integral consulting inc.

TECHNICAL MEMORANDUM NO. 2

Results from the 2009 Field Sampling Program to Support the Ecological Risk Assessment of Koppers Pond Kentucky Avenue Wellfield Superfund Site Operable Unit 4 Horseheads, New York

Prepared for
Koppers Pond RI/FS Group

Prepared by
Integral Consulting Inc.
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June 10, 2010

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ACRONYMS AND ABBREVIATIONS

BOCES	Boards of Cooperative Educational Services
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cm	centimeters
CSLAP	New York Citizens Statewide Lake Assessment Program
DO	dissolved oxygen
ERA	ecological risk assessment
ERAGS	Ecological Risk Assessment Guidance for Superfund
EWB	Elmira Water Board
GPS	global positioning system
MDOC	Maine Department of Conservation
mg/L	milligrams per liter
mm	millimeter
mV	millivolt
NAD	North American Datum
NYNHP	New York Natural Heritage Program
NYSDEC	New York State Department of Environmental Conservation
ORP	oxidation-reduction potential
RI/FS	remedial investigation/feasibility study
RTE	rare, threatened, or endangered
SAV	submerged aquatic vegetation
S/m	siemens per meter
SP09	survey point for 2009
TDS	total dissolved solids
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency

1 INTRODUCTION

The Koppers Pond RI/FS Group (the Group) retained Cummings/Riter Consultants, Inc. and Integral Consulting Inc. (Integral) to conduct data gathering and evaluation activities for the performance of a Remedial Investigation and Feasibility Study (RI/FS) for Koppers Pond (Operable Unit 4, Kentucky Avenue Wellfield Superfund Site) in Horseheads, New York (the Site)[1]. The RI/FS is being performed in accordance with the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act, as amended (CERCLA or "Superfund"); the National Oil and Hazardous Substances Pollution Contingency Plan; and, more specifically, the Administrative Settlement Agreement and Order on Consent for Remedial Investigation/Feasibility Study, Index No. CERCLA-02-2006-2025 (Settlement Agreement), entered between the Group and the U.S. Environmental Protection Agency (USEPA) on September 28, 2006.

On behalf of the Group, Integral prepared this technical memorandum, which summarizes the results from the 2009 field sampling activities that were performed to support the Ecological Risk Assessment (ERA). This memorandum has been revised from the earlier version, which had been prepared by AMEC, in response to comments received from USEPA and the New York State Department of Environmental Conservation (NYSDEC) on March 18, 2010.

The ERA and related activities are designed to meet the requirements of Task VII of the Statement of Work appended to the Settlement Agreement (Section VII.B.2). Additional field sampling activities that may be needed to fill data gaps (e.g., sampling of reference ponds) are presented in the Ecological Risk Assessment Guidance under Superfund (ERAGS) Steps 3 through 5 Report, which was submitted to USEPA in February 2010.

1.1 SITE BACKGROUND

The Kentucky Avenue Wellfield Superfund Site is located within the Village of Horseheads and the Town of Horseheads in Chemung County, New York. The Kentucky Avenue Well is a municipal water supply well owned by the Elmira Water Board (EWB) that was used as part of the EWB system to furnish potable water to local communities. The Kentucky Avenue Well was closed in 1980 when it was found that the groundwater produced from this well contained

[1] The Respondents had contracted with AMEC Earth & Environmental, Inc. (AMEC) to perform the required human health and ecological risk assessment studies in support of the Koppers Pond RI/FS, and AMEC personnel conducted the risk assessment tasks over the 2007 through 2009 timeframe. In late 2009 and early 2010, however, several project team members moved from AMEC to other consulting firms, including Integral and ARCADIS. In order to maintain technical continuity on the project and reduce delays in the project schedule, the Respondents retained Integral to continue the ongoing risk assessment tasks for the Koppers Pond Site. The key project personnel who went to ARCADIS are available as consultants to Integral for this work.

trichloroethylene. In 1983, USEPA included the Kentucky Avenue Wellfield Site on the National Priorities List for response actions under CERCLA.

Beginning in the mid-1980s, several CERCLA response actions have been completed with respect to the Kentucky Avenue Wellfield Site:

- Operable Unit 1 involved initial Site investigations, identification of potentially impacted private wells, and connection of the affected residents to the public water supply system.

- Operable Unit 2 included supplemental investigations of the degree and extent of groundwater impacts, the installation of barrier wells and groundwater treatment system to intercept groundwater at the downgradient limits of the former Westinghouse Electric Corporation (Westinghouse) Horseheads plant site, and restoration of the Kentucky Avenue Well.

- Operable Unit 3 comprised the investigation and remediation of identified source areas at the former Westinghouse Horseheads plant site, the investigation of a waterway (i.e., the "Industrial Drainageway") that conveys surface water discharges from the former Westinghouse Horseheads plant site to Koppers Pond, and the remediation of the Industrial Drainageway.

The response actions specified under Operable Units 1 and 3 are completed. Operation, maintenance, and monitoring activities are continuing with respect to the barrier wells and attendant groundwater treatment system installed under Operable Unit 2. The RI/FS for Koppers Pond is being conducted under Operable Unit 4.

Koppers Pond is a man-made, V-shaped pond located in the Village of Horseheads, New York (Figure 1-1). At the northern end of its western leg, the pond receives inflow from the Industrial Drainageway, the watershed for which is a largely a commercial and industrial area. The drainageway receives much of its base flow from discharges originating at the former Westinghouse Horseheads plant site. The overflow from Koppers Pond discharges to two outlet streams located at the southern end of the pond, and these combine about 400 feet southeast of the pond to form a single outlet channel.

Koppers Pond is a shallow, flow-through water body with typical water depths of approximately two to six feet. Because of the relatively flat topography, the open water area of the pond is highly dependent on the surface water elevation, and open water areas of approximately seven to more than nine acres have been reported in the various studies of this pond. At a pond surface water elevation of approximately 886 feet above mean sea level, the

open water area of the pond covers about 8.9 acres. During the 2008 field sampling, water levels were lower than previously observed, presumably due to the removal of beaver dams that had been constructed in the outlets from the pond. Water levels were higher during the 2009 field studies (Section 2.3).

1.2 TECHNICAL MEMORANDUM OBJECTIVES AND ORGANIZATION

Integral has prepared this technical memorandum, which summarizes the results from the 2009 field sampling that was performed to support the ERA. The field work scope was defined in *Technical Memorandum No. 1: 2009 Field Sampling Program to Support the Ecological Risk Assessment of Koppers Pond* (AMEC, 2009a), which was submitted to USEPA and NYSDEC in August 2009. The field work was performed on September 16 and 17, 2009. The principal objectives of this field program were the following:

- Perform a survey for the native, New York State endangered plant slender pondweed (*Stuckenia filiformis alpinus*) in Koppers Pond and its Outlet Channels
- Perform an initial reconnaissance of candidate reference ponds.

Section 2 of this technical memorandum discusses the slender pondweed survey, and Section 3 presents the results of the initial reconnaissance of reference ponds. Supporting documents are provided in appendices.

2 RESULTS OF THE SLENDER PONDWEED SURVEY AT KOPPERS POND AND OUTLET CHANNELS

Appendix A of the *Screening Level Ecological Risk Assessment* prepared for Koppers Pond (AMEC, 2009b) compiles the correspondence with the New York Natural Heritage Program (NYNHP) and NYSDEC concerning whether there were reported observations of rare, threatened, or endangered (RTE) species at or near the Koppers Pond Site. In December 2008, the RTE summary was updated by NYNHP to include the potential presence of slender pondweed (*Stuckenia filiformis alpinus*) at or near Koppers Pond. This inclusion was based on a historical record from 1943 that this species was reported "in cold brook, Chemung Street, Horseheads." The supplemental field investigation was conducted to determine whether this species is present in Koppers Pond under current environmental conditions. In addition, a determination was made as to whether the habitats of Koppers Pond and the Outlet Channels are suitable to support this species.

There are several USEPA and New York guidance documents available for surveying aquatic macrophytes. USEPA (1998a) provides guidance for surveying of aquatic macrophytes that can be performed as part of the bioassessment of lakes and reservoirs. New York guidance documents describing aquatic plant survey methods include NYSDEC (1995, 2006) and the New York Citizens Statewide Lake Assessment Program (CSLAP) (2009). Because the slender pondweed is considered an RTE species in New York, a nondestructive sampling method was needed. Hence, the selected survey method primarily focused on the visual determination of the presence or absence of the slender pondweed from Koppers Pond or its Outlet Channels and whether the habitats are available to support this species. In addition, field measurements of the following nine parameters were collected from each of the survey locations:

Depth	Oxidation-Reduction Potential (ORP)
Temperature	Salinity
pH	Total Dissolved Solids
Conductivity	Turbidity
Dissolved Oxygen (DO)	

These parameters were collected for two reasons: First, this information was collected to allow comparisons to available comparable data for the slender pondweed. The second objective was to collect a similar set of water quality parameters relative to that collected from the 2008 sampling effort of Koppers Pond to determine whether there have been any changes in these parameters with time. Each survey location was designated with the code "SP09-nnn" to distinguish this field investigation from other sampling events.

2.1 MODIFICATIONS TO THE PROPOSED SURVEY PROTOCOL

There were no significant modifications relative to the proposed survey protocol presented in Technical Memorandum No. 1 (AMEC, 2009a). The global positioning system (GPS) survey was based on the 1983 North American Data (NAD [NAD83]) and not the 1972 NAD (NAD72) because of the survey equipment that was used. Field measurements of DO could not be obtained at one pond survey location and turbidity could not be measured at one of the outlet channel survey locations due to equipment failure. The optional boat survey was not required because there was limited submerged aquatic vegetation (SAV) present within the pond and the survey locations were readily accessible using chest waders.

Field water quality was measured using a Horiba U-22 Series multi-parameter water quality meter. The GPS measurements were collected using a Garmin 60CSx hand-held unit. The survey locations are shown in Figure 2-1. Photographs of the survey effort are provided in Attachment 1.

2.2 SLENDER PONDWEED LIFE HISTORY INFORMATION

A literature review was performed concerning the life history of the slender pondweed and to identify, to the extent possible, whether any information was available about its habitat preferences. The latter information could be used for comparison to the Koppers Pond habitats.

According to the on-line database *Flora of North America*[2] there are three subspecies of *Stuckenia affinis* (threadleaf-pondweed) that are distinguished by their relative size and also the peduncle (flower stalk) characteristics:

- *Stuckenia filiformis* subsp. *occidentalis* ranges in length from 20 to 100 centimeters (cm), has inflated nodes where the leaves connect to the stem (stipules) and lacks fruit
- *Stuckenia filiformis* subsp. *filiformis* ranges in length from 10 to 30 cm, the stipules clasp the stem, it has leaves that are quite narrow (0.0 to 0.5 millimeters [mm] wide) and the peduncles are more than 4 cm apart
- *Stuckenia filiformis* subsp. *alpinaus*[3] ranges in length from 10 to 30 cm, the stipules clasp the stem, it has leaves that are less narrow (up to 1 mm wide) and the peduncles are less than 4 cm apart. This is the slender pondweed that was included in the Koppers Pond survey. It is also called the northern slender pondweed in Maine and in Canada.

[2] Accessed from this URL: http://www.efloras.org/florataxon.aspx?flora_id=1&taxon_id=222000373

[3] The subspecies name as spelled from the "Flora of North America" website. This is an alternate for "*alpinus*."

All three species are rhizomatous, perennial herbs, and as noted above they can vary in whether they set fruit [*Stuckenia filiformis* subsp. *occidentalis* is generally considered to be a sterile hybrid; Hellquist et al (2002)].

The on-line database *Flora of North America* reports that the slender pondweed flowers from the spring to the early fall, and it prefers calcareous, saline, or brackish shallow to deep waters of ponds, lakes, streams, ditches, and coastal inshore waters. The depth range has been reported to 3,280 m. In the Great Lakes coastal wetlands, Johnston et al (2007) reported that *Stuckenia affinis* (the sub-species was not identified) was associated with silty substrates and open water.

