Screening Level Ecological Risk Assessment

for

Peter Cooper Markhams Site

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Prepared By:

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Executive Summary

Background

This Screening-Level Ecological Risk Assessment (SLERA) presents an assessment of potential ecological risks associated with chemicals detected at and adjacent to the Peter Cooper Markhams Superfund Site (the site; CERCLA Order 02-2000-2003). The objective was to fulfill Steps 1 and 2 outlined in the *Ecological Risk Assessment Guidance for Superfund* (ERAGS, USEPA, 1997b).

Peter Cooper Corp. and/or predecessor companies used the site for disposal of residue pile material and vacuum filter and cookhouse sludges from their Gowanda, NY plant (which produced animal glue and other adhesives). The site has mature hardwood tree cover and open fields. About 15-20-acres in the central and southeast portions of the site contain several covered/vegetated fill piles about 10-20 feet high arranged in an elliptical pattern. These piles are "waste fill," "mounded fill," or "fill piles." Some consist of re-worked native soil. Other piles consist of vacuum filter sludge and cookhouse sludge. The area covered by the piles approximates 7-acres.

Chemicals of Potential Concern (COPCs)

- Benzaldehyde
- Benzo(a)anthracene
- Benzo(b)fluoranthene
- Benzo(k)fluoranthene
- Benzo(ghi)perylene
- Benzo(a)pyrene
- Chrysene
- Fluoranthene
- 4-Methylphenol (p-Cresol)
- Naphthalene
- Pyrene
- Arsenic
- Chromium (total)
- Chromium (hexavalent or VI or Cr^{6+})

Conceptual Site Model

Problem Formulation results in the definition of the risk system of the site (schematically presented as the Conceptual Site Model or CSM), which describes the site and environs, presenting information regarding the fate and transport of site-related chemicals released from sources at the site and to which flora or fauna might be exposed.

Briefly, the problem at the Markhams Site is that placement of residues and sludges has resulted in the release of some chemicals into the environment. These chemicals, present in the terrestrial/upland habitat, may leach from the fill piles and/or soils (under and surrounding the piles) and enter groundwater under the site and then may migrate into wetlands on-site. Additionally, chemical contaminants sorbed onto soil particles may enter the wetlands via erosion due to overland flow. Once in the wetlands, these chemicals are likely to become associated with sediments. Figure 7 depicts the behavior of site-related chemicals at the Markhams Site, and the potential points, pathways, and routes of exposure in the terrestrial and wetland habitat.

Assessment and Measurement Endpoints

The Measurement Endpoints considered receptor exposure and risk using a two-step protocol.

- **Step i**—Assessment Endpoints were evaluated using maximum COPC concentrations compared to a set of Screening Criteria (Measurement Endpoint). If the maximum concentration of a COPC exceeded these criteria, then it was retained for **Step ii**.
- **Step ii**—Assessment Endpoints for COPCs passing **Step i** were evaluated using the Hazard Quotient (HQ) method for an appropriate model species (the Measurement Endpoint being the ratio of potential environmental and dietary exposure for adverse ecological effects to an appropriate Toxicity Reference Value [No Observed Adverse Effect Level]).

- Protection of **Terrestrial Plant Communities** from ecological changes related to chemical exposure, in particular maintenance of species diversity and survival, and biomass production at levels similar to areas not exposed to COPCs.
- Protection of the **Soil Biota Community** from decreased sustainability (such as, survival, growth, or reproductive success), as well as associated soil nutrient processes, from ecological changes due to COPC exposure.
- Protection of **Terrestrial Vertebrate Communities** from decreased sustainability (such as, survival, growth, or reproductive success) due to COPC exposure.
- Protection of **Wetland Community Components** including aquatic plant community, aquatic herbivore, aquatic insectivore, aquatic benthic/sediment-associated invertebrate community, and macro-benthic invertebrate community individually and collectively, which require protection from survival, growth, and/or reproductive success due to COPC exposure, and that might result in functional ecological changes.

Screening-Level Effects Assessment

Various Environmental Screening Criteria were obtained through the Oak Ridge National Laboratory Risk Assessment Information System (RAIS, updated and current as of March 2005). The Ecological Effects Evaluation describes the toxicological characteristics of the COPCs and establishes Toxicity Reference Values (TRVs) for each endpoint species identified at a site.

Screening-Level Exposure Estimates

The screening analysis used detected (bulk) levels of COPCs in various environmental media. For the SLERA, we also determined (modeled) concentrations in vegetation, soil invertebrates (earthworms), macrobenthic invertebrates in wetland sediments, bioaccumulation in secondary trophic species, and food chain exposure for higher level ecological receptors (green frog, painted turtle, American robin, marsh wren, deer mouse, short tailed shrew, and raccoon).

Screening-Level Risk Estimation

EnRG obtained various Environmental Screening Criteria, namely media-specific screening levels, for use in evaluating COPC concentrations. The screening-level estimation of risk was performed by a simple comparison for soil in the landfill area and wetland sediments and surface water. If measured environmental media concentrations exceed these criteria, then greater attention can be paid to those areas and COPCs.

- Soil
  - **Not Above Screening Criteria**: all polycyclic aromatic hydrocarbons (PAHs)
  - **No Screening Criteria:** Benzaldehyde was retained
  - **Arsenic**—maximum > most criteria; average > most stringent criteria; background > most stringent criteria
  - **Chromium**—average & maximum > most criteria; background > many criteria
- Wetland Sediment
  - **Arsenic**—maximum > 50% of criteria; average < all criteria
  - **Chromium**—maximum > most criteria; average > most stringent criteria
- Wetland Surface Water
  - **Arsenic**—maximum < all criteria
  - **Chromium**—maximum > all criteria; average < all criteria

Risk Estimation Based Upon Food Chain Modeling

The organic COPCs are limited in their detectable presence in the source material and generally at the Markhams site; and comparing the concentration levels to general ecological screening criteria little risk, if any, is indicated. That risk, if important, is limited to a couple of sample locations and on or immediately adjacent to fill piles. Inorganic COPCs predominate, with the concentrations spanning several orders-of-magnitude.

The SLERA, consistent with guidance, suggests some potential risk from arsenic and chromium (total and hexavalent). Potential ecological risk is determined by, among other things: concentration of the particular COPC, bioavailability and bioaccumulative potential of the COPCs, the mechanism of exposure, and exposure frequency and duration. The food chain modeling indicates minimal increased ecological hazard to wildlife preying upon plants and invertebrates exposed to elevated COPC concentrations at the Markhams Site; but the analysis clearly suggests that the most significant risk, if real, is primarily due to direct soil and/or sediment exposure. Considering the available concentration data, we conclude that any impact, if it occurs, will be highly localized.

Conclusion

We are of the opinion that the data and information are adequate for the risk management decision-making process and sufficient to conclude that ecological risks at Markhams are negligible in context. It is highly unlikely that further ecological study will change the conclusions of this assessment.

1. Introduction

This document presents the results of a Screening-Level Ecological Risk Assessment (SLERA) for the Peter Cooper Markhams Superfund Site (the site or Markhams Site). The purpose of this assessment was the identification and characterization of potential risks to ecological receptors associated with chemicals detected at and adjacent to the site. Statutory requirements for such assessments are found in the Comprehensive Environmental Resource Conservation and Liability Act (CERCLA) as amended by the Superfund Amendments and Reauthorization Act (SARA).

Preparation of the SLERA follows a Unilateral Administrative Order (UAO) of the United States Environmental Protection Agency (USEPA) (CERCLA-02-2000-2003), the Respondents' Notices of Intent to Comply (February 2001), and the USEPA approved Remedial Investigation/Feasibility Study (RI/FS) Work Plan dated February 2001, revised September 2001 prepared by Geomatrix and Benchmark. Preparation of the assessment followed methods defined by USEPA guidance, the most important of which are listed below (a complete list of guidance and other literature consulted as part of the preparation of this assessment can be found in Section 7.0).

- Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments
- Guidelines for Ecological Risk Assessment
- Wildlife Exposure Factors Handbook
- USEPA Ecological Soil Screening Levels
- Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities
- ECO Update: The Role of Screening-Level Risk Assessments and Refining Contaminants of Concern in Baseline Ecological Risk Assessments
- Generic Ecological Assessment Endpoints (GEAEs) for Ecological Risk Assessment
- New York State Department of Environmental Conservation (NYSDEC) Fish and Wildlife Impact Analysis for Hazardous Waste Sites

Subject Property

The Subject Property is the Peter Cooper Corporation (PCC) Markhams Site general location information for the Subject Property follows:

Street Address:	Bentley Road
Hamlet/Town:	Hamlet of Markhams/Town of Dayton
County:	Cattaraugus
State:	New York
Zip Code:	14138
Latitude (North):	42.392897 42° 23′ 34.4″
Longitude (West):	-79.012572 -79° 59′ 14.7″
Elevation:	1,300 feet above sea level (approx.)
EPA CERLIS#	NYD980592547

The site is situated within an approximate 103-acre, wooded property in a flat-lying, rural farmland area, bounded to the northwest by Bentley Road (with a forested wetland beyond the road), to the northeast by a wooded property and farm field, by a railroad right-of-way to the southeast, and wooded property to the southwest. Site access is restricted by a locked cable gate at the Bentley Road entrance. Surrounding property is entirely rural, consisting of small farm fields, open meadow, and forests, with scattered wetlands.

Figure 1 (Site Locus) graphically indicates the physical location of the Subject Property within the state and locally; and it can be found on the Perrysburg, NY USGS 7.5-min topographic quadrangle map (#42079-D1-TF-024 1954, Photorevised 1979).

Figure 2 (Site Layout) diagrammatically presents the boundaries and general layout of the Subject Property.

PCC and/or predecessor companies used the Markhams Site for disposal of residue pile material from their Gowanda, NY plant between 1955 and 1971. The plant produced animal glue and other adhesives. The Markhams Site also received vacuum filter and cookhouse sludges. Cookhouse sludge reportedly was derived from the animal glue manufacturing process, and is comprised of settled sludge resulting from the processing of animal hides, some of which were chrome-tanned. Residue pile material is described as air-dried cookhouse sludge, which was stabilized to a fairly dry, granular form. Vacuum filter sludge reportedly was produced during primary (settling) treatment of liquid wastes, including liquids generated during gravity dewatering of cookhouse sludge. Disposal activities, involving approximately 9,600 tons of manufacturing residues, resulted in covering an area of almost 15-acres in size.

Besides the manufacturing residues, PCC transferred approximately 38,600 tons of previously accumulated wastes from the Gowanda plant to the Markhams Site between August 1971 and late 1972. This transfer was required by and conducted in compliance with a New York State Supreme Court Order, which required PCC to remove all or part of waste residue piles from the Gowanda site. At the Markhams Site, PCC arranged the material into several waste piles approximately 20 feet high and covering a total of approximately 7-acres, mostly in the original disposal area. No disposal occurred at the Markhams Site after 1971, and the disposal area remains undisturbed and has since revegetated.

Most of the site is characterized by mature hardwood tree cover, as well as open fields. About 15 to 20-acres in the central and southeast portions of the site contain several covered/vegetated fill piles arranged in an elliptical pattern. These elevated piles of material disposed at the site may be termed "waste fill," "mounded fill," or "fill piles." Several of these piles consist only of re-worked native soil. Reworked native soil means native soil material previously excavated and stockpiled on the property and planned for use as cover material for the fill piles. Other fill piles consist of vacuum filter sludge and cookhouse sludge. The fill piles vary in size and elevation (with a base ranging from approximately 1,100 to 160,000 square feet and elevations of 5 to 15 feet above grade). Tbe area covered by these piles approximates 7-acres.

Site topography, with the exception of the fill piles, is relatively flat with some natural relief and a moderate grade to the west-southwest. An approximately 5-foot high berm, which provides an elevated bed for the Buffalo and Jamestown Railroad Company (also known as Erie-Lackawanna Railroad) rail track, runs along the entire southeast border of the site. A dirt access road extends to the fill area from Bentley Road and continues around a portion of the fill area perimeter. The road also appears to provide access to a natural gas wellhead located on the eastern side of the drive, north of the fill areas.

Scope of Work

Under the September 2000 USEPA UAO, fieldwork for a Remedial Investigation/Feasibility Study (or RI/FS) began in September 2001, with an additional round of samples taken in late 2003 (see the Geomatrix-Benchmark RI report of 2005). It is the data from this report that serves as the basis for the SLERA.

In August 2002, Geomatrix Consultants, Inc. (Geomatrix) and Benchmark Environmental Engineering and Science, PLLC (Benchmark) prepared and submitted a Pathway Analysis Report (PAR, Geomatrix and Benchmark 2002)) for the Markhams Site, which provided an initial in-depth review of the collected analytical data from the initial 2001 RI/FS fieldwork. The 2002 PAR included subsections addressing both human health and ecological risk assessment issues. The ecological section of the report was a preliminary SLERA, which concluded (based upon simple comparisons of chemical concentration data in soils, wetland sediments, and wetland surface waters to a single, conservative Environmental Data Quality Levels [or EDQLs] and Sediment Quality Criteria [or SQC]) that a small number of chemicals and pathways required further evaluation in a Baseline Ecological Risk Assessment (BERA), namely:

- Arsenic and chromium in soil
- Chromium in wetland sediment
- Hexavalent chromium in wetland surface water

In a December 24, 2002 letter, the USEPA provided comments on the submitted PAR. Geomatrix and Benchmark responded to these comments in a letter dated February 26, 2003. The USEPA respond to the 2003 Response to Comments letter in another letter dated September 15, 2004. Because of the collection of additional data in 2003 (to address certain data quality issues) and to more fully respond to comments by the USEPA, Benchmark requested that Environmental Risk Group (EnRG) re-visit the SLERA before committing to time and expense of the BERA. (See Appendix 1, which provides a Regulatory Comment Responsiveness Summary.)

The objective of this SLERA was to fulfill Steps 1 and 2 outlined in the *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments* (ERAGS, USEPA, 1997b). The goal of the SERA is to determine whether constituents from the site pose a potential risk to plants, animals, and/or ecologically valuable habitats in the vicinity of the site.

- **Step 1** of the assessment involves the compilation of existing data and formulation of the ecological risk problem at hand at the site and a toxicity (ecological effects) evaluation.
- **Step 2** of the assessment involves the development of exposure estimates and ecological risk calculations.

From these results a recommendation can be made as to whether site contaminants pose a negligible threat or whether additional work (such as a BERA) and/or remediation are required. This is the first Scientific Management Decision Point (or SMDP) of the ecological risk framework (USEPA 1997b and 1998).

2. Problem Formulation

Problem Formulation establishes the goals and focus of the SLERA. It does this by:

1. Defining the environmental setting and chemical constituents known or suspected at the site
2. Describing the various transport and fate mechanisms that might exist at the site
3. Outlining the mechanisms of ecotoxicity associated with the contaminants and likely categories of receptors (*e.g.*, plants, vertebrates, invertebrates, and feeding guilds)
4. Identifying what complete exposure pathways might exist (an exposure pathway should include a source, a release mechanism from the source, a transport pathway from the source to the environment, a receptor, an exposure point contacted by the receptor, and a route into the receptor)
5. Selecting an Assessment Endpoint(s) to define adverse effects to relevant and appropriate ecological receptors

Problem Formulation results in the definition of the risk system, as depicted in the Conceptual Site Model (CSM). The CSM is a schematic depiction of a site and its environment that presents several types of information. This information includes possible sources of chemical constituents at the site, how they might be transported through the environment resulting either in their ultimate fate in some environmental media (such as soil, sediment, water, or air), and/or in exposure to plants and/or animals, through various routes of exposure.

Environmental Setting

General Setting

The Markhams Site occurs in Nutrient Ecoregion VII, called the *Mostly Glaciated Dairy Region.* The following description was abstracted from USEPA (2005 Enviromapper):

> *In general, this region has a short growing season and is dominated by forests and agricultural operations. It was mostly glaciated and includes flat lake plains, rolling till plains, hummocky stagnation moraines, hills, and low mountains. It has many wetlands and lakes. Soils (a mix of nutrient-rich and nutrient-poor types), climate, vegetation, land use, and surficial water characteristics are transitional between other nearby Ecoregions.*
>
> *Surficial water also us transitional between more northerly and more southerly regions and are affected by land use, such as livestock, cropland agriculture, and urban areas contributing nutrients and fecal coliform bacteria to streams.*

There are seven Level III sub-ecoregions within Aggregate Ecoregion VII. The Markhams Site occurs in one of them called: #61—*Erie Drift Plains.* The following description is abstracted from USEPA (2005 Enviromapper):

Once largely covered by a maple-beech-birch forest, much of the Erie Drift Plain is now agricultural in use. The glaciated Erie Drift Plain is characterized by low rounded hills, scattered end moraines, kettles, and areas of wetlands, in contrast to the adjacent unglaciated ecoregions to the south and east that are hillier and less agricultural. Areas of urban development and industrial activity occur locally.

According to the Geomatrix-Benchmark RI report (2005), the Hamlet of Markhams and Town of Dayton are located within a broad glacial valley with large sedimentary deposits from the pro-glacial Lake Conewango. Lacustrine deposition and outwash deposition of clay to gravel-size material is prevalent throughout the valley. Upper Devonian age shale bedrock formations exist below the sediments.

Groundwater exists within the sediments of the glacial valley. The depth to groundwater is shallow throughout, generally occurring within 10 feet below ground surface (bgs). Wetland areas exist in the valley as a function of the shallow water table conditions and the presence of isolated clay lenses that produce perched groundwater conditions. The regional direction of groundwater flow within the valley floor is southward, toward and then following Conewango Creek.

Current Conditions

Geomatrix and Benchmark performed Remedial Investigation field activities on several occasions at the Markhams Site during the period of November 28, 2000 to December 4, 2003. A site visit was conducted from October 7th - 9th, 2001 by an ecologist from Vanasse Hangen Brustlin Incorporated (VHB) to prepare the original Pathway Analysis Report (Geomatrix and Benchmark 2002). A follow-up Site Reconnaissance was performed by EnRG in late December 2004 as part of the preparation of this report. General information collected during these events is provided in Appendix 2 Ecological Assessment Checklist, and developed below into a description of the site setting, current and future conditions, soils, cover types, and natural resources.

The majority of the site (the northeastern, northwestern, and southwestern portions) is characterized by mature hardwood tree cover as well as forested and open wetland area. A 15-20 acre area within the central and southeast portion of the site has several covered/vegetated fill piles arranged in an elliptical pattern, which vary in size and elevation, and with a total covered area of about 7-acres.

No structures are present on site, except for a natural gas wellhead located east of the access drive. The access drive is generally clear from Bentley Road to the fill area and along the northern perimeter of the fill piles. It is vegetated around the southern and eastern fill area perimeter, and is generally indistinguishable.

A dense mat of grassy vegetation, low-lying brush, and briar thickets cover the fill piles and immediate surrounding areas. No seeps or significant erosional features were observed on the fill piles. Low-lying brush and trees surround the fill pile area.

Beyond the area of the fill piles, non-contiguous wetland areas exist on site property west, north, and east of the fill piles. As shown in Figure 2, the larger wetland areas have an alphabetic designation (Wetland A through G). Standing water is present seasonally (generally December through April months) in all of the wetland areas. Wetland B, located north of the fill piles, retains standing surface water longer than the other wetland areas on the site. Wetland F, the largest wetland area on-site, contains both wetland vegetation and large trees with high water demand (cottonwoods and poplars).

There is a rail spur on the property that is disconnected from the main Erie-Lackawanna Railroad track. This spur is covered by heavy vegetative growth and partially covered with soil terminating below grade at the western end of the site. The switchgear was not observed on the adjacent active rail line, indicating that the siding was disconnected from the main rail following site closure.

Surrounding demographics are rural and sparsely populated as indicated by both direct observations during site reconnaissance and information provided by the Town of Dayton. The Hamlet of Markhams is generally characterized by large-acreage fields and pasture-lands and includes forested property. Agricultural fields (primarily livestock feed) surround the site. Land use near the site is consistent with the "agricultural/forestry" zoning designation for surrounding lands.

Soils

As stated above, the Markhams Site is located on glacial sediments. There are two types of human-placed fill material:

- Waste-fill material consisting of de-watered sludge, silt, sand, and gravel
- Non-waste fill, consisting of re-worked native soil with occasional construction/demolition debris.

According to the RI report, these fill materials (approximately 2 to 15 feet thick) are generally unsaturated and directly overlie the surface of the glacially-derived native soils. No seeps were observed on or below fill piles during the RI.

As discussed below, six distinct wetland areas were identified during the RI investigation. These areas are generally characterized by slightly lower topography with a thin veneer (< 2 feet) of vegetative matter, detrital matter, and peat, directly overlying native soil.

The native, glacial soils are described by Geomatrix-Benchmark (2005) in the RI report as consisting of a glacial outwash unit and a lacustrine (lake deposited) unit. The outwash deposits cross the site, with poorly sorted fine to coarse sand and fine gravel, varying in thickness from 8 feet near the center of the site to 18 feet at the southwest corner. Lacustrine silt and fine sand occurs below the outwash sand, and are stratified and discontinuous with alternating layers of silt and clay. The thickness of these fine-grained deposits is unknown.

NRCS Soil Component Descriptions

Site soils include a range of silty loams as described by the NRCS (2004). Figure 3 presents the soil survey information for the site and surrounding area. The following paragraphs present the NRCS Soil Component Descriptions of the soils identified in Figure 3. Additional technical information about these various soil map units is provided in Appendix 4 Soil Survey Data and Information.

Map Unit: 20A. Unadilla silt loam, 0-3% slopes—The Unadilla series consists of very deep, well drained soils on terraces, lake plains, and uplands. They formed in water or wind-deposited silt and very fine sand. Typically these soils have a dark brown silt loam surface layer that is 8 inches thick. The subsoil from 8 to 31 inches is yellowish brown silt loam and from 31 to 42 inches is yellowish brown very fine sandy loam. The substratum from 42 to 60 inches is dark grayish brown stratified very gravelly sand. Slopes range from 0 to 50%.

Map Unit: 22B. Allard silt loam, 3-8% slopes—The Allard series consists of deep, well drained soils on outwash terraces and valley trains. They formed in silty alluvium or outwash deposits that overlie sandy and gravelly outwash. Typically these soils have a dark grayish brown silt loam surface layer 8 inches thick. The subsoil layers from 8 to 24 inches are yellowish brown, brown, and dark brown silt loam. The substratum from 24 to 60 inches is brown and grayish-brown very gravelly loamy sand and very gravelly sands, and the slopes range from 0-15%.

Map Unit: 25A. Chenango Gravelly Silt Loam, 0-3% slopes—The Chenango series consists of very deep well drained to somewhat excessively drained soils on glacial outwash plains. They formed in water-sorted material. Typically these soils have a very dark grayish brown gravelly silt loam surface layer 8 inches thick. The subsoil layers from 8 to 30 inches are dark yellowish brown and brown gravelly and very gravelly silt loam and loam. The substratum occurs from 30 to 72 inches and is loose, very gravelly loamy coarse sand. Slopes range from 0 to 6%.

Map Unit: 25B. Chenango Gravelly Silt Loam, 3-8% slopes—The Chenango series consists of very deep well drained to somewhat excessively drained soils on glacial outwash plains. They formed in water-sorted material. Typically these soils have a very dark grayish brown gravelly silt loam surface layer 8 inches thick. The subsoil layers from 8 to 30 inches are dark yellowish brown and brown gravelly and very gravelly silt loam and loam. The substratum occurs from 30 to 72 inches and is loose, very gravelly loamy coarse sand. Slopes range from 0 to 60%.

Map Unit: 27A. Castile Gravelly Silt Loam, 0-3% slopes—The Castile series consists of deep, moderately well drained soils on outwash plains and valley trains. They formed in gravelly outwash deposits that overlie stratified sand and gravel. Typically these soils have a dark grayish brown gravelly loam surface layer 13 inches thick. The subsoil layers from 13 to 34 inches are yellowish brown, brown, and grayish brown very gravelly loam mottled helow 18 inches. The substratum occurs from 34 to 60 inches is grayish brown stratified sand and gravel. Slopes range from 0 to 15%.

Map Unit: 27B. Castile Gravelly Silt Loam, 3 to 8% slopes—The castile series consists of deep, moderately well drained soils on outwash plains and valley Trains. They formed in gravelly outwash deposits that overlie stratified sand and gravel. Typically these soils have a dark grayish brown gravelly loam surface layer 13 inches thick. The Subsoil layers from 13 to 34 inches are yellowish brown, brown, and grayish brown very gravelly loam mottled below 18 inches. The substratum occurs from 34 to 60 inches is grayish brown stratified sand and gravel. Slopes range from 0 to 15%.

Map Unit: 34. Getzville Silt Loam—The Getzville series consists of deep poorly drained and very poorly drained soils on Lake Plains. They formed in silty lake laid sediments over sandy deposits. Typically these soils have a dark grayish brown silt loam surface layer 8 inches thick. The mottled subsoil from 8 to 24 Inches is light brownish gray light silty clay loam and silt loam. The mottled substratum occurs from 24-60 inches and is dark brown fine sand. Slopes range from 0 to 3%.

Map Unit: 39A. Halsey Silt Loam, 0 to 3% slopes—The Halsey series consists of very deep, very poorly drained soils on terraces. They formed in glacial outwash material. Typically these soils have a very dark gray loam surface layer 9 inches thick. A mottled subsurface layer from 9 to 18 inches is gray loam. The mottled subsoil from 18 to 24 is gray loam and from 24 to 30 inches is light olive gray very fine sandy loam. The substratum occurs from 30 to 60 inches is gray and light olive brown stratified gravel and sand, with slopes ranging from 0-8%.

Map Unit: 43. Canandaigua Silt Loam—Canandaigua series consists of very deep, poorly drained, and very poorly drained soils on glacial lake plains and in upland depressions. They formed mainly in silt glacio-lacustrine sediments. Typically, these soils have a dark gray silt loam surface layer 8 inches thick. The friable silt loam subsoil, from 8 to 12 inches is light brownish gray; from 12 to gray, and from 19 to 30 in. Is light brownish gray. The substratum occurs from 30 to 72 in is light gray and light brown and light brown stratified layers of silt loam and very fine sandy loam; and with slopes ranging from 0-3%.

Map Unit: 44. Canandaigua Mucky Silt Loam—Canandaigua series consists of very deep, poorly drained and very poorly drained soils on glacial lake plains and in upland depressions. They formed mainly in silt glacio-lacustrine sediments. Typically, these soils have a dark gray silt loam surface layer 8 inches thick. The friable silt loam subsoil, from 8 to 12 inches is light brownish gray; from 12 to gray, and from 19 to 30 in. Is light brownish gray. The substratum occurs from 30 to 72 in is light gray and light brown and light brown stratified layers of silt loam and very fine sandy loam, and with slopes ranging from 0-3%.

Map Unit: 46. Swormville Silt Loam—Swormville series consists of very deep, somewhat poorly drained soils formed in fine-textured glacio-lacustrine sediments overlying coarse-textured glacio-lacustrine sediments on lake plains. Typically, these soils have a dark grayish brown clay loam surface layer, 8 inches thick. The mottled subsoil, from 8 to 20 inches is yellowish brown clay loam and loam and, from 20 to 26 inches, is light yellowish brown loamy fine sand. The substratum, from 26 to 72 inches, is gray sand. Slopes range from 0-3%.

Map Unit: 49A. Red Hook Silt Loam, 0-3% slopes—The red hook series consists of deep, somewhat poorly drained soils on terraces. They formed In outwash deposits that overlie stratified materials. Typically these soils have a very dark grayish brown silt loam surface layer 6 inches thick. The subsoil from 6 to 22 inches is brown and Grayish brown silt loam and loam that is mottled below 8 inches. The substratum occurs from 22 to 60 inches is grayish brown gravelly loam that is mottled. Slopes range from 0-8%.

Map Unit: 101. Udorthents Refuse Substratum—Udorthents, refuse substratum, consists of deep and very deep, excessively drained to moderately well drained soils in areas of sanitary land fills. These soils are filled and graded material that overlies refuse and other buried debris. Because of mixing of the soil material, soil profile development is absent or weak, and soil texture is variable. These areas commonly have about 2 feet of soil covering the landfilled debris, with slopes ranging from 0-15%.

RI Soil Observations

The Remedial Investigation (Geomatrix-Benchmark 2005) characterized the physical properties of the waste fill, fill cover and perimeter surface soils, native subsurface soils, and wetland sediments. A brief summary of this information follows and it compares well to the data for the various general NRCS Soil Map Units presented in Appendix 4.

Native Subsurface Soils—Soil grain size analysis indicate these soils are primarily sand, with some fines (mostly silt), and fine gravel. The lacustrine soil is primarily silt, with some fine sand, and clay. Total Organic Carbon (TOC) content ranged from 0.24% to 1.2%. Leachable pH analysis indicated slightly alkaline soil conditions within the saturated zone. Manganese concentrations in the native subsurface soils ranged from 210 to 561 mg/kg. Cation Exchange Capacity (CEC) is a direct measure of the amount of positively charged ions (cations) able to be retained by the soil matrix. CEC is directly related to the amount of organic matter and clay content of the soil, and ranged from 0.9 meq/100g to 19.2 meq/100g in an upgradient location (MW-9D). This reflects the relatively high organic and clay content of the soil. Higher CEC values indicate an increase in the soil's ability to retain cations such as sodium, magnesium, calcium, and other positively charged ions, like chromium and arsenic. The absence of trace metals such as arsenic, zinc, magnesium, and chromium in downgradient groundwater samples suggests that the lacustrine sediments, which tend to have a higher clay and TOC content than the outwash deposits, may have a higher capacity to bind with these cations.

Fill Cover and Perimeter Surface Soils—Fill cover soils were analyzed for TOC and ranged from 1.1% to 13.2%, while composite samples had a TOC ranging from 1.2

to 3.6%. The vertical hydraulic conductivity of cover soil ranged from 7.8 x 10^{-5} to 5.1 x 10^{-6} cm/s. Surface soils grain size distribution (based on composite samples) consist primarily of sand, silt, and gravel; although one composite sample (#156) consisted of sand, silt, and clay; this finer grained nature is possibly surface soil-like due to less disturbance than other areas nearer the fill piles.

Wetland Sediments—The northern and southwestern wetland areas are generally discontinuous, with seasonally present ponded water, and no observerable drainage. Ponding storm water drainage and groundwater discharge in these areas is underlain by organic-rich alluvial soil (wetland sediments). They have a grain size distribution of primarily fines (mostly silt) and sand. TOC ranged from 1.4% to 7.9%. Leachable pH of these soils ranged from 5.1 to 6.5, indicative of a weakly acid soil.

Waste Fill—This material is mixed within a silt and fine sand matrix (native soils) and contains various amounts of animal hair, ash and cinders, and gravel and clay; and is highly organic. Grain size analysis of the sludge fill indicates it is primarily sand and fines with some fine gravel. Non-waste fill (made-up of re-worked native soils, organic matter (roots and peat), and construction debris was encountered in several of the piles, and varies between three and six feet in thickness at these locations.

Terrestrial Setting

During the original site visit in 2001, four (4) distinct terrestrial habitat types were identified in the vicinity of the site (Figure 4). Plant species areas identified by cover type are presented in Table 1. No state or federal rare, endangered, or threatened (RET) plant species are known to be on site or in the general vicinity (see Appendix 3).

Cover Types

Each plant cover type area is described below as to the plant species composition, vegetation structure, and land use. Whenever possible, these areas were classified according to the New York State Natural Heritage Program's Ecological Communities of New York State (Edinger 2002 and Reschke 1990).

Cover Type 1: Successional Northern Hardwood Forest—This terrestrial forested upland community (#VI C 26 in Edinger, *et al.* 2002) is the dominant cover type at the site. This successional northern hardwood forest cover type is dominated by black cherry (*Prunus serotina*), cottonwood (*Populus deltoids*), and sugar maple (*Acer saccharium*). The understory is sparse except along the edges where more sunlight penetrates. It is comprised of staghorn sumac, dewberry (*Rubus flagellaris*) and tartarian honeysuckle (*Lonicera tatarica*). The ground layer also is sparse except along the forest edge and consists of hay scented fern (*Dennstaedtia punctiloba*) and garlic mustard (*Alliaria oficinalis*).

Cover Type 2: Successional Old Field—This terrestrial open upland community (#VI A 25 in Edinger, *et al.* 2002) is characterized as a weedy field dominated by grasses and forbs that occur on sites that historically were cleared for development. This cover type is found around an active gas well that is located in the northwest portion of the site. Dominant plant species include rough-stemmed goldenrod (*Solidago rugosa*), Canada goldenrod (*Solidago canadensis*), gray goldenrod (*Solidago nemoralis*), and late goldenrod (*Solidago gigantea*). In some areas, especially near the forested areas, woody vegetation such as staghorn sumac (*Rhus typhina*) and tartarian honeysuckle has begun to invade these fields.

Cover Type 3: Early Successional Field—This terrestrial open upland community (#VI A 25 in Edinger, *et al.* 2002) is similar to Cover Type 2 but it is in an earlier successional state. This cover type is found along the dirt roads and along the toe of some of the fill piles. It is dominated by late goldenrod, rough-stemmed goldenrod, burdock (*Arctium minus*), and red fescue (*Festuca rubra*).

Cover Type 4: Successional Northern Hardwood Forest—This terrestrial forested upland community (#VI C 26 in Edinger, *et al.* 2002) is the second most dominant cover type at the site, and is similar to Cover Type 1. This distinct cover type is dominated by 4- to 6-inch diameter quaking aspen (*Populus tremuloides*) trees, with a dense understory consisting of staghorn sumac, black raspberry (*Rubus occidentalis*) and tartarian honeysuckle. The groundcover is dense and consists of goldenrods and burdock.

Wetlands

The New York State Freshwater Wetlands Map, Gowanda and Perrysburg, New York topographic map was reviewed for the presence of state wetlands within two miles of the site. One state wetland, CK-3, is located on the site. The U.S. Fish and Wildlife Service (USFWS) National Wetlands Inventory (NWI) Map, Gowanda and Perrysburg, New York topographic map identifies the presence of several federal wetlands. Many federal wetlands were identified on and adjacent to the site during the site visit in 2001. Specifically, eight federal wetland plant communities were delineated within the boundary of the site (Figure 2). Plant species identified by cover type are presented in Table 1.

Cover Types

Each wetland is described below as to the plant species composition, vegetation structure, and land use. Whenever possible, these areas were classified according to the New York State Natural Heritage Program's Ecological Communities of New York State (Edinger, *et al.* 2002 and Reschke, 1990). In addition, the soil color and chroma as defined on a Munsell Color Chart is provided in parenthesis after the soil description.

Cover Type 5: Forested Wetland—This palustrine forested community (#V C 1 & 2 in Edinger, *et al.* 2002) is located in a depressional area in the western portion of the Site near monitoring well MW-1S, and is not indicated on the NWI map. It is dominated by cottonwood and red maple (*Acer rubrum*) trees, with an understory consisting of jewelweed (*Impatiens capensis*). The soil is dark-gray silty clay (gleyed 3/0). At the time of the survey, no standing water was present in the wetland.

Cover Type 6: Emergent/Scrub-Shrub Wetland—This wetland is a dominate feature of the site, located in its center. The wetland is identified on the NWI map as a palustrine, forested, broad-leaved deciduous, seasonal saturated (PFO1E) wetland (#V A 2 & 3 in Edinger, *et al.* 2002). This wetland is dominated by silky dogwood (*Cornus amomum*), northern arrowwood (*Viburnum recognitum*), jewelweed, broad-leaved cattail (*Typhia latifolia*), false nettle (*Boehmeria cylindrical*), soft rush (*Juncus effusus*), and Canada rush (*Juncus canadensis*). The wetland was saturated to the surface at the time of the survey. The soil is a gleyed muck (2.5Y 0).

Cover Type 7: Emergent/Open Water Wetland—This wetland is located north of Cover Type 6. This wetland is identified on the NWI map as a palustrine, unconsolidated bottom, intermittently exposed/permanent, excavated (PUBZx) wetland (#V A 2 in Edinger, *et al.* 2002). It is dominated by silky dogwood, soft rush, false nettle, black willow (*Salix nigra*), and cattails. At the time of the survey, 0.5 to 2 inches of standing water was present in the wetland. Auger refusal occurred at 2 inches below ground surface. The soil is a black organic material (2.5/0).

Cover Type 8: Forested/Scrub-Shrub Wetland—This wetland is located in the southeastern corner of the property. This wetland is identified on the NWI map as palustrine, forested, broad-leaved deciduous, seasonal saturated (PFO1E) wetland (#V A 3 & C 2 in Edinger, *et al.* 2002). It is dominated by cottonwood, slippery elm (*Ulmus rubra*), silky dogwood, false nettle, and jewelweed. This area is a depressional area where runoff from the surrounding berm areas and railroad deposit. Auger refusal occurred at 3 inches below ground surface. The soil is a silty loam (7.5YR 2.5/1).

Cover Type 9: Forested Wetland—This wetland borders the northern property line and extends into adjacent cornfields; it is not identified on the NWI wetland maps, and is dominated by red maple trees (#V C 1 & 2 in Edinger, *et al.* 2002). The understory consists of northern arrowwood, false nettle, and sensitive fern (*Onoclea sensibilis*). The soil is a light grey silty loam (10YR 5/2) with many orange mottles (7.5YR 5/8). An area of 3 to 6 inches of ponded water covered by duckweed with black muck (2.5Y 0) was observed. The soil in the non-ponded portion of the wetland was light-gray silty-clay (10YR 5/2) with many orange mottles (7.5YR 5/8).

Cover Type 10: Emergent/Scrub-Shrub/Forested Wetland—This is a large wetland complex that borders the western edge of the property, and is identified as state wetland CK-3 (#V A 2-3 & C 1-2 in Edinger, *et al.* 2002). It also is identified on the NWI maps as a palustrine, forested, broad-leaved, deciduous, seasonally saturated (PFO1E) wetland. The emergent portion of the wetland is near Bentley Road and is dominated by cattails and wool grass (*Scirpus cyperinus*). The scrub shrub borders the wetland and the dirt entrance road and is dominated by silky dogwood, northern arrowwood, and spice bush (*Lindera benzoin*). The forested portion dominates the southern portion of the wetland. It consists of cottonwood and red maple. The soils in the emergent portion are an organic muck (2.5Y 0). The soils in the forested and scrub-shrub portion are silty clay (10YR 5/2) with many yellow orange mottles (7.5YR 5/5).

Cover Type 11: Emergent/Scrub-Shrub Wetland—This wetland is located northeast of Cover Type 6. This wetland is identified on the NWI maps as a palustrine, forested, broad-leaved, deciduous, seasonally saturated (PFO1E) wetland (#V A 2-3 in Edinger, *et al.* 2002). The forested portion is dominated by red maple and slippery elm. The emergent portion is dominated by wool grass, sensitive fern, and *Carex lurida*. At the time of the survey, the wetland was saturated to the surface with less than an inch of standing water in some areas. The soil is a muck in the emergent area (2.5Y 0). The soil in the forested area is silty clay (10YR 5/2) with many orange mottles (7.5YR 5/8).

Cover Type 12: Forested/Scrub-Shrub Wetland—This wetland is found near the gas well in the northwestern portion of the site, and is not on the NWI wetland map. It is dominated by red maple, slippery elm, silky dogwood, wool grass, and sensitive fern (#V A 3 & C 2 in Edinger, *et al.* 2002). Auger refusal occurred at 2 inches. Soils within this are a loam (10YR 3/2) with yellow orange mottles (10YR 6/8).

Surface Water Bodies

Drainage patterns in the broad glacial valley of the Markhams/Dayton area are dendritic, generally flowing southwesterly. The area is located within the Allegheny River basin, with the site located specifically within the Conewango watershed (HUC#05010002; see Figure 5). The perennial stream—Johnson Creek (Branch Code #05010002000212)—occurs within ¼-mile east and south of the site (see Figure 5). Johnson Creek is classified by NYSDEC as a Class C Standard C, Unregulated Stream (according to J. Dietz of the Permits Office, Division of Water at NYSDEC Region 9). [Class C fresh surface waters are defined in 6 NYCRR §701.8 with the best usage of such waters as fishing, and shall be suitable for primary and secondary contact recreation and fish propagation and survival.] The site lies between Johnson Creek and Slab City Creek, and is approximately 1.5 miles north of their confluence, beyond the 100-year floodplain. The two creeks flow south ultimately into Conewango Creek (Branch Code #05010002000045).

Wetland areas in the northern portion of the site generally are not contiguous, and ponded water infiltrates directly to the subsurface. An area of wetlands in the southwestern portion of the site appears to be an area of localized groundwater discharge or surface water retention.

There is no visible drainage from wetland areas apparent on topographic maps or aerial photographs, nor were any observed during field mapping of site features. Therefore, direct discharge of surface water from on-site wetland areas does not occur to any near-by surface water bodies.

Fish and Wildlife Resources

In the vicinity of the Peter Cooper Markhams Site, land use is a mixture of wetlands, woodlands, and agricultural fields. This area appears to support a diversity of wildlife due to the limited amount of development. Wildlife uses in the area were evaluated using literature sources and field observations. Wildlife sightings included direct observations and identifications based on vocalizations, tracks, browse, and scat, and observed general wildlife values (*e.g.*, food and cover availability).

The USFWS and the New York State Department of Environmental Conservation Natural Heritage program were contacted for information concerning endangered and threatened species. No federal listed threatened or endangered species are known to exist on the site (Stoll 2005; see Appendix 3). No state listed threatened or endangered species are known to exist on the site (Mackey 2002 and Ketcham 2005; see Appendix 3).

Tables 2, 3, and 4 identify species of herptiles (amphibians and reptiles), birds, and mammals, respectively, that may potentially occur within and adjacent to the site based on the cover types identified during the field reconnaissance. The species observed during the 2001 field reconnaissance (which are representative for the point in time of the field reconnaissance) also are identified in these tables.

The successional old fields on the site serve as wildlife openings that provide edge, cover, and food. These areas will have songbirds and mammalian species such as goldfinches (*Carduelis tristis*), song sparrows (*Melospiza melodia*), white-footed mice (*Peromyscus leucopus*), and meadow voles (*Microtus pennsylvanicus*) which consume the seeds of grass and forbs. With an abundant prey base, carnivores, such as red fox (*Vulpes vulpes*), red-tailed hawks (*Buteo jamaicensis*), and barn owls (*Tyto alba*) may reside in the area.

When discussing the wildlife value of forest stands, the composition of tree species is important. The variability of each individual stand will slightly alter the wildlife present, and the greater the diversity of tree species, the greater the wildlife value. Although there is considerable overlap between food sources that wildlife may use in each stand, in general, the greater the diversity within the stand, and the larger the tract size, the more significant the value of the habitat.

The northern hardwood successional forest on the site is dominated by a variety of species including cottonwoods, maple, and black cherry. Black cherry is one of the most important wildlife food sources. Wild cherries comprise most of the diet of songbirds such as rose-breasted grosbeaks (*Pheucticus ludovicianus*), American robin (*Turdus migratorius*), cedar waxwing (*Bombycilla cedrorum*) and small mammals such as chipmunks (*Tamias striatus*) (Martin *et al.* 1951). The presence of sugar maples and cottonwoods increase the value of the area by providing additional sources of food and cover.

The wetland communities on or adjacent to the site provide habitat for many animals because of the seasonal presence of water. This water may be used directly for drinking by animals in the general area. In addition, ponded water is essential for breeding populations of amphibians.

Contaminants Known or Suspected to Exist at the Site

This assessment used data collected for the RI/FS process by Geomatrix-Benchmark (2005), and which is summarized below. A list of available data, samples numbers, and sample locations are provided in Tables 5 (Analytical Summary) and 6 (Sample Matrix), and Figure 6 shows where the different samples were collected on the site. This assessment considered only detected chemicals. Non-detected chemicals and essential nutrients (such as, calcium, potassium, sodium, and magnesium) were not considered in soil and wetland surface water and sediment. Only limited analytical data are available for subsurface soil (*i.e.*, generally greater than 2-feet bgs). These will be discussed as appropriate concerning environmental transport and fate, but are generally not a specific point of exposure to ecological (wildlife) resources. Chemicals detected in groundwater were not considered applicable for the ecological risk assessment because of the lack of wildlife exposure to these media. However, the potential fate and transport of these contaminants was considered in the evaluation.

Summary of RI Findings

A summary of findings from the 2005 RI for each site medium of interest follows.

Waste Fill

During the 2005 RI, waste fill samples were collected from three borings. The three samples were analyzed for total metal constituents of potential concern (COPCs), identified in the RI Work Plan as arsenic, chromium, and hexavalent chromium, as well as leachable metal COPCs via USEPA's Synthetic Precipitation Leaching Procedure SPLP. The metal COPCs detected in the waste fill were arsenic (65.6 mg/kg, max), chromium (31,200 mg/kg, max.), and hexavalent chromium (4.7 mg/kg, max.). Analysis of leachable metal COPCs detected the following maximum concentrations: arsenic (14.2 μg/L), chromium (1,010 μg/L), and hexavalent chromium (22.0 μg/L).

Surface Soil/Fill

Top of Fill Piles—Nine surface soil samples were collected from the cover of the fill piles and analyzed for metal COPCs. The highest concentrations detected in the cover soils were arsenic (95.5 mg/kg), chromium (65,300 mg/kg,), and hexavalent chromium (51.8 mg/kg).

Perimeter of Fill Piles—A total of 48 discrete surface soil samples were collected adjacent to and downgradient from the waste fill piles and analyzed for metal COPCs. The metal COPCs detected in perimeter surface soil samples were arsenic (55.1 mg/kg, max.), chromium (11,800 mg/kg, max.), and hexavalent chromium (33.0 mg/kg, max.).

Ten of the samples were analyzed for TCL VOCs and TCL SVOCs. No VOCs were detected above soil criteria. Five perimeter soil samples detected low concentrations of SVOCs: benzo(a)anthracene (27 μg/kg max.), benzo(b)fluoranthene (82 μg/kg max.), benzo(k)fluoranthene (41 μg/kg max.), benzo(a)pyrene (71 μg/kg max.), and indeno(1,2,3-cd)pyrene (40 μg/kg max.). As a group of chemicals, the SVOCs detected are known as PAHs.

Subsurface Soil/Fill

Perimeter of Fill Piles—Perimeter area subsurface soil samples were collected at 29 sample locations from depths of 6 to 12 inches bgs and analyzed for metal COPCs. The metal COPCs detected in the subsurface samples were arsenic (28.9 mg/kg, max.) and chromium (19,700 J mg/kg, max.). Hexavalent chromium was not detected in any of the perimeter subsurface soil samples.

Monitoring Well and Soil Borings—Native soil samples (non-waste fill) were collected below waste fill from four soil borings (B-1A, B-4, B-5, and B-6) at three depth discrete intervals: (1) immediately below the below the waste fill/native soil interface, (2) the subsequent one foot incremental depth, and (3) immediately above the water table. A subsurface soil sample was also collected from the unsaturated zone (1 foot above the water table) at monitoring well location MW-8S. The native soil samples were analyzed for metal COPCs.

Arsenic concentrations were detected within or near the range of values considered representative of background. Chromium concentrations were detected above all soil criteria at two boring locations: B-4 (16 to 17 feet below ground surface {depth interval of 1 to 2 feet below the waste fill}) and B-6 (7.5 to 8.5 feet below ground surface {depth interval of 1 to 2 feet below the waste fill}). The chromium concentration at these locations was 1,150 mg/kg (B-4) and 5,860 mg/kg (B-6). Chromium concentrations below these sample depths were within background levels. Hexavalent chromium was not detected in any of the samples analyzed. These data indicate that metal COPCs have not migrated substantially in native soil below the bottom of the waste fill piles.

Soil Vapor

Two field-measured soil vapor samples were analyzed using a calibrated multi-gas meter at gas probe GPZ-1 (see Appendix B, Figure 3-1); one during rhe initial monitoring event of the RI (November 5, 2001) and the other during the second monitoring event (April 22, 2002). The soil vapor monitoring data are summarized as follows:

- The lower explosive limit (percent of methane in air) exceeded the range of the instrument (0 to 5% methane) in all samples, indicating high methane amounts.
- Hydrogen sulfide was detected at low levels (1 to 4 ppm) during the first monitoring event, and ranged from 195 to 305 ppm during the second monitoring event. Hydrogen sulfide has a "rotten egg" odor with a very low concentration threshold.

- Oxygen content was detected near 0% (0.4 to 0.9 %) during the first monitoring event, indicating an anoxic or anaerobic subsurface condition, and ranged from 6.1 to 9.8 % during the second monitoring event.
- Carbon monoxide was detected at low levels (3 to 6 ppm) during the first monitoring event and ranged from 103 to 185 ppm during the second monitoring event.
- No vapors were detected in ambient air on or near the waste fill piles, indicating the elevated hydrogen sulfide and methane detected in the gas probe are not being emitted in significant quantities and/or they are being dispersed in ambient air.

Shallow Overburden Groundwater

Shallow overburden groundwater samples were collected from nine monitoring wells at the Site during two rounds of sampling. To allow for seasonal variations in groundwater quality, the first sampling event occurred during low water table conditions (November 2001) and the second sampling event occurred during high water table conditions (April 2002).

The results indicate that VOCs detected above NYS Division of Water Technical and Operational Series Ambient Water Quality Standards and Guidance Values (groundwater criteria) in downgradient monitoring wells MW-2S and MW-8S were benzene (1.8 µg/L max.) and trichloroethene (4.2 µg/L max.). The SVOCs detected above groundwater criteria in monitoring wells MW-6S and MW-8S were benzo(b)fluoranthene (0.6 µg/L max.) and bis(2-ethylhexyl)phthalate (5 µg/L max.). In addition, phenol was detected in MW-2S at a concentration of 2 µg/L.

The TAL metals detected above groundwater criteria in several samples were iron (11,100 µg/L, max. in MW-15), magnesium (96,400 µg/L, max. in MW-6S), manganese (15,000 µg/L, max. in MW-1S), and sodium (27,800 µg/L, max. in MW-7S). Arsenic and chromium were detected in MW-2S at estimated concentrations of 133 and 981 µg/L, respectively, during the first round of sampling. Hexavalent chromium was not detected in any of the groundwater samples. The metals analytical results for MW-2S vary significantly between the November 2001 and April 2002 sampling events. Considering the age and construction of MW 2S, and the extremely high and variable concentrations of iron and other metals in the RI samples, the 2005 RI report concludes that water samples from this well are no longer representative of groundwater quality in the surrounding formation.

The geochemical parameters resulting in concentrations above groundwater criteria in monitoring well samples included ammonia (2.0 to 2.9 mg/L), nitrate (12.4 to 50.9 mg/L), and sulfate (309 to 1,060 mg/L). Geochemical parameters are used to evaluate chemical fate and compare upgradient water quality parameters to constituents detected in downgradient groundwater. Ammonia was not detected in the upgradient shallow monitoring well. Bicarbonate is the form of alkalinity detected in groundwater with concentrations of 143 to 446 mg/L in downgradient wells and 131 mg/L in the upgradient well. Nitrate was detected at concentrations of <0.5 to 50.9 mg/L in downgradient wells and 9.3 mg/L upgradient of the Site. Nitrate is a common component of agricultural fertilizers. Sulfate was detected at concentrations of 25.6 to 1,060 mg/L in downgradient wells and 40 mg/L in upgradient groundwater; sulfide was not detected. Oxygen reduction potential (ORP) readings ranged from 1.8 to 252 mV, and DO concentrations ranged from 0.04 to 8.41 mg/L. The absence of sulfide, the lack of negative ORP readings, and the presence of DO indicate subsurface redox conditions are not anaerobic. TDS ranged from 185 to 2,100 mg/L in downgradient wells and was 232 mg/L in the upgradient well. The TOC concentration in downgradient wells ranged from 1.0 to 15.7 mg/L, and was 1.2 mg/L in the upgradient well. Ferrous iron concentrations measured in the field ranged from non-detection to 8.1 mg/L.

Deeper Overburden Groundwater

Deep overburden groundwater samples were collected from nine monitoring wells at the Site during two rounds of sampling. As discussed above, the sampling events occurred in November 2001 and April 2002.

One SVOC, bis(2-ethylhexyl)phthalate {BEHP} (19 μg/L), was detected above groundwater criteria [TOGS (5.0 μg/L) and PRG (4.8 μg/L)] in upgradient monitoring well MW-9D during the first sampling event. However, BEHP compound presence may be an artifact of using sampling equipment containing plastic. SVOCs in deep groundwater samples were not analyzed during the second sampling event. During the 1989 OBG RI, organic compounds were not detected in samples collected from two deep wells sampled (MW-3D2 and MW-6D).

The total metals detected during the first sampling event above groundwater criteria in a number of wells were iron (15,500 μg/L max., MW-1D), magnesium (125,000 μg/L max., MW-6D), manganese (2,330 μg/L max., MW-6D), and sodium (22,300 μg/L max., MW-1D). The concentration of hexavalent chromium (321 μg/L) detected in one Round 1 groundwater sample (MW-5D) exceeds TOG and PRG groundwater criteria; however, the result was flagged as estimated by the laboratory and the detected presence was not confirmed during the second sampling event nor was it detected in shallow groundwater. Only total metal COPCs (arsenic, chromium, and hexavalent chromium) were analyzed during the second sampling event and were not detected above groundwater criteria in any of the deep monitoring wells.

Due to elevated sample turbidity, a filtered metals sample was collected from deep monitoring well MW-2D during the first sampling event, which resulted in detections above groundwater criteria for soluble iron (351 μg/L) and selenium (10.6 μg/L). The detection of selenium is suspect since it was not detected in the unfiltered sample. The detection of iron in the filtered sample at a concentration about an order of magnitude lower than the unfiltered sample indicates suspended particulate matter affected the iron concentration in the unfiltered sample. Total and soluble metal COPCs were not detected in the sample collected from MW-2D.

The geochemical parameters resulting in concentrations above groundwater criteria in deep monitoring well samples included ammonia (ND to 150 mg/L) and sulfate (8.5 to 1,040 mg/L). The highest concentrations of these constituents were detected directly downgradient of waste fill piles at MW-1D and MW-6D. Nitrate was not detected in samples collected from the deep overburden wells.

Geochemical parameters are used to evaluate chemical fate and compare upgradient water quality parameters to constituents detected in downgradient groundwater. Bicarbonate is the form of alkalinity detected in groundwater with concentrations of 135 to 608 mg/L in downgradient wells and 108 mg/L in the upgradient well. Sulfate was detected at concentrations of 8.5 to 1,040 mg/L in downgradient wells and 40 mg/L in upgradient groundwater; similar to sulfate levels in the shallow zone. Nitrate and sulfide were not detected. TDS ranged from 133 to 1,770 mg/L in downgradient wells; concentrations were below 225 mg/L in all other wells. TOC concentrations ranged from 4.1 to 17.8 mg/L. Dissolved oxygen (DO) concentrations ranged from 0.03 to 1.2 mg/L. Oxygen reduction potential (ORP) readings ranged from 32 to 399 mV, with no negative readings. These data suggest weak aerobic conditions are present in deeper groundwater. Ferrous iron concentrations measured in the field ranged from non-detection to 7 mg/L.

Surface Water

Surface water samples were collected from wetland areas at the Site and analyzed for metal COPCs and geochemical parameters. Arsenic and total chromium were not detected in the surface water samples. Hexavalent chromium was detected at 13.0 μg/L in SW-2 during the December 2001 sampling event; however, the result was flagged as estimated by the laboratory and the detected presence was not confirmed during the April 2002 sampling event nor was total chromium detected in the sample above the reporting limit of 10 μg/L.

Sulfate levels (337 mg/L max.) in surface water samples collected from Wetland F were higher than other surface water sample locations. The sulfate concentration in sample SW-1 was above surface water criteria during the December 2001 sampling event but below the criteria during the April 2002 event. Surface water in Wetland F receives groundwater discharge with elevated sulfate concentrations. Sulfate was detected in Wetlands B and D at a maximum concentration of 34.5 mg/L and 27.8 mg/L. Sulfide was not detected in any of the surface water samples. Ammonia was detected during the April 2002 sampling event in sample SW-2 at a concentration of 0.11 mg/L but was not detected at that location during the December 2001 event or at other surface water sample locations. Other geochemical parameters detected in surface water include nitrate (<0.5 to 5.6 mg/L), TDS (111 to 603 mg/L), and TOC (17.8 to 33.0 mg/L). Dissolved oxygen concentrations ranged from 7.03 to 11.8 mg/L during the December 2001 sampling event and 0.66 to 1.09 mg/L during the April 2002 sampling event.

Wetland Sediment

Background wetland sediment samples and sediment samples near the waste fill piles were collected during the RI. Background wetland sediment samples were collected at nine sample locations during the first sampling event on October 15, 2001, and analyzed for arsenic (10.3 mg/kg max.) and chromium (23.1 mg/kg max.). Five of the nine background sediment samples analyzed for arsenic were within the range of the Low Effect Level (LEL) and Severe Effect Level (SEL) sediment quality guideline values presented in NYSDEC Division of Fish, Wildlife, and Marine Resources Technical Guidance for Screening Contaminated Sediments. All chromium concentrations were below the LEL. A sediment sample considered representative of wetland sediment background (Sample 17) was collected during the 1989 OBG RI. The metal COPCs detected were arsenic (25 mg/kg) and chromium (31mg/kg).

Fourteen sediment samples were collected from wetland areas near and downgradient from the waste fill piles during the initial sampling event on October 15, 2001, and analyzed for metal COPCs. The metal COPCs detected in wetland sediments were arsenic (11.4 mg/kg max.), chromium (215 J mg/kg max.), and hexavalent chromium (18.3 mg/kg max.). Chromium concentrations in 2 of the 14 wetland sediment samples were above background and sediment criteria. Arsenic concentrations were below background and sediment criteria. Hexavalent chromium was detected in two of the sediment samples. A sediment quality criterion is not available for hexavalent chromium.

Wetland F is the receptor of groundwater discharge from the Site. Metal COPCs detected in samples collected from this wetland were not elevated compared to Site background.

Soil

Several types of soil samples were collected (see Tables 5 and 6).

Surface Soil

Surface soil was defined as 0-6-inches for the purposes of the RI. Several samples were collected to define background conditions (Table 7). Cover soil atop the fill piles was sampled, as were areas around the pile perimeter. Some Volatile Organic Compounds (VOCs) and Tentatively Identified Compounds (TICs) were detected (Table 8); however, due to their low frequency of detection (≤5%), occurrence in Blank samples, and/or less than a screening concentration (USEPA values, see the respective table for references to specific criteria), no VOC compound was carried forward in this assessment. The justification for not carrying a chemical forward in the assessment is discussed in more detail below regarding the selection of Chemicals of Potential Concern (COPCs). Semi-Volatile Organic Compounds (SVOCs) also were detected, primarily several polycyclic aromatic hydrocarbons (PAHs), benzaldehyde, and p-cresol (4-methylphenol), as were the inorganics arsenic and chromium (including hexavalent chromium). Average concentrations were calucated by using the entire dataset for a particular medium and setting non-detect values at ½ of that samples particular detection level.

Subsurface Soil

Subsurface soil was defined as >6-inches for the purposes of the RI. Several samples were collected to define background or native soil conditions (Table 7). Fill soil on the piles was sampled along with fill/waste material itself, as were areas around the pile perimeter. Only inorganic data are available for these soils, and indicate that arsenic and chromium are present (Table 9). Per the Approved RI Work Plan (Geomatrix Consultants, September 2001), samples for organics (TCL-VOCs and TCL-SVOCs) were limited to ten surface soil locations; therefore, no subsurface soil organic data are available for this assessment.

Wetlands

Several types of samples were collected from the wetland areas (see Tables 5 and 6).

Sediment

Both background areas and wetland areas downstream of the piles were sampled. Arsenic and chromium (including hexavalent chromium) were detected (Table 10).

Surface Water

The wetland's surface water were sampled twice (December 2001 and April 2002), each of which had four samples, resulting in a total of seven usable surface water samples, plus two duplicate samples, and one dry sample (#4 from the December event). These samples are discussed in more detail in the Geomatrix RI report. Only chromium and hexavalent chromium were detected in two distinct samples, collected at different times (Table 11).

Transport and Fate

The transport and ultimate fate of chemicals in the environment are influenced by a variety of physical and chemical (physicochemical) factors of the chemicals themselves, as well as site-specific factors of the environmental media (soil, water, or air) where they occur.

The chemical constituents detected at the Markhams Site include VOCs, SVOCs, and inorganic constituents. However, as discussed briefly above, VOCs were not carried forward in this assessment; and their elimination from consideration in the assessment is discussed in detail later in this chapter. Environmental fate and transport processes for the retained types of chemicals are briefly discussed below.

Physicochemical Properties

The fate and transport of chemicals in the environment depends on the properties of both the chemicals and the environmental media in which they occur. Table 12 lists several principal organic constituents along with some of their respective physical and chemical properties (*e.g.*, water solubility, Henry's Law Constant, Octanol-Water partition coefficient, and organic-carbon partition coefficient).

Water solubility is the maximum concentration of a compound that dissolves in water at a specific temperature. Highly soluble compounds can be rapidly leached from soils and water and are generally mobile in groundwater and surface water. Chemicals of low water solubility are relatively immobile in aquifers but may be transported rapidly in turbulent surface waters as suspended particles. Some water-insoluble compounds become readily mobile when in contact with organic solvents.

Vapor pressure is a measure of the volatility of a chemical in its pure state and is a determinant of vaporization from waste sites. A compound's tendency to volatilize from water depends upon its Henry's Law Constant. Henry's Law Constant is the ratio, at equilibrium, of a compound's vapor pressure (atmospheres) to its water solubility (moles/m^3). Compounds with Henry's Law Constants greater than 10^{-3} atm-m^3/mol readily volatilize from water. Those with Henry's Law Constants from 10^{-3} to 10^{-5} atm-m^3/mol volatile less readily, while those with Henry's Law Constant less than 10^{-5} atm-m^3/mol volatilize slowly.

The Octanol-Water partition coefficient (K_{ow}) expresses the equilibrium distribution of an organic compound between octanol and water. Kow is often used to estimate the extent to which a chemical will partition from water into fatty tissues of animals. Log K_{ow} values range from –2.5 to 10.5. Organic chemicals with log K_{ow} values less than 3 are generally considered not to concentrate in animal tissues, namely, they have low potential to bioaccumulate in living organisms.

The Organic Carbon Partition Coefficient (K_{oc}) is a measure of the tendency of organic compounds to sorb to soil and sediment and is expressed by this equation:

$$K_{oc} = \frac{\text{(mg chemical sorbed / kg organic carbon)}}{\text{(mg chemical dissolved / L solution)}}$$

K_{oc} reflects the tendency of organic compounds to sorb to organic matter in soil and sediment. K_{oc} values for organic compounds range from 1 to 107; higher values indicate greater sorption potential. Chemicals with K_{oc} values less than 103 generally do not sorb strongly enough to soil to affect overall leachability.

