ADDENDUM 2 (2013) TO
WORK PLAN FOR PILOT TEST TO ADD NITRATE TO THE HYPOLIMNION OF ONONDAGA LAKE

Prepared for:

Honeywell

301 Plainfield Road, Suite 330
Syracuse, NY 13212

Prepared by:

PARSONS

301 Plainfield Road, Suite 350
Syracuse, New York 13212

JUNE 2013

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ACRONYMS

DUSR	Data Usability Summary Report
Hg	mercury
ISUS	*in situ* ultraviolet spectrophotometer
mg/L	milligrams per liter
ng/L	nanograms per liter
NYSDEC	New York State Department of Environmental Conservation
QAPP	quality assurance project plan
SMU	Sediment Management Unit
SOP	standard operating procedure
UFI	Upstate Freshwater Institute
USEPA	United States Environmental Protection Agency

EXECUTIVE SUMMARY

This second addendum to the Work Plan for Pilot Test to Add Nitrate to the Hypolimnion of Onondaga Lake (Parsons and Upstate Freshwater Institute (UFI), 2011) summarizes plans for the continuation of nitrate addition during 2013, the third year of the three-year nitrate addition pilot test being conducted in Onondaga Lake on behalf of Honeywell International. Nitrate addition objectives, unchanged for 2013, are to maintain nitrate concentrations in the Onondaga Lake hypolimnion at levels sufficient to inhibit release of methylmercury from underlying sediment to the water column where mercury can reach fish. Nitrate was added in 2011 and 2012 at three locations as planned and successfully spread throughout lower waters in the middle of Onondaga Lake resulting in virtually no release of methylmercury from lake sediment. Nitrate addition efforts during 2013 (as in 2012) will also include deep basin (Sediment Management Unit 8 or SMU 8) surface water monitoring, the scope for which is very similar to the 2012 monitoring scope. The objectives for surface water monitoring as discussed in the draft Onondaga Lake Maintenance and Monitoring Scoping Document (Parsons, Anchor QEA and Exponent, 2012) are to assess remedy effectiveness based on relevant preliminary remediation goals presented in the lake bottom Record of Decision (NYSDEC and USEPA, 2005) and to provide information supporting long-term lake recovery. Surface water monitoring is also needed in SMU 8 to assess the effectiveness of nitrate addition.

The 2013 work scope for nitrate addition is the same as the scope completed in 2011 and 2012 (Parsons and UFI, 2011; and Parsons and UFI, 2012a). Additions of nitrate are anticipated to start in late June or early July 2013, proceed at an average pace of two to three daily applications per week, and be completed by early-to-mid October depending on lake conditions.

The 2013 work scope for surface water monitoring is a continuation of baseline surface water monitoring conducted in SMU 8 on behalf of Honeywell from 2008 through 2011 and surface water monitoring conducted in 2012 as part of the nitrate addition pilot test. Laboratory analyses of surface water samples collected at the South Deep location in 2013 will include measurements of low-level total mercury, low-level methylmercury and other water column parameters important to assess the effectiveness of nitrate addition. Biota (*i.e.,* zooplankton) monitoring in SMU 8 will be conducted in 2013 as part of the remedial goal monitoring work scope not included herein.

Field and laboratory work efforts for nitrate addition monitoring will be based on standardized procedures and quality assurance measures contained in the Quality Assurance Project Plan (QAPP) for Onondaga Lake efforts (Parsons, UFI and Anchor QEA, 2012) consistent with procedures implemented in prior years. The only QAPP worksheet unique to 2013 nitrate addition monitoring is Worksheet 20 (Table 3 herein).

SECTION 1

INTRODUCTION

The remedy for Onondaga Lake is being completed in accordance with a Consent Decree (United States District Court, Northern District of New York, 2007; 89-CV-815) between Honeywell and the New York State Department of Environmental Conservation (NYSDEC). The nitrate addition pilot test is part of the lake remedy as specified in the Statement of Work (Appendix C of the Consent Decree) and is being conducted in the hypolimnion of Onondaga Lake as a three-year pilot test from 2011 through 2013.

