Site Investigation Report,
Voluntary Cleanup Agreement D2-0002-99-10

Newtown Station Elmhurst Holder Tank Site

Elmhurst, Queens County,
New York

Prepared for KEYSPAN ENERGY
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March 2001

Table of Contents

List of Tables

List of Figures

Appendices

Executive Summary

This report presents the results of a Site Investigation conducted at the Newtown Station/Elmhurst Holder Tank Site. The Newtown Station/Elmhurst Holder Tank Site is located in Elmhurst, Queens County, New York. The property is bounded on the south by 57th Avenue, on the west by a ConRail right-of-way, on the north by Grand Avenue and on the east by 80th Street.

The site is presently owned by KeySpan Energy Corporation (KeySpan). The site was utilized primarily for the temporary storage of manufactured and natural gas in two holder tanks on-site. These two gas holder structures were decommissioned in 1993. Demolition of the holders should be completed in 2001.

The Site Investigation was conducted under a Voluntary Cleanup Agreement (VCA), Index #D2-0002-99-10 effective December 10, 1999, between KeySpan, and the New York State Department of Environmental Conservation (NYSDEC). The field work and this report were performed by Vanasse Hangen Brustlin, Inc. (VHB) on behalf of KeySpan. In addition, all field work was conducted in accordance with the NYSDEC approved Investigation Work Plan dated June 2000.

The purpose of the Site Investigation was to determine if any chemical constituents from former operations remain on-site, and if so, to what extent these materials present a threat to human health or the environment. The objective of the Site Investigation is to identify the presence and extent (if they exist) of chemical constituents at the site, evaluate them through a risk assessment associated with the presence of chemical constituents, and provide NYSDEC and KeySpan with sufficient information to develop and implement Interim Response Measures (IRMs) or remedial action(s), if necessary.

The Site Investigation consisted of a detailed record review, site reconnaissance, test pits, monitoring well installation, sample collection, sample analysis, and reporting. Site sampling activities included surface soil, subsurface soil, groundwater, and air sampling and analysis. Soil and groundwater samples were collected and analyzed for Volatile Organic Compounds (VOCs), Semi-Volatile Organic Compounds (SVOCs), Pesticides, Polychlorinated Biphenyls (PCBs), Inorganics, and Total Cyanide. Air samples were analyzed for lead. All samples were collected by VHB and analyzed by Severn Trent Laboratories (STL).

Laboratory analysis of the samples collected from the site indicate the presence of several SVOCs and inorganics above analytical method detection limits in surface soil, subsurface soil, and groundwater.

The surface soil analytical results indicated widespread distribution of lead and polycyclic aromatic hydrocarbons (PAHs) on-site. The analytical results with respect to the PAHs are subject to further evaluation because off-site background surface soil samples also contain PAHs.

Subsurface soil analytical results indicate that isolated "hot-spots" of PAHs are present on-site (west of Holder #1). Inorganic concentrations, specifically arsenic, are low. Low levels of VOCs also were detected in subsurface soils. Groundwater analytical results are consistent with subsurface soil findings.

TCLP analysis of paint chips indicates that the Lead-Based Paint debris (LBP) may be a hazardous waste according to federal regulations. Analysis of the air samples were non-detect at analytical method detection limits.

A risk analysis was conducted on the compounds detected in surface and subsurface soil. No risk analysis was performed on groundwater since there is no exposure pathway for this media. The risk analysis indicated that the lead in existing concentrations, in surface soil, represents a potential concern for human health. However, further investigation is required for the purpose of developing and evaluating remedial alternatives.

A fish and wildlife impact analysis was conducted to identify actual or potential risks to fish and wildlife. Several Chemicals of Potential Ecological Concern (COPECs) were detected at concentrations greater than the toxicological benchmark values. However, the site is not supporting, nor likely to support, any fish or wildlife resources due to its current and anticipated future land use. In addition, any remediation activity implemented to eliminate potential human health concerns will further mitigate potential impacts to wildlife. The site and surrounding area are poor quality environmental resources, due to the limited presence of vegetation. The observed chemicals detected on-site do not pose a current risk, nor is any expected in the future.

Based on a review of the data and current and future site usage, VHB proposes to perform an Interim Response Measure (IRM) to mitigate potential human heath concerns associated with lead in surface and shallow subsurface soils. Additionally, off-site background sampling should be expanded to sufficiently characterize background concentrations of SVOCs and lead adjacent to the site. The IRM will be predicated on a grid sampling program to define the aerial extent of lead in soil prior to excavation and removal. The results of the grid sampling may preclude implementation of the IRM. The established grid will serve as control for verification sampling following removal. Clean-up goals also will be developed as part of this IRM.

1

Introduction

Report Organization

This report has been prepared for the KeySpan Energy Corporation (KeySpan) by Vanasse Hangen Brustlin, Inc. (VHB). The report summarizes field work and analytical data collected by VHB on behalf of KeySpan during the performance of a Site Investigation at the Newtown Station/Elmhurst Holder Tank Site.

Section 1 provides an introduction to this report, purpose and objectives, site layout, background and history, and the results of Record Reviews as described in the work plan. Section 2 summarizes the field activities. Section 3 presents the analytical data obtained from analysis of the samples collected during the field activities. Section 4 is the Risk Analysis which describes potential threats to humans and environmental receptors (if any) posed by existing conditions at the site. Section 5 provides conclusions and recommendations based on the Risk Analysis and analytical data collected during the investigation. Section 6 is a certification that the work was performed in substantial compliance with the approved work plan. Section 7 summarizes the references used during the generation of this Site Investigation report.

Purpose

KeySpan executed an Voluntary Cleanup Agreement (VCA), Index #D2-0002-99-10 effective December 10, 1999, with the New York State Department of Environmental Conservation (NYSDEC) for the development and implementation of an investigation and remediation program (if necessary) at the Newtown Station/Elmhurst Holder Tank Site.

Dvirka & Bartilucci Consulting Engineers (D&B) in conjunction with VHB prepared and submitted a work plan to NYSDEC on behalf of KeySpan in December 1999. The work plan included surface soil, subsurface soil, groundwater, and air sampling. A revised work plan based on initial NYSDEC and NYSDOH comments was submitted in June 2000. Final NYSDEC/NYSDEC comments received in July 2000 were incorporated via a letter addendum prepared by VHB dated August 3, 2000.

KeySpan received formal notification to proceed with the work plan from NYSDEC in October 2000. Field work commenced October 23, 2000 and concluded on November 10, 2000. This report presents the data from the aforementioned field effort.

Objective

The objective of this document is to provide NYSDEC sufficient information to determine whether chemical constituents associated with previous site use are present at the site, and if so, determine if they constitute a significant threat to public health or the environment. If a significant threat is associated with chemical constituents at the site, results from the investigation will serve as a basis for the development of Interim Response Measure (IRM), if necessary, and/or remedial measures.

Location

The Newtown Station/Elmhurst Holder Tank site is located in Elmhurst, Queens County, New York. The property is bounded on the south by 57th Avenue, on the west by a ConRail right-of-way, on the north by Grand Avenue and on the east by 80th Street (see Figure 1-1). The property includes the following parcels:

> Block 2805/Lot 31, which is zoned M3-1. This is the larger parcel of the overall site and includes the gas holders and compressor station ("Exhauster House") on the central and southern portion of the property.
>
> Block 2806/Lot 1, which is zoned residential. This is the smaller parcel of land adjacent to Grand Avenue, on the northern portion of the property.

The entire Newtown Station/Elmhurst Holder Tank site comprises approximately 6 acres. The two holder tanks, which collectively provided 20 million cubic feet of storage capacity for use during peak demand until 1993 when they were decommissioned, are located in the northern and central portion of the site and occupy approximately 3 acres. A compressor station referred to as the "Exhauster House" is located at the southeast corner of the site, and a one-story satellite station utilized for office space and parts storage exists in the southwest corner of the site. Two prefabricated hazardous waste storage sheds are also located on-site along the western property boundary. One of these sheds is utilized as a 90-day storage area and typically contains drummed personal protective equipment (PPE), oily rags, and other miscellaneous materials generated on-site. The other shed is utilized to store PPE and other spill-related control equipment and materials. Several other material/equipment storage buildings also exist in the southern portion of the site. Site topography is presented in Figure 1-2.

INSERT - Figure 1-1

Site Location Map

INSERT - Figure 1-2

Site Plan

The surrounding area is primarily urban and land use is mostly residential with some industrial and commercial areas. Commercial development consisting of neighborhood stores exists to the immediate north side of Grand Avenue (north of the site) and the "backyard" areas of attached single-family residential units are located immediately east of the site along the northern portion of 80th Street. A Bell Atlantic service center is also located immediately east of the site along the southern portion of 80th Street. Immediately to the south of the southern property boundary is 57th Avenue, and the Long Island Expressway is further to the south.

The region is characterized as having numerous small variations in topographic relief. Regionally, drainage occurs primarily through sheet flow runoff, which is conveyed to sewers and eventually discharges into local tidal water bodies. The 6-acre site, however, is relatively flat with little relief, and is approximately 75 feet above mean sea level (msl). Based on a regional 1989 United States Geological Survey (USGS) report, highly permeable, Pleistocene-aged glacial outwash deposits consisting of stratified medium to coarse sands and gravels comprise the unconfined Upper Glacial aquifer to approximately 100 feet below mean sea level (msl), or to a depth of approximately 175 feet below grade. A confining unit known as the Raritan Clay exists below the Upper Glacial aquifer, and is estimated to be between 50 and 75 feet thick. The site appears to be located beyond the reaches of the Magothy Aquifer. Bedrock is estimated to be between 150 and 175 feet below msl, or 225 to 250 feet below grade.

Site History

The site is presently owned by KeySpan. The site was utilized primarily for the temporary storage of manufactured and natural gas in two holder tanks. The two gas holder structures were decommissioned in 1993 and are currently being dismantled. The Station is out of service with the exception of the facility serving as a distribution operations satellite facility. A Site Plan is presented on Figure 1-2.

During its period of operation, the major function of the Newtown Station/Elmhurst Holder Tank site was for the temporary storage of gas for peak-demand use in the two "water seal" type holder tanks on-site. Although, the gas holders did, in fact, store manufactured gas during their initial years of operation, gas was not manufactured at the Elmhurst facility. Gas initially stored at this site was manufactured at nearby facilities and conveyed through the existing distribution system to the Elmhurst facility for temporary storage. Subsequently, the facility was utilized to store natural gas. Historically, the two gas holders have been referred to as the "Elmhurst Tanks." The base of Gas Holder No. 1 is approximately 35 feet below grade, has a diameter of 254 feet, and was constructed in approximately 1910. The base of Gas Holder No. 2 is approximately 12 feet below grade, has a diameter of 276 feet, and was constructed in approximately 1921. These two holders were both of "water seal" type construction, each with a capacity of approximately 10 million cubic feet. The holders were utilized until 1993, when KeySpan initiated the decommissioning of the facility.

KeySpan currently uses the site as a distribution operations satellite facility. The one-story satellite station facility, currently used for office space and parts storage to support current operations, was constructed in 1968.

Previous Investigations and Decommissioning/ Closure Activities

The following section provides a summary of prior investigations, analytical sampling programs and decommissioning/closure activities undertaken on-site. The following investigation and decommissioning/closure activities are being conducted independently of work performed under the VCA for the site.

Demolition of Holder Tank Structures

As previously mentioned, KeySpan initiated the decommissioning of the two holder tanks in 1993. Demolition was completed in June 2000.

In December 1993, the New York City Department of Environmental Protection (NYCDEP) issued KeySpan an authorization to discharge up to 30 gpm of water from the holder tanks to the combined city sewer system, subsequent to treatment with the existing carbon system as installed following the 1990 audit. A total of approximately 34 million gallons of water (17 million gallons from each holder) were removed in association with this program.

To support the dewatering and decommissioning of the holder tanks, analytical sampling of the water in the holders, treated effluent, and bottom sludge/sediment has been undertaken. In addition, KeySpan conducted monthly sampling of the treated effluent being discharged to the New York City sewerage system, as required by the NYCDEP discharge authorization.

In July 1996, each of the three "pipe wells" and associated piping components for each of the two gas holders were drained of any residual water, visually inspected to confirm its structural integrity, and backfilled to grade with clean fill.

In November 1996, KeySpan completed the dismantling and removal of the guide frame of each holder tank, and the telescoping walls of the holders were "collapsed" within their respective foundations.

Subsequent to the completion of the dewatering activities, residual solids were removed from the bottom of the holders. Analytical sampling of the sludge/sediment was conducted in 1992 and 1995. Additional analytical sampling of the holder sludge/sediment was also undertaken in August 1999.

Preparation for the environmental cleaning of the two retired gas holders began in September of 1999 and was completed in May 2000. All material was properly placarded and transported in accordance with 6 NYCRR Parts 364 and 372 to a Temporary Storage and Disposal Facility for treatment prior to off-site disposal at a landfill in Grows, Pennsylvania. Proper waste manifests were being used to document all shipments leaving the site.

Historical maintenance of the exterior walls of the holder tank structures has typically involved sand blasting of the aboveground portion of each holder’s water tank that resided partially above and below grade, and manual scraping of the holder shells, cups and structural steel guide frames followed by repainting activities. Due to the age of the structures, it is likely that lead based paint was utilized to support these maintenance programs. This is evidenced by the fact that elevated concentrations of lead have been detected in the holder sludge/sediment. Although lead based paint typically would only be utilized on the exterior of the structures, a pathway from the exterior walls to the interior of the tank exists due to the “cupped” design of the telescoping walls of the water seal type holders. In response to this concern, as well as a complaint from an adjacent residence to the New York City Department of Health that expressed concern over the potential presence of lead based paint chips associated with the historical maintenance of the holders, various activities have been undertaken by KeySpan to investigate and mitigate concerns over residual concentrations of lead based paint. These activities included, but are not limited to, analytical sampling for residual lead in air and soil samples in the vicinity of the site.

Based on an interview conducted by D&B with KeySpan on December 16, 1999, the following discussion presents a summary of the activities undertaken by KeySpan in response to concerns over lead based paint. KeySpan received an initial complaint on September 9, 1996 from a resident residing on or about 80th Street. KeySpan responded by conducting a sampling program at certain locations within the adjacent residential properties. In general, lead concentrations in soil were found to be within acceptable ranges, particularly given the highly urbanized location of the site. Although the lead levels at the Monroe residence were found to be acceptable, approximately 6 inches of topsoil was removed and replaced. Overall, approximately 12 paint chips were found in this yard, and 1 paint chip was found in the swimming pool of an adjacent yard. All remaining properties had no identifiable paint chips.

After a review of the results of all sampling activities, laboratory analysis, and remedial activities, the New York City Department of Health indicated that it was satisfied with the program and closed the case.

Former Diesel Storage Tanks

Two 15,000-gallon aboveground diesel storage tanks (ASTs) were previously located on the southwestern portion of the Newtown Station site. These ASTs were utilized for fueling of fleet vehicles. The aboveground tanks and associated supporting structures, including the secondary containment system, were demolished and all related fuel was removed for disposal in 1974.

Auto Repair Building

An Auto Repair Building was previously located in the southwestern section of the site. This facility was constructed in 1968 and was reportedly utilized for tire replacements and oil changes on fleet vehicles. Based on an interview conducted by D&B with KeySpan on November 16, 1999, this facility was demolished in the mid 1990's.

Former Underground Gasoline Storage Tank

Underground gasoline storage tanks (USTs) and a dispensing island are depicted on a 1970 construction plan of the east side of the former auto repair building. Handwritten notations on the plan indicate that while two 550-gallon USTs were proposed, only one 2,000-gallon UST was ultimately installed. This tank was utilized for fueling fleet vehicles. This UST was removed in November 1996. KeySpan received a "no further action" letter from NYSDEC for the UST.

Underground "Fogging Oil" Storage Tank

A 1,500-gallon underground storage tank was previously utilized on-site to contain "fogging oil" to the west of the exhauster house. Based on an interview conducted by D&B with KeySpan on December 16, 1999, "fogging oil" was previously utilized to lubricate seals in gas lines on site. KeySpan indicated that "fogging oils" typically used included petroleum-based lubricants, propylene glycol, as well as water.

KeySpan stated that all "fogging" equipment on site was retired 15 to 20 years ago. Based on the December 16th interview, we now understand that while a formal underground storage tank "closure report" was not prepared, as the work was completed prior to the enactment of specific state or federal environmental regulatory requirements, the tank closure was undertaken in accordance with the requirements prescribed by the New York City Fire Department (NYCFD) at that time. The NYCFD typically required the removal of material from the tank and its ancillary equipment, the decontamination of the tank and associated piping and pumps, and the backfilling of the tank with a cement slurry.

2

Field Investigation Activities

Overview

KeySpan has entered into a Voluntary Cleanup Agreement (VCA) with the New York State Department of Environmental Conservation (NYSDEC) to conduct an investigation at the Newtown Station/Elmhurst Holder Tank site. In accordance with the provisions of the VCA, a work plan was prepared by D&B which details the methods and procedures to be utilized during the implementation of the field investigation program. This work plan was approved by the NYSDEC in October 2000 and followed by VHB during the completion of all field investigation activities described herein. D&B identified the principal area of environmental concern to be "the potential presence of residual lead contamination in surface soil on-site." As specified in the work plan, the general objectives of the investigation were to:

> Sufficiently characterize the site to achieve an understanding of the nature and extent of any residual impact in on-site surface and subsurface soil, as well as groundwater;
>
> Identify and evaluate the health and environmental risks associated with any chemical constituents in an effort to determine the need for remedial action; and
>
> Obtain sufficient technical information to allow the identification, evaluation, selection, design and implementation of remedial alternatives, if required.

The objectives of the investigation later were later expanded to include the determination of off-site surface soil conditions north and south of the site along Grand and 57th Avenues, respectively. In addition, the drainage ditch associated with the former overflow discharge pipe extending from Holder Number 1 was targeted by VHB during off-site surface soil sampling activities as specified in correspondence dated August 3, 2000. This drainage ditch is located adjacent to the railroad siding immediately to the west of the site.

The field investigation program consisted of several subtasks including site reconnaissance; air exposure monitoring; test pit installation and sampling; surface soil sampling; subsurface soil sampling; groundwater monitoring well installation and sampling; and a sample location survey. On October 23, 2000 VHB mobilized a field team to the site. This team included two technical specialists from VHB and drilling support crews from VHB's subcontractor Miller Environmental Group

(MEG). VHB worked in closed coordination with KeySpan's site supervisors and direct subcontractors during the completion of all field investigation activities. The investigation work activities were substantially completed by November 9, 2000, and VHB and MEG were demobilized from the site by November 10, 2000. The following sections summarize all of the aforementioned field subtasks. In addition, a summary of all samples collected as part of the field investigation program can be found in Table 2-1 which follows.

Table 2-1
Summary of Collected Samples and Analytical Parameters

Sample Matrix / Location	Total Samples	Samples Analyzed	Analytical Parameters	Quality Assurance / Quality Control Samples
Ambient Air	4	4	Total Lead (Method 6010B)	NA
Test Pits	16	16	Total Lead (Method 6020), TCLP Lead (Methods 1311/ 6020)	1 MS/ MS Duplicate
Surface Soils	32	32	TCL Volatile Organic Constituents (Method 8260B), TCL Semivolatile Organic Constituents (Method 8270C), Polychlorinated Biphenyls (Method 8082), Pesticides (Method 8081A), TAL/ RCRA 8 Metals (Methods 6010B/ 7471A) and Total Cyanide (Method 9012A)	4 MS/ MS Duplicate
Subsurface Soils(1)	138	29	TCL Volatile Organic Constituents (Method 8260B), TCL Semivolatile Organic Constituents (Method 8270C), Polychlorinated Biphenyls (Method 8082), Pesticides (Method 8081A), TAL/ RCRA 8 Metals (Methods 6010B/ 7471A) and Total Cyanide (Method 9012A)	3 MS/ MS Duplicate
Groundwater	5	5	TCL Volatile Organic Constituents (Method 8260B), TCL Semivolatile Organic Constituents (Method 8270C) and RCRA 8 Metals (Methods 6010B/ 7471A)	1 MS/ MS Duplicate 1 Trip Blank

(1) Includes total amount of samples collected via both Hollow Stem Auger and Geoprobe drill rigs

NA - Not Applicable

MS - Matrix Spike

TCL - Target Constituent List

TAL - Target Analyte List

RCRA - Resource Conservation and Recovery Act

Site Reconnaissance

At the commencement of the field investigation program, VHB performed a site reconnaissance. The purpose of the site reconnaissance was for the field team to become familiar with the site; identify sample areas; adjust sample locations based on existing site conditions; review utility clearances with the site operators and MEG; identify potential Health and Safety (H&S) concerns; and determine if there were any recognized environmental conditions (RECs) which may/or may not be associated with potential source areas at the site. No potential areas of RECs were identified during the reconnaissance. In addition, potential areas of H&S concerns were mitigated through closely coordinated and constant interaction between VHB, KeySpan's site supervisors and their direct subcontractors.

Air Monitoring

Air monitoring for VOCs and dust was conducted at approximate 200-foot intervals around the perimeter of the site and directly upwind and downwind of the work area during intrusive work activities with the hollow-stem auger (HSA) rig. Perimeter air monitoring for VOCs and dust was conducted at approximate hourly intervals with a Photoionization Detector (PID) and a digital dust meter (*i.e.*, MiniRam), respectively. All data collected during the field program was documented in a dedicated field log book which is maintained in VHB's project file. Continuous perimeter air monitoring for lead was eliminated from the field program due to the redundancy with the on-going air monitoring program implemented at the site in support of the holder demolition program.