As with organic chemicals, inorganic chemicals, metals, have a different Soil-Water Partition Coefficient (called the distribution or adsorption coefficient, $K_d = C_{soil} / C_{water}$). The relationship between organic carbon and sorption does not apply to these constituents. The soil-water distribution coefficient (K_d) is affected by many geochemical parameters and processes such as pH, sorption to various materials in soil (clay, organic matter, iron oxides, etc.), the oxidation/reduction conditions of the soil, and the chemical form of the metal, as well as other major ions present. The greater the adsorption to soil, then the magnitude of K_d will be greater.

Because inorganic chemicals (which are typically positively charged or "cations") vary in their adsorption in soils, a common way of expressing a soil's ability to sorb these chemicals is the Cation Exchange Coefficient (CEC): the total amount of cations adsorbed by the negative charges in a unit mass of soil; and it is usually expressed as milliequivalents per 100 grams of soil (meq/100g); and generally speaking, the larger the CEC, the greater the ability of a soil to bind such chemicals. The CEC varies between soil types and even within a soil type depending upon local conditions. The relative ranges of CEC for soil types at the Markhams Site are shown in the tables in Appendix 4; and CEC data collected for the RI were discussed earlier in the soils section of Chapter 2 (Problem Formulation).

Transport Mechanisms and Fate of Detected Chemicals

The piles of waste and fill located at the site are the likely source of elevated detections of chemical constituents in environmental media. The chemicals in the source may potentially leach or otherwise be released from the wastes and residues within the piles and may migrate via various pathways as discussed below.

PAHs

PAHs, such as benzo(a)pyrene, were detected in site soils. The compounds contain only carbon and hydrogen and consist of two or more fused benzene rings in linear, angular or cluster arrangements. These compounds are the result of incomplete combustion of fossil fuels and are consequently ubiquitous in the environment. The number of rings in a PAH molecule affects its biological activity, and fate and transport in the environment. In general, most PAHs can be characterized as having low vapor pressure, low to very low water solubility, low Henry's Law constant, high log K_{ow}, and high K_{oc}.

High partition coefficients and low solubilities indicate that PAHs are likely to be adsorbed onto soil and sediment particles. Conversely, these properties indicate that most PAHs will not readily volatilize into the atmosphere. Accordingly, PAHs are considered generally immobile in the environment.

Although PAHs are associated with low mobility, some of the low molecular weight compounds are biologically degraded by microorganisms. Environmental factors, microbial flora, and physicochemical properties of the PAHs themselves influence degradation rates and degree of degradation. Environmental factors influencing degradation include temperature, pH, and redox potential and microbial species. Physicochemical properties, which influence degradation, include chemical structure, concentration, and lipophilicity.

In general, PAHs show little tendency to biomagnify in food chains, despite their high lipid solubility, because most PAHs are rapidly metabolized after uptake (Eisler 1987).

Benzaldehyde and p-Cresol (4-Methylphenol)

As reported in the Hazardous Substance Database (NLM 2005), benzaldehyde is a natural product of various plants and is released to the environment via combustion emissions from gasoline and diesel engines, incinerators and wood burning. It can form in the atmosphere through photochemical oxidation of toluene or other aromatic hydrocarbons. If released to the atmosphere, it degrades photochemically (with a 29-hour half-life). Physical removal from air by wet deposition can occur. Although it will dissolve to some degree in water it can transport from water via volatilization with half-lives of 37-hr to 17-days estimated using a model river (of 1-meter deep) and an environmental pond, respectively. Aquatic hydrolysis, adsorption to sediment, and bioconcentration are not expected to be important fate processes in water bodies, as it will more readily biodegrade. Based upon its Log K_{ow} and water solubility, its bioconcentration factor (BCF) is rather low (see Table 12), suggesting that bioconcentration in aquatic organisms is not important. Its K_{oc} value suggests that benzaldehyde will leach in soil; however, its readiness to biodegrade will mitigate significant leaching.

As reported in the Hazardous Substance Database (NLM 2005), p-cresol (4-methylphenol) along with the other cresols occur naturally in various plant and tree oils, and is a common solvent, disinfectant, and chemical intermediate. It also is released in automobile exhaust and tobacco smoke. Released to the atmosphere, its vapor pressure indicates that it will exist as a vapor. It will degrade by reaction with photochemical hydroxyl radicals, with a half-life of 8-hours. In water, p-cresol may adsorb to suspended solids and sediment in the water column based upon the log Koc values. p-Cresol is expected to biodegrade in water based on reported half-lives of 4 and 6 days. Volatilization from water surfaces may occur based upon this compound's Henry's Law constant, with a half-life of 38 and 281 days for river and lake models, respectively. Photolysis in surface water may be a more important fate process with a photolysis half-life of 3-days in a water/humic mixture. Its low BCF suggests bioconcentration in aquatic organisms is low. In soil, p-cresol is moderately to highly mobile based upon its Log K_{ow} and K_{oc} values. It is expected to biodegrade rapidly based upon half-lives of 1 and 0.5 days in 2 agricultural soils. Based upon its Henry's Law constant and vapor pressure p-cresol is not expected to volatilize.

Metals

In a terrestrial setting, trace elements released to the environment accumulate in the soil (Sposito and Page, 1984). Their mobility in soil is low and accumulated metals are depleted slowly by leaching, plant uptake, erosion, or chelation.

Trace element transport in soil occurs via dissolution of metals into pore water and leaching to groundwater, or colloidal or bulk movement (*i.e.*, wind or water erosion). The rate of migration is affected by the chemical, physical, and biological characteristics of the soil, the most important being:

- Redox (Eh)–pH system
- CEC & salt content
- Quantity of organic matter
- Plant species
- Water content &temperature
- Microbial activity

Metals mobilizing into soil pore water are most mobile under acid conditions, bioavailability decreasing with increasing pH. Generally, metals do not exist in soluble forms for long, tending to accumulate in the upper soil horizon or sediments. Once in soil/sediment, most metals sorb onto hydrous iron and manganese oxides, clayey minerals, and organic materials and eventually partitioned away from pore water. Metal bioavailability from soil/sediment particles generally is enhanced under conditions of low pH, high dissolved oxygen, high temperature, and an oxidative state. During these conditions, metals become soluble and freely move in the interstitial pore water and potentially the water column (McIntosh, 1992).

Arsenic—Arsenic has four valence states: -3, 0, +3, and +5. Elemental or metallic arsenic, As°, formed by arsenic oxide reduction, is rare. Arsenic trioxide (As^{+3}) is an industrial product, used in synthesizing most arsenical pesticides/rodenticides. It is oxidized catalytically or by bacteria to arsenic pentoxide (As^{+5}) or orthoarsenic acid (H_3AsO_4). At high Eh values (*i.e.*, high oxidation-reduction potential), pentavalent (As^{+5}) arsenic will predominate; while at lower Eh, the corresponding trivalent arsenic species can be present (Eisler 1988).

Although arsenic minerals and compounds are soluble, migration is greatly limited due to the strong sorption by clays, hydroxides, and organic matter. The reactions of arsenic in soil are governed by its oxidation state. However, arsenate ions are known to be readily fixed in order of retention: iron oxide, aluminum oxide, clay, humus, and calcium. Strongly adsorbed arsenic is unlikely to be desorbed and the retention of arsenic by soil increases with time (Kabata-Pendias and Pendias, 1992).

The chemistry of arsenic in water is complex and the form present in solution is dependent on such environmental conditions as Eh, pH, organic content, suspended solids, and sediment. In aquatic environments, volatilization is important when biological activity or highly reducing conditions produce arsine or methyl-arsenics. Sorption by the sediment is an important fate for the chemical. Arsenic is metabolized to organic arsenicals by a number of organisms (Clement Associates, 1985).

Chromium—the following discussion is based upon Chapters 3 & 4 of Dragun 1988, Chapter 7.6 of Bodek *et al.* 1988, Bartlett and Kimble 1976, Bartlett 1976, Bartlett and James 1979, and EPRI 1986 and 1988, among other references as indicated below.

Chromium can exist in oxidation-reduction (redox) or valence states between II and VI, but is commonly found only in states 0, III, and VI, with III being the most stable. Within the ranges of pH and redox potential (Eh) found in most soils, it can exist in four states: two trivalent forms (Cr^{3+} cation and CrO^{2-} anion), and two hexavalent anion forms (dichromate—$Cr_2O_7^{2-}$ and chromate CrO_4^{2-}). Chromium compounds with oxidation states below III are reducing and those greater than III are oxidizing. The trivalent form is less toxic and the hexavalent form is more toxic.

Chemically, the trivalent state is the most stable, existing primarily as stable 6-coordinated octahedral complexes with organic and inorganic ligands. Chromic ion (Cr^{3+}) does not exist in solution as such, forming complexes with water and other anions in acidic solutions (4.9-pH).

$$Cr^{3+} + 3\,H_2O \rightarrow Cr(OH)_3\downarrow + 3\,H^+$$

At higher pH, the hydoxo ions ($CrOH^{2+}$, $Cr(OH)_2^+$, $\mathbf{Cr(OH)_3^0}$, and $\mathbf{Cr(OH)_4^-}$) slowly precipitate from solution (and according to Rai, Sass, and Moore (1987), those species in **bold** predominant between pH 2.6-14). This behavior is predicted upon inspection of an Eh-pH diagram for a Cr-H_20 system (see Figure 3.10 of Dragun 1988), and is the property that most significantly contributes to the removal of Cr (III). The chromium hydroxide precipitate is highly insoluble, having a Solubility Product (or K_{sp}—*which is the equilibrium constant for the equilibrium existing between a slightly soluble salt and its ions in a saturated solution*) of $6.3x10^{-31}$ at 25°C (see Table 3.6 of Dragun 1988) or $2.9x10^{-29}$ at pH 8.5 (Shivas 1980) with solubilities in the range of 0.0008 to 0.005 mg/L for pure systems in water, or even lower in mixtures such as soil pore water.

Most hexavalent chromium compounds exist as oxo-species (chromium oxide (CrO_3), chromyl chloride (CrO_2Cl_2), chromate, and dichromate), which are all strongly oxidizing agents. In solution, hexavalent chromium exists as part of complex anions rather than as cations and thus does not readily precipitate from solution at alkaline (higher) pH. These compounds are more soluble in water than trivalent compounds. However, hexavalent chromium compounds are generally unstable (except in water) due to their high reactivity, and thus are rare in nature because they readily reduce to the trivalent form. Furthermore, transport of chromate is usually over-predicted by a factor of two-three times, due to binding constants based upon bulk measurements that overlook cooperative surface effects (Al-Abadleh *et al.* 2005).

If released into the air, chromium readily binds to particulate and is quickly removed via fallout and wet precipitation accounting for more than half of all deposition. Upon entering surface and ground waters, as a result of runoff, aerial deposition, or other releases, chromium is present in five possible forms: in solution as organic complexes, adsorbed onto particles, precipitated/co-precipitated, in organic solids, or in sediments. The majority of soluble forms are in the hexavalent state.

Hexavalent chromium compounds while "stable" reduce in the environment to the trivalent state by various reactions, especially in soil systems (see the figure below; see also Wielinga *et al.,* 2001):

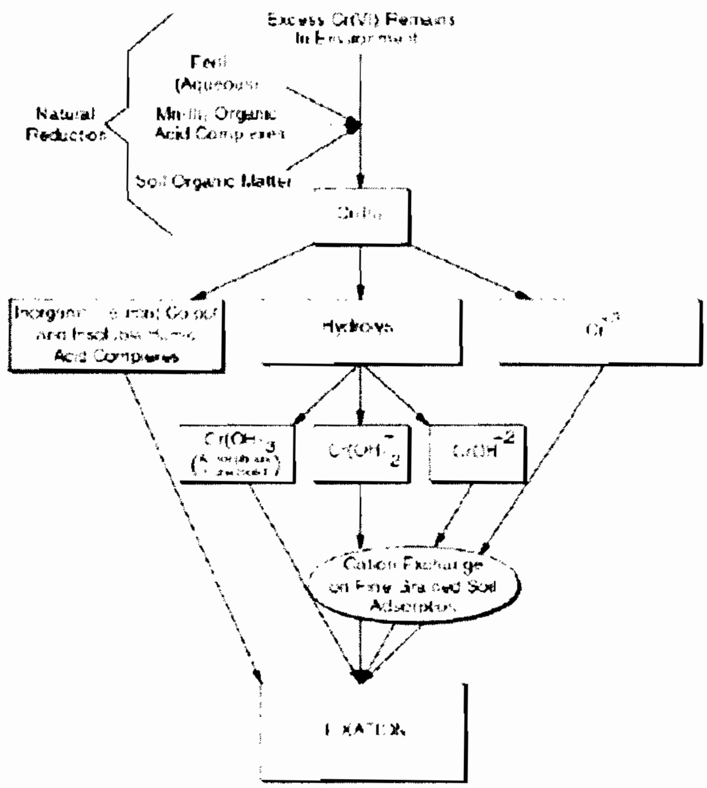
- With organic matter

$$Cr\ (VI) + OC_{red} \rightarrow Cr\ (III) + OC_{oxid}$$

- With iron (II) (and the Fe (III) is readily recycled (reduced) by microbial dissimilatory iron-reduction or an abiotic iron couple [Wielinga *et al.,* 2001].)

$$HCrO_4^{-} + 3Fe\ (II) + 8\ H_2O \rightarrow Cr(OH)_3 + 3Fe(OH)_3 + 5H^{+}$$

- Or by the sulfide-sulfate couple (which only predominates at pH below 5.5)



Summary of Reduction and Fixation of Chromium in Soil
(based on Figure 2-4 of USEPA 2000)

Thus in soil, chromium behavior is influenced by pH, redox conditions, clay minerals, competing ions, and complexing agents, and other factors, but is principally controlled by precipitation/dissolution reactions. Total inorganic carbon (*e.g.,* carbonate) has a sequestration mechanism based on a localized surface pH effect promoting $Cr(OH)_3$ formation. Additionally, more clay or higher CEC (that is, more negatively charged sites) leads to enhanced Cr adsorption (Stewart *et al.*, 2003).

Adsorption of Cr (III) increases with pH (above 5.5), while its solubility decreases leading to precipitation as hydroxides covering the surfaces of soil particles. At lower pH, Cr (III) sorbs or complexes onto negative soil charges (Stewart *et al.*, 2003). Therefore, more alkaline soils with high organic content would be capable of holding large concentrations of Cr (III). Generally, between a pH of 5-12 and in the presence of Fe (III), chromium will precipitate as the solid insoluble amorphous Cr (III) hydroxide, leaving an aqueous concentration less than its solubility (Palmer and Puls 1994).

If hexavalent chrome is present in soil it readily reduces to the trivalent form and then precipitates. Of course, Cr (VI) may remain in soil if it exceeds both the adsorbing and reducing capacities of the soil (Palmer and Puls 1994). Mechanistic studies indicate that Cr (VI) can be leached from soil under wet conditions in alkaline soils. Whereas in high clay content soils sorption increases with pH. Its behavior is controlled by adsorption/desorption reactions. Therefore, in low clay soils that are alkaline, and with relatively high concentrations of phosphate, Cr (VI) can stay in solution and be mobilized from the soil.

Therefore, speciation of chromium in soil depends on pH, the redox conditions, organic matter, and Fe (II) and MnO_2 concentrations (the latter of which are more or less mutually exclusive).

- Oxidative conditions (which favor Cr (VI) species) occur more readily under aerobic soil conditions of lower, more acidic pH soils with low organic matter, low Fe (II) levels, and high MnO_2 levels.
- In contrast, Cr (III) is favored in alkaline soils with a reducing (more negative Eh potential), high organic carbon content, high Fe (II), and low MnO_2 levels.

In the current case, total Mn concentrations average about 352 mg/kg in soils at Markhams. Only a fraction of this Mn occurs as Mn (IV) and only a fraction of that amount is surficially available for redox reactions with Cr (III). Considering that redox is a localized phenomenon in soil aggregates (Tokunaga *et al.*, 2001 and Tokunaga *et al.*, 2003) and the predominance of Fe (II), sulfur and sulfate, microbes, and organic matter, as well as pH in site soils, then Cr (IV) reduction will predominate over Cr (III) oxidation.

Conceptual Site Model

Problem Formulation results in defining the risk system to be assessed (the CSM, Figure 7). This schematic describes the site and environs, presenting information regarding site sources, the release, transport, and fate of site-related chemicals, exposed plant or animal receptors, or critical habitat:

- The Markhams Site has several thousand tons of disposed residue pile material, and vacuum filter and cookhouse sludges. These residues and sludges have released a limited number of chemicals into several environmental media. These chemicals may leach from the fill piles and/or soils and enter groundwater and/or migrate into wetlands. Additionally, chemicals sorbed onto soil particles may enter the wetlands via overland flow. Once in the wetlands, these chemicals are likely to become associated with sediments, although hexavalent chromium, as discussed previously, may remain in the water column.

- Various flora and fauna may ingest or contact these chemicals either directly in the piles or in contaminated media (soil, sediment, or water). Furthermore, some of these chemicals may accumulate within biota (*e.g.*, flora and/or terrestrial and benthic invertebrates) and when predated upon expose organisms higher in the food chain.

Selection of Chemicals of Potential Concern

Not all chemicals detected necessarily warrant detailed evaluation. Many chemicals are detected at low concentrations that will not pose a significant risk, and may be eliminated from further consideration. Selection of COPCs is essentially a refining of the list to focus the assessment on chemicals of critical importance. The selection must sieve the list of potential chemicals carefully to not over eliminate chemicals of potential concern, nor retain chemicals of little importance from a risk perspective. Selection criteria included (from USEPA 2001, details for excluding a detected chemical as a COPC are available below):

- Background concentrations in environmental media,
- Chemicals with a dietary function in organisms, and
- Frequency and magnitude of detection of a chemical—generally, chemicals detected at a frequency of <5% and at concentrations near detection limits, and/or significantly less (such as 1-2 orders of magnitude) than USEPA ecological screening criteria based upon a chemical's ecotoxicity.

Detected chemicals

Chemicals detected in background surface and subsurface soil (Table 7):

- Arsenic
- Chromium (total)
- Manganese

Chemicals detected in surface soil (Table 8):

- Acetone
- Carbon disulfide
- 2-Butanone (methyl ethyl ketone)
- Dichlorodifluoromethane
- Trichlorofluoromethane
- Hexane (a TIC)
- Unknown alcohol (a TIC)
- Unknown chemical (a TIC)

- Benzo(a)anthracene
- Benzo(b)fluoranthene
- Benzo(k)fluoranthene
- Benzo(ghi)perylene
- Benzo(a)pyrene
- Benzaldehyde
- Chrysene
- Fluoranthene
- Indeno(1,2,3-cd)pyrene
- 4-Methylphenol (p-Cresol)
- Naphthalene
- Phenanthrene
- Pyrene
- Arsenic
- Chromium (total)
- Chromium (hexavalent)

Chemicals detected in subsurface soil (Table 9):

- Arsenic
- Chromium (total)
- Chromium (hexavalent)

Chemicals detected in wetland sediment (including background sediment; Table 10):

- Arsenic
- Chromium (total)
- Chromium (hexavalent)

Chemicals detected in wetland surface water (Table 11):

- Arsenic
- Chromium (total)
- Chromium (hexavalent)

Detected Chemicals Eliminated from Consideration

The following media had no detected chemicals eliminated from consideration: subsurface soil, wetland sediment, and wetland surface water.

Certain chemicals detected in surface soil were eliminated from consideration as COPCs for the reasons cited below:

- Acetone—was eliminated because it is a common laboratory solvent, was used in sample collection to clean field utensils; and all detections were qualified "flagged" as "B" due to its occurrence in blank quality assurance samples.
- Carbon disulfide—was eliminated because it is a common laboratory contaminant and was detected only once at a level more than an order of magnitude below the USEPA listed ecological screening criteria in the Table 8.
- 2-Butanone (methyl ethyl ketone)—was eliminated because it is a common laboratory solvent and was detected only once at a level more than an order of magnitude below the USEPA listed ecological screening criteria in the Table 8.
- Dichlorodifluoromethane and Trichlorofluoromethane—are Freon compounds detected in three of the ten soil samples at concentrations near the cited analytical detection limits, and each detection was flagged as an estimated (J) value. The average detected level (*including all samples, even those where the chemical was not detected, in which case the concentration is set at ½ of the respective detection limit*) indicates detection at more than three orders of magnitude below the USEPA listed ecological screening criteria in the Table 8.
- Hexane (a TIC)—was eliminated because it is a common laboratory solvent and was used in sample collection to clean field utensils. In each case of detection the results were flagged (B) as occurring in the blank and data validation rejected all results for this chemical. All of the detections occurred at low concentration.
- Unknown alcohol (a TIC)—was eliminated because it was detected in one sample at a low level; more importantly, the lack of other information about the compound makes evaluation in this assessment impossible.
- Unknown chemical (a TIC)—was eliminated because other than being detected in five samples nothing else is known about the compound, and this lack of information makes evaluation in this assessment impossible.
- Indeno(1,2,3-cd)pyrene and Phenanthrene—were eliminated because they were only detected once at low concentrations that were several orders of magnitude below their respective USEPA listed ecological screening criteria in the Table 8.

Chemicals of Potential Concern (COPCs)

The following chemicals were retained as COPCs in this assessment:

- Benzaldehyde
- Benzo(a)anthracene
- Benzo(b)fluoranthene
- Benzo(k)fluoranthene
- Benzo(ghi)perylene
- Benzo(a)pyrene
- Chrysene
- Fluoranthene
- 4-Methylphenol (p-Cresol)
- Naphthalene
- Pyrene
- Arsenic
- Chromium (total)
- Chromium (hexavalent or VI or Cr6+)

Ecotoxicity

The ecological effect of a chemical depends on many factors, such as its concentration in the environment and/or receptor organism, its accessibility and bioavailability to biota, synergistic interactions among constituents, the duration and frequency of exposure to that constituent, the receptor species, and the metabolic rate and metabolic process characteristics of the species. Chemicals can affect biota and ecosystems in both lethal and sub-lethal ways, such as the following:

- Altered development, behavior metabolic/physiologic rates, or processes/functions
- Increased susceptibility to disease, parasitism, or predation
- Disrupted reproductive functions
- Mutations or other reductions in offspring viability

Evaluation of potential ecological effects of chemicals requires an understanding of the toxicology involved. Appendix 5 of this report briefly summarizes toxicological information for the COPCs.

Exposure Pathways

An Exposure Pathway is the course that a chemical may take from a source to an individual receptor, and includes:

- A source and release mechanism
- An Exposure Point—location/potential contact point in the environment (*e.g.,* soil, surface water, sediment, and the like) between receptor and a COPC

- An Exposure Route—the way a receptor contacts a COPC (ingestion of contaminated media or dietary items [uptake by plants] and dermal contact with contaminated media, such as soil).

The Conceptual Site Model (Figure 7) illustrates the complete exposure pathways at the site. Surface soil and sediment are the primary environmental media most likely to be encountered by biota through digging/burrowing, dermal contact, incidental ingestion of contaminated soil and/or sediment along with food items. Surface soil and sediment also can act as secondary contaminant sources. Surface water indicated limited occurrence of chromium (in the Cr III and Cr VI forms) and arsenic, although the data themselves are limited in extent.

Upon release, some constituents persist and may be transformed to more bioavailable forms and mobilized in the food chain via:

- Root uptake by wetland and terrestrial macrophytes
- Contact and absorption of chemicals in surface soil and sediments, leading to incidental ingestion
- Feeding on contaminated food by aquatic and terrestrial invertebrates
- Bioaccumulation from vegetation or animal prey at the base of the food chain by wildlife

Ecological Receptors

Based on the exposure pathways identified above, the following general classes of ecological receptors potentially might be exposed to chemicals at and in the vicinity of the Markhams Site:

- Plants (wetland and terrestrial)
- Terrestrial wildlife species that may be in contact with the soils and that feed within the terrestrial food chain
- Facultative aquatic wildlife species that may be in contact with the wetland sediments and/or frequently use the wetlands for foraging
- Avian species that use the terrestrial and/or wetland areas for forage and prey (invertebrates)
- Obligate aquatic species (such as herptiles) that contact wetland sediments and surface water regularly

Assessment and Measurement Endpoints

The ecological values of the site include populations and communities of plants and animals in terrestrial and wetland habitats. In broad terms, the values to be protected (Assessment Endpoints) for each of these habitat types includes the structure and function of site ecosystems, and the survival and reproduction of organisms/populations typical of the region.

Assessment Endpoints

This site has many ecological resources, but it is beyond this assessment's scope to evaluate every resource. Rather, Assessment Endpoints were developed based upon the CSM to evaluate whether chemicals are affecting or could affect ecological resources. These are explicit expressions of the actual environmental values to be protected, defined as an ecological entity with some particular attribute (USEPA, 1997b), and may include (USEPA 2003):

- Officially Designated Endpoints (critical habitat for rare, endangered, or threatened (RET) species or special places)
- Organism-Level Endpoints (particular organisms within an assessment population or community, such as RET species or organisms critical to the food chain)
- Population Endpoints (focus on critical game, resource species, or harvested species)
- Community- or Ecosystem-Level Endpoints (consider larger areas with important habitat, *e.g.,* certain plant assemblages, sensitive aquatic communities, or wetlands)

The Markhams Site Assessment Endpoints targeted ecological resources that, because of their characteristics, represent local ecosystem components in direct contact with COPCs.

For terrestrial resources, three general endpoints were identified:

- Protection of **Terrestrial Plant Communities** from ecological changes related to chemical exposure, in particular maintenance of species diversity and survival, and biomass production at levels similar to areas not exposed to COPCs.

  This endpoint was selected on the basis of the ecological value associated with terrestrial vegetation, namely food production and habitat. Terrestrial vegetation is ecologically important because of its role as the base of the food chain, in providing nesting, foraging, and providing shelter for vertebrate and invertebrate biota.

- Protection of the **Soil Biota Community** from decreased sustainability (such as, survival, growth, or reproductive success), as well as associated soil nutrient processes, from ecological changes due to COPC exposure.

  This endpoint was selected because of the ecological role of soil biota (*e.g.,* invertebrates) in food production for vertebrate biota and their importance as scavengers and decomposers in nutrient cycling.

- Protection of **Terrestrial Vertebrate Communities** from decreased sustainability (such as, survival, growth, or reproductive success) due to COPC exposure.

  This endpoint targets the Small Mammal Herbivore Community because of its important role as the principal food source for higher trophic level predators. This Assessment Endpoint also targets Avian Insectivores and Avian Omnivores because of their roles in controlling invertebrate populations and their high potential for exposure to site chemicals. In general, top-level predators are especially susceptible and sensitive to contaminants with significant bioaccumulating potential. However, none of the COPCs have such potential; therefore, higher trophic levels were not included.

For the prevalent wetland resources, the following Assessment Endpoint was identified:

- **Wetland Community** (including aquatic plant community, aquatic herbivore, aquatic insectivore, aquatic benthic/sediment-associated invertebrate community, and macro-benthic invertebrate community individually and collectively) requires protection from functional changes due to COPC exposure.

  Community components addressed by this Assessment Endpoint include wetland plants and benthic macroinvertebrates because of their ecological relevance as food for higher trophic-level organisms. This endpoint also targets aquatic herbivores (turtles) and insectivores (frogs) because of their greater potential for direct exposure and their trophic level immediately above plants and benthos.

Measurement Endpoints

Measurement Endpoints are actual measurements (estimates) for evaluating Assessment Endpoint. Measurement Endpoints are the basis for evaluating risk, and are discussed in detail in Section 3 Screening-Level Ecological Effects Evaluation.

3. Screening-Level Ecological Effects Evaluation

Introduction

This SLERA evaluated the ecological effects of organism exposure and refined the list of COPCs following a two-step process.

- **Step i** involved direct comparison of measured (maximum detected) concentrations in environmental media (soil and wetland sediment and surface water) to an appropriate set of Environmental Screening Criteria. Many of these criteria are based on generic assessment endpoints (*e.g.,* protection of certain ecological communities from changes in structure and function or organism survival) and were developed using a large database of ecological effect concentrations correlated with appropriate sensitive receptor species. The criteria set includes a range of values representing different organism, sensitivities, and/or concentrations at which no effects are seen, or at which certain effects are seen or are probable.
- For those COPCs passing through **Step i** (*i.e.,* the maximum environmental concentration of a COPC is greater than a range of Environmental Screening Criteria), they were then evaluated in **Step ii.** This evaluation process allows for a refinement of the group of COPCs under consideration. **Step ii** involved evaluating potential ecological effects using maximum detected concentrations in environmental media and considering potential ecological effects based upon dietary exposure to particular ecological receptors. This step included modeling of estimated concentrations of chemicals in food items, and evaluating potential exposure and the potential for adverse ecological effects (*e.g.,* loss of fecundity, growth effects, or survival) using the Hazard Quotient (HQ) method. Calculation of the HQ used appropriate (soil, sediment, or surface water quality) benchmarks or Toxicity Reference Values (TRV, based on NOAELs). Details of the selection of benchmarks and TRVs, and the use of and justification for uncertainty factors during derivation of TRVs is detailed at the end of Section 5 Screening-Level Risk Calculation.

Measurement Endpoints

Measurement Endpoints for Step i

Each Assessment Endpoint was addressed by using maximum detected) concentrations of COPCs in sampled environmental media and comparing them to an appropriate set of Environmental Screening Criteria that provide a range in which to evaluate endpoint protectiveness.

Assessment Endpoint—Terrestrial Plant Communities

Measurement Endpoint involved comparing maximum detected soil concentrations to available screening benchmark values. The benchmark values came from The Risk Assessment Information System (RAIS) web site (http://risk.lsd.ornl.gov/index.shtml) at the Oak Ridge National Laboratory (ORNL) (RAIS 2005). This measurement endpoint provides a straightforward evaluation of available concentration data to literature-based benchmarks established to evaluate potential impacts to plant species survival.

Assessment Endpoint—Terrestrial Vertebrate Community

Measurement Endpoint involved comparing maximum detected soil concentrations to available screening benchmark values (RAIS 2005). This endpoint provided a simple evaluation of available concentration data to established benchmarks designed to protect individual terrestrial vertebrates, namely small mammals and birds, and thereby promote community integrity.

Assessment Endpoint—Soil Biota Community

Measurement Endpoint involved comparing maximum detected chemical concentrations in soil compared to available screening benchmark values (RAIS 2005). This endpoint provided a simple evaluation of available concentration data to established benchmarks designed to protect soil invertebrates and microbes to promote a community critical to primary production and decomposition.

Assessment Endpoint—Wetland Community

Measurement Endpoint involved comparing maximum detected sediment concentrations to sediment and surface water benchmarks (NYSDEC 1998b and RAIS 2005). This endpoint provided a simple evaluation of available concentration data to established benchmarks designed to protect wetland plants, benthos, aquatic herbivores (reptile) and insectivores (amphibians).

Step ii

If the maximum concentration of a COPC exceeded these criteria, then it was retained for **Step ii**. During this step, each Assessment Endpoint is evaluated by considering the potential for ecological effects via measurement endpoints, that is selected receptors. These ecological receptors are selected based upon their relevance to the Assessment Endpoints discussed previously, and the availability of biological and toxicological data and information to support food chain (dietary) exposure modeling for which there.

The following Exposure Matrix, based on the CSM (Figure 7), identifies the different exposures evaluated for each receptor in this SLERA.

Table A
Ecological Receptor Exposure Matrix
Peter Cooper Markhams NPL Site

Exposure		Terrestrial Ecological Receptor						
Point	**Route**	**Plants**	**Inverts (Worms)**	**Herbivore (*Deer Mouse*)**	**Insectivore (*Short-tail Shrew*)**	**Omnivore (*Raccoon*)**	**Avian Insectivore (*Marsh Wren*)**	**Avian Omnivore (*Am. Robin*)**
Soil	Ingestion	X	X	X	X	X	X	X
	Dermal	X	X	X	X	X	X	X
Wtlnd Surface Water	Ingestion	O	O	X	X	X	X	X
	Dermal	O	O	O	X	X	O	O
Wetland Sediment	Ingestion	O	O	O	X	X	O	O
	Dermal	O	O	O	X	X	O	O
Food Chain	Ingestion Prey	O	O	Plants	Worms & Benthos	Worms, Benthos, Small Mammals, Birds, Terr. Plants	Worms & Benthos	Worms & Plants

Exposure		Wetland Ecological Receptor			
Point	**Route**	**Plants**	**Benthic Macro-invertebrates**	**Aquatic Herbivore (*Painted Turtle*)**	**Aquatic Insectivore (*Green Frog*)**
Soil	Ingestion	O	O	O	X
	Dermal	O	O	O	X
Wetland Surface Water	Ingestion	X	X	X	X
	Dermal	X	X	X	X
Wetland Sediment	Ingestion	X	X	X	X
	Dermal	X	X	X	X
Food Chain	Ingestion Prey	O	O	Plants	Benthos & Terrestrial Invertebrates

X—Exposure media & pathway/route is complete **O**– Exposure media & pathway/route is incomplete

Higher order predators, although potentially present (Table 4), were not included due to the low bioaccumulative/low biomagnifying nature of the COPCs. Therefore, based upon the CSM (Figure 7) and the Exposure Matrix above, the Assessment Endpoints will be addressed as follows.

Assessment Endpoint—Terrestrial Plant Communities

Measurement Endpoint involved calculating a HQ using the maximum detected soil concentrations of a COPC and a benchmark criterion based on plant toxicity.

Assessment Endpoint—Soil Biota Community

Measurement Endpoint involved calculating a HQ using maximum detected chemical concentrations in soil and an appropriate benchmark based on toxicity testing with Earthworms, a representative receptor with a significant amount of toxicity testing data.

Assessment Endpoint—Terrestrial Vertebrate Community

Measurement Endpoints involved calculating a HQ using maximum detected soil concentrations and modeled dietary doses of COPCs and an appropriate effect-level thresholds TRVs for the following animals with relevant diets and foraging behaviors whereby the receptors may have significant exposure. These receptors were selected because of the significant data available to evaluate dietary exposure and toxicity.

- Herbivorous Mammals—the Deer Mouse
- Insectivorous Mammals—the Short-tailed Shrew
- Omnivorous Mammals—the Raccoon
- Avian Insectivores—the Marsh Wren
- Avian Omnivores—the American Robin

Assessment Endpoint—Wetland Community

Measurement Endpoint involved comparing maximum detected sediment concentrations to sediment and surface water benchmarks (NYSDEC 1998b and RAIS 2005). This endpoint provided a simple evaluation of available concentration data to established benchmarks designed to protect wetland plants, benthos, aquatic herbivores (reptile) and insectivores (amphibians). These receptors were selected because of the significant data available to evaluate dietary exposure and toxicity.

- Wetland Plant Community—wetland plants
- Benthic Invertebrate Community—freshwater macrobenthos
- Aquatic Herbivore—the Painted Turtle (reptile)
- Aquatic Insectivore—the Green Frog (amphibian)

Environmental Screening Criteria

Various Environmental Screening Criteria were obtained by using the on-line (Internet) Risk Assessment Information System (RAIS) database available through the US Department of Energy (USDOE) Oak Ridge National Laboratory (ORNL). RAIS contains various criteria, including: Risk-Based Preliminary Remediation Goal (PRG) calculations, a Toxicity database, Risk Calculations, and Ecological Benchmarks. The Ecological Screening Benchmark Database was the major source of information used for this SLERA; and this database was updated and current as of March 2005.

These environmental criteria are media-specific screening levels to which site COPCS concentrations can be compared. If these criteria are exceed by measured environmental media concentrations, then those particular sampling locations where the criteria exclusions occurred can be evaluated in more detail. Thus, the purpose of these environmental screening criteria is to help focus the investigation on those areas and those COPCs that are most likely to pose an unacceptable risk to the environment.

Soil

As discussed previously in Chapter 2—Problem Formulation (under the COPC selection sub-section), the occurrence, distribution, and selection of COPCs in surface and sub-surface soils are presented in Tables 8 and 9, respectively. Background soil data are available in Table 7. These tables provide the number of samples, frequency of detection, range of detected concentrations, arithmetic averages (using ½ of the detection level for those samples where a non-detect was indicated). These tables also list the screening criteria from various USEPA regions as indicated on the tables and provide site-specific background concentrations where available.

Surface and subsurface soil samples were collected at the site. Most burrowing animals create dens in the upper four feet of soil. In addition, the deeper subsurface soil samples (*i.e.*, greater than four feet) are below the root zone of most plants. Due to the lack of exposure routes to wildlife, data for deeper subsurface soils were not evaluated in detail. More importantly, the soil data generally indicated higher concentrations in surface soil than in sub-surface soil. On this basis, deemphasizing sub-surface soils will not unduly bias the assessment towards less protection.

Criteria

A set of criteria were used to evaluate the soil concentration data (see Table 13). The criteria set has a range of protectiveness for a variety of potential receptors, including plants, soil invertebrates and microorganisms, and upper trophic levels. These criteria (derived as mentioned above from the ORNL (2005) RAIS Ecological Benchmark Database) included those on the following list. Additional information on each criterion and a reference citation are in Table 13. No Benzaldehyde-specific criterion was available]:

- USEPA Region 4 & Region 5 Ecological Screening Levels
- Dutch Intervention
- Dutch Target
- Eco-SSL Avian
- Eco-SSL Mammalian
- Eco-SSL Plants
- USEPA Reg-6 Plants
- ORNL Plants
- USEPA Reg-6 Earthworms
- ORNL Invertehrates
- ORNL Microbes

Screening Analysis

See Chapter 5 (Screening-Level Risk Calculation) for this analysis.

Wetland Sediment

Table 10 presents the wetland sediment COPC data, along with a small set of background sediment, and include: number of samples, frequency of detection, range of detected concentrations, arithmetic averages (using ½ of the detection level for those samples where a non-detect was indicated). The table also lists an ecotoxicity screening criteria together with site-specific background concentrations. Fourteen sediment samples were collected from and analyzed for arsenic, chromium, and hexavalent chromium. Hexavalent chromium was not detected in any of the 2001 samples, but was detected in one 2003 sample.

Criteria

A set of criteria were used in the evaluation (see Table 14). This set has a range of protectiveness for various potential receptors, including macrobenthic invertebrates, microorganisms, and upper trophic levels. The criteria are arranged in the table running from lower effects levels to higher effects levels as one reads left to right. USEPA criteria are listed in the first series, other federal criteria are listed in the second series, the third series has two state criteria sets (Florida and Washington), and the fourth series has two sets of Canadian criteria).

- Assessment and Remediation of Contaminated Sediments (ARCS) Program No Effect Concentration (NECs), Threshold Effect Concentration (TEC), Probable Effects Concentration (PEC)
- Canadian Interim Sediment Quality Guidelines (ISQG, which is a threshold effects level) and the Probable Effects Levels (PEL)
- Consensus Probable Effect Concentrations (PEC) and Threshold Effect Concentrations (TEC) (see MacDonald *et al.* 2000)
- USEPA Region 4 & Region 5 Ecological Screening Levels
- USEPA Region 6 Ecological Screening Benchmarks: Freshwater Sediment
- FL-DEP TEL & PEL: (Threshold Effects Levels and Probable Effects Levels)
- NOAA Effects Range-Low & Effects Range-Median criteria
- Ontario Low & Severe Effects Levels (these are the same values used by NYSDEC, see NYSDEC 1999)
- ORNL Equilibrium Partitioning Levels (EqP)
- OSWER Ecotox Thresholds
- Washington State NEL, MAEL, & AET criteria

Screening Analysis

See Chapter 5 (Screening-Level Risk Calculation) for this analysis.

Wetland Surface Water

A total of seven surface water samples and two duplicates were collected from the wetland areas and were analyzed for arsenic, chromium, and hexavalent chromium. Table 11 presents wetland surface water COPC data including: number of samples, frequency of detection, range of detected concentrations, arithmetic averages (using ½ of the detection level for those samples where a non-detect was indicated). Arsenic was not detected in any of these samples, but chromium and hexavalent chromium were detected in a couple of samples.

Criteria

A set of criteria were used to evaluate the soil concentration data (see Table 15), with a range of protectiveness for a variety of potential aquatic biota and levels of probable effects. The criteria are arranged in the table running from lower effects levels to higher effects levels as one reads left to right. General aquatic criteria are listed in the first series and other biotic category criteria are listed in the second series.

- USEPA Region 4 Acute & Chronic Values
- USEPA Region 5 Ecological Screening Levels
- USEPA Region 6 Freshwater Ecological Screening Benchmarks
- USEPA National Ambient Water Quality Criteria (NAWQC) Acute & Chronic Levels (as of 2002)
- OSWER AWQC (ambient water quality criteria based upon final chronic values, as of 1996)
- Canadian Water Quality Guidelines
- LCV Aquatic Plants (lowest acceptable chronic value)
- LCV Daphnids (lowest acceptable chronic value)
- LCV Fish (lowest acceptable chronic value)
- LCV Non-Daphnid Inverts (lowest acceptable chronic value)

Screening Analysis

See Chapter 5 (Screening-Level Risk Calculation) for this analysis.

Toxicity Reference Values (TRVs)

The Ecological Effects Evaluation describes the toxicological characteristics of the COPCs and establishes TRVs for each endpoint species identified at a site. Section 5 (Screening-Level Risk Calculation) details the refinement of COPCs that require TRVs as part of the analysis under Step ii of this SLERA; and the COPCs that were found to exceed criteria included:

- Benzaldehyde
- Arsenic
- Chromium III
- Chromium VI

The following subsections detail the selection of TRVs (for the purpose of begin protective of the environment we biased the TRV selection towards literature reported chronic values for the most sensitive life stages. In general, we tried to find no observed adverse effect levels for species relevant to the Markhams site. If such values were unavailable then the most protective value was selected and uncertainty factors applied in order to reduce the selected value to increase its protectiveness.

A brief profile summarizing the potential adverse ecological effects of each COPC developed to summarize information regarding effects of COPCs on growth, reproduction, and survival of endpoint species or their surrogates (see Appendix 5).

Terrestrial

TRVs for plants, earthworms, mammalian, and avian endpoint receptors came from published toxicity studies, with values judged most relevant for the site (Table 16).

Mammalian / Avian TRVs

The chemical applied in a laboratory study is often expressed as a concentration in food (*e.g.*, ppm). Therefore the concentration requires conversion to a dose (mg chemical/kg BW-day) to allow for a comparison among species of various body sizes. The conversion involves multiplying the concentration by the food ingestion rate (which is either from the toxicity study or can be estimated from published values for the test species), and dividing by the test organism's body weight (also taken from the study or estimated from the scientific literature). Differences in body size between the test species and the receptor species can also be a source of uncertainty. Therefore, the test species NOAEL is modified by a body-scaling factor to calculate the receptor species NOAEL (Sample *et al.*, 1996). No uncertainty factors were applied when the test value was a NOAEL. Therefore, receptor species NOAELs were calculated using the following equation:

$$TRV = NOAEL_R = NOAEL_T \times \left(BW_T / BW_R\right)^{1/4}$$

Where:

- $NOAEL_R$ (mg/kg/day) No observed adverse effect level for receptor species
- $NOAEL_T$ No observed adverse effect level for test species (mg/kg/day)
- BW_T Body weight of test species (kg)
- BW_R Body weight of receptor species (kg)
- $(BW_T/BW_R)^{1/4}$ Body scaling factor

For mammalian and avian endpoint species, various published sources were used as indicated. USEPA's (2005b and 2005c) recent ecological screening level document for chromium and arsenic provide an additional source of TRVs. The following summarizes the selections made (see Table 16).

- Avian/As—USEPA's review (2005b) cites a NOAEL based upon a well-designed and conducted study using chickens. We applied an uncertainty factor to adjust the chicken NOAEL for body weight to make it applicable to the Passeriformes used in the assessment.
- Avian/Cr—USEPA's (2005b) recommended geometric mean avian (NOAEL) TRV was used for the Robin and Wren without adjustment.
- Avian/Cr^{6+}—USEPA (2005b) made no recommendation concerning a TRV for hexavalent chromium. However, their Appendix 5.2 provides useful data in this regard. Using the NOAEL data presented in this appendix, an arithmetic mean of 3.4 mg/kg /day, and a geometric mean of 0.5 mg/kg/day were obtained. Such a result compares well with the 1 mg/kg/day value cited by Sample *et al.* (1996). Therefore, a TRV of 1 mg/kg/day was used for the Robin and Wren.
- Mammalian/As—USEPA's review (2005c) provides a bounded NOAEL/LOAEL pairing based upon a study with dogs, and this was adjusted for body weight as described above.
- Mammalian/Cr—USEPA's (2005b) recommended geometric mean mammalian (NOAEL) TRV for trivalent (total) chromium spreads across seven orders-of-magnitude. We truncated their NOAEL dataset to only mouse and rat data in order to develop an appropriate geometric mean TRV; this was then adjusted for body weight accordingly.
- Mammalian/ Cr^{6+}—USEPA's review (2005b) provides a bounded NOAEL/LOAEL pairing based upon a study with mice, and this was adjusted body weight.

Plants

Efroymson *et al.* (1997a) provides a considerable review of benchmarks for chemical toxicity to plants, and these were used where reasonable. Their discussion of chromium benchmarks indicates a lack of good information regarding the selection of an appropriate TRV for either total or hexavalent chromium, as does the recent analysis of chromium toxicity to plants by USEPA (2005b) in their Interim Final ecological screening levels document. The benchmark Efroymson *et al.* select is based upon soil solution studies using hexavalent chromium, where phytotoxicity is evinced by reduced root development. Unfortunately, this does not recognize the soil-plant barrier that exists for trivalent chromium, and that plants grown on serpentine soils containing upwards of 10,000 mg/kg show no adverse effects (Chaney *et al.* 1996). The benchmarks for chromium presented by Efroymson *et al.* are unreasonably low, even for a screening risk assessment, and unreflective of the chemistry (as previously discussed) of the conditions present at Markhams. This is because the study is based upon hexavalent chromium only and that the bulk concentration is wholly available (soluble). These assumptions are not appropriate for this assessment.

Efroymson *et al.*'s (1997a, see their Table 2) also present chromium benchmarks developed by:

- Canadian Environmental Quality Criteria for soil remediation (which are protective of human health and the environment)—total Cr 750 mg/kg and for hexavalent Cr 8 mg/kg
- RIVM (Netherlands) Ecotoxicological Intervention Values (which take into account plants, soil fauna, and microorganisms)—total Cr 230 mg/kg

For the purpose of this assessment, the RIVM benchmark was selected to evaluate total chromium toxicity and the Canadian value for hexavalent chromium was used, as they were judged to be more reflective of the chemical and biological reality present at Markhams.

Soil Invertebrates

Efroymson *et al.* (1997b) provides a considerable review of benchmarks for chemical toxicity to invertebrates. However, an argument similar to that for plant TRVs can be made concerning the total Cr TRV for invertebrates (also see USEPA 2005b). The single selected study (only with five samples) used for the 0.4 mg/kg TRV was based upon hexavalent chromium and is cited by Efroymson *et al.* (1997b) as having low confidence. Similar studies using total chromium and the Canadian and RIVM criteria for chromium are much higher (see above). In contrast, USEPA (2005b) cite Van Gestel *et al.'s* study with earthworms, which had a maximum acceptable toxicant concentration (MATC) of 57 mg/kg. However, Van Gestel *et al.* used $Cr\ (NO_3)_3$ in their studies, which is a compound that is very soluble in water and not comparable to the conditions present at Markhams. In fact, according to a review by Edwards and Bohlen (1996), a soil concentration of >50,000 ppm for chromium is protective of soil invertebrates. Nevertheless, for the purpose of this assessment, the RIVM benchmark was selected to evaluate total chromium toxicity and the Canadian value for hexavalent chromium was used, as they were judged to be more reflective of the chemical and biological reality present at Markhams.

Wetlands

Sediment

TRVs (benchmarks) used to evaluate risks to benthic invertebrates were based upon sediment quality criteria (NYSDEC, 1998b). The NYSDEC has established two levels of criteria for inorganic chemicals in sediments. These are the lowest effect level (LEL) and the severe effect level (SEL) derived from the Ontario Sediment Criteria of Persaud *et al.* (1993). The LEL indicates a level of sediment chemical that can be tolerated by the majority of benthic organisms, but still causes toxicity to a few species. The SEL indicates the concentration where effects to the sediment-dwelling community indicate highly contaminated sediments. The LEL was used for this assessment. TRVs for aquatic plants came from published toxicity studies, with values judged most relevant for the site. The TRVs are presented in Table 16.

Surface Water

Surface water was evaluated using previously discussed Ecological Screening Criteria as appropriate for ambient water quality conditions for the protection of freshwater aquatic life in New York State (NYSDEC, 1998a; all surface water standards and guidance values were obtained from either 6 NYCRR 703.5 or TOGS 1.1.1). The chromium TRV (benchmark) was calculated using an assumed hardness of >30 ppm, based upon a USGS water quality monitoring station (#03012831) on Johnson Creek at Markhams, NY, which compares to a generalized estimated of 5 ppm by Briggs and Ficke (1977) for the USGS survey of water hardness in the US.

The TRVs are presented in Table 16.

4. Screening-Level Exposure Estimates

This section includes site-specific information pertinent to the assessment of potential ecological exposures to chemicals at the site. The general estimation approach involved deriving exposure for the endpoint species identified in the Assessment and Measurement Endpoint sub-section of the Problem Formulation step (Chapter 2). To derive these estimates, we made assumptions regarding the ecological receptor's co-occurrence, contact with, and uptake of, potential contaminants. These assumptions were derived from published or readily available information and are detailed below.

Exposure Point Concentration

The Exposure Point Concentration (EPC) represents the environmental concentration of a chemical in a particular medium to which an ecological receptor at that site would be exposed.

Soil, Sediment, and Surface Water

Following SLERA guidance, maximal bulk media concentrations were used to evaluate potential exposure either in the terrestrial and/or wetland portions of the Markhams Site (see Table 17). Accordingly, it was assumed that each receptor received all exposure (from soil and sediment) from the site, including drinking water from wetland surface water, even though ponded water does not necessarily occur on site all year long.

However, as discussed in Chapter 2, the science concerning the behavior of chromium in soils is clear regarding the amount that is biologically available and accessible to biota, being far less than the bulk soil/sediment maximum measured by Geomatrix-Benchmark (2005):

$$C_{bulk\ total} = C_{fixed} + C_{sorb} + C_{sol}$$

Where,

C_{total}	=	total, measured concentration
C_{fixed}	=	the concentration fixed onto clay and soil/sediment minerals
C_{sorb}	=	that concentration adsorbed on the surfaces of soil/sediment minerals and organic matter
C_{sol}	=	the concentration of soluble species in pore or bulk water, which is bioaccessible

In fact, Stewart *et al.'s* (2003) bioaccessibility models make evaluating soil Cr (III) levels easier:

% Cr (III) Bioaccessible	=	16.02 + (0.426 x % clay) – (9.56 x % TIC)
	=	15.54 + (0.408 x % clay) – (3.78 x % TOC)

Where,

% Clay = is the percentage of the clay fraction in the soil of interest (for Markhams this is 3-12% according to Geomatrix-Benchmark [2005])

% TIC = is the percentage of Total Inorganic Carbon (essentially carbonate) in the soil of interest (Geomatrix-Benchmark [2005] did not collect such information for Markhams; however, according to the Cattaraugus Soil Survey (see Appendix 4) this will fall between 0 - <<1%)

% TOC = is the percentage of Total Organic Carbon in the soil of interest (for Markhams this is about 5% in surface soils and about 1% in the subsurface [Geomatrix-Benchmark 2005])

Using these models we can predict that the bioavailable/bioaccessible concentrations of Cr (III) range will be at least 1.5% but not more than 13% of the bulk soil/sediment concentration (the geometric mean of the percent of bioavailable Cr is 4.4%). A comparison of this modeled result to the available range of Synthetic Leaching Procedure data for chromium (4%, 5%, and 15%, with a geometric mean of 6.7%) for fill-soil developed by Geomatrix-Benchmark (2005) demonstrates good correspondence. Therefore,

- A Maximum Soil Concentration of 65,300 mg/kg (Table 8) yields a bioavailable/bioaccessible concentration of Cr (III) between 1,000 - 8,500 mg/kg
- An Average Soil Concentration of 7,600 mg/kg (Table 8, combined 2001 & 2003 data sets) yields bioavailable/bioaccessible concentrations of Cr (III) between 100 - 1,000 mg/kg

Vegetation / Wetland Plants

Surface soil and sediment chemicals also may be available to endpoint species through uptake by plants in their diet. No data on concentrations of chemicals in vegetation at the site were collected. Therefore, concentrations within vegetation were estimated:

- For organic compounds, we used the soil-to-plant part Bioconcentration Factors (BCFs) from ORNL RAIS (2005).
- For inorganic compounds, we used the values of Baes *et al.* (1984) to derive plant EPCs (see Table 12).

The predicted BCFs for vegetative uptake are shown in Table 17 with corresponding EPCs for each COPC calculated using the following equation (from Eq. 3-36 in USEPA 1999):

$$C_{plant} = C_{soil} \times BCF_{plant} \times 0.12$$

The factor of 0.12 was used to adjust from dry to wet weight (USEPA 1999).

Note that any hexavalent chromium absorbed by plants will be converted to trivalent chromium; therefore, vegetation used in the diets of animals will deliver only trivalent chromium.

Soil Invertebrates

The bioaccumulation model of Markwell et al. (1989) was used to determine the body burdens of organic COPCs (*i.e.*, benzaldehyde) in earthworms. This model considers the lipid content of soil invertebrates (Y_l) and organic carbon content (f_{oc}) of soils as the important components in calculating the BAF. This model uses the following equation to determine accumulation in earthworms:

$$BAF = \frac{Y_l}{(0.66 \times f_{oc})}$$

A lipid content of 2% was assumed for earthworms based on the work of Stafford and Tacon (1988). The average total organic carbon concentration of soils on the site was calculated to be 2.4%, using data collected by Geomatrix-Benchmark (2005)

For inorganic COPCs, the soil concentration was multiplied by an appropriate soil-to-invertebrate BCF to estimate the concentration in soil invertebrates. These BCF values generally came from USEPA (1999 Table C-1). However, these values are generally limited, being based upon one study.

Table 17 presents the EPC estimates for soil invertebrates.

Note that any hexavalent chromium absorbed by soil invertebrates (earthworms) will be converted to trivalent chromium; therefore, use of these organisms in estimating the dietary exposure of animals will yield only trivalent chromium to the higher trophic level consumer.

Wetland Benthic Macroinvertebrates

For modeling the Markhams Site wetlands, a simple uptake model from surface water and sediment to benthic organisms was used. There were no organic COPCs in wetland sediments.

For inorganic COPCs, the sediment concentration was multiplied by an appropriate sediment-to-invertebrate BCF to estimate the concentration in sediment and aquatic invertebrates. These BCF values generally came from USEPA (1999 Table C-6). Table 17 presents the EPC estimates for benthos.

Note that any hexavalent chromium absorbed by wetland benthos will be converted to trivalent chromium; therefore, use of these organisms in estimating the dietary exposure of animals will yield only trivalent chromium to the higher trophic level consumer.

Exposure Parameters

Total exposure for an ecological receptor is the sum of exposures from various components of the diet and from incidental soil and/or sediment ingestion, and ingestion of surface water. The cumulative dietary exposure is calculated by multiplying the tissue concentration in each prey item by the proportion that prey item represents in the diet and adding these values. The total is then multiplied by the exposure duration (ED), and ingestion rate (IR); and divided by the receptor's body weight (BW). The process is represented by the following equation:

$$EE_{diet} = \frac{\sum_{1-n}\left[(P_1 \times T_1) + (P_2 \times T_2) + \ldots (P_n \times T_n)\right] \times SUF \times ED \times IR}{BW}$$

Where:

- EE_{diet} = Estimated Exposure from diet (mg/kg/day)
- P_n = Percentage of diet by prey item ingested (designed to maximum exposure)
- T_n = Tissue concentration in prey item n (mg/kg dry weight)
- SUF = Site use factor (unitless)
- ED = Exposure duration (unitless), fraction of year spent in the region
- IR = Ingestion rate of receptor (kg/kg-day in dry weight; maximum)
- BW = Body weight of receptor (kg in fresh weight; minimum)

The COPC concentrations in prey items are based on the EPCs for soil, sediment, surface water, soil and benthic invertebrates, and plants listed in Tables 17. The calculations used to derive these EPCs were discussed in the previous section. Note however that the COPC concentration of hexavalent chromium within soil or sediment invertebrates will be converted to total chromium within the organism. Therefore, the total chromium burden within the worm/invertebrate or benthos will increase accordingly, while the hexavalent chromium concentration in the organism will decrease to zero.

Various exposure parameters for endpoint species, including dietary breakdown, home range, and body weight information, are presented in Table 18.

The SUF indicates that portion of an animal's home range comprised by the site. The SUF was set to allocate exposure to portions of the site (terrestrial landfill area or wetland) that maximize exposure and yet reasonably reflect typical behavior patterns of the wildlife (USEPA 1993).

The ED is the percentage of the year spent in the site area by the receptor species. Avian receptors may be considered either year round residents or migratory (the avian endpoint species are migratory birds). Regardless, all EDs were set at 1, see Table 18.

The estimation of receptor exposure to chemicals through incidental soil and/or sediment ingestion was similar to the dietary exposure estimate. A soil/sediment ingestion rate was calculated as a percentage of total diet (see Table 18), based on soil/sediment ingestion data in Beyer *et al.* (1994). The soil or sediment EPC was multiplied by the ingestion rate, as well as the SUF, and ED, and then divided by the minimal BW.

Maximum food ingestion rates for endpoint species were either taken from Chapter 2 of USEPA (1993) or estimated based on maximum body weight using the following equations:

Passerine Bird	Food intake (g/day) = $0.398(BW_{max})^{0.850}$
Mammal	Food intake (g/day) = $0.235(BW_{max})^{0.822}$
Rodent	Food intake (g/day) = $0.621(BW_{max})^{0.564}$
Herbivores	Food intake (g/day) = $0.577(BW_{max})^{0.727}$
Herptile Herbivores	Food intake (g/day) = $0.019(BW_{max})^{0.841}$
Herptile Insectivores	Food intake (g/day) = $0.013(BW_{max})^{0.773}$

Similarly, to estimate maximum drinking water intake for endpoint species values from Chapter 2 of USEPA (1993) were used or the following formula from USEPA were used:

Bird:	Water intake (kg/kg-day) = $0.059(BW_{max})^{0.67}$
Mammal:	Water intake (kg/kg-day) = $0.099(BW_{max})^{0.9}$

The total exposure for a receptor is the sum of exposure (as appropriate) from diet, landfill soil ingestion, wetland sediment ingestion, and wetland surface water ingestion, as represented by the following equation:

$$EE_{total} = EE_{diet} + EE_{sediment} + EE_{soil} + EE_{water}$$

Table 19 provides exposure estimates for the endpoint receptors within each area of concern. This table also presents the relative contributions of dietary, soil, sediment, and surface water exposure as a percentage of total exposure. The significance of these estimated exposures for wildlife receptors is discussed in the following sections.

Bioaccumulation in Secondary Trophic Species

The deer mouse, short-tailed shrew, American robin, and marsh wren were considered as possible prey species for the raccoon as a tertiary trophic level species.

To evaluate exposure a bioaccumulation factor was applied to exposure inputs to estimate the whole body tissue concentration of each COPEC. The approach for estimating concentrations in the deer mouse or short-tailed shrew followed that of USEPA (1999, Appendix F, Table F-1-2).

$$C_M = \left(C_{TP} \cdot BCF_{TP-M} \cdot P_{TP} \cdot F_{TP}\right) + \left(C_S \cdot BCF_{S-M} \cdot P_S\right) + \left(C_{WCTOT} \cdot BCF_{W-M} \cdot P_W\right)$$

Where:

C_M	=	Concentration in mouse/shrew (herbivorous/insectivorous mammals)
C_{TP}	=	Concentration of COPEC in food item
BCF_{P-M}	=	Bioconcentration factor for food item to mouse/shrew
P_{TP}	=	Proportion of contaminated food item in diet (assume 100%)
F_{TP}	=	Fraction of diet comprised of food item
C_S	=	Concentration of COPEC in soil and/or sediment
BCF_{S-M}	=	Bioconcentration factor for soil to mouse/shrew
P_S	=	Proportion of contaminated soil in diet (assume 100%)
C_{WCTOT}	=	Concentration of COPEC in water
BCF_{W-M}	=	Bioconcentration factor for water to mouse/shrew
P_W	=	Proportion of contaminated water in diet (assume 100%)

The BCF values, if available, for small mammals came from Appendix D Tables D-1 through D-3 of USEPA 1999. When BCF values were unavailable, the BCF was set to unity (1.0), which will overestimate the potential tissue concentration expected to be present in the prey species.

For COPC concentrations in avian prey species (robin and wren), the following equation was adapted from Appendix F of USEPA 1999 (see Table F-1-6).

$$C_B = \left(C_{INV} \cdot \frac{FCM_{TL3}}{FCM_{TL2}} \cdot P_{INV} \cdot F_{INV} \right) + \left(C_S \cdot BCF_{S-B} \cdot P_S \right) + \left(C_{WCTOT} \cdot BCF_{W-B} \cdot P_W \right)$$

Where:

C_B	=	Concentration of COPEC in American Robin/Marsh Wren (omnivorous/insectivorous birds)
C_{INV}	=	Concentration of COPEC in food item (*e.g.*, earthworm)
FCM_{TL3}	=	Food Chain Multiplier for tertiary level consumer (bird)
FCM_{TL2}	=	Food Chain Multiplier for secondary level consumer (*e.g.*, earthworm)
P_{INV}	=	Proportion of terrestrial invertebrate contaminated
F_{INV}	=	Fraction of diet composed of terrestrial invertebrate
C_S	=	Concentration of COPEC in soil
BCF_{S-B}	=	Bioconcentration factor for soil to bird
P_S	=	Proportion of soil in diet that is contaminated

C_{WCTOT}	=	Concentration of COPEC in water
BCF_{W-B}	=	Bioconcentration factor for water to bird
P_W	=	Proportion of water in diet that is contaminated

FCM values for the secondary and tertiary consumers were taken from Table 5-2 of USEPA (1999). Table 10 of that document provides the log K_{ow} values used for determining the FCM value; whereas BCF values for the bird species were taken from Appendix D Tables D-2 and D-3 of the same document. In the case of inorganic COPCs, the soil-to-bird and plant or invertebrate-to-animal BCF values came from USDOE (1999).

Table 19 presents the estimated exposure of the raccoon to the four COPCs carried through the food-chain exposure analysis. Two separate estimates were developed:

- The first analysis presents an exposure estimate assuming that the raccoon eats nothing but the particular prey item containing the maximal amount of a particular COPC.
- The second analysis presents an exposure estimate assuming that the raccoon eats prey items according to the site area and diet as indicated in the table, and which matches the dietary percentages shown in Table 18.

Table 19 also presents the relative contributions of dietary, soil, sediment, and surface water exposure as a percentage of total exposure. The significance of these estimated exposures for wildlife receptors is discussed in the following sections.

