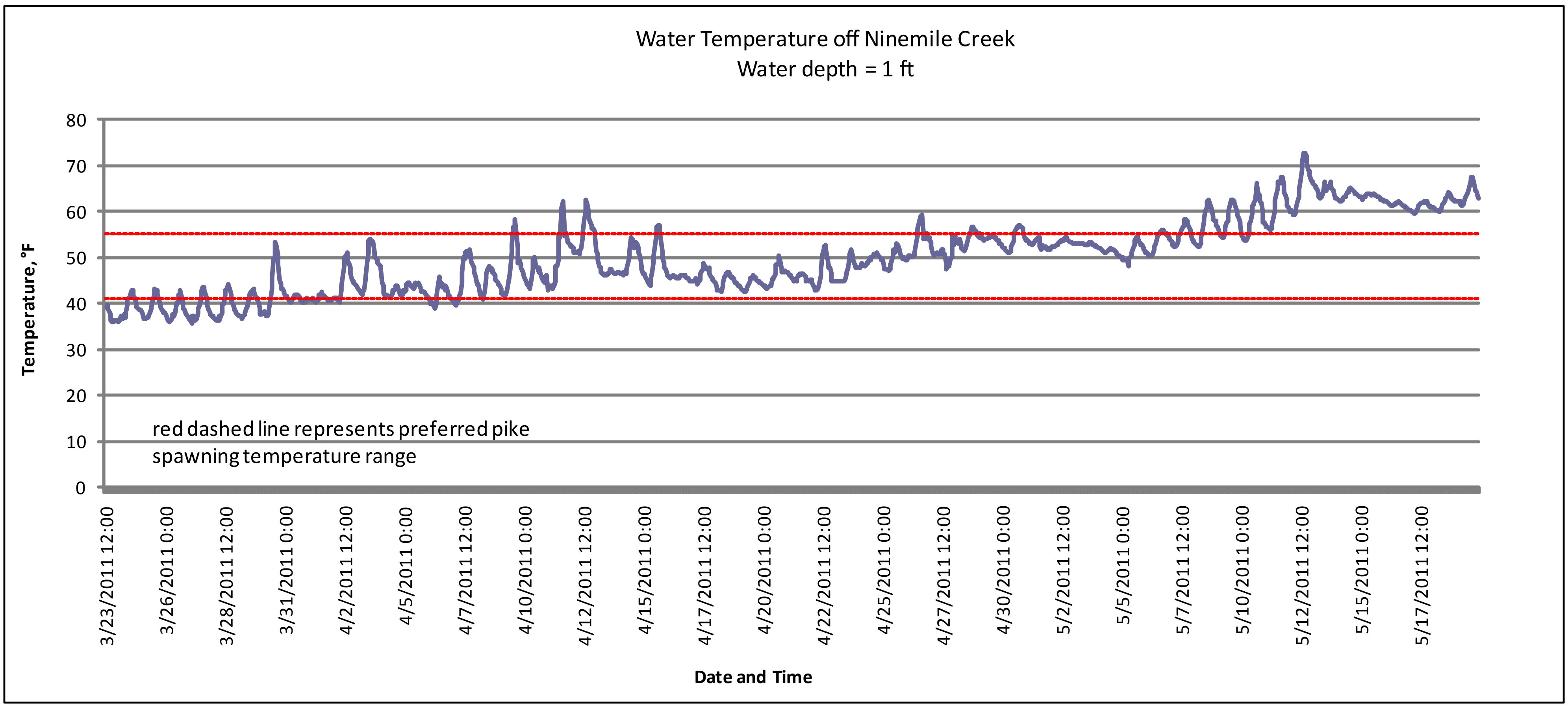
FIGURE K-12

Honeywell

Onondaga Lake
Syracuse, New York

Water Temperature in Harbor Brook and Along Banks

PARSONS
301 Plainfield Rd, Suite 350, Syracuse, NY, 13212, Phone 315-451-9560



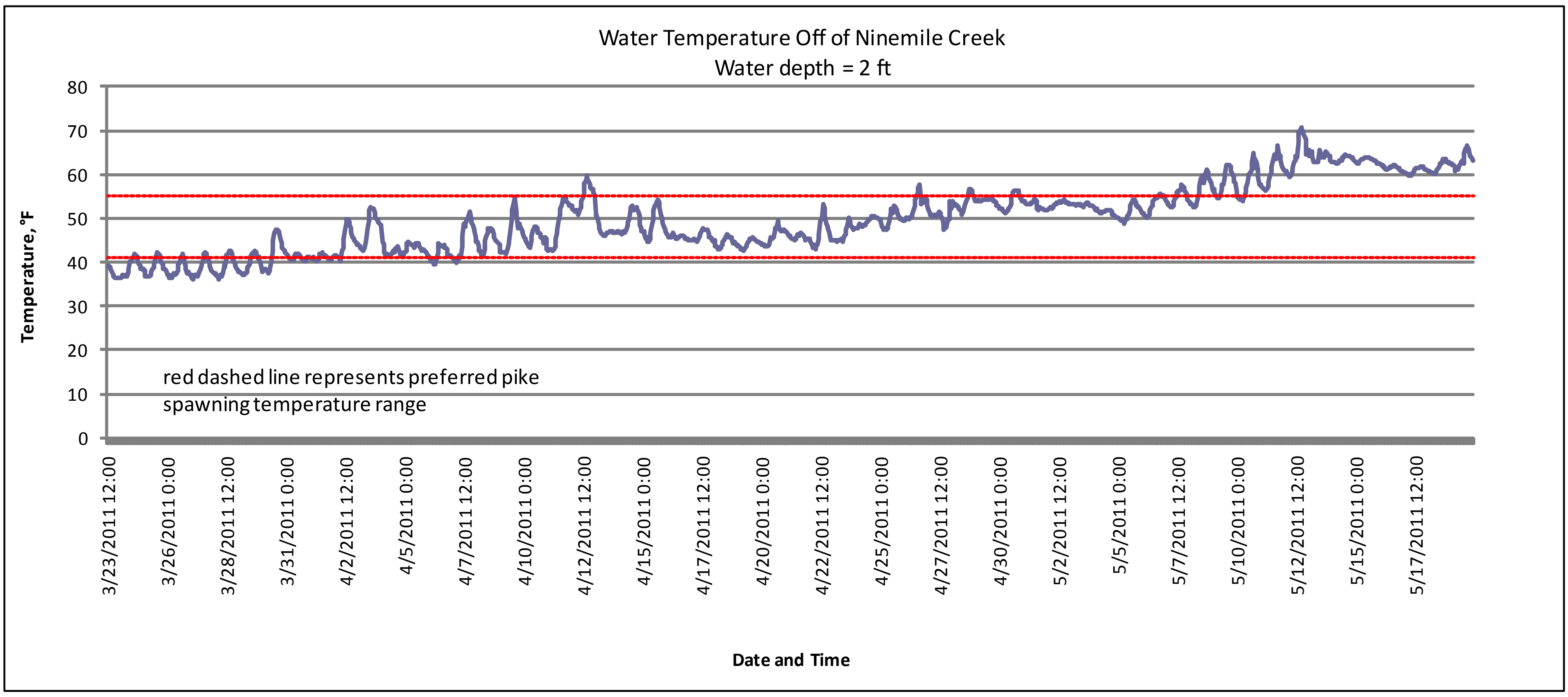


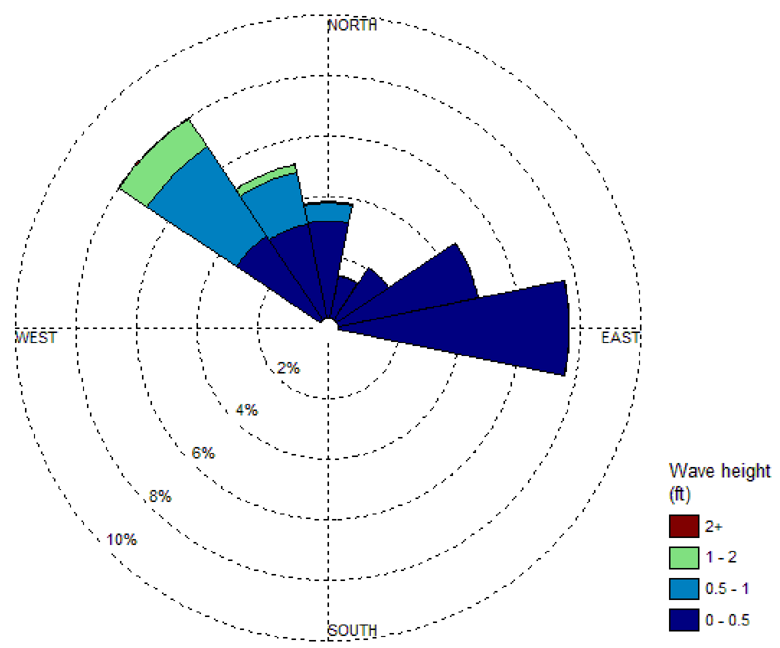
FIGURE K-13

Honeywell

Onondaga Lake