This second addendum to Honeywell's 2011 Work Plan for the Nitrate Addition Pilot Test (Parsons and UFI, 2011) presents changes to the work scope for Honeywell's 2013 nitrate addition pilot test effort. Contents of this work plan addendum are consistent with objectives, program elements, and data uses outlined in the 2011 work plan for the nitrate addition pilot test and with objectives and elements for surface water remedial goal monitoring presented in the Onondaga Lake Monitoring and Monitoring Scoping Document (Parsons, Anchor QEA and Exponent, draft under review),

This work plan addendum for 2013 has been developed in part based on results from the successful 2011 and 2012 nitrate addition pilot test efforts. Methylmercury concentrations measured in deep waters during 2011 and 2012 were lower than during any recent prior year as a result of adding nitrate (Parsons and UFI, 2012b; and Parsons and UFI, 2013). Objectives, data uses, and rationale for modifying the 2012 work scope are presented in this first section of the work plan addendum. Work scope modifications for 2013 are changes in the monitoring effort presented in Section 2. Sampling and analysis work proposed in this work plan addendum for 2013 will employ the QAPP developed for the lake remediation effort (Parsons, Anchor QEA and UFI, 2012) consistent with procedures employed during the 2008-2011 Onondaga Lake baseline monitoring work and the 2012 Onondaga Lake nitrate addition pilot test work completed on behalf of Honeywell.

1.1 OBJECTIVES

Onondaga Lake becomes thermally stratified each year typically beginning in late May and continuing through mid-to-late October. Oxygen and nitrate concentrations in the hypolimnion decline gradually over time as the lake remains stratified. When concentrations of oxygen become depleted and nitrate-nitrogen concentrations decline to below 0.5 to 1.0 milligrams per liter (mg/L), sediments can release methylmercury to the water column and inorganic mercury in the water column can become methylated.

The objective of adding nitrate is to demonstrate the ability to maintain nitrate concentrations in the hypolimnion of Onondaga Lake (i.e., waters deeper than 30 ft. that stratify each summer) at levels sufficient to inhibit release of methylmercury from lake sediment to overlying waters while the lake is stratified (typically from late May until mid-to-late October).

The objectives of surface water monitoring in Onondaga Lake are to:

- Assess lake remedy effectiveness based on relevant preliminary remediation goals presented in the lake bottom Record of Decision
- Provide information supporting long-term lake recovery
- Assess the effectiveness of nitrate addition

Mercury is the only Onondaga Lake chemical parameter of interest for which surface water concentrations have consistently exceeded applicable standards and guidance values. As a result, mercury is the primary focus of remedial goal surface water monitoring in Onondaga Lake, and the only water quality parameter with a remedial goal that will be monitored in the deep water zone (SMU 8) as part of this pilot test. Additional surface water monitoring related directly to lake dredging activities will be conducted in Onondaga Lake again during 2013 as described in the Water Quality Management and Monitoring Plan (Anchor QEA and Parsons, 2012).

1.2 SUMMARY OF 2011 AND 2012 NITRATE ADDITION AND ASSOCIATED MONITORING RESULTS

Nitrate was added to the lower, stratified waters of Onondaga Lake as 40 single-day applications between June 30 and October 10, 2011 and as 37 single-day applications between July 3 and October 4, 2012. For each application of nitrate, a target dose of 4,800 gallons of liquid calcium nitrate solution was applied over a four to seven hour period directly to deep hypolimnion waters at one of three pre-determined locations. Typically, nitrate was applied at each of the three locations one day a week. One application location was in the northern half of Onondaga Lake, and the other two application locations were in the southern half of the lake.

Sufficient quantities of nitrate were added to and distributed naturally throughout the lower waters of Onondaga Lake in 2011 and 2012 to inhibit methylmercury release from sediment. The target minimum nitrate-nitrogen concentration throughout the lower hypolimnion while the lake was stratified was 1.0 mg/L based on data available prior to 2011. The target quantity of nitrate applied during each single-day application was 2.3 metric tons which equated to 4,800 gallons of the liquid calcium nitrate.