5. Screening-Level Risk Calculation

The approach taken in this SLERA evaluated exposure of floral and faunal receptor species through a two-step process using different ecotoxicity criteria:

- **Step i**—direct comparison of measured (maximum detected) media concentrations to a set of Environmental Screening Criteria (see Chapter 3).
- **Step ii**—for COPCs passing through **Step i** (*i.e.,* COPC is greater than screening criteria), the potential for ecological effects (*e.g.,* loss of fecundity, growth effects, or survival) was evaluated using the Hazard Quotient (HQ) method.

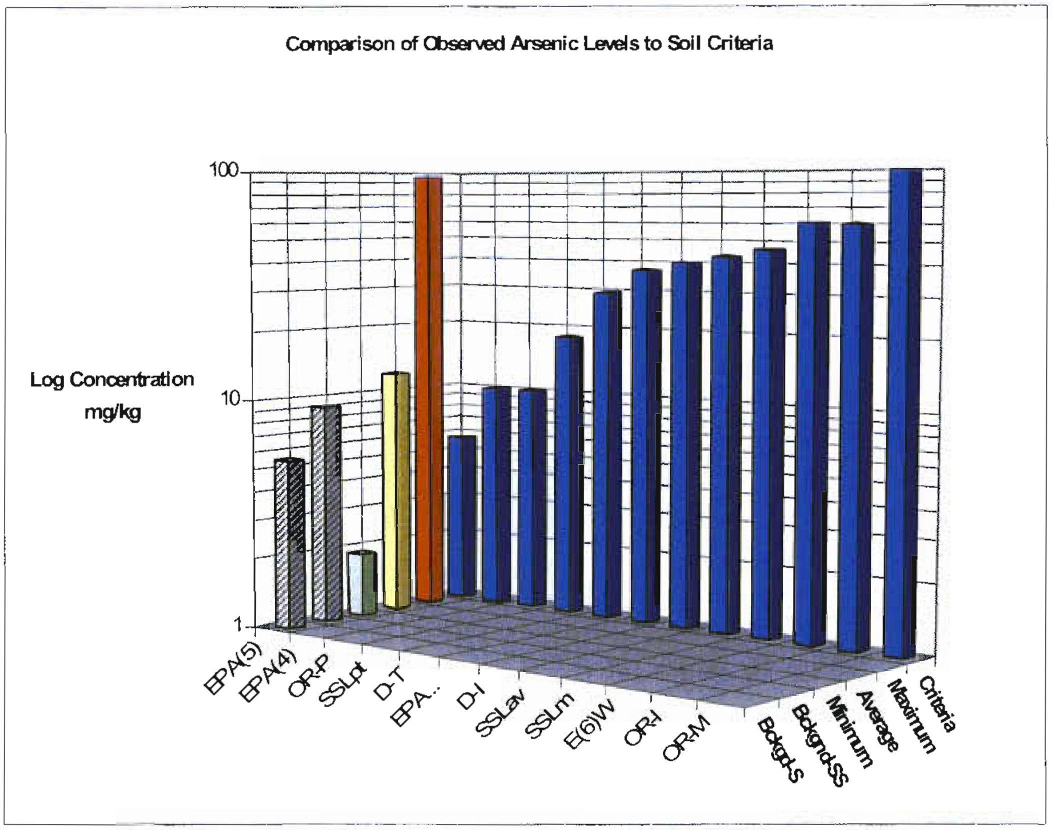
Step i. Screening-Level Analysis

As discussed in Chapter 3, various Environmental Screening Criteria were obtained by using the ORNL RAIS database. These environmental criteria are media-specific screening levels to which site COPCS concentrations can be compared. If measured environmental media concentrations exceed these criteria, then greater attention can be paid to those areas and COPCs that are most likely to pose an unacceptable risk to the environment. The analysis was performed by a simple comparison for soil in the landfill area and wetland sediments and surface water as discussed below.

Soil

Table 13 provides the screening analysis for soils at the Markhams Site, resulting in the following findings:

- **COPCs Without Criteria:** Benzaldehyde (This COPC was held-over for Step ii of this SLERA presented later in this chapter.)
- **COPCs Not Exceeding Criteria:** Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(ghi)perylene, Chrysene, Fluoranthene, 4-Methylphenol, Naphthalene, Pyrene
- **COPCs Exceeding Criteria** (These COPCs were held-over for Step ii of this SLERA presented later in this chapter.)
    - Arsenic—the maximum concentration exceeded all available criteria except one for microbes; while the average concentration only exceeded the most stringent criteria (the graph below corresponds to Table 13), also note the background soil concentrations compared to criteria

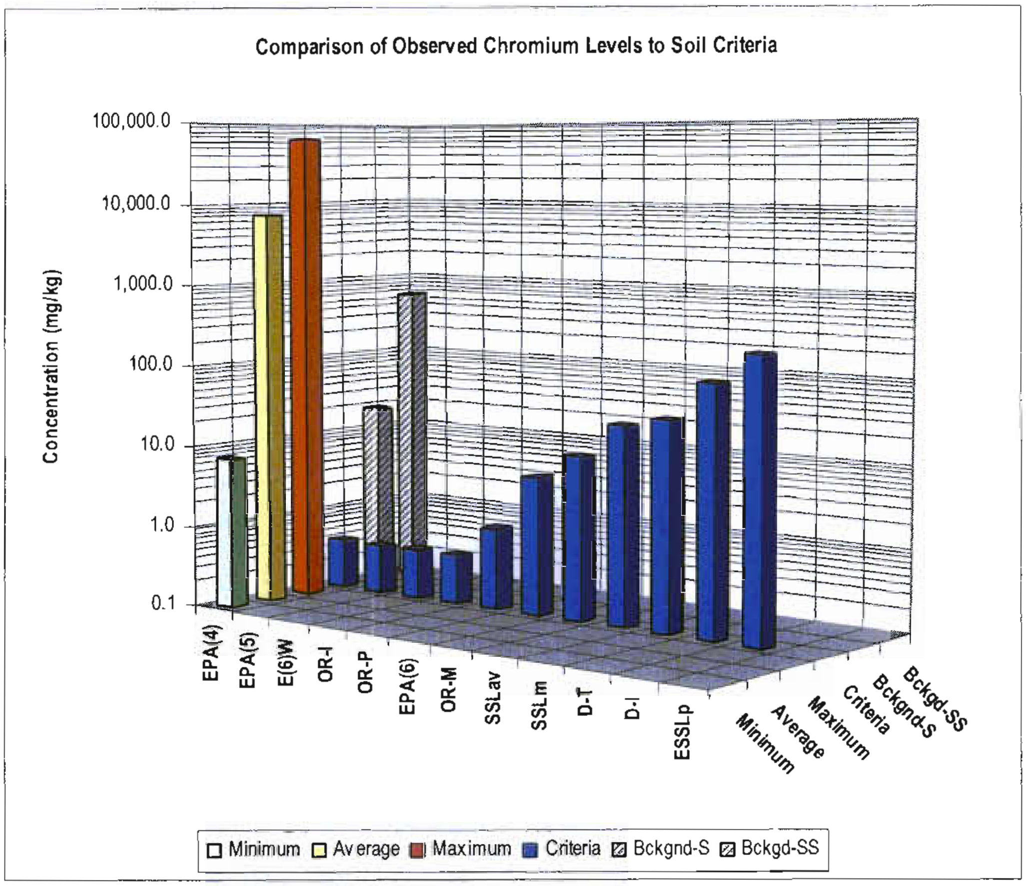


The graph above presents the arsenic concentration on a logarithmic scale and the different criteria are:

EPA(4) & EPA(5)	*USEPA Reg-4 & Reg-5 Ecological Screening Levels*
D-T & D-I	*Dutch Target or Intervention Levels*
SSLav & SSLm & SSLpt	*Eco-SSLs for Avian, Mammals, or Plants*
E(6)P & E(6)W	*USEPA Reg-6 Ecological Screening for Plants or Worms*
OR-P & OR-I & OR-M	*ORNL Criteria for Plants, Invertebrates, or Microbes*

Note that the background surface (Bckgd-S) and subsurface soil (Bckgd-SS) data for Markhams can be found in Table 7. The Minimum, Average, and Maximum values are surface soil results measured by Geomatrix-Benchmark (2005) (see Table 8).

- Chromium—the maximum and the average concentrations exceeded all available criteria (the graph below corresponds to Table 13), also note the background soil concentrations compared to criteria



The graph above presents the arsenic concentration on a logarithmic scale and the different criteria are:

EPA(4) & EPA(5)	*USEPA Reg-4 & Reg-5 Ecological Screening Levels*
D-T & D-I	*Dutch Target or Intervention Levels*
SSLav & SSLm & SSLpt	*Eco-SSLs for Avian, Mammals, or Plants*
E(6)P & E(6)W	*USEPA Reg-6 Ecological Screening for Plants or Worms*
OR-P & OR-I & OR-M	*ORNL Criteria for Plants, Invertebrates, or Microbes*

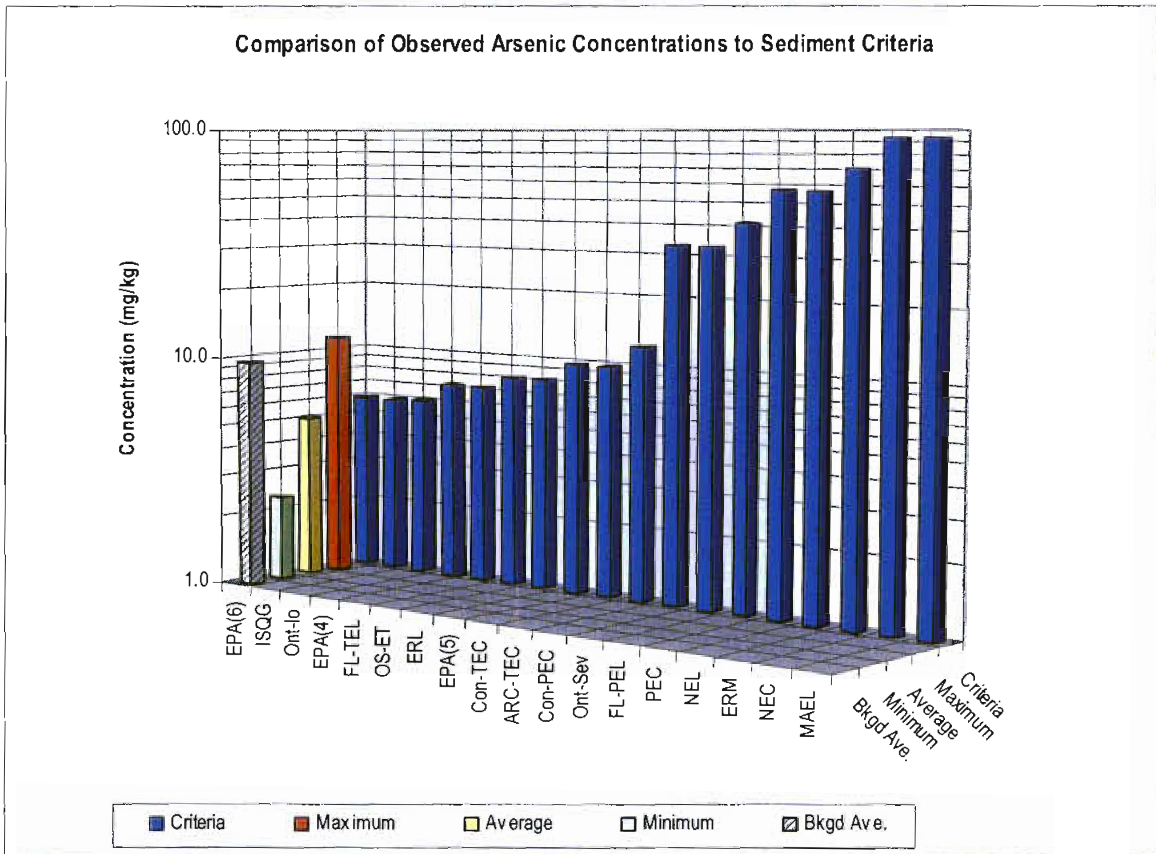
The minimum, average, and maximum values are surface soil results measured by Geomatrix-Benchmark (2005) (see Table 8). The background surface (Bckgd-S) and subsurface soil (Bckgd-SS) data for Markhams can be found in Table 7.

- Hexavalent Chromium—few criteria are specifically available for this COPC, and the maximum and the average concentrations exceeded two-out-of-three available criteria

Wetland Sediment

Table 14 provides the screening analysis of wetland sediments surveyed at the Markhams Site, resulting in the following findings:

- **COPCs Not Exceeding Criteria:** None
- **COPCs Exceeding Criteria**: (These COPCs were held-over for Step ii of this SLERA, which is presented later in this chapter.)
  - Arsenic—the maximum concentration exceeded all of the low, threshold-level–based criteria; while the average concentration did not exceed any criterion (the graph below corresponds to Table 14, see also Table 10). Also, note the average concentration value (which is based upon O'Brien & Gere's 1989 data as well as that of Geomatrix/Benchmark).

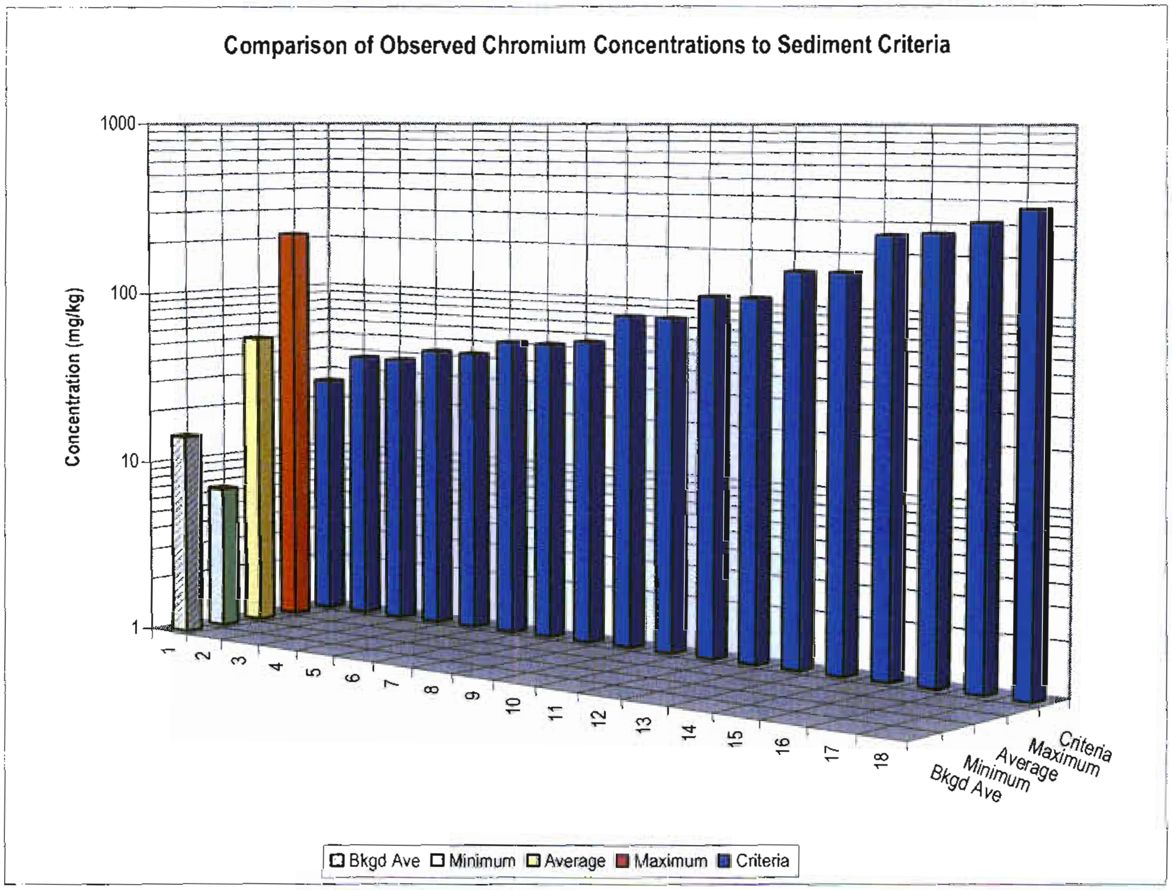


The graph above presents the arsenic concentration on a logarithmic scale and the different criteria are:

EPA(4), EPA(5), & EPA(6)	*USEPA Regions 4, 5 & 6 Freshwater Sediment Screening Levels*
ISQG & Ont (lo or Sev)	*Canadian Interim Sediment Quality Guidelines & Ontario low or severe effects screening criteria*
FL TEL & PEL	*Florida Dept. of Environ. Protection Threshold Effects Levels and Probable Effects Levels*
ARC NEC, TEC, & PEC	*USEPA Assessment and Remediation of Contaminated Sediments Program (No Effects, Threshold Effects, and Probable Effects concentrations)*
OS-ET	*USEPA OSWER Ecotox thresholds*
Con TEC & PEC	*Consensus-based Sediment Quality Guidelines*

ERL & ELM	*NOAA National Status and Trends Program Sediment Quality Guidelines Effects Range Low and Median*
NEL &MAEL	*Washington State Sediment Quality Standards (no effect and maximum level)*

- <u>Chromium</u>—the maximum concentration exceeded <u>most</u> of the criteria; while the average concentration was above most of the low, threshold-level–based criteria (the graph below corresponds to Table 14)



The graph above presents the arsenic concentration on a logarithmic scale and the different criteria are:

1	*Ontario Low*	*10*	*NOAA ERL Level*
2	*USEPA 6 Freshwater Sediment ESL*	*11*	*Ontario Severe*
3	*Canadian ISQG*	*12*	*Consensus Sed. Qual. PEC Guide*
4	*USEPA 5 Freshwater Sediment ESL*	*13*	*EPA ARCS Probable Effects Concen.*
5	*Consensus Sed. Qual. TEC Guide*	*14*	*FL-PEL*
6	*USEPA 4 Freshwater Sediment ESL*	*15*	*Washington State NEL*
7	*FL-TEL*	*16*	*Washington State MAEL*
8	*ARCS-TEC*	*17*	*EPA ARCS No Effects Concen.*
9	*USEPA OSWER Ecotox Threshold*	*18*	*NOAA ERM Level*

- <u>Hexavalent Chromium</u>—no specific criteria are available; however, there were no excursions above any of the chromium criteria

Wetland Surface Water

Table 15 provides a comparison of the maximum detected concentration of the COPCs in wetland surface water samples to the listed criteria. The results of this comparison provide the following findings:

- **COPCs Exceeding Criteria:**
  - Chromium—the maximum concentration exceeded the most stringent criteria; while the average concentration was below all criteria
  - Hexavalent Chromium—the maximum concentration exceeded the most stringent criteria; while the average concentration was below all criteria
- **COPCs Not Exceeding Criteria:** Arsenic

These COPCs were held-over for Step ii of this SLERA presented later in this chapter.

Step ii. Risk Estimation Based On Food Chain Modeling

Potential risks posed by COPCs were evaluated by calculating a screening Hazard Quotient (HQ) for each COPC and for each endpoint species in each area of concern.

The screening HQ_{total} for all pathways was determined by dividing the total exposure through all pathways (EE_{total} from Table 19) by the appropriate TRV or benchmark for the endpoint species and COPC:

$$HQ_{total} = \frac{EE_{total}}{TRV}$$

A resulting HQ_{total} greater than 1.0 indicates that a risk for adverse ecological effects from exposure to contaminants may exist. By referring to the percentages of exposure resulting from different pathways (*e.g.*, food ingestion, sediment ingestion and surface water ingestion) in the different areas of the site, the relative contribution to total potential risk for each exposure pathway can be identified.

The screening Hazard Quotients (across all exposure pathways and food/prey items) and cumulative screening Hazard Index (across all COPCs) are presented in Table 20 and discussed in the next chapter.

6. Conclusions

Assessment Findings

Table 19 presents the estimated exposure levels of each measurement (receptor) species for each COPC, while Table 20 presents the results of the screening HQ calculations. The findings of the risk estimation based upon food chain modeling for the Markhams Site are discussed in detail below.

Terrestrial (Landfill Area)

Ecological Risk to Terrestrial Plants

The Step i Screening Analysis indicated some potential for ecological risk to plants (page 56). Soil Quality Benchmark Analysis (Step ii) suggests a potential ecological risk for total chromium; while risk due to hexavalent chromium and arsenic approach the screening threshold, and benzaldehyde posed no risk. If the analysis is based on average concentrations instead of maximal concentrations, the estimated ecological risk to plants decreases about 9-times. If only bioaccessible (total) chromium is considered, then there is no risk.

Ecological Risk to Terrestrial Invertebrates

The Step i Screening Analysis indicated some potential for ecological risk to soil invertebrates (page 56). Soil Quality Benchmark Analysis (Step ii) indicates potential ecological risk due to arsenic, total chromium, and hexavalent chromium. However, if the analysis is based on average concentrations instead of maximal concentrations, the estimated ecological risk to soil invertebrates decreases about 9-times. If only bioaccessible (total) chromium is considered, then there is no risk. An analysis of ecological risk due to benzaldehyde was not possible due to a lack of a TRV. However, considering that this chemical is a common natural product of plants, it was detected only at low concentrations in soil, and that it is readily biodegraded, the potential for a significant risk from this COPC seems unlikely.

Ecological Risk to Small Mammals

The Step i Screening Analysis indicated some potential for ecological risk to small mammals (page 56).

Herbivorous Small Mammal (Deer Mouse)—screening-level risk calculations (Step ii) for this small mammal indicated only a limited potential ecological risk for total chromium. No significant risk is indicated for other COPCs using this analysis. The suggested ecological risk for total chromium was driven by soil ingestion; thus, if one considers average or bioaccessible chromium levels, then no risk is indicated.

Insectivorous Small Mammal (Short-tailed Shrew)—screening-level risk calculations (Step ii) for this small mammal indicated only a limited potential ecological risk for total chromium and arsenic. No significant risk is indicated for hexavalent chromium or benzaldehyde using this analysis. The suggested ecological risk for total chromium was driven by soil ingestion and the risk due to arsenic was driven by diet; thus, if one considers average concentrations or bioaccessible chromium levels, then no risk is indicated.

Ecological Risk to Omnivorous Mammal (Raccoon)

The Step i Screening Analysis indicated some potential for ecological risk to small mammals (page 56). The screening-level risk calculations (Step ii) indicated a limited potential ecological risk for arsenic and more risk due to total chromium. These risks are for maximal exposure to maximal concentrations, and are driven by the dietary pathway. A re-analysis of raccoon exposure using a more normal diet (see Table 18 and 19), and maximal concentrations of arsenic, benzaldehyde, and hexavalent chromium, and bioaccessible trivalent chromium then there is no ecological risk (Table 20). Consideration of median intake and body weight reinforces this conclusion. [NOTE: The initial analysis used a diet designed to maximize COPC exposure, that is, a focus on prey items that will have the highest concentration of COPCs within them, consistent with guidance. A more normal diet assumes a more typical diet as described in USEPA's {1993} Wildlife Exposure Factors Handbook]

Ecological Risk to Birds

Avian Omnivore (American Robin) & Avian Insectivore (Marsh Wren)—screening-level risk calculations indicated potential ecological risk due to arsenic, hexavalent chromium, and total chromium, and primarily via soil ingestion (≈50%, >90%, and ≈100%, respectively) (see Table 19). Dietary arsenic contributed the other significant portion of the risk. A re-analyzing exposure with average and/or bioaccessible concentrations results in a substantial decrease in risk (Table 20). Consideration of median intake and body weight reinforces this conclusion. Benzaldehyde risk estimation was impossible due to no TRV for birds; but this common, natural product of plants was detected only at low levels in soil and is readily biodegraded. Thus, potential risk from this COPC seems unlikely.

Wetland Area

Ecological Risk to Wetland Plants

There was no significant risk indicated for any COPC.

Ecological Risk to Wetland Invertebrates (Macrobenthic Organisms)

Limited potential ecological risk indicated for maximal arsenic and total chromium, but no risk for hexavalent chromium. There was no significant risk indicated for any

COPC at average concentrations, or considering bioaccessible/bioavailable levels of total chromium.

Ecological Risk to Herptiles

Aquatic Herbivore (Painted Turtle) & Aquatic Insectivore (Green Frog)—potential ecological risk is indicated for maximal arsenic and total chromium, but not hexavalent chromium. The suggested risk due to total chromium is driven by soil ingestion. There was no significant risk indicated for any COPC at average concentrations, or considering bioaccessible/bioavailable levels of total chromium.

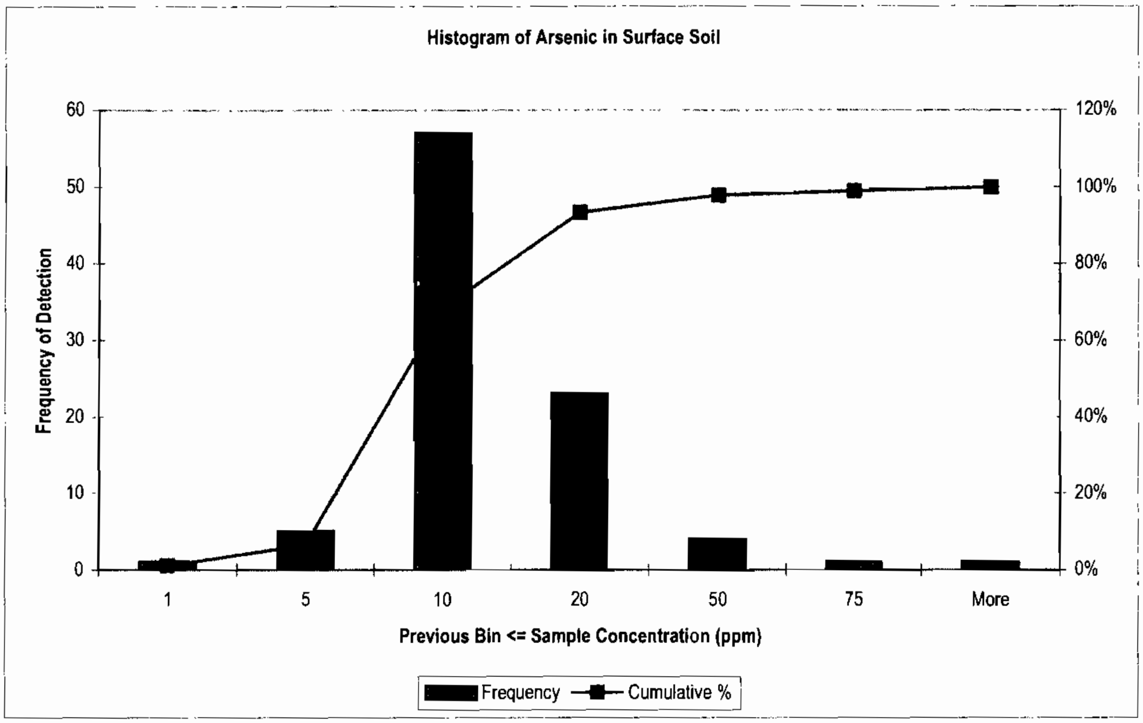
Significance

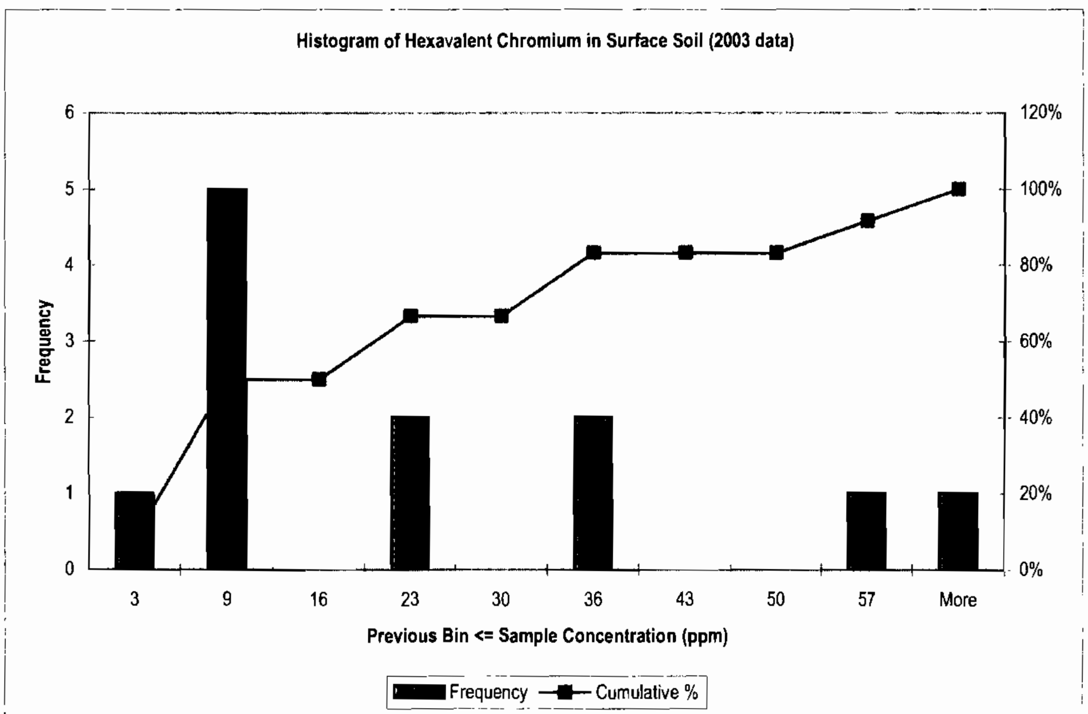
The list of COPCs included several PAHs, p-cresol, benzaldehyde, and the inorganics arsenic and chromium (total and hexavalent). The organics are limited in their detectable presence in the source material and generally at the site; and comparing the concentrations levels to general ecological screening criteria indicate little if any risk. That risk, if important, is limited to a couple of sample locations and can be considered "hot spots." Clearly the predominate COPCs are inorganic, with the concentrations spanning several orders-of-magnitude.

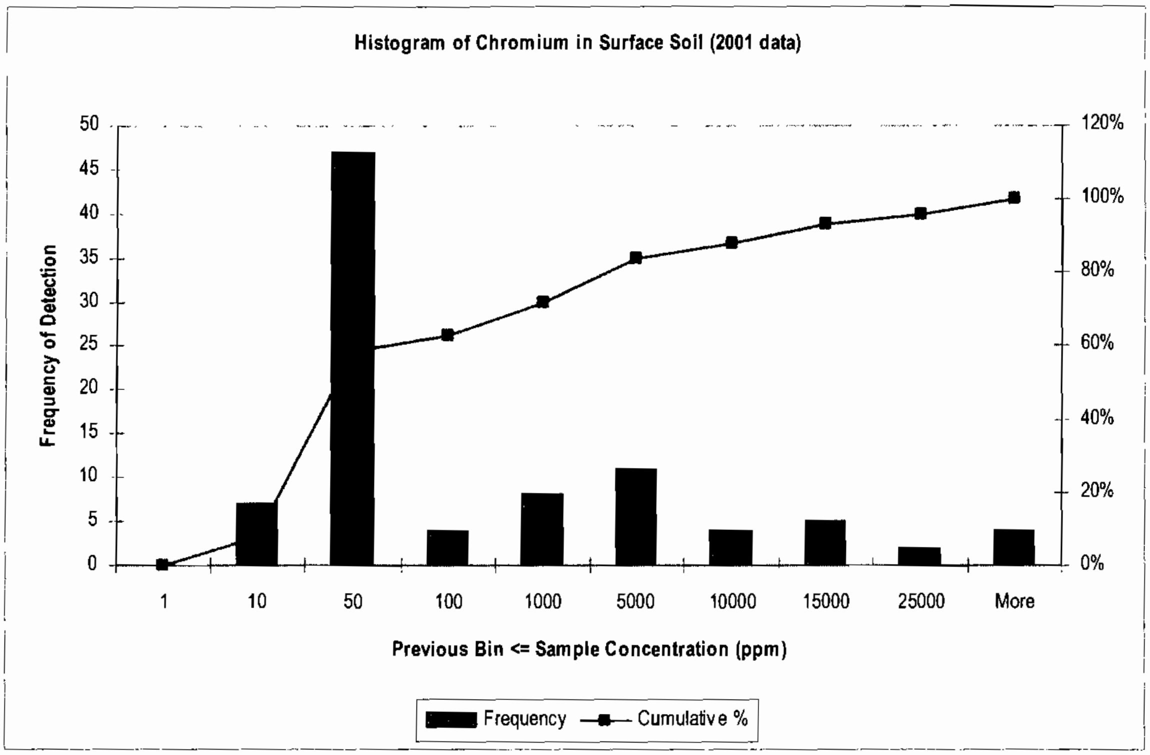
The distribution of high concentrations of inorganic COPCs generally correlates (high concentrations of arsenic, total chromium, and hexavalent chromium) although there is not a one-to-one correspondence. Sample locations Lathe #120 and #121 had the highest concentrations of each of these COPCs, and surface soils had far higher concentrations than other sampled media.

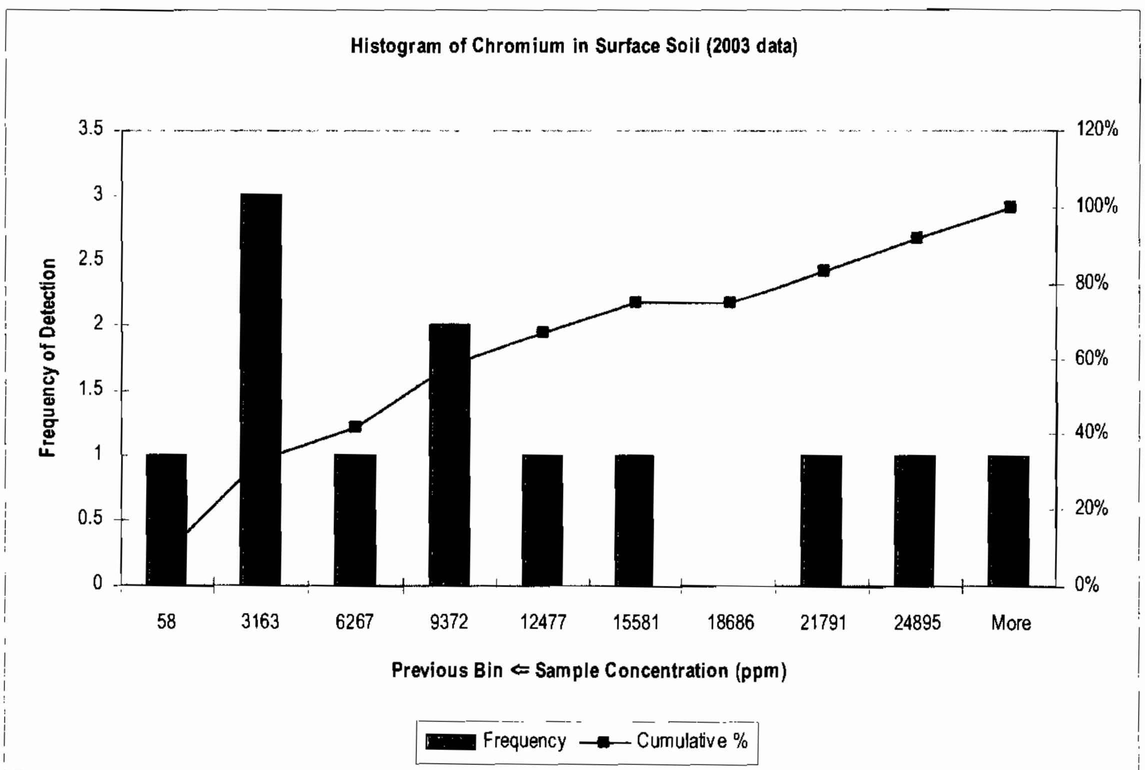
- The arsenic dataset has >90 samples, demonstrating skewed distribution of concentrations (histogram follows), with 68% having a concentration ≤10 mg/kg (ppm). The maximal concentration occurred in Lath #120 (Sample #97), which is associated with the fill piles. Almost all of the samples with high concentrations were pile associated.
- The hexavalent chromium dataset is limited, including only 12 samples from 2003. The 2001 dataset was rejected due to poor data quality. The 2003 data are widely distributed (histogram follows), but the distribution is skewed, similar to arsenic, with a mean of 20 mg/kg and 50% of samples ≤9 mg/kg (ppm). The maximal concentration occurred in Lathe #120 (Sample #97), the same as for arsenic. The significant difference in the distribution of concentrations between total and hexavalent chromium is not surprising in that the environmental conditions (soil chemistry) favors oxidation of hexavalent to trivalent chromium.
- The total chromium dataset has >90 samples from 2001 and 12 samples from 2003 (histograms follow). The concentration distribution is skewed with an exceptionally long high-concentration tail spanning two orders of magnitude. The maximal concentration occurred in Lathe #121 (Sample #92A), and also is pile associated. Almost all samples with high concentrations were associated with the fill piles. Over 58% of the 2001 samples had a concentration ≤10 mg/kg (ppm) and a mean of about 11 mg/kg. The distribution of concentrations in the 2003 data centered on 9,000 mg/kg (ppm), but had a similar spread of concentrations, although the dataset was smaller with a more linear frequency distribution.

Thus, the analysis, following guidance, suggests some potential risk from arsenic and chromium (total and hexavalent). Potential ecological risk is determined by concentration of the particular COPC and its bioavailability, the mechanism and amount of exposure, and exposure frequency and duration. The food chain modeling indicates minimal increased ecological hazard to wildlife preying upon plants and invertebrates exposed to elevated COPC concentrations at the Markhams Site; but the analysis clearly suggests that the most significant risk, if real, is primarily due to direct soil exposure. Considering the available data, we conclude that any impact will be highly localized.


Histogram of Arsenic in Surface Soil
Frequency of Detection
60
50
40
30
20
10
0
120%
100%
80%
60%
40%
20%
0%
1
5
10
20
50
75
More
Previous Bin <= Sample Concentration (ppm)
Frequency
Cumulative %


Histogram of Hexavalent Chromium in Surface Soil (2003 data)
Frequency
6
5
4
3
2
1
0
120%
100%
80%
60%
40%
20%
0%
3
9
16
23
30
36
43
50
57
More
Previous Bin <= Sample Concentration (ppm)
Frequency
Cumulative %


Histogram of Chromium in Surface Soil (2001 data)
Frequency of Detection
50
45
40
35
30
25
20
15
10
5
0
120%
100%
80%
60%
40%
20%
0%
1
10
50
100
1000
5000
10000
15000
25000
More
Previous Bin <= Sample Concentration (ppm)
Frequency
Cumulative %


Histogram of Chromium in Surface Soil (2003 data)
Frequency of Detection
3.5
3
2.5
2
1.5
1
0.5
0
120%
100%
80%
60%
40%
20%
0%
58
3163
6267
9372
12477
15581
18686
21791
24895
More
Previous Bin <= Sample Concentration (ppm)
Frequency
Cumulative %

Uncertainty

Various uncertainties are associated with the assessment of ecological risk using a SLERA as outlined below. The relative significance of the uncertainties has been discussed within the text whenever possible.

Concentration and Bioavailability

The use of maximal concentration data is a SLERA standard. The foregoing analysis of the concentration data informs us that such an assumption significantly biases the assessment findings. Furthermore, the use of bulk media chemistry overestimates the risk due to available concentrations of the inorganic COPCs, and in particular trivalent chromium.

Selection of Endpoint Species

Uncertainty is associated with the selection of endpoint species because it is impossible to evaluate all species potentially impacted by the site. However, the site characterization limits the range of species that would reasonably be expected to be impacted by site-related chemicals. While other species may visit the site, the small mammals, painted turtle and green frog, American robin and marsh wren, and raccoon are expected to be common here.

Selection of Surface Soil Stratum

Environmental data for surface soil at the site is within the EPA defined 0-2 ft bgs strata. Some additional data points lie just beneath this level. Although subsurface soils as deep as 6-feet may be available strata for some ecological receptors, the focus on surface soil in this SLERA is considered protective in that the COPC concentration levels were higher in these soils. Exclusion of the subsurface soil data presents a minor source of uncertainty.

Modeling of Chemical Uptake

The uptake and accumulation of organic substances in the benthic organisms is viewed as the result of equilibrium partitioning of the chemicals between the lipids of the organism, the organic fraction of sediments, and the interstitial pore water (Gobas *et al.* 1993). This assumes the system is in steady state. The steady-state assumption may not be appropriate for soluble and/or mobile metals or organic compounds in sediment. In addition, certain organic compounds can degrade over time. For example, the half-life of PAHs varies from months to several years (Mackay *et al.* 1999). Nevertheless, the conservative steady-state assumption was used because it provides the best understanding of conditions in the absence of change. Furthermore, this assumption is consistent with conditions at Markhams because there has been no changes at the site for almost 30 years

The analysis used a simple food chain model. Uncertainty arises from assuming simple large portions of the diet was one species, or skewed to different, maximal COPC-containing prey species; this was particularly demonstrated with the raccoon's exposure profile (see Table 19 for the exposure data and Table 20 for the Hazard Quotient results). If the lipid content of other food items is significantly higher or lower than assumed for invertebrates, the model may over- or under- estimate the chemical concentration. Clearly, the assumption is important in this case as the invertebrates' bioconcentrate significant levels of the COPCs.

Published BCFs (bioconcentration factors) and BAF (bioaccumulation factor) values were used to estimate concentrations of chemicals in invertebrates and through the food chain. In some instances, BCF and BAF values were unavailable from the literature, so surrogate values were developed from related metals, or simply assumed to be 100%, which will bias the exposure model towards overexposure.

Furthermore, the terrestrial food chain exposure models assumed 100% uptake from areas with the highest chemical concentrations, and 100% exposure to the most contaminated food items, and maximum food intake, and minimum body weight. Such exposure modeling (required by guidance) heavily biases this SLERA towards overexposure (as demonstrated in Tables 19 and 20); nevertheless, it is highly protective of the ecological resources of concern in the analysis.

Extrapolation from Literature Toxicity Data to TRVs

Principal uncertainties associated with the extrapolation process are identified and discussed in Chapter 3. A sensitivity analysis was conducted to determine the most important factors in deriving hazard quotients. The range of published TRV values were such that, in almost every case in which worst-case TRVs showed HQs greater than one, the middle or high range of the TRV published values (or comparing threshold screening criteria to probable or median effect level screening criteria) could be used to show no impact. This is supported by a review of the ecological effects screening criteria used in Step ii of the risk characterization (see Chapter 5). Criteria based upon the lowest NOAEL and/or most sensitive species were generally exceeded by the maximal and occasionally the average detected concentration. Criteria based upon probable or median effects levels showed far less potential for impact.

Interactive Effects of Chemicals

Uncertainty in toxic effects of a chemical can arise from its interaction with other chemicals in the environment. Chemicals can act synergistically, antagonistically, or additively. Because the effects of the interaction on toxicity of various chemicals are not known, it is not clear whether accounting for these interactions would increase or decrease the risk estimations.

Uncertainties in the sub-assessments result in uncertainties in the overall risk characterization. Uncertainty is associated with the extrapolation of risks to populations and ecological communities based upon risk estimates to an individual animal. Although bias in these extrapolations could either overestimate or underestimate actual risk to biota at higher levels of the biological organization, worst-case assumptions were used to make overestimated risks more likely. The potential for significant ecological risks where the analysis indicates a hazard quotient less than one is very low.

Scientific / Management Decision Point (SMDP)

Consistent with USEPA ERAGS (1997), the Scientific/Management Decision Point (SMDP) at the end of Step 2 of the Ecological Risk Assessment process is to focus on whether the information available to the site Risk Manager is adequate for making a risk management decision. According to the guidance, there are three possible decisions at this point:

- There is adequate information to conclude that ecological risks at the site are negligible and no need for remediation on the basis of ecological risks exists.
- There is inadequate information to make a decision at this point and the ecological risk assessment process will continue to Step 3.
- The available information indicates a potential for adverse ecological risk effects, and a more thorough assessment is warranted.

A conclusion concerning the adequacy of the information herein or the need for a more thorough assessment will be made in accordance with the risk management process.

We are of the opinion that the information is adequate for the risk management decision-making process and sufficient to conclude that ecological risks at Markhams are negligible in context. It is highly unlikely that further ecological study will change the conclusions of this assessment.

At sites where there is a potential for only marginal ecological impact, the uncertainty of the TRVs is the most important factor in the ecological risk assessment. Field studies (such as a study of wetland functions and values, a compilation of measures of soil quality, analysis of COPC concentrations in soil pore water versus bulk soil) or biological tests/ecological evaluations will not provide more or better site-specific information that would significantly aid in remedy selection or establishment of remedial goals.

7. References

Literature

Adema, DMM, and L Henzen, 2001, *De Invloed van 50 Prioritaire Stoffen op de Groei van Lactuca sativa (sla)*, TNO-Rapport No. 21003, TNO, Delft, Netherlands (OECDG Data File)

Agency for Toxics Substances and Disease Registry (ATSDR), 1990-2003, *Toxicological Profiles*, US Department of Health and Human Services, Atlanta, GA (available at: http://atsdr1.atsdr.cdc.gov/toxpro2.html)

Al-Abadleh, HA, AL Mifflin, PA Bertin, ST Nguyen, and FM Geiger, 2005, Control of Carboxylic Acid and Ester Groups on Chromium (VI) Binding to Functionalized Silica/Water Interfaces Studied by Second Harmonic Generation, *J Phys. Chem. B* ASAP Article 10.1021/jp050782o S1089-5647(05)00782-0

Baes, GF, RD Sharp, AL Sjoreen, and RW Shor, 1984, *A Review and Analysis of Parameters for Assessing Transport of Environmentally Released Radionuclides Through Agriculture*, ORNL-5786, Oak Ridge National Laboratory, Oak Ridge, TN

Bartlett, RJ and JM Kimble, 1976, Behavior of chromium in soils: I Trivalent forms, *J Environ Qual* 5:379-383

Bartlett, RJ, 1976, Behavior of chromium in soils: II Hexavalent forms, *J Environ Qual* 5:383-386

Bartlett, RJ and B James, 1979, Behavior of chromium in soils: III Oxidation, *J Environ Qual* 8:31-35

Bechtel Jacobs Company, 1998, Biota Sediment Accumulation Factors for Invertebrates: Review and Recommendations for the Oak Ridge Reservation, Prepared for the US Department of Energy, Oak Ridge, TN

Beyer, WE, E Connor, and S Gerould, 1994, Estimates of Soil Ingestion by Wildlife, *J Wildlife Management* 58(2): 375-382

Bodek, I WJ Lyman, WF Reehl, and DH Rosenblatt, 1988, Environmental Inorganic Chemistry, SETAC/Pergamon Press: New York

Briggs, JC and JF Ficke, 1977, Quality of Rivers of the United States, 1975 Water Year—Based on the National Stream Quality Accounting Network (NASQAN): US Geological Survey Open-File Report 78-200, 436 p)

Bruggeman, WA, JM Matron, D Kooiman, and O Hutzinger, 1981, Accumulation and Elimination Kinetics of di-, tri-, and tetra- Chlorobiphenyls by Goldfish After Dietary and Aqueous Exposure, Chemosphere 10: 811-832

Burt, WH and RP Grossenheider, 1976, Field Guide to the Mammals, Houghton Mifflin Company: Boston, MA

Chaney, RL, JA Ryan, and SL Brown, 1996, Development of the US–EPA Limits for Chromium in Land–Applied Biosolids and Applicability of These Limits to Tannery By--Product Derived Fertilizers and Other Cr–Rich Soil Amendments, *Proc. Chromium Environmental Issues Workshop*, San Miniato, Italy

Clark, KE, FAPC Gobas, and D Mackay, 1990, Model of Organic Chemical Uptake and Clearance by Fish from Food and Water, *Environ Sci Technol* 22: 99-103

Clement Associates, Inc, 1985, *Chemical, Physical, and Biological Properties of Compounds Present at Hazardous Waste Sites*, Final Report, Prepared for USEPA, Arlington, VA

Clough, MW, 2000, Personal Communication, US Department of the Interior, Fish and Wildlife Service, Cortland, NY

Conat, R and JT Collins, 1975, *A Field Guide to Reptiles and Amphibians of Eastern and Central North America*, Houghton Mifflin Company: Boston, MA

DeGraaf, RM and DD Rudis, 1983, *New England Wildlife: Habitat, Natural History, and Distribution*, General Technical Report NE-108, Northeast Forest Experiment Station, Amherst, MA

Dragun, J, 1988, *The Soil Chemistry of Hazardous Materials*, Hazardous Materials Control Research Institute: Silver Springs, MD, 458p

Edinger, GJ, DJ Evans, S Gebauer, TG Howard, DM Hunt, and AM Olivero (Editors) 2002, *Ecological Communities of New York State*, Second Edition—A revised and expanded edition of Carol Reschke's Ecological Communities of New York State, (Draft), New York Natural Heritage Program, NYSDEC, Albany, NY

Edwards, CA and PJ Bohlen, 1996, *Biology and Ecology of Earthworms,* 3rd Ed, Chapman & Hall: London, 426pp

Efroymson, RA, ME Will, GW Suter III, and AC Wooten, 1997a, *Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants*, ES/ER/TM-126/R2, Oak Ridge National Laboratory, Oak Ridge, TN

_______, 1997b, *Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process*, ES/ER/TM-126/R2

Eisler, R, 1987, *Polycyclic Aromatic Hydrocarbon Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review*, Biological Report 85(1.11) US Fish and Wildlife Service, Laurel, MD

Electric Power Research Institute (EPRI), 1986, *Geochemical Behavior of Chromium Species*, EPRI: Palo Alto, CA, #EA-4544

_______, 1988, *Chromium Reactions in Geologic Materials*, EPRI: Palo Alto, CA, #EA-5741

Fetter, CW, 1993, *Contaminant Hydrogeology*, Prentice-Hall: Upper Saddle River, NJ

Geomatrix Consultants Incorporated (Geomatrix) and Benchmark Environmental Engineering and Science, PLLC (Benchmark), 2002, *Pathway Analysis Report (PAR)*, August

Gilbert, RO, 1987, *Statistical Methods for Environmental Pollution Monitoring*, John Wiley & Sons, Inc: New York

Gobas, FAPC, 1993, A Model for Predicting the Bioaccumulation of Hydrophobic Organic chemicals in Aquatic Food-Webs: Application to Lake Ontario, *Ecological Modeling* 69: 1-17

Hill, EF and MB Camardese, 1986, *Lethal dietary toxicities of environmental contaminants and pesticides to Coturnix*, US Fish and Wildlife Services, Technical Report 2

Howard, PH, 1990, *Handbook of Environmental Fate and Exposure Data for Organic Chemicals*, Lewis Publishers, Chelsea, MI

Jones, D.S., G.W. Suter and R.N. Hall, 1997, *Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Sediment-Associated Biota,* ES/ER/TM-95/R4, Oak Ridge National Laboratory, Oak Ridge, TN

Kabata-Pendias, A and H Pendias, 1992, *Trace Elements in Soils and Plants*, PT Kostecki and EJ Calabrese Eds, Lewis Publishers, Inc, Chelsea, MI

Ketcham, B, 2005, Personal Communication, NYSDEC, Division of Fish, Wildlife & Marine Resources, NYS Natural Heritage Program, Latham, NY

Linday, WL, 1979, *Chemical Equilibria In Soils*, John Wiley & Sons: New York, p. 210-220

Long, ER, DD MacDonald, SL Smith, and FD Calder, 1995, Incidence of Adverse Biological Effects within Ranges of Chemical Concentrations in Marine and Estuarine Sediments, *Environ Manage* 19: 81-97 [See also: Long and Morgan, 1991, *The Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program*, Technical Memorandum NOS OMA 52, August, NOAA: Seattle, WA (for values for DDD, DDT, Antimony, Chlordane, Dieldrin, and Endrin); NOAA's National Status and Trends Program. Sediment Quality Guidelines (for values for As, Cd, Cr, Cu, Pb, Hg, Ni, Ag, Zn, DDE, PAHs, total DDT, total PCBs, and total PAH) available at http://response.restoration.noaa.gov/cpr/sediment/SPQ.pdf]

MacDonald, DD, CG Ingersoll, and TA Berger, 2000, Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems, *Arch Environ Contam Toxicol* 39: 20-31

Mackay, D, W-Y Shiu, and K-C Ma, 1999, *Physical-Chemical Properties and Environmental Fate Handbook*, Chapman & Hall/CRCnetBase: Boca Raton, FL (CD-ROM version)

Mackey, T, 2002, Personal Communication, NYSDEC, Division of Fish, Wildlife & Marine Resources, NYS Natural Heritage Program, Latham, NY

Martin, AC, HS Zim, and AL Nelson, 1951, *American Wildlife and Plants, A Guide to Wildlife Food Habits*, Dover Publications, Inc, New York

Markwell, RD, DW Connell, and AJ Gabric, 1989, Bioaccumulation of Lipophilic Compounds from Sediments to Oligochaetes, *Water Res* 23:1443-1450

McIntosh, A, 1992, Trace Metals in Freshwater Sediments: A Review of the Literature and an Assessment of Research Needs, In: *Metal Ecotoxicology Concepts & Applications*, MC Newman and AW McIntosh (Ed), Lewis Publishers, Inc, Chelsea, MI

Merck Index, 1989, *The Merck Index - Encyclopedia of Chemicals, Drugs and Biologicals*, Merck and Company, Inc.: Rahway, NJ

Nagy, KA, 1987, Field Metabolic Rate and Food Requirement Scaling in Mammals and Birds, *Ecol Monograph* 57: 111-128

Natural Resources Conservation Service (NRCS), 2004, *Soil Survey Geographic (SSURGO) Database for Cattaraugus County, New York*, US Department of Agriculture: Washington, DC (Accessed via INTERNET http://SoilDataMart.nrcs.usda.gov/)

New York State Department of Environmental Conservation (NYSDEC), 1994, *Fish and Wildlife Impact Analysis for Hazardous Waste Sites*, Division of Fish and Wildlife, Albany, NY

_______, 1998a, *Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations*, Division of Water Technical and Operational Guidance Series (TOGS) 1.1.1, Albany, NY

_______, 1998b, *Technical Guidance for Screening Contaminated Sediments*, Division of Fish and Wildlife, Albany, NY

_______, 2002, *New York Breeding Bird Atlas 2000 Project*, http://www.dec.state.ny.us/website/dfwmr/wildlife/bba/breedcode.html

Palmer, CD and RW Puls, 1994, *Natural Attenuation of Hexavalent Chromium in Groundwater and Soils*, EPA Ground Water Issue, USEPA Office of Research and Development, RS Kerr Laboratory: Ada, OK, EPA/540/5-94/505, 12pp

Persaud, D, R Jaagumagi, and A Hayton, 1993, *Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario*, Ontario Ministry of the Environment and Energy, August, ISBN 0-7729-9248-7 (available at http://www.ene.gov.on.ca/envision/gp/B1_3.pdf)

Rai, D, BM Sass, and DA Moore, 1987, Chromium (III) Hydrolysis Constants and Solubility of Chromium (III) Hydroxide, *Inorganic Chemistry* 26:345-349

Reschke, C, 1990, *Ecological Communities of New York State*, New York Natural Heritage Program, Latham, NY

Ridgon, RH and J Neal, 1963, Absorption and excretion of benzo(a)pyrene observation in the duck, chicken, mouse, and dog, *Texas Rep Biol and Med* 21(2):247-261

Sample, BE, DM Opresko, and GW Suter, 1996, *Toxicological Benchmarks for Wildlife: 1996 Revision*, ES/ER/TM-86/R3 Prepared for the U.S. Department of Energy, Office of Environmental Management, Oak Ridge National Laboratory, Oak Ridge, TN

Sass, BM and D Rai, 1987, Solubility of Amorphous Chromium (III)-Iron (II) Hydroxide Solid Solutions, *Inorganic Chemistry* 26:2228-2232

Schafer, P, W Bowles, Jr, and J Hurlbut, 1983, The acute oral toxicity, repellency, and hazard potential of 998 chemicals to one or more species of wild and domestic birds, *Arch Environ Contam Toxicol* 12:355-382

Shivas, SAJ, 1980, Factors Affecting the Oxidation State of Chromium Disposed in Tannery Waters, *J Am Leather Chem Assoc* 75:42-48

Sigg, L, 1985, "Metal Transfer Mechanisms in Lakes: The Roles of Settling Particles," pp 283-310, In: W Stumm (ed) *Chemical Processes in Lakes*, John Wiley and Sons, Inc., New York

Sposito, G and AL Page, 1984, "Cycling of Metal Ions in the Soil Environment," Chapter 9 Metal Ions in Biological Systems, Volume 18, IN: H Sigal (Ed.) *Circulation of Metals in the Environment*, Marcel Dekker, Inc: New York

Stafford, EA and AG Tacon, 1988, Use of earthworms as a food for rainbow Trout, In CA Edwards and EF Neuhauser Ed., *Earthworms in Waste and Environmental Management*, SPB Academic Publishing, The Hague, The Netherlands, pp 193-208

Stewart, MA, PM Jardine, MO Barnett, *et al.,* 2003, Influence of Soil Geochemical and Physical Properties on the Sorption and Bioaccessibility of Chromium (III), *J Environ Qual* 32:129-137

Stoll, MF, 2005, Personal Communication via Fax Transmittal RE: Listed Species Request, USFWS New York Field Office, April 13

Suter, GW and CL Tsao, 1996, *Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota: 1996 Revision*, Oak Ridge National Laboratory, Oak Ridge, TN, ES/ER/TM-96/R2

Tokunaga, TK, *et al.*, 2003, Distribution of Chromium Contamination and Microbial Activity in Soil Aggregates, *J Environ Qual* 32:541-549

Tokunaga, TK, *et al.*, 2001, Chromium Diffusion and Reduction in Soil Aggregates, *Environ Sci Technol* 35:3169-3174

Travis, C and HA Hattemer-Frey, 1988, Uptake of Organics by Aerial Plant Parts: A Call for Research, *Chemosphere* 17(2) 277-283

United States Department of Energy (USDOE), 1999, *Bioaccumulation and Bioconcentration Screening*, Savannah River Site Environmental Restoration Division, Manual ERD-AG-003 p.7.4, 8p

United States Environmental Protection Agency (USEPA), 1979, *Water-Related Environmental Fate Of 129 Priority Pollutants*, Office of Water Planning and Standards, Washington, DC, EPA 440/4-79/029a

_______, 1988, *Superfund Exposure Assessment Manual*, OWSER Directive 9285.5-1, Office of Remedial Response, Washington, DC, EPA/540/1-88/001

_______, 1988a, *Recommendations for and Documentation of Biological Values for Use in Risk Assessment*, Office of Health and Environmental Assessment, Cincinnati, OH, EPA/600/6-87/008

_______, 1991, *Proposed Sediment Quality Criteria for the Protection of Benthic Organisms*, Office of Water, Research and Development and Science and Technology, Health and Ecological Criteria Division, Washington, DC

_______, 1992, *Supplemental Guidance to RAGS: Calculating the Concentration Term*, Office of Emergency and Remedial Response, Hazardous Site Evaluation Division, NTIS Publication #PB92-963373

_______, 1992a, *Technical Support Document for Land Application of Sewage Sludge Volume 1*, Office of Water (Health & Criteria Division): Washington, DC, EPA/822/R-93/018a (NTIS PB93-110575)

_______, 1992b, *Technical Support Document for Land Application of Sewage Sludge Volume 2*, Office of Water (Health & Criteria Division): Washington, DC, EPA/822/R-93/018b (NTIS PB93-110583)

_______, 1992c, *Human Health Risk Assessment for the Use and Disposal of Sewage Sludge: Benefits of Regulation*, Abt Associates, Inc: Cambridge, MA, (NTIS PB93-111540)

_______, 1993, *Wildlife Exposure Factors Handbook*, Office of Research and Development: Washington, DC, EPA/600/R-93/187a

_______, 1993a, *Technical Support Document for the Surface Disposal of Sewage Sludge (Revised)*, Office of Water (Health & Criteria Division): Washington, DC, EPA/822/R-93/019 (NTIS PB93-110591)

_______, 1996, *Soil Screening Guidance: Fact Sheet*, Office of Solid Waste and Emergency Response, Washington, DC, EPA/540/F-95/041

_______, 1997a, *Health Assessment Effects Summary Tables* (HEAST), FY 1997 update

_______, 1997b, *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments*, Interim Final, Environmental Response Team, Edison, NJ

_______, 1998, *Guidelines for Ecological Risk Assessment*, Risk Assessment Forum, Washington, DC, EPA/630/R-95/002F

_______, 1999, *Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities*, Office of Air and Radiation, EPA/530/D-99/001A

_______, 1999b, *Understanding Variation in Partition Coefficient, K_d, Values*, Office of Solid Waste and Emergency Response, EPA/402/R-99/004B

_______, 2000, *In Situ Treatment of Soil and Groundwater Contaminated With Chromium*, National Risk Management Research Laboratory: Cincinnati, OH, EPA 625/R-00/004 October, 98p

_______, 2001, *ECO Update: The Role of Screening-Level Risk Assessments and Refining Contaminants of Concern in Baseline Ecological Risk Assessments*, OSWER, Washington, DC, Publication 9345.0-14, EPA 540/F-01/014

_______, 2003, *Generic Ecological Assessment Endpoints (GEAEs) for Ecological Risk Assessment*, Risk Assessment Forum, Washington, DC, EPA/630/P-02/004F

_______, 2005b, *Ecological Soil Screening Levels for Chromium*, Interim Final, OSWER Directive 9285.7- 66, March

_______, 2005c, *Ecological Soil Screening Levels for Arsenic*, Interim Final, OSWER Directive 9285.7- 66, March

Wielinga, B, MM Mizuba, CM Hansel, and S Fendorf, 2001, Iron Promoted Reduction of Chromate by Dissimilatory Iron-Reducing Bacteria, *Environ Sci Technol* 35(3)522-527

Werner, RG, 1980, *Freshwater Fishes of New York State,* Syracuse University Press, Syracuse, NY

Wisconsin Department of Natural Resources (WDNR), 1986, *The White-Tailed Deer,* Bureau of Wildlife Management, Madison, WI

Internet Web Resources

National Library of Medicine, 2005, Hazardous Substance Database, (available at: http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB)

National Toxicology Program, 2005, Chemical Health and Safety Data Website, (available at: http://ntp-server.niehs.nih.gov/Main_Pages/Chem-HS.html)

Oak Ridge National Laboratory (ORNL), 2005, The Risk Assessment Information System (RAIS) web site (available at: http://risk.lsd.ornl.gov/index.shtml) (RAIS 2005)

USEPA, 2005, ECOTOX Database (available at: http://www.epa.gov/ecotox/)

______, 2005, Integrated Risk Information System (IRIS) on-line database, (available at: http://www.epa.gov/ngispgm3/iris/index.html)

______, 2005, Enviromapper for Water (http://map8.epa.gov/enviromapper/ INTERNET); as based on: Omernik, JM, 1987, Ecoregions of the conterminous United States, Map Supplement (scale 1:7,500,000), *Annals of the Association of American Geographers* 77(1):118-125; USEPA, 1997, *Level III Ecoregions of the Continental United States*, Map M-1 (revision of Omernik, 1987), NHEERL: Corvallis, OR; Omernik, JM, 1995, Ecoregions: A spatial framework for environmental management, In: *Biological Assessment and Criteria: Tools for Water Resource Planning and Decision Making*, WS Davis and T.P. Simon (Eds), Lewis Publishers: Boca Raton, FL, pp. 49-62

TABLES

Table 1
Plant Species Identified During Field Reconnaissance
Peter Cooper Markhams NPL Site

ENVIRONMENTAL RISK GROUP

Common Name	Scientific Name	Cover Type	Common Name	Scientific Name	Cover Type
American beech	*Fagus grandifolia*	1	Orchard grass	*Dactylis glomerata*	2
Big-toothed aspen	*Populus grandidentata*	1	Ostrich fern	*Mateuccia struthopteris*	1
Bittersweet nightshade	*Solanum dulcamara*		Partridge berry	*Mitchella repens*	1
Black cherry	*Prunus serotina*	1	Poison ivy	*Rhus radicans*	5, 8, 12
Black raspberry	*Rubus occidentalis*	2, 3, 4	Pokeweed	*Phytolacca americana*	3
Black willow	*Salix nigra*	6, 7, 8, 10, 12	Quaking aspen	*Populus tremuloides*	4
Blue flag iris	*Iris versicolor*	11	Queen Anne's lace	*Daucus carota*	2
Boneset	*Eupatorium perfoliatum*	7, 10	Red fescue	*Festuca rubra*	3
Bracken fern	*Pteridium aquilinum*	1, 2	Red maple	*Acer rubrum*	5, 7, 9, 10, 11, 12
Broad-leaved cattail	*Typhia latifolia*	6, 7, 10	Red osier dogwood	*Cornus stolonifera*	5, 10
Bull thistle	*Cirsium vulgare*	3	Reed canary grass	*Phalaris arundinacea*	6, 7, 10
Burdock	*Arctium minus*	3, 4	Rough-stemmed goldenrod	*Solidago rugosa*	2, 3, 4
Button bush	*Cephalanthus occidentalis*	6, 11	Sandbar willow	*Salix interior*	7
Burweed	*Sparganium sp.*	6	Sedge	*Carex lurida*	6, 11
Canada goldenrod	*Solidago canadesis*	2, 4	Sedge	*Carex lupulina*	6, 7, 11, 12
Christmas fern	*Polystichum acrostichoides*	1	Sensitive fern	*Onoclea sensibilis*	5, 6, 7, 9, 11, 12
Cinnamon fern	*Osmunda cinnamomea*	5, 6, 9	Silky dogwood	*Comus amomum*	6, 7, 8, 10, 11, 12
Clubmoss		12	Slippery elm	*Ulmus rubra*	5, 8, 11, 12
Common cinquefoil	*Potentilla simplex*	2	Small white aster	*Aster vimineus*	2
Common milkweed	*Asclepias syriaca*	2, 3	Soft rush	*Juncus effuses*	6, 7, 9
Common mullein	*Verbascum thapsus*	3	Spearmint	*Mentha spicata*	3
Cottonwood	*Populus deltoides*	1, 5, 8, 10, 12	Spicebush	*Lindera benzoin*	10, 11
Dewberry	*Rubus flagellaris*	1	Spotted jewelweed	*Impatiens capensis*	5, 6, 8
English plantain	*Plantago lanceolata*	2	Spotted knapweed	*Centarea maculosa*	2
Evening primrose	*Oenothera biennis*	2, 3	Spreading dogbane	*Apocynum androsaemifolium*	3
False nettle	*Boehmeria cylindrical*	5, 6, 7, 8, 9	Staghorn sumac	*Rhus typhina*	1, 2, 4
Garlic mustard	*Alliaria officinalis*	1	Sugar maple	*Acer saccharum*	1
Gray goldenrod	*Solidago nemoralis*	2, 3	Tartarian honeysuckle	*Lonicera tatarica*	1, 2, 3, 4
Green ash	*Fraxinus pennsylvanica*	5, 8	Tear thumb	*Polygonum sagittatum*	6, 11
Hawthorne	*Crataegus sp.*	1	Tussocks sedge	*Carex stricta*	10
Hay-scented fern	*Dennstaedtia punctiloba*	1	Vervain	*Verbena hastate*	6, 10
Late goldenrod	*Solidago gigantea*	1, 2, 3, 4	White ash	*Fraxinus americana*	1
Many flowered aster	*Aster ericoides*	5, 7, 8, 10, 12	White wood aster	*Aster divaricatus*	1
Multi-flora rose	*Rosa multiflore*	1	Wild strawberry	*Fragaria virginiana*	2
New England aster	*Aster novae-angliae*	2	Witch hazel	*Hamamelis virginiana*	1
Northern arrowwood	*Viburnum recognitum*	5, 6, 9, 10	Wool grass	*Scirpus cyperinus*	6, 10, 11, 12
Nutsedge	*Cyperus esculentus*	6, 7, 11	Yellow birch	*Betula lutea*	1

Species observed by Vanasse Hangen Brustlin, Inc. ecological risk assessor during field reconnaissance August 2001

Cover Type 1: Successional Northern Hardwood Forest
Cover Type 2: Successional Old Field
Cover Type 3: Early Successional Field
Cover Type 4: Successional Northern Hardwood Forest
Cover Type 5: Forested Wetland
Cover Type 6: Emergent/Scrub-Shrub Wetland
Cover Type 7: Emergent/Open Water Wetland
Cover Type 8: Forested/Scrub-Shrub Wetland
Cover Type 9: Forested Wetland
Cover Type 10: Emergent/Scrub-Shrub/Forested Wetland
Cover Type 11: Emergent/Scrub-Shrub Wetland
Cover Type 12: Forested/Scrub-Shrub Wetland

Table 2
Herptile Species Identified During Field Reconnaissance
Peter Cooper Markhams NPL Site

ENVIRONMENTAL RISK GROUP

Common Name	Scientific Name	Habitat Requirements
Eastern toad	*Bufo americanus*	Found in almost any habitat.
Northern spring peeper	*Hyla crucifer*	Second growth woodlots.
Gray treefrog	*Hyla veriscolor*	Forested regions with small trees, shrubs and bushes near or in shallow water. Will breed in roadside ditches.
Green frog	*Rana clamitans*	Margins of shallow permanent water.
Northern leopard frog	*Rana pipiens*	Commonly found in wet open fields and woods.
Marbled salamander	*Ambystoma opacum*	Sandy and gravelly areas of mixed deciduous woodlands, especially oak-maple and oak-hickory.
Spotted salamander	*Ambystoma maculatum*	Found in moist woods, stream banks, beneath stones, logs and boards.
Red-spotted newt	*Notophthalmus viridescens*	Adults found in water with abundant submerged vegetation including lakes, marshes, ditches, and backwaters. Terrestrial juveniles live in moist areas on land.
Redback salamander	*Plethodon cinerus*	Entirely terrestrial. Mixed deciduous or coniferous woods, inhabiting interiors of decaying logs and stumps.
Northern two-lined salamander	*Euryce bislineata*	Along brooks and streams. Found under objects at water's edge in moist soil.
Northern dusky salamander	*Desognathus fuscus*	Woodlands at the margins of running water.
Eastern painted turtle	*Chrysemys picta*	Quiet, shallow ponds and marshes. Sometimes in brackish tidal waters and salt marshes.
Spotted turtle	*Clemmys guttata*	Small shallow bodies of water including roadside ditches and brackish tidal creeks.
Eastern box turtle	*Terrapene Carolina*	Typically found in well-drained forest bottomlands.
Red-eared slider	*Pseudemys scripta*	Ponds, shallow areas of lakes, creeks and drainage ditches.
Northern water snake	*Nerodia sipedon*	Inhabits salt or fresh water. Common around spillways and bridges.
Northern brown snake	*Storeria dekayi*	Ubiquitous.
Northern ringneck snake	*Diadophis punctatus*	Secretive. Found hiding in stony woodland pastures, under rocks, stone walls, junk piles, logs, debris, stumps and logs.
Northern black racer	*Coluber constrictor*	Moist or dry areas, forests and wooded areas, fields, roadsides, near old buildings.
Eastern smooth green snake	*Opheodrys vernalis*	Upland areas, grassy fields.
Eastern worm snake	*Carpophis amoenus*	Dry to moist forests, often near streams, in the loose soil of gardens or weedy pastures. Sandy areas are favored.
Black rat snake	*Elape obsolete*	Thickets, woodland edges, farmlands.
Eastern ribbon snake	*Thamnophis sauritus*	Semi-aquatic, inhabiting stream edges and ditches.
Eastern garter snake	*Thamnophis srtalis*	Ubiquitous.
Eastern hognose snake	*Heterodon platyrhinos*	Where sandy soils predominate, such as beaches, open fields, dry open woods.
Eastern milk snake	*Lampropeltis triangulum*	Various habitats, usually with brushy or woody cover.