Hellquist et al (2002) reported that *Stuckenia filiformis* subsp. *alpina* can be found in still waters of ponds and lakes. In New England it has been observed in eastern and northern Aroostook County, Maine; one location in Coos County; New Hampshire and presently in northeast Vermont. Historically, this taxon had been found in a few sites in the Champlain Valley. The U.S. Department of Agriculture (USDA) Plants Profile website[4] shows that this species has been reported in the New York counties north of the Site, principally those in the Finger Lakes ecozone, and the St. Lawrence Plains and St. Lawrence transition zones in the extreme north portion of the state (Figure 2-2). Wesley et al (2008) also reported that this species has been observed in the Cayuga Region of New York.

The Maine Department of Conservation [MDOC] (2004) reported that the slender pondweed has been observed in marl ponds with water column pH ranging from 7.3 to 9.1 (an average pH was not reported). Reschke (1990) defines a marl pond as "small, shallow spring-fed pond in which the water column has a high concentration of calcium" and in which the calcium precipitates out of the water column on to the sediment surface as calcium carbonate. These ponds have low primary productivity and sparse growth of aquatic macrophytes. Reschke (1990) also states that the marl ponds are known only in a portion of the Finger Lakes highlands subzone of the Appalachian Plateau ecozone. This is consistent with the information reported from the USDA Plants Profile website.

The water column pH preference and sediment substrate preference will be used for comparisons of the environmental conditions at Koppers Pond.

[4] Accessed from this URL: http://plants.usda.gov/java/county?state_name=New York&statefips=36&symbol=STFIA2

2.3 SLENDER PONDWEED SURVEY RESULTS FOR KOPPERS POND

The slender pondweed survey at Koppers Pond was performed on September 16, 2009. The day was sunny, and the daily temperatures ranged from 44 to 73 °F (average of 59 °F)[5]. It was moderately breezy at the time of the survey.

It was noted that the water levels were 12 to 18 inches higher at Koppers Pond during the September 2009 effort compared to the May 2008 field investigation, but were apparently comparable to historical water levels. This conclusion was based on the comparison of Site photographs during the two sampling events and water levels on the utility pole located within the pond. This change in water level may be due to several factors, including the increased precipitation in 2009 relative to 2008.

2.3.1 Koppers Pond Slender Pondweed Survey Results

The perimeter of Koppers Pond was walked as part of this survey, except for some inaccessible areas where there was heavy terrestrial vegetation growth. Water quality measurements were collected and a more detailed visual inspection of the pond was performed at eight survey points (SP09-005, SP09-006, SP09-007, SP09-009, SP09-010, SP09-011, SP09-012, and SP09-013). These locations are shown in Figure 2-1. In addition, one survey point (SP09-008) was located approximately 400 feet up the Industrial Drainageway from its juncture with Koppers Pond. The sample log sheet for the Koppers Pond survey points is provided in Attachment 2 (Table A2-1).

The slender pondweed was not observed at any of the eight pond locations, or while walking between these locations. The only SAV present in the pond were small pockets of coontail (*Ceratophyllum demersum*). The lesser duckweed (*Lemna minor*), a common floating aquatic plant, was present at the pond and covered much of the water surface (greater than 50 percent) along the southern and southwestern shorelines (i.e., backwater areas).

2.3.2 Outlet Channel Slender Pondweed Survey Results

Five survey point locations along the east (SP09-001, SP09-002), west (SP09-003, SP09-004), and main outlet channels (SP09-14) of Koppers Pond, were examined. The latter extended as far downstream as sediment sample location SD017. The sample log sheet for the outlet channel survey is provided in Attachment 2 (Table A2-2).

[5] Temperature data were from the Elmira Airport and was accessed on-line through the U.S. Department of Commerce, National Oceanic and Atmospheric Administration NOWData website [http://www.nws.noaa.gov/climate/xmacis.php?wfo=bgm].

The slender pondweed was not observed at any of these locations. There were also no apparent SAV at any of these locations. Many of the outlet channels had terrestrial vegetation overgrowing their surfaces.

2.4 WATER QUALITY PARAMETER MEASUREMENTS

Tables 2-1a and 2-1b present the georeferencing data and the field measurements collected from each of the survey points from Koppers Pond and the outlet channels, respectively. These field measurements were summarized and compared to the May 2008 field study results in Tables 2-2a and 2-2b for Koppers Pond and the outlet channels, respectively. Statistical comparisons were made between the 2008 and 2009 field measurements of pH, specific conductance, DO, and ORP results. These were four of the five parameters that were collected during both sampling events. Although water temperature was also collected, it was not considered for comparison because the samples were collected in different seasons between the two sampling events.

Normality testing was performed using the Ryan-Joiner Test (similar to Shapiro-Wilk's Test). If the data were normally distributed with or without $\log_e$-transformation, the 2008 and 2009 results were compared using the t-test. If the data did not fit a normal distribution with or without $\log_e$-transformation, then the non-parametric Mann-Whitney test of medians was used. Statistical analyses were performed using Minitab (v 12). The results are summarized below and in the Minitab output provided in Attachment 3.

2.4.1 Comparison of Water Quality Parameter Measurements to Slender Pondweed Water Quality Requirements

There is limited information on the water quality requirements for the slender pondweed. As discussed in Section 2.2, MDOC (2004) reported that the slender pondweed has been observed in marl ponds in Maine with water column pH ranging from 7.3 to 9.1 (an average pH was not reported). This range has been compared to the observed pH ranges from two sampling events in the table below.

	Koppers Pond		Outlet Channels		pH Range Reported in Marl Ponds in Maine (MDOC, 2004)
	May 2008	September 2009	May 2008	September 2009	
Ranges	7.84 - 8.13	8.05 - 8.46	7.76 - 8.14	5.9 – 8.46	7.3 - 9.1
Mean	8.00	8.25	7.95	7.29	

Although the observed ranges of pH for the two sampling events are within the range where this species has been reported, there are other factors (e.g., sediment substrate; see Section 2.5) which may be important to determine whether this species is present.

2.4.2 Koppers Pond – Comparison of 2008 and 2009 Field Measurements

The Koppers Pond water quality parameter results are shown in Table 2-1a and compared to the 2008 sampling results in Table 2-2a.

- *pH*: The pH data were normally distributed and evaluated using the t-test. The mean pH in 2009 (8.25) was greater than observed in 2008 (8.00). There was a statistically significant difference between the mean pH values ($t = -3.64$; $p=0.0039$; $df = 11$).

- *Specific Conductance*: The specific conductance data fit neither normal nor log-normal distributions, so they were compared using the non-parametric Mann-Whitney test. The median specific conductance in 2009 (0.0904 Siemens per meter [S/m]) was much larger than the median observed in 2008 (0.066 S/m), and there was a statistically significant different between these median values based on the non-parametric Mann-Whitney test ($W=27.0$; $p=0.024$).

- *Dissolved oxygen*: The DO data were normally distributed and evaluated using the t-test. The mean dissolved oxygen in 2009 (14.04 milligrams per liter [mg/L]) was greater than observed in 2008 (10.00 mg/L), but there was no statistically significant difference between the two years ($t = -2.02$; $p=0.090$; $df = 6$).

- *Oxidation-Reduction Potential*: The ORP data fit neither normal nor log-normal distributions, so they were compared using the non-parametric Mann-Whitney test. The median ORP in 2009 (231.5 millivolts [mV]) was much larger than the median observed in 2008 (67.85 mV), and there was a statistically significant different between these median values based on the non-parametric Mann-Whitney test ($W=21.0$)

2.4.3 Outlet Channels – Comparison of 2008 and 2009 Field Measurements

The outlet channel water quality parameter results are shown in Table 2-1b and compared to the 2008 sampling results in Table 2-2b.

- *pH*: The outlet channel pH data were normally distributed and evaluated using the t-test. The mean pH in 2009 (7.24) was lower than observed in 2008 (7.95). However, there was no statistically significant difference between the mean pH values ($t = 1.69$; $p=0.17$; $df = 4$).

- *Specific Conductance*: The median specific conductance in 2009 (0.102 S/m) was very similar to the median observed in 2008 (0.097 S/m), and there was no statistically

significant different between these median values based on the non-parametric Mann-Whitney test (W=13.0; p=0.1113).

- *Dissolved oxygen*: DO measurements were not available from the 2008 sampling of the outlet channels.

- *Oxidation-Reduction Potential*: The outlet channel ORP data were normally distributed and evaluated using the t-test. The mean ORP in 2009 (288 mV) was greater than observed in 2008 (136 mV), and there was a statistically significant difference between the mean ORP values (t = -5.49; p=0.0027; df = 5).

In summary, there were some differences between the water quality parameter measurements that were collected from Koppers Pond and the outlet channels between the two sampling events. These may be attributable to seasonal factors (early spring for the 2008 samples and early fall for the 2009 samples), or precipitation differences between the two sample years. Nonetheless, the water quality parameter measurements from both years indicated that the surface water in the pond was well oxygenated at the time of sampling.

2.4.4 Sediment Substrate Observations

Technical Memorandum No. 1 also included a determination of whether "suitable substrate" for the slender pondweed was present at the survey locations. This refers to general observations on the physical nature of the sediment substrate – i.e., whether it was stony, sandy, mucky, etc. – because this can affect whether the macrophytes can have root holds in the sediment. The littoral zone of Koppers Pond had a hard, gravel bottom, but the deeper areas quickly become soft and mucky. In a review of the literature on this species, the only indication of a preference is towards marl ponds. Reschke (1990) defines a marl pond as "small, shallow spring-fed pond in which the water column has a high concentration of calcium" and in which the calcium precipitates out of the water column on to the sediment surface as calcium carbonate. Reschke (1990) also states that the marl ponds in New York are known only in a portion of the Finger Lakes highlands subzone of the Appalachian Plateau ecozone. Although Koppers Pond is within the Appalachian plateau in New York, it is outside (south) of the Finger Lakes highlands (Figure 2-2).

Table 2-1b presents the field measurements collected from each of the survey points. These were summarized and compared to the May 2008 field study results in Table 2-2b. A statistical comparison of the results from the east and west outlet channels was not performed due to the small number of samples. As shown in Table 2-2c, there was overlap in the ranges of the different measured field parameters. On average, the west outlet samples had a greater pH, turbidity, and TDS compared to the east outlet samples. These results show that the surface water from both outlets was well oxygenated at the time of sampling.

The results were similar to those collected in May 2008, although the September 2009 samples were somewhat better oxygenated (i.e., greater DO and ORP; Table 2-2b). These differences may be attributable to increased flows from the pond due to the higher water levels in 2009 compared to 2008.

2.5 SLENDER PONDWEED SURVEY SUMMARY AND CONCLUSIONS

The visual survey for the slender pondweed in Koppers Pond and its outlet channels showed that this species was not present in either of these areas. Field measurements collected from each of the survey locations and inspection of the substrate indicate that the habitat is not appropriate for this species. Slender pondweed prefers more alkaline waters (MDOC, 2004) than is present at either Koppers Pond or its outlet channels.

3 RESULTS FROM THE FIELD RECONNAISANCE TO IDENTIFY CANDIDATE REFERENCE PONDS

The use of a reference area can facilitate the interpretation and evaluation of potential risks in an ecological risk assessment. Comparison of the Site to a comparable reference area is critical in the evaluation of the health of certain ecological communities that have been selected as measurement endpoints in the assessment. The selection and use of reference areas can also be critically important when ecologically significant chemicals may be present due to area-wide sources that are not attributable to the Site. For such chemicals, information about their concentrations in reference areas that are separate from Site-related releases can help in the determination of whether concentrations measured at the Site are elevated above background levels.

Ideally, reference sites are selected to be as similar as possible to physical and biological conditions at the Site prior to constituent releases so that differences can be attributed to chemical exposure. Both USEPA (1994, 1997, 1998b) and NYSDEC (2002) have relevant guidance concerning the selection of reference (or background) areas.

The reconnaissance survey for reference ponds in the vicinity of Koppers Pond was started on September 16, 2009 and completed the next day.

3.1 MODIFICATIONS TO THE PROPOSED REFERENCE POND RECONNAISSANCE PROTOCOL

There were no significant modifications relative to the proposed survey protocol presented in Technical Memorandum No. 1 (AMEC, 2009a). That document lists several key comparison metrics for the reference pond reconnaissance. In general, these metrics were all used, with some modifications, and some additional metrics were collected. These are summarized below:

- Modified metrics: The proposed approach included information on the percent vegetation cover types. These were modified to include the types of vegetation that were present, along with their relative dominance.