Monitoring of lake surface water during 2011 and 2012 nitrate addition efforts was based on 34 locations where water quality was monitored three times weekly for nitrate, sulfide, water temperature and specific conductivity at 0.25-meter water depth intervals. Mercury, nitrate, nitrite, ammonia, ferrous iron, and sulfide were also measured in water column samples collected on 24 and 22 different dates from late May or early June to late November in 2011 and 2012, respectively at the South Deep location. In addition during 2011, mercury analyses were conducted of water samples collected 22 times from late May to late November at the North Deep location and monthly at ten other locations. The highest methylmercury concentrations measured in the hypolimnion of Onondaga Lake during the first two years of nitrate addition were 0.44 nanograms per liter (ng/L) in 2011 and 0.23 ng/L in 2012. Both values were well below the peak Onondaga Lake hypolimnion methylmercury concentration in 2006 which exceeded 5 ng/L.

Recurring seasonal depletion of nitrate and increases in methylmercury concentrations in lower depths of SMU 8 were prevented during 2011 and 2012 as a result of nitrate additions (Figure 1). Methylmercury water concentrations in the lake hypolimnion were the lowest on record (Parsons and UFI, 2012). Higher ferrous iron (Fe^{2+}) concentrations measured in 2012 compared to 2010 and 2011 (e.g., 20-30 µg/L) are at the lower limit of what can be measured accurately with this analytical method and lower than concentrations measured during 2006. This ferrous iron analytical method is susceptible to false high results in the presence of high concentrations of ferric iron (Fe^{3+}). The plan for 2013 is to track implementation of the ferrous iron test procedure and results on a real-time basis.

1.3 WORK SCOPE MODIFICATIONS FOR 2013

Pilot test operations on the barge in 2013 are anticipated to be generally the same as in 2012 (Parsons and UFI, 2013).

Deep basin water quality conditions were very similar from 2008 through 2012 as summarized in Figure 1. This 2013 work plan addendum includes two modifications to the 2011-2012 monitoring scope. The two modifications for 2013 and rationale for the modifications are as follows:

- **Surface water sampling at South Deep at three to five water depths excluding the 10-meter water depth**

  Surface water sampling in 2012 included the 10-meter water depth as part of weekly sampling efforts in July, August, September, and October. However, nitrate has been and will continue in 2013 to be applied at water depths in the hypolimnion below the 14-meter water depth, and the 10-meter water depth is often at the base of the thermocline above the hypolimnion as shown with measurements recorded by the robotic buoy. Methylmercury concentrations at the 10-meter water depth did not change significantly over the course of monitoring. Measurements will be conducted again in 2013 at the 12-meter water depth in the upper hypolimnion above the water depth where nitrate is added.

- **Discontinue analyses of South Deep water samples for dissolved methane, sulfide, total inorganic carbon, dissolved organic carbon, and chloride**

  Dissolved methane has been detected in lower waters in prior summers; however, most detections have been at or just above reporting limits. Sulfide has not been significantly detected since 2006 and should be absent again in 2013 based on redox chemistry as long as nitrate is not completed depleted. Ferrous iron is a suitable indicator parameter for the redox sequence in lieu of dissolved methane and sulfide in case nitrate levels decline significantly below the project objective. Measurements of total inorganic carbon, dissolved organic carbon, and chloride data are being discontinued for 2013 given they are not related to nitrate addition efforts and are not needed for other purposes.

Nitrate water concentrations will be measured again during 2013 in Onondaga Lake three times weekly with the *in situ* ultraviolet spectrophotometer (ISUS) at 0.25-meter water depth intervals at each of 34 locations. If nitrate measurements during 2013 show significant concentrations below the nitrate objective of 1 milligram per liter (mg/L) as nitrogen in the hypolimnion at locations away from South Deep, then water samples and analyses for low-level total mercury and low-level methylmercury will be conducted in the vicinity of that location until nitrate-nitrogen concentrations climb back to their intended levels of 1 mg/L or higher. Based on pilot test results to date, significant concentrations of nitrate-nitrogen below 1 mg/L that could result in a release of methylmercury from sediments are defined as concentrations below 0.7 mg/L on two consecutive monitoring days.