Source: DeGraaf and Rudis 1983 and Conat and Collins 1975

[a]Species observed by VHB ecological risk assessor during field reconnaissance August 2001

Table 3
Avian Species Identified During Field Reconnaissance
Peter Cooper Markhams NPL Site

ENVIRONMENTAL RISK GROUP

Common Name	Scientific Name	Habitat Requirements
Great blue heron	*Ardea herodias*	Shallow shores of ponds, lakes, streams, fresh marshes.
Green heron	*Butorides virescens*	Makes use of nearly all fresh and salt water habitats.
Canada goose[a]	*Branta Canadensis*	Shores of ponds, wetland areas, grassy fields.
Black-crowned night heron	*Nycticorax nycticorax*	Occupies freshwater wetlands.
Sharp-shined hawk	*Accipter striatus*	Open woodlands, edges and clearings.
Red-tailed hawk[a]	*Buteo jamaicensis*	Deciduous and mixed woodlands interspersed with meadows.
Turkey vulture	*Cathartes aura*	Various habitats including wet, dry, open, and wooded.
Killdeer[a]	*Charadrius vociferous*	Fields, roadsides lawns.
American kestrel	*Falco sparverius*	Open areas, forest edges, cities.
Spotted sandpiper	*Actitis macularia*	Breeding in the vicinity of fresh water in dry pastures or fields.
Ruffed grouse[a]	*Bonasa umbellus*	Areas with dense woody cover.
Rock dove	*Columbia livia*	Near human habitation.
Mourning dove	*Zenaida macroura*	Suburbs, cities, open woodlands.
Eastern screech owl	*Otus asio*	Shade trees in suburbs.
Great horned owl	*Bubo virginianus*	Woodlands near large streams.
Barred owl	*Strix varia*	Low, wet woodlands.
Common nighthawk	*Chordeiles minor*	Cities, open areas.
Chimney swift	*Chaetura pelagica*	Buildings, cities.
Ruby-throated hummingbird	*Archilochus colubris*	Shade trees in residential landscapes.
Belted kingfisher	*Ceryle alcyon*	Near water containing fish.
Pileated woodpecker	*Dryocopus pileatus*	Extensive second growth woodlands.
Downy woodpecker	*Picoides pubescens*	Shade trees in towns and suburbs.
Hairy woodpecker[a]	*Picoides villosus*	Open coniferous, deciduous and mixed woodlots
Northern flicker	*Colaptes auratus*	Suburbs, woodland edges.
Eastern wood peewee	*Contopus virens*	Roadsides, parks. Closely associated with oaks.
Eastern phoebe	*Sayornis phoebe*	Suburban areas.
Great crested flycatcher	*Myiarchus crinitus*	Edges of deciduous woodlands
Eastern kingbird	*Tyrannus tyrannus*	Forest edges, fields, pastures.
Purple martin	*Progne subis*	Suburban areas near water.
Blue jay[a]	*Cyanocitta cristata*	Suburbs, cities, parks and gardens.
American crow[a]	*Corvus brachyrhynchos*	Edges of woodlots, coastal areas.
Black-capped chickadee[a]	*Parus atricapilus*	Residential areas, woodlands.
Tufted titmouse	*Parus bicolor*	Residential areas in shade trees.
White-breasted nuthatch[a]	*Sitta carolinensis*	Shade trees in villages.
House wren	*Troglodytes aedon*	Near human dwellings.
American robin[a]	*Turdus migratorius*	Shade trees in residential areas.
Gray catbird	*Dumetella carolinensis*	Shrubbery around buildings.
Cedar waxing	*Bombycilla cedrorum*	Shade trees in residential areas.
Red-winged blackbird[a]	*Agelaius phoeniceus*	Swamps and marshes.
Common grackle	*Quiscalus quiscula*	Suburbs.
Northern oriole[a]	*Icterus galbula*	Shade trees in residential areas.
Purple finch	*Carpodacus purpureus*	Residential areas.
House finch	*Carpodacus mexicanus*	Suburban and urban yards.
American goldfinch	*Cardeulis tristis*	Suburban gardens, shade trees.
Starling	*Sturnus vulgaris*	Cities, gardens, parks.
Yellow warbler	*Dendroica petechia*	Farmlands and roadsides.
American redstart	*Mniotilta varia*	Shade trees near dwellings.
Common yellowthroat	*Geothlypis trichas*	Fresh or salt water marshes.

Table 3
Avian Species Identified During Field Reconnaissance
Peter Cooper Markhams NPL Site

ENVIRONMENTAL RISK GROUP

Common Name	Scientific Name	Habitat Requirements
Blue-winged warbler	*Vermivora pinus*	Edges of woods, brushy overgrown fields.
Nashville warbler	*Vermivora ruficapilla*	Moist open deciduous woods.
Chestnut-sided warbler	*Dendroica pensylvanica*	Second-growth woodland edges.
Ovenbird	*Seiurus aurocapillus*	Mature deciduous woodlands.
Mourning warbler	*Oporornis philadelphia*	Dense underbrush.
Hooded warbler	*Wilsonia citrina*	Brushy, swampy lowlands.
Northern cardinal	*Cardinalis cardinalis*	Suburban gardens.
Rose-breasted grosbeak	*Pheucticus ludovicianus*	Shade trees in suburban areas.
House sparrow	*Passer domesticus*	Cities, parks.
Chipping sparrow	*Spizella paserina*	Suburban residential areas.
Field sparrow	*Spizella pusilla*	Briar thickets, old fields.
Song sparrow	*Melospiza melodia*	Suburbs, cities.
Swamp sparrow	*Melospiza georgiana*	Marshes, swamps, bogs.
Brown-headed cowbird	*Molothrus ater*	Open coniferous and deciduous woodlands.
Eastern towhee	*Pipilo erythrophthalmus*	Woodland edges.
Scarlet tanager	*Piranga olivacea*	Roadside shade trees, mixed woodlands.
Indigo bunting	*Passerina cyanea*	Edges of woods.
Bobolink	*Dolichonyx oryzivorus*	Hayfields, meadows, marshes.
Brown thrasher	*Toxostoma rufum*	Woodland edges. Often in cities.
Veery	*Catharus fuscescens*	Low moist deciduous woods.
Hermit thrush	*Catharus fuscescens*	Lowlands in wooded swamps.
Wood thrush	*Hylocichla mustelina*	Mature lowland forest.
Barn swallow	*Hirundo rustica*	Man-made structures for nesting.
Northern rough-winged swallow	*Stelgidopteryx serripennis*	Nearly any open area with nest sites.
Tree swallow	*Tachycineta bicolor*	Farmlands, river bottomlands.
Bank swallow	*Riparia riparia*	Riverbanks, gravel pits.
Cliff swallow	*Petrochelidon pyrrhonota*	Farmlands, villages, cliffs, bridges.
White-throated sparrow[a]	*Zonotricvhia albicollis*	Edges of deciduous forests.
Red-eyed vireo	*Vireo olivaceus*	Open deciduous and second-growth woodlands.
Northern harrier	*Circus cyaneus*	Fresh marshes, open country, swamps.
Common moorhen	*Gallinla chloropus*	Fresh water marshes.
Least flycatcher	*Empidonaz minimus*	Deciduous forest edges.
Warbling vireo	*Vireo gilvus*	Open deciduous woodlands.
Black-throated blue warbler	*Dendroica caerulescens*	Woodland edges.
Savannah sparrow	*Passerculus sandwixhensis*	Grassy swales, meadows, moist lowland habitat with dense ground vegetation.
Eastern meadowlark	*Sturnella magna*	Open grassy meadows.
American woodcock	*Scolopax minor*	Moist woodlands.
Willow flycatcher	*Empidonax traillii*	Open, newly clear cut areas.
Acadian flycatcher	*Empidonax virescens*	Deciduous woodlands.
Black-billed cuckoo	*Coccyzus erythropthalmis*	Shrubby hedgerows.
Yellow-billed cuckoo	*Coccyzus americnus*	Open woods, overgrown weedy fields.
Northern bobwhite	*Colinus virginianus*	Open fields of grass.
Ring-necked pheasant	*Phasianus colchicus*	Meadows with abundant weedy growth.

Source: DeGraaf and Rudis, 1983 and NYSDEC, 2002

[a]Species observed by VHB ecological risk assessor during field reconnaissance August 2001

Table 4
Mammalian Species Identified During Field Reconnaissance
Peter Cooper Markhams NPL Site

ENVIRONMENTAL RISK GROUP

Common Name	Scientific Name	Habitat Requirements
Virginia opossum	Didlphis virginiana	Near human habitation.
Masked shrew	Sorex cinereus	Damp deciduous woodlands with grass.
Least shrew	Cryptosis parva	Salt marshes, woodland edges.
Northern short-tailed shrew	Blarina brevicauda	Both timbered and fairly open habitats.
Eastern moles	Scalopus aquaticus	Lawns, sandy soils.
Star-nosed moles	Condylura cristata	Prefers low wet ground.
Keen's myotis	Myotis keenii	Barns, attics, tree cavities.
Little brown myotis	Myotis lucifugus	Dark warm sites for maternity colonies.
Big brown bat	Eptesicus fuscus	Buildings, bridges, tunnels.
Eastern cottontail	Sylvilagus floridanus	Suburban areas with adequate food and cover.
Eastern chipmunk[a]	Tamias striatus	Tree or shrub cover with elevated perches.
Woodchuck[a]	Marmota monax	Edges of woodlands, open cultivated land, meadows, open brushy hillsides.
Gray squirrel	Sciurus carolinensis	Suburban parks, shade trees, especially oaks.
Red squirrel	Tamiascuirus hudsonicus	Rural woodlands.
Deer mouse	Peromyscus maniculatus	Near out-buildings in shrubs.
White-footed mouse	Peromyscus leucopus	Edges of woodlands.
Meadow vole	Microtus pennsylvanicus	Freshwater and salt water marshes.
Norway rat	Rattus morevegicus	Buildings, dumps, cities.
House mouse	Mus musculus	Buildings.
Meadow jumping mouse	Zapus hudsonius	Moist, open grassy and brushy marshes and meadows.
Woodland jumping mouse	Mapaeozapus insignis	Areas with herbaceous groundcover and low woody plants.
Coyote	Canis latrans	Edges of second-growth forests.
Red fox[a]	Vulpes vulpes	Found in a variety of habitats. A mixture of forest and open areas is preferred.
Mink	Mustela vison	Stream banks.
Long-tailed weasel	Mustela frenata	Open woods and woodland edges.
Ermine	Mustela erminea	Open country with thickets, rock piles or other heavy cover.
White-tailed deer[a]	Odocoileus virginianus	Forest edges, swamp borders, areas interspersed with fields and woodlands.
Raccoon[a]	Procyon lotor	Found in wetlands near human habitation.
Striped skunk[a]	Mephitis mephitis	Suburban areas.

Source: DeGraaf and Rudis, 1983

[a]Species observed by VHB ecological risk assessor during field reconnaissance August 2001

Table 5
RI Analytical Summary
Peter Cooper Markhams NPL Site

ENVIRONMENTAL RISK GROUP

Sample Type/Location	Matrix	Parameter [1]	Quantity[2]	Container	Minimum Volume	Preservation (Cool to 4° >2 °C for all samples)	Holding Time from Sampling
Groundwater (Sampling Event 1)	water	TCL VOCs[3]	18	glass vial	2-40 ml	HCl to pH<2, Zero Headspace	14 days
		TCL SVOCs[3]	18	amber glass	2 liters	Cool to 4 ° < 2°C	14 days
		TAL Metals [3][4]	18	plastic	600 ml	HNO_3 to pH<2	6 months
		Hexavalent Chromium[4][5]	18	plastic	400 ml	Cool to 4 ° < 2°C	24 hours
		Alk (bi-carb)	18	plastic	100 ml	Cool to 4 ° < 2°C	14 days
		Alk (carb)	18	plastic	100 ml	Cool to 4 ° < 2°C	14 days
		Ammonia	18	plastic	500 ml	H_2SO_4 to pH<2	28 days
		DOC	18	amber glass	250 ml	Filtered, Cool to 4 ° < 2°C	28 days
		Nitrate	18	plastic	100 ml	H_2SO_4 to pH<2	48 hours
		Sulfate	18	plastic	50 ml	Cool to 4 ° < 2°C	28 days
		Sulfide	18	plastic	500 ml	NaOH, 20 drops Zn-Acetate pH>9, 4 °C	7 days
		Ferrous Iron[6]	2	plastic	8 oz.	Cool to 4 ° < 2°C	upon receipt
		TDS	18	plastic	100 ml	Cool to 4 ° < 2°C	7 days
		TOC	18	glass	(3) 40 ml	H_2SO_4 to pH<2	28 days
		Ferrous Iron[6]	18	field			
		pH	18	field			
		Specific Conductivity	18	field			
		Dissolved Oxygen	18	field			
		Turbidity	18	field			
		Oxidation-Reduction Potential	18	field			
Groundwater (Sampling Event 2)	water	COPCs as determined[3]	18	to be determined			
		Arsenic[4]	18	plastic	600 ml	HNO_3 to pH<2	6 months
		Chromium[4]	18	plastic	600 ml	HNO_3 to pH<2	6 months
		Hexavalent Chromium[4][5]	18	plastic	400 ml	Cool to 4 ° < 2°C	24 hours
		Ferrous Iron[6]	2	field			
		pH	18	field			
		Specific Conductivity	18	field			
		Dissolved Oxygen	18	field			
		Turbidity	18	field			
		Oxidation-Reduction Potential	18	field			

Table 5
RI Analytical Summary
Peter Cooper Markhams NPL Site

ENVIRONMENTAL RISK GROUP

Sample Type/Location	Matrix	Parameter [1]	Quantity[2]	Container	Minimum Volume	Preservation (Cool to 4° >2 °C for all samples)	Holding Time from Sampling
Wetland Surface Water	water	Arsenic[4]	4	plastic	600 ml	HNO_3 to pH<2	6 months
(Sampling Event 1)		Chromium[4]	4	plastic	600 ml	HNO_3 to pH<2	6 months
		Hexavalent Chromium[4][5]	4	plastic	400 ml	Cool to 4 ° < 2°C	24 hours
		Alk (bi-carb)	4	plastic	100 ml	Cool to 4 ° < 2°C	14 days
		Alk (carb)	4	plastic	100 ml	Cool to 4 ° < 2°C	14 days
		Ammonia	4	plastic	500 ml	H_2SO_4 to pH<2	28 days
		DOC	4	amber glass	250 ml	Filtered, Cool to 4 ° < 2°C	28 days
		Nitrate	4	plastic	100 ml	H_2SO_4 to pH<2	48 hours
		Sulfate	4	plastic	50 ml	Cool to 4 ° < 2°C	28 days
		Sulfide	4	plastic	500 ml	NaOH, 20 drops Zinc Acetate to pH>9, Cool to 4 °C	7 days
		Ferrous Iron[6]	1	plastic	8 oz.	Cool to 4 ° < 2°C	upon receipt
		TDS	4	plastic	100 ml	Cool to 4 ° < 2°C	7 days
		TOC	4	glass	(3) 40 ml	H_2SO_4 to pH<2	28 days
		Ferrous Iron[6]	4	field			
		pH	4	field			
		Specific Conductivity	4	field			
		Dissolved Oxygen	4	field			
		Turbidity	4	field			
		Oxidation-Reduction Potential	4	field			
Wetland Surface Water	water	COPCs as determined[3]	4				
(Sampling Event 2)		Arsenic[4]	4	plastic	600 ml	HNO_3 to pH<2	6 months
		Chromium[4]	4	plastic	600 ml	HNO_3 to pH<2	6 months
		Hexavalent Chromium[4][5]	4	plastic	400 ml	Cool to 4 ° < 2°C	24 hours
		Ferrous Iron[6]	1	plastic	8 oz.	Cool to 4 ° < 2°C	upon receipt
		Ferrous Iron[6]	4	field			
		pH & Dissol. Oxy. & Redox Pot.	4	field			
		Specific Conductivity	4	field			
		Turbidity	4	field			

Table 5
RI Analytical Summary
Peter Cooper Markhams NPL Site

ENVIRONMENTAL RISK GROUP

Sample Type/Location	Matrix	Parameter [1]	Quantity[2]	Container	Minimum Volume	Preservation (Cool to 4° >2 °C for all samples)	Holding Time from Sampling
Fill Piles (0-12 inches bgs)	soil/waste/fil	Insitu Permeability	3	Shelby Tube	3-inch tube	NA	NA
		In-Place Density	10	field			
		Grain Size Distribution	1	5 gallon bucket	5 gal.	NA	NA
Fill Piles (1--2 feet below cover soil)	waste/fill	SPLP[7] Arsenic	3	glass	4 oz.	Cool to 4 ° < 2°C	14 days
		SPLP[7] Chromium	3	glass	4 oz.	Cool to 4 ° < 2°C	14 days
		SPLP[7] Hexavalent Chromium	3	glass	4 oz.	Cool to 4 ° < 2°C	14 days
		Arsenic	3	glass	16 oz.	Cool to 4 ° < 2°C	6 months
		Chromium	3	glass	16 oz.	Cool to 4 ° < 2°C	6 months
		Hexavalent Chromium	3	glass	16 oz.	Cool to 4 ° < 2°C	28 days
Background Surface Soil (0-6 inches bgs)	soil	Arsenic	6	glass	16 oz.	Cool to 4 ° < 2°C	6 months
		Chromium	6	glass	16 oz.	Cool to 4 ° < 2°C	6 months
Cover Soil/Top of Fill Piles Surface Soil	soil	Arsenic	9	glass	16 oz.	Cool to 4 ° < 2°C	6 months
		Chromium	9	glass	16 oz.	Cool to 4 ° < 2°C	6 months
		Hexavalent Chromium	9	glass	16 oz.	Cool to 4 ° < 2°C	28 days
		TOC	9	glass	4 oz.	Cool to 4 ° < 2°C	28 days
		Grain Size Distribution	1	5 gallon bucket	5 gal.	NA	NA
Perimeter Areas of Fill Piles Surface Soil	soil	Arsenic	48	glass	16 oz.	Cool to 4 ° < 2°C	6 months
		Chromium	48	glass	16 oz.	Cool to 4 ° < 2°C	6 months
		Hexavalent Chromium	48	glass	16 oz.	Cool to 4 ° < 2°C	28 days
		TCL VOCs	10	EnCore Sampler		Cool to 4 ° < 2°C, no headspace	14 days
		TCL SVOCs	10	glass	16 oz.	Cool to 4 ° < 2°C	14 days
		TOC	5	glass	4 oz.	Cool to 4 ° < 2°C	28 days
		Grain Size Distribution	5	5 gallon bucket	5 gal.	NA	NA
Perimeter Areas of Fill Piles Subsurface Soil	soil	Arsenic	29	glass	16 oz.	Cool to 4 ° < 2°C	6 months
		Chromium & Hexavalent Chromium	29	glass	16 oz.	Cool to 4 ° < 2°C	6 months

Table 5
RI Analytical Summary
Peter Cooper Markhams NPL Site

ENVIRONMENTAL RISK GROUP

Sample Type/Location	Matrix	Parameter [1]	Quantity[2]	Container	Minimum Volume	Preservation (Cool to 4° >2 °C for all samples)	Holding Time from Sampling
Native Soil Under Fill Piles	soil	Arsenic	12	glass	16 oz.	Cool to 4 °< 2°C	6 months
(4 borings; sampled at 3 depths)		Chromium	12	glass	16 oz.	Cool to 4 °< 2°C	6 months
Subsurface Soil		Hexavalent Chromium	12	glass	16 oz.	Cool to 4 °< 2°C	28 days
Native Soil from Monitoring Well MW-8S	soil	Arsenic	1	glass	16 oz.	Cool to 4 °< 2°C	6 months
(8-10 feet bgs or 2-feet above water table)		Chromium	1	glass	16 oz.	Cool to 4 °< 2°C	6 months
Surface Soil		Hexavalent Chromium	1	glass	16 oz.	Cool to 4 °< 2°C	28 days
Native Soil from Monitoring Well Borings	soil	TOC	6	glass	4 oz.	Cool to 4 °< 2°C	28 days
Subsurface Soil		Cation Exchange Capacity	6	glass	4 oz.	Cool to 4 °< 2°C	NA
		Grain Size Distribution	6	5 gallon bucket	5 gal.	NA	NA
Composite Native Soil	soil	SPLP[7] Arsenic	1	glass	4 oz.	Cool to 4 °< 2°C	14 days
from 4 borings & MW-8s (8-10 ft bgs / 2-ft above watertable)		SPLP[7] Chromium & Hexavalent Chromium	1	glass	4 oz.	Cool to 4 °< 2°C	14 days
Subsurface Soil Downgradient Wells	soil	pH	4	glass	8 oz.	Cool to 4 °< 2°C	24 hours
Subsurface Soil		Manganese[8]	4				
Wetland	sediment	Arsenic	14	glass	16 oz.	Cool to 4 °< 2°C	6 months
(downstream or adjacent to waste piles)		Chromium & Hexavalent Chromium	14	glass	16 oz.	Cool to 4 °< 2°C	6 months
		TOC	3	glass	4 oz.	Cool to 4 °< 2°C	28 days
		pH	3	glass	8 oz.	Cool to 4 °< 2°C	24 hours
		ORP	3				
		Grain Size Distribution	3	5 gallon bucket	5 gal.	NA	NA
Background-Wetland	sediment	Arsenic & Chromium	9	glass	16 oz.	Cool to 4 °< 2°C	6 months
Fill Pile Gas	air	CO_2, H_2S, CH_4, & O_2	1	field			

ENVIRONMENTAL RISK GROUP

Sample Type/Location	Matrix	Parameter [1]	Quantity[2]	Container	Minimum Volume	Preservation (Cool to 4° >2 °C for all samples)	Holding Time from Sampling

References:

(1) Test Methods for Evaluating Solid Wastes, USEPA SW-846, revised 1991.
(2) Code of Federal Regulations Chapter 40 Part 136.

Notes:

1. Parameter list includes anticipated chemical constituents of concern and is subject to revision based on initial groundwater analysis for inactive landfill area. EPA-approved methods published in References 1 and 2 above may be used. The list of analytes, laboratory method and the method detection limit for each parameter are included in Tables 1-3 of the QAPP for each matrix.
2. Sample quantity does not include QA/QC samples. Sample frequency of QA/QC samples is detailed in Section 3 and Section 8 of the QAPP.
3. The specific analyte list for the second sampling event will be established after COPCs are developed.
4. Metals analysis will be for Total metals. Metals analysis will be for Soluble metals when water turbidity is field measured greater than 50 NTU.
5. Per Method 3060A, Mg^{+2} in a phosphate buffer will be added to the alkaline extraction solution to suppress oxidation of soluble Cr (III) to Cr (VI).
6. Ferrous iron analysis will be conducted in the field. Ten percent (10%) of the total number of ferrous iron samples will be submitted to the laboratory for assessment of precision and accuracy.
7. SPLP: Synthetic Precipitation Leaching Procedure, Extraction by Method 1312. Holding time from sample date reflects extraction requirements.
8. Soil samples to be analyzed for manganese will require modified extraction using NH_2-OH-HCl in 0.1 molar HNO_3.

Acronyms:

Alk (bi-carb) = Bi-carbonate alkalinity
Alk (carb) = Carbonate alkalinity
ORP = Oxidation Reduction Potential
SVOC = Semi-Volatile Organic Compounds
DOC = Dissolved Organic Carbon
TOC = Total Organic Carbon
TSS = Total Suspended Solids
VOC = Volatile Organic Compounds
TAL = Target Analyte List

Geotechnical Parameter Methods:

TOC=Walkey Black Method
Grainsize Distribution=ASTM D421, 422

Table 6
Sample Matrix
Peter Cooper Markhams NPL Site

ENVIRONMENTAL RISK GROUP

Sample Location	Easting	Northing	Ground Elevation (fmsl)	Location	Sample ID	Date	Comment	Analytes
				SOIL SAMPLES				
1	1032829.153	872819.435	1311.64	MW-9D; 20-28 fbgs	1	10/1/01	Native Subsurf	CEC, TOC
2	1032828.285	872824.536	1311.49	MW-9S; 8-10 fbgs	2	10/1/01	Native Subsurf	CEC, TOC
3	1032132.007	871559.739	1317.38	B-1; 9-10 fbgs	3	10/2/01	Native Subsurf	As, Cr^{+3}, Cr^{+6}
4	1032132.007	871559.739	1317.38	B-1; 10-11 fbgs	4	10/2/01	Native Subsurf	As, Cr^{+3}, Cr^{+6}
5	1032132.007	871559.739	1317.38	B-1; 17-19 fbgs	5	10/2/01	Native Subsurf	As, Cr^{+3}, Cr^{+6}
6	1031628.412	871347.571	1300.98	MW-8D; 20-21 fbgs	6	10/4/01	Native Subsurf	CEC, TOC, Mn, pH
7	1031629.638	871352.377	1301.06	MW-8S; 4-6 fbgs	7	10/4/01	Native Subsurf	As, Cr^{+3}, Cr^{+6}
8	1031629.638	871352.377	1301.06	MW-8S; 6-10 fbgs	8	10/4/01	Native Subsurf	CEC, TOC, Mn, pH
9	1032255.395	872080.175	1327.72	B-4; 15-16 fbgs	9	10/5/01	Native Subsurf	As, Cr^{+3}, Cr^{+6}
10	1032255.395	872080.175	1327.72	B-4; 23-25 fbgs	10	10/5/01	Native Subsurf	As, Cr^{+3}, Cr^{+6}
11	1032255.395	872080.175	1327.72	B-4, 4-5 fbgs (GPZ-1)	11	10/5/01 & 12/3/03	Fill Pile Boring & Confirm	As, Cr^{+3}, Cr^{+6}
12								
13	1032255.395	872080.175	1327.72	B-4; 16-17 fbgs	13	10/5/01	Native Subsurf	As, Cr^{+3}, Cr^{+6}
14	1031835.438	871355.608	1309.39	MW-7D; 24-32 fbgs	14	10/8/01	Native Subsurf	CEC, TOC, Mn, pH
15	1031836.426	871360.247	1309.62	MW-7S; 8-16 fbgs	15	10/8/01	Native Subsurf	CEC, TOC, Mn, pH
16								
17								
18	1032677.599	872666.396	1311.75	B-5, 4-5 fbgs	18	10/9/01	Fill Pile Boring	As, Cr^{+3}, Cr^{+6}
19	1032677.599	872666.396	1311.75	B-5; 8-9 fbgs	19	10/9/01	Native Subsurf	As, Cr^{+3}, Cr^{+6}
20	1032677.599	872666.396	1311.75	B-5; 9-10 fbgs	20	10/9/01	Native Subsurf	As, Cr^{+3}, Cr^{+6}
21	1032677.599	872666.396	1311.75	B-5; 14-16 fbgs	21	10/9/01	Native Subsurf	As, Cr^{+3}, Cr^{+6}
22	1032510.735	872420.617	1316.00	B-6, 5.5-6.5 fbgs	22	10/9/01	Fill Pile Boring	As, Cr^{+3}, Cr^{+6}
23	1032510.735	872420.617	1316.00	B-6; 6.5-7.5 fbgs	23	10/9/01	Native Subsurf	As, Cr^{+3}, Cr^{+6}
24	1032510.735	872420.617	1316.00	B-6; 7.5-8.5 fbgs	24	10/9/01	Native Subsurf	As, Cr^{+3}, Cr^{+6}
25	1032510.735	872420.617	1316.00	B-6; 9-11 fbgs	25	10/9/01	Native Subsurf	As, Cr^{+3}, Cr^{+6}
26				4 Borings/MW-8	26	10/9/01	Native Subsurf	As, Cr^{+3}, Cr^{+6}
27	1032892.897	872394.202	1312.05	MW-3SR; 8-14 fbgs	27	10/9/01	Native Subsurf	CEC, TOC
28				Lathe #106	28	10/10/01	SS Fll Perimeter	As, Cr^{+3}, Cr^{+6}
29				Lathe #106	29	10/10/01	Subsurf Fill Perimeter	As, Cr^{+3}, Cr^{+6}
30				Lathe #62	30	10/10/01	SS Fll Perimeter	As, Cr^{+3}, Cr^{+6}

Table 6
Sample Matrix
Peter Cooper Markhams NPL Site

ENVIRONMENTAL RISK GROUP

Sample Location	Easting	Northing	Ground Elevation (fmsl)	Location	Sample ID	Date	Comment	Analytes
31				Lathe #63	31	10/10/01	SS Fll Perimeter	As, Cr^{+3}, Cr^{+6}
32								
33				Lathe #64	33	10/10/01	SS Fll Perimeter	As, Cr^{+3}, Cr^{+6}
34				Lathe #65	34	10/10/01	SS Fll Perimeter	As, Cr^{+3}, Cr^{+6}
35				Lathe #107	35	10/10/01 & 12/3/03	SS Fll Perimeter	As, Cr^{+3}, Cr^{+6}
36				Lathe #107	36	10/10/01 & 12/3/03	Subsurf Fill Perimeter	As, Cr^{+3}, Cr^{+6}
37				Lathe #118	37	10/10/01	Fill Pile Cover	As, Cr^{+3}, Cr^{+6}, TOC
38				Lathe #108	38	10/10/01	SS Fll Perimeter	As, Cr^{+3}, Cr^{+6}
39				Lathe #108	39	10/10/01	Subsurf Fill Perimeter	As, Cr^{+3}, Cr^{+6}
40				Lathe #68	40	10/10/01	SS Fll Perimeter	As, Cr^{+3}, Cr^{+6}
41				Lathe #69	41	10/10/01	SS Fll Perimeter	As, Cr^{+3}, Cr^{+6}
42				Lathe #70	42	10/10/01	SS Fll Perimeter	As, Cr^{+3}, Cr^{+6}
43				Lathe #71	43	10/10/01	SS Fll Perimeter	As, Cr^{+3}, Cr^{+6}
44				Lathe #109	44	10/10/01	SS Fll Perimeter	As, Cr^{+3}, Cr^{+6}
45				Lathe #109	45	10/10/01	Subsurf Fill Perimeter	As, Cr^{+3}, Cr^{+6}
46				Lathe #110	46	10/10/01	SS Fll Perimeter	As, Cr^{+3}, Cr^{+6}
47				Lathe #110	47	10/10/01	Subsurf Fill Perimeter	As, Cr^{+3}, Cr^{+6}
48				Lathe #97	48	10/10/01	SS Fll Perimeter	As, Cr^{+3}, Cr^{+6}
49				Lathe #97	49	10/10/01	Subsurf Fill Perimeter	As, Cr^{+3}, Cr^{+6}
50	1031239.679	872183.843	1300.48	Lathe #95	50	10/10/01	SS Fll Perimeter	As, Cr^{+3}, Cr^{+6}
51	1031381.999	872324.680	1305.33	Lathe #95	51	10/10/01	Subsurf Fill Perimeter	As, Cr^{+3}, Cr^{+6}
52	1031531.506	872475.673	1308.67	Lathe #60	52	10/10/01	SS Fll Perimeter	As, Cr^{+3}, Cr^{+6}
53	1031723.701	872663.688	1312.37					
54	1031892.301	872846.091	1315.81	Lathe #59	54	10/10/01	SS Fll Perimeter	As, Cr^{+3}, Cr^{+6}
55	1032058.201	873012.950	1309.59	Lathe #98	55	10/10/01	SS Fll Perimeter	As, Cr^{+3}, Cr^{+6}
56	1032239.536	872710.514	1310.09	Lathe #98	56	10/10/01	Subsurf Fill Perimeter	As, Cr^{+3}, Cr^{+6}
57	1031821.912	872301.512	1312.42	Lathe #61	57	10/10/01	SS Fll Perimeter	As, Cr^{+3}, Cr^{+6}
58	1031695.490	872198.719	1310.52	Lathe #58	58	10/10/01	SS Fll Perimeter	As, Cr^{+3}, Cr^{+6}
59	1031489.896	871969.866	1301.78	Lathe #57	59	10/10/01	SS Fll Perimeter	As, Cr^{+3}, Cr^{+6}
60	1031605.618	871950.898	1304.63	Lathe #96	60	10/10/01	SS Fll Perimeter	As, Cr^{+3}, Cr^{+6}

Table 6
Sample Matrix
Peter Cooper Markhams NPL Site

Sample Location	Easting	Northing	Ground Elevation (fmsl)	Location	Sample ID	Date	Comment	Analytes
61	1031774.157	872118.307	1311.65	Lathe #96	61	10/10/01	Subsurf Fill Perimeter	As, Cr^{+3}, Cr^{+6}
62	1031758.212	871694.723	1308.09	Lathe #99	62	10/10/01	SS Fll Perimeter	As, Cr^{+3}, Cr^{+6}
63	1031650.327	871583.240	1302.42	Lathe #99	63	10/10/01	Subsurf Fill Perimeter	As, Cr^{+3}, Cr^{+6}
64	1031723.536	871428.370	1300.06	Lathe #117	64	10/11/01 & 12/4/03	Fill Pile Cover	As, Cr^{+3}, Cr^{+6}, TOC
65	1031832.235	871533.472	1309.45	Lathe #114	65	10/11/01	Fill Pile Cover	As, Cr^{+3}, Cr^{+6}, TOC
66	1032972.466	872753.924	1309.51	Lathe #115	66	10/11/01 & 12/3/03	Fill Pile Cover	As, Cr^{+3}, Cr^{+6}, TOC
67A	1033071.719	872651.665	1308.75	Lathe #116	67	10/11/01	Fill Pile Cover	As, Cr^{+3}, Cr^{+6}, TOC
68	1031937.632	871395.964	1313.39	Lathe #137	68	10/11/01 & 12/3/03	Fill Pile Cover	As, Cr^{+3}, Cr^{+6}, TOC
69	1031833.044	871287.810	1308.71	Lathe #105	69	10/10/01	SS Fll Perimeter	As, Cr^{+3}, Cr^{+6}
70	1031998.878	871232.578	1310.87	Lathe #105A	70	10/10/01	Subsurf Fill Perimeter	As, Cr^{+3}, Cr^{+6}
71	1032084.820	871322.791	1312.05	Lathe #104	71	10/10/01	SS Fll Perimeter	As, Cr^{+3}, Cr^{+6}
72	1032965.869	872362.476	1308.45	Lathe #104	72	10/10/01	Subsurf Fill Perimeter	As, Cr^{+3}, Cr^{+6}
73	1033060.894	872469.429	1307.69	Lathe #103	73	10/10/01	SS Fll Perimeter	As, Cr^{+3}, Cr^{+6}
74	1033195.641	872612.336	1308.32					
75	1031102.876	872071.758	1299.64	Lathe #103	75	10/10/01	Subsurf Fill Perimeter	As, Cr^{+3}, Cr^{+6}
76	1031097.176	871948.405	1298.95	Lathe #102A	76	10/10/01	SS Fll Perimeter	As, Cr^{+3}, Cr^{+6}
77	1031104.328	871811.364	1305.41	Lathe #102A	77	10/10/01	Subsurf Fill Perimeter	As, Cr^{+3}, Cr^{+6}
78	1031168.678	871960.829	1299.11	Lathe #101	78	10/10/01	SS Fll Perimeter	As, Cr^{+3}, Cr^{+6}
79A	1031666.840	872528.656	1308.02	Lathe #101	79	10/10/01	Subsurf Fill Perimeter	As, Cr^{+3}, Cr^{+6}
80	1031748.199	872547.704	1307.31	Lathe #100	80	10/10/01	SS Fll Perimeter	As, Cr^{+3}, Cr^{+6}
81A	1032001.621	872760.757	1309.57	Lathe #100	81	10/10/01	Subsurf Fill Perimeter	As, Cr^{+3}, Cr^{+6}
82	1032111.713	872772.706	1308.05	Lathe #56	82	10/10/01	SS Fll Perimeter	As, Cr^{+3}, Cr^{+6}
83	1032218.589	872913.939	1309.22	Lathe #66	83	10/10/01	SS Fll Perimeter	As, Cr^{+3}, Cr^{+6}
84A	1032568.158	872966.196	1309.51	Lathe #67A	84	10/10/01	SS Fll Perimeter	As, Cr^{+3}, Cr^{+6}
85	1032454.071	872812.406	1308.71	Lathe #74	85	10/10/01	SS Fll Perimeter	As, Cr^{+3}, Cr^{+6}
86	1032323.772	872637.942	1308.06	Lathe #73	86	10/10/01	SS Fll Perimeter	As, Cr^{+3}, Cr^{+6}
87	1032237.719	872459.167	1308.68	Lathe #72	87	10/10/01	SS Fll Perimeter	As, Cr^{+3}, Cr^{+6}
88	1032097.663	872317.771	1308.48	Lathe #113	88	10/10/01 & 12/3/03	SS Fll Perimeter	As, Cr^{+3}, Cr^{+6}
89	1031635.462	871759.796	1300.83	Lathe #113	89	10/10/01 & 12/3/03	Subsurf Fill Perimeter	As, Cr^{+3}, Cr^{+6}

Table 6
Sample Matrix
Peter Cooper Markhams NPL Site

ENVIRONMENTAL RISK GROUP

Sample Location	Easting	Northing	Ground Elevation (fmsl)	Location	Sample ID	Date	Comment	Analytes
90	1032173.018	872243.925	1308.86	Lathe #112	90	10/10/01 & 12/3/03	SS Fll Perimeter	As, Cr^{+3}, Cr^{+6}
91	1032313.973	872376.831	1308.38	Lathe #112	91	10/10/01 & 12/3/03	Subsurf Fill Perimeter	As, Cr^{+3}, Cr^{+6}
92A	1032803.207	872661.376	1310.86	Lathe #121	92	10/11/01 & 12/3/03	Fill Pile Cover	As, Cr^{+3}, Cr^{+6}, TOC
93	1032886.259	872586.675	1308.46	Lathe #111	93	10/10/01	SS Fll Perimeter	As, Cr^{+3}, Cr^{+6}
94A	1032860.329	872435.780	1310.49	Lathe #111	94	10/10/01	Subsurf Fill Perimeter	As, Cr^{+3}, Cr^{+6}
95	1031682.897	871937.743	1307.86					
96	1031878.494	872235.013	1312.87	Lathe #119	96	10/11/01	Fill Pile Cover	As, Cr^{+3}, Cr^{+6}, TOC
97	1031758.364	871924.476	1309.15	Lathe #120	97	10/12/01 & 12/3/03	Fill Pile Cover	As, Cr^{+3}, Cr^{+6}, TOC
98	1031830.049	872065.910	1307.30	Lathe #129	98	10/12/01	SS Fll Perimeter	VOC, TIC, SVOC, As, Cr^{+3}, Cr^{+6}, Moist
99	1031946.186	872169.611	1311.85	Lathe #129	99	10/12/01	Subsurf Fill Perimeter	As, Cr^{+3}, Cr^{+6}
100	1032411.777	872571.546	1310.03	Lathe #128	100	10/12/01 & 12/3/03	SS Fll Perimeter	VOC, TIC, SVOC, As, Cr^{+3}, Cr^{+6}, Moist
101	1032510.282	872707.345	1311.01	Lathe #128	101	10/12/01 & 12/3/03	Subsurf Fill Perimeter	As, Cr^{+3}, Cr^{+6}
102A	1032578.213	872893.247	1310.32	Lathe #127	102	10/12/01 & 12/3/03	SS Fll Perimeter	VOC, TIC, SVOC, As, Cr^{+3}, Cr^{+6}, Moist
103	1032627.234	872833.725	1311.40	Lathe #127	103	10/12/01 & 12/3/03	Subsurf Fill Perimeter	As, Cr^{+3}, Cr^{+6}
104	1032775.851	872766.724	1311.98	Lathe #126	104	10/12/01	SS Fll Perimeter	VOC, TIC, SVOC, As, Cr^{+3}, Cr^{+6}, Moist
105	1032744.398	872612.359	1319.91	Lathe #126	105	10/12/01	Subsurf Fill Perimeter	As, Cr^{+3}, Cr^{+6}
106	1031859.890	871794.486	1308.93	Lathe #130	106	10/12/01	SS Fll Perimeter	VOC, TIC, SVOC, As, Cr^{+3}, Cr^{+6}, Moist
107	1031895.601	871597.379	1311.29					
108	1032005.682	871469.783	1312.83	Lathe #130	108	10/12/01	Subsurf Fill Perimeter	As, Cr^{+3}, Cr^{+6}
109	1032154.163	871394.294	1312.99	Lathe #131	109	10/12/01	SS Fll Perimeter	VOC, TIC, SVOC, As, Cr^{+3}, Cr^{+6}, Moist
110	1032187.900	871424.927	1312.82	Lathe #131	110	10/12/01	Subsurf Fill Perimeter	As, Cr^{+3}, Cr^{+6}
111	1032636.064	871916.418	1310.22	Lathe #124	111	10/12/01	SS Fll Perimeter	VOC, TIC, SVOC, As, Cr^{+3}, Cr^{+6}, Moist
112	1032781.484	872067.977	1311.52	Lathe #124	112	10/12/01	Subsurf Fill Perimeter	As, Cr^{+3}, Cr^{+6}
113	1032836.805	872145.164	1311.53	Lathe #125	113	10/12/01	SS Fll Perimeter	VOC, TIC, SVOC, As, Cr^{+3}, Cr^{+6}, Moist
114	1032120.282	871959.179	1321.51	Lathe #125	114	10/12/01	Subsurf Fill Perimeter	As, Cr^{+3}, Cr^{+6}
115	1032387.173	872185.659	1324.97	Lathe #123	115	10/12/01 & 12/4/03	SS Fll Perimeter	VOC, TIC, SVOC, As, Cr^{+3}, Cr^{+6}, Moist
116	1032476.860	872419.634	1315.80	Lathe #123	116	10/12/01 & 12/4/03	Subsurf Fill Perimeter	As, Cr^{+3}, Cr^{+6}
117	1031998.553	872123.728	1314.26					
118	1032097.512	871557.348	1313.95	Lathe #122	118	10/12/01 & 12/4/03	SS Fll Perimeter	VOC, TIC, SVOC, As, Cr^{+3}, Cr^{+6}, Moist
119	1032354.966	871827.574	1316.23	Lathe #122	119	10/12/01 & 12/4/03	Subsurf Fill Perimeter	As, Cr^{+3}, Cr^{+6}

Table 6
Sample Matrix
Peter Cooper Markhams NPL Site

ENVIRONMENTAL RISK GROUP

Sample Location	Easting	Northing	Ground Elevation (fmsl)	Location	Sample ID	Date	Comment	Analytes
134				Lathe #52	134	10/15/01	Bk SS	As, Cr
141				Lathe #55	141	10/15/01	Bk SS	As, Cr
142				Lathe #54	142	10/15/01	Bk SS	As, Cr
143				Lathe #53	143	10/15/01	Bk SS	As, Cr
144				Lathe #51	144	10/15/01	Bk SS	As, Cr
145				Lathe #50	145	10/15/01	Bk SS	As, Cr
151	1031578.969	871290.468	1298.73	Composite	151	10/15/01	SS Fill Pile Perimeter	TOC
154				Composite	154	10/15/01	SS Fill Pile Perimeter	TOC
155				Composite	155	10/15/01	SS Fill Pile Perimeter	TOC
156				Composite	156	10/15/01	SS Fill Pile Perimeter	TOC

Table 6
Sample Matrix
Peter Cooper Markhams NPL Site

ENVIRONMENTAL RISK GROUP

Sample Location	Easting	Northing	Ground Elevation (fmsl)	Location	Sample ID	Date	Comment	Analytes
				Wetland Sediment				
120	1032715.151	872242.533	1313.26	Lathe #94A	120	10/15/01	Wet Sed	As, Cr^{+3}, Cr^{+6}
121	1032673.353	872037.343	1312.95	Lathe #93	121	10/15/2001&12/3/03	Wet Sed	As, Cr^{+3}, Cr^{+6}
122	1031883.937	872010.482	1309.74	Lathe #92A	122	10/15/01	Wet Sed	As, Cr^{+3}, Cr^{+6}
123	1031825.904	871760.510	1308.81	Lathe #84A	123	10/15/01	Wet Sed	As, Cr^{+3}, Cr^{+6}
124	1031928.975	871634.198	1311.10	Lathe #86	124	10/15/01	Wet Sed	As, Cr^{+3}, Cr^{+6}
125	1032038.983	871498.837	1312.40	Lathe #85	125	10/15/2001&12/3/03	Wet Sed	As, Cr^{+3}, Cr^{+6}
126	1032210.309	871776.825	1319.30	Lathe #87	126	10/15/01	Wet Sed	As, Cr^{+3}, Cr^{+6}
127	1032305.709	871945.269	1315.30	Lathe #88	127	10/15/01	Wet Sed	As, Cr^{+3}, Cr^{+6}
128	1032469.686	871989.121	1318.27	Lathe #90	128	10/15/01	Wet Sed	As, Cr^{+3}, Cr^{+6}
129	1032560.959	872135.328	1314.04	Lathe #91	129	10/15/01	Wet Sed	As, Cr^{+3}, Cr^{+6}
130	1032776.681	872459.328	1309.62	Lathe #150	130	10/15/01	Wet Sed	As, Cr^{+3}, Cr^{+6}
131	1032547.477	872591.859	1310.43	Lathe #151	131	10/15/01	Wet Sed	As, Cr^{+3}, Cr^{+6}
132				Lathe #152	132	10/15/01	Wet Sed	As, Cr^{+3}, Cr^{+6}
133				Lathe #89	133	10/15/2001&12/3/03	Wet Sed	As, Cr^{+3}, Cr^{+6}
135				Lathe # 79A	135	10/15/01	Bkgrnd Wet Sed	As, Cr
136				Lathe # 80	136	10/15/01	Bkgrnd Wet Sed	As, Cr
137	1032678.590	872687.325	1311.30	Lathe # 81A	137	10/15/01	Bkgrnd Wet Sed	As, Cr
138								
139				Lathe #82	139	10/15/01	Bkgrnd Wet Sed	As, Cr
140				Lathe #83	140	10/15/01	Bkgrnd Wet Sed	As, Cr
146				Lathe #76	146	10/15/01	Bkgrnd Wet Sed	As, Cr
147				Lathe #75	147	10/15/01	Bkgrnd Wet Sed	As, Cr
148				Lathe #77	148	10/15/01	Bkgrnd Wet Sed	As, Cr
149				Lathe #78	149	10/15/01	Bkgrnd Wet Sed	As, Cr
150	1031342.332	871535.782	1298.46	Composite	150	10/15/01	Wet Sed	TOC
152	1031718.724	871144.312	1298.75	Composite	152	10/15/01	Wet Sed	TOC
153				Composite	153	10/15/01	Wet Sed	TOC
174				Composite	174	37202	Wet Sed	pH
175				Composite	175	37202	Wet Sed	pH
176				Composite	176	37202	Wet Sed	pH

Table 6
Sample Matrix
Peter Cooper Markhams NPL Site

Sample Location	Easting	Northing	Ground Elevation (fmsl)	Location	Sample ID	Date	Comment	Analytes
Surface Water								
SW-1	1031694.654	871148.151	1299.17	Surface Water #1	186	12/3/01	Wetland SW	As, Cr^{+3}, Cr^{+6}, Geochem & Field
SW-1	1031694.654	871148.151	1299.17	Surface Water #1	206	4/24/02	Wetland SW	As, Cr^{+3}, Cr^{+6}, Geochem & Field
SW-2	1031361.517	871550.358	1300.19	Surface Water #2	184	12/3/01	Wetland SW	As, Cr^{+3}, Cr^{+6}, Geochem & Field
SW-2	1031361.517	871550.358	1300.19	Surface Water #2	185 DUP	12/3/01	Wetland SW	As, Cr^{+3}, Cr^{+6}, Geochem & Field
SW-2	1031361.517	871550.358	1300.19	Surface Water #2	212	4/25/02	Wetland SW	As, Cr^{+3}, Cr^{+6}, Geochem & Field
SW-2	1031361.517	871550.358	1300.19	Surface Water #2	-213 DUP	4/25/02	Wetland SW	As, Cr^{+3}, Cr^{+6}, Geochem & Field
SW-3	1032346.296	872482.175	1308.00	Surface Water #3	183	12/3/01	Wetland SW	As, Cr^{+3}, Cr^{+6}, Geochem & Field
SW-3	1032346.296	872482.175	1308.00	Surface Water #3	214	4/25/02	Wetland SW	As, Cr^{+3}, Cr^{+6}, Geochem & Field
SW-4				Surface Water #4	215	4/25/02	Wetland SW	As, Cr^{+3}, Cr^{+6}, Geochem & Field
SW-4				Surface Water #4	215-dry	12/3/01	Wetland SW	As, Cr^{+3}, Cr^{+6}, Geochem & Field
Other Samples								
SG-1	1031694.654	871148.151	1299.17					
SG-2	1031381.517	871530.358	1300.19					
SG-3	1032159.394	872522.136	1311.02					
SG-4	1032853.450	872670.994	1309.78					
B-2	1032366.292	871856.069	1314.88					
B-3	1032697.516	872246.032	1314.50					
GPZ-1/B-4	1032255.395	872080.175	1327.72					
MW-1D	1031825.608	871731.879	1309.53					
MW-1S	1031828.212	871740.001	1309.61					
MW-2D	1032253.295	872189.459	1313.91					
MW-2S	1032246.104	872202.978	1313.39					
MW-3D2	1032876.681	872394.993	1312.78					
MW-4D	1032472.135	871752.336	1312.87					
MW-4S	1032484.435	871740.005	1311.43					
MW-5D	1031494.137	871571.433	1302.78					
MW-5S	1031499.099	871572.441	1303.05					
MW-6D	1032103.921	871457.282	1313.79					
MW-6S	1032110.464	871458.434	1313.68					

Table 7

Occurrence and Distribution of Chemicals in Background Soils

Peter Cooper Markhams NPL Site

ENVIRONMENTAL RISK GROUP

Exposure Point	Chemical	Total Samples	Minimum Concentration		Maximum Concentration		Units	Location of Maximum Concentration	Frequency of Detection	Screening Criteria?	Average Concentration (mg/kg)
Bkgrnd-SS	Arsenic	6	1.4	U	8.1		mg/kg	Lathe #52	83%	Yes	5.5
Bkgrnd-SS	Chromium ('01 data)	6	7.8	J	31.8	J	mg/kg	Lathe #54	100%	Yes	19
Bkgrnd-SS	Chromium ('03 data)	0	NA		NA		mg/kg	NA	NA	NA	NA
Bkgrnd-SS	Hex Chromium ('01 data)	0	NA		NA		mg/kg	NA	NA	NA	NA
Bkgrnd-SS	Hex Chromium ('03 data)	0	NA		NA		mg/kg	NA	NA	NA	NA
Bkgrnd-SS	Manganese	0	NA		NA		mg/kg	NA	NA	NA	NA
Bkgrnd-Sub	Arsenic	13	4.7		13.4		mg/kg	B-4; 16-17 fbgs	100%	Yes	9.1
Bkgrnd-Sub	Chromium ('01 data)	13	9.8		5860		mg/kg	B-6; 7.5-8.5 fbgs	100%	Yes	564
Bkgrnd-Sub	Chromium ('03 data)	0	NA		NA		mg/kg	NA	NA	NA	NA
Bkgrnd-Sub	Hex Chromium ('01 data)	13	0.43	UJ	0.48	UJ	mg/kg	NA	0%	Yes	NA
Bkgrnd-Sub	Hex Chromium ('03 data)	0	NA		NA		mg/kg	NA	NA	NA	NA
Bkgrnd-Sub	Manganese	4	210		561		mg/kg		100%	Yes	352

Notes:

Bkgrnd-SS = Background Surface Soil

Bkgrnd-Sub = Background Sub-surface Soil

Data Qualifiers:

NA = not analyzed

U = constituent analyzed for, but not detected; reported with the detection limit

R = rejected concentration as a result of data validation

J = an estimated value, either when estimating a concentration for tentatively identified compounds where a 1:1 response is assumed, or when a compound meets the identification criteria but the result is less than the

Sample List:

Bkgrnd-Sub

Name	ID #	Date	Name	ID #	Date
B-1; 9-10 fbgs	*3*	*10/02/01*	*MW-7D; 24-32 fbgs*	*14*	*10/08/01*
B-1; 10-11 fbgs	*4*	*10/02/01*	*MW-7S; 8-16 fbgs*	*15*	*10/08/01*
B-1; 17-19 fbgs	*5*	*10/02/01*	*B-5; 8-9 fbgs*	*19*	*10/09/01*
MW-8D; 20-21 fbgs	*6*	*10/04/01*	*B-5; 9-10 fbgs*	*20*	*10/09/01*
MW-8S; 4-6 fbgs	*7*	*10/04/01*	*B-5; 14-16 fbgs*	*21*	*10/09/01*
MW-8S; 6-10 fbgs	*8*	*10/04/01*	*B-6; 6.5-7.5 fbgs*	*23*	*10/09/01*
B-4; 15-16 fbgs	*9*	*10/05/01*	*B-6; 7.5-8.5 fbgs*	*24*	*10/09/01*
B-4; 23-25 fbgs	*10*	*10/05/01*	*B-6; 9-11 fbgs*	*25*	*10/09/01*
B-4; 16-17 fbgs	*13*	*10/05/01*	*4 Borings/MW-8*	*26*	*10/09/01*

Bkgrnd-SS

Name	ID #	Date
Lathe #52	134	10/15/01
Lathe #55	141	10/15/01
Lathe #54	142	10/15/01
Lathe #53	143	10/15/01
Lathe #51	144	10/15/01
Lathe #50	145	10/15/01

