108527

REMEDIAL INVESTIGATION/FEASIBILITY STUDY WORK PLAN - OPERABLE UNIT 2 (OU-2)

RTI SUPERFUND SITE
ROCKAWAY TOWNSHIP, NEW JERSEY

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1.0 INTRODUCTION

This report presents the Operable Unit 2 (OU-2) Remedial Investigation/Feasibility Study (RI/FS) Work Plan for the Radiation Technology Incorporated (RTI) Superfund Site located near Lake Telemark, New Jersey (Site). This RI/FS Work Plan is being submitted in compliance with the requirements of an Administrative Order on Consent (AOC) entered into by United States Environmental Protection Agency (USEPA) and Alliant Techsystems Inc. (ATK) on October 4, 2004 for OU-2. The AOC for OU-2 concerns addressing source(s) of groundwater contamination at the Site, namely, soil, sediment, and surface water.

The purpose of this RI/FS Work Plan is to outline the necessary information and data to be collected in order to characterize the nature and extent of potential contamination from rocket motor-related activities in soil, sediment, and surface water and to support the selection of a remedy, if required.

1.1 SITE DESCRIPTION

The Site is located near the small residential community of Lake Telemark, New Jersey in the western portion of Morris County. The Site is located approximately 5 miles north of Exit 37 off U.S. Interstate 80 and has an address of 108 Lake Denmark Road, Rockaway Township, New Jersey. The Site location is depicted on Figure 1.1. A Site Plan is presented as Figure 1.2.

The Site consists of 263 acres of land which is comprised of the following four parcels (Rockaway Township Tax Map, see Acres (1987)):

- Lot 132A -- 22 acres (northwest corner of Site);
- Lot 132B -- 15 acres (west central portion of Site);
- Lot 132C -- 25 acres (southwest corner of Site); and
- Lot 4 -- 201 acres (east portion of Site).

The area around the Site is generally low-density residential in nature. However, there has been significant residential and industrial development in the region. To the west of the Site, significant heavy industrial activities have been ongoing at the Army and Navy portions of the Picatinny Military Arsenal facilities since the early 1900s. Areas to the east of the Site consist mainly of single-family residences situated in the population centers mentioned previously. Present land use within the Site is generally considered

light industrial and commercial. There are also significant undeveloped portions of the property.

1.2 CHRONOLOGY OF PREVIOUS STUDIES

During the period from November 1980 to May 1981, New Jersey Department of Environmental Protection (NJDEP) and the Rockaway Township Health Department conducted various inspections of the Site. NJDEP also conducted investigations into the chemical types and quantities, waste disposal practices, and chemical waste characteristics associated with various production and manufacturing processes used at the Site.

In March 1981, the Rockaway Township Health Department informed NJDEP that it had tested two principal water supply wells on site due to taste and odor complaints from some RTI employees about untreated drinking water on Site. Both wells were found to be contaminated with volatile organic compounds (VOCs) and were condemned by the Rockaway Township Health Department in June 1981.

An Administrative Order and Notice of Prosecution were issued to RTI on August 27, 1981, ordering RTI to properly remove and clean up all spills, buried wastes and improperly stored waste materials. NJDEP issued a directive to RTI in November 1981, which stated that its activities had contaminated the shallow groundwater table with VOCs and mandated that RTI hire a hydrogeological consultant to determine the degree and extent of the contamination.

In December 1981, RTI responded to NJDEP's directive and disclaimed responsibility for the groundwater contamination associated with the Site. As a result of RTI's failure to comply with the various enforcement and administrative actions issued by the NJDEP, the NJDEP filed a verified complaint in March 1982 with the Superior Court of New Jersey. In settlement of the verified complaint, RTI and NJDEP entered into a Consent Order in July 1983 under which RTI was required to install six groundwater monitoring wells on-Site.

Subsequent to the Consent Order, six monitoring wells were installed by RTI in September and October of 1983. In September 1983, the RTI site was proposed for inclusion on the National Priorities List (NPL) of federal Superfund sites. In August 1984, NJDEP issued a Site Evaluation Report with the objective of identifying sources of groundwater contamination at and around the RTI property. The results of the well sampling and analysis indicated that elevated levels of VOCs were present in the

samples analyzed. Subsequently, the RTI Site was included on the NPL on September 21, 1984.

NJDEP issued RTI a directive in June 1986 outlining the findings of NJDEP site investigations, to date, and requiring RTI to pay costs associated with the performance of the RI/FS. In March 1987, RTI entered into an AOC with NJDEP requiring RTI to pay for Phase I of the RI to be performed by a NJDEP contractor. In August 1987, NJDEP's contractor, Acres International Corporation (Acres), initiated the RI/FS.

The NJDEP and its subcontractor (Acres International Corporation (Acres)) conducted a multi-phased RI between 1987 and 1992. The RI involved the installation and sampling of thirty (30) monitoring wells, sampling of three (3) existing site production ("P") wells, packer testing at P-6, and sampling of five (5) residential wells. Also, forty-seven (47) surface water and sediment samples were collected from surface runoff drainage routes and Lake Denmark. A total of ninety-three (93) surface and subsurface soil samples were collected to investigate potential impacts to soil.

In addition to the RI/FS, other surveys and remedial work were performed. Radiological surveys were conducted within the 15-acre RTI site under Nuclear Regulatory Commission (NRC) supervision. RTI was licensed by the NRC to possess and use cobalt-60 and cesium 137, both of which NRC regulates pursuant to the Atomic Energy Act. Remediation of all radiologically contaminated soil areas found during the surveys was completed by RTI under NRC direction in two stages during August 1990 and February 1991. NRC and NJDEP investigative work to date has not indicated the presence of any radiological contaminants exceeding state and/or federal standards.

Additional removal actions were conducted by RTI under the direction of NJDEP. During July 1990, a leaking underground storage tank (UST) containing solvents was excavated and later disposed of off site. Also, RTI performed an Interim Removal Action in May 1993 that included the removal and disposal of tanks, drums, contaminated soil and sumps, under a separate Memorandum of Agreement (MOA) with NJDEP.

In December 1992, RTI and Thiokol Chemical Corporation (Thiokol) entered into an AOC to reimburse NJDEP for the remainder of the RI/FS and to conduct design and remedial activities for contaminated groundwater with NJDEP oversight.

The RI/FS reports, which addressed the groundwater contamination, were released to the public in July 1993. A Proposed Plan, that identified USEPA's and NJDEP's preferred remedial alternative, was also released in July 1993.

The decision by the NJDEP on the remedial action to be implemented at the Site for contaminated groundwater is embodied in a final record of decision (ROD), executed on May 9, 1994, on which USEPA gave its concurrence in a letter dated March 30, 1994. The ROD includes a responsiveness summary to the public comments.

In 1995 to early 1997, RTI conducted a pilot test to determine if hydrogen peroxide (CleanOX) injection would be a viable option for the Site. The NJDEP determined that the technology would not achieve acceptable results and required RTI to submit a Remedial Action (RA) Work Plan in accordance with the 1994 ROD.

In July 1997, a RA Work Plan was submitted by RTI and was subsequently approved in February 1998.

In July 1998, a New Jersey Pollution Discharge Elimination System (NJPDES) discharge to surface water permit application was submitted by RTI for the groundwater remediation system. A NJPDES permit (NJ0133035) was issued to RTI in 1999.

In November 1999, RTI filed for Chapter 11 bankruptcy. As a result, NJDEP identified RTI as an unresponsive recalcitrant responsible party.

On September 30, 2003, a consent decree (CD) between ATK and USEPA was lodged by the Court regarding the implementation of the remedial design and remedial action for contaminated groundwater at the Site.

In September 2004, ATK began conducting pre-remedial design investigation activities to obtain a better understanding of current groundwater contamination conditions and to confirm the viability of the groundwater remedy selected in the ROD.

2.0 BACKGROUND

2.1 SITE BACKGROUND

The RTI site is approximately 263 acres in size. The Site includes the following five main areas:

- RTI 23 acres
- P2 16 acres
- East Stand 22 acres
- South Stand 27 acres
- Undeveloped area 175 acres

Figure 2.1 shows the five areas.

Prior to 1956, the Site was not developed. In 1956, Reaction Motors, Inc. that was later acquired by Thiokol, operated a rocket testing facility at the Site until 1969 when Thiokol-related activities ceased. In 1972, RTI purchased a 15 acre parcel of the Site (located northwest of Lake Denmark Road) where it conducted irradiation activities until it sold this operation to Sterigenics in 1996. In 1978, RTI purchased the remaining 248 acres of the Site from Thiokol and leased portions of this property to various tenants. RTI tenants have included Sterigenics International (RTI area), Ion Beam Applications, SA (RTI area), Hazard Research Corporation (S-46 Building Area), Kronenberg/Image Boat Company (R47 building area), Autobody Repair (R47 building area), and Talon Landscaping (R51 building area).

RTI was licensed in 1970 to operate megacurie pool irradiator in the RTI portion of the Site. Radioactive related investigative and remedial measures, including remediation of radiological contaminated soils, were conducted by RTI from 1986 until 1996. NRC delisted the Site and terminated RTI's license in 1997. RTI declared bankruptcy in 2000 and according to ATK, there is currently no financially-solvent owner of the Site.

Section 2.2 from the Remedial Investigation Report (Acres, September, 1991[1]) provides a comprehensive background of the Site and is included as Appendix A.

[1] Acres International Corp., Remedial Investigation Report PD-11, November 1990.

2.2 DEMOGRAPHY

The area around the Site is generally rural in nature. The Site is located within Rockaway Township in Morris County, New Jersey. Rockaway Township has a population of approximately 23,000 people. The closest residential community is Lake Telemark, New Jersey which is located south of the Site. Lake Telemark has a population of approximately 1,200 people. To the west of the Site are the U.S. Army and U.S. Navy portions of the Picatinny Military Arsenal facilities. To the east of the Site are single family residences.

2.3 LAND USE

As indicated above, the area around the Site is generally low-density residential in nature. To the west of the Site, significant heavy industrial activities have been ongoing at the U.S. Army and U.S. Navy portions of the Picatinny Military Arsenal facilities since the early 1900s. Present land use within developed portions of the Site is generally considered light industrial and commercial. Many of the buildings and structures are either vacant or being used for storage by current tenants. Current tenants include IBA Sterigenics, Talon Landscaping, and an unknown number of other entities utilizing buildings or open areas for storage, etc.

2.4 PHYSICAL CHARACTERISTICS OF SITE

The Site lies on the eastern side of the Dover, New Jersey and the western side of Booton, New Jersey topographical quadrangles. According to U.S. Geological Survey topographical quadrangles, the Site elevation ranges from approximately 840 to 1,000 feet above mean sea level (AMSL) (Figure 1.1).

To varying degrees, the topography shows the effects of Pleistocene glaciation. A terminal moraine of the Wisconsin glacial stage is situated in the central part of Morris County, New Jersey. The terminal moraine forms a belt, which is approximately two to three miles wide and is roughly parallel to the Rockaway River. In general, north of the terminal moraine the topography is moderately rugged and the bedrock is usually well exposed, except in the valleys. South of the terminal moraine, the topography reflects terrain typically associated with glaciation--valleys filled with alluvium and sparse rock exposures.

2.4.1 TOPOGRAPHY

The Site is located within the New Jersey Highlands, which is part of the Reading Prong of the New England physiographic province. In general, the regional topography is characterized by northeastward trenching ridges and parallel valley features with interspersed lakes. The ridges may reach elevations of 1,000 feet (ft) or more AMSL and lowland valleys may drop to elevations of below 600 ft or less AMSL.

The topography associated with the New Jersey Highlands is controlled mainly by the structure and lithologic character of the bedrock. In general, the ridges represent the more massive and resistant bedrock and the valleys on the less resistant bedrock.

The topography of the Site is complex rolling terrain. In general, the Site slopes to the south and west, although local terrain features direct surface water flow to the south and east on the portions of the Site east of Lake Denmark Road. A portion of the southeast corner of the site slopes to the south and east.

2.4.2 FLORA AND FAUNA

An evaluation of Site flora and fauna was conducted by Acres during the 1989/1990 remedial investigation. The findings from the Acres evaluation were summarized in the Remedial Investigation Report (Acres, September 1991). A copy of this information is included in Appendix B.

On December 22, 1992, TRC Environmental Corporation, on behalf of the USEPA, conducted a supplemental habitat and species characterization. Findings from the habitat and species characterization were summarized in the Draft Final Risk Assessment (TRC Environmental Corporation, July 1993). A copy of this information is also included in Appendix B.

Ecological information will be reviewed and additional information gathered, if necessary, as part of the baseline risk assessment to be completed as part of the RI/FS activities.

2.4.3 REGIONAL AND SITE GEOLOGY

The geology of the Site is described in the RI/FS report (Acres, 1991), based on available literature and site-specific investigations. The Site is located on the northwestern flank

of a northeast plunging syncline; the plunge of the axis is 16^0. There are three distinct geologic units: glacial overburden, saprolite, and bedrock. A brief summary is presented here.

The overburden consists of 0 to 21 ft of unconsolidated glacial sediment. In general, the overburden is described as an unstratified sandy loam deposit composed of brown sand with some silt along with little clay and gravel, and occasional boulders. The overburden is underlain by extremely weathered bedrock called saprolite.

Saprolite is an in-situ chemically weathered and thoroughly decomposed bedrock, which maintains the structure of the original rock. Saprolite is situated between the bedrock and the overburden. Significant weathering of the bedrock surface has occurred in the Lake Denmark area, forming a layer of saprolite under portions of the Site, which ranges in thickness from 0 to 22 ft.

The bedrock at the Site consists of a wide variety of igneous rocks, migmatites, and intrusive igneous rocks, which are locally intruded by small diabase dikes. The bedrock is predominately granitic gneiss that is typically medium to coarse grained, massive, dense, and moderately fractured. Site measurements of bedrock outcrops show a major joint set oriented $N20^0W$ with a dip between 65^0 and 90^0 (Acres, 1991). At the Site, the bedrock surface ranges from 866.6 ft AMSL (MW-1D) to 785.5 ft AMSL (MW-4D).

2.4.4 SURFACE WATER AND DRAINAGE

The major surface water feature in the vicinity of the Site is Lake Denmark, which lies along its western edge. Lake Denmark is a man-made lake fed by Burnt Meadow Brook that flows into the Lake at a point northwest of the Site. Lake Denmark is part of the Picatinny Arsenal. Water flows from Lake Denmark southwest to Green Pond and eventually into the Rockaway River. The Site is within the Dover segment of the Rockaway River drainage, which is part of the Passaic, Hackensack, and New York Harbor Complex Basin. Surface waters on the Site are classified as FW2-TM(Cl) (Fresh Water, other than those set aside for posterity or Pinelands Waters - Trout Maintenance, (Category 1).

There is a number of other surface water features on the Site including streams, seeps, springs, marshes, and ponds as shown on Figure 1.2.

2.4.5 GROUNDWATER HYDROGEOLOGY

The Site contains two hydrologic basins, which are separated by the north-south bedrock ridge along Lake Denmark Road. West of the bedrock ridge, groundwater flows towards Lake Denmark in both the overburden and bedrock. East of the ridge, groundwater is found primarily in the bedrock. Groundwater flow within this eastern basin is towards its low lying center, which then flows southward off the Site.

The Site has two identified groundwater bearing units - the overburden and bedrock groundwater systems. The overburden groundwater system is comprised of the glacial sediment and the saprolite. The overburden system is underlain by the granitic bedrock groundwater system. These two water bearing units are considered to be hydraulically connected.

Hydraulic testing of the overburden/saprolite water bearing unit showed hydraulic conductivity ranging from 1×10^{-4} ft/min to 1×10^{-3} ft/min. Horizontal hydraulic gradient across the Site range from 0.03 ft/ft to 0.06 ft/ft. These hydraulic parameters correspond to an average linear groundwater velocity range of 6×10^{-5} ft/min (32 ft/yr) to 1×10^{-4} ft/min (53 ft/yr), based on an effective porosity of 0.35 (Acres, 1991).

Hydraulic parameters for the bedrock water bearing unit were evaluated during the RI. Hydraulic conductivities in the bedrock water bearing unit range from 4×10^{-5} ft/min to 6×10^{-4} ft/min. Horizontal hydraulic gradients ranges from 0.02 ft/ft to 0.07 ft/ft, with an average value of 0.04 ft/ft at the RTI area (Acres, 1991). Assuming an effective porosity of 2 percent (Fetter, 1994[2]), the average linear velocity for the bedrock ranges from 8×10^{-5} ft/min (42 ft/yr) to 1.2×10^{-3} ft/min (630 ft/yr).

Horizontal hydraulic gradients measured during the RI conduct by Acres are consistent with the average hydraulic gradient of 0.04 ft/ft to 0.07 ft/ft measured during the September/October 2004 groundwater monitoring event. The steep horizontal hydraulic gradient is reflective of a low permeability environment.

Due to the existing hydrogeologic conditions of a low permeability environment, in conjunction with steep horizontal hydraulic gradients, steep vertical hydraulic gradients are observed at certain locations across the Site. In the topographically high areas of RTI and P-2, strong downward vertical gradients exist (e.g., MW-14S and MW-14D; MW-2S and MW-2D) ranging from 0.2 to 0.03 ft/ft (CRA, November 2004).

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[2] Fetter, C.W. 1994. Applied Hydrogeology; MacMilliam Publishing Company, New York, New York; 690 pages.

Conversely, groundwater flow in the topographically low regions near Lake Denmark show upward vertical gradients (e.g., MW-13S and MW-13D; MW-15S and MW-15D). These overall upward vertical gradients are comparable to the downward gradient with values ranging from -0.14 ft/ft to -0.01 ft/ft (CRA, November 2004). The upward gradients observed at these monitoring well locations indicate groundwater discharging to Lake Denmark.

3.0 SITE ASSESSMENT

As described in Section 1.2, the NJDEP and its subcontractor (Acres) previously conducted a multi-phased RI at the Site. Supplemental investigations and interim remedial activities, including: sump cleaning, above-ground storage tank (AST) and UST removal or closure, soil excavation and drum removal, have been conducted subsequent to the Acres RI. These activities have resulted in the collection of approximately 220 soil, sediment and surface water samples across the Site.

Summaries of the previous remedial investigations and remedial actions were prepared by ATK and submitted to the USEPA in accordance with the USEPA's schedule for interim deliverables. The following provides a list of the background summary documents submitted to the USEPA:

- March 3, 2004 submittal related to the Northwest Drum Disposal Area;
- March 15, 2004 submittal related to the condition of the RTI property at the time of the two sales to RTI;
- April 14, 2004 submittal providing ATK's assessment of historical data sources to be considered for risk assessment purposes;
- April 28, 2004 submittal providing ATK's summary of the previous investigative and remedial decisions made at the RTI site;
- June 10, 2004 submittal containing results of drum investigation; and
- July 14, 2004 Preliminary Assessment of the undeveloped portion of the Site.

Upon review of the documents listed above, the USEPA concluded the RI/FS for OU-2 could be limited to specific areas requiring additional investigation. Therefore, in accordance with the AOC, the scope of this RI/FS Work Plan is limited to the areas shown on Figure 3.1. Furthermore, the investigation within these areas will be focused on historic operations related to the rocket motor industry, specifically operations related to ATK's predecessor, Thiokol.

3.1 POTENTIAL SOURCE AREAS

The following sections describe historical operations associated with potential source areas not previously assessed by Acres or require additional investigative work. Additional background information may be found in Section 2.2 of the Remedial

Investigation Report (Acres, September, 1991[3]) included as Appendix A. Locations of potential source areas are shown on Figure 3.1.

3.1.1 RTI AREA

Potential source areas in the RTI include the drum disposal area located northwest of buildings R-60 and R-61 and drainage swale leading from building R-62 to Lake Denmark as described below.

Drum Disposal Area

Historically, drums have been disposed of in this area by various tenants of the property. A limited field investigation was conducted in this area in March 2004. Results of the investigation indicated elevated concentrations of metals and one detection of perchlorate. Therefore, this area is being considered as a potential source area.

Drainage Swale

The drainage swale leading from building R-62 to Lake Denmark is a surface water drainage for the RTI area. Historically, a secondary waste disposal area, detonation bunker, and burning pads were located northeast of this area. Due to the proximity of the waste disposal area, detonation bunker, and burning pads and lack of existing data, this area is being considered as a potential source area.

3.1.2 P-2 AREA

Potential source areas in the P-2 Area include the area around buildings R-34 and R-47 as described below.

Building R-34

Building R-34 was historically used as a machine shop and for diesel engine assembly and testing. A former five chamber UST was located on the north side of R-34 and a former fuel oil AST was located on the southwest side of R-34. Limited information exists in the vicinity of the former above ground fuel oil storage tank located on the southwest side of building R-34. Based on historic operations and limited data in some areas, the area around R-34 is being considered as a potential source area.

[3] Acres International Corp., Remedial Investigation Report PD-11, November 1990.

Building R-47

Building R-47 was historically used for filling and loading packaged liquid propellant powerplants. To the north of R-47 was a former mixed amine fuel (MAF) tank, further north of R-47 was a former igniter storage bunker, to the north-northwest of R-47 was a former drum storage area, and on the northwest side of R-47 was a former paint locker. Based on historic operations, the area around R-47 is being considered as a potential source area.

3.1.3 EAST STAND AREA

Potential source areas in the East Stand Area include the area around test stands R-2, R-3 and R-4 and ASTs as described below.

Test Stands

Historically, test stand R-2 was used for firing a variety of rocket engines, test stand R-3 was used to test rocket motor systems and included a scrubber building for the collection of exhaust gases, and test stand R-4 was an enclosed facility used to test developmental engines. Propellants used in the R-2 area included ammonia, Jet-propulsion (JP) fuel, liquid oxygen and hydrogen peroxide. Test systems used in the R-3 area used chlorine trifluoride and mixed amine fuel. Engines tested in the R-4 area used hydrazines and nitrogen tetroxide propellants. Runoff and/or discharges associated with the R-3 were routed to a lagoon located southwest of R-3. A former sewage treatment unit was located north of R-3. Based on historic operations, the area around test stands R-2, R-3 and R-4 are being considered as potential source areas.

ASTs

Historically, a former AST was located south of R-21 and an AST remains south of building R-51. Both ASTs were reportedly used to store fuel oil. Based on historic tank usage, the AST areas are being considered as a potential source area.

3.1.4 SOUTH STAND AREA

Potential source areas in the South Stand Area include the former storage bunkers located west of the South Stand Area, the area around buildings S-37, S-46 and S-48, the area around test stands S-11, S-12 and S-49, and ASTs as described below.

Storage Bunkers

Historically, the two former storage bunkers located west of the South Stand Area were used for the storage of solid propellants that may have contained ammonium perchlorate. Based on historic usage, the former storage bunkers are being considered as a potential source area.

Buildings S-37, S-46 and S-48

Historically building S-37 was used for preparation of solid rocket fuel grains that may have contained ammonium perchlorate. Building S-46 was historically used as a boiler house, equipment storage and assembly area for equipment used in experiments. The S-48 structure (currently a foundation only) was likely used as a storage area. Based on historic operations and limited data, the area around buildings S-37, S-46 and S-48 are being considered as potential source areas.

Test Stands

Historically test stands S-11 and S-12 were used for rocket engine component test firing. Test stand S-49 was historically used for firing small rocket motors with propellants containing beryllium. A former flammable liquid storage area and sewage treatment unit were located south of S-11. Based on historic operations, the area around test stands S-11, S-12 and S-49 are being considered as potential source areas.

Former Tanks

Historically, a former fuel oil storage tank was located on the southwest side of building S-46. An AST located between S-46 and S-49 has been moved from its original location, which may have been inside the beryllium test chamber at S-49. Based on historic operations, and limited information these former storage tanks are being considered as potential source areas.

3.1.5 SEDIMENT AND SURFACE WATER

Historically, lagoons received discharges from operations in the East Stand Area, the lagoons subsequently discharged to Site surface water which flowed southwest toward the South Stand Area. Surface water from the South Stand Area also flowed toward Site surface water in this area. Based on historic operations in the East and South Stand Areas, surface water and sediment are being considered as potential source areas.

3.2 MEDIA OF CONCERN

In accordance with the AOC, this RI/FS Work Plan has been developed for OU-2. Media of concern associated with OU-2 include soil, sediment and surface water. Groundwater at the Site (OU-1) is addressed under a separate CD between ATK and the USEPA.

3.3 COMPOUNDS OF POTENTIAL CONCERN

In accordance with the AOC, OU-2 addresses potential source(s) of groundwater contamination at the Site. Based on groundwater analytical data collected from Site monitoring wells during September through October 2004, the following conclusions pertaining groundwater quality at the Site were presented in the Draft Pre-Remedial Design Investigation (PRDI) Report (CRA, November 2004):

- The primary contaminants of concern are chlorinated VOCs (1,1,1-trichloroethane, 1,1-dichloroethene, trichloroethene, carbon tetrachloride, chloroform, and vinyl chloride).
- Semi-volatile organic compounds (SVOCs) are not considered to be contaminants of concern.
- Perchlorate was detected in 11 of the 38 wells sampled at the Site. Currently there is no federal maximum contaminant level (MCL), New Jersey MCL, or New Jersey Groundwater Quality Standard for perchlorate. Detections of perchlorate were not widespread and are limited to the RTI and P-2 areas.
- Naturally occurring conditions may explain the high concentrations of metals found in the groundwater samples, particularly iron and manganese. Elevated chromium and nickel may also be naturally elevated- but would require further study. The presence of thallium in the samples is questionable and may be due to matrix interference.

Potential operations in the rocket motor industry utilizing VOCs, metals (beryllium), perchlorate, and other energetics such as hydrazine and mixed amine fuels are described in Section 2.2 of the Remedial Investigation Report (Acres, September, 1991[4]) included as Appendix A.

[4] Acres International Corp., Remedial Investigation Report PD-11, November 1990.

Based on a review of groundwater conditions at the Site and operations associated with the rocket motor industry, the compounds of potential concern in soil, sediment and surface water have been identified as VOCs, metals, and energetics. A summary of analytical parameters is included as Table 3.1. A description of the energetics is provided below:

Energetic	*Description*
Perchlorate	Dissolved form of solid ammonium perchlorate, an oxidzer used in solid rocket motor fuels
Hydrazine	Liquid Propellant (N2H4)
Monomethyl Hydrazine (MMH)	Liquid propellant (CH3NHNH2)
Unsymmetrical Dimethyl Hydrazine (UDMH)	Liquid propellant ((CH3)2NNH2)
N-nitrosodimethylamine (NDMA)	Suspected degradation product of UDMH.
Diethylene Triamine (DETA)	Found in mixed amine fuel (MAF) blends ((NH2C2H4)2NH).

4.0 PRELIMINARY APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS)

ARARs represent standards, requirements, and criteria limitations under Federal, State, or local regulations that may govern Site remedial investigation and remedial action. The National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (USEPA, 1992a) and CERCLA/Superfund Amendments and Reauthorization Act (SARA) require that, upon completion, remedial actions attain all Federal and State applicable or relevant and appropriate requirements (ARARs). The more stringent of consistently and legally enforceable State or Federal regulations must be met. All ARARs must be identified during the RI/FS to aid in the preparation of a list of remedial alternatives, the evaluation of remedial alternatives under a FS, and, ultimately, the selection of a remedy.

4.1 ARAR CATEGORIES

A preliminary review of potential ARARs was conducted as part of this RI/FS Work Plan. ARARs are categorized as either chemical-specific, location-specific, or action-specific as described below:

Chemical-Specific

Chemical-specific requirements define acceptable exposure levels for specific hazardous substances and, therefore, may be used as basis for establishing soil screening criteria, preliminary remediation goals and cleanup levels for chemicals of concern in the designated media. Chemical-specific ARARs are also used to determine treatment and disposal requirements that may occur in a remedial activity. In the event a chemical has more than one requirement, the more stringent requirement will govern.

Location-Specific

Location-specific requirements set restrictions on the types of remedial activities that can be performed based on site-specific characteristics or location. Certain types of actions may be restricted or precluded based on Federal, State, or local zoning laws for hazardous waste facilities, proximity to wetlands or floodplains, or to man-made features such as existing landfills, disposal areas, and local historic landmarks or buildings.

Action-Specific

Action-specific requirements set controls or restrictions on the design, implementation, and performance of waste management actions. They are triggered by the particular

types of treatment or remedial actions that are selected to accomplish the cleanup. After remedial alternatives are developed, action-specific ARARs that specify performance levels, as well as specific levels for discharges or residual chemicals, provide a basis for assessing the feasibility and effectiveness of the remedial actions.

Table 4.1 provides a preliminary summary of the potential chemical-specific ARARs and to be considered(s) (TBCs). The chemical-specific ARARs/TBCs are relevant to screening of soil, sediment, and surface water analytical data. The potential ARARs/TBCs may also be relevant to the development of cleanup criteria.

Generic screening levels or Project Action Limits (PALs) have been developed for the Site based on the ARARs presented on Table 4.1. Tables 4.2, 4.3, and 4.4 summarize the soil, sediment and surface water PALs, respectively. Soil, sediment, and surface water analytical data will be evaluated against the PALs to determine the need for response action. In areas where contaminant concentrations equal or exceed the PALs, further study or investigation may be required. In the event contaminant concentrations equal or exceed the PALs, Site-specific PALs may be developed based information collected during the RI activities.

5.0 ADDITIONAL DATA REQUIREMENTS

Areas where EPA requested additional soil investigation were identified in the USEPA's letter to Archer & Greiner (ATK legal counsel) dated July 29, 2004. The general areas for additional investigation are shown on Figure 3.1 in accordance with the AOC. Based on field observations, Figure 3.1 was modified, as shown on Figure 5.1, to represent the drainage swale in the RTI area as an area of soil investigation rather than an area of surface water and sediment investigation. The drainage swale leading from building R-62 to Lake Denmark is a surface water drainage and is typically dry except during precipitation events.

In order to determine naturally occurring background concentrations of selected inorganics, soil samples will also be collected from the undeveloped portion of the Site.

Soil, sediment, and surface water will be analyzed for target compound list (TCL), VOCs, target analyte list (TAL) metals, SVOCs, and/or energetics depending on historical operations in the vicinity of the individual sample location. An acid volatile sulfide (AVS) analysis will be conducted on sediment samples to evaluate the variation in AVS concentrations on metal bioavailability. Soil and sediment samples will also be analyzed for total organic carbon (TOC). A summary of analytical parameters is included as Table 3.1.

Data collected will be used for the following purposes:

- To determine the sources of contamination;
- To define the nature and extent of contamination;
- To determine background concentrations of select naturally occurring inorganics;
- To determine Site-specific cleanup criteria; and
- For the development of a Baseline Human Health Risk Assessment and Screening-level Ecological Risk assessment.

6.0 DRAFT RISK ASSESSMENT (RA) WORK PLAN

A Draft RA Work Plan has been completed for the Site and is included as Appendix C. The Draft RA Work Plan presents the conceptual site model and methodology that is anticipated to be used in conducting the Baseline Human Health Risk Assessment and Screening-Level Ecological Risk Assessment.

7.0 REMEDIAL INVESTIGATION (RI) ACTIVITIES

In order to define the nature and extent of contamination, soil, sediment, and surface water samples will be collected for laboratory analysis from the general areas shown on Figure 5.1. Also, soil samples will be collected from the undeveloped portions of the Site to determine naturally occurring background concentrations of selected inorganics and the extent of subsurface waste will be determined in the RTI/Drum Disposal Area.

7.1 ACCESS AGREEMENTS

Site related tasks to be performed under this work plan will not be performed on property owned by ATK. In regard to access for the performance of these tasks, ATK has affirmed the following position:

> As previously mentioned, there is no financially-solvent property owner for the Site. ATK was granted access by the Superior Court of New Jersey in October 2004 for the purposes of conducting investigation and remediation of the RTI Superfund Site. EPA has been provided with a copy of this court order. As such, ATK and its authorized representatives and subcontractors have access to the Site.
>
> Moreover, ATK has received a signed access agreement from the one remaining of the Site: IBA Sterigenics.

ATK does not believe that access to the Site will be an issue in conducting the tasks outlined in this Work.

7.2 SUBSURFACE WASTE DELINEATION

A preliminary assessment as to the extent of subsurface waste in the RTI/Drum Disposal Area was completed. The preliminary assessment consisted of delineating the extent of surface disturbance as observed on historical aerial photos and completing a visual inspection of the area of interest. The aerial photographs reviewed as part of this assessment consisted of nine aerial photographs taken between 1940 through 2003. The source of the aerial photographs is from a report commissioned by EPA titled "Aerial Photographic Analysis of Radiation Technology, Inc. Site, Rockaway Township, New Jersey prepared by Environmental Research, Inc, April 2005". The areas of observed disturbance in the RTI/Drum Disposal Area were combined into one contiguous area in

order to estimate the potential extent of subsurface waste. The extent of this area is shown on Figure 7.1a.

In conjunction with the aerial photograph assessment, a site visit was completed in April 2006 with EPA to complete a visual inspection of the RTI/Drum Disposal Area and record the visual boundary of waste. A GPS was used to record the limits of observed waste materials. Two types of waste were noted and occupied two different areas: drums/containers occupied one area as noted on Figure 7.1a while demolition debris/non-container type or refuse debris occupied another area. The refuse area is also shown on Figure 7.1a.

Test pits will be used to further refine the extent of the disturbance in the RTI/Drum Disposal Area. In addition, the test pits will allow for the characterization of subsurface waste and investigation of potential impacts to soil in the RTI/Drum Disposal Area.

The delineation and characterization of waste and subsurface soils will be performed by excavating test pits, collecting subsurface soil samples, and recording stratigraphic information obtained from test pits. Test pits will be excavated to explore and define geologic conditions, define the extent of subsurface waste/debris, and to allow the collection of subsurface soil samples for field and laboratory analysis. Test pits will be used for this task as they tend to give a more complete view of the subsurface soil conditions than soil borings.

Given the somewhat unknown nature of waste types and contamination that may be encountered in conducting this work, it is anticipated that the selected subcontractor will perform this work at a Level B personal protection level as waste materials, including drummed waste, may be encountered. Also, this work will be conducted within an area that Picatinny Arsenal personnel have identified as containing potential unexploded ordinance (UXO). Based on ATK's review of the Stakeholder Draft Site Inspection (SI) Report, Picatinny Arsenal, New Jersy (Malcolm Pirnie, Inc., November 2007), the potential for UXO on the RTI site results from munitions firing and discarded UXO following the 1926 Lake Denmark Powder Depot explosion. Appendix D provides ATK's review summary of the SI Report for UXO as it relates to the RTI site. ATK will retain a contractor that specializes in UXO operations and also can conduct excavation activities.

Prior to the start of subsurface work, private and public utilities are to be identified and marked in the area of investigation and utility conflicts resolved; the limits of the area to be investigated along with initial test pit locations as shown on Figure 7.1a are to be

staked/flagged; and performance of tree clearing as necessary. If it is necessary to relocate any proposed test pit due to terrain, utilities, access, etc., the Project Coordinator must be notified and an alternate location will be selected and approved.

Test pits will be excavated using either a rubber-tired backhoe or track-mounted excavator that can extend 10 to 15 feet below ground surface. Excavation work will progress from outside the edge of anticipated waste inward as to minimizing impacts to clean areas. Decontamination of the excavator between test pit locations without waste will consist of scraping soils from the bucket and arm between locations. In addition, for test pits in which waste is encountered but waste materials are not of a liquid state or adhere readily to the excavator, soil and waste material will be scraped from the equipment. In all other cases, high pressure water wash/rinse, detergent wash (brushing, as necessary, to remove particulate matter) and a high pressure water rinse will be performed. All decontamination materials in this latter case will be collected and containerized.

As noted above, Figure 7.1a shows the location in which the excavation of test pits are initially planned. Typical test pit lengths are anticipated to be 10 feet in length and extend to the water table, approximately 2 to 8 feet below ground surface, or to the point of refusal, whichever occurs first. Should drums be encountered during excavation that appear or are known to contain waste materials, no further excavation will occur at that location. In refining the extent of waste, test pits may be lengthened to delineate the edge of subsurface waste but will not extend beyond the western edge of the fence line as shown on Figure 7.1a. The fence demarcation point is attributed to previous remedial actions conducted by others on the eastern side of the fence and hence falls outside the areas of investigation as described in the AOC and shown on Figure 3.1. Following the completion of each test pit, the location will be marked, photographed, stratigraphy/waste logged, and backfilled.

During the excavation of a test pit, samples will be collected to assist the geologist/engineer in assessing and characterizing the waste types and geology, and where designated on Figure 7.1a. Soil from the base of each test pit excavation will be assessed visually for evidence of staining/visual or olfactory indications of contaminant impacts. Soil for this assessment will be collected from the backhoe/excavation bucket, as entry into the test pit will not be allowed. In addition, soil samples will be screened with a PID by running the PID across the soil sample and the highest reading and sustained readings recorded. Soil from the base of the test pit which exhibits indications of contaminant impacts will be sampled and submitted for laboratory analysis. At a minimum, soil samples will be collected for laboratory analysis from the designated test

pits shown on Figure 7.1a. Other documentation will include the completion of field logs, field books, and photographs to document the work. Logs for each test pit will be prepared that describe soil and waste types and also the following:

- native or fill components;
- secondary and minor soil components;
- relative densities/consistency;
- grain size/plasticity;
- gradation/structure;
- color;
- moisture content;
- observations of odor and type;
- PID readings;
- presence of NAPL; and
- presence of groundwater and the rate of seepage (if groundwater is encountered).

Following the completion of the test pit, the excavation will be backfilled using the soil/waste excavated from the pit. To the extent practicable, materials will be replaced into the test pit in the same intervals from which they were extracted.

7.3 SOIL

Soil sampling and quality assurance/control procedures to be followed during the RI are described in the Sampling and Analysis Plan (SAP) and Quality Assurance/Quality Control Plan (QAPP) included as Appendices D and E, respectively.

Soil borings will be installed using direct-push technology when possible. Hand auger methods may be employed in areas of shallow overburden thickness or in areas with access issues due the physical characteristics of the Site (wooded, hilly). The number of soil samples collected from each boring will be based on the overburden thickness and groundwater elevation. Table 7.1 provides the sampling methodology. Sample locations may be modified in the field due to rocky conditions at the Site.

7.3.1 RTI AREA

RI activities in the RTI Area will consist of test pit work in the vicinity of the Drum Disposal Area and two surface soil samples located in the drainage swale leading from building R-62 to Lake Denmark. Based on field observations, the drainage swale leading from building R-62 to Lake Denmark is a surface water drainage and is typically dry except during precipitation events. As such, surface water samples will not be collected from this location. Figures 7.1a and 7.1b present the sample locations. Table 7.2 provides the rationale for each location, compounds to be analyzed, overburden thickness, and number of samples.

7.3.2 P-2 AREA

RI activities in the P-2 Area will consist of two soil borings in the vicinity of building R-34. Soil samples in the vicinity of building R-47 will be limited to surface soil due to minimal overburden thickness in this area. A total of fourteen surface soil samples will be collected in the vicinity of building R-47. Soil borings will be completed at three locations in an open area northeast of R-47. This area contains RI derived materials staged by others, various types of surface debris, and was formerly used for outdoor storage. Figure 7.2 presents the sample locations. Table 7.3 provides the rationale for each location, compounds to be analyzed, overburden thickness, and number of samples.

7.3.3 EAST STAND AREA

RI activities in the East Stand Area will consist of installing a total of 14 soil borings for sample collection. Three soil borings will be located in the vicinity of R-4, two borings in the former R-3 lagoon area, five borings in the vicinity of R-3 and the scrubber building, one boring in the vicinity of R-2, one boring adjacent to building R-33, and one boring adjacent to an existing AST and former AST. The proposed soil boring in the vicinity of R-2 will be located a minimum of 30 ft southwest of R-2, outside the area of previous remedial action. A sample of the contents of the existing AST located south of building R-51 will also be collected for analysis. Figure 7.3 presents the sample locations. Table 7.4 provides the rationale for each location, compounds to be analyzed, overburden thickness, and number of samples.

An inspection of soil/topography will be completed of the area delineated on Figure 7.3. Previous remedial action consisted of the excavation of PCB impacted soil from within

this area. A visual inspection for evidence of a change in condition since the remedial took place (i.e. indications of excavation or other disturbance(s)) will be performed in these areas. Current conditions will be documented in the field log and photographs will be taken of the area.

7.3.4 SOUTH STAND AREA

RI activities in the South Stand Area will consist of installing a total of 19 soil borings for sample collection. Four soil borings will be located in the vicinities of S-37 and test stand S-49, four borings in the vicinity of S-46, two borings in the vicinities of S-48 and S-12, and three soil borings in the vicinity and downgradient of S-11. One soil boring will be installed adjacent to each former bunker located in the "undeveloped" area to the west of the South Stand Area. The proposed soil boring in the vicinity of building S-37 will be located a minimum of 15 feet southwest of S-37, outside the area of previous remedial action. A sample of the contents of the existing AST located between test stand S-49 and building S-46 will also be collected for analysis. Figure 7.4 presents the sample locations. Table 7.5 provides the rationale for each location, compounds to be analyzed, overburden thickness, and number of samples.

An inspection of soil/topography will be completed of the area delineated on Figure 7.4. Previous remedial action consisted of the excavation of PCB impacted soil from within this area. A visual inspection for evidence of a change in condition since the remedial took place (i.e. indications of excavation or other disturbance(s)) will be performed in these areas. Current conditions will be documented in the field log and photographs will be taken of the area.

7.3.5 UNDEVELOPED AREA

A total of ten soil borings will be installed in the undeveloped portion of the Site for the collection of background soil samples. Soil boring will be installed in the general areas shown on Figure 7.5. Boring locations in the undeveloped area will be field located due to rocky conditions at the Site.

7.4 SEDIMENT AND SURFACE WATER

Sediment and/or surface water samples will be collected from the locations shown on Figure 7.6. Table 7.6 provides the rationale for each location, compounds to be analyzed, and number of samples.

7.5 SAMPLING AND ANALYSIS PLAN (SAP)

Soil, sediment and surface water sampling and analysis will be conducted in accordance with the protocols detailed in the SAP provided in Appendix E.

7.6 QUALITY ASSURANCE/QUALITY CONTROL PLAN (QAPP)

Sampling and quality assurance/control procedures to be followed during the RI are described in the QAPP provided in Appendix F.

7.7 HEALTH AND SAFETY PLAN (HASP)

The RI activities will be conducted under the Site-specific HASP which specifies procedures for protecting remediation workers during the RI activities. The Site-specific HASP is presented in Appendix G. One item of note is that the U.S. Army has indicated there is a potential to encounter UXO as the result of testing activities from adjacent Picatinny arsenal operations. The extent of the potentially affected area on the Site is shown on Figure 1 of the Health and Safety Plan. Prior to the start of surface soil sampling, soil boring work, sediment sampling or subsurface waste delineation work within this area, UXO clearance by a qualified UXO technician, as described in the HASP will be required. With exception of the subsurface waste delineation, a qualified UXO technician is to clear a radial area originating from the boring/sampling location to a distance of at least 6-feet. Additional detail in regards to UXO clearance for subsurface waste delineation work is described in Section 3.6 of the SAP.

8.0 PROJECT ORGANIZATION

If retained by ATK, CRA will oversee the advancement of soil borings and perform the sample collection. Installation of soil borings will be performed by a licensed subcontractor. Samples collected for chemical analysis will be analyzed by Severn Trent Laboratories (STL) and Data/Analysis Technologies, Inc. (DAT).

All subcontracted firms will provide project management as appropriate to their responsibilities. CRA will maintain a file copy of all laboratory deliverables. All final project deliverables will be issued by CRA at the explicit direction of ATK. A summary of each of the key person's responsibilities is presented in the QAPP as provided in Appendix E.

Primary responsibility for the project quality rests with CRA's project Manager. Independent quality assurance will be provided by the laboratory's Project Manager and Quality Assurance (QA) Officer prior to the release of all data to CRA.

During the sampling stage of the project, routine telephone contact between the field sampling personnel and the laboratory subcontractor will occur. The laboratory will provide status updates by means of preliminary data submittals. Should unexpected delays or other problems with the laboratory analyses occur, these would be communicated directly to CRA's Project Coordinator for resolution. Routine meetings/discussions with subcontractors will be conducted to update the progress of project activities.

Key CRA contacts during the RI activities are:

Ron Frehner	Project Manager/Project Engineer
Robert Martin	Project/Field Coordinator
Brian Sandberg	Senior Project Hydrogeologist
Grant Anderson	QA Officer
Bill Doyle	Health and Safety Officer

ATK Personnel:

Karie Mars	Project Manager
Jon Bode	Alternate Project Manager

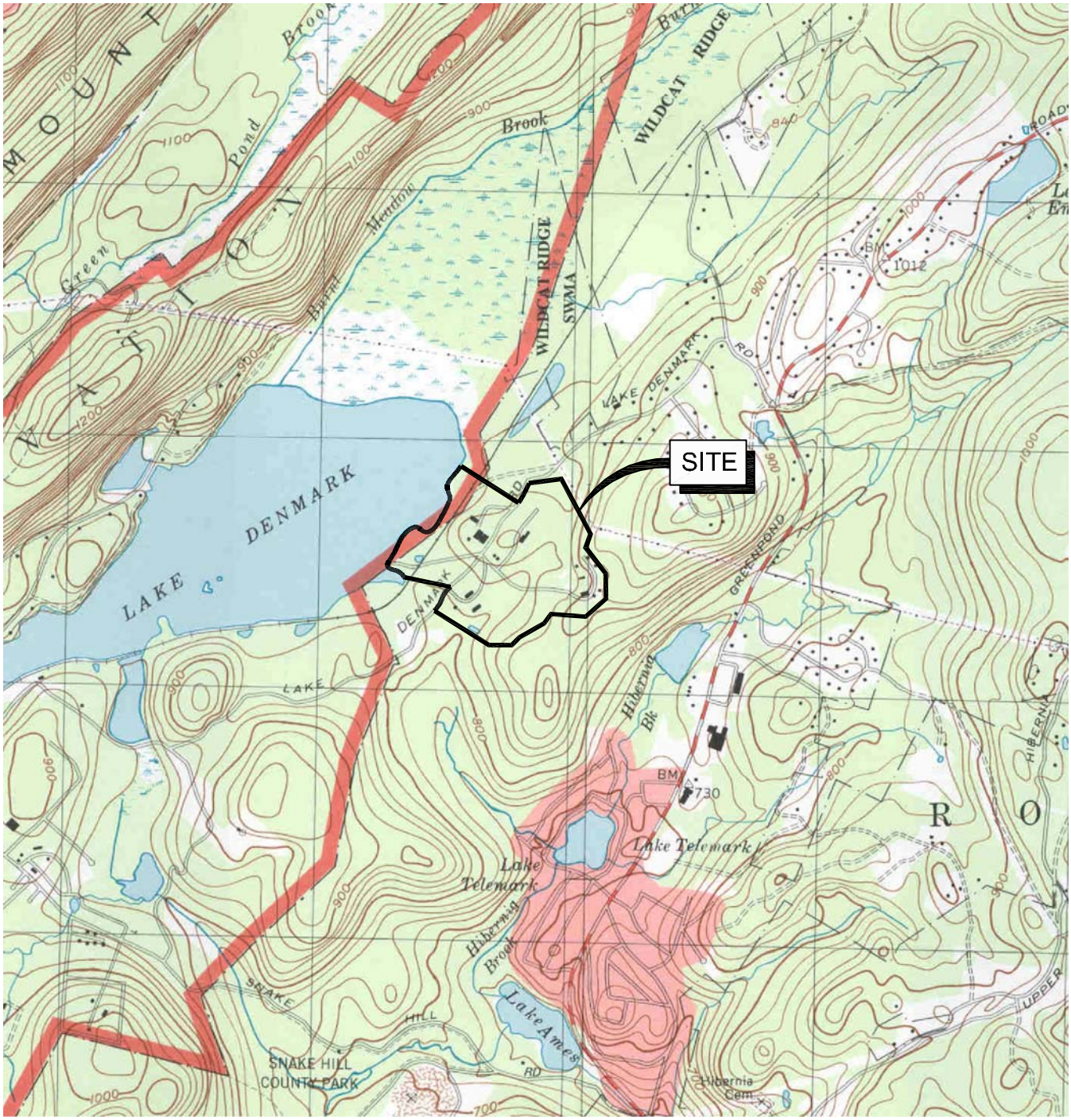
In the event that a contractor other than CRA is retained for the field work, ATK will provide an alternate Section 8 for this work plan.

9.0 REPORTING AND SCHEDULE

Upon completion of RI field sampling activities and analysis work, ATK will prepare and submit a draft Site Characterization Summary Report (SCSR). This report will summarize the investigative activities performed by ATK and describe/present the locations and characteristics of surface and subsurface contamination, and recommend additional RI work, if required. The draft SCSR will provide EPA with a preliminary reference for the development of the risk assessment, evaluation of the development and screening of remedial alternatives, and the refinement and identification of ARARs.

Approximately 14 days from the submittal of the draft SCSR to EPA, ATK will meet with EPA and present the findings of the RI work and discuss project direction and future scope of work items.

A detailed schedule outlining AOC tasks and the anticipated schedule for the RI/FS process is provided in Figure 9.1. Note that the schedule assumes that a Baseline Ecological Risk Assessment (BERA) and treatability study will not be required. The schedule will be revised, as necessary, as the project progresses.



SOURCE: USGS 7.5 MINUTE QUADS
DOVER AND BOONTON, N.J.

N

0 1000 2000ft

figure 1.1

SITE LOCATION
RTI SUPERFUND SITE
Rockaway Township, New Jersey

04354-50(010)GN-SP008 Jan 24/2008

300037

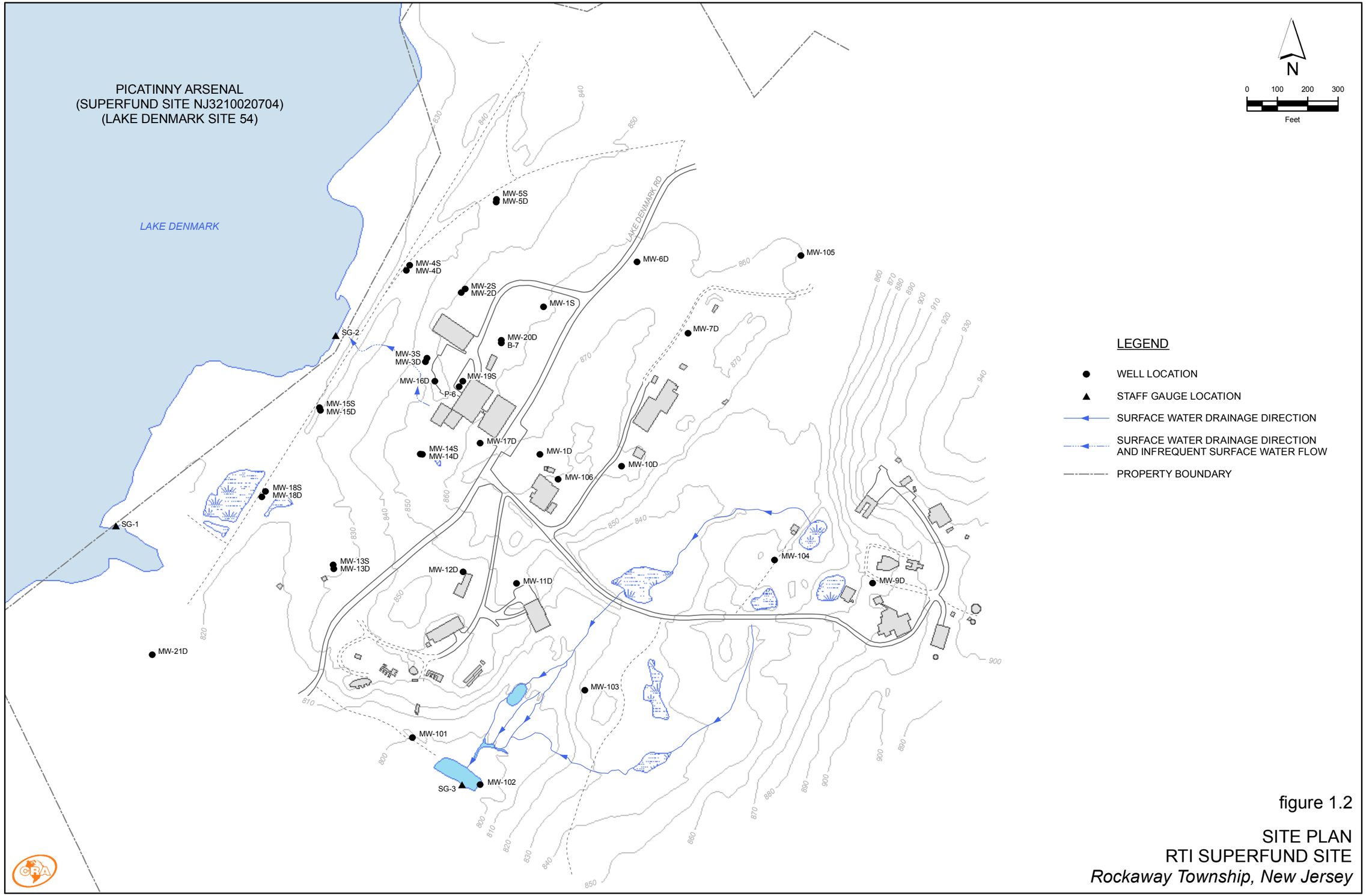


figure 1.2

SITE PLAN
RTI SUPERFUND SITE
Rockaway Township, New Jersey

4354-50(010)GIS-SP003 JAN 25/2008

300038

LEGEND

- RTI AREA
- EAST STAND AREA
- P-2 AREA
- SOUTH STAND AREA
- UNDEVELOPED AREA

N

0 250 500

Feet

figure 2.1

SITE AREAS
RTI SUPERFUND SITE
Rockaway Township, New Jersey

4354-50(010)GIS-SP004 JAN 25/2008

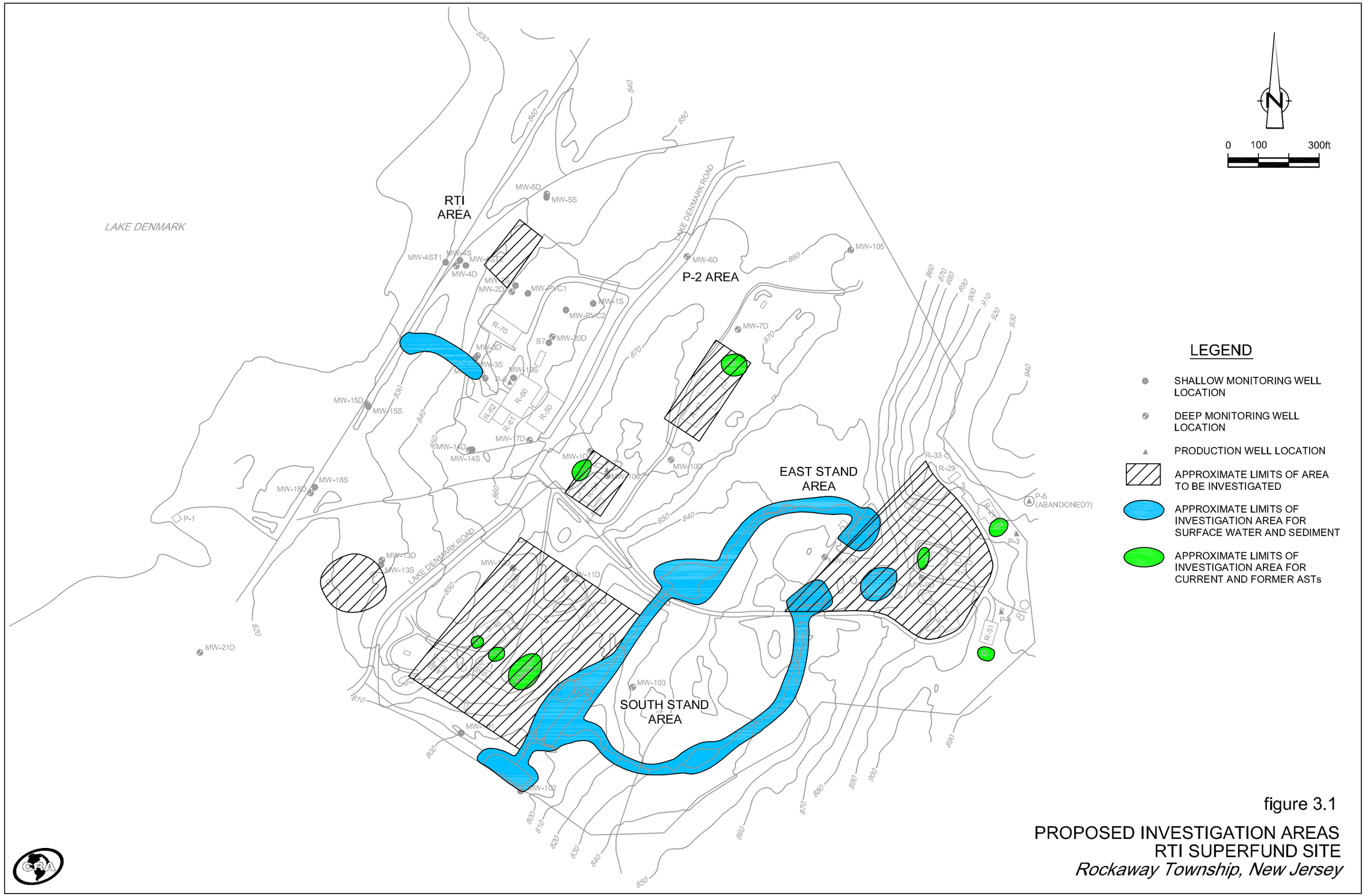


figure 3.1

PROPOSED INVESTIGATION AREAS
RTI SUPERFUND SITE
Rockaway Township, New Jersey

04354-50(010)GN-SP005 Jan 31/2008

300040

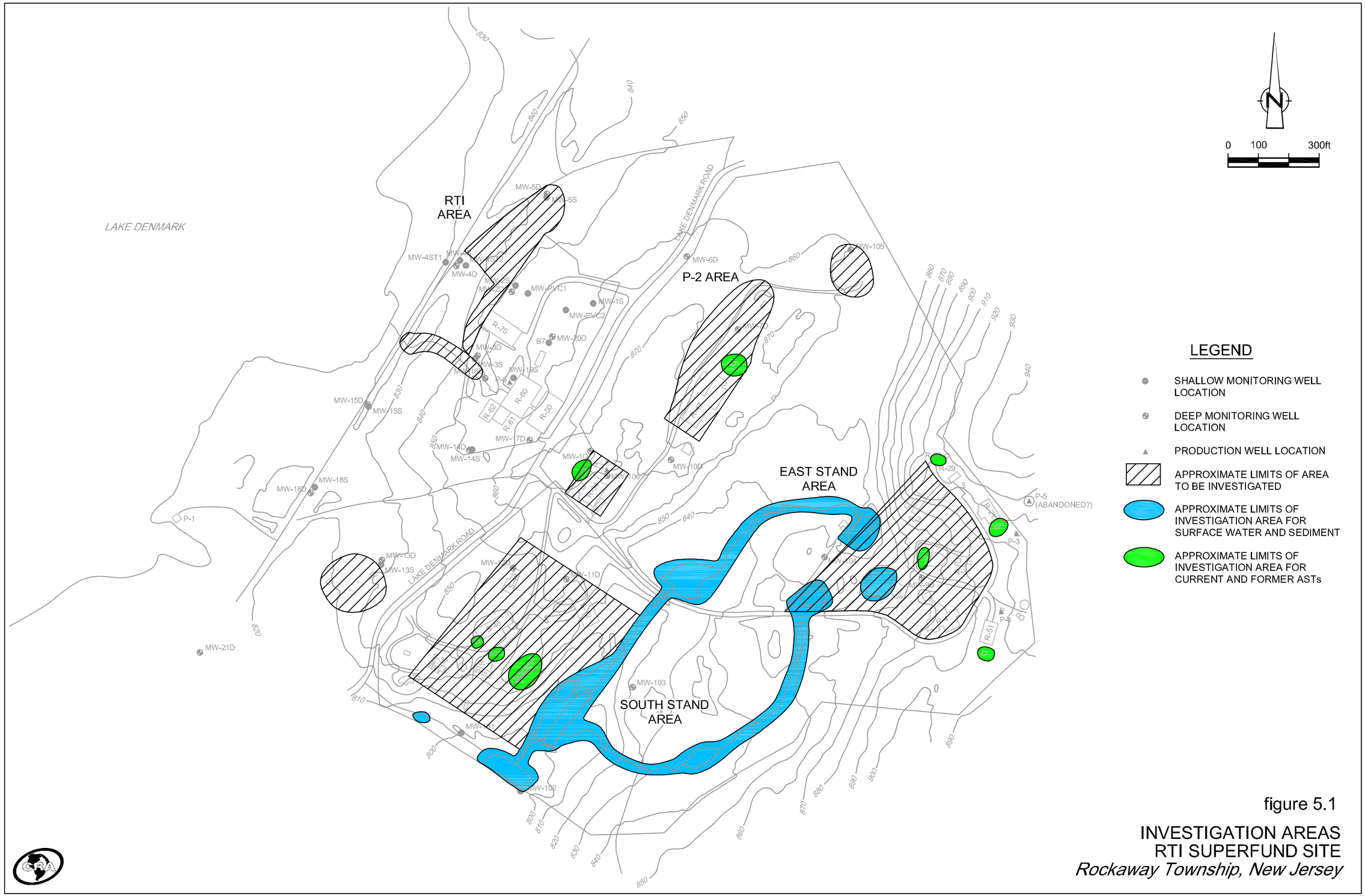


figure 5.1

INVESTIGATION AREAS
RTI SUPERFUND SITE
Rockaway Township, New Jersey

04354-50(010)GN-SP007 Jan 24/2008

300041

LEGEND

- TEST PIT / SAMPLING LOCATION
- TEST PIT LOCATION
- MONITORING WELL LOCATION
- DRUM LOCATION
- DISTURBED AREA - HISTORICAL AERIAL PHOTO BASED BOUNDED BY SITE FENCE
- WASTE DRUM AREA - GPS DELINEATED ON 4/27/06
- REFUSE DISPOSAL AREA - GPS DELINEATED ON 4/27/06
- CHAIN LINK FENCE

N

0 30 60

Feet

figure 7.1a

RTI AREA
PROPOSED TEST PIT / SAMPLING LOCATIONS
RTI SUPERFUND SITE
Rockaway Township, New Jersey

4354-50(010)GIS-SP001 FEB 1/2008

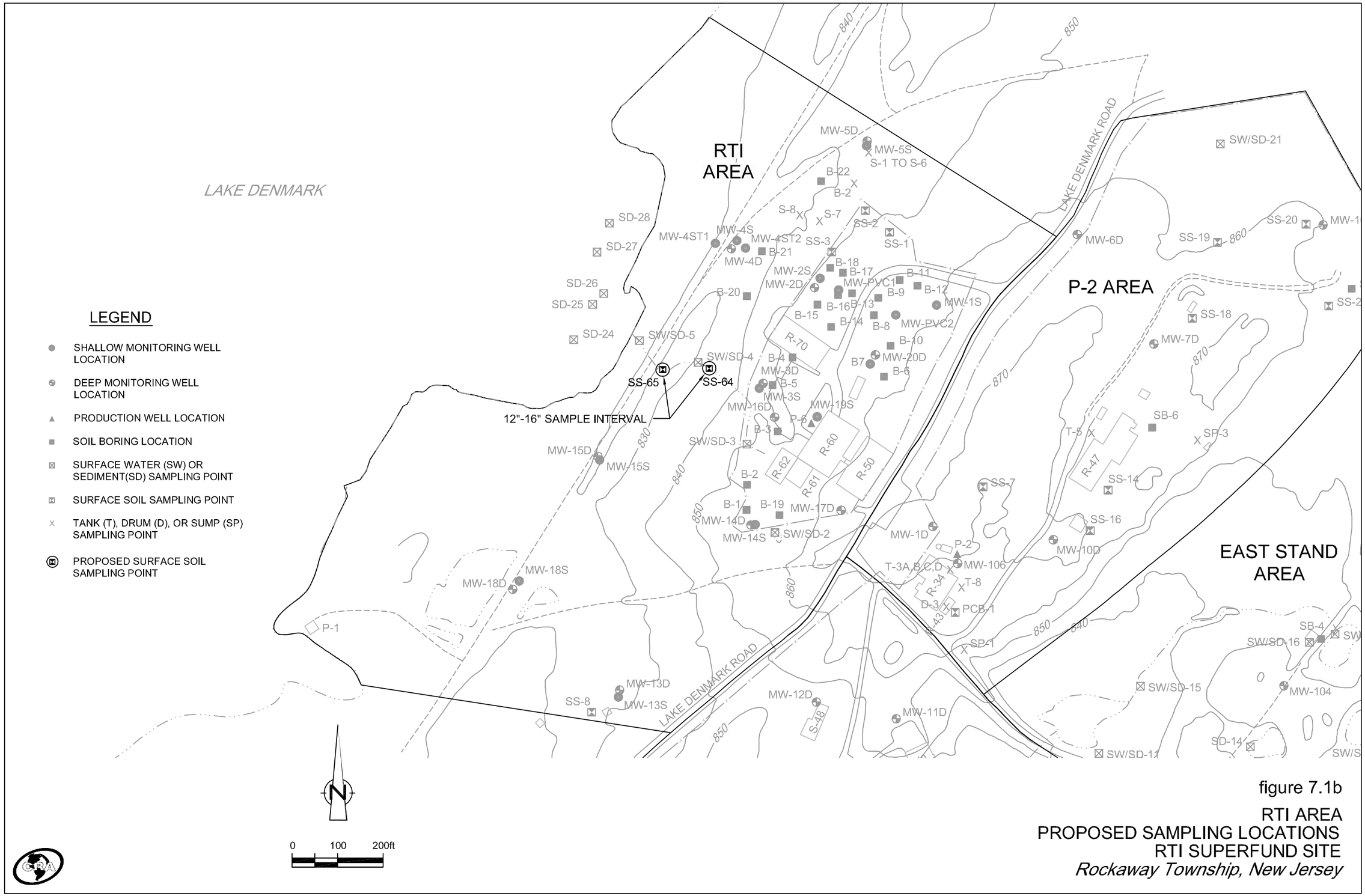


figure 7.1b

RTI AREA
PROPOSED SAMPLING LOCATIONS
RTI SUPERFUND SITE
Rockaway Township, New Jersey

04354-50(010)GN-SP001 Jan 25/2008

300043

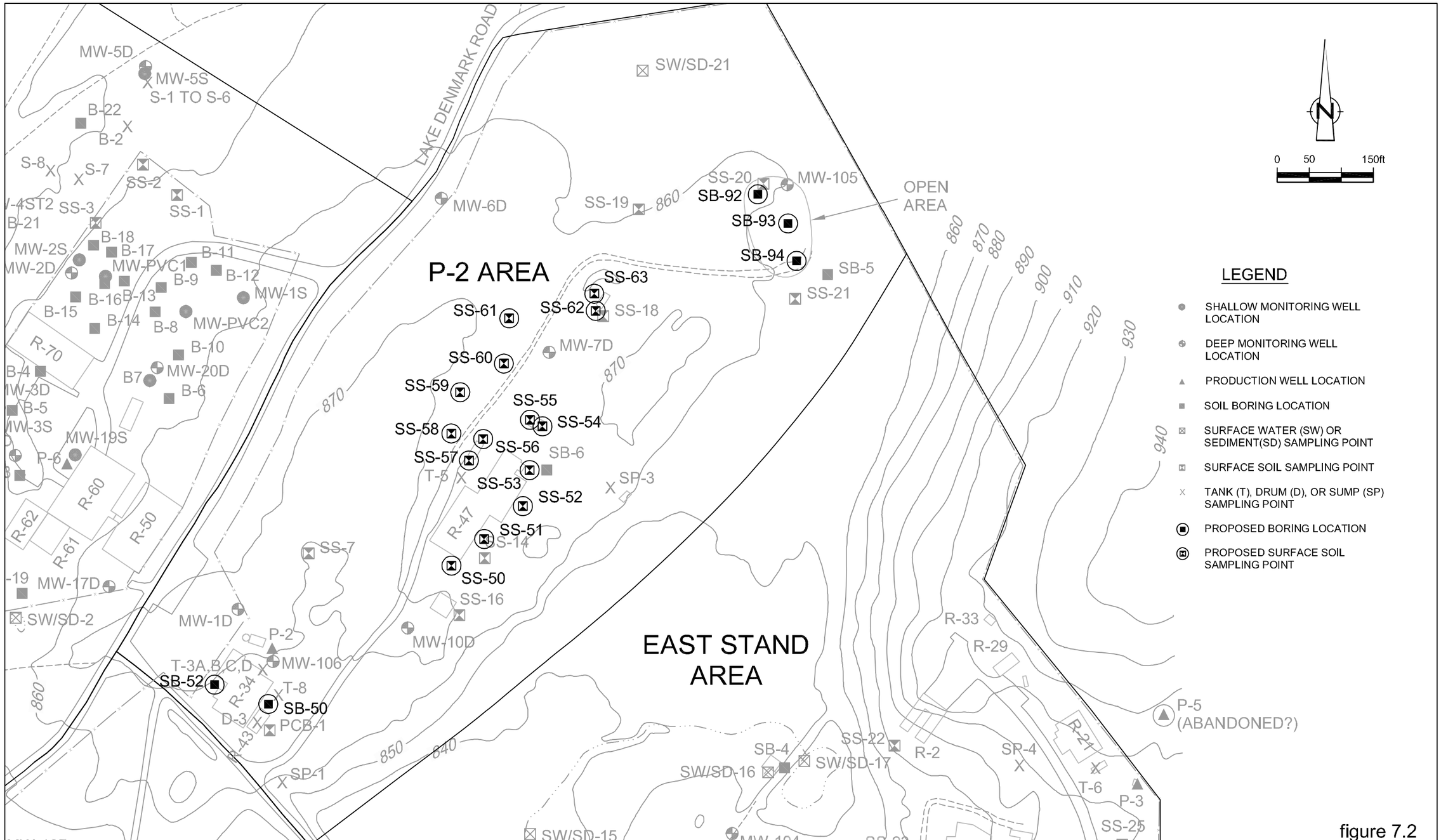


figure 7.2

P-2 AREA
PROPOSED SAMPLING LOCATIONS
RTI SUPERFUND SITE
Rockaway Township, New Jersey

04354-50(010)GN-SP002 Jan 24/2008

300044

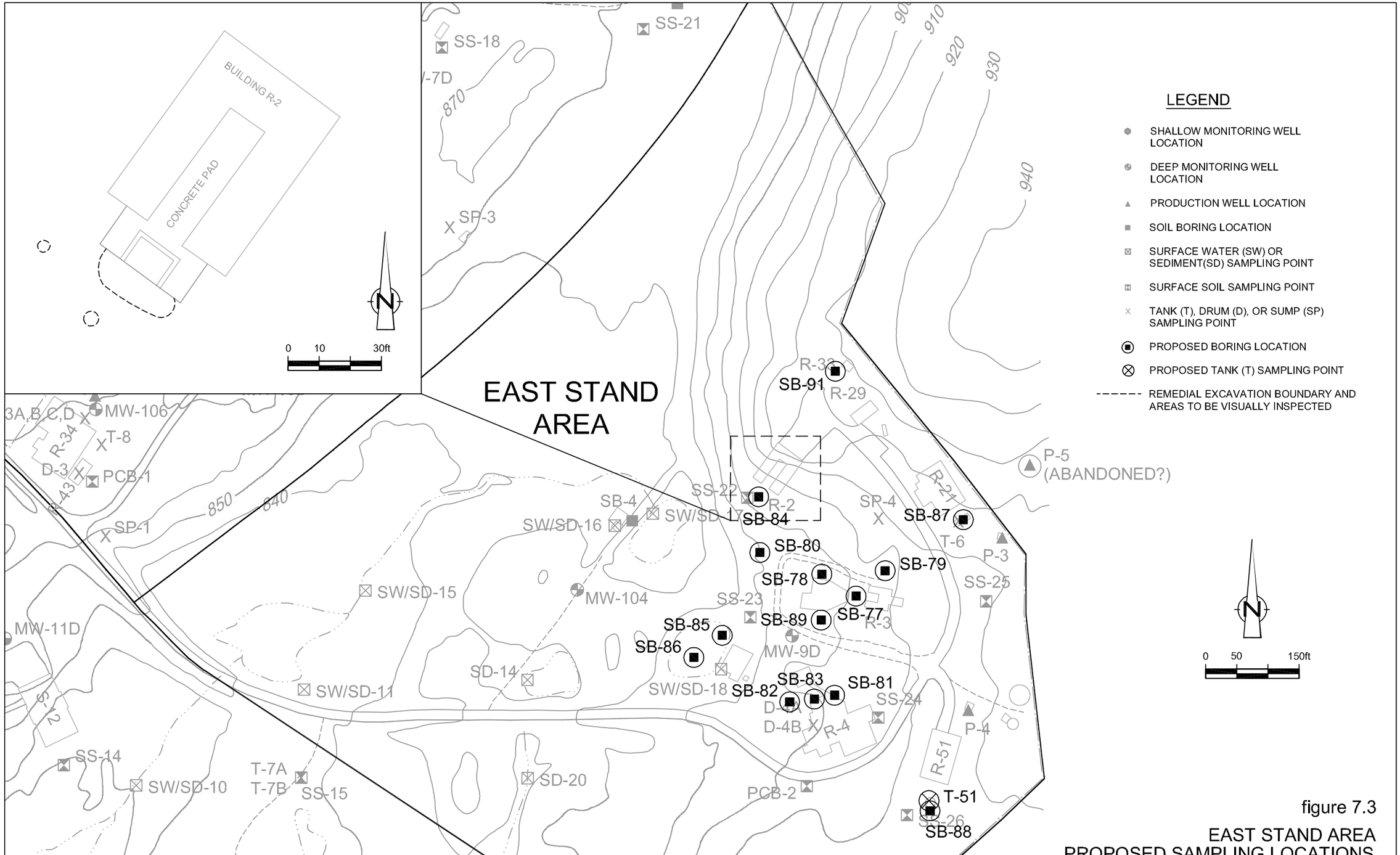


figure 7.3

EAST STAND AREA
PROPOSED SAMPLING LOCATIONS
RTI SUPERFUND SITE
Rockaway Township, New Jersey

04354-50(010)GN-SP003 Feb 01/2008

300045

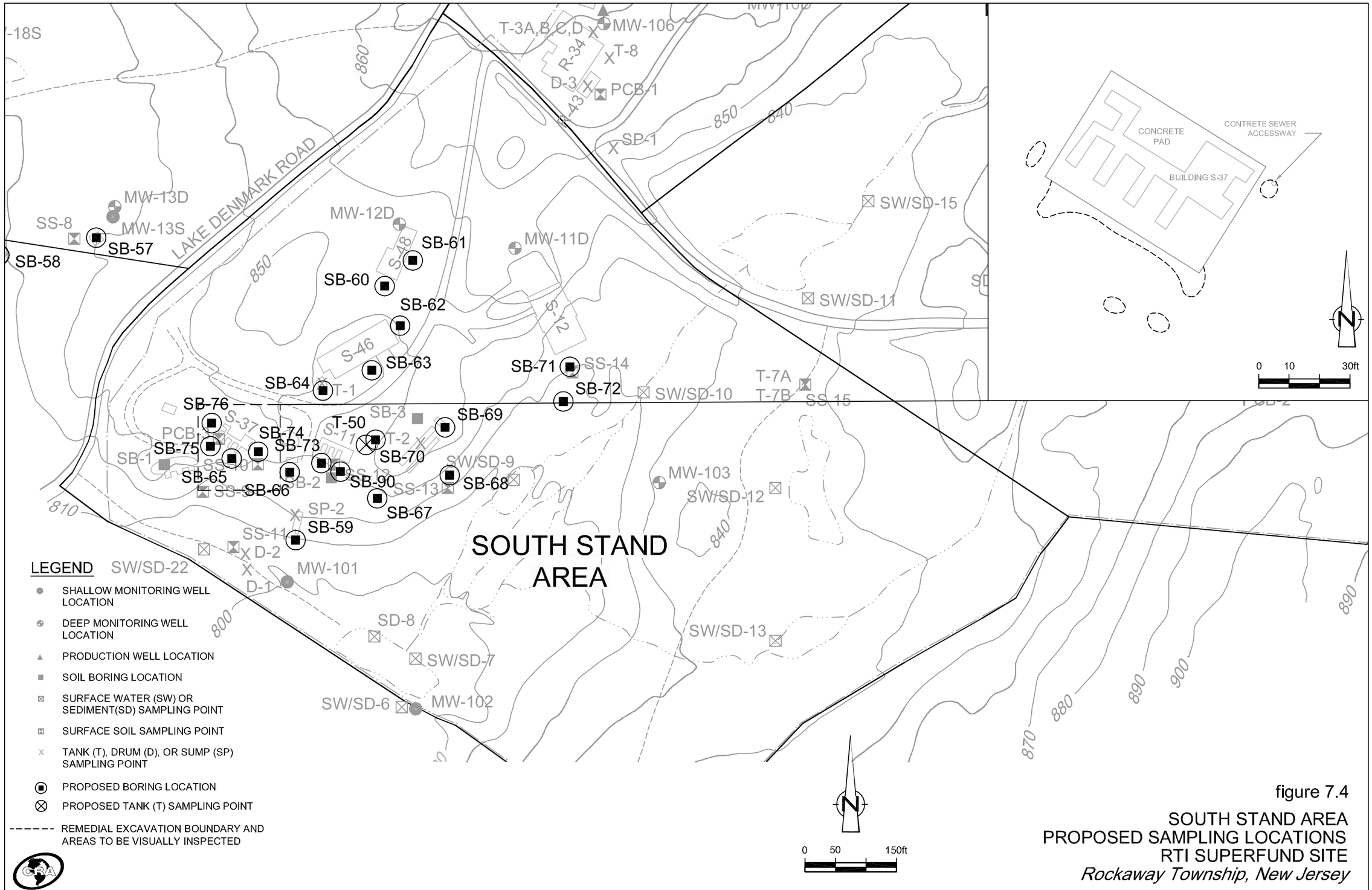
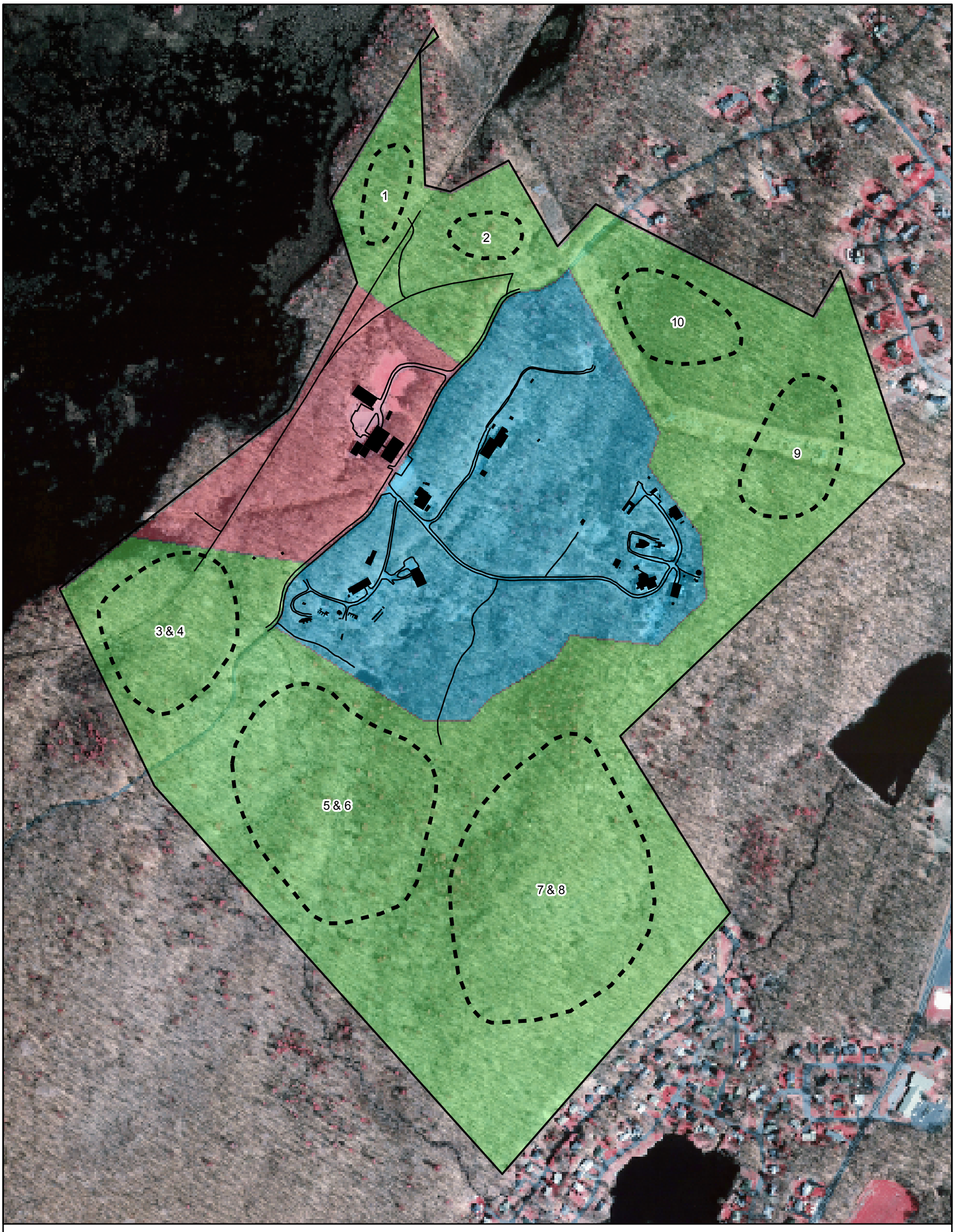


figure 7.4

SOUTH STAND AREA
PROPOSED SAMPLING LOCATIONS
RTI SUPERFUND SITE
Rockaway Township, New Jersey

04354-50(010)GN-SP004 Feb 01/2008

300046



LEGEND

1 — PROPOSED SOIL BORING GENERAL LOCATION

FORMER ROCKAWAY INDUSTRIAL PARKWAY

RADIATION TECHNOLOGY, INC. PROJECT SITE

UNDEVELOPED

SOURCE: ACRES RI (SEPT 1991) / 2002 COLOR-IR AERIAL PHOTO

N

0 250 500

Feet

figure 7.5

UNDEVELOPED AREA
PROPOSED BACKGROUND SAMPLING LOCATIONS
RTI SUPERFUND SITE
Rockaway Township, New Jersey

4354-50(010)GIS-SP002 JAN 25/2008

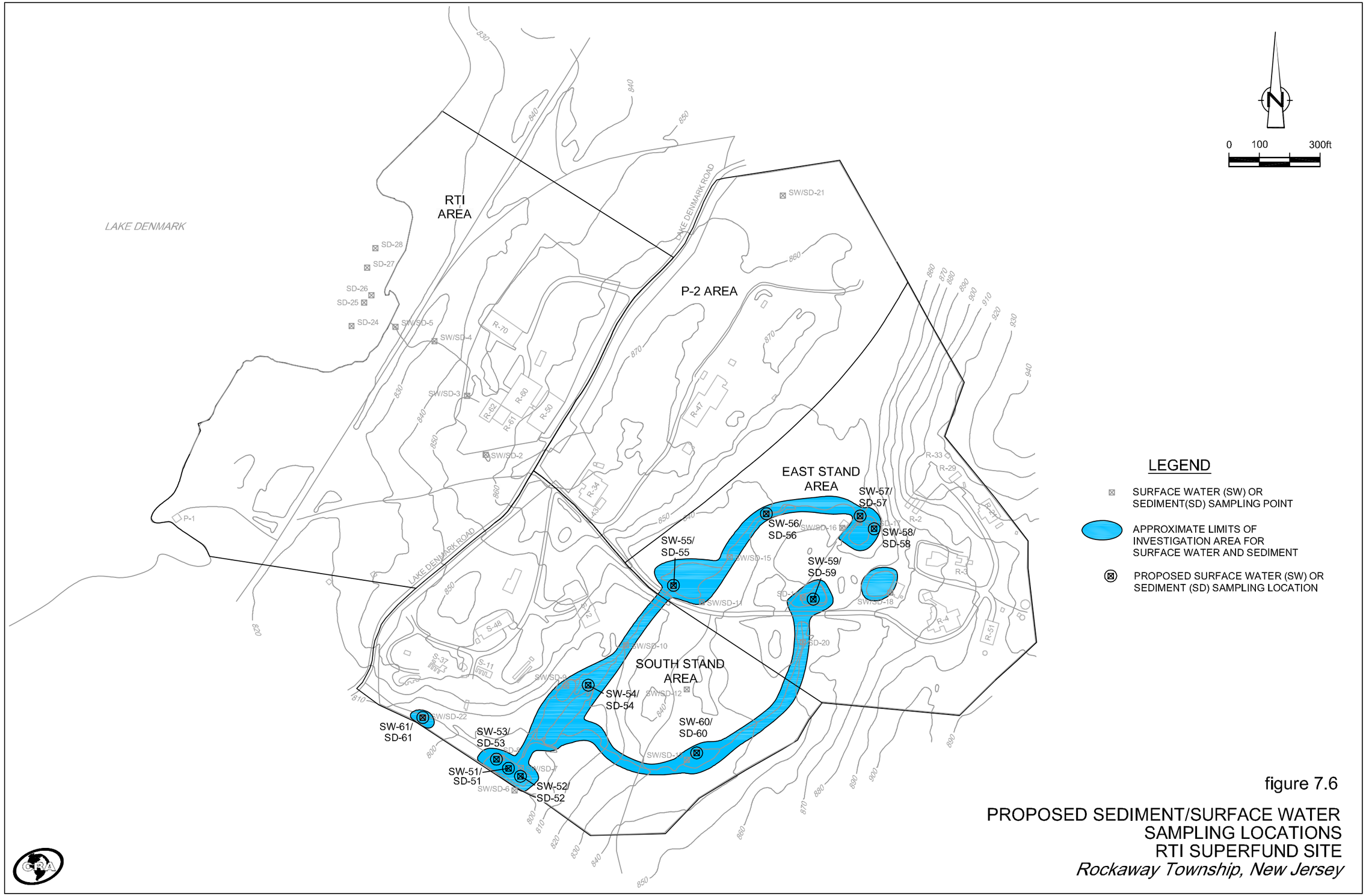


figure 7.6

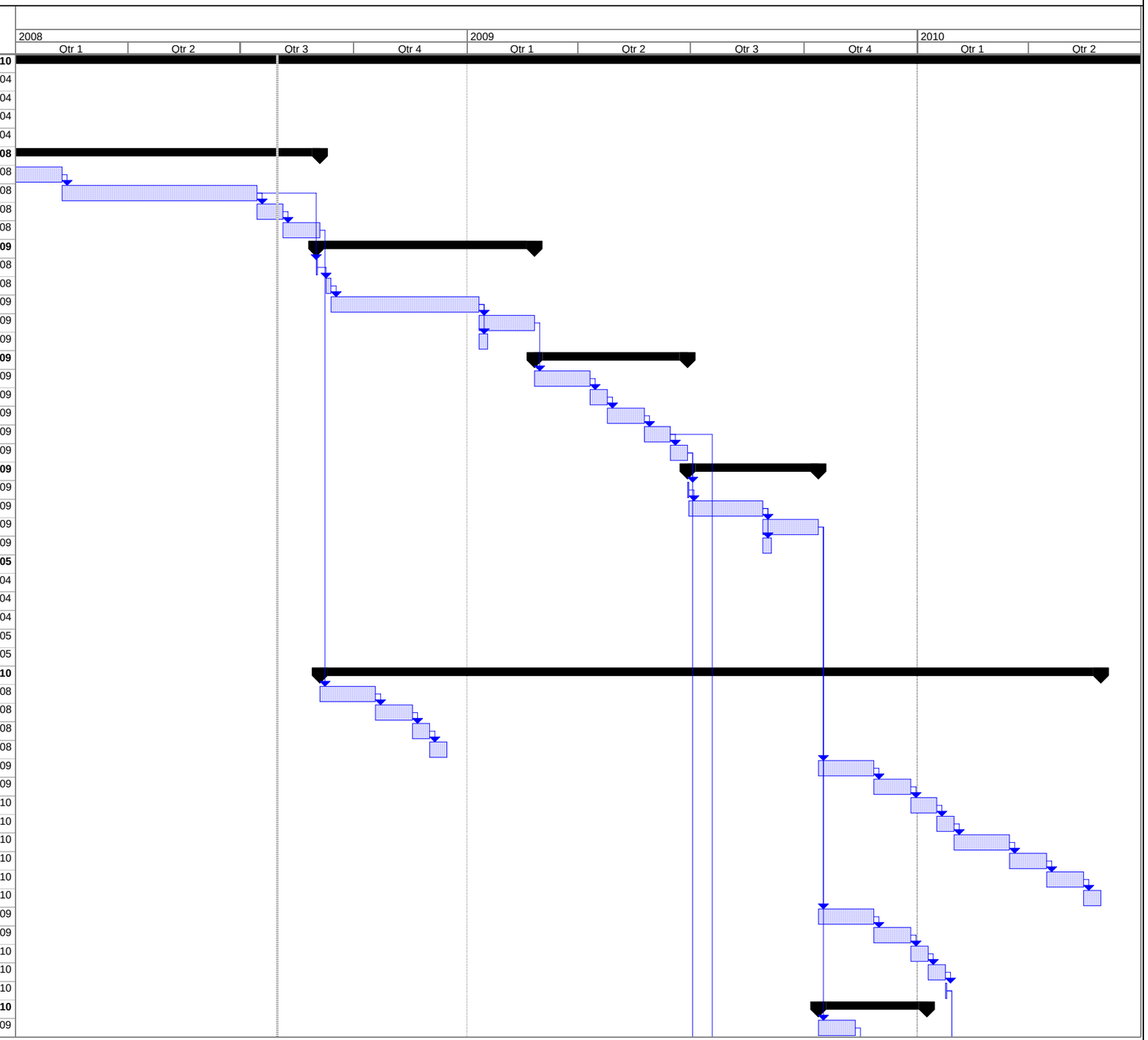
PROPOSED SEDIMENT/SURFACE WATER SAMPLING LOCATIONS
RTI SUPERFUND SITE
Rockaway Township, New Jersey

04354-50(010)GN-SP006 Jan 31/2008

300048

FIGURE 9.1
ESTIMATED PROJECT SCHEDULE
REMEDIAL INVESTIGATION AND FEASIBILITY STUDY - OU2
RTI SITE - ROCKAWAY TOWNSHIP, NEW JERSEY

ID	Task Name	Duration (Calendar Days)	Start	Finish
1	**Tasks Required Under Administrative Order on Consent (AOC)**	**2138 days**	**Mon 10/4/04**	**Wed 8/11/10**
2	Effective Date of AOC	1 day	Mon 10/4/04	Mon 10/4/04
3	Obtain Access Agreements	30 days	Mon 10/4/04	Tue 11/2/04
4	Notify USEPA of Project Coordinator	14 days	Mon 10/4/04	Sun 10/17/04
5	Notify USEPA of project personnel and subcontractors	45 days	Mon 10/4/04	Wed 11/17/04
6	**RI/FS Work Plan - OU-2**	**1431 days**	**Mon 10/4/04**	**Wed 9/3/08**
7	Prepare and Submit Limited RI/FS Work Plan	1222 days	Mon 10/4/04	Thu 2/7/08
8	USEPA Review and Conditional Approval	158 days	Fri 2/8/08	Mon 7/14/08
9	Prepare and Submit Final RI/FS Work Plan	21 days	Tue 7/15/08	Mon 8/4/08
10	USEPA Review/Approval	30 days	Tue 8/5/08	Wed 9/3/08
11	**RI Field Activities - Phase I**	**177 days**	**Mon 9/1/08**	**Tue 2/24/09**
12	Notify USEPA of Field Activity Start Date (7 days prior to start)	1 day	Mon 9/1/08	Mon 9/1/08
13	Conduct UXO Clearance Work/Site Field Work Preparation	4 days	Tue 9/9/08	Fri 9/12/08
14	Conduct RI Field Activities	120 days	Sat 9/13/08	Sat 1/10/09
15	Conduct Data Analysis and Validation and Submit to USEPA	45 days	Sun 1/11/09	Tue 2/24/09
16	Notify USEPA of Completion of Field Activities	7 days	Sun 1/11/09	Sat 1/17/09
17	**Site Characterization Summary**	**124 days**	**Wed 2/25/09**	**Sun 6/28/09**
18	Prepare and Submit Site Characterization Summary Report	45 days	Wed 2/25/09	Fri 4/10/09
19	Conduct Presentation to USEPA on Findings of Site Characterization Summary Report	14 days	Sat 4/11/09	Fri 4/24/09
20	USEPA Review and Comment	30 days	Sat 4/25/09	Sun 5/24/09
21	Prepare and Sumbit Revised Site Characterization Summary Report	21 days	Mon 5/25/09	Sun 6/14/09
22	USEPA Review and Approval	14 days	Mon 6/15/09	Sun 6/28/09
23	**RI Field Activities - Phase II (If Required)**	**106 days**	**Mon 6/29/09**	**Mon 10/12/09**
24	Notify USEPA of Field Activity Start Date (7 days prior to start)	1 day	Mon 6/29/09	Mon 6/29/09
25	Conduct RI Field Activities	60 days	Tue 6/30/09	Fri 8/28/09
26	Conduct Data Analysis and Validation and Submit to USEPA	45 days	Sat 8/29/09	Mon 10/12/09
27	Notify USEPA of Completion of Field Activities	7 days	Sat 8/29/09	Fri 9/4/09
28	**Supplemental Site Characterization Summary**	**124 days**	**Mon 10/4/04**	**Fri 2/4/05**
29	Prepare and Submit Supplemental Site Characterization Summary Report	45 days	Mon 10/4/04	Wed 11/17/04
30	Conduct Presentation to USEPA on Findings of Supplemental Site Characterization Summary Report	14 days	Thu 11/18/04	Wed 12/1/04
31	USEPA Review and Comment	30 days	Thu 12/2/04	Fri 12/31/04
32	Prepare and Sumbit Revised Supplemental Site Characterization Summary Report	21 days	Sat 1/1/05	Fri 1/21/05
33	USEPA Review and Approval	14 days	Sat 1/22/05	Fri 2/4/05
34	**Risk Assessment**	**633 days**	**Thu 9/4/08**	**Sat 5/29/10**
35	Prepare and Sumbit Memorandum on Exposure Scenarios	45 days	Thu 9/4/08	Sat 10/18/08
36	USEPA Review and Comments	30 days	Sun 10/19/08	Mon 11/17/08
37	Prepare and Submit Revised Memorandum	14 days	Tue 11/18/08	Mon 12/1/08
38	USEPA Review and Approval	14 days	Tue 12/2/08	Mon 12/15/08
39	Prepare and Submit Pathway Analysis Report	45 days	Tue 10/13/09	Thu 11/26/09
40	USEPA Review and Comment	30 days	Fri 11/27/09	Sat 12/26/09
41	Submit Revised Pathway Analysis Report	21 days	Sun 12/27/09	Sat 1/16/10
42	USEPA Review and Approval	14 days	Sun 1/17/10	Sat 1/30/10
43	Prepare and Submit Draft Baseline Human Health Risk Assessment (BHHRA)	45 days	Sun 1/31/10	Tue 3/16/10
44	USEPA Review and Comment	30 days	Wed 3/17/10	Thu 4/15/10
45	Submt Revised BHHRA	30 days	Fri 4/16/10	Sat 5/15/10
46	USEPA Approval of BHHRA	14 days	Sun 5/16/10	Sat 5/29/10
47	Prepare and Submit Screening-Level Ecological Risk Assessment (SLERA)	45 days	Tue 10/13/09	Thu 11/26/09
48	USEPA Review and Comments	30 days	Fri 11/27/09	Sat 12/26/09
49	Prepare and Submit Revised SLERA	14 days	Sun 12/27/09	Sat 1/9/10
50	USEPA Review and Approval	14 days	Sun 1/10/10	Sat 1/23/10
51	USEPA Notification - Baseline Ecological Risk Assessment (BERA) - Not Required	1 day	Sun 1/24/10	Sun 1/24/10
52	**Identification of Candidate Technologies**	**88 days**	**Tue 10/13/09**	**Fri 1/8/10**
53	Prepare and Submit Identification of Candidate Technologies Memorandum	30 days	Tue 10/13/09	Wed 11/11/09



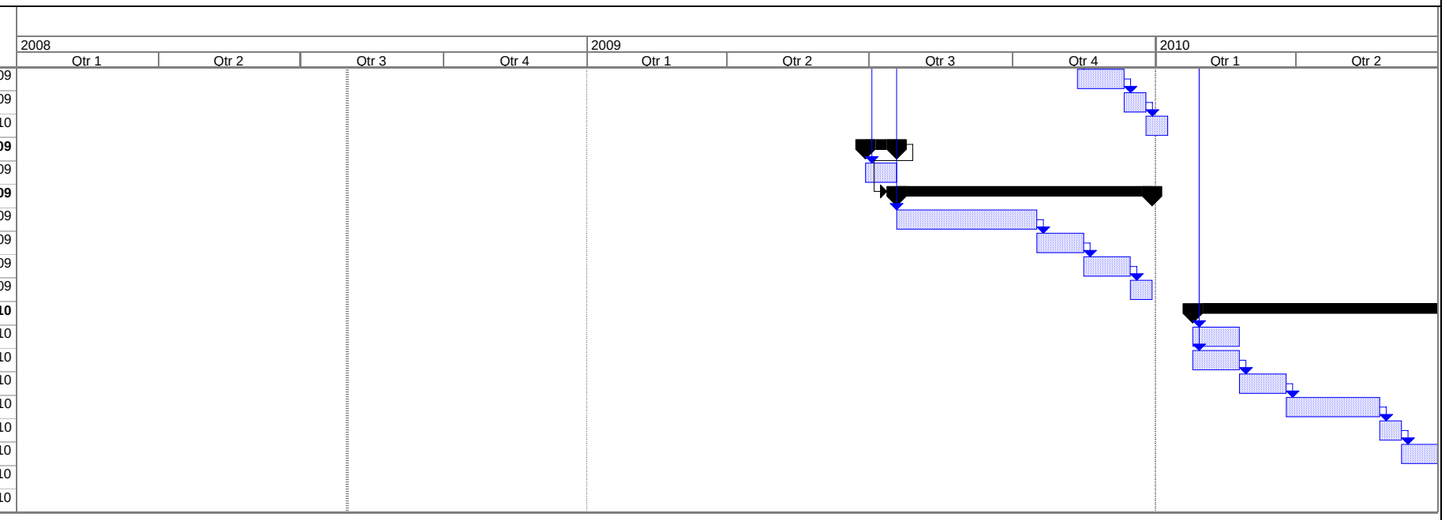
Project: 4354-50
Date: Thu 7/31/08

Task | Progress | Summary | External Tasks | Deadline
Split | Milestone | Project Summary | External Milestone

300049

FIGURE 9.1
ESTIMATED PROJECT SCHEDULE
REMEDIAL INVESTIGATION AND FEASIBILITY STUDY - OU2
RTI SITE - ROCKAWAY TOWNSHIP, NEW JERSEY

ID	Task Name	Duration (Calendar Days)	Start	Finish
54	USEPA Review and Comment	30 days	Thu 11/12/09	Fri 12/11/09
55	Prepare and Submit Revised Technical Memorandum	14 days	Sat 12/12/09	Fri 12/25/09
56	USEPA Review and Approval	14 days	Sat 12/26/09	Fri 1/8/10
57	**Treatability Studies, As Necessary**	**20 days**	**Mon 6/29/09**	**Sat 7/18/09**
58	Determine Need for Treatability Studies	20 days	Mon 6/29/09	Sat 7/18/09
59	**Remedial Investigation Report**	**164 days**	**Sun 7/19/09**	**Tue 12/29/09**
60	Prepare and Submit Draft Remedial Investigation Report	90 days	Sun 7/19/09	Fri 10/16/09
61	USEPA Review and Comment	30 days	Sat 10/17/09	Sun 11/15/09
62	Prepare and Submit Final Remedial Investigation Report	30 days	Mon 11/16/09	Tue 12/15/09
63	USEPA Review and Approval	14 days	Wed 12/16/09	Tue 12/29/09
64	**Development and Screening of Remedial Alternatives**	**199 days**	**Mon 1/25/10**	**Wed 8/11/10**
65	Prepare and Present Remedial Action Objectives to USEPA	30 days	Mon 1/25/10	Tue 2/23/10
66	Prepare and Submit Development and Screening of Remedial Alternatives Memorandum	30 days	Mon 1/25/10	Tue 2/23/10
67	Prepare and Submit a Memorandum on the Comparative Analysis	30 days	Wed 2/24/10	Thu 3/25/10
68	Prepare and Submit Draft Feasiblity Study (FS)	60 days	Fri 3/26/10	Mon 5/24/10
69	Prepare and Present Findings of Draft FS	14 days	Tue 5/25/10	Mon 6/7/10
70	USEPA Review and Comment	30 days	Tue 6/8/10	Wed 7/7/10
71	Prepare and Submit Revised Draft FS Report	21 days	Thu 7/8/10	Wed 7/28/10
72	USEPA Review and Approval	14 days	Thu 7/29/10	Wed 8/11/10



Project: 4354-50
Date: Thu 7/31/08

Task | Progress | Summary | External Tasks | Deadline
Split | Milestone | Project Summary | External Milestone

300050

TABLE 3.1

ANALYTICAL PARAMETERS
RTI SUPERFUND SITE
ROCKAWAY TOWNSHIP, NEW JERSEY

TCL VOCs - (V)

1,1,1-Trichloroethane
1,1,2,2-Tetrachloroethane
1,1,2-Trichloro-1,2,2-trifluoroethane
1,1,2-Trichloroethane
1,1-Dichloroethane
1,1-Dichloroethene
1,2,4-Trichlorobenzene
1,2-Dibromo-3-chloropropane
1,2-Dibromoethane
1,2-Dichlorobenzene
1,2-Dichloroethane
1,2-Dichloropropane
1,3-Dichlorobenzene
1,4-Dichlorobenzene
2-Butanone
2-Hexanone
4-Methyl-2-pentanone
Acetone
Acetonitrile
Benzene
Bromodichloromethane
Bromoform
Bromomethane
Carbon disulfide
Carbon tetrachloride
Chlorobenzene
Chloroethane
Chloroform
Chloromethane
cis-1,2-Dichloroethene
cis-1,3-Dichloropropene
Cyclohexane
Dibromochloromethane
Dichlorodifluoromethane
Ethylbenzene
Isopropylbenzene
Methyl acetate
Methyl tert-butyl ether
Methylcyclohexane
Methylene chloride
Styrene
Tetrachloroethene
Toluene
trans-1,2-Dichloroethene
trans-1,3-Dichloropropene
Trichloroethene
Trichlorofluoromethane
Vinyl chloride
Xylenes (total)

TAL Metals (M)

Aluminum
Antimony
Arsenic
Barium
Beryllium
Cadmium
Calcium
Chromium
Cobalt
Copper
Iron
Lead
Magnesium
Manganese
Mercury
Nickel
Potassium
Selenium
Silver
Sodium
Thallium
Vanadium
Zinc

Energetics (E1)

Hydrazine
Monomethyl Hydrazine (MMH)
N-nitrosodimethylamine (NDMA)
Perchlorate
Unsymmetrical Dimethyl Hydrazine (UDMH)

Energetics (E2)

Hydrazine
Monomethyl Hydrazine (MMH)
N-nitrosodimethylamine (NDMA)
Perchlorate
Unsymmetrical Dimethyl Hydrazine (UDMH)
Diethylene Triamine (DETA)

Additional Parameters - Water (W)

pH
ORP
Temperature
Conductivity
Dissolved Oxygen (DO)
Hardness

Additional Parameters - Soil (S1)

pH
Total organic carbon (TOC)

TABLE 3.1

ANALYTICAL PARAMETERS
RTI SUPERFUND SITE
ROCKAWAY TOWNSHIP, NEW JERSEY

TCL SVOCs - (SV)

Acenaphthene
Acenaphthylene
Acetophenone
Anthracene
Atrazine
Benzaldehyde
Benzo(a)anthracene
Benzo(b)fluoranthene
Benzo(k)fluoranthene
Benzo(ghi)perylene
Benzo(a)pyrene
1,1'-Biphenyl
bis(2-Chloroethoxy)methane
bis(2-Chloroethyl) ether
bis(2-Ethylhexyl) phthalate
4-Bromophenyl phenyl ether
Butyl benzyl phthalate
Caprolactam
Carbazole
4-Chloroaniline
4-Chloro-3-methylphenol
2-Chloronaphthalene
2-Chlorophenol
4-Chlorophenyl phenyl ether
Chrysene
Dibenz(a,h)anthracene
Dibenzofuran
Di-n-butyl phthalate
3,3'-Dichlorobenzidine
2,4-Dichlorophenol
Diethyl phthalate
2,4-Dimethylphenol
Dimethyl phthalate
4,6-Dinitro-2-methylphenol
2,4-Dinitrophenol
2,4-Dinitrotoluene
2,6-Dinitrotoluene
Di-n-octyl phthalate
Fluoranthene
Fluorene
Hexachlorobenzene
Hexachlorobutadiene
Hexachlorocyclopentadiene
Hexachloroethane
Indeno(1,2,3-cd)pyrene
Isophorone
2-Methylnaphthalene
2-Methylphenol
4-Methylphenol
Naphthalene
2-Nitroaniline
3-Nitroaniline
4-Nitroaniline
Nitrobenzene

TCL SVOCs (continued)

2-Nitrophenol
4-Nitrophenol
N-Nitrosodiphenylamine
N-Nitrosodi-n-propylamine
2,2'-oxybis(1-Chloropropane)
Pentachlorophenol
Phenanthrene
Phenol
Pyrene
2,4,5-Trichlorophenol
2,4,6-Trichlorophenol

Additional Parameters - Sediment (S2)

pH
TOC
Grain Size
(1)AVS-SEM:
- Sulfide
- Cadmium
- Copper
- Lead
- Mercury
- Nickel
- Zinc

Notes:
(1) Acid-Volatile Sulfide (AVS) (EPA1991) - Simultaneously Extracted Metals (SEM)

TABLE 4.1

PRELIMINARY CHEMICAL-SPECIFIC ARARS AND TBCs
RTI SUPERFUND SITE
ROCKAWAY TOWNSHIP, NEW JERSEY

Matrix	*Requirements*	*Citation*	*Description*	*ARAR or TBC*	*Comment*
Federal					
Surface Water	Ambient Water Quality Criteria Guidelines	40 CFR Part 131	Establishes toxicity based surface water quality criteria for protection of aquatic organisms and human health.	ARAR	Ambient water quality criteria are potentially applicable for surface water.
Sediment	Aquatic Sediment Guidelines (Ontario)	Guidance Criteria	Guidelines for screening contaminants in freshwater sediments	TBC	
Soil	Region 9 Preliminary Remediation Goals (PRGs)	Guidance Criteria	Guidelines for screening contaminants in soil	TBC	A screening goal intended to provide health protection without knowledge of the specific exposure conditions at a site.
Soil	OSWER Guidance for Developing Ecological Soil Screening Levels	OSWER 9285.7.55	Guidance for deriving risk based eco-SSLs for soil contaminants of ecological concern.	TBC	
Soil	OSWER Soil Screening Guidance	OSWER 9285.7.55	Guidance for developing site specific soil screening levels.	TBC	
State					
Surface Water	Surface Water Quality Standards	N.J.A.C. 7:9B	Establishes toxicity based surface water quality criteria for protection of aquatic organisms and human health.	ARAR	
Sediment	Guidance for Sediment Quality Evaluations	Guidance Criteria	Establishes sediment screening criteria and provides maximum concentrations for specified parameters.	ARAR	
Soil	Soil Cleanup Criteria	State Guidance	Establishes soil cleanup criteria and provides maximum concentrations for specified parameters.	ARAR	

TABLE 4.2

SUMMARY OF TARGET COMPUNDS AND ANALYTES - SOIL
RTI SUPERFUND SITE
ROCKAWAY TOWNSHIP, NEW JERSEY

Analyte	*CAS Number*	*Project Action Limit (mg/kg)(a)*	*Project Required Detection Limit (mg/kg)(b)*	*Project Ecological and Human Health Risk Values*		*Achievable Laboratory Limits*	
				Ecological (mg/kg)	*Human H ealth (mg/kg)*	*MDLs (mg/kg)*	*QLs (mg/kg)*
METALS INDUCTIVELY COUPLED PLASMA (SW3050A/6010B/7000 Series)							
Aluminum	7429-90-5	7600	253	pH>5.5	7,600	2.3	20
Antimony	7440-36-0	0.27	0.09	0.27	3.1	0.23	6
Barium	7440-39-3	330	110	330	540	0.15	20
Beryllium	7440-41-7	15	5	21	15	0.031	0.5
Cadmium	7440-43-9	0.36	0.12	0.36	3.7	0.023	0.5
Calcium	7440-70-2	NA	500	NA	NA	15	500
Chromium	7440-47-3	81	27	81	210	0.12	1
Cobalt	7440-48-4	13	4.3	13	900	1	5
Copper	7440-50-8	28	9.3	28	310	0.16	2.5
Iron	7439-89-6	2,300	767	pH>5.5	2,300	4.3	10
Lead	7439-92-1	11	3.7	11	400	0.23	10
Magnesium	7439-95-4	NA	500	NA	NA	2.1	500
Manganese	7439-96-5	180	60	220	180	0.31	1.5
Nickel	7440-02-0	38	12.7	38	160	0.17	4
Potassium	4770-09-7	NA	500	NA	NA	1.3	500
Selenium	7782-49-2	0.52	0.17	0.52	39	0.27	25
Silver	7440-22-4	4.2	1.4	4.2	39	0.11	1
Sodium	7440-23-5	NA	500	NA	NA	0.7	500
Vanadium	7440-62-2	7.8	2.6	7.8	55	0.11	5
Zinc	7440-66-6	46	15	46	2300	0.87	2
METALS (6020)							
Arsenic	7440-38-2	0.39	0.13	18	0.39	0.022	0.5
Thallium	7446-18-6	0.52	0.17	1	0.52	0.0021	0.1
METALS (7471A)							
Mercury(total)	7439-97-6	0.1	0.03	0.1	2.3	0.0045	0.1
VOLATILE ORGANICS (SW846-8260)							
1,1,1-Trichloroethane	71-55-6	1200	400	NSV	1200	0.00076	0.005
1,1,2,2-Tetrachloroethane	79-34-5	0.41	0.14	NSV	0.41	0.00046	0.005
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	--	0.005	NSV	NSV	0.0008	0.005
1,1,2-Trichloroethane	79-00-5	0.73	0.24	NSV	0.73	0.00032	0.005
1,1-Dichloroethane	75-34-3	51	17	NSV	51	0.00021	0.005
1,1-Dichloroethene	75-35-4	12	4	NSV	12	0.00031	0.005
1,2,4-Trichlorobenzene	120-82-1	6.2	2.1	NSV	6.2	0.00032	0.005
1,2-Dibromo-3-chloropropane	96-12-8	0.46	0.15	NSV	0.46	0.0014	0.01
1,2-Dibromoethane	106-93-4	0.0032	0.0011	NSV	0.0032	0.00037	0.005
1,2-Dichlorobenzene	95-50-1	600	200	NSV	600	0.00022	0.005
1,2-Dichloroethane	107-06-2	0.28	0.093	NSV	0.28	0.00048	0.005
1,2-Dichloropropane	78-87-5	0.34	0.11	NSV	0.34	0.00035	0.005
1,3-Dichlorobenzene	541-73-1	53	18	NSV	53	0.00026	0.005
1,4-Dichlorobenzene	106-46-7	3.4	1.1	NSV	3.4	0.00034	0.005
2-Butanone	78-93-3	--	0.02	NSV	NSV	0.001	0.02
2-Hexanone	591-78-6	--	0.005	NSV	NSV	0.00084	0.02
4-Methyl-2-Pentanone	108-10-1	--	0.02	NSV	NSV	0.00054	0.02
Acetone	67-64-1	1400	467	NSV	1400	0.0027	0.02
Acetonitrile	75-05-8	42	14	NSV	42	0.0056	0.1
Benzene	71-43-2	0.64	0.21	NSV	0.64	0.00023	0.005

TABLE 4.2

SUMMARY OF TARGET COMPUNDS AND ANALYTES - SOIL
RTI SUPERFUND SITE
ROCKAWAY TOWNSHIP, NEW JERSEY

Analyte	*CAS Number*	*Project Action Limit (mg/kg)(a)*	*Project Required Detection Limit (mg/kg)(b)*	*Project Ecological and Human Health Risk Values*		*Achievable Laboratory Limits*	
				Ecological (mg/kg)	*Human H ealth (mg/kg)*	*MDLs (mg/kg)*	*QLs (mg/kg)*
Bromodichloromethane	75-27-4	0.82	0.27	NSV	0.82	0.00048	0.005
Bromoform	75-25-2	62	21	NSV	62	0.00065	0.005
Bromomethane	74-83-9	0.39	0.13	NSV	0.39	0.00061	0.005
Carbon Disulfide	75-15-0	36	12	NSV	36	0.0002	0.005
Carbon Tetrachloride	56-23-5	0.25	0.083	NSV	0.25	0.00045	0.005
Chlorobenzene	108-90-7	15	5	NSV	15	0.00028	0.005
Chloroethane	75-00-3	3	1	NSV	3	0.00054	0.005
Chloroform	67-66-3	0.22	0.073	NSV	0.22	0.0004	0.005
Chloromethane	74-87-3	4.7	1.6	NSV	4.7	0.00025	0.005
Cis-1,2-Dichloroethene	156-59-2	4.3	1.4	NSV	4.3	0.00041	0.005
Cis-1,3-Dichloropropene	542-75-6	0.78	0.26	NSV	0.78	0.00035	0.005
Cyclohexane	110-82-7	140	47	NSV	140	0.00049	0.01
Dibromochloromethane	124-48-1	1.1	0.37	NSV	1.1	0.00036	0.005
Dichlorodifluoromethane	75-71-8	9.4	3.1	NSV	9.4	0.0004	0.005
Ethylbenzene	100-41-4	400	133	NSV	400	0.00053	0.005
Isopropylbenzene	98-82-8	--	0.005	NSV	NSV	0.00021	0.005
Methyl acetate	79-20-9	2200	733	NSV	2200	0.00077	0.01
Methyl tert-butyl ether	1634-04-4	17	6	NSV	17	0.00028	0.02
Methylcyclohexane	108-87-2	260	87	NSV	260	0.00046	0.01
Methylene Chloride	75-09-2	9.1	3	NSV	9.1	0.0013	0.005
Styrene	100-42-5	1700	567	NSV	1700	0.0002	0.005
Tetrachloroethene	127-18-4	0.48	0.16	NSV	0.48	0.00083	0.005
Toluene	108-88-3	520	173	NSV	520	0.00029	0.005
Trans-1,2-Dichloroethene	156-60-5	6.9	2.3	NSV	6.9	0.00055	0.005
Trans-1,3-Dichloropropene	542-75-6	0.78	0.26	NSV	0.78	0.00035	0.005
Trichloroethene	79-01-6	0.053	0.017	NSV	0.053	0.00083	0.005
Trichlorofluoromethane	75-69-4	39	13	NSV	39	0.00041	0.005
Vinyl Chloride	75-01-4	0.079	0.026	NSV	0.079	0.00044	0.005
Xylenes (total)	1330-20-7	27	9	NSV	27	0.00076	0.01
SEMI-VOLATILE ORGANICS (SW846-8270)							
Acenaphthene	83-32-9	29	9.7	Use LPAH	370	0.0013	0.33
Acenaphthylene	208-96-8	29	9.7	Use LPAH	370	0.0012	0.33
Acetophenone	98-86-2	--	0.0666	NSV	NSV	0.009	0.0666
Anthracene	120-12-7	29	9.7	Use LPAH	2200	0.0013	0.33
Atrazine	1912-24-9	2.2	0.73	NSV	2.2	0.021	0.33
Benzaldehyde		610	203	NSV	610	0.021	0.33
Benzo(a)anthracene	56-55-3	0.62	0.21	Use LPAH	0.62	0.00095	0.33
Benzo(b)fluoranthene	205-99-2	0.62	0.21	Use HPAH	0.62	0.0012	0.33
Benzo(k)fluoranthene	207-08-9	1.1	0.37	Use HPAH	6.2	0.0017	0.33
Benzo(ghi)perylene	191-24-2	1.1	0.37	Use HPAH	230	0.0013	0.33
Benzo(a)pyrene	50-32-8	0.062	0.021	Use HPAH	0.062	0.0013	0.33
1,1'-Biphenyl	92-52-4	300	100	NSV	300	0.023	0.33
bis(2-Chloroethoxy)methane	111-91-1	--	0.33	NSV	NSV	0.022	0.33
bis(2-Chloroethyl) ether	111-44-4	0.22	0.073	NSV	0.22	0.002	0.33
bis(2-Ethylhexyl) phthalate	117-81-7	35	12	NSV	35	0.018	0.33
4-Bromophenyl phenyl ether	101-55-3	--	0.33	NSV	NSV	0.021	0.33
Butyl benzyl phthalate	85-68-7	1200	400	NSV	1200	0.019	0.33
Caprolactam		3100	1033	NSV	3100	0.037	0.33
Carbazole	86-74-8	24	8	NSV	24	0.019	0.33
4-Chloroaniline	106-47-8	24	8	NSV	24	0.017	0.33

TABLE 4.2

SUMMARY OF TARGET COMPUNDS AND ANALYTES - SOIL
RTI SUPERFUND SITE
ROCKAWAY TOWNSHIP, NEW JERSEY

Analyte	*CAS Number*	*Project Action Limit (mg/kg)(a)*	*Project Required Detection Limit (mg/kg)(b)*	*Project Ecological and Human Health Risk Values*		*Achievable Laboratory Limits*	
				Ecological (mg/kg)	*Human H ealth (mg/kg)*	*MDLs (mg/kg)*	*QLs (mg/kg)*
4-Chloro-3-methylphenol	59-50-7	--	0.33	NSV	NSV	0.021	0.33
2-Chloronaphthalene	91-58-7	490	163	NSV	490	0.022	0.33
2-Chlorophenol	95-57-8	6.3	2.1	NSV	6.3	0.026	0.33
4-Chlorophenyl phenyl ether	7005-72-3	--	0.33	NSV	NSV	0.024	0.33
Chrysene	218-01-9	29	9.7	Use LPAH	62	0.0009	0.33
Dibenz(a,h)anthracene	53-70-3	0.062	0.021	Use HPAH	0.062	0.0013	0.33
Dibenzofuran	132-64-9	15	5	NSV	15	0.02	0.33
Di-n-butyl phthalate	84-74-2	610	203	NSV	610	0.019	0.33
3,3'-Dichlorobenzidine	91-94-1	1.1	0.37	NSV	1.1	0.018	1.6
2,4-Dichlorophenol	120-83-2	18	6	NSV	18	0.02	0.33
Diethyl phthalate	84-66-2	4900	1633	NSV	4900	0.019	0.33
2,4-Dimethylphenol	105-67-9	120	40	NSV	120	0.02	0.33
Dimethyl phthalate	131-11-3	100000	33000	NSV	100000	0.021	0.33
4,6-Dinitro-2-methylphenol	534-52-1	--	1.6	NSV	NSV	0.013	1.6
2,4-Dinitrophenol	51-28-5	12	4	NSV	12	0.083	1.6
2,4-Dinitrotoluene	121-14-2	12	4	NSV	12	0.018	0.33
2,6-Dinitrotoluene	606-20-2	6.1	2	NSV	6.1	0.021	0.33
Di-n-octyl phthalate	117-84-0	240	80	NSV	240	0.018	0.33
Fluoranthene	206-44-0	29	9.7	Use LPAH	230	0.0012	0.33
Fluorene	86-73-7	29	9.7	Use LPAH	270	0.0012	0.33
Hexachlorobenzene	118-74-1	0.3	0.1	NSV	0.3	0.0021	0.33
Hexachlorobutadiene	87-68-3	6.2	2.1	NSV	6.2	0.026	0.33
Hexachlorocyclopentadiene	77-47-4	37	12	NSV	37	0.016	1.6
Hexachloroethane	67-72-1	0.35	0.12	NSV	0.35	0.028	0.33
Indeno(1,2,3-cd)pyrene	193-39-5	1.1	0.37	Use HPAH	0.62	0.0015	0.33
Isophorone	78-59-1	510	170	NSV	510	0.021	0.33
2-Methylnaphthalene	91-57-6	29	9.7	Use LPAH	5.6	0.0015	0.33
2-Methylphenol	95-48-7	310	103	NSV	310	0.028	0.33
4-Methylphenol	106-44-5	31	10	NSV	31	0.022	0.33
Naphthalene	91-20-3	29	10	Use LPAH	5.6	0.0016	0.33
2-Nitroaniline	88-74-4	18	6	NSV	18	0.022	1.6
3-Nitroaniline	99-09-2	1.8	0.6	NSV	1.8	0.016	1.6
4-Nitroaniline	100-01-6	23	8	NSV	23	0.026	1.6
Nitrobenzene	98-95-3	2	0.7	NSV	2	0.0022	0.33
2-Nitrophenol	88-75-5	--	0.33	NSV	NSV	0.019	0.33
4-Nitrophenol	100-02-7	--	1.60	NSV	NSV	0.11	1.6
N-Nitrosodiphenylamine	86-30-6	99	33	NSV	99	0.021	0.33
N-Nitrosodi-n-propylamine	621-64-7	0.07	0.023	NSV	0.07	0.023	0.33
2,2'-oxybis(1-Chloropropane)	108-60-1	--	0.33	NSV	NSV	0.026	0.33
Phenanthrene	85-01-8	29	10	Use LPAH	5.6	0.002	0.33
Phenol	108-95-2	1800	600	NSV	1800	0.025	0.33
Pyrene	129-00-0	1.1	0.37	Use HPAH	230	0.0011	0.33
2,4,5-Trichlorophenol	95-95-4	610	203	NSV	610	0.025	0.33
2,4,6-Trichlorophenol	88-06-2	0.61	0.20	NSV	0.61	0.021	0.33
LPAH	NA	--	--	29	NA	NA	NA
HPAH	NA	--	--	1.1	NA	NA	NA

TABLE 4.2

SUMMARY OF TARGET COMPUNDS AND ANALYTES - SOIL
RTI SUPERFUND SITE
ROCKAWAY TOWNSHIP, NEW JERSEY

Analyte	*CAS Number*	*Project Action Limit (mg/kg)(a)*	*Project Required Detection Limit (mg/kg)(b)*	*Project Ecological and Human Health Risk Values*		*Achievable Laboratory Limits*	
				Ecological (mg/kg)	*Human H ealth (mg/kg)*	*MDLs (mg/kg)*	*QLs (mg/kg)*
ENERGETICS (EPA 314.0, SW846-9056/8070/8015)							
Perchlorate	7601-90-3	0.78	0.26	NSV	0.78	0.02	0.04
Hydrazine	302-01-2	0.16	0.053	NSV	0.16	0.0014	0.05
Monomethyl Hydrazine (MMH)	60-34-4	0.16	0.053	NSV	0.16	0.0032	0.05
Unsymmetrical Dimethyl Hydrazine (UDMH)	57-14-7	0.16	0.053	NSV	0.16	0.0091	0.1
N-nitrosodimethylamine (NDMA)	62-75-9	0.01	0.003	NSV	0.0095	0.013	0.03
Diethylene Triamine (DETA)		--	40.00	NSV	NSV	8	40
ADDITIONAL PARAMETERS							
pH (SW 846 9045C)	NA	NA		NA	NA	NA	NA
Total Organic Carbon (Walkley-Black)	NA	NA		NA	NA	100	100

Notes:
IDL = Instrument Detection Limit
MDL = Method Detection Limit
QL - Quantitation Limit
NSV = No Screening Value
LPAH = Light polycyclic aromatic hydrocarbons
HPAH = Heavy polycyclic aromatic hydrocarbons
NA Not applicable
-- No screening value
Human Health Project Action Limit is the Region IX Preliminary Remediation Goal (PRG) for residential soil (USEPA 2004).
1/10th the PRG is used for non-carcinogens.
Ecological Project Action Limit is from (1) Efroymson et al. (1997a), (2) RIVM (1997), (3) Efroymson et al (1997b), EcoSSL
The lower of the Human Health or Ecological Project action Limit was established as the final Project Action Limit.