- Additional metrics: The relative position of the reference pond relative to the location of Koppers Pond (e.g., north, southwest) was added. In addition, more detailed information on ownership of the ponds was collected when available from public domain sources or informal resident interviews.

Field measurements of water quality were collected from the candidate ponds if they could be accessed. A detailed assessment for the potential availability of additional chemical data was not performed at this preliminary stage.

There were several ponds that were located in addition to the original seven listed in the Technical Memorandum No. 1. These additional ponds were identified based on review of aerial photographs and informal interviews with residents and municipal representatives.

3.2 FIELD RECONNAISSANCE RESULTS OF CANDIDATE REFERENCE PONDS

A total of 15 distinct candidate ponds were identified, and these are summarized in the table below.

Pond ID	Description
1a, 1b and 1c	Group of 3 ponds on BOCES school property
2	Too small to locate
3	Pond on private residential property
4	Pond on airport property
5	Stormwater basin
6	Stormwater basin
7a and 7b	Two quarry pits
8a and 8b	Lowe Ponds (small and large)
9	Restoration effort at "The Center at Horseheads"
10	Eldridge Pond
11	Weyer Pond

The locations of these candidate ponds are shown in Figure 3-1. Ponds 8a, 8b, 9, 10, and 11 were new ponds added during the field reconnaissance.

Table 3-1 provides a detailed comparison of the reference ponds evaluated during the 2009 field reconnaissance. The following is a brief summary of key items regarding these ponds:

- Pond #1 Group: This is a group of three ponds located near the school. They appear to have a similar sediment substrate and fish assemblages compared to Koppers Pond, but have more diverse surrounding vegetation. The ponds are separated by berms, and may have originated as borrow pits related to school construction activities (e.g., for athletic fields).

- Pond #2: This was not inspected but is quite small on the map.

- Ponds #3 and #4: These ponds were both formerly owned by a local resident (Well family). Pond #4 was sold to the airport some time ago. The airport (which is owned and operated by Chemung County) plans to fill this pond in the near future to alleviate some of the goose problems (e.g., bird strike potential) at the airport.

  Pond #3 is still privately owned. This pond has similar sediment substrate and fish assemblages compared to Koppers Pond but the surrounding area is highly maintained (it is used as a recreational pond for the residential owner). The resident recommended looking at two additional ponds west of this area - Lowe Ponds - that are discussed below as Ponds #8a or #8b.

- Ponds #5 and #6: These are both stormwater detention basins for nearby developed properties. A chain-link fence secures them both ponds and there was no access to the shoreline. From viewpoints outside of the fences, the sediment substrates in both of these ponds differ from that at Koppers Pond.

- Ponds #7a and 7b: Pond #7a is a pit for a quarry operation (owned by Hanson) and is typical of water-filled quarry pits (i.e., limited soft substrate, limited vegetation and fish). Pond #7b is located on state correctional facility property and was not closely inspected.

- Ponds #8a and 8b: These are two ponds suggested by a local homeowner and are located in a town park southwest of the airport. The ponds are called Lowe Pond and consist of a small and large pond. The sediment substrate, fish assemblages and surrounding vegetation are similar to Koppers Pond (the larger pond is more heavily vegetated). The small pond has a somewhat lower pH compared to Koppers Pond but the larger pond has similar pH to Koppers Pond.

- Pond #9 Group: This is a series of ponds and associated wetlands in the northern portion of Horseheads. There is an adjoining rail line and the pond group has similar sediment and soil substrates to Koppers Pond and adjoining wetland areas. It is adjacent to an industrial complex that was converted to office/storage operations, called "Center at Horseheads."

- Pond #10: This is Eldridge Lake located in Eldridge Park in Elmira. The adjoining area is a well-maintained park. The sediment substrate is sandy. There are no apparent surface water inlets or outlets, so surface runoff or groundwater likely contribute to the water levels.

- Pond #11: This is Weyer Pond located in Elmira, southeast of Eldridge Park. It is bounded by residential properties and may be privately owned (or owned by a local municipal group). The sediment substrate is sandy and the immediate vicinity of the

pond is well maintained lawn. There are no apparent surface water inlets or outlets, so surface runoff or groundwater likely contribute to the water levels.

Of the ponds evaluated, the best candidate ponds for further consideration as a potential reference pond are the following:

- Pond #1 group - located behind the school west of Koppers Pond
- Ponds #8a or #8b (Lowe Pond group, located in a county park)
- Pond #9 (just west of Pond #7a; "Center at Horseheads").

Photographs of this subset of the surveyed ponds are provided in Attachment 4. The Pond #1 group, Pond #8a, and Pond #8b likely would present minimal accessibility issues because all are on public lands. The Pond #9 group appears to represent the best match to Koppers Pond for sediment characteristics and adjoining wetland areas, but some of the individual ponds in this group are privately owned.

3.3 REFERENCE POND RECONNAISSANCE SUMMARY

In summary, 15 distinct candidate ponds were evaluated as part of the 2009 field effort. These were compared using different hydrologic, land use, sediment lithology, and fish community metrics. Based on this evaluation, three potential reference ponds (or reference pond groups) were identified as candidates for further evaluation. Access agreements may be required to provide permission to access the ponds for sampling. A pond that is located on public property may ultimately serve as the most practical choice for a reference pond.

The rationale and recommendation for the reference pond is discussed in the ERAGS 3 through 5 Report.

4 REFERENCES

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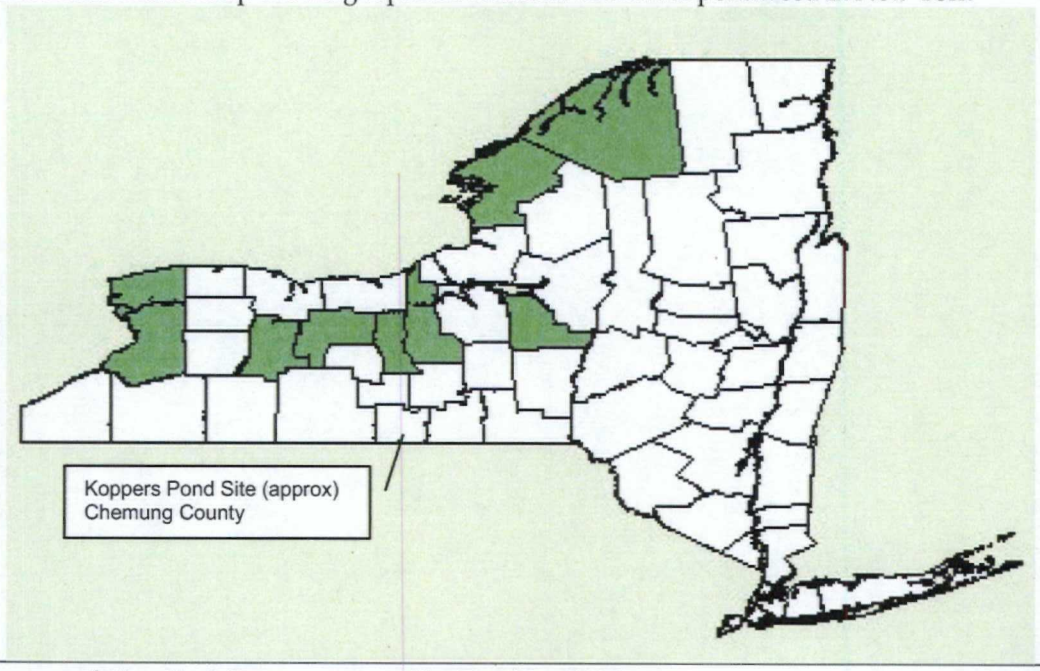
Figure 1-1. Sampling Locations from Koppers Pond and Outlets
Kentucky Avenue Wellfield Site - OU4
Horseheads, New York

Figure 2-1. Slender Pondweed Survey Locations for Koppers Pond and Outlet Channels
Kentucky Avenue Wellfield Site - OU4
Horseheads, New York

(a) USDA Plants Profile map showing reported locations of slender pondweed in New York



(b) Ecozones of New York State as reported by Reschke (1990)

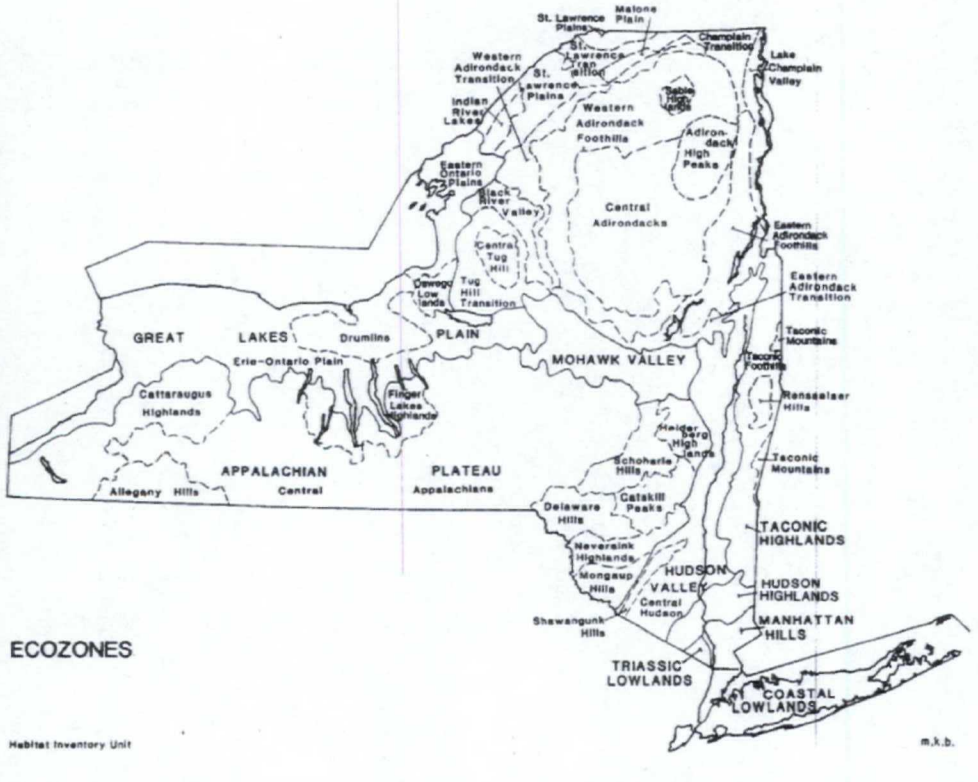


Figure 2-2. County Map Showing Reported Locations of Slender Pondweed in New York State, and Ecozone Map

Figure 3-1. Locations of Candidate Reference Ponds Surveyed in September 2009

Table 2-1a. Georeferencing and Field Measurements from Slender Pondweed Survey of Koppers Pond
Kentucky Avenue Wellfield OU4 - Koppers Pond, Horseheads, NY

Parameter	Location	Pond	Pond	Pond	Pond	Pond	Pond	Pond	Pond	Industrial Drainageway
	Units	SP09-005	SP09-006	SP09-007	SP09-009	SP09-010	SP09-011	SP09-012	SP09-013	SP09-008
Lat Coord		N42.14838	N42.14960	N42.15024	N42.14963	N42.14886	N42.14980	N42.15006	N42.14904	N42.15142
Long Coord		W76.82979	W76.83016	W76.83069	W76.82950	W76.82832	W76.82719	W76.82639	W76.82709	W76.83023
Elevation (msl)	ft	891	891	902	901	893	895	891	889	902
pH	(unitless)	8.1	8.41	8.19	8.05	8.14	8.33	8.33	8.46	8.2
Specifc Conductance	S/m	0.0916	0.0904	0.151	0.0947	0.0904	0.0884	0.09	0.0626	0.104
Turbidity	NTU	160	52.2	631	158	26.3	5.7	18.6	4.9	13.4
Dissolved Oxygen	mg/L	17.21	[a]	3.2	11.46	16.6	16.89	15.39	17.5	12.54
Temperature	°C	17.91	18.06	15.2	16.46	18.87	19.55	19.37	19.93	15.04
Sampling Depth	m	0.76	0.46	0.2	0.3	0.61	0.15	0.46	0.3	0.3
Salinity	‰	0.04	0.04	0.08	0.04	0.04	0.04	0.04	0.03	0.05
Total Dissolved Solids	g/L	0.587	0.581	1.09	0.606	0.579	0.566	0.575	0.401	0.67
ORP	mV	239	256	241	203	212	222	226	237	214

Notes:
Survey was performed on 16 September 2009.
The Industrial Drainageway sample was collected near the juncture with Koppers Pond.
"SP09-nnn" refers to survey point locations. See Figure 2-1 for plot of sampling locations.
[a] Not available

Table 2-1b. Georeferencing and Field Measurements from Slender Pondweed Survey of Koppers Pond Outlet Channels
Kentucky Avenue Wellfield OU4 - Koppers Pond, Horseheads, NY

	Location	East outlet	East outlet	West outlet	West outlet	East outlet
Parameter	Units	SP09-001	SP09-002	SP09-003	SP09-004	SP09-014
Lat Coord		N42.14848	N42.14760	N42.14754	N42.14776	N42.14640
Long Coord		W76.82771	W76.82799	W76.82943	W76.82993	W76.82678
Elevation (msl)	ft	905	886	898	902	886
pH	(unitless)	5.9	7	7.27	7.56	8.46
Specifc Conductance	S/m	0.102	0.107	0.098	0.138	0.096
Turbidity	NTU	9.5	104	[a]	283	144
Dissolved Oxygen	mg/L	12.57	8.26	15.73	5.26	12.1
Temperature	°C	18.58	16.85	17.28	15.04	18.82
Sampling Depth	m	0.8	0.15	0.2	0.15	0.15
Salinity	‰	0.05	0.05	0.04	0.08	0.04
Total Dissolved Solids	g/L	0.65	0.64	0.62	1.07	0.61
ORP	mV	363	313	301	233	229

Notes:
Survey was performed on 16 September 2009.
"SP09-nnn" refers to survey point locations. See Figure 2-1 for plot of sampling locations.
[a] No measurement due to instrument error.