SECTION 2

2013 DEEP BASIN (SMU 8) SURFACE WATER MONITORING AND SEDIMENT TRAP DEPLOYMENTS

Surface water samples for laboratory analyses will be collected at South Deep at the depths and frequencies specified in Table 1 consistent with samples collected at South Deep in 2011 and 2012 with the exception of the 10-meter water depth as discussed in Section 1. Analytes will be those pertinent to nitrate addition based on the sequence of electron acceptor reduction from oxygen to nitrate to ferrous iron.

Spatially detailed monitoring of multiple parameters with the ISUS rapid profiling instrument will be conducted weekly at the same 34 locations monitored in 2011 and 2012. Field samples and quality control samples for laboratory analyses of water samples are listed in Tables 2 and 3.

Consistent with lake monitoring efforts conducted on behalf of Honeywell since 2008, *in situ* robotic measurements of dissolved oxygen, temperature, specific conductance, pH, fluorometric chlorophyll, redox potential, and turbidity will be made daily from May through November 2013 at 1-meter water depth intervals from a buoy located at South Deep. Although these data will not be presented formally as part of the Honeywell monitoring program, the robotic data will be available online at www.ourlake.org within a few hours of data collection.

Sediment trap samples will be collected again during 2013 at South Deep consistent with UFI's sediment trap design and deployment protocols. A set of three traps will be deployed from May 20 to mid-October 2013 at the South Deep sampling location below the thermocline (at the 10-meter water depth). Sediment traps will generally be deployed for seven-day intervals. As during 2012, low-level mercury measurements of sediment trap slurry solids will be made for seven-day composite samples collected every other week except during September and October 2013 prior to fall turnover when sediment trap solids will be measured weekly for low-level mercury and total solids.

Health and safety, quality assurance, data validation, data management, and reporting for 2013 will be consistent with 2011 and 2012 nitrate addition efforts. Results will be reviewed with NYSDEC as nitrate addition is being conducted. A report will be prepared that will summarize 2011 through 2013 nitrate addition results. Usability of 2013 laboratory surface water analytical results will be presented in a Data Usability Summary Report (DUSR) that will be presented as an appendix to the 2013 report.

SECTION 3

REFERENCES

Anchor QEA and Parsons. 2012. *Water Quality Management and Monitoring Plan* (for construction). Prepared for Honeywell. May 2012.

Heaney, S.I., and W. Davison. 1977. *The Determination of Ferrous Iron in Natural Waters with 2,2´-bipyridyl*. Limnol. Oceanogr. 22(4):753–759.

New York State Department of Environmental Conservation and United States Environmental Protection Agency Region 2. 2005. Record of Decision. *Onondaga Lake Bottom Subsite of the Onondaga Lake Superfund Site*. July 2005.

Parsons, Anchor QEA and Exponent. 2012. *Onondaga Lake Monitoring and Maintenance Scoping Document*. April 2012. Draft.

Parsons and Exponent. 2011. *Addendum 3 (2011) to Onondaga Lake Baseline Monitoring Book 1 Deep Basin Water and Zooplankton Monitoring Work Plan for 2008*. Prepared for Honeywell. May 2011.

Parsons, Exponent and Anchor QEA. 2012. *Onondaga Lake Baseline Monitoring Report for 2011.* Prepared for Honeywell. February 2012. Draft.

Parsons and UFI. 2011. *Work Plan for Pilot Test to Add Nitrate to the Hypolimnion of Onondaga Lake.* Prepared for Honeywell. March 2011.

Parsons and UFI. 2012a. *Addendum 1 (2012) to Work Plan for Pilot Test to Add Nitrate to the Hypolimnion of Onondaga Lake.* Prepared for Honeywell. May 2012.

Parsons and UFI. 2012b. *Report for the First Year of the Nitrate Addition Pilot Test in the Hypolimnion of Onondaga Lake (2011).* Prepared for Honeywell. August 2012.

Parsons and UFI. 2013. *Report for the Second Year of the Nitrate Addition Pilot Test (2012) in the Hypolimnion of Onondaga Lake.* Prepared for Honeywell. January 2013. Draft.