TABLE 4.3

SUMMARY OF TARGET COMPUNDS AND ANALYTES - SEDIMENT
RTI SUPERFUND SITE
ROCKAWAY TOWNSHIP, NEW JERSEY

Analyte	*CAS Number*	*Project Action Limit (mg/kg)(a)*	*Project Required Detection Limit (mg/kg)(b)*	*Project Ecological and Human Health Risk Values*		*Achievable Laboratory Limits*	
				Ecological (mg/kg)	*Human H ealth (mg/kg)*	*MDLs (mg/kg)*	*QLs (mg/kg)*
METALS INDUCTIVELY COUPLED PLASMA (SW3050A/6010B/7000 Series)							
Aluminum	7429-90-5	7600	2533	26000	7,600	2.3	20
Antimony	7440-36-0	3	1	3	3.1	0.23	6
Barium	7440-39-3	48	16	48	540	0.15	20
Beryllium	7440-41-7	15	5	NSL	15	0.031	0.5
Cadmium	7440-43-9	0.99	0.33	0.99	3.7	0.023	0.5
Calcium	7440-70-2	NA	500	EN	NA	15	500
Chromium	7440-47-3	43.4	14.5	43.4	210	0.12	1
Cobalt	7440-48-4	10	3.33	10	900	0.1	5
Copper	7440-50-8	31.6	10.5	31.6	310	0.16	2.5
Iron	7439-89-6	2,300	767	EN	2,300	4.3	10
Lead	7439-92-1	35.8	12	35.8	400	0.23	0.3
Magnesium	7439-95-4	NA	500	EN	NA	2.1	500
Manganese	7439-96-5	180	60	630	180	0.31	1.5
Nickel	7440-02-0	121	40	121	160	0.17	4
Potassium	4770-09-7	NA	500	EN	NA	3.6	500
Selenium	7782-49-2	1	0.33	1	39	0.27	0.5
Silver	7440-22-4	4.5	1.5	4.5	39	0.11	1
Sodium	7440-23-5	NA	500	EN	NA	70	500
Vanadium	7440-62-2	55	18	NSL	55	0.11	5
Zinc	7440-66-6	121	40	121	2300	0.87	2
METALS (6020)							
Arsenic	7440-38-2	0.39	0.13	9.8	0.39	0.022	0.5
Thallium	7446-18-6	0.52	0.17	NSL	0.52	0.0021	0.1
METALS (7471A)							
Mercury(total)	7439-97-6	0.18	0.06	0.18	2.3	0.0045	0.1
VOLATILE ORGANICS (SW846-8260)							
1,1,1-Trichloroethane	71-55-6	1200	400	NSL	1200	0.00076	0.005
1,1,2,2-Tetrachloroethane	79-34-5	0.41	0.14	8.3	0.41	0.00046	0.005
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	--	0.005	NSL	NSL	0.0008	0.005
1,1,2-Trichloroethane	79-00-5	0.73	0.24	NSL	0.73	0.00032	0.005
1,1-Dichloroethane	75-34-3	51	17	NSL	51	0.00021	0.005
1,1-Dichloroethene	75-35-4	4.8	4	4.8	12	0.00031	0.005
1,2,4-Trichlorobenzene	120-82-1	6.2	2.1	NSL	6.2	0.00032	0.005
1,2-Dibromo-3-chloropropane	96-12-8	0.46	1.53	NSL	0.46	0.0014	0.01
1,2-Dibromoethane	106-93-4	0.032	0.011	NSL	0.0032	0.00037	0.005
1,2-Dichlorobenzene	95-50-1	600	200	NSL	600	0.00022	0.005
1,2-Dichloroethane	107-06-2	0.28	0.093	NSL	0.28	0.00048	0.005
1,2-Dichloropropane	78-87-5	0.34	0.11	NSL	0.34	0.00035	0.005
1,3-Dichlorobenzene	541-73-1	53	18	NSL	53	0.00026	0.005
1,4-Dichlorobenzene	106-46-7	3.4	1.1	NSL	3.4	0.00034	0.005
2-Butanone	78-93-3	2.9	0.02	2.9	NSL	0.001	0.02
2-Hexanone	591-78-6	--	0.005	NSL	NSL	0.00084	0.02
4-Methyl-2-Pentanone	108-10-1	--	0.02	NSL	NSL	0.00054	0.02
Acetone	67-64-1	2.3	467	2.3	1400	0.0027	0.02
Acetonitrile	75-05-8	42	14	NSL	42	0.0056	0.1
Benzene	71-43-2	0.64	0.21	NSL	0.64	0.00023	0.005
Bromodichloromethane	75-27-4	0.82	0.27	NSL	0.82	0.00048	0.005
Bromoform	75-25-2	62	21	NSL	62	0.00065	0.005
Bromomethane	74-83-9	0.39	0.13	NSL	0.39	0.00061	0.005
Carbon Disulfide	75-15-0	36	12	NSL	36	0.0002	0.005
Carbon Tetrachloride	56-23-5	0.25	0.083	NSL	0.25	0.00045	0.005
Chlorobenzene	108-90-7	15	5	NSL	15	0.00028	0.005
Chloroethane	75-00-3	3	1	NSL	3	0.00054	0.005
Chloroform	67-66-3	0.22	0.073	NSL	0.22	0.0004	0.005
Chloromethane	74-87-3	2.1	0.7	2.1	4.7	0.00025	0.005

TABLE 4.3

SUMMARY OF TARGET COMPUNDS AND ANALYTES - SEDIMENT
RTI SUPERFUND SITE
ROCKAWAY TOWNSHIP, NEW JERSEY

Analyte	*CAS Number*	*Project Action Limit (mg/kg)(a)*	*Project Required Detection Limit (mg/kg)(b)*	*Project Ecological and Human Health Risk Values*		*Achievable Laboratory Limits*	
				Ecological (mg/kg)	*Human H ealth (mg/kg)*	*MDLs (mg/kg)*	*QLs (mg/kg)*
Cis-1,2-Dichloroethene	156-59-2	4.3	1.4	NSL	4.3	0.00041	0.005
Cis-1,3-Dichloropropene	542-75-6	0.78	0.26	NSL	0.78	0.00035	0.005
Cyclohexane	110-82-7	140	47	NSL	140	0.00049	0.01
Dibromochloromethane	124-48-1	1.1	0.37	NSL	1.1	0.00036	0.005
Dichlorodifluoromethane	75-71-8	9.4	3.1	NSL	9.4	0.0004	0.005
Ethylbenzene	100-41-4	9.7	133	9.7	400	0.00053	0.005
Isopropylbenzene	98-82-8	--	0.005	NSL	NSL	0.00021	0.005
Methyl acetate	79-20-9	2200	733	NSL	2200	0.00077	0.01
Methyl tert-butyl ether	1634-04-4	17	6	NSL	17	0.00028	0.02
Methylcyclohexane	108-87-2	260	87	NSL	260	0.00046	0.01
Methylene Chloride	75-09-2	3.7	3	3.7	9.1	0.0013	0.005
Styrene	100-42-5	1700	567	NSL	1700	0.0002	0.005
Tetrachloroethene	127-18-4	0.48	0.16	8.7	0.48	0.00083	0.005
Toluene	108-88-3	8.2	173	8.2	520	0.00029	0.005
Trans-1,2-Dichloroethene	156-60-5	6.9	2.3	NSL	6.9	0.00055	0.005
Trans-1,3-Dichloropropene	542-75-6	0.78	0.26	NSL	0.78	0.00035	0.005
Trichloroethene	79-01-6	0.053	0.017	6.5	0.053	0.00083	0.005
Trichlorofluoromethane	75-69-4	27	9	NSL	39	0.00041	0.005
Vinyl Chloride	75-01-4	0.079	0.026	NSL	0.079	0.00044	0.005
Xylenes (total)	1330-20-7	9.7	3.2	9.7	27	0.00076	0.01
ENERGETICS (EPA 314.0, SW846-9056/8070/8015)							
Perchlorate	7601-90-3	0.78	0.26	NSL	0.78	0.02	0.04
Hydrazine	302-01-2	0.16	0.053	NSL	0.16	0.0014	0.05
Monomethyl Hydrazine (MMH)	60-34-4	0.16	0.053	NSL	0.16	0.0032	0.05
Unsymmetrical Dimethyl Hydrazine (UDMH)	57-14-7	0.16	0.053	NSL	0.16	0.0091	0.1
N-nitrosodimethylamine (NDMA)	62-75-9	0.0095	0.013	NSL	0.0095	0.013	0.03
Diethylene Triamine (DETA)		--	8	NSL	NSL	8	40
ADDITIONAL PARAMETERS							
pH (SW 846 9045C)	NA	NA	NA	NA	NA	NA	NA
Total Organic Carbon (Walkley-Black)	NA	NA	NA	NA	NA	100	100

Notes:
IDL = Instrument Detection Limit
MDL = Method Detection Limit
QL - Quantitation Limit
NA = Not Applicable
(a) = Based on Comparison of Human Health and Ecological Risk Values-Sediment.
(b) = Project Required Detection Limit (PRDL) = PAL/3 (if the MDL is > PRDL, the PRDL=MDL).
NSL = No Screening Value
EN = Essential Nutrient
NA Not applicable
-- No screening value

(a) Human Health Project Action Limit is the Region IX Preliminary Remediation Goal (PRG) for residential soil (USEPA 2004). 1/10th the PRG is used for non-carcinogens.

(b) Ecological Project Action Limit is from (1) Ingersoll et al. 1996, (2) Buchman 1999, (3) MacDonald et al. (2000), (4) DiToro et al (2000) assuming 1% organic carbon..

The lower of the Human Health or Ecological Project action Limit was established as the final Project Action

TABLE 4.4

SUMMARY OF TARGET COMPOUNDS AND ANALYTES - SURFACE WATER
RTI SUPERFUND SITE
ROCKAWAY TOWNSHIP, NEW JERSEY

Analyte	*CAS Number*	*Project Action Limit (ug/L)(a)*	*Project Required Detection Limit (ug/L)(b)*	*Project Ecological and Human Health Risk Values*		*Achievable Laboratory Limits*	
				Ecological (ug/L)	*Human H ealth (ug/L)*	*MDLs (ug/L/kg)*	*QLs (ug/L)*
METALS INDUCTIVELY COUPLED PLASMA (SW3050A/6010B/7000 Series)							
Aluminum	7429-90-5	3600	1200	NSL	3600(3)	52	200
Antimony	7440-36-0	12.2	4.1	12.2	12.2(1)	3.1	10
Barium	7440-39-3	4	1.3	4	2000(1)	0.82	200
Beryllium	7440-41-7	5.1	1.7	5.1	7.3(3)	0.47	5
Cadmium	7440-43-9	0.25	0.08	0.25	10 (1)	0.077	1
Calcium	7440-70-2	NA	5000	EN	NA	79	5000
Chromium	7440-47-3	11	3.7	11	160 (1)	1	5
Cobalt	7440-48-4	73	24.3	NSL	73(3)	1.1	7
Copper	7440-50-8	9	3	9	150(3)	1.8	25
Iron	7439-89-6	1,100	366	EN	1100(3)	44	100
Lead	7439-92-1	5	1.7	5.4	5(1)	2.3	3
Magnesium	7439-95-4	NA	5000	EN	NA	36	5000
Manganese	7439-96-5	80	26.7	80	100(1)	0.66	15
Nickel	7440-02-0	50	16.7	50	516(1)	2.1	40
Potassium	4770-09-7	NA	5000	EN	NA	35	5000
Selenium	7782-49-2	5	1.7	5	10(1)	0.75	5
Silver	7440-22-4	3.2	1.1	3.2	164(1)	1.1	5
Sodium	7440-23-5	NA	5000	EN	NA	260	5000
Vanadium	7440-62-2	3.6	1.2	13	3.6(3)	0.96	7
Zinc	7440-66-6	120	40	120	1100(3)	13	20
METALS (6020)							
Arsenic	7440-38-2	0.017	0.006	150	0.017(1)	0.49	5
Thallium	7446-18-6	1.7	0.57	1.7	1.7(1)	0.027	1
METALS (7470A)							
Mercury(total)	7439-97-6	0.144	0.048	0.144	0.144(1)	0.029	0.0002
VOLATILE ORGANICS (SW846-8260B)							
1,1,1-Trichloroethane	71-55-6	127	42	NSL	127(1)	0.21	1
1,1,2,2-Tetrachloroethane	79-34-5	1.72	0.57	NSL	1.72(1)	0.22	1
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	--	1	NSL	--	0.26	1
1,1,2-Trichloroethane	79-00-5	13.5	4.5	NSL	13.5(1)	0.22	1
1,1-Dichloroethane	75-34-3	81	27	NSL	81(3)	0.21	1
1,1-Dichloroethene	75-35-4	4.81	1.6	NSL	4.81(1)	0.18	1
1,2,4-Trichlorobenzene	120-82-1	30.6	10.2	NSL	30.6(1)	0.19	1
1,2-Dibromo-3-chloropropane	96-12-8	0.048	0.28	NSL	0.048(3)	0.28	2
1,2-Dibromoethane	106-93-4	0.0056	0.21	NSL	0.0056(3)	0.21	1
1,2-Dichlorobenzene	95-50-1	2520	840	NSL	2520(1)	0.2	1
1,2-Dichloroethane	107-06-2	0.291	0.16	NSL	0.291(1)	0.16	1
1,2-Dichloropropane	78-87-5	15	5	NSL	15(2)	0.15	1
1,3-Dichlorobenzene	541-73-1	2620	873	NSL	2620(1)	0.18	1
1,4-Dichlorobenzene	106-46-7	343	114	NSL	343(1)	0.22	1
2-Butanone	78-93-3	14000	4670	14000	--	0.39	10
2-Hexanone	591-78-6	--	10	NSL	--	0.35	10

TABLE 4.4

SUMMARY OF TARGET COMPOUNDS AND ANALYTES - SURFACE WATER
RTI SUPERFUND SITE
ROCKAWAY TOWNSHIP, NEW JERSEY

Analyte	*CAS Number*	*Project Action Limit (ug/L)(a)*	*Project Required Detection Limit (ug/L)(b)*	*Project Ecological and Human Health Risk Values*		*Achievable Laboratory Limits*	
				Ecological (ug/L)	*Human H ealth (ug/L)*	*MDLs (ug/L/kg)*	*QLs (ug/L)*
4-Methyl-2-Pentanone	108-10-1	--	10	NSL	--	0.32	10
Acetone	67-64-1	550	183	1500	550(3)	0.74	10
Acetonitrile	75-05-8	0.25	1.5	NSL	0.25(2)	1.5	20
Benzene	71-43-2	0.15	0.22	NSL	0.150(1)	0.22	1
Bromodichloromethane	75-27-4	0.266	0.14	NSL	0.266(1)	0.14	1
Bromoform	75-25-2	4.38	1.46	NSL	4.38(1)	0.17	1
Bromomethane	74-83-9	0.87	0.36	NSL	0.87(3)	0.36	1
Carbon Disulfide	75-15-0	0.92	0.31	0.92	100(3)	0.28	1
Carbon Tetrachloride	56-23-5	0.363	0.19	NSL	0.363(1)	0.19	1
Chlorobenzene	108-90-7	22	7.3	NSL	22(1)	0.2	1
Chloroethane	75-00-3	4.6	1.5	NSL	4.6(3)	0.24	1
Chloroform	67-66-3	5.67	1.9	28	5.67(1)	0.16	1
Chloromethane	74-87-3	16	5.3	NSL	16(3)	0.14	1
Cis-1,2-Dichloroethene	156-59-2	6.1	2	NSL	6.1(3)	0.21	1
Cis-1,3-Dichloropropene	542-75-6	0.193	0.12	NSL	0.193(1)	0.12	1
Cyclohexane	110-82-7	0.15	0.12	NSL	1000(3)	0.12	1
Dibromochloromethane	124-48-1	72.6	24.2	NSL	72.6(1)	0.19	1
Dichlorodifluoromethane	75-71-8	39	13	NSL	39(3)	0.25	1
Ethylbenzene	100-41-4	3030	1010	NSL	3030(1)	0.19	1
Isopropylbenzene	98-82-8	--	1	NSL	--	0.15	1
Methyl acetate	79-20-9	610	203	NSL	610(3)	0.52	10
Methyl tert-butyl ether	1634-04-4	6.2	2.1	NSL	6.2(3)	0.18	5
Methylcyclohexane	108-87-2	520	173	NSL	520(3)	0.5	1
Methylene Chloride	75-09-2	2.49	0.83	NSL	2.49(1)	0.19	1
Styrene	100-42-5	160	53	NSL	160(3)	0.13	1
Tetrachloroethene	127-18-4	0.388	0.19	NSL	0.388(1)	0.19	1
Toluene	108-88-3	130	43	130	7440(1)	0.17	1
Trans-1,2-Dichloroethene	156-60-5	592	197	NSL	592(1)	0.16	1
Trans-1,3-Dichloropropene	542-75-6	0.193	0.17	NSL	0.193(1)	0.17	1
Trichloroethene	79-01-6	1.09	0.36	NSL	1.09(1)	0.19	1
Trichlorofluoromethane	75-69-4	130	43	NSL	130(3)	0.16	1
Vinyl Chloride	75-01-4	0.083	0.21	NSL	0.083(1)	0.21	1
Xylenes (total)	1330-20-7	21	7	NSL	21(3)	0.44	2
ENERGETICS (EPA 314.0, SW846-9056/8070/8015)							
Perchlorate	7601-90-3	3.6	1.2	NSL	3.6(3)	2	4
Hydrazine	302-01-2	0.022	0.14	NSL	0.022(3)	0.14	10
Monomethyl Hydrazine (MMH)	60-34-4	0.022	0.31	NSL	0.022(3)	0.31	10
Unsymmetrical Dimethyl Hydrazine (UDMH)	57-14-7	0.022	0.91	NSL	0.022(3)	0.91	10
N-nitrosodimethylamine (NDMA)	62-75-9	0.0013	0.0004	NSL	0.0013(3)	0.0001	0.07
Diethylene Triamine (DETA)		--	2000	5850	--	2000	10000

TABLE 4.4

SUMMARY OF TARGET COMPOUNDS AND ANALYTES - SURFACE WATER
RTI SUPERFUND SITE
ROCKAWAY TOWNSHIP, NEW JERSEY

Analyte	*CAS Number*	*Project Action Limit (ug/L)(a)*	*Project Required Detection Limit (ug/L)(b)*	*Project Ecological and Human Health Risk Values*		*Achievable Laboratory Limits*	
				Ecological (ug/L)	*Human H ealth (ug/L)*	*MDLs (ug/L/kg)*	*QLs (ug/L)*
ADDITIONAL PARAMETERS							
Hardness (Standard Methods 2340 B-by calculation)	NA	NA	1000	NA	NA	1000	5000
pH (SW 846 9045C) done in field	NA	NA	NA	NA	NA	NA	NA

Notes:
IDL = Instrument Detection Limit
MDL = Method Detection Limit
QL = Quantitation Limit
NSL = No Screening Value
EN = Essential Nutrient
NA = Not Applicable
(a) = Based on Comparison of Human Health and Ecological Risk Values-Sediment.
(b) = Project Required Detection Limit (PRDL) = PAL/3 (if the MDL is > PRDL, the PRDL=MDL).
Human Health Project Action Limit is from:
(1) NJDEP 2004,
(2) EPA 2002
(3) Region IX Preliminary Remediation Goal (PRG) for residential tap water: 1/10th for non-carcinogens. (USEPA 2004).

TABLE 7.1

SAMPLING METHODOLOGY
RTI SUPERFUND SITE
ROCKAWAY TOWNSHIP, NEW JERSEY

Approximate Overburden Thickness (ft)	*Sample Location*	*Number of Samples*
< 2	Surface soil. Surface soil samples will be collected from 0 to 1 foot below ground surface.	1
>2 and < 6	Surface soil. Water table interface, if no water is present, the sample will be collected from the mid-depth of the borehole.	2
> 6	Surface soil. Water table interface, if no water is present, the sample will be collected from the mid-depth of the borehole. Bedrock interface.	3

Notes:

1. Soil borings will be advanced to top of bedrock or to the soil/water interface, whichever is encountered first.
2. Sample locations may be adjusted based on field observation of contamination, if present.

TABLE 7.2

SAMPLING RATIONALE - RTI AREA
RTI SUPERFUND SITE
ROCKAWAY TOWNSHIP, NEW JERSEY

Sample ID	*Analytes*	*Rationale for Locations*	*Approximate Overburden Thickness (ft)*	*Approximate Number of Samples*
TPS-1 through TPS-7	V, M, E1, S1[(1)]	These will provide information on potential impacts to soil due to the disposal of drums in this area. Lack of accessability to this area due to the drums remaining, may limit the number and location of samples installed in this area.	17-20	7
SS-64, SS-65	V, M, E1, S1[(1)]	These surface soil samples will provide information on potential impacts due to the former operation of the secondary waste disposal area, detonation bunker and burning pads which were located northeast of this area. Sample interval to be 12 to 16 inches below ground surface, if possible.	NA	2
			Total	9

Notes:

Refer to Table 3.1 for complete analyte list
[(1)] S1 - Surface soil sample only
V: VOC
M: Metals
E1: Energetics
S1: Additional Parameters - Soil

TABLE 7.3

SAMPLING RATIONALE - P-2 AREA
RTI SUPERFUND SITE
ROCKAWAY TOWNSHIP, NEW JERSEY

Sample ID	*Analytes*	*Rationale for Sample Locations*	*Approximate Overburden Thickness (ft)*	*Approximate Number of Samples*
SB-50	V, M, E1, S1[(1)]	This boring will provide information on potential impacts to soil due to operations associated with building R-34 which was used as a machine shop and for diesel engine assembly.	6	2
SB-52	V, M, S1[(1)]	This boring will provide information on potential impacts to soil due to the operation of a 500 gallon fuel oil storage tank located in the southwest area of building R-34.	6	2
SS-50, SS-51, SS-52, SS-53	V, M, E2, S1[(1)]	These surface soil samples will provide information on potential impacts to soil due to operations associated with building R-47 which was used for filling and loading packaged liquid propellant powerplants.	1.5	4
SS-54, SS-55	E2, S1[(1)]	These surface soil samples will provide information on potential impacts to soil due to the operation of a former 4,000 gallon mixed amine fuel (MAF) AST.	1.5	2
SS-56, SS-57	V, M, S1[(1)]	These surface soil samples will provide information on potential impacts to soil due to operations associated with the former paint locker area.	1.5	2

TABLE 7.3

SAMPLING RATIONALE - P-2 AREA
RTI SUPERFUND SITE
ROCKAWAY TOWNSHIP, NEW JERSEY

Sample ID	*Analytes*	*Rationale for Sample Locations*	*Approximate Overburden Thickness (ft)*	*Approximate Number of Samples*
SS-58, SS-59, SS-60, SS-61	V, M, E1, S1[(1)]	These surface soil samples will provide information on potential impacts to soil due to operations associated with the former drum storage area located on the west and west/northwest side of R-47.	1.5	4
SS-62, SS-63	M, E1, S1[(1)]	These surface soil samples will provide additional information on potential impacts to soil due to operations associated the igniter storage bunker.	1.5	2
SB-92, SB-93, SB-94	V, M, E1, S1[(1)]	These surface soil samples will provide additional information on potential impacts to soil associated with an area formerly used for outdoor storage as identified by Acres.	12	9
			Total	27

Notes:

Refer to Table 3.1 for complete analyte list
[(1)] S1 - Surface soil sample only
V: VOC
M: Metals
E1: Energetics
E2: Energetics - Modified
S1: Additional Parameters - Soil

TABLE 7.4

SAMPLING RATIONALE - EAST STAND AREA
RTI SUPERFUND SITE
ROCKAWAY TOWNSHIP, NEW JERSEY

Sample ID	*Analytes*	*Rationale for Proposed Sample Locations*	*Approximate Overburden Thickness (ft)*	*Approximate Number of Samples*
SB-89, SB-77, SB-78	V, M, E2, S1[(1)]	These borings will provide information on potential impacts to soil due to the operation of test stand R-3 and associated scrubber building. The scrubber building was designed to clean exhaust gases from test firings of rocket motors.	5.6	6
SB-79, SB-80	V, M, E1, S1[(1)]	These borings will provide information on potential impacts to soil due to the operation of the former sewage treatment unit. Boring SB-79 is located in the area of the the former sewage treatment unit. Boring SB-80 is located in the vicinity of the former sewage treatment discharge area.	5.6	4
SB-81, SB-82, SB-83	M, E1, S1[(1)]	These borings will provide information on potential impacts to soil due to the operation test stand R-4. Test stand R-4 was used for testing of developmental engines which used mixed hydrazine and nitrogen tetroxide.	5.6	6
SB-84	V, M, E1, S1[(1)]	This boring will provide information on potential impacts to soil due to the operation of test stand R-2. The boring will be installed a minimum of 30 feet southwest of R-2, outside the area of previous remedial action.	5.6	2
SB-85, SB-86	V, M, E2, S1[(1)]	These borings will provide information on potential impacts due to runoff and/or discharges associated with the R-3 lagoon which received discharge from the scrubber associated with Test Stand R-3.	10	6

TABLE 7.4

SAMPLING RATIONALE - EAST STAND AREA
RTI SUPERFUND SITE
ROCKAWAY TOWNSHIP, NEW JERSEY

Sample ID	*Analytes*	*Rationale for Proposed Sample Locations*	*Approximate Overburden Thickness (ft)*	*Approximate Number of Samples*
SB-87	V, M, S1[(1)]	This boring will provide information on potential impacts to soil due to the operation of a former AST TR-2 located south of R-21 which was reportedly used to store fuel oil.	5	2
SB-88	V, M, S1[(1)]	This boring will provide information on potential impacts to soil due to the operation of an AST located south of building R-51 which was used to store fuel oil.	5	2
SB-91	V, M, S1[(1)]	This boring will provide information on potential impact to soil due to the operation of former ASTs located in front of building R-33.	1	1
T-51	V, M, pH	This tank sample will provide information on the contents of the AST located south of building R-51.	NA	1
			Total	30

Notes:

Refer to Table 3.1 for complete analyte list
[(1)] S1 - Surface soil sample only
V: VOC
M: Metals
E1: Energetics
E2: Energetics - Modified
S1: Additional Parameters - Soil

TABLE 7.5

SAMPLING RATIONALE - SOUTH STAND AREA
RTI SUPERFUND SITE
ROCKAWAY TOWNSHIP, NEW JERSEY

Sample ID	*Analytes*	*Rationale for Sample Locations*	*Approximate Overburden Thickness (ft)*	*Approximate Number of Samples*
SB-57, SB-58	M, E1, S1[(1)]	These borings will provide information on potential impacts to soil due the operation of two former bunkers used for the storage of solid propellant.	14-15	6
SB-59	V, M, E1, S1[(1)]	This boring will provide information on potential impacts to soil due to the operation of the former sewage treatment unit.	10	3
SB-60, SB-61	V, M, E1, S1[(1)]	These borings will provide information on potential impacts to soil due to operations associated with former S-48 area. The S-48 area was reportedly used for storage.	2.8	4
SB-62, SB-63	V, M, E1, S1[(1)]	These borings will provide information on potential impacts to soil due to operations associated with building S-46. Building S-46 was reportedly used as a boiler house, office and pump assembly facility.	3-5.5	4
SB-64	V, M, S1[(1)]	This boring will provide information on potential impacts to soil due to the operation of former storage tank TS-1 and operations associated with building S-46. Tank TS-1 was reportedly used for heating oil storage.	3-5.5	2

TABLE 7.5

SAMPLING RATIONALE - SOUTH STAND AREA
RTI SUPERFUND SITE
ROCKAWAY TOWNSHIP, NEW JERSEY

Sample ID	*Analytes*	*Rationale for Sample Locations*	*Approximate Overburden Thickness (ft)*	*Approximate Number of Samples*
SB-65, SB-74, SB-75, SB-76	V, M, E1, S1[(1)]	These borings will provide information on potential impacts to soil due to operation of S-37 which was formerly used for solid motor mixing and casting. Borings SB-65 and SB-75 will be installed a minimum of 15 feet southwest of S-37, outside the area of previous remedial action.	9	12
SB-66	V, E1, S1[(1)]	This boring will provide information on potential impacts to soil due to the operation of the former flammable liquid storage area.	5.5	2
SB-67	V, M, E1, S1[(1)]	This boring will provide information on potential impacts to soil due to operations associated with test stand S-49 and the former igniter storage bunker.	3.2	2
SB-68, SB-69	V, M, E1, S1[(1)]	These borings will provide information on potential impacts to soil due to the operation of former storage tank SI-4 and/or the operations associated with test stand S-49. Tank SI-4 may have been used to accept exhaust from the firing of small motors with beryllium-containing propellants.	5	4
SB-70	V, SV, M, E1, S1[(1)]	This boring will provide information on potential impacts to soil due to operations associated with test stand S-49 and the AST currently located between S-46 and test stand S-49. The SB-70 boring location will be adjusted depending on the location of the AST located between S-46 and S-49.	3.2	2

TABLE 7.5

SAMPLING RATIONALE - SOUTH STAND AREA
RTI SUPERFUND SITE
ROCKAWAY TOWNSHIP, NEW JERSEY

Sample ID	*Analytes*	*Rationale for Sample Locations*	*Approximate Overburden Thickness (ft)*	*Approximate Number of Samples*
T-50	V, M, E1, pH	This tank sample will provide information on the contents of the AST located between S-46 and S-49.	NA	1
SB-71, SB-72	V, M, E2, S1[(1)]	These borings will provide information on potential impacts to soil due to the operation of test stand S-12	6-10	6
SB-73, SB-90	V, SV, M, E1, S1[(1)]	This boring will provide information on potential impacts to soil due to the operation of test stand S-11.	5.5	4
			Total	52

Notes:

Refer to Table 3.1 for complete analyte list
[(1)] S1 - Surface soil sample only
V: VOC
SV: SVOCs
M: Metals
E1: Energetics
E2: Energetics - Modified
S1: Additional Parameters - Soil

TABLE 7.6

SAMPLING RATIONALE - SURFACE WATER/SEDIMENT
RTI SUPERFUND SITE
ROCKAWAY TOWNSHIP, NEW JERSEY

Sample ID	*Analytes*	*Rationale for Sample Locations*	*Approximate Overburden Thickness (ft)*	*Approximate Number of Samples* [1]
SW-51/SD-51, SW-52/SD-52, SW-53/SD-53, SW-54/SD-54	V, M, E1, W, S2	These sediment and/or surface water samples will provide information on potential impacts due to runoff and/or discharges associated with the East and South Stand Areas.	NA	8
SW-55/SD-55, SW-56/SD-56	V, M, E1, W, S2	These sediment and/or surface water samples will provide information on potential impacts due to runoff and/or discharges associated with upgradient lagoon R-2 and the East Stand Area.	NA	4
SW-57/SD-57, SW-58/SD-58	V, M, E1, W, S2	These sediment and/or surface water samples will provide information on potential impacts due to runoff and/or discharges associated with the R-2 lagoon which received treated sewage discharge from the former sewage treatment unit located north of Test Stand R-3.	NA	4
SW-59/SD-59	V, M, E1, W, S2	This sediment and/or surface water sample will provide information on potential impacts due to runoff and/or discharges associated with lagoon R-1 and the East Stand Area.	NA	2
SW-60/SD-60	V, M, E1, W, S2	This sediment and/or surface water sample will provide information on potential impacts due to runoff and/or discharges associated with upgradient lagoon R-1 and the East Stand Area.	NA	2
SW-61/SD-61	V, M, E1, W, S2	This sediment and/or surface water sample will provide information on potential impacts due to runoff and/or discharges associated with the South Stand Area.	NA	2
			Total	22

Notes:

Refer to Table 3.1 for complete analyte list
V: VOC
M: Metals
E1: Energetics
W: Additional Parameters - Water
S2: Additional Parameters - Sediment

APPENDIX A

SITE BACKGROUND (ACRES, SEPTEMBER 1991)

2 - SITE BACKGROUND AND REMEDIAL INVESTIGATION SUMMARY

2.1 - Property Ownership and Use

The RTI study area consists of 263 acres of land, which includes the 15-acre RTI site, the former RIP, and adjacent undeveloped land. All 263 acres are owned by RTI.

The chronology of ownership is (Ref. 2):

- Prior to 1941, Singer Manufacturing Co.;
- 1941 to 1963, Reaction Motors, Inc.;
- 1963 to 1972 and 1978, Reaction Motors Division of Thiokol Chemical Corp; and
- 1972 and 1978 to Present, RTI, Inc.

Beginning in 1978, RTI leased portions of the RIP to two companies. Hazards Research Corporation (HRC) rented approximately 2 to 3 acres until April 1986. HRC's operations were generally concentrated near Building S-46 (see Plate 2.1). Image Boat Company rented approximately 2 acres near Building R-47 until 1984 (Ref. 2).

2.2 - Site Background

Prior to 1941, the 263-acre study area was owned by the Singer Manufacturing Company. Reaction Motors, Inc. purchased the property in 1941 and, in approximately 1947, began the construction of facilities to support rocket engine and component testing programs. Reaction Motors, Inc. was acquired by a corporate predecessor to the Olin Corporation in 1953 and thereafter by Thiokol Chemical Corporation (Thiokol) in 1958. In 1964, Reaction Motors was formally combined with Thiokol and became a separate working division within the company.

Reaction Motors/Thiokol conducted research and development testing of rocket engines and related components, rocket engine fill and load activities, and other relatively small scale research and development programs of

non-aerospace products on 80 acres of the study area comprised of the 15-acre RTI site and the 65-acre former Rockaway Industrial Park. Construction and development was divided into two distinct areas, the "R-Area" and the "S-Area" (Ref. 3). Each is shown on Plate 2.1.

The "R-Area" was developed during the 1950s and 1960s and was utilized for:

- Testing of rocket engines and engine system components;
- Propellant loading and partial assembly of rocket engines;
- Chemical steam generation;
- Research and development on diesel engine design;
- Machine shop related activities; and
- Engineering and administrative offices.

Major facilities and structures of this area are shown on Plate 2.1. Their known uses are summarized below (Ref. 3-4).

Test Stand R-2 was built in the late 1950s and used for test firing a variety of rocket engines, with a majority of the testing conducted on the LR-99 and X-15 engines. Ammonia, JP fuel (kerosene based), and liquid oxygen were used as propellants. Hydrogen peroxide was also used to drive turbine pumps for the LR-99 engine.

Test Stand R-3 was built in the 1960s to test systems which used fluorinated oxidizers (primarily chlorine trifluoride). This stand was reportedly used for testing a propellant expulsion system for the Lance Missile in which hydrazine-type fuels were used with fluorinated oxidizers. The stand included an 83-ft long, one story structure known as a "scrubber" which was designed to clean exhaust gases from the tests by injecting a caustic solution (NaOH) through various orifices positioned around the exhaust jet. Water for the scrubber was supplied from a 124-ft high, 100,000-gallon tower on site. Treated scrubber discharge was directed, via a flume, into an adjacent lagoon (lagoon R-3).

Test Stand R-4 was an enclosed facility which was built in the mid-1960s for simulated high altitude testing. It possessed single and multiple

engine testing capability, and was reportedly used to test a developmental engine which used mixed hydrazine and nitrogen tetroxide propellants.

Building R-21 served as an instrumentation center.

Building R-34 was used during the 1960s on a program for developing a novel design diesel engine. This facility included a machine shop, engine testing area, and support offices.

Building R-47 housed a production facility used for filling and loading of packaged liquid propellant power plants for LR-62 Bullpup B rocket engines. Mixed amine fuel and red fuming nitric acid were used as propellants. The facility was operated for 2 to 3 years during the mid-1960s.

Building R-50 was used as engineering offices to support the site testing activities.

Building R-51 housed a chemical steam generating facility used for operating ejectors in Test Stand R-4.

Building R-60 housed a machine shop and warehouse.

Numerous ancillary structures were situated throughout the "R-Area" and included treatment facilities, storage tanks and bunkers, lagoons, burning and detonation pads, and secondary waste disposal areas (Ref. 5-7). Sewage treatment facilities are believed to have been operated near Buildings R-21 (No. 2 sewage treatment unit) and R-47. Lagoons R-1, R-2 and R-3 were constructed west of the "R-Area" test stands and were designed to receive direct and treated effluent from operations on the test stands and from the No. 2 sewage treatment unit. Reaction Motors/Thiokol also maintained a drum storage area immediately west of Building R-47.

The 15-acre RTI site is situated within the former "R-Area" where, in addition to Buildings R-50 and R-60, Reaction Motors/Thiokol performed pyrotechnical flame testing, burning, and detonation on surface pads (Ref. 5). The surface pads were also reportedly used for disposal of fuels

and explosive materials which were occasionally brought to ignition temperatures by using alcohol (Ref. 3). Portions of this 15-acre area were also used by Reaction Motors/Thiokol for secondary waste disposal (Ref. 5).

The "S-Area" was developed during the 1960s and utilized by Reaction Motors/Thiokol as described below (Ref. 3-4).

- Testing and development of prototype rocket engines, propellants, and a high capacity steam generation system;
- Quality control firing of packaged liquid fuel rocket engines;
- Solid fuel grain preparation and storage; and
- Research for the manufacture of synthetic rubber materials.

This area also included a packaged sewage treatment facility.

Major facilities and structures of this area are shown on Plate 2.1. Their known uses are summarized below:

Test stands S-11 and S-12 were used for rocket engine and component test firing.

Building S-37 was used for preparation of solid rocket fuel grains and pilot plant operation in which ammonium perchlorate, hydrazinium diper chlorate, and decaborane formulations were used. The building included fuel preparation bays, a machine shop and support rooms.

Small research and development programs were also performed which involved the use of nitrate explosives such as nitrocellulose and nitroglycerine. Other programs involved small quantities of mainly flammable or explosive oxidizers. Residual materials of these substances were typically disposed of by burning or detonation in a designated area.

A research and development program for manufacture of synthetic rubber materials was also conducted at Building S-37. The following chemicals are believed to have been used for this program: trifluoronitroso methane, tetrafluoroethylene, nitrosoperfluoro butyric acid, poly tetrafluoro

ethylene-trifluoro nitroso methane carboxylic acid, Freon 113 (1,1,2-trichloro-1,2,2,-trifluoroethane), trifluoromethyl hypofluorite, tetrafluoroethyl ethyl ether, trifluoroacetic acid, poly tetrafluoro ethylene-trifluoronitroso methane, trifluoroacetic acid anhydride, methyl nitrite and perfluoro succinic anhydride.

Building S-46 served as a boiler house, office, data acquisition facility, and assembly area for ancillary equipment used in experimental programs.

Test Stand S-49 was used for firing small motors with propellants containing beryllium under simulated vacuum conditions.

A packaged sewage treatment plant (No. 1 sewage treatment plant) was situated near buildings S-11 and S-37 (Ref. 5-7). Discharge from this plant flowed into a pond at the south end of the "S-Area".

The use of chlorinated cleaning agents by Reaction Motors/Thiokol has been alleged by RTI based on personal interviews with former Reaction Motors/Thiokol employees (Ref. 8). These chlorinated agents include:

- trichloroethylene - used as a cleaner and degreaser;

- carbon tetrachloride - used to flush out oxidant lines prior to 1955;

- trichlorofluoromethane - used to flush out oxidant lines; and

- "Precision Cleaning Agent" - a NASA and military specified chlorfluoroethane cleaning agent used for cleaning critical metal parts. This chemical was reportedly used by Reaction Motors/Thiokol throughout the 1960s.

Trichloroethane was commonly used during this time period as a cleaning solvent by Reaction Motors/Thiokol at their local research, development and manufacturing facilities in Denville, New Jersey (Ref. 9).

Freon was reportedly used in the study area as a leak testing agent for some rocket engines and propellant system components (Ref. 4).

During Reaction Motors/Thiokol's operation of the site, three professionals were reportedly used to perform waste handling services (Ref. 3). The names and locations of these individuals are currently unknown.

Reaction Motors/Thiokol operated the site until 1969 and officially closed it in 1970 (Ref. 3). RTI leased a 15-acre portion of the site from Thiokol during 1970 to 1972 (Ref. 10-11), and subsequently purchased it in 1972. RTI purchased the additional 248 acres of the property from Thiokol in 1978 (Ref. 12).

Beginning in 1978, RTI leased portions of the former RIP to two companies. Hazards Research Corporation (HRC) rented approximately 2 to 3 acres near Building S-46 from 1969 until 1986. HRC conducted research on the flammability and explosive properties of various materials. Image Boat Company rented approximately 2 acres adjacent to and including Building R-47 until 1984. Their activity on site involved the manufacture of fiberglass boat shells (Ref. 10). There are also allegations that Kronenberg Industries and the Walter Kiddee Company utilized portions of the RIP (Ref. 3).

Since 1970, RTI has been principally involved in three different manufacturing and production activities at their Rockaway facility. These activities were associated with radiation sterilization, production of architectural products, and production and finishing of hardwood flooring. A list of RTI's manufacturing and production activities is presented in Table 2.1.

The third activity noted in Table 2.1, the production and finishing of Radwood, involved a two-step impregnation and irradiation process. The manufacturing of Radwood (no longer performed at the site) involved the use of methyl methacrylate (MMA) and certain resin dyes. Wood products were soaked in these chemical compounds in a pressurized stainless steel vessel and then irradiated to form the final Radwood product. Cobalt 60 was used as the irradiation source.

The waste material from the Radwood production process was known as "heels" and consisted of methylene chloride, MMA, resin dyes, and water. This waste was periodically emptied from the steel vessel and dumped into 55-gallon drums for later recycling and disposal. Prior to June 1981, the waste heels were spread on polyethylene liners in the presence of sunlight to facilitate the polymerization of the MMA. From June 1981 until May 1985, waste material generated by the Radwood process was converted to a solid by either adsorption on vermiculite and/or air curing in lined and unlined troughs.

Based on site evidence and observations documented by NJDEP and the Rockaway Township Health Department, NJDEP reported that heels of Radwood waste material were dumped and spread out on the ground surface in portions of the RTI site. NJDEP also reported that waste heels were buried in 55-gallon drums in different portions of the site (Ref. 1, 13-16).

2.3 - Previous Site Investigations

Numerous inspections and investigations have led to the performance of this RI. Appendix H contains a chronological list of these inspections and activities during the period from 1980 to 1986. A summary of the chronology is presented in this section.

During the period November 1980 to May 1981, NJDEP and the Rockaway Township Health Department conducted various inspections of the RTI site. NJDEP also conducted investigations into the chemical types and quantities, waste disposal practices, and chemical waste characteristics associated with the various production and manufacturing processes utilized at the site.

In March 1981, the Rockaway Township Health Department informed NJDEP that as a result of taste and odor complaints received from some RTI employees, it had tested the two principal water supply wells on the site (P-2 and P-6). Both wells were found to be contaminated with volatile organic chemicals, and in June 1981 were condemned by the Health Department (Ref. 17).

TABLE 2.1

RADIATION TECHNOLOGY INC. RI/FS
LIST OF MANUFACTURING AND PRODUCTION ACTIVITIES
PERFORMED BY RTI AT THE ROCKAWAY FACILITY

1) Radiation sterilization of food, medical, and industrial products.*

2) A line of architectural and construction products, which include:

- Radgrout - Road and industrial concrete repair material;
- Radlag - Acoustical coating;
- Radseal - Concrete joint sealant;
- J-27 - Freezer floor patch;
- Radguard - Permanent water proofing/sealing compound;
- Radstripe - A product for striping high traffic areas and game lines;
- Radgripp - Skid resistant surface coating;
- Radfast - Instant fasteners; and
- Radcryl - Concrete additive.

3) Production and finishing of hardwood flooring (Radwood).

*Note: Radiation sterilization is the only production activity currently being performed at the RTI site.

APPENDIX B

FLORA AND FAUNA (ACRES, SEPTEMBER 1991)/SUPPLEMENTAL HABITAT AND SPECIES CHARACTERIZATION (TRC ENVIRONMENTAL CORPORATION, JULY 1993)

FLORA AND FAUNA
(ACRES, SEPTEMBER 1991)

about 70 percent of the total iron-ore produced in the state of New Jersey. During the early 1700s to 1950, the district yielded in excess of 26 million tons of iron ore valued at more than $100 million (Ref. 27).

The ore is produced from magnetite-rich skarn, gneiss, and granite associated with Precambrian gneisses and granites. At this time, almost all iron-ore mining operations in the Dover district have ceased.

3.9 - Flora and Fauna

The RTI site basically contains eight habitat categories consisting of three wetland and five upland cover types. Wetland cover types include forested, scrub-shrub and emergent wetlands. Mixed forest, deciduous forest, evergreen, industrial and other built up land comprise the upland categories. A list of vegetation identified in the project boundaries is presented in Table 3.1. Generalized vegetative cover types within the RTI study area are shown on Figure 3.6.

The project area contains a mixture of habitats which provide for a variety of wildlife. Birds, mammals and amphibians observed in the study area are presented in Table 3.1. Fifteen species of birds were observed including wild turkey, ring-necked pheasant, pileated woodpecker, northern cardinal and red-tailed hawk. Four species of mammals observed in the study area were white-tailed deer, grey squirrel, eastern chipmunk, and eastern cottontail rabbit. Only one amphibian, the leopard frog, was observed at the project site.

All the wetland areas are located to the east of Lake Denmark Road except for three emergent wetlands at the southern and western portion of the project bordering Lake Denmark. These sites were dominated by cattail, woolgrass, common reed and reed canary grass. Some fragrant water-lily was also observed in the emergent wetlands. Scrub-shrub wetland areas were mainly comprised of silky dogwood, mountain laurel, spice bush and poison ivy. Species commonly found in the forested wetlands include pin oak, American elm, green ash and black willow.

The upland areas include deciduous forest, mixed forest and evergreen stands. Deciduous forests were found throughout the project site. Two forest types, Oak-Hickory and Beech-Maple, were identified within the deciduous forests. The Oak-Hickory forest is identified by the presence of White Oak, Red Oak, Scarlet Oak, Chestnut Oak and Shagbark Hickory. Other species observed in this association which are associated with highly mezic areas are the Tulip Tree, American Elm, and Red Maple. In the Beech-Maple forest, American Beech and Sugar Maple are the dominant species, however, White Ash, Tulip Tree, White Oak and Eastern Hemlock are also common in this association. The mixed forest located in the northern portion of the site just west of Lake Denmark Road included species such as Eastern Hemlock, Yellow Birch, Black Cherry, American Hornbeam, Cottonwood and Sycamore. The herbaceous layer in both the deciduous and mixed forests contained species such as Sensitive Fern, Goldenrod, Queen Annes Lace and Christmas Fern. An evergreen stand is located on the eastern edge of the site and consists entirely of Eastern Hemlock.

The industrial areas within the project boundaries are composed of the former RIP facilities, roadways and parking lots located east of Lake Denmark Road and RTI buildings, roadways and parking areas located west of Lake Denmark Road. The category of other built-up areas includes roadways not included in the above, transmission corridors and debris piles located on the site.

TABLE 3.1

RADIATION TECHNOLOGY INC. RI/FS
VEGETATION AND WILDLIFE OBSERVED DURING
NOVEMBER - DECEMBER 1989

Vegetation

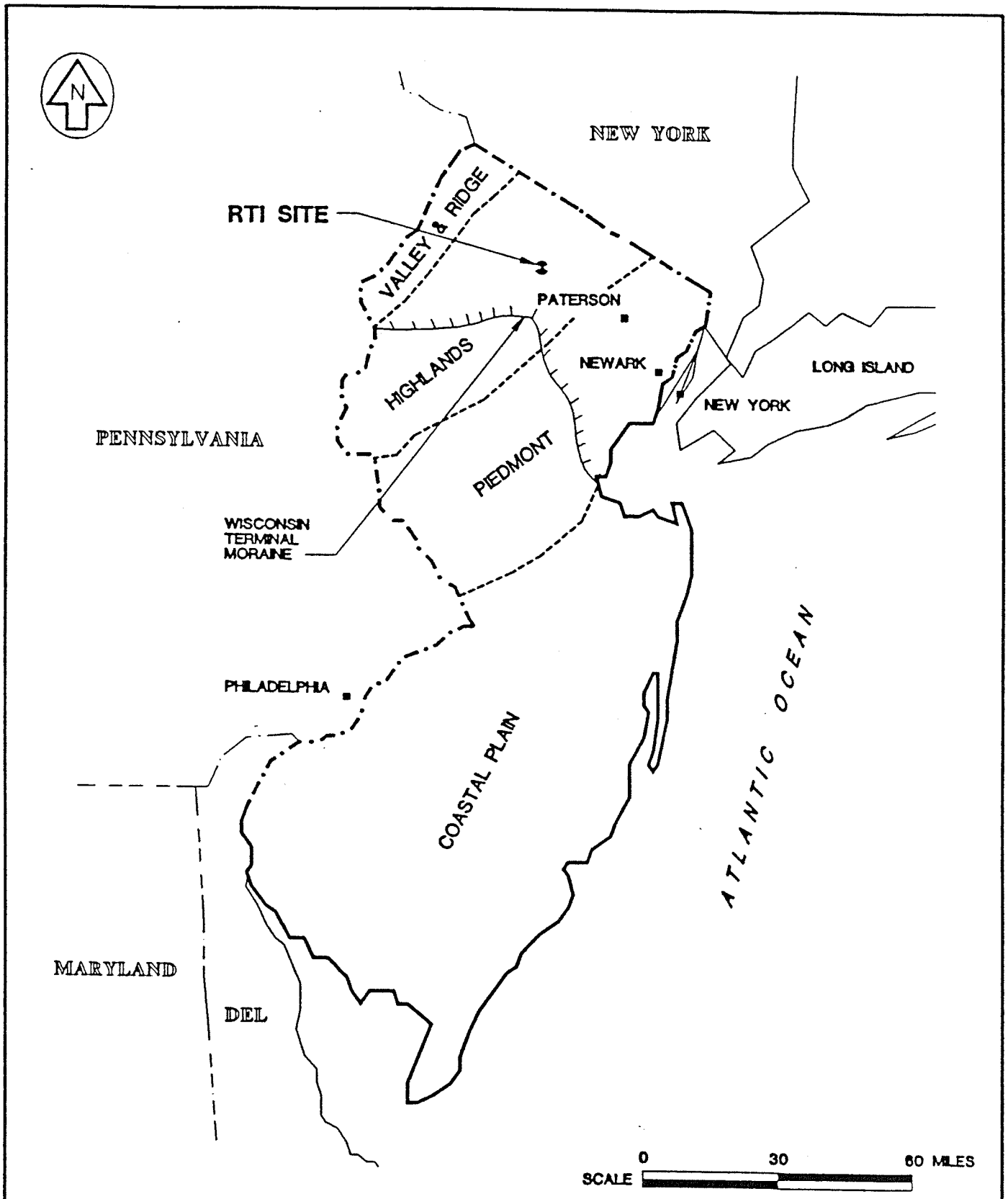
Common Name	Scientific Name
Trees	
Eastern Hemlock	*Tsuga canadensis*
Red Cedar	*Juniperus virginiana*
White Oak	*Quercus alba*
Red Oak	*Quercus rubra*
Pin Oak	*Quercus palustris*
Chestnut Oak	*Quercus prinus*
Scarlet Oak	*Quercus coccinea*
Yellow Birch	*Betula lutea*
Gray Birch	*Betula populifolia*
Black Birch	*Betula lenta*
American Elm	*Ulmus americana*
Black Cherry	*Prunus serotina*
Red Maple	*Acer rubrum*
Sugar Maple	*Acer saccharum*
White Ash	*Fraxinus americana*
Green Ash	*Fraxinus pennsylvanica*
Tulip Tree	*Liriodendron tulipifera*
American Hornbeam	*Caprinus caroliniana*
Hop Hornbeam	*Ostrya virginiana*
Shagbark Hickory	*Carya ovata*
Cottonwood	*Populus deltoides*
Trembling Aspen	*Populus tremuloides*
American Beech	*Fagus grandifolia*
Black Willow	*Salix nigra*
Black Locust	*Robinia pseudo-acacia*
Sycamore	*Platanus occidentalis*
Shrubs and Vines	
Staghorn Sumac	*Rhus typhina*
Spicebush	*Lindera benzoin*
Mountain Laurel	*Kalmia latifolia*
Silky Dogwood	*Cornus amomum*
Poison Ivy	*Rhus radicans*
Grape	*Vitis* sp.
Raspberry	*Rubus* sp.
Greenbrier	*Smilax* sp.
Multifloral Rose	*Rosa multiflora*

TABLE 3.1

RADIATION TECHNOLOGY INC. RI/FS
VEGETATION AND WILDLIFE OBSERVED DURING
NOVEMBER - DECEMBER 1989
(Cont'd)

Common Name	Scientific Name
Herbaceous	
Goldenrod	*Solidago* sp.
Common Mullein	*Verbascum thapsus*
Evening Primrose	*Oenothera biennis*
Common Milkweed	*Asclepias syriaca*
Queen Annes Lace	*Daucus carota*
Christmas Fern	*Polystichum acrostichoides*
Sensitive Fern	*Onoclea sensibilis*
Cattail	*Typha* sp.
Woolgrass	*Scirpus cyperinus*
Common Reed	*Phragmites australis*
Reed Canary Grass	*Phalaris arundinacea*
Foxtail	*Alopecurus* sp.
Fragrant Waterlily	*Nymphaea odorata*
Wildlife	
Birds	
Wild Turkey	*Meleagris gallopavo*
Ring-necked Pheasant	*Phasianus colchicus*
American Crow	*Corvus brachyrhynchos*
Pileated Woodpecker	*Dryocopus pileatus*
Downy Woodpecker	*Picoides pubescens*
Black Capped Chickadee	*Parus atricapillus*
Tufted Titmouse	*Parus bicolor*
Ruby Crowned Kinglet	*Regulus calendula*
Blue Jay	*Cyanocitta cristata*
Song Sparrow	*Melospiza melodia*
Dark-eyed Junco	*Junco hyemalis*
Northern Cardinal	*Cardinalis cardinalis*
Ruffed Grouse	*Bonasa umbellus*
Turkey Vulture	*Cathartes aura*
Red-tailed Hawk	*Buteo jamaicensis*
Mammals	
White-tailed deer	*Odocoiceus virginianus*
Gray Squirrel	*Sciurus carolinensis*
Eastern Cottontail	*Sylvilagus floridanus*
Eastern Chipmunk	*Tamias striatus*
Reptile-Amphibians	
Leopard Frog	*Rana pipiens*

DRG024



RADIATION TECHOLOGY INC. RI/FS

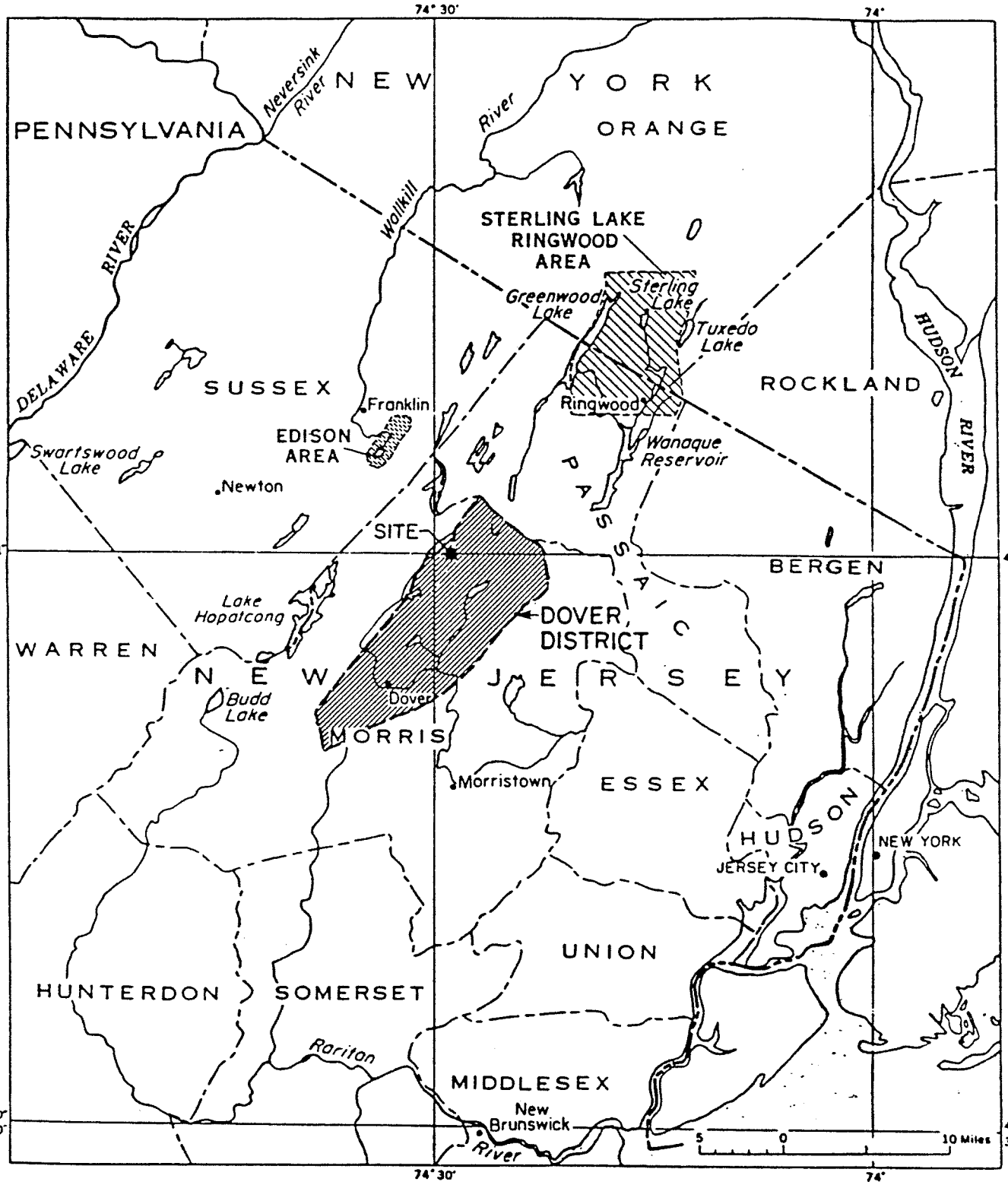
PHYSIOGRAPHIC MAP OF NEW JERSEY

300088

SOURCE: TAKEN FROM OWENS AND SOHL, 1969.

FIGURE 3.1

ACRES



SOURCE: SIMS, PAUL K., GEOLOGY AND MAGNETITE DEPOSITS OF DOVER DISTRICT, MORRIS COUNTY, NEW JERSEY, 1958

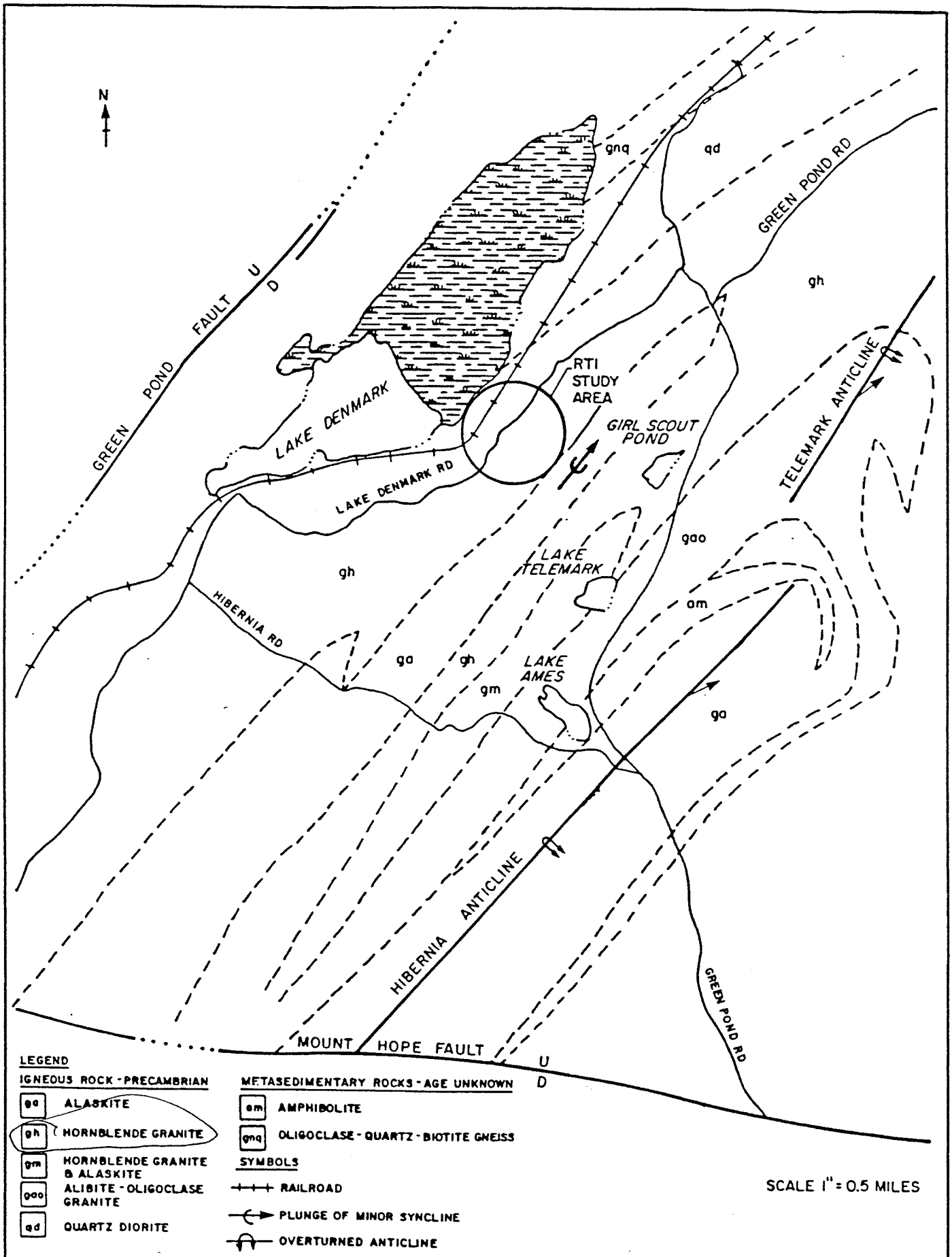
RADIATION TECHNOLOGY, INC. RI/FS

LOCATION MAP OF THE DOVER DISTRICT

300089

ACRES

FIGURE 3.2



RADIATION TECHNOLOGY, INC. RI/FS

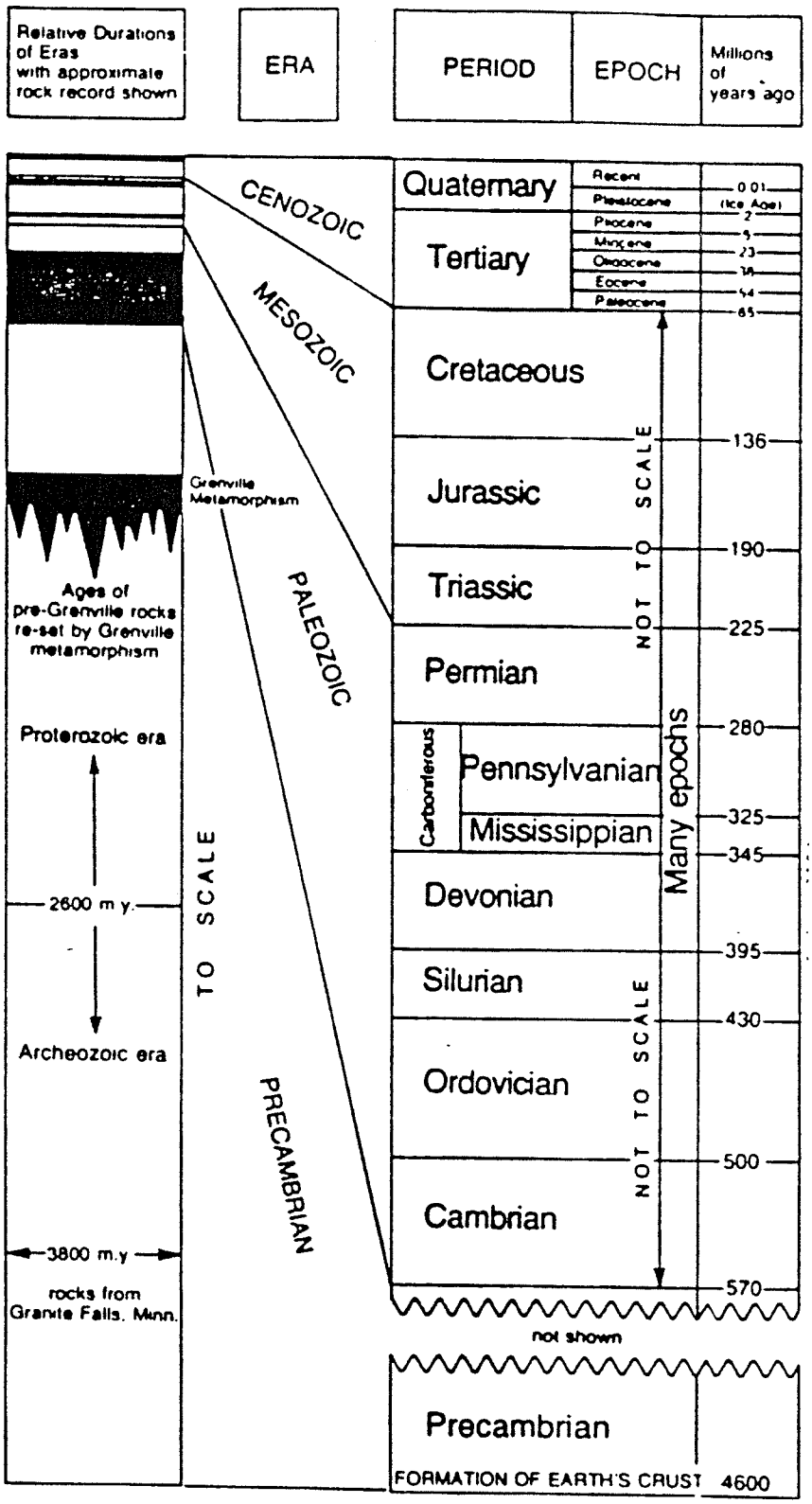
GENERALIZED REGIONAL GEOLOGIC MAP

SOURCE: MODIFIED FROM SIMS, P.K. GEOLOGY & MAGNETITE DEPOSITE OF DOVER DISTRICT, 1958

300090

ACRES

FIGURE 3.3



SOURCE: VAN DIVER, BRADFORD B., ROADSIDE GEOLOGY OF NEW YORK, 1985.

RADIATION TECHNOLOGY, INC. RI/FS

GEOLOGIC TIME SCALE

300091

ACRES

FIGURE 3.4

FILE: FIG33
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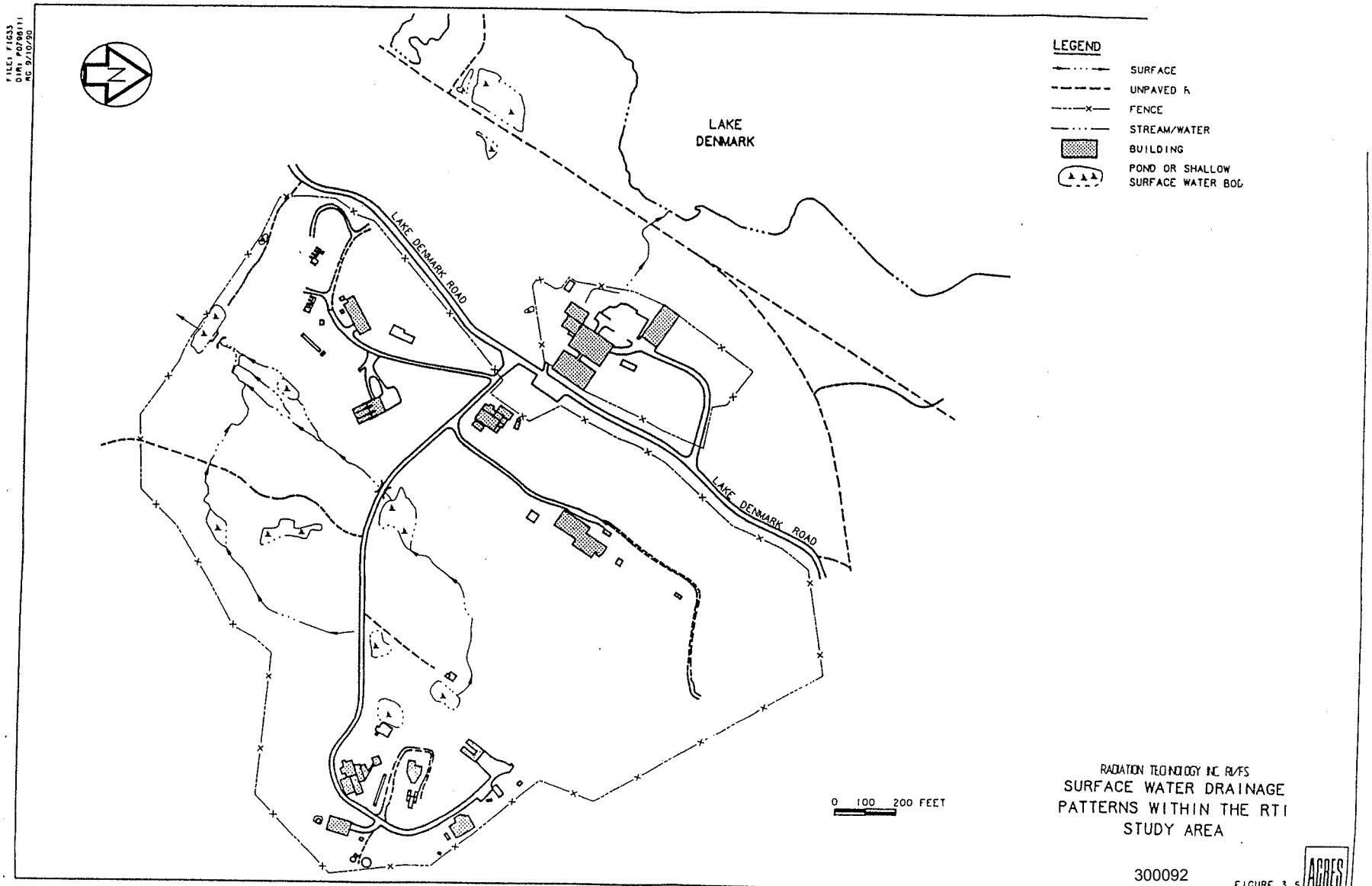
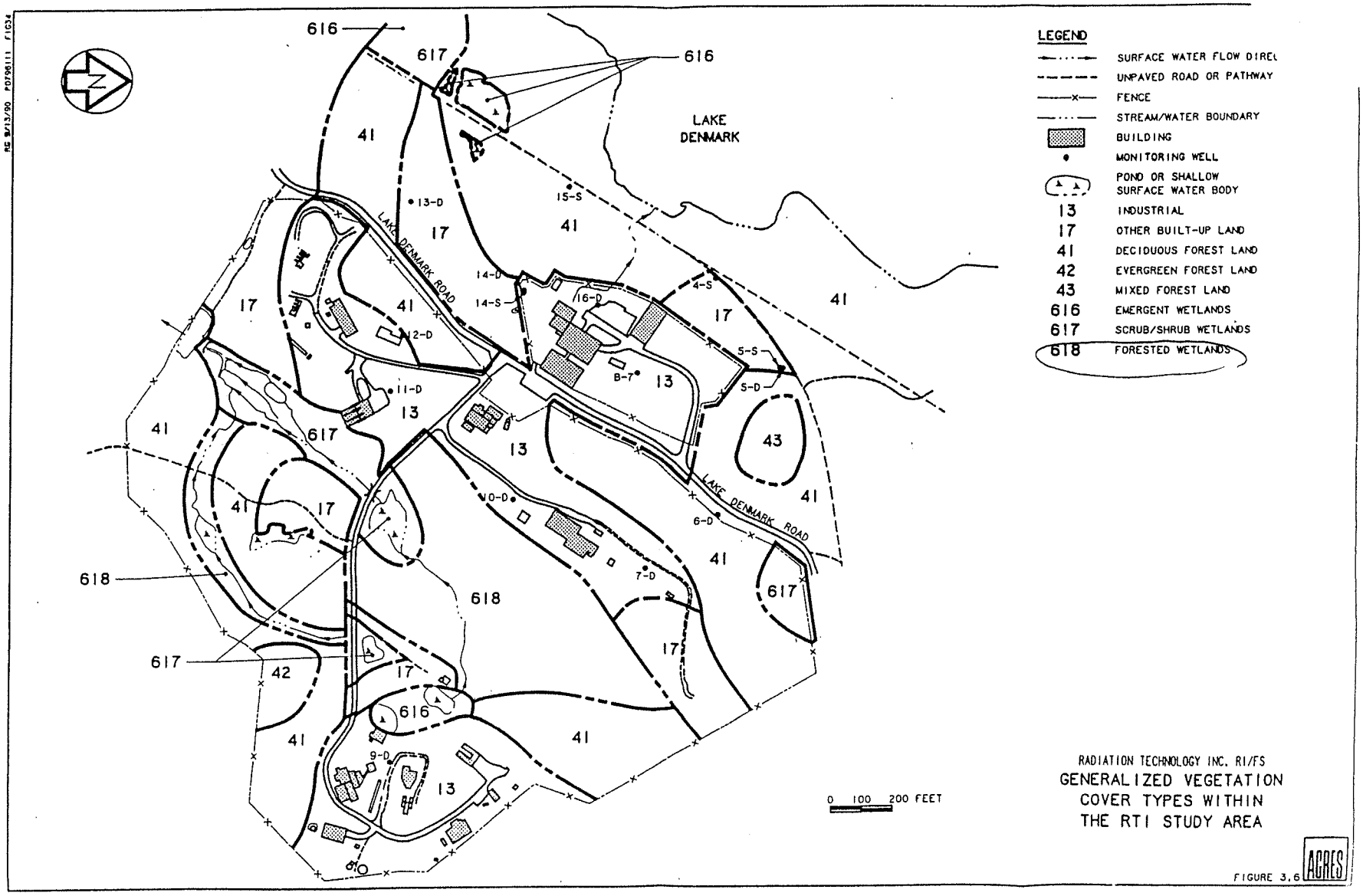


RADIATION TECHNOLOGY INC RI/FS
SURFACE WATER DRAINAGE
PATTERNS WITHIN THE RTI
STUDY AREA

300092

FIGURE 3.5

ACRES



RADIATION TECHNOLOGY INC. RI/FS
GENERALIZED VEGETATION COVER TYPES WITHIN THE RTI STUDY AREA

FIGURE 3.6

ACRES

300093

SUPPLEMENTAL HABITAT AND SPECIES CHARACTERIZATION (TRC ENV. CORP, JULY 1993)

The ecological risk assessment is composed of four parts:

- Problem Formulation;
- Exposure Assessment;
- Ecological Effects Assessment; and
- Risk Characterization.

5.2 Problem Formulation

Problem Formulation is comprised of two primary components: Habitat and Species Characterization and Hazard Identification. Habitat and Species Characterization describes habitats present in the vicinity of the site and identifies potential receptor species. Hazard Identification discusses exposure pathways and identifies contaminants of ecological concern.

5.2.1 Habitat and Species Characterization

A TRC ecologist visited the RTI site and adjacent areas December 22, 1992 in order to characterize aquatic and terrestrial habitats and to identify potential receptor species. Although the site visit was not conducted during the optimal time of the year for confirming the presence of wildlife receptors, the reconnaissance was sufficient to characterize habitats and identify wildlife species that may potentially use the site during the breeding and non-breeding seasons. The ecological supplemented the information provided in the site RI (Acres, 1991). Scott J. Heim (TRC Senior Ecologist) conducted the site reconnaissance. The site visit was approximately four hours in length and consisted primarily of habitat characterization, identification of potential receptor species, and an assessment of potential exposure pathways within the RTI facility parcel and former RIP parcel. The undeveloped forested portion of the RTI site that consists of 183 acres was not characterized during the site reconnaissance. Contamination within this portion of the RTI site was not

characterized in the site RI. Therefore, estimated exposure to receptor species inhabiting this area is unknown (although it is likely to be less than the remaining portions of the RTI site).

5.2.1.1 Onsite Habitats

The portion of the RTI site that was investigated during the site reconnaissance consists of two distinct areas: the RTI industrial facility located west of Lake Denmark Road and the former RIP located east of Lake Denmark Road. The remaining 183 acres of the RTI site consists primarily of undeveloped forested uplands and forested wetlands.

RTI Facility Parcel: The RTI facility includes approximately three acres that are extensively developed with little natural vegetation present. This area is relatively flat and comprised primarily of buildings, paved parking areas and roadways. A perimeter fence is present that surrounds the RTI facility. This area represents an urbanized habitat.

Approximately 12 acres of upland forest and early successional vegetation are also present within the 15-acre parcel containing the RTI facility. Deciduous and mixed forested uplands comprise most of the area of this parcel. Deciduous forest tree species noted during the site reconnaissance include various oaks (*Quercus spp.*), sugar maple (*Acer saccharum*), and birches (*Betula spp.*). The area of mixed forest upland contains eastern hemlock (*Tsuga canadensis*), yellow birch (*Betula alleghaniensis*), black cherry (*Prunus serotina*), and quaking aspen (*Populus tremuloides*) in the tree overstory.

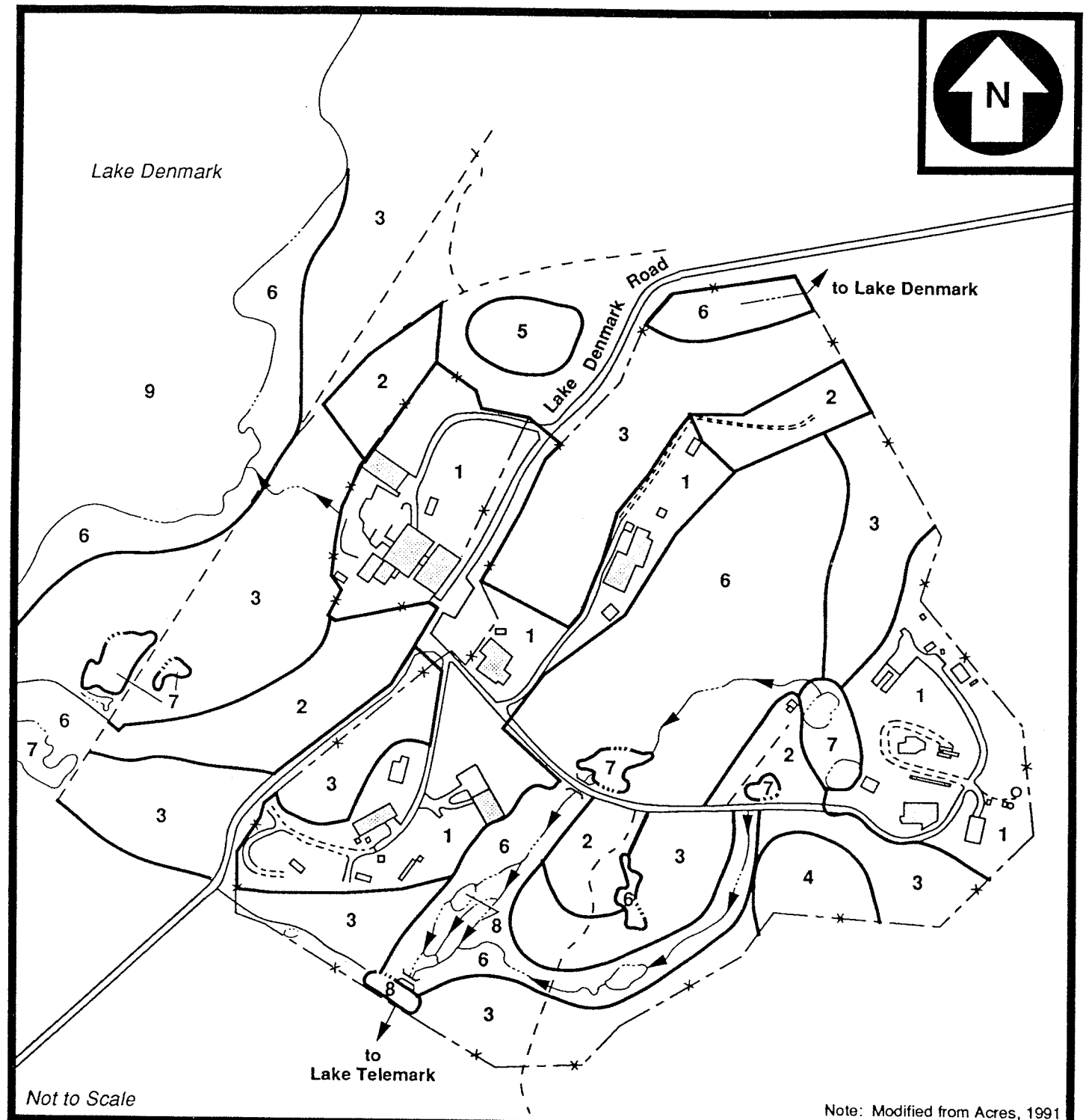
A small stream that conveys intermittent surface water from the RTI facility to Lake Denmark is also present. Surface water flow was negligible or not present within this

small stream at the time of the Phase I and Phase II surface water sampling events, respectively. However, at the time of the site reconnaissance, shallow (one to three inches in depth) surface water flows were observed within the stream. The infrequent periods of water flow within this stream are likely to limit its habitat suitability for many species of aquatic biota.

Former RIP: The former RIP is an inactive, partially developed area consisting of approximately 65 acres. Topography within the former RIP site is characterized by a centrally located valley (containing several streams that drain to the southwest) with ridges of higher elevations located to the east and west. Developed areas of the RIP contain buildings, paved surfaces, and various debris (e.g. metal pipes, building demolition material). These areas are present within the western portion of the former RIP (adjacent to Lake Denmark Road) and at the far eastern portion of the RIP (on graded portions of the elevated ridges).

The remaining portion of the former RIP consists of a variety of aquatic and terrestrial vegetative cover types. These habitats include deciduous forested wetlands, shallow emergent marshes, several small streams (and pond/pool areas), forested uplands (deciduous and evergreen), and prior disturbed areas currently undergoing natural vegetative succession. The locations of these habitats are depicted in Figure 5-1.

Deciduous forested wetlands are present primarily adjacent to small streams within the centrally located valley. A small isolated forested wetland is also present in the southeastern portion of the former RIP. In addition, an area of forested wetland is present within the northern portion of the former RIP. Surface water within this wetland drains into Lake Denmark while the streams within the remaining forested wetland areas discharge to Lake Telemark. The small isolated forested wetland contained standing water (approximate average depth of one foot) that lacked a surface water outlet at the time of the site reconnaissance. Vegetation within the areas of



Building	Surface Water Boundary	1 Urban	6 Forested Wetland
Unpaved Road	Surface Water Pathway	2 Old Field	7 Emergent Marsh
Paved Road	Fence	3 Deciduous Forest Upland	8 Stream
		4 Evergreen Forest Upland	9 Open Water/Deep Marsh
		5 Mixed Forest Upland	

HABITAT COVER TYPES

RADIATION TECHNOLOGY, INC.
ROCKAWAY, NEW JERSEY

TRC

Figure 5-1.

A92-1760/E

300098

forested wetlands consist of red maple (*Acer rubrum*), yellow birch, green ash (*Fraxinus pennsylvania*), tupelo (*Nyssa sylvatica*) and swamp white oak (*Quercus bicolor*) in the tree overstory. Shrub understory vegetation is typically dense and contains spicebush (*Lindera benzoin*), American hornbeam (*Caprinus caroliniana*), arrow-wood (*Viburnum dentatum*), and winterberry holly (*Ilex verticillata*). Herbaceous vegetation within the areas of forested wetland was sparse at the time of the winter site reconnaissance. Skunk-cabbage (*Symplocarpus foetidus*) and several fern species including sensitive (*Onoclea sensibilis*), royal (*Osmunda regalis*), cinnamon (*Osmunda cinnamomea*) and wood ferns (*Dryopteris spp.*) were noted. Areas containing sphagnum moss (*Sphagnum sp.*) were common within the forested wetlands.

Shallow marsh areas comprised primarily of emergent herbaceous vegetation are present on the former RIP. The shallow marshes present in the eastern portion of the former RIP are located in the vicinity of the former lagoons of the sewage treatment plant and are dominated by common reed (*Phragmites australis*), a plant species that typically forms dense colonies in disturbed areas. The remaining areas of shallow emergent marsh are comprised primarily of cat-tail (*Typha latifolia*) with various grasses and sedges also present. Shrub species including highbush blueberry (*Vaccinium corymbosum*) and meadowsweet (*Spiraea latifolia*) are also present around the periphery of these areas.

Two streams (eastern and western) are located within the central valley of the former RIP. These streams flow southwestward where they merge prior to entering a small shallow, excavated pooling area. Overflow from this pool (ponding area) flows south (onto the undeveloped 183-acre portion of the RTI site) and eventually discharges into Lake Telemark.

The western stream is an intermittent waterway that originates in the vicinity of the shallow emergent marsh, the vegetation which is comprised of common reed. Springs and seep areas located within the large area of forested wetland also contribute to the surface water flow. The stream then enters a shallow emergent marsh where surface water flow becomes diffuse and undefined. The stream exits this marsh through a weir structure that conveys flow beneath a roadway and discharges to another forested wetland. The stream in this vicinity is approximately five feet in width with a bottom substrate comprised of rocks, gravel, and sand. Surface water depths range from approximately 3 to 12 inches (average of five inches). The stream soon diverges into three distinct channels with portions of the flow within each of these streams limited to subterranean flows at the time of the site reconnaissance. These three streams (and the eastern stream) eventually rejoin and discharge into an excavated ponding area. This ponding area is approximately one to three feet in water depth and contains a silty and leaf-covered bottom substrate. No aquatic vegetation was observed within the ponded area at the time of the site reconnaissance.

The eastern stream is smaller and shallower with a steeper gradient than the western stream. This stream has an average width of 1.5 feet and an average depth of approximately three inches. The eastern stream flows through a narrow band of forested wetland and merges with one of the subdivided western streams. The substrate of the eastern stream consists primarily of gravel and sand with large rocks also present.

Upland areas comprised of deciduous and evergreen forests are also present on the former RIP. An area of evergreen forested cover type is present within the southeastern portion of the former RIP. This forest stand is comprised of eastern hemlock. Deciduous forested uplands comprise a large proportion of the former RIP. Oak-hickory stands containing red oak (*Quercus rubra*), white oak (*Q. alba*), chestnut oak (*Q. prinus*), and shagbark hickory (*Carya ovata*) predominate although stands of

RECYCLED PAPER ENFORCEMENT CONFIDENTIAL TRC 300100

northern hardwoods including American beech (*Fagus grandifolia*), sugar maple, and black cherry are also present. The majority of the trees present on the site appear to be second growth with diameters at breast height (dbh) less than 12 inches (although a large 30+ inch dbh beech was also noted).

Early successional areas containing small scattered trees with shrubs and herbaceous vegetation predominating are also present on the former RIP. These areas were previously disturbed and are currently reverting through natural successional processes to forested areas. Vegetation within these areas contains quaking aspen gray birch (*Betula populifolia*), staghorn sumac (*Rhus typhina*), multiflora rose (*Rosa multiflora*), bramble (*Rubus sp.*), goldenrod (*Solidago sp.*) and various grasses.

5.2.1.2 Off-site Habitats

Land uses to the east and northeast of the RTI site consist predominantly of single - family residences. Lake Telemark is located southeast of the RTI site and receives much of the surface water drainage originating from the former RIP. Lake Telemark is surrounded by a residential community. The U.S. Military Picatinny Arsenal facility is located southwest and west of the RTI site.

Lake Denmark (part of the Picatinny Arsenal) is present adjacent to and downgradient of the 15-acre RTI facility parcel. Surface and ground water from the RTI facility parcel discharge into Lake Denmark (Acres, 1991). Lake Denmark is a shallow body of water with a maximum depth of 20 feet (Acres, 1991). The lake is triangular in shape with a length of approximately 4,300 feet and a maximum width of approximately 2,500 feet. Lake Denmark in the vicinity of the RTI site consists of an interspersion of open water with emergent shrub and herbaceous vegetation and is best described as a deep marsh habitat. The bottom substrate is reported to contain a high

proportion of organic matter (Acres, 1992). A large wetland area (approximately two times as large as Lake Denmark) is present north of the lake. Smaller wetland areas are also present south and east of Lake Denmark.

5.2.1.3 Regionally Significant Habitats

Several state-listed Species of Special Concern (includes threatened and endangered species) are known to be present in the vicinity of the site (NJNHP, 1991). In addition, wetland areas are present on both the RTI facility parcel and the former RIP. Lake Denmark (and its associated wetlands) are also located within a short distance of the RTI facility.

State-listed threatened species that have formerly been reported to occur within the general vicinity of the RTI site include the red-shouldered hawk (*Buteo lineatus*), barred owl (*Strix varia*), red-headed woodpecker (*Melanerpes erythrocephalus*), and wood turtle (*Clemmys insculpta*).

The red-shouldered hawk inhabits cool, moist, lowland forests containing large mature trees for nesting. This hawk was present recently within the large wetland area located north of Lake Denmark, however, it is unlikely that either the RTI facility parcel or the former RIP provide suitable breeding habitat for this species.

The barred owl is found in a similar habitat as the preceding species. This species requires extensive cool, damp, wooded swamps with large trees containing cavities for nesting. Although nesting habitat is unlikely to be present on the RTI facility parcel or former RIP, the barred owl may potentially forage in these areas. This species was noted fairly recently southwest of the RTI site and north of Lake Denmark.

The red-headed woodpecker prefers open deciduous woodlands (particularly with beech and oaks present) and open areas containing snags (dead trees) with lush herbaceous ground cover. It is potentially feasible that this species could occur within the deciduous forested uplands present on the former RIP.

The wood turtle typically inhabits deciduous forested areas in close proximity to streams or rivers. The species overwinters in the bank or bottom of a stream and also require open sandy areas for nesting (egg deposition). This turtle species has fairly recently been observed south and east of the RTI site. It is possible that this species may inhabit the former RIP in the vicinity of the noted streams.

In addition to the four species noted above, the lateral bluet (*Enallagma laterale*) a rare butterfly, was observed near the outlet of Lake Denmark sometime in the 1970s (NJNHP, 1991). Seven species of state-endangered plants have also been historically recorded within the general vicinity of the RTI site. However, none of these observations have occurred within the past 50 years; therefore, it is uncertain that these populations are still present. Additional state-listed species potentially present in Morris County and on the RTI site include the long-tailed salamander (*Eurycea longicauda*), Cooper's hawk (*Accipiter cooperii*), great blue heron (*Ardea herodias*), northern goshawk (*Accipiter gentilis*) and pied-billed grebe (*Podilymbus podiceps*). These species are noted in the following section.

Wetlands are present on the RTI facility parcel and the former RIP. The general characteristics of these areas were briefly discussed in the preceding sections. The isolated forested wetland noted within the former RIP contained a large area of standing water at the time of the site reconnaissance. This ponded area appears to be ephemeral and may provide important breeding habitat for various species of amphibians.

Lake Denmark and its associated wetlands are present immediately adjacent to and downgradient of the RTI facility parcel and represent a diverse natural environment that likely provides suitable habitat for a variety of organisms. The lack of significant areas of development adjacent to the lake and wetlands increases the suitability of the area for species that require limited human disturbance.

Water quality of Lakes Denmark and Telemark (and their tributaries) is classified as Class FW2-NT (NJDEP, 1989). Class FW2-NT water bodies are defined as being non-trout waters suitable for biota maintenance, migration, and propagation, primary and secondary contact recreation, industrial and agricultural water supply, and public potable water supply (after treatment).

5.2.1.4 Receptor Species Profile

The site reconnaissance (and ecological data provided in the RI report) were based on very limited observations conducted during the winter when most species of wildlife have either migrated from the area or are inactive. Therefore, potential receptor species are identified based on a review of the available literature and habitat features noted during the ecological site reconnaissance by the TRC ecologist. Plant species provide an important component of the habitats identified on the RTI site and have been briefly discussed in the previous sections. Wildlife species that may potentially inhabit the RTI site (and Lake Denmark) are listed in Table 5-1. This list includes amphibians, reptiles, birds, and mammals that may inhabit the RTI site (and vicinity) as breeding and/or wintering habitat. Additional avian species are also expected to utilize the variety of habitats present on the RTI site during periods of spring and fall migration.

TABLE 5-1. POTENTIAL WILDLIFE SPECIES LIST FOR HABITAT COVER TYPES IDENTIFIED ON RTI SITE[1]

Family	Common Name	Latin Name	Guild[3]	Forage Method	Breeding Substrate	HABITAT COVER TYPE USE[2] 1	2	3	4	5	6	7	8	9
Amphibians														
Ambystomatidae	Jefferson Salamander	*Ambystoma jeffersonianum*	I	Ground Gleaner	Water						X		X	
	Marbled Salamander	*Ambystoma opacum*	I	Ground Gleaner	Water					X	X			
	Spotted Salamander	*Ambystoma maculatum*	I	Ground Gleaner	Water			X	X	X	X		X	
Bufonidae	Eastern American Toad	*Bufo a. americanus*	I	Ground Ambusher	Water		X	X	X	X	X	X	X	X
	Fowler's Toad	*Bufo woodhousei fowleri*	I	Ground Ambusher	Water					X	X			X
Hylidae	Gray Treefrog	*Hyla versicolor*	I	Bark Ambusher	Water			X		X	X			X
	Northern Cricket Frog	*Acris c. crepitans*	I	Riparian Ambusher	Water							X	X	X
	Northern Spring Peeper	*Pseudacris c. crucifer*	I	Riparian Ambusher	Water			X	X	X	X	X	X	X
Plethodontidae	Four-toed Salamander	*Hemidactylium scutatum*	I	Ground Gleaner	Riparian Ground				X		X		X	
	Long-tailed Salamander	*Eurycea l. longicauda*	I	Water Gleaner	Water								X	
	N. Two-lined Salamander	*Eurycea b. bislineata*	I	Water Gleaner	Water						X		X	
	Northern Red Salamander	*Pseudotriton r. ruber*	I	Water Gleaner	Water								X	
	Redback Salamander	*Plethodon c. cinereus*	I	Ground Gleaner	Terrestrial Subsurface	X		X	X	X	X			
Ranidae	Bullfrog	*Rana catesbeiana*	C	Water Ambusher	Water									X
	Green Frog	*Rana clamitans melanota*	C	Riparian Ambusher	Water						X	X	X	X
	Pickerel Frog	*Rana palustris*	I	Riparian Ambusher	Water						X		X	X
	Southern Leopard Frog	*Rana utricularia*	I	Riparian Ambusher	Water							X		X
	Wood Frog	*Rana sylvatica*	I	Ground Ambusher	Water			X	X	X	X		X	X
Salamandridae	Red-spotted Newt	*Notophthalmus viridescens*	I	Water Gleaner	Water				X		X	X	X	X
Birds														
Accipitridae	Broad-winged Hawk	*Buteo platypterus*	C	Ground Pouncer	Tree-Branch			X	X					
	Cooper's Hawk	*Accipiter cooperii*	C	Air Hawker	Tree-Branch		X	X	X	X	X			
	Northern Goshawk	*Accipiter gentilis*	C	Air Hawker	Tree-Branch				X	X				
	Red-tailed Hawk	*Buteo jamaicensis*	C	Ground Pouncer	Tree-Branch		X	X	X					
	Sharp-shinned Hawk	*Accipiter striatus*	C	Air Hawker	Tree-Branch		X	X	X	X	X			
Alcedinidae	Belted Kingfisher	*Ceryle alcyon*	P	Water Plunger	Riparian Subsurface									X
Anatidae	American Black Duck	*Anas rubripes*	O	Water Forager	Riparian Ground								X	X
	American Wigeon	*Anas americana*	H	Water Grazer	Not applicable[4]									X

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TABLE 5-1. POTENTIAL WILDLIFE SPECIES LIST FOR HABITAT COVER TYPES IDENTIFIED ON RTI SITE[1] (Continued).

Family	Common Name	Latin Name	Guild[3]	Forage Method	Breeding Substrate	HABITAT COVER TYPE USE[2] 1	2	3	4	5	6	7	8	9
Anatidae	Blue-winged Teal	*Anas discors*	O	Water Forager	Riparian Ground									X
	Canada Goose	*Branta bernicla*	H	Ground Grazer	Riparian Ground									X
	Common Goldeneye	*Bucephala clangula*	O	Bottom Forager	Not applicable[4]									X
	Common Merganser	*Mergus merganser*	P	Water Diver	Not applicable[4]									X
	Gadwall	*Anas strepera*	H	Water Grazer	Riparian Ground									X
	Hooded Merganser	*Lophodytes cucullatus*	P	Water Diver	Riparian Tree Cavity									X
	Mallard	*Anas platyrhynchos*	G	Water Forager	Riparian Ground								X	X
	Red-breasted Merganser	*Mergus serrator*	P	Water Diver	Not applicable[4]									X
	Ring-necked Duck	*Aythya collaris*	H	Bottom Forager	Not applicable[4]									X
	Wood Duck	*Aix sponsa*	G	Water Forager	Riparian Tree Cavity			X			X		X	X
Apodidae	Chimney Swift	*Chaetura pelagica*	I	Air Screener	Buildings	X	X							
Ardeidae	Great Blue Heron	*Ardea herodias*	C	Water Ambusher	Riparian Twig-Branch							X	X	X
	Green-backed Heron	*Butorides striatus*	C	Water Ambusher	Riparian Shrub								X	X
Bombycillidae	Cedar Waxwing	*Bombycilla cedrorum*	F	Upper Canopy Gleaner	Tree-Twig		X	X		X	X			
Caprimulgidae	Common Nighthawk	*Chordeiles minor*	I	Air Screener	Buildings	X	X							
	Whip-poor-will	*Caprimulgus vociferus*	I	Air Screener	Ground-Herb		X	X		X				
Cathartidae	Turkey Vulture	*Cathartes aura*	C	Ground Scavenger	Ground-Herb			X						
Certhiidae	Brown Creeper	*Certhia americana*	I	Bark Gleaner	Not applicable			X	X		X			
Columbidae	Mourning Dove	*Zenaida macroura*	G	Ground Gleaner	Tree-Branch		X	X	X	X	X			
	Rock Dove	*Columba livia*	O	Ground Gleaner	Buildings	X								
Corvidae	American Crow	*Corvus brachyrhynchos*	O	Ground Gleaner	Tree-Branch		X	X	X					
	Blue Jay	*Cyanocitta cristata*	O	Ground Gleaner	Tree-Branch		X	X	X	X	X			
Cuculidae	Black-billed Cuckoo	*Coccyzus erythropthalmus*	I	Lower Canopy Gleaner	Tree-Branch		X	X			X			
	Yellow-billed Cuckoo	*Coccyzus americanus*	I	Lower Canopy Gleaner	Tree-Branch		X	X		X	X			
Falconidae	American Kestrel	*Falco sparverius*	C	Ground Pouncer	Tree Cavity-Crevice		X					X		
Fringillidae	American Goldfinch	*Carduelis tristis*	O	Ground Gleaner	Shrub		X	X	X	X	X	X		
	American Tree Sparrow	*Spizella arborea*	O	Ground Gleaner	Not applicable		X					X		
	Chipping Sparrow	*Spizella passerina*	O	Ground Gleaner	Shrub			X						
	Dark-eyed Junco	*Junco hyemalis*	G	Ground Gleaner	Not applicable		X	X	X	X	X			
	Evening Grosbeak	*Coccothraustes vespertinus*	G	Ground Gleaner	Not applicable		X	X	X	X	X			

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TABLE 5-1. POTENTIAL WILDLIFE SPECIES LIST FOR HABITAT COVER TYPES IDENTIFIED ON RTI SITE[1] (Continued).