Test Pit Installation and Sampling

A total of 6 shallow test pits were excavated and sampled during this subtask to profile the subsurface burial depth of potentially lead containing paint chips along the western property boundary of the site (see Figure 1-2). The excavation and sampling of test pits was not initially a component of the field investigation program work plan. Based on site reconnaissance and discussions with KeySpan, test pits were performed in an attempt to delineate the areal extent of paint chip disposal. The test pits were excavated between one and three feet below ground surface. These soils were potentially impacted with lead through the deposition of paint chips generated during routine holder maintenance activities. KeySpan provided internal earth moving equipment and an operator and a VHB technical specialist observed the work which was handled under a change order. Representative surficial and endpoint samples (12 total) were collected upon reaching the extents of the excavations. In addition, 4 composite paint chip samples were collected off of the scrap steel from Holder Number 1 for reference analysis.

Both the test pit and paint chip samples were submitted for analysis of total lead by ICP using EPA method 6020. One matrix spike (MS)/matrix spike duplicate (MSD) sample was collected from the test pits for Quality Assurance/Quality Control (QA/QC) analyses. In addition, in an effort to assess hazard characteristics and potential leachability of lead into soil, one of the paint chip samples was analyzed for total lead utilizing the Toxicity Characteristic Leaching Procedure (TCLP) as specified in EPA method 1311/6020.

Surface Soil Sampling

Based on the results of the field reconnaissance and the sampling protocol in the work plan, a total of 32 surface soil samples were collected at selected locations on- and off-site. Surface soil samples NSSS-01 through -16 were collected on-site; surface sample locations NSSS-17 through 26 were collected from the right-of-ways along both Grand and 57th Avenues; and samples NSSS-27 through 32 were collected from the drainage ditch adjacent to the western boundary of the site. Refer to Figure 1-2 for the sample locations. The 10 samples along the right-of-ways on Grand and 57th Avenues were not in the initial scope of work for the field program. These samples were collected to represent a background condition data set for the site.

The samples were collected, handled, packaged, shipped and analyzed as specified in the work plan. Each of the surface soil samples was a composite of the 0-2 inch interval below ground surface. The samples were collected using dedicated polystyrene sampling scoops and transferred directly to laboratory provided sample glassware. All of the samples were inspected for purposes of determining the physical characteristics of the soil and screened for volatile organic vapors utilizing a PID immediately upon collection. The samples were labeled and packaged in coolers, chilled to 4 degrees C, and transported to STL for analysis by courier.

The samples were analyzed for Target Constituent List (TCL) Volatile Organic Constituents (VOCs) and Semivolatile Organic Constituents (SVOCs), and Target Analyte List (TAL) / Resource Conservation and Recovery Act (RCRA) metals including total cyanide. In addition, selected samples were analyzed for Polychlorinated Biphenyls (PCBs) and pesticides. Four MS/MSD samples were collected for QA/QC analyses. Refer to section 3 for a summary of the analytical results, and sample information records for each sample which are presented in Appendix A.

Subsurface Soil Sampling

Up to 8 soil borings were initially proposed to be installed during this subtask of the field investigation program. In total, 15 subsurface soil borings (designated NSSB-01 through NSSB-15) were attempted. Refer to Figure 1-2 for subsurface soil boring locations. Shallow refusal was encountered several times during installation efforts at soil boring locations NSSB-11 and NSSB-12, and as a result these borings were not advanced beyond an approximate depth of 4 feet below grade.

In general, the soil borings were installed as specified in the NYSDEC approved Work Plan for the field investigation program. The additional 7 borings installed during the field work were advanced to delineate a "hot spot" in the area extending from the location of the former diesel aboveground storage tank (AST) approximately 200 feet north adjacent to Holder Number 1. The following matrix details the general installation locations of the all of the soil borings as well as the sampling methodology employed:

Soil Boring Designation	Installation Location	Sampling Methodology
NSSB-01 & NSSB-02	Location of former auto repair building and fogging oil tank.	Continuous soil sampling to approximately 20' bgs with selection of 2 samples per boring for analysis.
NSSB-03, NSSB-09, NSSB-10, NSSB-11 & NSSB-12	Location of former diesel AST. (Note: shallow refusal encountered at NSSB-11 & NSSB-12).	Continuous soil sampling to approximately 20' bgs with selection of 2 samples per boring for analysis. (Note: only 1 sample selected for analysis at locations NSSB-09 & NSSB-10; no samples collected at NSSB-11 & NSSB-12)
NSSB-04, NSSB-05 & NSSB-06	North and south of Holder Number1.	Soil sampling at 5-foot intervals to approximately 51' bgs with selection of 1 sample per 10-foot interval for analysis.
NSSB-07 & NSSB-08	North of Holder Number 2.	Soil sampling at 5-foot intervals to approximately 28' bgs with selection of 1 sample per 10-foot interval for analysis.
NSSB-13, NSSB-14 & NSSB-15	West of Holder Number 1.	Soil sampling at 5-foot intervals to maximum depth possible, or 10 feet beneath noted impact, with collection of 1 endpoint sample per boring for analysis.

bgs – below ground surface

All of the soil borings were installed using an AMS Power Probe® drill rig supplied by MEG. The AMS Power Probe® utilizes the direct-push drilling methodology to advance narrow-diameter sampling tools into the subsurface which are capable of retrieving soil samples at discrete intervals. All subsurface sampling tools were decontaminated between soil boring locations by steam cleaning. The soil borings were filled to grade utilizing the cuttings removed during the sampling process, and each one was capped at grade with a bentonite seal.

Upon collection all samples were screened for total organic vapors utilizing a PID and inspected for purposes of determining the physical characteristics of the soil and presence of subsurface impact, if applicable. All of the borings were described in the project field log-book consistent with American Society for Testing and Materials

(ASTM) standard D 2488-00, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure). Descriptive logs for each one of the soil borings completed during the field investigation program is included in Appendix B.

The samples selected for analysis were properly labeled and packaged in coolers, chilled to 4 degrees C, and sent via courier to STL. All of the samples were analyzed for TCL VOCs and SVOCs, and TAL / RCRA metals including total cyanide. In addition, selected samples were analyzed for PCBs and pesticides. Three MS/MSD samples were collected for QA/QC analyses. Refer to section 3 for a summary of the analytical results.

Groundwater Monitoring Well Installation and Sampling

A total of 5 permanent groundwater monitoring wells, designated NSMW-01 through NSMW-05 were installed on-site during the field investigation program. Refer to Plan 1 for the monitoring well locations. The monitoring wells were installed utilizing the HSA drilling methodology and constructed with 2-inch I.D., Schedule 40 PVC, 15-foot long, 0.010-inch slot screens and flush-joint threaded PVC casing extending to grade. Ideally, the well screens were set 5 feet above and 10 feet below the groundwater table interface. Due to problems encountered with the initial installation attempts for wells NSMW-02 and NSMW-04, 20-foot long screens were utilized during their reinstallation. Additionally, based on the variable depth to water at the site, the wells were screened at total depths ranging from approximately 60 to 75 feet below grade.

During the installation of the wells split-spoon samples were collected on 5-foot intervals to determine the physical characteristics of the subsurface soils at the site. None of these samples were selected for chemical analyses. Standard accepted well construction practices were employed during the installation of the 5 wells. In particular, a #10 inert silica gravel pack was installed in the borehole extending from depth to 2 feet above the well screen. A bentonite seal of at least 2-foot thickness was installed in the borehole immediately above the gravel pack. The remainder of the annular space was filled to grade with a Portland cement/bentonite grout. The wells were finished at grade in locking, steel protective casings anchored in concrete pads. Monitoring well construction diagrams and specifications for sand pack and bentonite grout can be found in Appendix C.

After the installation of all 5 monitoring wells, MEG and VHB worked together to develop them utilizing numerous methodologies. The technologies employed included submersible pump, surging and evacuation with a blank packer and steel bailer and air lifting. Numerous parameters including turbidity, pH, temperature, specific conductance and dissolved oxygen were monitored and recorded during the development of the wells. The wells were developed until the monitored turbidity dropped below 50 Nephelometric Turbidity Units (NTU), or two hours had elapsed since commencement. Due to the nature of the subsurface at the site, the later was ordinarily the case.

Following development, the wells were allowed to stabilize for at least 48-hours prior to sampling. Depth to groundwater and total well depth measurements were collected relative to the north side of the casing of each of the wells prior to sampling to determine purge volumes and potentiometric surface characteristics. These elevations were tied to local datum during the field survey subtask detailed below. Groundwater elevation data collected on November 9, 2000 is summarized in Table 2-2 which follows.

Table 2-2
Summary of November 9, 2000 Groundwater Monitoring Data

Monitoring Well Designation	Ground Surface Elevation	Well Casing Elevation	Depth to Water	Depth of Well	Water Table Elevation
NSMW-01	80.50	80.35	42.86	60.30	37.49
NSMW-02	81.30	80.92	51.07	65.08	29.85
NSMW-03	81.00	80.77	62.35	74.60	18.42
NSMW-04	82.40	82.15	64.10	74.50	18.05
NSMW-05	80.30	80.12	61.70	75.00	18.42

All elevations and measurements are in feet above mean sea level.

Parameters such as turbidity, pH, temperature, specific conductance and dissolved oxygen were monitored and recorded during purging to determine well stability in preparation for sampling. In addition, 3 to 5 calculated well volumes were purged from the wells on November 9, 2000 prior to sampling. The samples were labeled and packaged in coolers, chilled to 4 degrees C, and sent to STL by courier for analysis. All five groundwater samples were analyzed for TCL VOCs and SVOCs and RCRA metals. One MS/MSD samples was collected for QA/QC analyses. One Trip Blank was al submitted with these samples for TCL VOC analysis only. Refer to section 3 for a summary of the analytical results, and sample information records for each sample which are presented in Appendix A.

Sample Location Survey

VHB's internal survey crews were utilized to provide locating services at the site. VHB is certified to provide survey services in the State of New York under license number 50310. All sample locations were surveyed on November 10, 2000. Groundwater monitoring well casing were surveyed to the nearest 0.01 foot, and ground elevations for the wells and all other sample locations were surveyed to the nearest 0.1 foot. A topographic and boundary survey previously performed by Lynch, Giuliano & Associates, Inc. was used as the base map for this survey. This map was provided to VHB by KeySpan in electronic format prior to the commencement of the field investigation program. All sample locations were located on this base map. Refer to Figure 1-2 for details regarding the survey.

Deviations from the Work Plan

In general, the field investigation tasks were implemented and completed in accordance with the specifications provided in the work plan. A total of four (4) primary Field Changes were executed during the investigation field program. Each one of these Field Changes is briefly described below:

Field Change One - Test pit excavation and subsurface profiling of the burial depth of lead paint chips at six (6) locations along the western property boundary of the site. Collection of a surficial and endpoint soil sample for analysis from each excavation. Collection of a total of four (4) composite paint chip samples from the Holder Number 1 scrap steel for reference analysis.

Field Change Two - Collection of background surface soil samples for chemical analysis at a total of ten (10) selected locations along Grand and 57th Avenues north and south of the site, respectively. Samples will represent a background condition data set for the site and support spatial and statistical calculations made during data reduction.

Field Change Three - Elimination of lead in air sampling from perimeter air monitoring program established for the field investigation program. Sampling eliminated due to the redundancy with the on-going air monitoring program implemented at the site in support of the demolition program. Hourly site perimeter walks with "real-time" monitoring instruments during intrusive work activities were maintained to satisfy the requirements of the community air monitoring plan.

Field Change Four - Installation of a total of six (6) additional Geoprobe soil borings at selected locations proximal to the area of the former diesel aboveground storage tanks (AST) adjacent to the west side of Holder #1. Sampling was employed to verify the nature and extent of residual subsurface hydrocarbon impact. Selection of a maximum of two (2) samples per boring for chemical analysis under standard work plan parameters.

Additionally, one modification to the air sampling program was incorporated. Air sampling pumps equipped with a 0.8 μm MCE filters were setup at temporary stations to collect 8-hour grab samples for particulate lead concentrations. The samples were submitted to Severn Trent Laboratories (STL) for analysis of lead in air by United States Environmental Protection Agency (EPA) method 6010B. Due to laboratory communication problems, the appropriate equipment to conduct air sampling for lead was not received on-site until late in the program. Air sampling for lead was only conducted during the installation of groundwater monitoring well NSMW-05.

3

Field Investigation Analytical Results

Overview

The following paragraphs summarize the results of the samples collected for analysis over the course of the field investigation program based upon field screening data and organoleptic (visual and olfactory) appraisal, and in an effort to remain in substantial compliance with the NYSDEC approved work plan for the site. This discussion of analytical results is broken down into discrete sections for air exposure monitoring, test pit sampling, surface soil sampling, subsurface soil sampling and groundwater monitoring well sampling. In addition to the specific analytes quantified, each discrete section describes potential sources for the compounds as well as any potential impact to human health and the environment.

Analytes quantified at or above method detection limits (MDL) are presented in summary tables included throughout this section. Complete Form I records and case narratives for the sample delivery groups (SDG) managed and analyzed by STL during the investigation program are included in Appendix D. In addition, all analytical results underwent Data Validation by a third party contractor. Based on this review, all data collected during the field program is usable for environmental assessment purposes. The complete validation report is included in its entirety in Appendix E.

Air Exposure Monitoring Results

As indicated in Section 2, air exposure monitoring was conducted routinely at the site during intrusive hollow-stem auger drill rig work. Upwind and downwind samples were collected at well location NSMW-05 utilizing calibrated air sample pumps and 0.8μm MCE filters. Upon analysis the samples revealed less than method detection limit concentrations of lead. It should be noted that the method detection limit specified by the laboratory was greater than the Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL) for lead of 0.05 mg/m^3. This analytical data is summarized in Table 3-1, and the analytical reports are included in Appendix D.

Test Pit Sampling Results

All 12 soil samples collected from the test pits revealed concentrations of lead greater than method detection limits. Total lead concentrations quantified in these samples ranged from 85.2 to 196,000 mg/Kg. Concentrations of lead detected in the paint chip samples ranged from 41,900 to 50,900 mg/Kg. A lead concentration of 121 mg/L was detected in the paint chip sample selected for TCLP analysis. It should be noted that the EPA Toxicity Characteristic (TC) regulatory level for lead is 5 mg/L indicating that this media is hazardous. The ICP analysis conducted on soils and paint chips to compare the lead in the paint versus the lead in the soil was inconclusive. The sample results are summarized in Table 3-2, and the analytical reports are included in Appendix D. Sample Information Records are presented in Appendix A and summarized below. Additionally, the sample results are summarized graphically in Figure 3-1 which follows.

Generally, concentrations of lead in surficial samples collected from the test pits were orders of magnitude greater than those quantified in the endpoint samples collected at the bottom of the excavations. In addition, the endpoint sample results, with the exception of the sample collected at NSTP-06, exhibited concentrations consistent with eastern USA background levels for lead. These data suggest that the vertical extent of lead impacted soil was effectively delineated during the test pit program. The data also indicate that the test pit locations bound the areal extent of surficial lead impact. However, the endpoint samples collected at test pit locations NSTP-01 and NSTP-06 indicate that deeper verification sampling may need to be performed at these locations prior to the design and approval of an interim remedial action (IRM).

Test Pit	Depth	Soil Description
NSTP-1	0 - 1.5'	Gravel
	1.5' – 3.5'	Brown, fine to medium sand.
NSTP-2	0 –1.5'.	Gravel
	1.5' – 3'	Dark brown medium sands and fines, organic fill
	3' – 4'	Red medium sand.
NSTP-3	0 – 1'	Gravel, light to dark brown sand; paint chips
NSTP-4	0 – 1'	Paint chips
	1' – 3'	Dark brown, fine to medium sand, organics
NSTP-5	0 – 1'	Gravel
	1' – 4'	Dark brown sand and gravel with paint chips
NSTP-6	0 – 1'	Gravel, paint chips
	1' – 3'	Dark brown, fine to medium sands, organics loose

INSERT - Figure 3-1

Summary of Test Pit Sample Results

Surface Soil Sampling Results

All 32 surface soil samples collected during the field investigation program were inspected and screened for total organic vapors with a PID upon collection. All of the surface soil samples were submitted to STL for analysis under standard chain-of-custody protocol. None of the samples revealed residual impact characteristics upon organoleptic appraisal. In addition, none of the samples revealed organic vapor concentrations as determined by PID response. Surface soil samples (NSSS-01 through 16) collected on-site general consisted of brown medium to coarse sands with gravel and a trace of cobbles and organics. The samples collected from the right-of-ways along both Grand (NSSS-17 through 21) and 57th Avenues (NSSS-22 through 26) consisted of fill materials composed of relatively clean medium sands with little coarse materials and fines. Samples NSSS-27 through 32, which were collected in the overflow ditch adjacent to the western boundary of the site, were generally composed of dark brown loose organic topsoil (loam) with some cobbles. The analytical results generated from these samples are summarized in the following paragraphs. Figure 3-2 presents a graphical summary of selected constituents quantified in the surface soil samples which pose a potential threat to human health and the environment.

All of the surface soil samples were analyzed for TCL VOCs. Nondetect concentrations of all VOCs were detected in 8 of the 32 surface soil samples. The remainder of the samples revealed concentrations of VOCs either at estimated levels below or just above method detection limits (MDL). A number of the surface soil samples, 18 in total, were analyzed twice to confirm matrix interference. Both of the analyses were reported by the lab and are summarized in Table 3-3 with an "RE" data qualifier. The initial results were utilized for purposes of assessing threats posed to human health and the environment, if any. In addition, methylene chloride was detected in the sample and method blank matrices of all of the surface soil samples, while acetone and toluene where detected in the samples and blanks of a few samples. All three of these constituents are common lab contaminants which were summarized during data reduction, but screened out during data review. However, it should be noted that all of the VOCs were detected at levels substantially lower than the EPA Region III promulgated Risk Based Concentrations (RBCs) for industrial soil.

Concentrations of SVOCs were detected in all 32 of the surface soil samples. Two of the samples were analyzed twice to confirm matrix interference, and two other samples were analyzed at lesser secondary dilution factors to also confirm matrix interference. All of these secondary analyses were reported by the lab and are summarized in Table 3-4 with "RE" and "DL" data qualifiers for the former and later, respectively. Bis(2-Ethylhexyl)phthalate, which is a laboratory spike recovery compound and plasticizer, was detected in the samples and blanks of 20 of the 32

INSERT - Figure 3-2

Summary of Surface Soil Sample Results

surface soil samples submitted for analysis. Levels of potentially carcinogenic polycyclic aromatic hydrocarbons (CPAH) greater than EPA industrial soil RBCs were detected in surface soil both on- and off-site. The CPAH subset of SVOCs consists of eight compounds - carbazole, benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno(1,2,3-cd)pyrene and dibenzo(a,h) anthracene. The remainder of the SVOCs were generally detected at concentrations below the RBC guidance values. In addition, the levels and distribution of SVOCs appear to be generally consistent between on- an off-site surface soils. Notable exceptions to this are samples NSSS-08 (on-site) and NSSS-17 (off-site) which exhibited concentrations of CPAHs 2 to 3 orders of magnitude greater than the levels characteristically detected at the site. These findings suggest adjacent off-site sources such as the Long Island Expressway (to the south), the railroad (to the west) and a former gas station (to the north).

A selected number of the surface soil samples, 4 in total, were also analyzed for PCBs and pesticides. All of the samples exhibited concentrations of PCBs and pesticides. The PCB congeners detected in the samples were Aroclor-1254 and Aroclor-1260. All of the PCBs and pesticides were detected at concentrations below EPA industrial soil RBCs. However, it should be noted that two of the pesticides, Endosulfan Sulfate and Endrin Ketone, do not have associated RBC guidance values. PCB and pesticide data are summarized in Tables 3-5 and 3-6, respectively.

All 32 of the surface soil samples were analyzed for inorganics. In total, 28 of the 32 samples were analyzed for RCRA metals while the remaining 4 samples were selected for analysis of the full complement of TAL metals including total cyanide. Total cyanide was not detected in any of these samples. Concentrations of arsenic detected in the samples were generally consistent with eastern USA soil background levels, and at or just above the conservative EPA industrial soil RBC for arsenic of 3.8 milligrams per kilogram (mg/kg). The remainder of the inorganic constituents in the samples were quantified at concentrations which were generally consistent with eastern USA soil background levels and less than EPA industrial soil RBCs. Spiked sample recovery results for selenium in all of the samples and arsenic and mercury in a number of the samples were reported by the lab as not being within control limits. In addition, duplicate analysis results for chromium and lead in the majority of the surface soil samples were not within control limits. The results of the samples submitted for RCRA metals analysis are summarized in Table 3-7, while the data for the 4 samples submitted for TAL metals analysis are summarized in Table 3-8.

Subsurface Soil Sampling Results

A total of 138 subsurface soil samples were collected during the completion of the HSA and direct-push soil borings installed during the field investigation program. Of these samples, 29 were selected and submitted to STL for analysis under standard chain-of-custody protocol. Physical characteristics and descriptions of all of the samples were recorded in the field logbook upon collection by the supervising technical specialist. Subsurface soils at the site generally consist of brown to yellowish-orange, medium dense fine and medium sands with trace coarse sand, gravel and cobbles. The lithology at the site seems to grade downward with and appreciably great amount of fine silty-sand/clay deposits identified at greater depths. This is important implication particularly as regards the vertical component of migration at the site. An interesting native layer detected at depth (approximately 35 to 40 feet bgs) was a bog (peat) type deposit with heavy organics and petrified wood fragments.

Organoleptic appraisal of all samples upon collection limited the extent of subsurface impact to the area of the former diesel AST approximately 200 feet due north adjacent to Holder Number 1. In addition, all of the samples were screened for organic vapors upon collection utilizing a PID which confirmed the results of the foregoing appraisals. These screening results ranged from less than instrument detection limits at the majority of the soil borings to approximately 400 parts per million (ppm) at soil boring location NSSB-15. As detailed in Section 2, the sample collection and selection methodology employed at the site was consistent with what was specified in the NYSDEC approved Investigation Work Plan. The analytical results generated from the 29 subsurface soil samples selected for laboratory analysis are summarized in the following paragraphs. Additionally, Figure 3-3 presents a graphical summary of selected constituents quantified in the subsurface soil samples which pose a potential threat to human health and the environment.