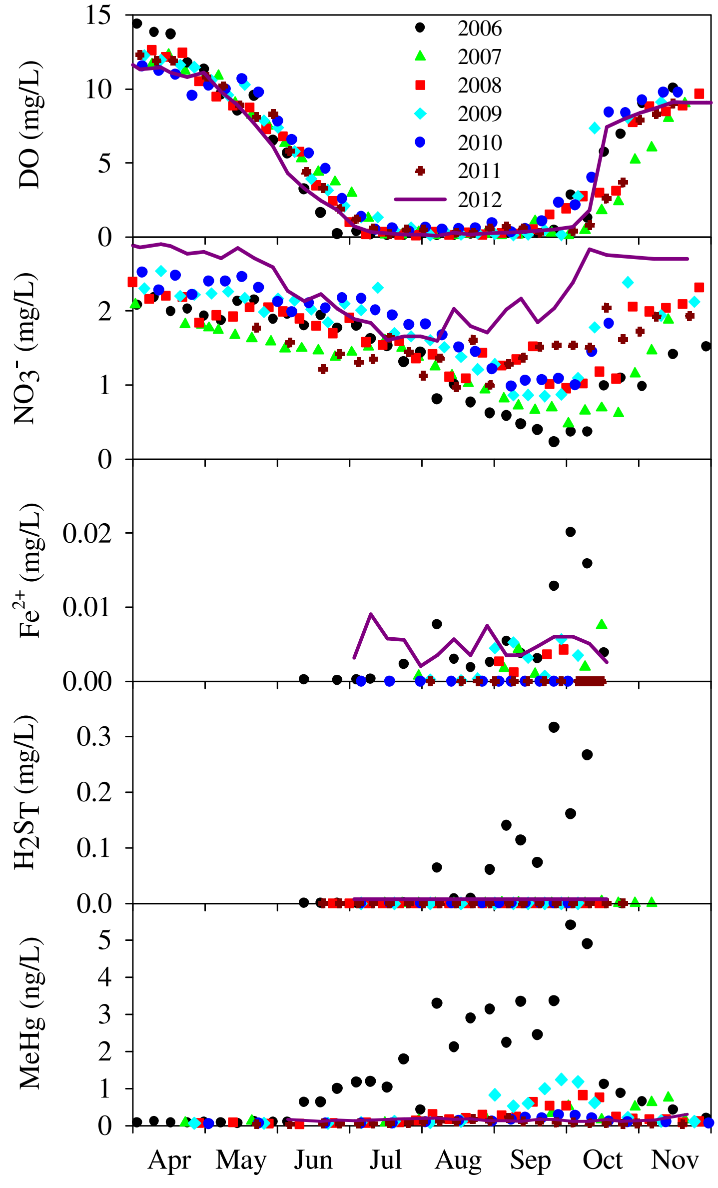
Parsons, UFI and Anchor QEA. 2012. *Quality Assurance Project Plan for Onondaga Lake Remedial Goal and Construction Water Quality Monitoring*. Prepared for Honeywell. December 2012. Draft.

United States District Court, Northern District of New York. 2007. State of New York and Denise M. Sheehan against Honeywell International, Inc. Consent Decree Between the State of New York and Honeywell International, Inc. Senior Judge Scullin. Dated October 11, 2006. Filed January 4, 2007.

FIGURES

FIGURE 1

VOLUME-WEIGHTED HYPOLIMNETIC AVERAGE WATER QUALITY CONDITIONS (10 TO 19-METER WATER DEPTHS)



DO – dissolved oxygen
Fe^{2+} - ferrous iron
MeHg – methylmercury
ng/L – nanograms per liter
NO_3^- - nitrate-nitrogen
H_2S_T – sulfide
mg/L – milligram per liter (mg/L)

TABLES

TABLE 1
WATER COLUMN SAMPLING SCHEDULE FOR 2013

Month	Water Column		
	Frequency	Sampling Date	South Deep Depths (m)
June	bi-weekly	5/20, 6/17 and 6/24	2, 12, 18
July	weekly	7/1, 7/8, 7/15, 7/22 and 7/29	2, 12, 16, 18
August	weekly	8/5, 8/12, 8/19, 8/26	2, 12, 16, 18
September	weekly	9/3, 9/9, 9/16, 9/23, and 9/30	2, 12, 14, 16, 18
October	weekly	10/7, 10/14, 10/21, and 10/28	2, 12, 14, 16, 18
November	bi-weekly	11/4, 11/18	2, 12, 18

Notes:

1. This sampling schedule is based on the lake being stratified from late May until the end of October and nitrate being added from late June until mid-October to maintain nitrate concentrations in the lake's hypolimnion above 1 mg/L. Weather and variations in lake inflows may result in changing the above dates. Any potential adjustments will be discussed with NYSDEC before being implemented.
2. Sediment traps will also be deployed and collected again consistent with 2011 and 2012 efforts.