Syracuse, New York

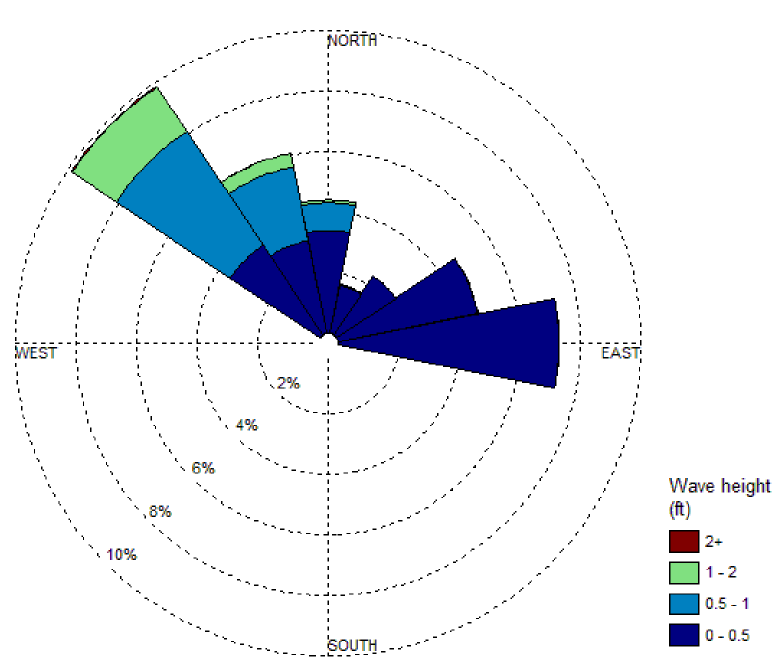
Water Temperature in Littoral Zone
Off Nine Mile Creek

PARSONS
301 Plainfield Rd, Suite 350, Syracuse, NY, 13212, Phone 315-451-9560



note: no waves are generated at this location when the wind originates between 90° and 300°.

Significant Wave Height for Outboard Area – All Months