Table 8

Occurrence, Distribution, and Selection of Chemicals in Surface Soil

Peter Cooper Markhams NPL Site

ENVIRONMENTAL RISK GROUP

Exposure Point	Chemical	Total Samples	Minimum Concentration		Maximum Concentration		Average Concentration	Units	Screening Concentration	Background Concentration
	VOCs (mg/kg)[4]									
SS	Chloromethane	10	0.009	U	0.019	U	NA	mg/kg	NA	NA
SS	Bromomethane (Methyl bromide)	10	0.009	U	0.019	U	NA	mg/kg	NA	NA
SS	Vinyl chloride	10	0.009	U	0.019	U	NA	mg/kg	NA	NA
SS	Chloroethane	10	0.009	U	0.019	U	NA	mg/kg	NA	NA
SS	Methylene chloride	10	0.009	U	0.019	U	NA	mg/kg	NA	NA
SS	Acetone	10	0.01	U	0.55	B	0.170	mg/kg	2.5	NA
SS	Carbon Disulfide	10	0.002	J	0.002	J	0.006	mg/kg	0.094	NA
SS	1,1-Dichloroethene	10	0.009	U	0.019	U	NA	mg/kg	NA	NA
SS	1,1-Dichloroethane	10	0.009	U	0.019	U	NA	mg/kg	NA	NA
SS	Chloroform	10	0.009	U	0.019	U	NA	mg/kg	NA	NA
SS	1,2-Dichloroethane	10	0.009	U	0.019	U	NA	mg/kg	NA	NA
SS	2-Butanone (Methyl ethyl ketone)	10	0.01	U	0.05	B	0.012	mg/kg	89	NA
SS	1,1,1-Trichloroethane	10	0.009	U	0.019	U	NA	mg/kg	NA	NA
SS	Carbon Tetrachloride	10	0.009	U	0.019	U	NA	mg/kg	NA	NA
SS	Bromodichloromethane	10	0.009	U	0.019	U	NA	mg/kg	NA	NA
SS	1,2-Dichloropropane	10	0.009	U	0.019	U	NA	mg/kg	NA	NA
SS	cis-1,3-Dichloropropene	10	0.009	U	0.019	U	NA	mg/kg	NA	NA
SS	Trichloroethene	10	0.009	U	0.019	U	NA	mg/kg	12	NA
SS	Dibromochloromethane	10	0.009	U	0.019	U	NA	mg/kg	0.035	NA
SS	1,1,2-Trichloroethane	10	0.009	U	0.019	U	NA	mg/kg	NA	NA
SS	Benzene	10	0.009	U	0.019	U	NA	mg/kg	0.26	NA
SS	trans-1,3-Dichloropropene	10	0.009	U	0.019	U	NA	mg/kg	NA	NA
SS	Bromoform	10	0.009	U	0.019	U	NA	mg/kg	16	NA
SS	4-Methyl-2-pentanone	10	0.009	U	0.019	U	NA	mg/kg	NA	NA
SS	2-Hexanone (Methyl butyl ketone)	10	0.009	U	0.019	U	NA	mg/kg	13	NA
SS	Tetrachloroethene	10	0.009	U	0.019	U	NA	mg/kg	9.9	NA
SS	Toluene	10	0.009	U	0.019	U	NA	mg/kg	5.45	NA
SS	1,1,2,2-Tetrachloroethane	10	0.009	U	0.019	U	NA	mg/kg	NA	NA
SS	Chlorobenzene	10	0.009	U	0.019	U	NA	mg/kg	1.3	NA
SS	Ethylbenzene	10	0.009	U	0.019	U	NA	mg/kg	5.2	NA

Table 8

Occurrence, Distribution, and Selection of Chemicals in Surface Soil

Peter Cooper Markhams NPL Site

ENVIRONMENTAL RISK GROUP

Exposure Point	Chemical	Total Samples	Minimum Concentration		Maximum Concentration		Average Concentration	Units	Screening Concentration	Background Concentration
SS	Styrene	10	0.009	U	0.019	U	NA	mg/kg	4.7	NA
SS	Total Xylenes	10	0.009	U	0.019	U	NA	mg/kg	10	NA
SS	cis-1,2-Dichloroethene	10	0.009	U	0.019	U	NA	mg/kg	NA	NA
SS	trans-1,2-Dichloroethene	10	0.009	U	0.019	U	NA	mg/kg	0.78	NA
SS	Dichlorodifluoromethane	10	0.003	J	0.006	J	0.006	mg/kg	40	NA
SS	Trichlorofluoromethane	10	0.003	J	0.007	J	0.006	mg/kg	16	NA
SS	Methyl tertbutyl ether	10	0.009	U	0.019	U	NA	mg/kg	NA	NA
SS	1,2-Dibromoethane	10	0.009	U	0.019	U	NA	mg/kg	NA	NA
SS	Isopropylbenzene (Cumene)	10	0.009	U	0.019	U	NA	mg/kg	NA	NA
SS	1,3-Dichlorobenzene	10	0.009	U	0.019	U	NA	mg/kg	3.8	NA
SS	1,4-Dichlorobenzene	10	0.009	U	0.019	U	NA	mg/kg	0.54	NA
SS	1,2-Dichlorobenzene	10	0.009	U	0.019	U	NA	mg/kg	2.9	NA
SS	1,2-Dibromo-3-chloropropane	10	0.009	U	0.019	U	NA	mg/kg	NA	NA
SS	1,2,4-Trichlorobenzene	10	0.009	U	0.019	U	NA	mg/kg	1.1	NA
	TICs (*m* g/kg)4									
SS	Hexane	7	0.005	BJNR	0.012	BJNR	NA	mg/kg	NA	NA
SS	Unknown Alcohol	1	0.005	J	0.005	J	NA	mg/kg	NA	NA
SS	Unknown	5	0.019	J	0.092	J	NA	mg/kg	NA	NA
	SVOCs (*m* g/kg)4									
SS	Acenaphthene	10	0.36	U	0.52	U	NA	mg/kg	682	NA
SS	Acenaphthylene	10	0.36	U	0.52	U	NA	mg/kg	682	NA
SS	Acetophenone	10	0.36	U	0.52	U	NA	mg/kg	300	NA
SS	Anthracene	10	0.36	U	0.52	U	NA	mg/kg	1500	NA
SS	Atrazine	10	0.36	U	0.52	U	NA	mg/kg	0.00005	NA
SS	Benzo(a)anthracene	10	0.02	J	0.027	J	0.17	mg/kg	5.2	NA
SS	Benzo(b)fluoranthene	10	0.038	J	0.082	J	0.12	mg/kg	60	NA
SS	Benzo(k)fluoranthene	10	0.028	J	0.041	J	0.17	mg/kg	148	NA
SS	Benzo(ghi)perylene	10	0.031	J	0.043	J	0.17	mg/kg	119	NA
SS	Benzo(a)pyrene	10	0.022	J	0.071	J	0.13	mg/kg	1.5	NA
SS	Benzaldehyde	10	0.043	J	0.17	J	0.19	mg/kg	780	NA
SS	Biphenyl (1,1-Biphenyl)	10	0.36	U	0.52	U	NA	mg/kg	NA	NA

Table 8
Occurrence, Distribution, and Selection of Chemicals in Surface Soil
Peter Cooper Markhams NPL Site

ENVIRONMENTAL RISK GROUP

Exposure Point	Chemical	Total Samples	Minimum Concentration		Maximum Concentration		Average Concentration	Units	Screening Concentration	Background Concentration
SS	Bis(2-chloroethoxy)methane	10	0.36	U	0.52	U	NA	mg/kg	NA	NA
SS	Bis(2-chloroethyl)ether	10	0.36	U	0.52	U	NA	mg/kg	237	NA
SS	2,2'-Oxybis(1-Chloropropane) (Bis(2-chloro-1-methylethyl)ether)	10	0.36	U	0.52	U	NA	mg/kg	200	NA
SS	Bis(2-ethylhexyl) phthalate	10	0.36	U	0.52	U	NA	mg/kg	0.92	NA
SS	4-Bromophenyl phenyl ether	10	0.36	U	0.52	U	NA	mg/kg	NA	NA
SS	Butyl benzyl phthalate	10	0.36	U	0.52	U	NA	mg/kg	0.24	NA
SS	4-Chloroaniline	10	0.36	U	0.52	U	NA	mg/kg	1.1	NA
SS	4-Chloro-3-methylphenol	10	0.36	U	0.52	U	NA	mg/kg	NA	NA
SS	2-Chloronaphthalene (beta-Chloronaphthalene)	10	0.36	U	0.52	U	NA	mg/kg	NA	NA
SS	2-Chlorophenol	10	0.36	U	0.52	U	NA	mg/kg	0.24	NA
SS	4-Chlorophenyl phenyl ether	10	0.36	U	0.52	U	NA	mg/kg	NA	NA
SS	Caprolactam	10	0.36	U	0.52	U	NA	mg/kg	NA	NA
SS	Carbazole	10	0.36	U	0.52	U	NA	mg/kg	NA	NA
SS	Chrysene	10	0.024	J	0.034	J	0.15	mg/kg	4.7	NA
SS	Dibenzo(a,h)anthracene	10	0.36	U	0.52	U	NA	mg/kg	184	NA
SS	Dibenzofuran	10	0.36	U	0.52	U	NA	mg/kg	NA	NA
SS	Di-n-butyl phthalate (Dibutyl phthalate)	10	0.36	U	0.52	U	NA	mg/kg	200	NA
SS	3,3'-Dichlorobenzidine	10	0.36	U	0.52	U	NA	mg/kg	0.64	NA
SS	2,4-Dichlorophenol	10	0.36	U	0.52	U	NA	mg/kg	875	NA
SS	Diethyl phthalate	10	0.36	U	1.3	U	NA	mg/kg	248	NA
SS	2,4-Dimethylphenol	10	0.36	U	0.52	U	NA	mg/kg	0.01	NA
SS	Dimethyl phthalate	10	0.36	U	0.52	U	NA	mg/kg	NA	NA
SS	4,6-Dinitro-2-methylphenol	10	0.9	U	1.3	U	NA	mg/kg	NA	NA
SS	2,4-Dinitrophenol	10	0.9	U	1.3	U	NA	mg/kg	0.06	NA
SS	2,4-Dinitrotoluene	10	0.36	U	0.52	U	NA	mg/kg	1.3	NA
SS	2,6-Dinitrotoluene	10	0.36	U	0.52	U	NA	mg/kg	0.033	NA
SS	Di-n-octyl phthalate	10	0.36	U	0.52	U	NA	mg/kg	NA	NA

Table 8

Occurrence, Distribution, and Selection of Chemicals in Surface Soil

Peter Cooper Markhams NPL Site

ENVIRONMENTAL RISK GROUP

Exposure Point	Chemical	Total Samples	Minimum Concentration		Maximum Concentration		Average Concentration	Units	Screening Concentration	Background Concentration
SS	Fluoranthene	10	0.033	J	0.059	J	0.14	mg/kg	122	NA
SS	Fluorene	10	0.36	U	0.52	U	NA	mg/kg	122	NA
SS	Hexachlorobenzene	10	0.36	U	0.52	U	NA	mg/kg	0.2	NA
SS	Hexachlorobutadiene	10	0.36	U	0.52	U	NA	mg/kg	0.04	NA
SS	Hexachlorocyclopentadiene	10	0.36	U	0.52	U	NA	mg/kg	0.76	NA
SS	Hexachloroethane	10	0.36	U	0.52	U	NA	mg/kg	0.6	NA
SS	Indeno(1,2,3-cd)pyrene	10	0.04	J	0.04	J	0.19	mg/kg	109	NA
SS	Isophorone	10	0.36	U	0.52	U	NA	mg/kg	139	NA
SS	2-Methylnaphthalene	10	0.36	U	0.52	U	NA	mg/kg	3.2	NA
SS	2-Methylphenol	10	0.36	U	0.52	U	NA	mg/kg	NA	NA
SS	4-Methylphenol	10	0.04	J	0.11	J	0.16	mg/kg	NA	NA
SS	Naphthalene	10	0.033	J	0.047	J	0.15	mg/kg	0.099	NA
SS	2-Nitroaniline	10	0.9	U	1.3	U	NA	mg/kg	3.2	NA
SS	3-Nitroaniline	10	0.9	U	1.3	U	NA	mg/kg	74	NA
SS	4-Nitroaniline	10	0.9	U	1.3	U	NA	mg/kg	22	NA
SS	Nitrobenzene	10	0.36	U	0.52	U	NA	mg/kg	1.3	NA
SS	2-Nitrophenol	10	0.36	U	0.52	U	NA	mg/kg	1.6	NA
SS	4-Nitrophenol	10	0.9	U	1.3	U	NA	mg/kg	5.1	NA
SS	N-nitrosodiphenylamine	10	0.33	U	0.52	U	NA	mg/kg	0.54	NA
SS	N-Nitroso-Di-n-propylamine	10	0.36	U	0.52	U	NA	mg/kg	NA	NA
SS	Pentachlorophenol	10	0.9	U	1.3	U	NA	mg/kg	0.12	NA
SS	Phenanthrene	10	0.024	J	0.024	J	0.19	mg/kg	46	NA
SS	Phenol	10	0.36	U	0.52	U	NA	mg/kg	120	NA
SS	Pyrene	10	0.027	J	0.042	J	0.13	mg/kg	78	NA
SS	2,4,5-Trichlorophenol	10	0.9	U	1.3	U	NA	mg/kg	14	NA
SS	2,4,6-Trichlorophenol	10	0.36	U	0.52	U	NA	mg/kg	9.9	NA

Table 8

Occurrence, Distribution, and Selection of Chemicals in Surface Soil

Peter Cooper Markhams NPL Site

ENVIRONMENTAL RISK GROUP

Exposure Point	Chemical	Total Samples	Minimum Concentration		Maximum Concentration		Average Concentration	Units	Screening Concentration	Background Concentration
	Metals (mg/kg)									
SS	Arsenic	57	1.9		96		12	mg/kg	5.7	5.5
SS	Chromium ('01 data)	57	7.1		65,300		4,251	mg/kg	0.4	19
SS	Chromium ('03 data)	12	58		28,000		10,350	mg/kg	0.4	19
SS	Hex Chromium ('01 data)	57	0.45	UR	20	UR	NA	mg/kg	0.4	NA
SS	Hex Chromium ('03 data)	12	2.5		63	J	20	mg/kg	0.4	NA

Table 8
Occurrence, Distribution, and Selection of Chemicals in Surface Soil
Peter Cooper Markhams NPL Site

ENVIRONMENTAL RISK GROUP

Exposure Point	Chemical	Location of Maximum Concentration	Frequency of Detection	COPC Flag (Y/N)	Deletion Rationale
	VOCs (mg/kg)[4]				
SS	Chloromethane	NA	0.0%	N	ND
SS	Bromomethane (Methyl bromide)	NA	0.0%	N	ND
SS	Vinyl chloride	NA	0.0%	N	ND
SS	Chloroethane	NA	0.0%	N	ND
SS	Methylene chloride	NA	0.0%	N	ND
SS	Acetone	NA	60.0%	N	B, <SC
SS	Carbon Disulfide	Lathe #123	10.0%	N	LF, <SC
SS	1,1-Dichloroethene	NA	0.0%	N	ND
SS	1,1-Dichloroethane	NA	0.0%	N	ND
SS	Chloroform	NA	0.0%	N	ND
SS	1,2-Dichloroethane	NA	0.0%	N	ND
SS	2-Butanone (Methyl ethyl ketone)	NA	10.0%	N	B, LF, <SC
SS	1,1,1-Trichloroethane	NA	0.0%	N	ND
SS	Carbon Tetrachloride	NA	0.0%	N	ND
SS	Bromodichloromethane	NA	0.0%	N	ND
SS	1,2-Dichloropropane	NA	0.0%	N	ND
SS	cis-1,3-Dichloropropene	NA	0.0%	N	ND
SS	Trichloroethene	NA	0.0%	N	ND
SS	Dibromochloromethane	NA	0.0%	N	ND
SS	1,1,2-Trichloroethane	NA	0.0%	N	ND
SS	Benzene	NA	0.0%	N	ND
SS	trans-1,3-Dichloropropene	NA	0.0%	N	ND
SS	Bromoform	NA	0.0%	N	ND
SS	4-Methyl-2-pentanone	NA	0.0%	N	ND
SS	2-Hexanone (Methyl butyl ketone)	NA	0.0%	N	ND
SS	Tetrachloroethene	NA	0.0%	N	ND
SS	Toluene	NA	0.0%	N	ND
SS	1,1,2,2-Tetrachloroethane	NA	0.0%	N	ND
SS	Chlorobenzene	NA	0.0%	N	ND
SS	Ethylbenzene	NA	0.0%	N	ND

Sample List:		
Lathe #118	37	10/10/01
Lathe #117	64	10/11/01 & 12/4/03
Lathe #114	65	10/11/01
Lathe #115	66	10/11/01 & 12/3/03
Lathe #116	67	10/11/01
Lathe #137	68	10/11/01 & 12/3/03
Lathe #121	92	10/11/01 & 12/3/03
Lathe #119	96	10/11/01
Lathe #120	97	10/12/01 & 12/3/03
Lathe #106	28	10/10/01
Lathe #62	30	10/10/01
Lathe #63	31	10/10/01
Lathe #65	34	10/10/01
Lathe #107	35	10/10/01 & 12/3/03
Lathe #108	38	10/10/01
Lathe #68	40	10/10/01
Lathe #69	41	10/10/01
Lathe #70	42	10/10/01
Lathe #71	43	10/10/01
Lathe #109	44	10/10/01
Lathe #110	46	10/10/01
Lathe #97	48	10/10/01
Lathe #95	50	10/10/01
Lathe #60	52	10/10/01
Lathe #59	54	10/10/01
Lathe #98	55	10/10/01
Lathe #61	57	10/10/01
Lathe #58	58	10/10/01

Table 8
Occurrence, Distribution, and Selection of Chemicals in Surface Soil
Peter Cooper Markhams NPL Site

Exposure Point	Chemical	Location of Maximum Concentration	Frequency of Detection	COPC Flag (Y/N)	Deletion Rationale
SS	Styrene	NA	0.0%	N	ND
SS	Total Xylenes	NA	0.0%	N	ND
SS	cis-1,2-Dichloroethene	NA	0.0%	N	ND
SS	trans-1,2-Dichloroethene	NA	0.0%	N	ND
SS	Dichlorodifluoromethane	Lathe #128 & 129	30.0%	N	<SC
SS	Trichlorofluoromethane	Lathe 129	30.0%	N	<SC
SS	Methyl tertbutyl ether	NA	0.0%	N	ND
SS	1,2-Dibromoethane	NA	0.0%	N	ND
SS	Isopropylbenzene (Cumene)	NA	0.0%	N	ND
SS	1,3-Dichlorobenzene	NA	0.0%	N	ND
SS	1,4-Dichlorobenzene	NA	0.0%	N	ND
SS	1,2-Dichlorobenzene	NA	0.0%	N	ND
SS	1,2-Dibromo-3-chloropropane	NA	0.0%	N	ND
SS	1,2,4-Trichlorobenzene	NA	0.0%	N	ND
	TICs (*m* g/kg)4				
SS	Hexane	Lathe #127	100.0%	N	B
SS	Unknown Alcohol	Lathe #131	100.0%	N	Unk
SS	Unknown	Lathe #122	100.0%	N	Unk
	SVOCs (*m* g/kg)4				
SS	Acenaphthene	NA	0.0%	N	ND
SS	Acenaphthylene	NA	0.0%	N	ND
SS	Acetophenone	NA	0.0%	N	ND
SS	Anthracene	NA	0.0%	N	ND
SS	Atrazine	NA	0.0%	N	ND
SS	Benzo(a)anthracene	Lathe #126	20.0%	Y	
SS	Benzo(b)fluoranthene	Lathe #126	50.0%	Y	
SS	Benzo(k)fluoranthene	Lathe #126	20.0%	Y	
SS	Benzo(ghi)perylene	Lathe #126	20.0%	Y	
SS	Benzo(a)pyrene	Lathe #126	40.0%	Y	
SS	Benzaldehyde	Lathe #125	30.0%	Y	
SS	Biphenyl (1,1-Biphenyl)	NA	0.0%	N	ND

Sample List:		
Lathe #57	59	10/10/01
Lathe #96	60	10/10/01
Lathe #99	62	10/10/01
Lathe #105	69	10/10/01
Lathe #104	71	10/10/01
Lathe #103	73	10/10/01
Lathe #102A	76	10/10/01
Lathe #101	78	10/10/01
Lathe #100	80	10/10/01
Lathe #56	82	10/10/01
Lathe #66	83	10/10/01
Lathe #67A	84	10/10/01
Lathe #74	85	10/10/01
Lathe #73	86	10/10/01
Lathe #72	87	10/10/01
Lathe #113	88	10/10/01 & 12/3/03
Lathe #112	90	10/10/01 & 12/3/03
Lathe #111	93	10/10/01
Lathe #129	98	10/12/01
Lathe #128	100	10/12/01 & 12/3/03
Lathe #127	102	10/12/01
Lathe #126	104	10/12/01
Lathe #130	106	10/12/01
Lathe #131	109	10/12/01
Lathe #124	111	10/12/01
Lathe #125	113	10/12/01
Lathe #123	115	10/12/01
Lathe #122	118	10/12/01

Occurrence, Distribution, and Selection of Chemicals in Surface Soil

Peter Cooper Markhams NPL Site

ENVIRONMENTAL RISK GROUP

Exposure Point	Chemical	Location of Maximum Concentration	Frequency of Detection	COPC Flag (Y/N)	Deletion Rationale
SS	Bis(2-chloroethoxy)methane	NA	0.0%	N	ND
SS	Bis(2-chloroethyl)ether	NA	0.0%	N	ND
SS	2,2'-Oxybis(1-Chloropropane) (Bis(2-chloro-1-methylethyl)ether)	NA	0.0%	N	ND
SS	Bis(2-ethylhexyl) phthalate	NA	0.0%	N	ND
SS	4-Bromophenyl phenyl ether	NA	0.0%	N	ND
SS	Butyl benzyl phthalate	NA	0.0%	N	ND
SS	4-Chloroaniline	NA	0.0%	N	ND
SS	4-Chloro-3-methylphenol	NA	0.0%	N	ND
SS	2-Chloronaphthalene (beta-Chloronaphthalene)	NA	0.0%	N	ND
SS	2-Chlorophenol	NA	0.0%	N	ND
SS	4-Chlorophenyl phenyl ether	NA	0.0%	N	ND
SS	Caprolactam	NA	0.0%	N	ND
SS	Carbazole	NA	0.0%	N	ND
SS	Chrysene	Lathe #126	30.0%	Y	
SS	Dibenzo(a,h)anthracene	NA	0.0%	N	ND
SS	Dibenzofuran	NA	0.0%	N	ND
SS	Di-n-butyl phthalate (Dibutyl phthalate)	NA	0.0%	N	ND
SS	3,3'-Dichlorobenzidine	NA	0.0%	N	ND
SS	2,4-Dichlorophenol	NA	0.0%	N	ND
SS	Diethyl phthalate	NA	0.0%	N	ND
SS	2,4-Dimethylphenol	NA	0.0%	N	ND
SS	Dimethyl phthalate	NA	0.0%	N	ND
SS	4,6-Dinitro-2-methylphenol	NA	0.0%	N	ND
SS	2,4-Dinitrophenol	NA	0.0%	N	ND
SS	2,4-Dinitrotoluene	NA	0.0%	N	ND
SS	2,6-Dinitrotoluene	NA	0.0%	N	ND
SS	Di-n-octyl phthalate	NA	0.0%	N	ND

Table 8
Occurrence, Distribution, and Selection of Chemicals in Surface Soil
Peter Cooper Markhams NPL Site

ENVIRONMENTAL RISK GROUP

Exposure Point	Chemical	Location of Maximum Concentration	Frequency of Detection	COPC Flag (Y/N)	Deletion Rationale
SS	Fluoranthene	Lathe #130	40.0%	Y	
SS	Fluorene	NA	0.0%	N	ND
SS	Hexachlorobenzene	NA	0.0%	N	ND
SS	Hexachlorobutadiene	NA	0.0%	N	ND
SS	Hexachlorocyclopentadiene	NA	0.0%	N	ND
SS	Hexachloroethane	NA	0.0%	N	ND
SS	Indeno(1,2,3-cd)pyrene	Lathe #126	10.0%	N	LF, <SC
SS	Isophorone	NA	0.0%	N	ND
SS	2-Methylnaphthalene	NA	0.0%	N	ND
SS	2-Methylphenol	NA	0.0%	N	ND
SS	4-Methylphenol	Lathe #126	30.0%	Y	
SS	Naphthalene	Lathe #128	30.0%	Y	
SS	2-Nitroaniline	NA	0.0%	N	ND
SS	3-Nitroaniline	NA	0.0%	N	ND
SS	4-Nitroaniline	NA	0.0%	N	ND
SS	Nitrobenzene	NA	0.0%	N	ND
SS	2-Nitrophenol	NA	0.0%	N	ND
SS	4-Nitrophenol	NA	0.0%	N	ND
SS	N-nitrosodiphenylamine	NA	0.0%	N	ND
SS	N-Nitroso-Di-n-propylamine	NA	0.0%	N	ND
SS	Pentachlorophenol	NA	0.0%	N	ND
SS	Phenanthrene	Lathe #130	10.0%	N	LF, <SC
SS	Phenol	NA	0.0%	N	ND
SS	Pyrene	Lathe #130	40.0%	Y	
SS	2,4,5-Trichlorophenol	NA	0.0%	N	ND
SS	2,4,6-Trichlorophenol	NA	0.0%	N	ND

Table 8

Occurrence, Distribution, and Selection of Chemicals in Surface Soil

Peter Cooper Markhams NPL Site

ENVIRONMENTAL RISK GROUP

Exposure Point	Chemical	Location of Maximum Concentration	Frequency of Detection	COPC Flag (Y/N)	Deletion Rationale
	Metals (mg/kg)				
SS	Arsenic	Lathe #120	100.0%	Y	
SS	Chromium ('01 data)	Lathe #121	100.0%	Y	
SS	Chromium ('03 data)	Lathe #121	100.0%	Y	
SS	Hex Chromium ('01 data)	NA	0.0%	Y	
SS	Hex Chromium ('03 data)	Lathe #120	100.0%	Y	

Notes:

SS = Surface Soil

Includes surface soil fill perimeter and fill pile cover samples!

VOCs = Volatile Organic Compounds

TICs = Tentatively Identified Compounds

SVOCs = Semi-Volatile Organic Compounds

Screening Criterion: USEPA Region 5 Ecological Screening Levels (August 2003)
USEPA Region 4 Ecological Screening Values (Checked Jan. 2005)
USEPA Region 3 Risk Based Concentrations (Oct. 2004) [Benzaldehyde only]

Data Qualifiers:

NA Not Analyzed
R Rejected concentration as a result of data validation
U Constituent analyzed for, but not detected; reported with the detection limit
J An estimated value, either when estimating a concentration for tentatively identified compounds where a 1:1 response is assumed, limit criteria but the result is less than the quantitation or when a compound meets the identification

Rationale Criteria:

ND Non-detection
LD ND detection limits higher than detected levels, biasing high
B Occurs in Blank samples
LF Low frequency of detection (<=10%)
LC Likely lab contaminant
Unk Unknown Chemical, cannot assess
<SC Far less than Ecological Screening Criteria

Table 9

Occurrence, Distribution, and Selection of Chemicals in Subsurface Soil

Peter Cooper Markhams NPL Site

ENVIRONMENTAL RISK GROUP

Exposure Point	Chemical	Total Samples	Minimum Concentration		Maximum Concentration		Average Concentration	Units	Screening Concentration	Background Concentration
	Metals (mg/kg)									
SubSS	Arsenic	29	3.7	J	29		11	mg/kg	5.7	9.1
SubSS	Chromium ('01 data)	29	14	J	19,700	J	2,686	mg/kg	0.4	564
SubSS	Hex Chromium ('03 data)	29	0.5	UJ	1.3	UJ	NA	mg/kg	0.4	NA

Exposure Point	Chemical	Location of Maximum Concentration	Frequency of Detection	COPC Flag (Y/N)	Selection / Deletion Rationale
	Metals (mg/kg)				
SubSS	Arsenic	Lathe #128	100%	Y	
SubSS	Chromium ('01 data)	Lathe #106	100%	Y	
SubSS	Hex Chromium ('03 data)	Lathe #113	0%	Y	

Notes:
SubSS = Subsurface Soil
VOCs = Volatile Organic Compounds
TICs = Tentatively Identified Compounds
SVOCs = Semi-Volatile Organic Compounds

Screening Criterion:
USEPA Region 5 Ecological Screening Levels (August 2003)

Data Qualifiers:
- NA Not Analyzed
- R Rejected concentration as a result of data validation
- U Constituent analyzed for, but not detected; reported with the detection limit
- J An estimated value, either when estimating a concentration for tentatively identified compounds where a 1:1 response is assumed, limit criteria but the result is less than the quantitation or when a compound meets the identification

Rationale Criteria:
- ND Non-detection
- LD ND detection limits higher than detected levels, biasing high
- B Occurs in Blank samples
- LF Low frequency of detection (<=10%)
- LC Likely lab contaminant
- Unk Unknown Chemical, cannot assess
- <SC Far less than Ecological Screening Criteria

Table 10
Occurrence, Distribution, and Selection of Chemicals in Wetland Sediment

Peter Cooper Markhams NPL Site

ENVIRONMENTAL RISK GROUP

Sample Location	Lathe # 79A	Lathe # 80	Lathe # 81A	Lathe #82	Lathe #83	Lathe #76	Lathe #75	Lathe #77	Lathe #78	Freq. of Detection	Average Concentration
Sample ID#	135	136	137	139	140	146	147	148	149		
Date Sampled	10/15/01	10/15/01	10/15/01	10/15/01	10/15/01	10/15/01	10/15/01	10/15/01	10/15/01		
	Bkgrnd	Bkgrnd	Bkgrnd	Bkgrnd	Bkgrnd	Bkgrnd	Bkgrnd	Bkgrnd	Bkgrnd	Bkgrnd	Bkgrnd
Total Metals, mg/kg											
Arsenic	9.6	7.1	**10.3**	8.9	1.4 U	5.2	9.3	6	4.2	89%	6.8
Chromium (2001)	13.2 J	14.1 J	9.3 J	**23.1** J	8.3 J	13.9 J	7.8 J	11.8 J	16.4 J	100%	13

Sample Location	Lathe #94A	Lathe #93	Lathe #92A	Lathe #84A	Lathe #86	Lathe #85	Lathe #87	Minimum Concen.	Maximum Concen.	# Samples	Freq. of Detection
Sample ID#	120	121	122	123	124	125	126				
Date Sampled	10/15/01	10/15/01	10/15/01	10/15/01	10/15/01	10/15/01	10/15/01				
	Site Sed.	Site Sed.	Site Sed.	Site Sed.	Site Sed.	Site Sed.	Site Sed.	Site Sed.	Site Sed.	Site Sed.	Site Sed.
Total Metals, mg/kg											
Arsenic	**11.4**	8.6	9.0	3.8	6.6 U	2.3	6.3	2.3	11	14	69%
Chromium (2001)	75.4 J	136 J	51.8 J	9.2 J	6.6 UJ	87.4 J	19.2 J	6.6 UJ	215 J	14	88%
Chromium (2003)		**97.8**				14.2 J		14	98	3	100%
Hex. Chromium (2001)	0.47 UR	0.52 UR	0.52 UR	0.53 UR	**2.8** UR	0.92 UR	2.4 UR	0.5 UR	2.8 UR	14	0%
Hex. Chromium (2003)		1.3				4.0 UJ		1.3	18	3	100%

Sample Location	Lathe #88	Lathe #90	Lathe #91	Lathe #150	Lathe #151	Lathe #152	Lathe #89	Average Concentration	Screening Concentration	COPC Flag	Selection / Deletion Rationale
Sample ID#	127	128	129	130	131	132	133				
Date Sampled	10/15/01	10/15/01	10/15/01	10/15/01	10/15/01	10/15/01	10/15/01				
	Site Sed.	Site Sed.	Site Sed.	Site Sed.	Site Sed.	Site Sed.	Site Sed.	Site Sed.	Site Sed.		
Total Metals, mg/kg											
Arsenic	6.8 U	5.9 U	6.7 U	4.5	3.2 U	3.9	6.4	5.1	9.8	N	BB, BSC
Chromium (2001)	26.7 J	46.8 J	42.4 J	24.4 J	14.6 J	23.9 J	**215** J	55	43	Y	
Chromium (2003)							29.0	47	--	Y	
Hex. Chromium (2001)	2.6 UR	2.4 UR	1.6 UR	0.88 UR	1.2 UR	1.0 UR	1.3 UR	0.7 UR	--	Y	
Hex. Chromium (2003)							**18.3**	7.9	--	Y	

Table 10

Occurrence, Distribution, and Selection of Chemicals in Wetland Sediment

Peter Cooper Markhams NPL Site

ENVIRONMENTAL RISK GROUP

Sample Location	Composite	Composite	Composite	Composite	Composite	Composite	Average
Sample ID#	150	152	153	174	175	176	
Date Sampled	10/15/01	10/15/01	10/15/01	11/7/01	11/7/01	11/7/01	
	Site Sed.	Site Sed.	Site Sed.	Site Sed.	Site Sed.	Site Sed.	Site Sed.
Other Parameters							
Leachable pH				6.5	5.1	5.8	5.8 **pH**
Total Organic Carbon, %	1.4	7.9	1.6				3.6 **TOC %**

Notes:

Data qualifications reflects 100% data validation performed by Data Validation Services

Values Are maximum dectected values

Sample 150 is a composite of Lathes #94, 86, and 92
Sample 152 is a composite of Lathes #93, 84, 150, 151, and 152
Sample 153 is a composite of Lathes #86, 85, 87, 88, 89, 90, and 91
Sample 174 is a composite of Lathes #152, 84, 151, and 152
Sample 175 is a composite of Lathes #153, 85, and 86
Sample 176 is a composite of Lathes #150, 92, and 94

Data Qualifiers: U = element was analyzed for, but not detected; reported with the detection limit value
J = a value greater than or equal to the instrument detection limit, but less than the quantitation limit
R = rejected concentration as a result of data validation

Rationale Criteria: BB Below background
BSC Below sediment criteria

Screening Criterion: USEPA Region 5 Ecological Screening Levels (August 2003)

Table 11

Occurrence, Distribution, and Selection of Chemcials in Wetland Surface Water

Peter Cooper Markhams NPL Site

ENVIRONMENTAL RISK GROUP

Sample Location	Surface Water #1		Surface Water #2				Surface Water #3		Surface Water #4	
Sample ID#	186	206	184	-185 DUP	212	-213 DUP	183	214	dry	215
Date Collected	12/3/01	4/24/02	12/3/01	12/3/01	4/25/02	4/25/02	12/3/01	4/25/02	12/3/01	4/25/02
Total Metals (µg/L)										
Arsenic	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	NA	10 U
Chromium	10 U	10 U	10 UJ	10 UJ	10 U	13.8	10 U	10 U	NA	10 U
Hexavalent Chromium	10 UJ	10 UJ	13 J	14 J	10 UJ	11.8 J	10 UJ	10 J	NA	10 UJ
Other Geochemical Parameters (mg/L)										
Ammonia	0.1 U	0.1 U	0.1 U	0.1 U	0.1 J	0.4 J	0.1 U	0.1 U	NA	0.1 U
Bicarbonate Alkalinity	38	NA	41	38	NA	NA	10	NA	NA	NA
Carbonate Alkalinity	5 U	NA	5 U	5 U	NA	NA	5 U	NA	NA	NA
Nitrate	0.5 U	6	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	NA	2
Sulfate	337	190	198	197	83	83	35	18	NA	28
Sulfide	1 U	NA	1 U	1 U	NA	NA	1 U	NA	NA	NA
Total Dissolved Solids	603	NA	432	386	NA	NA	111	NA	NA	NA
Total Organic Carbon	18	NA	26	27	NA	NA	33	NA	NA	NA
Field Measured Parameters										
Temperature, °C	NA	17	11	NA NA	8	NA	10	11	NA	10
pH, standard units	NA	7.4	5.9	NA NA	7.4	NA	3.4	7.2	NA	7.0
Specific Conductivity, µS/cm	NA	925	4	NA NA	491	NA	1100	69	NA	242
Dissolved Oxygen, mg/L	NA	0.7	7	NA NA	0.7	NA	12	1	NA	0.9
Redox Potential, mV	NA	140	NA	NA NA	70	NA	NA	85	NA	35
Turbidity, NTU	NA	0.3	4	NA NA	11	NA	3	NA	NA	NA
Ferrous Iron, mg/L	NA	NA	0	NA NA	NA	NA	0	NA	NA	NA

	# Samples	Minimum Concentration	Maximum Concentration	Units	Ave. Concentration	USEPA Screening	NYSDEC SW Qual Criteria
Arsenic	9	10 U	10 U	µg/L	5	148	150
Chromium	9	10 U	14	µg/L	6	42	34
Hexavalent Chromium	9	10 U	14 J	µg/L	8		11

Notes:
1. Sample locations provided on Figure 6
2. Data qualifications reflect 100% data validation performed by Data Validation Services (for December sampling event)

NA Not Analyzed

Data Qualifiers:
U Chemical analyzed for, but not detected; reported with the detection limit value
J An inorganic value greater than or equal to the instrument detection limit, but less than the quantitation limit
J An estimated organic value, either when estimating a concentration for tentatively identified compounds where a 1:1 response is assumed, or when a compound meets the identification criteria but the result is less than the quantitation limit

Screening Criterion: USEPA Region 5 Ecological Screening Levels (August 2003)
NYSDEC Ambient Water Quality Standards & Guidance Values (TOGS 1.1.1) June 1998, as updated

Table 12
Physico-Chemcial Parameters of Chemicals of Potential Concern
Peter Cooper Markhams NPL Site

ENVIRONMENTAL RISK GROUP

Chemical Name	CAS #	Molecular Weight (g/mole)	Physical State at 20°C	Melting Point (°C)	Boiling Point (°C)	Ref.	Water Solubility (mg/l)	Ref.	Log K_{ow}	Ref.	K_{oc} (L/kg)	Ref.	Soil-Water Partition Coef. (Kd) (L/kg)	Ref.
Arsenic	7440-38-2	74.9	Solid	188	473	B	34,700	B	NA		14.3	B	29	A & D, pH 6.8
Chromium	7440-47-3 / 1308-14-1	52.0	Solid	1900 / 321	2642 / 698	B	0.05	F	NA		14 / 35	B	1,800,000	A & D, pH 6.8
Chromium, hexavalent	18540-29-9 / 1333-82-0	52.0	Solid	/ 283	/ 564	B	1,460	B	NA		/ 35	B	180	G Table 5.7
Benzo(a)anthracene	56-55-3	228.3	Solid	162	399	B	0.0094	A	5.70	A	398,000	B	NA	
Benzo(a)pyrene	50-32-8	252.3	Solid	176.5	442.75	B	0.0016	A	6.11	A	787,000	B	NA	
Benzo(b)fluoranthene	205-99-2	252.0	Solid	168	442.75	B	0.0015	A	6.20	A	803,000	B	NA	
Benzo(k)fluoranthene	207-08-9	252.0	Solid	217	480	B	0.0008	A	6.20	A	787,000	B	NA	
Benzo(ghi)perylene	191-24-2	276.0	Solid	278	486.31	B	0.00026	B	6.58	A	2,680,000	B	NA	
Benzaldehyde	100-52-7	106.1	Liquid	-26	179	B	6,100	B	1.48	B	33	B	NA	
Chrysene	218-01-9	228.2	Solid	258	448	B	0.0016	A	5.70	A	236,100	B	NA	
Fluoranthene	206-44-0	202.0	Solid	107.8	384	B	0.206	A	5.12	A	70,900	B	NA	
4-Methylphenol	106-44-5	108.9	Liquid	15	190	B	21,500	B	1.48	C	434	B	NA	
Naphthalene	91-20-3	128.2	Solid	80.2	217.9	B	31	A	3.36	A	1,837	B	NA	
Pyrene	129-00-0	202.3	Solid	151.2	404	B	0.14	A	5.11	A	69,400	B	NA	

References:

A USEPA, 1996, Soil Screening Guidance, EPA/540/F-95/041
B USEPA, 2000, EPI Suite Software (V3.11 June 2003)
C Mackay, Shiu, and Ma 1999 Physical-Chemical Prop. & Environ. Fate Hndbk., CRCnetBASE
D ORNL, 2004, Risk Assessment Information System (at http://risk.lsd.oml.gov/)
E Baes *et al.*, 1984--average of Bv & Br values
F Rai, Sass, & Moore 1987
G USEPA 1999b

Table 12
Physico-Chemcial Parameters of Chemicals of Potential Concern
Peter Cooper Markhams NPL Site

ENVIRONMENTAL RISK GROUP

Chemical Name	Vapor Pressure (mm Hg)	Ref.	Unitless Henry's Law Constant	Ref.	Henry's Law Constant (atm-m3/mol)	Ref.	Diffusivity in Air (cm^2/s)	Ref.	Diffusivity in Water (cm^2/s)	Ref.	Bioconcentration Factor (BCF_{aq}) (L/kg)	Ref.	Soil-to-Plant Uptake (BCF_{plant})	Ref.
Arsenic	1.01E+04	D	3.16E+01	D	7.70E-01	B					3.2	B	0.023	E
Chromium											3.2	B	0.006	E
Chromium, hexavalent											200	D	0.006	E
Benzo(a)anthracene	2.10E-07	B	1.37E-04	A	3.35E-06	A	5.10E-02	A	9.00E-06	A	5,435	B	0.02	D
Benzo(a)pyrene	5.49E-09	B	4.63E-05	A	1.13E-06	A	4.30E-02	A	9.00E-06	A	11,000	B	0.01	D
Benzo(b)fluoranthene	5.00E-07	B	4.55E-03	A	1.11E-04	A	2.26E-02	A	5.56E-06	A	5,600	B	0.01	D
Benzo(k)fluoranthene	9.65E-10	B	3.40E-05	A	8.29E-07	A	2.26E-02	A	5.56E-06	A	10,000	B	0.004	D
Benzo(ghi)perylene	1.00E-10	B			1.41E-07	C					25,000	B	0.006	D
Benzaldehyde	1.27E-01	B			2.67E-05	B	7.30E-02	B	9.07E-06	B	2.8	B	1.8	D
Chrysene	6.23E-09	B	3.88E-03	A	9.46E-05	A	2.48E-02	A	6.21E-06	A	5,939	B	0.02	D
Fluoranthene	9.22E-06	B	6.60E-04	A	1.61E-05	A	3.02E-02	A	6.35E-06	A	1,900	B	0.06	D
4-Methylphenol	1.10E-01	B			7.92E-07	C	7.40E-02	B	1.00E-05	B	6.2	B	3	D
Naphthalene	8.50E-02	B	1.98E-02	A	4.83E-04	A	5.90E-02	A	7.50E-06	A	69	B	0.5	D
Pyrene	4.50E-06	B	4.51E-04	A	1.10E-05	A	2.72E-02	A	7.24E-06	A	1,142	B	0.06	D

References:

References:

A — A USEPA, 1996, Soil Screening Guidance, EPA/540/F-95/041
B — B USEPA, 2000, EPI Suite Software (V3.11 June 2003)
C — C Mackay, Shiu, and Ma 1999 Physical-Chemical Prop. & Environ. Fate Hndbk., CRCnetBASE
D — D ORNL, 2004, Risk Assessment Information System (at http://risk.lsd.ornl.gov/)
E — Baes *et al.*, 1984--average of Bv & Br values
F — Rai, Sass, & Moore 1987
G — USEPA 1999b

Table 13
Comparison of COPC Concentrations in Soil to Ecological Screening Criteria
Peter Cooper Markhams NPL Site

ENVIRONMENTAL RISK GROUP

COPC	Minimum Conc.	Maximum Conc.	Average Conc.	USEPA Reg-4	USEPA Reg-5 ESL	Dutch Interven.	Dutch Target	Eco-SSL Avian	Eco-SSL Mammalian	USEPA Reg 6 Plants	Eco-SSL Plants	ORNL Plants	USEPA Reg-6 Earthworms	ORNL Invertebrates	ORNL Microbes
Arsenic	1.9	**96**	**12**	10	5.7	40	29	43	46	37	18	10	60	60	100
Chromium	7.1	**65,300**	**7,301**	0.4	0.4	230	100	26	34	5	NA	1	0.4	0.4	10
Chromium, hexavalent	2.5	**63**	**20**	NA	NA	NA	NA	NA	81	NA	NA	1	NA	0.4	NA
Benzaldehyde	0.04	**0.17**	0.19	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(a)anthracene	0.02	0.03	0.17	NA	5.21	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(a)pyrene	0.02	0.07	0.13	0.1	1.52	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	0.04	0.08	0.12	NA	59.8	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(k)fluoranthene	0.03	0.04	0.17	NA	148	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(ghi)perylene	0.03	0.04	0.17	NA	119	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chrysene	0.02	0.03	0.15	PQL	4.7	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fluoranthene	0.03	0.06	0.14	0.1	122.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-Methylphenol	0.04	0.11	0.16	0.5	163.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Naphthalene	0.03	0.05	0.15	0.1	0.1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pyrene	0.03	0.04	0.13	0.1	78.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes: All concentrations and criteria are in mg/kg **Bold** Concentration Significantly > Screening Criteria **NA** Not Available

Comments: Note that the average concentration for some of the PAHs is biased high due to elevated detection limits

SOIL ECOLOGICAL CRITERIA

Dutch Intervention & Taget Values

Target Values for soil are related to negligible risk for ecosystems. This is assumed to be 1% of the Maximal Permissible Risk (MPR) level for ecosystems, where MPR is the concentration expected to be hazardous for 5% of the species in the ecosystem, or the 95% protection level. For metals, background concentrations are taken into account in arriving at a value. The relationship between soil concentration and irreparable damage to terrestrial species composition and the relationship between soil concentration and adverse effects on microbial and enzymatic processes were derived to quantify the ecotoxicological effects on ecosystems. The ecological Intervention Value is the concentration expected to be hazardous to 50% of the species in the ecosystem. It cannot be assumed that sensitive species will be protected at the Intervention levels. Site concentrations less than Target Values indicate no restrictions necessary; concentrations between Target Values and Intervention Values suggests further investigation or restrictions may be warranted. Site concentrations exceeding the Intervention Value indicate remediation is necessary. Site-specific values based on percent clay and organic matter for metals and percent organic matter for organic compounds may be derived.

Swartjes, F.A. 1999. Risk-based Assessment of Soil and Groundwater Quality in the Netherlands: Standards and Remediation Urgency. Risk Analysis 19(6): 1235-1249

The Netherlands Ministry of Housing, Spatial Planning and Environment's Circular on target values and intervention values for soil remediation http://www.minvrom.nl/minvrom/docs/bodem/S&I2000.PDF and Annex A: Target Values, Soil Remediation Intervention Values and Indicative Levels for Serious Contamination http://www.minvrom.nl/minvrom/docs/bodem/annexS&I2000.PDF were also consulted, but they combine the ecological and human health values.

EPA Eco-SSLs	EPA Ecological Soil Screening Level (Eco-SSL) Guidance. The Eco-SSL guidance provides a set of risk-based soil screening levels (Eco-SSLs) for several soil contaminants that are frequently of ecological concern for terrestrial plants and animals at hazardous waste sites. It also describes the process used to derive these levels and provides guidance for their use.
Eco-SSL Plants; Eco-SSL Inverts; Eco-SSL Avian; Eco-SSL Mammalian	Interim Final values available
	EPA 2003. Guidance for Developing Ecological Soil Screening Levels. Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, DC. OSWER Directive 9285.7-55. November 2003. (http://www.epa.gov/superfund/programs/risk/ecorisk/ecossl.htm). EPA. 2005. Ecological Soil Screening Levels for Arsenic (Chromium): Interim Final. Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, DC. OSWER Directive 9285.7-61
EPA Region 4	EPA. 2001. Supplemental Guidance to RAGS: Region 4 Bulletins, Ecological Risk Assessment. Originally published: EPA Region IV. 1995. Ecological Risk Assessment Bulletin No. 2: Ecological Screening Values. U.S. Environmental Protection Agency Region 4, Waste Management Division, Atlanta, GA. Website version last updated 30 November 2001: http://www.epa.gov/region4/waste/ots/epatab4.pdf
EPA Region 5 ESLs - Soil	The ESL reference database consists of Region 5 media-specific (soil, water, sediment, and air) Ecological Screening Levels (ESLs) for RCRA Appendix IX hazardous constituents. The ESLs are initial screening levels with which the site contaminant concentrations can be compared. The ESLs help to focus the investigation on those areas and chemicals that are most likely to pose an unacceptable risk to the environment. ESLs also impact the data requirements for the planning and implementation of field investigations. ESLs alone are not intended to serve as cleanup levels. See the August 2003 revision of the ESLs (formerly EDQLs) at http://www.epa.gov/reg5rcra/ca/ESL.pdf
EPA Region 6 Ecological Screening Benchmarks: Surface Soil -- Plants	U.S. EPA Region 6 recommends use of benchmarks adopted by the Texas Natural Resource Conservation Commission. For the most part, these are benchmark values for terrestrial plants developec by Efroymson et al. (1997), but values for arsenic, cadmium, chromium, and zinc are from EPA's Ecological Soil Screening Level Guidance effort. Texas Natural Resource Conservation Commission. 2001. Guidance for Conducting Ecological Risk Assessments at Remediation Sites in Texas. Toxicology and Risk Assessment Section, Texas Natural Resource Conservation Commission, Austin, TX. RG-263 (revised).
EPA Region 6 Ecological Screening Benchmarks: Surface Soil – Soil Invertebrates	U.S. EPA Region 6 recommends use of benchmarks adopted by the Texas Natural Resource Conservation Commission. For the most part, these are benchmark values for earthworms developed by Efroymson et al. (1997), but values for cadmium, copper, and zinc are from EPA's Ecological Soil Screening Level Guidance effort. Texas Natural Resource Conservation Commission. 2001. Guidance for Conducting Ecological Risk Assessments at Remediation Sites in Texas. Toxicology and Risk Assessment Section, Texas Natural Resource Conservation Commission, Austin, TX. RG-263 (revised).
ORNL Invertebrates	Efroymson, R.A. , M.E. Will, and G.W. Suter II. 1997b. Toxicological Benchmarks for Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process: 1997 Revision. Oak Ridge National Laboratory, Oak Ridge, TN. ES/ER/TM-126/R2. (Available at http://www.esd.ornl.gov/programs/ecorisk/documents/tm126r21.pdf)
ORNL Microbes	Efroymson, R.A. , M.E. Will, and G.W. Suter II. 1997b. Toxicological Benchmarks for Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process: 1997 Revision. Oak Ridge National Laboratory, Oak Ridge, TN. ES/ER/TM-126/R2. (Available at http://www.esd.ornl.gov/programs/ecorisk/documents/tm126r21.pdf)
ORNL Plants	Efroymson, R.A. , M.E. Will, G.W. Suter II, and A.C. Wooten. 1997a. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants: 1997 Revision. Oak Ridge National Laboratory, Oak Ridge, TN. ES/ER/TM-85/R3. (Available at http://www.esd.ornl.gov/programs/ecorisk/documents/tm85r3.pdf)

ENVIRONMENTAL RISK GROUP

Table 14
Comparison of COPC Concentrations in Wetland Sediment to Ecological Screening Values
Peter Cooper Markhams NPL Site

COPC	Maximum Conc.	Minimum Conc.	Average Conc.	USEPA Reg-6	USEPA Reg-4	USEPA Reg-5	ARCS TEC	ARCS PEC	ARCS NEC
Arsenic	**11**	2.3	5.1	5.9	7.2	9.8	12	57	93
Chromium	**215**	6.6	**51**	37	52	43	56	159	312
Chromium, hexavalent	**18**	1.3	7.9	NA	NA	NA	NA	NA	NA

COPC	OSWER ET	NOAA ERL	Consensus TEC	Consensus PEC	NOAA ERM
Arsenic	8.2	8.2	9.8	33	70
Chromium	81	81	43	111	370
Chromium, hexavalent	NA	NA	NA	NA	NA

COPC	FDEP TEL	FDEP PEL	WA NEL	WA MAEL
Arsenic	7.2	42	57	93
Chromium	52	160	260	270
Chromium, hexavalent	NA	NA	NA	NA

COPC	Ontario Low	Canadian ISQG	Ontario Severe
Arsenic	6	5.9	33
Chromium	26	37	110
Chromium, hexavalent	NA	NA	NA

Notes: All units in mg/kg

Bold Concentration Significantly > Screening Criteria

NA Not Available

NYSDEC Sediment Criteria (NYSDEC 1999) are equivalent to the Ontario Low Effects Level and Severe Effects Levels shown above

ENVIRONMENTAL RISK GROUP

SEDIMENT ECOLOGICAL BENCHMARKS

ARCS NEC, TEC, & PEC:

Assessment and Remediation of Contaminated Sediments Program-The representative effect concentration selected from among the **high** No-Effect-Concentrations (NECs) for Hyalella azteca and Chironomus riparius. It is a concentration above which statistically significant adverse biological effects always occur. Effects may occur below these levels. The majority of the data are for freshwater sediments. The Threshold Effect Concentration (TEC) is the geometric mean of the 15th percentile in the effects data set and the 50th percentile in the no effects data set. It is a concentration that represents the upper limit of the range dominated by no effects data. Concentrations above the TEC may result in adverse effects to these organisms; concentrations below the TEC are unlikely to result in adverse effects. The majority of the data are for freshwater sediments. These are possible-effects benchmarks. The Probable Effects Concentration (PEC) is the geometric mean of the 50th percentile in the effects data set and the 85th percentile in the no effects data set. It represents the lower limit of the range of concentrations usually associated with adverse effects.

A concentration that is greater than the PEC is likely to result in adverse effects to these organisms. The majority of the data are for freshwater sediments. These are probable-effects benchmarks.

USEPA, 1996, Calculation and evaluation of sediment effect concentrations for the amphipod Hyalella azteca and the midge Chironomus riparius, EPA 905/R96/008, Great Lakes National Program Office: Chicago, IL (http://www.cerc.usgs.gov/clearinghouse/data/brdcerc0004.html http://www.cerc.usgs.gov/pubs/sedtox/sec-dev.html)

Canadian ISQG & PEL:

The Water Quality Guidelines Task Group of the Canadian Council of Ministers of the Environment (CCME) developed chemical concentrations recommended to support and maintain aquatic life associated with bed sediments. These values are derived from available scientific information on biological effects of sediment-associated chemicals and are intended to support the functioning of healthy ecosystems. The Sediment quality guidelines protocol relies on the National Status and Trends Program approach and the Spiked-Sediment Toxicity Test approach. The Interim Sediment Quality Guidelines (ISQG) correspond to threshold level effects below which adverse biological effects are not expected. The Probable Effects Levels (PEL) correspond to concentrations above which adverse biological effects are frequently found.

See Environment Canada's Environmental Quality Guidelines at http://www.ec.gc.ca/ceqg-rcqe/English/Ceqg/Sediment/default.cfm and http://www.ccme.ca/assets/pdf/e1_06.pdf

Consensus PEC & TEC:

Consensus-based Sediment Quality Guidelines (SQG) represent the geometric mean of published SQGs from a variety of sources. Sources for Probable Effect Concentrations (PEC) include probable effect levels, effect range median values, severe effect levels, and toxic effect thresholds (see MacDonald et al. 2000 for references). PECs are intended to identify contaminant concentrations above which harmful effects on sediment-dwelling organisms are expected to occur more often than not. Sources for Threshold Effect Concentrations (TEC) include threshold effect levels, effect range low values, lowest effect levels, minimal effect thresholds, and sediment quality advisory levels. TECs are intended to identify contaminant concentrations below which harmful effects on sediment-dwelling organisms are not expected.