Family	Common Name	Latin Name	Guild[3]	Forage Method	Breeding Substrate	HABITAT COVER TYPE USE[2] 1	2	3	4	5	6	7	8	9
Fringillidae	Field Sparrow	*Spizella pusilla*	O	Ground Gleaner	Ground-Herb		X							
	Fox Sparrow	*Passerella iliaca*	O	Ground Gleaner	Not applicable		X							
	Indigo Bunting	*Passerina cyanea*	I	Lower Canopy Gleaner	Ground-Herb		X	X		X	X			
	Northern Cardinal	*Cardinalis cardinalis*	O	Ground Gleaner	Shrub		X			X	X			
	Pine Siskin	*Carduelis pinus*	G	Ground Gleaner	Not applicable			X	X	X	X			
	Purple Finch	*Carpodacus purpureus*	G	Ground Gleaner	Not applicable			X	X	X				
	Rose-breasted Grosbeak	*Pheucticus ludovicianus*	O	Lower Canopy Gleaner	Tree-Twig		X	X		X	X			
	Savannah Sparrow	*Passerculus sandwichensis*	O	Ground Gleaner	Ground-Herb							X		
	Song Sparrow	*Melospiza melodia*	O	Ground Gleaner	Ground-Herb		X				X	X		
	Swamp Sparrow	*Melospiza georgiana*	I	Ground Gleaner	Riparian Ground								X	X
	White-throated Sparrow	*Zonotrichia albicollis*	G	Ground Gleaner	Not applicable		X	X						
Hirundinidae	Bank Swallow	*Riparia riparia*	I	Air Screener	Terrestrial Subsurface									X
	Barn Swallow	*Hirundo rustica*	I	Air Screener	Buildings	X	X							X
	N. Rough-winged Swallow	*Stelgidopteryx serripennis*	I	Air Screener	Terrestrial Subsurface									X
	Tree Swallow	*Tachycineata bicolor*	I	Air Screener	Tree Cavity-Crevice		X				X			X
Icteridae	Brown-headed Cowbird	*Molothrus ater*	O	Ground Gleaner	Nest Parasite		X	X	X	X	X			
	Common Grackle	*Quiscalus quiscula*	O	Ground Gleaner	Tree-Branch						X	X	X	X
	Northern Oriole	*Icterus galbula*	O	Upper Canopy Gleaner	Tree-Twig			X		X	X			
	Red-winged Blackbird	*Agelaius phoeniceus*	O	Ground Gleaner	Shrub							X		X
Meleagrididae	Wild Turkey	*Meleagris gallopavo*	O	Ground Gleaner	Ground-Herb		X	X	X	X	X			
Mimidae	Brown Thrasher	*Toxostoma rufum*	O	Ground Gleaner	Shrub		X				X			
	Gray Catbird	*Dumetella carolinensis*	O	Ground Gleaner	Shrub		X				X			
	Northern Mockingbird	*Mimus polyglottos*	O	Ground Gleaner	Shrub		X							
Paridae	Black-capped Chickadee	*Parus atricapillus*	I	Lower Canopy Gleaner	Tree Cavity-Crevice		X	X	X	X	X			
	Tufted Titmouse	*Parus bicolor*	I	Lower Canopy Gleaner	Tree Cavity-Crevice			X		X	X			
Parulidae	American Redstart	*Setophaga ruticilla*	I	Lower Canopy Gleaner	Tree-Twig			X	X	X	X			
	Black-and-White Warbler	*Mniotilta varia*	I	Bark Gleaner	Ground-Herb			X	X	X	X			
	Blue-winged Warbler	*Vermivora pinus*	I	Lower Canopy Gleaner	Ground-Herb		X				X			
	Canada Warbler	*Wilsonia canadensis*	I	Lower Canopy Gleaner	Riparian Ground				X		X			
	Chestnut-sided Warbler	*Dendroica pensylvanica*	I	Lower Canopy Gleaner	Shrub		X							

TABLE 5-1. POTENTIAL WILDLIFE SPECIES LIST FOR HABITAT COVER TYPES IDENTIFIED ON RTI SITE[1] (Continued).

Family	Common Name	Latin Name	Guild[3]	Forage Method	Breeding Substrate	HABITAT COVER TYPE USE[2] 1	2	3	4	5	6	7	8	9
Parulidae	Common Yellowthroat	*Geothlypis trichas*	I	Lower Canopy Gleaner	Ground-Herb						X	X	X	X
	Golden-winged Warbler	*Vermivora chrysoptera*	I	Lower Canopy Gleaner	Ground-Herb		X							
	Ovenbird	*Seiurus aurocapillus*	I	Ground Gleaner	Ground-Herb			X		X	X			
	Prairie Warbler	*Dendroica discolor*	I	Lower Canopy Gleaner	Shrub		X							
	Worm-eating Warbler	*Helmitheros vermivorus*	I	Ground Gleaner	Ground-Herb			X		X				
	Yellow Warbler	*Dendroica petechia*	I	Lower Canopy Gleaner	Shrub		X				X			
Phasianidae	Northern Bobwhite	*Colinus virginianus*	O	Ground Gleaner	Ground-Herb		X							
	Ring-necked Pheasant	*Phasianus colchicus*	O	Ground Gleaner	Ground-Herb		X					X		
Picidae	Downy Woodpecker	*Picoides pubescens*	I	Bark Gleaner	Tree Cavity-Crevice			X	X	X	X			
	Hairy Woodpecker	*Picoides villosus*	I	Bark Gleaner	Tree Cavity-Crevice			X	X					
	Northern Flicker	*Colaptes auratus*	I	Ground Gleaner	Tree Cavity-Crevice		X	X	X		X			
	Pileated Woodpecker	*Dryocopus pileatus*	I	Bark Excavator	Tree Cavity-Crevice			X	X					
	Red-bellied Woodpecker	*Melanerpes carolinus*	I	Bark Gleaner	Tree Cavity-Crevice			X						
	Red-headed Woodpecker	*Melanerpes erythrocephalus*	I	Bark Gleaner	Tree Cavity-Crevice			X						
	Yellow-bellied Sapsucker	*Sphyrapicus varius*	I	Bark Gleaner	Not applicable			X		X	X			
Ploceidae	House Sparrow	*Passer domesticus*	G	Ground Gleaner	Buildings	X	X							
Podicipedidae	Pied-billed Grebe	*Podilymbus podiceps*	O	Bottom Forager	Water									X
Rallidae	American Coot	*Fulica americana*	O	Bottom Forager	Riparian Ground									X
	Common Moorhen	*Gallinula chloropus*	O	Riparian Gleaner	Riparian Ground									X
	Sora	*Porzana carolina*	O	Riparian Gleaner	Riparian Ground									X
	Virginia Rail	*Rallus limicola*	O	Riparian Gleaner	Riparian Ground									X
Scolopacidae	American Woodcock	*Scolopax minor*	I	Ground Prober	Ground-Herb						X			
	Spotted Sandpiper	*Actitis macularia*	O	Riparian Gleaner	Ground-Herb									X
Sittidae	Red-breasted Nuthatch	*Sitta canadensis*	I	Bark Gleaner	Not applicable			X	X					
	White-breasted Nuthatch	*Sitta carolinensis*	I	Bark Gleaner	Tree Cavity-Crevice			X		X	X			
Strigidae	Barred Owl	*Strix varia*	C	Ground Pouncer	Tree Cavity-Branch				X		X			
	Eastern Screech-Owl	*Otus asio*	C	Ground Pouncer	Tree Cavity-Crevice		X	X	X	X	X	X		
	Great Horned Owl	*Bubo virginianus*	C	Ground Pouncer	Tree-Branch		X	X	X	X	X			
Sturnidae	European Starling	*Sturnus vulgaris*	O	Ground Gleaner	Buildings	X	X							
Sylviidae	Blue-gray Gnatcatcher	*Polioptila caerulea*	I	Upper Canopy Gleaner	Tree-Branch		X	X		X	X			

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TABLE 5-1. POTENTIAL WILDLIFE SPECIES LIST FOR HABITAT COVER TYPES IDENTIFIED ON RTI SITE[1] (Continued).

Family	Common Name	Latin Name	Guild[3]	Forage Method	Breeding Substrate	HABITAT COVER TYPE USE[2] 1	2	3	4	5	6	7	8	9
Sylviidae	Golden-crowned Kinglet	*Regulus satrapa*	I	Lower Canopy Gleaner	Not applicable			X	X	X	X			
	Ruby-crowned Kinglet	*Regulus calendula*	I	Lower Canopy Gleaner	Not applicable				X	X				
Tetraonidae	Ruffed Grouse	*Bonasa umbellus*	O	Ground Gleaner	Ground-Herb		X	X	X	X	X			
Thraupidae	Scarlet Tanager	*Piranga olivacea*	I	Upper Canopy Gleaner	Tree-Twig			X	X	X	X			
Trochilidae	Ruby-throated Hummingbird	*Archilochus colubris*	O	Floral Hover-Gleaner	Tree-Branch		X	X	X	X	X			
Troglodytidae	Carolina Wren	*Thryothorus ludovicianus*	I	Lower Canopy Gleaner	Tree Cavity-Crevice		X				X			
	House Wren	*Troglodytes aedon*	I	Lower Canopy Gleaner	Tree Cavity-Crevice	X	X	X		X	X			
	Marsh Wren	*Cistothorus palustris*	I	Ground Gleaner	Riparian Ground							X	X	X
Turdidae	American Robin	*Turdus migratorius*	O	Ground Gleaner	Tree-Branch		X	X	X	X	X			
	Eastern Bluebird	*Sialia sialis*	O	Ground Gleaner	Tree Cavity-Crevice		X							
	Hermit Thrush	*Catharus guttatus*	I	Ground Gleaner	Ground-Herb				X					
	Veery	*Catharus fuscescens*	O	Ground Gleaner	Ground-Herb				X		X			
	Wood Thrush	*Hylocichla mustelina*	O	Ground Gleaner	Tree-Branch			X	X	X	X			
Tyrannidae	Eastern Kingbird	*Tyrannus tyrannus*	I	Air Sallier	Tree-Twig		X							X
	Eastern Phoebe	*Sayornis phoebe*	I	Air Sallier	Buildings	X	X	X	X					
	Eastern Wood-Pewee	*Contopus virens*	I	Air Sallier	Tree Branch			X		X	X			
	Great Crested Flycatcher	*Myiarchus crinitus*	I	Air Sallier	Tree Cavity-Crevice			X	X					
	Least Flycatcher	*Empidonax minimus*	I	Air Sallier	Tree-Branch			X		X	X			
Tytonidae	Common Barn-Owl	*Tyto alba*	C	Ground Pouncer	Buildings	X								
Vireonidae	Red-eyed Vireo	*Vireo olivaceus*	I	Upper Canopy Gleaner	Tree-Twig			X	X	X	X			
	Warbling Vireo	*Vireo gilvus*	I	Upper Canopy Gleaner	Tree-Twig			X						
	Yellow-throated Vireo	*Vireo flavifrons*	I	Upper Canopy Gleaner	Tree-Twig			X						
Mammals														
Canidae	Coyote	*Canis latrans*	O	Ground Forager	Terrestrial Subsurface		X	X	X	X	X	X	X	X
	Gray Fox	*Urocyon cinereoargenteus*	O	Ground Forager	Ground-Herb			X		X	X	X	X	X
	Red Fox	*Vulpes vulpes*	O	Ground Forager	Terrestrial Subsurface		X	X	X	X	X	X	X	
Castoridae	Beaver	*Castor canadensis*	H	Water Grazer	Riparian Subsurface									X
Cervidae	White-tailed Deer	*Odocoileus virginianus*	H	Ground Grazer	Ground-Herb		X	X	X	X	X	X		
Cricetidae	Meadow Vole	*Microtus pennsylvanicus*	H	Ground Grazer	Terrestrial Subsurface		X					X		

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TABLE 5-1. POTENTIAL WILDLIFE SPECIES LIST FOR HABITAT COVER TYPES IDENTIFIED ON RTI SITE[1] (Continued).

Family	Common Name	Latin Name	Guild[3]	Forage Method	Breeding Substrate	HABITAT COVER TYPE USE[2] 1	2	3	4	5	6	7	8	9
Cricetidae	Muskrat	*Ondatra zibethicus*	H	Water Grazer	Riparian Subsurface								X	X
	S. Red-backed Vole	*Clethrionomys gapperi*	H	Ground Grazer	Terrestrial Subsurface				X		X			
	White-footed Mouse	*Peromyscus leucopus*	O	Ground Forager	Terrestrial Subsurface	X	X	X	X	X	X			
	Woodland Vole	*Microtus pinetorum*	H	Ground Grazer	Terrestrial Subsurface		X	X		X				
Didelphidae	Virginia Opossum	*Didelphis virginiana*	O	Ground Forager	Tree Cavity-Crevice	X	X	X		X	X	X	X	X
Leporidae	Eastern Cottontail	*Sylvilagus floridanus*	H	Ground Grazer	Ground-Herb		X					X		
Muridae	House Mouse	*Mus musculus*	O	Ground Forager	Buildings	X	X							
	Norway Rat	*Rattus norvegicus*	O	Ground Forager	Terrestrial Subsurface	X	X							
Mustelidae	Ermine	*Mustela erminea*	C	Ground Pursuer	Ground-Herb		X	X		X	X			
	Long-tailed Weasel	*Mustela frenata*	C	Ground Pursuer	Terrestrial Subsurface		X	X		X	X	X	X	X
	Mink	*Mustela vison*	P	Water Diver	Riparian Subsurface				X		X	X	X	X
	River Otter	*Lutra canadensis*	P	Water Diver	Riparian Subsurface									X
	Striped Skunk	*Mephitis mephitis*	O	Ground Forager	Terrestrial Subsurface		X	X	X	X	X	X	X	X
Procyonidae	Raccoon	*Procyon lotor*	O	Ground Forager	Tree Cavity-Crevice	X	X	X	X	X	X	X	X	X
Sciuridae	Eastern Chipmunk	*Tamias striatus*	G	Ground Forager	Terrestrial Subsurface		X	X	X					
	Gray Squirrel	*Sciurus carolinensis*	G	Ground Forager	Tree Cavity-Crevice			X						
	Red Squirrel	*Tamiasciurus hudsonicus*	G	Upper Canopy Forager	Tree Cavity-Crevice			X	X	X	X			
	S. Flying Squirrel	*Glaucomys volans*	G	Ground Forager	Tree Cavity-Crevice			X						
	Woodchuck	*Marmota monax*	H	Ground Grazer	Terrestrial Subsurface		X	X						
Soricidae	Least Shrew	*Cryptotis parva*	I	Ground Gleaner	Terrestrial Subsurface		X							
	Long-tailed Shrew	*Sorex dispar*	I	Ground Gleaner	Terrestrial Subsurface			X	X	X				
	Masked Shrew	*Sorex cinereus*	I	Ground Gleaner	Terrestrial Subsurface				X		X	X	X	
	N. Short-tailed Shrew	*Blarina brevicauda*	I	Ground Gleaner	Terrestrial Subsurface	X	X	X	X	X	X	X	X	
	Pygmy Shrew	*Sorex hoyi*	I	Ground Gleaner	Riparian Subsurface				X					
	Smoky Shrew	*Sorex fumeus*	I	Ground Gleaner	Terrestrial Subsurface				X		X			
Talpidae	Eastern Mole	*Scalopus aquaticus*	I	Ground Gleaner	Terrestrial Subsurface		X							
	Star-nosed Mole	*Condylura cristata*	I	Water Gleaner	Riparian Subsurface							X	X	
Vespertilionidae	Big Brown Bat	*Eptesicus fuscus*	I	Air Hawker	Buildings	X	X					X	X	X
	Eastern Pipistrelle	*Pipistrellus subflavus*	I	Air Hawker	Cave-Crevice								X	X
	Little Brown Bat	*Myotis lucifugus*	I	Air Hawker	Buildings	X	X					X	X	X

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TABLE 5-1. POTENTIAL WILDLIFE SPECIES LIST FOR HABITAT COVER TYPES IDENTIFIED ON RTI SITE[1] (Continued).

Family	Common Name	Latin Name	Guild[3]	Forage Method	Breeding Substrate	HABITAT COVER TYPE USE[2] 1	2	3	4	5	6	7	8	9
Vespertilionidae	N. Long-eared Bat	*Myotis septentrionalis*	I	Air Hawker	Tree Cavity-Crevice	X	X						X	X
	Red Bat	*Lasiurus borealis*	I	Air Hawker	Tree-Twig		X	X		X	X		X	X
	Silver-haired Bat	*Lasionycteris noctivagans*	I	Air Hawker	Tree-Twig								X	X
Zapodidae	Meadow Jumping Mouse	*Zapus hudsonius*	O	Ground Forager	Ground-Herb		X					X		
	Woodland Jumping Mouse	*Napaeozapus insignis*	O	Ground Forager	Ground-Herb			X		X				
Reptiles														
Chelydridae	Snapping Turtle	*Chelydra serpentina*	O	Bottom Forager	Riparian Subsurface									X
Colubridae	Black Rat Snake	*Elaphe o. obsoleta*	C	Ground Ambusher	Terrestrial Subsurface	X	X	X		X	X			
	E. Smooth Green Snake	*Opheodrys v. vernalis*	I	Ground Ambusher	Terrestrial Subsurface		X					X		
	Eastern Garter Snake	*Thamnophia s. sirtalis*	C	Ground Ambusher	Terrestrial Subsurface	X	X	X	X	X	X	X	X	
	Eastern Hognose Snake	*Heterodon platyrhinos*	C	Ground Ambusher	Terrestrial Subsurface		X	X						
	Eastern Milk Snake	*Lampropeltis t. triangulum*	C	Ground Ambusher	Terrestrial Subsurface	X		X		X				
	Eastern Ribbon Snake	*Thamnophis s. sauritus*	C	Water Ambusher	Riparian Subsurface						X	X		X
	Eastern Worm Snake	*Carphophis a. amoenus*	I	Ground Gleaner	Terrestrial Subsurface			X		X				
	Northern Black Racer	*Coluber c. constrictor*	C	Ground Ambusher	Terrestrial Subsurface	X	X	X		X	X	X		
	Northern Brown Snake	*Storeria d. dekayi*	I	Ground Ambusher	Terrestrial Subsurface	X	X	X	X	X	X			
	Northern Redbelly Snake	*Storeria o. occipitomaculata*	I	Ground Ambusher	Terrestrial Subsurface				X		X			
	Northern Ringneck Snake	*Diadophis punctatus edwardsi*	C	Ground Ambusher	Terrestrial Subsurface	X		X	X		X			
	Northern Water Snake	*Nerodia s. sipedon*	C	Water Ambusher	Riparian Subsurface								X	X
Emydidae	Eastern Box Turtle	*Terrapene c. carolina*	O	Ground Forager	Terrestrial Subsurface		X	X		X				
	Eastern Painted Turtle	*Chrysemys p. picta*	O	Bottom Forager	Terrestrial Subsurface								X	X
	Spotted Turtle	*Clemmys guttata*	O	Bottom Forager	Riparian Subsurface						X	X	X	X
	Wood Turtle	*Clemmys insculpta*	O	Ground Forager	Terrestrial Subsurface			X	X		X	X	X	X
Kinosternidae	Stinkpot	*Sternotherus odoratus*	C	Bottom Forager	Riparian Subsurface								X	X
Scincidae	Five-lined Skink	*Eumeces fasciatus*	I	Ground Ambusher	Terrestrial Subsurface			X			X			
Viperidae	Northern Copperhead	*Agkistrodon contortrix*	C	Ground Ambusher	Terrestrial Subsurface			X	X	X	X			
Fish														
Catostomidae	White Sucker	*Catostomus commersoni*	O	Bottom Forager	Aquatic Substrate									X

TABLE 5-1. POTENTIAL WILDLIFE SPECIES LIST FOR HABITAT COVER TYPES IDENTIFIED ON RTI SITE[1] (Continued).

Family	Common Name	Latin Name	Guild[3]	Forage Method	Breeding Substrate	HABITAT COVER TYPE USE[2] 1	2	3	4	5	6	7	8	9
Centrarchidae	Largemouth Bass	*Micropterus salmoides*	P	Water Forager	Aquatic Substrate									X
	Bluegill	*Lepomis macrochirus*	I	Water Forager	Aquatic Substrate									X
	Pumpkinseed	*Lepomis gibbosus*	I	Water Forager	Aquatic Substrate									X
Cyprinidae	Common Carp	*Cyprinus carpio*	O	Bottom Forager	Aquatic Vegetation									X
	Golden Shiner	*Notemigonus crysoleucas*	O	Water Forager	Aquatic Vegetation									X
Esocidae	Chain Pickerel	*Esox niger*	P	Water Ambusher	Aquatic Vegetation									X
	Grass Pickerel	*Esox americanus*	P	Water Ambusher	Aquatic Vegetation									X
Ictaluridae	Brown Bullhead	*Ictarus nebulosus*	I	Bottom Forager	Aquatic Substrate									X
Percidae	Yellow Perch	*Perca flavescens*	P	Water Forager	Aquatic Vegetation									X

[1] Includes resident, breeding, and wintering amphibian, avian, mammalian, and reptilian species. Migratory species also are likely to utilize the area, however, these species would have a lesser potential for exposure to site contaminants than species inhabiting the site for extended periods.

[2] Habitat cover types include the following:

1: Urban (includes buildings, debris)
2: Old Fields (early successional stage of vegetation)
3: Deciduous Forest Upland (oaks/northern hardwoods)
4: Evergreen Forest Upland (eastern hemlock)
5: Mixed Forest Upland (deciduous/conifer trees)
6: Deciduous Forested Wetland (wooded swamp)
7: Shallow Marsh
8: Stream (includes excavated pools/ponds)
9: Lake Denmark (shallow lake/deep marsh)

[3] Guilds include:

I: Insectivore H: Herbivore
C: Carnivore O: Omnivore
P: Piscivore G: Granivore
F: Frugivore

[4] Not applicable since species is winter resident only of RTI site.

Birds

Avian species observed and expected to inhabit the RTI site and vicinity represent a diverse avian community and are primarily a result of the diverse vegetation communities present within the area (see Table 5-1). The wooded areas present on the RTI facility parcel and former RIP likely provide breeding habitat for many avian species such as warblers, thrushes, flycatchers, and woodpeckers. The areas of early successional vegetation and existing buildings also provide nesting habitat for additional species (see Table 5-1). Although waterfowl were not observed by the TRC ecologist or reported within the RI, various species of ducks (and wading birds) likely utilize the open water and deep emergent marshes present within that portion of Lake Denmark in the vicinity of the RTI facility.

Mammals

A variety of mammals are reported or expected to be present in the vicinity of the RTI site (Table 5-1). White-tailed deer, gray squirrel, and eastern cotton-tail have been observed on the site. Smaller mammals, such as voles, shrews, and mice are also likely to inhabit the variety of cover types present. A variety of bat species are likely to forage for insects above Lake Denmark and open areas of the RTI site. Aquatic habitats are generally productive sites for invertebrates including emerging insects that provide an important food resource for foraging bats. Species such as the little brown bat (*Myotis lucifugus*) are often associated with structures located in close proximity to aquatic habitats. Additional bat species may utilize on-site structures or adjacent forested areas for roosting.

Mammalian predators such as the red fox (*Vulpes vulpes*), raccoon (*Procyon loter*), and various mustelids are expected to forage on the RTI site and along the shoreline of Lake Denmark. The raccoon, oppossum (*Didelphis virginiana*), and striped skunk

(*Mephitis mephitis*) are omnivorous feeders that may consume a wide variety of items found within the habitat cover types present on the RTI site. The river otter (*Lutra canadensis*) and mink (*Mustela vision*) are carnivorous members of the weasel family that consume a high proportion of fish in their diet. These species may utilize Lake Denmark and its associated wetlands.

Reptiles and Amphibians

A diverse assemblage of amphibians and reptiles are expected to inhabit the habitats present on (or in close proximity) to the RTI site (see Table 5-1). Several amphibian species such as the bullfrog (*Rana catesbienana*) and adult red-spotted newt (*Notaphthalmus viridescens*) are associated with aquatic habitats throughout the year while other amphibian species may use these areas seasonally (e.g. as a breeding area). At other times of the year, these species may forage within uplands located adjacent to these aquatic habitats. Amphibians are generally insectivorous consuming insects and other invertebrates, although larger species such as the bullfrog may also feed on small vertebrates. A variety of salamanders also likely inhabit the RTI facility and former RIP.

Several species of turtles and snakes are likely to utilize the aquatic and terrestrial habitats found on the RTI facility parcel and former RIP. Most of the turtle species expected to inhabit the RTI site or vicinity are omnivorous species that typically forage on the water bottom. Snake species expected to inhabit the area are generally carnivorous and are found both within aquatic and terrestrial habitats.

Fish

The RI reports did not indicate whether fish are present within the small streams found on the former RIP. No fish were observed at the time of the ecological site

reconnaissance. Due to the intermittent surface water flows present within these streams, it is likely that fish, if present, would primarily be restricted to the small areas of permanent ponded water present on the former RIP.

Information regarding fisheries present within Lake Denmark were also not provided in the RI reports. Since the lake is shallow (maximum depth is 20 feet), it is likely that Lake Denmark supports a warm-water fishery. Species that are likely to be present include largemouth bass (*Micropterus salmoides*), brown bullhead (*Ictarus nebulosus*), various sunfish (*Lepomis spp.*), pickerel (*Esox spp.*), yellow perch (*Perca flavescens*), white sucker (*Catostomus commersoni*), and a wide variety of minnow species (*Cyprinidae*).

5.2.2 Hazard Identification

5.2.2.1 Exposure Pathways

For the characterization of ecological risk, the primary media of concern at the RTI site are surface waters and sediments associated with streams present on the RTI facility parcel and former RIP as well as the downgradient Lake Denmark. Possible exposure pathways for ecological receptors on or adjacent to the RTI site include:

- ingestion of contaminated biota in the food chain; and
- contact with and/or ingestion of surface water and sediment contaminants.

Surface soils on the site also represent a potential exposure medium; however, the areas of soil contamination are primarily limited to developed portions of the site. Therefore, significant exposure by most receptor species would be precluded. Exposure of biota to subsurface soils and airborne contaminants (through volatilization or fugitive dust emissions) is assumed to be negligible. Ground water from the RTI

APPENDIX C

DRAFT RISK ASSESSMENT WORK PLAN

Draft Risk Assessment Work Plan
Operable Unit 2
RTI Superfund Site
Rockaway Township, New Jersey

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February 2008

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LIST OF ACRONYMS

AA	Atomic Absorption
AT	Averaging Time
ADI	Average Daily Intake
AET	Apparent Effect Threshold
AOC	Administrative Order of Consent
ATK	Alliant Techsystems, Inc.
BAF	Bioaccumulation Factor
BCF	Bioconcentration Factor
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
COPC	Constituent of Potential Concern
CSF	Cancer Slope Factor
CSM	Conceptual Site Model
EcoSSL	Ecological Soil Screening Level
EPA	U.S. Environmental Protection Agency
EPC	Exposure Point Concentration
ERA	Ecological Risk Assessment
ft	feet/foot
GC	Gas Chromatograph
HEAST	Heath Effects Assessment Summary Tables
HHRA	Human Health Risk Assessment
HI	Hazard Index
HQ	Hazard Quotient
IEUBK	Integrated Exposure Uptake Biokinetic Model
IRIS	Integrated Risk Information System
LADI	Lifetime Average Daily Intake
LDL	Laboratory Detection Limit
LOAEL	Lowest Observed Adverse Effect Level
mg/kg	milligram per kilogram
NCEA	National Center for Environmental Assessment
NJDEP	New Jersey Department of Environmental Protection
NOAEL	No Observed Adverse Effect Level
NRC	National Research Council
PAH	Polyaromatic Hydrocarbon
PRG	Preliminary Remedial Goal
RA	Risk Assessment
RAGS	Risk Assessment Guidance for Superfund
RfCs	Reference Concentrations
RfDs	Reference Doses
RI	Remedial Investigation
RIP	Rockaway Industrial Park
RME	Reasonable Maximum Exposure
ROC	Receptor of Concern
ROD	Record of Decision

RTI	Radiation Technology Inc.
SFs	Slope Factors
SLERA	Screening Level Ecological Risk Assessment
SQL	Sample Quantitation Limit
TEC	Threshold Effect Concentration
TEL	Threshold Effect Level
TRV	Toxicity Reference Value
UCL	Upper Confidence Limit
UCLM	Upper Confidence Limit of the Mean
UET	Upper Effect Threshold
µg	microgram
VOAs	Volatile Organic Analytes
VOCs	Volatile Organic Compounds

1. INTRODUCTION

The RTI site is located at 108 Lake Denmark Road in Rockaway Township, Morris County, New Jersey. The area consists of 263 acres. Included on the site is a 15 acre parcel which is an active facility, currently operated by several small businesses, referred to as the Radiation Technology Site, a 65 acre parcel which is largely abandoned, referred to as the Rockaway Industrial Park (RIP), and a 183 acre parcel which is undeveloped and mostly wooded. The entire parcel is referred to as the RTI Site. Forest habitat is reclaiming the land and access to the property is limited.

Eileen Mahoney Associates, Inc. has been retained by Alliant Techsystems, Inc. (ATK) to provide risk assessment services for the RTI site. A Human Health Risk Assessment (HHRA) will be conducted at the Site, in response to the *Administrative Order of Consent (AOC) and Statement of Work for Performance of the Remedial Investigation/Feasibility Study for the Second Operable Unit at the Radiation Technology Inc. Superfund Site, Morris County, New Jersey* (September 30, 2004). This Work Plan presents the methodology which will be used in conducting the HHRA at the Site.

This Work Plan also documents the proposed methodology which will be followed in conducting a Screening Level Ecological Risk Assessment (SLERA) for the RTI Site, and incorporates comments received from EPA Region 2 on the Draft ERA.

The remaining sections of this report are organized as follows:

- chapter 2 presents a brief description of the data which will be used for both the HHRA and SLERA
- chapter 3 presents the methodology proposed for conducting the HHRA; and
- chapter 4 presents the methodology proposed for conducting the SLERA.

2. DATA EVALUATION

Surface soil, subsurface soil, sediment, and surface water samples will be taken as described in *Draft Remedial Investigation/Feasibility Study Work Plan - Operable Unit 2 (OU-2), RTI Superfund Site, Rockaway Township, New Jersey*, (Conestoga Rovers, 2004) (RI Work Plan). These data will be used to support the HHRA and SLERA. These samples will be analyzed for the target analyte list of metals, volatile organic chemicals, and energetics. In addition, background soil samples (ten surface and ten subsurface) will be taken for target analyte list metals. These will be used for comparison to site soil data.

Historical site data used in the 1993 risk assessments will not be utilized in this risk assessment because there are no detection limits available for those data. ATK believes the current sampling plan provides the data necessary to assess risks at the Site under current and potential future conditions.

The data quality will be evaluated as discussed in Section 3.4.3, reduced, and utilized in both the HHRA and SLERA, as described in chapters 3 and 4.

3. HUMAN HEALTH RISK ASSESSMENT

3.1 INTRODUCTION

The purpose of the Human Health Risk Assessment (HHRA) is to determine whether there are potential human health risks associated with current or potential future human exposures to constituents of potential concern (COPCs) in environmental media at or in the vicinity of the RTI Site.

The HHRA for the RTI Site will be conducted in accordance with the following EPA Guidance:

- Risk Assessment Guidance for Superfund, Volume 1: Human Health Evaluation Manual (Part A) (Interim Final), EPA 1989.
- Risk Assessment Guidance for Superfund, Volume 1: Human Health Evaluation Manual Supplemental Guidance – "Standard Default Exposure Factors" (Interim Final), EPA 1991.
  ProUCL Version 4.0 Software developed by U.S. EPA.
  Las Vegas Technical Support Center for Monitoring and Site Characterization.
  Office of Research and Development, EPA, 2007.

- Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Interim Guidance, EPA 2001a.
- Exposure Factors Handbook, Volumes I, II, and III, EPA 1997a.
- EPA Region IX Preliminary Remediation Goals Table (update), EPA Region IX, 2004.

The risk assessment methodology that will be used in this HHRA involves a four-step process: hazard identification, exposure assessment, toxicity assessment, and risk characterization. A brief description of each step is provided below:

- In the *hazard identification*, environmental monitoring data are evaluated, COPCs are selected for inclusion throughout the remainder of the risk assessment, and the rationale for their selection is documented.
- In the *exposure assessment*, the human population, or groups of individuals potentially exposed to COPCs, (i.e., potential human receptors) are characterized.

From the many potential pathways of exposure, pathways applicable to potential receptors at the site are identified. The concentrations of COPCs in relevant media (e.g., surface soil, air) are converted into systemic doses, taking into account rates of contact (e.g., ingestion rates) and absorption rates of different COPCs. The magnitude, frequency, and duration of these exposures are then integrated to obtain estimates of daily doses over a specified period of time (e.g., lifetime, less-than-lifetime).

- In the *toxicity assessment*, the relationship between extent of exposure and extent of toxic injury or disease is estimated for each COPC. Chemical-specific toxicity values, such as cancer slope factors (SFs) and reference doses (RfDs) or reference concentrations (RfCs) for non-carcinogens, are presented along with a discussion of their scientific basis and derivation.
- *Risk characterization* integrates the results of the toxicity assessment and the exposure assessment to derive quantitative estimates of human health risk, including the risks both of cancer and from non-carcinogens. The major uncertainties and limitations associated with the estimates of risk and their potential ramifications are presented in this section.

3.2 PREVIOUS HUMAN HEALTH RISK ASSESSMENT RESULTS

A human health risk assessment was completed for the Site by TRC, as contractor to NJDEP, entitled *Draft Final Risk Assessment, Radiation Technology Incorporated, Rockaway Township, New Jersey, Risk Assessment* (TRC 1993). Receptors of concern included commercial workers, adolescent trespassers, residents, and construction workers. Media of concern included groundwater, surface and total soil, surface water, and sediment. The results indicate unacceptable risks due to groundwater at the Site, under a future residential scenario. These risks were addressed in the Record of Decision (EPA 1994a). There were no unacceptable risks identified for surface water or sediment at the Site. Risks from potential exposures to soils were acceptable for all receptors except for non-cancer risks for a potential future resident exposed to surface soil. These risks were driven by antimony. EPA Region 2 has requested that additional data be taken and human health risks assessed utilizing these data.

3.3 CONCEPTUAL SITE MODEL (CSM)

The RTI Site consists of three parcels. The first is a 183 acre undeveloped woodland. It is believed that this area has never been developed. The second parcel is a 65 acre

industrial park formerly used by Thiokol as a rocket testing facility, until 1969. There are currently several small businesses operating there. Most of the buildings have deteriorated and are not in use. The third is a 15 acre parcel that is separated from the rest of the property by Lake Denmark Road. This building was formerly used by Thiokol for administration and warehousing. It was later operated by Radiation Technology Inc for the irradiation of food products, and for manufacturing a radiation-treated wood product. It is currently occupied by Ion Beam Applications, Inc for the irradiation of food products.

Potential receptors at the site under current land use are employees at the small businesses and trespassers, including hunters. Land in the vicinity is mostly rural, but there is a residential development nearby. Therefore, commercial workers and adolescent trespassers are potential current receptors at the site. Hunters are not considered for ingestion of game due to the broad range of these animals. There are no residences at the site, and there are currently no plans to develop the land for residential use. However, ATK will evaluate potential risks for future residents as a baseline in this HHRA. Construction workers may be potential future receptors if construction takes place in the future. Therefore, receptors assessed at the site will include commercial workers, adolescent trespassers, residents, and construction workers.

Media of concern include soil and air (that could result from dispersion of surface and subsurface soil into air, or volatiles), as well as surface water, and sediment in the on-site stream. Groundwater is not considered a medium of concern because it has been addressed in *Record of Decision, Radiation Technology Incorporated (RTI)* (USEPA, May 5, 1994) (ROD).

The exposure pathways considered for current commercial workers include incidental soil ingestion, dermal exposure to, and inhalation of air emissions from surface soil. Incidental ingestion of, and dermal contact with sediment in the stream, are also evaluated for commercial workers. Inhalation is not considered to be a complete pathway for sediments because they are wet and unlikely to become airborne. There is little reason for workers to come in contact with surface water. Therefore exposures to surface water are not evaluated for this receptor. An exposure pathway analysis is presented in Table 3.1.

The exposure pathways considered for current adolescent trespassers include incidental soil ingestion, dermal exposure to, and inhalation of air emissions from surface soil.

Incidental ingestion of, and dermal contact with surface water and sediment in the stream, are also evaluated for adolescent trespassers. Inhalation exposures to sediment and surface water are not considered to be complete because sediments are wet and not likely to become airborne, and any volatiles in surface water are likely to have evaporated. An exposure pathway analysis is presented in Table 3.1.

The exposure pathways considered for future resident adults and children include incidental soil ingestion, dermal exposure to, and inhalation of air emissions from total soil. Total soil includes surface and subsurface soil. Incidental ingestion of, and dermal contact with surface water and sediment in the stream, are also evaluated for residents. An exposure pathway analysis is presented in Table 3.1.

The exposure pathways considered for future construction workers include incidental soil ingestion, dermal exposure to soil, and inhalation of air emissions from total soil. Incidental ingestion of, and dermal contact, with sediment or surface water in the stream are not considered to be significant for the construction worker because of the very short exposure duration for this receptor. An exposure pathway analysis is presented in Table 3.1.

The potential for inhalation of vapors resulting from vapor intrusion from soil into on-site buildings, and potential use scenarios under which buildings may be constructed, will be considered as a possible exposure pathway at the site. This evaluation will be based on an analysis of soil data collected at the site during the Operable Unit 2 RI for soil. Potential impacts from vapors from ground water at the site will be assessed in the ground water HHRA.

3.4. HAZARD IDENTIFICATION

The purpose of the hazard identification process is to summarize data and identify COPCs that will be evaluated in the baseline risk assessment.

3.4.1 Data Summary

Data will be entered into a database and summarized separately for each of the media of concern identified. Details of the sampling plan is provided in *Draft Remedial Investigation/Feasibility Study Work Plan - Operable Unit 2 (OU-2), RTI Superfund Site, Rockaway Township, New Jersey,* (Conestoga Rovers, 2004) (RI Work Plan). The data

will be compiled by chemical, medium, sample identification, and sample depth, and will include sample-specific quantitation limits for all non-detects. Surface soil (0 to 1 ft below ground surface (bgs) and total soil (0 to 10 ft bgs) data will be summarized separately. Data summary tables will consist of information presented in the format of the Risk Assessment Guidance D (RAGS, 1996) Tables 2s and 3s, and will include the following: minimum and maximum detected concentrations; the arithmetic mean concentration; detection frequency; 95 percent upper confidence limit (95UCL) on the mean; Reasonable Maximum Exposure (RME); Exposure Point Concentration (EPC); EPC statistic; and EPC rationale. The data summary tables will present the 95 percent UCL of the mean for the appropriate data distribution of each chemical. Only RME data will be presented.

All compounds that are detected at least once within a site/medium grouping will be included in the summary tables for that particular site/medium. Non-detects for such chemicals will be evaluated as one-half the sample quantitation limit.

3.4.2 Selection of COPCs

Initially, all target analytes (identified in the individual sampling plans) detected at concentrations exceeding the Sample Quantitation Limit (SQL) or the laboratory detection limit (LDL) will be evaluated. The frequency of detection and range of SQLs for each analyte, in each medium of interest, will be examined. Selection of COPCs for inclusion in the HHRA will include the following steps:

- Analysis and evaluation of data quality;
- Utilization of a risk-based concentration screen (i.e., Preliminary Remedial Goals (PRG)s [EPA 2004]) to identify COPCs, as recommended by EPA Region I;
- Review of the preliminary COPC list and exclusion of analytes based on additional considerations, such as essential nutrient status, as per EPA guidance (EPA 1989);
- Evaluation of the potential toxicity of COPCs for which there are no risk-based screening concentrations and inclusion of analytes, where warranted, on the basis of known toxicity (e.g., elemental lead), structural similarity to other toxicants, other relevant guidance, and/or additional considerations;
- Evaluation of frequency of detection;
- Comparison to background; and

- Review of the final COPC list to ensure that both selection and exclusion of COPCs for the HHRA were justified. All Class A carcinogens detected in site media will be retained in the HHRA.

3.4.3 Data Quality Evaluation

The first step in the process of selecting COPCs will be the evaluation of analytical data on the basis of qualifiers and the frequency of detection in each medium of concern. Inclusion or exclusion of data on the basis of analytical qualifiers will be performed in accordance with EPA guidance (EPA 1989):

- Analytical results bearing the U qualifier (indicating that the analyte was not detected at the given SQL) will be retained in the data set and considered nondetects. Where warranted for statistical purposes, each COPC will be assigned a numerical value of one-half its SQL;
- Analytical results bearing the J qualifier (indicating that the reported value was estimated because the analyte was detected at a concentration below the SQL or for other reasons) will be retained at the measured concentration;
- Analytical results bearing the D qualifier (indicating that the analyte was identified in an analysis involving dilution) will be retained at the measured concentration;
- Analytical results bearing the N qualifier (indicating presumptive evidence of compound) will be retained at the measured concentration;
- Analytical results bearing the E qualifier (indicating that the reported value was estimated due to matrix interferences) will be retained at the measured concentration;
- Analytical results bearing the S qualifier (indicating that the reported concentration was determined by the Method of Standard Additions) will be retained at the measured concentration;
- Analytical results bearing the W qualifier (indicating that post-digestion spike for furnace atomic absorption (AA) analysis is out of control limits, while sample absorbency is <50 percent of spike absorbency) will be retained at the measured concentration;
- Analytical results bearing the * qualifier (indicating that duplicate analyses are not within control limits) will be retained at the measured concentration; and
- Analytical results bearing the P qualifier (indicating the reported results, using gas chromatograph (GC) columns, are not within 25 percent of each other) will be retained at the measured concentration.

If duplicate samples are collected or duplicate analyses are conducted on a single sample, the following guidelines will be employed to select the appropriate sample measurement:

- If both samples/analyses show that the analyte was present, the average of the two detected concentrations will be utilized;
- If only one sample/analysis indicates that the analyte is present, it will be retained; and
- If both samples/analyses are non detect, the lower SQL will be retained, if selected as a COPC.

Common laboratory contaminants, including acetone, 2-butanone, methylene chloride, chloroform, toluene, phthalate esters, and "uncommon" laboratory contaminants, will be considered to be COPCs unless it is evident that their presence is not related to site-specific activities but is in fact due to laboratory contamination (e.g., due to presence in blanks).

Analytical results for these compounds will be evaluated according to EPA guidance (EPA 1989a) concerning the occurrence of common and uncommon laboratory contaminants in blank samples. For common and uncommon laboratory contaminants, individual sample results bearing the B or BJ qualifiers (which indicate that the chemical was detected in an associated blank for organic compounds) will be retained in the risk analysis and treated as non-detects. The B or BJ qualified concentration will be treated as the new detection limit.

3.4.4 Risk-Based Screening

Risk-based screening will be conducted by comparing maximum detected chemical concentrations in soil to EPA Region IX residential PRGs (EPA 2004a). The EPA Region IX PRG tables combine current EPA toxicity values with standard exposure factors to estimate contaminant concentrations in environmental media (soil, air, water) that are protective of humans, including sensitive groups, over a lifetime. The PRGs consist of concentrations for nearly 600 chemicals that, in general, correspond to fixed levels of risk (i.e., either a one-in-one-million cancer risk or a non-carcinogenic hazard quotient of one, whichever occurs at a lower concentration) in soil, air, and water. There are two important exceptions to risk-based standards for soil: (1) PRGs are based on a soil saturation equation for several VOCs; and (2) a non-risk-based "ceiling limit" is given as 10^{+5} mg/kg for relatively less toxic semivolatile contaminants.

For each chemical at each site, maximum detected concentrations will be compared against health-based screening criteria. Soil data will be compared against EPA Region IX residential soil PRGs (EPA 2004a). Sediment data will also be compared against EPA Region IX residential soil PRGs; this is a conservative approach because human exposure to sediment is likely to be considerably less than daily residential soil exposure. Surface water will be compared against (1) *Surface Water Quality Standards* (NJDEP, 2004), (2) *National Recommended Water Quality Criteria:2002* (EPA 2002b) for assessment of direct exposures (EPA 2002b), or (3) Region IX tap water PRGs, in that order. In accordance with EPA Region IX guidance, PRG values used will be those at a cancer risk level of $1x10^{-6}$ and a hazard quotient of 0.1, for the purpose of screening.

Per EPA guidance, the following process will be utilized.

1. The maximum concentration of each chemical detected in each medium will be identified.
2. If the maximum concentration of a specific chemical exhibiting carcinogenic effects exceeds its screening value, the chemical will be retained as a COPC, and will be assessed for risk assessment for all routes of exposure involving the medium.
3. If the maximum concentration of a specific chemical exhibiting non-carcinogenic health effects exceeds its screening value, the chemical will be retained as a COPC, and will be assessed for all routes of exposure involving the medium.
4. If the maximum concentration of a specific chemical in surface water exceeds its screening value, the chemical will be retained as a COPC.
5. In a given medium, if no carcinogenic chemicals are present at concentrations exceeding its screening value, then the medium will be excluded from the risk assessment.
6. If a chemical is detected in at least one sample in a specific medium, it will be retained for consideration in the screening of COPCs. If the chemical is retained as a COPC, all reported non-detects for the chemical will be considered to be present at one-half the SQL.

3.4.5 Additional Considerations in Screening for COPCs

The preliminary list of COPCs selected on the basis of risk-based screening will be further evaluated, using additional considerations:

1. If a risk-based screening concentration (i.e., EPA Region IX PRGs) is not available for a specific chemical in a particular medium, the risk-based screening concentration for a structurally similar compound will be used, if warranted. The hierarchy of sources for toxicity values for this purpose is described in section 3.6.

For example, PRGs for pyrene could be used for structurally similar non-carcinogenic PAHs, including benzo(g,h,i)perylene and phenanthrene.

2. An analyte will be eliminated from the list of COPCs if it is an essential nutrient of low toxicity, and its reported maximum concentration is unlikely to be associated with adverse health impacts. COPCs to be excluded from further consideration on this basis includes calcium, magnesium, potassium, and sodium. Iron will be screened using the newly issued RfD from the PPRTV database, and will be assessed qualitatively and quantitatively, if values in site media exceed risk-based screening values.

3.4.6 Frequency of Detection

Constituents that are detected in fewer than 5% of total samples, will be eliminated from the list of COPCs.

3.4.7 Comparison to Background

The recent OSWER Directive on Background at CERCLA sites (9285.6-07P) states that it is acceptable to screen out background constituents in the COPC selection process, if the potential risks associated with background analytes are addressed in the HHRA (EPA 2001b).

Reference soil samples will be taken from areas of the site the have not been impacted by site activities. Ten samples will be taken, 0-1 foot representing surface soil, and 1-3 feet (or refusal) to represent subsurface soil. The details of reference sampling are discussed in the RI Work Plan (Conestoga Rovers, 2004). A comparison of surface to subsurface reference soil samples will be conducted in order to determine if the matrices need to be considered separately for risk assessment. A paired t-test at the 95% significance level will be used to determine if co-located surface and subsurface samples can be averaged for determination of a combined soil EPC and comparison to reference data. If the paired t-test shows that surface and subsurface soils are significantly different, comparisons with

site data will be made separately for surface soil and subsurface soil. If the paired t-test shows that there is no significant difference between reference surface and subsurface soil, the data will be combined for statistical comparison to site soils.

Soil samples collected at the RTI Superfund Site will be compared to reference samples using hypothesis testing with the following null hypothesis:

$$H_0: \mu_{site} \leq \mu_{ref}$$
$$H_a: \mu_{site} > \mu_{ref}$$

The hypothesis test will be evaluated in accordance with USEPA (2007a) 95% significance level. Rejection of the null hypothesis will result in the conclusion that analyte concentrations at the RTI Superfund Site exceed reference concentrations. If the frequency of detection (FOD) for both the site and background data sets is at least 60%, the Wilcoxon Rank Sum (WSR) test will be used. If the FOD exceeds 60% for either the site or background data sets, then the Gehan test will be used. All statistical tests will be computed using ProUCL version 4.0 or SAS^{Ò} version 8.

The results of the background comparison will be presented to EPA as a separate deliverable, and will examine each of the three exposure areas at the site separately. If EPA agrees with ATK's assessment, background analytes will not be carried through the quantitative risk assessment, but will be assessed qualitatively in the Risk Characterization section.

For constituents that are eliminated from the HHRA based on background screening, a semi-quantitative discussion of their potential impact on overall site risks will be presented in the Risk Characterization. Chemicals that fall below background or health-based screening criteria will not be evaluated quantitatively in the risk assessment.

Comparison to Published Background Data

If unacceptable risks are identified due to inorganics in Site soil, site-specific data for these analytes will be compared to published ambient levels of metals in New Jersey Soils (Sanders 2003). For these comparisons, the 95% upper confidence limit on the 90th percentile will be compared to the published values of 90th percentile concentrations of

ambient metals. These results will be discussed in the Summary and Uncertainty Sections of the Risk Assessment Report.

3.5 EXPOSURE ASSESSMENT

An exposure assessment is conducted to estimate the magnitude of actual and/or potential human exposures. In the exposure assessment, average and maximum estimates of potential exposure are developed in accordance with EPA guidance for both current and potential future land-use assumptions. Conducting an exposure assessment involves analyzing releases of COPCs; identifying all potential pathways of exposure; estimating average and maximum potential exposure point concentrations for specific pathways based both on environmental monitoring data and predictive chemical modeling results; and estimating potential chronic daily intakes for specific pathways. The results of this assessment are pathway-specific maximum estimates of potential intakes for current and future exposures to individual COPCs.

3.5.1 Potential Receptor Populations

Potential receptors at the site under current land use are employees at the small businesses. Land in the vicinity is mostly rural, but there is a residential development nearby. Therefore, adolescent trespassers are potential current receptors at the site. There are no residences at the site, and there are currently no plans to develop the land for residential use. However, ATK will evaluate potential risks for future residents as a baseline in this HHRA. Construction workers may be potential future receptors if construction takes place in the future. Therefore, receptors assessed at the site will include commercial workers, adolescent trespassers, residents, and construction workers.

3.5.2 Exposure Pathways

An exposure pathway describes a mechanism by which a population or individual may be exposed to chemicals present at a site. A completed exposure pathway requires the following four components:

- A source and mechanism of chemical release to the environment;
- An environmental transport medium for the released chemical;
- A point of potential human contact with the contaminated medium; and
- A human exposure route at the point of exposure.

All four components must exist for an exposure pathway to be complete and for exposure to occur. Incomplete exposure pathways do not result in actual human exposure and are not included in the exposure assessment and resulting risk characterization. The following human exposure pathways were identified for evaluation for the RTI Site and are listed in Table 3.1.

Exposures via Surface Soil

The following exposure pathways are considered to be complete for the RTI Site under current trespasser and commercial worker use:

- Incidental ingestion of surface soil during commercial worker activities and
- Dermal contact with surface soil during commercial worker activities.
- Incidental ingestion of surface soil during trespassing activities and
- Dermal contact with surface soil during trespassing activities.

Exposures via Total Soil

The following exposure pathways are considered to be complete for RTI Site under potential future residential and construction worker use:

- Incidental ingestion of total soil during residential activities and
- Dermal contact with total soil during residential activities.
- Incidental ingestion of total soil during construction activities and
- Dermal contact with total soil during construction activities.

Exposures via Air

The following exposure pathways are considered to be complete for the RTI Site under current trespassers and commercial workers, and under potential future residential and construction worker use:

- Inhalation of suspended soil particles during trespasser, commercial worker, construction worker and residential activities and
- Inhalation of volatiles in total soil, if identified.

The potential for inhalation of vapors resulting from vapor intrusion from soil into on-site buildings, and potential future buildings, will be considered as a possible exposure pathway at the site. This evaluation will be based on an analysis of soil data collected at the site during the Operable Unit 2 RI for soil. Potential impacts from vapors from ground water at the site will be assessed in the ground water HHRA.

Exposures via Surface Water

The following exposure pathways are considered to be complete for the RTI Site under current and potential future use:

- Incidental ingestion of surface water during recreational activities by adolescent trespassers or residents and
- Dermal contact with surface water during recreational activities by adolescent trespassers or residents.

Exposures via Sediment

The following exposure pathways are considered to be complete for the RTI Site under current or potential future use:

- Incidental ingestion of sediment during recreational activities by adolescent trespassers, commercial workers, or residents and
- Dermal contact with sediment during recreational activities by adolescent trespassers, commercial workers, or residents.

3.5.3 Quantification of Potential Exposures

3.5.3.1 Estimating Exposure Point Concentrations

Sampling data for media of concern will be evaluated for use in this HHRA. Fate and transport modeling will be performed to estimate air concentrations of COPCs in the particulate phase (EPA 1996b). The methods to be used to estimate exposure point concentrations (EPCs) for each of these media are described below. For each medium of concern at the Site, EPCs will be calculated across the site, as one exposure area.

EPCs in media of concern will be estimated as the 95 percent upper confidence limit of the mean (95UCLM) for purposes of estimating reasonable maximum exposures (RMEs). In cases where the 95UCLM values exceed the maximum detected concentration, the maximum detected concentration will be used.

Calculation of the One-Tailed 95% UCLM for Reasonable Maximum Exposure Concentration

The 95% UCLM for each COPC will be calculated using USEPA's ProUCL Version 4.0 software (EPA 2007a). ProUCL, Version 4.0 consists of all parametric and non-parametric UCL computation methods as described in this revised EPA UCL Guidance Document. ProUCL also computes the UCLs of the unknown population mean based upon the positively skewed gamma distribution, which is often better suited to model environmental data sets than the lognormal distribution.

Air

Air samples will not be collected at the RTI Site. Therefore, it will be necessary to model concentrations of semivolatile and inorganic COPCs in suspended surface and subsurface soil, using standard assumptions published by EPA Region IX.

3.5.3.2 Exposure Equations

The final step in the exposure assessment will be to estimate COPC intakes for each of the pathways considered in the assessment. In this exposure assessment, two different measures of intake will be provided, depending on the nature of the effect being evaluated. When evaluating longer-term (i.e., subchronic and chronic) exposures to chemicals that produce adverse non-carcinogenic effects, intakes are averaged over the period of exposure (i.e., the averaging time [AT]) (EPA 1989). This measure of intake is referred to as the average daily intake (ADI) and is a less than lifetime exposure. For chemicals that produce carcinogenic effects, intakes are averaged over a lifetime (e.g., 70-year lifetime) and are referred to as the lifetime average daily intake (LADI) (EPA 1989).

The generic equation to calculate intakes is given below:

$$(L)ADI = \frac{C \text{ x } IF \text{ x } EF \text{ x } ED \text{ x } RAF}{BW \text{ x } AT} \text{ x CF}$$

Where:

(L)ADI	=	(Lifetime) Average daily intake (mg/kg-day)
C	=	Concentration in a specific medium (mg/L or mg/kg)
IF	=	Intake factor[1] (mg/day)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
RAF	=	Relative absorption factor (unitless)
BW	=	Body weight (kg)
AT	=	Averaging time (days)
CF	=	Conversion Factor (10^{-6} kg/mg)

3.5.3.3 Selection of Exposure Factor Values

All exposure factor values used in estimating intakes are described and referenced in Tables 3.2 through 3.13. The following guidance documents were used in defining exposure factor values for estimating intakes for exposure pathways evaluated at the RTI Site:

- Office of Solid Waste and Emergency Response (OSWER) Directive 9285.6-03; Human Health Evaluation Manual Supplemental Guidance: "Standard Default Exposure Factors" EPA 1991.
- Risk Assessment Guidance for Superfund, Volume I Human Health Evaluation Manual Part A, EPA, December 1989 (RAGS A).
- Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual, Part E Supplemental Guidance for Dermal Assessment, Interim Guidance, (RAGS E). EPA 2001a.

For all exposure pathways that have exposure factor values specified in OSWER Directive 9285.6-03, those values will be used in this risk assessment. For exposure values not specified in the OSWER Directive, RAGS A and RAGS E will be used as guidance.

[1] The intake factor is the product of all intake variables that, when multiplied by the concentration of the chemical of potential concern in a specific medium, results in an estimate of the chemical intake in mg/kg-day for that population and exposure pathway. Intake factors may include ingestion rate, inhalation rate, body surface area exposed to soil or water, dermal permeability constants, and soil adherence factors.

3.6 TOXICITY ASSESSMENT

For all COPCs, toxicity values for carcinogens and non-carcinogens will be taken, when available, from the Integrated Risk Information Systems (IRIS) database (EPA 2007). IRIS chronic Reference Doses (RfDs), Reference Concentrations (RfCs) and Cancer Slope Factors (CSFs) are developed by EPA and undergo an extensive process of scientific peer review. Therefore, IRIS values are judged as adequately verified.

If toxic potency concentrations for COPCs are not available from IRIS (EPA 2007b), the EPA Provisional Peer Review Toxicity Values (PPRTV) database will be used. If PPRTV values are not available, EPA will request values from the National Center for Environmental Assessment (NCEA) Office of Research and Development. Health effects assessment summary tables (HEAST) (EPA 1999a) will be used as a source, if the sources listed above cannot provide values. As HEAST toxicity values are not scientifically peer-reviewed for quality or scientific acceptability, they may not be derived in strict accordance with EPA-approved methodologies.

3.7 RISK CHARACTERIZATION

Risk characterization is the final step of the HHRA process. In this step, the toxicity values will be combined with the estimated chemical intakes for the receptor populations in order to quantitatively estimate both carcinogenic risks and risks for non-carcinogens. The methodologies used to estimate cancer risks and chronic and subchronic risks for non-carcinogens are described further in the sections below.

3.7.1 Cancer Risks

Carcinogenic risk will be estimated as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to a potential carcinogen at the site. The numerical estimate of excess lifetime cancer risk will be calculated by multiplying the LADI by the risk per unit dose (the slope factor), as shown in the following equation:

$$Risk = LADI \times SF$$

Where:

Risk	=	The unitless probability of an exposed individual developing cancer
LADI	=	Lifetime average daily intake (mg/kg-day)
SF	=	Cancer slope factor $(mg/kg\text{-}day)^{-1}$

Because the slope factor is the statistical 95th percent upper-bound confidence limit on the dose-response slope, this method provides a conservative, upper bound estimate of risk. If cumulative cancer risks exceed 10^{-2}, section 8.2 of RAGS A guidance will be used to assess accurate cancer risks.

Chemical-specific and pathway-specific risk estimates for each medium, as well as total risk estimates for each receptor across media, will be presented by receptor group.

3.7.2 Hazard Index for Noncarcinogenic Effects

The potential human health risks associated with exposures to non-carcinogenic COPCs at the RTI Site will be estimated by comparing ADIs with established RfDs, per EPA Guidance (EPA 1989). A hazard quotient (HQ) will be derived for each COPC, as shown in the equation below:

$$HQ = \frac{ADI}{RfD}$$

Where:

HQ	=	Hazard Quotient; ratio of average daily intake level to acceptable daily intake level (unitless)
ADI	=	Estimated average daily intake (mg/kg-day)
RfD	=	Reference dose (mg/kg-day)

If the average daily dose exceeds the RfD, the HQ will exceed one and there may be concern that potential adverse systemic health effects will be observed in the exposed populations. If the ADI does not exceed the RfD, the HQ will not exceed one and there may be no concern that potential adverse systemic health effects will be observed in the exposed populations. However, if the sum of several HQs exceeds one, and the COPCs affect the same target organ, there may be concern that potential adverse systemic health effects will be observed in the exposed populations. In general, the greater the value of

the HQ above one, the greater the level of concern. However, the HQ does not represent a statistical probability that an adverse health effect will occur.

For consideration of exposures to more than one chemical causing systemic toxicity via several different pathways, the individual HQs are summed to provide an overall Hazard Index (HI). If the HI is less than 1.0, then no adverse health effects are likely to be associated with exposures at the site. However, if the total HI is greater than 1.0, separate endpoint-specific HIs may be calculated based on toxic endpoint of concern or target organ (e.g., HQs for neurotoxins are summed separately from HQs for renal toxins). Only if an endpoint-specific HI is greater than 1.0 is there reason for concern about potential health effects for that endpoint.

3.7.3 Risks Associated With Lead

Lead risks will be evaluated using EPA's Integrated Exposure Uptake Biokinetic Model (IEUBK), if lead is identified as a COPC at the site. The IEUBK Model is used to estimate blood lead concentrations resulting from exposure to environmental sources. This method has been suggested by the EPA Office of Air Quality Planning and Standards (OAQPS) Staff Report (EPA 1994b). The IEUBK Model is a three-stage method for estimating total blood lead levels. First, the intake of lead from each source is assessed. Second, the uptake of lead from each source is determined. Finally, the relationship between the uptake of lead and blood lead concentration is applied using the "Integrated Metabolic Model for Humans of All Ages," as revised by Harley and Kneip (1985).

The EPA has created a software program of the IEUBK Model, for predicting blood lead levels in children ages 0-84 months, for use on a personal computer. The most current software is LEAD version 0.99D (LEAD99D). LEAD99D will be used in this assessment for estimating blood lead levels in children at this site. Standard default values used as input parameters for the model are described by EPA (1994b). The model output is a probability distribution function describing the percentage of children predicted to have blood lead levels exceeding 10 µg/dL.

3.8 UNCERTAINTIES ASSESSMENT

There are numerous uncertainties involved in the human health risk assessment process. These will be discussed briefly in the uncertainty assessment.

4. SCREENING LEVEL ECOLOGICAL RISK ASSESSMENT

4.1 INTRODUCTION

A Screening-Level Ecological Risk Assessment (SLERA) will be conducted based on these new soil, sediment and surface water data. The purpose of the SLERA will be to determine if, under expected exposure conditions, chemicals and metals found in soil, sediment and surface water at the RTI site are at concentrations that may cause unacceptable risk to organisms using the area.

EPA utilizes an 8-step process for assessing ecological risk (Figure 2, EPA 1997b). A SLERA consists of Step 1 and 2, which is a preliminary screening process using very conservative assumptions. This process is of such conservatism that it is not unusual for any detected chemical or metal to be found to be of potential risk for ecological receptors. Consequently a second tier of the risk assessment process will be performed consistent with EPA guidance (EPA 2001c), specifically refining of exposure assumptions, which will provide a more realistic assessment of potential risks to ecological receptors at the RTK Site. This work plan presents the exposure and toxicity assumptions that will be used not only in the conservative Step 1 and 2 ERA, but also in the revised Step 3 ERA.

EPA Region II uses the Federal EPA Guidance for designing and conducting ecological risk assessments (EPA 1997b). The ecological risk assessment approach will incorporate the following available guidance on ecological risk assessment:

- *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments* (EPA 1997b)
- *Guidelines for Ecological Risk Assessment* (EPA 1998)
- *Issuance of Final Guidance: Ecological Risk Assessment and Risk Management Principles for Superfund Sites* (EPA 1999b)
- *The Role of Screening-Level Risk Assessments and Refining Contaminants of Concern in Baseline Ecological Risk Assessments* (EPA 2001c)

4.2 CONCEPTUAL SITE MODEL

The conceptual site model (CSM) is a description of the physical and ecological characteristics of the site, potential exposure scenarios, identification of receptors of concern (ROCs), and assessment and measurement endpoints.

A major element in every CSM is a description of the exposure scenarios. This consists of four elements:

- Source of constituents of potential concern (COPC) and release mechanism(s)
- Transport medium and mechanism of transfer from primary to subsequent media
- Point (or area) of potential ROC contact with the COPC
- Route of uptake by the ROC (ingestion of soil, sediment, food, and bioconcentration)

The CSM for the RTI Site is shown in Figure 3. On the basis of this CSM, there are complete exposure pathways for surface soil in terrestrial habitats and complete exposure pathways for sediment and surface water for ecological receptors at the RTI Site. From these environmental media, some COPCs could bioaccumulate in plants and prey animals that may be eaten by other consumers.

4.2.1 Receptors of Concern

Ecological Receptors of Concerns (ROCs) are species or guilds of species that are important to the ecology of the study area and that may be susceptible to chemical constituents detected at the site. The earlier risk assessment (TRC 1993) provided an excellent summary of the environment at the RTI site in 1992. Since then the site has been left alone, and reforestation has taken over many of the former industrial areas so much so that it is no longer a reasonable assumption that the former industrial areas do not represent habitat for ecological receptors. Consequently a terrestrial SLERA will be conducted in addition to an aquatic SLERA. ROC examples could include an area of riparian wetland, a particular bird species, a benthic community, or a fish. Selection of ROCs is systematic, representative, and ecologically based to ensure that assessment endpoints are adequately addressed. Criteria used to identify ecological ROCs include the following:

- Presence – known or expected to occur onsite
- Susceptibility – exposure pathway is likely complete and of sufficient duration/magnitude
- Representative – of the food web and/or guild
- Data Availability – sufficient and appropriate type of toxicity and exposure information
- Societal Importance – species merits public attention

No known Federal listed threatened or endangered species are known to exist at the RTI site, however TRC (1993) identified several State-listed species of special concern. As a part of the SLERA the status of Federal and State species of concern will be re-investigated. Ecological receptors of concern identified for the RTI Site include:

- **Terrestrial ROCs**

Terrestrial Plants—Plant communities are important to the structure and function of terrestrial ecosystems and are directly exposed to soils on a site. No observations of impacted plants were made during a site walkover on November 18, 2004 (although November is not a particularly good time of year of observe such impacts), or are expected at the site. Plants represent the base of food webs, and thus are critical receptors of concern.

Terrestrial Invertebrates (Earthworms)—Soil invertebrates are very important to the fertility of soils because of their role in the aeration and turnover of surface soils. Earthworms will serve as a guild representative for the other invertebrates (i.e., beetles, termites, grasshoppers, butterflies, spiders, moths, and wasps). Earthworms are in continuous contact with any soil-associated contaminants that may be present.

Terrestrial Avian Species—Numerous avian species utilize the habitat at the RTI Site. Two avian receptors of concern have been selected, the American robin and American kestrel. The robin is a thrush, and consumes relatively large amounts of invertebrates and fruit. The kestrel is a small raptor that utilizes edge habitat such as that found at the RTI Site and consumes invertebrates and mice.

Terrestrial Mammalian Species—Small and medium mammals utilize habitat like that found at the RTI Site. Four mammal species have been selected as ROCs, all of which have available exposure and toxicological information. Both the short-tailed shrew and meadow vole are small mammals; however, they consume different food. The short-tailed shrew is more of a carnivore that consumes almost its entire body weight per day in food. The meadow vole is more of a herbivore, and does not consume as much food per day. One medium mammal ROC is the Eastern cottontail, which is an herbivore that prefers habitat represented by the RTI Site. The red fox has been selected as a medium-sized omnivore that is expected to be found around and on the site.

- **Aquatic ROCs**

Surface Water Receptors—Surface water ROCs include aquatic plants and animals. COPCs may impact these receptors in the streams and wetlands found at the site.

Sediment Receptors—Sediment ROCs at the RTI Site include benthic organisms such as oligochaetes (worms), mayflies, and midges that live in the sediments found in streams and wetlands.

Aquatic Mammalian Species—Medium-sized mammals may utilize habitat like that found at the RTI Site. The American mink has been selected as the ROC for evaluating potential adverse effects to small mammals from the ingestion of fish and aquatic invertebrates. The diet of the mink consists primarily of fish and benthic organisms, and this ROC is consequently exposed to risks from contaminants accumulated through the food chain from both surface water and sediments.

4.2.2 Assessment and Measurement Endpoints

EPA guidance stresses the importance of ecologically significant endpoints. As discussed by EPA, "Assessment endpoints are explicit expressions of the actual environmental value that is to be protected, operationally defined by an ecological entity and its attributes." (EPA 1998). Failure to select appropriate assessment and measurement endpoints can result in the inability to answer the risk questions central to an ERA. Several criteria are applicable for endpoint selection (Suter 1993; EPA 1998):

- Unambiguous Definition—Assessment endpoints should indicate a subject and a characteristic of the subject (such as American robin reproduction).
- Accessibility to Prediction and Measurement—Assessment endpoints should be reliably predictable from measurements.
- Susceptibility to the Hazardous Agent/Stressor—Susceptibility of an organism (plant or animal) results from the combination of potential for exposure and the sensitivity to the concentrations of contaminants or other stressors of concern.
- Biological Relevance—Biological relevance of impacts to an individual organism is determined by the importance of the impact to higher levels of biological organization such as populations or communities.
- Social Relevance and Policy Goals—Assessment endpoints should be of value to

decision-makers and the public. The assessment endpoints should represent effects that, if adversely affected, could warrant consideration of site remediation or alteration of project plans. Assessment endpoint selection should also include endpoints that may be mandated legally (e.g., protected species).

The extent to which these items are considered varies from site to site, and it depends on several factors including the level of public involvement, the ecological character of the site, and the lead regulatory agency involved in the assessment.

Based on the ROCs identified for the RTI site, the habitat, and the above observations, the following ecological assessment endpoints are defined:

1. Protection of plant communities to ensure that COPCs in soil do not have unacceptable adverse effects on survival, growth, and reproduction of key plant species, which may result in adverse effects to the community structure such as diversity or biomass.
2. Protection of soil-invertebrate communities to ensure that COPCs in soil do not have unacceptable adverse effects on survival, growth, and reproduction of key soil invertebrate species, which may result in adverse effects to the community structure such as diversity or biomass.
3. Ecological health of aquatic water column communities to ensure that aquatic organisms that live in the streams and wetlands do not experience adverse effects on survival, growth, and reproduction.
4. Protection of benthic organisms that live in the sediment streams and wetlands to ensure that COPCs in these media do not have adverse effects on survival, growth, and reproduction.
5. Protection of birds, represented by the omnivorous American robin and carnivorous American kestrel, to ensure that ingestion of COPCs in food items and soil does not have unacceptable adverse impacts on survival, growth, and reproduction.
6. Protection of terrestrial mammals, represented by the small omnivorous short-tailed shrew, small omnivorous meadow vole, medium-sized herbivorous Eastern cottontail, and medium-sized carnivore red fox to ensure that ingestion of COPCs in food items and soil does not have unacceptable adverse impacts on survival, growth, and reproduction.
7. Protection of aquatic mammals, represented by the American mink, to ensure that ingestion of COPCs in food items exposed to surface water and sediment and incidental ingestion of sediment does not have unacceptable adverse impacts on

survival, growth, and reproduction.

Measurement endpoints are measurable ecological characteristics that are related to the assessment endpoints (EPA 1998). Because it is difficult to "measure" assessment endpoints, measurement endpoints were chosen that permit inference regarding the above-described assessment endpoints. Measurement endpoints selected for this risk assessment include:

1. Media Chemistry for Surface Soils—The measurement of chemical constituent concentrations in surface soil provides the means, when compared to appropriate background and ecotoxicological-based screening concentrations, for drawing inferences regarding the first and second measurement endpoints above. Because soil invertebrates and plants are in direct contact with the soil, direct measurement of soil concentrations is an appropriate endpoint.
2. Media Chemistry for Surface Water—The measurement of chemical constituent concentrations in surface water provides the means, when compared to water quality criteria, for drawing inferences regarding the protection of aquatic organisms that live in the water column (third endpoint above).
3. Media Chemistry for Sediment—The measurement of chemical constituent concentrations in sediment provides the means, when compared to appropriate sediment screening values, to assess the protection of aquatic organisms that live in the sediment (fourth endpoint above).
4. Calculated Dietary Doses—Calculated chemical doses in the diet for birds and mammals address the fifth and sixth endpoints above. The primary exposure route for terrestrial birds and terrestrial mammals is via intake of food and incidental soil. The knowledge of specific COPC concentrations in surface soil cannot be used to address this assessment endpoint directly. Rather, these measurements are used in conjunction with food ingestion rate and other factors to calculate the daily intake, or dietary dose of a constituent. These are then compared to toxicological thresholds to address the assessment endpoint. The same protocol is followed for aquatic mammals, specifying the primary exposure route to be via intake of aquatic and benthic food sources and incidental ingestion of sediment.

4.3 SELECTION OF COPCs

Data from the site will be assessed for data qualifiers according to the methodology discussed in Section 4.4.3. A risk assessment begins with a list of analytes that include

compounds and/or elements known or suspected to have originated from site-related activities. Analytes measured at non-hazardous concentrations may be candidates for elimination. Analytes remaining after this screening process are Constituents of Potential Concern (COPCs).

The screening process that identifies COPCs must be environmentally conservative. That is, the process must not eliminate analytes that could pose potential ecological risk. In statistical terms, the screening process must minimize the potential for false negatives. This potential is minimized by using conservative assumptions and appropriate screening values during the COPC screening process. If possible, these screening values should be toxicologically based. For the SLERA the most current conservative screening values for soil, sediment, and surface water have been identified and are shown in Table 4-1. These will be used for an initial screen of data from current sampling efforts. Maximum measured Site concentrations will be compared against these screening values. If the maximum measured site concentration exceeds the screening value, the chemical will be designated as a COPC. The scientific literature will be reexamined to determine if there are appropriate screening values for detected chemicals for which there are no appropriate screening values. If no appropriate screening values are located the chemical will be designated as a COPC and carried through the SLERA. In addition, detection limits will be compared with these screening values, and if necessary addressed in the uncertainty section of the ERA.

4.4 EXPOSURE ASSESSMENT

Exposure assessment is a key component of risk quantitation, linking contaminants to receptors through complete pathways. Exposure refers to the degree of contact between ecological receptors at a site and the COPCs.

The appropriate exposure units for characterization of risks to aquatic organisms such as aquatic or benthic organisms living in the sediment of streams and wetlands are the measured concentrations. The method used to determine exposure concentrations is detailed in Section 4.4.1.

The method of calculating dietary dose for mammals and birds follows. Dietary exposures for ROCs will be estimated as body-weight-normalized daily doses for comparison to a body-weight-normalized daily dose toxicity reference value (TRV). Separate doses are presented for food, soil, and water contributions, and these are

summed to produce the total dose for each ROC.

$$Dose_{total} = Dose_{food} + Dose_{soil\ or\ sediment}$$

where:

$Dose_{total}$ = Total daily dose of COPC received by receptor; mg COPC/kg-body wt/day

$Dose_{food}$ = Daily dose of COPC received by receptor; mg COPC/kg-body wt/day from food items

$Dose_{soil\ or\ sediment}$ = Daily dose of COPC received by receptor; mg COPC/kg-body wt/day from incidentally ingested soil or sediment; terrestrial receptors are exposed to soil through incidental ingestion, and the American mink is exposed to sediment through incidental ingestion.

The total dose from food is given by:

$$Dose_{food} = \sum (F_f \times C_f \times fx_f) \times U$$

where:

Σ = Represents summing of the dose for each food item.

F_f = Total daily feeding rate in kg food/kg-body weight of ROC/day.

C_f = Concentration of COPC in food item; calculated based on Bioaccumulation Factors (BAFs) or Bioconcentration Factors (BCFs) (mg chemical/kg food). This is assumed to be 1.0 for the Step 2 food web.

fx_f = fraction of the food item in the receptor diet.

U = Habitat usage factor (fraction of habitat range represented by site) for receptor, assumed to be 1.0 for the Step 2 food web.

The total dose from soil is given by:

$$Dose_{soil} = F_s \, x \, U \, x \, C_s$$

where:

F_s = Total daily incidental soil feeding rate in kg sediment/ kg-body weight of ROC/day

U = Habitat usage factor (fraction of habitat range represented by site) for receptor

C_s = Concentration of COPC in soil or sediment; mg/kg

Information necessary for calculation includes organism body weight (BW), food ingestion rate (F_f), fraction incidental soil ingestion as a proportion of food ingestion rate

(F_{xsoil}), food item fractions, area use factors, and analyte concentrations of ingested materials. Information specifically relevant to the ecology of the ROCs (i.e., body weights, food ingestion rates, and incidental sediment ingestion rates) is presented in Table 4-2. The primary source used for these exposure parameters was the Exposure Factors Handbook (EPA 1993). Some parameters were calculated allometrically as per Nagy (1987).

4.4.1 Exposure Concentrations

Exposure concentrations for most ROCs for the Step 2 food web will be the maximum detected concentration, and for the refined Step 3 food web will be represented by the arithmetic mean (EPA 1992a). However for sedentary organisms (such as benthic organisms) or for the four small home range terrestrial ROCs (American robin, meadow vole, short-tailed shrew, and Eastern cottontail), the exposure concentration will be represented by the 95% upper confidence limit of the mean (UCLM).

The Shapiro-Wilk W-test, $p < 0.05$ will be used to test the assumption that soil, sediment and surface water data are normally distributed. If the statistical test supports the assumption that the sample data for a COPC is normally distributed, the 95UCLM will be determined using the Student's *t*-statistic as (EPA 2002b),

$$95\text{UCLM} = \left(\bar{x} + t_{.05,n-1} s / \sqrt{n}\right)$$

where:

95UCLM	=	95th percent upper confidence limit on the mean
$\bar{x}$	=	Mean of the sample data
s	=	Standard deviation of the sample data
$t_{.05,n-1}$	=	The 95th quantile of the Student's-*t* statistic for *n*-1 degrees of freedom
n	=	Number of samples in the data set

If the data are not normally distributed, the 95% UCLM will be determined using the standard bootstrap estimation. The bootstrap method (Efron 1981) is a convenient way to estimate the standard error of a sample statistic, $\hat{\theta}$, without making any assumptions of how the original data are distributed. The following is a brief description of how the standard bootstrap procedure is used to estimate the upper confidence limit (UCL) of a sample statistic (Singh et al., 1997; EPA 2002b).

Step 1. From the original sample $\boldsymbol{X_n} = (X_1, X_2, \ldots, X_n)$; where the deviates Xi are independently and identically distributed, draw a sample of *n* observations with replacement such that each observation has the same probability of being drawn ($= \frac{1}{n}$). The new data set is called the bootstrap sample, and is typically denoted as $\boldsymbol{X_n^*} = (X_1^*, X_2^*, \ldots, X_n^*)$.

Step 2. Compute the sample statistic, $\hat{\theta}^*$, of interest (in this case the sample mean $\overline{X}$) from $\boldsymbol{X_n^*}$.

Step 3. The procedures in Steps 1 and 2 will be repeated N = 100,000 times generating N bootstrap estimates of the sample statistic. The general bootstrap estimate is the arithmetic mean of the N estimates, $\overline{\theta}_B = \frac{1}{N}\sum_{i=1}^{N}\hat{\theta}_i^*$. The bootstrapped standard error of $\hat{\theta}$, denoted by $\hat{\sigma}_B$, is given by

$$\hat{\sigma}_B = \sqrt{\frac{1}{N-1}\sum_{i=1}^{N}\left(\hat{\theta}_i - \overline{\theta}_B\right)^2} .$$

Step 4. Finally, the (1-p)100% confidence limits of $\hat{\theta}$ are given by

$\hat{\theta} \pm z_p \hat{\sigma}_B$.

where z_p is the pth quantile of the standard normal distribution.

4.4.2 Bioaccumulation Factors

The conservative Step 2 exposure assessment assumes that food concentrations are the same as that found in soil on a dry weight basis. Step 3 exposure assessments consider the propensity for a COPC to bioaccumulate in the food organism. Chemicals that bioaccumulate are chemicals with higher concentrations in organisms than found in the abiotic matrix (soil, sediment, or surface water). Appropriate accumulation factors will be used during the Step 3 exposure assessment.

Table 4-3 presents bioaccumulation factors (BAFs) for the Step 3 food web food items (soil invertebrates, plants, and small mammals). To the extent possible, BAFs have been identified from the scientific literature for soil invertebrates, terrestrial plants, and small mammals. In Sample et al. (1999), the scientific literature for uptake into earthworms was reported. When sufficient toxicological data points were located, a log-log regression equation was developed directly relating expected concentrations in the organism relative to concentrations in the soil:

$$\ln [X]_{earthworm} = B_0 + B_1 \, x \, \ln [X]_{soil}$$

where:

$\ln[X]_{earthworm}$ = the natural log of the concentration of chemical X in earthworm (dry weight),

B_0 and B_1 are constants identified in Sample et al. (1999),and

$\ln [X]_{soil}$ = the natural log of the concentration of chemical X in soil (dry weight).

Earthworm regression relationships have been found for arsenic, cadmium, copper, lead, manganese, mercury, selenium, and zinc and values for B0 and B1 are shown in Table 4-4. In the absence of sufficient data to produce regression relationships, uptake factors, which are the equivalent of a bioaccumulation factor, were developed, and median uptake factors, reported in Table 4-4, were used to estimate soil invertebrate concentrations. The uptake factor or bioaccumulation factor (BAF) is used as follows:

$$[X]_{earthworm} = [X]_{soil} \, x \, BAF$$

where:

$[X]_{earthworm}$ = the concentration of chemical X in earthworm (dry weight),

BAF = the bioaccumulation factor, and

$[X]_{soil}$ = the concentration of chemical X in soil (dry weight).

In addition, the scientific literature was examined for earthworm BAFs, and are shown in Table 4-3. In the absence of any literature-based BAFs for certain chemicals, concentrations in earthworms will be assumed to be the same as in wet weight soil (calculated from dry weight values and sample percent moisture).

Similar to the regression equations and uptake factors discussed above for earthworms, Bechtel (1998a) and Sample et al. (1998) report either B0 or B1 values or uptake factors for plants (arsenic, cadmium, copper, lead, mercury, nickel, selenium, and zinc) and small mammals (arsenic, cadmium, chromium, copper, lead, manganese, nickel,

selenium, and zinc), respectively (Table 4-4). Again, in the absence of values from these sources for certain chemicals, other literature was examined, and BAFs applied as appropriate for both plants and small mammals (Table 4-3).

Table 4-5 presents bioaccumulation factors (BAFs) and bioconcentration factors (BCFs) for the benthic invertebrates and fish, respectively: the Step 3 food web food items for the American mink. To the extent possible, BAFs and BCFs have been identified from the scientific literature. Some values were calculated by the authors of the publications where indicated in Table 4-5 and footnotes. In some instances, for sediment BAFs where only octanol/water partition coefficient (K_{ow}) values were available, BAFs were calculated using eqn. 2 from Meylan et al. (1999), although all compounds with $K_{ow} < 1$ were allotted BAFs of 0.5, following Meylan et al. (1999). The BAF or BCFs will be used to calculate contaminant concentration in prey items as follows:

$$[X]_{\text{benthic invertebrates}} = [X]_{\text{sediment}} \times \text{BAF}$$

and

$$[X]_{\text{fish}} = [X]_{\text{surface water}} \times \text{BCF}$$

where:

$[X]_{\text{benthic invertebrate}}$ = the concentration of chemical X in benthic invertebrates (dry weight),
$[X]_{\text{fish}}$ = the concentration of chemical X in fish (dry weight),
BAF = the bioaccumulation factor,
BCF = the bioconcentration factor,
$[X]_{\text{sediment}}$ = the concentration of chemical X in sediment (dry weight),
$[X]_{\text{surface water}}$ = the concentration of chemical X in surface water (dry weight).

4.5 TOXICITY ASSESSMENT

This section summarizes the TRVs to be used in the SLERA. EPA (1997b) guidance specifies that a screening ecotoxicity value should be “equivalent to a documented or best conservatively estimated chronic No Observed Adverse Effect Level (NOAEL).” In addition, Lowest Adverse Effect Levels (LOAELs) have also been located, and are documented below. These latter endpoints serve to provide a range of risks for

ecological receptors.

4.5.1 Soil Invertebrates

Risks to soil invertebrates are assessed relative to soil concentrations, using the earthworm as a representative species for the guild. In the absence of appropriate TRVs for earthworms, soil microbial endpoints were used as a surrogate for soil invertebrates. The TRVs used for earthworms and microbial endpoints are, with the exception of zinc, from Efroymson et al. (1997a) and are shown in Table 4-6. Earthworm toxicological benchmarks were derived based on growth, reproduction, and activity parameters, while microbial endpoints were based on mineralization, enzyme production, and other bacterial functions. Efroymson et al. (1997a) ranked the confidence in these TRVs based on numbers of studies, variety of species tested, and appropriateness of the toxic endpoint, which are provided in Table 4-6. With the exception of silver and vanadium, all of these TRVs have a low confidence level indicating limited toxicological data. An Ecological Soil Screening Level (EcoSSL) (EPA 2000) has been used for zinc, which was based on reproduction, growth, and population-level effects of soil invertebrates. Finally, few organic chemical soil invertebrate TRVs are available (Table 4-6).

4.5.2 Terrestrial Plants

Risk to terrestrial plants, as with invertebrates, is expressed relative to concentrations found in soil. Arsenic, chromium, and zinc plant toxicity data (Table 4-7), based on growth effects from EcoSSLs, have been used as provided by EPA (2000). Most of the TRVs used for terrestrial plant risk characterization (Table 4-7) are the toxicological benchmarks for terrestrial plants provided by Oak Ridge National Laboratory (Efroymson et al. 1997b). These benchmarks were derived based on growth and yield parameters. The authors for both EPA (2000) and Efroymson et al. (1997b) reviewed toxicological literature, and selected appropriate and valid studies used to develop the toxicity value. Efroymson et al. (1997b) values were assigned confidence intervals, ranging from low confidence (a minimal confidence value based on few studies or few plant species) to high confidence (a strong confidence value based on many toxicity studies, covering many plant families). TRVs for plants tend to be relatively low due to the necessity for soil to have a soluble form of the metal of concern. Metal speciation in soil is very different from that found in a soluble spiked solution. Simple organic carbon partitioning was used to calculate plant TRVs assuming that the chemical must be associated with soil interstitial water before it can be taken up into the plant, and that soil

organic matter is the primary sorptive agent. This list of chemicals can be expanded as long as K_{oc} can be estimated and the water quality criteria found. This partitioning was made assuming 1 percent organic carbon in the soil, and using the following equation:

$$C_{plant} = foc \times K_{oc} \times C_{water}$$

where:

C_{plant} = TRV for plant
foc = fraction organic carbon
K_{oc} = organic carbon partitioning coefficient
C_{water} = water solution TRV

4.5.3 Sediment Benthic Organisms

No sediment criteria have been established; rather, various sediment guidelines and peer-reviewed papers have been published, which have been used to establish sediment toxicity values (Table 4-8). Sediment toxicity values used in this risk characterization have been based on the following references.

MacDonald et al. (2000a) published a paper in which they derived consensus-based sediment effect concentrations for freshwater ecosystems. The authors reviewed the scientific literature for toxicity effect endpoints, and established their recommended sediment quality guideline at the geometric mean of all toxicity values found. Threshold Effect Concentrations (TECs) below which harmful effects on sediment dwelling organisms are not expected were used as the appropriate endpoint, and are shown in Table 4-8 for arsenic, cadmium, chromium, copper, lead, mercury, nickel, and zinc.

Ingersoll et al. (1996) used toxicity tests using the freshwater amphipod *Hyalella azteca* to establish Threshold Effect Levels (TEL). These toxicity tests were used for aluminum and manganese.

Washington State has published two sets of sediment standards that are applicable to their State freshwater and marine sediments. Based on site-specific tests, freshwater upper effects thresholds (UETs) were selected in the absence of any other sediment toxicity data, followed by marine apparent effects threshold values (AETs). Because these are site-specific tests, applicable to Washington State sediments, the confidence in these toxicity values are low. Antimony (UET), barium (AET), cobalt (AET), selenium (AET),

and silver (UET) sediment toxicity values were selected from this source.

DiToro and McGrath (2000) developed sediment quality guidelines (SQGs) for narcotic chemicals. Narcotic chemicals are those that result in no apparent direct toxicity, but cause narcosis of the organisms, making them more vulnerable to being eaten by predators. These values will be used for volatile organics. Acetone has been shown as an example.

No sediment toxicity data are available for energetics.

4.5.4 Surface Water Quality Standards

New Jersey Water Quality Criteria (NJDEP 2004) will be used for toxicity values for the protection of aquatic plants and animals, followed by Federal Water Quality Criteria (EPA 2002a). In the absence of State or Federal standards, water toxicity data from Suter and Tsao (1996) and DiToro et al. (2000) will be utilized.

4.5.5 NOAEL and LOAEL Toxicity Reference Values

Terrestrial and aquatic ROCs were selected in Section 4.2.1, and include both avian species (American robin and kestrel), and mammalian species (short-tailed shrew, meadow vole, Eastern cottontail, red fox, and American mink). Food web risks for avian and terrestrial mammalian species will be expressed relative to a dose of chemical (mg/kg body weight/day) taken up by the organism from food and soil. Food web risks for aquatic mammalian species (American mink) will be expressed relative to a dose of chemical (mg/kg body weight/day) taken up by the organism from food and incidental sediment ingestion. The diet of mink will be assumed to be 84% fish and 16% benthic invertebrates, determined from the ratio of fish:invertebrates recorded in the stomach contents of mink from stream habitats (Alexander 1977; USEPA 1993) (Table 4-2). Literature-reported wildlife NOAEL TRVs (Sample et al. 1996) were primarily used as TRVs for food-web risks (Table 4-9). NOAEL-based risks will be presented for the conservative Step 2 risk assessment as well as the more realistic Step 3 food-web risk calculations. LOAEL values have been shown in Table 4-10 for terrestrial ROCs. Risk based comparisons to LOAEL values will be presented as an alternative estimate of risk to ecological receptors in the Step 3 risk characterization. When analyte/receptor combinations were not located in Sample et al. (1996), the scientific literature was used to select alternative toxicity values, and these have been reported in Table 4-9 and 4-10.

As noted in Sample et al. (1996), the current state of avian toxicology indicates that the use of allometric relationships, used to relate the body weight of the toxicity test organism to that of the receptor of concern, are not appropriate. Consequently, toxicity values for avian ROCs taken from Sample et al. (1996) are the same regardless of the receptor of concern, and are equivalent to those found in the test species (pheasant, chickens, and ducks; i.e., those tested by others for reference purposes). An allometric conversion was performed to modify the toxicity value from the test species to mammalian ROCs (Sample et al. 1996). This is due to the finding that smaller animals, such as rats and mice that are commonly used as test species in toxicity tests, have higher metabolic rates, and detoxify contaminants faster than larger animals.

4.6 RISK CHARACTERIZATION

The risk characterization phase of the ERA will follow EPA guidance (EPA 1997b, 1998), and represents the linkage between exposure of ROCs to COPCs with the appropriate toxicity endpoints. Consistent with guidance, a detailed uncertainty section will be produced. One issue that will be addressed in the uncertainty section will be the issue of detection limits applied to risk screening values. While there has been an attempt to use analytical methods that achieve detection limits that are lower than risk screening values, occasionally there are circumstances where standard methods do not allow sufficiently low detection limits. Consistent with current EPA guidance (EPA 2001c), this issue will be addressed. In addition, the uncertainty of background metal concentrations will be discussed in the SLERA uncertainty section. As discussed in Section 3.4.7, site metal data will be compared with both site-specific reference concentrations as well as State reference concentrations. Other uncertainties related to the ERA will also be discussed.

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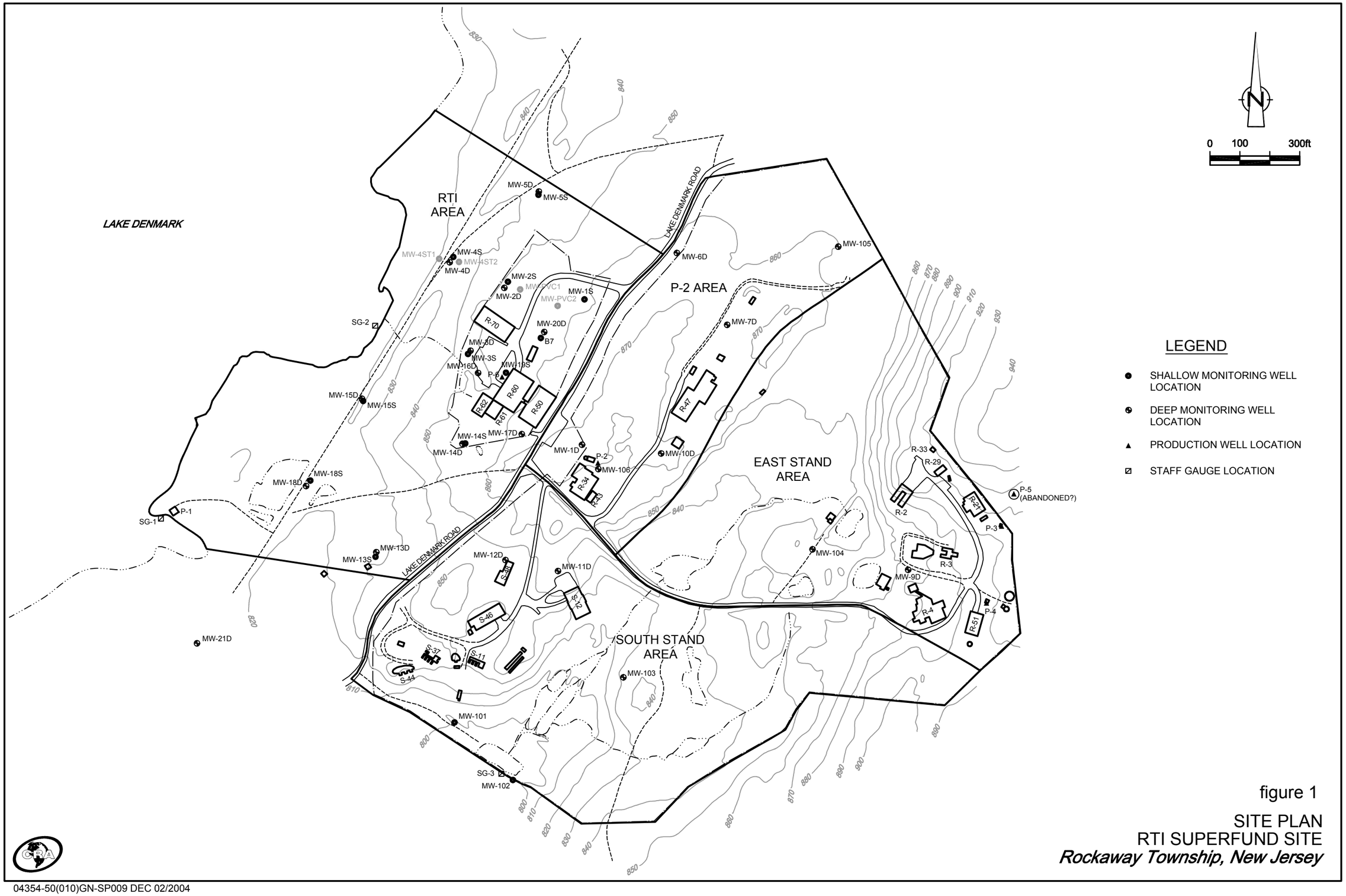

figure 1

SITE PLAN
RTI SUPERFUND SITE
Rockaway Township, New Jersey

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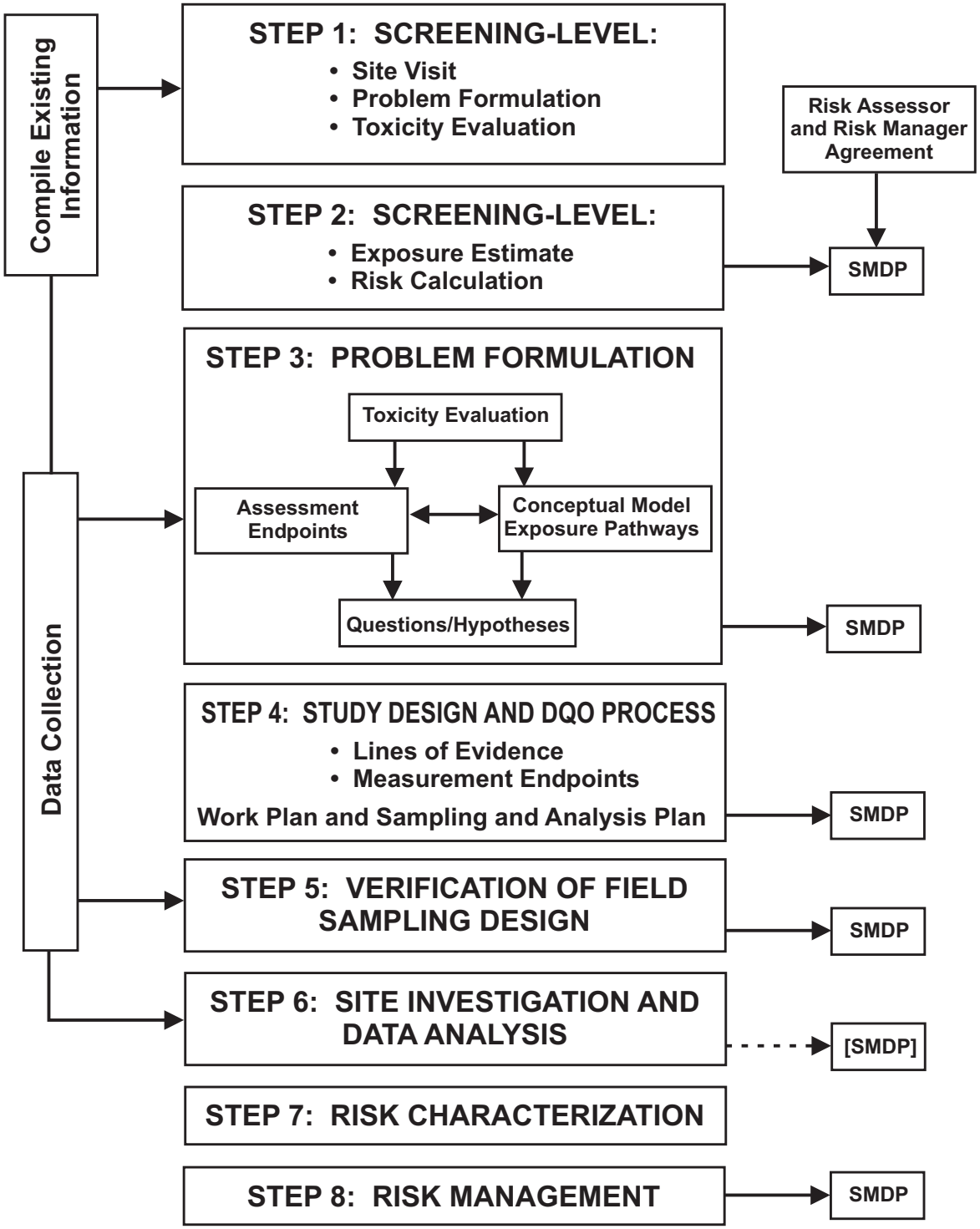

Figure 2. The EPA Eight-Step Ecological Risk Assessment Process for Superfund.

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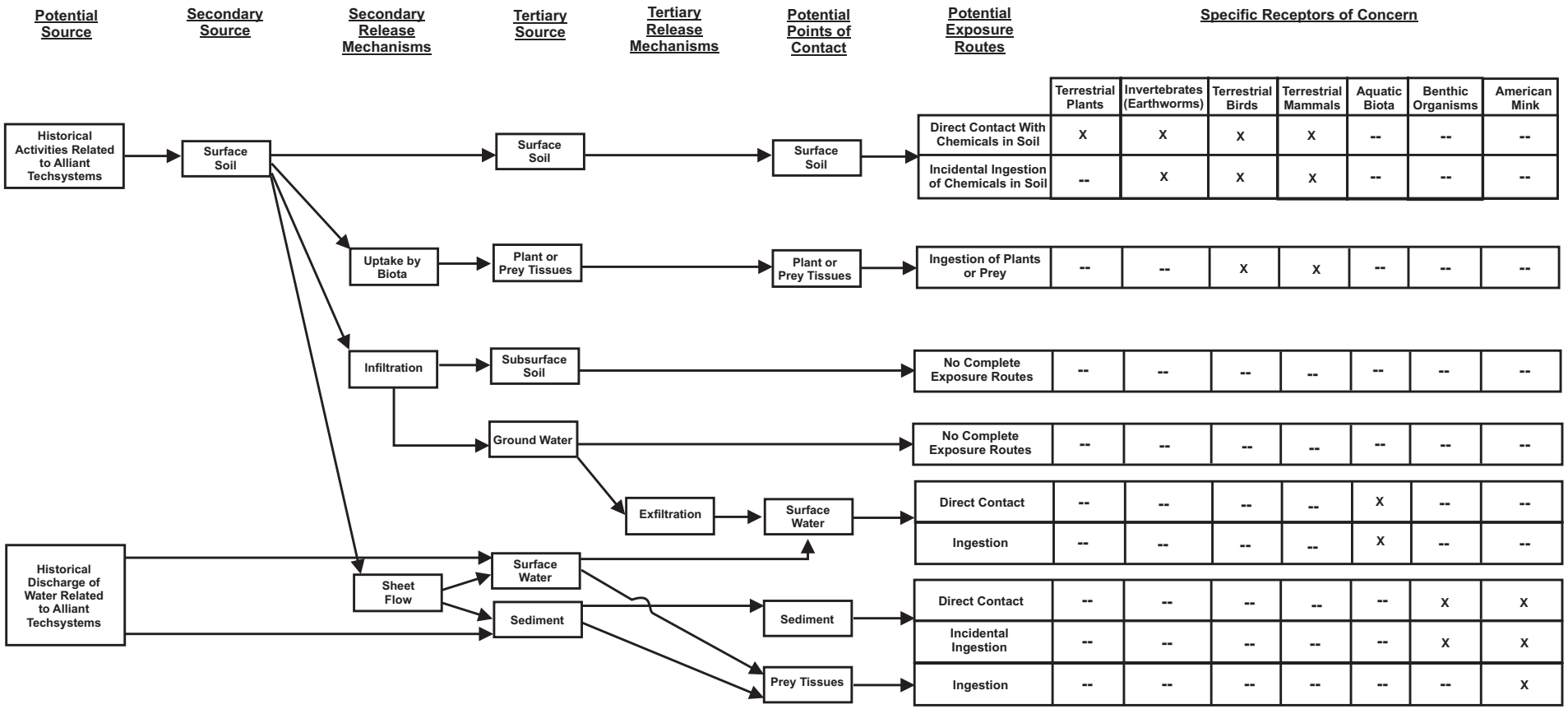

Figure 3. Ecological Conceptual Site Model for RTI Site at Rockaway, New Jersey.

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Table 3.1
Selection of Exposure Pathways
RTI Site, Rockaway Township, New Jersey

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	On-Site/ Off-Site	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current	Soil	Surfce Soil	RTI	Commercial Worker	Adult	Ingestion	On-Site	Quant	Workers may contact soil.
					Adult	Dermal	On-Site	Quant	Workers may contact soil.
				Trespasser	Adolescent	Ingestion	On-Site	Quant	Trespassers may contact soil.
					Adolescent	Dermal	On-Site	Quant	Trespassers may contact soil.
		Air	RTI	Commercial Worker	Adult	Inhal Dust	On-Site	Quant	Workers may inhale dust from from wind dispersion.
					Adult	Inhal VOCs	On-Site	Quant	Workers may inhale VOCs from soil.
				Trespasser	Adolescent	Inhal Dust	On-Site	Quant	Trespassers may inhale dust from from wind dispersion.
					Adolescent	Inhal VOCs	On-Site	Quant	Trespassers may inhale VOCs from soil.
	Groundwater	Groundwater	RTI	Commercial Worker	Adult	Ingestion	On-Site	None	Groundwater has been addressed in the ROD.
				Trespasser	Adolescent	Ingestion	On-Site	None	Groundwater has been addressed in the ROD.
	Surface Water	Surface Water	On-Site Stream	Commercial Worker	Adult	Ingestion	On-Site	None	Workers are unlikely to contact surface water.
					Adult	Dermal	On-Site	None	Workers are unlikely to contact surface water.
					Adult	Inhalation	On-Site	None	VOAs in surface water are likely to be minimal.
				Trespasser	Adolescent	Ingestion	On-Site	Quant	Trespassers may contact surface water..
					Adolescent	Dermal	On-Site	Quant	Trespassers may contact surface water..
					Adolescent	Inhalation	On-Site	None	VOAs in surface water are likely to be minimal.
	Sediment	Sediment	On-Site Stream	Commercial Worker	Adult	Ingestion	On-Site	Quant	Workers may contact sediment.
					Adult	Dermal	On-Site	Quant	Workers may contact sediment.
					Adult	Inhalation	On-Site	None	Sediments are wet and not likely to become airborne.
				Trespasser	Adolescent	Ingestion	On-Site	Quant	Trespassers may contact sediment.
					Adolescent	Dermal	On-Site	Quant	Trespassers may contact sediment.
					Adolescent	Inhalation	On-Site	None	Sediments are wet and not likely to become airborne.
Future	Soil	Total Soil	RTI	Resident	Adult	Ingestion	On-Site	Quant	Residents may be exposed to soil
					Child	Ingestion	On-Site	Quant	Residents may be exposed to soil
					Adult	Dermal	On-Site	Quant	Residents may be exposed to soil
					Child	Dermal	On-Site	Quant	Residents may be exposed to soil
				Construction Worker	Adult	Ingestion	On-Site	Quant	Workers may be exposed to soil
					Adult	Dermal	On-Site	Quant	Workers may be exposed to soil
		Air	RTI	Resident	Adult	Inhal Dust	On-Site	Quant	Residents may inhale dust from from wind dispersion.
					Adult	Inhal VOCs	On-Site	Quant	Residents may inhale VOCs from soil.
					Child	Inhal VOCs	On-Site	Quant	Residents may inhale VOCs from soil.
					Child	Inhal Dust	On-Site	Quant	Residents may inhale dust from from wind dispersion.
				Construction Worker	Adult	Inhal Dust	On-Site	Quant	Workers may inhale dust from from wind dispersion.
					Adult	Inhal VOCs	On-Site	Quant	Workers may inhale VOCs from soil.
	Groundwater	Groundwater	RTI	Resident	Adult	Ingestion	On-Site	None	Groundwater has been addressed in the ROD.
					Child	Ingestion	On-Site	None	Groundwater has been addressed in the ROD.
				Construction Worker	Adult	Ingestion	On-Site	None	Groundwater has been addressed in the ROD.
	Surface Water	Surface Water	On-Site Stream	Resident	Adult	Ingestion	On-Site	Quant	Residents may contact surface water.
					Child	Ingestion	On-Site	Quant	Residents may contact surface water.
					Adult	Dermal	On-Site	Quant	Residents may contact surface water.
					Child	Dermal	On-Site	Quant	Residents may contact surface water.
					Adult	Inhalation	On-Site	None	VOAs in surface water are likely to be minimal.
					Child	Inhalation	On-Site	None	VOAs in surface water are likely to be minimal.
				Construction Worker	Adult	Ingestion	On-Site	None	Workers are unlikely to contact surface water..
					Adult	Dermal	On-Site	None	Workers are unlikely to contact surface water..
					Adult	Inhalation	On-Site	None	VOAs in surface water are likely to be minimal.
	Sediment	Sediment	On-Site Stream	Resident	Adult	Ingestion	On-Site	Quant	Residents may contact sediment.
					Child	Ingestion	On-Site	Quant	Residents may contact sediment.
					Adult	Dermal	On-Site	Quant	Residents may contact sediment.
					Child	Dermal	On-Site	Quant	Residents may contact sediment.
					Adult	Inhalation	On-Site	None	Sediments are wet and not likely to become airborne.
				Construction Worker	Adult	Ingestion	On-Site	None	Workers are unlikely to contact sediment.
					Adult	Dermal	On-Site	None	Workers are unlikely to contact sediment.
					Adult	Inhalation	On-Site	None	Sediments are wet and not likely to become airborne.