note: no waves are generated at this location when the wind originates between 90° and 300°.

Significant Wave Height for Outboard Area – March 15 through May 15

FIGURE K-14

Honeywell

Onondaga Lake
Syracuse, New York

Wave Analysis for Outboard Area

PARSONS
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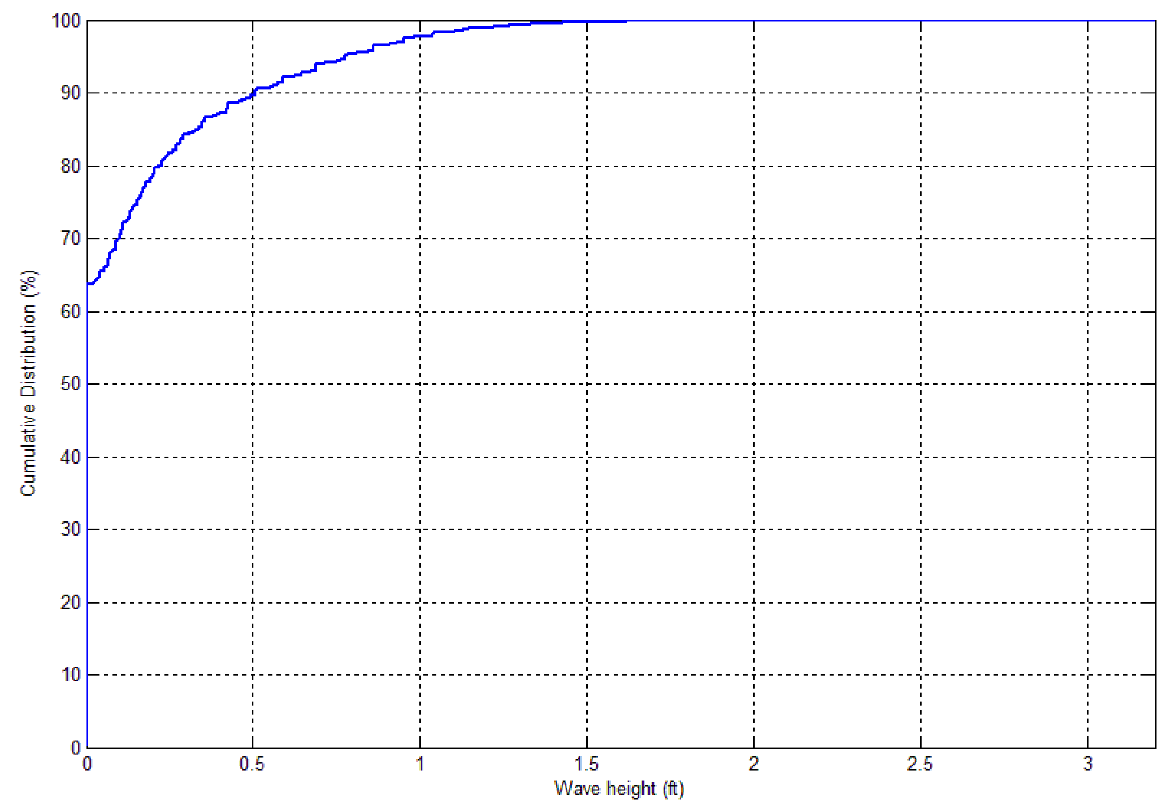