TABLE 2
SPECIFICATIONS FOR 2013 LAKE MONITORING LABORATORY ANALYTES

Parameter	Method	South Deep Depths (m) and Dates	Total Number of Field Samples[x]
WATER			
Nitrate plus nitrite (NO_X)	EPA 353.2	See Table 1	96
Nitrite (NO_2^-)	EPA 353.2	See Table 1	96
Total ammonia ($T\text{-}NH_3$)	EPA 350.1	See Table 1	96
Calcium	SM 18-20 3111B	See Table 1	96
[+*]Total mercury	EPA 1631E	See Table 1	96
[+*]Total mercury, dissolved	EPA 1631E	2-meter water depth once in June, bi-weekly thereafter to November 4 plus the 14-meter water depth biweekly from September 9 to November 4.	17
[+*]Methylmercury	EPA 1630	See Table 1	96
Ferrous iron (Fe^{2+})	Heaney and Davison (1977)	Weekly at anoxic water depths during nitrate applications	63
Soluble reactive phosphorus	SM 18-20 4500-PE	Eleven dates from mid-June through October	44
SEDIMENT TRAP SOLIDS (10-meter water depth)			
Total suspended solids	SM 2540D	Every two weeks from May 20 to November 18 except weekly during September and October prior to lake turnover.	18
Total mercury	EPA 1631E	Every two weeks from May 20 to November 18 except weekly during September and October prior to lake turnover.	18

Notes for Table 2:

The timing of nitrate applications in 2013 is assumed for planning purposes to be the week of July 1 through the week of October 14 (16 weeks) based on typical summertime lake conditions and 2011-2012 nitrate addition results. Actual sampling may vary from planned sampling; NYSDEC will be notified accordingly.

[x] Numbers of field samples are based on dates and water depths presented in Table 1. See QAPP Worksheet #20 (Table 3) for total numbers of samples to be analyzed including quality assurance / quality control blank and duplicate samples.

[+] Total mercury and methylmercury analysis will be performed by Test America's North Canton, OH laboratory. All other laboratory analyses will be performed by UFI.

TABLE 3

QAPP WORKSHEET 20 – FIELD QUALITY CONTROL SAMPLE SUMMARY TABLE FOR 2013 SMU 8 SURFACE WATER MONITORING

Matrix	Analytical Group	Concen-tration Level	Analytical and Preparation SOP Reference[1]	No. of Field Samples for Laboratory Analyses[2]	No. of Field Duplicates	Inorganic No. of MS[3]	No. of Field Blanks[4]	No. of Equip. Blanks	No. of PT Samples	Total No. of Samples to Lab
Water	Nitrate + Nitrite as N (NO_x)	Low		96	23		23			142
Water	Nitrate as N (NO_2)	Low		96	23		23			142
Water	Ammonia as N (T-NH_3)	Low		96	23		23			142
Water	Calcium			96	23		23			142
Water	Ferrous iron	Low		63	18		18			99
Water	Soluble reactive phosphorus	Low		44	11		11			66
Water	Total mercury	Low		96	23		23	12		154
Water	Filtered mercury	Low		17	2		2	2		23
Water	Methylmercury	Low		96	23		23	12		154
Sediment trap solids	Total suspended solids	Moderate		18						18
Sediment trap solids	Total mercury	Low		18	5					23

Notes for Table 3:

1 See Worksheet 23 in the Quality Assurance Project Plan (Parsons, UFI and Anchor QEA, 2012, draft).
2 See Tables 1 and 2. Samples will be collected at different depths at the same location are counted separately.
3 Matrix spike and matrix spike duplicate samples will be prepared by the laboratory at a frequency of at least one pair per 20 samples.
4 Field blanks will consist of analyte-free water transported from the lab to the field and then poured into a second clean sample bottle prior to transport.