All of the subsurface soil samples were analyzed for TCL VOCs. Nondetect concentrations of all VOCs were detected in 2 of the 29 samples, both collected from NSSB-06. The remainder of the samples revealed concentrations of VOCs either at estimated levels below or just above MDL. One of the samples was reanalyzed to confirm matrix interference and both results were reported by the lab. Both results are also summarized on Table 3-9 with an "RE" data qualifier. In addition, the initial results were utilized for purposes of assessing potential threats to human health and the environment, if any. Methylene chloride was detected in the sample and method blank matrices of all of the subsurface soil samples, while acetone was detected in the samples and blanks of a number of the samples. In general, note that all of the VOCs were detected at levels substantially lower than EPA industrial soil RBCs.

All of the subsurface soil samples were analyzed for TCL SVOCs. Nondetect concentrations of all SVOCs were detected in 9 of the 29 samples at MDL. One of the samples was analyzed twice to confirm matrix interference, and one additional sample was analyzed at a secondary dilution factor also to confirm matrix interference. The secondary analyses were also reported by the lab and are summarized in Table 3-10 with "RE" and "DL" qualifiers for the former and latter,

INSERT - Figure 3-3

Summary of Subsurface Soil Sample Results

respectively. Concentrations of SVOCs were detected at estimated levels below or just above MDL. Overall, the SVOC concentrations, including the CPAH subset, were below EPA industrial soil RBCs. However, it should be noted that MDLs for a few of the CPAHs were greater than their associated RBC guidance values.

Two of the subsurface soil samples were also selected for PCB and pesticide analyses. Neither of the samples exhibited detectable concentrations of PCBs. One of the two samples revealed concentrations of pesticides which were all below EPA industrial soil RBCs. However, it should be noted that one of the pesticides, Endosulfan Sulfate, does not have an associated RBC guidance value. PCB and pesticide data are summarized in Tables 3-11 and 3-12, respectively.

All 29 of the subsurface soil samples were analyzed for inorganics. In total, 28 of the samples were analyzed for RCRA metals, and the remaining sample was analyzed for TAL metals including total cyanide. Total cyanide was not detected in this sample. Concentrations of arsenic in all of the samples were detected at levels within acceptable eastern USA soil background levels. In addition, only 4 of the samples exhibited detectable concentrations of arsenic greater than EPA industrial soil RBCs. The remainder of the inorganic constituents in the samples were quantified at concentrations which were generally consistent with eastern USA soil background levels and less than EPA industrial soil RBCs. Spiked sample recovery results for arsenic, mercury and selenium in a number of the samples were reported by the lab as not being within control limits. In addition, duplicate analysis results for mercury in a number of the subsurface soil samples were not within control limits. The results of the samples submitted for RCRA metals and TAL metals analyses are summarized in Tables 3-13 and 3-14, respectively.

Groundwater Monitoring Well Sampling Results

A total of five samples were collected on November 9, 2000 from the groundwater monitoring wells installed during the field investigation program. One laboratory provided trip blank which followed the groundwater samples throughout the collection process was also submitted for analysis. All of these samples were submitted to STL for analysis under standard chain-of-custody protocol. Based upon an organoleptic appraisal of all of the samples upon collection, no indication of water table aquifer degradation was noted at the site. All of the samples were collected under high turbidity conditions, and as a result the metals samples were field filtered during collection. Figure 3-4 presents a graphical summary of selected constituents quantified in the groundwater samples which pose a potential threat to human health and the environment.

INSERT - Figure 3-4

Summary of Groundwater Sample Results

The five groundwater samples were analyzed for TCL VOCs. The trip blank was analyzed for TCL VOCs only. All of the samples contained concentrations of VOCs either at estimated levels below or just above MDL. In particular, the maximum VOC concentration of 100 micrograms per liter (ug/L) of benzene was detected in the sample collected from NSMW-01. This sample as well as the samples collected from wells NSMW-02 and NSMW-03 contained a limited number of VOCs, 4 in total, at levels at or above NYSDEC Class GA Water Quality Standards. The other VOCs quantified in the five groundwater samples were at levels less than NYSDEC Class GA Water Quality Standards and/or Guidance Values. It should also be noted that methylene chloride was detected at estimated concentrations in the trip blank and 4 of the groundwater samples indicating possible laboratory contamination. Refer to Table 3-15 for a summary of the TCL VOC results.

All five groundwater samples were analyzed for TCL SVOCs. Nondetect levels of all SVOCs were exhibited in the sample collected from NSMW-03. The remaining four samples revealed SVOCs at estimated concentrations below both MDL and NYSDEC Class GA Water Quality Standards and/or Guidance Values. Concentrations of CPAHs were also not detected in any of the samples. It should be noted that the laboratory specified MDL for bis(2-Ethylhexyl)phthalate, a laboratory spike recovery compound and plasticizer, was greater than the conservative NYSDEC Class GA Water Quality Standard of 5 ug/L for this SVOC. Table 3-16 presents a summary of the TCL SVOC laboratory data.

The five groundwater samples were also analyzed for RCRA metals. All of these samples revealed concentrations of inorganic constituents. In addition, all of the samples exhibited levels of at least one inorganic constituent greater than NYSDEC Class GA Water Quality Standards. Arsenic was detected in 3 of the samples and cadmium in 1 of the samples at levels between instrument detection limits (IDL) and the contract required detection limit (CRDL). Duplicate analysis for arsenic in all of the groundwater samples was also reported as not being within control limits. Finally, the concentrations of barium and chromium quantified in all 5 of the groundwater samples were reported as estimated values due to matrix interference. A summary of the inorganic constituent data can be found in Table 3-17.

Data Validation

All analytical data packages submitted by STL were validated in accordance with the Quality Assurance/Quality Control (QA/QC) provisions of the October 1995 version of the NYSDEC Analytical Services Protocol (ASP). A 100% review of all sample results was performed as a component of this field investigation program to confirm proper data transcription, data completeness and compliance with applicable method and QA/QC requirements. All validation activities were performed by a third party validator under contract with VHB.

The data validator reported that the overall quality of the data was good and the results are usable for environmental assessment purposes.

Full details regarding the results of the validation process can be found in the Data Validation Report(s) which is presented in its entirety in Appendix E. In addition, laboratory analytical data packages are included in Appendix D.

4

Risk Assessment

Introduction

This risk analysis evaluates the analytical results from the field investigation in order to determine if there are potential threats to human health posed by existing conditions at the site. Measured concentrations of chemicals in site soil and modeled concentrations in air were used to quantitatively assess potential human exposures, cancer risks, and noncancer hazards at the site. The risk analysis was conducted according to United States Environmental Protection Agency guidance (USEPA 1989; 1991; and 1997a).

Following this introduction, a discussion of data analysis procedures is provided, along with the methodology used for selecting chemicals of potential concern. Qualitative and quantitative exposure assessments are followed by the toxicity assessment and risk characterization portions of the analysis. Conclusions are provided at the end of this section.

Data Analysis and Selection of Chemicals of Potential Concern

A number of substances were detected in surface and subsurface soil at the Newtown site. In order to focus the risk assessment on those chemicals that may pose a potential risk to public health, chemicals of potential concern (COPCs) were selected. This section describes how they were selected and why.

Data Evaluation

Summaries of data collected in surface and subsurface soil are provided in Tables 4-1 through 4-9. For the purpose of the risk assessment, these data have been evaluated with the goal of developing a 95% upper confidence limit (UCL) on the arithmetic mean concentration determined from the detected concentrations and the substitution of one-half the limit of detection for samples reported as nondetect.

The qualifiers encountered in the data for the Newtown site, their meaning, and their effect on the risk assessment are summarized below.

Chemical concentrations that were U-qualified were analyzed for but not detected at the specified quantitation limit. U-qualified chemical concentrations were used in the risk assessment at one-half the limit of detection if other samples in the data set were reported at least once above the limit of detection (USEPA 1989). This introduces a level of conservatism since the actual concentration may well be below the value used in the calculation of average concentrations.

A J-qualifier indicates that the sample concentration was estimated (USEPA 1989), either for a Tentatively Identified Compound (TIC) or when a compound was present (spectral identification criteria are met, but the value was below the contract-required contract limit). J-qualified data were included in the risk assessment unless they were also U-qualified.

An N-qualifier indicates that the spiked sample recovery was not within control limits (USEPA 1989). N-qualified data were included in the risk assessment.

A D-qualifier indicates that the compound was identified in an analysis at a secondary dilution factor (USEPA 1989). D-qualified results were included in the risk assessment.

A B-qualifier for organic results indicates that an analyte was found in an associated blank sample (*e.g.*, trip blank, field blank, or rinsate blank) as well as in the sample (USEPA 1989). B-qualified concentrations were used in the risk assessment only if the sample concentration was more than 10 times the blank concentration for common laboratory contaminants (*e.g.*, acetone, 2-butanone, toluene, and the phthalate esters), or more than five times the blank value for other compounds.

A B-qualifier was also associated with metals results. The B-flag indicates that the constituent was present at a concentration greater than the instrument detection limit but below the contract-required detection limit. B-flagged sample results were included in the risk assessment.

Selection of Chemicals of Potential Concern

Chemicals of potential concern for the Newtown site were selected using the following criteria:

Frequency of detection for chemicals in soil was considered. Chemicals with a frequency of detection of less than 5% in a data set of 20 or more samples were excluded from the risk assessment.

Chemicals not detected at least once above the limit of detection were automatically excluded from the risk assessment, regardless of the size of the data set.

Nutrient screening to evaluate the concentrations of essential nutrients (*i.e.*, calcium, iron, magnesium, potassium and sodium) in soil was performed by comparing detected concentrations to Recommended Daily Allowances (RDAs) using exposure parameters set forth by the USEPA, Region III in their derivation of risk-based concentrations (USEPA 2000b). The exposure equations used in this methodology are found in USEPA's *Risk Assessment Guidance for Superfund* (RAGS) (USEPA 1989) and the exposure factors are recommended in RAGS or supplemental guidance from the Superfund Program. Based on the exposure scenarios considered in the human health evaluation, nutrient screening concentrations for soil were derived for ingestion by a construction worker. All concentrations of essential nutrients were below the screening concentrations; therefore, further analysis of the essential nutrients was not necessary.

Calculation of Exposure Point Concentrations

USEPA states that most large or "complete" environmental data sets are lognormally rather than normally distributed (USEPA 1992a). However, because the data sets for the Newtown site may depart from this USEPA ideal, statistical tests were performed to identify the best distributional assumption for the data sets (USEPA 1992a). Data sets for the Newtown site that contained ten or greater samples were evaluated using the W-test developed by Shapiro and Wilk (Gilbert 1987). If the data set was found to be consistent with the normal distribution, then the 95% UCL was calculated from the following equation (USEPA 1992a):

$$95\%\ UCL = \bar{x} + t\left(\frac{s}{\sqrt{N}}\right)$$

where:

$\bar{x}$ = mean of the (untransformed) data;
t = Student t-statistic (from Gilbert 1987);
S = standard deviation of the (untransformed) data;
N = number of samples.

If the data set was assumed to be consistent with the lognormal distribution, then the 95% UCL concentration was calculated from the following equation (USEPA 1992a):

$$95\%\ UCL = e^{\left(\bar{x} + 0.5s^2 + \frac{SH}{\sqrt{N-1}}\right)}$$

where:

e = base of the natural log = 2.718;
$\bar{x}$ = mean of the log transformed data;
S = standard deviation of the log transformed data;
H = H-statistic (from Gilbert 1987); and
N = number of samples

Maximum concentrations were used to represent the mean concentration in small data sets (sample size < 10). If the calculated 95% UCL exceeded the maximum detected concentration, the maximum concentration was used to represent the mean (USEPA 1992a).

Tables 4-1 through 4-9 list the chemical's distribution (either normal or lognormal), and the calculated 95% UCL concentration. A summary list of COPCs by medium and receptor is provided in Table 4-10.

Exposure Assessment

The exposure assessment provides qualitative and quantitative descriptions of potential exposure to site-related COPCs for all human populations who may reasonably be expected to contact site media under present or future conditions. The exposure assessment is comprised of several components:

Identification of potentially exposed populations;
Identification of exposure pathways;
A description of the equations used to quantitate exposure; and
A discussion of exposure assessment uncertainty.

The site setting and site history were discussed previously (see pages 4 through 11). The current site plan is presented in Figure 4-1A; a historic aerial photo is presented in Figure 4-1B; and environmental attributes and the location of sensitive receptors are depicted in Figure 4-1C.

The sections below provide more detail concerning each of these components.

Exposure Setting and Identification of Potentially Exposed Populations

As described previously, COPCs have been detected in surface and subsurface soil at the Newtown site. Under current and future site use conditions, the potentially exposed populations (*i.e.*, potential receptors) are those that might come into contact with these COPCs. Figure 4-1D presents the conceptual risk system model (CRSM) that identifies the exposure routes evaluated for current and future on- and off-site human receptors. Potentially exposed populations and pathways of exposure, as outlined in the CRSM, are described below.

Current Scenarios

The Newtown site is an approximate 6-acre former gas holder site surrounded by fencing that is topped with cyclone wire and secure from public access. The site is comprised of two parcels, the smaller of which is zoned residential. This smaller parcel is adjacent to Grand Avenue, in the northeastern corner of the property. Two gated entrances to the northern portion of the property are maintained closed and locked. Two former gas holders comprise approximately three acres of the site. These holders have been dismantled and are in the process of being backfilled. Recycled material (*i.e.,* recycled soil or dredged sediment, discussed in more detail in the Risk Characterization section) is being placed in the former holders to a depth of two feet below ground surface; this recycled material will then be covered with two feet of clean fill.

There is an active KeySpan distribution operations satellite facility in the southwest corner of the site that is used for office space and parts storage. It is expected that this operations facility will remain active in the future. A compressor station referred to as the "Exhauster House" is located at the southeast corner of the site. The Exhauster House is currently used as a field operations office while the holders are being backfilled, however, it is expected that this building will be dismantled upon completion of the backfilling. Workers that may frequent this office were not considered in this analysis. Several other material/equipment storage buildings also exist in the southern portion of the site.

A ConRail railroad right-of-way is located to the west of the property. Trespassing occurs on the strip of property between the Newtown site and the rail tracks as evidenced by beverage containers and other debris. Fifty percent of the site is occupied by the former holder areas. Approximately twenty percent of the site is covered by building foundations, access roads, and a parking lot. The remaining thirty percent is dirt with patches of vegetation.

Receptors considered in the risk assessment under current site conditions include:

> On-site operations workers – *i.e.*, those KeySpan employees working at the distribution operations satellite facility; and
>
> On- and off-site trespassers – adolescents, age 12 to 18.

Future Scenarios

Future uses of the immediate off-site areas are not expected to change substantially. However, several redevelopment scenarios are under consideration for the site. These scenarios include commercial/industrial or residential uses. Additionally, the active KeySpan operations facility, currently located in the southwest corner of the site, may continue to occupy a portion of the property under any future use plan.

To account for the possibility that construction activities may occur in support of site redevelopment, future on-site construction workers were considered. Commercial workers were also evaluated under a future use scenario. An on-site residential scenario was evaluated using data collected from the small portion of the site that is zoned residential. This scenario is referred to as the “resident small parcel” scenario in this report. A separate residential scenario, which considers site-wide redevelopment to residential use, was also considered. This scenario is referred to as "resident site-wide".

Identification of Exposure Pathways

The CRSM and Table 4-11 provide a qualitative description of the complete exposure pathways for all potential current and future on- and off-site receptors. Exposure media include surface and subsurface soil, ambient air, and indoor air. A list of samples used to evaluate each exposure scenario is provided in Table 4-12.

Under current site conditions, dermal contact with, incidental ingestion of, and inhalation of particulates from chemical constituents in surface soil were assumed to occur for the on-site operations workers, and on- and off-site trespassers. Exposure to volatile chemical constituents in ambient air was also assumed to occur for these receptors. Additionally, potential exposure to COPCs in indoor air was considered for the on-site operations worker. The employees working at the operations satellite facility may also periodically use the on-site storage buildings; however, given the relatively small percentage of their on-site time spent at these buildings, this exposure scenario was not quantitatively evaluated.

Under future site use conditions, on-site construction workers were assumed to receive exposure to surface and subsurface soil via ingestion, dermal contact, inhalation of soil particulates and soil vapor inhalation as a consequence of their work (*e.g.*, trenching, excavation, installing deep piles, etc.). Construction workers are not expected to contact groundwater during trenching activities, because the depth to groundwater is greater than 35 feet.

Future on-site commercial workers were assumed to be inside office workers, and thus theoretically exposed only to identifiable COPCs in indoor air. Potential exposure to COPCs was not evaluated for visitors to the commercial establishments, as their exposure would be much less than that of the office workers. Potential exposure for future on-site residents (small parcel) was evaluated for dermal contact with and ingestion of surface soil, inhalation of vapors in ambient air; and inhalation of particulates from chemical constituents in surface soil. For the site-wide residential scenario, dermal contact with and ingestion of surface soil; inhalation of vapors in indoor air and ambient air; and inhalation of particulates were considered.

Quantitative Exposure Assessment

USEPA's RAGS (USEPA 1989, Chapter 6) describes the mathematical equations used to quantitate human exposures to chemicals in environmental media. This guidance served as the basis for estimating exposure to chemicals in site soil and air.

For each relevant exposure pathway, two cases were evaluated. A reasonable maximum exposure (RME) case was used to estimate the greatest exposure as defined by regulatory guidance and an alternate or average case was used to estimate a more typical exposure reflecting central tendency. The RME case is a specific type of exposure situation defined by USEPA (1989) guidance as "…the maximum exposure that is reasonably expected to occur at a site." USEPA guidance requires that, in order to be health-protective, specific assumptions and factors must be used for the RME case, most of which are not based on site-specific data and are designed to err on the side of extreme protection of public health. The resulting calculated theoretical risks therefore likely overestimate the actual risks posed by chemicals at the site.

An alternate case, called the average case, was also evaluated. The case was based on estimates of the central tendency (average values and 50th percentile values) of the exposure parameters. When central tendency estimates were not available, USEPA default exposure parameters were used. Therefore, average case exposures are still health protective.

Parameters for Estimating Human Exposure

The approach to calculating human exposures to site COPCs involves combining the following:

- estimates of exposure media chemical concentrations;
- estimates of contact rate and the frequency and duration of exposure that receptor populations are likely to experience; and
- estimates of various physiological parameters (*e.g.*, skin surface area, body weight, breathing rate, etc.).

Standard default exposure factors were obtained primarily from USEPA's *Supplemental Risk Assessment Guidance for Superfund* (USEPA 1991) and USEPA's *Exposure Factors Handbook* (USEPA 1997a). Best professional judgment was used when guidance for exposure parameters was unavailable.

In the evaluation of dermal exposure to chemicals in soil, the USEPA has derived default exposure factors of 1.0% for organics and 0.1% for inorganics (USEPA 1998). However, a more technically sound method for determining absorption is the methodology developed by the Massachusetts Department of Environmental Protection (MADEP). Relative absorption factors (RAFs) are used to account for differences in the absorption of a COPC under assumed exposure conditions at a site relative to the absorption of the COPC under the experimental conditions upon which a toxicity value is based (MADEP 1995). For example, the RAF may be used to adjust the calculated exposure, such as soil ingestion for a construction worker, in such a way that it is consistent with the toxicity information derived from a study in which rats were administered by gavage (stomach tube) a chemical dissolved in olive oil.

The MADEP guidance provides RAF values for a limited number of chemicals. The remaining RAFs were calculated using the following equation:

$$\text{RAF} = \frac{\text{Absorption Efficiency}_{\text{Site Route}/\text{Medium Exposure}}}{\text{Absorption Efficiency}_{\text{Study Route}/\text{Medium Exposure}}}$$

In the absence of readily available site-specific and chemical specific information, the default absorption efficiencies presented in the MADEP guidance were used to estimate a RAF.

The relative absorption factor (RAF) is a unitless, chemical-specific parameter. The adherence factor (AF) is a unitless value used to represent soil adherence to the surface of the skin. The AF is the percentage of the total soil contacted that remains on the skin for a sufficient period of time to permit dermal exposure to a chemical in the soil. The value used here, 0.08 (or 8%), is based on USEPA guidance (USEPA 1998).

The averaging time (AT) referenced in Tables 4-13 through 4-31 depends on the type of toxic effect being assessed. When evaluating exposures for potential non-cancer health effects, intakes are calculated by averaging over the period of exposure. This is equal to the ED multiplied by 365 days/year. When evaluating potential carcinogenic risks, intakes are calculated by prorating the total cumulative intake over a lifetime (*i.e.*, lifetime average daily intake). For calculation purposes, this is equal to 70 years multiplied by 365 days/year. This distinction is consistent with the hypothesis that the mechanism of action for each of these effects is different. The approach for carcinogens is based on the assumption that a high dose received over a short period of time is equivalent to a corresponding low dose spread over a lifetime.

Variables used in estimating chemical intakes are described below. Application of the exposure equations results in intake or, for dermal contact exposure, absorbed dose, expressed in mg of chemical per kg of body weight per day (mg/kg-day).

Commercial Worker. The equation and exposure assumptions for evaluating exposure to indoor air for the future on-site commercial worker are presented in Table 4-13. An inhalation rate (IR) of 0.55 m^3/hour is assumed which is the average value for long term exposure (USEPA 1997a). An exposure time (ET) of eight hours/day, the length of a typical workday, is assumed for indoor exposure**.**

Exposure frequencies (EFs) of 250 days/year and 200 days/year are assumed for the RME and average case, respectively**.** The average case assumed the commercial worker would use three weeks vacation, holiday time and sick time. Exposure duration's (EDs) of 25 years (RME) and 6.6 years (average) are assumed. The body weight (BW) of an adult, 70 kg, is used.