note: no waves are generated at this location when the wind originates between 90° and 300°.

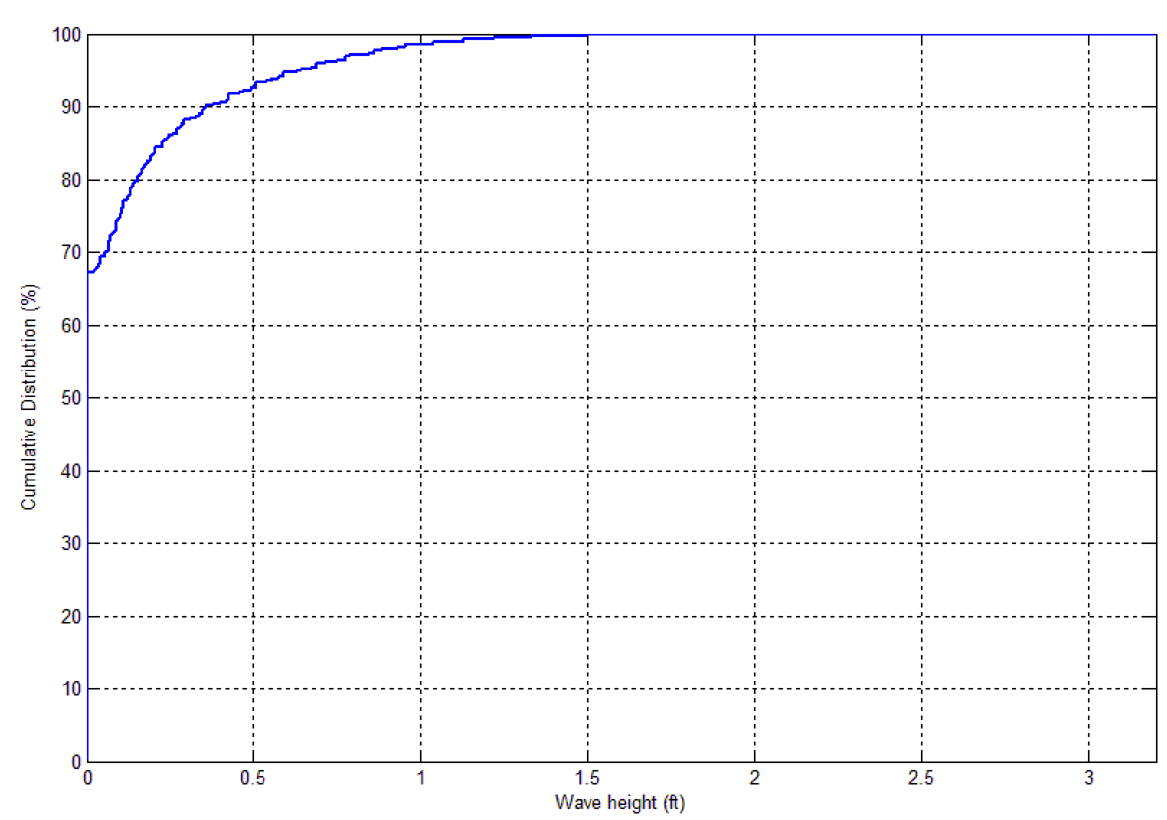
ANCHOR QEA

Figure 4

Cumulative Frequency Distribution of Computed Significant Wave Height for Outboard Area – March 15 through May 15

Wave Analysis for Onondaga Lake Outboard Area

Honeywell



note: no waves are generated at this location when the wind originates between 90° and 300°.