Table 2-2a. Summary and Comparison of May 2008 and September 2009 Field Measurements of Surface Water from Koppers Pond
Kentucky Avenue Wellfield OU4 - Koppers Pond, Horseheads, NY

		May 2008 Field Investigation			September 2009 Slender Pondweed Survey			
Parameter	Units	Frequency Detected	Range	Mean	Frequency Detected	Range	Mean	Stat Comparison
pH	(unitless)	6/6	7.84 - 8.13	8.00	8/8	8.05 - 8.46	8.25	Sig
Specific Conductance [1]	S/m	6/6	0.065 - 0.069	0.067	8/8	0.0626 - 0.151	0.1	NSig
Turbidity	NTU	---	NC	NC	8/8	4.9 - 631	132.1	NE
Dissolved Oxygen [2]	mg/L	6/6	8.73 - 10.75	10.0	7/7	3.2 - 17.5	14.0	NSig
Temperature	°C	6/6	13.34 - 16.03	14.6	8/8	15.2 - 19.93	18.2	NE
Depth	m	---	NC	NC	8/8	0.15 - 0.76	0.41	NE
Salinity	‰	---	NC	NC	8/8	0.03 - 0.08	0.04	NE
Total Dissolved Solids	g/L	---	NC	NC	8/8	0.401 - 1.09	0.62	NE
Redox Potential	mV	6/6	17.9 - 70.1	58	8/8	203 - 256	230	Sig
Corresponding Samples		SW08-02, SW08-04, SW08-05, SW08-08, SW08-10, and SW08-13			SP09-005, SP09-006, SP09-007, SP09-009, SP09-010, SP09-011, SP09-012, and SP09-013			

Notes:
The summary for the 2009 slender pondweed survey includes only those samples collected from Koppers Pond.
NC = Not collected
NE = Not evaluated
NSig = no significant difference
Sig = significant difference
[1] The May 2008 sample results for specific conductance were reported in µmho/cm (see Table 9 of the Site Characterization Study Report) and were converted to S/m by dividing by 10,000 to be consistent with the 2009 reporting units.
[2] The May 2008 sample results for dissolved oxygen were reported in ppm, which is equivalent to mg/L.

Table 2-2b. Summary and Comparison of May 2008 and September 2009 Field Measurements of Surface Water from Outlet Channels
Kentucky Avenue Wellfield OU4 - Koppers Pond, Horseheads, NY

		May 2008 Field Investigation			September 2009 Slender Pondweed Survey			
Parameter	Units	Frequency Detected	Range	Mean	Frequency Detected	Range	Mean	Stat Comparison
pH	(unitless)	4/4	7.76 - 8.14	7.95	5/5	5.9 - 8.46	7.24	NSig
Specific Conductance [1]	S/m	4/4	0.095 - 0.097	0.096	5/5	0.096 - 0.138	0.108	NSig
Turbidity	NTU	---	NC	NC	4/4	9.5 - 283	135	NE
Dissolved Oxygen	mg/L	---	NC	---	5/5	5.26 - 15.73	10.8	NE
Temperature	°C	4/4	14.9 - 15.8	15.3	5/5	15.04 - 18.82	17.3	NE
Depth	m	---	NC	NC	5/5	0.15 - 0.8	0.29	NE
Salinity	‰	---	NC	NC	5/5	0.04 - 0.08	0.05	NE
Total Dissolved Solids	g/L	---	NC	NC	5/5	0.61 - 1.07	0.72	NE
Redox Potential	mV	4/4	114 - 157	136	5/5	229 - 363	288	Sig
Corresponding Samples		SW08-14, SW08-15, SW08-16, and SW08-17			SP09-001, SP09-002, SP09-003, SP09-004, and SP09-014			

Notes:
The summary for the 2009 slender pondweed survey includes only those samples collected from the Outlet Channels.
NC = Not collected
NE = Not evaluated
NSig = no significant difference
Sig = significant difference
[1] The May 2008 sample results for specific conductance were reported in µmho/cm (see Table 9 of the Site Characterization Study Report) and were converted to S/m by dividing by 10,000 to be consistent with the 2009 reporting units.

Table 2-2c. Summary and Comparison of Field Measurements of Surface Water from the East and West Outlet Channels
Kentucky Avenue Wellfield OU4 - Koppers Pond, Horseheads, NY

Parameter	Units	East Outlet (n=3)		West Outlet (n=2)	
		Range	Mean	Range	Mean
pH	(unitless)	5.9 - 8.46	7.12	7.27 - 7.56	7.41
Specific Conductance	S/m	0.096 - 0.107	0.1	0.098 - 0.138	0.118
Turbidity	NTU	9.5 - 144	85.8	283 - 283	283
Dissolved Oxygen	mg/L	8.26 - 12.57	10.98	5.26 - 15.73	10.5
Temperature	°C	16.85 - 18.82	18.08	15.04 - 17.28	16.16
Salinity	‰	0.04 - 0.05	0.05	0.04 - 0.08	0.06
Total Dissolved Solids	g/L	0.61 - 0.65	0.63	0.62 - 1.07	0.845
Redox Potential	mV	229 - 363	302	233 - 301	267
Corresponding Samples		SP09-001, SP09-002 and SP09-014		SP09-003 and SP09-004	

Note:
Statistical comparisons between the two outlet channel were not performed due to the small sample size.

Table 3-1. Key Comparison Metrics for Selection of Reference Pond Site Kentucky Avenue Wellfield OU4 - Koppers Pond, Horseheads, NY

Location	Koppers Pond	Candidate Reference Sites																
		1a (southernmost)	1b (middle)	1c (northernmost)	2	3	4	5	6	7a	7b	8a	8b		9		10	11
Descriptor	OU4	Group of 3 ponds on BOCES school property.			---	Pond on private residential property.	Pond on airport property.	Stormwater basin	Stormwater basin	Quarry pit	Quarry pit	Lowe Pond (small)	Lowe Pond (large)		Restoration effort at "The Center at Horseheads"		Eldridge Lake	Weyer Pond
Distance from site (ft)	---	3,240	3,240	3,240	[1]	17,460	17,280	10,620	7,380	10,350	11,700	TBD	TBD	TBD	TBD	TBD	TBD	9,000
Relative position from Koppers Pond	---	W	W	W	[1]	W	W	W-NW	NW	N-NE	N-NE	W-SW	W-SW	W-SW	N	N	S	S
Size (acres)	8.9	Unknown	Unknown	Unknown	[1]	Unknown	N/A	N/A	N/A	Unknown		TBD	TBD	TBD	TBD	TBD	TBD	TBD
Elevation (ft ASL)	890	978	978	978	[1]	922	[2]	[3]	[3]	Unknown	907	921	918	913	881	888	859	859
Inlet (Y/N)	Yes	No	No	No	[1]	No	[2]	[3]	[3]	No	No	Yes	Yes	Yes	Yes	Yes	No	No
Outlet (Y/N)	Yes	No	No	No	[1]	No	[2]	[3]	[3]	No	No	Yes	Yes	Yes	Yes	Yes	No	No
Etiology (if known)	Man-made	Man-made (old borrow pits?)	Man-made (old borrow pits?)	Man-made (old borrow pits?)	[1]	Borrow pit dug for the creation of County Route 64 and/or I-86.	Borrow pit dug for the creation of County Route 64 and/or I-86.	[3]	[3]	Filled in quarries	Filled in quarries	Unknown	Unknown	Unknown	Not fully known, but it is an active restoration project.	Not fully known, but it is an active restoration project.	Unknown	Unknown
Water depth range (ft)	1-8	Unknown (deep)	Unknown (deep)	Unknown (deep)	[1]	Uknown (deep)	[2]	[3]	[3]	Unknown (deep)	Unknown (deep)	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
Sediment substrate	Muck and silt, underlain by medium sand	Muck and silt, underlain by medium sand	Muck and silt, underlain by medium sand	Muck and silt, underlain by medium sand	[1]	Sand, gravel, and cobble bottom	[2]	[3]	[3]	Sand and gravel	Sand and gravel	Muck and silt, underlain by medium sand.	Muck and silt, underlain by medium sand.	Muck and silt, underlain by medium sand.	Silt, underlain by medium sand.	Silt, underlain by medium sand.	Medium sand	Medium sand
Percent open water	>90	>90	>90	>90	[1]	>90	[2]	[3]	[3]	>90	>90	>90	>90	>90	>90	>90	>90	>90
Same watershed as site (Y/N)	---	Yes	Yes	Yes	[1]	TBD	[2]	[3]	[3]	TBD	TBD	TBD	TBD	TBD	TBD	TBD	No	No
Adjoining land use	Commercial, industrial, old field	Maintained lawn and landscaping for school grounds	Maintained lawn and landscaping for school grounds	Maintained lawn and landscaping for school grounds	[1]	Maintained lawn and private residence (rural).	[2]	[3]	[3]	Quarry	Quarry	County park	County park	County park	Commercial and residential	Commercial and residential	Residential and park	Residential and park
Vegetation	Dominated by scrub/shrub community of willows and soft rush. (100% vegetative cover).	Dominated by herbaceous community of soft rush, common cattail, various sedges, smartweeds, spike rush, and some shrub willows. (100% vegetative cover).	Dominated by herbaceous community of soft rush, common cattail, various sedges, smartweeds, spike rush, and some shrub willows. (100% vegetative cover).	Dominated by herbaceous community of soft rush, common cattail, various sedges, smartweeds, spike rush, and some shrub willows. (100% vegetative cover).	[1]	Dominated by scrub/shrub community of willows and soft rush. (100% vegetative cover).	[2]	[3]	[3]	Dominated by mixed (deciduous and evergreen) young to medium stage woods.	Dominated by mixed (deciduous and evergreen) young to medium stage woods.	Dominated by herbaceous community of tickseed sunflower, teasel, sweet clover, goldenrod, teasel, sparganium, Canada thistle, crown vetch, common cattail, jewelweed, and duckweed.	Dominated by herbaceous community of tickseed sunflower, teasel, sweet clover, goldenrod, teasel, sparganium, Canada thistle, crown vetch, common cattail, jewelweed, and duckweed.	Dominated by herbaceous community of tickseed sunflower, teasel, sweet clover, goldenrod, teasel, sparganium, Canada thistle, crown vetch, common cattail, jewelweed, and duckweed.	Dominated by scrub/shrub to young woods with purple loosestrife, stiff dogwood, willows, alders, goldenrod, common cattail, and duckweed.	Dominated by scrub/shrub to young woods with purple loosestrife, stiff dogwood, willows, alders, goldenrod, common cattail, and duckweed.	Mostly maintained lawn.	Mostly maintained lawn.
Proximity to known sources (Y/N)		No	No	No	[1]		[2]	[3]	[3]			TBD	TBD	TBD	TBD	TBD	TBD	TBD
Known inputs (e.g., culverts, CSOs)	Runoff, industrial drainageway	Runoff from school	Runoff from school	Runoff from school	[1]	Runoff from I-86 and residential property.	[2]	[3]	[3]	Runoff from State Route 13.	Runoff from State Route 13.	Runoff	Runoff	Runoff	Runoff	Runoff	Runoff	Runoff
Adjoining roadways/type	Trails	School roads	School roads	School roads	[1]	I-86 and County Route 64	[2]	[3]	[3]	State Route 13.	State Route 13.	County Route 63	County Route 63	County Route 63	County Routes 67 and 68, and abandoned railroad bed that bisects the pond(s).	County Routes 67 and 68, and abandoned railroad bed that bisects the pond(s).	Local roads	Local roads
Adjoining railways (Y/N)	Yes	No	No	No	[1]	No	[2]	[3]	[3]	No	No	No	No	No	Yes	Yes	No	No
Evidence of aquatic life (Y/N)	Yes	Yes	Yes	Yes	[1]	Yes	[2]	[3]	[3]	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Existing chemistry data [5]					[1]		[2]	[3]	[3]									
pH	8.05 - 8.46	8.29	8.21	7.96	[1]	8.24	[2]	[3]	[3]	Unknown	7.9	7.88	8.02	7.83	7.53	7.67	7.72	8.08
Conductivity (S/m)	0.151 - 94.7	0.215	33.3	31	[1]	63.7	[2]	[3]	[3]	Unknown	37.4	0.12	59.7	0.251	0.09	48.8	70	38.6
Turbidity (NTU)	4.9 - 631	18.3	12.9	116	[1]	3.7	[2]	[3]	[3]	Unknown	10.6	93	266	204	20.3	7.3	2.8	10.7
Dissolved oxygen (mg/L)	3.2 - 17.5	4.82	9.11	5.19	[1]	9.95	[2]	[3]	[3]	Unknown	8.44	9.24	9.23	2.92	2.58	5.81	7.46	8.13
Temperature (C)	15.2 - 19.93	33.17	21.47	20.93	[1]	21.48	[2]	[3]	[3]	Unknown	20.07	21.28	22.11	19.22	16.95	18.03	19.95	19.62
Measurement Depth (ft. below ws)	0.15 - 0.76	1	3	2	[1]	1.5	[2]	[3]	[3]	Unknown	1.5	2	2	2	1	0.1	1	0.3
Salinity (‰)	0.03 - 0.08	0.12	0.01	0.01	[1]	0.03	[2]	[3]	[3]	Unknown	0.02	0.05	0.03	0.12	0.05	0.02	0.03	0.02
Total dissolved solids (g/L)	0.401 - 1.09	1.6	0.218	0.203	[1]	0.401	[2]	[3]	[3]	Unknown	0.243	0.76	0.386	1.62	0.39	0.318	0.449	0.25
Oxidation-reduction potential (mV)	203 - 256	234	231	212	[1]	275	[2]	[3]	[3]	Unknown	249	280	273	183	274	226	270	267
Ownership	Hardinge, Elmira Water Board, Village of Horseheads	Office of the Board of Education Clerk; 459 Philo Road; Elmira, NY 14903	Office of the Board of Education Clerk; 459 Philo Road; Elmira, NY 14903	Office of the Board of Education Clerk; 459 Philo Road; Elmira, NY 14903	[1]	Known locally as the "Welles Property" but owned by Curtis and Ann Hameister; 18 Welles Lane; Elmira, NY 14903. (607) 562-3388; (607) 562-2133.	[2]	[3]	[3]	Ryan & Company c/o Hanson Aggregates NY, Inc.; Three Galleria Tower; 13155 Noel Road, 12th Floor; Dallas, TX 75240	Ryan & Company c/o Hanson Aggregates NY, Inc.; Three Galleria Tower; 13155 Noel Road, 12th Floor; Dallas, TX 75240	Chemung County	Chemung County	Chemung County	Numerous owners - see table footnote [4].	Numerous owners - see table footnote [4].	Town of Elmira	May be private
Access issues	None	None	None	None	[1]	None	[2]	[3]	[3]	Could not find access, unless through NY State Correctional Facility road.	Very steep slopes and limited access	None	None	None	None	None	None	May be private