Table 3.2
Values Used for Resident Adult Daily Total Soil Intake Equations
RTI Site, Rockaway Township, New Jersey

Scenario Timeframe: Future
Medium: Total Soil
Exposure Medium: Total Soil, Air
Exposure Point: RTI Site

Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/Reference
Ingestion	IR	Ingestion Rate	mg/day	100	U.S. EPA 1991
	EF	Exposure Frequency	day/yr	350	U.S. EPA 1991
	ED-NC	Exposure Duration - Noncancer	yr	30	U.S. EPA 1991
	ED-C	Exposure Duration - Cancer	yr	24	U.S. EPA 1991
	BW	Body Weight	kg	70	U.S. EPA 1991
	AT-NC	Averaging time - Noncancer	days	EDx365	U.S. EPA 1991
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1991
	CF	Conversion Factor	kg/mg	1.00E-06	U.S. EPA 1989
Dermal	SA	Surface Area for Contact	cm2/event	5,700	U.S. EPA 2001a
	AF	Adherence Factor	mg/cm2	0.07	U.S. EPA 2001a
	ABS	Absorption Factor	chemical-specific		
	EF	Exposure Frequency	event/yr	350	U.S. EPA 1991
	ED-NC	Exposure Duration - Noncancer	yr	30	U.S. EPA 1991
	ED-C	Exposure Duration - Cancer	yr	24	U.S. EPA 1991
	BW	Body Weight	kg	70	U.S. EPA 1991
	AT-NC	Averaging time - Noncancer	days	EDx365	U.S. EPA 1991
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1991
	CF	Conversion Factor	kg/mg	1.00E-06	U.S. EPA 1989
Inhalation	IR	Inhalation Rate	m3/hr	0.833	U.S. EPA 1991
	ET	Exposure Time	hr/day	24	U.S.EPA 1991
	EF	Exposure Frequency	day/yr	350	U.S. EPA 1991
	ED-NC	Exposure Duration - Noncancer	yr	30	U.S. EPA 1991
	ED-C	Exposure Duration - Cancer	yr	24	U.S. EPA 1991
	BW	Body Weight	kg	70	U.S. EPA 1991
	AT-NC	Averaging time - Noncancer	days	EDx365	U.S. EPA 1991
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1991

Table 3.3
Values Used for Resident Child Daily Total Soil Intake Equations
RTI Site, Rockaway Township, New Jersey

Scenario Timeframe: Future
Medium: Total Soil
Exposure Medium: Total Soil, Air
Exposure Point: RTI Site
Receptor Population: Resident Child
Receptor Age: Child

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/Reference
Ingestion	IR	Ingestion Rate	mg/day	200	U.S. EPA 1991
	EF	Exposure Frequency	day/yr	350	U.S. EPA 1991
	ED	Exposure Duration	yr	6	U.S. EPA 1991
	BW	Body Weight	kg	15	U.S. EPA 1991
	AT-NC	Averaging time - Noncancer	days	EDx365	U.S. EPA 1991
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1991
	CF	Conversion Factor	kg/mg	1.00E-06	U.S. EPA 1989
Dermal	SA	Surface Area for Contact	cm2/event	2,800	U.S. EPA 2001a
	AF	Adherence Factor	mg/cm2	0.2	U.S. EPA 2001a
	ABS	Absorption Factor	chemical-specific		U.S. EPA 2001a
	EF	Exposure Frequency	event/yr	350	U.S. EPA 1991
	ED	Exposure Duration	yr	6	U.S. EPA 1991
	BW	Body Weight	kg	15	U.S. EPA 1991
	AT-NC	Averaging time - Noncancer	days	EDx365	U.S. EPA 1991
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1991
	CF	Conversion Factor	kg/mg	1.00E-06	U.S. EPA 1989
Inhalation	IR	Inhalation Rate	m3/hr	0.417	U.S. EPA 2002b
	ET	Exposure Time	hr/day	24	U.S. EPA 1991
	EF	Exposure Frequency	day/yr	350	U.S. EPA 1991
	ED	Exposure Duration	yr	6	U.S. EPA 1991
	BW	Body Weight	kg	15	U.S. EPA 1991
	AT-NC	Averaging time - Noncancer	days	EDx365	U.S. EPA 1991
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1991

Table 3.4
Values Used for Resident Child Daily Sediment Intake Equations
RTI Site, Rockaway Township, New Jersey

Scenario Timeframe: Future
Medium: Sediment
Exposure Medium: Sediment
Exposure Point: On-Site Stream
Receptor Population: Resident
Receptor Age: Child

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/Reference
Ingestion	IR	Ingestion Rate	mg/day	25	Access is limited
	EF	Exposure Frequency	day/yr	50	2 days/wk:6 mos/yr
	ED-NC	Exposure Duration - Noncancer	yr	6	U.S.EPA1997
	ED-C	Exposure Duration - Cancer	yr	6	U.S.EPA 1997
	BW	Body Weight	kg	15	U.S.EPA 1991
	AT-NC	Averaging time - Noncancer	days	EDx365	U.S. EPA 1989
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1989
	CF	Conversion Factor	kg/mg	1.00E-06	U.S. EPA 1989
Dermal	SA	Surface Area for Contact	cm2/event	2,800	U.S. EPA 2001a
	AF	Adherence Factor	mg/cm2	0.2	U.S. EPA 2001a
	ABS	Absorption Factor	chemical-specific		U.S. EPA 2001a
	EF	Exposure Frequency	event/yr	50	2 days/wk:6 mos/yr
	ED-NC	Exposure Duration - Noncancer	yr	6	U.S. EPA 1991
	ED-C	Exposure Duration - Cancer	yr	6	U.S. EPA 1991
	BW	Body Weight	kg	15	U.S. EPA 1991
	AT-NC	Averaging time - Noncancer	days	EDx365	U.S. EPA 1989
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1989
	CF	Conversion Factor	kg/mg	1.00E-06	U.S. EPA 1989

Table 3.5
Values Used for Resident Child Surface Water Intake Equations
RTI Site, Rockaway Township, New Jersey

Scenario Timeframe: Future
Medium: Surface Water
Exposure Medium: Surface Water
Exposure Point: On-Site Stream
Receptor Population: Resident
Receptor Age: Child

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/Reference
Ingestion	IR	Ingestion Rate	L/day	0.01	5th swimming rate(1989)
	EF	Exposure Frequency	day/yr	50	2 days/wk:6 mos/yr
	ED-NC	Exposure Duration - Noncancer	yr	6	U.S.EPA 1991
	ED-C	Exposure Duration - Cancer	yr	6	U.S.EPA 1991
	BW	Body Weight	kg	15	U.S.EPA 1991
	AT-NC	Averaging time - Noncancer	days	EDx365	U.S.EPA 1989
	AT-C	Averaging Time - Cancer	days	25,550	U.S.EPA 1989
Dermal	SA	Surface Area for Contact	cm2/event	2,800	U.S.EPA 2001a
	PC	Permeability Coefficient	cm/hr	chem specific	U.S.EPA 2001a
	EF	Exposure Frequency	event/yr	50	2 days/wk:6 mos/yr
	ED-NC	Exposure Duration - Noncancer	yr	6	U.S.EPA 1991
	ED-C	Exposure Duration - Cancer	yr	6	U.S.EPA 1991
	BW	Body Weight	kg	15	U.S.EPA 1991
	AT-NC	Averaging time - Noncancer	days	EDx365	U.S.EPA 1989
	AT-C	Averaging Time - Cancer	days	25,550	U.S.EPA 1989
	CF	Conversion Factor	L/cm3	1.00E-03	U.S. EPA 1989

Table 3.6
Values Used for Resident Adult Daily Sediment Intake Equations
RTI Site, Rockaway Township, New Jersey

Scenario Timeframe: Future
Medium: Sediment
Exposure Medium: Sediment
Exposure Point: On-Site Stream
Exposure Population: Resident
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/Reference
Ingestion	IR	Ingestion Rate	mg/day	25	1/2 soil rate
	EF	Exposure Frequency	day/yr	26	1 days/wk:6 mos/yr
	ED-NC	Exposure Duration - Noncancer	yr	30	U.S. EPA 1991
	ED-C	Exposure Duration - Cancer	yr	24	U.S. EPA 1991
	BW	Body Weight	kg	70	U.S. EPA 1991
	AT-NC	Averaging time - Noncancer	days	EDx365	U.S. EPA 1989
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1989
	CF	Conversion Factor	kg/mg	1.00E-06	U.S. EPA 1989
Dermal	SA	Surface Area for Contact	cm2/event	5,700	U.S.EPA 2001a
	AF	Adherence Factor	mg/cm2	0.07	U.S.EPA 2001a
	ABS	Absorption Factor	chemical-specific		U.S.EPA 2001a
	EF	Exposure Frequency	event/yr	26	1 days/wk:6 mos/yr
	ED-NC	Exposure Duration - Noncancer	yr	30	U.S. EPA 1991
	ED-C	Exposure Duration - Cancer	yr	24	U.S. EPA 1991
	BW	Body Weight	kg	70	U.S. EPA 1991
	AT-NC	Averaging time - Noncancer	days	EDx365	U.S. EPA 1989
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1989
	CF	Conversion Factor	kg/mg	1.00E-06	U.S. EPA 1989

Table 3.7
Values Used for Resident Adult Daily Surface Water Intake Equations
RTI Site, Rockaway Township, New Jersey

Scenario Timeframe: Future
Medium: Surface Water
Exposure Medium: Surface Water
Exposure Point: On-Site Stream
Exposure Population: Resident
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/Reference
Ingestion	IR	Ingestion Rate	mg/day	0.01	5th swimming rate (1989)
	EF	Exposure Frequency	day/yr	26	1 days/wk:6 mos/yr
	ED-NC	Exposure Duration - Noncancer	yr	30	U.S. EPA 1991
	ED-C	Exposure Duration - Cancer	yr	24	U.S. EPA 1991
	BW	Body Weight	kg	70	U.S. EPA 1991
	AT-NC	Averaging time - Noncancer	days	EDx365	U.S. EPA 1989
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1989
Dermal	SA	Surface Area for Contact	cm2/event	5,700	U.S.EPA 2001a
	PC	Permeability Coefficient	cm/hr	chem-spec	U.S.EPA 2001a
	EF	Exposure Frequency	event/yr	26	1 days/wk:6 mos/yr
	ED-NC	Exposure Duration - Noncancer	yr	30	U.S. EPA 1991
	ED-C	Exposure Duration - Cancer	yr	24	U.S. EPA 1991
	BW	Body Weight	kg	70	U.S. EPA 1991
	AT-NC	Averaging time - Noncancer	days	EDx365	U.S. EPA 1989
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1989
	CF	Conversion Factor	L/cm3	1.0E-03	U.S. EPA 1989

Table 3.8
Values Used for Commercial Worker Daily Surface Soil Intake Equations
RTI Site, Rockaway Township, New Jersey

Scenario Timeframe: Future
Medium: Surface Soil
Exposure Medium: Surface Soil, Air
Exposure Point: RTI Site

Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/Reference
Ingestion	IR	Ingestion Rate	mg/day	50	U.S. EPA 1991
	EF	Exposure Frequency	day/yr	250	U.S. EPA 1991
	ED-NC	Exposure Duration - Noncancer	yr	25	U.S. EPA 1991
	ED-C	Exposure Duration - Cancer	yr	25	U.S. EPA 1991
	BW	Body Weight	kg	70	U.S. EPA 1991
	AT-NC	Averaging time - Noncancer	days	EDx365	U.S. EPA 1991
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1991
	CF	Conversion Factor	kg/mg	1.00E-06	U.S. EPA 1989
Dermal	SA	Surface Area for Contact	cm2/event	3,300	U.S. EPA 2001a
	AF	Adherence Factor	mg/cm2	0.2	U.S. EPA 2001a
	ABS	Absorption Factor	chemical-specific		
	EF	Exposure Frequency	event/yr	250	U.S. EPA 1991
	ED-NC	Exposure Duration - Noncancer	yr	25	U.S. EPA 1991
	ED-C	Exposure Duration - Cancer	yr	25	U.S. EPA 1991
	BW	Body Weight	kg	70	U.S. EPA 1991
	AT-NC	Averaging time - Noncancer	days	EDx365	U.S. EPA 1991
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1991
	CF	Conversion Factor	kg/mg	1.00E-06	U.S. EPA 1989
Inhalation	IR	Inhalation Rate	m3/hr	0.833	U.S. EPA 1991
	ET	Exposure Time	hr/day	8	U.S. EPA 1991
	EF	Exposure Frequency	day/yr	250	U.S. EPA 1991
	ED-NC	Exposure Duration - Noncancer	yr	25	U.S. EPA 1991
	ED-C	Exposure Duration - Cancer	yr	25	U.S. EPA 1991
	BW	Body Weight	kg	70	U.S. EPA 1991
	AT-NC	Averaging time - Noncancer	days	EDx365	U.S. EPA 1991
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1991

Table 3.9
Values Used for Commercial Worker Daily Sediment Intake Equations
RTI Site, Rockaway Township, New Jersey

Scenario Timeframe: Future
Medium: Sediment
Exposure Medium: Sediment
Exposure Point: On-Site Stream
Exposure Population: Commercial Worker
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/Reference
Ingestion	IR	Ingestion Rate	mg/day	25	1/2 soil rate
	EF	Exposure Frequency	day/yr	10	Access is limited
	ED-NC	Exposure Duration - Noncancer	yr	25	U.S. EPA 1991
	ED-C	Exposure Duration - Cancer	yr	25	U.S. EPA 1991
	BW	Body Weight	kg	70	U.S. EPA 1991
	AT-NC	Averaging time - Noncancer	days	EDx365	U.S. EPA 1989
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1989
	CF	Conversion Factor	kg/mg	1.00E-06	U.S. EPA 1989
Dermal	SA	Surface Area for Contact	cm2/event	3,300	U.S.EPA 2001a
	AF	Adherence Factor	mg/cm2	0.2	U.S.EPA 2001a
	ABS	Absorption Factor	chemical-specific		U.S.EPA 2001a
	EF	Exposure Frequency	event/yr	10	Access is limited
	ED-NC	Exposure Duration - Noncancer	yr	25	U.S. EPA 1991
	ED-C	Exposure Duration - Cancer	yr	25	U.S. EPA 1991
	BW	Body Weight	kg	70	U.S. EPA 1991
	AT-NC	Averaging time - Noncancer	days	EDx365	U.S. EPA 1989
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1989
	CF	Conversion Factor	kg/mg	1.00E-06	U.S. EPA 1989

Table 3.10
Values Used for Construction Worker Daily Total Soil Intake Equations
RTI Site, Rockaway Township, New Jersey

Scenario Timeframe: Future
Medium: Total Soil
Exposure Medium: Total Soil, Air
Exposure Point: RTI Site

Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/Reference
Ingestion	IR	Ingestion Rate	mg/day	480	U.S. EPA 1991
	EF	Exposure Frequency	day/yr	250	U.S. EPA 1991
	ED-NC	Exposure Duration - Noncancer	yr	1	U.S. EPA 1991
	ED-C	Exposure Duration - Cancer	yr	1	U.S. EPA 1991
	BW	Body Weight	kg	70	U.S. EPA 1991
	AT-NC	Averaging time - Noncancer	days	EDx365	U.S. EPA 1991
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1991
	CF	Conversion Factor	kg/mg	1.00E-06	U.S. EPA 1989
Dermal	SA	Surface Area for Contact	cm2/event	3,300	U.S. EPA 2001a
	AF	Adherence Factor	mg/cm2	0.2	U.S. EPA 2001a
	ABS	Absorption Factor	chemical-specific		
	EF	Exposure Frequency	event/yr	250	U.S. EPA 1991
	ED-NC	Exposure Duration - Noncancer	yr	1	U.S. EPA 1991
	ED-C	Exposure Duration - Cancer	yr	1	U.S. EPA 1991
	BW	Body Weight	kg	70	U.S. EPA 1991
	AT-NC	Averaging time - Noncancer	days	EDx365	U.S. EPA 1991
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1991
	CF	Conversion Factor	kg/mg	1.00E-06	U.S. EPA 1989
Inhalation	IR	Inhalation Rate	m3/hr	2.5	U.S. EPA 1991
	ET	Exposure Time	hr/day	8	U.S. EPA 1991
	EF	Exposure Frequency	day/yr	250	U.S. EPA 1991
	ED-NC	Exposure Duration - Noncancer	yr	1	U.S. EPA 1991
	ED-C	Exposure Duration - Cancer	yr	1	U.S. EPA 1991
	BW	Body Weight	kg	70	U.S. EPA 1991
	AT-NC	Averaging time - Noncancer	days	EDx365	U.S. EPA 1991
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1991

Table 3.11
Values Used for Trespasser Daily Surface Soil Intake Equations
RTI Site, Rockaway Township, New Jersey

Scenario Timeframe: Future
Medium: Surface Soil
Exposure Medium: Surface Soil, Air
Exposure Point: RTI Site
Receptor Population: Trespasser
Receptor Age: Adolescent

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/Reference
Ingestion	IR	Ingestion Rate	mg/day	50	U.S. EPA 1991
	EF	Exposure Frequency	day/yr	75	3days/wk:6mos/yr
	ED	Exposure Duration	yr	10	U.S. EPA 1997
	BW	Body Weight	kg	36	U.S. EPA 1997
	AT-NC	Averaging time - Noncancer	days	EDx365	U.S. EPA 1991
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1991
	CF	Conversion Factor	kg/mg	1.00E-06	U.S. EPA 1989
Dermal	SA	Surface Area for Contact	cm2/event	3,300	U.S. EPA 2001a
	AF	Adherence Factor	mg/cm2	0.2	U.S. EPA 2001a
	ABS	Absorption Factor	chemical-specific		U.S. EPA 2001a
	EF	Exposure Frequency	event/yr	75	3days/wk:6mos/yr
	ED	Exposure Duration	yr	10	U.S. EPA 1997
	BW	Body Weight	kg	36	U.S. EPA 1997
	AT-NC	Averaging time - Noncancer	days	EDx365	U.S. EPA 1991
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1991
	CF	Conversion Factor	kg/mg	1.00E-06	U.S. EPA 1989
Inhalation	IR	Inhalation Rate	m3/hr	0.8	U.S. EPA 2002b
	ET	Exposure Time	hr/day	2	U.S. EPA 1997
	EF	Exposure Frequency	day/yr	75	3days/wk:6mos/yr
	ED	Exposure Duration	yr	10	U.S. EPA 1997
	BW	Body Weight	kg	36	U.S. EPA 1997
	AT-NC	Averaging time - Noncancer	days	EDx365	U.S. EPA 1991
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1991

Table 3.12
Values Used for Trespasser Daily Sediment Intake Equations
RTI Site, Rockaway Township, New Jersey

Scenario Timeframe: Future
Medium: Sediment
Exposure Medium: Sediment
Exposure Point: On-Site Stream
Exposure Population: Trespasser
Receptor Age: Adolescent

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/Reference
Ingestion	IR	Ingestion Rate	mg/day	25	1/2 soil rate
	EF	Exposure Frequency	day/yr	50	2 days/wk;6 mos/yr
	ED-NC	Exposure Duration - Noncancer	yr	10	U.S.EPA 1997
	ED-C	Exposure Duration - Cancer	yr	10	U.S.EPA 1997
	BW	Body Weight	kg	36	U.S.EPA 1997
	AT-NC	Averaging time - Noncancer	days	EDx365	U.S. EPA 1989
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1989
	CF	Conversion Factor	kg/mg	1.00E-06	U.S. EPA 1989
Dermal	SA	Surface Area for Contact	cm2/event	3,300	U.S.EPA 2001a
	AF	Adherence Factor	mg/cm2	0.2	U.S.EPA 2001a
	ABS	Absorption Factor	chemical-specific		U.S.EPA 2001a
	EF	Exposure Frequency	event/yr	50	2 days/wk;6 mos/yr
	ED-NC	Exposure Duration - Noncancer	yr	10	U.S.EPA 1997
	ED-C	Exposure Duration - Cancer	yr	10	U.S.EPA 1997
	BW	Body Weight	kg	36	U.S.EPA 1997
	AT-NC	Averaging time - Noncancer	days	EDx365	U.S. EPA 1989
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1989
	CF	Conversion Factor	kg/mg	1.00E-06	U.S. EPA 1989

Table 3.13
Values Used for Trespasser Surface Water Intake Equations
RTI Site, Rockaway Township, New Jersey

Scenario Timeframe: Future
Medium: Surface Water
Exposure Medium: Surface Water
Exposure Point: On-Site Stream
Receptor Population: Trespasser
Receptor Age: Adolescent

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/Reference
Ingestion	IR	Ingestion Rate	L/day	0.01	1/5th swim rate (1989)
	EF	Exposure Frequency	day/yr	50	2 days/wk;6 mos/yr
	ED-NC	Exposure Duration - Noncancer	yr	10	U.S.EPA 1997
	ED-C	Exposure Duration - Cancer	yr	10	U.S.EPA 1997
	BW	Body Weight	kg	36	U.S.EPA 1997
	AT-NC	Averaging time - Noncancer	days	EDx365	U.S.EPA 1989
	AT-C	Averaging Time - Cancer	days	25,550	U.S.EPA 1989
Dermal	SA	Surface Area for Contact	cm2/event	3,300	U.S.EPA 2001a
	PC	Permeability Coefficient	cm/hr	chem specific	U.S.EPA 2001a
	EF	Exposure Frequency	event/yr	50	2 days/wk;6 mos/yr
	ED-NC	Exposure Duration - Noncancer	yr	10	U.S.EPA 1997
	ED-C	Exposure Duration - Cancer	yr	10	U.S.EPA 1997
	BW	Body Weight	kg	36	U.S.EPA 1997
	AT-NC	Averaging time - Noncancer	days	EDx365	U.S.EPA 1989
	AT-C	Averaging Time - Cancer	days	25,550	U.S.EPA 1989
	CF	Conversion Factor	L/cm3	1.00E-03	U.S. EPA 1989

TABLE 4-1 RISK-BASED ECOLOGICAL SCREENING VALUES FOR SURFACE SOIL, SURFACE WATER, AND SEDIMENT AT THE RTI SITE

Analyte	Benchmark Values					
	Surface Soil (mg/kg)		Surface Water (µg/L)		Sediment (mg/kg)	
	Value	Reference	Value	Reference	Value	Reference
INORGANICS						
Aluminum	pH > 5.5	(1)	--	--	26000	(26)
Antimony	0.27	(2)	12.2	(21)	3	(27)
Arsenic	18	(3)	150	(22)	9.8	(28)
Barium	330	(4)	4	(23)	48	(10)
Beryllium	21	(5)	5.1	(24)	--	--
Cadmium	0.36	(6)	0.25	(22)	0.99	(28)
Calcium	NA	(a)	NA	(a)	NA	(a)
Chromium	81	(7)	11	(22)	43.4	(28)
Cobalt	13	(8)	--	--	10	(27)
Copper	28	(9)	9	(22)	31.6	(28)
Iron	pH > 5.5	(10)	NA	(a)	NA	(a)
Lead	11	(11)	5.4	(21)	35.8	(28)
Magnesium	NA	(a)	NA	(a)	NA	(a)
Manganese	220	(12)	80	(27)	630	(27)
Mercury	0.1	(13)	0.144	(21)	0.18	(28)
Nickel	38	(14)	50	(22)	121	(28)
Potassium	NA	(a)	NA	(a)	NA	(a)
Selenium	0.52	(15)	5	(22)	1	(27)
Silver	4.2	(16)	3.2	(22)	4.5	(27)
Sodium	NA	(a)	NA	(a)	NA	(a)
Thallium	1	(17)	1.7	(21)	--	--
Vanadium	7.8	(18)	13	(24)	--	--
Zinc	46	(19)	120	(22)	121	(28)
VOLATILE ORGANICS						
1,1,1-Trichloroethane	--	--	--	--	--	--
1,1,2,2-Tetrachloroethane	--	--	--	--	8.3	(29)
1,1,2-Trichloro-1,2,2-trifluoroethane	--	--	--	--	--	--
1,1,2-Trichloroethane	--	--	--	--	--	--
1,1-Dichloroethane	--	--	--	--	--	--
1,1-Dichloroethene	--	--	--	--	4.8	(29)
1,2,4-Trichlorobenzene	--	--	--	--	--	--
1,2-Dibromo-3-chloropropane	--	--	--	--	--	--

Analyte	Benchmark Values					
	Surface Soil (mg/kg)		Surface Water (µg/L)		Sediment (mg/kg)	
	Value	Reference	Value	Reference	Value	Reference
1,2-Dibromoethane	--	--	--	--	--	--
1,2-Dichlorobenzene	--	--	--	--	--	--
1,2-Dichloroethane	--	--	--	--	--	--
1,2-Dichloropropane	--	--	--	--	--	--
1,3-Dichlorobenzene	--	--	--	--	--	--
1,4-Dichlorobenzene	--	--	--	--	--	--
2-Butanone	--	--	14000	(23)	2.9	(29)
2-Hexanone	--	--	--	--	--	--
4-Methyl-2-Pentanone	--	--	--	--	--	--
Acetone	--	--	1500	(23)	2.3	(29)
Acetonitrile	--	--	--	--	--	--
Benzene	--	--	--	--	--	--
Bromodichloromethane	--	--	--	--	--	--
Bromoform	--	--	--	--	--	--
Bromomethane	--	--	--	--	--	--
Carbon Disulfide	--	--	0.92	(23)	--	--
Carbon Tetrachloride	--	--	--	--	--	--
Chlorobenzene	--	--	--	--	--	--
Chloroethane	--	--	--	--	--	--
Chloroform	--	--	28	(23)	--	--
Chloromethane	--	--	--	--	2.1	(29)
Cis-1,2-Dichloroethene	--	--	--	--	--	--
Cis-1,3-Dichloropropene	--	--	--	--	--	--
Cyclohexane	--	--	--	--	--	--
Dibromochloromethane	--	--	--	--	--	--
Dichlorodifluoromethane	--	--	--	--	--	--
Ethylbenzene	--	--	--	--	9.7	(29)
Isopropylbenzene	--	--	--	--	--	--
Methyl acetate	--	--	--	--	--	--
Methyl tert-butyl ether	--	--	--	--	--	--
Methylcyclohexane	--	--	--	--	--	--
Methylene Chloride	--	--	--	--	3.7	(29)
Styrene	--	--	--	--	--	--
Tetrachloroethene	--	--	--	--	8.7	(29)
Toluene	--	--	130	(23)	8.2	(29)
Trans-1,2-Dichloroethene	--	--	--	--	--	--
Trans-1,3-Dichloropropene	--	--	--	--	--	--
Trichloroethene	--	--	--	--	6.5	(29)
Trichlorofluoromethane	--	--	--	--	--	--
Vinyl Chloride	--	--	--	--	--	--

Analyte	Benchmark Values					
	Surface Soil (mg/kg)		Surface Water (µg/L)		Sediment (mg/kg)	
	Value	Reference	Value	Reference	Value	Reference
Xylenes (total)	--	--	--	--	9.7	(29)
SEMIVOLATILE ORGANICS						
Light PAH (3-4 rings)	29	(20)	--	--	--	--
Heavy PAH (>4 rings)	1.1	(20)	--	--	--	--
ENERGETICS						
Perchlorate	--	--	--	--	--	--
Hydrazine	--	--	--	--	--	--
Monomethyl Hydrazine (MMH)	--	--	--	--	--	--
Unsymmetrical Dimethyl Hydrazine (UDMH)	--	--	--	--	--	--
N-nitrosodimethylamine (NDMA)	--	--	--	--	--	--
Diethylene Triamine (DETA)	--	--	5850	(25)	--	--

Notes:

(a) Essential Nutrient
-- None Available
NA Not Appropriate

(1) U.S. Environmental Protection Agency (USEPA). 2003a. Ecological Soil Screening Levels for Aluminum, Interim Final. OSWER Directive 9285.7-60. November.
(2) U.S. Environmental Protection Agency (USEPA). 2005a. Ecological Soil Screening Levels for Antimony Interim Final. OSWER Directive 9285.7-61. February.
(3) U.S. Environmental Protection Agency (USEPA). 2005b. Ecological Soil Screening Levels for Arsenic Interim Final. OSWER Directive 9285.7-62. March.
(4) U.S. Environmental Protection Agency (USEPA). 2005c. Ecological Soil Screening Levels for Barium Interim Final. OSWER Directive 9285.7-63. February.
(5) U.S. Environmental Protection Agency (USEPA). 2005d. Ecological Soil Screening Levels for Beryllium Interim Final. OSWER Directive 9285.7-64. February.
(6) U.S. Environmental Protection Agency (USEPA). 2005e. Ecological Soil Screening Levels for Cadmium Interim Final. OSWER Directive 9285.7-65. March.
(7) U.S. Environmental Protection Agency (USEPA). 2005f. Ecological Soil Screening Levels for Chromium Interim Final. OSWER Directive 9285.7-66. March.
(8) U.S. Environmental Protection Agency (USEPA). 2005g. Ecological Soil Screening Levels for Cobalt Interim Final. OSWER Directive 9285.7-67. March.
(9) U.S. Environmental Protection Agency (USEPA). 2007a. Ecological Soil Screening Level for Copper, Interim Final. OSWER Directive 9285.7-68. February.
(10) U.S. Environmental Protection Agency (USEPA). 2003b. Ecological Soil Screening Levels for Iron, Interim Final. OSWER Directive 9285.7-69. November.

(11) U.S. Environmental Protection Agency (USEPA). 2005h. Ecological Soil Screening Level for Lead, Interim Final. OSWER Directive 9285.7-70. March.

(12) U.S. Environmental Protection Agency (USEPA). 2007b. Ecological Soil Screening Level for Manganese, Interim Final. OSWER Directive 9285.7-71. April.

(13) Efroymson, R.A., M.E. Will, and G.W. Suter II. 1997a. *Toxicological Benchmarks for Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process: 1997 Revision*. U.S. Department of Energy, Office of Environmental Management. November.

(14) U.S. Environmental Protection Agency (USEPA). 2007c. Ecological Soil Screening Level for Nickel, Interim Final. OSWER Directive 9285.7-76. March.

(15) U.S. Environmental Protection Agency (USEPA). 2007d. Ecological Soil Screening Level for Selenium, Interim Final. OSWER Directive 9285.7-72. July.

(16) U.S. Environmental Protection Agency (USEPA). 2006. Ecological Soil Screening Levels for Silver, Interim Final. OSWER Directive 9285.7-77. October.

(17) Efroymson, R.A., M.E. Will, G.W. Suter, and A.C. Wooten. 1997b. *Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants: 1997 Revision*. Oak Ridge National Lab Report ES/ER/TM-85/R3.

(18) U.S. Environmental Protection Agency (USEPA). 2005i. Ecological Soil Screening Level for Vanadium, Interim Final. OSWER Directive 9285.7-75. April.

(19) U.S. Environmental Protection Agency (USEPA). 2007e. Ecological Soil Screening Level for Zinc, Interim Final. OSWER Directive 9285.7-73. June.

(20) U.S. Environmental Protection Agency (USEPA). 2007f. Ecological Soil Screening Level for Polycyclic Aromatic Hydrocarbons (PAHs) , Interim Final. OSWER Directive 9285.7-78. June.

(21) New Jersey Department of Environmental Protection (NJDEP). 2004. Surface Water Quality Standards. N.J.A.C. 7:9B. August

(22) U.S. Environmental Protection Agency (EPA). 2002a. *National Recommended Water Quality Criteria: 2002*. EPA 822-R-02-047. Office of Water. November.

(23) Suter, G.W. II, and C.L. Tsao. 1996. *Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota: 1996 Revision.* Prepared by Risk Assessment Program Health Sciences Research Division Oak Ridge, TN.

(24) U.S. Environmental Protection Agency (EPA). 1996. *ECO Update-Ecotox Threshold*. EPA 540/F-95/038. January.

(25) U.S. Environmental Protection Agency (EPA). 1980. *Ambient Water Quality Criteria for Nitrosoamines.* EPA 440/5-80-064.

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TABLE 4-2 FOOD-WEB EXPOSURE FACTORS FOR RTI SITE ECOLOGICAL RECEPTORS OF CONCERN

Exposure Factor	Receptor						
	American Robin	**American Kestrel**	**Meadow Vole**	**Short-Tailed Shrew**	**Eastern Cottontail**	**Red Fox**	**American mink**
Body Weight (kg)	0.0773 (EPA 1993) Mean for adult, both sexes, all seasons, PA location	0.115 (EPA 1993) Mean female from CA studies	0.0355 (EPA 1993) Adult male average, all year, IN location	0.0156 (EPA 1993) Mean value for males from PA study	1.13 (EPA 1993) Mean for adult male, MD, WV populations	3.94 (EPA 1993) Mean for adult female, Iowa	1.04 (Mitchell 1961; EPA 1993) Mean for adult males in MT
Food Ingestion Rate (g wet/g/day)	1.52 (EPA 1993) Mean for both sexes, free-living in KS location	0.31 (EPA 1993) Adult male in summer, OH location	0.325 (EPA 1993) Mean value for adults, Russia	0.62 (EPA 1993) Mean value for adults, both sexes, WI	0.464 (EPA 1993) Calculated using equation for herbivores, 5X to acct for moisture	0.069 (EPA 1993) Nonbreeding adult, North Dakota captive	0.22 (EPA 1993) Estimated from allometry, body mass, and diet
Incidental Soil or Sediment Ingestion Rate (g/g/day)	0.16 (EPA 1993) Based on 10.4% soil in diet of American woodcock	0.0047 No data available; assumed low rate of 1.5% soil in diet based on food items and capture mode	0.0078 (EPA 1993) Based on 2.4% soil in diet of meadow vole	0.062 No data available; a relatively high rate [10% soil in diet] was assumed because of the preponderance of earthworms and soil invertebrates in diet.	0.0017 (Beyer 1990) Used 2% soil in diet of woodchuck	0.0019 (EPA 1993) Based on 2.8 percent soil in diet of red fox	0.0044 (Sample & Suter 1994) Based on 2% sediment in diet of mink

Exposure Factor	Receptor						
	American Robin	**American Kestrel**	**Meadow Vole**	**Short-Tailed Shrew**	**Eastern Cottontail**	**Red Fox**	**American mink**
Home Range (ha)	0.42 (EPA 1993) Based on means of adults in Tennessee	131 (EPA 1993) Based on adult means in the summer, located in Michigan	0.083 (EPA 1993) Based on MA grassy meadow, adult male	0.16 (EPA 1993) Based on mid of range both sexes in New York	2.2 (EPA 1993) Based on average of females in PA	96 (EPA 1993) Based on mean of females in WI	19.3 (Mitchell 1961) Based on mean for females in densely vegetated area of MT
Dietary Composition	37 % (EPA 1993) invertebrates, 63% vegetation Based on Eastern United States adult robins over the year	50 % invertebrates, 50 % vertebrates (EPA 1993) Based on Florida woodlots	100 % vegetation (EPA 1993)	100 % invertebrates (EPA 1993)	100 % vegetation (EPA 1993)	93 % vertebrates 7 % vegetation (EPA 1993) Maryland/Appalachian Province in fall and winter	84 % fish 16 % benthic invertebrates (Alexander 1977; EPA 1993) Michigan stream (see text)

TABLE 4-3 BIOACCUMULATION FACTORS FOR THE STEP 3 TERRESTRIAL FOOD WEB

COPC	Invertebrate Bioaccumulation Factors (dw)	Plant Bioaccumulation Factors (dw)	Small Mammal Bioaccumulation Factors (dw)
INORGANICS			
Arsenic	Regression (b)	Regression (d)	Regression (f)
Cadmium	Regression (b)	Regression (d)	Regression (f)
Chromium	0.76 (a)	0.0075 (c)	Regression (f)
Copper	Regression (b)	Regression (d)	Regression (f)
Lead	Regression (b)	Regression (d)	Regression (f)
Manganese	Regression (b)	0.25 (c)	Regression (e)
Mercury	Regression (b)	Regression (d)	0.0543 (f)
Nickel	0.60 (a)	Regression (d)	Regression (f)
Selenium	Regression (b)	Regression (d)	Regression (f)
Thallium	ND	0.00085 (c)	0.1124 (f)
Tin	ND	0.0055 (c)	ND
Vanadium	0.042 (a)	0.0055 (c)	0.0104 (f)
Zinc	Regression (b)	Regression (d)	Regression (f)
VOLATILE ORGANIC and ENERGETICS			
No BAF data are available for earthworms or small mammals. Concentrations of any chemicals of concern will be assumed to be the same as in wet weight soil. Concentrations of any chemicals of concern in plants will be estimated based on Travis and Arms (1988); Geometric mean regression log $B_v = 1.588 - 0.578 \log K_{ow}$.			

ND = no BAF data available. Chemical concentrations in food will be assumed to be the same as in wet weight soil (calculated from dry weight values and sample percent moisture).
(a) UF = Median invertebrate uptake factor from Table 7 in Sample et al. (1999).
(b) Invertebrate concentrations calculated using the regression model of Sample et al. (1999), see Table 4-4.
(c) Baes et al. (1984).
(d) Plant concentrations calculated using the regression model of Bechtel (1998), see Table 3-5.
(e) Assumes invertebrate BAF.
(f) Mammal concentrations calculated using the regression model of Sample et al. (1998); mercury, thallium and vanadium are the median general UF from this same citation.

TABLE 4-4 BIOACCUMULATION REGRESSION COEFFICIENTS

COPC	Soil Invertebrates[1]		Plants[2]		Small Mammals[3]	
	B0	**B1**	**B0**	**B1**	**B0**	**B1**
Arsenic	-1.42	0.70	-1.992	0.564	-4.579	0.735
Cadmium	2.11	0.79	-0.476	0.546	-1.538	0.566
Chromium	NA	NA	NA	NA	-1.495	0.733
Copper	1.67	0.26	0.669	0.394	-1.459	0.268
Lead	-0.21	0.81	-1.328	0.561	0.567	0.219
Manganese	-0.80	0.68	NA	NA	-0.80	0.68
Mercury	-0.68	0.12	-0.996	0.544	NA	NA
Nickel	NA	NA	-2.224	0.748	-0.414	0.478
Selenium	-0.075	0.73	-0.678	1.104	-0.426	0.379
Zinc	4.44	0.33	1.575	0.555	4.499	0.0745

Regression Equation is (ln [food]) = B0 + B1(ln [soil]) where the [soil] and [food] are in mg/kg dry weight.

Example calculation for arsenic in soil invertebrates with a concentration of 5 mg/kg in soil:

ln [food]) = B0 + B1(ln [soil]) = -1.42 + (0.7 * (ln 5 mg/kg)) = -1.42 + (0.7 * 1.6094) =-1.42 + 1.1266 = -0.2934. Therefore the concentration in soil invertebrate is the antilog of -0.2934 which is 0.75 mg/kg.

NA = Not Applicable

(1) Sample, B.E., G.W. Suter II, J.J. Beauchamp, and R.A. Efroymson. 1999. Literature-derived bioaccumulation models for earthworms: Development and Validation. *Environ. Toxicol. Chem.* 18:2110-2120.
(2) Bechtel Jacobs Co. 1998. *Empirical Models for the Uptake of Inorganic Chemicals from Soil by Plants*. BJC/OR-133. September.
(3) Sample, B.E., J.J. Beauchamp, R.A. Efroymson, and G.W. Suter II. 1998. *Development and Validation of Bioaccumulation Models for Small Mammals.* Oak Ridge. ES/ER/TM-219. February.

TABLE 4-5 BIOACCUMULATION FACTORS FOR THE STEP 3 AQUATIC AND BENTHIC FOOD WEBS

COPC	Benthic Invertebrate Bioaccumulation Factors (dw)		Fish Bioaccumulation Factors (dw)	
	Value	Notes and Reference	Value	Notes and Reference
INORGANICS				
Aluminum	0.90	(1)	2.70	(6)
Antimony	0.90	(1)	40.0	(6)
Arsenic	0.90	(1)	114	(6)
Barium	0.69	(2)	4.00	(7)
Beryllium	0.90	(1)	62.0	(6)
Cadmium	7.99	(2)	907	(6)
Calcium	NA	(a)	NA	(a)
Chromium (VI)	0.47	(2)	200	(7)
Cobalt	0.90	(1)	300	(7)
Copper	5.25	(2)	710	(6)
Iron	NA	(a)	NA	(a)
Lead	0.61	(2)	0.09	(6)
Magnesium	NA	(a)	NA	(a)
Manganese	0.90	(1)	400	(7)
Mercury	2.87	(2)	3,530	Mercury chloride, (6)
Nickel	2.32	(2)	78.0	(6)
Potassium	NA	(a)	NA	(a)
Selenium	0.90	(1)	129	(6)
Silver	0.90	(1)	87.7	(6)
Sodium	NA	(a)	NA	(a)
Thallium	0.90	(1)	10,000	(6)
Vanadium	0.90	(1)	633	Calculated average from 14 surrogate metals, (6)
Zinc	7.53	(2)	2,059	(6)
VOLATILE INORGANICS				
1,1,1-Trichloroethane	5.81	(3)	2.59	Bluegill, (8)
1,1,2,2-Tetrachloroethane	5.33	(3)	2.46	Bluegill, (8)
1,1,2-Trichloro-1,2,2-trifluoroethane	--	--	8.76	(9)
1,1,2-Trichloroethane	4.49	(3)	2.72	(10)
1,1-Dichloroethane	3.18	(3)	3.10	(9)
1,1-Dichloroethene	2.46	(3)	4.01	(9)
1,2,4-Trichlorobenzene	25.1	(3)	27.7	Fathead Minnow, (11)
1,2-Dibromo-3-chloropropane	--	--	2.86	(9)

COPC	Benthic Invertebrate Bioaccumulation Factors (dw)		Fish Bioaccumulation Factors (dw)	
	Value	Notes and Reference	Value	Notes and Reference
1,2-Dibromoethane	--	--	2.72	(10)
1,2-Dichlorobenzene	12.6	(3)	6.17	Bluegill, (12)
1,2-Dichloroethane	2.26	(3)	1.35	Bluegill, (12)
1,2-Dichloropropane	4.89	(3)	2.72	(10)
1,3-Dichlorobenzene	12.6	(3)	15.80	Rainbow Trout, (13)
1,4-Dichlorobenzene	13.7	(3)	5.93	Bluegill, (12)
2-Butanone	--	--	0.99	(9)
2-Hexanone	--	--	2.39	Calculated, (14)
4-Methyl-2-Pentanone	--	--	1.46	Calculated, (9)
Acetone	0.05	(4)	0.66	Calculated, (9)
Acetonitrile	0.11	(4)	0.66	Calculated, (9)
Benzene	4.12	(3)	2.72	(15)
Bromodichloromethane	3.47	(3)	3.90	Calculated, (9)
Bromoform	4.89	(3)	1.67	Goldfish, (16)
Bromomethane	1.60	(3)	1.95	Calculated, (9)
Carbon Disulfide	--	--	2.89	Calculated, (9)
Carbon Tetrachloride	12.0	(4)	4.38	Bluegill, (12)
Chlorobenzene	17.8	(3)	14.2	Fathead Minnow, (11)
Chloroethane	2.46	(3)	2.36	Calculated, (9)
Chloroform	2.82	(4)	2.51	Bluegill, (8)
Chloromethane	0.50	(5)	1.58	Calculated, (9)
Cis-1,2-Dichloroethene	2.46	1,1-Dichloroethene, (3)	3.25	Calculated, (9)
Cis-1,3-Dichloropropene	3.78	(3)	2.34	1,3-Dichloropropene, Calculated, (9)
Cyclohexane	--	--	10.8	Calculated, (9)
Dibromochloromethane	4.12	(3)	4.31	Calculated, (9)
Dichlorodifluoromethane	2.07	Dichloromethane, (3)	4.10	Calculated, (9)
Ethylbenzene	9.74	(3)	6.11	Goldfish, (17)
Isopropylbenzene	--	--	4.66	Goldfish, (17)
Methyl acetate	--	--	0.78	Calculated, (9)
Methyl tert-butyl ether	--	--	1.20	Japanese Carp, (18)
Methylcyclohexane	--	--	NA	-
Methylene Chloride	2.07	(3)	2.05	Calculated, (9)
Styrene	--	--	3.10	Goldfish, (17)
Tetrachloroethene	7.52	(3)	5.42	Bluegill, (8)
Toluene	4.49	(3)	4.81	Bluegill, (19)
Trans-1,2-Dichloroethene	2.46	1,1-Dichloroethene, (3)	3.90	Calculated, (9)
Trans-1,3-Dichloropropene	3.78	Trans(3),2-Dichloropropene, (3)	2.34	1,3-Dichloropropene, Calculated, (9)

COPC	Benthic Invertebrate Bioaccumulation Factors (dw)		Fish Bioaccumulation Factors (dw)	
	Value	Notes and Reference	Value	Notes and Reference
Trichloroethene	5.33	(3)	3.42	Bluegill, (8)
Trichlorofluoromethane	13.7	(3)	5.42	Calculated, (9)
Vinyl Chloride	0.62	(4)	<1	Golden Ide Fish (20)
Xylenes (total)	--	(3)	3.25	m-Xylene, Goldfish, (17)
ENERGETICS				
Perchlorate	--	--	--	--
Hydrazine	--	--	0.34	Calculated, (9)
Monomethyl Hydrazine (MMH)	--	--	--	--
Unsymmetrical Dimethyl Hydrazine (UDMH)	--	--	--	--
N-nitrosodimethylamine (NDMA)	0.50	(5)	0.52	Calculated, (9)
Diethylene Triamine (DETA)	--	--	--	--

(a) Essential Nutrient
-- None Available
NA Not Appropriate

(1) - Calculated average from 6 surrogate metals; Table C-6, U.S. Environmental Protection Agency 1999. Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities (Appendix C: Media-to-Receptor Bioconcentration Factors (BCFs)). EPA 530-D-99-001A. August.
(2) - 90th percentile of BSAFs for conservative estimate, dry weight benthos; Oak Ridge National Laboratory 1998. *Biota Sediment Accumulation Factors for Invertebrates: Review and Recommendations for the Oak Ridge Reservation.* BJC/OR-112. August.
(3) – Calculated using eqn. 2 from Meylan, W.M., Howard, P.H., Boethling, R.S., Aronson, D., Printup, H., and Gouchie, S. 1999. Improved method for estimating bioconcentration/bioaccumulation factor from octanol/water partition coefficient. *Environmental Toxicology and Chemistry*, 4: 664-672.
(5) – BAF value for non-ionic compounds with $K_{ow} < 1$, from Meylan, W.M., Howard, P.H., Boethling, R.S., Aronson, D., Printup, H., and Gouchie, S. 1999. Improved method for estimating bioconcentration/bioaccumulation factor from octanol/water partition coefficient. *Environmental Toxicology and Chemistry*, 4: 664-672.
(4) – Calculated; Table C-6, U.S. Environmental Protection Agency 1999. *Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities (Appendix C: Media-to-Receptor Bioconcentration Factors (BCFs)).* EPA 530-D-99-001A. August.
(6) - Table C-5, U.S. Environmental Protection Agency 1999. *Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities (Appendix C: Media-to-Receptor Bioconcentration Factors (BCFs)).* EPA 530-D-99-001A. August.

(7) - Oak Ridge National Laboratory Risk Assessment Information System online, Chemical-Specific Factors: http://rais.ornl.gov/cgi-bin/tox/TOX_select?select=csf
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TABLE 4-6 SOIL INVERTEBRATE TOXICITY REFERENCE VALUES
(From (a) EcoSSL or (b) Efroymson et al. 1997a)

COPC	Toxicity Reference Value (mg/kg)	Toxicity Endpoint Type	ORNL Rated Confidence in Value
INORGANICS			
Aluminum[(a)]	pH > 5.5	-----	-----
Antimony[(a)]	78	Maximum Allowable Toxicant Concentration/EC_{10}	-----
Arsenic[(b)]	60	Growth and reproduction, single study	Low
Barium[(a)]	330	Maximum Allowable Toxicant Concentration/EC_{10}	-----
Beryllium[(a)]	40	Maximum Allowable Toxicant Concentration/EC_{10}	-----
Cadmium[(a)]	140	Maximum Allowable Toxicant Concentration/EC_{10}	-----
Chromium[(b)]	0.4	Survival, based on Cr^{+6}	Low
Copper[(a)]	80	Maximum Allowable Toxicant Concentration/EC_{10}	-----
Lead[(a)]	1,700	Maximum Allowable Toxicant Concentration/EC_{10}	-----
Manganese[(a)]	450	Maximum Allowable Toxicant Concentration/EC_{10}	-----
Mercury[(b)]	0.1	Survival and reproduction, few studies	Low
Nickel[(a)]	280	Maximum Allowable Toxicant Concentration/EC_{10}	-----
Selenium[(a)]	4.1	Maximum Allowable Toxicant Concentration/EC_{10}	-----
Silver[(b)]	50	Seventeen studies, multiple endpoints	Moderate
Vanadium[(b)]	20	Microbial endpoint, based on multiple endpoints	Moderate
Zinc[(a)]	120	Maximum Allowable Toxicant Concentration/EC_{10}	-----
VOLATILE ORGANICS			
1,1,2,2-Tetrachloroethane[(b)]	1,000	Based on carbon tetrachloride microbial endpoint	Low
Chloromethane[(b)]	1,000	Based on carbon tetrachloride microbial endpoint	Low
Ethylbenzene[(b)]	40	Based on nitrobenzene and chlorobenzene	Low
Methylene chloride[(b)]	1,000	Based on carbon tetrachloride microbial endpoint	Low
Tetrachloroethene[(b)]	1,000	Based on carbon tetrachloride microbial endpoint	Low
Trichloroethene[(b)]	1,000	Based on carbon tetrachloride microbial endpoint	Low

COPC	Toxicity Reference Value (mg/kg)	Toxicity Endpoint Type	ORNL Rated Confidence in Value
ENERGETICS			
No invertebrate toxicity data are available for energetics			

TABLE 4-7 VEGETATION TOXICITY REFERENCE VALUES
(From (a) EcoSSL or (b) Efroymson et al. 1997b)

COPC	Toxicity Reference Value (mg/kg)	Toxicity Endpoint Type	ORNL Rated Confidence in Value
INORGANICS			
Aluminum[(a)]	pH > 5.5	-----	-----
Arsenic[(a)]	18	Growth, multiple species	-----
Cadmium[(a)]	32	Growth, multiple species	-----
Chromium	1	Single Study, growth	Low
Cobalt[(a)]	13	Growth, multiple species	-----
Copper[(a)]	70	Growth, multiple species	-----
Lead[(a)]	120	Growth, multiple species	-----
Manganese[(a)]	220	Growth, multiple species	-----
Mercury[(b)]	0.3	Unspecified, secondary citation	Low
Nickel[(a)]	38	Growth, multiple species	-----
Selenium[(a)]	0.52	Growth, multiple species	-----
Silver[(a)]	560	Growth, multiple species	-----
Thallium[(b)]	1	Unspecified, secondary citation	Low
Tin[(b)]	50	Single bush bean study, shoot weight endpoint	Low
Vanadium[(b)]	2	Unspecified, secondary citation	Low
Zinc [(a)]	160	Growth, multiple species	-----
VOLATILE ORGANICS (examples shown, will be expanded as necessary)			
1,1,2,2-Tetrachloroethane	79	Based on trichloroethane, partitioning using Koc of 79 and water TRV of 100 mg/L	Low
Tetrachloroethene	36.2	Based on partitioning using Koc of 363 and water TRV of 10 mg/L	Low
Trichloroethene	104	Based on partitioning using Koc of 104 and water TRV of 100 mg/L	Low
Xylenes, total	260	Based on partitioning using K_{oc} of 260 and water TRV of 100 mg/L	Low

COPC	Toxicity Reference Value (mg/kg)	Toxicity Endpoint Type	ORNL Rated Confidence in Value
ENERGETICS			
Will be based on partitioning using water quality data when available.			

TABLE 4-8 SEDIMENT TOXICITY VALUES (mg/kg)[a]

COPC	Toxicity Reference Value	Source
INORGANICS		
Aluminum	26,000	Ingersoll et al. (1996) low confidence
Antimony	3.0	Washington State UET, microtox endpoint, low confidence
Arsenic	9.8	MacDonald et al. (2000)
Barium	48	Washington State AET, amphipod endpoint
Cadmium	0.99	MacDonald et al. (2000)
Chromium	43.4	MacDonald et al. (2000)
Cobalt	10	Washington State AET, *Neanthes* bioassay
Copper	31.6	MacDonald et al. (2000)
Lead	35.8	MacDonald et al. (2000)
Manganese	630	Ingersoll et al. (1996)
Mercury	0.18	MacDonald et al. (2000)
Nickel	121	MacDonald et al. (2000)
Selenium	1.0	Washington State AET, amphipod endpoint
Silver	4.5	Washington State UET, *Hyalella azteca* bioassay
Zinc	121	MacDonald et al. (2000)
VOLATILES (Acetone as an example)		
Acetone *	2.26	DiToro and McGrath (2000)
ENERGETICS		
No sediment toxicity data are available for energetics.		

(a) These values are the same as those shown in Table 4-1
* Converted assuming 1% organic carbon.

TABLE 4-9 NOAEL TOXICITY REFERENCE VALUES (TRVs) FOR USE IN FOOD WEBS
(mg/kg-bw/day)
(Based on Sample et al. 1996 unless otherwise noted)

COPC	Vole	Shrew	Robin	Rabbit	Kestrel	Red Fox	American mink	Comments
INORGANICS								
Aluminum	1.754	2.295	109.7	0.767	109.7	0.551	0.803	NOAEL for vole, shrew, fox, rabbit, and mink based on mouse exposed to $AlCl_3$. NOAEL for robin and kestrel based on dove exposed to aluminum sulfate.
Antimony	0.114	0.149	NA	0.05	NA	0.036	0.052	NOAEL for vole, shrew, fox ,rabbit, and mink based on mouse exposed to antimony potassium tartrate. No toxicity studies for avian species have been identified.
Arsenic	0.114	0.15	5.1	0.05	5.1	0.036	0.052	NOAEL for shrew, vole, fox, rabbit, and mink based on mouse exposed to arsenite. NOAEL for robin and kestrel based on mallard exposed to sodium arsenite.
Barium	3.33	43.5	20.8	1.46	20.8	1.05	1.52	NOAEL for shrew, vole, fox, rabbit, and mink based on LOAEL/10 for rat exposed to barium hydroxide. NOAEL for robin and kestrel based on day old chicks exposed to barium hydroxide.
Beryllium	1.11	1.45	NA	0.49	NA	0.35	0.510	NOAEL for shrew, vole, fox, rabbit, and mink based on rat exposed to beryllium sulfate. No toxicity studies for avian species have been identified.
Cadmium	1.62	2.12	1.45	0.71	1.45	0.51	0.743	NOAEL for shrew, vole, rabbit, and mink based on rat exposed to cadmium chloride. NOAEL for robin and kestrel based on duck NOAEL for cadmium chloride.

TABLE 4-9 (continued)

COPC	Vole	Shrew	Robin	Rabbit	Kestrel	Red Fox	American mink	Comments
Chromium	4,600	6,015	1	2,010	1	1,445	2,105	NOAEL for vole, shrew, fox, rabbit, and mink based on rat NOAEL for Cr^{+3}. NOAEL for robin and kestrel based on duck NOAEL for Cr^{+3}.
Cobalt	5	5	16.7	5	16.7	5	5	NOAEL for vole, shrew, fox, rabbit, and mink based on rats fed cobalt chloride (Nation 1983). NOAEL for robin and kestrel based on ducks exposed to cobalt chloride (Van Vleet 1982).
Copper	25.5	33.4	47	11.2	47	8	11.7	NOAEL for vole, shrew, fox, rabbit, and mink based on mink NOAEL for copper sulfate. NOAEL for robin and kestrel based on chick NOAEL exposed to copper oxide.
Lead	13.44	17.58	3.85	5.88	3.85	4.22	6.15	NOAEL for vole, shrew, fox, rabbit, and mink based on rat NOAEL for lead acetate. NOAEL for robin and kestrel based on kestrel NOAEL exposed to metallic lead.
Manganese	148	193	997	65	997	46	67	NOAEL for vole, shrew, fox, rabbit, and mink based on rat NOAEL. NOAEL for robin and kestrel based on quail NOAEL.
Mercury	2.18	2.86	0.45	0.96	0.45	0.69	1.00	NOAEL for shrew, vole, fox, rabbit, and mink based on mink exposed to mercuric chloride. NOAEL for robin and kestrel based on quail exposed to mercuric chloride.
Nickel	67.18	87.91	77.4	29.4	77.4	21.12	30.76	NOAEL for vole, shrew, fox, rabbit, and mink based on rat NOAEL for nickel sulfate hexahydrate. NOAEL for robin and kestrel based on mallard NOAEL exposed to nickel sulfate.

TABLE 4-9 (continued)

COPC	Vole	Shrew	Robin	Rabbit	Kestrel	Red Fox	American mink	Comments
Selenium	0.336	0.44	0.5	0.147	0.5	0.106	0.154	NOAEL for vole, shrew, fox, rabbit, and mink based on rat NOAEL for selenate. NOAEL for robin and kestrel based on mallard exposed to sodium selenite.
Silver	18	18	12	3.6	12	3.6	3.6	The vole and shrew TRV is based on a mouse 125-day NOAEL with a systemic endpoint [Agency for Toxic Substances and Disease Registry (ATSDR) 1989]. This NOAEL was divided by 5 to account for intertaxon variability, resulting in 3.6 mg/kg/day for the rabbit, mink, and red fox. The avian TRV was based on a 2-week LOAEL for newly hatched chickens (decreased body weight), divided by 10 to account for chronic exposure and by 10 again to account for LOAEL to NOAEL extrapolations.
Thallium	0.013	0.016	0.42	0.005	2.1	0.004	0.006	NOAEL for vole, shrew, fox, rabbit, and mink based on rat NOAEL exposed to thallium sulfate. The avian TRV is based on a single dose NOAEL for golden eagles (Bean and Hudson 1976) with loss of muscular coordination and other physical effects at 21 mg/kg/day. This was divided by 10 to approximate the chronic NOAEL of 2.1 mg/kg/day for the kestrel. The raptor value of 2.1 mg/kg/day was divided by 5 to account for inter-taxon variability resulting in a TRV of 0.42 mg/kg/day for the robin.

TABLE 4-9 (continued)

COPC	Vole	Shrew	Robin	Rabbit	Kestrel	Red Fox	American mink	Comments
Vanadium	0.327	0.428	11.4	0.143	11.4	0.103	0.150	NOAEL for vole, shrew, fox, rabbit, and mink based on rat NOAEL exposed to sodium metavanadate. NOAEL for robin and kestrel based on mallard NOAEL exposed to vanadyl sulfate.
Zinc	268.7	351.7	14.5	117.6	14.5	84.5	123.1	NOAEL for vole, shrew, fox, rabbit, and mink based on rat NOAEL exposed to zinc oxide. NOAEL for robin and kestrel based on chicken NOAEL exposed to zinc sulfate.
VOLATILES (if other volatile COPC identified the literature will be examined to determine if there are TRVs available)								
1,1,2,2-Tetrachloroethane (based on tetrachloroethylene as surrogate)	1.27	1.66	NA	0.56	NA	0.4	0.58	NOAEL for vole, shrew, fox, rabbit, and mink based on mouse NOAEL. No avian TRVs found.
2- Butanone (Methyl Ethyl Ketone (MEK))	2,974	3,892	NA	1301	NA	935	1362	NOAEL for vole, shrew, fox, rabbit, and mink based on rat NOAEL. No avian TRVs found.
Acetone	16.8	22	NA	7.3	NA	5.3	7.7	NOAEL for vole, shrew, fox, rabbit, and mink based on rat NOAEL. No avian TRVs found.

TABLE 4-9 (continued)

COPC	Vole	Shrew	Robin	Rabbit	Kestrel	Red Fox	American mink	Comments
Benzene	24	31.3	NA	10.5	NA	7.5	10.9	NOAEL for vole, shrew, fox, rabbit, and mink based on mouse reproductive toxicity test. No avian TRVs found.
Carbon Disulfide	3	3	NA	0.6	NA	0.6	0.6	The vole and shrew TRV are based on a single 14-day study at a dose of 300 mg/kg/day, which resulted in no adverse effects on rats. This was divided by 100 to approximate the chronic NOAEL of 3 mg/kg/day (ATSDR 1990). The rabbit, mink, and fox TRV were based on this value divided by 5 to account for intertaxon variability. No avian TRVs found.
Chloromethane (based on methylene chloride (dichloromethane))	9.8	12.9	NA	4.3	NA	3.1	4.5	NOAEL for vole, shrew, fox, rabbit, and mink based on rat NOAEL. No avian TRVs found.
Ethylbenzene (based on benzene)	24	31.3	NA	10.5	NA	7.5	10.9	NOAEL for vole, shrew, fox, rabbit, and mink based on mouse reproductive toxicity test. No avian TRVs found.
Methylene Chloride	9.8	12.9	NA	4.3	NA	3.1	4.5	NOAEL for vole, shrew, fox, rabbit, and mink based on rat NOAEL. No avian TRVs found.
Tetrachloroethene	1.27	1.66	NA	0.56	NA	0.4	0.58	NOAEL for vole, shrew, fox, rabbit, and mink based on mouse NOAEL. No avian TRVs found.
Trichloroethene	0.636	0.832	NA	0.278	NA	0.2	0.291	NOAEL for vole, shrew, fox, rabbit, and mink based on mouse NOAEL. No avian TRVs found.
Xylenes, Total	1.908	2.497	NA	0.835	NA	0.6	0.874	NOAEL for vole, shrew, fox, rabbit, and mink based on mouse NOAEL. No avian TRVs found.
ENERGETICS (No TRVs have been found for the energetics)								

NOAEL values for the red-tailed hawk used for the American kestrel.
NA = None Available.

TABLE 4-10 LOAEL TOXICITY REFERENCE VALUES (TRVs) FOR USE IN FOOD WEBS
(mg/kg-bw/day)
(Based on Sample et al. 1996 unless otherwise noted)

COPC	Vole	Shrew	Robin	Rabbit	Kestrel	Red Fox	American Mink	Comments
INORGANICS								
Aluminum	17.5	22.9	1097	7.7	1,097	5.5	8.0	LOAEL for vole, shrew, fox, rabbit, and mink based on mouse exposed to $AlCl_3$. LOAEL for robin and kestrel based on NOAEL for the dove exposed to aluminum sulfate times 10.
Antimony	1.14	1.49	NA	0.50	NA	0.36	0.52	LOAEL for vole, shrew, fox, rabbit, and mink based on mouse exposed to antimony potassium tartrate. No toxicity studies for avian species have been identified.
Arsenic	1.1	1.5	12.8	0.5	12.8	0.36	0.52	mink based on mouse exposed to arsenite. LOAEL for robin and kestrel based on mallard exposed to sodium arsenite.
Barium	33.3	43.5	41.7	14.6	41.7	10.5	15.2	LOAEL for shrew, vole, fox, rabbit, and mink based on rat exposed to barium hydroxide. LOAEL for robin and kestrel based on day old chicks exposed to barium hydroxide.
Beryllium	11.1	14.5	NA	4.9	NA	3.5	5.1	LOAEL for shrew, vole, fox, rabbit, and mink based on rat NOAEL times 10, exposed to beryllium sulfate. No toxicity studies for avian species have been identified.
Cadmium	16.2	21.2	20	7.1	20	5.1	7.4	LOAEL for shrew, vole, fox, rabbit, and mink based on rat exposed to cadmium chloride. LOAEL for robin and kestrel based on duck LOAEL for cadmium chloride.
Chromium	45,970	60,150	5	20,110	5	14,450	21,046	LOAEL for vole, shrew, fox, rabbit, and mink

COPC	Vole	Shrew	Robin	Rabbit	Kestrel	Red Fox	American Mink	Comments
								based on rat NOAEL for Cr^{+3} times 10. LOAEL for robin and kestrel based on duck LOAEL for Cr^{+3}.
Cobalt	50	50	167	50	167	50	72	LOAEL for vole, shrew, fox, rabbit, and mink based on rat NOAEL times 10 fed cobalt chloride (Nation 1983). LOAEL for robin and kestrel based on duck NOAEL times 10 exposed to cobalt chloride (Van Vleet 1982).
Copper	33.6	44.0	61.7	14.7	61.7	10.6	15.4	LOAEL for vole, shrew, fox, rabbit, and mink based on mink LOAEL for copper sulfate. LOAEL for robin and kestrel based on chick LOAEL for copper oxide.
Lead	134.4	175.8	38.5	58.8	38.5	42.3	61.5	LOAEL for vole, shrew, fox, rabbit, and mink based on rat LOAEL. LOAEL for robin and kestrel based on kestrel NOAEL times 10.
Manganese	477	624	9,970	209	9,970	150	218	LOAEL for vole, shrew, fox, rabbit, and mink based on rat LOAEL. LOAEL for robin and kestrel based on quail NOAEL times 10.
Mercury	21.8	28.6	0.9	9.6	0.9	6.9	10.1	LOAEL for shrew, vole, fox, rabbit, and mink based on mink mercuric chloride NOAEL times 10. LOAEL for robin and kestrel based on quail exposed to mercuric chloride.
Nickel	134.4	175.8	107	58.8	107	42.25	61.5	LOAEL for vole, shrew, fox, rabbit, and mink based on rat LOAEL exposed to nickel sulfate hexahydrate. LOAEL for robin and kestrel based on mallard LOAEL exposed to nickel sulfate.
Selenium	0.55	0.73	1	0.24	1	0.174	0.254	LOAEL for vole, shrew, fox, rabbit, and mink based on rat LOAEL exposed to selenate. LOAEL for robin and kestrel based on mallard exposed to sodium selenite.

COPC	Vole	Shrew	Robin	Rabbit	Kestrel	Red Fox	American Mink	Comments
Silver	180	180	120	36	120	36	120	The vole and shrew TRV is based on a mouse 125-day LOAEL with a systemic endpoint (ATSDR 1989). This NOAEL was divided by 5 to account for intertaxon variability, resulting in 3.6 mg/kg/day for the fox, rabbit, and mink. The avian TRV was based on a 2 week LOAEL for newly hatched chickens (decreased body weight), divided by 10 to account for chronic exposure and by 10 again to account for LOAEL to NOAEL extrapolations.
Thallium	0.13	0.16	4.2	0.055	21	0.039	0.058	LOAEL for vole, shrew, fox, rabbit, and mink based on rat LOAEL. The avian TRV is based on a single dose NOAEL for golden eagles (Bean and Hudson 1976) with loss of muscular coordination and other physical effects at 21 mg/kg/day. This was divided by 10 to approximate the chronic NOAEL of 2.1 mg/kg/day for the kestrel. The raptor value of 2.1 mg/kg/day was divided by 5 to account for inter-taxon variability resulting in a TRV of 0.42 mg/kg/day for the robin. LOAEL TRV equals NOAEL times 10.
Vanadium	3.27	4.29	114	1.43	114	1.03	1.50	LOAEL for vole, shrew, fox, rabbit, and mink based on rat LOAEL exposed to sodium metavanadate. LOAEL for robin and kestrel based on mallard LOAEL exposed to vanadyl sulfate.
Zinc	537	703	131	235	131	169	246	LOAEL for vole, shrew, fox, rabbit, and mink based on rat LOAEL exposed to zinc oxide. LOAEL for robin and kestrel based on chicken LOAEL exposed to zinc sulfate.

COPC	Vole	Shrew	Robin	Rabbit	Kestrel	Red Fox	American Mink	Comments
VOLATILES (if other volatile COPC identified the literature will be examined to determine if there are TRVs available)								
1,1,2,2-Tetrachloroethane (based on tetrachloroethylene as surrogate)	6.4	8.3	NA	2.78	NA	2	2.91	LOAEL for vole, shrew, fox, rabbit, and mink based on mouse LOAEL. No avian TRV found.
2- Butanone (Methyl Ethyl Ketone)	7,677	10,046	NA	3,359	NA	2,414	3,516	LOAEL for vole, shrew, fox, rabbit, and mink based on rat LOAEL. No avian TRV found.
Acetone	84	110	NA	36.7	NA	26.4	38.5	LOAEL for vole, fox, rabbit, and mink based on rat LOAEL. No avian TRV found.
Benzene	240	314	NA	105	NA	75	109	LOAEL for vole, shrew, fox, rabbit, and mink based on mouse reproductive toxicity test. No avian TRV found.
Carbon Disulfide	30	30	NA	6	NA	6	6	The vole and shrew TRV are based on a single 14-day study at a dose of 300 mg/kg/day, which resulted in no adverse effects on rats. This was divided by 100 to approximate the chronic NOAEL of 3 mg/kg/day (ATSDR 1990). The fox, rabbit, and mink TRV were based on this value divided by 5 to account for intertaxon variability. LOAEL equals NOAEL times 10. No avian TRV found.
Chloromethane (based on methylene chloride (dichloromethane))	84	110	NA	36.7	NA	26.4	38.5	LOAEL for vole, shrew, fox, rabbit, and mink based on rat LOAEL. No avian TRV found.
Ethylbenzene (based on benzene)	240	314	NA	105	NA	75	109	LOAEL for vole, shrew, fox, rabbit, and mink based on mouse reproductive toxicity test. No avian TRV found.
Methylene Chloride	84	110	NA	36.7	NA	26.4	38.5	LOAEL for vole, shrew, fox, rabbit, and mink based on rat LOAEL. No avian TRV found.
Tetrachloroethene	6.36	8.32	NA	2.78	NA	2	2.91	LOAEL for vole, shrew, fox, rabbit, and mink based on mouse LOAEL. No avian TRV found.

COPC	Vole	Shrew	Robin	Rabbit	Kestrel	Red Fox	American Mink	Comments
Trichloroethene	6.36	8.32	NA	2.78	NA	2	2.91	LOAEL for vole, shrew, fox, rabbit, and mink based on mouse LOAEL. No avian TRV found.
Xylenes, Total	2.36	3.09	NA	1.03	NA	0.74	1.08	LOAEL for vole, shrew, fox, rabbit, and mink based on mouse LOAEL. No avian TRV found.

LOAEL values for the red-tailed hawk used for the American kestrel.
NA = None Available.

APPENDIX D

UXO BACKGROUND INFORMATION

PICATINNY UXO BACKGROUND

Based on ATK's review of the Stakeholder Draft Site Inspection (SI) Report, Picatinny Arsenal, New Jersey (Malcolm Pirnie, Inc., November 2007), the potential for UXO on the RTI site results from munitions firing and discarded UXO following the 1926 Lake Denmark Powder Depot explosion.

In 2007, Picatinny conducted a visual survey of 4.75-acres at the RTI site. According to the SI report, no munitions and explosives of concern (MEC) or munitions debris were observed. A map of the SI field activities and findings is attached as Figure 1.

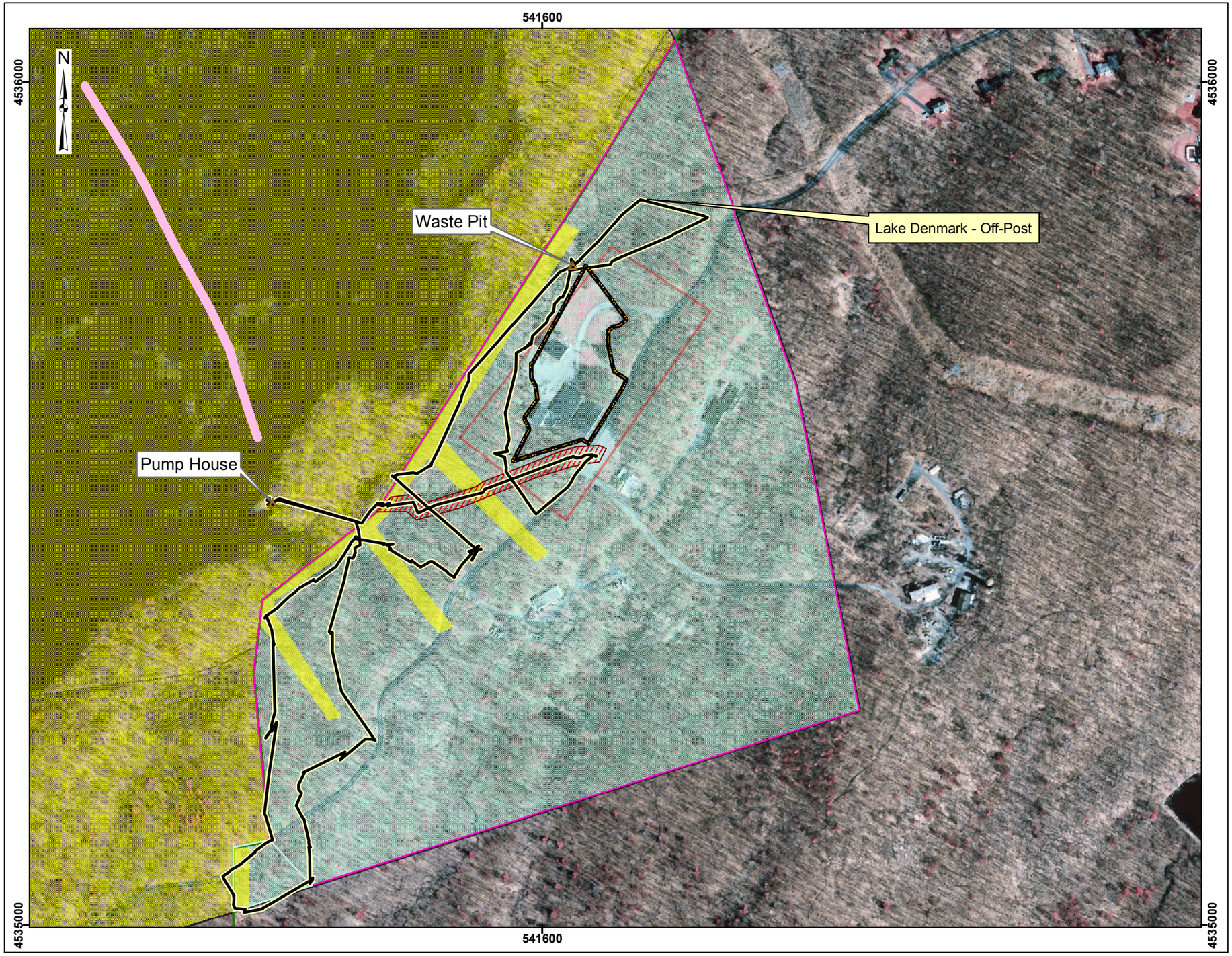
The following table provides a summary of the potential and actual munitions debris and MEC for the RTI Site (a.k.a. Lake Denmark – Off-Post)

Munitions Debris/MEC Observed During SI Field Activities	Munitions Debris/MEC Identified during Historical Records Review	Primary Release Mechanism
None	• Mortars: 60-mm, 81-mm, 4.2-inch inert • 20-mm cannons • Primary and secondary explosives • Pyrotechnics • Experimental munitions	• Munitions firing and testing • Discarded UXO following the 1926 Lake Denmark Powder Depot explosion

According to the USACE's Ordnance and Explosives Response Manual (EM1110-1-4009), June 2000, the maximum probable penetration depth for a 4.2-inch mortar is 5.4 feet. According to the SI report, no MEC was observed on the surface during the SI visual survey; therefore, the MEC density at the site is unknown.

PICATINNY CONTACT INFORMATION

In the event an anomaly is detected during the UXO clearing activities, the Picatinny Police Department (973-724-6666) and Paul Greene of USACE (410-962-6741) will be contacted to investigate, and if necessary, remove the UXO. ATK's UXO contractor will not be responsible for conducting UXO removal activities.



Site Inspection
Picatinny Arsenal, NJ

MALCOLM PIRNIE

Map 4-5
SI Field Activities and Findings
Lake Denmark - Off-Post

Legend

- Installation Boundary
- Site Survey
- Approximate Furthest Extent of Mortar Impact Area
- SI Work Plan Proposed Area for Visual Survey
- Radiation Technology Superfund Site
- Berm
- Fenced Area

Military Range Area

- Lakes Site
- Lake Denmark - Off-Post

Off-Post Owners*

- Rockaway Township
- Radiation Technology, Inc

*Notes: 1) Off-Post Owners areas are approximate
2) Transects for the visual survey were not conducted in straight lines because of sporadic GIS satellite coverage, site topography and dense vegetation. GIS interference was caused by overhead tree canopy.

0 90 180 360 Meters

Data Source: Aerials: NJDEP, CIR Orthoimagery, 2002
CTT Data: AEC, CTT Range Inventory, 2005

Coordinate System: UTM Zone 18N
Datum: NAD 83
Units: Meters

Contract: W912DR-05-D-0004
Edition: Draft SI Report
Date: November 2007

300212

APPENDIX E

SAMPLING AND ANALYSIS PLAN (SAP)

SAMPLING AND ANALYSIS PLAN
REMEDIAL INVESTIGATION/
FEASIBILITY STUDY

RTI SUPERFUND SITE
ROCKAWAY TOWNSHIP, NEW JERSEY

DISCLAIMER:
SOME FORMATTING CHANGES MAY HAVE OCCURRED WHEN THE ORIGINAL DOCUMENT WAS PRINTED TO PDF; HOWEVER, THE ORIGINAL CONTENT REMAINS UNCHANGED.

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1.0 INTRODUCTION

This Sampling and Analysis Plan (SAP) has been prepared to provide the field procedures and sampling protocols for the Remedial Investigation/Feasibility Study (RI/FS) Work Plan (Work Plan) for the Radiation Technology Incorporated (RTI) Superfund Site located near Lake Telemark, New Jersey (Site). The Site location is depicted on Figure 1.1 and a Site Plan is provided as Figure 1.2.

The Work Plan is specific to Operable Unit 2 (OU-2), and addresses potential source(s) of groundwater contamination at the Site, namely, soil, sediment, and surface water. In addition to the Work Plan and SAP, other documents have been prepared to assist in the goal of successfully completing the RI/FS and are incorporated by reference including:

- Quality Assurance Project Plan (QAPP); and
- Health and Safety Plan (HASP).

1.1 BACKGROUND

The RTI site is approximately 263 acres in size. The Site includes the following five main areas:

- RTI 23 acres
- P2 16 acres
- East Stand 22 acres
- South Stand 27 acres
- Undeveloped area 175 acres

Figure 1.3 shows the five areas.

Prior to 1956, the Site was not developed. In 1956, Reaction Motors, Inc., that was later aquired by Thiokol, operated a rocket testing facility at the Site until 1969 when Thiokol-related activities ceased. In 1972, RTI purchased a 15 acre parcel of the Site (located northwest of Lake Denmark Road) where it conducted irradiation activities until it sold this operation to Sterigenics in 1996. In 1978, RTI purchased the remaining 248 acres of the Site from Thiokol and leased portions of this property to various tenants. RTI tenants have included Sterigenics International (RTI area), Ion Beam Applications, SA (RTI area), Hazard Research Corporation (S-46 Building Area), Kronenberg/Image Boat

Company (R47 building area), Autobody Repair (R47 building area), and Talon Landscaping (R51 building area).

RTI was licensed in 1970 to operate megacurie pool irradiator in the RTI portion of the Site. Radioactive related investigative and remedial measures, including remediation of radiological contaminated soils, were conducted by RTI from 1986 until 1996. NRC delisted the Site and terminated RTI's license in 1997. RTI declared bankruptcy in 2000 and according to ATK, there is currently no financially-solvent owner of the Site.

The New Jersey Department of Environmental Protection (NJDEP) and its subcontractor, Acres, previously conducted a multi-phased RI at the Site. Supplemental investigations and interim remedial activities, including: sump cleaning, above-ground storage tank (AST) and underground storage tank (UST) removal or closure, soil excavation, and drum removal have been conducted subsequent to the Acres RI. These activities have resulted in the collection of approximately 220 soil, sediment, and surface water samples across the Site.

Based on their review of existing data, the United States Environmental Protection Agency (USEPA) concluded that the RI/FS for OU-2 could be limited to specific areas requiring additional investigation. Therefore, the scope of the RI/FS Work Plan is limited to the areas shown on Figure 1.4. Furthermore, the investigation within these areas will be focused on historic operations related to the rocket motor industry, specifically operations related to ATK's predecessor, Thiokol.

1.2 OBJECTIVES

This SAP has been developed for OU-2. Media of potential concern associated with OU-2 include soil, sediment, and surface water. Groundwater at the Site (OU-1) is addressed under a separate Consent Decree between ATK and the USEPA.

The compounds of potential concern related to the rocket motor industry include volatile organic compounds (VOCs), metals, and energetics.

The areas requiring additional investigation are described in the Work Plan and are shown on Figure 1.4. In order to determine naturally-occurring background concentrations of selected inorganics, soil samples will be collected from the undeveloped portions of the Site.

Soil, sediment, and surface water will be analyzed for target compound list (TCL), VOCs, SVOCs (semi-volatile organic compounds), target analyte list (TAL) metals, and/or energetics depending on historical operations in the vicinity of the individual sample location. An acid volatile sulfide (AVS) analysis will be conducted on sediment samples to evaluate the variation in AVS concentrations on metal bioavailability. Sediment samples will also be analyzed for grain size, total organic carbon (TOC), and pH. Surface soil samples will also be analyzed for pH and TOC. A summary of analytical parameters is presented in Table 1.1.

Collected data will be used for the following purposes:

- To determine the sources of contamination;
- To define the nature and extent of contamination;
- To determine background concentrations of select naturally occurring inorganics;
- To determine Site-specific cleanup criteria; and
- For the development of Baseline Human Health Risk Assessment and Screening-Level Ecological Risk Assessment.

1.3 SAMPLING AND ANALYSIS PLAN CONTENTS

The SAP contains procedures and protocol for the following investigation tasks:

- Utility and subsurface structure clearance;
- Unexploded ordinance assessment;
- Subsurface waste delineation;
- Installation and sampling of borings (hand auger, direct push technology, and drill rig);
- Surface water, surface soils, and sediment sampling;
- AST liquid and sediment sampling;
- Surveying of investigation locations;
- Removal, transport, testing, and proper disposal of investigation-derived wastes (IDW) generated during drilling and sampling; and
- Laboratory testing of soil, surface water, and sediment samples.

1.4 STANDARD OPERATING PROCEDURES

The SAP incorporates a number of field Standard Operating Procedures (SOPs) for various investigative tasks to be performed during the RI/FS.

The field SOPs are provided in Appendix A and include the following:

- SOP 1 Decontamination of Heavy Equipment;
- SOP 2 Decontamination of Field Equipment;
- SOP 3 Borehole Installation and Sampling;
- SOP 4 Surficial Soil Sampling;
- SOP 5 Collecting Sediment Samples;
- SOP 6 Collecting Surface Water Samples; and
- SOP 7 Sample Management and Field QA/QC.

The field SOPs are supplied to provide field personnel with additional general information concerning the specific investigative tasks. The SOPs are intended to supplement the Site-specific procedures and protocols provided in the SAP. However, in the event that the general protocols in the SOPs might conflict with the Site-specific procedures in the SAP, the Site-specific procedures in the SAP shall supercede the general protocols in the SOPs.

2.0 GENERAL FIELD PROTOCOLS

2.1 OVERVIEW

General protocols that are applicable to a number of field activities to be completed during the RI/FS are summarized in this section. The field teams will follow all applicable health and safety protocols while decontaminating equipment.

During the RI/FS field sampling activities, a staging area will be established on the northwest side of the Sterigenics facility for equipment storage, a central decontamination pad, and temporary storage of IDW. This location is preferred because it is level, paved, has access to electricity and telephone, and it is relatively secure because it is inside a fenced area that is locked during non-business hours. However, the final location of the decontamination and central staging area will be established following discussions with Sterigenics.

2.2 EQUIPMENT DECONTAMINATION PROTOCOLS

2.2.1 DRILLING RIGS AND EQUIPMENT

Decontamination of drill rigs and associated equipment will be performed at each drilling location prior to proceeding to the next location. General protocols for decontamination of drill rigs and associated equipment are described in SOP 1, contained in Appendix A.

All equipment brought to the job site will be in good repair and free from oil, dirt, and debris. Any equipment or supplies found to be unsuitable will be removed from the Site.

Drilling equipment will be decontaminated prior to commencing any drilling activity. Decontamination will entail thoroughly cleaning the down-hole and all associated drilling and sampling equipment to remove oil, grease, mud, and other foreign matter as described below:

i. Brush with non-phosphate detergent solution as necessary to remove foreign matter;

ii. Rinse thoroughly with potable water; and

iii. Rinse with distilled water.

Before initiating drilling and sampling at each location (and at each subsequent location), downhole drilling equipment and associated equipment will be decontaminated to prevent potential cross-contamination from the previous drilling activities.

Decontamination of the direct-push downhole equipment and manual sampling equipment can generally be performed in a series of 5-gallon plastic buckets as described below:

i. The first bucket contains the low-phosphate detergent solution for brushing and washing the equipment;
ii. The second bucket contains clean tap water for the first rinse; and
iii. The third bucket is used to catch and contain the distilled/deionized rinse water as it is poured over the equipment.

Decontamination fluids and sediment will be transferred to 55-gallon drums and staged on-Site pending proper disposal. Drums will be labeled and handled in accordance with the procedures outlined in Section 2.4.2.

2.2.2 TEST PIT EXCAVATION EQUIPMENT

Decontamination of test pit excavation equipment will be performed at each test pit location prior to proceeding to the next location. General protocols for decontamination of excavation equipment are described in SOP 1, contained in Appendix A.

All equipment brought to the job site will be in good repair and free from oil, dirt, and debris. Test pit equipment will be decontaminated prior to commencing any excavation activity. Decontamination of the excavator between test pit locations without waste will consist of scraping soils from the bucket and arm between locations. In addition, for test pits in which waste is encountered but waste materials are not of a liquid state or adhere readily to the excavator, soil and waste material will be scraped from the equipment. In all other cases, high pressure water wash/rinse, detergent wash (brushing, as necessary, to remove particulate matter) and a high pressure water rinse will be performed. All decontamination materials in this latter case will be collected and containerized.

Decontamination of manual sampling equipment can generally be performed in a series of 5-gallon plastic buckets as described below:

i. The first bucket contains the low-phosphate detergent solution for brushing and washing the equipment;

ii. The second bucket contains clean tap water for the first rinse; and

iii. The third bucket is used to catch and contain the distilled rinse water as it is poured over the equipment.

Decontamination fluids and sediment will be transferred to 55-gallon drums and staged on-Site pending proper disposal. Drums will be labeled and handled in accordance with the procedures outlined in Section 2.4.2.

2.2.3 SOIL SAMPLING EQUIPMENT

The procedures described in this section pertain to sampling equipment used for collecting soil samples. Non-disposable soil sampling equipment (macro-core samplers, trowels, spoons, hand augers, scoops, etc.) will be decontaminated prior to field use and after each sample is collected to prevent cross-contamination between samples. Duplicate samples will be collected concurrently with original samples; therefore, sampling equipment will not be decontaminated before collection of the duplicate samples. General protocols for decontamination of field equipment used to collect soil samples are provided in SOP 2, Decontamination of Field Equipment (Appendix A).

Decontamination of equipment used for collecting soil samples for laboratory analyses will be performed as follows:

i. Disassemble equipment as appropriate and wash with potable water and Alconox™ detergent (or equivalent non-phosphate detergent) using a brush, if necessary, to remove all visible foreign matter;

ii. Rinse thoroughly with distilled water;

iii. Rinse with distilled or deionized water;

iv. Allow the equipment to air dry on clean plastic or clean aluminum foil for as long as possible; and

v. Wrap equipment in aluminum foil as necessary prior to transport to sampling location.

2.2.4 SURFACE WATER AND SEDIMENT SAMPLING EQUIPMENT

During surface water and sediment sampling, the sampling team's personal protective equipment (PPE) generally remains free of mud and debris with the exception of wading boots and waders. However, sediment sampling equipment will require decontamination as discussed below.

2.2.4.1 SURFACE WATER AND AST SAMPLING EQUIPMENT

Surface water and AST samples will be collected using a simple technique of submersing the sampling vessel into the water to be sampled. The sampling teams will receive clean sample containers directly from the analytical laboratory. These sample containers will be filled with surface water and with the contents of the two ASTs. Once filled, the sampling containers will be shipped to the laboratory using the protocols outlined in Section 5.3. Because there are no additional sampling materials beyond the sample containers used to collect the surface water, no decontamination procedures are required associated with sampling surface water for this project.

Surface water samples submitted for dissolved metals analysis will be filtered in the field at the time of collection. A peristaltic pump, disposable one-time use Teflon tubing, and a disposable 0.45 μm filter will be utilized in the field. Therefore, no decontamination of this equipment will be required.

2.2.4.2 SEDIMENT SAMPLING EQUIPMENT

Sediment sampling requires a number of different items to complete collection activities. The items include but are not limited to:

- Waders;
- Disposable acetate liners or stainless steel core barrel;
- Core barrel caps;
- Core extruder;
- Stainless steel knife;
- Stainless steel bowl;
- Stainless steel spoon/trowel;
- Powder-free nitrile gloves;

- Stainless steel extension bar; and
- Stainless steel "tee" handle.

Most sediment samples will likely be collected with acetate or stainless steel core barrels, stainless steel spoons, and bowls. If used, acetate core barrels will be discarded after each use, so decontamination will not be necessary for them. Stainless steel items will require decontamination prior to being used for sampling sediment. General protocols for decontamination of field equipment used to collect sediment samples are provided in SOP 2, Decontamination of Field Equipment (Appendix A).

Sampling crews will establish a temporary decontamination area away from areas that may cause cross-contamination to equipment. Areas that will be avoided include but are not limited to highway/major traffic areas, railroad rights-of-way, and areas where sampling materials could come into contact with airborne contaminants from industrial emissions (stacks, vent pipes, etc.). The sampling crews will acquire several sets of sediment sampling materials so that multiple locations can be sampled.

Decontamination of equipment used for collecting sediment samples for laboratory analyses will be performed as follows:

i) Disassemble equipment as appropriate and wash with potable water and Alconox™ detergent (or equivalent non-phosphate detergent) using a brush, if necessary, to remove all visible foreign matter;

ii) Rinse thoroughly with distilled water;

iii) Rinse with distilled or deionized water;

iv) Allow the equipment to air dry on clean plastic or clean aluminum foil for as long as possible; and

v) Wrap equipment in aluminum foil as necessary prior to transport to sampling location.

2.2.4.3 DECONTAMINATION OF PERSONAL PROTECTIVE EQUIPMENT (PPE)

Non-disposable sediment sampling PPE, such as waders, will be rinsed off to prevent cross-contamination between sampling locations. With the assistance from other sampling personnel, the boots and waders of each sampling crew member will be

thoroughly rinsed, and brushed if necessary, using a garden sprayer, or similar, filled with potable water. This rinse water will not be containerized.

2.3 UNEXPLODED ORDINANCE AND UTILITY CLEARANCE

The U. S. Army has indicated there is a potential to encounter unexploded ordinance (UXO) as the result of testing activities from adjacent Picatinny arsenal operations. The extent of the potentially affected area on the Site is shown on Figure 1 of the Health and Safety Plan. Prior to the start of surface soil sampling, soil boring work, sediment sampling or subsurface waste delineation work within this area, UXO clearance by a qualified UXO technician, as described in the HASP, will be required. With exception of the subsurface waste delineation, a qualified UXO technician is to clear a radial area originating from the boring/sampling location to a distance of at least 6-feet. Additional detail in regards to UXO clearance for subsurface waste delineation work is provided below in Section 3.6.

2.3.1 DOCUMENTATION

The subcontractor performing the intrusive activity will provide ATK with the New Jersey One-Call utility clearance reference number. The subcontractor will complete a Property Access/Utility Clearance Data Sheet (Appendix B) or equivalent prior to commencing intrusive activities.

2.4 MANAGEMENT OF INVESTIGATIVE WASTE

2.4.1 GENERAL REFUSE

General refuse, including PPE, plastic sheeting, buckets, etc., will be removed from the Site and disposed as normal municipal waste.

2.4.2 INVESTIGATION-DERIVED WASTE (IDW)

IDW including decontamination fluids and soil cuttings will be transferred to Department of Transportation (DOT) approved 55-gallon steel drums and staged at a secure location on-Site.

General IDW requirements include the following:

- 55-gallon drums will be clearly and conspicuously labeled on the lid and side with paint marker or drum label. Labels will include a description of the contents and the date of generation. Drill cuttings from separate direct-push boreholes will be consolidated into a single drum.
- Decontamination fluids will be kept separate from drill cuttings and will be transferred into DOT-approved steel 55-gallon drums. The drums will be clearly and conspicuously labeled on the lid and side with paint marker or drum label with a description of the contents and date of generation.
- Alternatively, decontamination fluids may be collected in plastic containers and delivered to a larger storage tank that will be staged in a secure location on-Site. The storage tank will be clearly and conspicuously labeled with paint marker or label with a description of the contents and date of generation.

The separate IDW streams will be characterized for proper disposal. Representative samples of each waste stream will be collected and sent to an environmental laboratory for waste characterization. Following the results of waste characterization activities, IDW will be disposed of at a permitted facility or will be discharged to the ground surface as appropriate based on characterization data and waste medium.

3.0 FIELD SAMPLING PROTOCOLS

3.1 OVERVIEW

Several types of samples will be collected for chemical analysis during the investigation. Environmental media collected for laboratory analysis of chemical concentrations includes soil, sediments, and surface water.

Prior to mobilizing to an investigative area, the specific sampling locations will be marked in the field with stakes, pin flags, or flagging tape by field personnel. General protocols for soil sampling are provided in SOP 3 (Appendix A).

All samples collected for chemical or geotechnical analysis will be documented in the project field logbook.

3.2 SOIL BORINGS

Specific details regarding the number of samples, sampling locations, rationale, and laboratory analytes for the RI soil sampling program are provided in Section 7.0 of the RI/FS Work Plan. SAP Tables 3.1 through 3.6 and Figures 3.1 through 3.7 summarize the proposed soil sampling program.

At each soil boring location, soil samples will be collected at the surface (0"-12") and at the water table interface. If the water table is not encountered, one sample will be collected between 2 feet and 6 feet below ground surface (bgs) and one sample will be collected below 6 feet bgs. The actual depths are dependent on the depth to the bedrock surface, as indicated in Table 3.1.

Soil boring samples will be analyzed for VOCs, SVOCs, metals, and energetics as described in Tables 3.2 through 3.5. Surface soil samples will also be analyzed for pH and TOC. The full list of analytes is provided in Table 1.1.

3.2.1 SOIL BORING SAMPLING PROCEDURE

Soil samples will be collected using direct-push technology such as a Geoprobe® rig or similar. Surface samples may also be collected manually using a stainless steel spoon/trowel. If a sampling location is not accessible to the drill rig, soil borings may be drilled using a hand auger or other manual drilling and sampling method. Direct-push

drilling is preferred over hollow-stem auger drilling because the sampling method minimizes the volume of IDW generated during the investigation. Also, the direct-push rigs are typically smaller, which makes it easier to access off-road locations. If below-ground obstructions prevent the use of a direct-push rig, a drilling rig equipped with hollow stem augers (HSA) may be used.

The direct-push sampler consists of a 4-foot long MacroCore® or similar soil sampling device such that a sufficient volume of soil is obtained for sample collection purposes. The MacroCore® soil sampling tool will be fitted with clean acetate liners prior to advancement to the target depth. Acetate liners will be discarded and managed as IDW following each use.

Direct-push soil samples will be collected using the following procedure:

- A new pair of disposable nitrile gloves will be worn for each sample.
- Prior to use at each sampling location, sampling equipment will be decontaminated in accordance with Section 2.2.
- The direct-push sampler, equipped with a new acetate liner for each sample, will be advanced from the surface to the top of bedrock in 4-foot intervals.
- The soil sample will be retrieved by pulling the rod string and sampler from the probe hole and removing the soil filled liner from the sample tube. The 4-foot acetate liner will be slit lengthwise to expose the full length of the soil sample.
- The soil sample(s) selected for VOC analysis will be collected from the selected sample interval in accordance with USEPA SW-846 Method 5035 using Encore samplers. Samples will be collected from the appropriate sample interval as described in Section 3.2 above and in Table 3.1. Three Encore samplers will be cored into each soil sample interval in close proximity to one another to recover a total of approximately 15 grams of soil. Because all VOC sampling locations will also be sampled for metals and/or energetics, a separate jar for percent moisture analysis will not be necessary. The recovered soil samples will be immediately labeled and placed into a cooler containing ice pending shipment to the project laboratory for analysis.
- For non-VOC analysis sample(s) a representative aliquot of each soil sample from the target interval will be transferred into a clean stainless steel bowl and thoroughly homogenized using a stainless steel mixing utensil. The sample will then be split among the appropriate laboratory-supplied containers, labeled, and placed into a cooler containing ice.

- Subsurface soil samples will be logged by a qualified geologist, engineer, or technician in accordance with the Unified Soil Classification System (USCS). The boring and soil data will be recorded on Overburden Stratigraphic Log forms. An example Overburden Stratigraphic Log form is presented in Appendix B.
- A representative aliquot of each length of soil sample from the target depth interval will be placed in a re-sealable plastic bag for headspace monitoring. The bag will be sealed and agitated, if necessary, to break up clumps of soil. After approximately 5 minutes, a headspace reading will be obtained by inserting the tip of the photoionization detector (PID) into the bag and recording the highest headspace reading. The PID reading will be recorded on the Overburden Stratigraphic Log form. The soil and bag used for headspace monitoring will be containerized with soil cuttings.
- If a soil boring cannot be completed due to a subsurface obstruction, such as a large cobble, the borehole will be moved a short distance (5 feet or less) and retried. A maximum of four boreholes will be attempted at a particular sampling location. If all four meet with refusal, samples will be collected as available at the appropriate depths in accordance with Table 3.1.

If the borehole is drilled and sampled using HSA methods, the protocols for split-spoon standard penetration testing described in SOP 3 will be utilized. If hand augers or other manual drilling and sampling methods are used, a protocol will be established that will include applicable procedures described above, will minimize the potential for cross-contamination, and will minimize disturbance of samples for VOC analysis.

Boreholes will be closed by filling the borehole from the base to the ground surface with bentonite chips or granules. The top 6 inches of boreholes installed in areas covered by asphalt or concrete will be capped with asphalt or concrete patching material as appropriate to match the existing surface.

3.3 SURFACE SOIL SAMPLING

At locations where surface soil sampling activity is concurrent with subsurface borings, soil samples will be collected from 0 to 12-inches using the procedures described below. General surface soil sampling procedures are described in SOP 4, Surficial Soil Sampling (Appendix A). Site-specific procedures are described below:

Surface soil samples may be collected using a direct-push rig to collect the samples following the Site-specific protocols outlined in Section 3.2.1. Soil will be collected from

below the thatch zone and excessive organic matter (roots, plant debris) will be removed from the soil sample.

Alternatively, surface soil samples may be collected using the following procedures:

- Prior to soil sample collection, a hole will be excavated to a minimum depth of 12 inches bgs using a pre-cleaned, stainless steel spoon/trowel.
- A new pair of disposable nitrile gloves (or equivalent) will be worn at each location.
- The soil present in the hole will be described using the USCS and the information will be entered onto Overburden Stratigraphic Log forms. Care will be taken to carefully describe any unusual staining or odors that may be present.
- Soil samples will be collected from the sidewalls of the hole.
- The soil sample(s) selected for VOC analysis will be collected in accordance with USEPA SW-846 Method 5035 using Encore samplers. Three Encore samplers will be cored into the soil in the 0 to 12-inch interval. A total of approximately 15 grams of soil will be recovered from the interval. Because all VOC sampling locations will also be sampled for metals and/or energetics, a separate jar for percent moisture analysis will not be necessary. Soil samples will be immediately labeled and placed into a cooler containing ice.
- For non-VOC analysis, a pre-cleaned stainless steel spoon/trowel will be used to obtain the soil samples from the 0 to 12-inch interval. A sufficient volume of soil to fill the sample containers will be placed into a clean stainless steel bowl and thoroughly homogenized. The sample will then be split among the laboratory-supplied containers, labeled, and placed into a cooler containing ice.

3.4 SEDIMENT AND SURFACE WATER

Specific details regarding the number, rationale, and locations for the sediment and surface water sampling program are provided in Section 7.0 of the RI/FS Work Plan and are summarized in SAP Table 3.6. Sediment and surface water sample locations are presented on Figure 3.6.

3.4.1 SEDIMENT SAMPLING

Standard procedures for the sampling of sediment are provided in SOP 5, which is located in Appendix A. Alternate techniques may be used only if local conditions

prohibit sediment coring. Sediment samples will be analyzed for VOCs, metals, energetics, SEM-AVS, pH, TOC, and grain size.

The collection of sediment samples will be paired with the collection of surface water samples whenever possible. At locations where both sediment and surface water samples are to be collected, the surface water samples will be collected prior to the collection of sediment to minimize the presence of disturbed sediment in the surface water sample. At locations where multiple sediment and/or surface water samples are to be collected from a flowing body of water (creek, stream, or active drainage ditch), sampling will be initiated at the downstream location and will proceed upstream to the farthest upstream location. This will minimize the potential impact to samples from upstream sediment disturbed during sampling activity.

At locations with standing or flowing water, sediment samples will be collected with a coring device whenever possible. Some of the drainage ditch sediment sample locations may be dry at the time of sample collection. These samples may be collected with a coring device or with a stainless steel sampling spoon/trowel. Sediment sampling strategy will consist of targeting the top 6 inches of sediments at each location as the top 6 inches represents the zone most likely to contain biological receptors.

The following procedures may be used to collect sediment samples from below standing water:

ii) Wear a new pair of disposable nitrile gloves (or equivalent) at each location.

iii) Retrieve a 6-inch long core of sediment using a Wildco sediment core sampler (or equivalent) equipped with a replaceable acetate or stainless steel liner, a core retainer, and check valve. Alternatively, in shallow water and soft sediments, the acetate or stainless steel liner can be pushed into the sediment directly by hand without the Wildco apparatus. A gloved hand cupped over the open end of the liner often provides a better seal and allows for better sample recovery.

iv) Extrude the sediment core into a precleaned stainless steel bowl with minimal disturbance of the sediment core. Collect the VOC Encore sample immediately and prior to homogenizing the sample.

v) For non-VOC analysis, collect addition sample volume, if necessary. Thoroughly homogenize the sediment and split among the laboratory-supplied containers. Label the sample jars and place into a cooler containing ice.

3.4.2 SURFACE WATER

Surface water samples will be collected as summarized in Table 3.6. The standard procedures for the sampling of surface water are presented in SOP 6, which is contained in Appendix A.

Two types of surface water bodies will be sampled. Drainage water in small streams that flow generally to the southwest through the East Stand and South Stand Areas, and the small pond on the southwest side of the South Stand Area (see Figure 3.6).

At stream locations, the sampler will face upstream and collect the sample without disturbing the sediment. Surface water samples will be collected prior to the collection of sediments at the same location as to avoid sediment disturbance. Water samples will be collected by immersing uncapped analytically clean sample bottles into the water body. Only non-preserved sample containers will be submerged into the water body. For those sample containers that contain preservative, a non-preserved sample container will be used to collect a sub-sample of surface water and transfer the contents into the sample container with preservative. This procedure avoids cross-contamination among samples because only the dedicated sample bottle contacts the sample. Unfiltered samples will be collected for total metals chemical analysis, and a second sample will be filtered in the field for dissolved metals analysis. Samples being submitted for dissolved metals analysis, a peristaltic pump, disposable Teflon tubing, and disposable 0.45 μ filters will be used in the field for collection.

Immediately after the collection of surface water samples, the temperature and dissolved oxygen content of the water will be field measured using a Yellow Springs Incorporated (YSI™) Model 55 meter (or equivalent). These field measurements will be conducted after the collection of surface water samples to avoid cross-contamination. Also, the following ancillary chemistry parameters will be collected after the surface water sample has been collected: pH, electrical conductivity, and oxidation/reduction potential (ORP), using direct-read meters.

Surface water samples will be analyzed for VOCs, metals, and energetics.

3.5 TANK SAMPLING

Two AST have been identified for liquid and sediment sampling. These tanks are designated T-50 and T-51 and their locations are presented on Figures 3.3 and 3.4. T-50 is a cylindrical tank lying on it's side on the ground. T-51 is a large cylindrical tank

standing upright. It includes bolted manways near the ground surface and a ladder for accessing the top of the tank.

It is anticipated that T-51 will be sampled from the top of the tank or from the manway, if necessary. T-50 may have to be rolled over in order to obtain access for inspection and sampling. This may require some mechanical assistance from a truck, skid loader, or similar.

3.5.1 TANK ASSESSMENT

The condition of the tank must be assessed to determine the best method to obtain required samples. The pre-sampling tank assessment should include an inspection of the tank walls to discover the presence of any labeling or warning information. Screening for potential organic vapors and an assessment of the volume of liquid and thickness of sediment in the tank will also be performed.

The assessment data will be used by sampling personnel to determine the safest sampling procedure. At no time will sampling personnel enter the tanks.

3.5.2 PRESAMPLE CONSIDERATIONS

It is important that personal protective equipment, as specified within the HASP, be worn or used at all times. Air monitoring must be conducted in accordance with the HASP to identify the need to upgrade respiratory protection during sampling. It is anticipated that the inside of the tanks will be monitored for combustible gas, percent oxygen, and organic vapors, at a minimum, prior to opening and sample collection. All tank assessment data must be documented in the project field log book.

Extreme care must be exercised in opening tank manways when the contents are unknown or known to be dangerous to sampling personnel. Tanks must be grounded prior to opening or sampling. A tank with unknown contents that has badly rusted bolts must be entered with a non-sparking penetrating device operated remotely, or by an equivalently safe method. Hand operated, non-sparking tools may be used to open a tank manhole, if the contents of the tank are known and acceptable for such activity.

3.5.3 TANK SAMPLING PROCEDURES FOR CONTAINED LIQUID

Liquid samples will be collected first.

i. A new pair of disposable nitrile gloves will be worn for each sample.

ii. Prior to use at each sampling location, sampling equipment will be decontaminated in accordance with Section 2.2.

iii. Choose the appropriate sample method from a variety of devices that include glass thief, coliwasa sampler, or a new disposable bailer. Insert the sampling device near the bottom of the tank or until a solid layer is encountered. The sample collected should represent the entire column of liquid within the tank.

iv. Remove the liquid sampling device from the tank and decant into the appropriate laboratory-supplied sample containers.

3.5.4 TANK SAMPLING PROCEDURES FOR CONTAINED SOLIDS

Tank sediment will be sampled with a stainless steel spoon, trowel, or similar method. An extension bar may be helpful for reaching from the tank opening.

i. A new pair of disposable nitrile gloves will be worn for each sample.

ii. Prior to use at each sampling location, sampling equipment will be decontaminated in accordance with Section 2.2.

iii. For non-VOC analysis, collect a representative sample from several locations within the tank, if possible, and composite them in a precleaned stainless steel bowl. Transfer the composited sample material into the appropriate laboratory-supplied bottles.

iv. For VOC samples, collect a representative sample and place in a stainless steel bowl with minimal disturbance. Collect the VOC Encore sample immediately and prior to homogenizing the sample.

3.6 SUBSURFACE WASTE DELINEATION

The delineation and characterization of waste and subsurface soils will be performed by excavating test pits, collecting subsurface soil samples, and recording stratigraphic

information obtained from test pits. Test pits will be excavated to explore and define geologic conditions, define the extent of subsurface waste/debris, and to allow the collection of subsurface soil samples for field and laboratory analysis. Test pits will be used for this task as they tend to give a more complete view of the subsurface soil conditions than soil borings.

Given the somewhat unknown nature of waste types and contamination that may be encountered in conducting this work, it is anticipated that the selected subcontractor will perform this work at a Level B personal protection level as waste materials, including drummed waste, may be encountered. This work will be conducted within an area that Picatinny Arsenal personnel have identified as possibly containing UXO. To date, there has been no indications of any UXO present in this area or any other areas of the site. Despite this fact, ATK will retain a contractor that specializes in UXO operations and also can conduct excavation activities. The need for specialized excavation equipment (i.e. shielding), if any, will be incorporated into the UXO contractor's health and safety plan.

Prior to the start of subsurface work, private and public utilities are to be identified and marked in the area of investigation and utility conflicts resolved; the limits of the area to be investigated along with initial test pit locations as shown on Figure 3.7 are to be staked/flagged; and performance of tree clearing as necessary. If it is necessary to relocate any proposed test pit due to terrain, utilities, access, etc., the Project Coordinator must be notified and an alternate location will be selected and approved.

Test pits will be excavated using either a rubber-tired backhoe or track-mounted excavator that can extend 10 to 15 feet below ground surface. Excavation work will progress from outside the edge of anticipated waste inward as to minimizing impacts to clean areas. Decontamination of the excavator between test pit locations without waste will consist of scraping soils from the bucket and arm between locations. In addition, for test pits in which waste is encountered but waste materials are not of a liquid state or adhere readily to the excavator, soil and waste material will be scraped from the equipment. In all other cases, high pressure water wash/rinse, detergent wash (brushing, as necessary, to remove particulate matter) and a high pressure water rinse will be performed. All decontamination materials in this latter case will be collected and containerized.

As noted above, Figure 3.7 shows the location in which the excavation of test pits are initially planned. Typical test pit lengths are anticipated to be 10 feet in length and extend to the water table, approximately 2 to 8 feet below ground surface, or to the point

of refusal, whichever occurs first. Should drums be encountered during excavation that appear or are known to contain waste materials, no further excavation will occur at that location. In refining the extent of waste, test pits may be lengthened to delineate the edge of subsurface waste but will not extend beyond the western edge of the fence line as shown on Figure 3.7. The fence demarcation point is attributed to previous remedial actions conducted by others on the eastern side of the fence and hence falls outside the areas of investigation as described in the AOC and shown on Figure 3.1. Following the completion of each test pit, the location will be marked, surveyed, photographed, stratigraphy/waste logged, and backfilled.

During the excavation of a test pit, samples will be collected to assist the geologist/engineer in assessing and characterizing the waste types and geology, and where designated on Figure 3.7. Soil from the base of each test pit excavation will be assessed visually for evidence of staining/visual or olfactory indications of contaminant impacts. Soil for this assessment will be collected from the backhoe/excavation bucket, as entry into the test pit will not be allowed. In addition, soil samples will be screened with a PID by running the PID across the soil sample and the highest reading and sustained readings recorded. Soil from the base of the test pit which exhibits indications of contaminant impacts will be sampled and submitted for laboratory analysis. At a minimum, soil samples will be collected for laboratory analysis from the designated test pits shown on Figure 7.1a. Other documentation will include the completion of field logs, field books, and photographs to document the work. Logs for each test pit will be prepared that describe soil and waste types and also the following:

- native or fill components;
- secondary and minor soil components;
- relative densities/consistency;
- grain size/plasticity;
- gradation/structure;
- color;
- moisture content;
- observations of odor and type;
- PID readings;
- presence of NAPL; and
- presence of groundwater and the rate of seepage (if groundwater is encountered).

Following the completion of the test pit, the excavation will be backfilled using the soil/waste excavated from the pit. To the extent practicable, materials will be replaced into the test pit in the same intervals from which they were extracted.

3.7 SURVEYING

Soil, sediment, and surface water sampling locations will be staked in the field and surveyed by field personnel using portable global positioning system (GPS) equipment (sub-meter accuracy). The survey data for each location will be documented in the project field logbook. Any stakes removed during sampling will be replaced in the general sampling area to assist the surveying team in locating the location markers. Surveying may also be performed by a licensed surveyor.

4.0 ANALYTICAL PROTOCOL

4.1 OVERVIEW

During the RI field program, soil, sediment, and surface water samples will be collected for chemical and geotechnical analysis. Details regarding the number of samples to be collected and the analytical methods to be used for the samples collected during the RI are summarized in Tables 3.2 through 3.6. The analytical method for each set of analytes is listed in Table 4.1. Table 4.2 provides details regarding the container, preservation, shipping and packaging requirements for each sampling parameter.

4.2 GEOTECHNICAL ANALYSES

Surface soil and sediment samples will be analyzed for several geotechnical parameters to assist with evaluations of contaminant fate and transport. Geotechnical parameters include TOC, soil pH, and grain size distribution. These samples will be collected using the same procedures described in Section 3.0 above.

Analytical methods for the geotechnical samples are as follows:

TOC	Walkley-Black
pH	SW-846 Method 9045
Grain Size Distribution	ASTM D422

Collected geotechnical samples will be shipped to the project laboratory for analysis.

4.3 CHEMICAL ANALYSES

The chemical analyses to be used for each sample are summarized in Tables 3.2 through 3.6 and Table 4.1. Chemical parameters include TCL VOCs; SVOCs; TAL metals; energetics, and SEM-AVS. Table 1.1 presents the full list of analytes.

4.4 SAMPLE MANAGEMENT AND FIELD QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

4.4.1 SAMPLE LABELING

General sample labeling, handling, shipping, documentation, chain-of-custody (COC), and quality assurance/quality control procedures are described in SOP 7, Sample Management and Field QA/QC, (Appendix A). Site-specific sample labeling, handling, and shipping requirements are described below.

The sample labels will include a unique sample identification number, which includes the sample matrix, the date of collection, and the sampler ID. An example of the sample format is described below:

SD-050418-JD-001:	The prefix identifies the sample media. (S = soil, SD = sediment; SW = surface water);
SD-050418-JD-001:	The second part of the number identifies the sampling date (year, month, day);
SD-050418-JD-001:	The third part of the number provides the sampler's initials; and
SD-050418-JD-001:	The fourth part of the number is the unique sample number; numbered consecutively beginning with 001.

Sample labels will also include the site name, sample preservative, if any, and analyses to be conducted. Sample labels will be filled out using waterproof, non-erasable ink. The adhesive labels will be secured to the bottle. The labels will be further secured to the sample container using wide clear tape over the label and completely around the container before packing in a cooler for secure label protection during transportation and at the laboratory. The sample team members will ensure that the clear tape is not placed across the cap of the sample container. An example sample label is presented on Figure 4.1.

4.4.2 SAMPLE CONTAINERS AND HANDLING

Samples will be placed in appropriate sample containers, labeled, and properly sealed. Foam chips or bubble pack will be used to cushion sample containers. Samples will be kept cool by the use of ice. A trip blank will accompany each shipment of samples submitted for analysis of VOCs. Samples will be shipped by commercial overnight

courier to the project laboratory. Samples collected on a Saturday will be shipped with additional ice in the coolers. Samples collected late on Saturday, on Sunday, or on a holiday will be placed in coolers with extra ice. Sample hold-time will be evaluated prior to collecting samples on weekend or holidays. The coolers will be sealed, stored in a secure location, and shipped by the courier on the next business day. Two COC seals will be placed over the lid on the front and back of each shipping cooler. The seal will secure the lid and provide evidence that the samples have not been tampered with en-route to the project laboratory. Clear tape will be placed over the COC seals to ensure that they are not accidentally broken during shipment.

Upon receipt of the cooler by the project laboratory, the designated sample custodian will inspect the cooler. The condition of the cooler and seal will be noted on the COC form. The sample custodian will then check the contents of the cooler against the information noted on the COC form. If damage or discrepancies are observed, they will be recorded in the "remarks" column of the COC form. The form then will be signed and dated. Moreover, any observed damage or discrepancies will be reported immediately to project chemist for guidance.

4.4.3 CHAIN-OF-CUSTODY FORMS

COC forms will be completed for all samples collected. The form documents the transfer of sample containers. An example of a typical COC is provided in Appendix B.

Each set of sample coolers being shipped to the laboratory will contain a COC form. The COC form will consist of four copies which will be distributed as follows: the shipper will keep two copies (one for the project file and one for CRA's project chemist) while the other two copies will be enclosed in a waterproof zip-lock bag within the cooler with the samples. The cooler will then be sealed properly for shipment. The laboratory, upon receiving the samples, will complete the two remaining copies. The laboratory will maintain one copy for their records. The executed original will be returned to CRA with the data deliverables package.

The COC records will contain, but not be limited to, the sample number, date and time of sampling, analyses required, and the name of the sampler. The COC document will be signed and dated by the sampler when transferring the samples.

The following list provides guidance for the completion and handling of all COCs.

- COCs used should be standardized forms or those supplied by the project analytical laboratory. (Do not use any COC forms from other labs, even if the heading is blocked out.)
- COCs must be completed in black or blue ball-point ink only.
- COCs must be completed neatly using printed text.
- If a simple mistake is made, line out the error with a single line and write initials and date next to it.
- Each separate sample entry must be sequentially numbered.
- The use of "Ditto" or quotation marks to indicate repetitive information in columnar entries should be avoided. If numerous repetitive entries must be made in the same column, place a continuous vertical arrow between the first entry and the next different entry.
- When more than one COC form is used for a single shipment, each form must be consecutively numbered using the "Page ___ of ___" format.
- If necessary, place additional instructions directly onto the COC. Do not enclose separate loose instructions.
- Include a contact name and phone number on the COC in case there is a problem with the shipment.
- A copy of the COC must be maintained in the field site file.
- Do not indicate the source of the sample as this may produce a biased lab result.

Upon receipt of the cooler by the project laboratory, the designated sample custodian will inspect the cooler. The condition of the cooler and seal will be noted on the COC form. The sample custodian will then check the contents of the cooler against the information noted on the COC form. If damage or discrepancies are observed, they will be duly recorded in the remarks column of the COC form. The form then will be signed and dated. Moreover, any observed damage or discrepancies will be reported immediately to the project chemist for guidance.

4.5 QUALITY CONTROL

To assess the quality of data resulting from the field sampling program, field duplicate samples, matrix spike samples, laboratory duplicate samples, field blank samples, and trip blank samples will be collected and submitted to the laboratories. Field QC samples will be collected at the frequencies specified in the QAPP and as summarized in Table 4.3.

Field duplicate samples will be collected at a frequency of one per ten or fewer investigative samples per parameter set, with a minimum of one field duplicate sample submitted per sampling event.

Matrix spike/matrix spike duplicate (MS/MSD) samples will be collected for organic analyses at a minimum frequency of one per 20 or fewer samples for each analysis. MS/MSD samples will be collected for inorganics analyses at a frequency of one per 20 or fewer samples.

Field blank samples will be submitted at a frequency of one per ten sampling equipment cleanings or a least once per day of sampling equipment cleanings, whichever is more frequent. Field blank samples will be collected by routing deionized water through decontaminated sampling equipment. Field blank samples will be analyzed to check procedural contamination and/or ambient conditions at the Site and/or sample container contamination that may cause sample contamination. Field blank samples will not be collected for samples collected using pre-cleaned or pre-cleaned, disposable sampling equipment.

Trip blank samples will be prepared by the laboratory, shipped with the sample containers, and returned unopened to the laboratory with aqueous samples for VOC analysis. MS/MSD samples will be collected at frequency of one per 20 investigative samples. The COC forms sent to the project laboratory will identify the samples collected for MS/MSD analysis. Additional sample volume will be provided as necessary to the laboratory for MS/MSD analysis. MS/MSD samples are investigative samples that are analyzed by the laboratory to evaluate analytical accuracy and precision relative to the sample matrices. The QA/QC procedures for the laboratory analyses are provided in the QAPP.

4.6 ANALYTICAL LABORATORIES

The laboratories that will be used for the RI/FS activities are as follows:

The laboratory that will be used for VOC, metals, SVOC, hardness, TOC, and pH analyses is:

Test America North Canton
4101 Shuffle Dr NW
North Canton, OH 44720-6961
Contact: Amy McCormick
Phone: (330) 497-9396
Fax: (330) 497-0772

The laboratory that will be used for analysis of perchlorate samples is:

Test America Sacramento
880 Riverside Parkway
West Sacramento, CA 95608
Contact: Karen Dahl
Phone: (916) 373-5600
Fax: (916) 372-1059

The laboratory that will be used for analysis of hydrazine, unsymmetrical dimethylhydrazine (UDMH), and monomethyl hydrazine (MMH) analyses is:

Test America Denver
4955 Yarrow Street
Denver, Colorado 80002
Contact: Brett VanDelinder
Phone: (303) 736-0100
Fax: (303) 431-7171

The laboratory that will be used for acid volatile sulfide (AVS) and grain size analyses is:

Test America Burlington
30 Community Drive, Suite 11
South Burlington, Vermont 05403
Contact: Don Dawicki
Phone: (802) 660-1990
Fax: (802) 660-1919

The laboratory that will be used for DETA Analysis is:

DAT - Columbus
Data Analysis Technologies, Inc.
7715 Corporate Boulevard
Plain City, Ohio 43064
Contact: Deborah Johnson
Phone: (800) 733-8644
Fax: (614) 873-0810

With the exception of hydrazine, UDMH, and MMH, all samples will be shipped to the Test America-North Canton facility. Due to short holding times, the hydrazine, UDMH, and MMH samples will be shipped directly to Test America-Denver.