Construction Worker. The equations and exposure assumptions for evaluating exposure to on-site construction workers are presented in Tables 4-14 through 4-17**.** An RME skin surface area (SA) value of 4,260 cm^2 (represents surface area of hands, forearms and head) and average SA value of 2,600 cm^2 (represents surface area of hands and head) are assumed for dermal contact with soil**.** An RME soil ingestion rate (SIR) of 400 mg/day and average SIR of 50 mg/day are used to evaluate incidental ingestion of soil**.** An IR is assumed to be 2.5 m^3/hour for the RME case (assumes heavy activity) and 1.3 m^3/hour for the average (hourly average IR for outdoor workers) case**.** The ET is eight hours/day.

The EFs are assumed to be 20 days (RME) and 10 days (average) because construction work is limited in duration. The ED is assumed to be one year. The USEPA (1991) acknowledges that for construction workers, exposure frequency would generally be less than one year and exposure duration would vary according to site-specific construction/maintenance plans**.** The average BW of adult males, 70 kg, is used.

Operations Worker. The equations and exposure assumptions for evaluating exposure to the operations worker are presented in Tables 4-18 through 4-22. Based on observations during the field investigation, the operations employee spends approximately 2 hours per weekday at the satellite station. It is assumed that approximately one-half of that time is spent outdoors, therefore, for the RME and average cases the ETs are 0.5 and 0.25. An RME SA value of 4,260 cm^2 (represents surface area of hands, forearms and head) and average SA value of 2,600 cm^2 (represents surface area of hands and head) are assumed. For incidental ingestion of surface soil, SIRs of 100 mg/day and 50 mg/day for the RME and average case are used. An IR is assumed to be 1.6 m^3/hour for the RME case (assumes short-term moderate activity) and 1.0 m^3/hour for the average case (assumes a mixture of sedentary, light and moderate activity).

The EF is assumed to be 250 days/year for the RME case and 200 days/year for the average case. An ED of 25 years (RME) and 6.6 years (average) is assumed. The average BW of adult males, 70 kg, is used.

On-Site Resident. The equations and exposure assumptions for determining exposure to future on-site residents are presented in Tables 4-23 and 4-27**.** For dermal exposure to surface soil, the SA exposed to soil is assumed to be 18% of the total body surface. This equates to 3,933 cm^2 (RME) and 3,267 cm^2 (average) for the adult. For children these values are 1,433 cm^2 (RME) and 1,238 cm^2 (average). For incidental ingestion of surface soil, SIRs of 100 mg/day (RME) and 50 mg/day (average) are used for the adult while SIRs of 200 mg/day (RME) and 100 mg/day (average) are used for the child. For inhalation of volatile chemicals in air, IRs of 0.75 and 0.70 m^3/hour for adult and child, respectively, are used for short-term outdoor exposures. These rates correspond to the average of light activities, which are defined as walking at speed levels of 1.5 to 3.0 mph and sedentary activities, which are defined as sitting and standing. IRs of 0.55 m^3/hour (adult) and 0.27 m^3/hour (child) are assumed for long-term indoor air exposure. The IR for children is derived by averaging the recommended values for children less than six years of age (USEPA 1997a).

ETs of seven hours/day and two hours/day are assumed for the RME and average case, respectively, for outdoor air exposure. The RME case represents a residential gardener and the average case corresponds to the average time spent outdoors by residents. For indoor air exposure, an ET of 21 hours/day (assumes two hours spent outdoors and one hour in a car) and 12 hours/day (assumes two hours spent outdoors, one hour in car and nine hours at work or school) are assumed for the RME and average case, respectively for indoor air exposures.

EFs of 350 days/year (RME) and 180 days/year (average) are assumed for all residential exposure scenarios**.** ED values of 24 years (RME) and nine years (average) are assumed for the adult**.** For the child, an ED of 6 years is assumed for both the RME and average cases. The body weight for an adult is 70 kg and 15 kg for a child.

On- and Off-Site Trespasser. While trespassing at the site is unlikely given current security measures, the potential for trespasser exposure is evaluated since the property could be accessed, with difficulty, over the fence. The off-site trespasser scenario was evaluated for the strip of land between the site and the ConRail tracks. The equations and exposure assumptions for determining exposure to the adolescent trespasser are presented in Tables 4-28 through 4-31. For dermal exposure to surface soil, the SA exposed to soil is assumed to be 18% of the total body surface (18% = percentage of total body surface for lower legs and hands). This equates to 3,438 cm^2 (RME) and 2,844 cm^2 (average). For incidental ingestion of surface soil, a SIR of 100 mg/day is used. For inhalation of volatile chemicals and particulates in outdoor air, an IR of 0.6 m^3/hour is assumed which equates to the average short-term inhalation rate for 12 to 18 year olds (USEPA 1997a). The ET is assumed to be one hour/day.

EFs of 70 days/year (RME) and 35 days /year (average) is assumed. This corresponds to two visits per week for the months April through November for the RME case and one time per week for the average case. The ED is six years, which corresponds to the number of years between 12 and 18 years of age. The average body weight for males aged 12 to 18 is 57.7 kg.

Exposure to Lead

Based on the findings of a site walkover and a review of previous investigations/studies and related site material, a potential environmental concern at the Newtown site is the potential presence of residual lead contamination in surface soil. Historical maintenance of the exterior walls of the holder tank structures typically involved sand blasting of the aboveground portion of each holder's water tank and manual scraping of the holder shells, cups and structural steel guide frames followed by repainting activities. Due to the age of the structures, it is likely that lead based paint was utilized to support these maintenance programs. This is evidenced by the fact that elevated concentrations of lead have been detected in the holder sludge/sediment. Although lead based paint typically would only be utilized on the exterior of the structures, a pathway from the exterior walls to the interior of the tank exists due to the "cupped" design of the telescoping walls of the water seal type holders. In response to this concern, lead was extensively evaluated in this assessment.

There are no verified or EPA consensus toxicological indices available for lead. The absence of such indices reflects the scientific community's inability to agree on a threshold dose for lead's noncarcinogenic effects or estimate its carcinogenic potency, therefore, risks associated with potential exposures to lead cannot be quantitatively assessed using the USEPA's reference dose (RfD) methodology (see the Toxicity Assessment). Rather, assessment of non-cancer hazards associated with potential exposure to lead is performed using the USEPA's Integrated Exposure Uptake Biokinetic (IEUBK) model (USEPA 1994a) and the Bowers et al. model for assessing adult lead exposures (Bowers et al., 1994).

IEUBK Model

The Agency conceived of the IEUBK model as a means to evaluate potential health effects for children who may experience direct contact with lead in a residential setting. Young children represent the segment of the population at greatest risk from lead exposure. The reasons for children's relatively high sensitivity are twofold. First, in comparison to adults, their ability to absorb lead from the gastrointestinal tract is greater (50% for children versus 6% for adults) and second, their developing organ systems are more sensitive (USEPA 1994a).

The IEUBK model estimates potential blood lead concentrations in children resulting from their exposure to soil (and other media such as air, drinking water, diet, dust, and paint) containing lead. Currently, a blood lead concentration of 10 μg/dL is the level at which public health officials begin to investigate for possible environmental exposures (Centers for Disease Control 1991). The USEPA recommends a level of either 95% of the child resident population having blood lead concentrations below the 10 μg/dL benchmark or a 95% probability of an individual child having a blood lead concentration below 10 μg/dL. This level corresponds to a lead concentration in soil of approximately 400 mg/kg, if all of the USEPA's assumptions about a child's exposure are used in the IEUBK model. The USEPA emphasizes that this 400 mg/kg screening concentration is not a cleanup goal for soils (USEPA 1994b). Rather it means that residential soil lead concentrations greater than 400 mg/kg should be evaluated more carefully in order to make any decision concerning possible action.

The IEUBK model combines estimates of lead intake from air, water, soil, dust, diet, and other ingested material (*e.g.*, paint) with estimates of absorption into the body (through uptake of lead in the lung or gastrointestinal (GI) tract). With this information, the model determines how the lead will distribute itself in a child's body and how fast it will be eliminated. This information is then used to predict possible blood lead concentrations for those children who might be exposed to lead from these environmental sources (USEPA 1994a). The model uses site-specific, multi-source lead data to the extent that they are available.

This model is only for evaluating a relatively stable exposure situation and not rapidly changing exposures. Therefore, it cannot predict the effects of short-term exposure, which is over a few days or weeks. This model also does not consider the variability in consumption patterns and media concentrations on a daily or seasonal basis. Instead it assumes continuous growth of a child and simulates the changing environment of the child only on a yearly basis (USEPA 1994a).

The assumptions used by USEPA for typical childhood exposure are used whenever site-specific information is unavailable. These assumed values (*e.g.*, dietary lead concentrations, and consumption values) come from several studies of the American diet and activity patterns of children. An evaluation of the model's sensitivity to these many different values revealed that the critical input parameters are dietary lead intake, soil and dust ingestion rate, and gastrointestinal absorption of lead (USEPA 1994a).

The model default air concentration value of 0.1 $\mu g/m^3$ was used for the inhalation pathway. This value corresponds to the approximate average 1990 urban air lead concentration (USEPA 1994a). An air concentration lead value of greater than 0.1 $\mu g/m^3$ may be appropriate for assessment at locations near active point sources of lead emissions, such as lead smelters or battery plants (USEPA 1994a). However, because the Newtown site is not in such an area, model default values were used. Changing the default air concentration had little to no affect on model results, indicating that blood lead concentrations are relatively insensitive to the air lead concentration (USEPA 1994a).

Surface soil lead concentrations were used in the model. In the case of lead in dust, the model's assumption of 200 µg/g was used. The default value for total intake of soil and dust depends on age, and ranges from 85 to 135 mg/day. These values represent an average value within those possible values seen in different studies. The current assumption in the model is that 30% of dust and soil lead intake is absorbed into the blood (USEPA 1994a).

The dietary lead intake values for each age group are based on the typical American diet and quarterly surveys of lead in this diet (USEPA 1994a). These values were used to assess exposures for a typical child living in a residential area.

To evaluate the risks associated with ingestion of lead in tap water, the model uses the concentrations of lead in first-draw and 3-minute purge samples. The model's assumed water lead concentration is set at a typical 1990 urban value of 4 µg/L. First-draw samples (those collected as soon as the tap is turned on) generally have higher lead concentrations than purged samples. The model scenario assumes that 50% of the water ingested by a child is consumed at home as first-draw. The remaining intake consists of 3-minute purge sample results (samples collected after running the tap for three minutes) with the remaining water (15%) consumed outside the home (evaluated using a the model assumption concentration of 10 µg/L) (USEPA 1994a). Exposure to lead in water was assessed using default values.

In most uses of the IEUBK Model, a site is defined as an area in which further action may be considered. Such an area could be a residential yard with a single housing unit, or an area of multi-unit buildings or undeveloped lots. The home and its surrounding yard is often used because lead exposure for pre-school children typically occurs within this area. Risk is then calculated as the probability that the blood lead concentration of a single child at a single site, will exceed a specified level of concern, in this case 10 µg/dL (USEPA 1994a). In this assessment, the IEUBK model was run by assuming that each of the surface soil sampling points represented a residential yard.

The IEUBK model can also be applied on a neighborhood-wide basis. Using this approach, the percentage of children living in the neighborhood likely to have a blood lead concentration exceeding the level of concern can be calculated. This can be done where children of the same age are assumed to have similar exposures to lead (USEPA 1994a).

Bowers et al., Adult Lead Model

Historically, concern about lead has focused on its effects on young children. Given the same set of exposure conditions and concentrations, children's exposure to lead will be higher than adults due to their higher hand-to-mouth behaviors, and the amount of time they spend playing outside, coming into contact with and ingesting more lead-contaminated dirt. In addition, children absorb more ingested lead than adults do and are more sensitive to its toxic effects due to their developing organ systems. However, adults may be exposed to high levels of lead in soil and dust in situations where children are not a population of concern. These situations include adults working on a daily basis in occupations that involve lead exposures, or adults involved in construction or remediation activities at lead-contaminated sites. To address this data gap, Bowers et al., developed an adult lead model that predicts adult blood lead levels given statistical information on baseline exposures (Bowers and Cohen 1998). This model is recommended by the USEPA for use in calculating industrial site soil lead cleanup levels (Bowers and Cohen 1998; USEPA 1996b). The estimated baseline exposure is applicable to adults with no large pre-existing burden of lead, or no previous excessive occupational exposures to lead.

The basic premise of the Bowers' model is similar to the IEUBK model; however, the Bowers' model uses a biokinetic slope factor to relate total uptake of lead in adults to blood lead levels, rather than the multiple compartment distribution model for children used by the IEUBK model. The equation takes the following form:

$$PbB = PbB_{baseline} + (BSF \times C \times I \times A \times EF \times K)$$

where,

PbB = Predicted blood lead level, µg/dL
$PbB_{baseline}$ = Baseline blood lead level, µg/dL
BSF = Biokinetic slope factor, µg/dL blood lead increase per µg/day lead uptake
C = Concentration of lead in soil, mg/kg
I = Soil ingestion rate, g/day
A = Fraction of lead in soil that is absorbed, unitless
EF = Exposure frequency, equal to the number of days per year during which an individual is exposed to site soil, days/year
K = Conversion constant, years/day, or 1/365

This model was used to evaluate lead exposure for the on-site operations worker and the future on-site construction worker. The baseline blood lead level, 1.8 µg/dL, is the average of the reasonable range for the geometric standard deviation of women of childbearing age (Bowers and Cohen 1998). A USEPA-recommended value of 0.4 was used for the biokinetic slope factor that relates blood lead concentrations to lead uptake. This value is based on an extensive study by Pocock et al. on the relationship between tap water lead concentrations and blood lead concentrations for a sample of adult males (USEPA 1996b). The concentration of soil is the average lead concentration in samples representative of a receptor's exposure, *e.g.,* to evaluate lead hazards for the operations worker, the average concentration of lead in surface soil samples collected from the operations area was used. The fraction of lead absorbed through the gastrointestinal tract is assumed to be 0.12. The USEPA recommends this value based on the assumption that the absorption factor for soluble lead is 0.2 and that the relative bioavailability of lead in soil compared to soluble lead is 0.6; the product of these two values is 0.12. The exposure frequency and soil ingestion rates are the same as those used in the assessment of other chemicals at the site.

Air Modeling Approaches

Indoor Air. Concentrations of volatile COPCs accumulating within indoor air of on-site buildings were modeled. The modeling approach used to develop these concentrations followed the methods described by the ASTM in their risk-based corrective action guides (ASTM 1998). The first step in the model was to develop volatilization factors (VFs) for subsurface soil to enclosed space. The VF approach involved the use of two different models: an infinite source model (assumes there is an unlimited supply of the volatile COPC) and a finite or mass-limited model (assumes there is only a limited supply of the volatile COPCs). In accordance with ASTM (1998) guidance, the model resulting in the lowest VF was used. In this way, the physical laws of mass balance are not violated and the estimated air concentrations are more accurate. The chosen chemical-specific subsurface-soil-to-enclosed-space VF is then multiplied by measured subsurface soil concentrations to obtain the indoor air concentration.

Ambient (Outdoor) Air. Methods recommended by the USEPA in its Air / Superfund National Technical Guidance Study Series (NTGS Series) were used to determine ambient air exposures for the construction worker scenario. For the inhalation of volatile COPCs, the evaluation considered construction workers digging an excavation on the site. It was assumed that volatile COPCs were emitted from the exposed soil from the bottom of the excavation and that the construction worker was located at the very edge of the excavation. The excavation was modeled as an area source with a unitized emission flux using a standard dispersion model. Nine receptor locations were selected to represent the workers and maximum one-hour average ambient air concentrations of the volatile COPCs were estimated at each location. The receptor location yielding the highest maximum one-hour average ambient air concentration of the volatile COPC was used in the evaluation.

Methods recommended by ASTM in their risk-based corrective action guides were used to determine ambient air concentrations for the on- and off-site adolescent trespassers; future on-site residents; and operations workers at the Newtown site. This approach involved the use of two different models: an infinite source model (assumes there is an unlimited supply of the volatile COPC) and a finite model (assumes there is a limited supply of the volatile COPCs). The model resulting in the lowest VF was used. In this way, the physical laws of mass balance are not violated and the estimated air concentrations are more accurate (ASTM 1998).

Respirable Particulates. For construction worker inhalation exposure to respirable particulates, it was assumed that emissions of particulate matter were generated by excavation of soil and by dumping of soil onto a storage pile. Emission rates for these operations were determined using methods described in the *USEPA*'s *Estimation of Air Impacts from Area Sources of Particulate Matter Emissions at Superfund Sites* (USEPA 1993b). The air concentration was estimated by modeling the excavation as a volume source. The receptor location that yielded the highest impact was used in the evaluation.

Site-specific particulate emission factors were developed for the on-and off-site adolescent trespassers, future on-site residents, and operations workers. These factors were used in estimating the concentration of COPCs attached to dust that may emanate from the site. The approach used in developing this factor followed that described by the *USEPA* in their soil screening guidance (USEPA 1996a). The maximum hourly respirable particulate concentrations were multiplied by the concentration of each constituent in the surface soil to develop the chemical concentration of each COPC in the respirable particulates.

The models used to predict air concentrations of COPCs at the Newtown site are described in more detail in Appendix F.

Exposure Assessment Uncertainty

A number of factors may cause the exposure levels estimated in the exposure assessment to differ from the exposures that potential human populations may actually experience. This subsection identifies these factors, discusses the potential effects of the factors on the exposure assessment, and where possible and appropriate, estimates the degree of confidence that should be placed in the various assumptions made in developing the exposure assessment. Uncertainty issues discussed below include:

estimated exposure media concentrations;
analytical data limitations; and
exposure assumptions.

Additional sources of risk assessment uncertainty are presented in the toxicity assessment section.

Estimated Exposure Media Concentrations

Samples collected during the site investigation were intended to characterize the nature and distribution of chemicals at the Newtown site**.** Accordingly, samples were collected from locations selected in a biased or directed manner to accomplish this goal; that is, most samples were collected from areas where the highest chemical concentrations would likely be found**.** Samples collected in this manner provide considerable information about the site, but are not necessarily statistically representative of the chemicals that may be present in a specific area or over the site as a whole**.** Therefore, data from sampling locations selected in this way tend to overestimate the average concentrations in a representative exposure area.

All of the exposure calculations used in this risk assessment assume that the concentrations of chemicals in source media are at steady-state levels and will remain constant for the duration of exposure and under future site conditions. The steady-state assumption may not be appropriate for soluble and/or mobile metals or organic compounds in soil. In addition, certain organic chemicals can degrade over time. For example, the half-life of PAHs varies from months to several years (ATSDR 1999). Nevertheless, the conservative steady-state assumption was used because it provides the best understanding of conditions in the absence of change.

Air concentrations were modeled from soil concentrations. Standard default values developed by the USEPA were used for many parameters where site-specific information was not available. The default values were designed to overpredict emissions and thus, overestimate risk associated with air exposure.

Analytical Data Limitations

One aspect of the analytical data that could marginally reduce the level of confidence in the estimates of chemical concentrations in environmental media is the inclusion of estimated results (*e.g.*, J-qualified data). These data may not have the same precision and accuracy as data meeting all of the standard quality assurance (QA) criteria. However, this effect is very minor.

A second limitation concerns the fact that, in cases of sample nondetection, a value of one-half the limit of detection was used to represent the chemical concentration in that sample. This introduces a level of conservatism since the actual concentration may be well below the value used in the calculation of exposure point concentrations.

Exposure Assumptions

The primary uncertainty regarding the exposure assessment is that associated with the selection of appropriate exposure parameter values. The values used in the exposure assessment were primarily derived from USEPA guidance. These values are intentionally conservative (that is, health protective) and designed to err on the side of overestimation. Therefore, there is considerable uncertainty regarding the actual exposure that a person would experience. Specific parameter values were selected on the basis of the required guidance so that the overall pathway exposure estimates would approximate the reasonable maximum and average exposures. However, by combining a number of upper-bound values into the exposure calculation, the resulting exposure estimates, especially for the RME case, are most certainly above the 95th percentile exposure. Although this assures health protectiveness, it is not predictive of actual exposures.

The use of generic absorption efficiency data in the calculation of RAF values increases the uncertainty in the risk assessment results. This is because there is a wide variation in absorption efficiency among chemicals, even between chemicals within the same class.

Modeling Assumptions

There are several uncertainties associated with the air modeling for the site. A primary uncertainty, which results in overestimation of modeled air concentrations, is due to the conservative assumptions that are used in developing the models. One assumption is that partitioning between sorbed, dissolved, and vapor phase is a function of constant chemical and soil-specific parameters. Additionally, for the site construction worker, on-site trespasser, and future resident (site-wide), the modeled concentrations were based on the conservative assumption that contamination is uniform across the site. Because the 95% UCL concentration or the maximum detected concentration, (whichever is less) is used to assess exposure, this approach over-estimates modeled concentrations for areas of the site where concentrations are lower or zero. An additional source of uncertainty lies in the modeling for indoor air. Concentrations for the indoor air modeling for the operations worker were based on subsurface soil sample results for samples near the building, not directly underneath the building. Due to dispersion, concentrations in air decrease with increasing distance from the source.

Toxicity Assessment

The human health toxicity assessment provides information about the COPCs found at the Newtown site and describes the relationship between the extent of exposure to a chemical and the likelihood and/or severity of adverse effects in humans. This assessment has two parts (USEPA 1989):

> Hazard Identification – a qualitative description of the potential toxic properties of the COPCs at the site.
>
> Dose-Response Assessment – a process that results in a quantitative estimate or index of toxicity for each COPC at the site. For carcinogens, this index is the cancer slope factor (CSF). For systemically acting agents (*i.e.*, noncarcinogens), it is the reference dose (RfD).

Hazard identification information is available in many on-line databases. These include the following:

> Agency for Toxic Substances and Disease Registry (http://www.atsdr.cdc.gov/hazdat.html);
>
> The United States Environmental Protection Agency (http://www.epa.gov/ngispgm3/iris/index.html). This site also includes the dose-response measures (*i.e.*, cancer slope factors and reference doses) for the COPCs.
>
> The National Library of Medicine (http://sis.nlm.nih.gov/sis1); and
>
> The Oak Ridge National Laboratory (http://risk.lsd.ornl.gov/tox/rap_toxp.html).