MacDonald, DD, CG Ingersoll, and TA Berger, 2000, Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems, Arch Environ Contam Toxicol 39: 20-31

USEPA Region 4:	The higher of the EPA Contract Laboratory Program Practical Quantitation Limit and the Effects Value, which is the lower of the ER-L and the TEL. These are possible effects benchmarks. USEPA Region IV, 1995, Ecological Screening Values, Ecological Risk Assessment Bulletin No. 2, Waste Management Division. Atlanta, Georgia. (Superseded by http://www.epa.gov/region04/waste/ots/ecolbul.htm#tbl3)
USEPA Region 5 ESLs:	The ESL reference database consists of Region 5 media-specific (soil, water, sediment, and air) Ecological Screening Levels (ESLs) for RCRA Appendix IX hazardous constituents. The ESLs are initial screening levels with which the site contaminant concentrations can be compared. The ESLs help to focus the investigation on those areas and chemicals that are most likely to pose an unacceptable risk to the environment. ESLs also impact the data requirements for the planning and implementation of field investigations. ESLs alone are not intended to serve as cleanup levels. (See the August 2003 revision of the ESLs (formerly EDQLs) at http://www.epa.gov/reg5rcra/ca/ESL.pdf.)
USEPA Region 6 Ecological Screening Benchmarks: Freshwater Sediment:	USEPA Region 6 recommends use of benchmarks developed for the Texas Natural Resource Conservation Commission. These benchmarks are conservative screening level values intended to be protective of benthic biota. Values were compiled from a prioritized list of published values. The primary benchmarks are Threshold Effects Levels (TELs) from Smith et al. (1996), but values for antimony and silver are Effect Range-Low (ER-L) values from Long and Morgan (1990), values for iron, manganese, total PAHs, several pesticides, and PCBs are Lowest Effects Levels (LELs) from Persaud et al. (1993), anthracene, dibenzo(a,h)anthracene, and naphthalene are Threshold Effect Concentrations (TECs) from MacDonald et al. (2000), and DDT, DDE, and DDD values are from Environment Canada (1997). Texas Natural Resource Conservation Commission, 2001, Guidance for Conducting Ecological Risk Assessments at Remediation Sites in Texas, Toxicology and Risk Assessment Section, Texas Natural Resource Conservation Commission, Austin, TX, RG-263 revised).
FDEP TEL & PEL: (Threshold Effects Levels and Probable Effects Levels)	Sediment quality assessment guidelines developed for the State of Florida for 34 priority substances based on the approach recommended by Long and Morgan (1990). They are intended to assist sediment quality assessment applications, such as identifying priority areas for non-point source management actions, designing wetland restoration projects, and monitoring trends in environmental contamination. They are not intended to be used as sediment quality criteria. Long, ER and LG Morgan, 1990, The potential for biological effects of sediment-sorbed contaminants tested in the National Status and Trends Program, NOAA Technical Memorandum NOS OMA 52, National Oceanic and Atmospheric Administration, Seattle, WA; and MacDonald, DD, 1994, Approach to the Assessment of Sediment Quality in Florida Coastal Waters, Office of Water Policy, Florida Department of Environmental Protection, Tallahassee, FL http://www.dep.state.fl.us/dwm/documents/sediment/volume1.pdf)
NOAA ERL & ERM:	Effects Range Low and Median are from-NOAA National Status and Trends Program, Sediment Quality Guidelines (Has values for As, Cd, Cr, Cu, Pb, Hg, Ni, Ag, Zn, DDE, PAHs, total DDT, total PCBs, and total PAH were obtained from this source, see http://response.restoration.noaa.gov/cpr/sediment/SPQ.pdf); Long, ER and LG Morgan,1991,The Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program, National Oceanographic and Atmospheric Administration, Tech. Memorandum NOS OMA 52, August 1991,Seattle, WA (Has values for DDD, DDT, Antimony, Chlordane, Dieldrin, and Endrin were obtained from this source.); and Long, ER, DD MacDonald, SL Smith, and FD Calder, 1995, Incidence of Adverse Biological Effects within Ranges of Chemical Concentrations in Marine and Estuarine Sediments, Environ Manage19: 81-97 (for all other metals and organics not listed the other two sources.)
Ontario Low & Severe:	See-Persaud, D, R Jaagumagi, and A Hayton, 1993, Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario, Ontario Ministry of the Environment and Energy, August, ISBN 0-7729-9248-7. (Available at http://www.ene.gov.on.ca/envision/gp/B1_3.pdf)

ORNL EqP:	The ORNL EqP sediment values are sediment values derived from the corresponding water quality benchmarks using equilibrium partitioning (i.e., ORNL_SCV_EqP is from the Jones et al. sediment benchmarks and is derived from the surface water Secondary Chronic Value.
OSWER:	OSWER Ecotox thresholds, US Environmental Protection Agency (ECO Update 3 (2):1-12 1996, (http://www.epa.gov/superfund/programs/risk/eco_updt.pdf)
WA NEL, MAEL, & AET:	Washington NEL: Washington NEL Sediment Quality Standards are used as a sediment quality goal for Washington state sediments. These are "no effects" level values. No effects means a concentration that does not result in acute or chronic adverse effects to biological resources relative to reference and does not result in significant human health risk. Washington lists criteria for organics other than phenol, 2-methyl phenol, 4-methyl phenol, 2,4-dimethyl phenol, benzyl alcohol, and benzoic acid on a total organic carbon basis. The values included in SADA have been converted to mg/kg sediment assuming 1% organic carbon (criteria from Washington table were multiplied by 0.01). The value for Low Molecular Weight PAHs (LPAH) applies to the sum of concentrations of Naphthalene, Acenaphthylene, Acenaphthene, Fluorene, Phenanthrene, and Anthracene. The value for High Molecular Weight PAH's (HPAH) applies to the sum of Fluoranthene, Pyrene, Benz(a)anthracene, Chrysene, total Benzofluoranthenes, Benzo(a)pyrene, Indeno(1,2,3-c,d)pyrene, Dibenzo(a,h)anthracene, and Benzo(g,h,i)perylene. Total Benzofluoranthenes represents the sum of the b, j, and k isomers. MAEL values represent Impact Zone Maximum Level and Cleanup Screening Level / Minimum Cleanup Level values. These are an upper regulatory level for source control and cleanup decision making. They are "minor adverse effects" level values--concentrations that result in an acute/chronic adverse effect to biological resources relative to reference in no more than one appropriate biological test, result in a significant response relative to reference , and do not result in significant human health risk. WA lists criteria for organics other than phenol, 2-methyl phenol, 4-methyl phenol, 2,4-dimethyl phenol, benzyl alcohol, and benzoic acid on a total organic carbon basis. The values included in RAIS are converted to mg/kg sediment assuming 1% TOC (criteria from WA table were multiplied by 0.01). Low Molec. Weight PAH (LPAH) applies to the sum of Naphthalene, Acenaphthylene, Acenaphthene, Fluorene, Phenanthrene, and Anthracene. High Molec. Weight PAH (HPAH) applies to the sum of Fluoranthene, Pyrene, Benz(a)anthracene, Chrysene, total Benzofluoranthenes, Benzo(a)pyrene, Indeno(1,2,3-c,d)pyrene, Dibenzo(a,h)anthracene, and Benzo(g,h,i)perylene. Total Benzofluoranthenes represent b/j/k isomers. The AET is a concentration above which toxic effects occurred at all sites in Puget Sound. These are probable effects benchmarks See Washington Department of Ecology, Sediment Management Unit, Sediment Quality Chemical Criteria, http://www.ecy.wa.gov/programs/tcp/smu/sed_chem.htm

Table 15
Comparison of COPC Concentrations in Wetland Surface Water to Ecological Screening Values
Peter Cooper Markhams NPL Site

ENVIRONMENTAL RISK GROUP

COPC	Minimum Conc.	Average Conc.	Maximum Conc.	USEPA R5 ESL	Canadian WQG	NAWQC Chronic	USEPA Reg-4 Chronic	USEPA Reg-6 Freshwater	OSWER Ambient Water Quality Criteria	NAWQC Acute	USEPA Reg-4 Acute
mg/L											
Arsenic	0.01	0.005	0.01	0.15	0.005	0.15	0.19	0.19	0.19	0.34	0.36
Chromium	0.01	0.006	**0.014**	0.04	0.009	0.07	0.11	0.10	0.18	0.57	0.98
Chromium, hexavalent	0.01	0.008	**0.014**	NA	0.001	0.01	0.01	0.01	0.01	0.01	0.01

Solubility

COPC	Minimum Conc.	Average Conc.	Maximum Conc.	LCV Daphnids	LCV Fish		LCV Aquatic Plants
mg/L							
Arsenic	0.01	0.005	0.01	0.91	3.0		2.3
Chromium III	0.01	0.006	**0.014**	0.04	0.06		0.39
Chromium VI	0.01	0.008	**0.014**	0.006	0.07		0.002

SURFACE WATER ECOLOGICAL BENCHMARKS

Canadian WQG

Canadian Water Quality Guidelines (CWQG) are developed to provide basic scientific information about water quality parameters and ecologically relevant toxicological threshold values for Canadian species to protect specific water uses. In deriving Canadian water quality guidelines for aquatic life, all components of the aquatic ecosystem (eg, algae, macrophytes, invertebrates, fish) are considered if the data are available. For most water quality variables, a single maximum value, which is not to be exceeded, is recommended. This maximum value is based on a long-term no-effect concentration. Unless otherwise specified, a guideline value refers to the total concentration in an unfiltered sample. When available, the lowest-observable-effects level (LOEL) from a chronic exposure study on the most sensitive native Canadian species is multiplied by a safety factor of 0.1 to arrive at the final guideline concentration. Alternatively, the lowest LC50 or EC50 from an acute exposure study is multiplied by an acute/chronic ratio or the appropriate application factor (i.e., 0.05 for non-persistent variables; 0.01 for persistent variables) to determine the final guideline concentration. (See http://www.ec.gc.ca/CEQG-RCQE/English/Ceqg/Water/default.cfm and http://www.ccme.ca/assets/pdf/e1_06.pd

USEPA Region 4 - Acute & Chronic

These benchmarks are criteria or test endpoints divided by a factor of 10. The values come from Water Quality Criteria documents and represent chronic ambient water quality criteria values for the protection of aquatic life. They are intended to protect 95% of the species, 95% of the time. If there was insufficient information available to derive a criterion, the lowest reported effect level was used with the application of a safety factor of ten to protect for a more sensitive species. A safety factor of ten was also used to derive a chronic value if only acute information was available. Since these numbers are based on conservative endpoints and sensitive ecological effects data, they represent a preliminary screening of site contaminant levels to determine if there is a need to conduct further investigations at the site. Note that equations for hardness dependent metals do not match those in EPA (2002). (See http://www.epa.gov/region04/waste/ots/ecolbul.htm#tbl1)

USEPA Region 5 ESLs	The ESL reference database consists of Region 5 media-specific (soil, water, sediment, and air) Ecological Screening Levels (ESLs) for RCRA Appendix IX hazardous constituents. The ESLs are initial screening levels with which the site contaminant concentrations can be compared. The ESLs help to focus the investigation on those areas and chemicals that are most likely to pose an unacceptable risk to the environment. ESLs also impact the data requirements for the planning and implementation of field investigations. ESLs alone are not intended to serve as cleanup levels. See the August 2003 revision of the ESLs (formerly EDQLs) at http://www.epa.gov/reg5rcra/ca/ESL.pdf
USEPA Region 6 Ecological Screening Benchmarks: Freshwater	U.S. EPA Region 6 recommends use of surface water benchmarks developed for the Texas Natural Resource Conservation Commission. These benchmarks are conservative screening level values intended to be protective of aquatic biota. Values were compiled from a prioritized list of published values. The primary benchmarks are chronic criteria obtained from Texas surface water quality standards or the most current federal National Ambient Water Quality Criteria. Additional benchmarks were derived using the LC50 approach. TNRCC Water Quality Division chronic values, ORNL secondary chronic values (Suter and Tsao 1996), or EPA Region 4 chronic screening values, in that order, were consulted to expand the number of chemicals with acceptable benchmarks. Values for hardness-dependent metals assume a hardness of 50 mg/L. Values for arsenic, cadmium, chromium, copper, lead, nickel, silver, uranium, and zinc apply to dissolved concentrations. (TNRCC, 2001, Guidance for Conducting Ecological Risk Assessments at Remediation Sites in Texas, Toxicology and Risk Assessment Section, RG-263 revised)
LCV Aquatic Plants	The lowest acceptable chronic value for aquatic plants is based on the geometric mean of the Lowest Observed Effect Concentration and the No Observed Effect Concentration. Chronic values are used to calculate the chronic NAWQC, but the lowest chronic value may be lower than the chronic NAWQC. Because of the short generation time of algae and the relative lack of standard chronic tests for aquatic plants, EPA guidelines are followed in using any algal test of at least 96-hour duration and any biologically meaningful response for the plant values. (Suter, GW and CL Tsao, 1996, Toxicological benchmarks for screening potential contaminants of concern for effects on aquatic biota: 1996 revision, ES/ER/TM-96/R2, ORNL, Oak Ridge, TN, http://www.hsrd.ornl.gov/ecorisk/tm96r2.pdf)
LCV Daphnids	The lowest acceptable chronic value for daphnids is based on either of the following: geometric mean of the Lowest Observed Effect Concentration & the No Observed Effect Concentration, or an extrapolation from 48-hour LC50s using equations from Suter et al (1987) and Suter (1993). The equations for a daphnid CV for a metallic contaminant is Log CV = 0.96 log LC50 - 1.08 (PI = 1.56). For a non-metallic contaminant Log CV = 1.11 log LC50 - 1.30 (PI = 1.35). The LC50 is the lowest species mean 48-hour EC50 for Daphnids. The 95% prediction interval is log CV +- the PI value (95% prediction intervals contain 95% of observations). (Suter, et al., 1987, Endpoints for responses of fish to chronic toxic exposures, Environmental Toxicology and Chemistry 6:793-809 & Suter, 1993, Ecological Risk Assessment, Lewis Publishers, Chelsea, MI)
LCV Fish	The lowest acceptable chronic value for fish is based on either of the following: geometric mean of the Lowest Observed Effect Concentration & the No Observed Effect Concentration, or an extrapolation from 96-hour LC50s using equations from Suter et al (1987) and Suter (1993). The equations for a fish CV for a metallic contaminant is: Log CV = 0.73 log LC50 - 0.70 (PI = 1.2). For a non-metallic contaminant: Log CV = 1.07 log LC50 - 1.51 (PI = 1.5). The LC50 is the lowest species mean 96-hour EC50 for fish. The 95% prediction interval is log CV +- the PI value (95% prediction intervals contain 95% of observations).
LCV Non-Daphnid Inverts	The lowest acceptable chronic value for aquatic plants is based on the geometric mean of the Lowest Observed Effect Concentration and the No Observed Effect Concentration. Chronic values are used to calculate the chronic NAWQC, but the lowest chronic value may be lower than the chronic NAWQC. Because of the short generation time of algae and the relative lack of standard chronic tests for aquatic plants, EPA guidelines are followed in using any algal test of at least 96-hour duration and any biologically meaningful response for the plant values. (See Suter and Tsao 1996)

NAWQC- Acute & Chronic	These are applicable regulatory standards. The National Ambient Water Quality Criteria (NAWQC) are calculated by the EPA as half the Final Acute Value (FAV), which is the fifth percentile of the distribution of 48- to 96-hour LC50 values or equivalent median effective concentration (EC50) values for each criterion chemical (Stephan et al. 1985). The acute NAWQC are intended to correspond to concentrations that would cause less than 50% mortality in 5% of exposed populations in a brief exposure. They may be used as a reasonable upper screening benchmark because waste site assessments are concerned with sublethal effects and largely with continuous exposures, rather than the lethal effects and episodic exposures to which the acute NAWQC are applied. The chronic NAWQC are the FAVs divided by the Final Acute-Chronic Ratio (FACR), which is the geometric mean of quotients of at least three LC50/CV ratios from tests of different families of aquatic organisms (Stephan et al. 1985). It is intended to prevent significant toxic effects in chronic exposures and is used as a lower screening benchmark. NAWQC for several metals are functions of water hardness. Values for hardness-dependent metals default to 100 mg CaCO3/L, but equations are provided to obtain values based on site-specific hardness values. Recommended values for metals are expressed in terms of dissolved metal in the water column. (USEPA, 2002, National Recommended Water Quality Criteria:2002, EPA 822-R-02-047, At http://www.epa.gov/ost/pc/revcom.pdf)
OSWER AWQC	These are values from OSWER (1996). The AWQC are NAWQC or FCV's (final chronic values) as of 1996.

Table 16
Toxicity Reference Values (TRVs)
Peter Cooper Markhams NPL Site

ENVIRONMENTAL RISK GROUP

COPC	Avian Test Species Dose		American Robin Dose	Marsh Wren Dose		Surface Water Quality for Herptiles & Benthos[8]	Sediment Quality for Wetland Plants[4]	Soil Quality for Terrestrial Plants[4,5]
	(mg/kg/day)		(mg/kg/day)	(mg/kg/day)		(mg/L)	(mg/kg)	(mg/kg)
Benzaldehyde	NAv		NAv	NAv		NApp	NApp	32
Arsenic	2.24	Chick[9]	4.02	6.54		0.15	10	10
Chromium	2.66	GeoMean[9]	2.66	2.66		8.E+07	230	230
Chromium, hex	1	bd[1]	1	1		0.016	8	8

	Mammalian Test Species Dose		Raccoon Dose	Short-Tailed Shrew Dose	Deer Mouse Dose		Sediment Quality for Herptiles & Benthos[6]	Soil Quality for Terrestrial Invertebrates[7]
	(mg/kg/day)		(mg/kg/day)	(mg/kg/day)	(mg/kg/day)		(mg/kg)	(mg/kg)
Benzaldehyde	143	Rat[2]	68	314	286		NApp	NAv
Arsenic	1.04	Dog[9]	1.14	5.28	4.80		6	60
Chromium	38	Mu & Rat[9]	15	71	78		26	230
Chromium, hex	5.6	Mu[9]	1.4	6.7	6.1		26	8

Notes: All values based on NOAEL or NOEC concentrations unless otherwise indicated.
Surface water hardness assumed to be >30 ppm (see text)
See text for discussion of Cr Mammalian & Avian TRV

NApp = Not Applicable
NAv = Not Available

Test Species and Body Weights[1 or 3]	
Mallard Duck (md)	1.17
Chicken	0.80
Am Robin	0.08
Marsh Wren	0.01
Rat	0.35
Mouse (mu)	0.03
Raccoon	7.00
S-T Shrew	0.02
Deer Mouse	0.02
Dog	10.00

References:

1. Sample et al 1996
2. IRIS 2005
3. USEPA 1988a
4. Efroymson *et al.* 1997a (CEQC & RIVM)
5. Adema, D.M.M., and L. Henzen 2001
6. Jones *et al.* 1997 and NYSDEC, 1999
7. Efroymson *et al.* 1997b (CEQC & RIVM)
8. NYSDEC 1998 (TOGS)
9. USEPA 2005b or 2005c

Table 17
Exposure Point Concentrations (EPCs)
Peter Cooper Markhams NPL Site

ENVIRONMENTAL RISK GROUP

Parameter	BCF_{plant}	BCF_{invert}	Maximal EPCs — Landfill Area: Bulk Soil EPC (mg/kg)	Plant EPC (mg/kg)	Earthworm EPC (mg/kg)	Average Soil EPC (mg/kg)	Bioaccessible Cr Soil Concen. (mg/kg)	Soil Pore Water Concen. (mg/L)
Benzaldehyde	1.8	1.2	0.2	0.04	0.2	0.2		
Arsenic	0.02	0.11	96	0.3	10.5	12		3
Chromium	0.006	0.01	65,300	47	654	7,301	2,900	0.04
Chromium, hexavalent	0.006	0.01	63	0.05	0.6	20		0.4

Parameter	K_d	$BCF_{aq\ invert}$ (L/kg)	Maximal EPCs: Wetland Surf. Water EPC (mg/L)	Wetland Sediment EPC (mg/kg)	Wtlnd. Plant EPC (mg/kg)	Sed. Pore Water Concen. (mg/L)	Benthos EPC (mg/kg)
Benzaldehyde	NA	NA	0	0	0	0	0
Arsenic	29	0.9	0.01	11	0.03	0.4	10
Chromium	1,800,000	0.39	0.01	215	0.2	0.0001	91
Chromium, hexavalent	180	0.39	0.01	18	0.01	0.1	7

Equations:

Worm Organic BCF = 2% / (0.66 * f_{oc})

Soil Pore Water Concen. = Soil EPC / K_d

Bioaccessible Cr Soil Concen. = Soil EPC * 4.4% (4.4% is GeoMean of bioaccessible Cr% using site data in Stewart *et al.*'s (2003) model)

Worm EPC = Soil EPC * BCF

Plant EPC = (Soil/Sed) EPC * BCF * 0.12

Notes:

BCFs, Kd: See Table 12 — $BCF_{invert\ \&\ aq\ invert}$: USEPA 1999 (Tables C-1 & C-6)

Average TOCsoil: 2.5% — Geomtrx-Bnchmrk '05

Average TOCsed: 3.6% — Geomtrx-Bnchmrk '05

Soil & Sediment EPC = maximum detected concentration (Benzaldehyde used average concen.)

Table 18
Ecological Receptor Exposure Parameters
Peter Cooper Markhams NPL Site

ENVIRONMENTAL RISK GROUP

Assessment Endpoint	Measurement Endpoint	Percent of Diet[a]						Home Range[a]	Minimum Body Weight[b]	Maximum Body Weight[b]
Species/Functional Group	Species	Benthic Invertebrates	Terrestrial Invertebrates	Aquatic Plant Material	Terrestrial Plant Material	Small Mammals	Birds	(acres)	(kg)	(kg)
Herbivorous small mammal	Deer Mouse	--	--	10%	90%	--	--	0.07	0.015	0.032
Insectivorous small mammal	Short-tailed Shrew	10%	90%	--	–	--	--	1	0.013	0.023
Omnivorous mammal	Raccoon	20%	25%	10%	25%	15%	5%	500	4.2	8.8
Avian Omnivore	American Robin	--	70%	--	30%	--	--	1	0.064	0.103
Avian Insectivore	Marsh Wren	10%	90%	--	–	--	--	0.3	0.009	0.013
Aquatic Herbivore	Painted Turtle	--	--	90%	10%	--	--	3	0.084	0.45
Aquatic Insectivore	Green Frog	90%	10%	--	–	--	--	0.02	0.026	0.1

Assessment Endpoint	Measurement Endpoint	Site Use Factor			Seasonal Activity	Sediment or Soil[c,d]	Maximum Food Ingestion	Maximum Water Ingestion	Maximum Soil/Sed Ingestion
Species/Functional Group	Species	Landfill Area	Wetland Area	Total	(% year on site)	(% of Food Intake)	Rate[a] (kg/day)	Rate[d] (L/day)	Rate (kg/day)
Herbivorous small mammal	Deer Mouse	90%	10%	100%	100%	2%	0.009	0.01	0.0002
Insectivorous small mammal	Short-tailed Shrew	90%	10%	100%	100%	2%	0.009	0.005	0.0002
Omnivorous mammal	Raccoon	75%	25%	100%	100%	9%	0.41	0.7	0.04
Avian Omnivore	American Robin	100%	0%	100%	100%	9%	0.2	0.01	0.02
Avian Insectivore	Marsh Wren	90%	10%	100%	100%	9%	0.01	0.004	0.0009
Aquatic Herbivore	Painted Turtle	10%	90%	100%	100%	5%	0.003	0.009	0.0002
Aquatic Insectivore	Green Frog	10%	90%	100%	100%	5%	0.0005	0.0	0.00002

Notes:
a USEPA (1993)
b USEPA (1993)
d Beyer et al. 1994; American robin & Wren based on feeding habit value of turkey
c USEPA (1993); Frog intake based on turtle value
-- - Not Applicable

Table 19

Estimated Exposure of Ecological Receptor to COPCs

Peter Cooper Markhams NPL Site

ENVIRONMENTAL RISK GROUP

Measurement Endpoint Species: Insectivorous Small Mammal -- Short-tailed Shrew

COPC	Landfill Area				Wetland Area						EE Total (mg/kg/day)		
	EE Soil (mg/kg/day)	% Expo.	EE Diet-worms (mg/kg/day)	% Expo.	EE Sediment (mg/kg/day)	% Expo.	EE Diet-benthos (mg/kg/day)	% Expo.	EE Drinking Water (mg/kg/day)	% Expo.	Landfill Area	Wetland Area	S-T Shrew Dose (mg/kg/day)
Benzaldehyde	2.20E-03	1.6%	1.34E-01	**98.4%**	0.00E+00	0.0%	0.00E+00	0.0%	0.00E+00	0.0%	1.36E-01	0.00E+00	1.36E-01
Arsenic	1.24E+00	14.1%	6.81E+00	**77.3%**	1.64E-02	0.19%	7.39E-01	8.4%	4.16E-03	0.0%	8.04E+00	7.59E-01	8.80E+00
Chromium, total	8.46E+02	**66.2%**	4.24E+02	33.2%	3.10E-01	0.02%	7.06E+00	0.6%	5.82E-03	0.0%	1.27E+03	7.38E+00	1.28E+03
Chromium, hex	8.20E-01	**96.2%**	0.00E+00	0.0%	2.64E-02	3.1%	0.00E+00	0.0%	5.82E-03	0.7%	8.20E-01	3.22E-02	8.53E-01

Measurement Endpoint Species: Herbivorous Small Mammal -- Deer Mouse

COPC	Landfill Area				Wetland Area						EE Total (mg/kg/day)		
	EE Soil (mg/kg/day)	% Expo.	EE Diet-plants (mg/kg/day)	% Expo.	EE Sediment (mg/kg/day)	% Expo.	EE Diet-plants (mg/kg/day)	% Expo.	EE Drinking Water (mg/kg/day)	% Expo.	Landfill Area	Wetland Area	Deer Mouse Dose (mg/kg/day)
Benzaldehyde	1.84E-03	8%	1.98E-02	**92%**	0.00E+00	0.0%	0.00E+00	0.0%	0.00E+00	0.0%	2.17E-02	0.00E+00	2.17E-02
Arsenic	1.03E+00	**86.2%**	1.42E-01	12%	1.37E-02	1%	2.27E-03	0.2%	6.67E-03	0.6%	1.17E+00	2.26E-02	1.20E+00
Chromium, total	7.05E+02	**96.5%**	2.54E+01	3%	2.58E-01	0.04%	1.30E-02	0.0%	9.33E-03	0.0%	7.31E+02	2.80E-01	7.31E+02
Chromium, hex	6.84E-01	**95.6%**	0.00E+00	0%	2.20E-02	3%	0.00E+00	0.0%	9.33E-03	1.3%	6.84E-01	3.13E-02	7.15E-01

COPC	Short-tailed Shrew				Deer Mouse			
	BAFs or BCFs				BAFs or BCFs			
	Soil To Animal[3]	Water to Animal[4]	Inverts to Animal	S-T Shrew EPC (mg/kg)	Soil To Animal[3]	Water to Animal[4]	Plant to Animal	Deer Mouse EPC (mg/kg)
Benzaldehyde	1.00E+00	1.00E+00	1.00E+00	3.38E-01	1.00E+00	1.00E+00	1.00E+00	1.86E-01
Arsenic	2.73E-05	3.01E-04	1.24E-03	1.54E-02	2.88E-06	3.02E-04	1.20E-03	5.42E-04
Chromium, total	7.50E-05	8.29E-04	3.41E-03	6.45E+00	7.91E-06	8.30E-04	3.30E-03	6.05E-01
Chromium, hex	7.50E-05	8.29E-04	3.41E-03	4.42E-03	7.91E-06	8.30E-04	3.30E-03	4.77E-04

Table 19
Estimated Exposure of Ecological Receptor to COPCs
Peter Cooper Markhams NPL Site

ENVIRONMENTAL RISK GROUP

Measurement Endpoint Species: Avian Omnivore -- American Robin

	Landfill Area										EE Total (mg/kg/day)		
COPC	EE Soil (mg/kg/day)	% Expo.	EE Diet-worms (mg/kg/day)	% Expo.			EE Diet-plants (mg/kg/day)	% Expo.	EE Drinking Water (mg/kg/day)	% Expo.	Landfill Area	Wetland Area	Am. Robin Dose (mg/kg/day)
Benzaldehyde	4.98E-02	9%	4.54E-01	**84%**			3.47E-02	6%	0.00E+00	0.0%	5.39E-01	0.00E+00	5.39E-01
Arsenic	2.80E+01	**54%**	2.32E+01	45%			2.49E-01	0.5%	2.20E-03	0.0%	5.14E+01	0.00E+00	5.14E+01
Chromium, total	1.91E+04	**93%**	1.44E+03	7%			4.45E+01	0.2%	3.09E-03	0.0%	2.06E+04	0.00E+00	2.06E+04
Chromium, hex	1.85E+01	**100%**	0.00E+00	0%			0.00E+00	0.0%	3.09E-03	0.0%	1.85E+01	0.00E+00	1.85E+01

Measurement Endpoint Species: Avian Insectivore -- Marsh Wren

	Landfill Area				Wetland Area						EE Total (mg/kg/day)		
COPC	EE Soil (mg/kg/day)	% Expo.	EE Diet-worms (mg/kg/day)	% Expo.	EE Sediment (mg/kg/day)	% Expo.	EE Diet-benthos (mg/kg/day)	% Expo.	EE Drinking Water (mg/kg/day)	% Expo.	Landfill Area	Wetland Area	Marsh Wren Dose (mg/kg/day)
Benzaldehyde	1.58E-02	7%	2.06E-01	93%	0.00E+00	0.0%	0.00E+00	0.0%	0.00E+00	0.0%	2.22E-01	0.00E+00	2.22E-01
Arsenic	8.88E+00	43%	1.05E+01	**51%**	1.18E-01	1%	1.14E+00	5.5%	4.36E-03	0.0%	1.94E+01	1.26E+00	2.06E+01
Chromium, total	6.07E+03	**90%**	6.54E+02	9.7%	2.22E+00	0.0%	1.09E+01	0.2%	6.10E-03	0.0%	6.73E+03	1.31E+01	6.74E+03
Chromium, hex	5.89E+00	**97%**	0.00E+00	0%	1.89E-01	3%	0.00E+00	0.0%	6.10E-03	0.1%	5.89E+00	1.95E-01	6.08E+00

	American Robin				Marsh Wren			
	BAFs or BCFs				BAFs or BCFs			
COPC	Soil To Animal[3]	Water to Animal[4]	Plants & Inverts to Animal	Am. Robin EPC (mg/kg)	Soil To Animal[3]	Water to Animal[4]	Inverts to Animal	Marsh Wren EPC (mg/kg)
Benzaldehyde	1.00E+00	1.00E+00	1.00E+00	2.74E-01	1.00E+00	1.00E+00	1.00E+00	3.38E-01
Arsenic	6.60E-03	1.00E+00	1.00E-01	1.22E+00	6.60E-03	1.00E+00	1.00E-01	1.63E+00
Chromium, total	1.60E-01	1.00E+00	2.80E-01	7.46E+03	1.60E-01	1.00E+00	2.80E-01	9.57E+03
Chromium, hex	1.60E-01	1.00E+00	2.80E-01	7.98E+00	1.60E-01	1.00E+00	2.80E-01	9.42E+00

Table 19
Estimated Exposure of Ecological Receptor to COPCs
Peter Cooper Markhams NPL Site

ENVIRONMENTAL RISK GROUP

Measurement Endpoint Species: Aquatic Herbivore -- Painted Turtle

	Landfill Area				Wetland Area						EE Total (mg/kg/day)		
COPC	EE Soil (mg/kg/day)	% Expo.	EE Diet-plants (mg/kg/day)	% Expo.	EE Sediment (mg/kg/day)	% Expo.	EE Diet-plants (mg/kg/day)	% Expo.	EE Drinking Water (mg/kg/day)	% Expo.	Landfill Area	Wetland Area	Painted Turtle Dose (mg/kg/day)
Benzaldehyde	3.28E-05	19%	1.41E-04	**81%**	0.00E+00	0.0%	0.00E+00	0.0%	0.00E+00	0.0%	1.74E-04	0.00E+00	1.74E-04
Arsenic	1.84E-02	44.5%	1.02E-03	2%	1.98E-02	**48%**	1.09E-03	2.6%	1.07E-03	2.6%	1.94E-02	2.19E-02	4.13E-02
Chromium, total	1.26E+01	**95.7%**	1.82E-01	1%	3.73E-01	2.8%	6.28E-03	0.0%	1.50E-03	0.0%	1.28E+01	3.81E-01	1.31E+01
Chromium, hex	1.22E-02	26.8%	0.00E+00	0%	3.17E-02	**70%**	0.00E+00	0.0%	1.50E-03	3.3%	1.22E-02	3.32E-02	4.54E-02

Measurement Endpoint Species: Aquatic Insectivore -- Green Frog

	Landfill Area				Wetland Area						EE Total (mg/kg/day)		
COPC	EE Soil (mg/kg/day)	% Expo.	EE Diet-worms (mg/kg/day)	% Expo.	EE Sediment (mg/kg/day)	% Expo.	EE Diet-benthos (mg/kg/day)	% Expo.	EE Drinking Water (mg/kg/day)	% Expo.	Landfill Area	Wetland Area	Green Frog Dose (mg/kg/day)
Benzaldehyde	1.49E-05	4%	3.62E-04	**96%**	0.00E+00	0.0%	0.00E+00	0.0%	0.00E+00	0.0%	3.77E-04	0.00E+00	3.77E-04
Arsenic	8.39E-03	4%	1.85E-02	9%	9.02E-03	5%	1.62E-01	**81.9%**	0.00E+00	0.0%	2.69E-02	1.71E-01	1.98E-01
Chromium, total	5.74E+00	**67%**	1.15E+00	13.4%	1.70E-01	2.0%	1.55E+00	18.0%	0.00E+00	0.0%	6.89E+00	1.72E+00	8.61E+00
Chromium, hex	5.56E-03	28%	0.00E+00	0%	1.45E-02	**72%**	0.00E+00	0.0%	0.00E+00	0.0%	5.56E-03	1.45E-02	2.00E-02

	BAFs or BCFs				BAFs or BCFs			
COPC	Soil To Animal[3]	Water to Animal[4]	Inverts to Animal	Green Frog EPC (mg/kg)	Soil To Animal[3]	Water to Animal[4]	Plant to Animal	Painted Turtle EPC (mg/kg)
Benzaldehyde	1.00E+00	1.00E+00	1.00E+00	3.76E-02	1.00E+00	1.00E+00	1.00E+00	2.07E-02
Arsenic	6.60E-03	1.00E+00	1.00E-01	1.16E+00	6.60E-03	1.00E+00	1.00E-01	1.46E-01
Chromium, total	1.60E-01	1.00E+00	2.80E-01	1.12E+03	1.60E-01	1.00E+00	2.80E-01	1.08E+03
Chromium, hex	1.60E-01	1.00E+00	2.80E-01	3.65E+00	1.60E-01	1.00E+00	2.80E-01	3.66E+00

Table 19
Estimated Exposure of Ecological Receptor to COPCs
Peter Cooper Markhams NPL Site

ENVIRONMENTAL RISK GROUP

Measurement Endpoint Species: Omnivorous Mammal -- Raccoon with Maximized Contaminated Diet

	Landfill Area				Wetland Area						EE Total (mg/kg/day)		
COPC	EE Soil (mg/kg/day)	% Expo.	EE Max Diet Item (mg/kg/day)	% Expo.	EE Sediment (mg/kg/day)	% Expo.			EE Drinking Water (mg/kg/day)	% Expo.	Landfill Area	Wetland Area	Raccoon Dose (mg/kg/day)
Benzaldehyde	1.09E-03	3%	3.31E-02	**97%**	0.00E+00	0.0%			0.00E+00	0.0%	3.42E-02	0.00E+00	3.42E-02
Arsenic	6.14E-01	**76%**	1.60E-01	20%	3.14E-02	4%			1.67E-03	0.2%	7.74E-01	3.31E-02	8.07E-01
Chromium, total	4.20E+02	31%	9.37E+02	**69%**	5.93E-01	0.0%			2.33E-03	0.0%	1.36E+03	5.95E-01	1.36E+03
Chromium, hex	4.07E-01	**89%**	0.00E+00	0%	5.04E-02	11%			2.33E-03	0.5%	4.07E-01	5.28E-02	4.60E-01

COPC	Food Source of Maximum Exposure	
Benzaldehyde	Marsh Wren	3.38E-01
Arsenic	Marsh Wren	1.63E+00
Chromium, total	Marsh Wren	9.57E+03
Chromium, hex	Marsh Wren	9.42E+00

Measurement Endpoint Species: Omnivorous Mammal -- Raccoon with Normalized (Distributed) Diet & Range

	Landfill Area				Wetland Area						EE Total (mg/kg/day)		
COPC	EE Soil (mg/kg/day)	% Expo.	EE Terr Diet Items (mg/kg/day)	% Expo.	EE Sediment (mg/kg/day)	% Expo.	EE Wtlns Diet Items (mg/kg/day)	% Expo.	EE Drinking Water (mg/kg/day)	% Expo.	Landfill Area	Wetland Area	Raccoon Dose (mg/kg/day)
Benzaldehyde	2.25E-04	8%	2.58E-03	**92%**	0.00E+00	0%	0.00E+00	0%	0.00E+00	0.0%	2.81E-03	0.00E+00	2.81E-03
Arsenic	1.27E-01	**55%**	5.59E-02	24%	6.47E-03	3%	4.14E-02	18%	3.43E-04	0.1%	1.82E-01	4.82E-02	2.31E-01
Chromium, total	3.81E+00	**75%**	8.51E-01	17%	5.37E-03	0%	3.95E-01	8%	4.81E-04	0.0%	4.66E+00	4.01E-01	5.06E+00
Chromium, hex	8.39E-02	**89%**	0.00E+00	0%	1.04E-02	11%	0.00E+00	0%	4.81E-04	0.5%	8.39E-02	1.09E-02	9.47E-02
			Worms--25% Plants--25% Shrew--15% Wren--5%				Benthos--20% Aq. Plants--10%						

Range Fraction (103-ac site / 500-ac range): 0.206

Table 20
Hazard Quotients for Ecological Receptors Exposed to COPCs
Peter Cooper Markhams NPL Site

Maximal Exposure

Endpoint Functional Group	Terrestrial Plants	Terrestrial Invertebrates	Wetland Plants	Wetland Invertebrates	Herbivorous Small Mammal	Insectivorous Small Mammal	Avian Omnivore	Avian Insectivore	Aquatic Herbivore	Aquatic Insectivore	Omnivorous Mammal
Measurement Species					Deer Mouse	Short-tailed Shrew	American Robin	Marsh Wren	Painted Turtle	Green Frog	Raccoon
COPCs	Hazard Quotient										
Benzaldehyde	0.003	No TRV	No Aq. Exposure	No Aq. Exposure	0.0001	0.0004	No TRV	No TRV	No TRV or Aq. Exposure	No TRV or Aq. Exposure	0.0005
Arsenic	1	1.6	0.1	2	0.2	1.7	13	3	3.3	3.3	1
Chromium	34	284	0.0007	9	9	18	7,750	2,534	259	259	88
Chromium, hexavalent	0.9	7.9	0.002	0.7	0.1	0.1	19	6	0.9	0.9	0.3

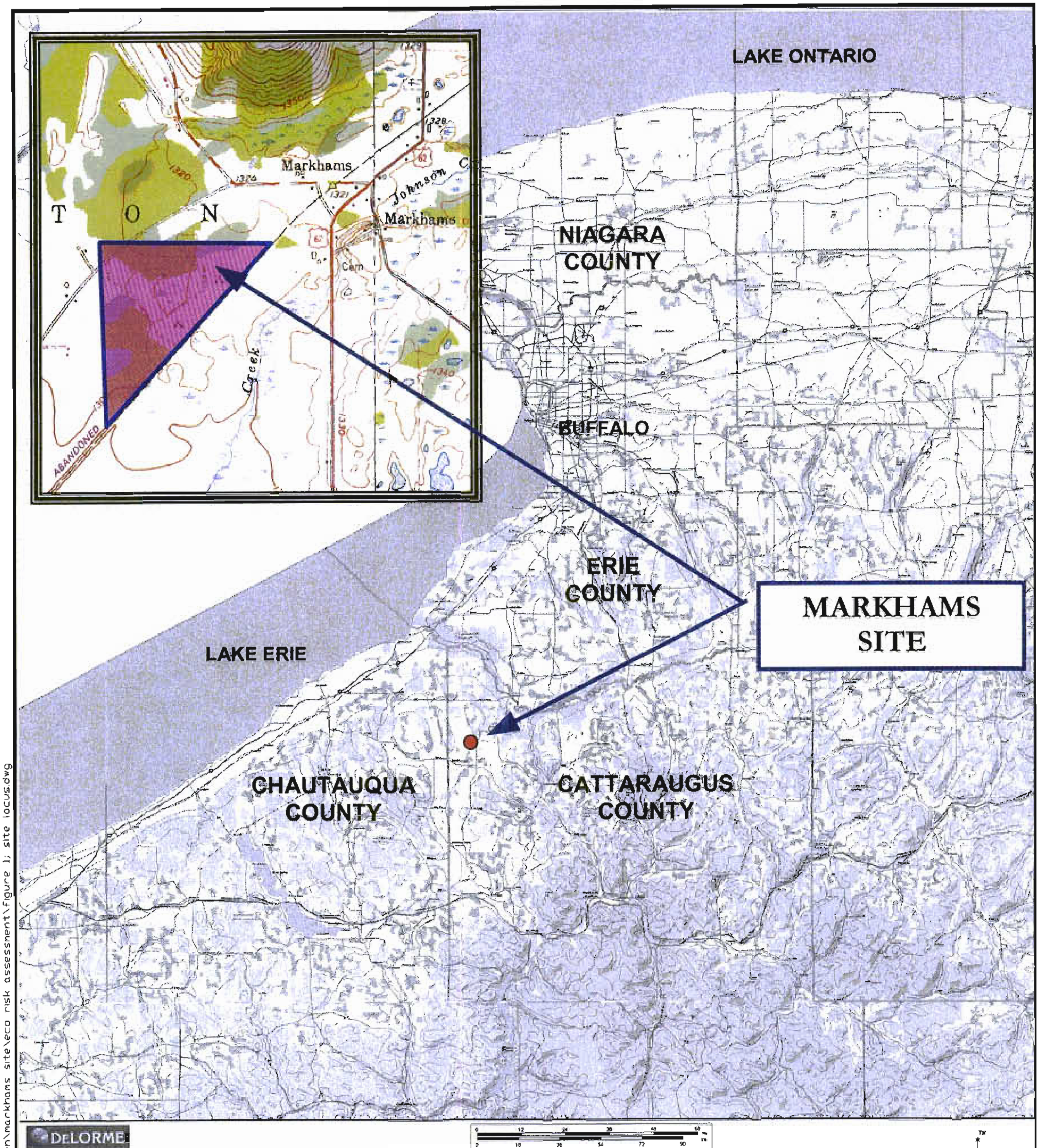
Non-Maximal Exposure Examples to Demonstrate Uncertainty

Endpoint Functional Group	Terrestrial Plants	Terrestrial Invertebrates		Wetland Invertebrates			Avian Omnivore	Avian Insectivore	Aquatic Herbivore	Aquatic Insectivore	Omnivorous Mammal
Measurement Species							American Robin	Marsh Wren	Painted Turtle	Green Frog	Raccoon
COPCs	Hazard Quotient										
Benzaldehyde											0.00004
Arsenic							1.6	0.4			0.2
Chromium	1.4	1.4		0.09			35	11	0.6		0.3
Chromium, hexavalent							6	2			0.07
Comments:	*Average & Bioaccessible-Cr^{3+} Concen.*			*Average & Bioaccessible-Cr^{3+} Concen.*			*Average Concen. & Bioaccessible-Cr^{3+} Concen.*		*Average Concen. & Bioaccessible-Cr^{3+} Concen.*		*Distributed Diet w/ Normal Range & Bioaccessible-Cr^{3+} Concen.*

Notes: Those HQs that are based upon Soil Quality TRVs use either soil concentration data or the TRVs are converted to organismal TRVs by multiplying the value by the appropriate BCF prior to quotient calculation

FIGURES

FIGURE 1



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PROJECT NO.: 0021-003-200

DATE: MARCH 2005

DRAFTED BY: BCH

SITE LOCUS

SCREENING LEVEL ECOLOGICAL RISK ASSESSMENT

PETER COOPER MARKHAMS SITE
MARKHAMS, NEW YORK

PREPARED FOR

RESPONDENTS FOR PETER COOPER MARKHAMS SITE

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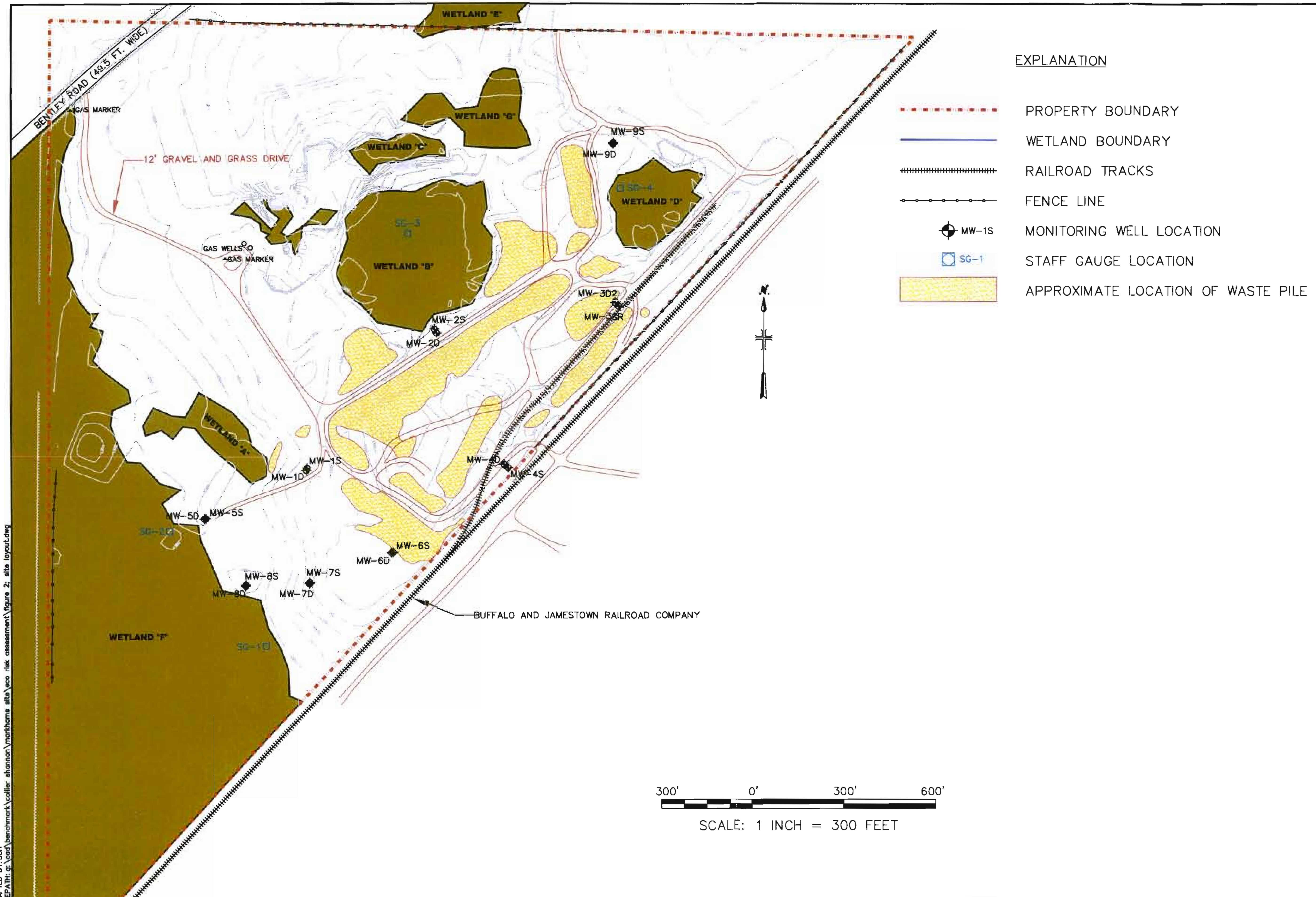

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SITE LAYOUT

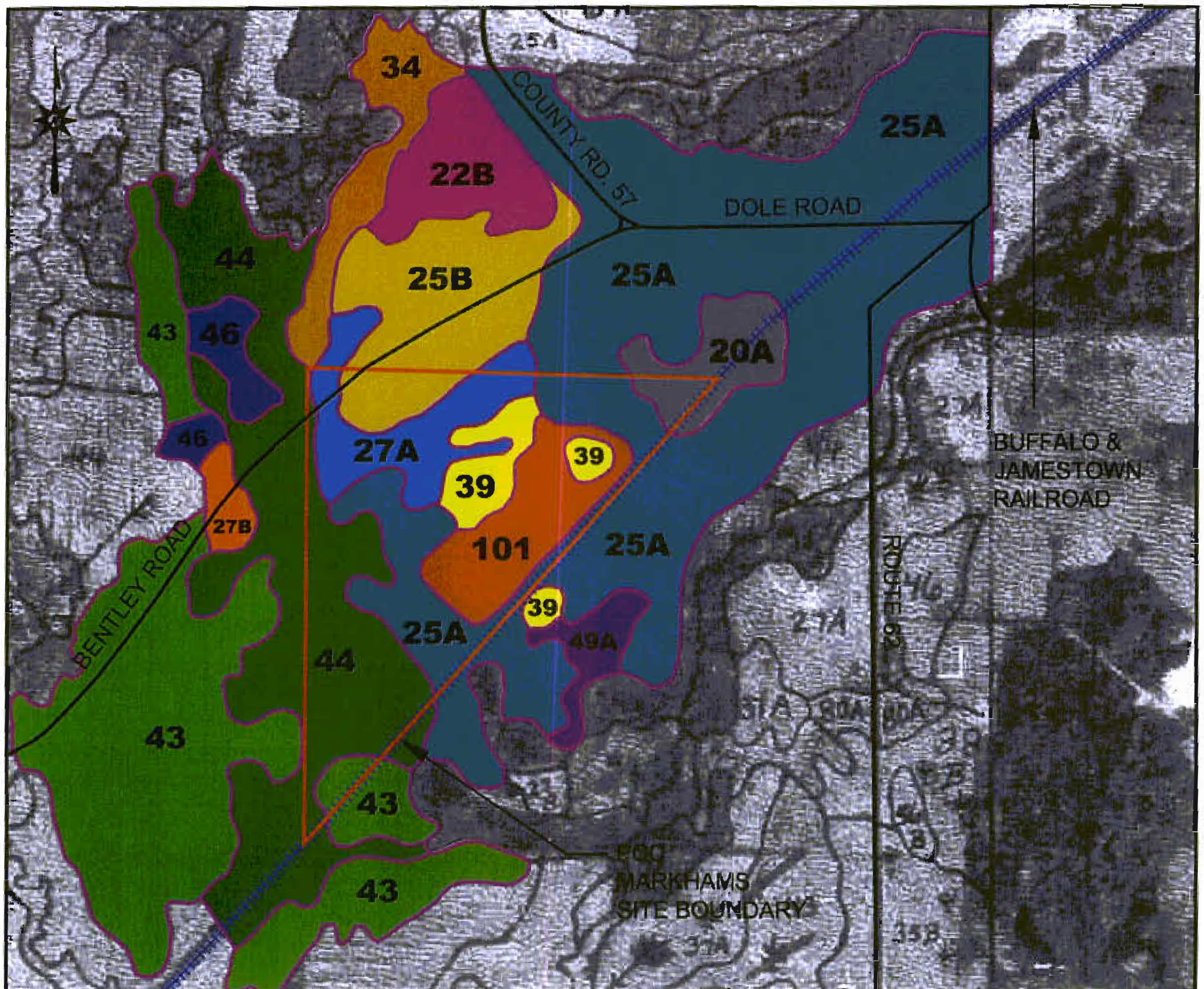
SCREENING LEVEL ECOLOGICAL RISK ASSESSMENT

PETER COOPER MARKHAMS SITE
MARKHAMS, NEW YORK

PREPARED FOR
RESPONDENTS FOR PETER COOPER MARKHAMS SITE

FIGURE 2

FIGURE 3



LEGEND

20A	UNADILLA SILT LOAM, 0 to 3 percent slopes	**39**	HALSEY MUCKY SILT LOAM, 0 to 3 percent slopes
22B	ALLARD SILT LOAM, 3 to 8 percent slopes	**43**	CANANDAIGUA SILT LOAM, 0 to 3 percent slopes
25A	CHENANGO GRAVELLY SILT LOAM, 0 to 3 percent slopes	**44**	CANANDAIGUA MUCKY SILT LOAM, 0 to 3 percent slopes
25B	CHENANGO GRAVELLY SILT LOAM, 3 to 8 percent slopes	**46**	SWORMVILLE SILT LOAM, 0 to 3 percent slopes
27A	CASTILE GRAVELLY SILT LOAM, 0 to 3 percent slopes	**49A**	RED HOOK LOAM, 0 to 3 percent slopes
27B	CASTILE GRAVELLY SILT LOAM, 3 to 8 percent slopes	**101**	UDORTHENTS, REFUSE SUBSTRATUM
34	GETZVILLE SILT LOAM, 0 to 3 percent slopes		

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SOILS MAP

SCREENING LEVEL ECOLOGICAL RISK ASSESSMENT

PETER COOPER MARKHAMS SITE
MARKHAMS, NEW YORK

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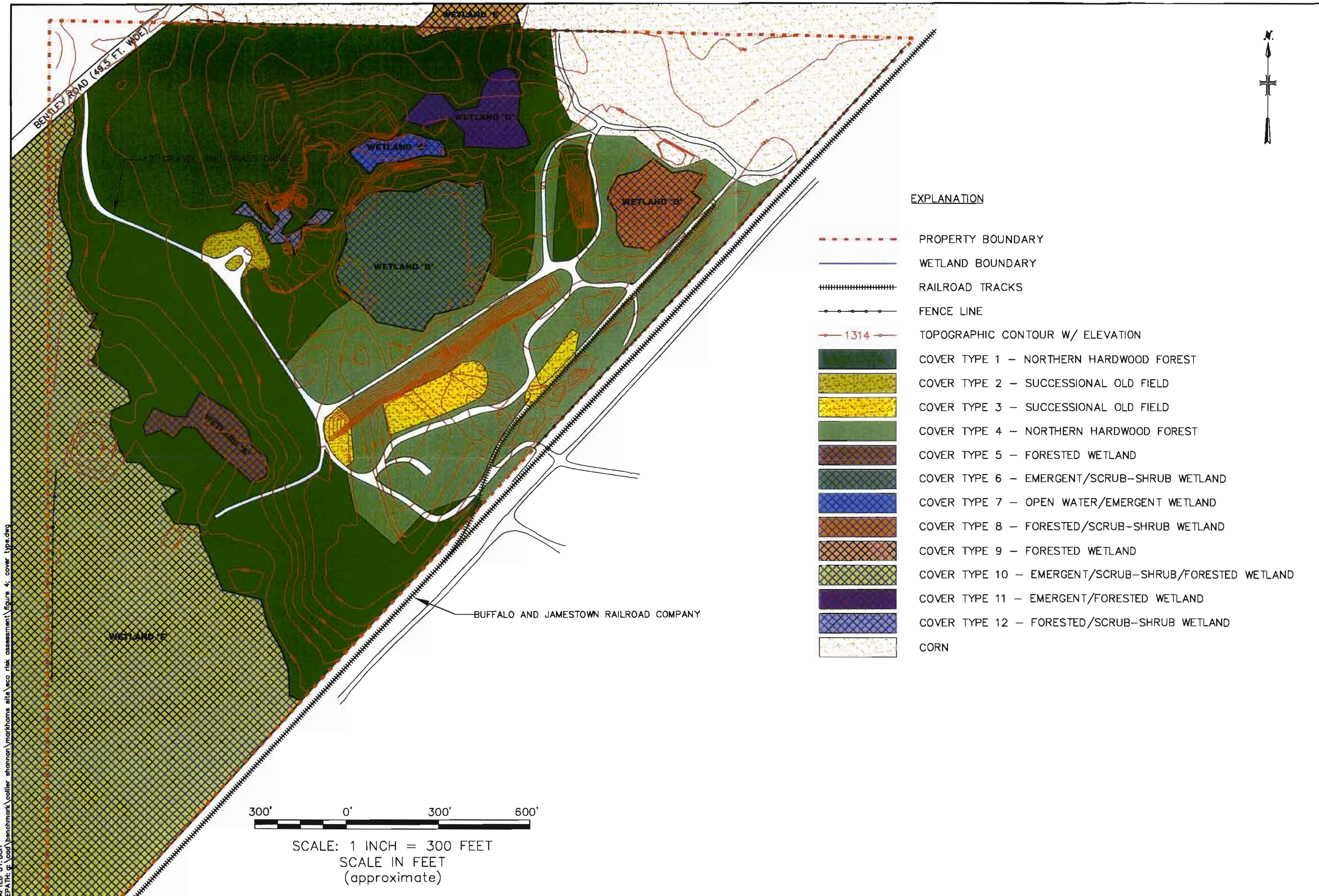

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PETER COOPER MARKHAMS SITE
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FIGURE 4

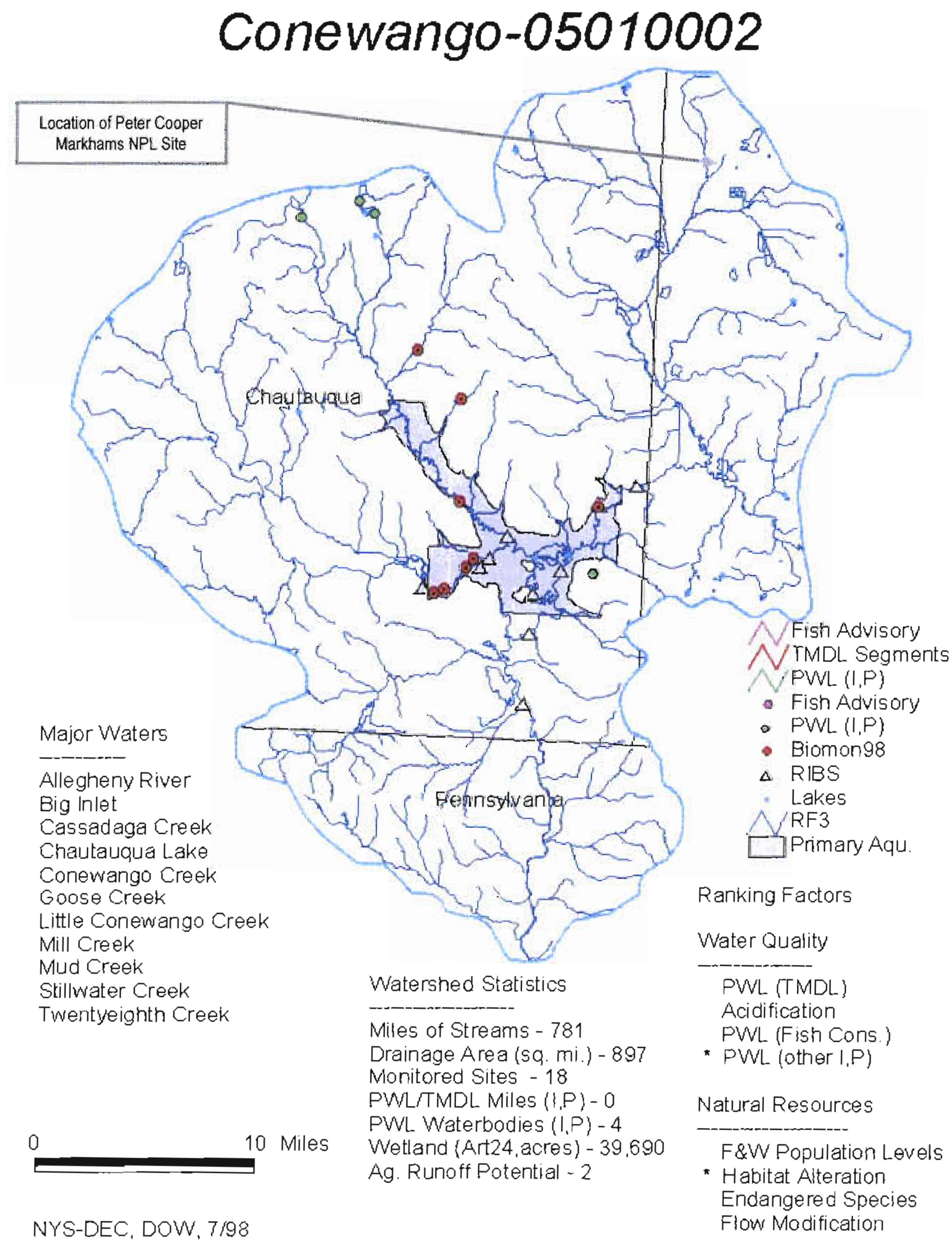
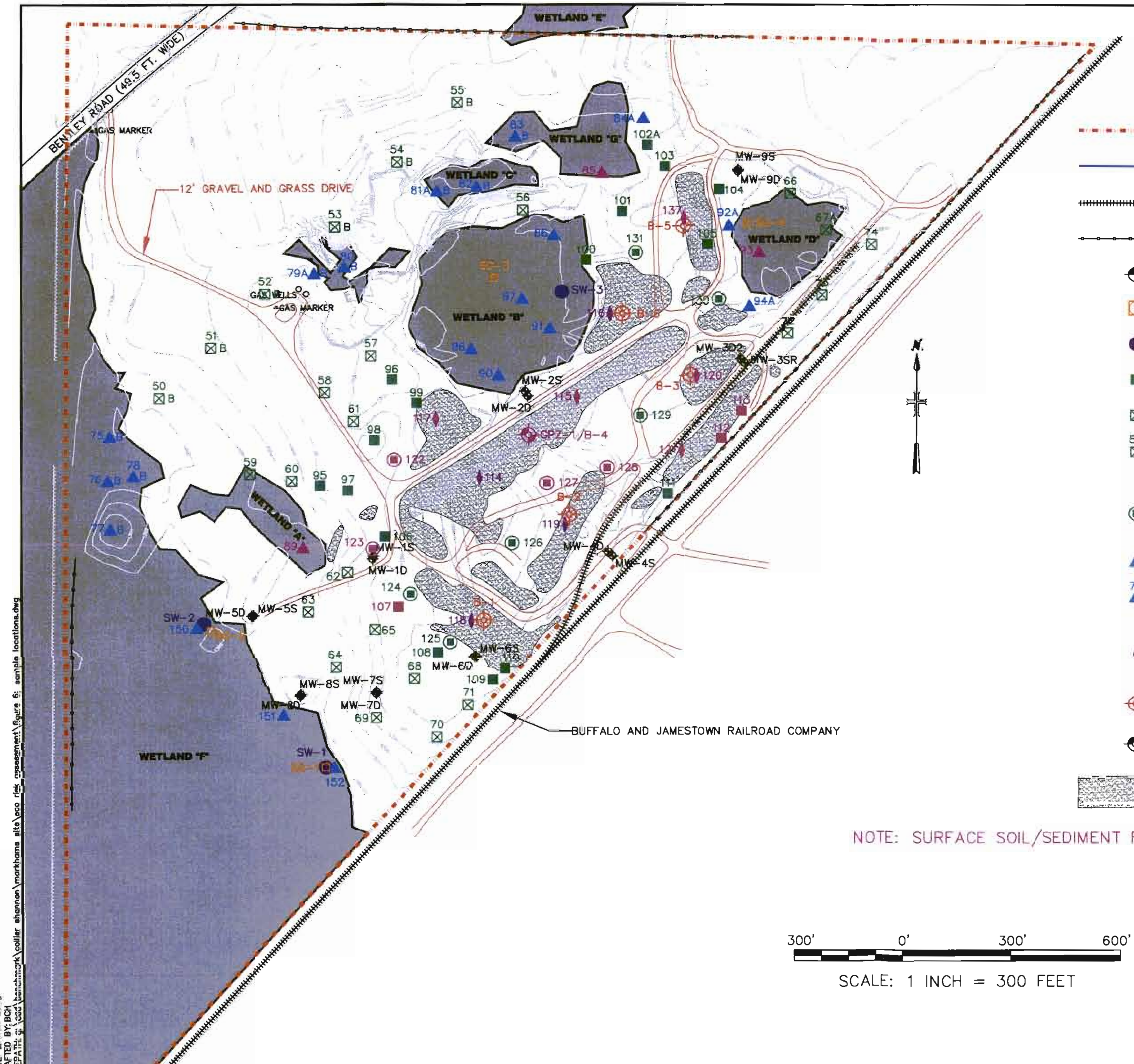


Figure 5 Conewango Watershed

Map derived from NYSDEC Unified Watershed Assessment Website (http://www.dec.state.ny.us/website/dow/uwa/p5010002.gif)



EXPLANATION

- PROPERTY BOUNDARY
- WETLAND BOUNDARY
- RAILROAD TRACKS
- FENCE LINE
- MW-1S MONITORING WELL LOCATION
- SG-1 STAFF GAUGE LOCATION
- SW-1 SURFACE WATER LOCATION
- 95 SURFACE/SUBSURFACE SOIL SAMPLE LOCATION
- 56 SURFACE SOIL SAMPLE LOCATION
- 50 B BACKGROUND SURFACE SOIL SAMPLE LOCATION
- 122 SURFACE/SUBSURFACE SOIL SAMPLE LOCATION (SS ANALYZED FOR TCL VOCs/SVOCs AS WELL AS COPCs)
- 84A SEDIMENT SAMPLE LOCATION
- 75 B BACKGROUND SEDIMENT SAMPLE LOCATION
- 114 WASTE PILE SURFACE SOIL SAMPLE LOCATION
- B-1 BORING LOCATION
- GPZ-1/B-4 PIEZOMETER/GAS SAMPLING WELL/ BORING LOCATION
- APPROXIMATE LOCATION OF WASTE PILE

NOTE: SURFACE SOIL/SEDIMENT RESAMPLE LOCATIONS ARE SHADED MAGENTA.

DATE: MARCH 2005
DRAFTED BY: BCH

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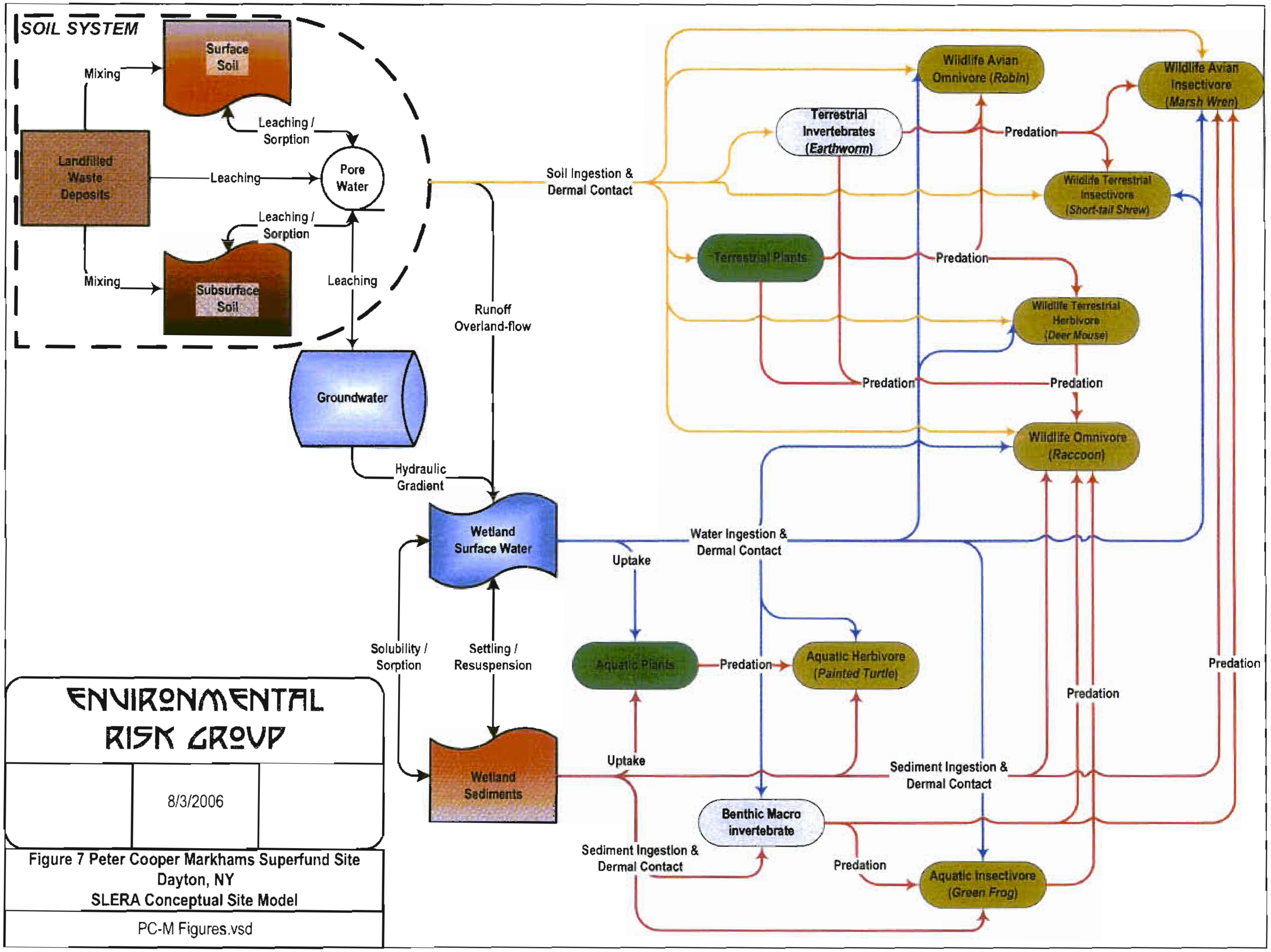
SAMPLE LOCATIONS

SCREENING LEVEL ECOLOGICAL RISK ASSESSMENT

PETER COOPER MARKHAMS SITE
MARKHAMS, NEW YORK

PREPARED FOR
RESPONDENTS FOR PETER COOPER MARKHAMS SITE

FIGURE 6



ENVIRONMENTAL RISK GROUP

8/3/2006

Figure 7 Peter Cooper Markhams Superfund Site
Dayton, NY
SLERA Conceptual Site Model

PC-M Figures.vsd

ENVIRONMENTAL RISK GROUP

Appendix 1

Regulatory Comment Responsiveness Summary

ENVIRONMENTAL
RISK GROUP

Memo

To: File

From: Kurt A. Frantzen

CC: T Forbes (Benchmark)

Date: March 1, 2005

Re: Peter Cooper Markhams NPL Site
SLERA Report
Regulatory Comment Responsiveness Summary

This memorandum summarizes how this report was prepared in order to address comments made in the USEPA's letter (dated December 24, 2002) regarding the Geomatrix-Benchmark August 2002 Pathways and Analysis Report (PAR document); and in particular, comments directed to the ecological risk portion of the PAR document. The entire USEPA comment is not included here, but a copy is included as a component of the Markhams SLERA report (Appendix 1).