Note:
Ponds 1 through 7 were identified during the development of Tech Memo 1 (AMEC, 2009a). The remaining ponds were added during the field reconnaissance.
NA = Not available or unknown
TBD: To be determined if pond is selected as a reference pond.
Distances from Koppers Pond are linear distances calculated from Figure 3-1 of Technical Memorandum No. 1 (AMEC, 2009a).

[1] Pond #2 was too small to evaluate

[2] Pond is slated to be filled in by the airport in the near future, as an attempt to discourage the use of the open water by Canada goose.

[3] Ponds are stormwater basins that are secured by a chain-link fence, with no access to the shoreline.

[4] Property owners for Pond 9 include the following:
James Drake c/o Chemung County Federation; 711 Lattabrook Road, Elmira, NY 14901
Theodore Aikman, 147 Ormiston Road, Breesport, NY 14816
Ricky Chase, 2734 Gorton Road, Corning, NY 14830
Philip Menges, 922 Rambler Road, Elmira, NY 14905

[5] Ranges of values from the slender pondweed survey.

ATTACHMENT 1

SLENDER PONDWEED SURVEY PHOTOGRAPH LOG

Photo A1-1

Industrial Drainageway, looking upstream

Photo A1-2

East shoreline
N42.14904
W76.82709

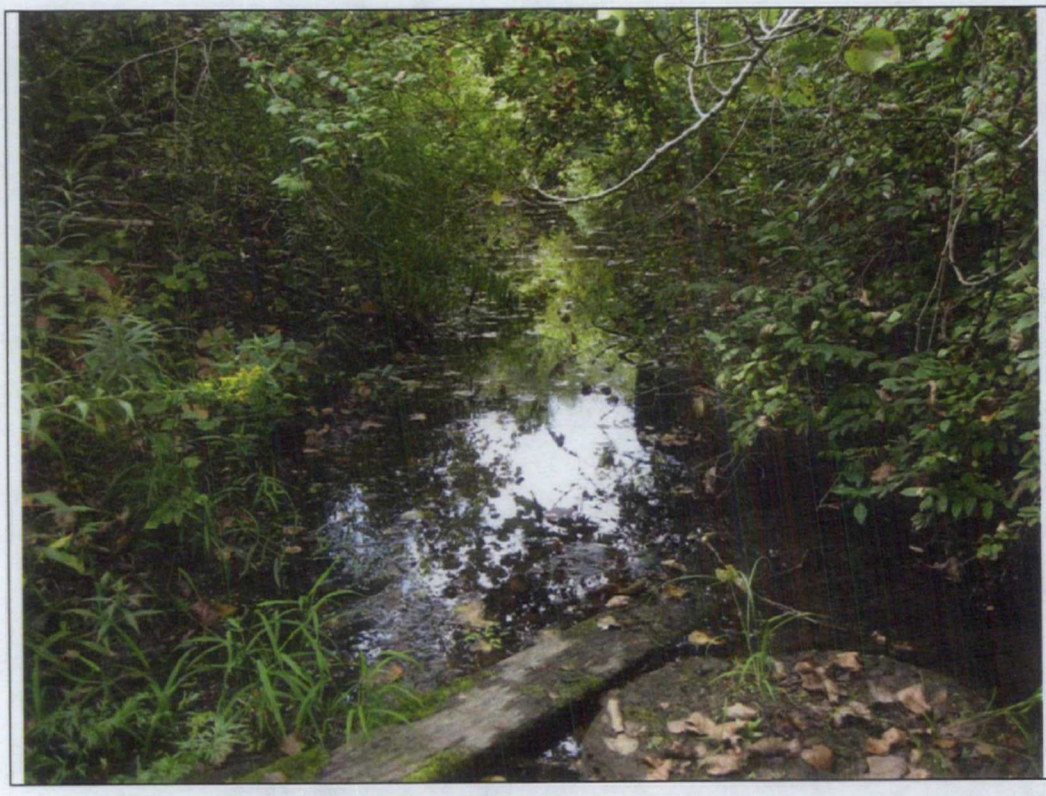


Photo A1-3

East outlet
(SP09-002)
N42.14760
W76.82799

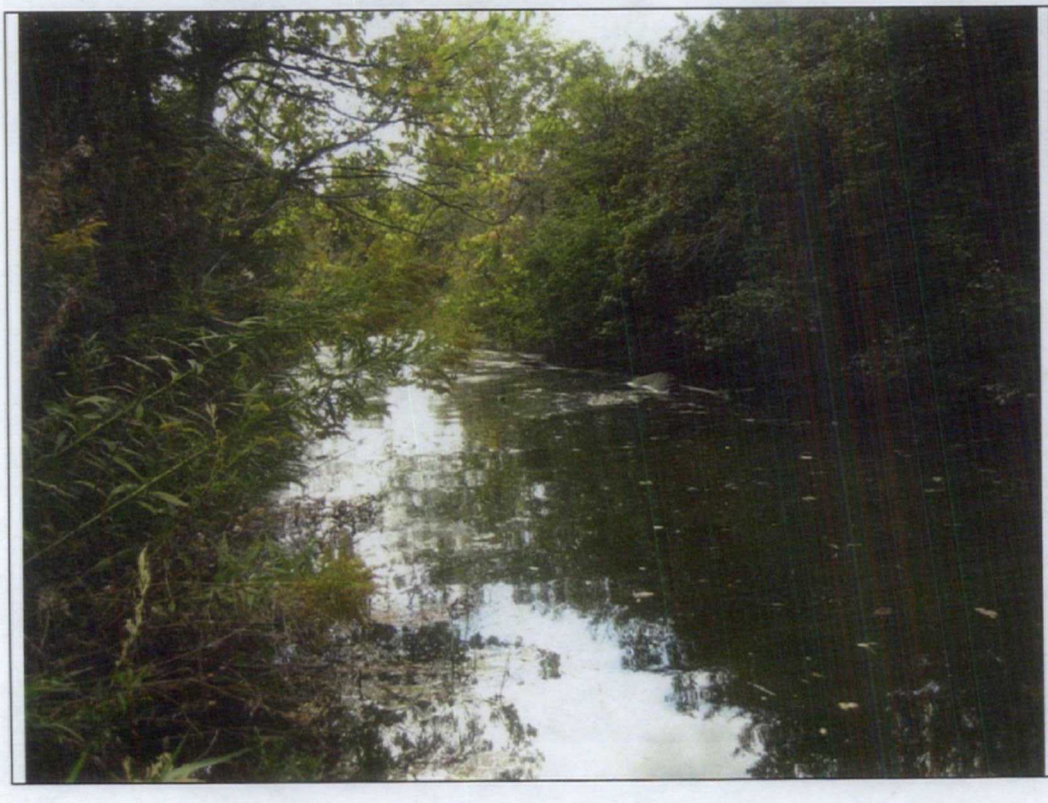


Photo A1-4

East outlet
(SP09-001)
N42.14848
W76.82771

Photo A1-5

Northeast shoreline
N42.14980
W76.82719

Photo A1-6

Northeast shoreline
N42.15006
W76.82639

Photo A1-7

Northwest backwater, near SP09-07
N42.15024
W76.83070

Photo A1-8

South shoreline, near SP09-10
N42.14886
W76.82832

Photo A1-9

Southwest shoreline, near SP09-05
N42.14838
W76.82979

Photo A1-10

West shoreline, near SP09-06
N42.14960
W76.83015

Photo A1-11

West shoreline, near SP09-09
N42.14963
W76.62950

ATTACHMENT 2

PLANT SURVEY FORM

Lake Name: Koppers Pond						Start Time: 10:25 am			Description Starting Point: East Outlet					Station	
Sampling Date: 9/16/2009						End Time: 1:40 pm			Lat: W76.82771			Long: N42.14848		Description	Comment
						Exotics/Target Plants			Native and Other Plants						
Station #	Sample #	Lat	Long	Depth (m)	Overall Plant Abundance	Northern Slender Pondweed (*Stuckenia filiformis v. alpinus*)			Coontail (*Ceratophyllum demersum*)	Duckweed (*Lemna minor*)					
5	1	W76.82979	N42.14838	0.76	S	Z			S	C				SP09-005	Pond location
6	1	W76.83016	N42.14960	0.46	S	Z			S	Z				SP09-006	Pond location
7	1	W76.83069	N42.15024	0.20	S	Z			S	Z				SP09-007	Pond location
8	1	W76.83023	N42.15142	0.30	S	Z			S	Z				SP09-008	Industrial drainageway
9	1	W76.82950	N42.14963	0.30	S	Z			S	Z				SP09-009	Pond location
10	1	W76.82832	N42.14886	0.61	S	Z			S	Z				SP09-010	Pond location
11	1	W76.82719	N42.14980	0.15	S	Z			S	Z				SP09-011	Pond location
12	1	W76.82639	N42.15006	0.46	S	Z			S	Z				SP09-012	Pond location
13	1	W76.82709	N42.14904	0.30	S	Z			S	Z				SP09-013	Pond location
Abundance Value: Z = Zero; T = Trace, S = Sparse; C = Common															
Additional Comments:		The CSLAP abundance codes were modified since a rake was not used for sample survey (see Technical Memorandum No. 1 for discussion).													
		Lat/Long values based on NAD83.													
		Station # was the GPS waypoint. The corresponding sample ID is shown under the description column.													