5.0 HEALTH AND SAFETY PLAN

A site-specific Health and Safety Plan (HASP) has been developed to address activities to be performed at the Site. All field activities will be conducted in accordance with the health and safety protocols outlined in the HASP. The HASP is presented in a separate document.

A safety briefing will be conducted in the field for all personnel prior to the start of each day's activities.

6.0 FIELD MANAGEMENT PLAN

ATK has not formally retained CRA to conduct or manage the execution of the RI/FS. If retained, the following sections apply. If ATK retains another party, then an alternate Section 6 will be provided to EPA.

6.1 ROLES AND RESPONSIBILITIES

ATK retained CRA Inc. to manage execution of the RI/FS. CRA Inc. retained STL for chemical and geotechnical analyses. The various quality assurance (QA) and management responsibilities of key project personnel are defined in the QAPP.

6.2 FIELD RESPONSIBILITIES

CRA Project Manager - Robert Martin

The CRA Project Manager has responsibility for ensuring that the project meets the USEPA's and ATK's objectives. The CRA Project Manager will provide assistance in terms of revising and distributing the RI/FS Work Plan, QAPP, and SAP to all those parties connected with the project. The CRA Project Manager is responsible for technical QC and project oversight. Specifically, the CRA Project Manager has responsibility for managing the sampling of soil, sediment, and surface water.

CRA Field Supervisor

The CRA Project Manager will be a senior level technician or field geologist. He is responsible for leading and coordinating the day-to-day activities of the various resource specialists under his supervision with specific regard to the collection of soil, sediment and surface water samples. The CRA Field Supervisor will report directly to the CRA Project Manager. Specific Field Supervisor responsibilities include the following:

- Responsible for the day-to-day coordination with the CRA Project Manager on technical issues in specific areas of expertise;
- Developing and implementing field-related Work Plans, assurance of schedule compliance, and adherence to management-developed study requirements;
- Coordinating and managing of field staff including sampling and drilling;

- Acting as field sample custodian;
- Implementing of QC for technical data provided by the field staff including field measurement data;
- Adhering to work schedules provided by the CRA Project Manager;
- Authoring, writing, and approving of text and graphics required for field team efforts;
- Coordinating and overseeing technical efforts of subcontractors assisting the field team;
- Identifying problems at the field team level, resolving difficulties in consultation with the CRA Project Manager, implementing and documenting corrective action procedures, and provision of communication between team and upper management; and
- Participating in preparation of the final report.

CRA Field Technical Staff

The CRA technical staff (team members) for this project will be drawn from CRA's pool of corporate resources. The technical team staff will be utilized to gather and analyze data, and to prepare various task reports and support materials. All of the designated technical team members are experienced professionals who possess the degree of specialization and technical competence required to effectively and efficiently perform the required work.

6.3 FIELD SUBCONTRACTORS

Subcontractors will be required in order to complete field investigative tasks. The subcontractors will be hired based upon availability and qualifications. The name and qualifications of the subcontractor(s) will be provided to the Agency prior to start of field investigation activities.

6.4 CONTACT INFORMATION

6.4.1 GENERAL PROJECT CONTACTS

Project personnel involved with the field investigation effort, roles, and contact information are listed below:

CRA Project Manager	Robert Martin	(651) 639-0913
CRA Field Supervisor	To Be Determined	(651) 639-0913
CRA Database Manager	Mark Siekmeier	(651) 639-0913
USEPA Project Manager	Diego Garcia	(212) 637-4947
ATK Project Manager	Karie Mars	(952) 351-3000
ATK Alternate Project Manager	Jon Bode	(952) 351-3000

The above list will be updated as necessary during the course of the project. This list will kept by the Field Supervisor and will be posted near the field office trailer telephone during the major field effort.

6.4.2 EMERGENCY CONTACTS

Emergency contact information is provided in Section 15.0 of the HASP. If an emergency, dial 911.

7.0 FIELD DOCUMENTATION AND DATA MANAGEMENT PLAN

During day-to-day field activities, field data will be generated that will require management pursuant to this SAP. Examples of field data that will be generated during the project include:

- Stratigraphic observations;
- Environmental media sampling information (i.e., PID readings, sample type, sample location, sample depth intervals, sample numbers, observations, etc.); and
- Survey data.

Field documentation and data management procedures described herein will ensure all relevant field data are properly recorded and disseminated for evaluation.

7.1 FIELD DOCUMENTATION PROTOCOLS

Methods of documenting activities conducted during the RI are discussed herein.

7.1.1 FIELD LOGBOOK

A summary of activities performed at the Site will be recorded in field logbooks. The field logbooks will be bound with consecutively numbered pages. The entries for each day will commence on a new page, which will be dated. All entries will be in non-erasable ink and corrections will be made by marking through the error with a single line, so as to remain legible, and initialing this action followed by writing the correction. Upon completion of the fieldwork or during periods when fieldwork is not scheduled, the field logbooks generated will be numbered consecutively and maintained in CRA's office.

The following information will be recorded in the field logbook:

- Site personnel present;
- Time and date;
- Equipment calibration activities undertaken and results;
- Weather conditions;
- Type of work being performed and location of the work;

- Type of equipment used;
- Time of day tasks were begun and completed;
- Any pertinent observations or description of unusual conditions;
- Difficulties or problems encountered;
- Description actions taken or direction given to resolve a situation;
- Contractors, subcontractors, and government agencies present on site;
- Decontamination activities;
- All samples collected; and
- Any other relevant or pertinent comments related to field work.

It is the responsibility of the CRA Field Supervisor to ensure that field personnel are properly documenting the work in the field logbooks.

7.1.2 FIELD FORMS

Field forms to be used to record data and observations are presented in Appendix B. Field forms to be used are as follows:

- Documentation of utility locates;
- All samples will be shipped under COC forms; and
- Subsurface soil will be logged in accordance with the USCS and recorded on an Overburden Stratigraphic Log form.

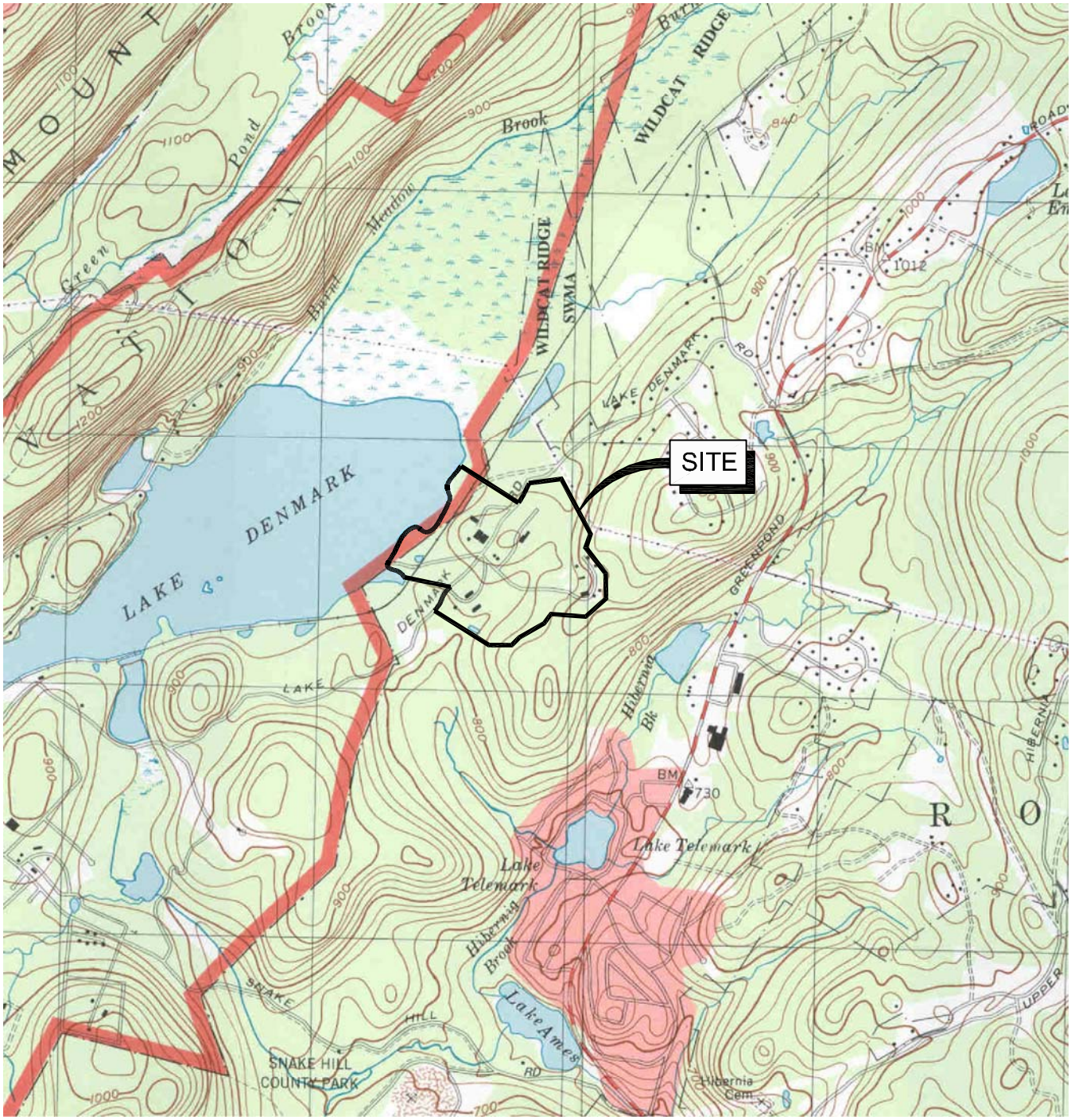
7.2 DISSEMINATION OF FIELD DATA

7.2.1 ENVIRONMENTAL SAMPLE RECORDS

Field personnel will record sample data and information in the project field log book. Additionally, COC forms will be completed for all environmental samples shipped from the Site. The CRA Field Supervisor will ensure that the COC forms for the day's sampling activity are transmitted on a daily basis by electronic mail or facsimile to CRA's Project Chemist. CRA's Project Chemist will be responsible for confirming sample receipt at the laboratory and coordinating sample analyses. In the event there is a problem with the samples received by the project laboratory, CRA's Project Chemist

will immediately communicate the problem to the CRA Field Supervisor so that corrective actions can be developed and implemented to correct the problem.

Stratigraphic logs will be submitted to CRA's Database Manager for production of stratigraphic logs. CRA's Database Manager also will ensure that data from other field forms is entered into the project's electronic database.



SOURCE: USGS 7.5 MINUTE QUADS
DOVER AND BOONTON, N.J.

N

0 1000 2000ft

figure 1.1

SITE LOCATION
RTI SUPERFUND SITE
Rockaway Township, New Jersey

04354-55(013)GN-SP002 Jan 29/2008

300255

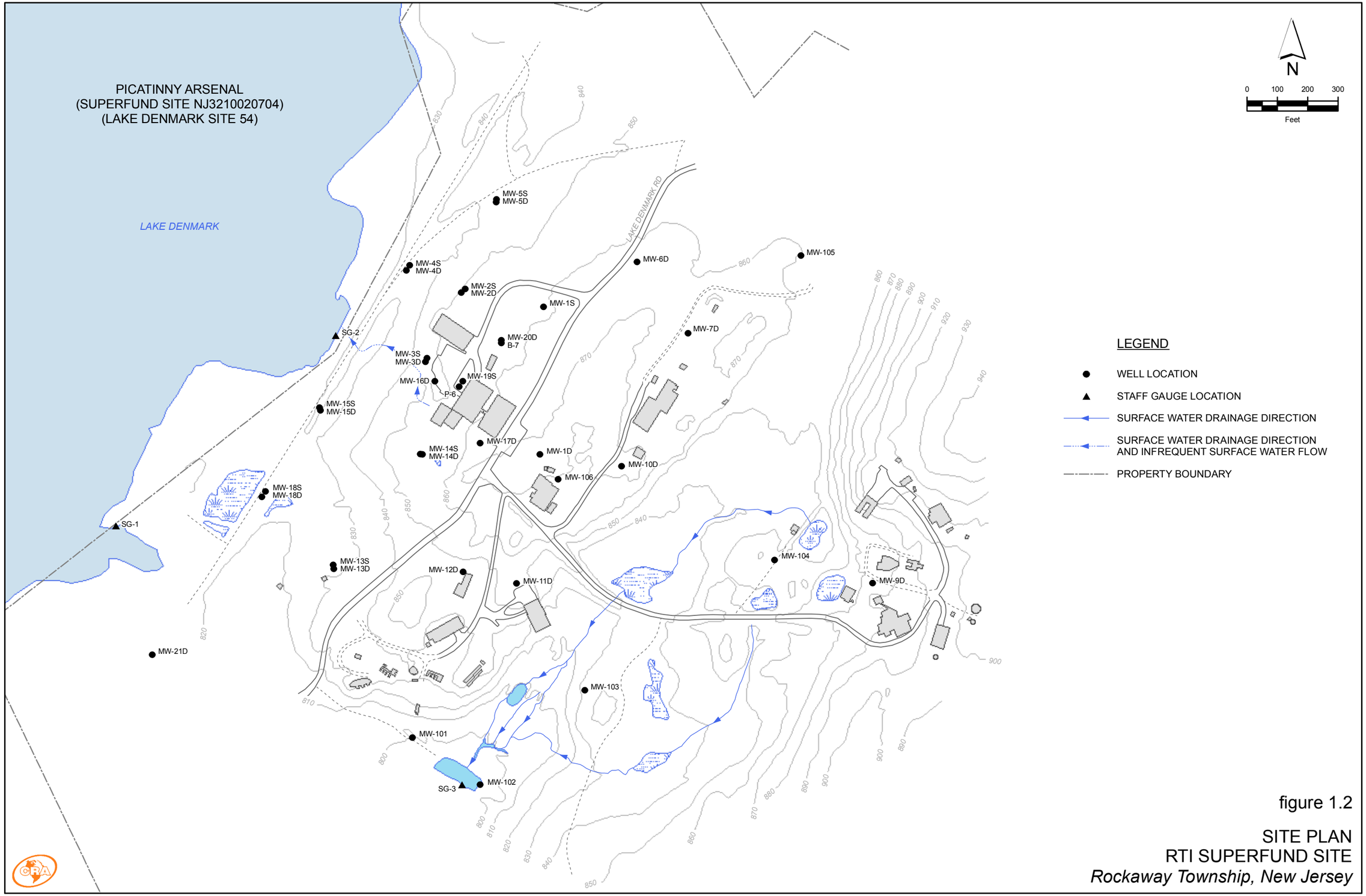


figure 1.2

SITE PLAN
RTI SUPERFUND SITE
Rockaway Township, New Jersey

4354-55(013)GIS-SP003 JAN 29/2008

300256

LEGEND

- RTI AREA
- EAST STAND AREA
- P-2 AREA
- SOUTH STAND AREA
- UNDEVELOPED AREA

N

0 250 500

Feet

figure 1.3

SITE AREAS
RTI SUPERFUND SITE
Rockaway Township, New Jersey

4354-55(013)GIS-SP004 JAN 29/2008

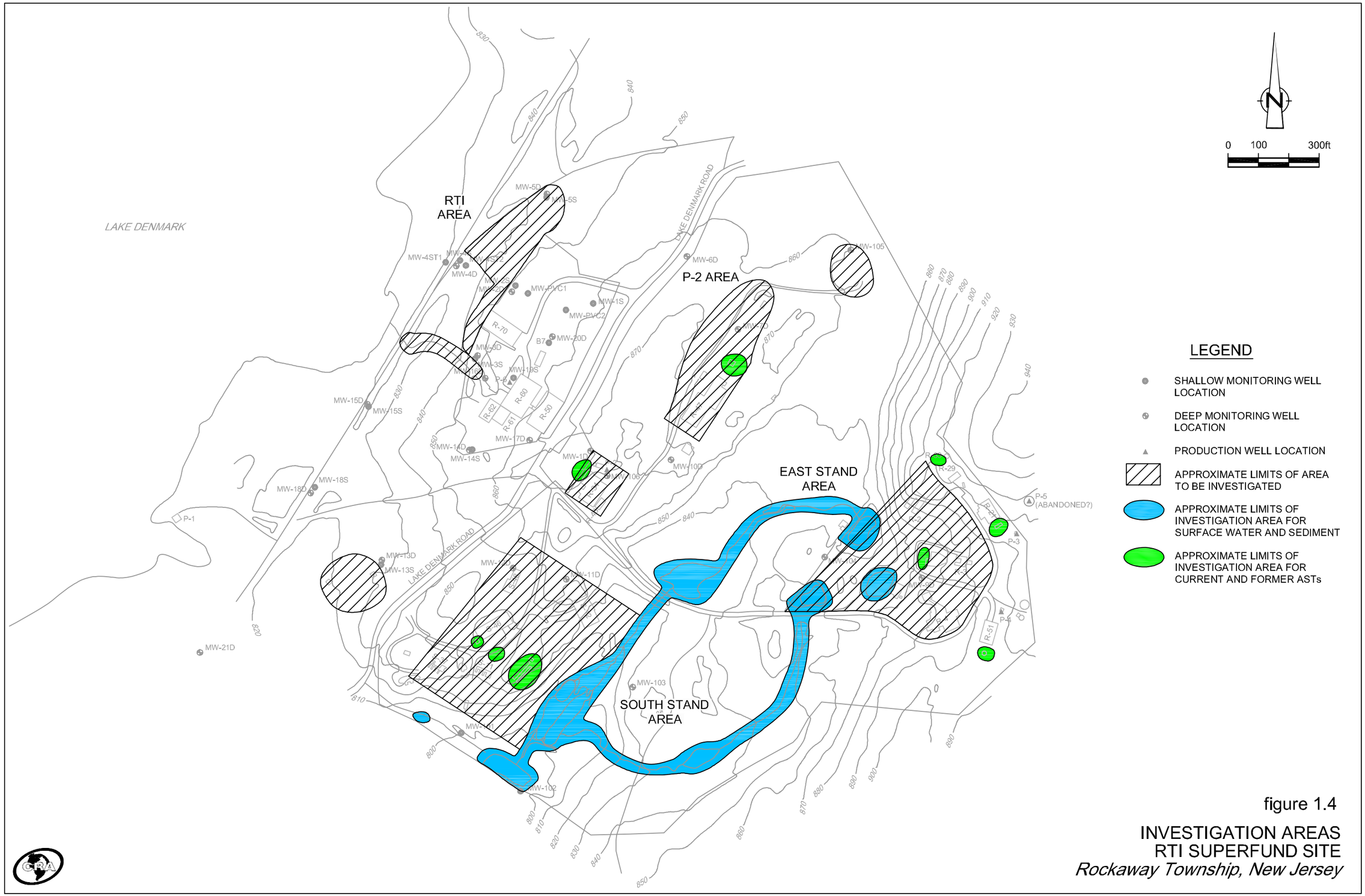


figure 1.4

INVESTIGATION AREAS
RTI SUPERFUND SITE
Rockaway Township, New Jersey

04354-55(013)GN-SP003 Jan 29/2008

300258

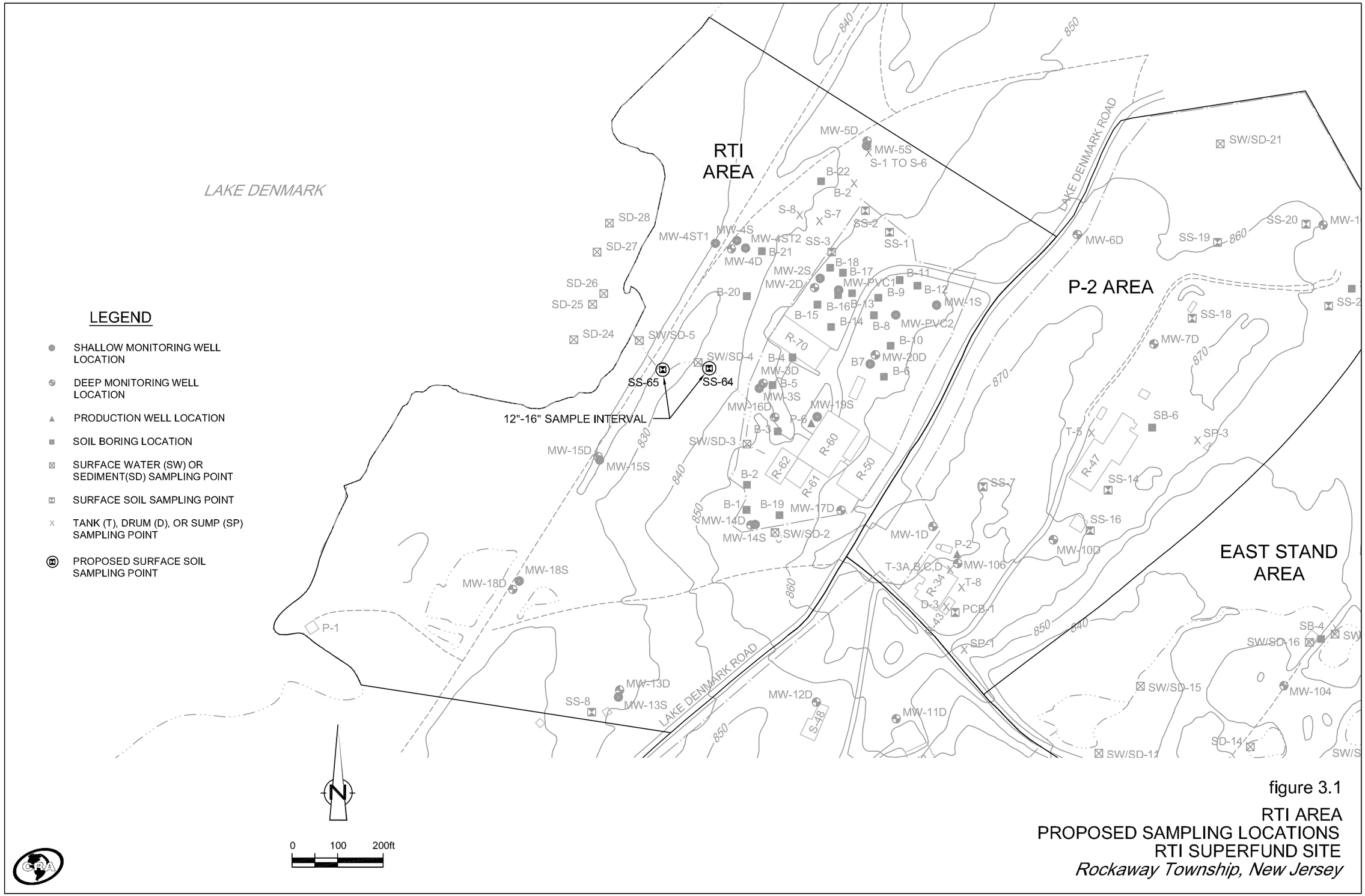


figure 3.1

RTI AREA
PROPOSED SAMPLING LOCATIONS
RTI SUPERFUND SITE
Rockaway Township, New Jersey

04354-55(013)GN-SP006 Jan 29/2008

300259

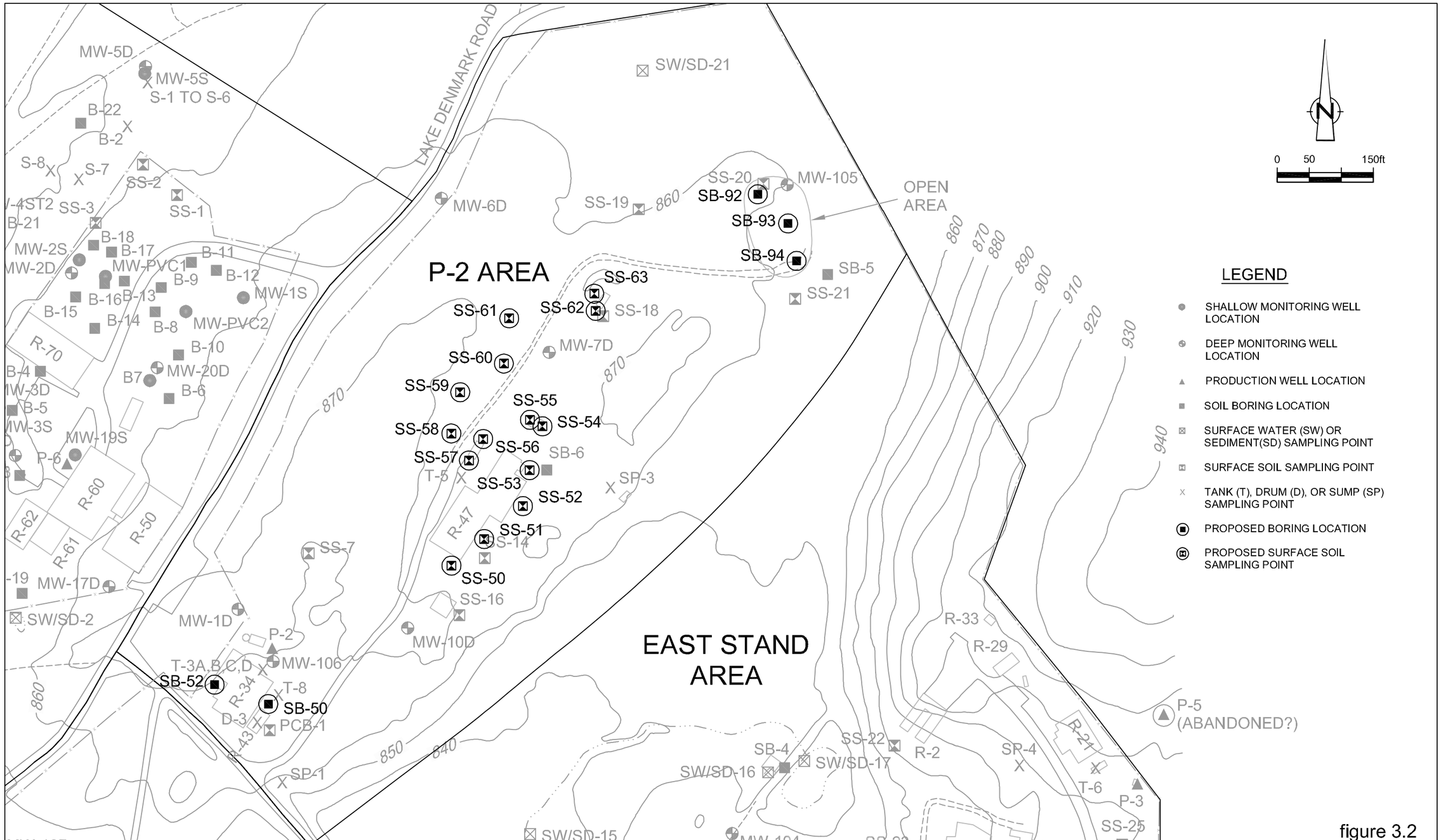


figure 3.2

P-2 AREA
PROPOSED SAMPLING LOCATIONS
RTI SUPERFUND SITE
Rockaway Township, New Jersey

04354-55(013)GN-SP007 Jan 29/2008

300260

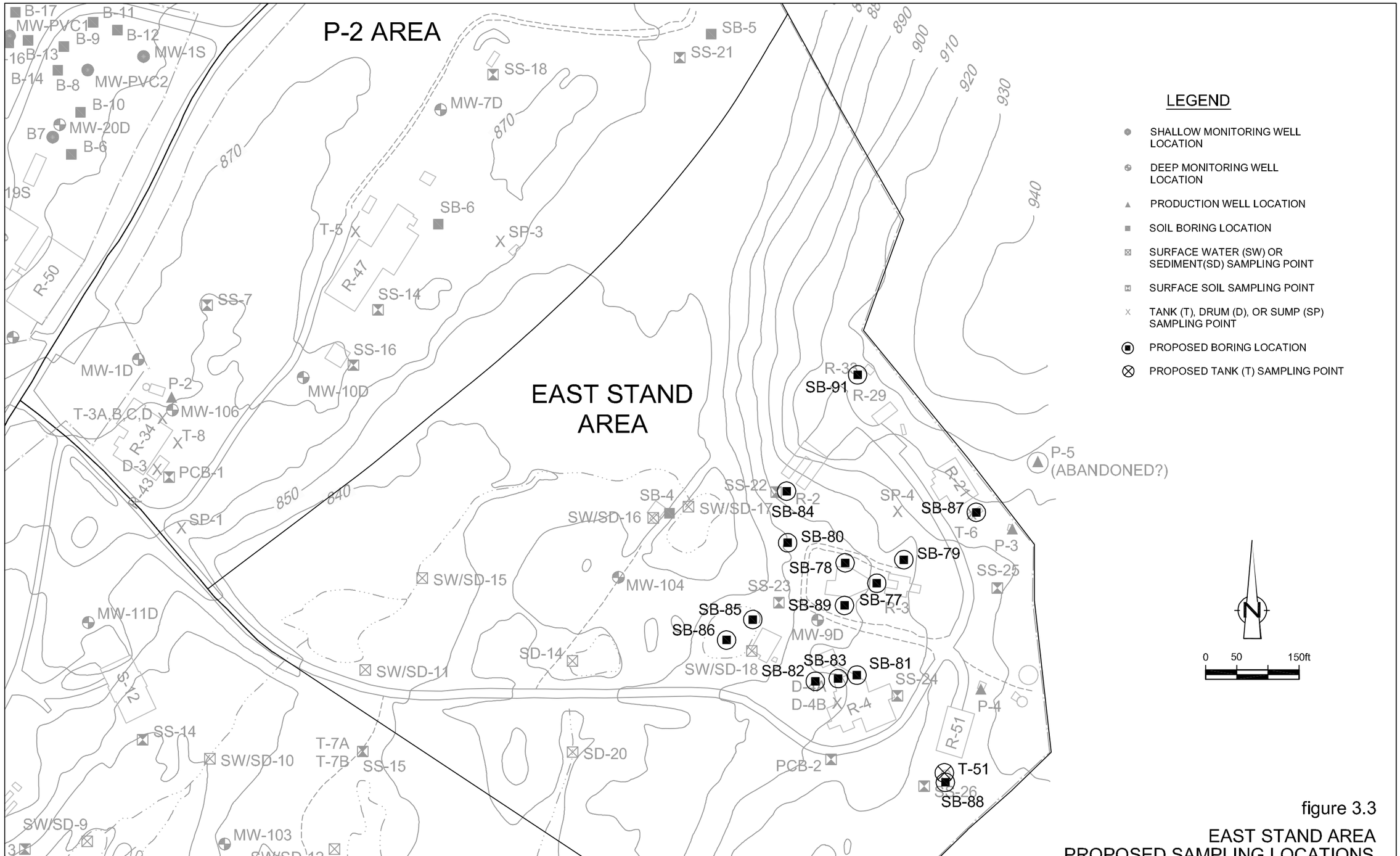


figure 3.3

EAST STAND AREA
PROPOSED SAMPLING LOCATIONS
RTI SUPERFUND SITE
Rockaway Township, New Jersey

04354-55(013)GN-SP008 Jan 29/2008

300261

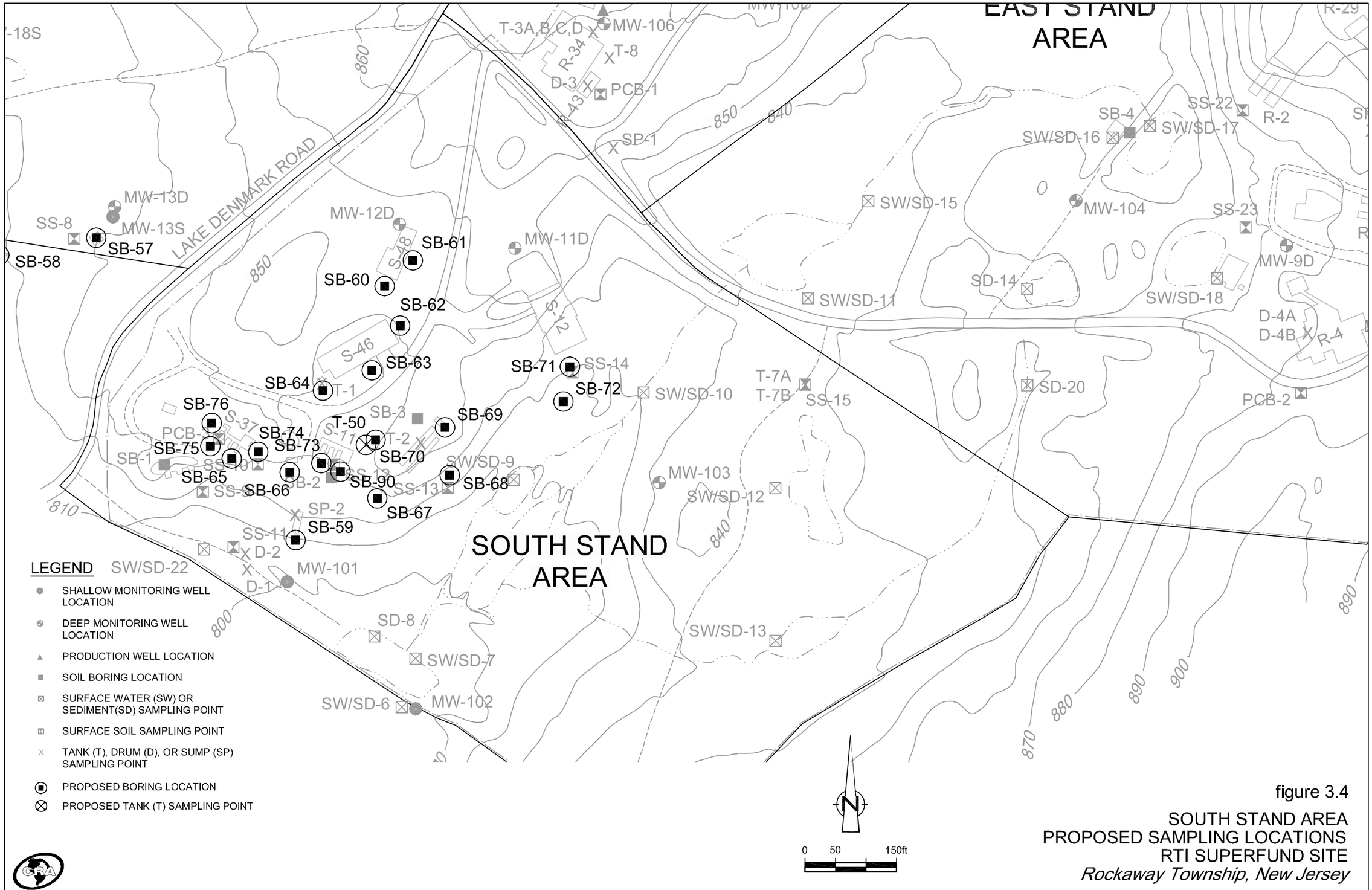
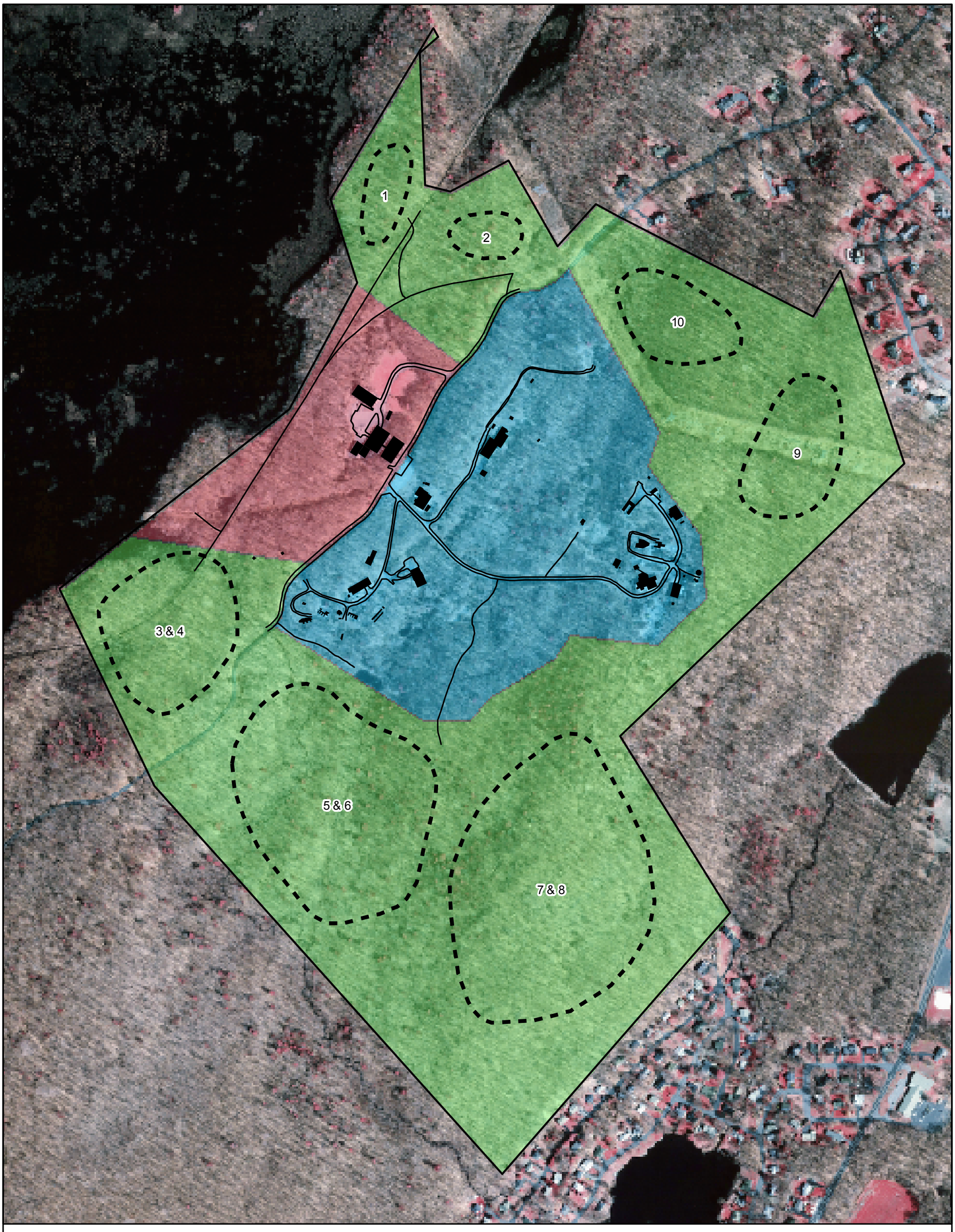


figure 3.4

SOUTH STAND AREA
PROPOSED SAMPLING LOCATIONS
RTI SUPERFUND SITE
Rockaway Township, New Jersey

04354-55(013)GN-SP009 Feb 05/2008

300262



LEGEND

1 — PROPOSED SOIL BORING GENERAL LOCATION

FORMER ROCKAWAY INDUSTRIAL PARKWAY

RADIATION TECHNOLOGY, INC. PROJECT SITE

UNDEVELOPED

SOURCE: ACRES RI (SEPT 1991) / 2002 COLOR-IR AERIAL PHOTO

N

0 250 500

Feet

figure 3.5

UNDEVELOPED AREA
PROPOSED BACKGROUND SAMPLING LOCATIONS
RTI SUPERFUND SITE
Rockaway Township, New Jersey

4354-55(013)GIS-SP001 JAN 29/2008

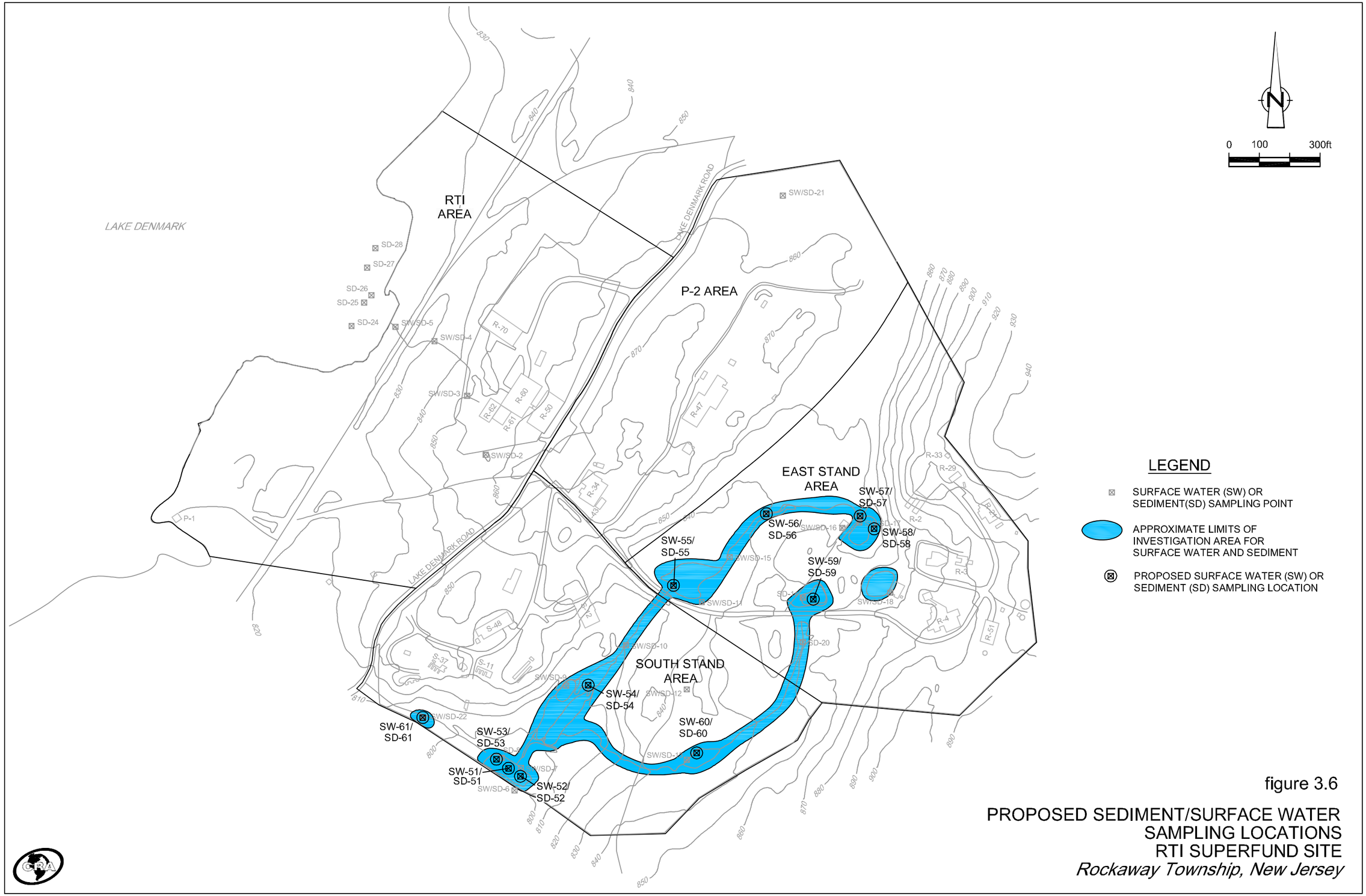


figure 3.6

PROPOSED SEDIMENT/SURFACE WATER SAMPLING LOCATIONS
RTI SUPERFUND SITE
Rockaway Township, New Jersey

04354-55(013)GN-SP005 Jan 29/2008

300264

LEGEND

- TEST PIT / SAMPLING LOCATION
- TEST PIT LOCATION
- MONITORING WELL LOCATION
- DRUM LOCATION
- DISTURBED AREA - HISTORICAL AERIAL PHOTO BASED BOUNDED BY SITE FENCE
- WASTE DRUM AREA - GPS DELINEATED ON 4/27/06
- REFUSE DISPOSAL AREA - GPS DELINEATED ON 4/27/06
- CHAIN LINK FENCE

N

0 30 60

Feet

figure 3.7

RTI AREA
PROPOSED TEST PIT / SAMPLING LOCATIONS
RTI SUPERFUND SITE
Rockaway Township, New Jersey

4354-55(013)GIS-SP002 FEB 1/2008

CRA - Conestoga Rovers & Associates

Job #: 4354 **Date:** April 18, 2005
Job Name: RTI **Sampler:** John Doe

Sample I.D.: SD- 050418 - JD - 001
Analysis: VOCs
Notes: Method 5035 8260B

CRA
Conestoga Rovers & Associates

Date: April 18, 2005
Job #: 4354
Job Name: RTI
Sample I.D.: SW-050418-JD-001
Sampler: John Doe
Analysis: VOCs 8260B

Notes: HCl preservative

figure 4.1

SOIL, SEDIMENT & SURFACE WATER SAMPLE LABELS
RTI SUPERFUND SITE
Rockaway Township, New Jersey

TABLE 1.1

ANALYTICAL PARAMETERS
RTI SUPERFUND SITE
ROCKAWAY TOWNSHIP, NEW JERSEY

TCL VOCs - (V)

1,1,1-Trichloroethane
1,1,2,2-Tetrachloroethane
1,1,2-Trichloro-1,2,2-trifluoroethane
1,1,2-Trichloroethane
1,1-Dichloroethane
1,1-Dichloroethene
1,2,4-Trichlorobenzene
1,2-Dibromo-3-chloropropane
1,2-Dibromoethane
1,2-Dichlorobenzene
1,2-Dichloroethane
1,2-Dichloropropane
1,3-Dichlorobenzene
1,4-Dichlorobenzene
2-Butanone
2-Hexanone
4-Methyl-2-pentanone
Acetone
Acetonitrile
Benzene
Bromodichloromethane
Bromoform
Bromomethane
Carbon disulfide
Carbon tetrachloride
Chlorobenzene
Chloroethane
Chloroform
Chloromethane
cis-1,2-Dichloroethene
cis-1,3-Dichloropropene
Cyclohexane
Dibromochloromethane
Dichlorodifluoromethane
Ethylbenzene
Isopropylbenzene
Methyl acetate
Methyl tert-butyl ether
Methylcyclohexane
Methylene chloride
Styrene
Tetrachloroethene
Toluene
trans-1,2-Dichloroethene
trans-1,3-Dichloropropene
Trichloroethene
Trichlorofluoromethane
Vinyl chloride
Xylenes (total)

TAL Metals (M)

Aluminum
Antimony
Arsenic
Barium
Beryllium
Cadmium
Calcium
Chromium
Cobalt
Copper
Iron
Lead
Magnesium
Manganese
Mercury
Nickel
Potassium
Selenium
Silver
Sodium
Thallium
Vanadium
Zinc

Energetics (E1)

Hydrazine
Monomethyl Hydrazine (MMH)
N-nitrosodimethylamine (NDMA)
Perchlorate
Unsymmetrical Dimethyl Hydrazine (UDMH)

Energetics (E2)

Hydrazine
Monomethyl Hydrazine (MMH)
N-nitrosodimethylamine (NDMA)
Perchlorate
Unsymmetrical Dimethyl Hydrazine (UDMH)
Diethylene Triamine (DETA)

Additional Parameters - Water (W)

pH
ORP
Temperature
Conductivity
Dissolved Oxygen (DO)
Hardness

Additional Parameters - Soil (S1)

pH
Total organic carbon (TOC)

TABLE 1.1

ANALYTICAL PARAMETERS
RTI SUPERFUND SITE
ROCKAWAY TOWNSHIP, NEW JERSEY

TCL SVOCs - (SV)

Acenaphthene
Acenaphthylene
Acetophenone
Anthracene
Atrazine
Benzaldehyde
Benzo(a)anthracene
Benzo(b)fluoranthene
Benzo(k)fluoranthene
Benzo(ghi)perylene
Benzo(a)pyrene
1,1'-Biphenyl
bis(2-Chloroethoxy)methane
bis(2-Chloroethyl) ether
bis(2-Ethylhexyl) phthalate
4-Bromophenyl phenyl ether
Butyl benzyl phthalate
Caprolactam
Carbazole
4-Chloroaniline
4-Chloro-3-methylphenol
2-Chloronaphthalene
2-Chlorophenol
4-Chlorophenyl phenyl ether
Chrysene
Dibenz(a,h)anthracene
Dibenzofuran
Di-n-butyl phthalate
3,3'-Dichlorobenzidine
2,4-Dichlorophenol
Diethyl phthalate
2,4-Dimethylphenol
Dimethyl phthalate
4,6-Dinitro-2-methylphenol
2,4-Dinitrophenol
2,4-Dinitrotoluene
2,6-Dinitrotoluene
Di-n-octyl phthalate
Fluoranthene
Fluorene
Hexachlorobenzene
Hexachlorobutadiene
Hexachlorocyclopentadiene
Hexachloroethane
Indeno(1,2,3-cd)pyrene
Isophorone
2-Methylnaphthalene
2-Methylphenol
4-Methylphenol
Naphthalene
2-Nitroaniline
3-Nitroaniline
4-Nitroaniline
Nitrobenzene

TCL SVOCs (continued)

2-Nitrophenol
4-Nitrophenol
N-Nitrosodiphenylamine
N-Nitrosodi-n-propylamine
2,2'-oxybis(1-Chloropropane)
Pentachlorophenol
Phenanthrene
Phenol
Pyrene
2,4,5-Trichlorophenol
2,4,6-Trichlorophenol

Additional Parameters - Sediment (S2)

pH
TOC
Grain Size
(1)AVS-SEM:
- Sulfide
- Cadmium
- Copper
- Lead
- Mercury
- Nickel
- Zinc

Notes:
(1) Acid-Volatile Sulfide (AVS) (EPA1991) - Simultaneously Extracted Metals (SEM)

TABLE 3.1

SAMPLING METHODOLOGY
RTI SUPERFUND SITE
ROCKAWAY TOWNSHIP, NEW JERSEY

Approximate Overburden Thickness (ft)	*Sample Location*	*Number of Samples*
< 2	Surface soil.	1
>2 and < 6	Surface soil. Water table interface, if no water is present, the sample will be collected from the mid-depth of the borehole.	2
> 6	Surface soil. Water table interface, if no water is present, the sample will be collected from the mid-depth of the borehole. Bedrock interface.	3

Notes:

Soil borings will be advanced to top of bedrock or to the soil/water interface, whichever is

Surface soil samples will be collected from 0 to 1 ft-bgs.

Sample locations may be adjusted based on field observation of contamination, if present.

TABLE 3.2

SAMPLING RATIONALE - RTI AREA
RTI SUPERFUND SITE
ROCKAWAY TOWNSHIP, NEW JERSEY

Sample ID	*Analytes*	*Rationale for Locations*	*Approximate Overburden Thickness (ft)*	*Approximate Number of Samples*
TPS-1 through TPS-7	V, M, E1, S1 [(1)]	These will provide information on potential impacts to soil due to the disposal of drums in this area. Lack of accessability to this area due to the drums remaining, may limit the number and location of samples installed in this area.	17-20	7
SS-64, SS-65	V, M, E1, S1 [(1)]	These surface soil samples will provide information on potential impacts due to the former operation of the secondary waste disposal area, detonation bunker and burning pads which were located northeast of this area. Sample interval to be 12 to 16 inches below ground surface, if possible.	NA	2
			Total	9

Notes:

Refer to Table 3.1 for complete analyte list
[(1)] S1 - Surface soil sample only
V: VOC
M: Metals
E1: Energetics
S1: Additional Parameters - Soil

TABLE 3.3

SAMPLING RATIONALE - P-2 AREA
RTI SUPERFUND SITE
ROCKAWAY TOWNSHIP, NEW JERSEY

Sample ID	*Analytes*	*Rationale for Sample Locations*	*Approximate Overburden Thickness (ft)*	*Approximate Number of Samples*
SB-50	V, M, E1, S1[(1)]	This boring will provide information on potential impacts to soil due to operations associated with building R-34 which was used as a machine shop and for diesel engine assembly.	6	2
SB-52	V, M, S1[(1)]	This boring will provide information on potential impacts to soil due to the operation of a 500 gallon fuel oil storage tank located in the southwest area of building R-34.	6	2
SS-50, SS-51, SS-52, SS-53	V, M, E2, S1[(1)]	These surface soil samples will provide information on potential impacts to soil due to operations associated with building R-47 which was used for filling and loading packaged liquid propellant powerplants.	1.5	4
SS-54, SS-55	E2, S1[(1)]	These surface soil samples will provide information on potential impacts to soil due to the operation of a former 4,000 gallon mixed amine fuel (MAF) AST.	1.5	2
SS-56, SS-57	V, M, S1[(1)]	These surface soil samples will provide information on potential impacts to soil due to operations associated with the former paint locker area.	1.5	2

TABLE 3.3

SAMPLING RATIONALE - P-2 AREA
RTI SUPERFUND SITE
ROCKAWAY TOWNSHIP, NEW JERSEY

Sample ID	*Analytes*	*Rationale for Sample Locations*	*Approximate Overburden Thickness (ft)*	*Approximate Number of Samples*
SS-58, SS-59, SS-60, SS-61	V, M, E1, S1[(1)]	These surface soil samples will provide information on potential impacts to soil due to operations associated with the former drum storage area located on the west and west/northwest side of R-47.	1.5	4
SS-62, SS-63	M, E1, S1[(1)]	These surface soil samples will provide additional information on potential impacts to soil due to operations associated the igniter storage bunker.	1.5	2
SB-92, SB-93, SB-94	V, M, E1, S1[(1)]	These surface soil samples will provide additional information on potential impacts to soil associated with an area formerly used for outdoor storage as identified by Acres.	12	9
			Total	27

Notes:

Refer to Table 3.1 for complete analyte list
[(1)] S1 - Surface soil sample only
V: VOC
M: Metals
E1: Energetics
E2: Energetics - Modified
S1: Additional Parameters - Soil

TABLE 3.4

SAMPLING RATIONALE - EAST STAND AREA
RTI SUPERFUND SITE
ROCKAWAY TOWNSHIP, NEW JERSEY

Sample ID	*Analytes*	*Rationale for Proposed Sample Locations*	*Approximate Overburden Thickness (ft)*	*Approximate Number of Samples*
SB-89, SB-77, SB-78	V, M, E2, S1[(1)]	These borings will provide information on potential impacts to soil due to the operation of test stand R-3 and associated scrubber building. The scrubber building was designed to clean exhaust gases from test firings of rocket motors.	5.6	6
SB-79, SB-80	V, M, E1, S1[(1)]	These borings will provide information on potential impacts to soil due to the operation of the former sewage treatment unit. Boring SB-79 is located in the area of the the former sewage treatment unit. Boring SB-80 is located in the vicinity of the former sewage treatment discharge area.	5.6	4
SB-81, SB-82, SB-83	M, E1, S1[(1)]	These borings will provide information on potential impacts to soil due to the operation test stand R-4. Test stand R-4 was used for testing of developmental engines which used mixed hydrazine and nitrogen tetroxide.	5.6	6
SB-84	V, M, E1, S1[(1)]	This boring will provide information on potential impacts to soil due to the operation of test stand R-2. The boring will be installed a minimum of 30 feet southwest of R-2, outside the area of previous remedial action.	5.6	2
SB-85, SB-86	V, M, E2, S1[(1)]	These borings will provide information on potential impacts due to runoff and/or discharges associated with the R-3 lagoon which received discharge from the scrubber associated with Test Stand R-3.	10	6

TABLE 3.4

SAMPLING RATIONALE - EAST STAND AREA
RTI SUPERFUND SITE
ROCKAWAY TOWNSHIP, NEW JERSEY

Sample ID	*Analytes*	*Rationale for Proposed Sample Locations*	*Approximate Overburden Thickness (ft)*	*Approximate Number of Samples*
SB-87	V, M, S1[(1)]	This boring will provide information on potential impacts to soil due to the operation of a former AST TR-2 located south of R-21 which was reportedly used to store fuel oil.	5	2
SB-88	V, M, S1[(1)]	This boring will provide information on potential impacts to soil due to the operation of an AST located south of building R-51 which was used to store fuel oil.	5	2
SB-91	V, M, S1[(1)]	This boring will provide information on potential impact to soil due to the operation of former ASTs located in front of building R-33.	1	1
T-51	V, M, pH	This tank sample will provide information on the contents of the AST located south of building R-51.	NA	1
			Total	30

Notes:

Refer to Table 3.1 for complete analyte list
[(1)] S1 - Surface soil sample only
V: VOC
M: Metals
E1: Energetics
E2: Energetics - Modified
S1: Additional Parameters - Soil

TABLE 3.5

SAMPLING RATIONALE - SOUTH STAND AREA
RTI SUPERFUND SITE
ROCKAWAY TOWNSHIP, NEW JERSEY

Sample ID	*Analytes*	*Rationale for Sample Locations*	*Approximate Overburden Thickness (ft)*	*Approximate Number of Samples*
SB-57, SB-58	M, E1, S1[(1)]	These borings will provide information on potential impacts to soil due the operation of two former bunkers used for the storage of solid propellant.	14-15	6
SB-59	V, M, E1, S1[(1)]	This boring will provide information on potential impacts to soil due to the operation of the former sewage treatment unit.	10	3
SB-60, SB-61	V, M, E1, S1[(1)]	These borings will provide information on potential impacts to soil due to operations associated with former S-48 area. The S-48 area was reportedly used for storage.	2.8	4
SB-62, SB-63	V, M, E1, S1[(1)]	These borings will provide information on potential impacts to soil due to operations associated with building S-46. Building S-46 was reportedly used as a boiler house, office and pump assembly facility.	3-5.5	4
SB-64	V, M, S1[(1)]	This boring will provide information on potential impacts to soil due to the operation of former storage tank TS-1 and operations associated with building S-46. Tank TS-1 was reportedly used for heating oil storage.	3-5.5	2

TABLE 3.5

SAMPLING RATIONALE - SOUTH STAND AREA
RTI SUPERFUND SITE
ROCKAWAY TOWNSHIP, NEW JERSEY

Sample ID	*Analytes*	*Rationale for Sample Locations*	*Approximate Overburden Thickness (ft)*	*Approximate Number of Samples*
SB-65, SB-74, SB-75, SB-76	V, M, E1, S1[(1)]	These borings will provide information on potential impacts to soil due to operation of S-37 which was formerly used for solid motor mixing and casting. Borings SB-65 and SB-75 will be installed a minimum of 15 feet southwest of S-37, outside the area of previous remedial action.	9	12
SB-66	V, E1, S1[(1)]	This boring will provide information on potential impacts to soil due to the operation of the former flammable liquid storage area.	5.5	2
SB-67	V, M, E1, S1[(1)]	This boring will provide information on potential impacts to soil due to operations associated with test stand S-49 and the former igniter storage bunker.	3.2	2
SB-68, SB-69	V, M, E1, S1[(1)]	These borings will provide information on potential impacts to soil due to the operation of former storage tank SI-4 and/or the operations associated with test stand S-49. Tank SI-4 may have been used to accept exhaust from the firing of small motors with beryllium-containing propellants.	5	4
SB-70	V, SV, M, E1, S1[(1)]	This boring will provide information on potential impacts to soil due to operations associated with test stand S-49 and the AST currently located between S-46 and test stand S-49. The SB-70 boring location will be adjusted depending on the location of the AST located between S-46 and S-49.	3.2	2

TABLE 3.5

SAMPLING RATIONALE - SOUTH STAND AREA
RTI SUPERFUND SITE
ROCKAWAY TOWNSHIP, NEW JERSEY

Sample ID	*Analytes*	*Rationale for Sample Locations*	*Approximate Overburden Thickness (ft)*	*Approximate Number of Samples*
T-50	V, M, E1, pH	This tank sample will provide information on the contents of the AST located between S-46 and S-49.	NA	1
SB-71, SB-72	V, M, E2, S1[(1)]	These borings will provide information on potential impacts to soil due to the operation of test stand S-12	6-10	6
SB-73, SB-90	V, SV, M, E1, S1[(1)]	This boring will provide information on potential impacts to soil due to the operation of test stand S-11.	5.5	4
			Total	52

Notes:

Refer to Table 3.1 for complete analyte list
[(1)] S1 - Surface soil sample only
V: VOC
SV: SVOCs
M: Metals
E1: Energetics
E2: Energetics - Modified
S1: Additional Parameters - Soil

TABLE 3.6

SAMPLING RATIONALE - SURFACE WATER/SEDIMENT
RTI SUPERFUND SITE
ROCKAWAY TOWNSHIP, NEW JERSEY

Sample ID	*Analytes*	*Rationale for Sample Locations*	*Approximate Overburden Thickness (ft)*	*Approximate Number of Samples* [1]
SW-51/SD-51, SW-52/SD-52, SW-53/SD-53, SW-54/SD-54	V, M, E1, W, S2	These sediment and/or surface water samples will provide information on potential impacts due to runoff and/or discharges associated with the East and South Stand Areas.	NA	8
SW-55/SD-55, SW-56/SD-56	V, M, E1, W, S2	These sediment and/or surface water samples will provide information on potential impacts due to runoff and/or discharges associated with upgradient lagoon R-2 and the East Stand Area.	NA	4
SW-57/SD-57, SW-58/SD-58	V, M, E1, W, S2	These sediment and/or surface water samples will provide information on potential impacts due to runoff and/or discharges associated with the R-2 lagoon which received treated sewage discharge from the former sewage treatment unit located north of Test Stand R-3.	NA	4
SW-59/SD-59	V, M, E1, W, S2	This sediment and/or surface water sample will provide information on potential impacts due to runoff and/or discharges associated with lagoon R-1 and the East Stand Area.	NA	2
SW-60/SD-60	V, M, E1, W, S2	This sediment and/or surface water sample will provide information on potential impacts due to runoff and/or discharges associated with upgradient lagoon R-1 and the East Stand Area.	NA	2
SW-61/SD-61	V, M, E1, W, S2	This sediment and/or surface water sample will provide information on potential impacts due to runoff and/or discharges associated with the South Stand Area.	NA	2
			Total	22

Notes:

Refer to Table 3.1 for complete analyte list
V: VOC
M: Metals
E1: Energetics
W: Additional Parameters - Water
S2: Additional Parameters - Sediment

TABLE 4.1

SUMMARY OF ANALYTICAL METHODS
RI/FS QUALITY ASSURANCE PROJECT PLAN
RTI SUPERFUND SITE
ROCKAWAY TOWNSHIP, NEW JERSEY

Parameter	*Preparation Method* [1]	*Analytical Method*
Volatile Organic Compounds (VOC) - water	SW 8260B	SW 8260B
Volatile Organic Compounds (VOC) - soil	SW 5035	SW 8260B
Semivolatile Organic Compounds (SVOC) - soil	SW 3500	SW 8270C low level
Perchlorate	EPA 314.0	EPA 314.0
Total Metals - water	SW 3005A	SW 6010B/6020/7470A
Dissolved Metals - water	SW 3005A	SW 6010B/6020/7470A
Metals - soil/sediment	SW 3050B	SW 6010B/6020/7471A
Total Hardness	EPA 130.2	EPA 130.2
Hydrazine/Monomethyl Hydrazine (MMH)/ Unsymmetrical Dimethyl Hydrazine (UDMH)	SW 9056	SW 9056
N-nitrosodimethylamine (NDMA)	SW 8270	SW 8270
Diethylene Triamine (DETA)	SW 8015	SW 8015
TOC - soil	Walkley-Black	Walkley-Black
Acid Volatile Sulfide (AVS) - Simultaneously Extracted Metals (SEM)	SW 9030/9034/3010/6010B	SW 9030/9034/3010/6010B
Grain Size	D422	D422
pH	SW 9045	SW 9045

TABLE 4.2

CONTAINER, PRESERVATION, SHIPPING, AND PACKAGING REQUIREMENTS
RI/FS QUALITY ASSURANCE PROJECT PLAN
RTI SUPERFUND SITE
ROCKAWAY TOWNSHIP, NEW JERSEY

Analyses	*Sample Containers*	*Preservation* [1]	*Maximum Holding Time from Sample Collection* [2]	*Volume of Sample*	*Shipping*	*Normal Packaging*
WATER						
VOCs	Three 40-ml teflon-lined septumvials per analysis	HCl to pH<2; Iced	14 days for analysis	Fill completely, no air bubbles	Overnight or Hand Deliver	Foam Liner or Bubble-wrap
N-nitrosodimethylamine	Two 1-liter Amber glass bottles	Iced	7 days from collection to extraction, 40 days from extraction to analysis	Fill to neck of bottle	Overnight or Hand Deliver	Bubble Pack or Foam Chips
Total Metals, hardness	One 1-liter polyethylene bottle	HNO_3 to pH<2; Iced	180 days for analysis, mercury 28 days	Fill to neck of bottle	Overnight or Hand Deliver	Bubble Pack or Foam Chips
Dissolved Metals, dissolved hardness	One 1-liter polyethylene bottle	HNO_3 to pH<2; Iced	180 days for analysis, mercury 28 days	Fill to neck of bottle	Overnight or Hand Deliver	Bubble Pack or Foam Chips
Perchlorate	One 250-ml polyethylene bottle	Iced	28 days for analysis	Fill to neck of bottle	Overnight or Hand Deliver	Bubble Pack or Foam Chips
Hydrazine/UDMH/MMH	One 1L Amber glass bottle	Iced	48 hours to filter and preserve at the lab; 28 days from filter/preservation to analysis	Fill to neck of bottle	Overnight or Hand Deliver	Bubble Pack or Foam Chips

TABLE 4.2

CONTAINER, PRESERVATION, SHIPPING, AND PACKAGING REQUIREMENTS
RI/FS QUALITY ASSURANCE PROJECT PLAN
RTI SUPERFUND SITE
ROCKAWAY TOWNSHIP, NEW JERSEY

Analyses	*Sample Containers*	*Preservation* [1]	*Maximum Holding Time from Sample Collection* [2]	*Volume of Sample*	*Shipping*	*Normal Packaging*
SOIL/SEDIMENT						
VOCs	Three - 5 gram Encores	Iced	48 hours for preservation at the lab, 14 days for analysis.	Fill completely, and cap	Overnight or Hand Deliver	Bubble Pack or Foam Chips
SVOCs	One 4 oz jar	Iced	14 days from collection to extration/40 days from extraction to analysis	Fill completely, no air bubbles	Overnight or Hand Deliver	Bubble Pack or Foam Chips
N-nitrosodimethylamine	One 4 oz jar	Iced	14 days from collection to extration/40 days from extraction to analysis	Fill completely, no air bubbles	Overnight or Hand Deliver	Bubble Pack or Foam Chips
Metals	One 4 oz jar	Iced	180 days to analysis, mercury 28 days	Fill to neck of jar	Overnight or Hand Deliver	Bubble Pack or Foam Chips
Perchlorate	One 4 oz jar	Iced	28 days for analysis	Fill to neck of jar	Overnight or Hand Deliver	Bubble Pack or Foam Chips
Hydrazine/UDMH/MMH	One 8 oz jar	Iced	28 days for analysis	Fill to neck of jar	Overnight or Hand Deliver	Bubble Pack or Foam Chips
Diethylene Triamine	One 4 oz jar	Iced	14 days for analysis	Fill to neck of jar	Overnight or Hand Deliver	Bubble Pack or Foam Chips
Total Organic Carbon, pH	One 2 oz jar	Iced	TOC - 28 days for analysis, pH - NA	Fill to neck of jar	Overnight or Hand Deliver	Bubble Pack or Foam Chips
AVS-SEM	One 4 oz jar	Iced	14 days for analysis	Fill to the top	Overnight or Hand Deliver	Bubble Pack or Foam Chips
Grain size	One 8 oz jar	None	NA	Fill to neck of jar	Overnight or Hand Deliver	Bubble Pack or Foam Chips

Notes:

[1] Samples requiring refrigeration will be sent in coolers with bags of cubed iced. Following receipt and log-in, samples will be refrigerated at 4 ± 2°C.

[2] These are technical holding times and are based on time elapsed from time of sample collection.

TABLE 4.3

SUMMARY OF
RI/FS QUALITY ASSURANCE PROJECT PLAN
RTI SUPERFUND SITE
ROCKAWAY TOWNSHIP, NEW JERSEY

Sample Matrix	*Field Parameters*	*Laboratory Parameters*	*Investigative Samples*	*QA/QC Samples [1]*			*Total Per Round*	*Frequency*
				Field Blanks	*Field Duplicates*	*Matrix Spike MS/MSD [2]*		
Soil Borings, Test Pits, and Surface Soil	• N/A	• TCL VOCs [5], TCL SVOC (low level) [6], TAL Metals[7], Hydrazine/UDMH[8]/MMH[9], perchlorate, DETA[10], TOC[11] (surface soil only), pH (surface soil only)	145	14	14	7	169	Once
Sediment	• N/A	• TCL VOCs [5], TAL Metals[7], Hydrazine/UDMH[8]/MMH[9], perchlorate, TOC[11], grain size, AVS-SEM[12]	10	1	1	1	12	Once
Surface Water	• pH, conductivity, temperature, ORP[3], DO[4]	• TCL VOCs [5], TAL Metals[7], Dissolved TAL Metals[13], Hydrazine/UDMH[8]/MMH[9], perchlorate, total hardness, dissolved hardness	10	1	1	1	12	Once
Tank Contents	• pH	• TCL VOCs [5], TAL Metals[7], Hydrazine/UDMH[8]/MMH[9], perchlorate	2	0	0	0	2	Once

Notes:

This table presents an overview of the sampling. For details on actual parameter lists for specific Soil Boring or Surface Soil locations please, see Work Plan Tables 7.2 through 7.6.

[1] QA/QC - Quality Assurance/Quality Control

[2] MS/MSD - Matrix Spike/Matrix Spike Duplicate pair. MS/MSD samples are not figured into the total per round.

[3] ORP- Oxidation Reduction Potential

[4] DO - Dissolved Oxygen

[5] VOCs - Volatile Organic Compounds

[6] SVOC - Semivolatile Organic Compounds

[7] TAL Metals - Target Analyte List Metals

[8] UDMH - Unsymmetrical Dimethyl Hydrazine

[9] MMH - Monomethyl Hydrazine

[10] DETA - Diethylene Triamine

[11] TOC - Total Organic Carbon

[12] AVS-SEM - Acid Volatile Sulfide - Simultaneously Extracted Metals.

[13] Dissolved metals samples will be filtered using a 0.45 µm filter prior to preservation.

APPENDIX A

FIELD STANDARD OPERATING PROCEDURES

SOP 1 - Decontamination of Heavy Equipment
SOP 2 - Decontamination of Field Equipment
SOP 3 - Borehole Installation and Sampling (overburden and bedrock)
SOP 4 - Surficial Soil Sampling
SOP 5 - Collecting Sediment Samples
SOP 6 - For Collecting Surface Water Samples
SOP 7 - Sample Management and Field QA/QC

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SOP 4 - SURFICIAL SOIL SAMPLING.....1

SOP-5 - COLLECTING SEDIMENT SAMPLES.....1

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SOP 7 - SAMPLE MANAGEMENT AND FIELD QA/QC.....1

SOP 1

DECONTAMINATION OF HEAVY EQUIPMENT

GENERAL

The following guideline presents decontamination procedures for heavy equipment/vehicles that have been used in areas that are within the exclusion zones or restricted access areas due to chemical presence. Decontamination of equipment and vehicles is required to eliminate spreading of chemical presence and prevent chemical cross-contamination from site to site.

Equipment exiting an exclusion zone must adhere to the site FMGs for contaminant reduction zone/decontamination zone protocols. The zone configuration and protocols will vary from site to site and will be defined in the site-specific HASP.

Decontamination methods for heavy equipment include physical removal of dirt/debris, and both physical/chemical means to clean surfaces. The types of chemicals at a site and their concentration and state will determine the appropriate method of decontamination to be employed.

PRIOR PLANNING AND PREPARATION

Cleaning of heavy equipment is commonly outlined in the site-specific Work Plan or the contractual documents that apply to the activities being conducted. Common scenarios which frequently occur are cleaning of backhoes and dump trucks from soil excavation and drum removal projects or cleaning of a drilling rig and the associated drilling equipment (i.e., augers, rods, split spoons, tools). The following describes preparatory tasks prior to implementation of heavy equipment decontamination:

i) Assembly and inventory of necessary cleaning equipment and supplies.

ii) Review Work Plan, HASP, and specific equipment cleaning protocols.

iii) Check on acquisition, storage, and transportation of solvents/potable water source.

iv) Evaluate disposition of cleaning fluids upon completion of the work.

v) Evaluation of where the cleaning of heavy equipment will be performed.

FIELD PROCEDURE

The following cleaning procedures are applicable to most programs requiring heavy equipment decontamination:

i) Remove by hand (i.e., shovel, bar, scraper, brush) excess visible dirt and debris from the equipment paying particular attention to track, cleats, tires, and other irregular surfaces.

ii) Clean the equipment using high pressure/low volume hot water or steam equipment.

iii) Clean/scrub the equipment with water and natural soap (biodegradable-phosphate free, i.e., Alconox or equivalent) solution.

iv) Final rinse of equipment with high pressure/low volume hot water or steam equipment.

The cleaning procedure for liquid recirculation equipment (i.e., drilling pumps and hoses) shall be as follows:

- all exposed surfaces shall be surface cleaned as described above;
- a solution of natural soap (biodegradable-phosphate free) and water shall be circulated through the system for 15 minutes or appropriate duration; and
- potable water shall be circulated through the system for 15 minutes or appropriate duration.

Once the heavy equipment is cleaned and approved, the washwater, soil debris, and spent protective wear must be containerized, labeled, and properly staged in the approved area on the site. The Client is then to be notified in writing by CRA, of the volume, state, and condition of the materials to be disposed of/treated.

Note:	*Proper disposal of waste materials requires careful segregation of waste media. For example, if solvents are utilized for cleaning, they should not be mixed with washwater and should be containerized separately. The impact on disposal costs is greatly influenced if various media (i.e., solvents/washwaters) are mixed. Solids as well must be segregated where possible and prevented from mixing with the washwaters.*

FOLLOWUP ACTIVITIES

The activities completed for each heavy equipment decontamination shall be documented in writing in the field book. Included in the field book shall be following information:

i) Site location, date, time, weather.

ii) Equipment use location.

iii) Location where decontamination was performed.

iv) Personnel performing decontamination.

v) Decontamination procedures.

vi) Sources of materials (solutions) used for decontamination.

vii) Volume of decontamination fluids generated.

viii) Location where decontamination fluids have been stored.

ix) Individuals approving adequacy of decontamination.

x) QA/QC sampling performed (if required).

The washwaters, soil debris, and spent protective wear must be properly segregated, containerized, labeled, and stored.

SOP 2

DECONTAMINATION OF FIELD EQUIPMENT

GENERAL

The following guideline presents decontamination procedures for field equipment used in the sampling of soil and groundwater, which are to undergo either physical or chemical analyses.

The purposes of decontamination are as follows:

- to prevent cross-contamination of individual sites and specific sampling locations;
- to ensure that representative samples are collected for analysis;
- to ensure proper operation of equipment and instrumentation; and
- to reduce exposure hazards to workers involved in handling potentially contaminated materials.

PRIOR PLANNING AND PREPARATION

The following shall be considered prior to implementation of the decontamination procedures:

i) Assembly of and inventory of necessary equipment and supplies.

ii) Review Work Plan and HASP.

iii) Determination of where equipment decontamination activities will be performed.

iv) Disposition of cleaning fluids upon completion of work.

FIELD PROCEDURE

The decontamination procedures for field equipment can be subdivided into two categories of cleaning:

i) Those pieces of equipment that will come in direct contact with samples that are to be submitted for chemical analysis (i.e., pumps, stainless steel trowels, etc.).

ii) Those pieces of equipment that perform field measurements (i.e., pH meters, temperature probes) or are used to collect samples that are not to be submitted for chemical analyses (i.e., split spoons that are use to collect geologic record samples).

The first category of equipment requires extensive, documented and defensible procedures. The second category is less intensive. Both categories of decontamination procedures are described in the following:

I. Equipment Which Contacts Samples to be Chemically Analyzed

Non-disposable soil sampling equipment (trowels, spoons, hand shovels, scoops, etc.) will be decontaminated prior to field use and after each sample is collected to prevent cross-contamination between samples. Duplicate samples will be collected concurrently with original samples; therefore, sampling equipment will not be decontaminated before collection of the duplicate samples. Decontamination of equipment used for collecting samples for laboratory analyses will be performed as follows:

i) disassemble equipment as appropriate and wash with potable water and Alconox™ detergent (or equivalent non-phosphate detergent) using a brush, if necessary, to remove all visible foreign matter;

ii) rinse thoroughly with potable water;

iii) rinse with laboratory grade deionized water or organic free water;

iv) allow the equipment to air dry for as long as possible; and

v) wrap equipment in aluminum foil as necessary prior to transport to sampling location.

Following the final rinse, equipment will be visually inspected to verify that it is free of soil particles and other solid material that could contribute to possible sample cross-contamination.

Decontamination of submersible pumps is performed as follows:

i) disassemble pumps as necessary;

ii) use a brush, if necessary, to remove all visible foreign matter;

iii) place pump in a clean 2- to 4-inch diameter polyvinyl chloride (PVC) tube or a plastic tub containing a non-phosphate detergent solution;

iv) activate pump and allow water/detergent solution to circulate through pump and tubing for several minutes;

v) place sampling pump in a tub or clean PVC tube containing a minimum of 2 gallons of distilled water;

vi) activate pump and allow distilled water to circulate for several minutes then exit tub or tube through tubing;

vii) transport pump to next sampling location inside PVC tube; and

viii) prior to placing the pump into the next well rinse the outside of the pump with laboratory grade deionized water or organic free water.

Note: If a pump such as the QED Sample Pro Portable Bladder Pump is used to sample a monitoring well ,items iii) through vi) are eliminated. This type of pump is designed to be completely disassembled for decontamination and a new bladder is installed between sample locations.

II. Equipment Which Does Not Contact Samples Requiring Chemical Analysis

This category of cleaning includes sampling equipment used for collecting samples for physical analysis (i.e., inspection, grain-size distribution, etc.) and also those pieces of equipment that actually perform in field testing where no subsequent analyses of that portion of the samples is to be analyzed any further (i.e., pH meter, temperature probes, etc.).

For all field testing equipment, it is imperative that the cleaning procedures be completed in compliance with the manufacturer's specifications. Other cleaning methods may impact the instruments operating functions.

For all other sampling equipment that does not contact a sample requiring chemical analysis, a simple cleaning with potable water is typically sufficient between uses. Before leaving the site, the sampling equipment shall be decontaminated in a manner consistent with that described in the first category to ensure that site contaminants are not transferred to another site.

Spent Decontamination Fluids

All used cleaning fluids are to be placed into appropriate secure containers (i.e., drums), labeled as to contents and left at the site for the owner/Client to properly dispose of. To the extent practicable, different cleaning fluids should be kept segregated to minimize the costs for treatment or disposal.

Site/Sample Location-Specific Dedicated Equipment

Prior to the first use of dedicated sampling equipment, it is necessary to clean and inspect the equipment in a manner consistent with the intended data use (chemical or non-chemical).

Prior to any subsequent sampling, the site-dedicated groundwater sampling equipment that contacts the sample should be purged several times to acclimate the equipment to fresh conditions. The purge volume shall be in accordance with the project-specific sampling protocols.

It is recommended that whenever possible, sample tubing for use in monitoring well programs be left inside the well for reuse at later dates. Sample tubing shall not be decontaminated. If the tubing becomes soiled or damaged, it should be discarded and replaced with new tubing.

SOP 3

BOREHOLE INSTALLATION AND SAMPLING (OVERBURDEN AND BEDROCK)

GENERAL

The following SOP presents the methods generally employed for the installation of boreholes (overburden) or coreholes (bedrock). The basic soil and bedrock description techniques are discussed; as well as the collection procedures for subsurface samples (both soils and bedrock). Boreholes/coreholes are typically installed to define geologic conditions for hydrogeologic and geotechnical evaluation; to allow the installation of monitoring wells and piezometers; and to allow the collection of subsurface samples for chemical analysis; and for soil/bedrock record retention purposes.

Several manual methods are available for the collection of shallow subsurface soil samples (e.g., hand augers, post-hole augers). However, the most common method used to advance boreholes are drill rigs equipped with hollow-stem augers (HSA) and split-spoon samplers, or direct-push drilling units equipped with solid tube soil samplers. Bedrock core samples are typically collected using a rotary drill rig equipped with a core-barrel or other tooling. Bedrock boreholes are also advanced without collecting core, using drill bits that chip out the bedrock.

PRIOR PLANNING AND PREPARATION

The following activities must be undertaken prior to undertaking a borehole installation and subsurface soil sampling program.

i) Review the work program, project documents, and the health and safety requirements.

ii) Complete an equipment requisition form. Assemble all equipment and supplies.

iii) Obtain a site plan and any previous stratigraphic logs. Determine the exact number and location of boreholes to be installed and the depths of samples for chemical analysis.

iv) Establish borehole locations in field using available landmark or by surveying methods if necessary.

v) Arrange for utility clearance of franchised utilities and site utilities.

vi) Establish a water source for drilling and decontamination activities. Determine the methods for handling and disposal of drill cuttings, wash waters, and spent decontamination fluids.

PROCEDURE

Once the prior planning and preparation activities are completed, the drilling and subsurface sampling program can proceed. The typical series of events, which takes place is:

- locating and marking of borehole locations (if not already completed);
- final visual examination of proposed drilling area for utility conflicts;
- equipment decontamination;
- advancement of borehole and collection of soil samples and/or advancement of corehole and the collection of bedrock core samples;
- field screening of soil sample;
- description of soil and /or bedrock core samples;
- sample preparation and packaging;
- abandonment of boreholes/coreholes or installation of monitoring wells (SOP 5);
- surveying of drilling locations and elevations; and
- field note completion and review.

i) Location and Marking of Drill Sites/Final Visual Check

The proposed borehole locations marked on the site plan are located in the field and staked. Once the final location for the proposed boring has been selected and utility clearances are complete, one last visual check of the immediate area should be performed before drilling proceeds. This last visual check should confirm the locations of any adjacent utilities (subsurface or overhead) and verification of adequate clearance. If gravity sewers or conduits exist in the area, any access manholes or chambers should be opened and the conduit/sewer alignments confirmed, if possible.

If it is necessary to relocate any proposed borehole due to terrain, utilities, access, etc., the Project Coordinator must be notified and an alternate location will be selected.

ii) Equipment Decontamination for Environmental Sites

Prior to use and between each borehole location at an environmental site, the drilling and sampling equipment must be decontaminated. All decontamination must be conducted in accordance with the project-specific plans or the methods.

iii) Sample Collection

The boring is advanced incrementally to permit intermittent or continuous sampling. Test intervals and locations are site specific and are normally stipulated in a Work Plan or by the project coordinator. Typically, the depth intervals for sampling is 2.5 to 5 feet or less in homogeneous strata with at least

one test and sampling location at every change of strata. In some cases samples are taken continuously (i.e., 2 feet long samples at 2 feet intervals).

For environmental sampling, always change gloves between collecting subsequent soil samples to prevent cross-contamination. All tools (e.g., samplers, spatulas, etc.) must be field cleaned prior to use on each sample to prevent cross-contamination.

Any drilling procedure that provides a suitably clean and stable hole before insertion of the sampler and assures that the penetration test or other sampling technique is performed on essentially undisturbed soil is acceptable. The drilling method is to be selected based on the subsurface conditions. Each of the following procedures have proven to be acceptable for specific subsurface conditions:

- continuous flight hollow-stem auger method (with inside diameter between 2.25 and 6.25 inches);
- continuous flight solid auger method (with auger diameter between 2.2 and 6.5 inches);
- direct-push methods (dual tube systems, discrete soil sample systems);
- open-hole rotary drilling method; and
- wash boring method.

Several drilling methods are not acceptable. These include: jetting through an open tube sampler and then sampling when the desired depth is reached; use of continuous flight solid auger equipment below the groundwater table in non-cohesive soils; casing driven below the sampling depth prior to sampling; and advancing a borehole with bottom discharge bits. It is not permissible to advance the boring for subsequent insertion of the sampler solely by means of previous sampling when performing standard penetration testing (the open hole must be larger in diameter than the split-spoon sampler).

The following subsections describe the specific protocol for Standard Penetration Test sampling and Shelby Tube sampling.

Standard Penetration Testing (SPT) Sampling and Testing Procedure

This method is used to obtain representative samples of subsurface soil materials and to determine a measure of the in situ relative density of the subsurface soils. The test methods described below must be followed to obtain accurate SPT values.

SPT sampling is performed by using a split barrel sampler in accordance with ASTM D1586. The split barrel sampler, or split-spoon, consists of an 18- or 24-inch long, 2-inch outside diameter tube, which comes apart length wise into two halves.

Once the borehole is advanced to the target depth and the borehole cleaned of cuttings, representative soil samples are collected in the following manner:

- the split-spoon sampler should be inspected to ensure it is properly cleaned and decontaminated. The driving shoe (tip) should be relatively sharp and free of severe dents and distortions;
- the cleaned split-spoon sampler is attached to the drill rods and lowered into the borehole. Do not allow the sampler to drop onto the soil;
- after the sampler has been lowered to the bottom of the hole, it is given a single blow to seat it and make sure that it is in undisturbed soil. If there still appears to be excessive cuttings in the bottom of the borehole, remove the sampler from the borehole and remove the cuttings; and
- mark the drill rods in three or four successive 6-inch increments, depending on sampler length, so that the advance of the sampler under the impact of the hammer can be easily observed for each 6-inch increment.

The sampler is then driven continuously for either 18 or 24 inches by use of a 140-pound hammer. The hammer may be lifted and dropped by either the cathead and rope method, or by using a trip, automatic, or semi-automatic drop system. The hammer should free-fall a distance of 30 inches (±1 inches) per blow. Measure the drop at least daily to ensure that the drop is correct. To ensure a free-falling hammer, no more than 2 1/4 turns of the rope may be wound around the cathead (see ASTM D1586). The number of blows applied in each 6-inch increment is counted until one of the following occurs:

- a total of 50 blows have been applied during any one of the 6-inch increments described above;
- a total of 100 blows have been applied;
- there is no advancement of the sampler during the application of ten successive blows of the hammer (i.e., the spoon is "bouncing" on a stone or bedrock); or
- the sampler has advanced the complete 18 or 24 inches without the limiting blow counts occurring as described above.

In some cases where the limiting number of blow counts has been exceeded, the geologist may direct the driller to attempt to drive the sampler more if collection of a greater sample length is essential.

On the field form, record the number of blows required to drive each 6-inch increment of penetration. The first 6 inches is considered to be a seating drive. The sum of the number of blows required for the second and third 6 inches of penetration is termed the "standard penetration resistance" or the "N-value".

The sampler is then removed from the borehole and unthreaded from the drill rods. The open shoe (cutting end) and head of the sampler are partially unthreaded by the drill crew and the sampler is transferred to the geologist/engineer work surface.

The open shoe and head are removed by hand, and the sampler is tapped so that the tube separates.

Measure and record the length of sample recovered making sure to discount any sloughed material that is present on top of the sample core.

Caution must be used when conducting SPT sampling below the groundwater table, particularly in sand or silt. These soils tend to heave or "blow back" into the hollow-stem augers due to the difference in hydraulic pressures between the inside of the HSA and the undisturbed soil. To equalize the hydraulic pressure, it may be necessary to fill the inside of the HSA with water or drilling mud. The drilling fluid level within the boring or hollow-stem augers needs to be maintained at or above the in situ groundwater level at all times during drilling, removal of drill rods, and sampling. Since heave or blow back is not always obvious to the driller, it is essential that the water level in the borehole always be maintained at or above the groundwater level.

Heaving conditions and the use of water or mud and volume used should be noted on the field logs. The volume of water added generally must be removed during well development prior to groundwater sampling. This practice may not be acceptable if environmental samples are to be collected.

SPT sampling below the water table in sands and silt occasionally results in low SPT values being obtained due to the heaving effect disturbing the soil especially if the water level in the hole has not been maintained at the in situ water level. Suspect low N values should be noted on the field logs. If it is critical to have accurate N values below the water table, other methods can be employed, such as conducting a dynamic cone penetration test. This quick and easy test involves attaching a cone shaped tip to the end of the drill rods, and driving the tip into the ground similar to the SPT method, except that the borehole is not pre-augered. Cones may be driven 20 to 40 feet through a formation without augering. Blow counts are recorded for each foot of advancement. Consult the Project Manager if such conditions are unexpectedly encountered.

A variation of split barrel sampling involves the use of a longer larger diameter barrel in conjunction with hollow stem augers. The sampling barrel is installed inside the auger with a swivel attachment to limit rotation of the barrel. After completion of a 5-foot auger penetration, the auger is left in place and the barrel retrieved from the borehole. The sampler should be handled and the sample retrieved in the same way as described above for SPT sampling.

Another variation involves the use of resonant sonic drilling methods that drives a core sampler by vibration means and recovers a tube that can contain a 10 to 20 foot soil sample core. The cores are handled in the same manner as the SPT sampler.

Thin-Walled Samplers (Shelby Tubes)

Thin-walled samplers such as Shelby Tubes are used to collect relatively undisturbed samples (as compared to split-spoon samples) of soft to stiff clayey soils. The Shelby Tube has an outside diameter of 2 or 3 inches and is 3 feet long. These undisturbed samples are used for certain laboratory tests of structural properties (consolidation, hydraulic conductivity, shear strength) or other tests that might be influenced by sample disturbance. Procedures for conducting thin-walled tube sampling are provided in ASTM D1587, and are briefly described below.

- the soil deposit being sampled must be cohesive in nature, and relatively free of gravel, and cobble materials, as contact with these materials will damage the sampler;
- clean out the borehole to the sampling elevation using whatever method is preferred that will ensure the material to be sampled is not disturbed. If groundwater is encountered, maintain the liquid level in the borehole at or above groundwater level during the sampling operation;
- bottom discharge bits are not permitted. Side discharge bits may be used, with caution. Jetting through an open-tube sampler to clean out the borehole to sampling elevation is not permitted. Remove loose material from the center of a casing or hollow-stem auger as carefully as possible to avoid disturbance of the material to be sampled;
- place the sample tube so that its bottom rests on the bottom of the hole. Advance the sampler into the formation without rotation by a continuous and relatively rapid motion; usually hydraulic pressure is applied to the top of the drill rods;
- determine the length of advance by the resistance and condition of the formation, but the length shall never exceed 5 to 10 diameters of the tube in sands and 10 to 15 diameters of the tube in clays;
- in no case should the length of advance be greater than the sample-tube length minus an allowance for the sampler head and a minimum of 3 inches for cuttings.
- the tube may be rotated to shear the bottom of the sample 2 to 3 minutes after pressing in, and prior to retrieval to ensure the sample does not slide out of the tube. Lift the weight of the rods off of the tube prior to rotating.
- withdraw the sampler from the formation as carefully as possible in order to minimize disturbance of the sample;
- package and transport the sample .

Direct-Push Sampling Systems

Direct-push refers to the sampler being "pushed" into the soil material without the use of drilling to remove the soil. This method relies on the drill unit static weight combined with hammer percussion for advancement of the tool string. Discrete soil samples are continuously obtained; as well, groundwater and vapor samples can also be collected utilizing this method and appropriate tooling. Subsurface investigations typically sample to depths of 30 feet or more, however depth will vary based on the site-specific geology.

This method is becoming more popular due to the limited cuttings that are produced during the sampling process and the sampling process speed.

Discrete continuous soil samples are collected in tube samplers (various lengths), affixed with a cutting shoe and internal liner (PVC, teflon, or acetate are available). The soil sampler may be operated in the "open-mode" (when borehole collapse is not a concern), or in the "closed-mode" (when minimization of sample "slough " is desired). Closed-mode operations involve the placement of a temporary "drill-point" in the cutting shoe and driving the assembled sampler to depth. Once at the required depth, the temporary "drill –point " is released (via internal threading) and the sampler is driven to the desired soil interval. The drill-point slides inside the sample liner, riding above the collected soil column. Once driven to depth, the sampler is retrieved to the ground surface and the sample liner with soil, is removed for examination.

Use caution when opening interval liners with knives, as severe cuts may result from the knife slipping. A special 2-blade hooked knife is available for opening the liners. Generally the driller/helper will open the liner for you.

Rotosonic Sonic Systems

A variant of the direct push sampling system involves the use of a drilled core barrel. The drilling method used to drive the core barrel is the rotosonic sonic drilling method. This method uses a drill head that imparts a high-frequency, high bounce vibration into a steel drill pipe that advances to the desired depth. The drill pipe is usually advanced in 10 to 20 foot increments and can retrieve a continuous, relatively undisturbed soil core through virtually any formation. The soil core is retrieved in a disposable liner similar to that for the direct push methodology. The advantage of the resonant sonic drilling methods are:

- limited drill water is used
- no drill cutting are produced
- depths in excess of 500 feet are possible.

v) Field Sample Screening

When sampling for environmental cases, it is often required to measure the soil for evidence of chemical presence. This field screening can be performed using a photoionization detector (PID). Immediately upon the opening of the split-spoon or discrete soil sampler, the soil is screened with a PID for the presence of organic vapor. This is accomplished by running the PID along the length of the soil sample. Record the highest reading.

Note: The PID measurement must be done upwind of the drill rig or any running motors so that exhaust fumes will not affect the measurements.

Another method of field screening is head space measurements. This consists of placing a portion of the soil sample in a sealable glass jar, placing aluminum foil over the jar top and tightening the lid. The jar shall only be partially filled. The jar shall be shaken and set aside for at least 5 minutes. After the sample has equilibrated, the lid of the jar is opened; the foil is punctured with the PID probe, and the air (headspace) above the soil sample is monitored. Record this headspace reading on the field form or in the field book. As an alternative, the soil can be placed in a sealable poly bag.

vi) Soil/Bedrock Descriptions

a) Soils

The criteria and procedures for identifying and describing soil include:

i) Standard field identification method based on visual examination and manual tests.

ii) A standard method of describing the soil by name and group symbol.

iii) Verifying field description through inspection of representative soil samples by the person responsible for interpretation of subsurface conditions at the site.

iv) Confirming descriptive information by laboratory determination of selected soil characteristics for representative soil samples.

v) Factual stratigraphic logs confirmed by the person responsible for interpreting the subsurface conditions.

The stratigraphic log is a factual description of the soil at the borehole location and is relied upon to interpret the soil characteristics, and their influence and significance in the subsurface environment. The accuracy of the stratigraphic log is to be verified by the person responsible for interpreting subsurface conditions. An accurate description of the soil stratigraphy is essential for a reasonable understanding of the subsurface conditions. Confirmation of the field description by examination of representative soil samples by the project

geologist, hydrogeologist, or geotechnical engineer (whenever practicable) is recommended.

The description for natural undisturbed soil is recorded on the Stratigraphy Log . Descriptions are completed in the following order:

- Unified Soil Classification System (USCS) group symbol(s) (e.g., SM) of primary soil components or dual and borderline symbols;
- name and adjective description of primary, secondary, and minor grain size components;
- relative density (for non-cohesive soil) or consistency (for cohesive soil);
- gradation and soil structure (for non-cohesive soil) or structure and plasticity (for cohesive soil);
- color;
- moisture condition; and
- other physical observations such as presence of stains or odors.

Note: When describing vegetative matter presence in the soil column, do not use the term "organic" as this often leads to confusion with regards with organic chemical (i.e., NAPL) presence.

The description of fill soil is similar to that of natural undisturbed soil except that it is identified as fill and not classified by USCS group, relative density, or consistency (i.e., SP/GP-Sand and Gravel (Fill)).

It is necessary to identify and group soil samples consistently to determine the subsurface pattern or changes and non-conformities in soil stratigraphy in the field at the time of drilling. The stratigraphy in each borehole during drilling is to be compared to the stratigraphy found at the previously completed boreholes to ensure that pattern or changes in soil stratigraphy are noted and that consistent terminology is used.

Visual examination, physical observations and manual tests (adapted from ASTM D2488, visual-manual procedures) are used to classify and group soil samples in the field and are summarized in this subsection. ASTM D2488 should be reviewed for detailed explanations of the procedures. Visual-manual procedures used for soil identification and classification include:

- visual determination of grain size, soil gradation, and percentage fines;
- dry strength, dilatancy, toughness, and plasticity (thread or ribbon test) tests for identification of inorganic fine grained soil (e.g., CL, CH, ML, or MH); and
- soil compressive strength and consistency estimates based on thumb indent and pocket penetrometer (preferred) methods.

The three main soil divisions are: coarse grained soil (e.g., sand and gravel), fine grained soil (e.g., silt and clay), and soil with high natural organic matter content (e.g., peat and marl).

Coarse Grained Soil

The USCS group symbols for coarse grained soil are primarily based on grain or particle size, grain size distribution (gradation), and percent fines (silt and clay content).

Coarse grained soil is made up of more than 50 percent, by weight, sand size, or larger (75 μm diameter, No. 200 sieve size or larger). It is noted that there are other definitions for coarse grained or coarse textured soil and for sand size such as soil having greater than 70 percent particles equal to or greater than 50 μm diameter (after "Guidelines for Contaminated Sites in Ontario") or 60 μm diameter ("Canadian Foundation Manual").

Descriptions for grain size distribution of soil include; poorly graded (i.e., soil having a uniform grain size, SP and GP) and well graded (i.e., poorly sorted; having wide range of particle sizes with substantial intermediate sizes, SW and GW).

Coarse grained soils are further classified based on the percentage of silt and clay they contain (fines content). Coarse grained soils containing greater than 12 percent fines are commonly described as dirty. This description arises from the soil particles that adhere when the soil is rubbed between the hands or adhere to the sides of the jar after shaking or rolling the soil in the jar. The jar shake test which results in segregation of the sand and gravel particles is also used as a visual aid in determining gravel and sand percentages.

Examples of the group symbol, name, and adjectives used to describe the primary, secondary, and minor components of soil are; GW - Sandy Gravel (e.g., 70 percent gravel and 30 percent sand) or Sandy Gravel trace silt (less than 10 percent silt), and SP - Sand, uniform.

Relative density is an important parameter in establishing the engineering properties and behavior of coarse grained soil. Relative density of non-cohesive (granular) soil is determined from standard penetration test (SPT) blow counts (N values) (after ASTM Method D1586).

The SPT gives a reliable indication of relative density in sand and fine gravel. N values in coarse grained soil are influenced by a number of factors that can result in overestimates of relative density (e.g., in coarse gravel and dilatent silty fine sand) and can be conservative and underestimate the relative density (e.g., sand below the groundwater table and uniform coarse sand). These effects

will be assessed by the project geotechnical engineer, if required, and need not be taken into account by field personnel.

Other dynamic methods, such as modified SPT and cone penetration tests, are used on occasion to supplement or replace the SPT method for certain site-specific conditions. The details of all modifications to the SPT or substitute methods should be recorded as they are required to interpret test results and correlate to relative density.

Fine Grained Soil

A soil is fine grained if it is made up of half or more of clay and silt (i.e., fines greater than 50 percent by weight passing the 75 µm (No. 200) sieve size). A description of visual-manual field methods and criteria that are used to further characterize and group fine grained soil (e.g., CL, CH, ML, or MH) including dry strength, dilatancy, toughness, and plasticity (thread or ribbon test) follows.

CRITERIA FOR DESCRIBING DRY STRENGTH

Description	*Criteria*
None	The dry specimen crumbles into powder with mere pressure of handling.
Low	The dry specimen crumbles into powder with some finger pressure.
Medium	The dry specimen breaks into pieces or crumbles with considerable finger pressure.
High	The dry specimen crumbles into powder with finger pressure. Specimen will break into pieces between thumb and a hard surface.
Very High	The dry specimen cannot be broken between the thumb and a hard surface.

CRITERIA FOR DESCRIBING DILATANCY

Description	*Criteria*
None	No visible change in small wetted specimen when rapidly shaken in palm of hand.
Slow	Water appears slowly on the surface of the specimen during shaking and does not disappear or disappears slowly upon squeezing.
Rapid	Water appears quickly on the surface of the specimen during shaking and disappears quickly upon squeezing or stretching.

CRITERIA FOR DESCRIBING TOUGHNESS

Description	*Criteria*
Low	Only slight pressure is required to roll the thread near the plastic limit. The thread and the lump are weak and soft.
Medium	Medium pressure is required to roll the thread to near the plastic limit. The thread and the lump have medium stiffness.
High	Considerable pressure is required to roll the thread to near the plastic limit. The thread and the lump have very high stiffness.

CRITERIA FOR DESCRIBING PLASTICITY

Description	*Criteria*
Nonplastic	A 1/8-inch thread cannot be rolled at any water content.
Low	The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit.
Medium	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be re-rolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit.
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be re-rolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit.

Examples of group symbol identification based on visual-manual procedures and criteria for describing fine grained soil are:

Group Symbol	*Dry Strength Plasticity*	*Dilatancy*	*Toughness*	
ML	None to low	Slow to rapid	Low or thread cannot be formed	Slight
CL	Medium to high	None to slow	Medium	Low
MH	Low to medium	None to slow	Low to medium	Low
CH	High to very high	None	High	High

A requirement for positive classification by USCS group symbols (as described in ASTM D2487) is laboratory determination of particle size characteristics, liquid limit and plasticity index. The need for this type of testing will be determined by the project geologist, hydrogeologist, or geotechnical engineer.

Examples of name terminology that accompanies the group symbols are ML - Sandy Silt (e.g., 30 percent sand) and CL - Lean Clay with sand (e.g., 15 to 29 percent sand).

The correlation between N value and consistency for clays is rather unreliable. It is preferable to determine consistency using more appropriate static test methods, particularly for very soft to stiff clay soil. N value estimates of consistency are more reasonable for hard clay.

Unconfined compressive strength (Su) may be estimated in the field from the pocket penetrometer test method. To obtain a pocket penetrometer estimate of consistency and compressive strength, the soil core is cut perpendicular to the core length, the length of core (minimum 4 inches) is held in the hand and a moderate confining pressure is applied to the core (not sufficient to deform the core); the penetrometer piston tip is slowly inserted into the perpendicular face of the core until the penetrometer indents into the soil core to the mark indicated on the tip of the penetrometer piston; the penetrometer estimate of soil compressive strength (Su) is the direct reading of the value mark on the graduated shaft (in tons per square foot or other unit of pressure as indicated) indicated by the shaft ring marker, or in some models, by the graduated piston reading at the shaft body. To obtain an average estimate, this procedure is completed several times on both ends and mid cross-section of the core. For Shelby Tube (or thin wall sampler) samples the pocket penetrometer tip is applied to the exposed bottom of the sample at several locations.

Estimates of compressive strength for clay soil of very soft to stiff consistency are better established by in situ shear vane tests or other static test methods.

The description of consistency (or strength) is an important element in determining the engineering properties and strength characteristics of fine grained cohesive soil. Consistency terms (e.g., soft, hard) are based on the unconfined compressive strength (Su) and shear strength or cohesion (cu) of the soil.

The ease and pattern of soil vapor and groundwater movement in the subsurface is influenced by the natural structure of the soil. Soil structure, for the most part, depends on the deposition method and, to a lesser extent, climate. The identification of fill soil (soil altered by man) is equally important in determining behavioral characteristics of the subsurface.

b) Bedrock

In typical bedrock drilling programs, a steel surface casing is initially installed through the overburden soils to minimize groundwater migration/penetration and isolate the bedrock zone from the overburden regime. Surface casings are sealed using cement, cement-bentonite, or bentonite grout, depending on the depth of installation and regulatory requirements. Regardless of the type of grout, the grout should be allowed to set for a minimum of 24 hours prior to resuming drilling. A field test of the grout seal is often performed by filling the inside of the steel casing with water and recording any decline in water level with time. The test should have a decline of less than 0.1 feet over 5 minutes.

Bedrock drilling is typically performed either using rotary methods or less commonly rotosonic methods; advancing reaming tools (roller-bits or equivalent), or coring tools (core barrels). Rotary drilling with reaming tools breaks the rock into small fragments (drill cuttings), the size is dependent on the style of drill bit, formation characteristics, and drilling rate. The description of rotary/reamed drill cuttings is difficult to do in detail due to the small size of the cuttings/destructive nature of this technique. However, an experienced geologist can often detect the presence of major fractures and other geologic changes through careful observation of the drill penetration and drill cuttings. Coring methods produce a continuous cylindrical drill core that is then described as discussed below.

The following are standard core drilling diameters, although other sizes may also be available, depending on the manufacturer.

Core Size	*Core Diameter (inches, mm)*	*Corehole Diameter (inches, mm)*
AQ	1.06", 27.0 mm	1.89", 48.0 mm
BQ	1.43", 36.5 mm	2.236", 60.0 mm
NQ	1.88", 47.6 mm	2.98", 75.7 mm
HQ	2.50", 63.5 mm	3.78", 96.0 mm
PQ	3.35", 85 mm	4.83", 122.6 mm

Rotary drill bits come in numerous sizes depending on the bit style and manufacturer.

Bedrock units are defined by rock type and formal unit names are assigned by the *North American Commission on Stratigraphic Nomenclature* and the *International Commission on Stratigraphy*. The rock type and unit names are generally found on bedrock geology maps or other published geologic resources for the area. The major terms used to describe bedrock and a suite of terminology for fractures are described in the following paragraphs. However, there are literally hundreds of types of bedrock (sedimentary, metamorphic, and igneous), and the brief general description provided below does not cover all types of bedrock.

Formation Name: The unit name from geologic maps or other resources. The unit name is critical for defining the context of other rock and fracture features. Usually listed as a name followed by Group/Formation/Member or rock type. A Group is composed of named Formations. A Formation may be composed of named Members.

Rock Type: The type of rock (sedimentary, metamorphic, and igneous). Common rock types include:

Sedimentary	Clastic	Conglomerate, Breccia, Sandstone, Graywacke, Shale, Siltstone, Mudstone, etc
	Non-clastic	Limestone (sometimes with clastic or bioclastic component), Dolomite, Gypsum, Salt, etc
Metamorphic		Quartzite, Slate, Phyllite, Schist, Gneiss, Marble, etc
Igneous	Intrusive	Granite, Grandiorite, Diorite, Tonalite, Syenite, Gabbro, Monzonite, Anorthosite, Norite, Pyroxenite, Dunite, Peridotite, etc
	Extrusive	Rhyolite, Porphyry, Dacite, , Trachyite, Diabase, Andesite, Basalt, Tephrite, Obsidian, Pumice, etc

Bedding: Thickness of bedding or range of thickness of bedding for sedimentary rocks. Bedding planes are planar features that often have a slight change in color or grain size in the plane of bedding or between different beds. Metamorphosed sedimentary rocks may retain the original bedding under low grade metamorphism. At high grade metamorphism, original bedding is destroyed by the mobilization of fluids and crystallization of minerals. Extrusive igneous rocks sometimes exhibit bedding planes between depositional events (e.g., lava flows). Metamorphic and igneous rock may exhibit foliation or banding due to mineralogical layering.

Thick Bedded (or massive)	>60 cm (2 feet)
Thin Bedded	1 cm to 60 cm (1/2 inches to 2 feet)
Thick Laminated	0.5 to 1 cm (1/4 to 1/2 inch)
Thin Laminated	<0.5 cm (1/4 inch)

Grain Size: The size and shape of particles in sedimentary rocks or mineral grains in metamorphic and igneous rocks. Descriptive terms include coarse-, medium-, and fine-grained, coarse-, medium-, fine, and micro-crystalline, amorphous, etc.

Texture/Fabric: Physical appearance, distribution and arrangement of grains/minerals. Commonly a preferred arrangement of grains/minerals is noticeable.

Weathering: Weathering results in a decomposition of the rock. The degree of weathering can be visually determined by discoloration, decomposition, and

disintegration. Slightly weathered rock is discolored only along and in the vicinity of fractures. Moderately weathered rock is stained and discolored throughout but still retains original bedding and other details. Highly weathered rock is completely discolored and decomposed, destroying original bedding and other details. Moderately and highly weathered rock are not common in temperate climates. Other weathering features are disintegration (i.e., mechanical weathering) producing friable rock. Alteration of the rock from the original type to the degraded occurs primarily by chemical weathering.

Karstification of soluble bedrock (i.e. limestone, dolomite, gypsum, salt, etc) is a type of chemical weathering. Karstification may form solution widened fractures and interconnected voids, solution channels, pockets and caves within soluble bedrock.

Cementation: Cements are precipitated compounds that bind the sedimentary grains together. Most common cements are calcite and silica. Cements are typically amorphous or microcrystalline.

Fossils: Indicate the general type of fossil present, such as brachiopod, bryozoan, horn coral, colonial coral, crinoid, gastropod, etc. If you know the specific name of a fossil, and can identify that fossil, especially where a fossil is used to define a rock unit, then list the fossil explicitly. Fossils are sometimes only present as a fossil mold, where the original fossil has been dissolved, leaving a mold of the outer portion of the fossil. Internal casts are also sometimes present.

Porosity: Porosity in the bedrock consists of intergranular, intercrystalline, or interfragmental, where the porosity occurs between grains, crystals, or fossil fragments, respectively. Porosity that occurs by dissolution of fossils or crystals takes the form of voids or vugs. The size, shape and type of porosity should be described.

Dolomite typically forms from the migration of formation fluids through limestone causing the replacement of Ca ions by Mg ions and recrystallization of the rock. This process results in an approximate 4 percent increase in porosity, which occur as intercrystalline porosity in the rock. As well, dolomitization usually results in the dissolution of fossils, leaving fossil molds.

Infilling or partial infilling of vugs should also be described. The filling material is typically crystalline. Silty and clayey infilling material is deposited by flowing water indicating an interconnection of the vug with a water transmissive fracture.

Supplementary Descriptors: A number of other descriptors can be used when describing bedrock. Carbonate bedrock commonly exhibits stylolites. A stylolite is a contact marked by irregular penetration of the adjoining sides forming

teeth-like projections. Stylolites form from pressure solution and are usually marked by a dark line caused by insoluble residues in the stylolite plane.

The following section is for the description of fractures. A fracture is a crack, joint, break or fault in a rock. In drill core, the term fracture is used as the dimension and source of the discontinuity are unknown. Fractures occur from natural breakages in the rock, such as stress relief forming open fractures, usually oriented approximately parallel to bedding and at right angles to bedding, faulting (shear movement) where one side of the rock moved against the other side (often marked by slickensides), and dissolution along planes of weakness. Fractures also occur by the drilling process. Mechanical fractures are marked by sharp, unweathered edges, very close fitting of the two sides to each other, and lack of dissolution, discoloration, or precipitation along the fracture plane.

Fracture Type: Natural fractures consist primarily of bedding-plane fractures (parallel to bedding), fractures that are cross-cutting or angled to bedding, and faults (parallel to or cross-cutting bedding) where movement has occurred along the fracture plane. The fracture shape is typically planar or arcuate.

Fracture Orientation: The orientation of the fracture relative to the center axis of the drill core; such as horizontal, dipping (give angle from horizontal), near-vertical (cuts core along core for at least three times core diameter, which is approximately 70° from horizontal), or vertical (cuts core for a much longer distance). In undeformed bedrock, fractures are commonly nearly horizontal (bedding-plane) and nearly vertical with much fewer inclined fractures. In deformed bedrock, bedding-plane fractures are no longer horizontal and the numerous fracture can form fracture sets of common fracture orientations, oriented with respect to historic and current stress directions and other planes of weakness in the bedrock.

Spacing: The spacing and range of spacing of fractures. The spacing of fractures is often related to bedding and bed thicknesses.

Very Close	<5 cm (2 inches)
Close	5 to 30 cm (2 inches to 12 inches)
Moderate	0.3 m to 1 m (1 foot to 3 feet)
Wide	1 to 3 m (3 feet to 10 feet)
Very Wide	>3 m (10 feet)

Roughness: Roughness and unevenness of the fracture surfaces, generally caused by dissolution or precipitation on the fracture surface. Typically rough, smooth, slickensided (shear movement), wavy.

Aperture: The aperture is the perpendicular distance between the walls of the fracture. Apertures are tight (<0.25 mm) or open (>0.25 mm). Note that drill core pieces cannot be fit together (if broken apart) to get an accurate aperture width. Apparent aperture width is a function of the degree of dissolution or

infilling and weathering, along with breakage, spinning, and plucking of the fracture surface during drilling. Since a fracture cannot be open for great distances without support from adjoining fracture surfaces touching (asperities), true effective aperture cannot generally be determined from drill core.

Weathering: Weathering of the adjoining bedrock along a fracture (same as above) and weathering of fracture filling materials.

Infilling: Fracture infilling materials are typically brought in by flowing water such as silts and clays, or are crystalline from precipitation out of flowing water. Describe color, grain size, stiffness, moisture content of sedimentary infilling and crystal size and mineralogy (if known) for crystalline infilling. If crystalline infilling mineralogy is uncertain or unknown, describe shape and color of crystals, and any other aspects that are visible.

Core Recovery: This is the length of drill core recovered in the core run. It is possible to get a longer piece of drill core than the length of the core run. This happens as the core bit is several inches in front of the core barrel. The drill core usually breaks near the end of the core barrel but may break at the core bit, if the rock is weaker at that point. As well, if core is lost due to falling out of the core barrel during core retrieval or the natural break within the core barrel, the core barrel may ride over the lost core when dropped down the drill rods resulting in retrieving at least some of the lost core. In some soft formations, expansion of the drill core occurs after removal from the core barrel resulting in an increased core length.