A letter dated February 26, 2003 from Geomatrix and Benchmark to the USEPA responded to the Agency's comments. The comments and the response to comments were considered in the preparation of this SLERA, as noted below.

General Comments

Comment 1—*the report Introduction should include an overview of site history, possible stressor sources, and sampling and analysis approach.*

- The SLERA has incorporated the requested language.

Comment 2—*Split the PAR document into separate reports addressing the Human Health Risk Assessment and the Ecological Risk Assessment, in a manner consistent with Agency guidance (ERAGS USEPA 1997).*

- This report is the outcome of addressing this comment.

Comment 3—*Naming convention is COPCs not COPECs as in the PAR document.*

- This SLERA followed the COPC convention.

ENVIRONMENTAL
RISK GROUP

Specific Comments

Comment 45—*The SLERA should properly reference the correct Agency guidance. Furthermore, the SLERA should include the ERAGS checklist.*

- This SLERA was prepared following ERAGS 1997 and Eco-Risk Assessment Guidelines (1998), as well as used the Wildlife Exposure Factors Handbook (1993).
- The ERAGS checklist is included in this SLERA as Appendix 2.

Comment 46—*The ecological effects evaluation should include, consistent with ERAGS, appropriate and justified Toxicity Reference Values (TRVs).*

- This SLERA has responded to this request as demonstrated in Chapter 3.

Comment 47—*Provide adequate definition and description of the Conceptual Site Mode, and include all appropriate exposure pathways, routes, and points.*

- This SLERA uses the term Conceptual Risk System Model (CRSM) as shown in Figure 7 and developed in detail in Chapter 2 and specifically in the CRSM subsection of that chapter.

Comment 48—*Provide a well-developed outline of all potentially exposed trophic levels and feeding strategies.*

- This SLERA developed a multi-level trophic exposure model as described in the Assessment Endpoint subsection of Chapter 2.

Comment 49—*Provide adequate support of appropriate Assessment and Measurement Endpoints.*

- This SLERA addressed this comment as described in the Assessment Endpoint subsection of Chapter 2.

Comment 50—*A SLERA should consider non-detected chemicals ½ of the DL. COPCs should include all detected contaminants in each media samples, and evaluate them using an appropriate food chain model. When using screening criteria, more than one type of criteria should be employed.*

- This SLERA screened non-detected chemicals (at ½-DL) against available criteria, but none the less focused on detected chemicals. Providing a detailed analysis of non-detected chemicals for simple completeness goes beyond the reduced list of COPCs developed during the RI/FS Work Plan stage and calls into question previously resolved issues associated with the project's Data Quality Objectives (DQOs), which were previously agreed to by the parties.
- This SLERA included both a detailed, multi-media, multi-criteria screening of COPCs, as well as food chain modeling on an appropriate sub-set of COPCs

Comment 51—*Various errors were noted in the screening tables.*

- This SLERA re-developed the entire screening approach addressing the cited errors.

KAF/

PETER COOPER MARKHAMS SITE

ECOLOGICAL RISK ASSESSMENT

RESPONSES TO USEPA COMMENTS

COMMENT	***RESPONSE & ACTION***
GENERAL	
1. The screening-level ecological risk assessment (SLERA) appears to follow a combination of the EPA SLERA requirements (EPA 1997) and a baseline ecological risk assessment requirements (EPA 1998). Assumptions for exposure parameters must follow the screening-level guidance, which explicitly states the requirements for the screening-level assessment. In addition, site-specific parameters for bioavailability, site-use, and percentage of the diet should be set to default parameters given in the EPA guidance (EPA 1997). Therefore, some conclusions of the Ecological Risk Assessment (ERA) are not appropriate, especially for food-web modeling, and should be recalculated based on default parameters. The text needs to be modified once appropriate calculations have been completed. See specific comments for further discussion of this issue.	**Response:** The document complies with SLERA requirements. While the assessment approach used is consistent with SLERA requirements, the authors also sought to extend the assessment in a reasonable and intelligent fashion by providing additional analysis based upon conservative assumptions and in certain instances somewhat modified assumptions. The current assessment essentially provides a two tiered finding: 1) using SLERA conservative regulatory protocols it was found that certain COPCs pose a significant ecological risk and 2) using reasonable and scientifically sound analysis it was found that the potential ecological risk was not significant. The analysis provided presents a more accurate picture of ecological risks.
2. Section 2 - Problem Formulation - A table with preliminary SLERA hazard estimates, the available data, and background concentrations should be included in an appendix as background information for this report.	**Response:** Not Accepted. The request goes beyond EPA requirements and would add little value to the report. All of the requested information is already available in the tables included in the report. If additional data are of interest, they are available in the Remedial Investigation (RI) Report.
3. A brief, yet descriptive, discussion of the available data would be beneficial to evaluate the appropriateness and quality of the available data according to guidelines (EPA 1992).	**Response:** Some additional text will be included within the report describing the full range of data available within the RI report.

COMMENT	RESPONSE & ACTION
4. The SLERA does not address whether limits of quantitation for non-detect contaminants exceeded benchmark toxicity values. ERAGS (EPA 1997) explicitly state that contaminants with limits of quantitation that exceeds benchmark values should be carried through the assessment.	**Response:** This analysis will be included in the document.
5. The SLERA did not include some exposure pathways such as sediment and surface water ingestion for upper-level trophic predators. These should be included in the dose equation.	**Response:** ACCEPTED
6. The evaluation of the contaminant concentration data was conducted using a set of criteria which has a range of protectiveness. However, for a screening level ecological risk assessment the contaminant data should be compared to the most conservative value rather than a set of values. Additionally, the comparisons should involve the maximum detected value instead of the average.	**Response:** While we appreciate the comment, we fail to understand why providing a range of criteria, with a range of protectiveness, is inconsistent with SLERA requirements as long as that range includes "conservative values" and maximum detected concentration values. The analysis provided meets SLERA requirements.

COMMENT	RESPONSE & ACTION
SPECIFIC	
1. Conceptual Site Model, Page 1	**Response:** ACCEPTED
a. "Conceptual Site Model" and not "Conceptual Risk System Model" is the proper term as described in EPA. To avoid confusion, consistency with EPA guidance (EPA 1997, 1998) should be maintained and all mention of the "Conceptual Risk System Model" in the report should be changed to "Conceptual Site Model."	**Action:** a) We will modify the text accordingly.
b. Paragraph 2: This paragraph briefly discusses threats to wetlands but does not mention a terrestrial/upland habitat, although in the following section of the report, terrestrial plant communities are named as an assessment endpoint. The potential release to terrestrial environment should be discussed.	b) We will modify the text accordingly.
2. Assessment and Measurement Endpoints, Page 1	**Response:** ACCEPTED
a. Bullets need to include a more detailed description of assessment endpoints, i.e., protection of the diversity, growth, and biomass of terrestrial plant communities, etc.	**Action:** a) We will modify the text accordingly.
b. The "Wetland Community" is too broad a term for the assessment endpoint. A better focus would be protection of aquatic plant communities, aquatic vertebrate communities, and sediment-associated invertebrates. Various feeding guilds and trophic levels of the aquatic community should be evaluated.	b) We will modify the text accordingly.
c. The elimination of trophic levels above small mammal herbivores is not justified based on the information provided. The justification for eliminating these contaminants is based on the bioaccumulative potential of COPCs, but according to previous statements describing chemical fate and transport, contaminants do have bioaccumulative potential (Kow>3.0), and therefore, assessment endpoints that evaluate upper trophic level exposure are required.	c) While we appreciate the comment, we disagree. Our disagreement stems from the fact that the bioaccumulative potential of the most predominant COPCs (arsenic and chromium) are not at issue here, the comment is driven by the limited occurrence of PAHs in surface soils. While PAHs may enter into a SLERA as a COPC, they will not affect any reasonable evaluation of ecological risk at the Markhams site. Therefore, the specific exposure assessment cited as being required under the guidance is unjustified by the facts in evidence and would generate useless or misleading information

COMMENT	RESPONSE & ACTION
3. Screening-Level Exposure Estimates, Page 2	**Response:** ACCEPTED
Sentence 2: "higher levels measurement species" should be replaced with "higher level ecological receptors."	**Action:** We will modify the text accordingly.
4. Screening-Level Risk Estimation, Page 2	**Response:** ACCEPTED
Please include an introduction sentence describing the risk estimation.	**Action:** We will modify the text accordingly.
5. Risk Estimation Based Upon Food Chain Modeling, P. 2	**Response:** ACCEPTED
Sentence 2, mentions "hot spots," however, there is no discussion of "hot spots" (e.g., location, separation into operable units, contaminants present) except in the executive summary and the conclusion. Additional discussion describing "hot spots" should be added to the text.	**Action:** We will eliminate the term "hot spots;" and the section revised to clarify that the risks, if important, are associated with sample locations on or immediately adjacent to fill piles.
6. Risk Estimation Based Upon Food Chain Modeling, Paragraph 1, Page 3	**Response:** ACCEPTED
a. Sentence 2: Bioaccumulative potential should also be included. b. Sentence 3: In addition to soil exposure, sediment exposure should also be included.	**Action:** We will modify the text accordingly.
7. Conclusion, Page 3	**Response:** NOT ACCEPTED
Given the concern for inorganic and the failure of this assessment to apply conservative exposure parameters, the conclusion should be adjusted accordingly once the conservative exposure parameters are applied.	**Action:** We are of the opinion that the two tiered approach used in this assessment does indeed apply conservative exposure parameters, as well as additional analysis to more fully inform the reader so as to give them an appreciation of the meaning of the findings. For example, to simply evaluate maximal concentrations of chromium without appreciating the chemical behavior that dictates its environmental behavior, bioavailability and toxicity is not conservative or consistent with guidance. Such analysis does not lead to a fully informed conclusion, but rather would present misleading and grossly inaccurate inflormation.
8. Section 1, Introduction, Page 4	**Response:** ACCEPTED
Guidance documents consulted to develop this SLERA should be listed.	**Action:** We will modify the text accordingly.

COMMENT	RESPONSE & ACTION
9. Section 1, Subject Property, Page 5	**Response:** ACCEPTED
a. Paragraph 3: "Locus Plan" should be "Site Locus" as is the title of Figure 1. b. Paragraph 4: "Site Plan" should be "Site Layout" as is the title of Figure 2.	**Action:** a) We will modify the text accordingly. b) We will modify the text accordingly.
10. Section 1, Subject Property, 1st Paragraph, Page 6	**Response:** ACCEPTED
Please define "Re-worked native soil."	**Action:** Reworked native soil will be defined as native soil material that was excavated and stockpiled on the property, and was likely slated for use as cover material for the fill piles.
11. Section 1, Scope of Work, Page 7	**Response:** ACCEPTED
a. Paragraph 2: The word of "simple" should be replaced with "preliminary". b. Last Paragraph: It states "From these results a determination can be made . . . " The word "determination" should be changed to "recommendation."	**Action:** a) We will modify the text accordingly. b) We will modify the text accordingly.
12. Section 2, Problem Formulation, Page 8	**Response:** ACCEPTED
a. Number 3: Examples in parentheses should be described as (*e.g.,* plants, vertebrates, invertebrates, and feeding guilds). b. Number 4: Please replace the information in the parenthesis with the following: (an exposure pathway should include a source, a release mechanism from the source, a transport pathway from the source to the environment, a receptor, an exposure point contacted by the receptor, and a route into the receptor.)	**Action:** a) We will modify the text accordingly. b) We will modify the text accordingly.
13. Section 2, Current Conditions, Paragraph 2, Page 10	**Response:** ACCEPTED
It states, "An approximately 20-acre area within the central..." However, Executive Summary states 15 to 20-acres. Please clarify.	**Action:** We will modify the text accordingly.

COMMENT	RESPONSE & ACTION
14. Section 2, Terrestrial Setting, Page 15	**Response:** ACCEPTED
The RET information from the United States Fish and Wildlife Service was requested. However, there is no mention of the requested information in the report. Federally listed RET information should be cited in the report and correspondence should be included in Appendix 3.	**Action:** We will correct this oversight.
15. Section 2, Fish and Wildlife Resources, Paragraph 2, Page 19	**Response:** ACCEPTED
Please change sentence two and three to state that no species are "known to exist" at the site. In addition, this paragraph states that the USFWS was contacted and also stated "no federal listed threatened or endangered species are located (See Appendix 3). However, no letter from USFWS was included in Appendix 3.	**Action:** We will correct this oversight.
16. Section 2, Surface Soil, Paragraph 1, Page 21	**Response:** ACCEPTED
a. Please explain how the average concentration was calculated, specifically, how the non-detects are addressed in the calculation. b. The use of <10% detection is not a conservative assumption and should be justified or changed to 5% if sampling size of a medium is 20 or more.	**Action:** a) We will modify the text accordingly. b) We will modify the text accordingly.
17. Section 2, Subsurface Soil, Paragraph 2, Page 21	**Response:** Acknowledged
The last Sentence states, "only inorganic data are available..." Please explain why the organic data for subsurface soil (>6 inches) are not "available."	**Action:** Per the Approved RI Work Plan (Geomatrix Consultants, September 2001), samples for organics (TCL-VOCs and TCL-SVOCs) were limited to ten surface soil locations.
18. Section 2, Wetlands, Surface Water, Page 21	**Response:** ACCEPTED
The first sentence refers to eight surface water samples. However, Table 11 lists seven surface water samples, two duplicates and one dry sample. Page 44 refers to seven surface water samples and two duplicates. The descriptions of sample numbers should be consistent. In addition, the dry sample listed in Table 11 should be defined.	**Action:** We will modify the text accordingly.

COMMENT	RESPONSE & ACTION
19. Section 2, Octanol-Water Partition Coefficient, Page 22	**Response:** ACCEPTED
Please change "that is, they do not bioaccumulate." to "they have low potential to bioaccumulate in living organisms."	**Action:** We will modify the text accordingly.
20. Section 2, Conceptual Risk System Model, Page 30	**Response** See response to Comment #1
See Specific Comment No. 1.	**Action:** No Action
21. Section 2, Selection of Chemical of Potential Concern, Page 30	**Response:** ACCEPTED
Paragraph 1: Please add details to describe how the "analytical parameters and Data Quality Objection" limited the assessment. Paragraph 2, Last Sentence: The sentence states "Selection criteria may include:". The report should specify the criteria for the COPC selection in this SLERA. Last Bullet: Please clarify the second sentence.	**Action:** ¶ 1 We will add appropriate language from the RI. ¶2 We presume the commenter seeks greater specificity and clarity. The re-draft of the assessment will do so. Bullet 3 ACCEPTED
22. Section 2, Detected Chemical Eliminated from Consideration, Page 32	**Response:** ACCEPTED
Chemicals included in this section should be listed by medium. In addition, rationale for eliminating chemicals as COPCs were not clearly stated in the report. For example, "a condition of ecotoxicity" was used to eliminate a chemical. The phrase of "a "condition of ecotoxicity" should be defined.	**Action:** We will modify the text accordingly to provide greater clarity.
23. Section 2, Plant Communities, First Bullet, Page 37	**Response:** ACCEPTED
a. "Plant Communities" should be "Terrestrial Plant Communities". b. Species diversity should also be included in addition to survival and biomass production. c. The statement that plants are expected to incur maximum exposure to soil/sediment contaminants should be deleted. Many contaminants do not cross the soil-root barrier, and therefore, do not incur the maximum exposure to contaminants. Plants also provide a very localized assessment of exposure to contaminants, and therefore, only plants from	Action: We will modify the text accordingly.

COMMENT	RESPONSE & ACTION
areas of "hot spot" contamination are maximally exposed.	
24. Section 2, Terrestrial Vertebrate Communities, Third Bullet, P. 37	**Response:** This is a reiteration of Specific Comment #2c
As stated on page 22, organic contaminants with log Kow values greater than 3.0 are considered to bioaccumulate. Organic contaminants with log Kow greater than 3.0 are listed in Table 12. Thus, the higher trophic levels should be included as an assessment endpoint. Also, behavior, as a measure of stress, should be included in the assessment endpoint.	**Action:** None The comment regarding behavior is accepted.
25. Section 2, Wetland Communities, Fourth Bullet, Page 37	**Response:** ACCEPTED
This assessment endpoint is too broad. The endpoints aquatic plant community, aquatic herbivore, aquatic insectivore, aquatic benthic/sediment-associated invertebrate community, and macro-benthic invertebrate community should be included.	**Action:** We will modify the text accordingly.
26. Section 2, Measurement Endpoints, Page 38	**Response:** ACCEPTED
This section is redundant, as it is repeated in Section 3 (page 41). This section basically describes measures of exposure and the refinement of COPCs and is better suited to the Ecological Effect Evaluation Section of the document. Justification for the selection of each receptor should be addressed including how each receptor is representative of the assessment endpoint.	**Action:** We will modify the text accordingly.
27. Section 2, Measurement Endpoints, Step i, Page 38	**Response:** NOT ACCEPTED
a. An evaluation of surface water should also be included in the Step i. b. There should be an explanation of how COPCs are chosen to continue to step ii (*e.g.* above screening criteria).	**Action:** a) This was done (see page 44). We will modify the text to make this clear. b) This was included, please read ¶1 under Step ii on P38. We will modify the text to make this clear.
28. Table, Page 39	**Response:** ACCEPTED
a. The table needs to have a title, table number, and key describing the meaning of the symbols within the table. b. "Exposure Matrix." Benthic invertebrates-Aquatic insects should also be included in the wetland community assessment endpoints.	Action: a) We will modify the table accordingly. b) This was included; compare p 39 and text on p 40 under Wetland Community.

COMMENT	RESPONSE & ACTION
29. Section 3, Screening-Level Ecological Effects Evaluation, Page 41	**Response:** ACCEPTED
The text of this section beginning at "Step ii" is disjointed and the overall purpose of the step is confusing as it has been described. The step should be clarified to indicate that step ii is a further refinement of COPCs (COPCs carried through step i) based on dietary exposure to ecological receptors. There is no mention of whether uncertainty factors were applied to selected toxicity reference values (TRVs). Justification for the use or emission of these factors for each TRV should be given. The application of any uncertainty factors during derivation of TRVs should be mentioned at this point with further discussion in the TRV section of the document.	**Action:** We will modify the text accordingly.
30. Section 3, Environmental Screening Criteria, Soil, ¶2, P 42	**Response:** NOT ACCEPTED
Reference should be given for the depth of burrowing mammals and the root zone of plants. This is an important assumption and DTSC (1999) guidance recommends a depth of 6 ft. for burrowing mammals.	**Action:** RI groundwater elevation data indicate that the typical depth to shallow groundwater at the site is within 5 feet of ground surface. In addition, with the exception of native soil samples collected from 5 boring locations, all soil and sediment samples were collected from depths of 1 foot or less per the approved RI Work Plan (Geomatrix Consultants, September 2001). As such, the assertions made in the risk assessment are appropriate.
31. Section 3, Wetland Surface Water, Criteria, Page 44	**Response:** ACCEPTED
EC values are generally not acceptable for derivation of screening criteria. They should not be used as screening criteria for SLERAs.	**Action:** We will modify the text and delete reference to the EC criteria.
32. Section 3, Toxicity Reference Values (TRVs), Page 45	**Response:** ACCEPTED
Criteria for the selection of TRVs in the introduction portion of this section (*e.g.*, chronic exposure, sensitive life stages, etc.) should be provided. In addition, justification for not-applying uncertainty factors to TRVs based on other species should be provided.	**Action:** We will modify the text accordingly.

COMMENT	RESPONSE & ACTION
33. Section 3, Mammalian/Avian TRVs, Page 46	**Response:** ACCEPTED
a. Check the reference EPA 2005b because some of the references on the page should be EPA 2005c. b. Bullet "Avian/As". Please elaborate further on study selected and define "good NOAEL". c. Bullet "Avain/Cr+6". Please provide the EPA reference. d. Describe "adjusted accordingly" when selecting TRVs.	**Action:** We will modify the text accordingly.
34. Section 4, Screening-Level Exposure Estimates, Page 49	**Response:** NOT ACCEPTED
a. Paragraph 3: According to EPA (1997), exposure estimates should be based on conservative assumptions of exposure. While the derivation of values from published literature is appropriate for a baseline assessment, it is inappropriate for a screening level assessment. Exposures based on conservative values explicitly stated in EPA guidance should be substituted for literature-derived values. b. Soil, Sediment, and Surface Water: Bioavailability should be evaluated at 100% according to EPA guidance. The evaluation of bioaccessibility of chromium is appropriate for a baseline risk assessment, but not in a screening-level risk assessment.	**Action:** Please see our response to General Comment #1.
35. Section 4, Wetland Benthic Macroinvertebrates, Page 51	**Response:** Acknowledged
BCFs for benthic invertebrates are developed from soil invertebrates. This is not appropriate and sediment-based BCF should be used for wetland benthic macroinvertebrates.	**Action:** We will check for values that are more appropriate to the circumstance under evaluation.
36. Section 4, Exposure Parameters, Page 52	**Response:** Acknowledged
The calculation of exposure is not based on conservative assumptions described in EPA (1997) guidance and does not follow acronym convention. Below are several aspects to be addressed. a. Exposure Estimate (EE) should be Average potential daily dose (ADDpot) in accordance with EPA (1993) guidance. b. Tissue concentration (T) should be concentration in prey items (C) in accordance with EPA (1993) guidance.	**Action:** Please see our response to General Comment #1.

COMMENT	RESPONSE & ACTION
c. Exposure parameters should be dry weight or wet weight (only soil should be dry weight), not mixed. d. Dietary composition should be evaluated based on a diet composed entirely of the most contaminated food item (EPA 1997). e. The site use factor should assume that the home range of the receptor is located entirely (100%) within the area of concern (EPA 1997). f. Exposure equation and exposure calculations should be adjusted to reflect conservative assumptions.	
37. Section 4, Bioaccumulation in Secondary Trophic Species, P. 54	**Response:** LIMITED ACCEPTANCE
a. Some acronyms in the equation do not match the definition, such as BCF_{TP-M}, P_{TP} and F_{TP} in the equation, and BCF_{P-M}, P_P and F_P in the definition. b. Again, conservative assumption should be applied to the exposure equation.	**Action:** a) We will adjust the text accordingly. b) Please see our response to General Comment #1.
38. Section 4, Bioaccumulation in Secondary Trophic Species, P. 55	**Response:** NOT ACCEPTED
Secondary evaluation of exposure estimates based on site use and diet is not necessary. Only dietary exposure evaluated for the prey item with the maximum concentration is necessary.	**Action:** Please see our response to General Comment #1.
39. Section 5, Screening-Level Risk Calculation, Figure, Page 57	**Response:** NOT ACCEPTED
This figure is difficult to evaluate on a 3-dimensional scale. Information is better presented in a 2-dimensional bar graph. Also, the y-axis should be identified as a log scale.	**Action:** We conclude that the 3-D presentation is quite informative; nevertheless, we will re-label the y-axis.
40. Section 5, Risk Estimation Based on Food Chain Modeling, P. 62	**Response:** ACKNOWLEDGED
a. ¶3, Sent. 2: States, "The magnitude of the HQs generally indicates the relative risk posed to endpoint species." However, the magnitude of the HQ does not indicate the relative risk. It is only a value relative to a threshold for effects. b. ¶4: The calculation of a HI across all COPCs is inappropriate. HQs for COPCs can only be summed when toxic response is associated with the same mechanism of action. Only HQs	**Action:** Acknowledged. Only HQs will be presented

COMMENT	RESPONSE & ACTION
should be presented in this document.	
41. Section 6, Conclusions, Page 63	**Response:** NOT ACCEPTED
a. ¶1, Sentence 2: Be more specific when referring to the "second part"(e.g. Step ii or food chain modeling). b. Terrestrial (Landfill Area): This is the first reference of the terrestrial/upland areas as the landfill area. An approach evaluating the landfill area and wetland area as separate operable unit was not discussed previously in this document. A description of these two areas as separate operable units should be discussed before the conclusion section. c. The conclusions are not based on conservative assumptions appropriate for a SLERA, therefore, they cannot be supported.	**Action:** a) We will change the text accordingly. b) The RI Report did not define any Operable Units (OUs) and the text in this assessment is not meant to imply multiple OUs, simply to present in the findings consistent with the Cover Types present at the site and with the Assessment Endpoints described previously. c) We disagree; see our response to General Comment #1.
42. Section 6, Ecological Risk to Omnivor. Mammal (Raccoon), P. 64	**Response** NO ACTION
Please define "normal diet." Does it mean "literature-derived"?	**Action:** The initial analysis used a diet designed to maximize COPC exposure, that is, a focus on prey items that will have the highest concentration of COPCs within them, consistent with guidance. A more normal diet assumes a more typical diet as described in USEPA's Wildlife Exposure Factors Handbook.
43. Table 1, Plant Species identified During Field Reconnaissance	**Response:** ACCEPTED
Please include definition of cover types in the table. In addition, please define the acronym VHB.	**Action:** We will change the text accordingly.
44. Table 7, Occurrence and Distribution of Chemicals in Background Soils	**Response:** ACCEPTED
A portion of the text for the Data Qualifier "J" in the footnote is missing.	**Action:** We will change the text accordingly.
45. Tables 8 - 11, Occurrence, Distribution, and Selection of Chemicals	**Response:** ACCEPTED
Laboratory detection limits should be listed in these tables for the evaluation of data during the selection of COPCs.	**Action:** We will change the text accordingly.

COMMENT	RESPONSE & ACTION
46. Tables 8, Occurrence, Distribution, and Selection of Chemicals Surface Soil	**Response:** NOT ACCEPTED
Sources of the screening criteria, which are not given in footnotes, should be provided.	**Action:** The sources are provided in footnotes; please see Page 10 of 10 of Table 8.
47. Appendix 5, Page 3	**Response:** NOT ACCEPTED
Summary of toxicity to aquatic systems for benzaldehyde should be included.	**Action:** The chemical was not detected in aquatic systems; therefore, it should not be included.
48. Appendix 5, Ecotoxicological Profiles for COPCs	**Response:** ACCEPTED
Ecotoxicological profiles should be given for all COPCs.	**Action:** Profiles will be provided.

Appendix 2

Ecological Assessment Checklist

ENVIRONMENTAL RISK GROUP

Ecological

Assessment

Checklist

Site Name:	Peter Cooper Markhams
Client:	Benchmark
Project Number:	2004-BE-1
Prepared by:	K Frantzen
Date:	December 2004

Introduction

The Ecological Assessment Checklist supports the determination of whether or not further ecological evaluation is necessary at a subject property.

The checklist serves to inform a relatively simple screening process:

1. **Ecological Exclusion Criteria Worksheet**—this worksheets supports the collection of general information about the site, historical and current facility operations, physical site characteristics, ecological habitats, and receptors using the site in order to determine if incomplete or insignificant exposure pathways exist at the site/property and support the conclusion to eliminate further ecological evaluation. It is derived from USEPA Region 6 Corrective Action Strategy document (Appendix E)
2. Ecological Assessment Checklist—if the site cannot be excluded from further evaluation, collecting more detailed information about the site's ecology via a straightforward checklist will assist in deciding upon further ecological evaluations. This checklist is intended to support a screening-level assessment of a site. It takes its pattern from USEPA Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments (ERAGS June 1997) Appendix A (Checklist for Ecological Assessment/Sampling. The checklist should reflect an assessment of existing conditions and not future remedial actions at or development of the site.

If the property meets the exclusion criteria, then the assessor should document the site conditions and justification for how the criteria have been met within a risk evaluation report.

If the property does not meet the exclusion criteria, then further evaluation is warranted and the assessor should address additional activities (such as, Screening-Level or Baseline Risk Assessment and/or Interim Measures) within a Risk Assessment/Management Plan. Additional ecological risk screening or baseline assessment should follow appropriate guidance, such as USEPA's ERAGS (1997) and Guidelines for Ecological Risk Assessment (EPA/630/R-95/002F, April 1998) or a state approved guidance for ecological risk evaluation. The assessor should also consider the needs and interests of the relevant Natural Resources Trustees, to ensure that natural resources under their jurisdiction are adequately addressed.

The checklist is generally applicability to any site; however, some circumstances may require professional judgment to determine the need for further evaluation. Sources and general information available for the identification of ecological receptors and habitats may include: the U.S. Fish and Wildlife Service (http://www.fws.gov), State Game and Fish Conservation Services, United States Geological Service (USGS), National Wetland Inventory Maps (http://nwi.fws.gov) National Audubon Society, National Biological Survey, national and local wildlife clubs, National and State Heritage Programs, State and National Parks System, and tribal organizations.

Contents

ENVIRONMENTAL RISK GROUP

Ecological Exclusion Criteria Worksheet

USEPA Region 6 adapted the Exclusion Criteria Worksheet from the Texas Natural Resources Conservation Commission (TNRCC) Texas Risk Reduction Program (TRRP) Tier 1 Checklist. TNRCC has additional guidance regarding use of the Tier 1 Checklist is available in Chapter 2 of *Guidance for Conducting Ecological Risk Assessments at Remediation Sites in Texas*, Draft Final, August 2000 http://www.tnrcc.state.tx.us/permitting/remed/techsupp/erag8_00.pdf.

The Exclusion Criteria Worksheet is aid assessors in determining whether or not further ecological evaluation is necessary at a property. Exclusion criteria refer to those conditions at an affected property which preclude the need for a formal ecological risk assessment (ERA) because there are incomplete or insignificant ecological exposure pathways due to the nature of the affected property setting and/or the condition of the affected property media. The assessor completing the worksheet should be familiar with the property but need not be a professional scientist in order to respond, although some questions will likely require professional or natural resource agency input. The worksheet is designed for general applicability to all property; however, there may be unusual circumstances which require professional judgment in order to determine the need for further ecological evaluation (*e.g.*, cave-dwelling receptors).

The worksheet has three parts:

1. Property Identification and Background Information
2. Exclusion Analysis
3. Qualitative Summary Statement and Certification

Worksheet answers should reflect existing conditions and not future remedial actions at or future development of the property. Worksheet contents should lead to a logical conclusion regarding the need for further ecological evaluation. Definitions of terms used in the worksheet are provided.

Part 1 Property Identification and Background Information

1. Provide a description of the specific area of the response action and the nature of the release. Include estimated acreage of the affected property and the facility property, and a description of the type of facility and/or operation associated with the affected property. Also, describe the location of the affected property with respect to the facility property boundaries and public roadways.

   Location: Bentley Road, Hamlet of Markhams/Town of Dayton, Cattaraugus (C), New York 14041
   Latitude (North): 42.392897 42° 23' 34.4'' **Longitude (West):** -79.012572 -79° 59' 14.7''
   Elevation: 1,300 feet above sea level (approx.)
   EPA CERLIS#: NYD980592547

   The site is situated within a 106-acre, wooded property in a flat-lying, rural farmland area, bounded by railroad tracks to the southeast, a forested wetland to the northwest and the remainder of the wooded property to the northeast and southwest. The area consists mostly of farmland and meadows, with scattered wetlands.

   Attach available USGS topographic maps and/or aerial or other affected property photographs to the worksheet depicting the property and its environs.

   ☒ Topo Map **See attached figures depicting site location and lay-out (Perrysburg, NY USGS 7.5-min topographic quadrangle map #42079-D1-TF-024 1954, Photorevised 1979)**

   ☒ Aerial Photo **See attached figures and Geomatrix and Benchmark RI/FS Report (2005)**

   ☒ Other **See attached sample location, watershed, and soil survey figures**

2. Identify the environmental media known or suspected to contain Chemicals of Concern (COCs) at the present time. Check all that apply:

   Known/Suspected COC Location Based on sampling data?

   ☒ Soil < 5 ft below ground surface ☒ Yes ☐ No

   ☒ Soil > 5 ft below ground surface ☒ Yes ☐ No

   ☒ Groundwater ☒ Yes ☐ No

   ☒ Surface Water/Sediments ☒ Yes ☐ No ***wetlands***

   Explain (previously collected information may be referenced):

   See Remedial Investigation Data

3. Provide the information below for the nearest surface water body which has become or has the potential to become impacted from migrating COCs via surface water runoff, air deposition, groundwater seepage, etc.

Exclude: Wastewater Treatment Facilities, Stormwater Conveyances/Impoundments authorized by permit, Conveyances, Decorative ponds, or those portions of the process facilities which are:

a) Not in contact with surface waters of the State or other surface waters which are ultimately in contact with surface waters of the State

b) Not consistently or routinely utilized as valuable habitat for natural communities including birds, mammals, reptiles, etc.

The nearest surface water body is **0 feet** from the property.

The surface water body is named **N/A**

The surface water body is best described as a:

☒ Freshwater stream: **Johnson Creek** is perennial (about <¼ mile to south & east)

☐ Intermittent (dries up completely for at least one week per year)

☐ Intermittent with perennial pools

☒ Freshwater swamp/marsh/wetland

☐ Saltwater or brackish swamp/marsh/wetland

☐ Reservoir, lake or pond; approximate surface acres ____________

☒ Drainage ditch

☐ Tidal stream

☐ Other (specify) ____________

Is the water body listed as a State classified segment?

☒ Yes Segment # Johnson Creek is **Reach Code 05010002000212**
Use classification: **NYSDEC Class C Standard C Unregulated Stream**

☐ No

Subpart B. Affected Property Setting

In answering Yes to the following question, it is understood that the property is not attractive to wildlife or livestock, including threatened or endangered species (i.e., the affected property does not serve as valuable habitat, foraging area, or refuge for ecological communities). Developing the answer may require consultation with the relevant agencies.

1. Is the affected property wholly contained within contiguous land characterized by: pavement, buildings, landscaped area, functioning cap, roadways, equipment storage area, manufacturing or process area, or other surface cover or structure, or otherwise disturbed ground?

   ☐ Yes ☒ No

   Explain

   Site is generally undeveloped and occurs within a mostly agricultural land use area.

If the answer is *Yes* to Subpart B above, the affected property meets the exclusion criteria, assuming the answer to Subpart A was *No*.

Skip Subparts C and D and complete Part 3, Qualitative Summary and Certification

If the answer is *No* to Subpart B above, go to Subpart C.

ENVIRONMENTAL RISK GROUP

Subpart C. Soil Exposure

1. Are COCs present in the soil at the property; and if so, are they solely present below the 5-feet bgs or does the property have a physical barrier present to prevent exposure to receptors to COCs in the surface soil?

☐ Yes ☒ No

Explain

COCs (primarily arsenic & chromium) are present in surface and subsurface soils

If the answer is *Yes* to Subpart C above, the affected property meets the exclusion criteria, assuming the answer to Subpart A was *No*.

Skip Subpart D and complete Part 3, Qualitative Summary and Certification

If the answer is *No* to Subpart C above, go to Subpart D.

NYSDEC Fish and Wildlife Resources Impact Analysis Decision Key

1. Is the site or area of concern a discharge or spill event? **NO**

   If "YES" go to: 13 If "NO" go to: 2

2. Is the site or area of concern a point source of contamination to the groundwater which will be prevented from discharging to surface water? Soil contamination is not widespread, or if widespread, is confined under buildings and paved areas. **NO**

   If "YES" go to: 13 If "NO" go to: 3

3. Is the site and all adjacent property a developed area with buildings, paved surfaces and little or no vegetation? **NO**

   If "YES" go to: 4 If "NO" go to: 9

4. Does the site contain habitat of an endangered, threatened, or special concern species?

   If "YES" go to: PRC If "NO" go to: 5

5. Has the contamination gone off site?

   If "YES" go to: 6 If "NO" go to: 14

6. Is there any discharge or erosion of contamination to surface water or the potential for discharge or erosion of contamination?

   If "YES" go to: 7 If "NO" go to: 14

7. Are the site contaminants PCBs, pesticides or other persistent, bioaccumulable substances?

   If "YES" go to: PRC If "NO" go to: 8

8. Does contamination exist at concentrations that could exceed SCGs or be toxic to aquatic life if discharged to surface water?

   If "YES" go to: PRC If "NO" go to: 14

9. Does the site or any adjacent or downgradient property contain any of the following resources? **YES**

   a) Any endangered, threatened or special concern species or rare plants or their habitat
   b) Any State designated significant habitats or rare State Ecological Communities
   c) Tidal or <u>freshwater wetlands</u>
   d) Stream, <u>creek</u>, or river
   e) Pond, lake, lagoon
   f) Drainage ditch or channel
   g) Other surface water feature
   h) Other marine or freshwater habitat
   i) <u>Forest</u>
   j) Grassland or grassy field
   k) Parkland or woodland
   l) Shrubby area
   m) Urban wildlife habitat
   n) Other terrestrial habitat

   If "YES" go to: 11 If "NO" go to: 10

10. Is the lack of resources due to the contamination?

    If "YES" go to: PRC If "NO" go to: 14

11. Is the contamination a localized source which has not migrated and will not migrate from the source to impact any on-site or off-site resources? **NO**

    If "YES" go to: 14 If "NO" go to: 12

12. Does the site have widespread soil contamination that is not confined under and around buildings or paved areas? YES

    If "YES" go to: **PRC** If "NO" go to: 13

13. Does the contamination at the site or area of concern have the potential to migrate to, erode into or otherwise impact any on-site or off-site habitat of endangered, threatened or special concern species or other fish and wildlife resource? (See #9 for list of potential resources. Contact appropriate agency for information regarding endangered species.)

    If "YES" go to: PRC If "NO" go to: 14

14. No Fish and Wildlife Resources Impact Analysis needed.

* *PRC = Perform Resource Characterization*

Definitions (Applicable to Exclusion Worksheet)

Property: The entire area (*i.e.*, on-site and off-site; including all environmental media) which contains releases of chemicals of concern at concentrations equal to or greater than the assessment level applicable for the land use (*i.e.*, residential or commercial/industrial) and groundwater classification.

Assessment Level: a critical protective concentration level for a chemical of concern used for affected property assessments where the human health protective concentration level is established by State regulation or guidance.

Bedrock: the solid rock (*i.e.*, consolidated, coherent, and relatively hard naturally formed material that cannot normally be excavated by manual methods alone) that underlies gravel, soil, or other surficial material.

Chemicals of Concern: any chemical that has the potential to adversely affect ecological or human receptors due to its concentration, distribution, and mode of toxicity.

Community: an assemblage of plant and animal populations occupying the same habitat in which the various species interact via spatial and trophic relationships (*e.g.*, a desert community or a pond community).

Complete Exposure Pathway: an exposure pathway where a human or ecological receptor is exposed to a chemical of concern via an exposure route (*e.g.*, incidental soil ingestion, inhalation of volatiles and particulates, consumption of prey, etc).

De Minimus: the description of an area of affected property comprised of one acre or less where the ecological risk is considered to be insignificant because the small extent of contamination, the absence of protected species, the availability of similar unimpacted habitat nearby, and the lack of adjacent sensitive environmental areas.

Ecological Protective Concentration Level: the concentration of a chemical of concern at the point of exposure within an exposure medium (*e.g.*, soil, sediment, groundwater, or surface water) which is determined to be protective for ecological receptors. These concentration levels are intended to be protective for more mobile or wide-ranging ecological receptors and, where appropriate benthic invertebrate communities within waters of the State. These concentration levels are not intended to be directly protective of receptors with limited mobility or ranges (*e.g.*, plants, soil invertebrates, and small rodents), particularly those residing within active areas of a facility, unless these receptors are threatened/endangered species or unless impacts to these receptors result in disruption of the ecosystem or other unacceptable consequences to the more mobile or wide-ranging receptors (*e.g.*, impacts to an off-site grassland habitat eliminate rodents which causes a desirable owl population to leave the area).

Ecological Risk Assessment: a process that evaluates the likelihood that adverse ecological effects may occur or are occurring as a result of exposure to one or more stressors; however, as used in this context, only chemical stressors (*i.e.*, COCs) are evaluated.

Environmental Medium: a material found in the natural environment such as soil, (including non-waste fill materials), groundwater, air, surface water, and sediments, or a mixture of such materials with liquids, sludges, gasses or solids, including hazardous waste which is inseparable by simple mechanical removal processes, and is made up of primarily of natural environmental material.

Exclusion Criteria: those conditions at an affected property which preclude the need to establish a protective concentration level for an ecological exposure pathway because the exposure pathway between the chemical of concern and the ecological receptors is not complete or is insignificant.

Exposure Medium: the environmental medium or biological tissue in which or by which exposure to chemicals of concern by human or ecological receptors occurs.

Facility: the installation associated with the affected property where the release of chemicals of concern have occurred.

Functioning Cap: a low permeability layer or other approved cover meeting its design specifications to minimize water infiltration and chemical of concern migration, and prevent ecological or human receptor exposure to chemical of concern, where design requirements are routinely maintained.

Landscaped Area: an area of ornamental, or introduced, or commercially installed, or manicured vegetation, which is routinely maintained.

Off-Site Property: all environmental media which is outside the legal boundaries of the on-site property.

On-Site Property: all environmental media within the legal boundaries of a property that has become subject to corrective action, either through voluntary action, permit or order.

Physical Barrier: any structure or system, natural or manmade, which prevents exposure or prevents physical migration of chemicals of concern to points of exposure.

Point of Exposure: the location within an environmental medium where a receptor will be assumed to have a reasonable potential to come into contact with chemicals of concern. The point of exposure may be a discrete point, plane, or an area within or beyond some location.

Protective Concentration Level: the concentration of a chemical of concern which can remain within the source medium and not result in levels which exceed the applicable human health risk based exposure limit considering cumulative risk and hazard index for both carcinogenic and non-carcinogenic effects respectively, or ecological protective concentration level at the point of exposure for that exposure pathway.

Release: any spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing into the environment, with the exception of:

- a release that results in an exposure to a person solely within a workplace, concerning a claim that the person may assert against the persons employer;

- an emission from the engine exhaust of a motor vehicle, rolling stock, aircraft, vessel, pipeline pumping station engine;
- a release of source, by product, or special nuclear material a nuclear incident, as those terms identified by the Atomic Energy Act of 1954, as amended (42 USC 2201 et. seq.); if the release area is subject to requirements concerning financial protection established by the Nuclear Regulatory Commission under Section 170 of that Act; • for the purpose of the environmental response law Section 104, as amended, or other response action, release of source, by-product, or special nuclear material from a processing site designated under Section 102(a)(1) for Section 302(a) of the Uranium Mill Tailings Radiation Control Act of 1978 (42 USC Section 7912 and Section 7942) as amended; and
- the normal application of fertilizer.

Sediment: non-suspended particulate material lying below surface waters such as bays, the ocean, rivers, streams, lakes, ponds, or other similar surface water body (including intermittent streams). Dredged sediments which have been removed from surface water bodies and placed on land shall be considered soils.

Sensitive Environmental Areas: areas that provide unique and often protected habitat for wildlife species. These areas are typically used during critical life stages such as breeding, hatching, rearing of young, and overwintering, for example; critical habitat for threatened and endangered species, wilderness areas, parks and wildlife refuges.

Source Medium: an environmental medium containing Chemicals of Concern that must be removed, decontaminated, and/or controlled in order to protect human health and the environment. The source medium may be the exposure medium for some exposure pathways.

Stressor: any physical, chemical, or biological entity that can induce an adverse response; however, as used in this context, only chemical entities apply.

Subsurface Soil: for human health exposure pathways, the portion of the soil zone between the base of the surface soil and the top of the groundwater-bearing unit(s). For ecological exposure pathways, the portion of the soil zone between 0.5 feet and 5 feet in depth.

Surface Cover: a layer of artificially placed utility material (*e.g.*, shell, gravel)

Surface Soil: for human health exposure pathways, the soil zone extending from ground surface to 15 feet in depth for residential land use and from ground surface to 5 feet in depth for commercial/industrial land use; or to the top of the uppermost groundwater-bearing unit or bedrock, whichever is less. For ecological exposure pathways, the soil zone extending from ground surface to 0.5 feet in depth.

Surface Water: any water meeting the definition of surface water as defined by the authorized State

ENVIRONMENTAL RISK GROUP

Site Description

1. Site Name: Peter Cooper Markhams NPL Site

   Location: Bentley Road

   ____

   County/Parish: Cattaragus City: Town of Dayton State: New York

   Type of Facility: Disposal Site

2. Latitude: **(North)** 42.392897 42° 23' 34.4" Longitude: **(West)** -79.012572 -79° 59' 14.7"

3. What is the approximate area of the site? 110-acres

4. Is this the first site visit? Yes ☐ No ☒
   If no, attach trip report of previous site visit(s), if available.
   Date(s) of previous site visit(s): Based on visit to prepare Pathway Analysis Report by Geomatrix and Benchmark—performed 10/2001 by J Vanglio and reconnaissance visit in 12/2004 by K Frantzen

5. Attach to the checklist USGS topographic map(s) of the site, if available. SEE ATTACHED FIGURES

6. Are aerial or other site photographs available? Yes ☒ No ☐
   If yes, please attach any available photo(s) to the site map at the conclusion of this section.

7. The land use on the site is:

   _____ % Urban
   60 % Rural
   _____ % Residential
   _____ % Industrial ☐ Light ☐ Heavy
   _____ % Agriculture
   (Crops: ______________________)
   _____ % Recreational
   (Describe; note if it is a park, etc.)
   ____
   ____
   _____ % Undisturbed
   40 % Other—wetland

   The area surrounding the site is:
   ______________ mile radius
   _____ % Urban
   50 % Rural
   _____ % Residential
   _____ % Industrial ☐ Light ☐ Heavy
   50 % Agriculture
   (Crops: various row crops & alfalfa)
   _____ % Recreational
   (Describe; note if it is a park, etc.)
   ____
   ____
   _____ % Undisturbed
   _____ % Other

8. Has any movement of soil taken place at the site? Yes ☒ No ☐
   If yes, please identify the most likely cause of this disturbance:

   ☐ Agricultural Use ☒ Heavy Equipment ☐ Mining ☐ Natural Events ☐ Erosion ☒ Other

   Please describe: Disposal of wastes from Peter Cooper Corp Gowanda Operations

9. Do any potentially sensitive environmental areas exist adjacent to or in proximity to the site, *e.g.*, Federal and State parks, National and State Monuments, wetlands, prairie potholes? Remember, flood plains and wetlands are not always obvious, do not answer "no" without confirming information. Yes ☒ No ☐

   Wetlands

10. What type of facility is located at the site?

    ☐ Chemical ☐ Manufacturing ☐ Mixing ☒ Waste Disposal

    ☐ Other (specify) ____

11. What are the suspected contaminants of concern at the site? If known, what are their maximum concentration levels? Various PAHs (<100 ppm); Arsenic (100 ppm); Chromium (70,000 ppm); Hexavalent Chromium (60 ppm) ____

12. Check any potential routes of off-site migration of contaminants observed at the site:

    ☒ Swales ☐ Depressions ☒ Drainage ditches

    ☐ Runoff ☐ Windblown Particulate ☐ Vehicular traffic

    ☐ Other (specify) ____

13. If known, what is the approximate depth to the water table? ____

14. Is the direction of surface runoff apparent from site observations?

    Yes ☒ No ☐

    If yes, to which of the following does the surface runoff discharge? Indicate all that apply.

    ☒ Surface water (*wetlands*) ☒ Groundwater ☐ Sewer ☐ Collection Impoundment

15. Is there a navigable waterbody or tributary to a navigable waterbody?

Yes ☐ No ☒

16. Is there a waterbody anywhere on or in the vicinity of the site?

Yes ☒ approximate distance On Site No ☐

If yes, also complete Section 3 Aquatic Habitat Checklist—non-flowing systems and/or Section 4 Aquatic Habitat Checklist—flowing systems.

17. Is there evidence of flooding? Yes ☒ No ☐
Wetlands and flood plains are not always obvious; do not answer "no" without confirming information. If "yes," complete Section 5 Wetland Habitat Checklist.

Yes, wetlands are present on site

18. If a field guide was used to aid any of the identifications, please provide a reference (use a blank sheet if additional space is needed for text).

See Reference section in SLERA Report

Time spent identifying the fauna: 2-day

19. Are any threatened and/or endangered species (plant or animal) known to inhabit the area of the site?

Yes ☐ No ☒

See Appendix 3

If yes, you are required to verify this information with the U.S. Fish and Wildlife Service and/or relevant State agency.

If species identities are known, please list them : ____________________

20. Record weather conditions at the time this checklist was prepared:

Date: ____________ ____________ Cloud cover
____________ Temperature (0C /0F) ____________ Normal daily high temperature
____________ Wind (direction/speed) ____________ Precipitation (rain, snow)

Summary of Observations and Site Setting

Completed by: ______________________ Affiliation: ______________________

Additional Preparers: ____

Site Manager: ____

Date: ______________________

ENVIRONMENTAL RISK GROUP

Terrestrial Habitat Checklist

Wooded

1. Are there any wooded areas on the site?

   Yes ☒ No ☐
   If "*no*," go to Section IIB: Shrub/Scrub.

   What percentage of the area of the site is wooded? (60% 65-acres)
   Indicate the wooded area on the site map which is attached to a copy of this checklist.
   Please identify what information was used to determine the wooded area of the site.

   See figures in report

2. What is the dominant type of vegetation in the wooded area?

   (Circle one: Evergreen/**Deciduous**/Mixed) Provide a photograph if available.

   Dominant plant, if known: Various, see Environmental Setting and Cover Type Descriptions in Report

3. What is the predominant size of the trees at the site? Use diameter at breast height.

   ☒ 0-6 inches ☐ 6-12 inches ☐ >12 inches

4. Specify type of understory present, if known. Provide a photograph, if available.

   Various, see Environmental Setting and Cover Type Descriptions in Report

Shrub / Scrub

1. Is shrub/scrub vegetation present at the site?

   Yes ☒ No ☐
   If "*no*," go to Section IIC: Open Field.

2. What percentage of the site is covered by shrub/scrub vegetation? <10% <10-acres
   Indicate the acres of shrub/scrub on the site map. Please identify what information was used to determine this area.
   Various, see Environmental Setting and Cover Type Descriptions and figures in Report

3. What is the dominant type of shrub/scrub vegetation, if known? Provide a photograph if available.
   Various, see Environmental Setting and Cover Type Descriptions in Report

4. What is the approximate average height of the shrub/scrub vegetation?

   ☐ 0-2 feet ☒ 2-5 feet ☐ > 5 feet

5. Based on site observations, how dense is the shrub/scrub vegetation?

   _____ Dense X Patchy _____ Sparse

ENVIRONMENTAL RISK GROUP

Open Field

1. Are there open (bare, barren) field areas present at the site?

   Yes ☒ No ☐
   If "*yes*," then indicate the type below:

   ☐ Prairie/Plains ☐ Savannah ☒ Old Field ☐ Other (specify) _______

2. What percentage of the site is open field? 10% about 10-15-acres
   Indicate the open field areas on the site map.

3. What is/are the dominant plant plants? Provide a photograph if available. ________________

   Various, see Environmental Setting and Cover Type Descriptions in Report

4. What is the approximate average height of the dominant plant? __________________________

5. Describe the vegetation cover:

   _____ Dense _____ Sparse B Patchy

ENVIRONMENTAL RISK GROUP

Miscellaneous

1. Are other types of terrestrial habitats present at the site, other than woods, shrub/scrub, and open field?

   Yes ☐ No ☒

   If "*yes,*" then identify and describe below.

   ____

   ____

   ____

   ____

2. Describe the terrestrial miscellaneous habitat(s) and identify these areas on the site map.

   ____

   ____

   What observations, if any, were made at the site regarding the presence and/or absence of insects, fish, birds, mammals, etc?

   ____

   ____

   ____

   ____

   ____

   ____

   Review the questions in Section I to determine if any additional habitat checklists should be completed for this site.

   ____

   ____

   ____

   ____

ENVIRONMENTAL RISK GROUP

Aquatic Habitat Checklist (non-flowing systems)

Note: *Aquatic systems are often associated with wetland habitats. Please refer to Section 5, Wetland Habitat Checklist.*

1. What type of open-water, non-flowing system is present at the site?

   ☒ Natural: ☒ pond/wetland ☐ lake

   ☐ Artificial ☐ lagoon ☐ reservoir ☐ canal ☐ impoundment

2. If known, what is the name(s) of the waterbody(ies) on or adjacent to the site?

   ____

3. If a waterbody is present, what are its known uses (e.g., recreation, navigation, etc.)?

   ____

4. What is the approximate size of the waterbody (-ies)? <4 acre(s)

5. Is any aquatic vegetation present?

   Yes ☒ No ☐
   If "*yes*," please identify the type of vegetation present, if known.

   XX Emergent _____ Submergent _____ Floating

   ____

6. If known, what is the depth of the water? <1-foot______________________________

   ____

7. What is the general composition of the substrate? (*check all that apply*)

   ☐ Bedrock ☐ Sand ☒ Muck (fine/black)
   ☐ Boulder (>10 in) ☒ Silt (fine) ☐ Debris
   ☐ Cobble (2.5-10 in) ☐ Marl (shells) ☐ Detritus
   ☐ Gravel (0.1-2.5 in) ☐ Clay (slick) ☐ Concrete
   ☐ Other (specify) ______________________________

8. What is the source of water in the waterbody?

   ☐ River/Stream/Creek ☒ Groundwater ☒ Other (specify) Ponding

   ☐ Industrial Discharge ☒ Surface Runoff

9. Is there a discharge from the site to the waterbody?
   Yes ☒ No ☐
   If "*yes*," then describe this discharge and its path (also, indicate on a map).

   Potential from groundwater and/or surface runoff

10. Is there a discharge from the waterbody?
    Yes ☐ No ☒
    If "*yes*," and the information is available, identify from the list below the environment into which the waterbody discharges.

☐ River/Stream/Creek	☐ Onsite	☐ Offsite	Distance ______
☐ Groundwater	☐ Onsite	☐ Offsite	Distance ______
☐ Wetland	☐ Onsite	☐ Offsite	Distance ______
☐ Impoundment	☐ Onsite	☐ Offsite	Distance ______

11. Identify any field measurements and observations of water quality that were made. For those parameters for which data were collected, provide the measurement and their units below:

    ______ Area ______ Depth (average)
    ______ pH ______ Dissolved oxygen ______ Salinity
    ______ Turbidity (clear, slightly turbid, turbid, opaque) (Secchi disk depth _____-m)
    ______ Other (specify)
    See data (Table 11) included in Eco Risk Assessment

12. Describe observed color and area of coloration.

    See Environmental Setting section in SLERA Report

13. Mark the open-water, non-flowing system on the site map attached to this checklist (see Figures).

14. What observations, if any were made at the waterbody regarding the presence and/or absence of benthic macroinvertebrates, fish, birds mammals, etc.?

    See Environmental Setting section in SLERA Report

Aquatic Habitat Checklist (flowing systems)

Note: *Aquatic systems are often associated with wetland habitats. Please refer to Section 5, wetland Habitat Checklist.*

1. What type(s) of flowing water system(s) is (are) present at or near the site?

   ☐ River ☐ Stream ☒ Creek
   ☐ Dry wash ☐ Arroyo ☐ Brook
   ☐ Artificially created ☐ Intermittent stream ☐ Channeling (ditch, etc,)
   ☐ Other (specify) ____________________

2. If known, what is the name of the waterbody? Johnson Creek—NOT ON SITE, near-by (1/4-mile to east/south)

3. For natural systems, any indicators of physical alteration (e.g., channeling, debris, etc.)?

   Yes ☐ No ☒
   If "*yes*," then describe the indicators observed.

   ____

   ____

4. What is the general composition of the substrate? Check all that apply.

   ☐ Bedrock ☐ Sand ☐ Muck (fine/black)
   ☐ Boulder (>10 in) ☐ Silt (fine) ☐ Debris
   ☐ Cobble (2.5-10 in) ☐ Marl (shells) ☐ Detritus
   ☐ Gravel (0.1-2.5 in) ☐ Clay (slick) ☐ Concrete
   ☐ Other (specify) ____________________

   ____

5. What is the condition of the bank (*e.g.*, height, slope, extent of vegetative cover)?

   Not observed

   ____

6. Is the system influenced by tides?
   Yes ☐ No ☒
   What information was used to make this determination?

   ____

   ____

7. Is the flow intermittent?
   Yes ☐ No ☒
   If "*yes*," then please note the information that was used in making this determination.
   According to NYSDEC the creek is perennial

8. Is there a discharge from the site to the waterbody?
   Yes ☐ No ☒
   If "*yes*," then please describe the discharge and its path.
   Surface water does not discharge from the site

9. Is there a discharge from the waterbody?
   Yes ☒ No ☐
   If "*yes*," and the information is available, please identify what the waterbody discharges to and whether the discharge in onsite or off site.
   Johnson Creek is part of the Conewango watershed and flows southwest into the Conewango Creek

10. Identify any field measurements and observations of water quality that were made. For those parameters for which data were collected, provide the measurement and their units below:

    __________ Area __________ Depth (average)
    __________ pH __________ Dissolved oxygen __________ Salinity
    __________ Turbidity (clear, slightly turbid, turbid, opaque) (Secchi disk depth _____-m)
    __________ Other (specify)
    See Table 11

11. Describe observed color and area of coloration.

12. Is any aquatic vegetation present?

    Yes ☐ No ☒
    If "*yes*," please identify the type of vegetation present, if known.

    _____ Emergent _____ Submergent _____ Floating

13. Mark the open-water, non-flowing system on the site map attached to this checklist. (see figures)

14. What observations, if any were made at the waterbody regarding the presence and/or absence of benthic macroinvertebrates, fish, birds mammals, etc.?

    None made

ENVIRONMENTAL RISK GROUP

Wetlands Habitat Checklist

1. Based on observations and/or available information are designated or known wetlands definitely present at the site?
   Yes ☒ No ☐
   Please note the sources of observations and information used (*e.g.*, USGS Topographic maps, National Wetland Inventory, Federal or State Agency, etc.) to make this determination.

   See report and figures

2. Based on the location of the site (*e.g.*, along a waterbody, in a floodplain) and site conditions (*e.g.*, standing water; dark, wet soils; mud cracks; debris line; water marks), are wetland habitats suspected?
   Yes ☒ No ☐
   If "*yes*," proceed with the remainder of the wetland habitat identification checklist.

3. What type(s) of vegetation are present in the wetland?

   ☐ Submergent ☒ Emergent ☒ Shrub/scrub ☒ Wooded

   ☐ Other (specify) ______________________

4. Provide a general description of the vegetation present in and around the wetland (height, color, etc.). Provide a photograph of the known or suspected wetlands, if available.

   See Environmental Settings section of report

5. Is standing water present?
   Yes ☒ No ☐
   If "*yes*," is this water:

   Fresh ☒ Brackish ☐ What is the approximate area of the water (sq. ft.)?

   <5-acres, intermittent

   Please complete questions 4, 11, 12 in Checklist 3 - Aquatic Habitat -- Non-Flowing Systems.

6. Is there evidence of flooding at the site? What observations were noted?

☐ Buttressing ☐ Water marks ☐ Mud cracks ☐ Debris line

☐ Other (describe below)

7. If known, what is the source of water in the wetland?

☐ Stream/River/Creek/Lake/Pond ☒ Groundwater

☒ Flooding ☒ Surface runoff

8. Is there a discharge from the site to a known or suspected wetland?

Yes ☒ No ☐
If "*yes*," please describe.

On site

9. Is there a discharge from the wetland?

Yes ☐ No ☒
If "*yes*," to what waterbody is the discharge released?

☐ Surface stream/River ☐ Groundwater ☐ Lake/pond ☐ Marine

10. If a soil sample was collected, describe the appearance of the soil in the wetland area. Circle or write in the best response.