For the purpose of this risk assessment, COPCs were classified into two groups: potential carcinogens and noncarcinogens. The risk posed by these two types of agents are assessed differently because noncarcinogens generally exhibit a threshold dose below which no adverse effects occur, whereas guidance allows no such threshold to be used for potential carcinogens (USEPA 1989).

As used here, the term "carcinogen" means any chemical for which the USEPA has determined that there is sufficient evidence that exposure may result in continuing, uncontrolled cell division (cancer) in humans and/or animals. Conversely, the term "noncarcinogen" means any chemical for which the carcinogenic evidence is negative or insufficient. Exposure to some agents may result in both carcinogenic and noncarcinogenic effects. In these instances, both the carcinogenic and noncarcinogenic effects were evaluated in the risk assessment.

Carcinogenic Health Effects

Scientists generally have been unable to demonstrate experimentally a threshold for carcinogenic effects. In contrast, thresholds are thought to exist for noncarcinogens. Federal regulatory agencies (*e.g.*, USEPA, the Food and Drug Administration [FDA], and the Occupational Safety and Health Administration [OSHA]) have assumed that any exposure to a carcinogen theoretically entails some finite risk of cancer (USEPA 1989). However, depending on the potency of a specific carcinogen and the level of exposure, such a risk could be vanishingly small.

Cancer slope factors (CSFs) are used to predict the potential number of excess cancers that will arise in response to lifetime exposure to a chemical. CSFs are predominantly based on animal bioassay data, although human epidemiological data are preferred and used when available. Specifically, CSFs represent the 95 percent upper confidence limit of the slope of the dose-response curve that has been extrapolated to low doses, using a mathematical model known as the linearized multistage model (USEPA 1989). Use of the linearized multistage model, instead of other available models, represents a policy decision by USEPA to base risk management decisions on a model that likely overestimates actual cancer risks.

A relative potency approach is used to estimate cancer risks from exposure to carcinogenic PAHs (USEPA 1993a). This approach considers the relative potencies of the carcinogenic PAHs compared to benzo (a) pyrene (demonstrated to be one of the most potent PAHs). The slope factor for benzo (a) pyrene is multiplied by the following values to obtain CSFs for the other carcinogenic PAHs:

benzo (a) pyrene	1.0
benzo (a) anthracene	0.1
benzo (b) fluoranthene	0.1
benzo (k) fluoranthene	0.01
chrysene	0.001

dibenzo (a,h) anthracene	1.0
indeno(1,2,3-c,d)pyrene	0.1

In evaluating chemicals for carcinogenicity, USEPA developed a two-part assessment involving a weight-of-evidence classification and a quantitative determination of carcinogenic potency (the CSF). The weight-of-evidence classification reflects available data, adequacy of studies, types of studies, and observed responses. The following classifications are used (USEPA 1986):

Group A: human carcinogens;

Group B1: probable human carcinogens (limited human data);

Group B2: probable human carcinogens (sufficient evidence in animals; limited or no evidence in humans);

Group C: possible human carcinogens (limited evidence in animals; limited or no evidence in humans);

Group D: not classifiable as to human carcinogenicity; and

Group E: evidence of noncarcinogenicity in humans.

CSFs have typically been developed for Group A, B1, and B2 carcinogens. CSFs have also been developed for some Group C agents. The CSFs used in the risk assessment are listed in Table 4-32. The calculations and assumptions used to derive these values are presented in Table 4-33. USEPA currently reports unit risks, not CSFs, for chemicals that are carcinogenic via the inhalation route. Inhalation unit risks from USEPA's Integrated Risk Information System (IRIS) have been converted to CSFs using the following equation:

$$SF\left(mg/kg/day\right)^{-1} = Unit\ Risk\left(\mu g/m^3\right)^{-1} \times \frac{70\,kg \times 1,000\,\mu g/mg}{20\,m^3/day}$$

Noncarcinogenic Health Effects

Noncarcinogenic effects are assessed by comparing the estimated average exposure to the acceptable daily dose, referred to by the USEPA as the reference dose (RfD) (USEPA 1989). The RfD is a provisional estimate (with about an order of magnitude uncertainty) of a daily exposure to a human population, including sensitive subgroups, that is likely to be without an appreciable risk of deleterious effects during a portion of their lifetime, in the case of a subchronic RfD, or during a whole lifetime, in the case of a chronic RfD (USEPA 1989). USEPA selects the RfD by identifying the lowest reliable No Observed Adverse Effect Level (NOAEL) or Lowest Observed Adverse Effect Levels (LOAEL) in the scientific literature, then applying a suitable uncertainty (safety) factor (ranging from 3 to 10,000) to allow for differences between the study conditions and the human exposure condition to which the RfD is to be applied. NOAELs and LOAELs can be derived from either human epidemiological studies or animal studies; however, they are usually based on laboratory experiments in animals in which relatively large doses are used. Consequently, uncertainty or safety factors are applied when deriving RfDs to compensate for data limitations inherent in the underlying experiments, and for a lack of certainty created by extrapolating from high doses in animals to lower doses in humans. The RfDs used in the risk assessment are listed in Table 4-32. The calculations and assumptions used to derive these values are presented in Table 4-33.

USEPA is in the process of developing subchronic RfDs based on potential noncarcinogenic effects associated with exposure duration's ranging from a few weeks to seven years (USEPA 1989). Short-term exposures can occur when an activity resulting in exposure is performed for a limited period of time or when a chemical disperses to negligible concentrations within a short period. If subchronic RfDs were not available, chronic RfDs were used. The use of chronic RfDs to assess short-term exposure, *i.e.*, one year, overestimates noncarcinogenic hazards for potentially exposed populations.

Reference doses for the inhalation route of exposure are known as reference concentrations (RfCs). RfCs are expressed in units of μg/m³ and are converted to RfD units (mg/kg/day) using the following equation:

$$RfD\left(mg/kg/day\right) = RfC\left(mg/m^3\right) \times \frac{20\,m^3/day}{70\,kg} \times 0.001\,mg/\mu g$$

Route-to-Route Extrapolation of Slope Factors and Reference Doses

Once substances have been absorbed via the oral or dermal routes, their distribution, metabolism, and elimination patterns are usually assumed to be independent of the route of absorption. For this reason and because dermal route cancer slope factors and RfDs have not been developed by the USEPA, oral route slope factors and RfDs are sometimes used to evaluate exposures to substances by the dermal route (USEPA 1989). When this is done, the dermal intake is adjusted to account for differences in an agent's absorption between the oral and dermal routes of exposure. If the critical effect is at the point of contact, however, extrapolation of toxicological effects from the oral route to the dermal route is inappropriate.

Toxicity Assessment Uncertainty

In order to evaluate the meaning of any risk assessment, one must consider the uncertainties in the assumptions made, the potential impact of quantitative changes in those assumptions on the risk estimates, and the relevance of the findings to real world exposures and risks. Due to the number of assumptions, data points, and calculations, a degree of uncertainty is necessarily associated with the numerical risk values in any risk assessment.

Carcinogenic Toxicity Assessment Assumptions

The COPCs have been evaluated by the USEPA using its weight-of-evidence carcinogenicity evaluation criteria, and some have been placed in Group A (human carcinogens) or Group B (probable human carcinogens), based on sufficient data in humans or sufficient data in animals and insufficient data in humans, respectively (USEPA 1986).

Rodent bioassay and epidemiological studies, such as those performed on the COPCs, would require tens of thousands of animals or humans in order to determine whether an agent may be carcinogenic at low doses. As the relationship between location, time to appearance, and the proportion of animals with cancer determines the estimated slope factor, animal bioassay or human epidemiological data are not routinely sufficient for directly estimating slope factors at low doses. By necessity, therefore, agencies such as the USEPA use carcinogenic extrapolation models for estimating low dose slope factors. On the current basis of policy, USEPA endorses the theory that there is no dose or “threshold” below which carcinogenic effects will not occur (USEPA 1989). This is equivalent to the assumption that every dose above zero, no matter how low, carries with it a small but finite risk of cancer. USEPA also assumes that the dose-response relationship for all types of carcinogens, be they tumor initiators, mutagens (stimulators of cell division), or promoters, is linear at low doses, an approach contrary to that used for other effects for which thresholds are assumed to exist.

The current model favored by the USEPA and certain other federal regulatory agencies is the linearized multistage model (USEPA 1989). USEPA uses the statistically derived 95% UCL percentile confidence bounds, rather than a maximum likelihood value for the slope factor. The agency has concluded on theoretical grounds that cancer follows a series of discrete stages (initiation, promotion, and progression) that ultimately can result in uncontrolled cell proliferation (cancer). Consistent with this conclusion, the use of the linearized multistage model permits an estimation of a slope factor that is not likely to be exceeded if the real slope could be measured.

Compelling scientific arguments can be made, however, for several other extrapolation models, which if used, could result in significantly reduced values for the slope factor, many times lower than those estimated using the linearized multistage model. Thus, current USEPA slope factors calculated in this fashion represent upper-bound values based on animal data, which should not be interpreted as necessarily equivalent to actual human cancer potencies. Nevertheless, these conservative values were used in this risk assessment in accordance with USEPA policy and as required by New York State Department of Health.

Noncarcinogenic Toxicity Assessment Assumptions

Key assumptions used in assessing the likelihood of noncarcinogenic effects were that threshold doses exist below which various noncarcinogenic effects do not occur and that the occurrence or absence of noncarcinogenic effects can be extrapolated between species and occasionally between routes of exposure and over varying exposure duration's. The threshold assumption appears to be sound for most noncarcinogens based on reasonably good fits of experimental data to the usual dose-response curves.

The effects observed in one species or by one route of exposure may not occur in another species or by another route, or they may occur at a higher or lower dose due to differences in the biokinetics of a compound in a different species or when exposure occurs by different routes. The uncertainty in these assumptions is taken into account in the development of RfDs through the use of safety or uncertainty factors. These factors reflect uncertainty associated with species-to-species extrapolation and include safety factors to protect sensitive individuals. In addition to uncertainty factors, a modifying factor is applied to reflect a quantitative professional assessment of additional uncertainties in the critical study and in the entire database for the agent not explicitly addressed by the preceding uncertainty factors.

The uncertainty factors and modifying factors used by the USEPA are conservative (health protective) in nature in that they tend to overestimate the uncertainties associated with the derivation of the RfDs (USEPA 1989). Use of the resulting RfDs tend to overestimate the potential for noncarcinogenic effects occurring at a given exposure level. Some of the PAHs have no USEPA-derived RfD. Uncertainty is introduced through the use of surrogate RfDs (*e.g.*, naphthalene) for these PAHs.

Route-to-Route Extrapolation of Slope Factors and Reference Doses

Route-to-route extrapolation of slope factors and RfDs adds an additional source of uncertainty to the risk assessments. Such extrapolation may result in either under- or over-estimation of the true risks for the extrapolated route. Although this practice adds uncertainty to the risk assessment process, it is preferable to omitting exposure to an agent by a route for which no slope factor or RfD is available. This avoids underestimation of the overall risks.

Risk Characterization

Risk characterization combines results from the toxicity and exposure assessments to develop a quantitative expression of risk. The potential for health risks due to COPCs are assessed in two ways:

> To characterize potential carcinogenic effects, intakes are compared to chemical-specific cancer slope factors (CSFs). Specifically, the estimated lifetime exposure dose is multiplied by its estimated cancer slope factor. Risk is expressed as the probability of that exposure resulting in an excess incidence of cancer; that is, the occurrence of more cancers than would normally be expected in that population.
>
> To characterize potential effects for systemic (*i.e.*, noncarcinogenic) substances, comparisons are made between projected intakes, or absorbed doses for dermal exposure, and reference doses (RfDs). In this case, the comparison is made by calculating the ratio of the estimated chronic daily intake to the corresponding RfD. This ratio is called the Hazard Quotient.

The excess cancer risk or hazard quotient resulting from each COPC for each route of exposure and exposure case (RME and average) was calculated separately. The separate cancer risks were then summed across all COPCs and all pathways applicable to the same population. The resulting value is the total excess cancer risk for that population. In contrast, Hazard Quotients for noncarcinogens are only additive for chemicals that produce the same type of adverse effect (such as liver damage). Hazard Quotients for chronic (and subchronic, where applicable) effects were separately summed across all chemicals, exposure routes, and pathways applicable to the same population to obtain what are referred to as “Hazard Indices” for that population. Separate Hazard Indices for different types of health effects were not calculated because where overall hazard indices exceeded unity (1.0), the majority of the value was due to a single chemical.

In the sections below, detailed explanations are provided of how the risks from potential carcinogens and noncarcinogens were calculated.

Estimated Potential Risks from Carcinogens

Scientists have developed several mathematical models to estimate low-dose carcinogenic risks from observed high-dose chemical exposure. USEPA has selected the linearized multistage model for this purpose (USEPA 1986). In addition to using the linearized multistage model, USEPA uses the upper 95th percentile confidence limit for doses or concentrations in animal or human studies to estimate cancer slope factors (CSFs). By using these procedures, the regulatory agencies are unlikely to underestimate the actual CSFs (formerly known as cancer potency factors) for humans. In fact, overestimation is likely. Using USEPA CSFs, lifetime excess cancer risks can be estimated by the following mathematical expression:

$$Cancer\ Risk \ = \ \sum AD_j \ or \ I_j \times CSF_j$$

where:

AD = dermally absorbed dose (estimated according to the equations in the exposure assessment);
I = ingestion intake (estimated according to the equations in the exposure assessment) or inhalation intake (estimated according to the equations in the exposure assessment); and
CSF = route-specific cancer slope factor (listed in Table 4-32);
j = one in a list of COPCs.

Carcinogenic risks for the ingestion (oral), dermal and inhalation routes of exposure are calculated (and added, if applicable) as follows:

$$\text{Total Excess Cancer Risk} = \left(AD_d \times CSF\right)_d + \left(I_o \times CSF_o\right) + \left(I_i \times CSF\right)_i$$

where:

the "d" subscript indicates the dermal route of exposure;
the "o" subscript denotes the oral route of exposure; and
the "i" denotes the inhalation route.

As discussed previously, the USEPA has not formally developed CSFs for the dermal route of exposure. USEPA's *Risk Assessment Guidance for Superfund* (USEPA 1989), however, does describe a method for deriving dermal CSFs from oral CSFs. To account for the fact that many chemical substances are poorly absorbed via the dermal route of exposure, USEPA recommends that a chemical's oral CSF be *increased* by a factor equivalent to the chemical's gastrointestinal (GI) absorption factor. This is equivalent to *dividing* the oral CSF by the GI absorption factor to derive a dermal CSF.

USEPA has adopted a policy (that NYSDEC and NYSDOH follow) for making decisions about what is and what is not an acceptable exposure to known or suspected carcinogens (40 CFR 300.430[E][2][i][A][2], USEPA 1990). Risks ranging from 1E-04 (0.0001 or one-in-10,000 persons) to 1E-06 (0.000001 or one-in-one million persons) are generally considered acceptable by the USEPA.

Estimated Potential Hazards from Noncarcinogens

Hazards associated with noncarcinogenic effects are assessed by comparing the estimated exposure to the acceptable daily dose, referred to as the RfD by USEPA. RfDs are generally calculated using the following mathematical formula:

$$RfD\ (mg/kg/day) = \frac{N(L)OAEL\ (mg/kg/day)}{\text{Uncertainty Factor} \times \text{Modifying Factor}}$$

As discussed previously, the USEPA has not formally developed RfDs for the dermal route of exposure. To account for the fact that many chemical substances are poorly absorbed via the dermal route of exposure, USEPA (1989) recommends that a chemical's oral RfD be *decreased* by a factor equivalent to the chemical's GI absorption factor. This is equivalent to *multiplying* the oral RfD by the GI absorption factor to derive a dermal RfD.

Noncancer hazards are assessed by calculating a hazard quotient (HQ), which is the ratio of the estimated exposure to the RfD as follows:

$$HQ = \frac{AD_j \ or \ I_j}{RfD_j}$$

where:

HQ = hazard quotient;
AD = dermally absorbed dose (estimated according to the equations in the exposure assessment);
I = ingestion intake or inhalation intake (estimated according to the equations in the exposure assessment);
RfD = route-specific reference dose (listed in Table 4-32); and
j = one in a list of COPCs.

Hazard quotients summed across chemicals are known as a hazard index (HI).

$$HI = \sum \frac{AD_j \ or \ I_j}{RfD_j}$$

Noncancer hazards for the ingestion (oral), inhalation, and dermal routes of exposure are calculated and added (if applicable) as follows:

$$Total\ HI = \frac{AD_d}{RfD_d} + \frac{I_o}{RfD_o} + \frac{I_i}{RfD_i}$$

where:

the "d" subscript indicates the dermal route of exposure;
the "o" subscript denotes the oral route of exposure; and
the "i" denotes the inhalation route.

The USEPA has developed subchronic RfDs based on the potential noncarcinogenic effects associated with exposure duration's ranging from a few weeks to seven years. Short-term exposures can occur when an activity resulting in an exposure is performed for a limited period of time or when a chemical degrades or disperses to negligible concentrations within a short period. Subchronic RfDs were used when available. Chronic RfDs were used in the absence of subchronic RfDs. Because noncancer hazards are calculated by dividing absorbed dose or intake by the RfD, and subchronic RfDs are typically greater than chronic RfDs, the use of chronic RfDs results in more conservative noncarcinogenic hazard estimates.

For a number of carcinogenic compounds such as the PAHs, chemicals for which the USEPA has not developed estimates of noncarcinogenic toxicity, RfDs for structurally similar noncarcinogenic PAHs (*e.g.*, pyrene) were used in an attempt to more completely ascertain potential noncarcinogenic hazards posed by these compounds. This is a reasonable approach for carcinogenic compounds that are sufficiently similar in structure to noncarcinogenic compounds of the same class.

As with carcinogens, USEPA has adopted a policy for noncarcinogens (that NYSDEC and NYSDOH follow) for making decisions about what is and what is not an acceptable exposure (40 CFR 300.430[E][2][i][A][1], USEPA 1990). Exposures that are less than the RfD - *i.e.*, exposures with a noncancer hazard value less than one – are very unlikely to be associated with health risks. Exposures exceeding the RfD – *i.e.*, exposures with a noncancer hazard value greater than one - may be associated with adverse health effects in a population. Nonetheless, a clear distinction that would categorize all exposures below the RfD as acceptable (*i.e.*, risk-free) and all exposures above the RfD as unacceptable (causing adverse effects) cannot be made (USEPA 1991).

Table 4-34 summarizes total receptor cancer risks and noncancer hazard estimates for the populations of concern in this assessment. Risks and noncancer hazards are graphically depicted in Figures 4-2 through 4-19.

Cancer Risks for Soil

Exposure to soil was assumed to be a complete exposure pathway for operations workers; adolescent on- and off-site trespassers; and future on-site residents. Cancer risks were determined for each of these potentially exposed populations.

The total excess cancer risks (*i.e.*, the sum of cancer risks for soil ingestion, dermal contact, soil particulate inhalation, and soil vapor inhalation) calculated assuming RME case conditions are 3E-05 for the operations worker; 2E-05 and 4E-05 for the adult and child future on-site resident (small parcel), respectively; 8E-05 and 2E-04 for the adult and child future on-site resident (site-wide), respectively; 5E-06 for the on-site trespasser; and 6E-06 for the off-site adolescent trespasser (Table 4-34). Total excess cancer risks calculated assuming average case conditions were 4E-06 for the operations worker; 2E-06 and 1E-05 for the adult and child future on-site resident (small parcel), respectively; 1E-05 and 5E-05 for the adult and child future on-site resident (site-wide); 2E-06 for the on-site trespasser; and 3E-06 for the off-site adolescent trespasser (Table 4-34). Each of these estimated cancer risks is within the EPA acceptable risk range (1E-06 to 1E-04), with the exception of the child future on-site resident (site-wide). The estimated excess cancer risk for this scenario is primarily due to the presence of PAHs in site soils. However, the 95% UCL concentrations, *i.e.*, the exposure point concentrations for these carcinogenic PAHs (benzo(a)pyrene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene and indeno(1,2,3-c,d)pyrene) are generally consistent with concentrations detected in site background samples. Furthermore, the maximum detected concentration of these PAHs was detected in NSSS-8, a sample collected near the Verizon service center parking lot. Because PAHs are a byproduct of incomplete combustion, these PAHs may be associated with vehicular use of the nearby parking lot and streets.

Noncancer Hazards for Soil

Potential noncancer hazards were estimated for exposure to soil. Noncancer hazards under the RME case were 0.6 for the operations worker; 0.1 and 1 for the adult and child future on-site resident (small parcel), respectively; 6 and 40 for adult and child future on-site resident (site-wide), respectively; 1 for the on-site trespasser; and 0.07 for the off-site adolescent trespasser. Average case noncancer hazard estimates were 0.3 for the operations worker; 0.04 and 0.3 for the adult and child future on-site resident (small parcel), respectively; 3 and 17 for the adult and child future on-site resident (site-wide), respectively; 1 for the on-site trespasser; and 0.03 for the off-site adolescent trespasser. Each of these noncancer hazards was at or below a noncancer hazard value of one (Table 4-34) with the exception of the future adult and child on-site resident (site-wide). The exceedance of the noncancer value of one for the adult is due primarily (84%) to dermal contact with surface soils containing nickel. Two surface soil samples were analyzed for nickel, therefore, the maximum concentration of nickel detected was used to assess residential exposure. The nickel concentration used, 457 mg/kg, was detected at NSSS-13. Given the range of nickel concentrations in the two on-site surface soil samples, 16.1 mg/kg to 457 mg/kg, it is likely that this maximum concentration is not representative of the exposure a resident would receive. NSSS-13 also contained lead at a concentration of 6,050 mg/kg. Because surface soils containing lead at this concentration will be addressed in a remedial action, exposure to nickel at NSSS-13 will be eliminated.