Table A2-1. Field Macrophyte Survey Form for Koppers Pond and Industrial Drainageway

Lake Name: Koppers Pond Outlets						Start Time: 10:25 am			Description Starting Point: East Outlet					Station	
Sampling Date: 9/16/2009						End Time: 1:40 pm			Lat: W76.82771			Long: N42.14848		Description	Comment
						Exotics/Target Plants			Native and Other Plants						
Station #	Sample #	Lat	Long	Depth (m)	Overall Plant Abundance	Northern Slender Pondweed (*Stuckenia filiformis v. alpinus*)			Coontial (*Ceratophyllum demersum*)	Duckweed (*Lemna minor*)					
1	1	W76.82771	N42.14848	0.80	Z	Z			Z	Z				SP09-001	East outlet
2	1	W76.82799	N42.14760	0.15	Z	Z			Z	Z				SP09-002	East outlet
3	1	W76.82943	N42.14754	0.20	Z	Z			Z	Z				SP09-003	West outlet
4	1	W76.82993	N42.14776	0.15	Z	Z			Z	Z				SP09-004	West outlet
14	1	W76.82678	N42.14640	0.15	Z	Z			Z	Z				SP09-014	East outlet
Abundance Value: Z = Zero; T = Trace, S = Sparse; C = Common															
Additional Comments:		The CSLAP abundance codes were modified since a rake was not used for sample survey (see Technical Memorandum No. 1 for discussion).													
		Lat/Long values based on NAD83.													
		Station # was the GPS waypoint. The corresponding sample ID is shown under the description column.													

Table A2-2. Field Macrophyte Survey Form for Koppers Pond East and West Outlets

ATTACHMENT 3
SUPPORTING STATISTICAL CALCULATIONS

Preface

This attachment provides a copy of the Minitab output from the statistical comparisons of the 2008 and 2009 water quality measurements. The probability plots for the normality testing of the data are shown in the following figures:

- Figure A3-1: Normal Probability Plot of Untransformed pH data from Koppers Pond.
- Figure A3-2: Normal Probability Plot of Untransformed DO data from Koppers Pond.
- Figure A3-3: Normal Probability Plot of Untransformed Specific Conductance data from Koppers Pond
- Figure A3-4: Normal Probability Plot of Ln transformed Specific Conductance data from Koppers Pond
- Figure A3-5: Normal Plot of Untransformed ORP data from Koppers Pond
- Figure A3-6: Normal Plot of Natural Log-Transformed ORP data from Koppers Pond
- Figure A3-7: Normal Probability Plot of Untransformed pH data from the Outlet Channels
- Figure A3-8: Normal Plot of Untransformed ORP data from the Outlet Channels
- Figure A3-9: Normal Probability Plot of Ln transformed ORP Data from the Outlet Channels

Normality testing was based upon the Ryan-Joiner Test (similar to Shapiro-Wilks test). The 2008 and 2009 test results were combined when testing for normality.

MINITAB OUTPUT

STATISTICAL COMPARISON OF FIELD MEASUREMENTS FROM 2008 AND 2009 FROM KOPPERS POND SAMPLES

1. Comparison of Koppers Pond pH Data

> pH data are normally distributed [W-test for normality; r=0.9874, p>0.100]

Two Sample T-Test and Confidence Interval

Two sample T for KP08-pH vs KP09-pH

	N	Mean	StDev	SE Mean
KP08-pH	6	7.997	0.110	0.045
KP09-pH	8	8.251	0.152	0.054

95% CI for mu KP08-pH - mu KP09-pH: (-0.409, -0.101)
T-Test mu KP08-pH = mu KP09-pH (vs not =): T = -3.64 P = 0.0039 DF = 11

2. Comparison of Koppers Pond Dissolved Oxygen Data

>DO data are normally distributed [W-test for normality; r=0.9494, p>0.100]

Two Sample T-Test and Confidence Interval

Two sample T for KP08-DO vs KP09-DO

	N	Mean	StDev	SE Mean
KP08-DO	6	10.002	0.837	0.34
KP09-DO	7	14.04	5.21	2.0

95% CI for mu KP08-DO - mu KP09-DO: (-8.92, 0.9)
T-Test mu KP08-DO = mu KP09-DO (vs not =): T = -2.02 P = 0.090 DF = 6

3. Comparison of Koppers Pond Specific Conductance Data

> Specific conductance data were not normally distributed [W-test for normality; r=0.8518, p<0.010]
> Specific conductance were not lognormally distributed [W-test for normality; r=0.9014, p<0.010]

Mann-Whitney Confidence Interval and Test

KP08-CON N = 6 Median = 0.06615

KP09-CON N = 8 Median = 0.09040
Point estimate for ETA1-ETA2 is -0.02440
95.5 Percent CI for ETA1-ETA2 is (-0.02889,-0.02100)
W = 27.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.0239
The test is significant at 0.0236 (adjusted for ties)

4. Comparison of Koppers Pond ORP Data

> ORP data were not normally distributed [W-test for normality; r=0.9069, p=0.0110]
> ORP data were not lognormally distributed [W-test for normality; r=0.8953, p<0.010]

Mann-Whitney Confidence Interval and Test

KP08-ORP N = 6 Median = 67.85
KP09-ORP N = 8 Median = 231.50
Point estimate for ETA1-ETA2 is -169.45
95.5 Percent CI for ETA1-ETA2 is (-189.70,-149.30)
W = 21.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.0024

STATISTICAL COMPARISON OF FIELD MEASUREMENTS FROM 2008 AND 2009 OUTLET CHANNEL SAMPLES

1. Comparison of Outlet Channel pH Data

> pH data are normally distributed [W-test for normality; r=0.9458, p>0.100]

Two-Sample T-Test and CI: OC08-pH, OC09-pH

Two-sample T for OC08-pH vs OC09-pH

	N	Mean	StDev	SE Mean
OC08-pH	4	7.950	0.159	0.079
OC09-pH	5	7.238	0.928	0.42

Difference = mu (OC08-pH) - mu (OC09-pH)
Estimate for difference: 0.712
95% CI for difference: (-0.461, 1.885)
T-Test of difference = 0 (vs not =): T-Value = 1.69 P-Value = 0.167 DF = 4

2. Comparison of Outlet Channel Specific Conductance Data

> Specific conductance data were not normally distributed [W-test for normality; r=0.7640, p<0.010]
> Specific conductance were not lognormally distributed [W-test for normality; r=0.7854, p<0.010]

Mann-Whitney Confidence Interval and Test

OC08-CON N = 4 Median = 0.09653
OC09-CON N = 5 Median = 0.10200
Point estimate for ETA1-ETA2 is -0.00547
96.3 Percent CI for ETA1-ETA2 is (-0.04195,0.00101)
W = 13.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.1113

Cannot reject at alpha = 0.05

3. Comparison of Outlet Channel ORP Data

>> ORP data are normally distributed [W-test for normality; r=0.9692, p>0.100]

Two-Sample T-Test and CI: OC08-ORP, OC09-ORP

Two-sample T for OC08-ORP vs OC09-ORP

	N	Mean	StDev	SEMean
OC08-ORP	4	135.8	21.9	11
OC09-ORP	5	287.8	56.8	25

Difference = mu (OC08-ORP) - mu (OC09-ORP)
Estimate for difference: -152.1
95% CI for difference: (-223.2, -80.9)
T-Test of difference = 0 (vs not =): T-Value = -5.49 P-Value = 0.003 DF = 5