Color (blue/gray, brown, black, mottled) ______________________

Water content (dry, wet, saturated/unsaturated) ______________________

See descriptions in Environmental Setting section of report

11. Mark the observed wetland area(s) on the attached site map.

See figures in SLERA report

References

USEPA, 1999, *Ecological Risk Assessment and Risk Management Principles for Superfund Sites*, Final, OSWER Directive 9285.7-28 P http://www.epa.gov/superfund/programs/risk/ecorisk/ final99.pdf

______, 1999, *ECOTOX Version 2.0*, Office of Research and Development, National; Health and Environmental Effects Lab, Mid-Continent Ecology Division http://www.epa.gov/ecotox

______, 1998, *Guidelines for Ecological Risk Assessment*, Final, EPA/630/R-95/002F http://www.epa.gov/ncea/ecorsk.htm

______, 1997, *Ecological Risk Assessment Guidance for Superfund, Process for Designing and Conducting Ecological Risk Assessments*, Interim Final EPA 540-R-97-006, OSWER Directive # 9285.7-25 http://www.epa.gov/superfund/programs/risk/ecorisk/ecorisk.htm

______, 1996, *ECOTOX Thresholds*, ECO Update, Interim Bulletin, Volume 3, Number 2, Washington, D.C. Office of Emergency and Remedial Response, Hazardous Site Evaluation Division; Publication 9345.0-12Fsi EPA/540/F-95/038; NTIS PB95-963324

______, 1996, *Ecological Significance and Selection of Candidate Assessment Endpoints*, ECO Update, Interim Bulletin, Volume 3, Number 1, Washington, DC, Office of Emergency and Remedial Response, Hazardous Site Evaluation Division; Publication 9345.0-11Fsi; EPA/540/F-95/037; NTIS PB95-963323

______, 1994, *Selecting and Using Reference Information in Superfund Risk Assessments*, ECO Update, Interim Bulletin, Volume 2, Number 4, Washington, DC, Office of Emergency and Remedial Response, Hazardous Site Evaluation Division; Publication 9345.10; EPA/540/F-94/050; NTIS PB94-963319

______, 1994, *Field Studies for Ecological Risk Assessment*, ECO Update, Interim Bulletin, Volume 2, Number 3, Washington, DC, Office of Emergency and Remedial Response, Hazardous Site Evaluation Division; Publication 9345.05I; EPA/540/F-94/014; NTIS PB94-963305

______, 1994, *Catalogue of Standard Toxicity Tests for Ecological Risk Assessment*, ECO Update, Interim Bulletin, Volume 2, Number 2, Washington, DC, Office of Emergency and Remedial Response, Hazardous Site Evaluation Division; Publication 93450-05I; EPA/540/F-94/013; NTIS PB94-963304

______, 1994, *Using Toxicity Tests in Ecological Risk Assessment*, ECO Update, Interim Bulletin, Volume 2, Number 1, Washington, DC, Office of Emergency and Remedial Response, Hazardous Site Evaluation Division; Publication 9345.05I; EPA/540/F-94/012; NTIS PB94-963303

______, 1992, *Briefing the BTAG: Initial Description of Setting, History, and Ecology of a Site*, ECO Update, Interim Bulletin, Volume 1, Number 5, Washington, DC, Office of Emergency and Remedial Response, Hazardous Site Evaluation Division; Publication 9345.0-05I

______, 1992, *Developing a Work Scope for Ecological Assessments*, ECO Update, Interim Bulletin, Volume 1, Number 4, Washington, DC, Office of Emergency and Remedial Response, Hazardous Site Evaluation Division; Publication 9345.0-05I

______, 1992, *The Role of the Natural Resource Trustees in the Superfund Process*, ECO Update, Interim Bulletin, Volume 1, Number 3, Washington, DC, Office of Emergency and Remedial Response, Hazardous Site Evaluation Division; Publication 9345.0-05I

______, 1991, *Ecological Assessment of Superfund Sites: An Overview*, ECO Update, Interim Bulletin, Volume 1, Number 2, Washington, DC, Office of Emergency and Remedial Response, Hazardous Site Evaluation Division; Publication 9345-0-05I

______, 1991, *The Role of BTAGs in Ecological Assessment*, ECO Update, Interim Bulletin, Volume 1, Number 1, Washington, DC, Office of Emergency and Remedial Response, Hazardous Site Evaluation Division; Publication 9345-0-05I

ENVIRONMENTAL
RISK GROUP

Appendix 3

Rare, Endangered, and Threatened Species Inquiries

ENVIRONMENTAL RISK GROUP

PO Box 848
Colchester, CT 06415

99 Lamberton Road, Suite 201
Windsor, CT 06095

860-925-6276 voice
860-683-4206 fax

VIA US MAIL

January 3, 2005

Information Services
New York Natural Heritage Program
625 Broadway, 5th Floor
Albany, NY 12233-4757

RE: EnRG Project #2004-BE-1
Peter Cooper Markhams NPL Site (EPA ID#NYD980592547)
Natural Heritage Program Information

To Whom It May Concern:

Environmental Risk Group (EnRG) has been retained to update a screening level ecological risk assessment (SLERA) for remedial activities at the referenced site. It is a 106-acre, wooded property in a flat-lying, rural farmland area on Bently Road near the hamlet of Markhams in the Town of Dayton, Cattaraugus County, NY 14041 (Lat: 42.392897 Long: -79.012572). The Markhams site was used for disposal of animal glue and industrial adhesive manufacturing residues between 1955 and 1971 from the Peter Cooper plant in Gowanda, NY.

The purpose of the SLERA is to identify potential impacts to ecological receptors associated with potential migration of constituents from the site. This analysis is being conducted under the oversight of USEPA, and consistent with EPA and NYSDEC guidance. One component of the analysis requires the identification of any ecologically sensitive species (within a 2-muile radius) such as rare, endangered, and threatened species, protected plant communities, and any other ecologically sensitive are that may be present at, on, in, or near the vicinity of the site.

In closing, please direct any correspondence concerning this request to my attention at the address noted in the letterhead. We appreciate your assistance in this matter; should you have any questions concerning this request or desire additional information, please call us at 860-925-6276.

Sincerely,

ENVIRONMENTAL RISK GROUP

Kurt A. Frantzen, Ph.D.
Owner

KAF/kaf

Enclosures Site-Specific Abstract of USGS Topographic 7.5-min Quadrangle Map—Perrysburg
USFWS Wetlands Mapper (Geocortex) Approximate Site Location

New York State Department of Environmental Conservation
Division of Fish, Wildlife & Marine Resources
New York Natural Heritage Program
625 Broadway, 5th floor, Albany, New York 12233-4757
Phone: (518) 402-8935 • **FAX:** (518) 402-8925
Website: www.dec.state.ny.us

Erin M. Crotty
Commissioner

January 13, 2005

RECEIVED JAN 17 2005

Kurt A. Frantzen
Environmental Risk Group
99 Lamberton Rd, Suite 201
Windsor, CT 06095

Dear Mr. Frantzen:

In response to your recent request, we have reviewed the New York Natural Heritage Program databases with respect to an Environmental Assessment for the proposed Remedial Activities at Peter Cooper Markhams NPL Project #2004-BE-1, site as indicated on the map you provided, including a 2-mile radius, located on Bently Road, Hamlet of Markhams, Town of Dayton, Cattaraugus County.

> We have no records of <u>known</u> occurrences of rare or state-listed animals or plants, significant natural communities, or other significant habitats, on or in the immediate vicinity of your site.

The absence of data does not necessarily mean that rare or state-listed species, natural communities or other significant habitats do not exist on or adjacent to the proposed site. Rather, our files currently do not contain any information which indicates their presence. For most sites, comprehensive field surveys have not been conducted. For these reasons, we cannot provide a definitive statement on the presence or absence of rare or state-listed species, or of significant natural communities. This information should not be substituted for on-site surveys that may be required for environmental assessment.

Our databases are continually growing as records are added and updated. If this proposed project is still under development one year from now, we recommend that you contact us again so that we may update this response with the most current information.

This response applies only to known occurrences of rare or state-listed animals and plants, significant natural communities and other significant habitats maintained in the Natural Heritage Data bases. Your project may require additional review or permits; for information regarding other permits that may be required under state law for regulated areas or activities (e.g., regulated wetlands), please contact the appropriate NYS DEC Regional Office, Division of Environmental Permits, at the enclosed address.

Sincerely,
Betty Ketcham
Betty A. Ketcham, Information Services
New York Natural Heritage Program

Enc.
cc: Reg. 9, Wildlife Mgr.

ENVIRONMENTAL
RISK GROUP

PO Box 848
Colchester, CT 06415

99 Lamberton Road, Suite 201
Windsor, CT 06095

860-925-6276 voice
860-683-4206 fax

VIA US MAIL

January 3, 2005

Information Services
U.S. Fish and Wildlife Service
3817 Luker Road
Cortland, NY 13045-9349

RE: EnRG Project #2004-BE-1
Peter Cooper Markhams NPL Site (EPA ID#NYD980592547)
Natural Heritage Program Information

To Whom It May Concern:

Environmental Risk Group (EnRG) has been retained to update a screening level ecological risk assessment (SLERA) for remedial activities at the referenced site. It is a 106-acre, wooded property in a flat-lying, rural farmland area on Bently Road near the hamlet of Markhams in the Town of Dayton, Cattaraugus County, NY 14041 (Lat: 42.392897 Long: -79.012572). The Markhams site was used for disposal of animal glue and industrial adhesive manufacturing residues between 1955 and 1971 from the Peter Cooper plant in Gowanda, NY.

The purpose of the SLERA is to identify potential impacts to ecological receptors associated with potential migration of constituents from the site. This analysis is being conducted under the oversight of USEPA, and consistent with EPA and NYSDEC guidance. One component of the analysis requires the identification of any ecologically sensitive species (within a 2-muile radius) such as rare, endangered, and threatened species, protected plant communities, and any other ecologically sensitive are that may be present at, on, in, or near the vicinity of the site.

In closing, please direct any correspondence concerning this request to my attention at the address noted in the letterhead. We appreciate your assistance in this matter; should you have any questions concerning this request or desire additional information, please call us at 860-925-6276.

Sincerely,

ENVIRONMENTAL
RISK GROUP

Kurt A. Frantzen, Ph.D.
Owner

KAF/kaf

Enclosures Site-Specific Abstract of USGS Topographic 7.5-min Quadrangle Map—Perrysburg
USFWS Wetlands Mapper (Geocortex) Approximate Site Location

FAX TRANSMITTAL RE: LISTED SPECIES REQUEST

U.S. FISH AND WILDLIFE SERVICE
New York Field Office
3817 Luker Road, Cortland, NY 13045
Phone: (607) 753-9334 Fax: (607) 753-9699

April 13, 2005

To: Kurt A. Frantzen

This responds to your January 3, 2005, request for listed species information in the vicinity of the Peter Cooper Markhams NPL Site in the Town of Dayton, Cattaraugus County, New York.

Except for occasional transient individuals, no Federally-listed or proposed endangered or threatened species under our jurisdiction are known to exist within the project impact area. In addition, no habitat in the project impact area is currently designated or proposed "critical habitat" in accordance with provisions of the Endangered Species Act (ESA) (87 Stat. 884, as amended; 16 U.S.C. 1531 *et seq.*). Therefore, no further ESA coordination or consultation with the U.S. Fish and Wildlife Service (Service) is required. Should project plans change, or if additional information on listed or proposed species or critical habitat becomes available, this determination may be reconsidered. The most recent compilation of Federally-listed and proposed endangered and threatened species in New York* is available for your information. If the proposed project is not completed within one year from the date of this FAX, we recommend that you contact us to ensure that the listed species presence/absence information for the proposed project is current. Should our determination change and any part of the proposed project be authorized, funded, or carried out, in whole or in part, by a Federal agency, further consultation between the Service and that Federal agency pursuant to the ESA may be necessary.

The above comments pertaining to endangered species under our jurisdiction are provided pursuant to the ESA. This response does not preclude additional Service comments under other legislation.

For additional information on fish and wildlife resources or State-listed species, we suggest you contact the appropriate State regional office(s),* and:

New York State Department of Environmental Conservation
New York Natural Heritage Program Information Services
625 Broadway
Albany, NY 12233-4757
(518) 402-8935

Thank you for your time. If you require additional information please contact me at (607) 753-9334.

Sincerely,

Michael F. Stoll
Endangered Species Biologist

*Additional information referred to above may be found on our website at:
http://nyfo.fws.gov/es/section7.htm

ENVIRONMENTAL
RISK GROUP

Appendix 4

Soil Survey Data and Information

Appendix 4 Soil Survey Data and Information

Table Explanations

(Abstracted from NRCS 2004)

Soil Taxonomic Classification

The system of soil classification used by the National Cooperative Soil Survey has six categories (Soil Survey Staff, 1998 and 1999). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. The table in this appendix shows the classification of the soils in the survey area. Depth to the upper and lower boundaries of each layer is indicated. The categories are defined in the following paragraphs.

ORDER: Twelve soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in sol. An example is Alfisols.

SUBORDER: Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Udalfs (Ud, meaning humid, plus alfs, from Alfisols).

GREAT GROUP: Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; type of saturation; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Hapludalfs (Hapl, meaning minimal horizonation, plus udalfs, the suborder of the Alfisols that has an udic moisture regime).

SUBGROUP: Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic subgroup is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other taxonomic class. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective Typic identifies the subgroup that typifies the great group. An example is Typic Hapludalfs.

FAMILY: Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Generally, the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineralogy class, cation-exchange activity class, soil temperature regime, soil depth, and reaction class. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine-loamy, mixed, active, mesic Typic Hapludalfs.

SERIES: The series consists of soils within a family that have horizons similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile.

Physical Soil Properties (J1a)

The table shows estimates of some physical characteristics and features that affect soil behavior. These estimates are given for the layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Particle size is the effective diameter of a soil particle as measured by sedimentation, sieving, or micrometric methods. Particle sizes are expressed as classes with specific effective diameter class limits. The broad classes are sand, silt, and clay, ranging from the larger to the smaller.

Sand as a soil separate consists of mineral soil particles that are 0.05 millimeter to 2 millimeters in diameter. The estimated sand content of each soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

Silt as a soil separate consists of mineral soil particles that are 0.002 to 0.05 millimeter in diameter. The estimated silt content of each soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. The estimated clay content of each soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of sand, silt, and clay affects the physical behavior of a soil. Particle size is important for engineering and agronomic interpretations, for determination of soil hydrologic qualities, and for soil classification.

The amount and kind of clay affect the fertility and physical condition of the soil and the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, saturated hydraulic conductivity (Ksat), plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earthmoving operations.

Moist bulk density is the weight of soil (oven-dry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at 1/3- or 1/10-bar (33kPa or 10kPa) moisture tension. Weight is determined after the soil is dried at 105 degrees C. In the table, the estimated moist bulk density of each soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. Depending on soil texture, a bulk density of more than 1.4 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

Saturated hydraulic conductivity refers to the ability of a soil to transmit water or air. The term "permeability" indicates saturated hydraulic conductivity (**Ksat**). The estimates in the table indicate the rate of water movement, in micrometers per second (um/sec), when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Ksat is considered in the design of soil drainage systems and septic tank absorption fields.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each soil layer. The capacity varies, depending on soil properties that affect retention of water. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Linear extensibility refers to the change in length of an unconfined clod as moisture content is decreased from a moist to a dry state. It is an expression of the volume change between the water content of the clod at 1/3- or 1/10-bar tension (33kPa or 10kPa tension) and oven dryness. The volume change is reported in the table as percent change for the whole soil. The amount and type of clay minerals in the soil influence volume change. Linear extensibility is used to determine the shrink-swell potential of soils. The shrink-swell potential is low if the soil has a linear extensibility of less than 3 percent; moderate if 3 to 6 percent; high if 6 to 9 percent; and very high if more than 9 percent. If the linear extensibility is more than 3, shrinking and swelling can cause damage to buildings, roads, and other structures and to plant roots. Special design commonly is needed.

Organic matter is the plant and animal residue in the soil at various stages of decomposition. The estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter. The content of organic matter in a soil can be maintained by returning crop residue to the soil. Organic matter has a positive effect on available water capacity, water infiltration, soil organism activity, and tilth. It is a source of nitrogen and other nutrients for crops and soil organisms.

Erosion factors are shown in the table as the K factor (Kw and Kf) and the T factor. [Entries under "Erosion Factors--T" apply to the entire profile. Entries under "Wind Erodibility Group" and "Wind Erodibility Index" apply only to the surface layer. Absence of an entry indicates that data were not estimated.]

- **Erosion factor K** indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) and the Revised Universal Soil Loss Equation (RUSLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter and on soil structure and Ksat. Values of K range from 0.02 to 0.69. Other factors being equal, the higher the value, the more susceptible the soil is to sheet and rill erosion by water.
- **Erosion factor Kw** indicates the erodibility of the whole soil. The estimates are modified by the presence of rock fragments.
- **Erosion factor Kf** indicates the erodibility of the fine-earth fraction, or the material less than 2 millimeters in size.
- **Erosion factor T** is an estimate of the maximum average annual rate of soil erosion by wind and/or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their susceptibility to wind erosion in cultivated areas. The soils assigned to group 1 are the most susceptible to wind erosion, and those assigned to group 8 are the least susceptible. The groups are described in the National Soil Survey Handbook.

Wind erodibility index is a numerical value indicating the susceptibility of soil to wind erosion, or the tons per acre per year that can be expected to be lost to wind erosion. There is a close correlation between wind erosion and the texture of the surface layer, the size and durability of surface clods, rock fragments, organic matter, and a calcareous reaction. Soil moisture and frozen soil layers also influence wind erosion.

Engineering Properties

The table gives the engineering classifications and the range of engineering properties for the layers of each soil in the survey area.

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles that are coarser than sand is 15 percent or more, then an appropriate modifier is added for example, "gravelly." Textural terms are defined in the Glossary.

Classification of the soils is determined according to the **Unified Soil Classification System** (ASTM, 2001) and the system adopted by the American Association of State Highway and Transportation Officials (AASHTO, 2000).

Rock fragments larger than 3 to 10 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an oven-dry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and plasticity index (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

Chemical Soil Properties

The table shows estimates of some chemical characteristics and features that affect soil behavior. These estimates are given for the layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Cation-exchange capacity is the total amount of extractable bases that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. Soils having a low cation-exchange capacity hold fewer cations and may require more frequent applications of fertilizer than soils having a high cation-exchange capacity. The ability to retain cations reduces the hazard of ground-water pollution.

Effective cation-exchange capacity refers to the sum of extractable bases plus aluminum expressed in terms of milliequivalents per 100 grams of soil. It is determined for soils that have pH of less than 5.5.

Soil reaction is a measure of acidity or alkalinity. It is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Calcium carbonate equivalent is the percent of carbonates, by weight, in the fraction of the soil less than 2 millimeters in size. The availability of plant nutrients is influenced by the amount of carbonates in the soil. Incorporating nitrogen fertilizer into calcareous soils helps to prevent nitrite accumulation and ammonium-N volatilization.

Gypsum is expressed as a percent, by weight, of hydrated calcium sulfates in the fraction of the soil less than 20 millimeters in size. Gypsum is partially soluble in water. Soils that have a high content of gypsum may collapse if the gypsum is removed by percolating water.

Landfills

The table also presents the degree and kind of soil limitations that affect **sanitary landfills** and **daily cover for landfill.** The ratings are both verbal and numerical. Rating class terms indicate the extent to which the soils are limited by all of the soil features that affect these uses. Not limited indicates that the soil has features that are very favorable for the specified use. Good performance and very low maintenance can be expected. Somewhat limited indicates that the soil has features that are moderately favorable for the specified use. The limitations can be overcome or minimized by special planning, design, or installation. Fair performance and moderate maintenance can be expected. Very limited indicates that the soil has one or more features that are unfavorable for the specified use. The limitations generally cannot be overcome without major soil reclamation, special design, or expensive installation procedures. Poor performance and high maintenance can be expected.

Numerical ratings in the table indicate the severity of individual limitations. The ratings are shown as decimal fractions ranging from 0.01 to 1.00. They indicate gradations between the point at which a soil feature has the greatest negative impact on the use (1.00) and the point at which the soil feature is not a limitation (0.00).

A **trench sanitary landfill** is an area where solid waste is placed in successive layers in an excavated trench. The waste is spread, compacted, and covered daily with a thin layer of soil excavated at the site. When the trench is full, a final cover of soil material at least 2 feet thick is placed over the landfill. The ratings in the table are based on the soil properties that affect the risk of pollution, the ease of excavation, trafficability, and revegetation. These properties include saturated hydraulic conductivity (Ksat), depth to bedrock or a cemented pan, depth to a water table, ponding, slope, flooding, texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, onsite investigation may be needed.

Hard, non-rippable bedrock, creviced bedrock, or highly permeable strata in or directly below the proposed trench bottom can affect the ease of excavation and the hazard of ground-water pollution. Slope affects construction of the trenches and the movement of surface water around the landfill. It also affects the construction and performance of roads in areas of the landfill.

Soil texture and consistence affect the ease with which the trench is dug and the ease with which the soil can be used as daily or final cover. They determine the workability of the soil when dry and when wet. Soils that are plastic and sticky when wet are difficult to excavate, grade, or compact and are difficult to place as a uniformly thick cover over a layer of refuse.

The soil material used as the final cover for a trench landfill should be suitable for plants. It should not have excess sodium or salts and should not be too acid. The surface layer generally has the best workability, the highest content of organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

In an **area sanitary landfill**, solid waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site. A final cover of soil material at least 2 feet thick is placed over the completed landfill. The ratings in the table are based on the soil properties that affect trafficability and the risk of pollution. These properties include flooding, Ksat, depth to a water table, ponding, slope, and depth to bedrock or a cemented pan.

Flooding is a serious problem because it can result in pollution in areas downstream from the landfill. If Ksat is too rapid or if fractured bedrock, a fractured cemented pan, or the water table is close to the surface, the leachate can contaminate the water supply. Slope is a consideration because of the extra grading required to maintain roads in the steeper areas of the landfill. Also, leachate may flow along the surface of the soils in the steeper areas and cause difficult seepage problems.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste. The ratings in the table also apply to the final cover for a landfill. They are based on the soil properties that affect workability, the ease of digging, and the ease of moving and spreading the material over the refuse daily during wet and dry periods. These properties include soil texture, depth to a water table, ponding, rock fragments, slope, depth to bedrock or a cemented pan, reaction, and content of salts, sodium, or lime.

Loamy or silty soils that are free of large stones and excess gravel are the best cover for a landfill. Clayey soils may be sticky and difficult to spread; sandy soils are subject to wind erosion.

Slope affects the ease of excavation and of moving the cover material. Also, it can influence runoff, erosion, and reclamation of the borrow area.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock, a cemented pan, or the water table to permit revegetation. The soil material used as the final cover for a landfill should be suitable for plants. It should not have excess sodium, salts, or lime and should not be too acid.

Map Unit	Allard silt loam, 3-8% slopes	Component Name Local Phase	Component Kind	Soil Name	Taxonomic Classification	Hydric Soil?	Slope - Low	Slope - RV	Slope - High	Textures String	Horizon Depth Range
20A	Unadilla silt loam, 0-3% slopes	Unadilla	Series	Unadilla	Coarse-silty, mixed, active, mesic Typic Dystrudepts		-	2	3	Silt loam	0-9
										Silt loam, Very fine sandy loam	9-55
										Fine sandy loam, Gravelly sand, Gravelly sandy loam, Very gravelly sand	55-72
22B	Allard silt loam, 3-8% slopes	Allard	Series	Allard	Coarse-silty over sandy or sandy-skeletal, mixed, active, mesic Typic Dystrudepts		3	4	8	Silt loam	0-9
										Silt loam, Very fine sandy loam	9-34
										Very gravelly loamy sand, Stratified very gravelly sand, Stratified sand to very gravelly loamy sand	34-72
25A	Chenango gravelly silt loam, 0-3% slopes	Chenango	Series	Chenango	Loamy-skeletal, mixed, superactive, mesic Typic Dystrudepts		-	2	3	Gravelly silt loam	0-9
										Gravelly silt loam, Gravelly very fine sandy loam, gravelly fine sandy loam, Very gravelly loam, Very gravelly silt loam	9-30
										Gravelly loamy fine sand, Very gravelly coarse sandy loam, Very gravelly loamy coarse sand, Stratified gravelly sand, Stratified very gravelly sand	30-72

Map Unit	Allard silt loam, 3-8% slopes	Component Name Local Phase	Component Kind	Soil Name	Taxonomic Classification	Hydric Soil?	Slope - Low	Slope - RV	Slope - High	Textures String	Horizon Depth Range
25B	Chenango gravelly silt loam, 3-8%slopes	Chenango	Series	Chenango	Loamy-skeletal, mixed, superactive, mesic Typic Dystrudepts		3	6	8	Gravelly silt loam	0-9
										Gravelly silt loam, Gravelly very fine sandy loam, gravelly fine sandy loam, Very gravelly loam, Very gravelly silt loam	9-30
										Gravelly loamy fine sand, Very gravelly coarse sandy loam, Very gravelly loamy coarse sand, Stratified gravelly sand, Stratified very gravelly sand	30-72
27A	Castile gravelly silt loam, 0-3% slopes	Castile	Series	Castile	Loamy-skeletal, mixed, active, mesic Aquic Dystrudepts		-	2	3	Gravelly silt loam	0-10
										Gravelly silt loam, Very gravelly loam, Very gravelly sandy loam	10-30
										Very gravelly loam, Very gravelly loamy sand, Stratified very gravelly sand	30-72
27B	Castile gravelly silt loam, 3-8% slopes	Castile	Series	Castile	Loamy-skeletal, mixed, active, mesic Aquic Dystrudepts		3	6	8	Gravelly silt loam	0-10
										Gravelly silt loam, Very gravelly loam, Very gravelly sandy loam	10-30
										Very gravelly loam, Very gravelly loamy sand, Stratified very gravelly sand	30-72

Map Unit	Allard silt loam, 3-8% slopes	Component Name Local Phase	Component Kind	Soil Name	Taxonomic Classification	Hydric Soil?	Slope - Low	Slope - RV	Slope - High	Textures String	Horizon Depth Range
34	Getzville silt loam	Getzville	Series	Getzville	Fine-silty over sandy or sandy-skeletal, mixed, active, nonacid, mesic Aeric Endoaquepts	YES	-	2	3	Silt loam	0-9
										Silty clay loam, Silt loam	9-24
										Sand, fine sand, Stratified fine sand to sand, Stratified very gravelly sand to loamy fine sand	24-72
39A	Halsey silt loam, 0-3% slopes	Halsey	Series	Halsey	Coarse-loamy over sandy or sandy-skeletal, mixed, active, nonacid, mesic Mollic Endoaquepts	YES	-	2	3	Silt loam	0-6
										Gravelly fine sandy loam, Gravelly loam, Gravelly silt loam, Loam, Very fine sandy loam	6-34
										Very gravelly loamy fine sand, Stratified gravelly sand	34-72
43	Canandaigua silt loam	Canandaigua	Series	Canandaigua	Fine-silty, mixed, active, nonacid, mesic Mollic Endoaquepts	YES	-	2	3	Silt loam	0-9
										Silty clay loam, Silt loam, Very fine sandy loam	9-32
										Silty clay loam, Silt loam, Very fine sandy loam	32-72

ENVIRONMENTAL RISK GROUP

Map Unit	Allard silt loam, 3-8% slopes	Component Name Local Phase	Component Kind	Soil Name	Taxonomic Classification	Hydric Soil?	Slope - Low	Slope - RV	Slope - High	Textures String	Horizon Depth Range
44	Canandaigua mucky silt loam	Canandaigua	Series	Canandaigua	Fine-silty, mixed, active, nonacid, mesic Mollic Endoaquepts	YES	-	2	3	Mucky silt loam	0-10
										Silty clay loam, Silt loam, Very fine sandy loam	10-32
										Silty clay loam, Silt loam, Very fine sandy loam	32-72
46	Swormville silt loam	Swormville	Series	Swormville	Fine-silty over sandy or sandy-skeletal, mixed, active, mesic Aeric Endoaqualfs		-	2	3	Silt loam	0-8
										Clay loam, Loam, Silty clay loam, Silt loam	8-31
										Very gravelly very fine sandy loam, Loamy fine sand, Loamy very fine sand, Sandy loam	31-35
										Very gravelly sand, Loamy fine sand, Loamy sand, Sand	35-72
49A	Red Hook silt loam, 0-3% slopes	Red Hook	Series	Red Hook	Coarse-loamy, mixed, superactive, nonacid, mesic Aeric Endoaquepts		-	2	3	Silt loam	0-9
										Gravelly loam, Gravelly sandy loam, Very gravelly sandy loam, Loam, Silt loam	9-32
										Gravelly loam, Gravelly silt loam, Very gravelly sandy loam	32-72
101	Udorthents, refuse substratm	Udorthents, refuse substratu	Taxon above family				-	2	3	Gravelly loam	0-24
										Variable	24-70

Map Unit	Allard silt loam, 3-8% slopes	Total Sand Range	Total Silt Range	Total Clay Range	Moist Bulk Density Range	Ksat Range	AWC Range	Linear Extensibility Range	Organic Matter Range	Erosion- Kw Factor	Erosion- Kf Factor	Erosion- T Factor	Wind Erodibility Group	Wind Erodibility Index
20A	Unadilla silt loam, 0-3% slopes	0-50	50-80	0-17	1.20-1.50	4.00-14.00	0.18-0.21	0.0-2.9	2.0-7.0	0.49	0.49	4	5	56
		0-85	0-80	0-17	1.20-1.50	4.00-14.00	0.17-0.20	0.0-2.9	0.0-1.0	0.64	0.64			
		44-100	0-49	0-17	1.45-1.65	14.00-141.0	0.01-0.10	0.0-2.9	0.0-0.5	0.17	0.2			
22B	Allard silt loam, 3-8% slopes	0-50	50-80	0-17	1.20-1.50	4.00-14.00	0.16-0.21	0.0-2.9	2.0-7.0	0.43	0.43	3	5	56
		0-85	0-80	0-17	1.20-1.50	4.00-14.00	0.15-0.20	0.0-2.9	0.0-1.0	0.64	0.64			
		70-100	0-29	0-15	1.45-1.65	14.00-141.0	0.01-0.03	0.0-2.9	0.0-1.0	0.17	0.2			
25A	Chenango gravelly silt loam, 0-3% slopes	0-50	50-80	0-27	1.20-1.50	4.00-42.00	0.08-0.16	0.0-2.9	2.0-6.0	0.24	0.32	3	5	56
		0-85	0-80	0-27	1.25-1.55	4.00-42.00	0.07-0.15	0.0-2.9	0.0-1.0	0.17	0.24			
		44-100	0-49	0-20	1.45-1.65	42.00-141.0	0.01-0.05	0.0-2.9	0.0-1.0	0.17	0.24			

ENVIRONMENTAL RISK GROUP

Map Unit	Allard silt loam, 3-8% slopes	Total Sand Range	Total Silt Range	Total Clay Range	Moist Bulk Density Range	Ksat Range	AWC Range	Linear Extensibility Range	Organic Matter Range	Erosion-Kw Factor	Erosion-Kf Factor	Erosion-T Factor	Wind Erodibility Group	Wind Erodibility Index
25B	Chenango gravelly silt loam, 3-8%slopes	0-50	50-80	0-27	1.20-1.50	4.00-42.00	0.08-0.16	0.0-2.9	2.0-6.0	0.24	0.32	3	5	56
		0-85	0-80	0-27	1.25-1.55	4.00-42.00	0.07-0.15	0.0-2.9	0.0-1.0	0.17	0.24			
		44-100	0-49	0-20	1.45-1.65	42.00-141.0	0.01-0.05	0.0-2.9	0.0-1.0	0.17	0.24			
27A	Castile gravelly silt loam, 0-3% slopes	0-50	50-80	0-27	1.10-1.40	4.00-42.00	0.09-0.16	0.0-2.9	2.0-6.0	0.24	0.32	3	8	0
		0-85	0-80	0-27	1.25-1.55	14.00-42.00	0.05-0.13	0.0-2.9	0.0-1.0	0.17	0.24			
		24-100	0-50	0-27	1.45-1.65	42.00-141.0	0.01-0.02	0.0-2.9	0.0-1.0	0.17	0.24			
27B	Castile gravelly silt loam, 3-8% slopes	0-50	50-80	0-27	1.10-1.40	4.00-42.00	0.09-0.16	0.0-2.9	2.0-6.0	0.24	0.32	3	8	0
		0-85	0-80	0-27	1.25-1.55	14.00-42.00	0.05-0.13	0.0-2.9	0.0-1.0	0.17	0.24			
		24-100	0-50	0-27	1.45-1.65	42.00-141.0	0.01-0.02	0.0-2.9	0.0-1.0	0.17	0.24			

Map Unit	Allard silt loam, 3-8% slopes	Total Sand Range	Total Silt Range	Total Clay Range	Moist Bulk Density Range	Ksat Range	AWC Range	Linear Extensibility Range	Organic Matter Range	Erosion-Kw Factor	Erosion-Kf Factor	Erosion-T Factor	Wind Erodibility Group	Wind Erodibility Index
34	Getzville silt loam	0-32	50-80	0-27	1.20-1.50	1.40-14.00	0.15-0.22	0.0-2.9	4.0-8.0	0.49	0.49	3	6	48
		0-32	50-80	18-35	1.20-1.50	1.40-14.00	0.15-0.20	0.0-2.9	0.0-1.0	0.43	0.43			
		70-100	0-29	0-15	1.45-1.65	14.00-42.00	0.02-0.08	0.0-2.9	0.0-1.0	0.17	0.2			
39A	Halsey silt loam, 0-3% slopes	15-50	50-80	0-17	1.10-1.30	4.00-14.00	0.16-0.24	0.0-2.9	3.0-5.0	0.28	0.32	3	8	0
		15-85	0-80	0-17	1.20-1.40	4.00-42.00	0.12-0.18	0.0-2.9	0.0-0.5	0.24	0.28			
		70-100	0-29	0-15	1.40-1.60	42.00-141.0	0.02-0.07	0.0-2.9	0	0.1	0.17			
43	Canandaigua silt loam	0-32	50-80	0-27	1.20-1.40	4.00-14.00	0.18-0.24	0.0-2.9	4.0-8.0	0.49	0.49	4	6	48
		0-82	0-80	18-35	1.20-1.40	1.40-4.00	0.16-0.20	0.0-2.9	0.0-1.0	0.49	0.49			
		0-82	0-80	18-35	1.15-1.40	1.40-4.00	0.16-0.20	0.0-2.9	0.0-1.0	0.64	0.64			

Map Unit	Allard silt loam, 3-8% slopes	Total Sand Range	Total Silt Range	Total Clay Range	Moist Bulk Density Range	Ksat Range	AWC Range	Linear Extensibility Range	Organic Matter Range	Erosion-Kw Factor	Erosion-Kf Factor	Erosion-T Factor	Wind Erodibility Group	Wind Erodibility Index
44	Canandaigua mucky silt loam	0-32	50-80	0-27	1.00-1.25	4.00-14.00	0.18-0.30	0.0-2.9	38645	0.43	0.43	4	5	56
		0-82	0-80	18-35	1.20-1.40	1.40-4.00	0.16-0.20	0.0-2.9	0.0-1.0	0.49	0.49			
		0-82	0-80	18-35	1.15-1.40	1.40-4.00	0.16-0.20	0.0-2.9	0.0-1.0	0.64	0.64			
46	Swormville silt loam	0-50	50-80	0-27	1.20-1.50	1.40-4.00	0.17-0.22	0.0-2.9	3.0-6.0	0.49	0.49	3	6	48
		0-52	20-80	18-35	1.55-1.70	0.42-4.00	0.15-0.17	0.0-2.9	0.0-1.0	0.43	0.43			
		44-91	0-49	0-20	1.60-1.75	14.00-42.00	0.03-0.08	0.0-2.9	0.0-1.0	0.17	0.2			
		70-100	0-29	0-15	1.60-1.75	14.00-42.00	0.02-0.08	0.0-2.9	0.0-1.0	0.17	0.2			
49A	Red Hook silt loam, 0-3% slopes	15-50	50-80	0-17	1.10-1.40	4.00-14.00	0.14-0.19	0.0-2.9	4.0-8.0	0.28	0.32	4	5	56
		15-85	0-80	0-17	1.25-1.55	4.00-14.00	0.04-0.17	0.0-2.9	0.0-1.0	0.24	0.28			
		15-85	0-80	0-17	1.45-1.65	4.00-42.00	0.04-0.11	0.0-2.9	0.0-1.0	0.17	0.24			
101	Udorthents, refuse substratm	25-52	28-50	7-27	1.20-1.80	0.42-141.00	0.03-0.15	0.0-2.9	0.0-4.0	0.1	0.17	---	8	0
		---	---	---	---	0.42-141.00	---	---	0.0-1.0	---	---			

Map Unit	Allard silt loam, 3-8% slopes	3-10" Fragments Range	4 Sieve Range	10 Sieve Range	40 Sieve Range	200 Sieve Range	Liquid Limit Range	Plasticity Index Range	Cation Exchange Capacity Range	Effective Cation Exchange Capacity Range	Soil pH Range	Calcium Carbonate Range	Gypsum Range
20A	Unadilla silt loam, 0-3% slopes	0	100	92-100	75-100	45-90	0-35	NP-10	---	12-28	4.5 - 6.0	0	0
		0	95-100	92-100	75-100	45-90	0-25	NP-10	---	3.0-15	4.5 - 6.0	0	0
		0-10	45-100	30-100	15-75	1-45	0-14	NP	---	---	5.1 - 7.8	0	0
22B	Allard silt loam, 3-8% slopes	0	100	92-100	70-100	40-90	0-35	NP-10	---	---	4.5 - 6.0	---	---
		0	100	92-100	75-100	45-90	0-35	NP-10	---	---	4.5 - 6.0	---	---
		0	40-100	25-100	10-75	0-30	0-14	NP	---	---	5.1 - 7.3	---	---
25A	Chenango gravelly silt loam, 0-3% slopes	0-10	50-92	40-85	25-80	15-70	0-35	NP-10	---	12-28	4.5 - 6.0	0	0
		0-10	40-85	30-70	20-70	10-65	0-40	NP-10	---	3.0-15	4.5 - 6.0	0	0
		0-10	40-75	20-60	10-45	1-20	0-14	NP	3.0-12	---	5.1 - 7.8	0	0

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Map Unit	Allard silt loam, 3-8% slopes	3-10" Fragments Range	4 Sieve Range	10 Sieve Range	40 Sieve Range	200 Sieve Range	Liquid Limit Range	Plasticity Index Range	Cation Exchange Capacity Range	Effective Cation Exchange Capacity Range	Soil pH Range	Calcium Carbonate Range	Gypsum Range
25B	Chenango gravelly silt loam, 3-8%slopes	0-10	50-92	40-85	25-80	15-70	0-35	NP-10	---	12-28	4.5 - 6.0	0	0
		0-10	40-85	30-70	20-70	10-65	0-40	NP-10	---	3.0-15	4.5 - 6.0	0	0
		0-10	40-75	20-60	16711	1-20	0-14	NP	3.0-12	---	5.1 - 7.8	0	0
27A	Castile gravelly silt loam, 0-3% slopes	0-10	70-90	60-75	40-70	15-65	0-30	NP-10	---	---	4.5 - 6.0	---	---
		0-10	45-85	30-70	15-65	5-65	0-30	NP-10	---	---	4.5 - 6.0	---	---
		0-10	40-70	25-50	16711	0-40	0-14	NP	---	---	5.1 - 7.3	---	---
27B	Castile gravelly silt loam, 3-8% slopes	0-10	70-90	60-75	40-70	15-65	0-30	NP-10	---	---	4.5 - 6.0	---	---
		0-10	45-85	30-70	15-65	5-65	0-30	NP-10	---	---	4.5 - 6.0	---	---
		0-10	40-70	25-50	10-45	0-40	0-14	NP	---	---	5.1 - 7.3	---	---

Map Unit	Allard silt loam, 3-8% slopes	3-10" Fragments Range	4 Sieve Range	10 Sieve Range	40 Sieve Range	200 Sieve Range	Liquid Limit Range	Plasticity Index Range	Cation Exchange Capacity Range	Effective Cation Exchange Capacity Range	Soil pH Range	Calcium Carbonate Range	Gypsum Range
34	Getzville silt loam	0	95-100	92-100	80-100	65-95	35-45	10-20	---	---	5.1 - 7.3	---	---
		0	95-100	92-100	80-100	65-95	20-40	5-20	---	---	5.6 - 7.3	---	---
		0-5	55-100	45-100	20-80	1-35	0-14	NP	---	---	6.6 - 7.8	---	---
39A	Halsey silt loam, 0-3% slopes	0-5	65-100	50-100	35-100	20-90	20-30	3-10	10-20	---	5.6 - 7.3	0	0
		0-5	65-100	50-100	35-100	20-90	20-30	3-10	3.0-8.0	---	5.6 - 7.3	0	0
		0-10	45-100	30-100	15-70	0-30	0-14	NP	1.0-4.0	---	6.1 - 8.4	1-5	0
43	Canandaigua silt loam	0	90-100	85-100	55-100	35-90	20-40	5-15	19-36	---	5.6 - 7.8	0	0
		0	90-100	85-100	65-100	45-95	20-40	5-15	4.0-10	---	5.6 - 7.8	0	0
		0	95-100	85-100	65-100	45-95	20-30	3-10	2.0-5.0	---	6.1 - 8.4	0	0

Map Unit	Allard silt loam, 3-8% slopes	3-10" Fragments Range	4 Sieve Range	10 Sieve Range	40 Sieve Range	200 Sieve Range	Liquid Limit Range	Plasticity Index Range	Cation Exchange Capacity Range	Effective Cation Exchange Capacity Range	Soil pH Range	Calcium Carbonate Range	Gypsum Range
44	Canandaigua mucky silt loam	0	90-100	85-100	55-100	35-90	35-55	5-15	23-45	---	5.6 - 7.8	0	0
		0	90-100	85-100	65-100	45-95	20-40	5-15	4.0-10	---	5.6 - 7.8	0	0
		0	95-100	85-100	65-100	45-95	20-30	3-10	2.0-5.0	---	6.1 - 8.4	0	0
46	Swormville silt loam	0	95-100	92-100	80-100	65-95	35-45	10-20	10-35	---	5.1 - 7.3	0-3	0
		0	95-100	92-100	80-100	65-95	20-35	5-15	5.0-20	---	5.6 - 7.3	0-3	0
		0	65-100	45-100	30-95	10-80	0-14	NP	5.0-20	---	6.1 - 8.4	2-10	0
		0-5	55-100	45-100	20-80	1-35	0-14	NP	1.0-15	---	6.1 - 8.4	2-15	0
49A	Red Hook silt loam, 0-3% slopes	0-5	65-95	50-92	35-90	20-80	15-40	1-15	---	---	5.1 - 6.5	---	---
		0-5	45-92	30-85	15-80	10-70	15-30	1-15	---	---	5.6 - 7.3	---	---
		0-10	40-90	25-75	15-70	2-65	15-30	1-15	---	---	5.6 - 7.8	---	---
101	Udorthents, refuse substratm	0-5	60-100	55-100	30-100	10-90	0-30	NP-15	---	---	4.5 - 8.4	---	---
		0	---	---	---	---	---	---	---	---	---	---	---

ENVIRONMENTAL RISK GROUP

Map Unit	Allard silt loam, 3-8% slopes	Trench Sanitary Landfill (Rating Class / Limiting Features & Ranking Value)	Area Sanitary Landfill (Rating Class / Limiting Features & Ranking Value)	Daily Cover for Landfill (Rating Class / Limiting Features & Ranking Value)
20A	Unadilla silt loam, 0-3% slopes	Very limited	Not limited	Not limited
		Seepage / 1		
22B	Allard silt loam, 3-8% slopes	Very limited	Very limited	Very limited
		Too Sandy / 1	Seepage / 1	Too Sandy / 1
		Seepage / 1		Seepage / 1 & Gravel Content / 0.26
25A	Chenango gravelly silt loam, 0-3% slopes	Very limited	Very limited	Very limited
		Too Sandy / 1	Seepage / 1	Too Sandy / 1
		Seepage / 1		Seepage / 1 & Gravel Content / 1

Map Unit	Allard silt loam, 3-8% slopes	Trench Sanitary Landfill (Rating Class / Limiting Features & Ranking Value)	Area Sanitary Landfill (Rating Class / Limiting Features & Ranking Value)	Daily Cover for Landfill (Rating Class / Limiting Features & Ranking Value)
25B	Chenango gravelly silt loam, 3-8%slopes	Very limited	Very limited	Very limited
		Too Sandy / 1	Seepage / 1	Too Sandy / 1
		Seepage / 1		Seepage / 1 & Gravel Content / 1
27A	Castile gravelly silt loam, 0-3% slopes	Very limited	Very limited	Very limited
		Depth to saturated zone / 1	Depth to saturated zone / 1	Too Sandy / 1 & Seepage / 1
		Seepage / 1 & Too Sandy / 1	Seepage / 1	Gravel Content / 1 & Depth to saturated zone / 0.96
27B	Castile gravelly silt loam, 3-8% slopes	Very limited	Very limited	Very limited
		Depth to saturated zone / 1	Depth to saturated zone / 1	Too Sandy / 1 & Seepage / 1
		Seepage / 1 & Too Sandy / 1	Seepage / 1	Gravel Content / 1 & Depth to saturated zone / 0.96

ENVIRONMENTAL RISK GROUP

Map Unit	Allard silt loam, 3-8% slopes	Trench Sanitary Landfill (Rating Class / Limiting Features & Ranking Value)	Area Sanitary Landfill (Rating Class / Limiting Features & Ranking Value)	Daily Cover for Landfill (Rating Class / Limiting Features & Ranking Value)
34	Getzville silt loam	Very limited	Very limited	Very limited
		Depth to saturated zone / 1	Depth to saturated zone / 1	Depth to saturated zone / 1
		Too Sandy / 1 & Seepage / 1	Seepage / 1	Too Sandy / 1 & Seepage / 0.5
39A	Halsey silt loam, 0-3% slopes	Very limited	Very limited	Very limited
		Depth to saturated zone / 1 & Ponding / 1	Ponding / 1 & Depth to saturated zone / 1	Too Sandy / 1 & Seepage / 1
		Seepage / 1 & Too Sandy / 1	Seepage / 1	Gravel Content / 1 & Depth to saturated zone / 0.16
43	Canandaigua silt loam	Very limited	Very limited	Very limited
		Depth to saturated zone / 1	Ponding / 1	Ponding / 1
		Ponding / 1	Depth to saturated zone / 1	Depth to saturated zone / 1

ENVIRONMENTAL RISK GROUP

Map Unit	Allard silt loam, 3-8% slopes	Trench Sanitary Landfill (Rating Class / Limiting Features & Ranking Value)	Area Sanitary Landfill (Rating Class / Limiting Features & Ranking Value)	Daily Cover for Landfill (Rating Class / Limiting Features & Ranking Value)
44	Canandaigua mucky silt loam	Very limited	Very limited	Very limited
		Depth to saturated zone / 1	Ponding / 1	Ponding / 1
		Ponding / 1	Depth to saturated zone / 1	Depth to saturated zone / 1
46	Swormville silt loam	Very limited	Very limited	Very limited
		Depth to saturated zone / 1	Depth to saturated zone / 1	Depth to saturated zone / 1
		Too Sandy / 1 & Seepage / 1	Seepage / 1	Too Sandy / 1 & Seepage / 0.5
49A	Red Hook silt loam, 0-3% slopes	Very limited	Very limited	Very limited
		Depth to saturated zone / 1	Depth to saturated zone / 1	Depth to saturated zone / 1
		Seepage / 1	Seepage / 1	Gravel Content / 0.75 & Seepage / 0.21
101	Udorthents, refuse substratm	Not rated	Not rated	Not rated

ENVIRONMENTAL RISK GROUP

Appendix 5

Ecological Effects Summary

Ecotoxicological Profiles for COPCs

The following sections summarize information from scientific literature on chemical toxicity; likely mechanisms of toxicity; and potential effects on receptor biota, populations, and ecosystems.

Semi-Volatile Organic Compounds

Polycyclic Aromatic Hydrocarbons (PAHs)

This class of compounds are generally made-up of fused benzene (aromatic) rings, hence the name polycyclic (or polynuclear) aromatic hydrocarbons. These semi-volatile compounds generally have low water solubility and high lipophilicity ("fat-loving"), causing them to have a high affinity for soil and sediment particles. Various chemical and physical properties for some PAHs detected at the Markhams site are presented in Table 12.

They are produced in fires; thus, PAHs are found universally in the environment. However, concentrations of these compounds are typically elevated in non-biological materials in industrial areas due to anthropogenic sources. Human activities release approximately 43,000 metric tons of PAHs into the atmosphere and 230,000 metric tons into aquatic environments each year. Most PAHs released to the atmosphere eventually reach surface soils and waters by direct deposition (Eisler 1987a).

The lower molecular weight PAHs (typically considered as those with two benzene rings) can volatilize from soil and surface water, and either may be degrade by light (photolysis) or biodegraded through the action of microbes (ATSDR 1995 and Wild and Jones 1993). Higher molecular weight PAHs, with more fused benzene rings, are more resistant to volatilization, photolysis, and biodegradation; and thus, they can persist in the environment. Biodegradation in aquatic systems, when it occurs, is more rapid in oxygenated systems than in anoxic systems (Neff 1979). Persistent PAHs also can bioconcentrate in aquatic organisms; however, they are generally metabolized and broken down. Food chain transfer and biomagnification is low. PAH exposure to wildlife generally comes through ingestion, and again, the PAHs are metabolized and eliminated.

Terrestrial vegetation and invertebrates can accumulate significant levels of PAHs. Plants can assimilate PAHs deposited on leaf surfaces as well as take up PAHs through the roots (Simonich and Hites 1994). Translocation of PAHs occurs within the plant, but concentrations are usually greater on plant surfaces than in internal tissues. Aboveground vegetation typically has higher PAH levels than do the roots. Reported plant PAH concentrations range from 20 to 1,000 μg/kg (fresh weight) in vegetation from nonpolluted areas, and up to 25,000 μg/kg (fresh weight) in polluted areas. Phytotoxic effects of PAHs are rare. The biomagnification potential of PAHs in vegetation in terrestrial and aquatic food chains has not been adequately investigated (Eisler 1987a).

Concentrations of PAHs in fish are generally not elevated. Reported values range from 3 μg/kg (fresh weight) for fish muscle from specimens collected in Lake Ontario to >15,000 μg/kg (fresh weight) in fish muscle from specimens collected near a wastewater treatment plant in Michigan. In aquatic systems, the PAH toxicity generally increases with increased molecular weight and increased alkyl substitution on the aromatic ring. Toxicity is most pronounced among crustaceans and least pronounced among fish. Most aquatic organisms appear to bioconcentrate PAHs rapidly, and uptake is highly species-specific. Bioconcentration factors for whole organisms and tissues are affected by biotic and abiotic factors and range from 0.02->82,000. The greatest accumulation occurs in benthic invertebrates and bottom-dwelling fish (Eisler 1987a). The many carcinogenic, and cytotoxic effects, as well as inhibited reproduction, inhibited respiration, and inhibited photosynthesis, have been reported among various biota (Eisler 1987a).

Wildlife exposed to PAHs primarily take-up these chemicals through ingestion, although inhalation of particles with sorbed PAHs and/or dermal contact also occurs (HSDB 2005). PAHs can be absorbed across the mucosal lining of the lung and in the gastrointestinal tract.

Little information is available on the effects of PAHs on terrestrial wildlife, but significant concentrations that could cause adverse effects are unlikely. The LD_{50} acute oral doses reported for laboratory rodents range from 50 to 2,000 mg/kg body weight. Adverse effects observed in laboratory mammals include carcinomas, testicular damage, oocyte and follicle destruction, and altered blood serum chemistry and nephrotoxicity.

Benzaldehyde

Benzaldehyde (CAS #100-52-7) has the molecular formula of C_7H_6O and a molecular weight of 106.12. It is a colorless liquid with an almond-like odor (Merck Index 1989). Its various chemical and physical properties are presented in Table 12.

In animals it is rapidly translocated through the bloodstream to the liver where there are many aldehyde oxidases transforming aldehydes to the corresponding carboxylic acids (HSDB 2005). However, large injected doses of benzaldehyde are reported to exert their most important toxic effects on the medulla, with slowing or paralysis of respiration.

HSDB (2005) reports the following LD_{50}s: Guinea pig oral 1000 mg/kg; Rat oral 1300 mg/kg; Mouse intraperitoneal 1000 mg/kg, Rabbit dermal 1250 mg/kg, and Rabbit sc 5.0 g/kg.

Rats & mice treated daily (5 days/wk) by gavage either in 12 doses of 0 (vehicle control), 100 (rats only), 200, 400, 800, 1600 or (for mice only) 3200 mg/kg/day (followed by 2 days' observation without treatment), or for 90 days in doses of 0, 50, 100, 200, 400 or 800 mg/kg/day (rats) or 0, 75, 150, 300, 600 or 1200 mg/kg/day (mice). The NOEL gavage doses were 400 mg/kg/day in male & female rats, 300 mg/kg/day in male mice, and 600-1200 mg/kg/day in female mice (as reported by Kluwe, WM *et al.*, Food Chem Toxicol 21 (3): 245-50 (1983) cited in HSDB 2005).

4-Methylphenol (p-Cresol)

Cresol (CAS #106-44-5) has the molecular formula of C_7H_8O and a molecular weight of 108.14. It is crystalline at room temperature, having a phenolic-tar-like odor (Merck Index 1989). Its various chemical and physical properties are presented in Table 12.

4-Methylphenol (p-cresol) is used as a solvent, a disinfectant, and is a chemical intermediate in the production of synthetic resins. It is also released to the environment via automobile exhaust and tobacco smoke. In ambient air, 4-methylphenol exists in the vapor phase. It exhibits moderate to high mobility in soil and biodegrades rapidly. If released into water, 4-methylphenol may adsorb to suspended solids and sediment in the water column (HSDB 2001).

The 4-methylphenol animal toxicity database is limited. Administration of 4-methylphenol by gavage for six to eighteen days during gestation resulted in hypoactivity of the central nervous system, respiratory distress and maternal death in rabbits (HEAST 2005). Skin application studies of mice indicate that cresols can serve as tumor promoters of a polycyclic aromatic hydrocarbon. In these studies mice were given a single dose of 0.3% dimethylbenzanthracene (DMBA) followed by application of cresols. The mice were subsequently examined for the presence of skin papillomas. In one study, 7/20 mice developed papillomas; in the other study approximately 29% developed skin papillomas (Boutwell and Bosch 1959). In an acute dermal toxicity study, technical grade p-cresol caused severe skin damage on at least a third of shaved, female, albino New Zealand rabbits within 4 hours of application of 300 mg/kg p-cresol (Vernot *et al.* 1977). The oral LD50 for rats is 207 mg/kg (Sax and Lewis 1989).

Metals

Arsenic

Background concentrations of arsenic are generally <10 µg/L in surface water and <15 mg/kg in soil (Eisler 1988a). Commercial use and production of arsenic compounds, such as agricultural insecticides and herbicides, have raised local concentrations above natural background concentrations in some areas. In the United States, arsenic levels >240,000 µg/L in surface water and 2.5 x 10^6 mg/kg soil (DW) in arsenic-pesticide-treated soils have been reported (Eisler 1988a). Arsenic concentrations of up to 3,500 mg/kg sediment (DW) in contaminated areas (Eisler 1988a), up to 30 mg/kg sediment in Lake Michigan (Eisler 1988a), and 47 to 209 µg/g sediment in Lake Texoma (Hunter *et al.* 1981) have been reported.

Soil invertebrates are directly exposed to arsenic in soil and soil-pore water, leading to exposure via ingestion and dermal adsorption; however, bioconcentration is low (Rhett *et al.* 1988).

Arsenic toxicity depends strongly on its chemical form and oxidation state. In general, inorganic arsenic compounds are more toxic than organic compounds, and trivalent forms are the most toxic (Eisler 1988a). Biota may take up arsenic via ingestion, inhalation, or absorption through body surfaces, and cells take up arsenic via the active transport system normally used in phosphate transport (Eisler 1988a).

Adverse effects on crops and vegetation, such as poor growth, seedling death, defoliation, and inhibition of photosynthesis, have been reported at concentrations of 1 to 25 mg water soluble arsenic/kg soil (equivalent to approximately 25 to 85 mg total arsenic/kg soil) (Eisler 1988a). Data on effects of arsenic on soil biota and insects are limited. Tolerant soil microbiota can withstand arsenic concentrations as high as 1,600 mg/kg soil (NAS 1977). In contrast, reduced growth and metabolism in sensitive species have been reported at arsenic concentrations of 375 mg/kg soil (NAS 1977), and soils with arsenic levels of 150 to165 mg/kg soil lost their earthworm biota and showed reduced quantities of microfauna (Eisler 1988a).

Mammals and birds are exposed to arsenic primarily by ingestion of contaminated vegetation and water. Arsenic is bioconcentrated by organisms but is not biomagnified in the food chain (Eisler 1988a). In birds, arsenic poisoning produces many effects, including loss of muscular coordination, slowness, loss of righting reflex, seizures, and death. Single oral doses producing 50% fatality in sensitive species (such as the turkey) range from 17 to 33 mg/kg body weight. In mammals, arsenic toxicosis can produce trembling, extreme weakness, vomiting, and death (Eisler 1988a). Because arsenic detoxification and excretion are rapid, poisoning is generally caused by acute or subacute exposures. Single doses reported to produce 50% fatality in sensitive mammal species ranged in concentration from 2.5 to 33.0 mg/kg body weight. Susceptible species have been adversely affected at chronic arsenic doses of 1 to 10 mg/kg body weight or 50 mg/kg diet (Eisler 1988a).

Adverse effects on aquatic biota have been reported at concentrations of 19 to 85 μg/L (Eisler 1988a). Fish exposed to 1 to 2 mg/L total arsenic for 2-3 days exhibited gill hemorrhages; fatty infiltration of the liver; and necroses of the heart, liver, and ovarian tissues. Developing toad embryos exhibited increased malformity or mortality following a 7-day exposure to 40 μg trivalent arsenic/L, and concentrations of 48 μg pentavalent arsenic/L significantly reduced growth in freshwater algae (EPA 1986). Many organisms accumulate arsenic from water, but there is little evidence of magnification through aquatic food chains (NAS 1977; Eisler 1988a). The AWQC for trivalent arsenic for the protection of aquatic life are 360 and 190μg/L for acute and chronic exposure, respectively (EPA 1986). Although no criteria for the protection of aquatic life have been developed for pentavalent arsenic because of insufficient data, the lowest-observed-effect levels for freshwater acute and chronic exposure are 850 and 48 μg/L.

Chromium

Chromium concentrations range from 5 to 300 mg/kg in soils and 1 to 10 µg/L in contaminated rivers and lakes (Eisler 1986). Sheppard and Evenden (1990) reported a mean chromium concentration of 38 µg/g for soil collected from 64 sites throughout Canada, and the World Health Organization (WHO 1988) reported an average concentration of 53 mg/kg for 863 samples collected in the United States. Chromium is most frequently encountered in the trivalent (III) or hexavalent (VI) oxidation states; the hexavalent form is more toxic because it has a higher oxidation potential and can easily penetrate biological membranes (Eisler 1986).

A variety of plants take-up and accumulate chromium. Adverse effects include decreased growth and leaf necrosis (Peterson and Girling 1981). Treatment of plants with nutrient solutions containing chromium (VI) concentrations of 5 mg/L or less resulted in decreased chlorophyll concentration, inhibition of seed germination and growth, and decreased root uptake of nutrients (WHO 1988). The high chromium concentrations reported in many plants may represent a significant pathway of chromium transport to herbivorous biota. Adverse effects of chromium on sensitive wildlife species have been reported at concentrations of 5.1 and 10.0 mg/kg of diet for chromium (VI) and chromium (III), respectively (Eisler 1986). Documented effects in birds include limb deformities, everted viscera, and stunting. In mammals, chromium exposure has resulted in altered blood chemistry, skin ulcerations, bronchial carcinomas, kidney and liver lesions, and teratogenic effects (Eisler 1986).

In aquatic systems, exposure to 10 µ/L of chromium (VI) inhibited growth in algae; frond growth in common duckweed; and survival and fecundity in Daphnia (Eisler 1986). For chromium (VI), acute toxicity values range from 23.07 µg/1- for a cladoceran to 1,870,000 µg/L for a stonefly; chronic values range from <2.5 µg/L for a daphnid to 1,987 µg/L for fathead minnows (USEPA 1986). Acute values for chromium (VI) range from 2,221 µg/L for a mayfly to 71,060 µg/L for a caddisfly; chronic values range from 66 µg/L for Daphnia to 1,025 µg/L for fathead minnows (USEPA 1986). For fish, chromium (VI) concentrations of 16 to 21 µg/L resulted in reduced growth; altered plasma cortisol metabolism; altered enzyme activities; chromosomal aberrations; and morphological changes in gill, stomach, and kidney tissues. The AWQC for chromium (VI) for the protection of freshwater biota are 16 and 11 µg/L for acute and chronic exposure, respectively (USEPA 1986). The AWQC for chromium (III) is hardness dependent. At a hardness of 200, the AWQC are 3,100 and 370 µg/L for acute and chronic exposure, respectively.

References

Agency for Toxics Substances and Disease Registry (ATSDR), 1990-2003, Toxicological Profiles, US Department of Health and Human Services, Atlanta, GA (available at: http://atsdr1.atsdr.cdc.gov/toxpro2.html)

Biddinger, GR and SP Gloss, 1984, The importance of trophic transfer in the bioaccumulation of chemical contamination in aquatic systems, Residue Reviews 91: 103-145

Boutwell, RK and DK Bosch, 1959, The tumor-promoting action of phenol and related compounds for mouse skin, Cancer Research 19:413-424

Clement Associates, Inc., 1985, Chemical, Physical, and Biological Properties of Compounds Present at Hazardous Waste Sites, Final Report, Prepared for USEPA, Arlington, VA

Eisler, R, 1986, Chromium Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review, Biological Report 85(1.6), US Fish and Wildlife Service: Laurel, MD

______, 1987a, Polycyclic Aromatic Hydrocarbon Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review, Biological Report 85(1.11)

______, 1988a, Arsenic Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review, Biological Report 85(1.12)

Hazardous Substances Data Bank (HSDB), 2005, available on the Internet at http://toxnet.nlm.nih.gov

HEAST, 1997, Health Assessment Effects Summary Tables, FY 1997 update, USEPA, Washington, DC

Hunter, RG, *et al.*, 1981, The relationship of trophic level to arsenic burden in fish of a southern Great Plains lake, Journal of Freshwater Ecology 1:121-127

Kabata-Pendias, A and H Pendias, 1992, Trace Elements in Soils and Plants, PT Kostecki, EJ Calabrese, Eds, Lewis Publishers, Inc.: Chelsea, MI

National Academy of Sciences (NAS), 1977, Arsenic, Washington, DC

Neff, J, 1979, Polycyclic Aromatic Hydrocarbons in the Aquatic Environment: Sources, Fates and Biological Effects, Applied Science Publishers, Ltd: London

Peterson, PJ and CA Girling, 1981, Other Trace Metals, IN: Effects of Heavy Metal Pollution on Plants, Volume 1, Effects of Trace Metals on Plant Function, NW Lepp Ed, Pollution Monitoring Series, Applied Science Publishers Ltd.: Englewood, NJ

Rhett, RG, JW Simmers, and CR Lee, 1988, Eisenia Foetida Used as a Biomonitoring Tool to Predict the Potential Bioaccumulation of Contaminants from Contaminated Dredging Materials, SPB Academic Publishing, pp321-328

Sax, NI, 1992, Dangerous Properties of Industrial Materials, Van Nostrand Reinhold: New York

Sax, NI and RJ Lewis, Sr, 1989, Dangerous Properties of Industrial Materials, 7th Ed, Van Nostrand Reinhold: New York

Sheppard, SC and WG Evenden, 1990, Characteristics of plant concentration ratios assessed in a 64-site field survey of 23 elements, Journal of Environmental Radioactivity 11:15-36

Simonich, S and R Hites, 1994, Importance of Vegetation in Removing Polycyclic Aromatic Hydrocarbons from the Atmosphere Nature 370:49-51

United States Environmental Protection Agency (USEPA), 1980, Uptake Metabolism and Disposal of Xenobiotic Chemicals in Fish, EPA 600/3-80-082, pp1-157

_______, 1986, Quality Criteria for Water—1986, EPA/440/5-86/001, Office of Water Regulations and Standards: Washington, DC, as cited in USATHAMA 1991

_______, 1991, National Primary Drinking Water Regulations: Final Rule, FR: 563578-3596, 30, January, 1991

_______, 1991, Proposed Sediment Quality Criteria for the Protection of Benthic Organisms, Office of Water, Research and Development and Science and Technology; Health and Ecological Criteria Division: Washington, DC

Vernot, EH, JD MacEwen, CC Haun, and ER Kinkead, 1977, Acute Toxicity and Skin Corrosion Data for some Organic and Inorganic Compounds and Aqueous Solutions, Toxicology and Applied Pharmacology 42(2):417-423

Wild, S and K Jones, 1993, Biological and abiotic losses of polynuclear aromatic hydrocarbons (PAHs) from soils freshly amended with sewage sludge, Environ Toxicol Chem 12:5-12

WHO, 1988, Chromium, Geneva, Switzerland: Environmental Health Criteria #61