For the on-site child resident (site-wide) the noncancer hazard value of one is exceeded for both dermal contact and ingestion under the RME case. Under average case conditions, the hazard of one is exceeded for dermal contact. As with the adult resident, the exceedance for dermal contact is due primarily to nickel. Additionally, aluminum, beryllium and copper are present at concentrations associated with a hazard value greater than one. Exposure point concentrations for these metals were also based on the maximum of two samples collected. Like nickel, the maximum concentration of these metals was detected in NSSS-13.

For soil ingestion under RME case conditions, the noncancer hazard is due primarily to the ingestion of soils containing metals. However, exposure to these metals individually does not exceed the noncancer hazard value of one.

Cancer Risks for Combined Soil

The surface soil and subsurface soil sample analytical results were combined to calculate a "combined soil" 95% UCL concentration. This value was used to estimate soil exposures and potential risks for the construction worker. Cancer risks for construction worker combined soil exposure were calculated to be within EPA's acceptable range of 1E-04 to 1E-06 for both the RME and average cases (Table 4-34). RME and average case combined soil risks were 2E-06 and 4E-07, respectively.

Noncancer Hazards for Combined Soil

Potential noncancer hazards for combined soil exposure were predicted to exceed a noncancer hazard value of one for both the RME and average cases for construction worker exposure (Table 4-34). The predicted hazard was driven principally by soil particulate (*i.e.*, dust) inhalation. The noncancer hazards of 10 (RME) and 2 (average) were due almost exclusively to manganese (71% of the hazard) and aluminum (22% of the hazard). Air concentrations as a consequence of trenching activities for these two constituents were determined to be 0.012 mg/m^3 and 0.25 mg/m^3, respectively. It is important to note however, that the Occupational Safety and Health Administration's Permissible Exposure Limits (PELs) for manganese (ceiling concentration) and aluminum (respirable fraction) is 5 mg/m^3 for both (29 CFR 1910.1000, Subpart Z, Table Z-1). Thus, the PELs are roughly 400 times and 20 times greater, respectively, than the estimated manganese and aluminum concentrations in air. The OSHA PELs are designed to "protect workers against a wide variety of health effects that could cause material impairment of health or functional capacity. This includes protection against catastrophic effects such as cancer, cardiovascular, liver, and kidney damage; lung diseases, as well as subtle effects resulting in central nervous system damage, narcosis, respiratory effects, and sensory irritation" (29 CFR 1910.1000). In contrast, EPA's inhalation RfCs (which were used in the estimation of noncancer hazards for manganese and aluminum in this risk assessment) were developed to assess 24-hour (continuous) 70-year (lifetime) exposure. Occupational standards such as OSHA's PELs are more relevant for comparison in a discontinuous (8-hour per day), less-than lifetime (25-year) exposure situation befitting on-site construction workers. Therefore, the predicted air concentrations for manganese and aluminum as a consequence of trenching activity do not pose a human health threat.

Cancer Risks for Indoor Air

Indoor air exposure was assumed to be a complete exposure pathway for future on-site commercial workers and current on-site operations workers. Potential excess cancer risks associated with inhalation of indoor air for all relevant on- and off-site receptors were all below the USEPA's acceptable range. Cancer risks associated with indoor air exposure under the RME case were calculated to be 2E-07 for the commercial worker; 3E-08 for the operations worker; 8E-07 for the adult on-site resident (site-wide) and 5E-07 for the child on-site resident (site-wide). Cancer risks under the average case conditions were calculated to be 5E-08 for the commercial worker; 2E-09 for the operations worker; 9E-08 for the adult on-site resident (site-wide) and 1E-07 for the child on-site resident (site-wide). All of these estimated cancer risks are below EPA's acceptable risk range (1E-06 to 1E-04) (Table 4-34).

Noncancer Hazards for Indoor Air

Estimated noncancer hazards associated with inhalation of indoor air for all relevant on-site receptors were below the noncancer hazard value of one. RME case noncancer hazards were estimated to be 0.02 for commercial workers; 0.001 for the operations worker; 0.08 for the adult on-site resident (site-wide) and 0.2 for the child on-site resident (site-wide). Average case hazards were estimated to be 0.02 for commercial workers; 0.003 for operations workers; 0.02 for the adult on-site resident (site-wide) and 0.06 for the child on-site resident (site-wide) (Table 4-34). Each of these noncancer hazards is below the hazard threshold of one.

Assessment of Lead

As stated in the exposure and toxicity assessments, indices of toxicity (RfDs and SFs) are not available for lead. In the absence of these values, risks associated with lead exposure at the Newtown site were evaluated using the USEPA's IEUBK model and the Bowers et al. (1994) adult lead model.

IEUBK Model Results

In most applications of the IEUBK model, a site is generally defined as an area such as a residential yard with a single housing unit, or an area of multi-unit buildings or undeveloped lots. The home and surrounding yard is often used because lead exposure for children typically occurs within this area. Risk is then calculated as the probability that the blood lead concentrations of a single child at a single site will exceed a specified level of concern, in this case, 10 μg/dL (USEPA 1994a).

For this analysis, the IEUBK model was run using a "yard-by-yard" approach by assuming that each of the sixteen on-site surface soil sampling points represented a residential yard. Lead concentrations in these samples ranged from 122 mg/kg to 18,800 mg/kg with an average concentration of 4,777 mg/kg. Results of the model suggest that exceedance of the 10 μg/dL blood lead level occurred at fifteen of the sixteen sampling points or "yards." The probability of exceeding the 10 μg/dL blood lead level at these sampling points ranged from 17.50% at NSSS-2 to 99.57% at NSSS-6 and NSSS-10 (Table 4-35).

A model output value of 17.50% does not mean that approximately one of five children in a given home will have a blood lead level exceeding the 10 μg/dL benchmark. Rather, it is a probability that the 10 μg/dL blood lead level could be exceeded given the exposure scenario for that residence; *i.e.*, a 17.50% chance that any child could have a blood lead level exceeding 10 μg/dL.

Bowers et. al Adult Lead Model

Operations Worker. The average of lead concentrations detected in NSSS-1, NSSS-2 and NSSS-3 was used as input for the Bowers model. These three samples were collected from the operations area of the site. The predicted blood lead levels were 5.64 μg/dL (RME case conditions) and 3.34 μg/dL (average case conditions). The model was also used to estimate blood lead levels at each sampling point. Predicted blood lead levels ranged from 4.68 μg/dL at NSSS-2 to 6.83 μg/dL at NSSS-1 for the RME case. Under average case conditions, blood lead levels ranged from 2.95 μg/dL to 3.81 μg/dL (Table 4-35). All of these values are below the blood lead level of concern, 10 μg/dL.

Construction Worker. The arithmetic average of lead concentrations detected in all on-site surface soil samples, test pit samples, and subsurface soil samples, to a depth of 14', was used as model input. This average concentration, 11,118 mg/kg, was associated with predicted blood lead levels of 13.50 μg/dL (RME case) and 2.53 μg/dL (average case). Model input of lead concentrations detected in individual surface soil samples resulted in a range of predicted blood lead levels from 1.93 μg/dL to 21.58 μg/dL for the RME case. For the average case, predicted blood lead levels ranged from 1.81 μg/dL to 3.04 μg/dL. Predicted blood lead levels as a result of exposure to individual subsurface soil samples were essentially identical to baseline levels, 1.80 μg/dL. The baseline level is defined as a blood lead level for an individual not exposed to any site-affected soil containing lead. The baseline value used here is the average of geometric mean values reported for women of childbearing age (Bowers and Cohen 1998). Lead data from the test pits resulted in predicted blood lead levels ranging from 1.89 μg/dL to 208 μg/dL for the RME case and 1.81 μg/dL to 14.69 μg/dL for the average case (Table 4-35). The blood lead level of concern, 10 μg/dL, was exceeded in several instances. It should be noted that the Bowers model is sensitive to exposure frequency; therefore, the 10 μg/dL would be exceeded with greater occurrence if a construction worker was exposed to lead for greater than 20 days (RME case exposure frequency for the construction worker).

Although the Bowers model is not typically used to predict blood lead levels on a point-by-point basis, such an approach was used to evaluate occupational exposure to lead in order to aid in remedial action decisions. The USEPA is recommending the model developed by Bowers et al. for calculating industrial site soil lead cleanup levels. The acceptable soil lead concentration is based on a target blood lead level in fetuses of pregnant women in the workplace. Specifically, USEPA has stipulated that exposure to lead must be limited to ensure that a fetus has a 95% probability of having a blood lead level below 10 μg/dL (Bowers and Cohen 1998; USEPA 1996b).

OSHA's recommended blood lead level is also based on adverse reproductive and fetal effects. OSHA's recommendation is that blood lead levels of workers (both male and female) who intend to have children should remain below 30 µg/dL (29 CFR 1926.62 Appendices B and C). Although OSHA's recommended blood lead level is three times greater than that of the USEPA, the more conservative USEPA value was used as the blood lead level of concern in this assessment. As discussed in the exposure assessment, the USEPA and the Centers for Disease Control (CDC) have identified benchmarks of either 95% of the child resident population having blood lead concentrations below the 10 µg/dL benchmark or, a 95% probability of an individual child having a blood lead concentration below 10 µg/dL, as acceptable (CDC 1991; USEPA 1994b). Although this criterion was established for children and not adults, it is a useful screening tool for two reasons: 1) children are more susceptible to the adverse effects of lead; therefore, a benchmark value established for children is health-protective of adults and 2) because the USEPA has chosen to focus on fetuses in establishing lead cleanup goals for industrial sites, and the fetus is assumed to have 90% of the blood lead level of its mother (USEPA 1996b), the 10 µg/dL blood lead level would also achieve this target.

Holder Area

The area encompassed by the former gas holders at the Newtown site is approximately one-half of the site, *i.e.*, three acres. In order to allow for redevelopment of the site, approximately 100,000 cubic yards of fill material is required to backfill the concrete of each of the gas holders. A Beneficial Use Determination (BUD) was obtained from the NYSDEC for recycled soil or dredged sediment to be used as backfill for these decommissioned holders. The recycled material will be placed in the former gas holders to a depth of two feet below ground surface and covered with two feet of clean fill (BUD 2000). Sources of the recycled soil/dredged sediment do not include construction and demolition transfer stations, industrial sites, oil spill sites, inactive hazardous waste sites or previous fill/urban fill sites (BUD 2000). In addition, results of samples collected from the fill must meet the soil quality criteria as established in NYSDEC's Technical and Administrative Guidance Memorandum #4046, *Determination of Soil Cleanup Objectives and Cleanup Levels* for organic compounds. For organics, the following standards apply to the recycled material: VOCs must meet individual compound concentrations as listed in TAGM 4046; total SVOCs - 500 mg/kg; total carcinogenic SVOCs – 10 mg/kg; total pesticides and PCBs, 10 mg/kg each. For the RCRA-8 metals, the standards established in the BUD are the NYSDEC limits for General Reuse Options Category B. The two feet of clean fill to be placed above the recycled material must meet the Recommended Soil Cleanup Objectives (RSCOs) in TAGM 4046 for each individual parameter. The RSCOs in TAGM 4046 were developed to be protective of human health and the environment under residential exposure conditions. The backfilling process is underway at Newtown and analytical results performed on the fill indicate that the fill is in compliance with the BUD and, therefore, does not pose a potential threat of adverse health effects under future use scenarios for the site.

Risk Characterization Uncertainty

Risk characterization combines and integrates the information developed in the exposure and toxicity assessments. Therefore, uncertainties associated with these assessments also affect the degree of confidence that can be placed in the risk characterization results. The full discussions of the factors causing uncertainty in these components of this risk assessment are included in the exposure and toxicity assessment sections of this report. The table below summarizes the factors that could cause over- or under-estimation of the true exposures and risks characterized in this assessment.

Risk Assessment Uncertainties and Their Potential

Impact on the Characterization of Risk

Portion of Risk Assessment	Factor	Impact on Risk Characterization
Exposure Assessment	The use of the 95th percent UCL on the arithmetic average as the source concentration.	Overestimation
	The use of 90th percentile exposure assumption values.	Overestimation
	The use of the steady-state assumption for source concentration estimates.	Overestimation
	The use of ½ the detection limit to estimate non-detected chemical concentrations.	Overestimation
Toxicity Assessment	Design, execution, or relevance of the scientific studies that form the basis of the assessment.	Over- or Underestimation
	Extrapolating from the toxicological studies selected by the regulatory agency to the exposure situation being evaluated, including variable responses to chemical exposures within human and animal populations, between species, and between routes of exposure.	Over- or Underestimation
	The absence of EPA-approved toxicity factors for some compounds, which made it necessary to use surrogate values or to evaluate the effects of the contaminants qualitatively rather than quantitatively.	Over- or Underestimation

The toxicity assessment process compensates for some of these basic uncertainties through the use of safety factors (uncertainty factors) and modifying factors when assessing noncarcinogens, and the use of the upper 95% confidence limit from the linearized multistage model for the slope factors when assessing carcinogens. The use of the safety factors and the upper 95% confidence limit in deriving the reference doses (RfDs) and CSFs ensures that the toxicity values used in the risk estimating process are likely to overestimate the true toxicity of a chemical.

The cumulative effect of using conservative assumptions throughout the risk assessment process is that the resulting estimates could substantially overstate the true risks. *EPA's Risk Assessment Guidance for Superfund* (EPA 1989) recommends that individual parameter values be selected so that the overall estimate of exposure represents a reasonable maximal exposure. In many cases, the statistical distribution of an exposure parameter is unknown, and best professional judgment is used to select a value sufficiently conservative to avoid underestimating the true risk, yet not so conservative that the resulting risk estimate turns out to be unreasonably high. However, guidance recommends using the more conservative values to avoid the possibility of underestimating the potential risk. The resulting risk estimate often is unreasonably high, especially considering the compound effect of several conservative factors used together. The nature of the risk estimation process itself virtually ensures that the risk estimates are very likely to overestimate the true risk.

The last uncertainty factor to consider is the likelihood of the postulated exposures actually occurring. The exposure pathways identified as complete under current land use conditions are all plausible, and exposure is either presently occurring by these pathways or such exposure could reasonably be expected. The postulated frequencies of occurrence may overestimate routine occurrence, but could reflect the reasonable maximum occurrence.

Modeling Uncertainty

There are several uncertainties associated with the air modeling for the site. A primary uncertainty, which results in overestimation of modeled air concentrations, is due to the conservative assumptions which are used for input into the models. In the absence of site specific data, USEPA and ASTM defaults were used. These default values are generally conservative. Additionally, for the site construction worker and adolescent trespasser, on-site resident the modeled concentrations were based on the conservative assumption that contamination is uniform across the site. Because the 95% UCL concentration or the maximum detected concentration, whichever is less is used to assess exposure, this approach over-estimates modeled concentrations for areas of the site where concentrations are lower. An additional source of uncertainty lies in the modeling for indoor air. Concentrations for the indoor air modeling were based on subsurface soil results for samples collected near buildings, not directly underneath the buildings on-site.

Risk Analysis Conclusions

Table 4-34 lists the total receptor cancer risk and noncancer hazard estimates for the populations of interest in this assessment – future on-site commercial workers; future on-site construction workers; on-site operations workers; future on-site residents of the small residentially zoned parcel; and adolescent site trespassers, both on- and off-site. From this assessment, the following can be concluded:

> The predicted total cancer risks for <u>all</u> receptor populations were within or below the acceptable range of cancer risk as defined by the USEPA (*i.e.*, within 1E-06 to 1E-04) under both average and RME case conditions with the following exception:

> Total cancer risk for the future on-site child resident (site-wide) was predicted to be 2E-04 under the RME case. This risk is primarily associated with PAHs, however, concentrations of the carcinogenic PAHs are generally consistent with concentrations detected in site background samples.

Total noncancer hazards for <u>all</u> exposure scenarios were at or below a noncancer hazard of one, under both RME and average case conditions with the following exceptions:

> Noncancer hazards for both the adult and child on-site resident (site-wide) exceeded the hazard threshold of one under both RME and average case conditions. These hazards were primarily due to the presence of metals, particularly in NSSS-13. These metals concentrations will be addressed by the remedial action proposed for lead.
>
> Noncancer hazards for the construction worker were predicted to be 10 (RME case) and 2 (average case). These hazards are primarily due to modeled concentrations of aluminum and manganese in respirable particulates. The concentrations of these metals in airborne particulates are well below the OSHA PELs. Furthermore, only two surface soil samples were analyzed for the presence of aluminum and manganese; thus the maximum detected concentration was used for air modeling purposes. Use of this maximum value likely results in overprediction of air concentrations.

Assessment of lead was performed using the IEUBK Model to evaluate lead exposure for children and the Bowers et al. model to evaluate adult occupational exposures. Results from these models indicate that for both these populations the benchmark blood lead level of 10 µg/dL is exceeded at certain discrete sampling points.

Use of the IEUBK resulted in exceedance of the benchmark blood lead level at 15 of the 16 surface soil sampling points (all except NSSS-16). The blood lead level of concern was not exceeded for the operations worker. For the construction worker, predicted blood lead levels exceeded 10 µg/dL using average soil lead concentrations at the site. The 10 µg/dL benchmark was also exceeded at several sampling points: NSSS-6 (21.58 µg/dL); NSSS-10 (19.79 µg/dL); NSSS-12 (10.64 µg/dL); NSTP-03 6″ (50.4 µg/dL); NSTP-04 4″ (208 µg/dL); NSTP-05 4″ (40.41 µg/dL); and NSTP-06 4″ and 24″ (30.31 and 11.52 µg/dL, respectively).

5

Fish and Wildlife Impact Analysis

Introduction

This fish and wildlife impact analysis (FWIA) has been conducted to identify actual or potential risks to fish and wildlife residing in the vicinity of the Newtown Station/Elmhurst Holder Tank site. Specifically, it focused on risks associated with site-related chemicals detected in surface soil.

This analysis contains:

- Site descriptions including a characterization of the floral and faunal resources present and the value of these resources to humans,
- The identification of applicable regulatory standards and criteria for fish and wildlife,
- Evaluations of potential exposure pathways to fish and wildlife from site-related chemicals of potential ecological concern, and
- Comparison of chemical concentrations (for chemicals of ecological concern) to regulatory criteria or derived toxicological benchmarks for the protection of fish and wildlife.
- Conclusions regarding the potential of exposure and possible risks to fish and wildlife on or about the site.

Terrestrial Resources

The U.S. Fish and Wildlife Service (USFWS) and the New York State Department of Environmental Conservation (NYSDEC) Natural Heritage Program were contacted regarding species of concern, significant habitats, and fishery resources within two miles of the site. The NYSDEC databases indicated the potential presence of two endangered (Swamp Aster-*Aster radula* and Pink Wild Bean-*Strophostyles umbellata*) and one threatened (Swamp Lousewort-*Pedicularis lanceolata*) plant species within a two mile radius of the site. The USFWS confirmed that except for occasional transients, no Federally listed or proposed endangered or threatened species are known to exist in the site area. Furthermore, the USFWS stated that no habitat in the site area is currently designated or proposed "critical habitat" in accordance with provisions of the Endangered Species Act. In addition, VHB obtained a copy of the New York State Freshwater Wetland Maps to identify state wetlands within two miles of the site. The USFWS National Wetland Inventory Maps were obtained.

Due to the relatively urban nature of the site, no detailed ecological field reconnaissance surveys were proposed for the initial phase of the project. Instead, ecological information was collected in conjunction with the sampling activities conducted on site during the investigation.

Ecosystems were characterized in a 0.5-mile radius of the site. Typical wildlife species expected to occur in the study area are discussed based on the geographic range and habitat requirements. The value of each habitat to wildlife is also provided.

Each plant cover type is described below as to 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* (Reschke, 1990).

The Newtown Station site is located in an urban area and as such, there are no significant vegetative communities in the vicinity of the site. The site was utilized primarily for the temporary storage of manufactured gas during the early 1900's, followed by natural gas, for peak demand use. The site was decommissioned in 1993. The property is bounded on the south by 57th Avenue, on the west by a ConRail right-of-way, on the north by Grand Avenue and on the east by 80th Street. The surrounding area is primarily urban and land use is mostly residential with some industrial and commercial land. Commercial development consisting of neighborhood stores exists immediately north of Grand Avenue and the "backyard" areas of attached single-family residential units are located immediately east of the site along the northern portion of 80th Street. A Verizon service center is also located immediately east of the site along the southern portion of 80th Street.

The Newton Station site comprises 6 acres and is almost completely void of vegetation, with the exception of a few small patches of mowed grass. Most of the area is either covered with gravel, concrete, asphalt, a gravel and dirt mixture, or geotextile fabric and fill and gravel. Three acres of the site are taken up by the former holder tanks. A narrow strip of vegetation exists along the ConRail right-of-way. It consists of sycamore (*Platanus occidentalis)*, black locust (*Robinia pseudo-acacia,*), tartarian honeysuckle (*Lonicera tatarica*), summer grape (*Vitis aestivalis*), and goldenrods (*Solidago spp.*).

Beyond the site boundaries, habitats are consistent with a high density residential/commercial area. These areas typically consist of little to no mowed lawns interspersed with trees and shrubs which often times are introduced exotics used for ornamental purposes.

Aquatic Resources

There are no aquatic resources within 2 miles of the site. Drainage occurs primarily through sheet flow run-off, which is conveyed to sewers and eventually discharges into local tidal water bodies. Precipitation that is unable to enter the storm sewer system generally collects in large puddles in local low areas and eventually infiltrates or evaporates.

Freshwater and Tidal Wetlands

Wetlands have been identified on the U.S. Fish and Wildlife National Wetland Inventory (NWI) Maps (Brooklyn, NY quadrangle) and NYSDEC Tidal Wetland Maps (see Figure 4-1C). Some of the wetlands are downgradient from the site. However, there are no known direct migration pathways from the site into the wetlands. Also, due to distance involved and fate and transport mechanisms, no significant effects on wetlands are expected.