Rock Quality Designation (RQD): RQD is an engineering calculation designed to give an approximate measure of soundness of a rock. The RQD is the sum of the length of all core pieces in a core run greater than 10 cm (4 inches) long divided by the length of the core run, expressed as a percentage. Core length is measured along the center axis of the drill core. For near-vertical fractures, the core is generally considered to be unfractured for RQD calculation purposes (ASTM D6032-96).

Fracture Index: The fracture index is the number of fractures per foot of core drilled in each core run. This measure is similar to RQD but takes away the bias caused by specified minimum intact core lengths. For fragmented core, use non-intact (NI).

Both RQD and Fracture Index may be biased depending on the orientation of the drill hole relative to fracture sets.

Core Box Labeling: Core box lids should be labeled on the inside with the drill hole number, date, depth of top and bottom of the core run, core recovery, RQD and fracture index. When bedrock dries out, the rock may become friable and the original intact RQD/fracture index cannot be remeasured. The ends of the core box on the inside should be labeled with top and bottom depths for each

row of drill core in the core box. The core boxes should be tied or taped shut to prevent core falling out. Labels should be written on the outside tops and ends of the core boxes, however most labels exposed to sunlight and weathering fade with time.

When drill core is removed for testing or a significant space exists in the core box due to length of core run or loss of drill core, a spacer consisting of a cylinder of foam or similar material is suggested to be put in place to prevent mixing and breakage of the drill core. If core is removed, a note should be placed in the core box indicating the section removed, date, samplers name.

vii) Chemical Description

During soil examination and logging the sampler shall carefully check for the presence of light or dense Non-Aqueous Phase Liquids (NAPL). NAPL may be present in gross amounts or present in small/minute quantities. The adjectives and corresponding quantities used when describing NAPL within a soil matrix are as follows:

Visual Description	*Fraction of Soil Pore Volume Containing NAPL*
Saturated	>0.5
Some	0.5 - 0.25
Trace	<0.25

A complete description of NAPL must describe the following:

- color;
- quantity;
- density (compared to water, i.e., light/floats or heavy/sinks);
- odor (if observed); and
- viscosity (i.e., mobile/flowable, non-mobile/highly viscous-tar like).

The presence of an "iridescent sheen" by itself does not constitute 'NAPL presence', but may be an indicator that NAPL is close to the area.

NAPL presence within a soil matrix may be confirmed by placing a small soil sample within water, shaking, and observing for NAPL separation, i.e., light or dense, from the soil matrix.

Trace amounts of NAPL are identified/confirmed by a close visual examination of the soil matrix, i.e., separate soil by hand (wearing disposable gloves) and perform a careful inspection of the soil separation planes/soil grains for NAPL presence.

Often during the sample examination with an knife, an iridescent sheen will be noted on the soil surface (i.e., clay/silts) if the knife has passed through an area of NAPL.

Representative portions of the soil sample must be retained for geologic record following description. Place the soil portions into labeled, sealable sample containers (usually mason jars) without destroying any apparent stratification. If a stratigraphic change is observed within the split-spoon sampler, a separate geologic record sample is kept.

All geologic record samples are to be retained by the Client.

Communication of Field Findings

Field findings should be communicated frequently with the office technical staff responsible for the program. This communication allows the office staff: to confirm that the investigation meets the intent of the Work Plan; to alter procedures and sampling protocol if soil conditions are markedly different from those assumed; and to assist in determining screening intervals for piezometers or monitoring wells.

Call office staff no later than the completion of the first borehole, and sooner if possible. Be prepared to discuss the results by faxing the field logs beforehand (wherever possible) and by having a copy of the field log in hand when on the telephone. Call after each borehole and call before leaving the site.

Borehole Abandonment

DPT advanced boreholes will be closed by filling the borehole from the base to the ground surface with bentonite chips or granules. The top 6 inches of boreholes installed in areas covered by asphalt or concrete ground covering will be capped with asphalt or concrete patching material as appropriate to match the existing surface.

In the event a HSA advanced borehole requires closure, the borehole will be filled from the base to the ground surface with a pure bentonite grout or a cement bentonite grout mixture. The grout will be installed using a tremie pipe placed near the base of the borehole. The tremie pipe will be withdrawn as the borehole is filled with grout in a manner that minimizes the potential for bridging within the borehole annulus. The top 6 inches of boreholes installed in areas covered by asphalt or concrete ground covering will be capped with asphalt or concrete patching material as appropriate to match the existing surface.

Field Notes

The field notes must document all the events, equipment used, and measurements collected during the sampling activities and must be legible and concise.

The borehole observations will be recorded on the field stratigraphy log or when approved by the Project Coordinator/Manager in a standard bound 'survey' type field book issued for general note taking/field records.

All field book/form entries must be made in black ink and any changes/corrections shall be stroked out with a single line and initialed and dated to indicate who and when the correction was made.

The field notes should document the following for each borehole completed:

- identification of borehole;
- depth;
- static water level depth and measurement technique;
- time started and completed;
- measured field parameters;
- sample appearance;
- sample odors (if respiratory protection is not required);
- types of sample containers and sample identification numbers;
- parameters requested for analysis;
- field analysis data and method(s);
- sample distribution and transporter;
- laboratory shipped to;
- chain-of-custody number for shipment to laboratory;
- field observations on sampling event;
- name of collector(s);
- climatic conditions including air temperature; and
- problems encountered and any deviations made from the established sampling protocol.

SOP 4

SURFICIAL SOIL SAMPLING

GENERAL

The following SOP focuses on ways to obtain surficial soil samples for chemical analyses. The primary goal of surface soil sampling is to collect representative samples for examination and chemical analysis (if required).

Another important factor is the type of soil. If there are different types of soil present at the site, this may have a bearing on the sample interval. For example, it may be important to separately sample a layer of material with high organic carbon content which overlies a layer of fine grained soil.

PRIOR PLANNING AND PREPARATION

The following activities must be completed prior to undertaking a surficial soil sampling program:

i) Review the work program, project documents and the health and safety requirements.

ii) Assemble all equipment, materials, log books and forms required.

iii) Obtain a site plan and any previous stratigraphic logs. Determine the exact number and location of samples to be collected and the depths of samples for chemical analysis.

iv) Contact the analytical group to arrange/determine:

- laboratory;
- glassware/sample jars;
- cooler;
- shipping details;
- start date; and
- expected duration.

v) Complete property access/utility clearance data sheet. In most instances, surface sampling activities will not require utility clearances.

PROCEDURE

General Procedures

Soil sampling techniques are dependent upon the sample interval of interest, the type of soil material to be sampled, and the requirements for handling the sample after retrieval. Any surficial debris (i.e., grass cover) should be removed from the area where the sample is to be collected using a separate precleaned device.

The sampling team members should immediately report any conditions to the Project Coordinator that they believe may have a negative effect on the quality of the results.

Generally it is not advisable to collect samples containing excessive amounts of large particles such as gravel. Gravel presents difficulties for the laboratory in terms of sample preparation and may not be truly representative of contaminant concentrations in nearby soil.

All conditions at the time of sample collection should be properly documented in the field log book. This should include a thorough description of the sample characteristics, including grain size, color, and general appearance, as well as date/time of sampling and labeling information. The location of the sampling point should be described in words and three measurements should be taken to adjacent permanent structures so that the sample location can be readily identified in the field at a future date if necessary. It is often advisable to have a licensed land surveyor accurately survey the locations.

With the exception of VOC analyses, soil samples should be placed in a stainless steel bowl to be homogenized prior to filling sample containers. It is important that soil samples be mixed as thoroughly as possible to ensure that the sample is as representative as possible of the sample interval. When round bowls are used for sample mixing, mixing is achieved by stirring the material in a circular motion and occasionally turning the material over. Soil samples collected for volatile organic compounds analyses shall <u>not</u> be mixed. The sample container should be filled completely; no space should remain in the sample containers.

During the sampling program, the sampling team leader should stay in contact with the project chemist assigned to the project such that the chemist can properly inform the contract laboratory with the progress of the work. This includes submitting sample summaries and/or copies of completed chain-of-custody forms to the chemist.

SOP-5

COLLECTING SEDIMENT SAMPLES

SCOPE & SUMMARY

This standard operating procedure outlines techniques for collecting sediment samples from shallow freshwater streams, ponds, inland lakes, drainage pathways and ephemeral water bodies. This method is described for deployment from a small, stable boat or on foot.

Sediment samples are collected using a core sampler, and samples are placed into clean, labeled jars with minimum headspace and packed in ice (in coolers) during transportation to the laboratory. If no water is present in sampling locations that are only temporarily inundated, then a trowel can be used to collect the sediment sample.

REFERENCE DOCUMENTS

ASTM (E1391-90) *Standard guide for collection, storage, characterization and manipulation of sediments for toxicological testing*. American Society for Testing and Materials, Annual Book of ASTM Standards. vol. 11.02, Philadelphia, PA.

Baudo, R (1990) *Sediment sampling, mapping and data analysis*. In Sediments: the Chemistry and Toxicology of In-place Pollutants. R Baudo, J Giesy & H Muntau (eds.). Lewis Publishers. Chelsea, MI pp. 15-60.

Mudroch, A & S MacKnight (1994) *Bottom sediment sampling. In Handbook of Techniques for Aquatic Sediments Sampling*. Second Edition. A Mudroch & S. MacKnight (eds.) Lewis Publishers, Ann Arbor, MI pp. 29-96.

USEPA (1985) *Sediment sampling quality assurance user's guide*. EPA 600/4/85/048. U. S. Environmental Protection Agency, Environmental Monitoring and Support Lab., Las Vegas, NV 114 pp.

SIGNIFICANCE AND USE

The samples collected by this method are suitable for chemical characterization, but may not be suitable for biological analyses such as benthos characterization. This method is best for studies where sample replication is desired. Samples of the same depth interval and cross-section can be collected from each location, or a sample transect can be used.

POTENTIAL INTERFERENCES:

1. The sediment surface can be easily disturbed during sample collection. This disturbance will increase the turbidity of the overlying water and might cause errors in the analytical chemistry data. Therefore, caution must be exercised, especially when using the T-handle, to avoid disruption of the sediment-water interface.
2. Residual sediment might remain in the core sampler and contaminate subsequent samples. To prevent contamination, all sampling gear must be thoroughly decontaminated between sample locations.
3. Large objects (e.g. stones, sticks etc.) might obstruct the core barrel and prevent successful sample collection. If possible, sample locations should be selected to avoid these objects.
4. It might be difficult to penetrate very firm sediments (e.g. clay, gravel, or sand) with the core sampler. A pre-sampling site inspection should be conducted to evaluate the suitability of the sample gear for collecting samples.
5. The materials of which the core sampler is composed could contaminate the samples. To minimize potential contamination, the equipment that contacts the sample should be assembled using the materials least likely to result in contamination. For example:
6. Samples for metals analyses should be collected with plastic equipment. The core samplers are built of stainless steel, however, plastic liners, cutting heads, retainers, extruders, knives and compositing bowls should be used.
7. Samples for analysis of organic compounds should be collected with stainless steel liners, cutting heads, retainers, extruders, knives, and compositing bowls should be used. If a stainless steel extruder is not available, a brass extruder may be used.
8. Care must be taken to avoid having the sample or sample container come into contact with the ungloved hand or clothes of the sampler. The sampling team must always wear new sampling gloves appropriate for the specific media and constituents being analyzed. During sampling, if the sample container or sample comes into contact with the ungloved hand or clothes of the sampler, it is assumed that the sample has been cross-contaminated and a new sample container must be used or the location must be re-sampled.

<u>APPARATUS</u>

1. The Wildco sediment core sampler (or equivalent) consists of a steel cylinder fitted with a sharp nose piece and a "T" handle. This cylinder (core barrel) contains a replaceable plastic (acetate) or stainless steel liner that stabilizes the sediment

sample, and a (eggshell) core retainer that prevents the sample from exiting the liner. A check valve above the core barrel allows air and water to escape when the device is pushed into sediment, but closes during retrieval to prevent the sample from escaping. The Wildco sampler (or equivalent) can be used in shallow (< 15 feet) waters.

2. The K-B sediment core sampler (or equivalent) has the same barrel, liner, nosepiece, and core retainer. The check valve assembly has been modified to avoid backpressure within the core barrel. This design prevents the K-B core sampler from disturbing the sediment-water interface. The K-B corer also has a heavy weight (36 kg) affixed below the check valve that facilitates penetration into the sediments. It has no T-handle to push it into the sediments, but relies on weight. The K-B corer is operated with an 1/8 inch aircraft cable. It is designed to free-fall the last 30 feet (10 m) of the water column. A messenger is used to close the check valve once the core has penetrated the sediments. The K-B corer (or equivalent) is suitable for water depths < 600 feet (provided enough cable is attached).
3. If no water is present in ephemeral water bodies, then a metal or plastic trowel can be utilized to collect the sample. The composition of the trowel will be dependent upon the type of constituents to be analyzed.

MATERIALS

- Wildco core sampler (or equivalent) (core barrel with check valve and T- handle);
- K-B core sampler (or equivalent) (core barrel with check valve, aircraft cable and winch);
- core liners with end caps;
- core nose pieces;
- core retainers;
- core extruders;
- spatulas or knives;
- compositing vessels;
- sample containers with lids;
- sample labels;
- sample trowel;
- dissolved oxygen meter and probe with depths pre-marked on cable (YSI Model 57 DO meter (or equivalent) with 25 feet of (unmarked) cable can be rented from Hazco);
- pH meter and probe;

- specific conductance meter and probe with depths pre-marked on cable (YSI Model 33 conductivity meter (or equivalent) with 25 feet of (unmarked) cable can be rented from Hazco);
- temperature meter and probe with depths pre-marked on cable (YSI Model 57 DO meter (or equivalent) with 25 feet of cable can be rented from Hazco);
- waterproof marking pens;
- coolers (with ice) for sample storage;
- core-holding buckets;
- sample data forms/clip board;
- decontamination supplies;
- nitrile gloves;
- pipe wrench (minimum 14 inch) to disassemble corers;
- miscellaneous tools (vise grip pliers, shackles, wrenches, plumber's Teflon thread tape, utility knife);
- messenger for K-B corer;
- camera and film or disks; and
- personal & safety gear.

HAZARDS & PRECAUTIONS

Field-collected sediments might contain potentially toxic materials, and thus should be treated with caution to minimize exposure to workers. Waterproof clothing (waders) and gloves are recommended.

The project Health and Safety Plan must be reviewed to identify further hazards, precautions and safety procedures.

SAMPLE PREPARATION

Sample locations may be adjusted on-site as deemed necessary by the location of sedimentation zones, physical obstructions, or other factors. A pre-sampling site inspection should be conducted to evaluate whether these procedures are feasible for sampling the desired locations.

Appropriate new sample containers must be obtained from the analytical laboratory or a commercial supplier. The analytical procedures must be reviewed to identify the proper sample container material, size, and preparation.

The Field Team Leader must read the Quality Assurance Project Plan before field sampling procedures are undertaken to understand how many and what type of QA/QC samples are required.

The Field Team Leader and sampling staff must read the Health and Safety Plan prior to sampling to review applicable safety requirements.

PREPARATION OF APPARATUS

All sampling equipment (core samplers, liner tubes, caps, eggshell catchers, etc.) must be cleaned with a laboratory-grade detergent and triple-rinsed with analytical-grade water. Because additional preparations (acid or solvent rinses) might be necessary for specific analyses, the analytical methods should be reviewed to identify additional requirements.

The field meters and probes should be calibrated and tested.

Slits should be cut in the end caps for the core tubes to allow air to escape, and prevent disturbance of the sediment cores.

The core samplers should be field-tested to ensure the check valves are working properly.

The core sampler should be assembled using the appropriate contact material (plastic or stainless steel).

CALIBRATION & STANDARDIZATION

The field meters (pH, dissolved oxygen, and specific conductance) must be calibrated according to the manufacturer's manuals.

The sediment extruder should be calibrated to facilitate the removal of a pre-selected volume of sediment from the core liner. A pre-sampling field inspection should be conducted to determine the practical minimum depth the corer will penetrate into the sediments at the site. All sediment samples should then be collected to this (minimum) depth so the analytical results will be comparable.

The extruder post should be calibrated (marked) so that the amount of sediment extruded can be selected. This procedure ensures that the same amount of sediment is

extruded from each core so that samples are consistent and comparable. A small snap-type clamp can be used to mark the point of maximum extrusion so that the field personnel can focus their attention on capturing the surficial sediment layer as it is extruded. In most sediments this layer will be very flocculent and can easily be lost.

The K-B corer (or equivalent) is heavy, awkward to grasp, and relatively sensitive to jostling. It can't be operated with a hand-over-hand technique along the cable. Arrangements must be made to raise and lower it with a winch-pulley-roller system from a davit or tripod. The deployment design should be pre-assembled and tested before sampling is attempted. The deployment device will be specific to the actual boat, barge or other watercraft used, and cannot be prescribed in this SOP.

PROCEDURE

Identify the sample location from the sampling map.

Assemble the coring device, and make the necessary preparations to collect samples from the marked sample stations. When sampling from a boat or barge, preparations to secure the boat with anchors must be made. It is highly recommended that a davit or tripod structure, with the necessary winch and pulleys be used to raise and lower the K-B corer (or equivalent). It is heavy, awkward to grasp, and relatively sensitive to jostling. It cannot be operated with a hand-over-hand technique along the cable. These arrangements will be specific to the actual boat, barge or other watercraft used, and cannot be prescribed in this SOP.

If an ephemeral water body is being sampled and no water is present, make the necessary preparations to collect samples with a trowel. Because no water is present, no ancillary field measurements will be collected. Insert the trowel into the sediment approximately 6 inches and place material into homogenizing vessel. Continue sampling and adding material to the homogenizing vessel into an appropriate amount is collected. If the field team is collecting grab samples, place the media directly into the sample jar without homogenizing.

Collect ancillary field measurements (depth, pH, dissolved oxygen, temperature, specific conductance). When wading, this should be done in an area immediately upstream of, or away from the sampling site. When sampling from a boat, this should be done at the deepest point along the transect.

Collect sediment samples with the core sampler. Press the Wildco core barrel (or equivalent) into the sediment with a constant pressure. If the sediment is firm, the sampler may be twisted in a clockwise manner to increase penetration. Retrieve the core sampler (lift vertically) when the core barrel has been inserted its full length into the sediment (or can't be inserted further). When using a K-B corer (or equivalent), lower the corer with the aid of a winch. Once the corer has ceased to descend, the messenger is clipped to the cable and released. When the messenger closes the check valve there will be an audible click, and the corer can be retrieved using the winch.

Remove the sediment sample from the core barrel. Have one person stand and hold the device vertically while a second person unscrews the nose piece, then carefully lift the core barrel off the core liner (which now contains the sediment sample. Carefully place end caps over both ends of the core liner. (The end caps may force air into the sediment core and disturb the sample; the end caps can be slit to allow the air to escape). Set the core sample (in a vertical position) aside for extrusion. Rinse the core barrel with site water and reassemble with a new liner (and retainer), and continue sampling.

Decontaminate sampling equipment, including the pH and specific conductance meter probes, the spatula, the core barrel, and nose piece.

Extrude the sediment core(s) from the liner tube(s).

One person retrieves a core from a core-holding bucket and removes the top cap. Cut a slit along the side of the bottom cap to allow for easier removal but make sure that the bottom cap is still secure.

Carefully remove the bottom cap from the core liner, then remove the retainer.

Immediately insert the extruder into the bottom of the core liner to prevent the sediment sample from escaping. Push the extruder up into the core barrel (1/2 cm at a time) and scrape the extruded sediment sample into the compositing vessel. If the field team is collecting grab samples, extrude the first 6 inches of the sediment core directly into the sample vessel; do not composite.

Homogenize the composited sediment in the compositing vessel. Fill the appropriate sample bottles, and store on ice.

Decontaminate the equipment to be re-used. For metals analyses, the plastic core liners, trowels and eggshells are inexpensive, and can be discarded. Stainless steel equipment is much more expensive; however, it is also very durable and easy to decontaminate.

SOP 6

FOR COLLECTING SURFACE WATER SAMPLES

SCOPE & SUMMARY

This protocol outlines techniques for collecting surface water from shallow, freshwater streams, ponds and drainage pathways for chemical analyses. This method is described for deployment by personnel that are wading, but the techniques may also be applied from a small, stable boat.

Water samples are collected by immersing sample bottles below the water surface. Samples are placed into clean, labeled jars with minimum head space and packed in ice (in coolers) during transportation to the laboratory.

REFERENCE DOCUMENTS

USEPA (1982) *Handbook for sampling and sample preservation of water and wastewater.* EPA-600/4-82-029. U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Cincinnati OH 402 pp.

SIGNIFICANCE AND USE

The samples collected by these methods are suitable for chemical characterization, but may be inadequate for biological analyses such as benthos and/or plankton characterization.

POTENTIAL INTERFERENCES

When sampling sediments in conjunction with surface water sampling, the surface (overlying) water samples must be collected before the sediment samples. The sediment surface will most likely be disturbed during sediment sample collection. This disturbance will increase the turbidity of the overlying water and might cause errors in the analytical chemistry data.

The presence of head space (bubbles) in sample containers for volatile compounds might cause errors in the analytical chemistry data. Extra care must be taken to completely fill these sample containers. Full sample containers should be inverted to check for bubbles.

When possible, all water samples should be collected upstream of the sampling team when the sampling team must enter the water by foot or by boat to collect the sample. Disturbance of the sediments by the sampling team could potentially generate a surface water sample that is not representative of the sampling location and yield unreliable data.

The collection of ancillary field measurements (pH, dissolved oxygen, temperature, specific conductance) should occur after the collection of surface water. Also, ancillary measurements should be collected away from the surface water sampling location. The collection of ancillary field measurements could potentially disturb the sediment in the vicinity of the surface water sampling location and cause errors in the analytical chemistry data.

The sampling team must wear the proper sampling gloves so that the sampling container and/or sample will not come into contact with the skin of the sampler. Utilizing this procedure in the field minimizes the chances of the sample becoming contaminated by the sampler and yield unreliable data. Additionally, the wearing of gloves provides a layer of protection to the sampler from potential dermal hazards while sampling.

If the water body to be sampled is shallow, the sampling team should avoid disturbing the sediments with the sample container. If the sample container cannot be completely submerged into the water body, the sampling team should use a small sample container to collect the sample as to not disturb the underlying sediment. The sample water can then be transferred into the appropriate container for shipment to the laboratory.

APPARATUS

All surface water samples will be collected directly into the sample container. Sample container type will be determined by whichever chemical analysis is performed on the sample. The following table describes which sample container is used with which analytical procedure.

Analytical Procedure	*Sample Container*
VOCs (SW-846/8260))	40 ml glass containers with preservative
SVOCs (SW-846/8270))	1-liter amber jar
BTEX (SW-846/8020)	40 ml glass containers with preservative
PAHs (SW-846/8310)	1-liter amber jar
Metals (SW-846/6000-7000 Series)	500 ml plastic container with preservative
TOC (SW-846/9060)	50 ml plastic container with preservative
Pesticides/PCBs (SW-846/8081)	1-liter amber jar
pH	50 ml glass container

Please note that the 40-ml glass containers with preservative will not be submerged into the water for sampling. A separate, new 1-liter amber container will be filled with sample water and then transferred to the 40-ml glass containers with preservative as to not lose the preservative within the 40-ml sample container.

MATERIALS

- sample containers with lids;
- sample labels;
- dissolved oxygen meter and probe;
- pH meter and probe;
- specific conductance meter and probe;
- temperature probe;
- waterproof marking pens;
- ORP meter and probe;
- coolers (with ice) for sample storage;
- sample data forms/clip board;
- decontamination supplies;
- camera and film/disks;
- personal & safety gear;
- peristaltic pump;
- Disposable 1/4" O/D Teflon tubing; and
- Disposable inline disposable 0.45 um filters.

HAZARDS & PRECAUTIONS

Field-collected surface water might contain potentially toxic/hazardous materials, and thus should be treated with caution to minimize exposure to workers. Waterproof clothing (waders/heavy rubber boots) and gloves are recommended.

The sample containers might contain preservatives, which might be harmful to sampling personnel. Extra care must be taken to prevent worker exposure to these preservatives and loss of the preservatives during sample collection.

The project Health and Safety Plan must be reviewed to identify further hazards, precautions and safety procedures.

SAMPLE PREPARATION

Sample locations may be adjusted on-site as deemed necessary by the location of riffles, pools, swallow areas, areas of low to no water, or other factors. A pre-sampling site inspection should be conducted to evaluate whether these procedures are feasible for sampling the desired locations.

Appropriate new sample containers must be obtained from the analytical laboratory or a commercial supplier. The analytical procedures must be reviewed to identify the proper sample container material, size, and preparation.

The Field Team Leader must read the Quality Assurance Project Plan before field sampling procedures are undertaken to understand how many, and what type of QA/QC samples are required.

All field team personnel must read the Health and Safety Plan prior to sampling to review applicable safety requirements.

PREPARATION OF APPARATUS

All sampling containers will be pre-cleaned and delivered to the sampler without threat of contamination. During surface water sampling, if the sample container comes into contact with any surface other than the sample water or the samplers gloved hand, the sampler will discard the potentially contaminated container and use another sterilized container to retrieve the sample.

The field meters and probes should be calibrated and tested, according to the manufacturer's specifications.

CALIBRATION & STANDARDIZATION

The field meters (pH, dissolved oxygen, and specific conductance) must be calibrated according to the manufacturer's manuals.

PROCEDURE

1. Identify the sample location from the sampling map.
2. Label all sample bottles for the specific sample location.
3. Collect water samples (for samples not be submitted for dissolved metals analysis). Submerge the water sample containers to collect water samples. Be certain to avoid turbidity caused by disturbance of the sediment surface; completely fill (no bubbles) the sample containers for the VOC and SVOC analyses; do not spill sample preservatives. Pack the water samples in the cooler with ice. If the water body to be sampled is shallow, the sampling team should avoid disturbing the sediments with the sample container. If the sample container cannot be completely submerged into the water body, the sampling team should use a small sample container to collect the sample as to not disturb the underlying sediment. The sample water can then be transferred into the appropriate container for shipment to the laboratory. Please note that the 40-ml glass containers with preservative will not be submerged into the water for sampling. A separate 1-liter amber container will be filled with sample water and then transferred to the 40-ml glass containers with preservative as to not lose the preservative within the 40-ml sample container.
4. Collect water samples (for samples being submitted for dissolved metals analysis only). Connect one end of the disposable teflon tubing to peristaltic pump. Hold a disposable 0.45 um filter over the mouth of sample vessel. Put other end of Teflon tubing into sample water. Turn on peristaltic pump and allow sample water to flow through tubing for 30 seconds prior to filling sample vessel. Fill sample vessel by allowing sample water to flow through filter and into sample vessel. Once the sample vessel is filled, discard filter and tubing.
5. Collect ancillary field measurements (pH, dissolved oxygen, temperature, specific conductance) in an area immediately downstream of, or away from the sampling site.
6. Mark the sampling site with a stake, buoy, flagging, etc. so the exact location can be surveyed.

7. Photograph sample location and marker stake.
8. Verify sample identifications on the Chain-of-Custody form.
9. Decontaminate the pH and specific conductance meter probes.

SOP 7

SAMPLE MANAGEMENT AND FIELD QA/QC

FIELD SAMPLING MANAGEMENT

Sample management is the continuous care given to each sample from the point of collection to receipt at the analytical laboratory. Good sample management ensures that samples are properly recorded, properly labeled, not lost, broken, or exposed to conditions, which may affect the sample's integrity.

Often, due to weather or time constraints, the entry of sample data into the sample log or labeling of the sample containers does not occur immediately following sample collection. Additionally, the secure sample storage location on site may be distant from the actual area where sampling is being conducted. Field personnel must adjust to field conditions to ensure that good sample management practices are maintained. All sample submissions must be accompanied with a chain-of-custody (COC) document to record sample collection and submission.

The following sections provide the minimum standards for sample management.

FIELD HANDLING

Prior to entering the field area where sampling is to be conducted, especially at sites with defined exclusion zones, the sampler should ensure that all materials necessary to complete the sampling are on hand.

If samples must be maintained at a specified temperature after collection, proper coolers and ice/cool-packs must be brought out to the field. Consideration should be given to keeping reserve cooling media on hand if sampling events will be of long duration. Conversely, when sampling in extremely cold weather, proper protection of water samples, trip blanks, and field blanks must be considered.

Personnel performing sampling tasks must check the sample preparation and preservation requirements to ensure compliance with the project QAPP. Typical sample preparation may involve pH adjustment (i.e., preservation), sample filtration and preservation, or simply cooling to 4°C. Sample preparation requirements vary from site

to site and vary depending upon the analytical method for which the samples will be analyzed.

SAMPLE LABELING

Samples must be properly labeled as soon as practical after collection. The sample label data requirements are listed below for clarity.

i) Project name.

ii) Project number.

iii) Type of sample (soil, water)

ii) Sample number.

iii) Sampler's initials.

iv) Date of sample collection.

v) Time of sample collection.

vi) Analysis required.

vii) Preservatives.

Sample information will be written on the labels using waterproof, non-erasable ink. The adhesive labels will be secured to the bottle. The labels will be further secured to the sample container using wide clear tape over the label and completely around the container before packing in a cooler for secure label protection during transportation and at the laboratory.

The unique sample identification number may follow the format recommended below, or a specific sample protocol for labeling may be specified in the project Work Plan.

JOB NUMBER		DAY/MONTH/YEAR
	A 1886 WDG -07/11/94-AB	
SERIES	SAMPLER'S INITIALS	SAMPLE IDENTIFICATION DESIGNATION

This format has been selected to maximize the information content of the sample number. Minor modifications are certainly reasonable.

i) Series is a letter that designates a group of samples. This might include sample round, or might designate sample type (e.g., sediment, soil, volatile analysis, Round 2 Lower Aquifer wells), or sample source. For example, "A" might mean samples of influent to some treatment system, "B" might mean samples of effluent. Letters should be used, not numbers. Series is optional.

ii) Job number together with the series number, will allow easier tracking of samples.

iii) Sampler's initials will allow identification of the sampler, and so allow all project personnel to contact the correct person for information regarding that sample and its collection. The use of three initials is requested. Special arrangements will need to be made if two individuals have the same initials.

iv) Sample date will allow monitoring of actual holding time of samples and should ensure that all sample numbers are unique, even if sample location designation is used in a system, as opposed to assigned at random.

v) Sample identification designation will identify the sample, and can be any numerical or letter designation.

The decision of how to assign sample numbers should be made at the beginning of a job or phase, and should be consistent throughout the job.

Unless otherwise instructed, labels should not contain specific names of the sample source (i.e., "Well No. 16").

PACKAGING

When possible, sample container preparation and packing for shipment should be completed in a well-organized and clean area, free of any potential cross-contaminants. Sample containers should be prepared for shipment as follows:

i) Containers should be wiped clean of all debris/water using paper towels (paper towels must be disposed of with other potentially contaminated materials).

ii) Clear, wide packing tape should be placed over the sample label for protection (if not already completed.

While there is no one "best" way to pack samples for shipment, the following packing guidelines should be followed.

i) Plan time to pack your samples (and make delivery to shipper if applicable). Proper packing and manifesting takes time. (A day's worth of sampling can be easily wasted due to a few minutes of neglect when packing the samples).

ii) Always opt for more coolers and more padding rather than crowd samples. The cost and lost time associated with the packing and shipment of additional coolers is usually always small in comparison with re-sampling due to breakage during shipment.

iii) Do not bulk pack. Each sample must be individually padded.

iv) Large glass containers (1 liter and up) require much more space and padding between containers.

v) Ice is not a packing material due to the reduction in volume when it melts.

The following is a list of standard guidelines, which must be followed when packing samples for shipment.

i) Line the inside of the cooler with the laboratory supplied plastic liner.

ii) When using ice for a cooling media, always double bag the ice in "Zip-Lock" bags.

iii) Foam chips or preferably bubble pack will be used to cushion sample containers.

iii) Double-check to ensure trip and temperature blanks have been included for all shipments containing VOCs, or where otherwise specified in the QA/QC plan. A trip blank will accompany each shipment of multiple groundwater and/or surface water samples submitted for analysis of VOCs.

iv) Prior to sealing the cooler double check the samples in the cooler with the samples listed on the corresponding Chain-of-Custody form.

v) Enclose the completed and signed Chain-of-Custody form in a "Zip-Lock" bag. Each cooler shipped will contain at least one Chain-of-Custody form that identifies the samples contained in that cooler.

vi) Ensure custody seals/custody tape are placed on each cooler. Coolers with hinged lids should have seals placed on the opening edge of the lid. Coolers with "free" lids should have seals placed on opposite diagonal corners of the lid. The seal will secure the lid and provide evidence that the samples have not been tampered with en-route to the project laboratory. Clear tape will be placed over

the chain-of-custody seals to ensure that they are not accidentally broken during shipment.

vii) Ensure that all "Hazardous Material" stickers/markings or previous shipping labels have been removed from coolers being used which previously contained such materials.

Note: Never store clean sample containers in enclosures containing equipment that uses any form of fuel or volatile petroleum based product. An alternate means of secure storage must be planned for.

When conducting sampling in freezing conditions at sites without a heated storage area (free of potential cross contaminants), trip blanks and temperature blanks not being used in a QA/QC role should be isolated from coolers immediately after receipt. Trip and temperature blanks should be double-bagged and kept from freezing.

CHAIN-OF-CUSTODY RECORDS

Chain-of-custody forms will be completed for all samples collected. The form documents the transfer of sample containers. Chain-of-custody forms to be used on all projects include CRA's standard chain-of-custody form or the chain-of-custody form provided by the project laboratory.

The chain-of-custody record, completed at the time of sampling, will contain, but not be limited to, the sample number, date and time of sampling, and the name of the sampler. The chain-of-custody document will be signed and dated by the sampler when transferring the samples.

Each sample cooler being shipped to the laboratory will contain a chain-of-custody form. The chain-of-custody form will consist of four copies which will be distributed as follows: The shipper will maintain a copy while the other three copies will be enclosed in a waterproof envelop within the cooler with the samples. The cooler will then be sealed properly for shipment. The laboratory, upon receiving the samples, will complete the three remaining copies. The laboratory will maintain one copy for their records. The executed original will be returned with the data deliverables package.

Chain-of-custody (COC) records are legal documents. They must be completed and handled accordingly.

The following list provides guidance for the completion and handling of all COCs.

i) COCs used should be standard forms or those supplied by the project analytical laboratory. Do not use any COC forms from other labs, even if the heading is blocked out.

ii) COCs must be completed in black ballpoint ink only.

iii) COCs must be completed neatly using printed text.

iv) If a simple mistake is made, line out the error with a single line and initial and date next to it.

v) Each separate sample entry must be sequentially numbered.

vi) The use of "Ditto" or quotation marks to indicate repetitive information in columnar entries should be avoided. If numerous repetitive entries must be made in the same column, place a continuous vertical arrow between the first entry and the next different entry.

vii) When more than one COC form is used for a single shipment, each form must be consecutively numbered using the "Page ___ of ___" format.

viii) If necessary, place additional instructions directly onto the COC. Do not enclose separate loose instructions.

ix) Include a contact name and phone number on the COC in case there is a problem with the shipment.

x) A copy of the COC must be maintained in the field site file.

xi) Do not indicate the source of the sample as this may produce a biased lab result.

xii) Before using an acronym on a COC, define clearly the full interpretation of your designation [i.e., Polychlorinated Biphenyls - (PCBs)].

Upon receipt of the cooler by the project laboratory, the designated sample custodian will inspect the cooler. The condition of the cooler and seal will be noted on the chain-of-custody form. The sample custodian will then check the contents of the cooler against the information noted on the chain-of-custody form. If damage or discrepancies are observed, they will be duly recorded in the remarks column of the chain-of-custody form. The form then will be signed and dated. Moreover, any observed damage or discrepancies will be reported immediately to the project chemist for guidance.

SHIPMENT

In all but a few cases the QA/QC plan for the field work will require shipment of samples by overnight carrier. Many problems can be avoided by proper advance planning.

Prior to the start of the field sampling, the carrier should be contacted to determine if pickup can be made at the field site location. If pickup at the field site can be made, the "no-later-than" time for having the shipment ready must be determined.

If no pickup is available at the site, the nearest pickup or drop-off location should be determined. Again, the "no-later-than" time for each location should be determined.

Sufficient time must be allowed not only for packaging but also for delivery of samples if this becomes necessary. Driving at high rates of speed in order to make the drop time is unacceptable.

Sample shipments must not be left at unsecured or questionable drop locations (i.e., if the cooler will not fit in a remote drop box do not leave the cooler unattended next to the drop box).

Some overnight carriers do not in fact provide "overnight" shipment to/from some locations. Do not assume; call the carrier in advance before the start of the field work.

Copies of all shipment manifests must be maintained in the field file.

Samples collected on a Saturday will be shipped with additional ice in the coolers. Samples collect on late on a Saturday, on Sunday or on a holiday will be placed in coolers with extra ice. The coolers will be sealed, stored in a secure location, and shipped by the courier on the next business day. Analytical hold times will be reviewed prior to collecting samples on Saturday, Sunday or holidays.

FIELD QUALITY CONTROL/QUALITY ASSURANCE (QA/QC)

To ensure the validity of data from the sampling and analysis program, field Quality Control (QC) samples will be collected and submitted for analysis. Field QC samples consist of field duplicate samples, field equipment rinsate blank samples, trip blank samples, matrix spike/matrix spike duplicate (MS/MSD). Field duplicate samples will

be collected during each monitoring event at the frequencies specified in the QAPP or, in the absence of a project-specific QAPP, as directed by the Project Coordinator.

The QA/QC procedures for the laboratory analyses are provided in the QAPP. Field duplicates will be collected at a rate of one per 20 investigative samples. Field equipment rinsate blank samples will be collected at a frequency of one per 10 investigative aqueous samples and one per 20 investigative soil/sediment samples.

The following is a brief discussion defining the common types of field derived quality control samples which may be required for a groundwater sampling program. It should be noted that specific project QAPPs may include all or only some of the following quality control procedures.

EQUIPMENT RINSATE BLANKS

Equipment rinsate blanks are defined as QA/QC samples used to determine if cleaning procedures are effective and adequate. Equipment rinsate blanks are prepared by collecting laboratory supplied deionized water or organic free water has been "run through" or "poured over" the cleaned sample collection equipment. Equipment rinsate are submitted to the lab "blind". Equipment blanks are typically collected at the sample preparation area of the project site.

Preservation or filtration (if required) is completed on the respective blank aliquots to ensure that each step of the sampling procedure is evaluated.

Field equipment rinsate blank samples will not be collected for dedicated or disposable soil or groundwater sampling equipment. Field rinsate blank sample data provide information regarding the efficacy of the equipment decontamination procedures.

TRIP BLANKS

Trip blank samples will be prepared by the laboratory, shipped with the sample containers, and returned unopened to the laboratory with multiple aqueous samples for VOC analysis. Trip blank sample data provide information on sample cross-contamination by VOCs during sample shipping and storage. The samples should not be opened, and are intended to determine if the sample shipping or storage procedures influence the analytical results.

FIELD DUPLICATES

Field duplicates are collected and submitted to assess the potential for laboratory data inconsistency and the adequacy of the sampling and handling procedures. A duplicate sample is collected from the same source utilizing identical collection procedures.

During groundwater sample aliquot collection the original and duplicate sample are collected simultaneously by partially filling the original and then the duplicate and alternating back and forth until both samples have been fully collected. This will provide two representative samples for analyses. Transferring the sample aliquot from a bulk container to the respective sample containers is typically not permissible.

Field duplicates are typically submitted "blind" to the laboratory by providing a false identification number. The sampling key to ensure proper sample identification must be submitted to the appropriate personnel to enable completion of the QA/QC review process.

MATRIX SPIKE/MATRIX SPIKE DUPLICATE

MS/MSD groundwater samples will be collected from a well representative of the condition of the majority of the monitoring wells. The chain-of-custody forms sent to the project laboratory must identify the samples collected for MS/MSD analysis. Additional sample volume will be provided as necessary to the laboratory for matrix spike/matrix spike duplicate (MS/MSD) analysis. MS/MSD samples are investigative samples that are analyzed by the laboratory to evaluate analytical accuracy and precision relative to the sample matrices.

MS/MSD sample volumes are additional sample aliquots (additional for aqueous samples only) provided to the laboratory to evaluate the accuracy and precision of the sample preparation and analysis technique. Sample labeling identifies the respective sample location and each additional container that is labeled as the "MS/MSD" volume.

APPENDIX B

FORMS

CHAIN OF CUSTODY RECORD

CONESTOGA-ROVERS & ASSOCIATES

SHIPPED TO (Laboratory Name):

REFERENCE NUMBER:

SAMPLER'S SIGNATURE: _____ PRINTED NAME: _____

SEQ. No.	DATE	TIME	SAMPLE No.	SAMPLE TYPE	No. of Containers	PARAMETERS										REMARKS
TOTAL NUMBER OF CONTAINERS						HEALTH/CHEMICAL HAZARDS										

RELINQUISHED BY: ① _____	DATE: TIME:	RECEIVED BY: ① _____	DATE: TIME:
RELINQUISHED BY: ② _____	DATE: TIME:	RECEIVED BY: ② _____	DATE: TIME:
RELINQUISHED BY: ③ _____	DATE: TIME:	RECEIVED BY: ③ _____	DATE: TIME:

METHOD OF SHIPMENT: WAY BILL No.

White —Fully Executed Copy Yellow —Receiving Laboratory Copy Pink —Shipper Copy Goldenrod —Sampler Copy	SAMPLE TEAM: _____ _____	RECEIVED FOR LABORATORY BY: _____ DATE: _____ TIME: _____	Nº CRA 14994

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STRATIGRAPHY LOG (OVERBURDEN)

PAGE ____ OF ____

PROJECT NAME _____
PROJECT NUMBER _____
CLIENT _____
LOCATION _____

DRILLING CONTRACTOR _____
DRILLER _____
SURFACE ELEVATION _____
WEATHER (A.M.) _____
(P.M.) _____

HOLE DESIGNATION _____
DATE/TIME STARTED _____
DATE/TIME COMPLETED _____
DRILLING METHOD _____
CRA SUPERVISOR _____

STRATIGRAPHIC INTERVALS (DEPTHS IN ft/m BGS)			SAMPLE DESCRIPTION	SAMPLE DETAILS										
FROM	AT	TO	ORDER OF DESCRIPTORS: SOIL TYPE SYMBOL(S) – MAIN COMPONENT(S), (NATURE OF DEPOSIT), SECONDARY COMPONENTS, RELATIVE DENSITY/CONSISTENCY, GRAIN SIZE/PLASTICITY, GRADATION/STRUCTURE, COLOUR, MOISTURE CONTENT, SUPPLEMENTARY DESCRIPTORS NOTE: PLASTICITY DETERMINATION REQUIRES THE ADDITION OF MOISTURE IF THE SAMPLE IS TOO DRY TO ROLL (INDICATE IF MOISTURE WAS ADDED OR NOT).	SAMPLE #	SAMPLING METHOD	PENETRATION RECORD SPLIT SPOON BLOWS (RECORD N-VALUES & RECOVERIES)				SAMPLE INTERVAL	PID / FID (ppm)	CHEMICAL ANALYSIS	GRAIN SIZE
						6"	6"	6"	6"				

NOTES AND COMMENTS

DEPTH OF BOREHOLE CAVING _____ DEPTH OF FIRST GROUNDWATER ENCOUNTER _____ TOPSOIL THICKNESS _____

WATER LEVEL IN OPEN BOREHOLE ON COMPLETION _____, AFTER ____ HOURS ____

COMPLETION DETAILS: _____

NOTE: FOR EACH SPLIT-SPOON SAMPLE, RECORD BLOW COUNTS, N-VALUE, SAMPLE RECOVERY LENGTH, AND SAMPLE INTERVAL.

CRA

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SOIL CLASSIFICATION SYSTEM (MODIFIED U.S.C.S.)

MAJOR DIVISIONS			GROUP SYMBOL	TYPICAL DESCRIPTION
HIGHLY ORGANIC SOILS			PT	PEAT AND OTHER HIGHLY ORGANIC SOILS
COARSE-GRAINED SOILS (MORE THAN HALF BY WEIGHT LARGER THAN NO. 200 SIEVE SIZE)	GRAVELS MORE THAN HALF OF COARSE FRACTION LARGER THAN NO. 4 SIEVE SIZE	CLEAN GRAVELS	GW	WELL GRADED GRAVEL, GRAVEL-SAND MIXTURES, < 5% FINES
			GP	POORLY GRADED GRAVELS AND GRAVEL-SAND MIXTURES, < 5% FINES
		DIRTY GRAVELS	GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES, > 12% FINES
			GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES, > 12% FINES
	SANDS MORE THAN HALF OF COARSE FRACTION SMALLER THAN NO. 4 SIEVE SIZE	CLEAN SANDS	SW	WELL GRADED SANDS, GRAVELLY SANDS, < 5% FINES
			SP	POORLY GRADED SANDS, OR GRAVELLY SAND, < 5% FINES
		DIRTY SANDS	SM	SILTY SANDS, SAND-SILT MIXTURES > 12% FINES
			SC	CLAYEY SANDS, SAND-CLAY MIXTURES > 12% FINES
FINE-GRAINED SOILS (MORE THAN HALF BY WEIGHT PASSES NO. 200 SIEVE SIZE)	SILTS BELOW "A" LINE ON PLASTICITY CHART; NEGLIGIBLE ORGANIC CONTENT		ML	INORGANIC SILTS AND VERY FINE SAND, ROCK FLOUR, SILTY SANDS OF SLIGHT PLASTICITY
			MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS, FINE SANDY OR SILTY SOILS
	CLAYS ABOVE "A" LINE ON PLASTICITY CHART; NEGLIGIBLE ORGANIC CONTENT		CL	INORGANIC CLAYS OF LOW PLASTICITY, GRAVELLY, SANDY, OR SILTY CLAYS, LEAN CLAYS
			CI	INORGANIC CLAYS OF MEDIUM PLASTICITY, SILTY CLAYS
			CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
	ORGANIC SILTS & ORGANIC CLAYS BELOW "A" LINE ON PLASTICITY CHART		OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
			OH	ORGANIC CLAYS OF HIGH PLASTICITY

CONVENTIONAL SOIL DESCRIPTIONS

NON-COHESIVE (GRANULAR) SOIL

RELATIVE DENSITY	BLOWS PER FOOT (N-VALUE)
Very loose	less than 5
Loose	5 to 9
Compact	10 to 29
Dense	30 to 50
Very Dense	greater than 50

COHESIVE (CLAYEY) SOIL

CONSISTENCY	BLOWS PER FOOT (N-VALUE)
Very Soft	0 to 2
Soft	3 to 4
Firm	5 to 8
Stiff	9 to 15
Very Stiff	16 to 30
Hard	greater than 30

GRAIN SIZE CLASSIFICATION

COBBLES	Greater than 3 inches (76 mm)
GRAVEL	3 in. to No. 4 (4.76 mm)
Coarse Gravel	3 in. to 3/4 in.
Fine Gravel	3/4 in. to No. 4 (4.76 mm)
SAND	No. 4 (4.76 mm) to No. 200 (0.074 mm)
Coarse Sand	No. 4 (4.76 mm) to No. 10 (2.0 mm)
Medium Sand	No. 10 (2.0 mm) to No. 40 (0.42 mm)
Fine Sand	No. 40 (0.42 mm) to No. 200 (0.074 mm)
SILT	No. 200 (0.074 mm) to 0.002 mm
CLAY	Less than 0.002 mm

NOTE: The "No. ___ " refers to the standard sieve sizes.

COMPONENT PERCENTAGE DESCRIPTORS

Noun(s) (e.g. SAND and GRAVEL)	35 to 50%
Adjective (e.g. SANDY)	20 to 35%
With	10 to 20%
Trace	Less than 10%

SOIL STRUCTURE TERMS

Stratified	Blocky
Laminated	Lenses/Seams
Fissured	Homogeneous

CRA

PROPERTY ACCESS/UTILITY CLEARANCE DATA SHEET

(QSF-019)

PROJECT NAME: _____ PROJECT NUMBER: _____

CRA REPRESENTATIVE: _____

CLIENT: _____ CLIENT REPRESENTATIVE: _____ PHONE: _____

ON-SITE PROPERTY ACCESS APPROVAL _____ (OWNER OR AUTHORIZED AGENT SIGNATURE)

OFF-SITE PROPERTY ACCESS APPROVAL (if applicable) _____ (OWNER OR AUTHORIZED AGENT SIGNATURE)

UTILITY CLEARANCE APPROVAL _____ (OWNER OR AUTHORIZED AGENT SIGNATURE)

CONTRACTOR VERIFICATION APPROVAL _____ (OWNER OR AUTHORIZED AGENT SIGNATURE)

UTILITIES (INDICATE THAT LOCATION/UTILITY PRESENCE WAS CHECKED) *												
Borehole/ Excavation Location	Date (m/d/y)	Telephone	Water	Storm Sewer	Sanitary Sewer	Process Sewer	Gas	Electrical	Cable	Overhead Utilities	Other	Comments/Warnings

Additional Comments:

_____

_____

_____

* Note as appropriate, Contractor, Client or Owner, or Agent to sign, indicating no utilities are at the selected borehole/excavation locations.

TEST PIT STRATIGRAPHY LOG

Page ___ of ___

Project Name:	**Contractor:**	**Test Pit Designation:**
Project Number:		**Date Started:**
Client:	**Surface Elevation:**	**Date Completed:**
Location:	**Test Pit Method:**	**CRA Supervisor:**

Depth (m/ft)			*Soil Symbol, Primary Component, Secondary Components, Relative Density/Consistency, Grain Size/Plasticity, Gradation/Structure, Colour, Moisture Content, Supplementary Descriptors*	*Sample No.*	*Sample Interval*	*PID*	*Location:* *Geologic Profile*
From	*At*	*To*					

Completed by: _____ Date: _____

CRA 1001 (29) Rev. 5, September 13, 1999, Form SP-03

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APPENDIX F

QUALITY ASSURANCE/QUALITY CONTROL PLAN (QAPP)

REMEDIAL INVESTIGATION/FEASIBILITY STUDY QUALITY ASSURANCE PROJECT PLAN (QAPP)

RTI SUPERFUND SITE
ROCKAWAY TOWNSHIP, NEW JERSEY

DISCLAIMER:
SOME FORMATTING CHANGES MAY HAVE OCCURRED WHEN THE ORIGINAL DOCUMENT WAS PRINTED TO PDF; HOWEVER, THE ORIGINAL CONTENT REMAINS UNCHANGED.

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AUGUST 2008
REF. NO. 004354 (11)

REMEDIAL INVESTIGATION/FEASIBILITY STUDY (RI/FS)
QUALITY ASSURANCE PROJECT PLAN (QAPP)

PROJECT TITLE: REMEDIAL INVESTIGATION/FEASIBILITY STUDY (RI/FS) QAPP
RTI Superfund Site
Rockaway Township, New Jersey

PREPARED BY: CONESTOGA-ROVERS & ASSOCIATES (CRA)

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Amy McCormick - Project Manager - Analytical Laboratory
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Approved By: _____ Date:_____
Dorothy Leeson - Laboratory QA/QC Officer - Analytical Laboratory
Test America Laboratories, Inc.

Approved By: _____ Date:_____
Diego M. Garcia - Project Manager - Approval Authority
USEPA

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LIST OF ACRONYMS AND SHORT FORMS

AOC	-	Administrative Order of Consent
AST	-	Above-ground Storage Tank
ATK	-	Alliant Techsystems, Inc.
AVS		
CD	-	Consent Decree
CRA	-	Conestoga-Rovers & Associates
COC	-	Chain of Custody
DETA	-	Diethylene triamine
DQO	-	Data Quality Objective
DO	-	Dissolved Oxygen
EDD	-	Electronic Data Deliverables
GIS	-	Geographic Information Systems
HASP	-	Health and Safety Plan
HAZWOPER	-	Hazardous Waste Operations and Emergency Response
LCS	-	Laboratory Control Sample
LIMS	-	Laboratory Information Management System
MDL	-	Method Detection Limit
MMH	-	Monomethyl hydrazine
MS/MSD	-	Matrix Spike/Matrix Spike Duplicate
NELAP	-	National Environmental Laboratory Accreditation Program
NJDEP	-	New Jersey Department of Environmental Protection
NIST	-	National Institute of Standards and Technology
ORP	-	Oxidation Reduction Potential
OU-2	-	Operable Unit 2
PALs	-	Project Action Limit
PCBs	-	Poly-chlorinated Biphenyls
PM	-	Project Manager
%R	-	Percent Recovery
PRG	-	Preliminary Remediation Goals
QA	-	Quality Assurance
QAPP	-	Quality Assurance Project Plan

LIST OF ACRONYMS AND SHORT FORMS (CONT'D)

QC	-	Quality Control
QL	-	Quantitation Limit
RI/FS	-	Remedial Investigation/Feasibility Study
ROD	-	Record of Decision
RPD	-	Relative Percent Difference
RSD	-	Relative Standard Deviation
SAP	-	Sampling and Analysis Plan
Site	-	RTI Superfund Site
SOPs	-	Standard Operating Procedures
SOW	-	Statement of Work
SRM	-	Standard Reference Material
SVOC	-	Semi-volatile Organic Compounds
TAL	-	Target Analyte List
TCL	-	Target Compound List
Test America	-	Test America Laboratories, Inc.
TOC	-	Total Organic Carbon
UDMH	-	Unsymetrical dimethyl hydrazine
USEPA	-	United States Environmental Protection Agency
UST	-	Underground Storage Tank
VOC	-	Volatile Organic Compounds
WP	-	Water Pollution
WS	-	Water Supply

1.0 INTRODUCTION

This Quality Assurance Project Plan (QAPP) is for the Remedial Investigation/ Feasibility Study (RI/FS) at the RTI Superfund Site (Site), located near Lake Telemark, New Jersey. The Site location is shown on Figure 1.1 and the Site plan is shown on Figure 1.2. The report is being submitted in compliance with the requirements of the Administrative Order on Consent (AOC), and Statement of Work (SOW) for Operable Unit 2 (OU-2) issued by the United States Environmental Protection Agency (USEPA) for the Site. This report is a supporting document to the RI/FS Work Plan (4354 Report 10). In addition to the Work Plan and QAPP, several other documents have been prepared to assist in the overall goal of successfully completing the RI/FS program, including:

- Sampling and Analysis Plan (SAP) (4354 Report 13); and
- Health and Safety Plan (HASP).

The QAPP presents the organization, objectives, functional activities, and specific quality assurance (QA) and quality control (QC) activities associated with the RI/FS to be performed at the Site. The QAPP also describes the protocols, which will be followed for field sampling, sample handling and storage, chain of custody (COC), and laboratory and field analyses.

All QA/QC procedures will be in accordance with applicable professional technical standards, USEPA requirements, government regulations and guidelines, and specific project goals and requirements. This QAPP has been prepared by CRA in accordance with the following QAPP guidance documents:

- "Intergovernmental Data Quality Task Force Uniform Federal Policy for Quality Assurance Project Plans", Part 1: UFP - QAPP Manual, EPA-505-B-04-900A, March 2005
- " Intergovernmental Data Quality Task Force Workbook for Uniform Federal Policy for Quality Assurance Project Plans", Part 2A: UFP - QAPP Workbook, EPA-505-B-04-900C

2.0 PROJECT MANAGEMENT AND OBJECTIVES ELEMENTS

2.1 DOCUMENT CONTROL NUMBERING SYSTEM

A document control numbering system is in place for this QAPP. Controlled copies of this QAPP are assigned to individuals and/or companies. Individuals who receive a controlled copy of the QAPP are responsible for removing all outdated material from circulation as well as distributing revised or new material in order to update any copies within their organization. The distribution list and accompanying document control numbers associated with each individual and/or company are located in Section 2.3 of this QAPP.

2.2 QAPP IDENTIFYING INFORMATION

QAPP identifying information includes key project personnel, previous site work, and the program for which the work under this QAPP will be performed. The QAPP identifying information for the Site as well as a "cross-walk" for locating required QAPP elements is located in QAPP Worksheet #2.

2.3 DISTRIBUTION LIST AND PROJECT PERSONNEL SIGN-OFF SHEET

2.3.1 DISTRIBUTION LIST

There are 13 controlled copies of this QAPP document. The distribution list including document control numbers for this QAPP is located in QAPP Worksheet #3. A summary of the recipients of this QAPP is listed below (number of copies in parentheses).

Karie Mars - Project Coordinator - ATK (2);

CRA (2);

Test America Laboratories, Inc. (Test America) - North Canton, Ohio (1);

Test America - Denver, Colorado (1);

Test America - Sacramento, California (1);

Test America - Burlington, Vermont (1);

Data/Analysis Technologies, Inc (DAT) - Columbus, Ohio (1); and

USEPA (4).

2.3.2 PROJECT PERSONNEL SIGN-OFF SHEETS

The function of the project personnel sign-off sheet is to document that all key personnel performing work for this project have read the applicable sections of the QAPP and will perform the tasks as described. There exists a separate project sign off sheet for each organization involved with the project. There are eight organizations involved with this project. The project sign-off sheets are located in QAPP Worksheets #4-1 through #4-8.

2.4 PROJECT ORGANIZATION

ATK has not formally retained CRA to conduct or manage the execution of the RI/FS. If retained, the following sections apply. If ATK retains another party, then an alternate Section 2.4 will be provided to USEPA.

2.4.1 PROJECT ORGANIZATION CHART

The Test America and DAT laboratories will perform analysis of samples collected during the Site activities.

All firms will provide project management as appropriate to their responsibilities. CRA will provide administrative oversight and QA/QC for all deliverables. CRA will maintain a file copy of all laboratory deliverables. All final project deliverables will be issued by CRA on behalf of ATK.

The original version of the approved QAPP will be located at CRA's St. Paul office. Any subsequent revisions or significant modifications to the QAPP will be issued to the distribution list by CRA on behalf of ATK.

Figure 2.1 presents the organization of key staff with QA/QC responsibilities for the project.

2.4.2 COMMUNICATION PATHWAYS

Communication is one of the keys to a successful project. Communication pathways will follow the lines presented in Figure 2.1. These are considered to be primary pathways of communication and do not restrict communication between all parties, as necessary.

2.4.3 PERSONNEL RESPONSIBILITIES AND QUALIFICATIONS

A summary of each of the key person's responsibilities and qualifications is presented below:

Karie Mars - Project Coordinator - ATK

- Overview of project for PRP Group
- Participate in meetings with USEPA
- Coordinate with CRA's Project Engineer/Project Coordinator
- Responsible for document control and final disposition of records

  Education and Experience Qualifications:

  - 4 year Bachelor Applied Science (Engineering) degree
  - Health and Safety Certification
  - P.E.
  - Project management skills
  - 7+ years experience

Ronald Frehner - Project Engineer - CRA

- Overview of field activities
- Overview of laboratory activities
- Decide data corrective action
- Data assessment
- Preparation and review of reports
- Technical representation of project activities
- Coordinate CRA's technical group
- Evidence file custodian
- Approval of the QAPP

Education and Experience Qualifications:

- 4 year Bachelor Applied Science (Engineering) degree
- Health and Safety certification
- P.E.
- Complete PM training
- Expertise in at least one area of engineering
- 10+ years experience
- Project management skills

Robert Martin - Project Coordinator/Field Quality Assurance Officer - CRA

- Management of field activities and field QA/QC
- Data assessment
- Technical representation of field activities
- Preparation of standard operating procedures (SOPs) for field activities
- Approval of QAPP

  Education and Experience Qualifications:

  - 4 year Bachelor Applied Science (Engineering) degree
  - Health and Safety certification
  - Complete PM training
  - 4+ years experience

Grant Anderson - Analytical Quality Assurance Officer - CRA

- Laboratory systems audits
- Overview and review field QA/QC
- Review laboratory QA/QC
- Perform data validation and assessment
- Advise on data corrective action procedures
- Preparation and review of reports

- QA/QC representation of project activities
- Approval of QAPP

  Education and Experience Qualifications:

  - Bachelor of Science (Chemistry) degree
  - Health and Safety certification

To Be Determined - Field Sampler - CRA

- Perform field sampling activities
- Log soil borings
- Communicate with Project Coordinator
- Prepare Sampling Summary

  Education and Experience Qualifications:

  - 3 years technologist or 2-year technician diploma
  - Health and Safety Certification
  - Attend applicable field training courses and complete the field task three times under supervision

Amy McCormick - Project Manager – Test America N. Canton

- Ensures all resources of the laboratory are available on an as-required basis
- Overview of final analytical reports
- Approve final reports prior to submission to CRA
- Approval of the QAPP

  Education and Experience Qualifications:

  - BS/BA in Chemistry/Sciences or Business Management with coursework in chemistry
  - Minimum 3 years laboratory, program management or customer service experience

Ray Risden - Operations Manager – Test America N. Canton

- Coordinate laboratory analyses
- Supervise in-house chain-of-custody
- Schedule sample analyses
- Oversee data review
- Oversee preparation of analytical reports

  Education and Experience Qualifications:

  - BS degree in Chemistry or equivalent
  - 10 years laboratory experience including 2 years experience as a group supervisor

Dorothy Leeson - QA/QC Officer – Test America N. Canton

- Overview laboratory quality assurance
- Overview QA/QC documentation
- Conduct detailed data review
- Approve and document laboratory corrective actions, if required
- Technical representation of laboratory QA procedures
- Oversee preparation of laboratory SOPs
- Approval of the QAPP

  Education and Experience Qualifications:

  - BS/BA in Chemistry or related field
  - Minimum 5 years bench level analytical experience plus formal QA training or 2 years QA experience

John McFadden - Sample Custodian – Test America N. Canton

- Receive and inspect the incoming sample containers
- Record the condition of the incoming sample containers
- Sign appropriate documents

- Verify correctness of COC documentation
- Notify laboratory manager and laboratory supervisor of sample receipt and inspection
- Assign a unique identification number and customer number, and enter each into the sample receiving log
- With the help of the operations manager, initiate transfer of the samples to appropriate lab sections
- Control and monitor access/storage of samples and extracts

  Education and Experience Qualifications:

  - High school diploma or equivalent
  - DOT certificate for shipping hazardous chemicals

USEPA RESPONSIBILITIES

The USEPA Project Manager (PM) will be responsible for overview of this project. Diego M. Garcia is the USEPA PM. He will also be responsible for providing approval of the QAPP.

The USEPA Quality Assurance Reviewer is responsible for reviewing and providing final approval of the QAPP. In addition, USEPA may conduct external system and performance audits of laboratory and field activities as needed.

The USEPA provides oversight of the project and will provide review of documentation to ensure compliance with the AOC and SOW as they relate to the identified applicable or relevant and appropriate requirements.

2.4.4 SPECIAL TRAINING REQUIREMENTS AND CERTIFICATION

CRA's field sampling team members are required to have received the 40-hour Hazardous Waste Operations and Emergency Response (HAZWOPER) safety training

and annual 8-hour refresher courses required by 29 CFR Parts 1910 and 1926. On-Site subcontractor personnel involved in invasive activities (e.g., drilling) are required to have received the same training. The subcontractor is responsible for compliance of their personnel with the applicable regulations. Installation of soil borings will be performed by a licensed subcontractor.

The laboratories performing sample analysis for the work under this QAPP are required to be accredited by the National Environmental Laboratory Accreditation Program (NELAP) to demonstrate compliance with USEPA's requirement that the laboratories have a documented quality system that complies with ANSI/ASQC E4-94 ("Specifications and Guidelines for Quality System for Environmental Data Collection and Environmental Technology Programs", January 1995), and EPA QA/R-2 ("EPA Requirements for Quality Management Plans", March 2001).

In addition, the laboratories should be certified by the state of New Jersey for analyses requested that the state of New Jersey requires certification for.

2.5 PROJECT PLANNING/PROBLEM DEFINITION

2.5.1 PROJECT PLANNIING (SCOPING)

Significant investigation has already been completed by others in the late 1980s and early 1990s and subsequent phases of the project by New Jersey Department of Environmental Protection (NJDEP) and others. In addition to this investigative work, interim remedial activities have been completed at the Site which include sump cleanings, above-ground storage tank (AST) and underground storage tank (UST) removal or closures, soil excavation, and drum removal. However, additional Site investigation and characterization work in select areas is required to further characterize the nature and extent of potential contamination from rocket motor-related activities in soil, sediment, and surface water. This information collected as part of this investigative work will be used to support the selection of a remedy, if required.

The major tasks of the project to be performed have been outlined in the project AOC. Prior to the development of the RI/FS Work Plan, summaries of previous remedial investigations and remedial actions were prepared by ATK and submitted to the USEPA in accordance with the USEPA's schedule for interim deliverables. The following provides a list of the background summary documents previously submitted to USEPA:

- March 3, 2004, submittal related to the Northwest Drum Disposal Area;
- March 15, 2004, submittal related to the condition of the RTI property at the time of the two sales to RTI;
- April 14, 2004, submittal providing ATK's assessment of historical data sources to be considered for risk assessment purposes;
- April 28, 2004, submittal providing ATK's summary of the previous investigative and remedial decisions made at the RTI Site;
- June 10, 2004, submittal containing results of drum investigation; and
- July 14, 2004, Preliminary Assessment of the undeveloped portion of the Site.

The information in these documents was used to assist in the scoping phase of the project. In addition, several Site visits were made to assist in developing an understanding of potential source areas, access limitations, and potential receptors at and near the Site. In one of the Site visits, CRA and ATK staff met with USEPA to examine, mark, and relocate proposed sample locations of soil, sediment, and surface water. Additional detail in regards to Site history and Site assessment/scoping work can be found in Sections 1.0 through 3.0 of the RI/FS Work Plan.

2.5.2 PROBLEM DEFINITION, SITE HISTORY, BACKGROUND

Groundwater at the Site has been impacted by volatile organic compounds (VOCs) and perchlorate. As discussed above, a significant amount of investigative work has been completed at the Site from the late 1980s to present with respect to assessing groundwater, soil, sediment, and surface water impacts at the Site. In addition to this investigative work, interim remedial activities have been completed at the Site which

include sump cleanings, AST and UST removal or closures, soil excavation, and drum removal. However, USEPA requires additional Site investigative and characterization work in select areas to further characterize the nature and extent of potential contamination from rocket motor-related activities in soil, sediment, and surface water.

As outlined in the project AOC, the major tasks to be performed which form the basis of the of the RI/FS scope of work are as follows:

1. Investigate the extent of surface water and sediment contamination, if any, at the Site, excluding Lake Denmark;
2. Investigate the extent of potential soil contamination at the Site in select areas;
3. Assess and determine naturally-occurring background concentrations of select inorganics;
4. Investigate surrounding soils and contents of the above-ground tanks and tank saddles that were not previously investigated; and
5. Conduct a baseline human health risk assessment and screening level ecological risk assessment.

Additional detail in regards to Site history and background can be found in Sections 1.0 and 2.0 of the RI/FS Work Plan.

The environmental questions being asked and are to be addressed by this project are as follows:

- Is there a source or sources of contamination in soil that have not yet been identified or remediated that contributes to Site groundwater contamination?
- Are there contamination impacts to Site surface water and sediment as a result of past rocket motor business operations?
- What are the potential contaminants of concern associated with past rocket motor business operations?
- What is the extent of waste materials and drums in a portion of the RTI area?

- What are naturally-occurring concentrations of select inorganics in soil, such as beryllium and thallium, in background?
- Do any contents remain in ASTs at the Site?
- What are the possible constituents of tank contents, if any?
- Has soil been contaminated in tank areas not previously investigated by others?

The rationale and approach for answering these questions including areas of investigation, compounds of potential concern, and rationale for inclusion of chemical analyses is provided in Section 3.0 of the RI/FS Work Plan.

2.6 PROJECT QUALITY OBJECTIVES AND MEASUREMENT PERFORMANCE CRITERIA

The following section documents the environmental decisions that need to be made and the level of data quality needed to ensure that those decisions are based on sound scientific data.

2.6.1 DEVELOPMENT OF PROJECT QUALITY OBJECTIVES USING THE SYSTEMATIC PLANNING PROCESS

Data quality objectives (DQOs) are qualitative and quantitative statements derived from the outputs of each step of the DQO process. The DQO process is a series of planning steps based on the scientific method that is designed to ensure that the type, quantity, and quality of environmental data used in decision making are appropriate for the intended application.

There are seven steps in the DQO process that include:

1. Stating the problem;
2. Identifying the decision;
3. Identifying inputs to the decision;

4. Defining the boundaries of the study;
5. Developing a decision rule;
6. Specifying limits on decision errors; and
7. Optimizing the design for obtaining data.

The details of the DQO process for the soil, sediment, and surface water characterization tasks are provided below.

The problem, as identified in Section 2.5.2 of this QAPP, is to investigate the nature and extent of potentially affected media at the Site and to develop and evaluate potential remedial alternatives.

The decision for the soil and sediment investigation is to determine whether or not contaminant impacts to soil or sediment exceed their respective preliminary remediation goals (PRGs), which have yet to be determined by USEPA. The primary decision for the surface water investigation is to determine whether or not on-Site surface water bodies contain contaminant concentrations New Jersey Surface Water Quality Standards.

The inputs to the decision for the soil and sediment investigation are data to be collected in the RI/FS investigation, historical investigative data, and the yet to be determined PRGs. The inputs to the decision for surface water are data from previous investigations, data collected in the RI/FS investigation, and New Jersey Surface Water Quality Standards.

The spatial boundaries for the soil investigation are the horizontal boundaries detailed on Figure 2.2 and which will be advanced to a maximum depth that is immediately above the water table or bedrock. The spatial boundaries for the surface water and sediment investigation are detailed on Figure 2.2. The temporal boundary for the soil investigation is the sampling anticipated to occur in autumn 2002. The temporal boundaries for the soil, sediment, and surface water investigative work are detailed in project schedule provided as Figure 9.1 in the RI/FS Work Plan. Practical constraints for the soil investigation are inclement weather conditions and unexploded munitions detail

information from Picatinny Arsenal staff. The only practical constraint for the surface water and sediment investigation is inclement weather conditions.

The decision rules for the soil investigation are: if the concentrations of Target Compound List (TCL) organics, Target Analyte List (TAL) inorganics, and energetics detected in soil samples collected at depth from Site soil boring and test pit locations are less than the PRGs or if the water table or bedrock is encountered, then the vertical extent of residuals in soil has been delineated; and if the concentrations of TCL organics, TAL inorganics, and energetics detected in soil samples collected from areas outside of areas known to be impacted by residuals are less than the PRGs, then the horizontal extent of residuals in soil have been delineated.

The decision rules for the sediment investigation are: if the concentrations of TCL organics, TAL inorganics, and energetics detected in sediment samples collected at depth from Site surface water/sediment bodies are less than the PRGs then the extent of residuals in sediment has been delineated.

The decision rules for the surface water investigation are: if the concentrations of TCL organics, TAL inorganics, and energetics detected in surface water samples collected from Site surface water bodies are less than their respective NJDEP Surface Water Quality Standards, then the extent of impacted surface water is defined.

The limits on decision errors expressed as percent error for the RI activities should be no greater than 25 percent. The aggregate sampling and analysis error may be greater, but error resulting from sampling procedures or the nature of the sample matrix are not quantifiable.

2.6.2 MEASUREMENT PERFORMANCE CRITERIA

This section describes the measurement performance criteria for the project. The criteria relate to the parameters of precision, accuracy/bias, representativeness, comparability, sensitivity (quantitation limits), and completeness. A description of each criteria is

located in the subsections below. The criteria are grouped by sample matrix, analyte, and concentration level. The measurement performance criteria for the project are identified in Worksheet #12.

2.6.2.1 PRECISION

Precision is a measure of degree to which two or more measurements are in agreement. Precision data indicate how consistent and reproducible the field sampling or analytical procedures have been.

Precision of measurements will be assessed by determining the relative percent difference (RPD) between the data from either duplicate spiked sample analyses or duplicate sample analyses. RPD is calculated by dividing the absolute value of the difference between two numbers by their arithmetic mean and multiplying by 100. RPD data is used to evaluate the analytical precision of two replicate measurements (e.g., matrix spike/matrix spike duplicate). RPD data control charts are developed and maintained on a matrix and analyte-specific basis. RPD is calculated using the following simplified formula:

$$RPD = \frac{|R_1 - R_2|}{R_1 + R_2} X \ 200\%$$

where:

R_1 = value of first result
R_2 = value of second result

Precision control limits for the analyses are presented in Table 2.1.

RPDs will be calculated for detected analytes from field duplicate sample sets. A RPD of 25 percent for water and 50 percent for soil will be used as an advisory limit for field duplicate samples. If the RPD of an analyte is greater than 25 percent (waters) or 50 percent (soils), the results for both field duplicate samples for that analyte will be qualified as estimated (J/UJ). It should be noted that the RPD of two measurements can

be very high when the data approach the quantitation limit of an analysis. Therefore, the RPD will only be calculated for field duplicate sample data that are greater than or equal to 5 times the quantitation limit for an analysis.

2.6.2.2 ACCURACY/BIAS

Accuracy is the degree of agreement between an observed value (sample result) and an accepted reference value; bias describes the systematic or persistent distortion associated with a measurement process. The terms accuracy and bias are used interchangeably in this document.

Accuracy of the field sample collection procedures will be assessed by the data from trip blank samples. Trip blank sample data will be evaluated using the procedures specified in Sections 3.4 and 5.2. No contaminants should be found in the trip blank. Trip blank contamination will be assessed using the "five times" and "ten times" rules for blank contamination found in the "National Functional Guidelines for Organic Data Review", EPA 540/R-99/008, October 1999. Qualification of the associated sample data will be performed by CRA's QA Officer using professional judgment. Accuracy will be ensured through adherence to all sample handling procedures, sample preservation requirements, and holding time periods.

Accuracy of field measurements obtained during groundwater monitoring will be assessed by analyzing calibration check samples. Accuracy control limits for the field measurements obtained during the field activities are presented in the Standard Operating Procedures (SOPs) in Appendix A.

Laboratory accuracy will be assessed by determining percent recoveries from the analysis of matrix spikes, laboratory control samples (LCSs), or standard reference materials (SRMs). Accuracy of measurements will be assessed by determining the percent recovery (%R) of analytes spiked into samples or blank matrix materials. The %R of a parameter is calculated by dividing the amount recovered by the known amount added and multiplying by 100. The %R data are evaluated to establish the analytical accuracy of a measurement. Percent recovery control charts are developed

and maintained on a matrix and analyte-specific basis. Percent recovery is calculated using the following formula:

$$\%R = \frac{SSR - SR}{SA} \quad X \quad 100$$

where:

SSR = Spiked Sample Result
SR = Sample Result or Background
SA = Spike Added

Accuracy control limits for the analyses are presented in Worksheet #12 and Table 2.1.

The accuracy of the organic analyses will also be monitored through the analysis of surrogate compounds. Surrogate compounds are added to each sample, standard, blank, and QC sample prior to sample preparation and analysis. Surrogate compounds are not expected to be found occurring naturally in the samples, but behave analytically similar to the compounds of interest. Consequently, surrogate compound percent recoveries will provide information on the effect, which the sample matrix exhibits on the accuracy of the analyses. Table 2.2 provides surrogate compound percent control limits for the project.

2.6.2.3 SENSITIVITY AND QUANTITATION LIMITS

Sensitivity is the ability of the method or instrument to detect the target analytes at the level of interest. The quantitation limit (QL) is the minimum concentration of an analyte that can be routinely identified and quantified above the method detection limit (MDL) by a laboratory. MDLs and targeted QLs for the project are listed in Table 2.3. As noted in the table, quantitation limits may vary due to sample matrix effects, sample dilution, and/or QA/QC problems. In addition, laboratory MDLs and QLs are updated on a periodic basis. The laboratories will report the current MDLs and QLs in place at the time of sample analysis. The MDLs and QLs presented in Table 2.3 are current as of the writing of this QAPP.

Generic screening levels or Project Action Limits (PALs) have been developed for the Site which are protective of human health and the environment. Soil, sediment, and surface water analytical data will be evaluated against the PALs to determine the need for response action. In areas where contaminate concentrations equal or exceed the PALs, further study or investigation will be required. In the event contaminate concentrations equal or exceed the PALs, Site-specific PALs may be developed based information collected during the RI activities. The PALs are located in Tables 4.2, 4.3, and 4.4 of the Work Plan.

2.6.2.4 REPRESENTATIVENESS

Representativeness expresses the degree to which data accurately and precisely RI/FS represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition.

Representativeness as it pertains to field procedures is dependent upon the proper design of the sampling program. Representativeness will be ensured by following the SAP and using proper sampling techniques.

Representativeness as it pertains to laboratory procedures is ensured by using the proper analytical procedures, meeting sample holding times, and analyzing and assessing field duplicate samples. The sampling network has been designed to provide data representative of Site conditions. During development of this network, consideration was given to past waste disposal practices, existing analytical data, and physical settings and processes. The rationale for the sampling network is provided in Section 7.0 of the RI/FS Work Plan.

2.6.2.5 COMPARABILITY

Comparability is the degree to which different methods or data agree or can be represented as similar.

Comparability is dependent upon the proper design of the sampling program, and will be ensured by following the Sampling and Analysis Plan (SAP) and using proper sampling techniques. The sampling techniques that should be followed are located in Section 3.0 of the SAP.

The laboratory data to be obtained during the sample collection activities will be comparable to existing data when similar sampling and analytical methods are used. Comparability also is dependent on similar QA objectives.

The comparability of data sets will be evaluated by reviewing the sampling and analysis methods used to generate the data for each data set. Project comparability will be determined to be acceptable if the sampling and analysis methods specified in this QAPP and any approved QAPP revisions or amendments are used for generating the RI/FS data.

2.6.2.5.1 SPLIT SAMPLING DATA COMPARABILITY

Split samples are two or more representative portions taken from a sample in the field or laboratory and analyzed by at least two different laboratories to assess precision, variability, and data comparability between laboratories and/or methods. Overall comparability of data from split samples will be evaluated by determining the RPD of detected analytes in both samples following data verification/validation. Analytes that are detected in only one of the two samples will be assessed by reviewing the data verification/validation reports for both data sets and determining the cause of the discrepancy. Overall comparability of split sample data will be considered acceptable if the RPD for detected analytes with concentrations greater than or equal to 5 times their respective quantitation limits does not exceed RPD acceptance criteria for field duplicate samples (water - 25%, soil - 50%). For analyses with multiple analytes (ex: VOC, (semi volatile organic compounds (SVOC), TAL Metals), split sample results will be considered comparable if 90% of the analytes within the analysis have acceptable RPDs. Criteria for overall laboratory data comparability for the project will be to ensure that the analytical methods used for the RI/FS sampling and analysis events are comparable to the methods used for previous sampling events.

Following data validation/verification, if overall comparability criteria are not met the ATK project coordinator will decide if 1) data should be rejected, 2) resampling of using one or both laboratories should occur, and 3) if there is any adverse effect on historical data collected.

2.6.2.6 COMPLETENESS

Completeness is a measure of the amount of valid (usable) data obtained from a measurement system compared to the amount that was expected to be obtained under normal conditions. Completeness will be assessed by comparing the number of valid (usable) sample results to the total possible number of results within a specific sample matrix and/or analysis. Percent completeness will be calculated using the following formula:

$$\% \text{ Completeness} = \frac{\text{Number of Valid (usable) measurements}}{\text{Number of Measurements Planned}} \times 100$$

Field completeness is a measure of the amount of valid measurements obtained from all measurements taken in the project. The field completeness objective for this project will be 90 percent or greater. The Field QC Officer will make sure that field completeness objective is met. If field completeness objective is not met, the Field QC Officer will address changes to measurement of field data so that the field completeness objective is met the next sampling round. This may require resampling of field measurements or just making sure the proper equipment and properly trained field staff are available to perform the field measurements.

Laboratory completeness is a measure of the amount of valid measurements obtained from all the measurements taken in the project. Laboratory completeness for this project will be 90 percent or greater. If laboratory completeness is not met, the QA Officer - Investigative Organization and the Laboratory Project Manager will determine appropriate steps so that the laboratory completeness goal is met for the following sampling round. Depending on the situation, this may be achieved by collecting more

sample volume, collecting more samples, or having more laboratory equipment on hand.

2.7 SECONDARY DATA EVALUTAION

As previously discussed, significant investigation has already been completed and documented by others in the late 1980's and early 1990's and subsequent phases of the project by NJDEP and others. In addition to this investigative work, interim remedial activities have been completed at the Site which include sump cleanings, AST and UST removal or closures, soil excavation, and drum removal. Summaries of these previous remedial investigations and remedial actions were prepared by ATK and submitted to the USEPA in accordance with the USEPA's schedule for interim deliverables. These documents and information referenced within them were used in the development of the project scope. The following provides a list of the background summary documents:

- March 3, 2004, submittal related to the Northwest Drum Disposal Area;
- March 15, 2004, submittal related to the condition of the RTI property at the time of the two sales to RTI;
- April 14, 2004, submittal providing ATK's assessment of historical data sources to be considered for risk assessment purposes;
- April 28, 2004, submittal providing ATK's summary of the previous investigative and remedial decisions made at the RTI site;
- June 10, 2004, submittal containing results of drum investigation; and
- July 14, 2004, Preliminary Assessment of the undeveloped portion of the Site.

2.8 PROJECT OVERVIEW AND SCHEDULE

In order to answer the environmental questions being asked, an overview of the activities that will be performed are as follows:

- Collection of surface soil samples to investigation the nature and extent of impacts to surface soil;
- Completion and sampling of soil from soil borings and test pits to investigation the nature and extent of impacts to soil;
- Collection of surface water and sediment samples to assess the nature and extent of surface water impacts;
- Collection of surface soil samples to assess and determine background concentrations of select inorganics;
- Investigate surrounding soils and contents of the above-ground tanks and tank saddles that were not previously investigated; and
- Conduct a baseline human health risk assessment and screening level ecological risk assessment.

Additional project related tasks and the projected schedule for the completion of these tasks is provided in Figure 9.1 of the Work Plan.

3.0 MEASUREMENT AND DATA ACQUISITION ELEMENTS

This section of the QAPP details how project data will be collected, measured, and documented. Proper implementation of these activities will ensure that resulting data are scientifically sound, of known and documented quality, and suitable for their intended use.

3.1 SAMPLING TASKS

3.1.1 SAMPLING PROCESS DESIGN AND RATIONALE

The sampling process design and rationale are discussed in Sections 3.0 and 7.0 of the Work Plan.

3.1.2 SAMPLING PROCEDURES AND REQUIREMENTS

Table 3.1 provides a summary of the Sampling and Analysis Program for the RI/FS activities. Sampling procedures are detailed in Section 3.0 of the SAP (4354 Report 13, which is Appendix D of the RI/FS Work Plan (4354 Report 10). The rationale for the sampling locations is discussed in Section 7.0 of the SAP.

3.1.2.1 SAMPLE COLLECTION PROCEDURES

Sample collection procedures are detailed in Section 3.0 of the SAP.

3.1.2.2 SAMPLE CONTAINERS, VOLUME, AND PRESERVATION

Sample collection procedures are detailed in Section 3.0 of the SAP. Sample container, preservation shipping and packaging information is located in Table 3.2.

3.1.2.3 EQUIPMENT/SAMPLE CONTAINERS CLEANING AND DECONTAMINATION PROCEDURES

Equipment cleaning and decontamination procedures are discussed in Section 4.0 of the SAP.

3.1.2.4 FIELD EQUIPMENT CALIBRATION, MAINTENANCE, TESTING, AND INSPECTION PROCEDURES

The field equipment for the RI/FS activities include pH, conductivity, temperature, oxidation reduction potential (ORP), dissolved oxygen (DO), and water level meters. Specific preventive maintenance procedures to be followed for field equipment are those recommended by the manufacturer. Field instruments will be checked and calibrated daily before use. Maintenance logs for all field equipment are kept in CRA's field equipment files at the office from which equipment was shipped. Calibration, maintenance and acceptance criteria for field equipment are located in the Field SOPs located in Appendix A of this QAPP. The maintenance schedule and trouble-shooting procedures for field instruments are presented in Table 3.3.

Critical spare parts for field equipment and replacement field equipment are available at each CRA office and can be shipped for overnight delivery, picked up at the CRA office, or delivered to the field as necessary. In addition, field equipment vendors can also provide replacement equipment if needed. A list of critical spare parts for field equipment is provided in Table 3.3.

3.1.2.5 SUPPLY INSPECTION AND ACCEPTANCE PROCEDURES

The field supplies for the RI/FS sampling activities consist of calibration standard solutions for field instrument calibration and calibration checks, detergent (Alconox) for equipment cleaning, distilled water for sample collection equipment rinsing, and for collecting field blank samples, chemical preservatives for pH adjustment of the appropriate aliquots of samples (e.g., hydrochloric acid for VOCs, nitric acid for metals), and sample containers to collecting water and soil samples.

Field calibration standards (e.g., pH buffers, conductivity solutions) will be obtained from Cole Parmer and are traceable to National Institute of Standards and Technology (NIST) standards. CRA's Field QA Officer is ultimately responsible for ensuring that the field calibration standards for the project are acceptable. The calibration standards will be checked prior to being sent to the field to ensure that they have not expired or otherwise degraded. New calibration standards will be purchased if existing standards are found to be expired or degraded. Alconox, which is a standard laboratory-grade detergent, also is obtained from Cole Parmer. Distilled water will be purchased as needed from a variety of vendors.

Purge-and-trap grade water, chemical preservatives, and sample containers will be provided by Test America. Test America will maintain documentation of the purity/cleanliness for these materials. Test America's QA Officer is ultimately responsible for ensuring that these materials are acceptable for the project. The acceptability of these materials for use will be evaluated by reviewing lot analysis certificates (deionized water, chemical preservatives, and containers). Purge-and-trap grade water will be obtained from Test America's volatile organic analysis laboratory and will meet the acceptability requirements for method blank samples specified in their VOC analysis SOP. Water, preservatives, and containers that do not meet Test America's acceptability requirements will not be shipped to the field.

3.1.2.6 FIELD DOCUMENTATION PROCEDURES

Field documentation procedures are outlined in Section 7.0 of the SAP. Sample labeling, shipping and chain-of-custody procedures are outlined in Section 4.0 of the SAP.

3.2 ANALYTICAL TASKS

The laboratories that will be used for the RI/FS activities are as follows:

The laboratory that will be used for VOC, metals, SVOC, hardness, total organic carbon (TOC), and pH analyses is:

Test America North Canton
4101 Shuffle Dr NW
North Canton, OH 44720-6961
Contact: Amy McCormick
Phone: (330) 497-9396
Fax: (330) 497-0772

The laboratory that will be used for analysis of perchlorate samples is:

Test America Sacramento
880 Riverside Parkway
West Sacramento, CA 95608
Contact: Karen Dahl
Phone: (916) 373-5600
Fax: (916) 372-1059

The laboratory that will be used for analysis of hydrazine, unsymmetrical dimethylhydrazine (UDMH), and monomethyl hydrazine (MMH) analyses is:

Test America Denver
4955 Yarrow Street
Denver, Colorado 80002
Contact: Brett VanDelinder
Phone: (303) 736-0100
Fax: (303) 431-7171

The laboratory that will be used for acid volatile sulfide (AVS) and grain size analyses is:

Test America Burlington
30 Community Drive, Suite 11
South Burlington, Vermont 05403
Contact: Don Dawicki
Phone: (802) 660-1990
Fax: (802) 660-1919

The laboratory that will be used for diethylene triamine (DETA) analysis is:

DAT - Columbus
Data Analysis Technologies, Inc.
7715 Corporate Boulevard
Plain City, Ohio 43064
Contact: Deborah Johnson
Phone: (800) 733-8644
Fax: (614) 873-0810

With the exception of hydrazine, UDMH, and MMH, all samples will be shipped to the Test America-North Canton facility. Due to short holding times, the hydrazine, UDMH, and MMH samples will be shipped directly to Test America-Denver.

Laboratory SOPs for the analyses are listed in Appendix B. Quality Management Plans for the laboratories, along with New Jersey Certifications and PE sample results are provided in Appendix C.

The laboratory analytical methods that will be used during the RI/FS activities are detailed in the following subsections.

3.2.1 ANALYTICAL SOPS

Analytical SOPs for the RI/FS activities are located in Appendix B. A table of contents is provided for the Analytical SOPs in Appendix B.

3.2.2 ANALYTICAL INSTRUMENT CALIBRATION PROCEDURES

Calibration of laboratory equipment will be based on approved written procedures. Records of calibration, repairs, or replacement will be filed and maintained by the designated laboratory personnel performing quality control activities. These records will be filed at the location where the work is performed and will be subject to QA audit. For all instruments, the laboratories will maintain a properly trained repair staff with in-house spare parts or will maintain service contracts with vendors.

The records of calibration will be kept as follows:

1. If possible, each instrument will have record of calibration permanently affixed with an assigned record number.
2. A logbook will be assigned to each instrument showing description, manufacturer, model numbers, date of last calibration and the signature of the person who calibrated the instrument, due date of next calibration and compensation or correction figures, as appropriate.
3. A written stepwise calibration procedure will be available for each piece of test and measurement equipment.
4. Any instrument that is not calibrated within the manufacturer's original specification will display an appropriate warning tag.

Specific calibration procedures are detailed in the methods and in the SOPs in Appendix B.

3.2.3 ANALYTICAL INSTRUMENT AND EQUIPMENT MAINTENANCE, TESTING, AND INSPECTION PROCEDURES

The laboratories are responsible for keeping instrument and equipment maintenance logs. Logs should contain analytical instrumentation maintenance, testing, and inspection activities. A list of associated analytical instrumentation and the maintenance, testing, and inspection activities for each is located in Table 3.3 and the laboratory SOPs provided in Appendix B.

3.2.4 ANALYTICAL SUPPLY INSPECTION AND ACCEPTANCE PROCEDURES

Vendors for general labware, reagents, chromatography supplies, and organic standards used by Test America include, but are not limited to, Fisher Scientific and VWR Scientific Products. The lot numbers of reagents and standards are recorded and dates of receipt, first use, and expiration are documented by the laboratories. Certificates of analysis are maintained on file to document reagent/standard purity.

Test America SOPs provide details on identifying contaminants in reagents and standards, determining deterioration of reagents and standards, and the corrective actions required if contaminants or deterioration are identified. Test America's QA Officer is ultimately responsible for the ensuring the acceptability of supplies and consumables.

3.3 SAMPLE COLLECTION DOCUMENTATION, HANDLING, TRACKING, AND CUSTODY PROCEDURES

The following subsections detail sample collection documentation, handling, tracking, and custody procedures.

3.3.1 SAMPLE COLLECTION DOCUMENTATION

In order to ensure sample authenticity and data integrity, proper sample collection procedures will be followed. Sample labeling is discussed in Section 4.4 of the SAP. Documentation of sample collection procedures are discussed in Section 7.0 of the SAP.

3.3.2 SAMPLE HANDLING AND TRACKING SYSTEM

Proper sample handling and tracking will ensure sample authenticity and data defensibility. With the exception of hydrazine/UDMH/MMH samples, all samples will be shipped via overnight courier to the Test America-North Canton facility. Test America-North Canton will then ship samples to the other laboratories for proper analyses. Due to the short hold time for the analysis of hydrazine/UDMH/MMH, those samples will be shipped via overnight courier directly to the Test America-Denver facility.

Tracking and handling of the samples once they reach the laboratory are discussed in each laboratory's SOP for sample receiving and/or sample management located in Appendix B. Container information for each analysis is located in Table 3.2. This includes bottle type, number, preservative, volume, and packaging requirements.

3.3.2.1 SAMPLE HANDLING

Samples collected by the CRA field staff will be packaged for shipment by the CRA field staff. An overnight courier service (example: Federal Express) will be used for shipping of samples to the laboratories. Sample receipt and custody storage will be the responsibility of the laboratory's sample custodian. Samples will be analyzed by the laboratory analysts. Samples will be stored at each laboratory for 30 days following completion of the final report. After this period, the sample custodian will be responsible for proper sample disposal.

3.3.2.2 SAMPLE DELIVERY

All water and soil samples will be placed in laboratory supplied coolers with ice after collection and labeling. Sample labels may be covered with clear, waterproof tape. A non-combustible cushioning material, such as bubble wrap or vermiculite, will be placed around the sample containers in the cooler to protect them from breakage. Samples with short hold times will be shipped by commercial courier the same day they are sampled. Samples that do not have short hold times will be shipped by commercial courier within 48 hours of sampling collection.

Each cooler will be sealed with a transportation custody seal containing the shipper's initials and date. The cooler will then be sealed with packing tape.

Sample chain-of-custody is discussed in the following section.

3.3.3 SAMPLE CUSTODY

A sample is in "custody" if it is in the actual physical possession of authorized personnel or in a secured area that is restricted to authorized personnel. COC procedures from the field to the laboratory are described in Section 4.4 of the SAP. COC procedures within the laboratory are described in the Laboratory SOPs located in Appendix B. An example of a COC is presented in Appendix B of the SAP.

3.4 QUALITY CONTROL SAMPLES

The field and laboratory QC requirements for the RI/FS activities are discussed in the following subsections. Specific QC checks and acceptance criteria are provided in Section 2.6.2 as well as the Field SOPs located in Appendix A and the Laboratory SOPs located in Appendix B.

To assess the quality of data resulting from the field sampling program, field duplicate samples, matrix spike samples, laboratory duplicate samples, field blank samples, and trip blank samples will be collected and submitted to the laboratories.

Field duplicate samples will be collected at a frequency of one per ten or fewer investigative samples per parameter set, with a minimum of one field duplicate sample submitted per sampling event.

Matrix spike/matrix spike duplicate (MS/MSD) samples will be collected for organic analyses at a minimum frequency of one per 20 or fewer samples for each analysis. MS/MSD samples will be collected for inorganics analyses at a frequency of one per 20 or fewer samples.

Field blank samples will be submitted at a frequency of one per ten sampling equipment cleanings or a least once per day of sampling equipment cleanings, whichever is more frequent. Field blank samples will be collected by routing deionized water through decontaminated sampling equipment. Field blank samples will be analyzed to check procedural contamination and/or ambient conditions at the Site and/or sample container contamination that may cause sample contamination. Field blank samples will not be collected for samples collected using pre-cleaned or pre-cleaned, disposable sampling equipment.

Preserved trip blank samples for aqueous, investigative VOC analyses (prepared by the laboratory and consisting of organic-free water poured into the sample vials) will be shipped with each shipping container of VOC sample vials by the laboratory. Trip blank samples will be handled in a manner consistent with actual field sample handling and will be shipped back to the laboratory with the samples. Trip blank samples will provide a measure of potential cross-contamination of samples during shipment and handling. However, it should be noted that trip blanks will not be opened in the field.

Field duplicate samples will be analyzed to check for sampling and analytical reproducibility. Field duplicate samples will be used to measure precision throughout the sampling event.

The level of QC effort provided by the laboratories for analysis of the samples will be equivalent to the level of QC effort specified in the analytical methods specified in Table 3.4.

The level of QC effort for the field measurements of pH, conductivity, temperature, ORP, and DO will be as described in the SOPs in Appendix A. Temperature readings will be obtained with pH measurements.

3.4.1 SAMPLING QUALITY CONTROL SAMPLES

Field QC requirements include analyzing reference standards for instrument calibration and for routine calibration checks. The acceptance criteria for field instruments are provided in the Field SOPs in Appendix A. Field QC samples for this project include: field blank samples to determine the existence and magnitude of sample contamination resulting from ambient conditions or sampling procedures, field duplicate samples to assess the overall precision of the sampling and analysis events, and trip blank samples to monitor cross-contamination of samples by VOCs. The frequency of collection of these field QC samples are provided in Table 3.1. The evaluation of field QC data is provided in Section 5.2 of this QAPP.

3.4.2 ANALYTICAL QUALITY CONTROL SAMPLES

The laboratory QC requirements for soil samples, surface water samples, and sediment samples analyzed for TCL VOCs and TCL SVOCs include analyzing instrument performance check (mass tuning) standards, method blanks, initial calibration standards, continuing calibration standards, surrogate standards, internal standards, MS/MSDs, and LCSs.

The laboratory QC requirements for soil samples, surface water samples, and sediment samples analyzed for metals include analyzing preparation blanks, initial calibration blanks, continuing calibration blanks, initial calibration verification standards,

continuing calibration verification standards, interference check standards, serial dilution samples, MS/MSD or MS/Dup samples, and LCSs.

The laboratory QC requirements for soil samples, surface water samples, and sediment samples analyzed for hydrazine/UDMH/MMH include analyzing instrument performance evaluation standards, method blanks, instrument blanks, initial calibration standards, continuing calibration verification standards MS/MSDs, and LCSs.

The laboratory QC requirements for soil samples, groundwater samples, sediment samples, and residential well water samples analyzed for TCL polychlorinated biphenyl (PCBs) include analyzing method blanks, instrument blanks, initial calibration standards, continuing calibration verification standards, surrogate standards, MS/MSDs, and LCSs.

The laboratory QC requirements for soil samples, groundwater samples, sediment samples, and residential well water samples analyzed for total cyanide include analyzing method blanks, initial calibration standards, a distilled mid-point standard, which is also the LCS, calibration verification standards, and MS/MSD or MS/Dup samples.

The laboratory QC requirements for groundwater samples analyzed for dissolved gases include analyzing method blanks, initial calibration standards, continuing calibration verification standards, and MS/MSD samples

The laboratory QC requirements for groundwater samples analyzed for nitrate, nitrite, fluoride, chloride, and sulfate include analyzing method blanks, initial calibration standards, continuing calibration standards, MS/MSD or MS/Dup samples, and LCSs.

The laboratory QC requirements for groundwater samples analyzed for sulfide include analyzing method blanks, MS/MSD or MS/Dup samples, and LCSs.

The laboratory QC requirements for groundwater samples analyzed for dissolved organic carbon includes analyzing initial calibration standards, continuing calibration verification standards, surrogate standards, MS/MSDs, and LCSs.

The laboratory QC requirements for groundwater samples analyzed for alkalinity includes analyzing method blanks, MS/MSDs, and LCSs.

The laboratory QC requirements for groundwater samples analyzed for ammonia includes analyzing method blanks, MS/MSD or MS/Dup samples, and LCSs.

Hardness and carbonate hardness are calculated from other analyses. There are no additional laboratory QC requirements for these analyses.

The frequency and acceptance criteria for the QC samples are provided in Table 2.1, Table 2.2, Table 2.3, and in the Laboratory SOPs located in Appendix B.

Corrective action for not meeting analytical QC limits for analytical data are determined by the method and/or the Laboratory SOPs provided in Appendix B. The laboratory QA/QC Officer is responsible for taking corrective action if analytical QC samples fail criteria.

Corrective action for field QC samples is discussed in the data validation section of this QAPP (Section 5.0).

3.5 DATA MANAGEMENT TASKS

This section of the QAPP addresses how project data will be documented, tracked, and managed.

3.5.1 PROJECT DOCUMENTATION AND RECORDS

Sample collection, off-site analysis and data assessment documentation for the RI/FS activities will consist of the following:

1. Sample Collection and Field Measurement Records

   field data collection sheets or field books
   chain-of-custody records
   communication logs/email correspondence
   corrective action reports
   electronic data deliverables
   identification of QC samples
   calibration records of field instruments

2. Analytical Records

   chain-of-custody records
   sample receipt and tracking forms
   case narrative
   sample chronology (time of sample receipt, extraction, analysis)
   corrective action reports
   definition of laboratory qualifiers
   documentation of laboratory method deviations
   electronic data deliverables (EDD)
   laboratory sample identification numbers
   reporting forms with results
   signatures for sign off
   standards traceability records
   MDL studies

3. Project Data Assessment Records

ATK's project coordinator will be responsible for final disposition of records and documents.

3.5.2 DATA PACKAGE DELIVERABLES

The laboratory data packages will consist of the following deliverables:

1. Case narrative for the samples included in each data package;
2. Cross-reference of laboratory /to project sample identification numbers;
3. Description of data qualifiers used;
4. Methods of sample preparation and analysis;
5. Sample results in tabular format;
6. MS/MSD data, QC check sample data, surrogate compound percent recovery data; and
7. Fully executed chain-of-custody document.

3.5.3 DATA REPORTING FORMATS

Sample labeling and COC procedures are discussed in Section 4.0 of the SAP. Field documentation procedures are detailed in Section 7.0 of the SAP. Standard turn around time for analytical reporting will be 2 to 3 weeks. Analytical reports will be provided in hard copy format and as electronic data deliverables (EDD).

3.5.4 DATA HANDLING AND MANAGEMENT

3.5.4.1 DATA RECORDING

Field data will be recorded in field logbooks or on standard forms and consist of measurements from direct reading instruments or direct measurements. Field staff are responsible for recording field data and the Field QA Officer is responsible for identifying and correcting recording errors.

Laboratory data are recorded in a variety of formats. Data from instruments are recorded on magnetic media, strip charts, or bench sheets. The laboratory SOPs in

Appendix B provide the data recording requirement for each preparation and analysis method.

3.5.4.2 DATA TRANSFORMATIONS AND DATA REDUCTION

Field data reduction procedures will be minimal in scope compared to those implemented for laboratory data. Only direct reading instrumentation will be employed in the field. The use of field instrument meters will generate data read directly from the meters following calibration as outlined in the SOPs in Appendix A. These data will be recorded into field logbooks immediately after the measurements are taken.

Laboratory data reduction procedures will be followed according to the following protocol:

1. Raw data produced and checked by the responsible analyst is turned over for independent review by another analyst.
2. The area supervisor or senior chemist reviews the data for attainment of quality control criteria established by the QAPP.
3. The area supervisor will decide whether any sample re-analysis is required.
4. Upon completion of all reviews and acceptance of the raw data by the area supervisor, a report will be generated and sent to the laboratory Project Manager.
5. The laboratory Project Manager will complete a thorough inspection of all reports.
6. Following review and approval of the preliminary report by the laboratory Project Manager, final reports will be generated and signed by the laboratory Project Manager.

Specific equations and procedures used for data reduction are contained in the SOPs in Appendix B.

3.5.4.3 DATA TRANSFER AND TRANSMITTAL

Field data from surveying will be provided in an electronic format that is compatible with geographic information systems (GIS) software, and water level measurements will be entered into a standard Microsoft Excel spreadsheet format. CRA's Field QA Officer is responsible for verifying the correctness of the field data after the data are transferred to a spreadsheet format. The geographical data are maintained in a database that is described below.

The analytical laboratories will provide EDDs in the EQuIS 4-file format. EQuIS is a database product from EarthSoft that uses Microsoft Access as the database engine. The laboratory data are downloaded into the EDDs directly from the laboratory information management system (LIMS), thus eliminating the possibility of manual transcription errors. The EDDs are imported into EQuIS and the data are maintained in the database for manipulation and presentation.

CRA's QA Officer is responsible for verifying the correctness of the analytical database after the laboratory data for each event have been imported. This accomplished by comparing the data from the database to the hard copy analytical reports for a minimum of 10 percent of the sample results. If discrepancies between the database and hard copy analytical reports are detected, a complete verification of the database will be performed or a new EDD will be submitted, imported, and verified as described previously.

Analytical data for the RI/FS activities will also be submitted to the ANSETS data tracking through the USEPA's Superfund Program. The ANSETS program/procedures can be found at www.epa.gov/superfund/programs/clp/ansets.htm.

3.5.4.4 DATA ANALYSIS

The data from the RI/FS will be used to delineate the source, nature, and extent of constituents, and to delineate affected media. Fate and transport mechanisms for the constituents of concern will also be evaluated. It is anticipated that

commercially-available GIS software, such as ArcView, may be used to facilitate the evaluation/visualization of the RI/FS data.

3.5.4.5 DATA REVIEW

Assessment of laboratory data by the laboratories will be performed using the procedures detailed in the SOPs in Appendix B. These assessments included determining the mean, standard deviation, relative standard deviation (RSD), percent difference, RPD, and percent recovery for certain QC elements.

Assessment of QC data for data validation purposes will include determining the mean, standard deviation, RSD, percent difference, percent recovery, RPD, and percent completeness. The statistical equations to determine percent recovery, RPD, and percent completeness are provided in Section 2.6.2 of this QAPP.

3.5.5 DATA TRACKING AND CONTROL

3.5.5.1 DATA TRACKING

Data generated in the field, such as water level measurements, will be recorded in field logbooks or on standard forms. Survey data will be generated by the surveying subcontractor and provided to CRA. There are no unique or special tracking requirements for these data. The data will be transcribed for analysis and reporting as discussed in Section 5.9.4, and the original survey data and field logbooks will be maintained in the final evidence file.

Laboratory data tracking procedures are provided in the SOPs in Appendix B. These SOPs provide the procedures for tracking data from generation to reporting. The laboratories' LIMS also provides a means for tracking data in the laboratory. The laboratory Operations Manager is ultimately responsible for data tracking in the laboratory.

Tracking of analytical data in the EQuIS database includes recording the laboratory generating the data, the date when the EDD was received and imported, the date when qualifiers were applied to the results, and the level of data validation performed. CRA's Project Manager is ultimately responsible for tracking data from entry into the database to reporting.

3.5.5.2 DATA STORAGE, ARCHIVING, AND RETRIEVAL

Laboratory data will be stored by the laboratories in hard copy format at their facility. Data are archived on site for a period of 5 years, after which time the data are warehoused off site. Electronic instrument data are maintained on magnetic media (i.e., magnetic tape) for this same time period. The laboratories' records manager is responsible for data archiving and retrieval. All laboratory records for this project will be maintained consistent with the storage requirements in the consent decree (CD).

CRA's Project Manager is responsible for project data storage and retrieval. Field logbooks will be maintained at a CRA office between sampling events. Upon completion of the RI/FS, the final evidence file will be archived at CRA's Waterloo, Ontario, Canada headquarters consistent with the requirements of the CD.

3.5.5.3 DATA SECURITY

Laboratory data security is the responsibility of the laboratories' records manager. Archived data cannot be accessed without authorization and the name of purpose of personnel accessing archived data are recorded. The laboratories' LIMS is password protected and access rights are restricted by job function.

CRA's data security procedures include limiting project database access to database analysts and general building security procedures.

4.0 ASESSMENTS AND OVERSIGHT ELEMENTS

Performance and system audits of both field and laboratory activities may be conducted to verify that sampling and analysis are performed in accordance with the procedures established in the SAP and QAPP. The audits of field and laboratory activities include two separate, independent parts: internal and external audits.

4.1 ASESSMENTS AND RESPONSE ACTIONS

Internal audits of field activities, including sampling and field measurements, will be conducted by the Field QA Officer or his/her designee.

These audits will verify that all established procedures are being followed. Internal field audits will be conducted at the beginning of sample collection activities to identify deficiencies in the field sampling and documentation procedures. Any deficiencies identified will be documented and corrective actions will be taken to rectify the deficiencies. Follow-up audits will be performed as necessary to verify that deficiencies have been corrected, and that QA procedures are maintained throughout the project.

Internal field audits will include the examination of field sampling records, field instrument operating records, field instrument calibration records, and COC documentation. In addition, sample collection, handling, and packaging in compliance with the established procedures will be reviewed during field audits.

4.1.1 PLANNED ASSESSMENTS

External field audits may be conducted by USEPA. External field audits may be conducted any time during the field operations. These audits may or may not be announced and are at the discretion of the USEPA. External field audits may be conducted according to the field activity information presented in this QAPP.

Internal audits of field activities, including sampling and field measurements, will be conducted by the Field QA Officer or his/her designee.

These audits will verify that all established procedures are being followed. Internal field audits will be conducted at the beginning of sample collection activities to identify deficiencies in the field sampling and documentation procedures. Any deficiencies identified will be documented and corrective actions will be taken to rectify the deficiencies. Follow-up audits will be performed as necessary to verify that deficiencies have been corrected, and that QA procedures are maintained throughout the project.

Internal laboratory audits will be conducted by the laboratory's QA Officer. Internal laboratory system audits will be performed on an annual basis and laboratory performance audits will be conducted on quarterly basis.

The internal laboratory system audits will include examining laboratory documentation regarding sample receiving, sample log-in, sample storage, chain-of-custody procedures, sample preparation and analysis, and instrument operating records. Performance audits will involve analyzing performance evaluation samples provided through the auspices of the USEPA's water pollution (WP) and water supply (WS) or similar performance evaluation programs. Each laboratory's QA Officer will evaluate the results of the systems and performance audits and provide a final report to section managers and the Operations Manager which includes any deficiencies and/or noteworthy observations.

Test America is audited on a regular basis throughout the year by various agencies/clients as well as for their NELAC/NELAP accreditation. At this time, no audits of the field or laboratory are planned for this project.

4.1.2 ASSESSMENT FINDINGS AND CORRECTIVE ACTION RESPONSES

Audits of the field or laboratory, corrective action reports and/or nonconformances will be documented in a written report or memo format and filed in the project files.

4.2 QA MANAGEMENT REPORTS

Quality Assurance Management Reports will be prepared during the RI/FS. These QA Management Reports will be included with the monthly progress reports that are submitted to USEPA and EPA when data gathering or assessment activities are being conducted. Minimally, these reports will include project status, results of performance evaluations and system audits, results of periodic data quality validation and assessment and data use limitations, and any significant QA problems identified and corrective actions taken.

CRA's QA Officer will be responsible within the organizational structure for preparing these reports. CRA's Project Manager will be provided with these reports for distribution with monthly status reports. The Final RI Report will also include a separate QA/QC section that will summarize data quality information contained in the periodic QA Management Reports and provides an overall data quality assessment compared to the data quality objectives outlined in this QAPP.

4.3 FINAL PROJECT REPORT

Final project report details are discussed in Section 9.0 of the Work Plan.

5.0 DATA REVIEW ELEMENTS

5.1 OVERVIEW

- ***Step 1.*** Verification - Confirmation by examination and provision of objective evidence that the specified requirements (sampling and analytical) have been completed.
- ***Step 2.*** Validation - Confirmation by examination and provision of objective evidence that the particular requirements for a specific intended use are fulfilled. Validation is a sampling and analytical process that included evaluating compliance with method, procedure, or contract requirements and extends to evaluating against criteria based on the quality objective developed in the QAPP (measurement performance criteria). The purpose of validation is to assess the performance of the sampling and analysis processes to determine the quality of specified data. Validation is divided into two parts:
- ***Step 2a***. Assess and document compliance with methods, procedures, and contracts.
- ***Step 2b.*** Assess and document comparison of measurement performance criteria in QAPP.
- ***Step 3.*** Usability Assessment - Determination of the adequacy of data, based on the results of validation and verification, for the decisions being made. The usability step involves assessing whether the process execution and resulting data meet project quality objectives documented in the QAPP.

5.2 DATA REVIEW STEPS

5.2.1 STEP I: VERIFICATION

All field and laboratory data will be verified. The procedures and criteria used to verify field and laboratory data will consist of reviewing field books/sampling sheets to be ensure that the requirements of the sampling program were met. This will include checking number of samples, locations, sampling procedures, and sample handling/COC. Data from direct-reading instruments in the field will be internally verified by reviewing calibration and operating records. Verification of field procedures

will consist of checking field books and sampling notes to be sure proper sampling techniques were followed, cross checking to be sure proper sampling locations were sampled and proper field methods were used.

5.2.2 STEP II: VALIDATION

All analytical data for the project will be validated. The validation procedures are described in the sections that follow.

5.2.2.1 STEP IIA: VALIDATION ACTIVITIES

Validation of field data for this project will primarily consist of checking for transcription errors and review of data recorded in field logbooks or on standard forms. Data transcribed from the field logbook or standard forms into summary tables for reporting purposes will be verified for correctness by the Field QA Officer or his designee. Any limitations on the use of field data will be included in the RI reports.

Validation of the analytical data will be performed by CRA's QA Officer or his designee based on the evaluation criteria outlined in "USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review", EPA 540/R-99/008, October 1999 and "USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Methods Data Review", EPA 540/R-04-004, October 2004. The evaluation and action criteria specified in these documents (referred to hereafter as the National Functional Guidelines) will be used for validating the data. However, the acceptance limits for QC data will be the control limits determined statistically by the laboratory, not the control limits specified in the National Functional Guidelines. Calibration data will be validated using the acceptance criteria specified in the analytical methods, not the National Functional Guidelines. Qualifiers assigned to the data will be consistent with the data qualifiers specified in the National Functional Guidelines. All data used to determine the nature and extent of contamination and used for risk assessment purposes will be fully validated (i.e., including the review of all raw data). Region 2 Data

Validation SOPs will also be utilized for the data validation. These documents are located at www.epa.gov/region02/qa/documents.htm.

The following QC data deliverables will be evaluated on 100 percent of the analytical data.

Organic Analyses

1. Technical Holding Times;
2. Blanks;
3. Surrogate Spikes;
4. MS/MSD Results;
5. LCS Results;
6. Field Duplicates; and
7. Trip Blank Samples.

Inorganic Analyses

1. Technical Holding Times;
2. Blanks;
3. MS/MSD or MS/Dup results;
4. LCS Results; and
5. Field Duplicates.

The results of the data validation process will be documented in a memorandum that specifies all limitations on the usability of the analytical data.

In addition to the above list, the following deliverables will be evaluated on 10 percent of the data:

Organic Analyses

1. GC/MS Instrument Performance Check;
2. Initial Calibration;
3. Continuing Calibration;
4. Internal Standards; and
5. Raw Data Review.