ANCHOR QEA

Figure 3

Cumulative Frequency Distribution of Computed Significant Wave Height for Outboard Area – All Months

Wave Analysis for Onondaga Lake Outboard Area

Honeywell

FIGURE K-15

Honeywell

Onondaga Lake
Syracuse, New York

Wave Analysis for Outboard Area

PARSONS

301 Plainfield Rd, Suite 350, Syracuse, NY, 13212, Phone 315-451-9560

TABLES

1) Mean daily discharges were used in the analysis and a normal distribution was assumed for exceedance calculations.
2) 40 water years (1971-2010) are included in the analysis.
3) The minimum, average and maximum values are from daily values for the indicated period and are not statistics of the exceedance probabilities.

Harbor Brook at Hiawatha Blvd., USGS Gage 04240105

Exceedance Prob. (%)	Discharge (cfs)												
	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sep.	Avg.
5	19	23	32	28	31	59	53	27	22	23	16	17	29
10	13	16	23	20	22	42	38	21	16	15	12	11	21
20	8.6	11	15	14	16	28	29	16	11	9.4	8.6	8.4	15
30	7.1	8.8	11	12	13	22	23	13	9.3	7.4	7.1	6.9	12
40	6.1	7.4	9.1	10	11	18	19	11	8.1	6.4	6.2	5.9	9.9
50	5.2	6.5	7.9	8.8	9.3	15	16	9.7	7.1	5.7	5.5	5.2	8.5
60	4.7	5.7	6.9	7.6	8.2	13	14	8.7	6.5	5.2	4.9	4.7	7.5
70	4.3	5.0	6.0	6.4	7.5	11	12	7.9	6.0	4.8	4.3	4.2	6.6
80	4.0	4.5	5.4	5.5	6.8	9.7	9.9	7.3	5.5	4.5	3.9	3.8	5.9
90	3.6	4.0	4.7	4.8	5.6	7.6	8.6	6.3	4.9	3.8	3.3	3.4	5.1
95	3.3	3.7	4.3	4.5	5.2	6.2	7.3	5.5	4.3	3.4	3.0	3.1	4.5
Min.	1.3	1.3	2.8	2.9	4.0	4.7	4.5	3.6	2.3	2.5	2.4	2.2	1.3
Avg.	8.3	9.0	12	12	13	22	22	12	10	9.1	7.6	7.6	12
Max.	430	230	220	280	160	570	410	130	230	350	190	320	570

TABLE K-1

Honeywell

Onondaga Lake
Syracuse, New York

Annual Flow Evaluation Data Summary
Harbor Brook

PARSONS
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	DO Reading (mg/L)					
	3/15/2011	3/23/2011	4/4/2011	4/7/2011	4/14/2011	4/22/2011
HB-West1	11.28	12.47	11.37		12.71	12.27
HB-West2	12.39	12.46	11.27		11.9	12.18
HB-West5	12.36	12.73	11.67		12.15	12.14
HB-Cent1	12.68	12	11.42		12.09	12.6
HB-Cent2	12.7	11.98	11.87		12.02	12.25
HB-Cent5	12.47	12.3	10.95		11.6	12.16
HB-East1	9.19	11.44	11.86		11.44	12.26
HB-East2	no download	11.29	11.93		11.27	12.2
HB-East5	12.24	relocated	11.54		11.45	11.84
HB-BankEast	12.5	11.32	relocated		12.15	11.91
HB-BandWest	12.18	11.27	relocated		12.2	12.44
HB-Channel	12.31	12.5	11.18		12.39	12.79
NMC-1				12.13	11.29	11.75
NMC-2				12.18	11.52	11.75

TABLE K-2

Honeywell

Onondaga Lake
Syracuse, New York

Dissolved Oxygen Data Summary
Harbor Brook

PARSONS
301 Plainfield Rd, Suite 350, Syracuse, NY, 13212, Phone 315-451-9560