Fish and Wildlife Resources

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. General wildlife values (*e.g.*, food and cover availability) were also noted.

The surrounding two-mile radius consists of residential homes and industrial/ commercial properties. These areas typically consist of mowed lawns interspersed with trees and shrubs, which often times are introduced exotics used for ornamental purposes. These areas do not support an abundance of wildlife because of the lack of vegetation, which could provide food and cover, and constant human activity. The narrow strip of vegetation along the right-of-way does provide habitat for wildlife. However, the small size limits the size of the population it can support. Table 5-1 lists the herptile (amphibian and reptile), bird, and mammal species that may potentially occur within and adjacent to the site based on the land uses.

Observation of Stress

Signs of stress to vegetation and wildlife from site-related chemicals were not observed during the field reconnaissance.

Value of Habitat to Associated Fauna

The site and adjoining terrestrial properties are of little value to wildlife. The area is developed, and only isolated pockets of vegetation exists, and in most cases these areas are maintained by frequent mowing. The wildlife expected to occur in the vicinity of the site includes more urbanized bird and mammalian species such as mockingbird (*Mimus polyglottos*), gray squirrel (*Sciurus carolinensis*), and Norway rat (*Rattus norvegicus*).

Value of Resources to Humans

The site and surrounding area are of little value to humans for recreational use of wildlife. The developed nature of the area precludes small game and deer hunting.

Applicable Fish and Wildlife Criteria and Standards

Site-specific criteria protective of fish and wildlife resources associated with the site that may be applicable to future remediation are:

> Migratory Bird Treaty Act, which protects migratory birds, their eggs and nests from harm. The Treaty is found at Title 16 of the U.S. Code as Subchapter II of Chapter 7, Protection of Migratory Game and Insectivorous Birds. The Treaty states that "…the taking, killing or possession of migratory birds is unlawful" unless exempted by permit under the migratory bird regulations. The Treaty also stipulates enforcement actions for violations.

Exposure Pathways Analysis

Chemicals of Potential Ecological Concern

A number of substances were detected in surface soil and groundwater. In order to focus the FWIA on those chemicals that may pose risks to the environment, chemicals of potential ecological concern (COPECs) were selected. For this assessment, the chemicals detected in groundwater are not considered chemicals of potential ecological concern for ecological receptors except indirectly as a potential source of contamination to the surface water or sediment downgradient of the site. The depth to groundwater was greater than thirty feet below ground surface (bgs), which is below the root zone of most plants. Therefore, no exposure routes exist, and the chemicals detected in groundwater are not discussed.

Surface and subsurface soil (borings and test pits) samples were collected from the Newtown Station site and analyzed for volatile organic compounds, semi-volatile organic compounds, RCRA-8 metals and total cyanide. Only shallow subsurface soils (up to four feet below ground surface) were considered in this fish and wildlife impact analysis. A total of samples (32 surface soil and 12 subsurface soil) were analyzed in this depth interval. Data for deeper subsurface soils were not evaluated due to lack of exposure routes to wildlife. 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. Essential nutrients (calcium, iron, potassium, sodium and magnesium) are not considered chemicals of potential ecological concern.

Chloroform, tetrachloroethene, 1,4-dichlorobenzene, and benzyl alcohol were detected infrequently (*i.e.,* in less than 5% of the samples with sample sizes greater than 20 samples) (see Table 5-2). Therefore, these chemicals are not considered COPEC for this assessment. Methylene chloride is not considered a COPEC because it is detected in the method blank.

Chemical Migration and Fate

The chemicals of potential ecological concern consist of volatile organic compounds, polycyclic aromatic hydrocarbons and metals.

Volatile Organic Compounds – The volatile organic compounds of concern have high vapor pressures and, therefore, would be expected to volatilize readily from surface soil and surface water to the atmosphere. Once released to the atmosphere, these compounds are rapidly photodegraded.

In deeper soils, these compounds degrade slowly, are water soluble and may leach into groundwater. These compounds have low octanol/water coefficients (log K_{ow}) and, therefore, do not adsorb to sediment or particulate matter present in the water column.

PAHs - PAHs are a major component of coal tars. PAHs contain only carbon and hydrogen and consist of two or more fused benzene rings in linear, angular or cluster arrangements. 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 organic carbon partition coefficient (K_{oc}).

High partition coefficients and low solubilities suggest that PAHs are likely to be adsorbed onto sediment particles. Conversely, these properties indicate that most PAHs will not readily volatilize into the atmosphere.

Although PAHs are regarded as persistent in the environment, they are degradable by microorganisms. Environmental factors, microbial flora and physicochemical properties of the PAHs themselves influence degradation rates and degree of degradation. Important environmental factors influencing degradation include temperature, pH, and redox potential and microbial species. Physicochemical properties, which influence degradation, include chemical structure, concentration and lipophilicity.

Metals – In a terrestrial setting, trace elements released to the environment accumulate in the soil (Sposito and Page, 1984). Mobility of these trace elements in soil is low and accumulated metals are depleted slowly by leaching, plant uptake, erosion, or chelation. The half-life of trace elements in temperate climate ranges from 75 years for cadmium to more than 3,000 for zinc.

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

Eh-pH system
Cation exchange capacity and salt content
Quantity of organic matter
Plant species
Water content and temperature
Microbial activity

Metals that do mobilize from the soil into the water column are most mobile under acid conditions and increasing pH usually reduces their bioavailability. Generally, metals do not exist in soluble forms for long and generally accumulate in bottom sediment. Once in the sediment, most metals sorb onto hydrous iron and manganese oxides, clayey minerals and organic materials and are eventually partitioned into the sediments. Metal bioavailability from the sediment is enhanced under conditions of low pH, high dissolved oxygen, high temperature, and oxidation state. During these conditions, metals become soluble and freely move in the interstitial pore water and the water column (McIntosh, 1992).

The migration pathways for chemicals are illustrated on Figure 4-1D.

Exposure Pathways

Wildlife resources in the commercial/residential area surrounding the site are limited due to the lack of food and cover. Also, constant human disturbance limits the population to wildlife species more tolerant of human activity. Several wetlands were identified in the two-mile radius study area. These wetlands are currently too distant and/or up gradient of the site for any likely exposure to site-related chemicals. Also, some of the chemicals of potential ecological concern are selected metals and PAHs. The fate and transport mechanisms of these chemicals reduce the likelihood of future migration into these areas. Thus, exposure is likely to be limited to wildlife on, near, or immediately downgradient from the site.

Plant roots are not discriminating in the uptake of small organic molecules (molecular weight less than 500) except on the basis of polarity. The more water soluble molecules pass through the root epidermis and translocate throughout the plant and are eventually volatilized from the leaves (Efrymson *et al.,* 1997a). Plants selectively uptake metals in soil by absorption from soil solution by the root. Metals may be bound to exterior exchange sites on the root and not actually taken up. They may enter the root passively in organic or inorganic complexes or actively by way of metabolically controlled membrane transport (Kabata-Pendias and Pendias, 1992). Once in the plant, a metal can be stored in the root or translocated to other plant parts. Potential exposure to wildlife could occur through direct contact with or accidental ingestion of contaminated soil or through the terrestrial food chain.

Criteria-Specific Toxicity Assessment

Soil

The NYSDEC does not have soil cleanup criteria relating to the protection of wildlife and the availability of applicable soil screening values in scientific literature is limited. The screening of soil chemicals of potential ecological concern was conducted by comparing the chemical concentrations to available screening benchmark values derived by the Oak Ridge National Laboratory (Efroymson *et al.*, 1997a, 1997b and Sample *et al.*, 1996) for the U.S. Department of Energy. The benchmark values are the 10th-percentile of the distribution of various toxic effects threshold for the chemicals in soil for the group of organisms.

Transformation or loss due to environmental degradation is not considered in this assessment. It is assumed that following uptake, concentration in soil will equal concentrations in organisms. This assumption overestimates potential risk in that wildlife has limited contact with these chemicals in soil and plants.

Benchmark values for three groups of organisms, where available or derived, are presented in Table 5-2. Terrestrial plants were selected since they are critical in nutrient cycling and are a source of food in the diets of higher animals. Also, plants readily take up the chemicals of potential ecological concern. Earthworms were selected because of their importance in maintaining soil fertility through burrowing and feeding activities. Also, earthworms are at the base of the food chain and are an important food for higher organisms. Meadow voles were selected to represent a herbivorous small mammal. The benchmark values for meadow vole is presented as dietary concentrations in mg of chemical per kg of diet that would result in no observed adverse effect levels (NOAELs). For screening purposes, it was assumed that the chemical concentration in soil would be found in the food items of each species. As stated previously, this is a conservative approach that should result in the overestimation of potential exposure and risk.

As indicated in Table 5-2, screening values are available for a few of the chemicals of ecological concern. Therefore, the methodology of the Oak Ridge National Laboratory (Sample *et al.,* 1996) was used to derive toxicological benchmarks for the meadow vole from published toxicological data for laboratory animals. Literature sources included IRIS (USEPA, 2000), HEAST (USEPA, 1997), and the National Toxicology Program. It should be emphasized that the resulting benchmarks obtained from this methodology and toxicological data are based on a conservative approach whose resulting relationship to potential population effects is uncertain.

No observed adverse effect levels (NOAELs) and lowest observed adverse effect levels (LOAELs) are daily dose levels normalized to the weight of the test animal [*e.g.*, milligrams of chemical per kilogram body weight per day (mg/kg/day)]. The presentation of toxicity data on a mg/kg/day basis allows for comparison across species with appropriate consideration for differences in body sizes. If a NOAEL (or LOAEL) for a mammalian test species ($NOAEL_t$) is available, then the equivalent NOAEL (or LOAEL) for a mammalian wildlife species ($NOAEL_w$) can be calculated by using an adjustment factor for the difference in body size:

$$NOAEL_w = NOAEL_t \times \left({}^{bw_t}\!\!\diagup_{bw_w} \right)^{1/4}$$

where:

$NOAEL_w$ = No observed adverse effect level for wildlife species (mg/kg/day)
$NOAEL_t$ = No observed adverse effect level for test species (mg/kg/day)
bw_w = Body weight for wildlife species (kg)
bw_t = Body weight for test species (kg)

In some cases, a NOAEL for specific chemical was not available, but a LOAEL or lethal dose (LD_{50}) had been determined experimentally. The NOAEL can be estimated by applying an uncertainty factor (UF) to the LOAEL or LD_{50}. In the USEPA methodology (USEPA, 1989), the LOAEL or LD_{50} can be reduced by a factor of 10 or 50, respectively, to derive the NOAEL.

The dietary level or concentration in food (C_f) of a chemical in milligrams of chemical per kilogram of food that would result in a dose equivalent to the NOAEL can be calculated from the food factor (*f*):

$$C_f = \frac{NOAEL_w}{f}$$

The food factor, (*f*) is the amount of food consumed per day per unit of body weight. Table 5-3 provides the body weight, food intake and food factors used in the derivation of chemical-specific NOAELS for the meadow vole. Table 5-4 provides the derived toxicological benchmarks for the meadow vole. When literature values were not available for a chemical, a structurally similar surrogate was used. These surrogates are provided in Table 5-4.

Table 5-2 presents the results of screening the maximum concentrations of the COPECs against the literature and derived benchmark values.

Conclusions

Habitat Characterization

The site and surrounding area are poor quality environmental resources, due to the limited presence of vegetation. The site is mostly covered with buildings and asphalt. Wildlife species, typically present are adapted to urban setting. Due to the size of the vegetated areas, only a few individuals will be present. The New York Harbor and several wetland areas are located within 2 miles of the site. Potential migration of chemicals of potential ecological concern into these resources should be prevented.

Soil

Several COPECs were detected at concentrations greater than the toxicological benchmark values. This suggests that these chemicals may pose a risk to wildlife. In addition, toxicological benchmarks were not derived for several COPECs. However, these potential effects have minimal ecological significance.

The potential risk from COPECs is minimal, for several reasons. Exposure frequency, chemical concentration (especially within in the upper 6 inches), mechanism of exposure, and duration of exposure determines risk. The commercial area (*i.e.*, paved areas, buildings, etc.) provides minimal habitat in the form of "weedy" patches that would not support a wildlife population. This area experiences constant physical disturbance that prevents populations of wildlife from developing. Because only transient species and a few individual animals would use this area, the frequency and duration of exposure is limited. Thus, the observed chemicals detected on-site do not pose a current risk, nor is any expected in the future.

In addition, chemical availability for biological uptake and migration from soil is an essential factor in controlling risk these chemicals pose to ecological receptors. Many PAHs become less available as they age within soil. Furthermore, the presence and nature of the organic material in the soil has a profound influence on the availability of PAHs. This reduced availability, which results from chemical complexation or entrapment in very fine pores, results in an overestimation of risk (Stroo *et al.*, 2000).

6

Conclusions and Recommendations

Conclusions

Based upon the work performed under the approved VCA work plan we offer the following conclusions:

The Newtown Station/Elmhurst Holder Site served as a gas storage, gas transmission, and service center since the turn of the century. The gas holders have been demolished, the compressor building is slated for demolition, and service capabilities currently remain in the trailers located on the south side of the site.

KeySpan has conducted various discrete sampling, investigation, and closure activities prior to the implementation of this VCA. Those activities are summarized in this document and detailed in the approved work plan.

Site reconnaissance performed by VHB indicates that LBP debris are present on site in surface and shallow subsurface soil.

Analytical results from surface soil and test pit sampling indicate that inorganics, principally lead, are present in surface and shallow subsurface soils on-site. The lead in on-site surface soils is most likely attributable to LBP debris.

Analytical results indicate that SVOCs and Inorganics are present in surface soil on- and off-site. However, the source and background levels of the analytes detected have not been determined.

Organoleptic appraisal of subsurface soils indicate the majority of subsurface soils at the site are free of organic constituents.

Analytical results of the subsurface soil samples indicate the presence of VOCs, SVOCs, and Inorganics in specific “hot-spots” on-site.

Analytical results of the groundwater samples indicate the presence of low levels of VOCs, SVOCs and Inorganics in groundwater.

The COPCs at the site pose no ecological risk based on a Fish and Wildlife risk assessment.

The predicted total cancer risks for <u>all</u> receptor populations were within or below the acceptable range of cancer risk as defined by the USEPA (*i.e.*, within 1E-06 to 1E-04) under both average and RME case conditions except for:

> Total cancer risk for the future child resident under the site-wide residential scenario which was predicted to be 2E-04 under RME case conditions. This estimated excess cancer risk is due primarily to the presence of PAHs in site surface soils. On-site concentrations of PAHs are generally consistent with site background concentrations. Additionally, the highest concentrations of PAHs were detected in soil samples that contained lead at concentrations greater than 1,600 mg/kg. Surface soils containing lead at these concentrations will be addressed in a remedial action, thus addressing PAHs at these sampling points.

Total noncancer hazards for <u>all</u> exposure scenarios were at or below the acceptable level of noncancer hazard, *i.e.*, one, under both RME and average case conditions with the following exceptions:

> Noncancer hazards for both the adult and child on-site resident (site-wide) exceeded a noncancer hazard of one under both RME and average case conditions. These hazards primarily were due to the presence of metals, particularly in NSSS-13. These metals concentrations will be addressed by the remedial action proposed for lead.
>
> Noncancer hazards for the construction worker were predicted to be 10 (RME case) and 2 (average case). These hazards are primarily due to modeled concentrations of aluminum and manganese in respirable particulates. The concentrations of these metals in airborne particulates are well below the OSHA PELs. Two on-site surface soil samples, NSSS-2 and NSSS-13, were analyzed for the presence of aluminum and manganese; thus the maximum detected concentration was used for air modeling purposes. Use of this maximum value likely results in overprediction of air concentrations. Furthermore, NSSS-13 which contained the maximum detected concentration of both aluminum and manganese, contained lead at 6,050 mg/kg. As stated above, these metals concentrations will be addressed by the remedial action proposed for lead.

Assessment of lead was performed using the IEUBK Model to evaluate lead exposure for children and the Bowers et al. model to evaluate adult occupational exposures. Results from these models indicate that for both these populations the benchmark blood lead level of 10 μg/dL is exceeded at certain discrete sampling points.

Recommendation

Based on the information presented herein, VHB recommends implementing an IRM to mitigate the potential concern associated with surface and shallow subsurface COPCs, principally lead.

TCLP analysis of the paint chips from the site indicate that the LBP debris on-site may be characterized as hazardous waste under current federal regulations. However, the work performed to date provides limited data on the areal extent and characteristics of lead in soil. Therefore, VHB recommends an IRM to perform grid sampling, followed by excavation and off-site disposal.

The first portion of the IRM will include grid sampling to quantify and characterize lead in surface and shallow subsurface soils. A 50-foot grid interval over the entire site (refer to Figure 1-2), less backfilled holders, paved areas and the compressor building footprint, is proposed to be sampled at three discrete intervals (0-6”, 6-12”, 12-18”), and modified in the field as necessary based on stratigraphy. A direct-push drill rig will be used to recover soil from the 0-4' bgs interval. Three discrete samples will be collected based on visual inspection of the samples at changes in shallow stratigraphy. Isolated pockets of SVOCs will also be characterized. The sampling will be the basis for removal and disposal of soils. The grids will serve as benchmarks for verification sampling when excavation is complete. In addition, the area of the former AST will be excavated during the IRM. Soils will be characterized prior to off-site disposal. Clean-up goals will be established using exposure parameters identified in the risk assessment and verification sampling will be conducted to ensure compliance with the clean-up objectives.

Results of the IRM sampling may preclude implementation of removal efforts if the data identifies significant volumes of hazardous waste.

The IRM will be predicated by the development of a letter work plan which will identify the scope of work, air and soil analytical requirements, excavation techniques, survey and control, erosion control, waste management, dust control, air monitoring, transportation and disposal plans, project schedule, and report deliverable. Additionally, VHB will prepare IRM plans and specifications which will include:

- Site plan with grid sampling results and proposed excavation limits.
- Specifications Division 01.
  - Summary of work
  - Surveying
  - Health and safety
  - Sampling
  - Temporary facilities (sanitary service, communications, etc.)
  - Dust control
  - Temporary controls (signage, erosion control, etc.)
- Specifications Division 02.
  - Demolition
  - Excavation
  - Clearing and grubbing
  - Backfill and grading
  - Topsoil, seed, mulch (site restoration)

Off-site transportation

Off-site disposal

Additional off-site background sampling should also be conducted to establish accurate surface soil background concentrations of VOCs, SVOCs, and Lead adjacent to the site.

7

Certification

The following certification is required as prescribed in Voluntary Cleanup Agreement Index Number D2-0002-99-10.

I, ___________________________ responsible for the day to day performance of the Field Investigation Program for the Newtown Station/Elmhurst Holder Tank site certify that the work was performed in substantial compliance with the approved Investigation Work Plan, dated June 2000.

8

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TABLES

Section 3 Tables

Field Investigation Analytical Results

Section 4 Tables

Risk Assessment

Section 5 Tables

Fish and Wildlife Impact Analysis

FIGURES

Section 4 Figures

Risk Assessment

APPENDIX A

Sample Information Records

This Appendix contains Sample Information Records for the following:

Test Pits

Surface Soil Samples

Groundwater Monitoring Well Samples

APPENDIX B

Soil Boring Reports

SOIL CLASSIFICATION CHART[A]

Major Divisions			Group Symbol[C]	Typical Names
Coarse-grained soils More than 50% retained on No. 200 sieve (0.075 mm)	**Gravels** (More than 50% retained on No. 4 sieve)	Clean gravels (little or no fines)	GW	Well-graded[B] gravels, gravel-sand mixtures, little or no fines
			GP	Poorly-graded[B] gravels, gravel-sand mixtures, little or no fines
		Gravels with fines	GM	Silty gravels, gravel-sand-silt mixtures
			GC	Clayey gravels, gravel-sand-clay mixtures
	Sands (More than 50% between No. 4 and 200 sieves)	Clean sands (little or no fines)	SW	Well-graded[B] sands, gravelly sands, little or no fines
			SP	Poorly-graded[B] sands, gravelly sands, little or no fines
		Sands with fines	SM	Silty sands, sand-silt mixtures
			SC	Clayey sands, sand-clay mixtures
Fine-grained soils More than 50% smaller than No. 200 sieve (0.075 mm)	**Silts and clays** (Liquid limit <50)		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity
			CL	Inorganic clays of low to medium plasticity gravelly clays, sandy clays, silty clays, lean clays
			OL	Organic silts and organic silty clays of low plasticity
	Silts and clays (Liquid limit >50)		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
			CH	Inorganic clays of high plasticity, fat clays
			OH	Organic clays of medium to high plasticity, organic silts
Highly organic soils			PT	Peat and other organic soils

[A] Based on Unified Soil Classification System and ASTM D2487, adapted from Holtz and Kovacs 1981.

[B] “Well-graded” (or “poorly sorted”) indicates a wide range in grain sizes, including all intermediate particle sizes. “Poorly-graded” (or “well sorted”) indicates mostly one grain size or range of sizes with intermediate particle sizes missing.

[C] Other qualifiers may be added to group symbol. For example, if gravels or fines contain 15-30% sand, and “with sand.” If sands or fines contain 15-30% gravel, add “with gravel.” If fines contain >30% gravel or sand, add “gravelly” or “sandy,” whichever predominates. If soil contains cobbles or boulders, add “with cobbles” and/or “with boulders.”

APPENDIX C

Groundwater Monitoring Well Construction Diagrams

APPENDIX D

Laboratory Analytical Reports

APPENDIX E

Data Validation Reports

APPENDIX F

Air Pathways Analysis

Estimation of indoor and ambient (outdoor) air concentrations of chemicals was conducted using emissions and dispersion modeling. Methods recommended by the American Society for Testing and Materials (ASTM) were used to model air concentrations. Methods recommended by the USEPA in its Air/Superfund National Technical Guidance Study Series (NTGS Series) were also used for ambient air modeling. Chemical concentrations in indoor and ambient air were based on measured soil concentrations. The groundwater component was not included in these equations because the depth to groundwater is greater than 35 feet, therefore, exposure is not likely. Additionally, groundwater in the vicinity of the site is not used as a potable water supply.