Inorganic Analyses

1. Initial Calibration;
2. Continuing Calibration;
3. ICP Interference Check Samples;
4. ICP Serial Dilution ;
5. ICP-MS Tune; and
6. Raw Data Review.

5.2.2.2 STEP IIB: VALIDATION ACTIVITIES

Step IIB of the validation process is to compare data with measurement performance criteria detailed in Section 2.6.2.

The validation procedure will determine:

1. Impacts of any deviations from the sampling or analytical methods or SOPs;
2. Evaluate that proper sampling procedures were followed;
3. Compare results of field duplicates or split samples;
4. Determine that quantitation limits were met and successfully analyzed;
5. Evaluate agreement of laboratory results;

6. Evaluate QC data against project-specific performance criteria;
7. Determine data qualifiers; and
8. Summarize outcome of comparison to measurement performance criteria (including qualified data and explanation of data qualifiers).

5.2.3 STEP III: USABILITY ASSESSMENT

Data usability will be summarized in a data validation memo taking into account the Data Review steps outlined in Section 5.2.

5.2.3.1 DATA LIMITATIONS AND ACTIONS FROM USABILITY ASSESSMENT

The following data quality indicators will be reviewed for the usability assessment: precision, accuracy/bias, representativeness, comparability, completeness, and sensitivity). Detailed descriptions of these data quality indicators are located in Section 2.6.2. When project measurement performance criteria are not achieved a usability report will be prepared to address how the problem will be resolved and the potential need for resampling.

5.2.3.2 ACTIVITIES

The project team will determine the usability of the data. Acceptable departures from the planned sampling program, such as collecting a sample from and adjacent location due to a subsurface obstruction, will not impact data usability. However, data generated from sampling procedures that do not provide representative samples will be rejected.

Sample handling records will be reviewed to ensure that sample integrity remained intact from collection to laboratory receipt and that samples were properly preserved. Chain-of-custody documentation and sample condition upon laboratory receipt will be

reviewed. The data from samples for which the COC or sample identification cannot be verified will be rejected. The data for samples that were not properly preserved will be qualified or rejected depending on the severity of the deviation from the requirements of the SAP and QAPP. The criteria for rejecting improperly preserved samples will be that the sample has been rendered unsuitable for analysis. If minor pH adjustments are required at the laboratory to account for sample buffering affects, data qualification may be required. The criteria for qualifying or rejecting data for samples that are received at the laboratory without being properly preserved, but not rendered unsuitable for analysis, will be based on the sample holding time period evaluation criteria for unpreserved samples specified in the National Functional Guidelines. Data qualification will be consistent with the action specified in the National Functional Guidelines.

Field and laboratory data will be verified to ensure that the methods used to analyze the samples were consistent with the requirements of this QAPP. Data generated from the use of unapproved methods will be rejected. Acceptable departures from the methods and SOPs specified in this QAPP include using an alternate field meter of comparable capability if the specified meter becomes inoperable.

QC data will be reviewed to determine compliance with the acceptance criteria in Section 3.4 of this QAPP. QC data that do not meet the acceptance criteria will result in sample data qualification. Significant departures from the QC acceptance criteria may result in rejected data. Situations that result in data rejection include samples analyzed beyond twice the technical holding time period, analyte relative response factor less than 0.010 for GC/MS analyses, calibration internal standard recoveries less than 10 percent for non-detected analytes quantitated with that internal standard, surrogate standard recoveries less than 10 percent for non-detected analytes in that sample, inorganic LCS analyte recoveries less than 50 percent if the analyte is not detected in the associated samples, inorganic matrix spike analyte recoveries less than 30 percent if the analyte is not detected in the associated samples, organic matrix spike compound recoveries less than 10 percent if the compound is not detected in the MS/MSD sample, and organic LCS compound recoveries less than 10 percent if the compound is not detected in the associated samples.

5.3 STREAMLINING DATA REVIEW

Streamlining of the data review process may be performed to eliminate some validation requirements that are no longer necessary to preserve data integrity. Streamlining will reduce time and costs yet still confirm the quality of the data.

5.3.1 DATA REVIEW STEPS TO BE STREAMLINED

Steps IIA (validation), IIB (measurement performance criteria review), and III (usability assessment) may be streamlined. Streamlining of the data review process will be evaluated as the project progresses and only performed upon approval by the USEPA.

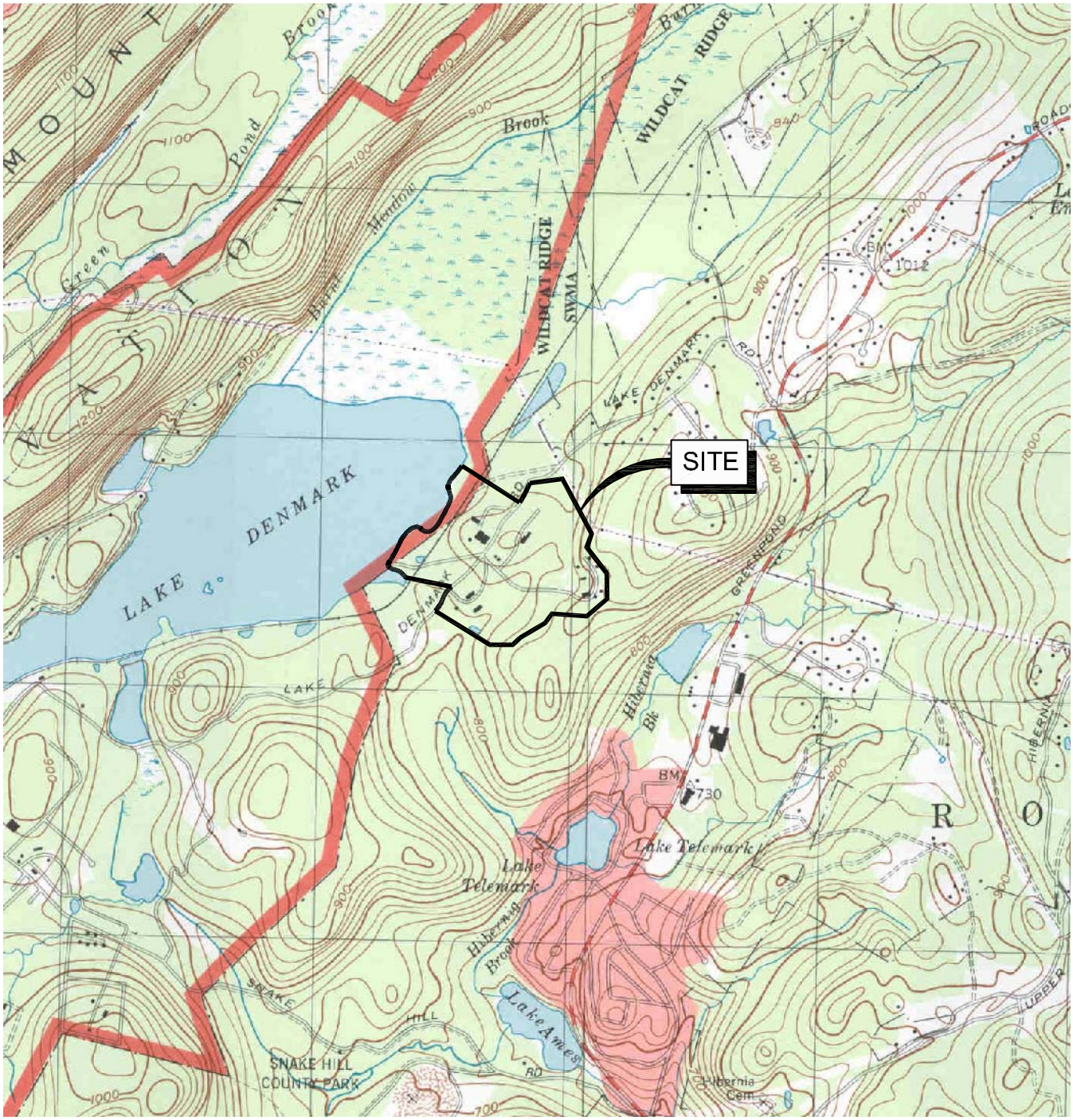
5.3.2 CRITERIA FOR STREAMLINING DATA REVIEW

The following criteria will be used when considering streamlining the data review process:

- Level of risk associated with target analytes;
- Cost and schedule demands;
- Decisions for which the data will be used;
- Complexity of analysis;
- Identifying critical samples;
- Results of audits;
- Proximity of results to action levels; and
- Availability of PT samples.

5.3.3 AMOUNTS AND TYPES OF DATA APPROPRIATE FOR STREAMLINING

The amounts and types of data to be streamlined will be determined by site-specific circumstances.



SOURCE: USGS 7.5 MINUTE QUADS
DOVER AND BOONTON, N.J.

0 1000 2000ft

figure 1.1

SITE LOCATION
RTI SUPERFUND SITE
Rockaway Township, New Jersey

04354-11(017)GN-SP002 NOV 30/2007

300404

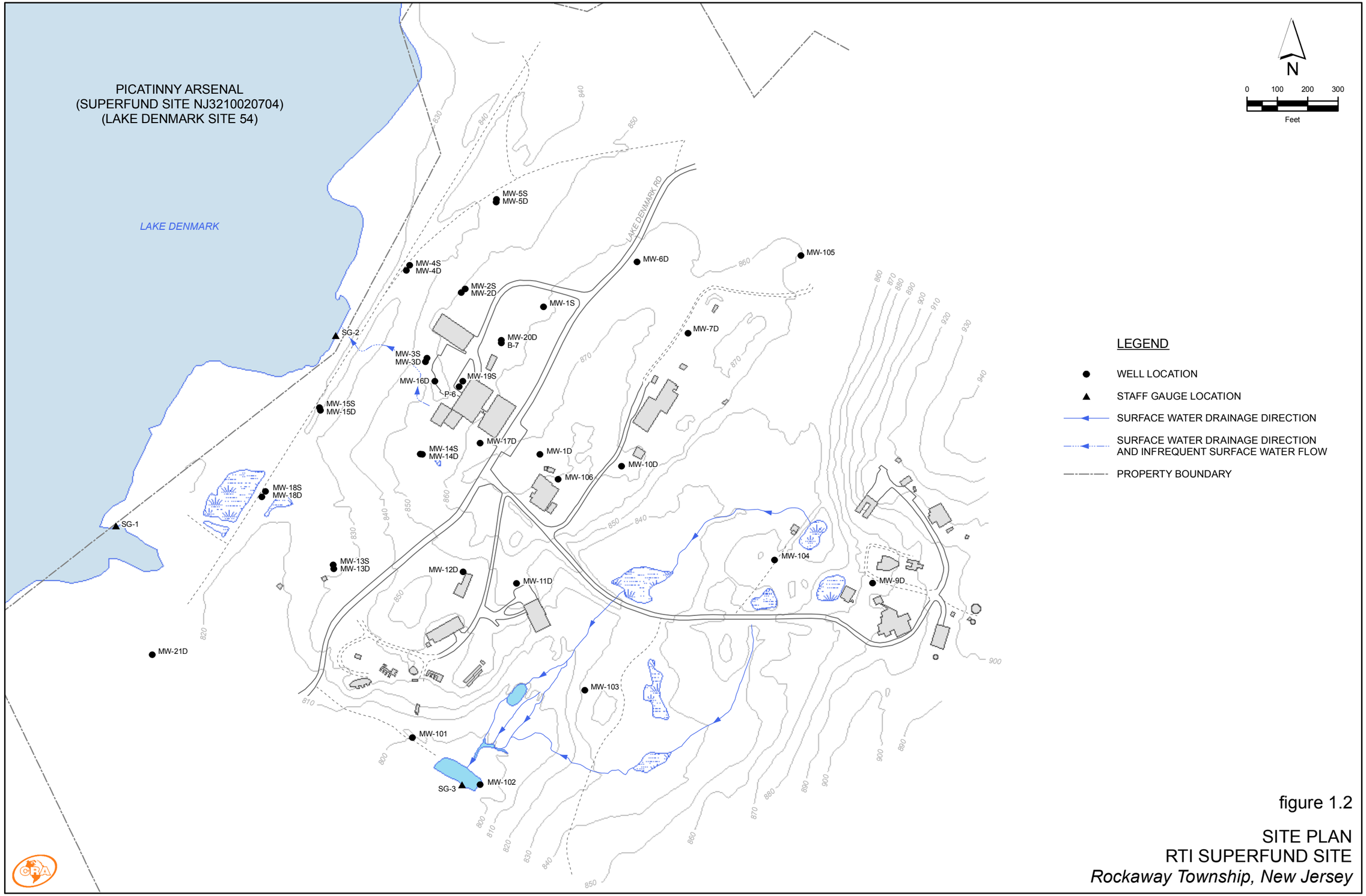


figure 1.2

SITE PLAN
RTI SUPERFUND SITE
Rockaway Township, New Jersey

4354-55(011)GIS-SP001 JAN 29/2008

300405

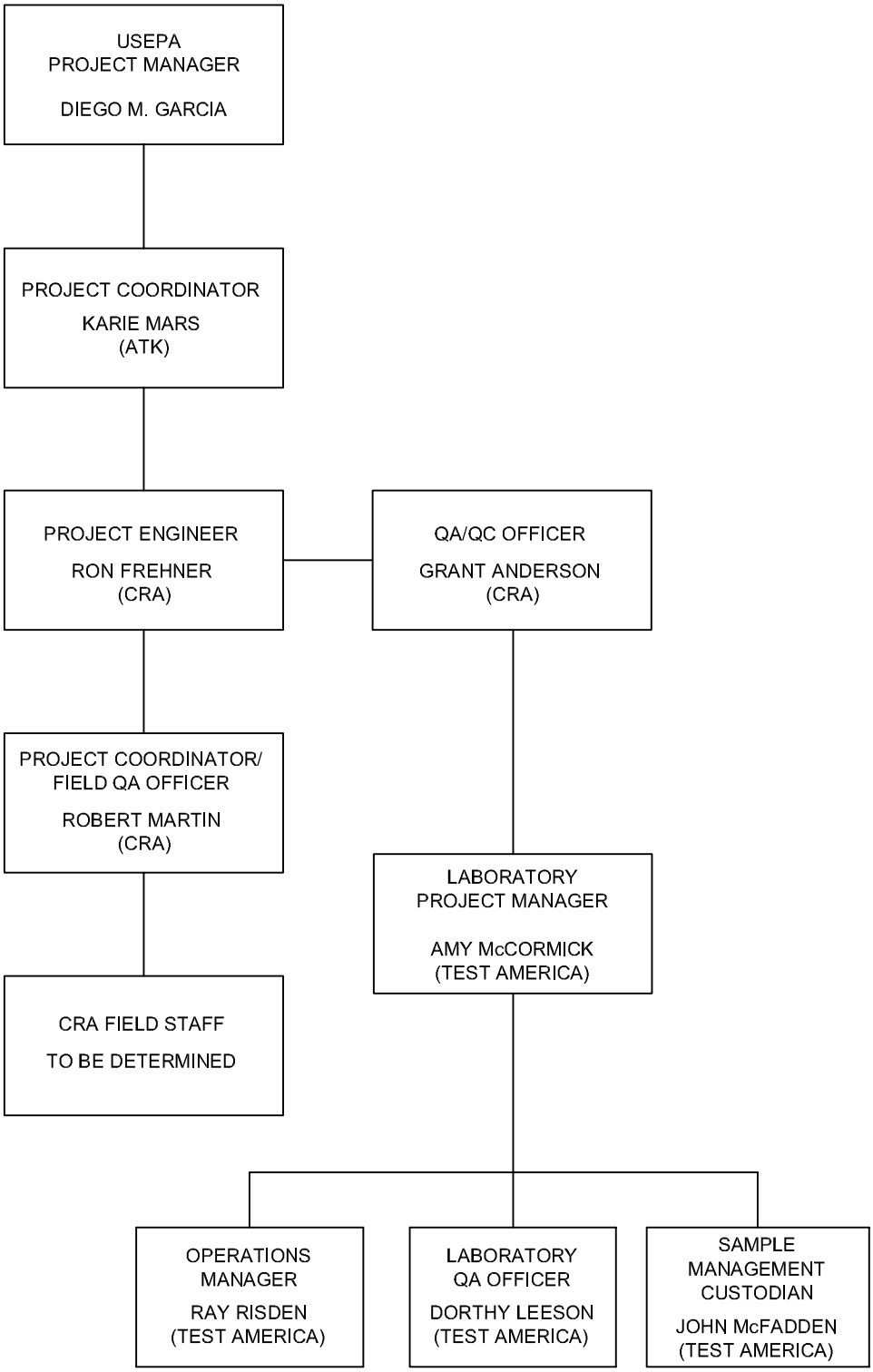


figure 2.1

PROJECT ORGANIZATION
RTI SUPERFUND SITE
Rockaway Township, New Jersey

TABLE 2.1

PRECISION AND ACCURACY CONTROL LIMITS
RI/FS QUALITY ASSURANCE PROJECT PLAN
RTI SUPERFUND SITE
ROCKAWAY TOWNSHIP, NEW JERSEY

Analyte	*CAS Number*	*LCS Control Limits*	*MS/MSD Control Limits*
WATER			
DISSOLVED METALS (SW3005A/6010B/7000 Series)			
Aluminum	7429-90-5	80-120 (20)	75-125 (20)
Antimony	7440-36-0	80-120 (20)	75-125 (20)
Barium	7440-39-3	80-120 (20)	75-125 (20)
Beryllium	7440-41-7	80-120 (20)	75-125 (20)
Calcium	7440-70-2	80-120 (20)	75-125 (20)
Chromium	7440-47-3	80-120 (20)	75-125 (20)
Cobalt	7440-48-4	80-120 (20)	75-125 (20)
Copper	7440-50-8	80-120 (20)	75-125 (20)
Iron	7439-89-6	77-127 (20)	75-125 (20)
Lead	7439-92-1	80-120 (20)	75-125 (20)
Magnesium	7439-95-4	80-120 (20)	75-125 (20)
Manganese	7439-96-5	80-120 (20)	75-125 (20)
Nickel	7440-02-0	80-120 (20)	75-125 (20)
Potassium	7440-09-7	80-120 (20)	75-125 (20)
Silver	7440-22-4	80-120 (20)	75-125 (20)
Sodium	7440-23-5	80-120 (20)	75-125 (20)
Vanadium	7440-62-2	80-120 (20)	75-125 (20)
Zinc	7440-66-6	80-120 (20)	75-125 (20)
DISSOLVED METALS (6020)			
Arsenic	7440-38-2	82-120 (20)	70-130 (20)
Cadmium	7440-43-9	82-116 (20)	70-130 (20)
Selenium	7782-49-2	90-131 (20)	70-130 (20)
Thallium	7446-18-6	69-114 (20)	70-130 (20)
DISSOLVED METALS (7470A)			
Mercury(total)	7439-97-6	70-118 (20)	53-135 (20)
VOLATILE ORGANICS (SW846-8260B)			
1,1,1-Trichloroethane	71-55-6	78-140 (30)	71-162 (30)
1,1,2,2-Tetrachloroethane	79-34-5	85-118 (30)	88-116 (30)
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	70-130 (30)	70-130 (30)
1,1,2-Trichloroethane	79-00-5	83-122 (30)	86-129 (30)
1,1-Dichloroethane	75-34-3	86-123 (30)	88-127 (30)
1,1-Dichloroethene	75-35-4	63-130 (20)	62-130 (20)
1,2,4-Trichlorobenzene	120-82-1	70-130 (30)	70-130 (30)
1,2-Dibromo-3-chloropropane	96-12-8	70-130 (30)	70-130 (30)
1,2-Dibromoethane	106-93-4	70-130 (30)	70-130 (30)

TABLE 2.1

PRECISION AND ACCURACY CONTROL LIMITS
RI/FS QUALITY ASSURANCE PROJECT PLAN
RTI SUPERFUND SITE
ROCKAWAY TOWNSHIP, NEW JERSEY

Analyte	*CAS Number*	*LCS Control Limits*	*MS/MSD Control Limits*
VOLATILE ORGANICS (SW846-8260B) (cont'd)			
1,2-Dichlorobenzene	95-50-1	70-130 (30)	70-130 (30)
1,2-Dichloroethane	107-06-2	79-136 (30)	71-160 (30)
1,2-Dichloropropane	78-87-5	82-115 (30)	87-114 (30)
1,3-Dichlorobenzene	541-73-1	70-130 (30)	70-130 (30)
1,4-Dichlorobenzene	106-46-7	70-130 (30)	70-130 (30)
2-Butanone	78-93-3	28-237 (65)	71-123 (30)
2-Hexanone	591-78-6	35-200 (52)	81-128 (30)
4-Methyl-2-Pentanone	108-10-1	78-141 (32)	82-135 (30)
Acetone	67-64-1	22-200 (95)	45-128 (30)
Benzene	71-43-2	80-116 (20)	78-118 (20)
Bromodichloromethane	75-27-4	87-130 (30)	80-146 (30)
Bromoform	75-25-2	76-150 (30)	58-176 (30)
Bromomethane	74-83-9	64-129 (30)	55-145 (30)
Carbon Disulfide	75-15-0	73-139 (30)	69-138 (41)
Carbon Tetrachloride	56-23-5	75-149 (30)	63-176 (30)
Chlorobenzene	108-90-7	76-117 (20)	76-117 (20)
Chloroethane	75-00-3	66-126 (30)	59-142 (30)
Chloroform	67-66-3	84-128 (30)	83-141 (30)
Chloromethane	74-87-3	48-123 (30)	40-137 (39)
cis-1,2-Dichloroethene	156-59-2	85-113 (30)	87-114 (30)
cis-1,3-Dichloropropene	542-75-6	84-130 (30)	82-130 (30)
Cyclohexane	110-82-7	70-130 (30)	70-130 (30)
Dibromochloromethane	124-48-1	81-138 (30)	71-158 (30)
Dichlorodifluoromethane	75-71-8	70-130 (30)	70-130 (30)
Ethylbenzene	100-41-4	86-116 (30)	86-132 (30)
Isopropylbenzene	98-82-8	70-130 (30)	70-130 (30)
Methyl acetate	79-20-9	70-130 (30)	70-130 (30)
Methyl tert-butyl ether	1634-04-4	70-130 (30)	70-130 (30)
Methylcyclohexane	108-87-2	70-130 (30)	70-130 (30)
Methylene Chloride	75-09-2	78-118 (30)	82-115 (30)
Styrene	100-42-5	85-117 (30)	83-120 (30)
Tetrachloroethene	127-18-4	88-113 (30)	85-121 (30)
Toluene	108-88-3	74-119 (20)	70-119 (20)
trans-1,2-Dichloroethene	156-60-5	79-120 (30)	85-116 (30)
trans-1,3-Dichloropropene	542-75-6	84-130 (30)	73-147 (30)
Trichloroethene	79-01-6	75-122 (20)	62-130 (20)
Trichlorofluoromethane	75-69-4	70-130 (30)	70-130 (30)
Vinyl Chloride	75-01-4	61-120 (30)	88-126 (30)
Xylenes (total)	1330-20-7	87-116 (30)	89-121 (30)

TABLE 2.1

PRECISION AND ACCURACY CONTROL LIMITS
RI/FS QUALITY ASSURANCE PROJECT PLAN
RTI SUPERFUND SITE
ROCKAWAY TOWNSHIP, NEW JERSEY

Analyte	*CAS Number*	*LCS Control Limits*	*MS/MSD Control Limits*
ENERGETICS (EPA 314.0, SW846-9056/8015)			
Perchlorate	7601-90-3	85-115 (15)	80-120 (20)
Hydrazine	302-01-2	81-121 (20)	35-148 (30)
MMH	60-34-4	82-122 (20)	57-138 (30)
UDMH	57-14-7	81-121 (20)	32-183 (30)
ADDITIONAL PARAMETERS			
Hardness (EPA 130.2)	NA	88-110 (20)	87-114 (20)
pH (SW 846 9045C) done in field	NA	NA	NA
SOIL/SEDIMENT			
METALS (SW3050A/6010B/7000 Series)			
Aluminum	7429-90-5	80-120 (20)	75-125 (20)
Antimony	7440-36-0	80-120 (20)	75-125 (20)
Barium	7440-39-3	80-120 (20)	75-125 (20)
Beryllium	7440-41-7	80-120 (20)	75-125 (20)
Cadmium	7440-43-9	80-120 (20)	75-125 (20)
Calcium	7440-70-2	80-120 (20)	75-125 (20)
Chromium	7440-47-3	80-120 (20)	75-125 (20)
Cobalt	7440-48-4	80-120 (20)	75-125 (20)
Copper	7440-50-8	80-120 (20)	75-125 (20)
Iron	7439-89-6	73-137 (20)	75-125 (20)
Lead	7439-92-1	80-120 (20)	75-125 (20)
Magnesium	7439-95-4	80-120 (20)	75-125 (20)
Manganese	7439-96-5	80-120 (20)	75-125 (20)
Nickel	7440-02-0	80-120 (20)	75-125 (20)
Potassium	7440-09-7	80-120 (20)	75-125 (20)
Selenium	7782-49-2	80-120 (20)	75-125 (20)
Silver	7440-22-4	80-120 (20)	75-125 (20)
Sodium	7440-23-5	80-120 (20)	75-125 (20)
Vanadium	7440-62-2	80-120 (20)	75-125 (20)
Zinc	7440-66-6	80-120 (20)	75-125 (20)
METALS (6020)			
Arsenic	7440-38-2	74-110 (20)	70-130 (20)
Thallium	7446-18-6	73-110 (20)	70-130 (20)
METALS (7471A)			
Mercury(total)	7439-97-6	73-123 (20)	10-199 (50)

TABLE 2.1

PRECISION AND ACCURACY CONTROL LIMITS
RI/FS QUALITY ASSURANCE PROJECT PLAN
RTI SUPERFUND SITE
ROCKAWAY TOWNSHIP, NEW JERSEY

Analyte	*CAS Number*	*LCS Control Limits*	*MS/MSD Control Limits*
VOLATILE ORGANICS (SW846-8260B)			
1,1,1-Trichloroethane	71-55-6	67-123 (30)	48-132 (57)
1,1,2,2-Tetrachloroethane	79-34-5	70-133 (30)	33-162 (90)
1,1,2-Trichloroethane	79-00-5	82-116 (30)	58-128 (52)
1,1-Dichloroethane	75-34-3	77-119 (30)	56-130 (54)
1,1-Dichloroethene	75-35-4	55-142 (27)	43-147 (27)
1,2-Dichloroethane	107-06-2	78-121 (30)	56-126 (38)
1,2-Dichloropropane	78-87-5	78-116 (30)	54-125 (43)
2-Butanone	78-93-3	27-200 (46)	21-195 (60)
2-Hexanone	591-78-6	29-200 (41)	20-190 (70)
4-Methyl-2-Pentanone	108-10-1	68-142 (60)	42-143 (60)
Acetone	67-64-1	58-130 (30)	10-200 (66)
Benzene	71-43-2	75-129 (20)	55-138 (20)
Bromodichloromethane	75-27-4	72-125 (30)	47-131 (51)
Bromoform	75-25-2	43-149 (30)	26-141 (64)
Bromomethane	74-83-9	24-152 (30)	15-152 (72)
Carbon Disulfide	75-15-0	50-137 (30)	27-149 (73)
Carbon Tetrachloride	56-23-5	57-137 (30)	32-143 (68)
Chlorobenzene	108-90-7	75-127 (22)	49-139 (22)
Chloroethane	75-00-3	31-144 (30)	32-140 (66)
Chloroform	67-66-3	73-115 (30)	59-128 (46)
Chloromethane	74-87-3	15-136 (30)	28-130 (81)
Cis-1,2-Dichloroethene	156-59-2	77-114 (30)	48-127 (52)
Cis-1,3-Dichloropropene	542-75-6	71-125 (30)	30-138 (49)
Dibromochloromethane	124-48-1	49-135 (30)	44-135 (61)
Ethylbenzene	100-41-4	79-114 (30)	36-133 (72)
Methylene Chloride	75-09-2	58-130 (30)	45-129 (49)
Styrene	100-42-5	80-114 (30)	23-136 (65)
Tetrachloroethene	127-18-4	72-120 (30)	31-137 (81)
Toluene	108-88-3	71-130 (24)	46-147 (24)
Trans-1,2-Dichloroethene	156-60-5	68-117 (30)	47-127 (58)
Trans-1,3-Dichloropropene	542-75-6	67-125 (30)	34-134 (57)
Trichloroethene	79-01-6	70-131 (23)	46-143 (23)
Vinyl Chloride	75-01-4	24-152 (30)	30-136 (80)
Xylenes (total)	1330-20-7	80-114 (30)	33-135 (78)
SEMI-VOLATILE ORGANICS (SW846-8270C, low level)			
Acenaphthene	83-32-9	46-110 (30)	10-200 (30)
Acenaphthylene	208-96-8	47-110 (30)	10-200 (30)
Acetophenone	98-86-2	50-130 (30)	50-130 (30)
Anthracene	120-12-7	56-111 (30)	10-200 (30)
Atrazine	1912-24-9	50-130 (30)	50-130 (30)

TABLE 2.1

PRECISION AND ACCURACY CONTROL LIMITS
RI/FS QUALITY ASSURANCE PROJECT PLAN
RTI SUPERFUND SITE
ROCKAWAY TOWNSHIP, NEW JERSEY

Analyte	*CAS Number*	*LCS Control Limits*	*MS/MSD Control Limits*
SEMI-VOLATILE ORGANICS (SW846-8270C, low level) (cont'd)			
Benzaldehyde	56-55-3	10-130 (30)	10-130 (30)
Benzo(a)anthracene	205-99-2	58-111 (30)	10-200 (30)
Benzo(b)fluoranthene	207-08-9	43-124 (30)	10-200 (30)
Benzo(k)fluoranthene	191-24-2	38-122 (30)	10-200 (30)
Benzo(ghi)perylene	50-32-8	44-120 (30)	10-200 (30)
Benzo(a)pyrene	111-91-1	44-115 (30)	10-200 (30)
1,1'-Biphenyl	111-44-4	50-130 (30)	50-130 (30)
bis(2-Chloroethoxy)methane	117-81-7	42-110 (30)	36-110 (30)
bis(2-Chloroethyl) ether	101-55-3	41-110 (30)	32-118 (30)
bis(2-Ethylhexyl) phthalate	85-68-7	56-123 (30)	10-200 (30)
4-Bromophenyl phenyl ether	106-47-8	53-112 (30)	44-120 (30)
Butyl benzyl phthalate	59-50-7	57-121 (30)	43-138 (30)
Caprolactam	91-58-7	50-130 (30)	50-130 (30)
Carbazole	95-57-8	56-115 (30)	10-162 (30)
4-Chloroaniline	7005-72-3	25-110 (30)	11-110 (30)
4-Chloro-3-methylphenol	218-01-9	42-110 (30)	32-117 (30)
2-Chloronaphthalene	53-70-3	46-110 (30)	40-110 (30)
2-Chlorophenol	132-64-9	39-110 (30)	32-110 (30)
4-Chlorophenyl phenyl ether	84-74-2	53-110 (30)	47-116 (30)
Chrysene	91-94-1	56-111 (30)	10-200 (30)
Dibenz(a,h)anthracene	120-83-2	45-122 (30)	10-200 (30)
Dibenzofuran	84-66-2	50-110 (30)	10-200 (30)
Di-n-butyl phthalate	105-67-9	57-119 (30)	31-145 (30)
3,3'-Dichlorobenzidine	131-11-3	31-110 (30)	10-110 (30)
2,4-Dichlorophenol	117-84-0	40-110 (30)	33-110 (30)
Diethyl phthalate	534-52-1	55-114 (30)	48-118 (30)
2,4-Dimethylphenol	51-28-5	28-110 (30)	19-114 (30)
Dimethyl phthalate	121-14-2	54-112 (30)	47-116 (30)
4,6-Dinitro-2-methylphenol	606-20-2	21-110 (30)	10-110 (30)
2,4-Dinitrophenol	206-44-0	10-110 (30)	10-110 (30)
2,4-Dinitrotoluene	86-73-7	55-116 (30)	42-118 (30)
2,6-Dinitrotoluene	118-74-1	54-115 (30)	28-137 (30)
Di-n-octyl phthalate	87-68-3	45-123 (30)	10-182 (30)
Fluoranthene	77-47-4	55-118 (30)	10-200 (30)
Fluorene	67-72-1	51-110 (30)	10-187 (30)
Hexachlorobenzene	193-39-5	51-110 (30)	37-122 (30)
Hexachlorobutadiene	78-59-1	39-110 (30)	30-110 (30)
Hexachlorocyclopentadiene	91-57-6	10-110 (30)	10-110 (30)
Hexachloroethane	95-48-7	38-110 (30)	13-110 (30)
Indeno(1,2,3-cd)pyrene	106-44-5	45-121 (30)	10-200 (30)
Isophorone	91-20-3	46-117 (30)	32-129 (30)

TABLE 2.1

PRECISION AND ACCURACY CONTROL LIMITS
RI/FS QUALITY ASSURANCE PROJECT PLAN
RTI SUPERFUND SITE
ROCKAWAY TOWNSHIP, NEW JERSEY

Analyte	*CAS Number*	*LCS Control Limits*	*MS/MSD Control Limits*
SEMI-VOLATILE ORGANICS (SW846-8270C, low level) (cont'd)			
2-Methylnaphthalene	88-74-4	46-110 (30)	10-200 (30)
2-Methylphenol	99-09-2	36-110 (30)	19-124 (30)
4-Methylphenol	100-01-6	40-110 (30)	27-116 (30)
Naphthalene	98-95-3	42-110 (30)	10-200 (30)
2-Nitroaniline	88-75-5	47-124 (30)	31-141 (30)
3-Nitroaniline	100-02-7	44-110 (30)	24-110 (30)
4-Nitroaniline	621-64-7	50-110 (30)	23-124 (30)
Nitrobenzene	86-30-6	40-110 (30)	33-111 (30)
2-Nitrophenol	87-86-5	35-110 (30)	17-110 (30)
4-Nitrophenol	85-01-8	24-117 (30)	10-125 (30)
N-Nitrosodiphenylamine	108-95-2	54-112 (30)	10-169 (30)
N-Nitrosodi-n-propylamine	129-00-0	40-114 (30)	30-121 (30)
2,2'-oxybis(1-Chloropropane)	95-95-4	36-116 (30)	25-124 (30)
Pentachlorophenol	88-06-2	10-110 (30)	10-182 (30)
Phenanthrene	86-74-8	54-110 (30)	10-200 (30)
Phenol	100-52-7	39-110 (30)	10-144 (30)
Pyrene	92-52-4	58-113 (30)	10-200 (30)
2,4,5-Trichlorophenol	108-60-1	42-110 (30)	32-112 (30)
2,4,6-Trichlorophenol	105-60-2	37-110 (30)	22-110 (30)
ENERGETICS (EPA 314.0, SW846-9056/8015)			
Perchlorate	7601-90-3	75-125 (20)	75-125 (20)
Hydrazine	302-01-2	79-122 (20)	70-122 (30)
MMH	60-34-4	81-122 (20)	64-129 (30)
UDMH	57-14-7	79-122 (20)	65-136 (30)
Diethylene Triamine (DETA)		60-140 (25)	60-140 (25)

TABLE 2.1

PRECISION AND ACCURACY CONTROL LIMITS
RI/FS QUALITY ASSURANCE PROJECT PLAN
RTI SUPERFUND SITE
ROCKAWAY TOWNSHIP, NEW JERSEY

Analyte	*CAS Number*	*LCS Control Limits*	*MS/MSD Control Limits*
ADDITIONAL PARAMETERS			
pH (SW 846 9045C)	NA	NA	NA
Total Organic Carbon (Walkley-Black)	NA	51-128 (20)	51-128 (20)
AVS	NA	85-115 (20)	85-115 (20)

TABLE 2.2

SURROGATE COMPOUND PERCENT RECOVERY CONTROL LIMITS
RI/FS QUALITY ASSURANCE PROJECT PLAN
RTI SUPERFUND SITE
ROCKAWAY TOWNSHIP, NEW JERSEY

Analyses	*Surrogate Control Limits % Recovery*
VOCs - water	
4-Bromofluorobenzene	74-116
1,2-Dichloroethane-d4	61-128
Toluene-d8	76-110
Dibromofluoromethane	73-122
VOCs - soil	
4-Bromofluorobenzene	47-158
1,2-Dichloroethane-d4	61-130
Toluene-d8	60-143
Dibromofluoromethane	59-138
SVOCs (low level) - soil	
2-Fluorobiphenyl	34-110
2-Fluorophenol	26-110
2,4,6-Tribromophenol	10-118
Nitrobenzene-d5	24-112
Phenol-d5	28-110
Terphenyl-d14	41-119

TABLE 2.3

TARGETED QUANTITATION LIMITS
RI/FS QUALITY ASSURANCE PROJECT PLAN
RTI SUPERFUND SITE
ROCKAWAY TOWNSHIP, NEW JERSEY

Analyte	*CAS Number*	*Achievable MDLs (µg/L)*	*Achievable QLs[1] (µg/L)*
WATER			
Dissolved Metals (SW3005A/6010B/7000 Series)			
Aluminum	7429-90-5	52	200
Antimony	7440-36-0	3.1	10
Barium	7440-39-3	0.82	200
Beryllium	7440-41-7	0.47	5
Calcium	7440-70-2	79	5000
Chromium	7440-47-3	1	5
Cobalt	7440-48-4	1.1	7
Copper	7440-50-8	1.8	25
Iron	7439-89-6	44	100
Lead	7439-92-1	2.3	3
Magnesium	7439-95-4	36	5000
Manganese	7439-96-5	0.66	15
Nickel	7440-02-0	2.1	40
Potassium	7440-09-7	35	5000
Silver	7440-22-4	1.1	5
Sodium	7440-23-5	260	5000
Vanadium	7440-62-2	0.96	7
Zinc	7440-66-6	13	20
Dissolved Metals (6020)			
Arsenic	7440-38-2	0.49	5
Cadmium	7440-43-9	0.077	1
Selenium	7782-49-2	0.75	5
Thallium	7446-18-6	0.027	1
Dissolved Metals (7470A)			
Mercury(total)	7439-97-6	0.029	0.0002
Volatile Organics (SW846-8260B)			
1,1,1-Trichloroethane	71-55-6	0.21	1
1,1,2,2-Tetrachloroethane	79-34-5	0.22	1
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	0.26	1
1,1,2-Trichloroethane	79-00-5	0.22	1
1,1-Dichloroethane	75-34-3	0.21	1
1,1-Dichloroethene	75-35-4	0.18	1
1,2,4-Trichlorobenzene	120-82-1	0.19	1
1,2-Dibromo-3-chloropropane	96-12-8	0.28	2
1,2-Dibromoethane	106-93-4	0.21	1
1,2-Dichlorobenzene	95-50-1	0.2	1
1,2-Dichloroethane	107-06-2	0.16	1
1,2-Dichloropropane	78-87-5	0.15	1

TABLE 2.3

TARGETED QUANTITATION LIMITS
RI/FS QUALITY ASSURANCE PROJECT PLAN
RTI SUPERFUND SITE
ROCKAWAY TOWNSHIP, NEW JERSEY

		Achievable	
Analyte	*CAS Number*	*MDLs (µg/L)*	*QLs*[1] *(µg/L)*
WATER (cont'd)			
1,3-Dichlorobenzene	541-73-1	0.18	1
1,4-Dichlorobenzene	106-46-7	0.22	1
2-Butanone	78-93-3	0.39	10
2-Hexanone	591-78-6	0.35	10
4-Methyl-2-Pentanone	108-10-1	0.32	10
Acetone	67-64-1	0.74	10
Acetonitrile	75-05-8	1.5	20
Benzene	71-43-2	0.22	1
Bromodichloromethane	75-27-4	0.14	1
Bromoform	75-25-2	0.17	1
Bromomethane	74-83-9	0.36	1
Carbon Disulfide	75-15-0	0.28	1
Carbon Tetrachloride	56-23-5	0.19	1
Chlorobenzene	108-90-7	0.2	1
Chloroethane	75-00-3	0.24	1
Chloroform	67-66-3	0.16	1
Chloromethane	74-87-3	0.14	1
cis-1,2-Dichloroethene	156-59-2	0.21	1
cis-1,3-Dichloropropene	542-75-6	0.12	1
Cyclohexane	110-82-7	0.12	1
Dibromochloromethane	124-48-1	0.19	1
Dichlorodifluoromethane	75-71-8	0.25	1
Ethylbenzene	100-41-4	0.19	1
Isopropylbenzene	98-82-8	0.15	1
Methyl acetate	79-20-9	0.52	10
Methyl tert-butyl ether	1634-04-4	0.18	5
Methylcyclohexane	108-87-2	0.5	1
Methylene Chloride	75-09-2	0.19	1
Styrene	100-42-5	0.13	1
Tetrachloroethene	127-18-4	0.19	1
Toluene	108-88-3	0.17	1
trans-1,2-Dichloroethene	156-60-5	0.16	1
trans-1,3-Dichloropropene	542-75-6	0.17	1
Trichloroethene	79-01-6	0.19	1
Trichlorofluoromethane	75-69-4	0.16	1
Vinyl Chloride	75-01-4	0.21	1
Xylenes (total)	1330-20-7	0.44	2
Energetics (EPA 314.0, SW846-9056/8270/8015)			
Perchlorate	7601-90-3	2	4
Hydrazine	302-01-2	2	10
Monomethyl Hydrazine (MMH)	60-34-4	1.37	10
Unsymmetrical Dimethyl Hydrazine (UDMH)	57-14-7	2.30	10

TABLE 2.3

TARGETED QUANTITATION LIMITS
RI/FS QUALITY ASSURANCE PROJECT PLAN
RTI SUPERFUND SITE
ROCKAWAY TOWNSHIP, NEW JERSEY

Analyte	*CAS Number*	*Achievable MDLs (µg/L)*	*Achievable QLs[1] (µg/L)*
WATER (cont'd)			
N-nitrosodimethylamine (NDMA)	62-75-9	0.0001	0.07
ADDITIONAL PARAMETERS			
Hardness (EPA 130.2)	NA	1000	5000
pH (SW 846 9045C) done in field	NA	NA	NA

Analyte	*CAS Number*	*Achievable MDLs (mg/kg)*	*Achievable QLs[1] (mg/kg)*
SOIL/SEDIMENT			
Metals (SW3050A/6010B/7000 Series)			
Aluminum	7429-90-5	2.3	20
Antimony	7440-36-0	0.23	6
Barium	7440-39-3	0.15	20
Beryllium	7440-41-7	0.031	0.5
Cadmium	7440-43-9	0.023	0.5
Calcium	7440-70-2	15	500
Chromium	7440-47-3	0.12	1
Cobalt	7440-48-4	1	5
Copper	7440-50-8	0.16	2.5
Iron	7439-89-6	4.3	10
Lead	7439-92-1	0.23	10
Magnesium	7439-95-4	2.1	500
Manganese	7439-96-5	0.31	1.5
Nickel	7440-02-0	0.17	4
Potassium	7440-09-7	1.3	500
Selenium	7782-49-2	0.27	25
Silver	7440-22-4	0.11	1
Sodium	7440-23-5	0.7	500
Vanadium	7440-62-2	0.11	5
Zinc	7440-66-6	0.87	2
Metals (6020)			
Arsenic	7440-38-2	0.022	0.5
Thallium	7446-18-6	0.0021	0.10
Metals (7471A)			
Mercury(total)	7439-97-6	0.0045	0.1

TABLE 2.3

TARGETED QUANTITATION LIMITS
RI/FS QUALITY ASSURANCE PROJECT PLAN
RTI SUPERFUND SITE
ROCKAWAY TOWNSHIP, NEW JERSEY

Analyte	*CAS Number*	*Achievable MDLs (mg/kg)*	*Achievable QLs[1] (mg/kg)*
SOIL/SEDIMENT (cont'd)			
Volatile Organics (SW846-8260B)			
1,1,1-Trichloroethane	71-55-6	0.00076	0.005
1,1,2,2-Tetrachloroethane	79-34-5	0.00046	0.005
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	0.0008	0.005
1,1,2-Trichloroethane	79-00-5	0.00032	0.005
1,1-Dichloroethane	75-34-3	0.00021	0.005
1,1-Dichloroethene	75-35-4	0.00031	0.005
1,2,4-Trichlorobenzene	120-82-1	0.00032	0.005
1,2-Dibromo-3-chloropropane	96-12-8	0.0014	0.01
1,2-Dibromoethane	106-93-4	0.00037	0.005
1,2-Dichlorobenzene	95-50-1	0.00022	0.005
1,2-Dichloroethane	107-06-2	0.00048	0.005
1,2-Dichloropropane	78-87-5	0.00035	0.005
1,3-Dichlorobenzene	541-73-1	0.00026	0.005
1,4-Dichlorobenzene	106-46-7	0.00034	0.005
2-Butanone	78-93-3	0.001	0.02
2-Hexanone	591-78-6	0.00084	0.02
4-Methyl-2-Pentanone	108-10-1	0.00054	0.02
Acetone	67-64-1	0.0027	0.02
Acetonitrile	75-05-8	0.0056	0.1
Benzene	71-43-2	0.00023	0.005
Bromodichloromethane	75-27-4	0.00048	0.005
Bromoform	75-25-2	0.00065	0.005
Bromomethane	74-83-9	0.00061	0.005
Carbon Disulfide	75-15-0	0.0002	0.005
Carbon Tetrachloride	56-23-5	0.00045	0.005
Chlorobenzene	108-90-7	0.00028	0.005
Chloroethane	75-00-3	0.00054	0.005
Chloroform	67-66-3	0.0004	0.005
Chloromethane	74-87-3	0.00025	0.005
Cis-1,2-Dichloroethene	156-59-2	0.00041	0.005
Cis-1,3-Dichloropropene	542-75-6	0.00035	0.005
Cyclohexane	110-82-7	0.00049	0.01
Dibromochloromethane	124-48-1	0.00036	0.005
Dichlorodifluoromethane	75-71-8	0.0004	0.005
Ethylbenzene	100-41-4	0.00053	0.005
Isopropylbenzene	98-82-8	0.00021	0.005
Methyl acetate	79-20-9	0.00077	0.01
Methyl tert-butyl ether	1634-04-4	0.00028	0.02
Methylcyclohexane	108-87-2	0.00046	0.01
Methylene Chloride	75-09-2	0.0013	0.005
Styrene	100-42-5	0.0002	0.005
Tetrachloroethene	127-18-4	0.00083	0.005
Toluene	108-88-3	0.00029	0.005

TABLE 2.3

TARGETED QUANTITATION LIMITS
RI/FS QUALITY ASSURANCE PROJECT PLAN
RTI SUPERFUND SITE
ROCKAWAY TOWNSHIP, NEW JERSEY

Analyte	*CAS Number*	*Achievable MDLs (mg/kg)*	*Achievable QLs[1] (mg/kg)*
SOIL/SEDIMENT (cont'd)			
Trans-1,2-Dichloroethene	156-60-5	0.00055	0.005
Trans-1,3-Dichloropropene	542-75-6	0.00035	0.005
Trichloroethene	79-01-6	0.00083	0.005
Trichlorofluoromethane	75-69-4	0.00041	0.005
Vinyl Chloride	75-01-4	0.00044	0.005
Xylenes (total)	1330-20-7	0.00076	0.01
Semivolatile Organics (SW846-8270C, low level)			
Acenaphthene	83-32-9	0.0013	0.00667
Acenaphthylene	208-96-8	0.0012	0.00667
Acetophenone	98-86-2	0.026	0.1
Anthracene	120-12-7	0.0013	0.00667
Atrazine	1912-24-9	0.021	0.2
Benzaldehyde	56-55-3	0.021	0.1
Benzo(a)anthracene	205-99-2	0.00095	0.00667
Benzo(b)fluoranthene	207-08-9	0.0012	0.00667
Benzo(k)fluoranthene	191-24-2	0.0017	0.00667
Benzo(ghi)perylene	50-32-8	0.0013	0.00667
Benzo(a)pyrene	111-91-1	0.0013	0.00667
1,1'-Biphenyl	111-44-4	0.023	0.05
bis(2-Chloroethoxy)methane	117-81-7	0.022	0.1
bis(2-Chloroethyl) ether	101-55-3	0.002	0.1
bis(2-Ethylhexyl) phthalate	85-68-7	0.018	0.05
4-Bromophenyl phenyl ether	106-47-8	0.021	0.05
Butyl benzyl phthalate	59-50-7	0.019	0.05
Caprolactam	91-58-7	0.037	0.33
Carbazole	95-57-8	0.019	0.05
4-Chloroaniline	7005-72-3	0.017	0.15
4-Chloro-3-methylphenol	218-01-9	0.021	0.15
2-Chloronaphthalene	53-70-3	0.022	0.05
2-Chlorophenol	132-64-9	0.026	0.05
4-Chlorophenyl phenyl ether	84-74-2	0.024	0.05
Chrysene	91-94-1	0.0009	0.00667
Dibenz(a,h)anthracene	120-83-2	0.0013	0.00667
Dibenzofuran	84-66-2	0.02	0.05
Di-n-butyl phthalate	105-67-9	0.019	0.05
3,3'-Dichlorobenzidine	131-11-3	0.018	0.1
2,4-Dichlorophenol	117-84-0	0.02	0.15
Diethyl phthalate	534-52-1	0.019	0.05
2,4-Dimethylphenol	51-28-5	0.02	0.15
Dimethyl phthalate	121-14-2	0.021	0.05
4,6-Dinitro-2-methylphenol	606-20-2	0.013	0.15
2,4-Dinitrophenol	206-44-0	0.083	0.33
2,4-Dinitrotoluene	86-73-7	0.018	0.2
2,6-Dinitrotoluene	118-74-1	0.021	0.2
Di-n-octyl phthalate	87-68-3	0.018	0.05
Fluoranthene	77-47-4	0.0012	0.00667
Fluorene	67-72-1	0.0012	0.00667

TABLE 2.3

TARGETED QUANTITATION LIMITS
RI/FS QUALITY ASSURANCE PROJECT PLAN
RTI SUPERFUND SITE
ROCKAWAY TOWNSHIP, NEW JERSEY

		Achievable	
Analyte	*CAS Number*	*MDLs (mg/kg)*	*QLs*[1] *(mg/kg)*
Semivolatile Organics (SW846-8270C, low level) (cont'd)			
Hexachlorobenzene	193-39-5	0.0021	0.00667
Hexachlorobutadiene	78-59-1	0.026	0.05
Hexachlorocyclopentadiene	91-57-6	0.016	0.33
Hexachloroethane	95-48-7	0.028	0.05
Indeno(1,2,3-cd)pyrene	106-44-5	0.0015	0.00667
Isophorone	91-20-3	0.021	0.05
2-Methylnaphthalene	88-74-4	0.0015	0.00667
2-Methylphenol	99-09-2	0.028	0.2
4-Methylphenol	100-01-6	0.022	0.2
Naphthalene	98-95-3	0.0016	0.00667
2-Nitroaniline	88-75-5	0.022	0.2
3-Nitroaniline	100-02-7	0.016	0.2
4-Nitroaniline	621-64-7	0.026	0.2
Nitrobenzene	86-30-6	0.0022	0.1
2-Nitrophenol	87-86-5	0.019	0.05
4-Nitrophenol	85-01-8	0.11	0.33
N-Nitrosodiphenylamine	108-95-2	0.021	0.05
N-Nitrosodi-n-propylamine	129-00-0	0.023	0.05
2,2'-oxybis(1-Chloropropane	95-95-4	0.026	0.1
Pentachlorophenol	88-06-2	0.082	0.15
Phenanthrene	86-74-8	0.002	0.00667
Phenol	100-52-7	0.025	0.05
Pyrene	92-52-4	0.0011	0.00667
2,4,5-Trichlorophenol	108-60-1	0.025	0.15
2,4,6-Trichlorophenol	105-60-2	0.021	0.15
Energetics (EPA 314.0, SW846-9056/8270/8015)			
Perchlorate	7601-90-3	0.02	0.04
Hydrazine	302-01-2	0.0042	0.05
Monomethyl Hydrazine (MMH)	60-34-4	0.00699	0.05
Unsymmetrical Dimethyl Hydrazine (UDMH)	57-14-7	0.0127	0.1
N-nitrosodimethylamine (NDMA)	62-75-9	0.013	0.03
Diethylene Triamine		8	40

TABLE 2.3

TARGETED QUANTITATION LIMITS
RI/FS QUALITY ASSURANCE PROJECT PLAN
RTI SUPERFUND SITE
ROCKAWAY TOWNSHIP, NEW JERSEY

		Achievable	
Analyte	*CAS Number*	*MDLs (mg/kg)*	*QLs*[1] *(mg/kg)*
Additional Parameters			
pH (SW 846 9045C)	NA	NA	NA
Total Organic Carbon (Walkley-Black)	NA	100	100
AVS-SEM	NA	15	16

Notes:
1 Targeted Quantitation limits are for guidance only. Actual quantitation limits may vary due to matrix effects, sample dilution, and/or QA/QC problems.
MDL - Method Detection Limit.
QL - Quantitation limit.
NA - Not applicable.

TABLE 3.1

SUMMARY OF SAMPLING AND ANALYSIS PROGRAM
RI/FS QUALITY ASSURANCE PROJECT PLAN
RTI SUPERFUND SITE
ROCKAWAY TOWNSHIP, NEW JERSEY

Sample Matrix	*Field Parameters*	*Laboratory Parameters*	*Investigative Samples*	*QA/QC Samples [1]*			*Total Per Round*	*Frequency*
				Field Blanks	*Field Duplicates*	*Matrix Spike MS/MSD [2]*		
Soil Borings, Test Pits, and Surface Soil	• N/A	• TCL VOCs [5], TCL SVOC (low level) [6], TAL Metals[7], Hydrazine/UDMH[8]/MMH[9], perchlorate, DETA[10], TOC[11] (surface soil only), pH (surface soil only)	145	14	14	7	169	Once
Sediment	• N/A	• TCL VOCs [5], TAL Metals[7], Hydrazine/UDMH[8]/MMH[9], perchlorate, TOC[11], grain size, AVS-SEM[12]	10	1	1	1	12	Once
Surface Water	• pH, conductivity, temperature, ORP[3], DO[4]	• TCL VOCs [5], TAL Metals[7], Dissolved TAL Metals[13], Hydrazine/UDMH[8]/MMH[9], perchlorate, total hardness, dissolved hardness	10	1	1	1	12	Once
Tank Contents	• pH	• TCL VOCs [5], TAL Metals[7], Hydrazine/UDMH[8]/MMH[9], perchlorate	2	0	0	0	2	Once

Notes:

This table presents an overview of the sampling. For details on actual parameter lists for specific Soil Boring or Surface Soil locations please, see Work Plan Tables 7.2 through 7.6.

[1] QA/QC - Quality Assurance/Quality Control

[2] MS/MSD - Matrix Spike/Matrix Spike Duplicate pair. MS/MSD samples are not figured into the total per round.

[3] ORP- Oxidation Reduction Potential

[4] DO - Dissolved Oxygen

[5] VOCs - Volatile Organic Compounds

[6] SVOC - Semivolatile Organic Compounds

[7] TAL Metals - Target Analyte List Metals

[8] UDMH - Unsymmetrical Dimethyl Hydrazine

[9] MMH - Monomethyl Hydrazine

[10] DETA - Diethylene Triamine

[11] TOC - Total Organic Carbon

[12] AVS-SEM - Acid Volatile Sulfide - Simultaneously Extracted Metals.

[13] Dissolved metals samples will be filtered using a 0.45 µm filter prior to preservation.

TABLE 3.2

CONTAINER, PRESERVATION, SHIPPING, AND PACKAGING REQUIREMENTS
RI/FS QUALITY ASSURANCE PROJECT PLAN
RTI SUPERFUND SITE
ROCKAWAY TOWNSHIP, NEW JERSEY

Analyses	*Analytical and Preparation SOP Reference*	*Sample Containers*	*Preservation* [1]	*Maximum Holding Time from Sample Collection* [2]	*Volume of Sample*	*Shippi*
WATER						
VOCs	CORP-MS-0002NC	Three 40-ml teflon-lined septumvials per analysis	HCl to pH<2; Iced	14 days	Fill completely, no air bubbles	Overnight Hand Deli
Total Metals, hardness	CORP-IP-0003NC, NC-MT-0001, NC-MT-0002, NC-MT-012, NC-WC-0036	One 1-liter polyethylene bottle	HNO_3 to pH<2; Iced	180 days, mercury 28 days	Fill to neck of bottle	Overnight Hand Deli
Dissolved Metals, dissolved hardness	CORP-IP-0003NC, NC-MT-0001, NC-MT-0002, NC-MT-012, NC-WC-0036	One 1-liter polyethylene bottle	HNO_3 to pH<2; Iced	180 days, mercury 28 days	Fill to neck of bottle	Overnight Hand Deli
Perchlorate	WS-WC-0010	One 250-ml polyethylene bottle	Iced	28 days	Fill to neck of bottle	Overnight Hand Deli
Hydrazine/UDMH/MMH	DEN-WC-0077	One 1L Amber glass bottle	Iced	48 hours to filter and preserve at the lab; 28 days from filter/preservation to analysis	Fill to neck of bottle	Overnight Hand Deli
Diethylene Triamine (DETA)	SOP 13: 8015B	One 1L Amber glass bottle	Iced	14 days	Fill to neck of bottle	Overnight Hand Deli

TABLE 3.2

CONTAINER, PRESERVATION, SHIPPING, AND PACKAGING REQUIREMENTS
RI/FS QUALITY ASSURANCE PROJECT PLAN
RTI SUPERFUND SITE
ROCKAWAY TOWNSHIP, NEW JERSEY

Analyses	*Analytical and Preparation SOP Reference*	*Sample Containers*	*Preservation* [1]	*Maximum Holding Time from Sample Collection* [2]	*Volume of Sample*	*Shippi*
SOIL/SEDIMENT						
VOCs	CORP-MS-0002NC	Three - 5 gram Encores	Iced	48 hours for preservation at the lab, 14 days for analysis.	Fill completely, and cap	Overnight Hand Deli
SVOCs	CORP-MS-0001NC, CORP-OP-0001NC	One 4 oz jar	Iced	14/40 days[3]	Fill completely, no air bubbles	Overnight Hand Deli
Metals	NC-MT-0001, NC-MT-012, NC-MT-0002, CORP-IP-0002NC	One 4 oz jar	Iced	180 days, mercury 28 days	Fill to neck of jar	Overnight Hand Deli
Perchlorate	WS-WC-0010	One 4 oz jar	Iced	28 days	Fill to neck of jar	Overnight Hand Deli
Hydrazine/UDMH/MMH	DEN-WC-0077	One 8 oz jar	Iced	28 days	Fill to neck of jar	Overnight Hand Deli
Diethylene Triamine (DETA)	SOP 13: 8015B	One 4 oz jar	Iced	14 days	Fill to neck of jar	Overnight Hand Deli
Total Organic Carbon (TOC)	NC-WC-0018	One 2 oz jar	Iced	28 days	Fill to neck of jar	Overnight Hand Deli
AVS-SEM	BR-WC-012	One 4 oz jar	Iced	14 days	Fill to the top	Overnight Hand Deli
Grain size	BR-GT-006	One 8 oz jar	None	NA	Fill to neck of jar	Overnight Hand Deli

Notes:

[1] Samples requiring refrigeration will be sent in coolers with bags of cubed iced. Following receipt and log-in, samples will be refrigerated at 4 ± 2°C.

[2] These are technical holding times and are based on time elapsed from time of sample collection.

[3] 14 days from sample collection to extraction/40 days from extraction to completion of analysis.

TABLE 3.3

ROUTINE MAINTENANCE PROCEDURES AND SCHEDULES
RI/FS QUALITY ASSURANCE PROJECT PLAN
RTI SUPERFUND SITE
ROCKAWAY TOWNSHIP, NEW JERSEY

Instrument/Equipment	*Maintenance Procedures/Schedule*	*Spare Parts in Stock*
Gas Chromatograph/Mass Spectrometer (GC/MS)	1. Replace pump oil as needed. 2. Change septa weekly or as often as needed. 3. Change gas line dryers as needed. 4. Replace electron multiplier as often as needed. 5. Replace gas jet splitter as needed. 6. Replace GC injector glass liner weekly or as often as needed. 7. Replace GC column as needed. 8. Check daily to ensure that gas supply is sufficient for the day's activity, and the delivery pressures are set as described in the SOP. 9. Check daily to ensure the pressure on the primary regulator never runs below 100 psi. 10. Clean source as needed.	1. Syringes 2. Septa 3. Various electronic components 4. Glass jet splitter 5. GC column 6. Glass liners
Gas Chromatograph	1. Change septa weekly or as often as needed. 2. Change gas line dryers as needed. 3. Replace GC injector glass liner weekly or as often as needed. 4. Replace GC column as needed. 5. Clean/replace GC detector as needed. 6. Check daily to ensure that gas supply is sufficient for the day's activity, and the delivery pressures are set as described in the SOP. 7. Check daily to ensure the pressure on the primary regulator never run below 100 psi.	1. Syringes 2. Septa 3. Detectors 4. Glass liner 5. GC column
Purge and Trap	1. Replace trap as needed.	1. Spare traps

TABLE 3.3

ROUTINE MAINTENANCE PROCEDURES AND SCHEDULES
RI/FS QUALITY ASSURANCE PROJECT PLAN
RTI SUPERFUND SITE
ROCKAWAY TOWNSHIP, NEW JERSEY

Instrument/Equipment	*Maintenance Procedures/Schedule*	*Spare Parts in Stock*
Sample Concentrator	2. Decontaminate the system after running high concentration samples or as required by blank analysis. 3. Leak check system daily and as often as needed 4. Check daily to ensure the gas supply is sufficient for the day's activity, and the delivery pressures are set as described in the SOP. 5. Check daily to ensure the pressure on the primary regulator never run below 100 psi.	2. Spare sparger vessels 3. Various electronic components/ circuits 4. Plumbing supplies - tubing, fittings
Inductively Coupled Plasma Spectrometer (ICP)	1. Clean torch assembly and mixing chamber when discolored or after eight hours of running high dissolved solid samples 2. Clean nebulizer as needed. 3. Check daily to ensure the gas supply is sufficient for the day's activity pressures are set as described in the SOP.	1. Spare torch and mixing chambers 2. Spare nebulizer 3. Spare capillary tubing
Autoanalyzer/Spectrophotometer	1. Inspect pump tubes after each 8-hour run; replace if discolored or distorted 2. Check daily to ensure the gas supply is sufficient for the day's activity, and the delivery pressures are set as described in the SOP.	1. Pump tubing 2. Colorimeter lamps

TABLE 3.3

ROUTINE MAINTENANCE PROCEDURES AND SCHEDULES
RI/FS QUALITY ASSURANCE PROJECT PLAN
RTI SUPERFUND SITE
ROCKAWAY TOWNSHIP, NEW JERSEY

Instrument/Equipment	*Maintenance Procedures/Schedule*	*Spare Parts in Stock*
pH Meter	1. Check battery; and replace if needed. 2. After use in samples containing free oil, wash the electrode in soap and rinse thoroughly with water. Immerse the lower third of the electrode in diluted HCl (1:9) solution for 10 minutes to remove any film formed. Rinse thoroughly with water. 3. Keep electrode properly filled with appropriate filling electrolyte solution.	1. Standard buffers 2. Electrolyte filling solution 3. Spare electrode
Conductivity Meter	1. Check battery; and replace if needed. 2. After use in samples containing free oil, wash the electrode in soap and rinse thoroughly with water.	1. Standard solution 2. Spare electrodes
DO Meter	1. Check batteries and replace if needed. 2. Check condition of probe membrane and o-ring, replace if needed.	1. Spare batteries 2. Spare membranes
ORP Meter	1. Check batteries and replace if needed. 2. If probe is dirty, clean probe with soap and rinse thoroughly with water.	1. Spare batteries 2. Spare probe or ORP meter

TABLE 3.4

SUMMARY OF ANALYTICAL METHODS
RI/FS QUALITY ASSURANCE PROJECT PLAN
RTI SUPERFUND SITE
ROCKAWAY TOWNSHIP, NEW JERSEY

Parameter	*Preparation Method* [1]	*Analytical Method*
Volatile Organic Compounds (VOC) - water	SW 8260B	SW 8260B
Volatile Organic Compounds (VOC) - soil	SW 5035	SW 8260B
Semivolatile Organic Compounds (SVOC) - soil	SW 3500	SW 8270C low level
Perchlorate	EPA 314.0	EPA 314.0
Total Metals - water	SW 3005A	SW 6010B/6020/7470A
Dissolved Metals - water	SW 3005A	SW 6010B/6020/7470A
Metals - soil/sediment	SW 3050B	SW 6010B/6020/7471A
Total Hardness	EPA 130.2	EPA 130.2
Hydrazine/Monomethyl Hydrazine (MMH)/ Unsymmetrical Dimethyl Hydrazine (UDMH)	SW 9056	SW 9056
N-nitrosodimethylamine (NDMA)	SW 8270	SW 8270
Diethylene Triamine (DETA)	SW 8015	SW 8015
TOC - soil	Walkley-Black	Walkley-Black
Acid Volatile Sulfide (AVS) - Simultaneously Extracted Metals (SEM)	SW 9030/9034/3010/6010B	SW 9030/9034/3010/6010B
Grain Size	D422	D422
pH	SW 9045	SW 9045

APPENDIX A

FIELD STANDARD OPERATING PROCEDURES

SOP 1 - Procedures for Measuring pH
SOP 2 - Procedures for Measuring Conductivity
SOP 3 - Procedures for Measuring Temperature
SOP 4 - Procedures for Measuring ORP
SOP 5 - Procedures for Measuring Do/Temperature

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APPENDIX A

SOP Title	*SOP Number*
Procedures for Measuring pH	Field S.O.P. No. 1
Procedures for Measuring Conductivity	Field S.O.P. No. 2
Procedures for Measuring Temperature	Field S.O.P. No. 3
Procedures for Measuring ORP	Field S.O.P. No. 4
Procedures for Measuring Do/Temperature	Field S.O.P. No. 5

FIELD S.O.P. NO. 1
PROCEDURES FOR MEASURING pH

1.0 CALIBRATION PROCEDURE

The pH meter will be calibrated daily.

1. Switch the unit on by pressing the ON/OFF key.

2. Immerse the electrode in a pH 7 buffer. Stir gently and wait for approximately 20 seconds.

3. Press "CAL" button, display will blink.

4. When reading stabilizes, press "HOLD/CON" button. This will calibrate meter to pH 7.0. Display will stop blinking.

5. If an error message appears, the calibration was not performed correctly. Try using fresh pH solution, changing batteries, or replacing pH sensor, if applicable.

6. Rinse electrode in water and repeat steps for pH 4.0 and/or pH 10.0 buffer solutions.

7. Rinse electrode in distilled/deionized water and then immerse probe in pH 7.0 solution again to check calibration.

8. Rinse electrode with distilled/deionized water. The meter is calibrated and ready for use.

2.0 OPERATION PROCEDURE

1. Calibrate pH meter.

2. Rinse probe in distilled/deionized water.

3. Fill plastic disposable beaker with water from the sample.

4. Insert probe into sample beaker. Stir gently and wait for approximately 20 seconds and obtain a reading. The meter will read between 0 and 14, in 0.1 increments.

5. Log results in field notebook.

6. Rinse probe off in distilled/deionized water.

7. If the electrodes become coated with foreign compounds, the probe should be cleaned with a detergent solution and then rinsed with distilled/deionized water.

3.0 MAINTENANCE PROCEDURE

1. Rinse probe free of white crystals or dirt with water.

2. Replace batteries on a regular basis.

3. When batteries are low, the unit will display an error message. Remove the cover with its O-ring and replace all batteries paying attention to their polarity. Reinsert the cover with the O-ring and close. Recalibrate the instrument..

4. Keep records of usage, maintenance, calibration, problems, and repairs.

5. A replacement meter will be available onsite or ready for overnight shipment.

6. Store electrode in wet, protective cap.

7. pH meter will be sent back to manufacturer for service when needed.

4.0 QUALITY CONTROL

1. Duplicate 1 out of 10 samples. If less than 10 samples are analyzed, a duplicate is still required. Duplicates must be ±0.2 pH units.

   If the results are outside of the control limits, rinse electrodes and repeat analysis. If results are still outside of the control limits, recollect samples and repeat analysis. If the results are still outside of the control limits, check calibration and recalibrate if necessary (see item 2, below). If drift is suspected to be the cause of the problem, clean the electrode and recalibrate. If drift is still apparent, replace electrode.

2. Calibration check results must be ±0.1 pH unit of the true value. If the result is outside of ±0.1 pH unit, rinse electrodes and check solution again. If still outside the control limit, recalibrate the meter and reanalyze all samples analyzed since the last in-control calibration.

FIELD S.O.P. NO. 2
PROCEDURES FOR MEASURING CONDUCTIVITY

Conductivity is the ability of a solution to pass an electric current. This current is carried by inorganic dissolved solids. The measure of conductivity is useful to relate the chemical purity of the water and the amount of dissolved solids in a solution.

1.0 CALIBRATION PROCEDURE

The conductivity meter will be calibrated daily.

1. Immerse tip in calibration solution for 20 seconds or until reading stabilizes.
2. Turn adjusting screw until proper reading is displayed.
3. Remove from calibration solution, rinse, and cap meter.
4. Always used pre-approved calibration solution.

2.0 OPERATION PROCEDURE

1. Calibrate meter.
2. Rinse probe in distilled/deionized water.
3. Fill plastic disposable beaker with water from the sample.
4. Insert probe into sample beaker. Stir gently and wait for approximately 20 seconds and obtain a reading.
5. Log results in field notebook.
6. Rinse probe off in distilled/deionized water.
7. If the electrodes become coated with foreign compounds, the probe should be cleaned with a detergent solution and then rinsed with distilled/deionized water.

3.0 MAINTENANCE PROCEDURE

1. Replace batteries on a regular basis.
2. Store electrode in wet, protective casing when not in use.

3. Keep records of usage, maintenance, calibration, and of any problems and repair.

4. A replacement meter will be available on-site or ready for overnight shipment.

5. Conductivity meter will be sent back to manufacturer for service when needed.

4.0 QUALITY CONTROL

1. The quality control calibration check standard must be analyzed daily. The standard must be within ±10 percent of the true value or the samples run after the last acceptable check standard are to be reanalyzed. Record the calibration standard in the field logbook.

2. Duplicate a minimum of 1 out of 10 samples. If less than 10 samples are analyzed, a duplicate is still required. Duplicate values are to be within ±15% of each other. If outside of this range, reanalyze the samples. If still outside the acceptance range, recollect sample and reanalyze. If still out, replace probe.

FIELD S.O.P. NO. 3
PROCEDURES FOR MEASURING TEMPERATURE

Temperature readings will be taken at each water sampling location to assist in pH and conductivity measurement. It will also assist in chemical and biological interpretations.

1.0 CALIBRATION PROCEDURE

1. There is no calibration procedure for this piece of equipment

2.0 OPERATION PROCEDURE

1. Rinse thermometer in distilled/deionized water.
2. Immerse thermometer in the water sample and read it to the nearest degree Celsius (°C) or Fahrenheit (°F).
3. Record reading in the field notebook or relevant log.

3.0 PREVENTATIVE MAINTENANCE

1. Replace batteries on a regular basis.
2. Store in protective casing when not in use.
3. Keep records of usage, maintenance, calibration, problems, and repairs.
4. A replacement meter will be available onsite or ready for overnight shipment.
5. Annually, check instrument against thermometer that has been manufactured to a National Standard or equivalent. Temperature reading should be within ±3 °C or ±5.4 °F.

4.0 QUALITY CONTROL

1. Duplicate 1 out of 10 samples. If less than 10 samples are analyzed, a duplicate is still required. Duplicates must be ±1 degree Celsius.

   If the results are outside of the control limits, rinse electrode and repeat analysis. If results are still outside of the control limits, recollect samples and repeat analysis. If the results are still outside of the control limits, check calibration and recalibrate

if necessary (see item 2, below). If drift is suspected to be the cause of the problem, clean the electrode and recalibrate. If drift is still apparent, replace electrode.

FIELD S.O.P. NO. 4
PROCEDURES FOR MEASURING ORP

1.0 CALIBRATION PROCEDURE

The ORP meter calibration will be checked daily. The ORP meter cannot be calibrated; it can only be checked for accuracy using a known solution.

1. Turn the meter on to ensure that the LCD displays are working.

2. Rinse probe with distilled water and verify that the correct probe is connected to the instrument (red probe for ORP).

3. Insert probe into calibration check solution.

4. If ORP probe does not measure within the accuracy specified in the instruction manual, check/replace batteries and/or prepare a fresh calibration solution. If this does not work, probe should be replaced.

2.0 OPERATION PROCEDURE

1. Turn meter on. The instrument is now ready to read ORP.

2. Rinse probe with distilled water in between samples.

3.0 MAINTENANCE PROCEDURE

1. Replace batteries when necessary.

2. Replace probe when necessary.

3. Keep records of usage, maintenance, calibration, problems, and repairs.

4.0 QUALITY CONTROL

1. The quality control calibration check standard must be analyzed daily. The standard must be within ±10 percent of the true value or the samples run after the last acceptable check standard are to be reanalyzed. Record the calibration standard in the field logbook.

2. Duplicate a minimum of 1 out of 10 samples. If less than 10 samples are analyzed, a duplicate is still required. Duplicate values are to be within ±15% of each other.

If outside of this range, reanalyze the samples. If still outside the acceptance range, recollect sample and reanalyze. If still out, replace probe.

FIELD S.O.P. NO. 5
PROCEDURES FOR MEASURING DO/TEMPERATURE

1.0 CALIBRATION PROCEDURE - DISSOLVED OXYGEN

The DO meter will be calibrated daily.

1. Ensure sponge inside instrument's calibration chamber is wet. Insert probe into the calibration chamber.

2. Switch the unit on by pressing the ON/OFF key.

3. Use two fingers to press and release the up and down arrow keys at the same time.

4. Enter the local altitude in hundreds of feet. Use arrow keys to increase of decrease the altitude (ex: 12 indicates 1200 feet). Then press ENTER.

5. Enter the salinity of the water you are about to analyze. The salinity can vary from 0 to 40 parts per thousand (PPT). Use the arrow keys to increase or decrease the number. (Fresh water has a salinity of 0) Then, press ENTER.

6. If the instrument is turned off, it may be necessary to re-calibrate before taking measurements.

2.0 CALIBRATION PROCEDURE - TEMPERATURE

Ensure the LCD is reading a temperature. There is no calibration procedure for the temperature probe on this instrument. If temperature is suspect, send to manufacturer for maintenance.

3.0 OPERATION PROCEDURE

1. Calibrate DO meter.

2. Rinse probe in distilled/deionized water.

3. Insert probe into sample. Allow reading to stabilize and then obtain a reading.

4. Log results in field notebook.

5. Rinse probe off in distilled/deionized water.

6. Replace probe in protective chamber.

4.0 MAINTENANCE PROCEDURE

1. Rinse probe free of white crystals or dirt with water.

2. Replace batteries on a regular basis or when "LO BAT" message is displayed

3. Replace O_2 probe solution and membrane on a regular basis. Replace membrane per instruction manual.

4. Recalibrate the instrument after replacing batteries, O_2 solution, or membrane.

5. Keep records of usage, maintenance, calibration, problems, and repairs.

6. A replacement meter will be available onsite or ready for overnight shipment.

7. Store electrode in wet, protective chamber.

5.0 QUALITY CONTROL

1. Duplicate 1 out of 10 samples. If less than 10 samples are analyzed, a duplicate is still required. Duplicates must be ± 0.5 mg/L DO and ± 1 degree Celsius.

   If the results are outside of the control limits, rinse probe and repeat measurement. If results are still outside of the control limits, recalibrate and repeat measurements of all samples since last in-control duplicate.

APPENDIX B

LABORATORY STANDARD OPERATING PROCEDURES

APPENDIX B - LABORATORY STANDARD OPERATING PROCEDURES has been removed from this document because it contained Company Confidential Business Information (CBI). See disclaimer from original report below.

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APPENDIX C

LABORATORY QUALITY MANAGEMENT PLAN, NEW JERSEY CERTIFICATIONS, AND PE RESULTS

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APPENDIX G

HEALTH AND SAFETY PLAN

SITE-SPECIFIC HEALTH AND SAFETY PLAN

RTI SUPERFUND SITE
ROCKAWAY TOWNSHIP, NEW JERSEY

DISCLAIMER:
SOME FORMATTING CHANGES MAY HAVE OCCURRED WHEN THE ORIGINAL DOCUMENT WAS PRINTED TO PDF; HOWEVER, THE ORIGINAL CONTENT REMAINS UNCHANGED.

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Hazard Communication Program
Fall Protection Program
Respiratory Protection Program

HEALTH AND SAFETY PLAN
Signature Page

Site Name: RTI Superfund Site

Location Address: 108 Lake Denmark Road, Rockaway Township, New Jersey

Ref. No. 04354 CRA Office: St. Paul

Anticipated Start Date: September 2008 Anticipated Project Duration: 6 months

Prepared By (Signature): _____ Date: _____

Project Manager (Signature): _____ Date: _____

Reviewed By (Signature): _____ Date: _____

This signature page must be completed and be available on site for review. This page does not, however, replace the QSF-016 requirements.

1.0 INTRODUCTION

1.1 PURPOSE

The purpose of this site-specific health and safety plan (HASP) is to provide specific guidelines and establish procedures for the protection of personnel performing the activities described in Section 2.0 — Site Operations. The information in this HASP has been developed in accordance with applicable standards and is, to the extent possible, based on information available to date. The HASP is also living document in that it must continually evolve as site conditions and knowledge of the site work activities develop.

A vital element of CRA's Health and Safety Policies and Procedures is the implementation of a site-specific HASP for field activities. This HASP, as applicable to this project, includes the following measures:

- Communicate the contents of this HASP to site personnel.
- Eliminate unsafe conditions. Efforts must be initiated to identify conditions that can contribute to an accident and to remove exposure to these conditions.
- Reduce unsafe acts. Personnel shall make a conscious effort to work safely. A high degree of safety awareness must be maintained so that safety factors involved in a task become an integral part of the task.
- Inspect frequently. Regular safety inspections of the work site, materials, and equipment by qualified persons ensure early detection of unsafe conditions. Safety and health deficiencies shall be corrected as soon as possible, or project activities shall be suspended. Documentation of daily inspections and corrective actions should be kept with the project files.

1.2 STOP WORK AUTHORITY

All CRA employees are empowered and expected to stop the work of co-workers, subcontractors, client employees, or other contractors if any person's safety or the environment are at risk. NO repercussions will result from this action.

The discovery of any condition that would suggest the existence of a situation more hazardous than anticipated shall result in the removal of site personnel from that area and reevaluation of the hazard and the levels of protection.

1.3 PERSONNEL REQUIREMENTS

All personnel conducting activities on site must conduct their activities in compliance with all applicable safety and health legislation throughout North America to include, but not limited to, the Occupational Safety and Health Administration (OSHA) 29 CFR 1910, 29 CFR 1926 and CRA polices and procedures. **Project personnel must also be familiar with the procedures and requirements of this HASP**. In the event of conflicting safety procedures/ requirements, personnel must implement those safety practices which afford the highest level of safety and protection.

Employees identified as CRA Short Service Employees (6 months or less) shall not be permitted to work without another non-short service CRA employee present.

1.4 PROJECT MANAGEMENT AND SAFETY RESPONSIBILITIES

Project Manager - CRA - Robert Martin

The CRA Project Manager (PM) shall be responsible for the overall implementation of the HASP and for ensuring that all health and safety responsibilities are carried out in conjunction with this project. This shall include, but is not limited to, review and approval of the HASP. The PM will also ensure the appropriate resources are provided to support the project with respect to all operations.

Site Supervisor - CRA - To be determined

The Site Supervisor (SS) is the person who, under the supervision of the PM, shall be responsible for the communication of the site requirements to site project personnel and subcontractors, and is responsible for carrying out the health and safety responsibilities by making sure that:

1. All necessary cleanup and maintenance of safety equipment is conducted by project personnel.
2. Emergency phone numbers/services including hospital/clinic locations are verified/contacted.
3. Forms attached to the HASP are completed, filed, and submitted correctly.

4. A pre-entry briefing is conducted and documented, which will serve to familiarize on-site personnel with the procedures, requirements, and provisions of this HASP.

Other duties include overall implementation of the HASP, and ensuring all health and safety responsibilities are carried out in conjunction with this project. This shall include, but is not limited to, review and approval of the HASP, communication of site requirements to subcontractor personnel, and consultation with the client/site representative regarding appropriate changes to the HASP.

The SS also has the responsibility of enforcing safe work practices for project employees. The SS watches for any ill affects on any crew member, especially those symptoms caused by cold/heat stress or chemical exposure. The SS oversees the safety of any visitors who enter the site. The SS maintains communication with the client/site representative(s).

Other specific duties of the SS include:

- Orders the immediate shutdown and/or stop work of site activities in the case of a medical emergency, unsafe condition, or unsafe practice.
- Provides the safety equipment, personal protective equipment (PPE), and other items necessary for employees.
- Enforces the use of required safety equipment, PPE, and other items necessary for employee or community safety.
- Conducts site inspections as a part of quality assurance for safety and health.
- Reports safety and health concerns to site and/or project management as necessary.

<u>Regional Safety and Health Manager - CRA - William Doyle</u>

The Regional Safety and Health Manager (SHM) is a full-time CRA employee who is trained as a health and safety professional, who serves in a consulting role to the PM, Safety and Health Officer (SHO), and SS regarding potential health and safety issues.

Employee Safety Responsibility

CRA employees are responsible for their own safety as well as the safety of those around them. CRA employees shall use any equipment provided in a safe and responsible manner, as directed by their supervisor.

Employees are directed to take the following actions when appropriate:

- Suspend any operations which may cause an imminent health hazard to employees, subcontractors, or others.
- Correct project site hazards when possible to do so without endangering life or health.
- Report safety and health concerns to the SS, PM, or Regional SHM.

Subcontractors

CRA subcontractors are responsible for the implementation of their HASP and agree to comply with its contents. In the event of conflicting safety procedures/requirements, personnel must implement those safety practices which afford the highest level of safety and protection. In addition, it is also understood that non-compliance with health and safety policies and procedures may subject the subcontractor to disciplinary action up to and including termination of their contract with CRA. Subcontractors will be required to attend an initial site orientation and subsequent safety meetings.

Equipment Operators

All equipment operators are responsible for the safe operation of heavy equipment. Operators are responsible for inspecting their equipment on a daily basis to ensure safe performance. Brakes, hydraulic lines, backup alarms, and fire extinguishers must be inspected routinely throughout the project. Equipment will be taken out of service if an unsafe condition occurs.

Authorized Visitors

Authorized visitors shall be provided with all known information with respect to the site operations and hazards as applicable to the purpose of their visit.

1.5 TRAINING REQUIREMENTS

All personnel conducting work at the site shall have completed the appropriate health and safety training as applicable to their job tasks/duties. The required training is referenced throughout the HASP and identified on each task hazard analysis sheet.

1.5.1 SITE-SPECIFIC TRAINING

An initial site-specific training session or briefing shall be conducted by the PM or SS prior to commencement of work activities. During this initial training session, employees shall be instructed on the following topics:

- Personnel responsibilities.
- Content and implementation of the HASP.
- Site hazards and controls.
- Site-specific hazardous procedures (e.g., drilling).
- Training requirements.
- PPE requirements.
- Emergency information, including local emergency response team phone numbers, route to nearest hospital, accident reporting procedures, and emergency response procedures.
- Instruction in the completion of required inspections and forms.
- Location of safety equipment (e.g., portable eyewash, first aid kit, fire extinguishers).

The various components of the HASP will be presented followed by an opportunity to ask questions to ensure that each attendee understands the HASP. Personnel will not be permitted to enter or work in potentially contaminated areas of the site until they have completed the site-specific training session. Personnel successfully completing this training session shall sign the HASP Training Acknowledgement Form, which is presented in Appendix A.

In addition to the initial site briefing conducted at the commencement of the project, supplemental brief safety meetings shall be conducted by the SS to discuss potential health and safety hazards associated with upcoming tasks and the necessary precautions to be taken.

1.5.2 SAFETY MEETING/HEALTH AND SAFETY PLAN REVIEW

"Tailgate" safety meetings will take place each day prior to beginning the day's work. All site personnel will attend these safety meetings conducted by the SS. The safety meetings will cover specific health and safety issues, site activities, changes in site conditions, and a review of topics covered in the site-specific pre-entry briefing. The safety meetings will be documented with written sign-in sheets containing a list of topics discussed. This form is located in Appendix A.

2.0 SITE OPERATIONS

2.1 SITE HISTORY/BACKGROUND

The site located near the small residential community of Lake Telemark, New Jersey in the western portion of Morris County. The site is located approximately 5 miles north of Exit 37 off U.S. Interstate 80 and has an address of 108 Lake Denmark Road, Rockaway Township, New Jersey.

The site consists of a total of 263 acres, including a 15-acre active industrial facility (RTI Area) currently occupied by Sterigenics International, the unoccupied 65-acre Rockaway Industrial Park (RIP), and 183 acres of undeveloped land, located north and south of the RTI and RIP areas. In addition, the RIP area is comprised of three distinct former process/testing areas: East Stand, South Stand, and P2 areas.

The area around the site is generally rural in nature. However, there has been significant residential and industrial development in the region. To the west of the site, significant heavy industrial activities have been ongoing at the Army and Navy portions of the Picatinny Military Arsenal facilities since the early 1900s. Areas to the east of the site consist mainly of single-family residences situated in the population centers mentioned previously. Present land use within the site is generally considered light industrial and commercial. There are also significant undeveloped portions of the property.

Prior to 1956, the site was not developed. In 1956, Reaction Motors, Inc., that was later acquired by Thiokol, operated a rocket testing facility at the site until 1969 when Thiokol-related activities ceased. In 1972, RTI purchased a 15 acre parcel of the site (located northwest of Lake Denmark Road) where it conducted irradiation activities until it sold this operation to Sterigenics in 1996. In 1978, RTI purchased the remaining 248 acres of the site from Thiokol and leased portions of the this property to various tenants. RTI tenants have included Sterigenics International (RTI area), Ion Beam Applications, SA (RTI area), Hazard Research Corporation (S-64 Building Area), Kronenberg/Image Boat Company (R47 building area), Autobody Repair (R47 building area), and Talon Landscaping (R51 building area).

RTI was licensed in 1970 to operate megacurie pool irradiator in the RTI portion of the site. Radioactive related investigative and remedial measures, including remediation of radiological contaminated soils, were conducted by RTI from 1986 until 1996. NRC

delisted the site and terminated RTI's license in 1997. Additionally, in 1987, a radioactive waste survey of the RTI area was conducted by Oak Ridge Associated Universities for the NRC. The results of the survey indicated that there was not a potential for significant personal exposure, but suggested a deficiency in contamination control procedures. Additional surveys have been conducted under NRC supervision since 1987, and remediation of some radiologically contaminated soils was completed in 1990 and 1991. Areas of soil remediation include the 15-acre RTI area, drainage swale, area adjacent to Building 61, and the area in the northwest corner of the fenced area. The compounds of concern for radiation are Cobalt-60 and Cesium-137.

The New Jersey Department of Environmental Protection (NJDEP) and its subcontractor, Acres, previously conducted a multi-phased RI at the site. Supplemental investigations and interim remedial activities, including: sump cleaning, AST and UST removal or closure, soil excavation, and drum removal have been conducted subsequent to the Acres RI. These activities have resulted in the collection of approximately 220 soil, sediment, and surface water samples across the site.

2.2 SCOPE OF WORK

The objectives of this project are to collect soil, surface water, sediment, and tank residue samples from various areas of the site.

This HASP covers the specific site activities that will be conducted by CRA personnel and their subcontractors. These activities are as follows:

- Mobilization of personnel, materials, and equipment to and from the site;
- Clearance of potential unexploded ordnance (UXO) at test pit and soil sampling locations in areas potentially containing UXOs. UXO clearance activities will be performed by a contractor specializing in UXO;
- Collection of soil samples (surface and subsurface) from a former drum disposal area. Samples will be collected from test pits excavated at the appropriate sampling locations. Samples will be collected directly from the excavator bucket using spoons trowels and bowls as necessary. Test pit excavation work will be performed by a subcontractor;
- Collection of soil samples (surface and subsurface) from various areas around the Site (outside of the former drum disposal area). Surface and subsurface samples will

be collected using direct push (geo-probe) methods employing Macrocore samplers with stainless steel or acetate liners and Encore samplers, spoons, and trowels as necessary. In areas inaccessible to direct push drill rigs, hand auger methods will be employed;

- Collection of surface water samples from a shallow pond (approximately 3-feet deep) and drainage water in small streams. Sampling equipment will include sample containers, peristaltic pumps and disposable tubing, dissolved oxygen/temperature meter, pH meter, conductivity meter, and ORP meter. Sampling in the pond area will be conducted using waders or a boat as necessary based on the depth of the water;
- Collection of sediment samples from a shallow pond (approximately 3-feet deep) and small drainage water streams. Sampling equipment used may include Wildco (or equivalent) samplers, Encore samplers, and stainless steel or acetate lined sampling tubes. Sampling in the pond area will be conducted using waders or a boat as necessary based on the water depth;
- Collection of tank residue samples from above ground storage tanks. Sampling will include ascension of above ground tanks (as necessary), opening of tanks, and collection of liquid and/or residue samples using disposable bailers, glass thief samplers, coliwasa samplers, peristaltic pumps with disposable tubing, Encore samplers, spoons, or trowels. At no time will sampling personnel be allowed to enter the storage tanks; and
- Decontamination of equipment and personnel.

If site operations are altered or if additional tasks are assigned, an addendum to this HASP shall be developed to address the specific hazards associated with these changes. All addendum are to be developed in conjunction with project management and a CRA safety professional.

3.0 HAZARD EVALUATION

This section identifies and evaluates the potential chemical, physical, and biological hazards, which may be encountered during the completion of this project. Specific activity task hazard analysis (THA) tables (located in Appendix B) have been developed to address the hazards associated with the site operations outlined in Section 2.

3.1 CHEMICAL HAZARDS

The chemical hazards associated with conducting site operations include the potential exposure to on-site contaminants encountered during field activities such as collection of soil, sediment, surface water, and tank residue samples, products used in decontamination of equipment, and support products such as fuel. The potential routes of exposure from these products during normal use may occur through inhalation of vapors/dusts or direct contact or absorption with the materials. The chemical hazards of concern that may be encountered during the tasks identified in the project's scope of work include volatile organic compounds (VOCs), metals, energetics, and low-level radioactive waste. A listing of the contaminants of concern are found in Table 1.0, which includes exposure limits, signs and symptoms of exposure, chemical properties, and physical characteristics.

3.1.1 CHEMICAL HAZARD CONTROLS

Exposure to potential on-site contaminants/chemicals, such as those listed in Table 1.0 and Appendix C - MSDSs, shall be controlled by:

- Monitoring air concentrations for volatile organic vapors and radiation shall be conducted in the breathing zone.
- Using PPE/respiratory protection as appropriate, in areas known to have concentrations above the specified action level for each contaminant.

3.1.2 SKIN CONTACT AND ABSORPTION CONTAMINANTS

Skin contact with chemicals may be controlled by use of the proper PPE and good housekeeping procedures. The proper PPE (e.g., Tyvek, gloves) as described in

Section 4.0 shall be worn for all activities where contact with potentially harmful media or materials is anticipated. Utilize manufacturer data on permeation and degradation to minimize skin contact potential (see Section 4.2.1 for additional information).

3.1.3 FLAMMABLE AND COMBUSTIBLE LIQUIDS

The storage, dispensing, and handling of flammable and combustible liquids must be in accordance with industry standards such as National Fire Protection Agency (NFPA) guidelines. The specific flammable or combustible liquids used at the site may include gasoline, diesel, kerosene, oils, and solvents.

Flammable and combustible liquids are classified according to flash point. This is the temperature at which the liquid gives off sufficient vapors to readily ignite. Flammable liquids have flash points below 100°F (37.8°C). Combustible liquids have flash points above 100°F (37.8°C) and below 200°F (93.3°C).

Storage

Many flammables can ignite at temperatures at or below room temperature. They are far more dangerous than combustibles when they are heated. As a result, these products must be handled very carefully. At normal temperatures, these liquids can release vapors that are explosive and hazardous to health. Exposure to heat can cause some of these liquids to break down into acids, corrosives, or toxic gases. For this reason, flammable/combustible liquids should be stored in cool, well ventilated areas away from any source of ignition. Always consult the MSDS of the product for specific information.

Flammable and combustible liquids must be stored in designated areas. Such areas must be isolated from equipment and work activity which may produce flames, sparks, heat, or any form of ignition, including smoking. The most practical method is the use of one or more approved (commercially available) flammable/combustible liquid storage cabinets.

Cabinets must be labeled "Flammable - Keep Fire Away". Doors must be kept closed and labeled accordingly. Containers must be kept in the cabinet when not in use.

General Requirements

- Keep containers of flammable/combustible liquids closed when not in use.
- Keep flammable/combustible liquids in designated areas and approved cabinets.
- Do not allow the use of unapproved containers for transfer or storage. Use only approved safety cans (5-gallon maximum) with a spring closing lid and spout cover, designated to safely relieve internal pressure when exposed to heat or fire.
- Use only approved self-closing spigots, faucets, and manual pumps when drawing flammable/combustible liquids from larger containers/barrels.
- Use only approved metal waste cans with lids for disposal of shop towels/oily rags.
- Designate "Smoking" and "No Smoking" areas.
- Designate fueling areas.
- Observe all signs indicating "No Smoking", "No Flames", "No Ignition."

Transferring Flammable/Combustible Liquids

- This seemingly routine task can be hazardous if certain precautions are not followed. Grounding and bonding must be observed at all times to prevent the accumulation of static electricity when transferring containers/barrels one to another.
- Drums should be grounded (No. 4 copper conductor) to a grounding rod.
- Bonding is necessary between conductive containers (e.g., a barrel and a 5-gallon container).

3.2 PHYSICAL HAZARDS

Physical hazards that may be present during project work include: potential for close proximity to heavy equipment and drilling devices, noise, overhead or underground utilities, vehicle traffic, material handling, heavy lifting, excavations, use of hand and power tools, slip/trip/hit/fall injuries, heat stress/cold stress, working on or near water, clearance of unexploded ordnance, biological hazards, and potential adverse weather conditions. In addition, personnel must be aware that the PPE worn may limit dexterity and visibility and may increase the difficulty of performing some tasks.

3.2.1 HEAVY EQUIPMENT AND DRILLING SAFETY

Heavy Equipment

The following practices shall be adhered to by personnel operating heavy equipment (such as backhoes) and personnel working in the vicinity of heavy equipment:

- Heavy equipment is to be inspected when equipment is initially mobilized/ delivered to a site or after it is repaired and returned to service to ensure that it meets all manufacturer and OSHA specifications (e.g., fire extinguishers, backup alarms).
- Heavy equipment is to be inspected on a daily basis. Documentation of this daily pre-operational inspection is to be filed in the project file.
- Heavy equipment is only to be operated by authorized competent operators.
- Seat belts are to be provided on heavy equipment that is not designed for stand up operation.
- Equipment/vehicles whose payload is loaded by crane, excavator, loader, etc. will have a cab shield and/or canopy to protect the operator.
- Personnel will not be raised/lowered in buckets.
- Personnel will not ride on fender steps or any place outside the cab.
- Before leaving the equipment controls, ensure that the equipment is in its safe resting position. For a backhoe, apply the parking brake, put the front-loader bucket down on the ground level, and ensure that the rear excavator bucket is locked in the travel position. Bulldozers and scraper blades, loader buckets, dump bodies, and similar equipment will be fully lowered or blocked when not in use.
- Before raising a boom or bucket, check for overhead obstructions.
- Employees involved in the operation shall not wear any loose fitting clothing which has the potential to be caught in moving machinery.
- Personnel shall wear high visibility safety vests, steel-toed shoes, safety glasses, hearing protection, and hard hats during heavy equipment operations.
- When moving heavy equipment or when working in tight quarters, a spotter should be used.

Drilling Equipment

The following practices shall be adhered to by drilling personnel:

- Equipment should be inspected daily by the operator to ensure that there are no operational problems.
- Before leaving the controls, shift the transmission controlling the rotary drive into neutral and place the feed lever in neutral. Before leaving the vicinity of the drill, shut down the drill engine.
- Before raising the mast, check for overhead obstructions.
- Before the mast of a drill rig is raised, the drill rig must first be leveled and stabilized with leveling jacks and/or cribbing. Re-level the drill rig if it settles after initial setup. Lower the mast only when the leveling jacks are down, and do not raise the leveling jack pads until the mast is lowered completely.
- Employees involved in the operation shall not wear any loose fitting clothing which has the potential to be caught in moving machinery.
- During freezing weather, do not touch any metal parts of the drill rig with exposed flesh. Freezing of moist skin to metal can occur almost instantaneously.
- Personnel shall wear steel-toed shoes, safety glasses, hearing protection, and hard hats during drilling operations.
- The area shall be roped off, marked, or posted to keep the area clear of pedestrian traffic or spectators.
- Personnel should be instructed in the location and use of the emergency kill switch on the drill rig.

3.2.2 NOISE

Project activities that include using power tools that generate noise levels exceeding the decibel range of 85 dBA, will require the use of hearing protection with a Noise Reduction Rating (NRR) of at least 20. Hearing protection (earplugs/muffs) will be available to personnel and visitors who require entry into these areas.

When it is difficult to hear a co-worker at normal conversation distance, the noise level is approaching or exceeding 85 dBA and hearing protection is necessary. All site

personnel who may be exposed to high noise levels will participate in CRA's Hearing Conservation Program.

3.2.3 UTILITY CLEARANCES

Elevated superstructures (e.g., drill rigs, backhoes, scaffolding, ladders, cranes) shall remain a distance of 10 feet (3 m) away from utility lines (<50 kV) and 20 feet (6 m) away from power lines (>50 kV). Underground utilities, if present, shall be clearly marked and identified prior to commencement of work. Follow local/state/provincial regulations with regards to utility locating requirements (e.g., One-Call).

Personnel involved in intrusive work shall:

- Review and adhere to CRA's Subsurface Utility Clearance Protocol.
- Utilize the Property Access/Utility Clearance Data Sheet (QSF-019).
- Be able to determine the minimum distance from marked utilities which work can be conducted with the assistance of the locator line service.

3.2.4 VEHICLE TRAFFIC AND CONTROL

The following safety measures are to be taken by CRA personnel that have the potential to be exposed to vehicle traffic:

- A high visibility safety vest meeting ANSI Class II garment requirements is to be worn at all times.
- Employees will work using the "buddy system".
- Cones will be used to demarcate a safe work zone around the monitoring wells.
- Appropriate signage will be posted as necessary to inform roadway/parking lot users of any additional control measures necessary to protect the public and CRA employees.

3.2.5 MATERIAL HANDLING AND STORAGE

Material handling and storage practices to be conducted at the site include manual lifting of materials. As a rule, use mechanical means for lifting heavy loads whenever possible.

General Storage Practices

The basic safety requirement for storage areas is that the storage of materials and supplies shall not create a hazard. Additional general storage area practices include the following:

- Bags, containers, and bundles stored in tiers shall be stacked, blocked, interlocked, and limited in height so that they are stable and secure against sliding or collapse.
- All stacked materials and cargo shall be examined for sharp edges, protrusions, signs of damage, or other factors likely to cause injury to persons handling these objects. Defects should be corrected as they are attached.
- Storage areas shall be kept free from accumulation of materials that constitute hazards from tripping, fire, explosion, or pest harborage.
- Storage areas shall have provision to minimize manual lifting and carrying. Aisles and passageways shall provide for the movement of mechanical lifting and conveyance devices.
- Stored materials shall not block or obstruct access to emergency exits, fire extinguishers, alarm boxes, first aid equipment, lights, electrical control panels, or other control boxes.
- "NO SMOKING" signs shall be conspicuously posted, as needed, in areas where combustible or flammable materials are stored and handled.
- Cylindrical materials such as pipes and poles shall be stored in racks or stacked on the ground and blocked.

Special Precautions for Hazardous or Incomplete Materials Storage

Generally, materials are considered hazardous if they are ignitable, corrosive, reactive, or toxic. Manufacturers and suppliers of these materials must provide the recipient with MSDSs, which describe their hazardous characteristics and give instructions for their safe handling and storage.

Many hazardous materials are incompatible, which means they form mixtures that may have hazardous characteristics not described on the individual MSDSs. The following special precautions shall be followed regarding the storage of hazardous materials:

- Based on the information available on the MSDSs, incompatible materials shall be kept in separate storage areas.
- Warning signs shall be conspicuously posted, as needed, in areas where hazardous materials are stored.

3.2.6 MANUAL LIFTING

When lifting objects, use the following proper lifting techniques:

- Feet must be parted, with one foot alongside the object being lifted and one foot behind. When the feet are comfortably spread, a more stable lift can occur and the rear foot is in a better position for the upward thrust of the lift.
- Use the squat position and keep the back straight - but remember that straight does not mean vertical. A straight back keeps the spine, back muscles, and organs of the body in correct alignment. It minimizes the compression of the gut that can cause a hernia.
- Grip is one of the most important elements of correct lifting. The fingers and the hand are extended around the object you're going to lift - using the full palm. Fingers have very little power - use the strength of your entire hand.
- The load must be drawn close, and the arms and elbows must be tucked into the side of the body. Holding the arms away from the body increases the strain on the arms and elbows. Keeping the arms tucked in helps keep the body weight centered.

The body must be positioned so that the weight of the body is centered over the feet. This provides a more powerful line of thrust and also ensures better balance. Start the lift with a thrust of the rear foot. Do not twist.

3.2.7 HAND AND POWER TOOLS

Hand Tools

- Hand tools must meet the manufacturer's safety standards.
- Hand tools must not be altered in any way.
- At a minimum, eye protection must be used when working with hand tools.
- Wrenches (including adjustable, pipe, end, and socket wrenches) must not be used when jaws are sprung to the point that slippage occurs.
- Impact tools (such as drift pins, wedges, and chisels) must be kept free of mushroom heads.
- Wooden handles must be free of splinters or cracks and secured tightly to the tool.

Power Tools

- All power tools must be inspected regularly and used in accordance with the manufacturer's instructions and the tool's capabilities.
- Electric tools must not be used in areas subject to fire or explosion hazards, unless they are approved for that purpose.
- Portable electric tools must be connected to a Ground Fault Circuit Interrupter (GFCI) when working in wet areas.
- Proper eye protection must be used when working with power tools.
- Personnel must be trained in the proper use of each specific tool.
- Damaged or defective power tools must be immediately tagged and removed from service.

3.2.8 EXCAVATIONS

All CRA excavation and trenching operations, which employees will enter, will be observed by a designated competent person. The competent person shall be responsible for evaluating and inspecting excavation and trenching operations to prevent possible cave-in and entrapment, and to avoid other hazards presented by excavation activities.

Each employee in an excavation shall be protected from cave-ins by one of three systems:

- Sloping and benching systems.
- Shoring.
- Shielding systems.

All excavation and trenching operations shall be conducted in accordance and compliance with OSHA's Standards for the Construction Industry, specifically those outlined in CRA's SOP for excavation and trenching activities. At a minimum, the following safety guidelines shall be adhered to while conducting excavation and trenching activities:

- Excavation and trenching operations require pre-planning to determine whether sloping or shoring systems are required, and to develop appropriate designs for such systems. Also, the estimated location of all underground installations must be determined before digging/drilling begins. Necessary clearances must be observed.
- If there are any nearby buildings, walls, sidewalks, trees, or roads that may be threatened or undermined by the excavation, or where the stability of any of these items may be endangered by the excavation, they must be removed or supported by adequate shoring, bracing, or underpinning.
- Excavations may **not** go below the base of footings, foundations, or retaining walls unless they are adequately supported or a registered professional engineer (PE) has determined that they will not be affected by the soil removal. Civil engineers or those with licenses in a related discipline and experience should be consulted in the design and use of sloping and shoring systems. PE qualifications must be documented in writing.

<u>Access and Egress</u>

Personnel access and egress from trench and/or excavations are as follows:

- A stairway, ladder, ramp, or other means of egress must be provided in trenches greater than 4 feet (1.2 m) deep and for every 25 feet (8 m) of lateral travel.
- All ladders shall extend 3 feet (1 m) above the top of the excavation.
- Structural ramps used for access or egress of equipment will be designed by a competent person qualified in structural design or by a licensed PE.

Atmosphere Monitoring and Testing

There are three parameters by which air quality is measured: 1) oxygen concentration, 2) flammability, and 3) the presence of hazardous substances.

Employees should not be exposed to atmospheres containing less than 19.5 percent oxygen, or having a lower flammable limit greater than 10 percent, and employees should not be exposed to hazardous levels of atmospheric contaminants.

Whenever potentially hazardous atmospheres are suspected in excavations and trenches, the atmosphere shall be tested by a competent person. Detector tubes, gas monitors, and explosion meters are examples of monitoring equipment that may be used.

In the event that an unusual odor or liquid is suspected in excavations and trenches, the competent person shall stop work on the site and arrange for air quality assessment and mitigation, if necessary.

Atmospheric testing and monitoring shall be performed in excavations in or adjacent to landfill areas, in areas where hazardous materials are/were stored, or in areas where the presence of hazardous materials is suspected.

Daily Inspections

The competent person shall perform daily inspections of excavations, the adjacent areas, and all protective systems for situations that could potentially result in slope failure.

Additionally, the competent person shall be aware of the potential for confined space situations and other hazardous work conditions.

The competent person shall inspect, evaluate, and complete the excavation checklist at the following intervals:

- Prior to the start of work, after each extended halt in work, and as needed throughout the shift as new sections of the excavation or trench are opened.
- After every rainstorm and other natural or man-made event that may increase the load on the walls of the excavation or otherwise affect their stability.

The inspections shall be documented using the Safety Inspection Checklist for Excavations attached to this HASP.

The competent person shall stop the work and instruct all employees to leave the excavation or trench when any potential hazards are detected. The competent person has the authority to immediately suspend work if any unsafe condition is detected.

3.2.9 FALL HAZARDS

Personnel that will use ladders and have the potential hazard of working on elevated surfaces or platforms of 6 feet (2 m) or greater during project activities shall attach and follow CRA's Fall Protection Program. The program includes leading edge work, roof top work, aerial lifts, ladders, and scaffolds. Specific guidelines for portable ladders are outlined below.

The emergency rescue plan for retrieving any worker who has fallen and is suspended in air is as follows:

- Self rescue if possible;
- Assisted rescue from co-workers; or
- Professional rescue (i.e. fire department).

3.2.10 PORTABLE LADDERS

Employees who use ladders on worksites must be familiar with safe ladder usage.

- Use the 4-to-1 ratio; that is, place the ladder so its feet are 1 foot (0.3 m) away from what it leans against for every 4 feet (1.2 m) in height to the point where the ladder rests. Example: If the top of a 16-foot (5 m) ladder leans against a wall, its feet should be placed 4 feet from the wall. The "fireman's method" is a convenient way of checking the angle of the ladder. Place your toes against the base of the ladder, fully extend both arms toward the side rail and parallel to the ground. When standing erect you should be able to hold the ladder's side rails.
- Do not use a ladder in a horizontal position as a runway or a scaffold.

- Do not place a ladder in front of a door that opens toward it unless the door is locked, blocked, or guarded by someone.
- Place a portable ladder so that both side rails have a secure footing. Provide solid footing on soft ground to prevent the ladder from sinking.
- Place the ladder's feet on a substantial and level base, not on a movable object.
- On uneven surfaces, use a block, wedge, or ladder foot.
- On wet or oily pavement, a smooth floor, or an icy or metal surface, the ladder footing must be lashed, blocked, or otherwise secured.
- Do not lean a ladder against unsafe backing, such as loose boxes or barrels.
- When using a ladder for access to high places, securely lash or otherwise fasten the ladder to prevent its slipping.
- To gain access to a roof or elevated platform, extend the ladder at least 3 rungs (3 feet) (1 m) above the point of support.

Ascending or Descending of Ladders

- Maintain three points of contact at all times when going up or down. If material must be handled, raise or lower it with a rope.
- Always face the ladder when ascending or descending.
- Maintain clean, dry footwear as much as possible to prevent slipping on the rungs.

3.2.11 SLIP/TRIP/HIT/FALL

Slip/trip/hit/fall injuries are the most frequent of all injuries to workers. They occur for a wide variety of reasons, but can be minimized by the following prudent practices:

- Spot check the work area to identify hazards.
- Establish and utilize a pathway which is most free of slip and trip hazards.
- Beware of trip hazards such as wet floors, slippery floors, and uneven surfaces or terrain.
- Carry only loads which you can see over.
- Keep work areas clean and free of clutter, especially in storage rooms and walkways.
- Communicate hazards to on-site personnel.

- Secure all loose clothing and ties, and remove jewelry while around machinery.
- Report and/or remove hazards.
- Keep a safe buffer zone between workers using equipment and tools.

3.2.12 HEAT STRESS

Recognition and Symptoms

Temperature stress is one of the most common illnesses that project personnel face when working during periods when temperatures and/or humidity are elevated. Acclimatization and frequent rest periods must be established for conducting activities where temperature stress may occur. Below are listed signs and symptoms of heat stress. Personnel should follow appropriate guidelines if any personnel exhibit these symptoms:

Heat Rash	Redness of skin. Frequent rest and change of clothing.
Heat Cramps	Painful muscle spasms in hands, feet, and/or abdomen. Administer lightly salted water by mouth, unless there are medical restrictions.
Heat Exhaustion	Clammy, moist, pale skin, along with dizziness, nausea, rapid pulse, fainting. Remove to cooler area and administer fluids.
Heat Stroke	Hot dry skin; red, spotted or bluish; high body temperature of 104°F; mental confusion; loss of consciousness; convulsions or coma. Immediately cool victim by immersion in cool water. Wrap with wet sheet while fanning, sponge with cool liquid while fanning; treat for shock. **DO NOT DELAY TREATMENT. COOL BODY WHILE AWAITING AMBULANCE.**

Work Practices

The following procedures will be carried out to reduce heat stress:

- Heat stress monitoring.
- Acclimatization.
- Work/rest regimes (schedule of breaks) – Mandatory breaks scheduled in summer months or during high risk activities for heat stress.

- Heat stress safety personal protective equipment (cool-vests, bandanas, etc.).
- Liquids that replace electrolytes, water, and salty foods available during rest.
- Use of buddy system.

Acclimatization

The level of heat stress at which excessive heat strain will result depends on the heat tolerance capabilities of the worker. Each worker has an upper limit for heat stress beyond which the resulting heat strain can cause the worker to become a heat casualty. In most workers, appropriate repeated exposure to elevated heat stress causes a series of physiologic adaptations called acclimatization, whereby the body becomes more efficient in coping with the heat stress. Work/rest regimes planned as a component of project preparation and discussed during the daily tailgate safety meetings.

Worker Information and Training

All new and current employees who work in areas where there is a reasonable likelihood of heat injury or illness should be kept informed through continuing education programs (hazards, effects, preventative measures, drug/alcohol interaction, etc.).

3.2.13 COLD STRESS

Cold stress is similar to heat stress in that it is caused by a number of interacting factors including environmental conditions, clothing, workload, etc., as well as the physical and conditioning characteristics of the individual. Fatal exposures to cold have been reported in employees failing to escape from low environmental air temperatures or from immersion in low temperature water. Hypothermia, a condition in which the body's deep core temperature falls significantly below 98.6°F (37°C), can be life threatening. A drop in core temperature to 95°F (35°C) or lower must be prevented.

Air temperature is not sufficient to determine the cold hazard of the work environment. The wind chill must be considered as it contributes to the effective temperature and insulating capabilities of clothing. The equivalent chill temperature should be used when estimating the combined cooling effect of wind and low air temperatures on exposed skin or when determining clothing insulation requirements to maintain the body's core temperature.

The body's physiologic defense against cold includes constriction of the blood vessels, inhibition of the sweat glands to prevent loss of heat via evaporation, glucose production, and involuntary shivering to produce heat by rapid muscle contraction.

The frequency of accidents increases with cold temperature exposures as the body's nerve impulses slow down, individuals react sluggishly, and numb extremities make for increased clumsiness. Additional safety hazards include ice, snow blindness, reflections from snow, and possible skin burns from contact with cold metal.

Pain in the extremities may be the first early warning of danger to cold stress. During exposure to cold, maximum severe shivering develops when the body temperature has fallen to 95°F (35°C). This must be taken as a sign of danger to the employees on site, and cold exposures should be immediately terminated for any employee when severe shivering becomes evident. Useful physical or mental work is limited when severe shivering occurs.

Predisposing Factors for Cold Stress

There are certain predisposing factors that make an individual more susceptible to cold stress. It is the responsibility of the project team members to inform the SHO/SS to monitor an individual, if necessary, or use other means of preventing/reducing the individual's likelihood of experiencing a cold related illness or disorder.