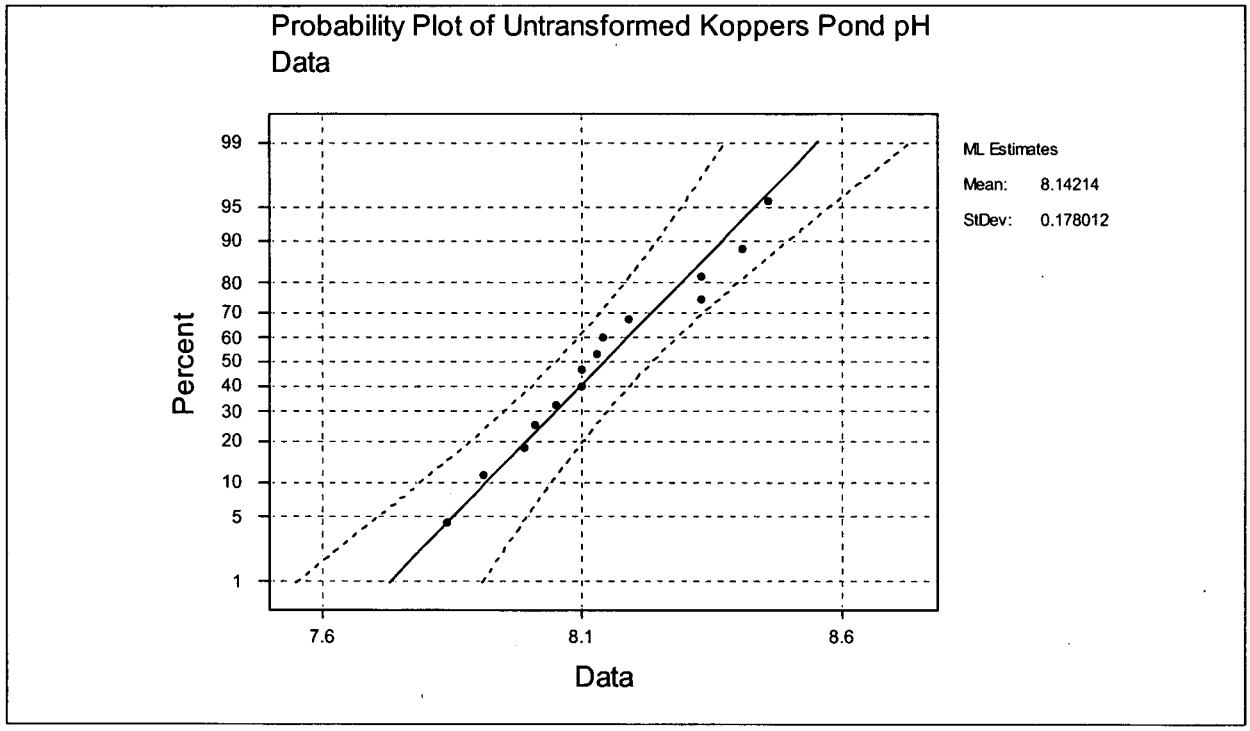


Figure A3-1: Normal Probability Plot of Untransformed pH data from Koppers Pond

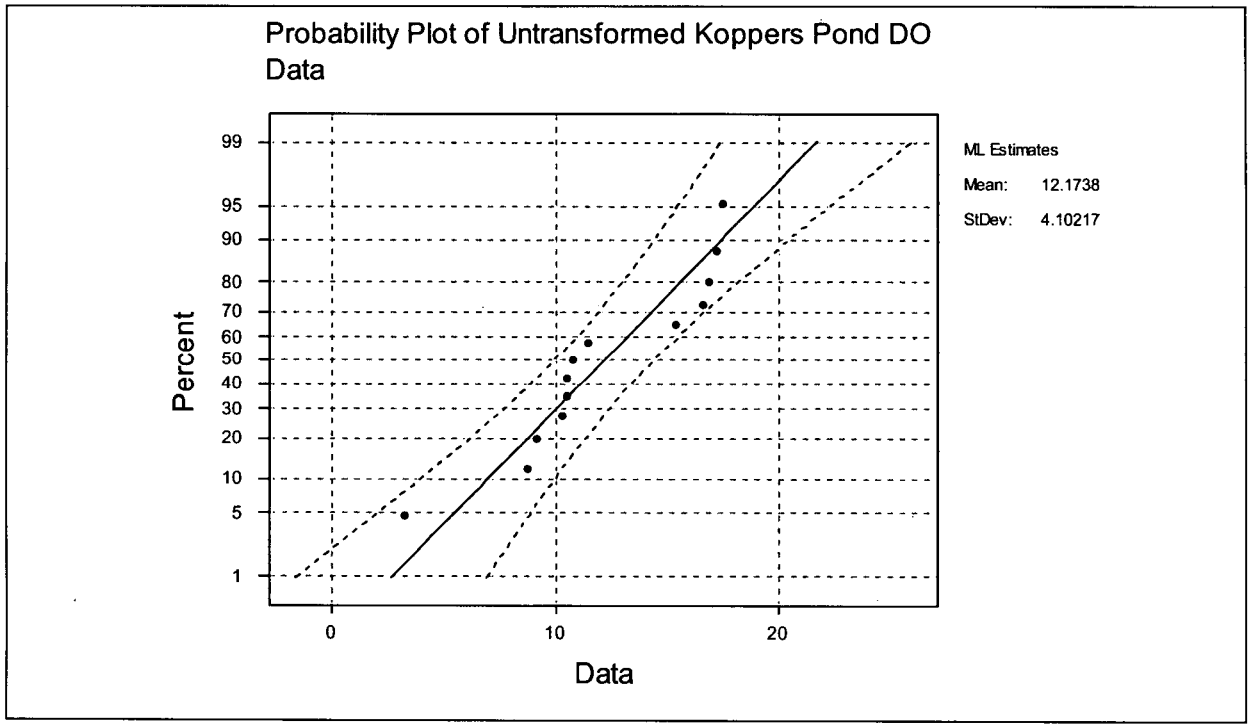


Figure A3-2: Normal Probability Plot of Untransformed DO data from Koppers Pond

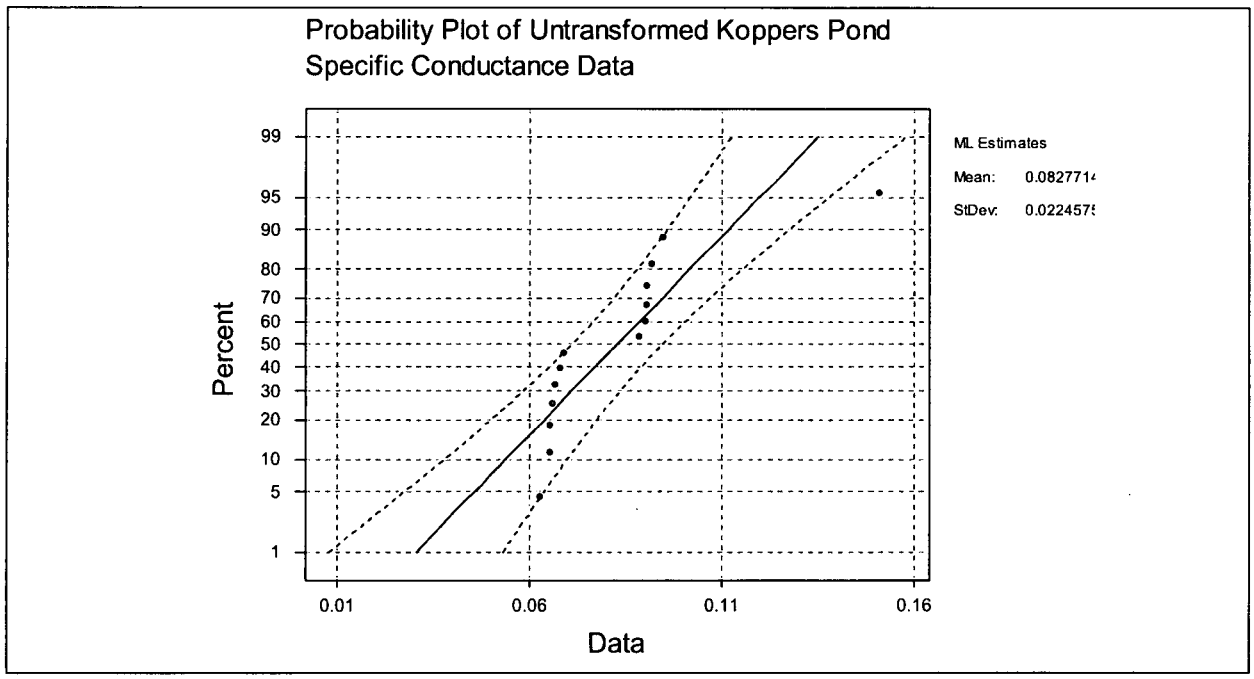


Figure A3-3: Normal Probability Plot of Untransformed Specific Conductance data from Koppers Pond

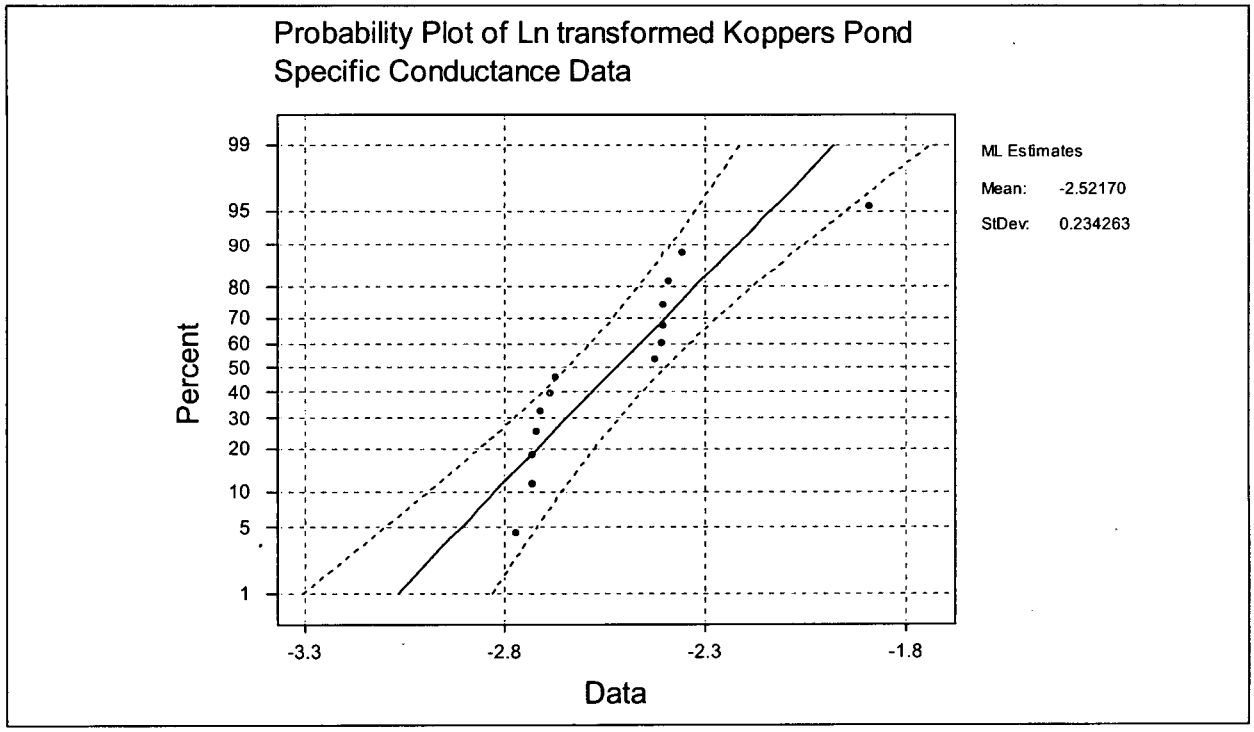


Figure A3-4: Normal Probability Plot of Ln transformed Specific Conductance data from Koppers Pond