The first step in modeling involved evaluating whether any of the organic chemical compounds were present in soil at concentrations that exceeded their saturation limit; *i.e.*, above the absorptive limits of the soil particles at the site. At concentrations above the absorptive limit the chemical may occur in free phase either as a liquid or as a mixture of other chemicals of potential concern (COPCs). Saturation limit values represent the concentration at which soil pore air is saturated with a contaminant, therefore, volatile emissions reach their maximum at the saturation concentration. Estimating the saturation limit was done using the model described by the USEPA in their soil screening guidance (USEPA 1996a). Table F-1 shows the calculation and the results for soil at the Newtown Station site. This table indicates that some COPCs occur at average (95% UCL) concentrations above their saturation limit. For these COPCs, the saturation limit concentration was used for modeling purposes.

Modeling Volatile Chemical Release to Indoor Air

ASTM Modeling Concentrations of volatile COPCs accumulating within buildings on site were modeled. The modeling approach used to develop these concentrations follows the methods described by the ASTM in their risk-based corrective action guide (ASTM 1998). The first step in this model is to develop volatilization factors (VFs) for subsurface soil to enclosed space. The chemical-specific subsurface-soil-to-enclosed-space VF is then multiplied by measured subsurface soil concentrations.

The volatilization factors from subsurface soil to enclosed space were calculated using the following equations:

$$VF_{sesp} = \frac{1}{\frac{K_d}{H}\times\left(1+\left(\frac{D^{eff}_{vad}}{DF_{esp}\times L_s}\right)+\left(\frac{D^{eff}_{vad}\times L_{crk}}{D^{eff}_{crk}\times L_s\times\eta}\right)\right)\times\frac{DF_{esp}}{D^{eff}_{vad}}\times L_s}\times 10^3$$

where:

VF_{sesp}= Subsurface soil to enclosed space volatilization factor (kg-soil/m^3-air)
K_d = Soil-water partition coefficient [= K_{oc} * f_{oc} (for organics)] (cm^3-water/g-soil)
H = Henry's Law constant (unitless)
D^{eff}_{vad} = Effective diffusivity in the vadose zone soils (cm^2/sec)
DF_{esp} = Dispersion factor for enclosed space air (cm/sec)
L_s = Depth to subsurface soil (cm)
10^3 = Conversion factor (kg-cm^3/g-m^3 for V_{sesp}, L/m^3 for V_{wesp})
L_{crk} = Enclosed space foundation or wall thickness (cm)
D^{eff}_{crk} = Effective diffusivity through foundation cracks (cm^2/sec)
η = Fraction of cracks in foundation/walls (unitless)

and where:

$$DF_{esp} = L_b \times ER \times \frac{1}{86400}$$

where:

L_b = Enclosed space volume/infiltration area ratio (cm)
ER = Enclosed space air exchange rate (1/day)
86400 = Number of seconds per day (sec/day)

and where:

$$D^{eff} = D_a \times\left(\frac{\theta^{3.33}_{air}}{\theta^2_T}\right)+\left[D_w\times\left(\frac{\theta^{3.33}_{water}}{H\times\theta^2_T}\right)\right]$$

where:

D^{eff} = Effective diffusion coefficient in homogeneous soil layers (cm^2/sec)
D_a = Chemical diffusivity in air (cm^2/sec)
θ_{air} = Air content in soils (cm^3 air/cm^3 soil)
θ_T = Total soil porosity, [cm^3-air/ cm^3-soil = θ_{air} + θ_{water}]
D_w = Chemical diffusivity in water (cm^2/sec)
θ_{water} = Water content in soils (cm^3 -water/cm^3-soil)
H = Henry's Law constant (unitless)

Note: This equation is applicable for estimating the effective diffusion coefficient for porous media in homogeneous soil. It is used to calculate a value for the vadose zone (D^{eff}_{vad}), the water table capillary fringe region (D^{eff}_{cap}) and in soil-filled enclosed space basement foundation cracks (D^{eff}_{crk}) by using the appropriate θ value. For D^{eff}_{vad} and D^{eff}_{crk} $\theta_{air} = 0.26$ and $\theta_{water} = 0.12$; for D^{eff}_{cap} $\theta_{air} = 0.038$ and $\theta_{water} = 0.342$.

Tables F-2 and F-3 show the calculations and variables used in deriving the volatilization factor (VF) for soil to an enclosed space for the on-site commercial worker and future on-site resident (site-wide), and the operations worker. Indoor air concentrations, which are the product of the subsurface-soil-to-enclosed-space VF and the measured subsurface soil concentration, also are presented in these tables.

Modeling Chemical Release to Ambient Air

Volatile Chemicals – Construction Worker

The methodology to evaluate potential exposure of construction workers to the COPCs emitted during the course of soil excavation during construction activities is described below. The modeling approach determines:

chemical emission rates;
chemical emission fluxes; and
chemical concentrations in the outdoor air at the excavation site.

Emission fluxes are derived by dividing the emission rate by the surface area of the excavation. Chemical concentrations in air were estimated using an USEPA-approved dispersion model.

Determination of Emission Rate and Emission Flux

The emission rate calculations considered the digging of a 1.5-m wide by 5.0-m long by 3.0-m deep excavation by a bulldozer. The use of a bulldozer was assumed for this analysis since emission rate equations are available for a bulldozer, but not for other equipment (*e.g.*, a backhoe). The soil removed from the excavation was assumed to be placed on the side of the excavation and covered to prevent the release of chemical vapors or wind-generated respirable particulates. Emissions of volatile chemicals were assumed to occur via diffusion from soil at the bottom of the excavation and groundwater directly below the excavation. Concentrations of volatile chemicals in soil at the bottom of the excavation were conservatively assumed to be the same as those reported for subsurface soil. This model assumes that the trench does not contact groundwater.

The following equations were used to derive emission rates (in g/sec) of volatile chemicals of potential concern from soil (USEPA 1992a; Johnson and Ettinger 1991) through the bottom of an excavation:

$$ER_{TOTAL} = ER_{DIFF}$$

The total emission rate (ER_{TOTAL}) is equal to the emission rates from the diffusion of volatile chemicals from soil (ER_{DIFF}) through the bottom of the trench. ER_{DIFF} is estimated by the following equation:

$$ER_{DIFF} = \frac{C_{source\ soil} \times 10{,}000\ \frac{cm^2}{m^2} \times A_g}{\left(\frac{\theta_{ai}}{K_{eq} \times K_g}\right) + \left(\frac{\pi \times t}{D_i^{eff} \times K_{eq}}\right)^{1/2}}$$

where:

$C_{source\ soil}$ = Concentration of component i in soil (g/cm^3)
A_g = Emitting surface area (m^2)
$\theta_{a,i}$ = Air-filled soil porosity (unitless)
K_{eq} = Equilibrium coefficient (unitless)
K_g = Gas-phase mass transfer coefficient (cm/sec)
π = 3.1416
t = time (sec)
D_i^{eff} = Effective diffusivity in air (cm^2/sec for ER_{DIFF})

and where,

$$C_{source\ soil} = \frac{H \times C_{i,\ soil} \times \rho_{b,i}}{\theta_{w,i} + \left(K_d \times \rho_{b,i}\right) + \left(H \times \theta_{a,i}\right)}$$

where:

H = Henry's Law constant (unitless)
$C_{i,soil}$ = Concentration of component i in soil (g/g)
$\rho_{b,i}$ = Dry soil bulk density (g/cm^3)
$\theta_{w,i}$ = Soil water-filled porosity (unitless)
K_d = Soil-water partition coefficient (= K_{oc} * f_{oc} (for organics), cm^3/g)
$\theta_{a,i}$ = Air-filled soil porosity (unitless)

and where,

$$K_{eq} = \frac{P_i \times MW_i \times \theta_{a,i}}{R \times T \times C_{source\ soil}}$$

where:

P_i = Vapor pressure of component i (mm Hg)
MW_i = Molecular weight of component i (g/mole)
$\theta_{a,i}$ = Air-filled soil porosity (unitless)
R = Molar gas constant (mm Hg-cm^3/mol-^{o}K)
T = Absolute temperature (^{o}K)

and where,

$$K_g = 0.00482 \times U^{0.78} \times SC_g^{-0.67} \times d_e^{-0.11} \times 10^2$$

where:

0.482 = Empirical constant (m/sec)
U = Wind speed (m/sec)
SC_g = Schmidt number (unitless)
d_e = Effective diameter of waste stream surface area (m)
10^2 = Conversion factor (cm/m)

and where,

$$SC_g = \frac{U_a}{\rho_a \times D_{a,i}}$$

where:

U_a = Viscosity of air (g/cm-sec)
ρ_a = Air density (g/cm^3)
$D_{a,i}$ = Diffusivity of component i in air (cm^2/sec)

and where,

$$d_e = 2 \times \left(\frac{A_g}{\pi} \right)^{0.5}$$

where:

A_g = Emitting surface area (m^2)
π = 3.1416

and where,

$$D_i^{eff} = \left(D_{a,i} \times \left(\frac{\theta_{a,i}^{3.33}}{\eta_i^2} \right) \right) + \left(\left(\frac{D_{w,i}}{H} \right) \times \left(\frac{\theta_{w,i}^{3.33}}{\eta_i^2} \right) \right)$$

where:

$D_{a,i}$ = Diffusivity of component i in air (cm^2/sec)
$\theta_{a,i}$ = Air-filled soil porosity (unitless)
η_i = Total soil porosity (unitless)
$D_{w,i}$ = Diffusivity of component i in water (cm^2/sec)
H = Henry's Law constant (unitless)
$\theta_{w,i}$ = Soil water-filled porosity (unitless).

In the absence of site-specific data, default soil properties as provided in USEPA guidance were used. An emission flux (in g/sec-m^2) was then derived by dividing the total emission rate, ER_{TOTAL}, by the surface area of the excavation.

Determination of Ambient Air Concentrations

Ambient (outdoor) air concentrations of the volatile COPCs emissions were determined using the USEPA-approved Point, Area and Line Source (PAL2.1) model, version 89272 (USEPA 1992b) assuming that the excavation represents an area source of emissions. PAL2.1 is a multi-purpose model that can be used to estimate dispersion for point, area, and line sources using Gaussian-plume steady-state assumptions. Simultaneous modeling of multiple sources and source types can be performed to calculate impacts of non-reactive constituents for a large number of receptors. Also, user-specified meteorological options allow for input of site-specific conditions that are representative of the site being modeled.

For this analysis, the source was modeled as a 1.5-m x 5.0-m flat area source. Nine receptors were used in the analysis: eight receptors were placed along the edge of the excavation: one at each of the four corners, and one at the center of each side. In addition, one receptor was placed over the center of the excavation. All receptors were modeled at a height of 1.8 m to simulate the height of a worker. The meteorological data consisted of an array of 54 meteorological conditions used in the USEPA-approved screening level model SCREEN3 (USEPA 1995). These conditions represent 54 combinations of stability classes (1 to 6) and wind speeds (1 m/sec to 20 m/sec) that routinely occur in the atmosphere. The wind directions were set such that each of the receptors was located downwind. Model options selected for the analysis included: a typical anemometer height of 6.1 meters, a mixing height of 5,000 meters, and an average temperature of 285.45°K. The wind was assumed to be constant below 10 meters (as fixed by PAL2.1). Land use was classified according to the population density procedure recommended by the USEPA and described in Appendix W to 40CFR51 – Guideline on Air Quality Models. Following this method, the average population density within the area circumscribed by a 3-kilometer radius circle about the site was computed. Because the average population density is above 750 people per square kilometer, the area is designated urban. The emission rate of the source area was set at 1 g/sec-m^2. Output was then in the form of g/m^3 per g/m^2.

An urban land use was determined from the population density procedure. As such, the urban modeling analysis predicted a maximum 1-hour average unitized impact of 0.0268 g/m^3 per g/s-m^2. The maximum one-hour average chemical concentrations (in mg/m^3) in the outdoor air at the excavation was calculated from the following equation:

$$C = \left[one-hour\ \ unitized\ \ impact\ \ in\ \ {}^{g}\!/_{m^3}\ \ per\ \ {}^{g}\!/_{s-m^2} \right] \times \left[emission\ \ flux\ \ in\ \ {}^{g}\!/_{s-m^2} \right] \times \left[1{,}000\ \ {}^{mg}\!/_{g} \right]$$

Table F-4 shows the calculations and variables used in deriving the emission rate, emission flux, and air concentrations of volatile chemicals for construction workers at the Newtown Station site.

Volatile Chemicals – Other Receptors

Concentrations of volatile COPCs released to outdoor air from surface soil and subsurface soil were also modeled for receptors other than construction workers. The modeling approach used to develop these concentrations followed the methods described by the ASTM in their risk-based corrective action guide (ASTM 1998). The first step in this model is to develop a volatilization factor (VF). This approach included the use of two different models for surface soils: an infinite source model (that assumes that there is an unlimited supply of the volatile COPC) and a finite or mass-limit model (that assumes that there is only a limited supply of the volatile COPCs). According to the ASTM guidance the smaller of the two VFs (*i.e.*, either the finite source VF or the infinite source VF) is the factor used to calculate the air concentration from surface soil concentrations. In this way, the physical laws of mass balance are not violated and the estimated air concentrations are more accurate. For subsurface soils, a constant chemical concentration (*i.e.*, an infinite source) is assumed. A VF

$$VF_{ssf} = \frac{L_{ss} \times \rho_s}{DF_{amb} \times \tau \times 31536000} \times 10^3$$

from surface (assuming a finite source) and subsurface soil to ambient air was calculated using the following equations:

$$VF_{sub} = \frac{1}{\left(1 + \left(\dfrac{DF_{amb} \times L_s}{D_{vad}^{eff}}\right)\right) \times \dfrac{K_d}{H}} \times 10^3$$

where:

VF_{ssf} = Volatilization factor for COPCs in surface soils to outdoor air (finite source) (kg/m^3)
L_{ss} = Thickness of surficial soils (cm)
ρ_s = Dry soil bulk density (g/cm^3)
DF_{amb} = Dispersion factor for ambient air (cm/s)
τ = Averaging time for surface emission vapor flux (years)
31536000= Number of seconds per year (sec/year)
VF_{sub} = Volatilization factor for COPCs in subsurface soils to outdoor air (kg/m^3)
L_s = Depth to subsurface soils (cm)
D^{eff}_{vad} = Effective diffusion coefficient – vadose zone soils (cm^2/sec)
K_d = Soil-to-water partition coefficient (cm^3-water-g-soil)
H = Henry's Law constant (unitless)
10^3 = Conversion factor (kg-cm^3/g-m^3)

A volatilization factor from surface soil (assuming an infinite source) to ambient air was calculated using the following equations:

$$VF_{ssi} = \frac{\rho_s}{DF_{amb}} \times \sqrt{\left(\frac{4 \times D^{eff}_{vad}}{\pi \times \tau \times 31536000}\right) \times \left(\frac{H}{K_d \times \rho_s}\right)} \times 10^3$$

where:

VF_{ssi} = Volatilization factor for COPCs in surface soils to outdoor air (kg/m^3)
ρ_s = Dry soil bulk density (g/cm^3)
DF_{amb} = Dispersion factor for ambient air (cm/s)
D^{eff}_{vad} = Effective diffusion coefficient – vadose zone soils (cm^2/sec)
π = 3.1416
τ = Averaging time for surface emission vapor flux (years)
31536000= Number of seconds per year (sec/year)
H = Henry's Law Constant (unitless)
K_d = Soil-to-water partition coefficient (cm^3-water/g-soil)

and where:

$$DF_{amb} = \frac{U_{air} \times W \times \delta_{air}}{A}$$

where:

D_{amb} = Dispersion factor for ambient air (cm/s)
U_{air} = Ambient air velocity in mixing zone (cm/s)
W = Width of source-zone area (cm)
δ_{air} = Mixing zone height (cm)
A = Source-zone area (cm^2)

and where:

$$D_{vad}^{eff} = D_a \times \left(\frac{\theta_{air}^{3.33}}{\theta_T^2} \right) + \left[D_w \times \left(\frac{\theta_{water}^{3.33}}{H \times \theta_T^2} \right) \right]$$

where:

D^{eff}_{vad}	=	Effective diffusion coefficient in vadose zone soils (cm^2/sec).
D_a	=	Chemical diffusivity in air (cm^2/sec)
θ_{air}	=	Volumetric air content in vadose zone soils (cm^3-air/cm^3-soil)
θ_T	=	Total soil porosity, [cm^3-air/cm^3-soil = θ_{air} + θ_{water}]
D_w	=	Chemical diffusivity in water (cm^2/sec)
θ_{water}	=	Volumetric water content in vadose zone soils (cm^3-water/cm^3-soil)
H	=	Henry's Law constant (unitless)

Tables F-5 through F-8 present the different calculations and variables used in deriving the VF for soil to ambient air for the operations worker, residents, and on- and off-site trespassers. The calculated ambient air concentrations (the product of the VF and the exposure point concentration in soil) also are included in these tables.

Respirable Particulates – Construction Worker

The methodology to evaluate potential exposure of construction workers to respirable particulates emitted during soil excavation activities is described below. Similar to the volatile chemical modeling, respirable particulate modeling requires determination of an emission rate, an emission flux, and the concentration of respirable particulates in the outdoor air at the excavation site.

Determination of Emission Rate and Emission Flux

The emission rate calculation considered the digging of the same excavation as described above for the volatile chemical modeling, except using a backhoe since equations for a backhoe are available. The excavation and dumping process are uncontrolled, but the pile is covered to prevent wind erosion. A worker downwind of the excavation was assumed to be exposed to respirable dust from emissions due to the material handling (excavating and dumping). Assuming a backhoe digs a 1.5-m wide x 5.0-m long x 3.0-m deep excavation, the total volume of excavated soil equals 22.5 m^3. The bucket of the backhoe was assumed to hold 2 m^3 (USEPA 1992a), requiring 11.25 scoops to dig the excavation. The backhoe was assumed to operate (dig and dump) at a rate of 75 scoops per hour (USEPA 1992a). As such, the excavation was dug in nine minutes or 540 seconds.

The following equation (USEPA 1993) was used to derive the emission rate (ER, in g/sec) of respirable particulates:

$$ER = \left(0.45\frac{g}{sec}(s)^{1.5}(M)^{-1.4}\right)$$

where:

s = Silt content of the soil in weight - %
M = Moisture content of the soil in weight - %

In the absence of site-specific data, default soil properties as provided in USEPA guidance were used.

Determination of Ambient Air Concentrations

Ambient air concentrations of respirable particulate emissions, generated from excavation of soil and subsequent dumping onto temporary storage piles, were modeled as a volume source using the latest version of the EPA-approved SCREEN3 (version 96043) model (USEPA 1995). In the SCREEN3 model, the size of the volume source was set equal to the entire volume of the excavated smear zone soil (22.5 m^3 or a 2.82-meter cube). The height of the volume source was set to one-half the source height, 1.4 meters (2.82 m ÷ 2 = 1.4 m). The initial lateral and vertical dimensions of the volume source were set at 0.66 meters, following EPA guidance. The height of the receptor was set at 1.8 m (breathing height for a construction worker). The source was modeled using the array of screening level meteorology hardwired in SCREEN3 (54 combinations of wind speed and stability). This results in predicting the worst-case impact. Using this methodology, it was found that the maximum hourly-normalized impact for the construction worker, 2.065E+04 µg/m^3 per g/sec, occurred at a distance of 50 meters downwind of the source. The maximum hourly average respirable particulate concentration (in kg/m^3) in ambient air was calculated from the following equation:

$$C = \left[hourly\ normalized\ impact\ in\ {}^{\mu g}\!/_{m^3}\ per\ {}^{g}\!/_{s} \right] \times \left[emission\ rate\ in\ {}^{g}\!/_{s} \right] \times \left[1E-09\ {}^{kg}\!/_{\mu g} \right]$$

The maximum hourly respirable particulate concentration is 2.07E-05 kg/m^3. This value was then multiplied by the concentration of each constituent in the soil (in units of mg/kg) to develop the chemical concentration of each COPC in the respirable particulates (in units of mg/m^3). Ambient air concentrations of particulate chemicals are presented in Table F-9 for construction workers at the Newtown Station site.

Respirable Particulates – Other Receptors

Site-specific particulate emission factors were developed for the site. These factors were used in estimating the concentration of COPCs attached to dust that may emanate from the site.

The approach used in developing these factors is described by the USEPA in their soil screening guidance (USEPA 1996a). The following equation was used:

$$PEF = {}^{Q}\!/_{C} \times \frac{3{,}600\ {}^{s}\!/_{hr}}{0.036 \times (1-V) \times \left(\frac{U_m}{U_t}\right)^3 \times F(x)}$$

Where:

PEF = Particulate emission factor (m^3/kg)
Q/C = Inverse of mean concentration at center of square source, Table 2, EPA, 1996
V = Fraction of vegetative cover, unitless
U_m = Mean annual wind speed (5.36 m/s, LaGuardia International Airport Meteorological record from NRCC (January 2001))
U_t = Equivalent threshold wind speed at 7 meters (11.32 m/s, presented in EPA 1996)
F(x) = Function derived after USEPA 1985 (0.394), unitless

The value for Q/C is the inverse of the average normalized annual concentration of particulate emissions for several sites in the United States. The maximum hourly respirable particulate concentrations, *i.e.*, PEF, were multiplied by the concentration of each constituent in the surface soil to develop the chemical concentration of each COPC in the respirable particulates. The fraction of vegetative cover are based on observations made during a site visit in January 2001. The values and equations used to calculate PEF for the receptors at the Newtown Station site are provided in Tables F-10 through F-13.

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Appendix F Air Pathways Analysis Tables

APPENDIX G

Photographic Documentation