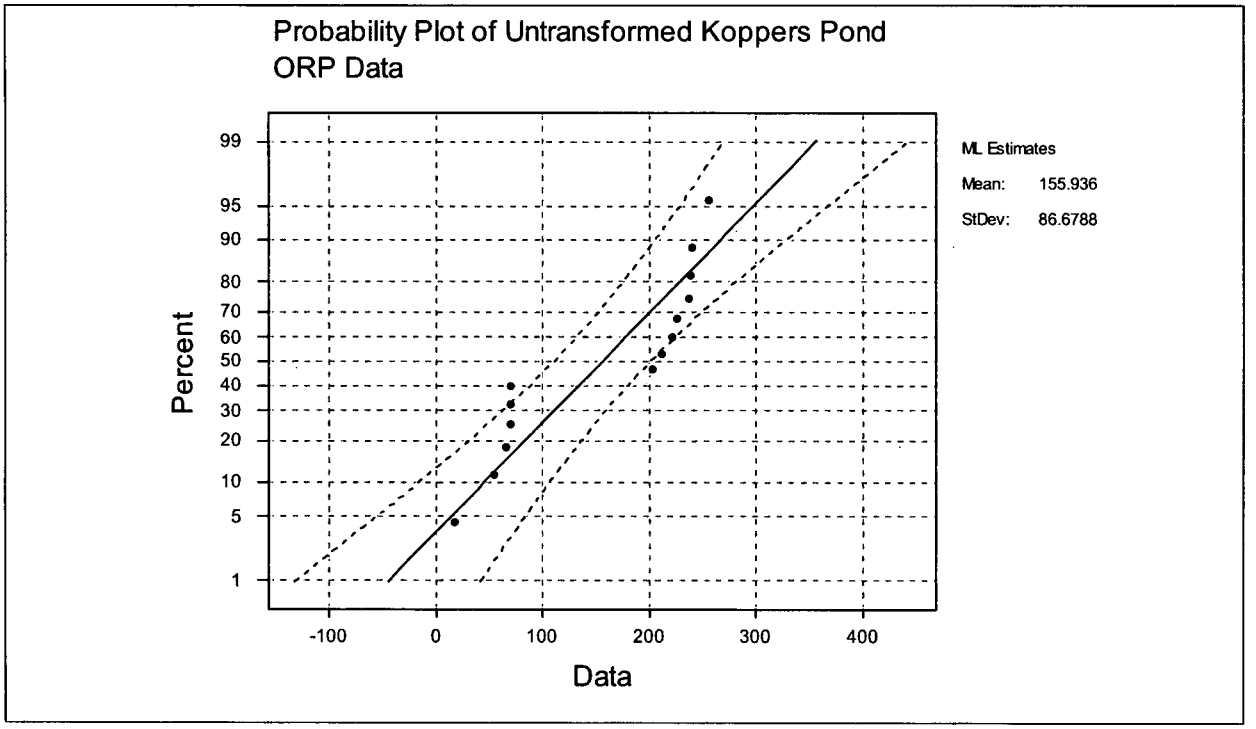


Figure A3-5: Normal Plot of Untransformed ORP data from Koppers Pond

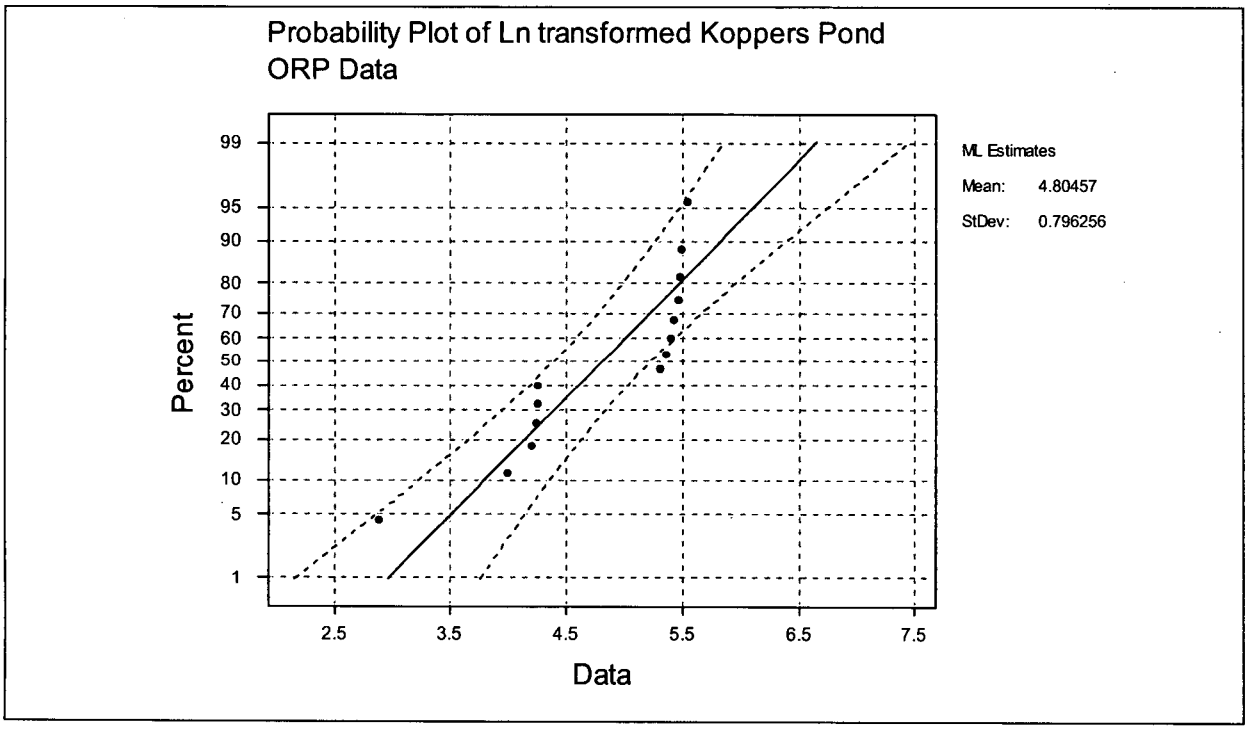


Figure A3-6: Normal Plot of Natural Log-Transformed ORP data from Koppers Pond

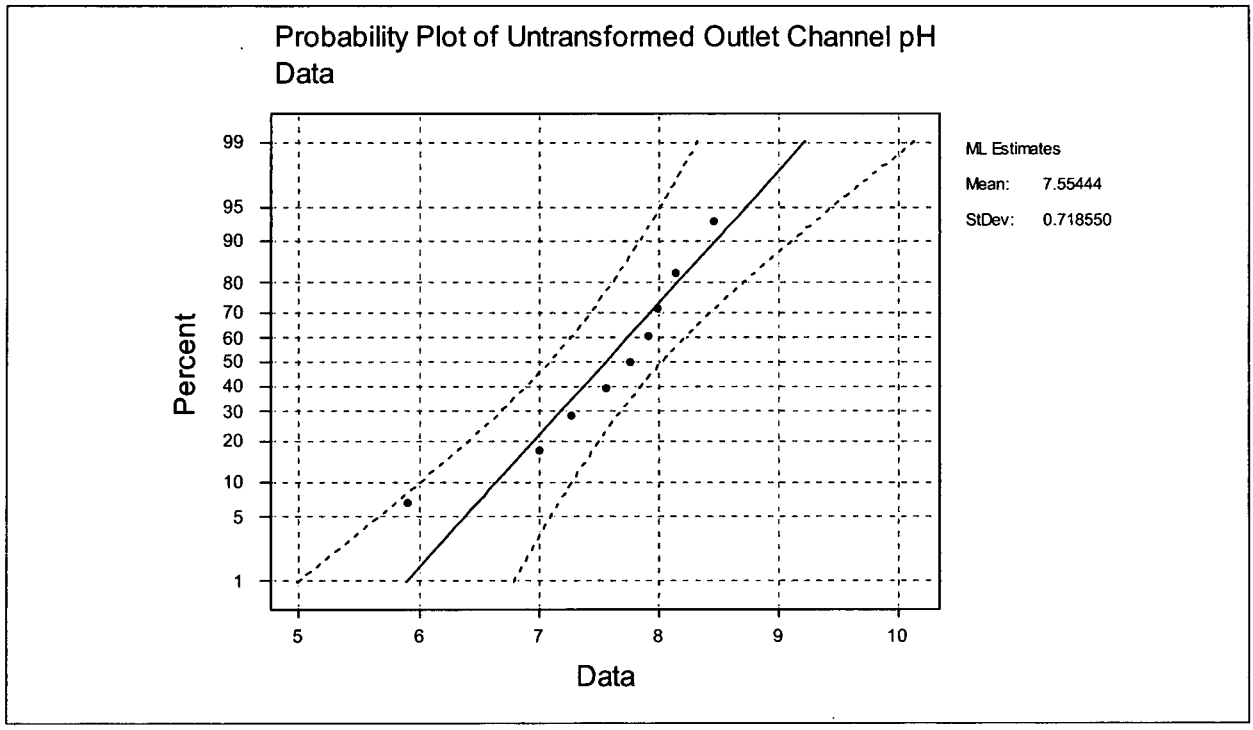


Figure A3-7: Normal Probability Plot of Untransformed pH data from the Outlet Channels

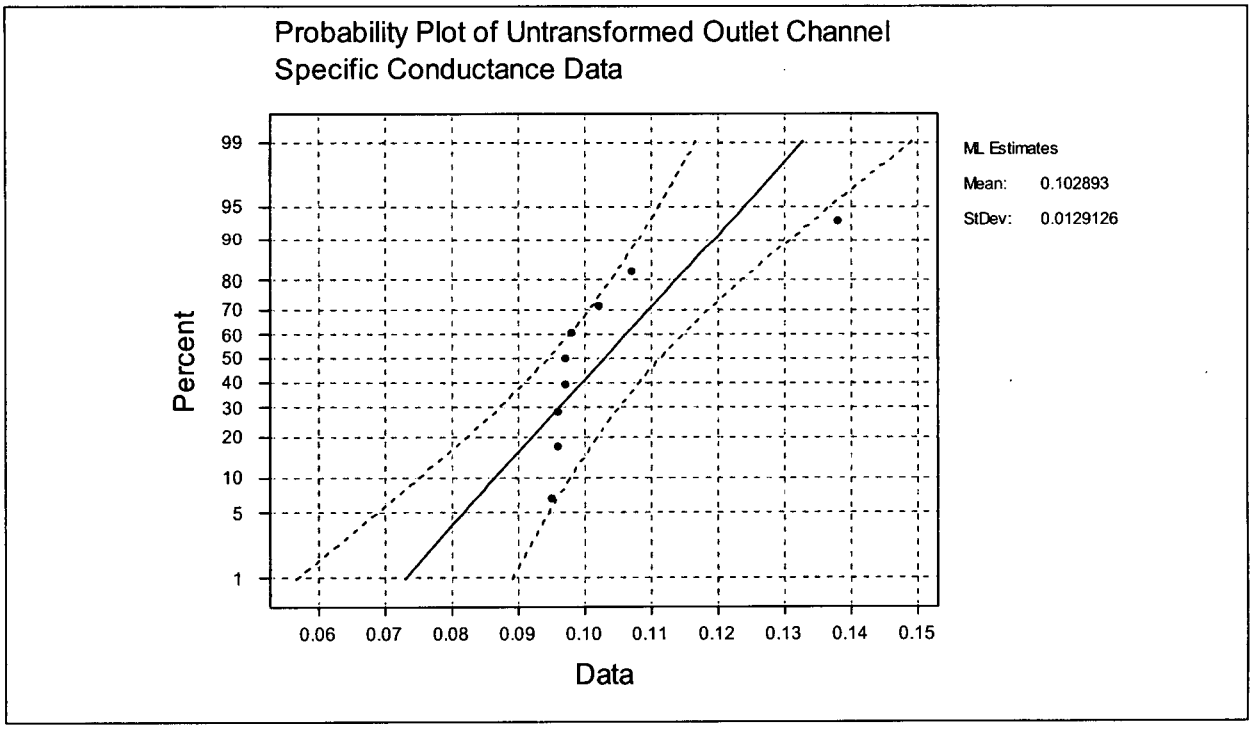


Figure A3-8: Normal Probability Plot of Untransformed ORP data from the Outlet Channels

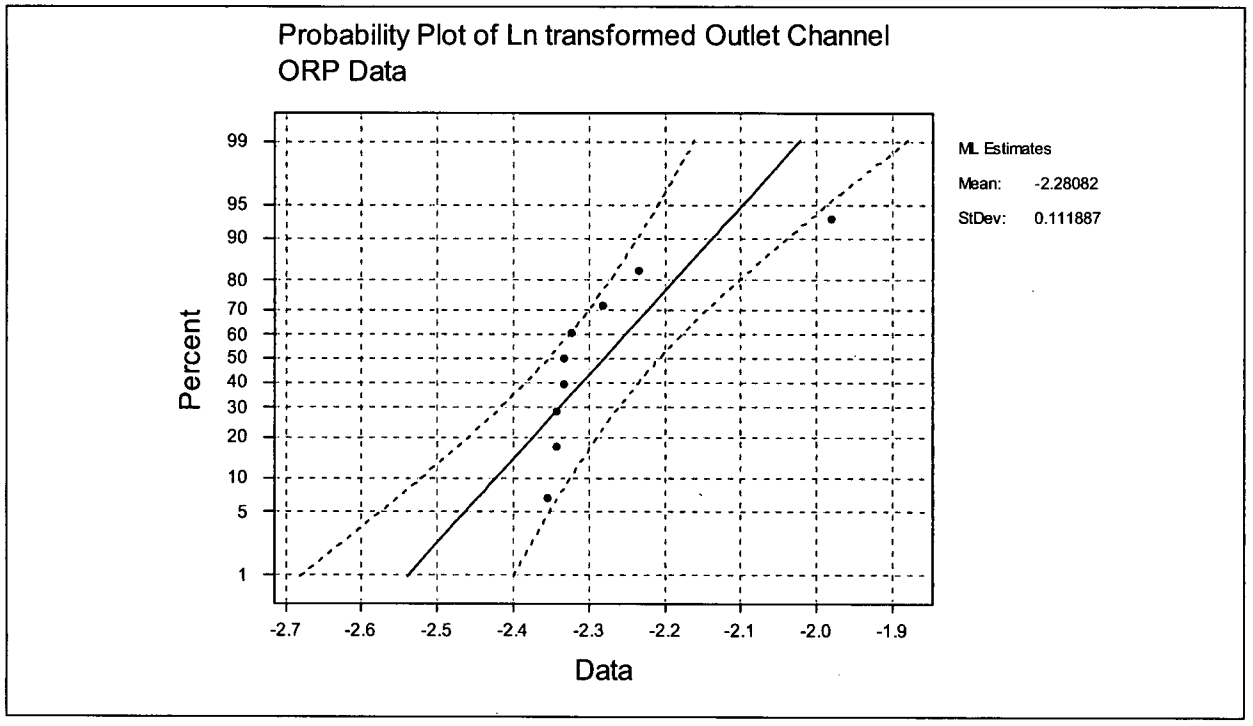


Figure A3-9: Normal Probability Plot of Ln transformed ORP Data from the Outlet Channels

ATTACHMENT 4
REFERENCE POND RECONNAISSANCE PHOTOGRAPH LOG

Preface

This attachment provides photographs from the following candidate reference pond reconnaissance performed on September 16 and 17, 2009:

- Pond #1 group - located behind the school west of Koppers Pond;
- Ponds #8a or #8b (Lowe Pond group, located in a county park); and
- Pond #9 (just west of Pond #7a; "Center at Horseheads").

Photo A4-1

Pond 1a - First of three ponds behind BOCES school

Photo A4-2

Pond 1b - Second of three ponds behind BOCES school

Photo A4-3

Pond 1c - Third of three ponds behind BOCES school

Photo A4-4

Pond 8a: Larger of Lowe Ponds

Photo A4-5

Pond 8b:
Smaller of
Lowe Ponds

Photo A4-6

Pond 9 Group

Photo A4-7

Pond 9 Group

Photo A4-8

Pond 9 Group