Predisposing factors that will increase an individual's susceptibility to cold stress are listed below:

- **Dehydration:** The use of diuretics and/or alcohol, or diarrhea can cause dehydration. Dehydration reduces blood circulation to the extremities.
- **Fatigue During Physical Activity:** Exhaustion reduces the body's ability to constrict blood vessels. This results in the blood circulation occurring closer to the surface of the skin and the rapid loss of body heat.
- **Age:** Some older and very young individuals may have an impaired ability to sense cold.
- **Poor Circulation:** Vasoconstriction of peripheral vessels reduces blood flow to the skin surface.

- **Heavy Work Load:** Heavy workloads generate metabolic heat and make an individual perspire even in extremely cold environments. If perspiration is absorbed by the individual's clothing and is in contact with the skin, cooling of the body will occur.
- **The Use of PPE:** PPE usage that traps sweat inside the PPE may increase an individual's susceptibility to cold stress.
- **Lack of Acclimatization:** Acclimatization, the gradual introduction of workers into a cold environment, allows the body to physiologically adjust to cold working conditions.
- **History of Cold Injury:** Previous injury from cold exposures may result in increased cold sensitivity.

Prevention of Cold Stress

There are a variety of measures that can be implemented to prevent or reduce the likelihood of employees developing cold related ailments and disorders. These include acclimatization, fluid and electrolyte replenishment, eating a well balanced diet, wearing warm clothing, the provision of shelter from the cold, thermal insulation of metal surfaces, adjusting work schedules, and employee education.

- **Acclimatization:** Acclimatization is the gradual introduction of workers into the cold environment to allow their bodies to physiologically adjust to cold working conditions. However, the physiological changes are usually minor and require repeated uncomfortably cold exposures to induce them.
- **Fluid and Electrolyte Replenishment:** Cold, dry air can cause employees to lose significant amounts of water through the skin and lungs. Dehydration affects the flow of blood to the extremities and increases the risk of cold injury. Warm, sweet, caffeine-free, non-alcoholic drinks and soup are good sources to replenish body fluids.
- **Eating a Well Balanced Diet:** Restricted diets including low salt diets can deprive the body of elements needed to withstand cold stress. Eat high-energy foods throughout the day.
- **Warm Clothing:** It is beneficial to maintain air space between the body and outer layers of clothing in order to retain body heat. However, the insulating effect provided by such air spaces is lost when the skin or clothing is wet.

- **Work/Rest Regimes:** Schedule work during the warmest part of the day, if possible. Rotate personnel and adjust the work/rest schedule to enable employees to recover from the effects of cold stress.

The parts of the body most important to keep warm are the feet, hands, head, and face. As much as 40 percent of body heat can be lost when the head is exposed.

3.2.14 ADVERSE WEATHER CONDITIONS

The SS shall decide on the continuation or discontinuation of work based on current and pending weather conditions. Electrical storms, heavy rains, hurricanes, tornado warnings, and sustained strong winds [approximately 40 mph (65 k/hr)] are examples of conditions that would call for the discontinuation of work and evacuation of site.

In addition, no work with elevated super structures (e.g., drilling, crane operations, etc.) will be permitted during any type of electrical storm or during wind events that have wind speeds exceeding 40 mph (65 k/hr).

3.2.15 WORKING OVER OR NEAR WATER

The procedures outlined in this section are to be implemented by all CRA and subcontractor personnel when there is potential to slip or fall into water that is greater than 3 feet (1 m) in depth. Additionally, these procedures are to be adhered to when water is flowing and has the potential to carry personnel away.

- When working at ground level, a 5-foot (1.5 m) "no entry zone" can be established between the work area and the water hazard. The "no entry zone" is to be clearly defined and/or demarcated. Personnel will not be permitted to enter into this area unless the other provisions of this section are in place.
- Standard guardrails are required on any walking/working surface over or near water.
- Where guardrails are not practical due to impairment of work being performed, other types of safeguarding, such as safety harnesses, lifelines, and lanyards may be used (see CRA's Fall Protection Program).
- All personnel participating in surface water and sediment sampling (both in-water sampler(s) and on-shore observer(s)) will be required to wear U.S. Coast

Guard-approved life jackets or buoyant work. Prior to each use and after each use, the buoyant work vests and life preservers must be inspected for defects which would affect strength and/or buoyancy. Any damaged or defective buoyant work vest or life preserver cannot be used.

- Call in or make prearranged contacts after each activity posing a drowning hazard is completed.
- If it is necessary to work on wet/slippery surfaces above water, non-slip tape or other methods are to be used to increase traction.
- Due to the anticipated scope of work, it is not expected that a life saving skiff will be necessary. However, the SS in conjunction with the Regional SHM will evaluate current site conditions to determine if a skiff is required.

3.2.16 CLEARANCE OF UNEXPLODED ORDNANCE (UXO)

Overview

Certain areas at this site have the potential of containing unexploded ordnance (UXO). Areas of the site that contain the potential for UXO are shown in Figure 1 with additional detail provided in Appendix D. Soil borings and test pits being performed in the areas shown on Figure 1 will require UXO avoidance activities, to be performed by a qualified UXO technician.

UXO avoidance activities to be performed at the site are detailed below.

UXO Avoidance Activities for Soil Sampling Locations (Geo-probe/hand auger)

Prior to conducting any soil sampling work within the area on Figure 1, surface UXO avoidance activities will be performed at each sampling location. A qualified contractor, with properly trained and experienced personnel, will perform surface UXO avoidance.

The UXO contractor will be provided maps of the sample locations within the potential UXO area at the site. CRA personnel will accompany the UXO contractor to provide assistance with the precise sample location and access points.

At each sample location, the UXO contractor will be required to perform screening for UXO at a minimum of a 6-foot radius from the sample location. The cleared sample

locations will be clearly marked by UXO personnel with fluorescent orange stakes and fluorescent orange flagging tape. If the UXO contractor identifies an unexplained anomaly, the anomaly will be clearly marked with red stakes and red flagging tape. If an anomaly is detected, the sample location will be relocated to avoid potential UXO. If it is not possible to relocated the sample location, the Picatinny Police Department (973-724-6666) and Paul Greene of USACE (410-962-6741) will be contacted to remove the potential UXO. The UXO contractor will not be responsible for conducting removal activities.

The UXO contractor will document all UXO avoidance activities. The UXO contractor will notify the CRA SS when areas have been cleared for work activities. The CRA SS will communicate the status of UXO avoidance activities to field personnel. Under no circumstances are field personnel authorized to initiate sampling activities without direct authorization of the CRA SS. The status of UXO avoidance activities will be discussed during daily health and safety briefings.

UXO Avoidance Activities for Test Pit Locations

In the identified potential UXO areas where test pit excavation will be performed, surface UXO avoidance activities will be conducted to clear pathways to test pit locations. Subsurface UXO avoidance activities will be employed at each test pit location during test pit excavations. A qualified contractor, with properly trained and experienced personnel, will perform surface and subsurface UXO avoidance, as well as excavation of the test pits.

The UXO/excavation contractor will be provided maps of test pit locations within the potential UXO areas. CRA personnel will accompany the UXO/excavation contractor to provide assistance with the identification of the best pathways to each required test pit location. However, CRA personnel will not enter any potential UXO area prior to the completion of UXO surface and near surface avoidance activities.

In the potential UXO areas, the UXO/excavation contractor will be required to establish safe passageways for personnel and equipment to each test pit location. Additionally, the UXO/excavation contractor will be required to perform subsurface UXO clearance during the excavation of each test pit. The UXO/excavation contractor will be responsible for ensuring an adequate interval for subsurface UXO surveys based upon information from U.S. Army personnel in regards to UXO potential sizes and types. The UXO/excavation contractor will be required to inform the CRA SS when it is safe to

enter test pit excavation areas for the collection of soil samples and inspection of the test pit. CRA personnel will be prohibited from the test pit area until notification from the UXO/excavation contractor that the area is clear. During entry into test pit areas, personnel will be required to stay along pathways that have been deemed clear of UXO.

If an anomaly is detected during excavation of a test pit, excavation operations will immediately cease. The U.S. Army personnel at Picatinny Arsenal will be contacted by ATK (in coordination with USEPA staff) to evaluate the anomaly and take any required corrective actions. Upon resolution of the anomaly by U.S. Army personnel, excavation activities may resume at the cleared locations. If the anomaly can not be adequately cleared, the test pit may be abandoned and relocated to a new location which has been previously cleared for the presence of UXO, following approval from the CRA Project Manager and CRA's Regional Safety and Health Manager.

The UXO/excavation contractor will document all surface and subsurface UXO avoidance activities. The UXO/excavation contractor will notify the CRA SS when areas have been cleared for access and work activities. The CRA SS will communicate the status of UXO avoidance activities to field personnel. Field personnel will not be allowed within potential UXO areas without direct authorization of the CRA SS. The status of UXO avoidance activities will be discussed during daily safety and health briefings.

3.2.17 SPECIAL WORK CONDITIONS/SITUATIONS

CRA may be asked to conduct work that requires special precautions/considerations due to the following factors:

- Remote work locations.
- Project site is in an area known for high crime or violence activity.
- Entry into abandoned buildings.
- Entry into wooded areas during hunting season.

If these situations are a potential, please consult with your Regional SHM to develop a plan.

Safety During Hunting Season

There may be a significant number of hunting clubs and deer stands in the project area; precaution is advised. During hunting season, blaze orange vests and hats must be worn at all times. Also, unless absolutely required, avoid field surveys or land entry before 10:00 am and after 3:00 pm during active hunting. When walking or driving on or near active hunting areas, make noise at regular intervals using air horn, whistle, or equivalent.

3.3 BIOLOGICAL HAZARDS

CRA employees conduct numerous project activities that have the possibility of encountering biological hazards, which include bloodborne pathogens, insects, spiders, snakes, and large predators. This section identifies precautions to be taken if these hazards are encountered.

3.3.1 VEGETATION OVERGROWTH

Overgrown weeds, bushes, trees, grass, and other vegetation are fire and safety hazards.

There are a number of hidden hazards not immediately recognized due to the overgrowth of vegetation in areas where field activities may occur, including discarded junk, litter, and debris. Construction materials such as boards, nails, concrete, and other debris may be hidden beneath blades of tall grass, weeds, and bushes. Other hazards may include steep slopes, potholes, trenches, soft spots, and dips; all dangerously concealed from the view of the individual walking or operating motorized equipment in the area. Additionally, there are biological hazards such as snakes, ticks, chiggers, and mosquitoes that breed in overgrowth conditions.

Here are some simple actions you can take:

- Assess the work area and determine if the area requires vegetation clearance. Consider that overgrowth that extends above the lowest level of motorized equipment (i.e., bumper or fender) or 6 inches (15 cm) above your ankle has hidden hazards that you will not be able to readily identify.

- Determine if the area is safe to walk or whether you need motorized equipment. Consider the limitations of the equipment.
- Identify slip, trip, and fall hazards and remove from the general work area. Remember to give adequate clearance so that the items being removed do not pose future hazards.
- Adequately protect yourself against the hazards by wearing boots that protect the ankles, long pants, and using insecticides.
- Consider the limitations of manual or mechanical equipment for the clearance of overgrowth, particularly the safety hazards when using sling blades, machetes, weed eaters, bush hogs, or other brush removing equipment.

Before taking any action, determine whether there any ecological issues that would affect or prevent the removal of overgrowth in protected areas such as wetlands, wildlife habitats, or sanctuaries for endangered and/or protected species.

3.3.2 POISONOUS PLANTS

Common **Poison Ivy** grows as a small plant, a vine, and a shrub. Poison Ivy occurs in every state. The leaves always consist of three glossy leaflets. **Poison Sumac** grows as a woody shrub or small tree 5 to 25 feet (1.5 to 7.5 m) tall. It usually contains nine leaves, with eight paired leaves and one on top, and is common in swampy areas. The plants are potent sensitizers and can cause a mild to severe allergic reaction, referred to as "contact dermatitis". These plants are found in the U.S. and Canada.

Dermatitis, in Rhus-sensitive persons, may result from contact with the milky sap found in the roots, stems, leaves, and fruit, and may be carried by contacted animals, equipment or apparel.

The best form of prevention is to avoid contact. Wearing long sleeves and gloves, and disposable clothing, such as Tyvek, is recommended in high-risk areas to avoid exposure from contaminated apparel. Barrier creams and cleaners are also recommended.

3.3.3 INSECTS

Ticks

Ticks are blood feeding external parasites of mammals, birds, and reptiles throughout the world. Some human diseases of current interest in the U.S. caused by tick-borne pathogens include Lyme disease, ehrlichiosis, babesiosis, rocky mountain spotted fever, tularemia, and tick-borne relapsing fever. Lyme disease is caused by a bacterial parasite called spirochete and is spread by infected ticks that live in and near wooded areas, tall grass, and brush. The ticks that cause the disease in the Northeast and Midwest are often no bigger than a poppy seed or a comma in a newsprint. The peak months for human infection are June through October. There are many other tick borne diseases such as Rocky Mountain Spotted Fever, which can be carried by a variety of ticks. The prevention and treatment of these diseases are similar to those of Lyme disease.

Prevention

Preventative measures include wearing light-colored clothing, keeping clothing buttoned, tucking pant legs in socks, and keeping shirttails tucked in. Periodic checks for ticks should be made during the day, and especially at night. Hair should also be checked by parting it and combing through it to make sure that no ticks have attached to the scalp. Also, check clothing when it is first removed, before ticks have a chance to crawl off.

The most common repellent recommended for ticks is N,N-dimethyl-m-toluamide, or DEET. It is important to follow the manufacturer's instructions found on the container for use with all insecticides especially those containing DEET.

In general, DEET insect repellent should only be applied to clothing, not directly on the skin. Do not apply to sunburns, cuts, or abrasions. Use soap and water to remove DEET once indoors.

Removal

The best way to remove a tick is removal by tweezers. If tweezers are not available, cover your fingers (tissue paper) while grasping the tick. It is important to grasp the tick as close as possible to the site of attachment and use a firm steady pull to remove it. When removing the tick, be certain to remove all the mouth parts from your skin so as

not to cause irritation or infection. Wash hands immediately after with soap and water, and apply antiseptic to the area where tick was removed. Get medical attention if necessary.

Symptoms of Lyme Disease

The first symptoms of Lyme Disease usually appear from 2 days to a few weeks after a person is bitten by an infected tick. Symptoms usually consist of a ring-like red rash on the skin where the tick attached, and is often bulls eye like with red on the outside and clear in the center. The rash may be warm, itchy, tender, and/or "doughy" and appears in only 60 to 80 percent of infected persons. An infected person also has flu-like symptoms of fever, fatigue, chills, headaches, a stiff neck, and muscle aches and pains (especially knees). Rashes may be found some distance away from original rash. Symptoms often disappear after a few weeks.

Bees, Wasps, and Yellow Jackets

Insects that sting are members of the order Hymenoptera of the class Insecta. There are two major subgroups: aphids (honeybees, bumblebees) and vespids (wasps, yellow jackets, hornets). Aphids are docile and usually do not sting unless provoked. The stinger of the honeybee has multiple barbs, which usually detaches after a sting. Vespids have few barbs and can inflict multiple stings.

Types of stinging insects that might be encountered on a site may include:

- Carpenter Bees
- Bumblebees
- Mud Dauber Wasps
- Africanized Killer Bees
- Cicada Killer Wasps
- Giant Hornets
- Honeybees
- Paper Wasps
- Yellow Jackets

Symptoms

If you are stung there are three types of reactions you can have, a normal, a toxic, or an allergic reaction.

- Normal reaction - only lasts a few hours and consists of pain, redness, swelling, itching, and warmth near the sting area.

- Toxic reaction - will last for several days and results from multiple stings and may cause cramps, headaches, fever, and drowsiness.
- Allergic reaction - might cause hives, itching, swelling, tightness in the chest area and a possibility of breathing difficulties, dizziness, unconsciousness, and cardiac arrest.

The stingers of many Hymenoptera may remain in the skin and should be removed as quickly as possible without concern for the method of removal. An ice cube placed over the sting will reduce pain; aspirin may also be useful. Persons with known hypersensitivity to such stings should carry a kit containing epinephrine in a prefilled syringe. Antihistamines may help decrease hives and angioedema. Persons who have severe symptoms of anaphylaxis, have positive venom skin test results, and are at risk for subsequent stings should receive immunotherapy regardless of age or time since anaphylaxis.

Precautions

The following precautions can help you avoid stings. Try to wear light colored clothing and shy away from dark or floral prints. Avoid wearing perfumes, hairsprays, colognes, and scented deodorants while working outside. If eating outside, keep all food and drinks covered; sweet foods and strong scents attract stinging insects as well. Never swat or swing at the insect, it is best to wait for it to leave, softly blow it away, or gently brush it aside. Seek medical attention when the reaction to a sting includes swelling, itching, dizziness or shortness of breath.

If physical control measures are not effective, use a pesticide that will have a minimal impact on both you and the environment.

Mosquitoes

Mosquitoes are common pests that can be found in any state and any work environment where warm, humid conditions exist. Mosquitoes can pass along diseases such as West Nile virus and Malaria. Several different methods can be used to control adult mosquito populations: repellants such as DEET, mosquito traps, foggers, and vegetation and water management. Mosquitoes are found from the tropics to the Arctic Circle and from lowlands to the peaks of high mountains.

3.3.4 POISONOUS SPIDERS

Black Widow

Black Widow spiders are not usually deadly (especially to adults) and only the female is venomous. The female spider is shiny black, usually with a reddish hourglass shape on the underside of her spherical abdomen. Her body is about 1.5 inches (4 cm) long while the adult male's is approximately half that. The spider's span ranges between 1 and 3 inches (2.5 and 8 cm). The adult males are harmless, have longer legs, and usually have yellow and red bands and spots over their back, and the young black widows are colored orange and white. The bite of a black widow is often not painful and may go unnoticed. However, the poison injected by the spider's bite can cause severe reactions in certain individuals.

Symptoms

Symptoms that may be experienced include abdominal pain, profuse sweating, swelling of the eyelids, pains to muscles or the soles of the feet, salivation and dry-mouth (alternating), and paralysis of the diaphragm. If a person is bitten, they should seek immediate medical attention. Clean the area of the bite with soap and water. Apply a cool compress to the bite location. Keep effected limb elevated to about heart level. Ask doctor if Tylenol or aspirin can be taken to relieve minor symptoms. Additional information can be obtained from the Poison Center (1-800-222-1222). Black widows are found throughout the tropics, U.S., and Canada.

Brown Recluse

Brown recluse spiders are usually light brown in color, but in some instances they may be darker. Brown recluse spiders are highly venomous spiders, native to the U.S. and found coast to coast. The brown recluse can vary in size, but some can obtain bodies of 5/8 inches (1.5 cm) in length with a leg span of 1 1/2 inches (4 cm) in diameter. They can be identified by their three pairs of eyes along the head area and their fiddle shaped markings on the back. Most brown recluse bites are defensive rather than offensive. They generally only bite when they feel threatened.

Symptoms

If bitten by a brown recluse, an individual may experience open, ulcerated sores, which when left untreated may become infected and cause tissue necrosis. If an individual believes a spider has bitten them, they need to seek medical attention as soon as possible. In order to minimize the occurrence of brown recluse bites, individuals should shake their clothing and shoes thoroughly, eliminate the presence of cluttered areas, and spray the building perimeters with pesticides. Brown recluse are found throughout the U.S., Mexico, and Canada.

3.3.5 SNAKES

Snakes may be found in any region of North America. While many snakes encountered are not venomous, a few are; so it is best that you give a wide berth to all snakes. Of the 7,000 venomous snakebites reported each year, only about 15 prove to be fatal; so your chances of survival are extremely high. The usual snake encounter is one in which they see you before you see them, and they slither away from you quickly, startling you. If you see a snake, back away from it slowly and do not touch it. If you or someone you know are bitten, try to see and remember the color and shape of the snake, which can help with treatment of the snakebite.

Venomous snakes include the Coral Snake, Cobra, and Pit Vipers, such as the Cottonmouth (Water Moccasin), Copperhead, and Rattlesnake. The venom of pit vipers is primarily hematoxic because it acts upon the victim's blood system. This venom breaks down blood cells and blood vessels and affects heart action. Bite victims experience severe burning pain, localized swelling and discoloration for the first 3 to 30 minutes, followed by nausea, vomiting, and occasional diarrhea and usually shock.

Preventing Snakebites

Watching where you step, put your hands, or sit down is one of the best ways to prevent snakebites. Poisonous snakes live on or near the ground and often like rocks, woodpiles, and other spots that offer both a place to sun and a place to hide. Most bites occur in and around the ankle. About 99 percent of all bites occur below the knee, except when someone accidentally picks up or falls on the snake.

Watching where you step and wearing boots in tall grass can prevent most snakebites. Another means to protect against snakebites is snake chaps.

Emergency First Aid for Poisonous Snakebite

Although it is important to obtain medical aid immediately, emergency first aid can slow the spread of poison from the bite. Remain calm and avoid unnecessary movement, especially if someone is with you. The rate of venom distribution throughout your body will be slower if you are still and quiet. **Do not** use home remedies, and **do not** drink alcoholic beverages.

In addition, learn the following procedures so you do not waste time before getting medical attention.

- If less than 60 minutes is required to reach a hospital or other medical aid, follow this procedure:
  - Apply a constricting band 2 to 4 inches (5 to 10 cm) on each side of the bite. The band should be loose enough to slip your finger under without difficulty, so that you do not cut off circulation completely. Properly applied, the constricting band can be left safely in place for 1 hour without adjustment.
  - If ice is available, place some in a towel, shirt, or other piece of cloth and apply it to the bite area. Do not bind it to the bite, but keep it loosely in place. Do not use the ice pack for more than 1 hour. The objective is to cool the venom and slow its action, but not to freeze the tissue.
  - The primary function of the constricting band and ice pack is to slow the spread of venom through your body. Remove them slowly so there will not be a sudden rush of venom through your blood stream.

3.3.6 OTHER WILDLIFE

Bears

Black bears generally avoid contact with humans; however, this species quickly adapts to **any** source of food that humans provide (whether intentionally or accidentally). Black Bears should not be fed - avoid unnecessary bear encounters! Signs of bear presence include tracks, droppings or torn-up trees. Stay on established trails, hike only

during daylight hours and use caution when traveling near natural bear foods (berries, fish, etc.). Its habitat ranges from the Tropics of Florida to the Arctic.

Cougars

The **Eastern Cougar** is the second largest cat (after the jaguar) found in the New World. The cougar, also puma or mountain lion, is a carnivore of North and South America with thick fur that ranges from reddish-brown in tropical forms to bluish-gray in northern forms. Its body is lithe, muscular, deep chested and compact; it has a rounded and shortened head, large eyes, and a distinctively long tail. The male can weigh up to 160 pounds (71 kg) and measure 6.5 feet (2 m) in length. Cougars are extremely elusive and usually avoid contact with people. However, they are known to stalk their prey, striking with full impact and most often kill by suffocating with a prolonged bite across the throat or by breaking the victim's neck.

3.4 BLOODBORNE PATHOGENS

Hepatitis B is largely transmitted through exposure to bodily fluids containing the virus which could be found on refuse encountered in subsurface investigations. This includes medical wastes, contaminated needles and syringes, and so on. The primary method of transmission depends on the prevalence of the disease in a given area.

Prevention

Preventative measures include wearing appropriate PPE – leather work gloves, long sleeved shirt, and safety footwear. Several vaccines have been developed for the prevention of hepatitis B virus infection. These rely on the use of one of the viral proteins (hepatitis B surface antigen or HbsAg). The vaccine was originally prepared from plasma obtained from patients who had long-standing hepatitis B virus infection. However, currently these are more often made using recombinant technology, though plasma-derived vaccines continue to be used; the two types of vaccines are equally effective and safe.

4.0 PERSONAL PROTECTIVE EQUIPMENT

4.1 GENERAL

This section shall cover the applicable personal protective equipment (PPE) requirements, which shall include eye, face, head, foot, and respiratory protection.

The purpose of PPE is to shield or isolate individuals from the chemical and physical hazards that may be encountered during work activities.

4.2 TYPES OF PPE

The type of PPE for a project will vary based on the level of protection required to protect the employee from site physical, chemical, biological, and thermal hazards.

4.2.1 TYPES OF PROTECTIVE MATERIAL

Protective clothing is constructed of a variety of different materials for protection against exposure to specific chemicals. No universal protective material exists. All will decompose, be permeated, or otherwise fail to protect under certain circumstances.

Fortunately, most manufacturers list guidelines for the use of their products. These guidelines usually concern gloves or coveralls and generally only measure rate of degradation (failure to maintain structure). It should be noted that a protective material may not necessarily degrade but may allow a particular chemical to permeate its surface. For this reason, guidelines must be used with caution. When permeation tables are available, they should be used in conjunction with degradation tables.

In order to obtain optimum usage from PPE, the following procedures are to be followed by all site personnel using PPE:

- When using disposable coveralls, don a clean, new garment after each rest break or at the beginning of each shift.
- Inspect all clothing, gloves, and boots both prior to and during use for:
  - imperfect seams;
  - non-uniform coatings;

- tears; and
- poorly functioning closures.

- Inspect reusable garments, boots, and gloves both prior to and during use for:
  - visible signs of chemical permeation;
  - swelling;
  - discoloration;
  - stiffness;
  - brittleness;
  - cracks;
  - any sign of puncture; and
  - any sign of abrasion.

Reusable gloves, boots, or coveralls exhibiting any of the characteristics listed above shall be discarded. PPE used in areas known or suspected to exhibit elevated concentrations of chemicals shall not be reused.

4.3 RESPIRATORY PROTECTION

Respiratory protection may be worn by personnel during project activities. Personnel required to work in these areas shall wear an air-purifying respirator and follow the procedures and guidelines as described below and follow CRA's Respiratory Protection Program.

All personnel required to use this equipment shall first be instructed in how to properly fit a respirator to achieve the required face-piece-to-face seal for respiratory protective purposes. Conditions, which could affect this face seal, are the presence of beards, sideburns, eyeglasses, and the absence of upper or lower dentures.

The air-purifying respirator cartridges selected for use during project work at the site are ***P-100 organic vapor cartridges***. These cartridges have the ability to protect against the known contaminant concentrations.

All cartridges shall be changed prior to breakthrough or at a minimum daily. Changes shall also be made when personnel begin to experience increased inhalation resistance or breakthrough of a chemical warning property.

4.3.1 RESPIRATOR CLEANING

Respiratory equipment and other non-disposable equipment shall be fully decontaminated and then placed in a clean storage area. Respirator decontamination shall be conducted at a minimum once daily. Face pieces shall be disassembled, the cartridges thrown away, and all other parts placed in a cleansing solution. After an appropriate amount of time in the solution, the parts shall be removed and re-seated with tap water.

Face pieces shall be allowed to air dry before being placed in sanitized bags, and then stored in a clean area.

4.4 LEVELS OF PROTECTION

The level of protection must correspond to the level of hazard known, or suspected, in the specific work area. PPE has been selected with specific considerations to the hazards associated with site activities. The specific PPE to be used for each activity is outlined in each THA table located in Appendix B.

- All PPE shall be disposed of and/or decontaminated at the conclusion of each work day as described below. Decontamination procedures shall follow the concept of decontaminating the most contaminated PPE first.
- All disposable equipment shall be removed before meal breaks and at the conclusion of the workday and replaced with new equipment prior to commencing work.
- Eating, drinking, chewing gum or tobacco, and smoking are prohibited while working in areas where the potential for chemical and/or explosive hazards may be present. Personnel must wash thoroughly before initiating any of the aforementioned activities.

4.4.1 REASSESSMENT OF PROTECTION LEVELS

Protection levels provided by PPE selection shall be upgraded or downgraded based upon a change in site conditions or the review of the results of air monitoring or the initial exposure assessment monitoring program, if one was conducted.

When a significant change occurs, the hazards shall be reassessed. Some indicators of the need for reassessment are:

- Commencement of a new work phase.
- Change in job tasks during a work phase.
- Change of season/weather.
- When temperature extremes or individual medical considerations limit the effectiveness of PPE.
- Chemicals other than those expected to be encountered are identified.
- Change in ambient levels of chemicals.
- Change in work scope, which affects the degree of contact with areas of potentially elevated chemical presence.

All proposed changes to protection levels and PPE requirements shall be reviewed and approved prior to their implementation by the SS.

5.0 AIR MONITORING PROGRAM

Inhalation hazards are caused from the intake of vapors and contaminated dust. Air monitoring shall be performed while intrusive activities are taking place to detect the presence and relative level of those air contaminants which are inhalation hazards. The purpose of air monitoring is to identify and quantify airborne contaminants in order to determine the level of worker protection needed. Initial screening for identification is often qualitative, but the determination of its concentration (quantification) must wait subsequent testing.

The data collected throughout the monitoring effort shall be used to determine the appropriate levels of protection.

5.1 EXPOSURE MONITORING

Air monitoring equipment to be used during site activities shall consist of photoionization detectors (PIDs), LEL meter, colorimetric detector tubes, and a radiation monitor.

5.1.1 PHOTOIONIZATION DETECTORS

Exposure to volatile organic compounds (VOCs) shall be monitored with a photoionization detector (PID) with a 11.8 eV lamp. The PID has the ability to detect organic vapor concentrations from 1 part per million (ppm) to 2,000 ppm. All PID monitoring shall be conducted in the breathing zone.

5.1.2 LEL/O_2 METER

The LEL/O_2 meter is a combination oxygen and combustible gas indicator which simultaneously monitors oxygen concentrations and LEL percentages in air. When used properly, the portable oxygen indicator will read the percent oxygen in the immediate atmosphere. The normal ambient oxygen concentration is 20.9 percent at sea level. It is necessary to be apprised of such readings as they impact LEL readings and vice versa.

The following table provides the action level for each contaminant being monitored.

Parameter	*Action Level*	
Oxygen	Less than 19.5 O_2 Greater than 23.5% O_2	Stop work and evacuate area if levels are less than 19.5% O_2 or greater than 23.5% O_2.
LEL	Less than 10% LEL	Continue work and evaluate work conditions.
	Greater than 10% LEL	Stop work and evacuate area if levels are greater than 10% LEL. Shut off or eliminate any ignition sources along perimeter of site. Consult the Regional SHM and PM.

5.1.3 COLORIMETRIC DETECTOR TUBES

Detector tubes are one of the most frequently used measuring methods for detecting contaminants in the work area. The reason they are used so often is that no other simple system is currently able to cover such a wide range of gases and vapors quantitatively. The major limitation of detector tubes is that their accuracy is commonly taken as within 25 percent of the true concentration of the contaminants sampled. Detector tubes are also known as "colorimetric tubes" or "indicator tubes". Detector tubes are small glass tubes filled with solid absorbents such as silica gel, activated alumina or inert granules, and impregnated with detecting chemicals through which air is aspirated at a controlled rate. Common types of Detector Tubes include: Draeger, Gastec, RAE, MSA, Sensidyne, etc.).

5.1.4 LOW-LEVEL RADIATION METERS

Exposure to possible low-level radiation at the site shall be monitored with a low-level radiation meter (i.e. Victoreen survey meter). All radiation monitoring shall be conducted in the breathing zone. Radiation monitoring is only expected to be required during the soil sampling in the former drum disposal area. If the radiation level exceeds 0.6 mrem/hr, the site will be evacuated and the RSHM and PM will be contacted.

5.1.5 MONITORING FREQUENCY

A summary of the monitoring equipment and frequency for each work activity is presented in the task hazard analysis tables, included in Appendix B. As noted in the

table, the monitoring equipment listed per work activity relates to the initial level of protection. The monitoring frequency may be decreased if the work areas and activities are unchanging, the result of the first hour of monitoring indicate contaminant concentrations are non-detect, and no differing conditions are observed.

5.1.6 HEALTH AND SAFETY ACTION LEVELS

An action level is a point at which increased protection or cessation of activities is required due to the concentration of contaminants in the work area. All activities shall be initiated in Modified Level D. The appropriate actions are to be taken at designated action levels. The initial action level for site work is 1 ppm (VOCs measured with PID) where an upgrade to Level C is required. If vinyl chloride is present greater than 1 ppm, level B will be utilized.

In addition to the action level, an upgrade to Level C is required if:

- Any symptoms occur, as described in Section 3.0.
- Requested by an individual performing the task.
- Any irritation to eye, nose, throat, or skin occurs.

A work stoppage and evacuation (cease and desist) at the specific work area is required if levels in the breathing zone exceed the protection factor of the respirator, or if any of the following occur:

- PID readings of 10-ppm or higher;
- Radiation readings of 0.6-mrem/hr or higher (where applicable);
- LEL readings greater than 10% LEL (where applicable); or
- Oxygen readings less than 19.5% or greater than 23.5% (where applicable).

In the event of a work stoppage, the RHSM and PM will be notified immediately.

6.0 SITE CONTROL

The purpose of site control is to minimize potential contamination of workers and protect the public from hazards found on site. Site control is especially important in emergency situations.

Site control and work area demarcation will be achieved through posting of signage and placement of barricades. All construction areas will have the appropriate signage posted. Barricades and warning signs will be placed to warn personnel of potential hazards. A standby person (spotter) may be utilized in place of barricades, where appropriate. The following materials may be used to barricade construction areas, crane swing radius, and control traffic, etc.:

- Temporary fence.
- High visibility tape, rope, or chains.
- Traffic cones.
- Sawhorses; and
- Wood or metal guardrails.

One pathway should be established for heavy equipment and one for personnel decontamination.

The majority of site operations, as well as access to the site, could be controlled from the support zone. The support trailer would provide for team communications and emergency response, and sanitary facilities (i.e., Porta-Potty). Appropriate safety and support equipment also will be located in this zone.

The support zone will be located upwind of site operations, if possible, and would be used as a potential evacuation point, if appropriate. No potentially contaminated personnel or materials are allowed in this zone.

6.1 COMMUNICATION

Each member of the site entry team will be able to communicate with another entry team member at all times. Communications may be by way of an air horn, walkie-talkie, telephone, or hand signals.

The primary means for external communication are telephones and radio. If telephone lines are not installed at a site, all team members should:

- Know the location of the nearest telephone.
- Have the necessary telephone numbers readily available.

The following standard hand signals will be mandatory for all employees to understand regardless of other means of communication:

- Hand gripping throat - Cannot breathe.
- Hands on top of head - Need assistance.
- Thumbs up - OK, I'm all right, I understand.
- Thumbs down - No, negative.
- Gripping partner's wrist, or gripping both of your own hands on wrist (if partner is out of reach) - Leave area immediately.

6.2 BUDDY SYSTEM

6.2.1 RESPONSIBILITIES

A buddy system shall be implemented when conducting intrusive activities on the site. This buddy shall be able to:

- Provide his or her partner with assistance.
- Observe his or her partner for signs of chemical exposure or temperature stress.
- Periodically check the integrity of his or her partner's protective clothing.
- Notify emergency personnel if emergency help is needed.

6.3 SITE SECURITY

Site security is necessary to prevent the exposure of unauthorized, unprotected people to site hazards and to avoid interference with safe working procedures. Security shall be maintained outside of the actual work area(s) so as to prevent unauthorized entry into the work area(s). Members of the general public are to be protected from site hazards.

6.4 DECONTAMINATION

It is the responsibility of the SS to ensure that all personnel and pieces of equipment coming off site are properly decontaminated according to the procedures outlined below. Documentation of decontamination must be made in the field log notebook that will become part of the permanent project file.

6.4.1 PERSONNEL AND EQUIPMENT DECONTAMINATION PROCEDURES

All PPE shall be disposed of and/or decontaminated at the conclusion of each workday as described below. Decontamination procedures shall follow the concept of deconning the most contaminated PPE first.

All disposable equipment shall be doffed before meal breaks and at the conclusion of the workday and replaced with new equipment prior to commencing work.

Procedures for decontamination must be followed to prevent the spread of contamination and to eliminate the potential for chemical exposure.

Personnel: Decontamination shall be initiated prior to exiting the contaminated work area and be completed in the Contamination Reduction Zone.

Modified Level D: First, remove outer protective wear. Remove gloves and properly dispose of in a designated waste container. Wash hands and face.

Level C: Wash and rinse outer gloves, boots and suit, and remove; then remove respirator; dispose of cartridges; wash respirator; remove inner gloves and dispose of them. Wash hands and face.

Handle all clothing inside out when possible.

Equipment: All equipment must be decontaminated with Alconox/Liquinox solution or discarded upon exit from the contaminated area in a well ventilated area. A temporary decon pad with a low-volume high-pressure washer will be set up on site during drilling operations. All decon materials shall be drummed for subsequent disposal.

7.0 EMERGENCY PROCEDURES

7.1 ON-SITE EMERGENCIES

Emergencies can range from minor to serious conditions. Various procedures for responding to site emergencies are listed in this section. The PM or SS is responsible for contacting local emergency services, if necessary, for specific emergency situations. Various individual site characteristics will determine preliminary action to be taken to assure that these entry procedures are successfully implemented in the event of an emergency. Address necessary facility/client emergency protocols to ensure compatibility between this document and facility/client programs and/or expectations.

An Emergency Information Sheet containing the hospital location, directions, government agency phone numbers, emergency phone numbers, and a map with directions to the hospital is located in Appendix A.

7.2 ACCIDENT, INJURY, AND ILLNESS REPORTING AND INVESTIGATION

Any work-related incident, accident, injury, illness, exposure, or property loss must be reported to your supervisor, the SS, and **within 1 hour** through the CRA Accident Reporting System. Motor vehicle accidents must also be reported through this system. CRA's Accident Report Form, located in Appendix A, must also be filled out and provided to the SS. The report must be filed for the following circumstances:

- Accident, injury, illness, or exposure of an employee.
- Injury of a subcontractor.
- Damage, loss, or theft of property.
- Any motor vehicle accident, regardless of fault, which involves a company vehicle, rental vehicle, or personal vehicle while the employee is acting in the course of employment.

Occupational accidents resulting in employee injury or illness will be investigated by the SS. This investigation will focus on determining the cause of the accident and modifying future work activities to eliminate the hazard.

All employees have the obligation and right to report unsafe work conditions, previously unrecognized safety hazards, or safety violations of others. If you wish to make such a report, it may be made orally to your supervisor or other member of management, or you may submit your concern in writing, either signed or anonymously.

7.3 EMERGENCY EQUIPMENT/FIRST AID

Safety equipment will be available for use by site personnel, will be located within 30 feet (9 m) of the work area(s), and will be maintained at the site. The safety equipment will include, but is not limited to, the following: a 10-unit first aid kit (dependent upon the number of personnel), emergency alarm (i.e., air horn), emergency eyewash, an ABC fire extinguisher (2A/10BC), potable water, anti-bacterial soap, and telephone.

1. **First-degree burns** are superficial but can be painful because these burns usually do not damage the nerves. These types of burns will cause outer layers of skin to redden or discolor and to swell slightly.
2. **Second-degree burns** penetrate skin more deeply and are more severe than first-degree burns. In addition, second-degree burns affect skin by creating a red or mottled appearance, blisters, and swelling. These burns are also very painful because the nerve endings are still intact.
3. **Third-degree burns** are the most severe burns and have the deepest penetration of the types of burns. Third-degree burns may appear white or charred. They may even look like second-degree burns but they extend through all skin layers. In addition, third-degree burns destroy nerve endings, so third-degree burns can be less painful than second-degree burns.

Burns must be treated by medical personnel. However, you may need to provide first aid until professional help arrives. Listed below are several actions that you can take if someone is burned:

- Cool minor burns with water.
- Refrain from applying ice to any but the most minor first-degree burns.
- Refrain from breaking open blisters.

- Refrain from touching a burned area because touching the burned area increases the risk of infection.
- Refrain from applying ointment to a severe burn.
- Refrain from removing anything stuck to a burned area.

7.4 EMERGENCY PROCEDURES FOR CONTAMINATED PERSONNEL

Whenever possible, personnel should be decontaminated in the contamination reduction zone before administering first aid, without causing further harm to the patient.

Skin Contact: Remove contaminated clothing, wash immediately with water and use soap if available.

Inhalation: Remove victim from contaminated atmosphere. Remove any respiratory protection equipment. Initiate artificial respiration, if necessary. Transport to the hospital.

Ingestion: Remove from contaminated atmosphere. Do not induce vomiting if victim is unconscious. Also never induce vomiting when acids, alkalis, or petroleum products are suspected. Transport to the hospital, if necessary.

Any person transporting an injured/exposed person to a clinic or hospital for treatment should take with them directions to the hospital and a listing of the contaminants of concern to which they may have been exposed.

Any vehicle used to transport contaminated personnel shall be cleaned or decontaminated, as necessary.

7.5 SITE EVACUATION

In the event of an emergency situation such as fire, explosion, significant release of toxic gases, etc., an air horn or other appropriate device will be sounded for approximately 10 seconds indicating the initiation of evacuation procedures. Personnel in the field will be notified through established communications to evacuate the area. In the event of an emergency, CRA personnel shall gather at their primary mustering point for a head count. The mustering point location will be determined by the SHO and SS and will be

communicated to the work crew(s) during the site-specific training prior to commencement of work activities.

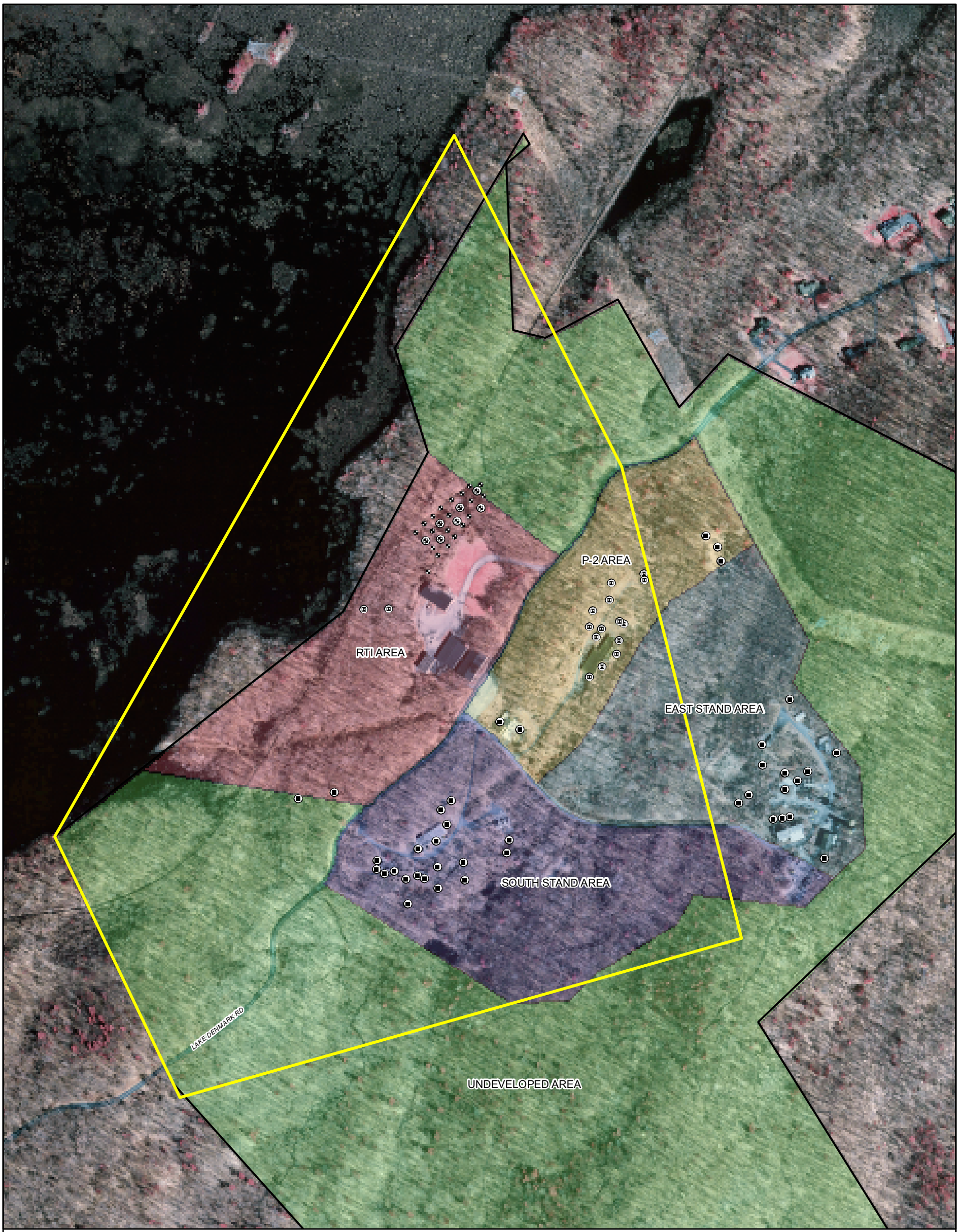
7.6 SPILL AND RELEASE CONTINGENCIES

If a spill has occurred, the first step is personal safety, then controlling the spread of contamination if possible. CRA personnel shall immediately contact site management to inform them of the spill and activate emergency spill procedures.

8.0 RECORDKEEPING

The SS shall establish and maintain records of all necessary and prudent monitoring activities as described below:

- Name and job classification of the employees involved on specific tasks.
- Air monitoring/sampling results and instrument calibration logs.
- Records of training acknowledgment forms (site-specific training, toolbox meetings, etc.)
- Documentation of site inspections, results of inspections and corrective actions implemented.
- Records of OSHA Training Certifications for site personnel (40-Hour HAZWOPER, 8-hour refreshers, etc.)
- Records of qualitative fit-testing and physical examination results for site personnel (as necessary).
- Emergency reports describing any incidents or accidents.



LEGEND

- PROPOSED TEST PIT / SAMPLING LOCATION
- PROPOSED TEST PIT
- PROPOSED BORING LOCATION
- PROPOSED SURFACE SOIL SAMPLING POINT
- UXO CLEARANCE AREA
- PROPERTY BOUNDARY
- RTI AREA
- EAST STAND AREA
- P-2 AREA
- SOUTH STAND AREA
- UNDEVELOPED AREA

N

0 200 400

Feet

figure 1

AREAS REQUIRING UXO CLEARANCE
RTI SUPERFUND SITE
Rockaway Township, New Jersey

4354-55(012)GIS-SP001 FEB 1/2008

300505

TABLE 1.0

PROPERTIES OF POTENTIAL SITE CONTAMINANTS

Chemical Name (Synonyms)	*Concentration at Site*	*Exposure Limits*	*Routes Of Entry*	*Symptoms/Health Effects*	*Chemical Properties*	*Physical Characteristics*
1,1,1 Trichloroethane Methyl chloroform Chlorothene CAS-71-55-6	51 ug/L (SW/GW), 15 ug/kg (sed/soil)	TLV: 350 ppm PEL: 350 ppm STEL: 450 ppm IDLH: 700 ppm	Inhalation Ingestion Skin contact Eye contact	ACUTE: Irritating to eyes, skin and respiratory tract. May affect CNS, heart, liver and kidneys resulting in cardiac disorders and respiratory failure. High level exposure may cause death. CHRONIC: Defatting of the skin, may cause liver damage.	(FP) NE (VP) 100 mm (IP) 11.00 eV (UEL) 12.5% (LEL) 7.5%	Colorless liquid with a mild, chloroform-like odor.
1,1-Dichloroethene 1,1-DCE VDC Vinylidene chloride CAS-75-35-4	27 ug/L (SW/GW), 130 ug/kg (sed/soil)	TLV: 5 ppm PEL: NE STEL: NE IDLH: NE	Inhalation Ingestion Skin contact Absorption Eye contact	ACUTE: Irritation of the eyes, skin and respiratory tract. Dizziness, headache, nausea. Ingestion may cause chemical pneumonitis. Exposure could cause lowering of consciousness. CHRONIC: Dermatitis. May cause damage to kidneys and liver. Possible human carcinogen.	(FP) -2°F (VP) 500 mm (IP) 10.00 eV (UEL) 15.5% (LEL) 6.5%	Colorless liquid or gas (>89°F) with a mild, sweet, chloroform-like odor.
Aluminium Aluminum metal Aluminum powder CAS-7429-90-5	3380 ug/L (SW/GW), 179,000 mg/kg (sed/soil)	TLV: 10 mg/m3 [Dust] PEL: TWA 15 mg/m3 STEL: NE IDLH: NE	Inhalation Skin contact Eye contact	ACUTE: Irritation eyes, skin, respiratory system. CHRONIC: Eyes, skin, respiratory system.	(FP) NE (VP) NE (IP) NE (UEL) NE (LEL) NE	Silvery-white, malleable, ductile, odorless metal. Combustible Solid, finely divided dust is easily ignited; may cause explosions.
Carbon tetrachloride Carbon chloride Tetrachloromethane Tetrachlorocarbon CAS-56-23-5	140 ug/L (SW/GW)	TLV: 2 ppm [skin] PEL: 10 ppm STEL: 10 ppm IDLH: 200 ppm	Inhalation Ingestion Skin contact Absorption Eye contact	ACUTE: Irritation of the eyes and skin. Nausea, dizziness. May affect liver, kidneys and CNS, resulting in unconsciousness. CHRONIC: Dermatitis. May cause damage to kidneys. Possible human carcinogen.	(FP) NE (VP) 91 mm (IP) 11.47 eV (UEL) NE (LEL) NE	Colorless liquid with a characteristic ether-like odor.
Chloroform Methane trichloride Trichloromethane CAS-67-66-3	10 ug/L (SW/GW), 120 ug/kg (sed/soil)	TLV: NE PEL: 50 ppm (C) STEL: 2 ppm IDLH: 500 ppm	Inhalation Ingestion Skin contact Absorption Eye contact	ACUTE: Irritation of the eyes and skin. Dizziness, headache, nausea and confusion. CHRONIC: Enlarged liver. Possible human carcinogen.	(FP) NE (VP) 160 mm (IP) 11.42 eV (UEL) NE (LEL) NE	Colorless liquid with a pleasant odor.
Chromium (metal) Chrome CAS-7440-47-3	167 ug/L (SW/GW)	TLV: 0.5 mg/m3 PEL: 1.0 mg/m3 STEL: NE IDLH: 250 mg/m3	Inhalation Ingestion Skin contact Eye contact	ACUTE: Irritation to eyes, skin and lungs. CHRONIC: Skin sensitization, fibrosis (histologic)	(FP) NA (VP) NA (IP) NA (UEL) NA (LEL) NA	Blue-white to steel gray, lustrous, brittle, hard, odorless solid.
Iron CAS-7439-89-6	8260 ug/L (SW/GW), 338,000 mg/kg (sed/soil)	TLV: 0.5 mg/m3 PEL: NE STEL: NE IDLH: NE	Absorption Inhalation Ingestion	ACUTE: Dust irritates eyes and respiratory tract CHRONIC:	(FP) NE (VP) NE (IP) NE (UEL) NE (LEL) NE	Grey crystalline powder

TABLE 1.0

PROPERTIES OF POTENTIAL SITE CONTAMINANTS

Chemical Name (Synonyms)	*Concentration at Site*	*Exposure Limits*	*Routes Of Entry*	*Symptoms/Health Effects*	*Chemical Properties*	*Physical Characteristics*
Nickel (metal) CAS-7440-02-0	94 ug/L (SW/GW), 35 mg/kg (sed/soil)	TLV: .015 mg/m3 PEL: 1 mg/m3 STEL: NE IDLH: 10 mg/m3	Inhalation Ingestion Skin contact Eye contact	ACUTE: May cause mechanical irritation, pneumonitis (fume inhalation). CHRONIC: Sensitization, asthma, damage to lungs. Possible human carcinogen.	(FP) NA (VP) NA (IP) NA (UEL) NA (LEL) NA	Lustrous, silvery, odorless, solid.
Thallium (metal) CAS-7440-28-0	unknown	TLV: 0.1 mg/m3 [skin] PEL: 0.1 mg/m3 [skin] STEL: NE IDLH: 15 mg/m3	Inhalation Ingestion Skin contact Absorption Eye contact	ACUTE: May affect gastrointestinal tract, nervous system, kidneys and cardiovascular system. May cause hair loss and atrophy of nails. Ingestion may cause death. Effects may be delayed. CHRONIC: May affect nervous system, cardiovascular system and may cause hair loss.	(FP) NA (VP) NA (IP) NA (UEL) NA (LEL) NA	Bluish-white, very soft metal. Turns grey on exposure to air.
Trichloroethene TCE Trichloroethylene Ethylene trichloride CAS-79-01-6	140 ug/L (SW/GW), 74 ug/kg (sed/soil)	TLV: 50 ppm PEL: 100 ppm STEL: 100 ppm IDLH: 1,000 ppm	Inhalation Ingestion Absorption	ACUTE: Irritation to eyes and skin. Ingestion may cause chemical pneumonitis. Affects CNS. Unconsciousness due to exposure. CHRONIC: Dermatitis. Affects CNS, loss of memory. May damage liver and kidneys. Probable human carcinogen.	(FP) NE (VP) 58 mm (IP) 9.45 eV (UEL) 10.5% @ 77°F (LEL) 8.0% @ 77°F	Colorless liquid with a chloroform-like odor. Sometimes dyed blue.
Vinyl Chloride Chloroethene VCM Chloroethylene CAS-75-01-4	99 ug/L (SW/GW),	TLV: 1 ppm PEL: 1 ppm STEL: 5 ppm (C) IDLH: NE	Inhalation Skin contact Eye contact	ACUTE: Irritation to eyes. Affects CNS. May cause unconsciousness. CHRONIC: Affects liver, spleen, blood and peripheral blood vessels, tissue and bones in fingers. Human carcinogen.	(FP) NA (gas) (VP) 3.3 atm (IP) 9.99 eV (UEL) 33.0% (LEL) 3.6%	Colorless gas or liquid (<7°F) with a pleasant odor at high concentrations.

APPENDIX A

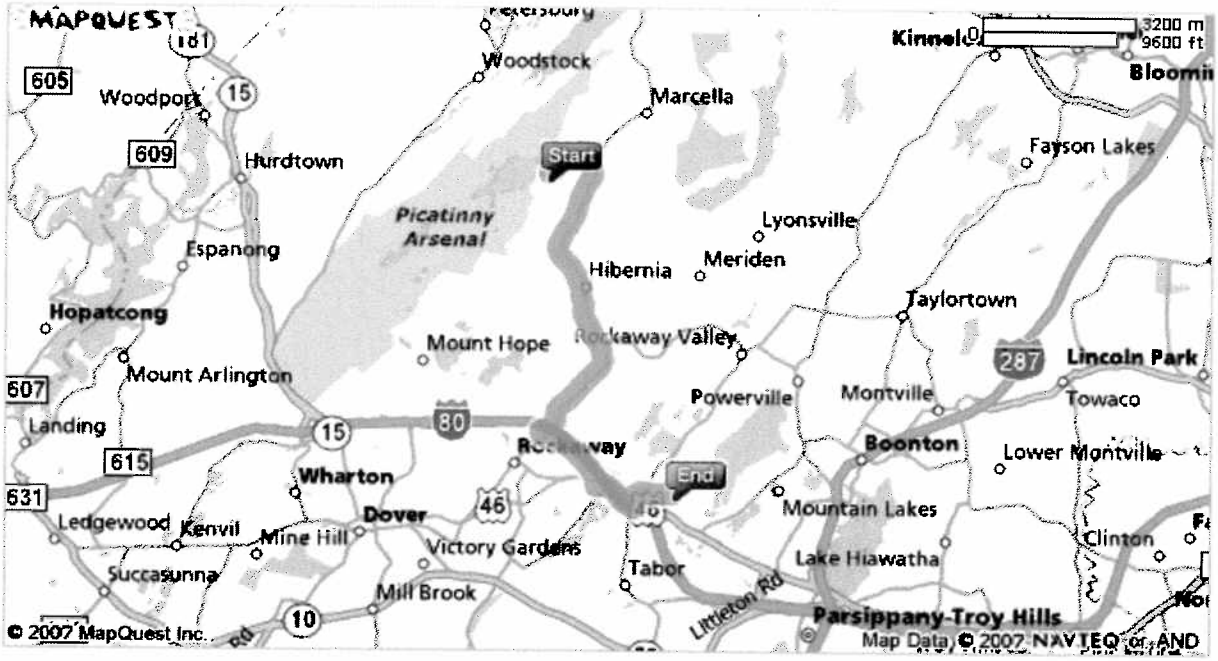
FORMS

- EMERGENCY CONTACT SHEET
- HASP ACKNOWLEDGEMENT FORM
- TAILGATE SAFETY MEETING FORM
- SAFETY INSPECTION CHECKLIST FOR EXCAVATIONS
- CRA ACCIDENT REPORTING FORM
- PROPERTY ACCESS/UTILITY CLEARANCE DATA SHEET

CRA RTI SUPERFUND SITE

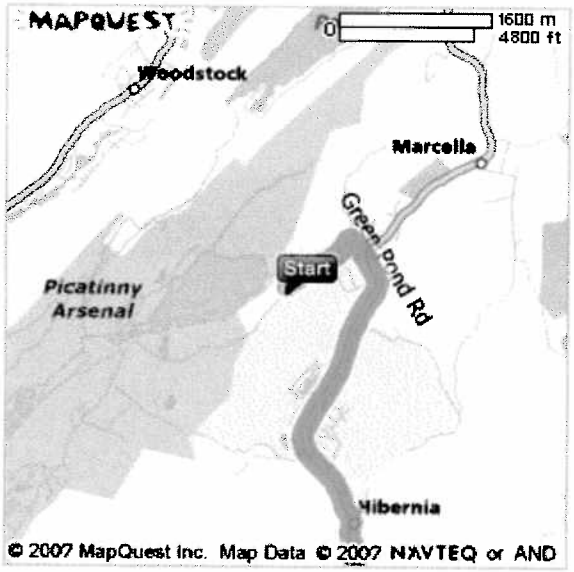
EMERGENCY INFORMATION		
Contact	**Phone Number**	**Hospital Directions**
Local Police	973-625-4000	From the site, take Lake Denmark Road to Green Pond Road (CR-513) (0.9 miles). Turn right (south) on Green Pond Road and continue 5.2 miles to I-80. Take I-80 east 1.5 miles to Highway 46 east (Exit 38). Take Highway 46 east 1.0 miles. Bear right toward RT-53, go 0.1 miles. Turn right on East Main Street and go 0.1 miles to Diamond Springs Road. Turn right on Diamond Springs Road, and go 0.3 miles to Pocono Road. Bear right on Pocono Road and proceed 0.5 miles to the hospital Driving Time: 19 minutes Driving Distance: 9.6 miles Attach Map. CRA – Accident Reporting System Please call (866) 529-4886 and provide: • Name and location of caller • Description of incident • Name of any injured persons • Description of injuries • Phone number for return call
Fire Department	973-983-2865	
Ambulance	973-983-2865	
Local Hospital: St. Clare's Hospital - Denville 25 Pocono Rd Denville, NJ	(973) 625-6000	
National Poison Center	800-222-1222	
Project Manager Robert Martin Work: Cell:	 (651) 639-0913 (651) 239-5137	
Site Supervisor To be determined Work: Cell:		
CRA Regional SHM William Doyle Work: Cell:	 (734) 453-5123 (734) 536-1282	
Client Contact Karie Mars, ATK Work: Cell:	 (952) 351-5511 (952) 797-2954	
UXO Contact Picatinny Police Department USACE - Paul Greene:	 (973) 724-6666 (410) 962-6741	

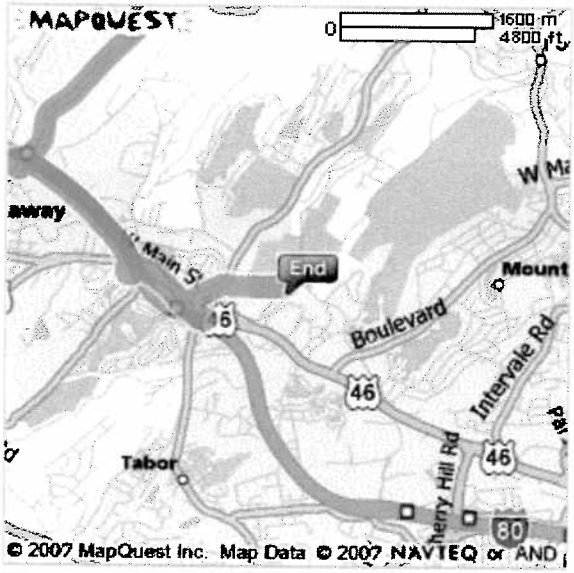
Hospital route must be field validated before site work commences.



Start:
108 Lake Denmark Rd
Rockaway, NJ 07866-4317, US

End:
25 Pocono Rd
Denville, NJ 07834-2954, US





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These directions are informational only. No representation is made or warranty given as to their content, road conditions or route usability or expeditiousness. User assumes all risk of use. MapQuest and its suppliers assume no responsibility for any loss or delay resulting from such use.

HASP ACKNOWLEDGMENT SHEET

This is to certify that I have received a pre-entry briefing regarding this HASP (CRA RTI Superfund Site) and I understand its contents. My failure to follow and comply with the requirements contained in this plan may result in disciplinary action and/or termination.

Print Name	Signature	Date

This page must be available on site during the project for review and filed with the project files upon project field work completion.

TAILGATE SAFETY MEETING FORM
CRA RTI SUPERFUND SITE

Date: _____ Time: _____

Site Location: _____

Site Personnel in attendance:

Print Name	Signature	Company

Safety Topics/Items discussed:

_____

_____

_____

_____

_____

Supervisor

Name: _____ Date: _____

This page must be available on site during the project for review and filed with the project files upon project field work completion.

CONESTOGA-ROVERS & ASSOCIATES (CRA) ACCIDENT REPORTING FORM

Report all accidents immediately by calling 1-866-529-4886

Instructions: For Personal Injuries, Occupational Illnesses, and Property Damage, complete Sections 1 and 2.
For Vehicle Accidents, Complete Sections 1, 2, and 4. Form must be completed within 24 hours.

SECTION 1

A. Employee Identification	( ) CRA Employee	( ) Temporary Employee	( ) Subcontractor	
Employee No.	Last Name	First Name	Middle Name/Initial	M or F
Area Code ( )	Telephone Number	Address (Street, City, State, Province, Zip Code)		
Date of Hire / /	Position/Title	Supervisor	Employee's Company/Office Location	

B. General Information						
Where did the accident occur? ( ) Office ( ) Project Site ( ) Canada ( ) United States		Type of Occurrence ( ) Employee Injury/Illness ( ) Vehicle Accident ( ) Property Damage Only				
Date and Hour of Accident		Date and Hour Reported to Employer		Date and Hour Last Worked		Time Employee Began Work
Month Day Year	a.m. p.m.	Month Day Year	a.m. p.m.	Month Day Year	a.m. p.m.	a.m. p.m.
Normal Work Hours on Last Day Worked		Witnesses?		Witness Name and Telephone Number		
From: To:	a.m. p.m.	( ) Yes ( ) No				

C. Project Information (Project Related Accidents Only)				
Project #	Project Name	Project Manager	Site Telephone Number ( )	Employee Cell Number ( )
Was the Client Advised of the Accident? ( ) Yes ( ) No Name:		Project Address (Street, City, State, Province, Zip Code)		
		Specific Location of Accident		

SECTION 2

A. Details of the Accident
1. What job/task was being performed when the accident occurred? (Example: collecting groundwater samples).
2. Provide a detailed description of the employee's specific activities at the time of the accident. Include details of equipment/materials being used, including the size and weights of objects being handled. If necessary, attach additional pages to the report.
3. For injuries, identify the specific part of body injured, and specify left or right side. For illnesses, identify and describe the affected area/body part.
4. Identify the object or substance that directly injured employee and how. Include size and weight of object, quantity of substance, etc.
5. Identify property damaged and how it was damaged (include owner of property, nature and source of damage, model and serial number, if appropriate).

B. Health Care/Medical Treatment	
Employee received health care? ( ) Yes ( ) No	Identify the type of health care provided and where it was performed. (Check all that apply). ( ) First Aid ( ) Medical treatment other than first aid (sutures, etc.) ( ) Hospitalized ( ) Clinic ( ) Hospital emergency room ( ) On location by self or CRA employee) ( ) On site by EMT
Name of Health Care Provider, Physician's Name, Address (Street, City, Province/State, and Postal/Zip Code)	

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Section 2 (Continued)

C. Accident Investigation	
H&S plan prepared and on site? ( ) Yes ( ) Not applicable	Did the safety plan identify and provide safety procedures for the specific tasks the employee was conducting when injured? ( ) Yes ( ) No If no, why not? (Explain) Did the employee utilize the STAR process before initiating the task? ( ) Yes ( ) No If no, why not? (Explain)
Did the employee have the proper safety training to conduct these tasks or use the equipment? ( ) Yes ( ) No If not, why not?	
Identify all of the potential contributing factors and how they led to the occurrence of the accident. (Lack of attention, wrong use of equipment, lack of training, hurrying/rushing, sort-cutting, environmental conditions, time of day, etc.)	
What contributing factor(s) above was the underlying root cause of the accident.	
Is any training or retraining recommended? If yes, describe.	
What actions have been or will be taken to correct this accident from reoccurring? Verify that these actions will be taken with the PM and/or employee supervisor.	
Additional information: Attach photos, witness statement(s), affected employee statement, accident diagrams, as applicable, to the end of this document.	

Report Date Month Day Year	Report Prepared by: (please print)	Report Prepared by: (signature)

Fax Completed Form to CRA's Accident Reporting Fax: (716) 297-3389
Send Original to CRA's Accident Reporting Department, Niagara Falls, New York

SECTION 3

D. Agency Reporting and Recording Information (To be completed by the Regional Safety and Health Manager)			
CANADA			
Form 7 Sent to WSIB? ( ) Yes ( ) Not required	Employee Injury Information (Injury met the following criteria) ( ) First Aid ( ) Medical Treatment ( ) Critical Injury ( ) Modified Duty ( ) Lost Time Injury If medical treatment, what?		
Joint Safety and Health Committee Notified? ( ) Yes ( ) No	Total days of modified duty If exceeds 7 days, report to WSIB.	Total days of lost time (if any)	Date employee returned to work Month Day Year
UNITED STATES			
OSHA Recordable Injury? ( ) Yes ( ) No	Employee Injury Information (Injury met the following OSHA 300 Log criteria) ( ) First Aid ( ) Medical Treatment ( ) Restricted Duty ( ) Lost Time Injury If medical treatment, what?		
Total days of restricted duty	Total days of lost time (if any)		Date employee returned to work Month Day Year

THE CONTENTS OF THIS DOCUMENT ARE THE SOLE PROPERTY OF CRA. REPRODUCTION OF ANY PART BY ANY MEDIUM IS NOT AUTHORIZED WITHOUT THE EXPRESS WRITTEN CONSENT OF CRA.

VEHICLE ACCIDENT SECTION

(Complete this Section for all Vehicle Accidents)

SECTION 4

A. CRA Vehicle

License Plate No.	State/Province	Police Department City State/Province	
Vehicle Year/Make/Model	Odometer Reading at Time of Accident	Police Report Number	Weather Conditions

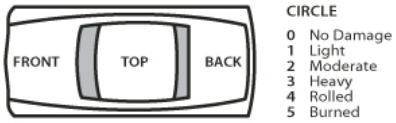
Name of Person Operating Vehicle

Address

City State/Province Zip Code

Telephone: Area Code ( )

"X" IN AREA OF VEHICLE DAMAGE



Vehicle Type: ( ) Personal ( ) Rental ( ) CRA-Own

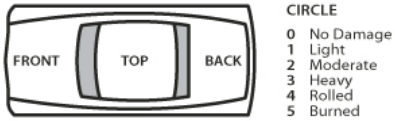
Description of Vehicle Damage:

B. Other Vehicles Involved

Name of Owner	Address	City/State/Prov./Zip	Area Code and Telephone Number ( )
Operator's Name (if different from above)	Address	City/State/Prov./Zip	Area Code and Telephone Number ( )

Year/Make/Model	Description of Property Damage:
Insurance Co. Name & Telephone	
License Plate No./State/Province	

"x" IN AREA OF VEHICLE DAMAGE



C. Injured Persons

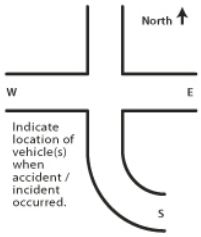
Name	Address Street, City, State/Prov./Zip Code	Phone Number	Nature of Injury	Indicate if Injured was a Vehicle Driver/ Passenger, CRA Employee, Other, or Pedestrian
1.				
2.				
3.				

D. Witnesses

Name	Address Street, City, State/Prov./Zip Code	Area Code and Telephone Number
1.		( )
2.		( )

E. Description of Accident

PLEASE COMPLETE OR ATTACH SEPARATE DIAGRAM



Was Ticket Issued:

Other Operator ☐

CRA Operator ☐

Reason: _____

Report Date Month Day Year	Report Prepared by: (please print)	Report Prepared by: (signature)

Note: If Additional Space is Required to Complete this Report, Use Separate Sheet of Paper and Attach.

Fax Completed form to CRA's Accident Reporting Fax: (716) 297-3389

Send Original to CRA's Accident Reporting Department, Niagara Falls, New York

APPENDIX B

JOB SAFETY ANALYSIS (JSA) FORMS

Job Safety Analysis (JSA)

JSA Filename: Decontamination

Safety Means Awareness Responsibility Teamwork

Field staff must review job-specific work plan and coordinate with project manager to verify that all up-front logistics are completed prior to starting work including, but not limited to, permitting, access agreements and notification to required contacts (e.g., site managers, inspectors, clients, subcontractors, etc.). Additionally, a tailgate safety meeting must be performed and documented at the beginning of each workday. **Stop, Think, Act, Review (STAR)** must be used prior to any activity. All personnel must possess the appropriate training prior to initiating scheduled tasks. Also consider weather conditions. CRA personnel have the authority and responsibility to use **Stop Work Authority.**

Date Issued/Revised	January 30, 2008	**JSA Type**	Decontamination
Work Type	Environmental	**Client**	ATK
Work Activity	Decontamination of equipment and personnel		
Work Site	RTI Superfund Site, 108 Lake Denmark Road, Rockaway Township, New Jersey		
Key Equipment	Alconox/liquinox, brushes, high pressure washer, etc.		
Task-specific Training			

MINIMUM REQUIRED PERSONAL PROTECTIVE EQUIPMENT (SEE JOB STEPS FOR TASK-SPECIFIC REQUIREMENTS)			
☒ REFLECTIVE VEST*	☐ GOGGLES	☐ APR: _____*	☒ GLOVES*
☒ HARD HAT	☒ FACE SHIELD*	☐ SUPPLIED AIR RESPIRATOR*	☐ COVERALLS*
☐ LIFELINE / HARNESS*	☒ HEARING PROTECTION*	☐ PPE CLOTHING*	☐ OTHER* _____
☒ SAFETY GLASSES	☒ STEEL TOED BOOTS	☐ OTHER* _____	☐ OTHER* _____
ADDITIONAL PPE: * Provide specific type(s) or descriptions of this item below			
Nitrile gloves to be worn when decontaminating reusable equipment, Face shield to be employed if pressure washing of equipment is performed			
Hearing protection as necessary around heavy equipment			

Development Team	**Position/Title**	**Reviewed By**	**Position/Title**	**Date**
Tom Hobday	Engineer	Robert Martin	Project Manager	1/30/08

Job Safety Analysis (JSA)

JSA Filename: Decontamination

JOB STEPS [1]	TASK ACTIVITY	POTENTIAL HAZARD(S) [2]	CORRECTIVE MEASURE(S)[3]	Person Responsible
1	Decontamination of sampling equipment to include pumps, bailers, tubing, etc.	Contaminant exposure Pinch points Slip/Trip/Hit/Fall Heavy lifting	• Wear appropriate PPE during decon activities (nitrile gloves) • Avoid putting hands in or near pinch points • Maintain good housekeeping, be aware of surroundings • Use proper lifting techniques, buddy lift when appropriate	Sampling personnel
2	Decontamination of heavy equipment/excavators	Contaminant exposure Pinch points Slip/Trip/Hit/Fall Noise Proximity to Heavy Equipment	• Wear appropriate PPE during decon activities • Avoid putting hands in or near pinch points - use tools/brushes to remove contaminants • Maintain good housekeeping, be aware of surroundings	Sampling personnel and/or subcontractor
3	Decontamination of personnel	Contaminant exposure Slip/Trip/Hit/Fall	• Dispose of used PPE in accordance with site requirements • Wash hands and face before eating, drinking, or using tobacco products • Take care when removing PPE (boots, gloves, etc.). Sit down to remove/change boots as necessary	Sampling personnel
4	Management of waste derived from decontamination activities	Contaminant exposure Heavy lifting	• Containerize decon waste (water, used PPE, etc) as required • Use proper lifting techniques, use buddy lifting or mechanical means when necessary	Sampling personnel

[1] Each Job or Task consists of a set of steps. Be sure to list all the steps in the sequence that they are performed. Specify the equipment or other details to set the basis for the potential (associated) hazards.

[2] A hazard is a potential danger. What can go wrong? How can someone get hurt? Consider, but do not limit, the analysis to: **Contact** - victim is struck by or strikes an object; **Caught** - victim is caught on, caught in or caught between objects; **Fall** - victim falls to ground or lower level (includes slips and trips); **Exertion** - excessive strain or stress / ergonomics / lifting techniques; **Exposure** - inhalation/skin hazards. Specify the hazards and do not limit the description to a single word such as "Caught"

[3] Aligning with the Job Steps, Task Activity Description, and Potential Hazard columns, describe what actions or procedures are necessary to eliminate or minimize the hazards. Be clear, concise and specific. Use objective, observable and quantified terms. Avoid subjective general statements such as, "be careful" or "use as appropriate".

Job Safety Analysis (JSA)

JSA Filename: Basic Mob/Demob Activities

Safety Means Awareness Responsibility Teamwork

Field staff must review job-specific work plan and coordinate with project manager to verify that all up-front logistics are completed prior to starting work including, but not limited to, permitting, access agreements and notification to required contacts (e.g., site managers, inspectors, clients, subcontractors, etc.). Additionally, a tailgate safety meeting must be performed and documented at the beginning of each workday. **Stop, Think, Assess, Review (STAR)** must be used prior to any activity. All personnel must possess the appropriate training prior to initiating scheduled tasks. Also consider weather conditions. CRA personnel have the authority and responsibility to use **Stop Work Authority.**

Date Issued/Revised	January 30, 2008	**JSA Type**	Mob-Demob
Work Type	General	**Client**	ATK
Work Activity	Mobilization and de-mobilization activities		
Work Site	RTI Superfund Site, 108 Lake Denmark Road, Rockaway Township, New Jersey		
Key Equipment			
Task-specific Training			

MINIMUM REQUIRED PERSONAL PROTECTIVE EQUIPMENT (SEE JOB STEPS FOR TASK-SPECIFIC REQUIREMENTS)			
☐ REFLECTIVE VEST*	☐ GOGGLES	☐ APR: _____*	☒ GLOVES*
☐ HARD HAT	☐ FACE SHIELD*	☐ SUPPLIED AIR RESPIRATOR*	☐ COVERALLS*
☐ LIFELINE / HARNESS*	☐ HEARING PROTECTION*	☐ PPE CLOTHING*	☐ OTHER* _____
☐ SAFETY GLASSES	☒ STEEL TOED BOOTS	☐ OTHER* _____	☐ OTHER* _____
ADDITIONAL PPE: * Provide specific type(s) or descriptions of this item below			

Development Team	**Position/Title**	**Reviewed By**	**Position/Title**	**Date**
Tom Hobday	Engineer	Robert Martin	Project Manager	1/30/08

Job Safety Analysis (JSA)

JSA Filename: Basic Mob/Demob Activities

JOB STEPS [1]	TASK ACTIVITY	POTENTIAL HAZARD(S) [2]	CORRECTIVE MEASURE(S)[3]	Person Responsible
1	Discuss STAR (Stop Think Assess & Review) and Stop Work Authority (SWA)	Site personnel not aware of STAR & SWA	• Project team (CRA) discusses importance of and documentation procedures for SWA during pre-job safety meeting. Use SWA to stop any work that is unsafe.	Site personnel
2	Check weather	Unexpected storm; Fog; Rain; Snow; Lightning/Thunder; Heat/Cold stress	• Check local weather forecast. Discuss weather issues and precautions to take while driving and on-site during the pre-job safety meeting. If weather conditions (e.g. fog, rain, snow, etc.) impair the ability/vision of the driver, exit at nearest safe location and assess the situation. While on-site, at first sign of lightning/thunder utilize SWA and assess weather conditions. In extreme temperatures, ensure all personnel have proper clothing, hydration, and heat/cold protection (e.g. canopy, fan, glove warmers).	Site Supervisor/Site personnel
3	Load equipment into vehicle	Back strain; Cuts; Pinch points; Hand/Foot injury; Forgotten equipment; Damaged equipment	• Use proper lifting techniques and buddy system if needed. Wear leather/cotton gloves and avoid placing hands/fingers in pinch point locations. Wear steel toe boots. Verify requested equipment against warehouse form. Load equipment in an organized manner to prevent shifting during transport or use cargo netting.	Site personnel
4	Complete CRA Daily Operator Vehicle Checklist	Damaged vehicle lights, tires, windows, mirrors, horn; Inadequate vehicle documents and/or safety items	• Check for fluid leaks under vehicle. Test operation of headlights, front/rear turn signals, backup lights, brake lights, and emergency flashers. Visually check the pressure/wear of tires. Ensure the vehicle has a spare tire. Assure windshield and window glass is clean and free from obstructions. Test the windshield wipers and horn. Verify vehicle registration, insurance card, and inspection sticker is present and valid. Ensure the vehicle contains a first aid kit, fire extinguisher, and road hazard kit.	Site personnel
5	Check and adjust seat, steering wheel, headrest, and mirrors	Back/body strain; Blind spots; Impaired vision.	• Adjust seat, headrest, and steering wheel height so body is fully supported/comfortable and pedals are within easy reach. Ensure mirrors are properly adjusted.	Site personnel
6	Fasten seat belt(s) and ensure passenger(s) seat belts are fastened	Serious injury, ejection, or death from collision and/or traffic citation	• Verify driver and passenger(s) seat belts are in good condition and properly latched.	Site personnel

Job Safety Analysis (JSA)

JSA Filename: Basic Mob/Demob Activities

JOB STEPS [1]	TASK ACTIVITY	POTENTIAL HAZARD(S) [2]	CORRECTIVE MEASURE(S)[3]	Person Responsible
7	Ensure vehicle doors are locked	Serious injury, ejection, or death from collision; Unwanted intrusion; Lost equipment	• Manually lock all doors to vehicle.	Site personnel
8	Start engine and check gauges and warning lights	Vehicle breakdown	• Verify sufficient fuel and other hazard lamps (e.g. battery, oil, and temperature) are not lit.	Site personnel
9	Mobilize to site	Arriving late; Collision; Injury or Death to occupants or other parties	• Do not use cell phones or perform other distracting activities while vehicle is in motion. Constantly scan intersections, move eyes, check mirrors, and assess traffic lights (fresh vs. stale). Maintain safety cushion around vehicle (front, sides, and rear) and 4 second following distance. Utilize all driving defensive techniques.	Site personnel
10	Arrive at site	Pedestrian injury; Collision	• Maintain awareness of pedestrian/vehicular traffic when entering site and traveling to work zone.	Site personnel
11	Park vehicle	Pedestrian injury; Collision; Property damage	• Maintain awareness of pedestrian/vehicular traffic. Park vehicle in pull-through parking space or facing the exit. Use caution and mirrors/spotter when backing vehicle.	Site personnel
12	Demobilization	Collision; Injury or Death to occupants or other parties	• Perform perimeter vehicle check. Maintain awareness of pedestrian/vehicular traffic when exiting site. Utilize defensive driving techniques. Complete post-departure checklist and report vehicle problems to company vehicle maintenance manager or rental car agency.	Site personnel

[1] Each Job or Task consists of a set of steps. Be sure to list all the steps in the sequence that they are performed. Specify the equipment or other details to set the basis for the potential (associated) hazards.

[2] A hazard is a potential danger. What can go wrong? How can someone get hurt? Consider, but do not limit, the analysis to: **Contact** - victim is struck by or strikes an object; **Caught** - victim is caught on, caught in or caught between objects; **Fall** - victim falls to ground or lower level (includes slips and trips); **Exertion** - excessive strain or stress / ergonomics / lifting techniques; **Exposure** - inhalation/skin hazards. Specify the hazards and do not limit the description to a single word such as "Caught"

[3] Aligning with the Job Steps, Task Activity Description, and Potential Hazard columns, describe what actions or procedures are necessary to eliminate or minimize the hazards. Be clear, concise and specific. Use objective, observable and quantified terms. Avoid subjective general statements such as, "be careful" or "use as appropriate".

Job Safety Analysis (JSA)

JSA Filename: Sediment Sampling

Safety Means Awareness Responsibility Teamwork

Field staff must review job-specific work plan and coordinate with project manager to verify that all up-front logistics are completed prior to starting work including, but not limited to, permitting, access agreements and notification to required contacts (e.g., site managers, inspectors, clients, subcontractors, etc.). Additionally, a tailgate safety meeting must be performed and documented at the beginning of each workday. **Stop, Think, Assess, Review (STAR)** must be used prior to any activity. All personnel must possess the appropriate training prior to initiating scheduled tasks. Also consider weather conditions. CRA personnel have the authority and responsibility to use **Stop Work Authority.**

Date Issued/Revised	January 30, 2008	**JSA Type**	Sampling
Work Type	Environmental	**Client**	ATK
Work Activity	Sediment Sampling (General Procedures) – Follow Quality Assurance Plan and/or Work Plan		
Work Site	RTI Superfund Site, 108 Lake Denmark Road, Rockaway Township, New Jersey		
Key Equipment	Wildco samplers, Encore samplers, stainless steel and acetate lined tubes, spoons, bowls, waders, small aluminum boat		
Task-specific Training	CRA Field Method Training on soil sampling procedures; Boating Safety; HazCom		

MINIMUM REQUIRED PERSONAL PROTECTIVE EQUIPMENT (SEE JOB STEPS FOR TASK-SPECIFIC REQUIREMENTS)			
☐ REFLECTIVE VEST*	☒ GOGGLES	☐ APR: _____*	☒ GLOVES*
☒ HARD HAT	☐ FACE SHIELD*	☐ SUPPLIED AIR RESPIRATOR*	☐ COVERALLS*
☒ LIFELINE / HARNESS*	☐ HEARING PROTECTION*	☐ PPE CLOTHING*	☐ OTHER*
☒ SAFETY GLASSES	☒ STEEL TOED BOOTS	☒ OTHER* PERSONAL FLOATATION DEVICE	☐ OTHER* _____
ADDITIONAL PPE: * Provide specific type(s) or descriptions of this item below			
Gloves will dependent on the task and chemical contamination present or suspected present.			

Development Team	**Position/Title**	**Reviewed By**	**Position/Title**	**Date**
Tom Hobday	Engineer	Robert Martin	Project Manager	1/30/08

Job Safety Analysis (JSA)

JSA Filename: Sediment Sampling

JOB STEPS [1]	TASK ACTIVITY	POTENTIAL HAZARD(S) [2]	CORRECTIVE MEASURE(S)[3]	Person Responsible
1	Inspection and Set-up of sampling equipment on shore or boat.	Lost time from improperly functioning equipment; Incorrect sampling procedures/collection due to malfunctioning equipment	• Ensure all PPE is worn including PFD for each person. • Ensure all equipment is functioning properly; complete Quality Control documents. • Ensure boat sufficiently stable for retrieval of samples. • For wading operations - ensure lifeline is attached to water personnel with on-shore spotter/support personnel	Sampling Technician
2	Prepare to collect samples.	Pinch points; Cuts; Punctures; Sample misidentification	• Avoid placing hands/fingers in pinch point locations. • Use proper tools when opening container packaging. Do not use fixed open blade knives when opening boxes or containers. • Ensure the sample id label matches sample location with site plan/CRA Site Supervisor/subcontractor.	Sampling Technician
3	Retrieve sampler when sample collected - transfer to stainless steel bowl.	Cuts due to sharp edges of sample sleeve; Contaminant exposure; Back Strain; Cuts from sharp objects retrieved by sampler; Contamination hazards	• Use proper lifting/lowering techniques and buddy system if system if needed. Sampler will be heavier when raised. • Wear nitrile gloves. Maintain awareness of sharp edges from objects that may be in sampler.	Sampling Technician
4	Collect appropriate samples	Bottle breakage; Contaminant exposure; Pinch points; Lost time due to incorrect sample selection	• Wear nitrile gloves when handling sample containers. • Confirm selected samples are correct based on work plan selection criteria. • Avoid placing hands/fingers in pinch point locations (e.g. between cooler and lid).	Sampling Technician
5	Packing samples in cooler(s)	Bottle breakage; Contaminant exposure; Cuts; Pinch points; Back strain; Lost time due to incorrect sample packaging or hold time exceedances	• Wear nitrile gloves when handling sample containers. Pack glass containers in bubble wrap. Check COC against sample labels and SSOW for accuracy before shipping. • Avoid placing hands/fingers in pinch point locations (e.g. between cooler and lid). • Use proper lifting techniques and buddy system if needed. • Ensure equipment and supplies are loaded correctly and do not shift during transport.	Sampling Technician

Job Safety Analysis (JSA)

JSA Filename: Sediment Sampling

JOB STEPS [1]	TASK ACTIVITY	POTENTIAL HAZARD(S) [2]	CORRECTIVE MEASURE(S)[3]	Person Responsible
6	Investigation derived waste (IDW) management	Contaminant exposure; Heavy lifting; Pinch points; Slips/trips/falls; Mislabeled waste	• Wear nitrile gloves when handling IDW. • Use proper lifting techniques to transport/dispose of IDW into drums and use buddy system if needed. • Avoid placing hands/fingers in pinch point locations. • Maintain awareness of walking surfaces. • Label IDW with generator, a contact number, identification of contents, and site location. Specify IDW as either hazardous or non-hazardous material.	Sampling Technician

[1] Each Job or Task consists of a set of steps. Be sure to list all the steps in the sequence that they are performed. Specify the equipment or other details to set the basis for the potential (associated) hazards.

[2] A hazard is a potential danger. What can go wrong? How can someone get hurt? Consider, but do not limit, the analysis to: **Contact** - victim is struck by or strikes an object; **Caught** - victim is caught on, caught in or caught between objects; **Fall** - victim falls to ground or lower level (includes slips and trips); **Exertion** - excessive strain or stress / ergonomics / lifting techniques; **Exposure** - inhalation/skin hazards. Specify the hazards and do not limit the description to a single word such as "Caught"

[3] Aligning with the Job Steps, Task Activity Description, and Potential Hazard columns, describe what actions or procedures are necessary to eliminate or minimize the hazards. Be clear, concise and specific. Use objective, observable and quantified terms. Avoid subjective general statements such as, "be careful" or "use as appropriate".

Job Safety Analysis (JSA)

JSA Filename: Soil Sampling (Drum Disposal Area)

Safety Means Awareness Responsibility Teamwork

Field staff must review job-specific work plan and coordinate with project manager to verify that all up-front logistics are completed prior to starting work including, but not limited to, permitting, access agreements and notification to required contacts (e.g., site managers, inspectors, clients, subcontractors, etc.). Additionally, a tailgate safety meeting must be performed and documented at the beginning of each workday. **Stop, Think, Assess, Review (STAR)** must be used prior to any activity. All personnel must possess the appropriate training prior to initiating scheduled tasks. Also consider weather conditions. CRA personnel have the authority and responsibility to use **Stop Work Authority.**

Date Issued/Revised	January 30, 2008	**JSA Type**	Soil Sampling (Drum Disposal Area)
Work Type	Environmental	**Client**	ATK
Work Activity	Soil Sampling (Drum Disposal Area) (Test Pits and Soil Borings) – Follow Quality Assurance Plan and/or Work Plan		
Work Site	RTI Superfund Site, 108 Lake Denmark Road, Rockaway Township, New Jersey		
Key Equipment	PID, Radiation meter, colorimetric tubes (VC), calibration kits, stainless steel spoons, trowels, bowls, etc.		
Task-specific Training	CRA Field Method Training on soil sampling procedures, HazCom, Training on air monitoring equipment		

MINIMUM REQUIRED PERSONAL PROTECTIVE EQUIPMENT (SEE JOB STEPS FOR TASK-SPECIFIC REQUIREMENTS)			
☒ REFLECTIVE VEST*	☐ GOGGLES	☒ APR: based on air monitoring*	☒ GLOVES*
☒ HARD HAT	☐ FACE SHIELD*	☐ SUPPLIED AIR RESPIRATOR*	☐ COVERALLS*
☐ LIFELINE / HARNESS*	☐ HEARING PROTECTION*	☒ PPE CLOTHING* Modified Level D	☐ OTHER* _____
☒ SAFETY GLASSES	☒ STEEL TOED BOOTS	☐ OTHER* _____	☐ OTHER* _____
ADDITIONAL PPE: * Provide specific type(s) or descriptions of this item below			
Gloves will dependent on the task and chemical contamination present or suspected present.			

Development Team	**Position/Title**	**Reviewed By**	**Position/Title**	**Date**
Tom Hobday	Engineer	Robert Martin	Project Manager	1/30/08

Job Safety Analysis (JSA)

JSA Filename: Soil Sampling (Drum Disposal Area)

JOB STEPS [1]	TASK ACTIVITY	POTENTIAL HAZARD(S) [2]	CORRECTIVE MEASURE(S)[3]	Person Responsible
1	Inspect and calibrate sampling and monitoring equipment	Lost time from improperly functioning equipment; Incorrect sampling procedures/collection due to malfunctioning equipment; exposure due to improperly functioning equipment	• Ensure all equipment is functioning properly; complete Quality Control documents for calibration daily.	Sampling Technician
2	Determine test pit location, arrange for UXO clearance, identify unsafe conditions, clearance of underground utilities	Traffic; Slip/Trip/Fall; Biological hazard; Overhead/underground hazards; UXOs;	• Call One-Call at least 48-hours prior to work for clearance of underground utilities. • Maintain awareness of surroundings, stay on paths cleared of potential UXOs. • Be aware of biological hazards (ants, poison ivy, etc.) and overhead/underground hazards when selecting test pit or sample locations	Site Supervisor, Sampling Technician
3	Air Monitoring of the breathing zones - PID, Colorimetric tubes, and Radiation monitor	Contaminant exposure; slip/trip/hit/fall	• Perform air monitoring in accordance with the HASP and the Air Monitoring Plan table below. • Colorimetric tubes to be pulled for Vinyl Chloride if PID readings exceed 1-ppm. • Upgrade PPE as necessary based on air monitoring results	Site Personnel, Sampling Technician
4	Set up work zone for test pit excavation or soil borings	Slips/trips/falls; Property damage; Overhead hazards; UXOs	• Maintain awareness of overhead hazards. Utilize barricades/cones/caution tape to define work zones. • Keep all equipment and personnel within areas previously found to be clear of UXOs. • Wear appropriate PPE.	Site Personnel
5	Contractor oversight/ subcontractor management of test pit excavation and UXO clearance	Slip/trip/fall; Underground utilities; Contaminant exposure; Heat/Cold Stress; UXOs	• Practice good housekeeping • Ensure subcontrators don appropriate PPE for task. • Ensure proper procedures for surface and subsurface UXO clearance are followed when required. • Ensure equipment and personnel remain within areas deemed safe from UXOs • Employ SWA if potential UXOs are encountered • Monitor breathing zones per above. • Monitor personnel for signs and symptoms of heat/cold stress and refer to HASP for recommendations	Site Personnel

JOB STEPS [1]	TASK ACTIVITY	POTENTIAL HAZARD(S) [2]	CORRECTIVE MEASURE(S)[3]	Person Responsible
6	Prepare to collect soil samples	Back strain; Pinch points; Cuts; Punctures; Sample misidentification	• Use proper lifting techniques and buddy system if needed. • Avoid placing hands/fingers in pinch point locations. • Use proper tools when opening container packaging. Do not use fixed open blade knives when opening boxes or containers. • Ensure the sample id label matches sample location with site plan/CRA Site Supervisor/subcontractor.	Sampling Technician
7	Sample collection	Contaminant exposure; Cuts from container breakage; Sample misidentification	• Wear nitrile gloves and replace between soil samples. • Inspect glass bottles for breaks/cracks. Do not attempt to use any suspect containers. Close glass sample containers carefully to avoid breakage. • Check sample labels for accuracy prior to placing in cooler.	Sampling Technician
8	Headspace screening of samples	Contaminant exposure; Incorrect headspace readings	• Wear nitrile gloves. • Ensure proper calibration of equipment. • Follow work plan procedures.	Sampling Technician
9	Packing samples in cooler(s)	Bottle breakage; Contaminant exposure; Cuts; Pinch points; Back strain; Lost time due to incorrect sample packaging or hold time exceedances	• Wear nitrile gloves when handling sample containers. Pack glass containers in bubble wrap. Check COC against sample labels and SSOW for accuracy before shipping. • Avoid placing hands/fingers in pinch point locations (e.g. between cooler and lid). • Use proper lifting techniques and buddy system if needed. • Ensure equipment and supplies are loaded correctly and do not shift during transport.	Sampling Technician
10	Investigation derived waste (IDW) management	Contaminant exposure; Heavy lifting; Pinch points; Slips/trips/falls; Mislabeled waste	• Wear nitrile gloves when handling IDW. • Use proper lifting techniques to transport/dispose of IDW into drums and use buddy system if needed. • Avoid placing hands/fingers in pinch point locations. • Maintain awareness of walking surfaces. • Label IDW with generator, a contact number, identification of contents, and site location. Specify IDW as either hazardous or non-hazardous material.	Sampling Technician

[1] Each Job or Task consists of a set of steps. Be sure to list all the steps in the sequence that they are performed. Specify the equipment or other details to set the basis for the potential (associated) hazards.

[2] A hazard is a potential danger. What can go wrong? How can someone get hurt? Consider, but do not limit, the analysis to: **Contact** - victim is struck by or strikes an object; **Caught** - victim is caught on, caught in or caught between objects; **Fall** - victim falls to ground or lower level (includes slips and trips); **Exertion** - excessive strain or stress / ergonomics / lifting techniques; **Exposure** - inhalation/skin hazards. Specify the hazards and do not limit the description to a single word such as "Caught"

[3] Aligning with the Job Steps, Task Activity Description, and Potential Hazard columns, describe what actions or procedures are necessary to eliminate or minimize the hazards. Be clear, concise and specific. Use objective, observable and quantified terms. Avoid subjective general statements such as, "be careful" or "use as appropriate".

AIR MONITORING PLAN

INSTRUMENT	MONITORING FREQUENCY	ACTION LEVELS		
		MODIFIED LEVEL D	UPGRADE TO LEVEL C	CEASE OPERATIONS
PID	Continuous during test pitting and during sample collection	Less than 1 ppm	1 ppm - 10 ppm	Greater than 10 ppm
Colorimetric Tubes - Vinyl Chloride	If PID levels greater than 1 ppm are discovered, hourly thereafter	Less than 1 ppm	NA	Vinyl Chloride greater than 1 ppm
Radiation Monitor	Continuous during test pitting and during sample collection	Less than 0.6 mrem/hr	NA	Greater than 0.6 mrem/hr

Notes:

- All work for this task to be initiated in Modified Level D
- All monitoring will be conducted in the breathing zone at the frequency noted
- To the extent practicable, gas powered equipment (generators, backhoe, geo-probe, etc.) will be placed such that exhaust and fumes are downwind of the breathing zone/work zone.

Job Safety Analysis (JSA)

JSA Filename: Soil Sampling (General Site Areas)

Safety Means Awareness Responsibility Teamwork

Field staff must review job-specific work plan and coordinate with project manager to verify that all up-front logistics are completed prior to starting work including, but not limited to, permitting, access agreements and notification to required contacts (e.g., site managers, inspectors, clients, subcontractors, etc.). Additionally, a tailgate safety meeting must be performed and documented at the beginning of each workday. **Stop, Think, Assess, Review (STAR)** must be used prior to any activity. All personnel must possess the appropriate training prior to initiating scheduled tasks. Also consider weather conditions. CRA personnel have the authority and responsibility to use **Stop Work Authority.**

Date Issued/Revised	January 30, 2008	**JSA Type**	Soil Sampling (General Site Areas)
Work Type	Environmental	**Client**	ATK
Work Activity	Soil Sampling (General Site Areas) – Follow Quality Assurance Plan and/or Work Plan		
Work Site	RTI Superfund Site, 108 Lake Denmark Road, Rockaway Township, New Jersey		
Key Equipment	PID, colorimetric tubes (VC), Macrocore liners, Encore samplers, spoons, trowels, bowls, hand auger, etc.		
Task-specific Training	CRA Field Method Training on soil sampling procedures, HazCom, Training on air monitoring equipment		

MINIMUM REQUIRED PERSONAL PROTECTIVE EQUIPMENT (SEE JOB STEPS FOR TASK-SPECIFIC REQUIREMENTS)			
☒ REFLECTIVE VEST*	☐ GOGGLES	☒ APR: based on air monitoring*	☒ GLOVES*
☒ HARD HAT	☐ FACE SHIELD*	☐ SUPPLIED AIR RESPIRATOR*	☐ COVERALLS*
☐ LIFELINE / HARNESS*	☐ HEARING PROTECTION*	☒ PPE CLOTHING* Modified Level D	☐ OTHER* _____
☒ SAFETY GLASSES	☒ STEEL TOED BOOTS	☐ OTHER* _____	☐ OTHER* _____
ADDITIONAL PPE: * Provide specific type(s) or descriptions of this item below			
Gloves will dependent on the task and chemical contamination present or suspected present.			

Development Team	**Position/Title**	**Reviewed By**	**Position/Title**	**Date**
Tom Hobday	Engineer	Robert Martin	Project Manager	1/30/08

JOB STEPS [1]	TASK ACTIVITY	POTENTIAL HAZARD(S) [2]	CORRECTIVE MEASURE(S)[3]	Person Responsible
1	Inspect and calibrate sampling and monitoring equipment	Lost time from improperly functioning equipment; Incorrect sampling procedures/collection due to malfunctioning equipment; exposure due to improperly functioning equipment	• Ensure all equipment is functioning properly; complete Quality Control documents for calibration daily.	Sampling Technician
2	Determine sample location, arrange for UXO clearance, conduct site walk, identify unsafe conditions, clearance of underground utilities	Traffic; Slip/Trip/Fall; Biological hazard; Overhead/underground hazards; UXOs;	• Call One-Call at least 48-hours prior to work for clearance of underground utilities. • Maintain awareness of surroundings, stay in areas cleared of potential UXOs. • Be aware of biological hazards (ants, poison ivy, etc.) and overhead/underground hazards when selecting sample locations	Site Supervisor, Sampling Technician
3	Air Monitoring of the breathing zones - PID and Colorimetric tubes	Contaminant exposure; slip/trip/hit/fall	• Perform air monitoring in accordance with the HASP and the Air Monitoring Plan table below. • Colorimetric tubes to be pulled for Vinyl Chloride if PID readings exceed 1-ppm. • Upgrade PPE as necessary based on air monitoring results	Site Personnel, Sampling Technician
4	Set up work zone for soil borings and sample collection	Slips/trips/falls; Property damage; Overhead hazards; UXOs	• Maintain awareness of overhead hazards. Utilize barricades/cones/caution tape to define work zones. • Keep all equipment and personnel within areas previously found to be clear of UXOs. • Wear appropriate PPE.	Site Personnel
5	Contractor oversight/ subcontractor management of geo-probe work, and UXO clearance	Slip/trip/fall; Underground utilities; Contaminant exposure; Heat/Cold Stress; UXOs	• Practice good housekeeping • Ensure subcontrators don appropriate PPE for task. • Ensure proper procedures for surface and subsurface UXO clearance are followed when required. • Ensure equipment and personnel remain within areas deemed safe from UXOs • Employ SWA if potential UXOs are encountered • Monitor breathing zones per above. • Monitor personnel for signs and symptoms of heat/cold stress and refer to HASP for recommendations	Site Personnel

JOB STEPS [1]	TASK ACTIVITY	POTENTIAL HAZARD(S) [2]	CORRECTIVE MEASURE(S)[3]	Person Responsible
6	Prepare to collect soil samples	Back strain; Pinch points; Cuts; Punctures; Sample misidentification	• Use proper lifting techniques and buddy system if needed. • Avoid placing hands/fingers in pinch point locations. • Use proper tools when opening container packaging. Do not use fixed open blade knives when opening boxes or containers. • Ensure the sample id label matches sample location with site plan/CRA Site Supervisor/subcontractor.	Sampling Technician
7	Opening the sample sleeve (if applicable)	Cuts due to sharp edges of sample sleeve; Contaminant exposure	• Use sleeve cutter for opening the sample sleeves. Keep hands clear of the sleeve when cutting. Wear nitrile gloves. Maintain awareness of sharp edges of sample sleeve.	Sampling Technician
8	Sample collection	Contaminant exposure; Cuts from container breakage; Sample misidentification	• Wear nitrile gloves and replace between soil samples. • Inspect glass bottles for breaks/cracks. Do not attempt to use any suspect containers. Close glass sample containers carefully to avoid breakage. • Check sample labels for accuracy prior to placing in cooler.	Sampling Technician
9	Headspace screening of samples	Contaminant exposure; Incorrect headspace readings	• Wear nitrile gloves. • Ensure proper calibration of equipment.	Sampling Technician
10	Packing samples in cooler(s)	Bottle breakage; Contaminant exposure; Cuts; Pinch points; Back strain; Lost time due to incorrect sample packaging or hold time exceedances	• Wear nitrile gloves when handling sample containers. Pack glass containers in bubble wrap. Check COC against sample labels and SSOW for accuracy before shipping. • Avoid placing hands/fingers in pinch point locations (e.g. between cooler and lid). • Use proper lifting techniques and buddy system if needed. • Ensure equipment and supplies are loaded correctly and do not shift during transport.	Sampling Technician

Job Safety Analysis (JSA)

JSA Filename: Soil Sampling (General Site Areas)

JOB STEPS [1]	TASK ACTIVITY	POTENTIAL HAZARD(S) [2]	CORRECTIVE MEASURE(S)[3]	Person Responsible
11	Investigation derived waste (IDW) management	Contaminant exposure; Heavy lifting; Pinch points; Slips/trips/falls; Mislabeled waste	• Wear nitrile gloves when handling IDW. • Use proper lifting techniques to transport/dispose of IDW into drums and use buddy system if needed. • Avoid placing hands/fingers in pinch point locations. • Maintain awareness of walking surfaces. • Label IDW with generator, a contact number, identification of contents, and site location. Specify IDW as either hazardous or non-hazardous material.	Sampling Technician

[1] Each Job or Task consists of a set of steps. Be sure to list all the steps in the sequence that they are performed. Specify the equipment or other details to set the basis for the potential (associated) hazards.

[2] A hazard is a potential danger. What can go wrong? How can someone get hurt? Consider, but do not limit, the analysis to: **Contact** - victim is struck by or strikes an object; **Caught** - victim is caught on, caught in or caught between objects; **Fall** - victim falls to ground or lower level (includes slips and trips); **Exertion** - excessive strain or stress / ergonomics / lifting techniques; **Exposure** - inhalation/skin hazards. Specify the hazards and do not limit the description to a single word such as "Caught"

[3] Aligning with the Job Steps, Task Activity Description, and Potential Hazard columns, describe what actions or procedures are necessary to eliminate or minimize the hazards. Be clear, concise and specific. Use objective, observable and quantified terms. Avoid subjective general statements such as, "be careful" or "use as appropriate".

AIR MONITORING PLAN

INSTRUMENT	MONITORING FREQUENCY	ACTION LEVELS		
		MODIFIED LEVEL D	UPGRADE TO LEVEL C	CEASE OPERATIONS
PID	Continuous during test pitting and during sample collection	Less than 1 ppm	1 ppm - 10 ppm	Greater than 10 ppm
Colorimetric Tubes - Vinyl Chloride	If PID levels greater than 1 ppm are discovered, hourly thereafter	Less than 1 ppm	NA	Vinyl Chloride greater than 1 ppm

Notes:

- All work for this task to be initiated in Modified Level D
- All monitoring will be conducted in the breathing zone at the frequency noted
- To the extent practicable, gas powered equipment (generators, backhoe, geo-probe, etc.) will be placed such that exhaust and fumes are downwind of the breathing zone/work zone.

Job Safety Analysis (JSA)

JSA Filename: Surface Water Sampling

Safety Means Awareness Responsibility Teamwork

Field staff must review job-specific work plan and coordinate with project manager to verify that all up-front logistics are completed prior to starting work including, but not limited to, permitting, access agreements and notification to required contacts (e.g., site managers, inspectors, clients, subcontractors, etc.). Additionally, a tailgate safety meeting must be performed and documented at the beginning of each workday. **Stop, Think, Assess, Review (STAR)** must be used prior to any activity. All personnel must possess the appropriate training prior to initiating scheduled tasks. Also consider weather conditions. CRA personnel have the authority and responsibility to use **Stop Work Authority.**

Date Issued/Revised	January 30, 2008	**JSA Type**	Sampling
Work Type	Environmental	**Client**	ATK
Work Activity	Surface Water Sampling (General Procedures) – Follow Quality Assurance Plan and/or Work Plan		
Work Site	RTI Superfund Site, 108 Lake Denmark Road, Rockaway Township, New Jersey		
Key Equipment	Peristaltic pumps, tubing, filters, sample containers, waders, small aluminum boat		
Task-specific Training	CRA Field Method Training on soil sampling procedures; Boating Safety; HazCom		

MINIMUM REQUIRED PERSONAL PROTECTIVE EQUIPMENT (SEE JOB STEPS FOR TASK-SPECIFIC REQUIREMENTS)			
☐ REFLECTIVE VEST*	☒ GOGGLES	☐ APR: _____*	☒ GLOVES*
☒ HARD HAT	☐ FACE SHIELD*	☐ SUPPLIED AIR RESPIRATOR*	☐ COVERALLS*
☒ LIFELINE / HARNESS*	☐ HEARING PROTECTION*	☐ PPE CLOTHING*	☐ OTHER*
☒ SAFETY GLASSES	☒ STEEL TOED BOOTS	☒ OTHER* PERSONAL FLOATATION DEVICE	☐ OTHER* _____
ADDITIONAL PPE: * Provide specific type(s) or descriptions of this item below			
Gloves will dependent on the task and chemical contamination present or suspected present.			

Development Team	**Position/Title**	**Reviewed By**	**Position/Title**	**Date**
Tom Hobday	Engineer	Robert Martin	Project Manager	1/30/08

Job Safety Analysis (JSA)

JSA Filename: Surface Water Sampling

JOB STEPS [1]	TASK ACTIVITY	POTENTIAL HAZARD(S) [2]	CORRECTIVE MEASURE(S)[3]	Person Responsible
1	Inspection and Set-up of sampling equipment on shore or boat.	Lost time from improperly functioning equipment; Incorrect sampling procedures/collection due to malfunctioning equipment	• Ensure all PPE is worn including PFD and lifeline for each person in water. • Ensure all equipment is functioning properly; complete Quality Control documents. • Ensure boat sufficiently stable for retrieval of samples. • If employing wading, ensure all employees in water have a lifeline attached to a fixed shore object. Each person in water must have a support person on shore.	Sampling Technician
2	Prepare to collect samples.	Back strain; Pinch points; Cuts; Punctures; Sample misidentification	• Avoid placing hands/fingers in pinch point locations. • Use proper tools when opening container packaging. Do not use fixed open blade knives when opening boxes or containers. • Ensure the sample id label matches sample location with site plan/CRA Site Supervisor/subcontractor.	Sampling Technician
3	Sample collection and selection	Bottle breakage; Contaminant exposure; Pinch points; Lost time due to incorrect sample selection	• Wear nitrile gloves when handling sample containers and while collecting samples. • Confirm selected samples are correct based on work plan selection criteria. • Avoid placing hands/fingers in pinch point locations (e.g. between cooler and lid).	Sampling Technician
4	Packing samples in cooler(s)	Bottle breakage; Contaminant exposure; Cuts; Pinch points; Back strain; Lost time due to incorrect sample packaging or hold time exceedances	• Wear nitrile gloves when handling sample containers. Pack glass containers in bubble wrap. Check COC against sample labels and SSOW for accuracy before shipping. • Avoid placing hands/fingers in pinch point locations (e.g. between cooler and lid). • Use proper lifting techniques and buddy system if needed. • Ensure equipment and supplies are loaded correctly and do not shift during transport.	Sampling Technician

Job Safety Analysis (JSA)

JSA Filename: Surface Water Sampling

JOB STEPS [1]	TASK ACTIVITY	POTENTIAL HAZARD(S) [2]	CORRECTIVE MEASURE(S)[3]	Person Responsible
5	Investigation derived waste (IDW) management	Contaminant exposure; Heavy lifting; Pinch points; Slips/trips/falls; Mislabeled waste	• Wear nitrile gloves when handling IDW. • Use proper lifting techniques to transport/dispose of IDW into drums and use buddy system if needed. • Avoid placing hands/fingers in pinch point locations. • Maintain awareness of walking surfaces. • Label IDW with generator, a contact number, identification of contents, and site location. Specify IDW as either hazardous or non-hazardous material.	Sampling Technician

[1] Each Job or Task consists of a set of steps. Be sure to list all the steps in the sequence that they are performed. Specify the equipment or other details to set the basis for the potential (associated) hazards.

[2] A hazard is a potential danger. What can go wrong? How can someone get hurt? Consider, but do not limit, the analysis to: **Contact** - victim is struck by or strikes an object; **Caught** - victim is caught on, caught in or caught between objects; **Fall** - victim falls to ground or lower level (includes slips and trips); **Exertion** - excessive strain or stress / ergonomics / lifting techniques; **Exposure** - inhalation/skin hazards. Specify the hazards and do not limit the description to a single word such as "Caught"

[3] Aligning with the Job Steps, Task Activity Description, and Potential Hazard columns, describe what actions or procedures are necessary to eliminate or minimize the hazards. Be clear, concise and specific. Use objective, observable and quantified terms. Avoid subjective general statements such as, "be careful" or "use as appropriate".

Job Safety Analysis (JSA)

JSA Filename: Tank Residue Sampling

Safety Means Awareness Responsibility Teamwork

Field staff must review job-specific work plan and coordinate with project manager to verify that all up-front logistics are completed prior to starting work including, but not limited to, permitting, access agreements and notification to required contacts (e.g., site managers, inspectors, clients, subcontractors, etc.). Additionally, a tailgate safety meeting must be performed and documented at the beginning of each workday. **Stop, Think, Assess, Review (STAR)** must be used prior to any activity. All personnel must possess the appropriate training prior to initiating scheduled tasks. Also consider weather conditions. CRA personnel have the authority and responsibility to use **Stop Work Authority.**

Date Issued/Revised	January 30, 2008	**JSA Type**	Sampling
Work Type	Environmental	**Client**	ATK
Work Activity	Tank Residue Sampling – Follow Quality Assurance Plan and/or Work Plan		
Work Site	RTI Superfund Site, 108 Lake Denmark Road, Rockaway Township, New Jersey		
Key Equipment	PID, colorimetric tubes (VC), LEL/O2 monitor, calibration kits, peristaltic pumps, bailers, spoons, trowels, Encore samplers, Fall protection		
Task-specific Training	CRA Field Method Training on sampling procedures, HazCom, Training on air monitoring equipment		

MINIMUM REQUIRED PERSONAL PROTECTIVE EQUIPMENT (SEE JOB STEPS FOR TASK-SPECIFIC REQUIREMENTS)			
☒ REFLECTIVE VEST*	☐ GOGGLES	☒ APR: based on air monitoring*	☒ GLOVES*
☒ HARD HAT	☐ FACE SHIELD*	☐ SUPPLIED AIR RESPIRATOR*	☐ COVERALLS*
☒ LIFELINE / HARNESS*	☐ HEARING PROTECTION*	☒ PPE CLOTHING* Modified Level D	☐ OTHER* _____
☒ SAFETY GLASSES	☒ STEEL TOED BOOTS	☐ OTHER* _____	☐ OTHER* _____
ADDITIONAL PPE: * Provide specific type(s) or descriptions of this item below			
Gloves will dependent on the task and chemical contamination present or suspected present. Fall protection required for work surfaces over 6-feet			

Development Team	**Position/Title**	**Reviewed By**	**Position/Title**	**Date**
Tom Hobday	Engineer	Robert Martin	Project Manager	1/30/08

JOB STEPS [1]	TASK ACTIVITY	POTENTIAL HAZARD(S) [2]	CORRECTIVE MEASURE(S)[3]	Person Responsible
1	Inspect and calibrate sampling and monitoring equipment	Lost time from improperly functioning equipment; Incorrect sampling procedures/collection due to malfunctioning equipment; exposure due to improperly functioning equipment	• Ensure all equipment is functioning properly; complete Quality Control documents for calibration daily.	Sampling Technician
2	Ascend tanks to be sampled, set-up of sampling and monitoring equipment. Opening of tanks. Entry of tanks not allowed.	Elevated work surfaces; Slip/Trip/Fall; Biological hazard; Heavy lifting; Contaminant exposure	• Use appropriate fall protection devices for elevated work surfaces. • Be aware of surroundings, maintain good housekeeping. • Be aware of biological hazards (ants, wasps, etc.) at tanks. • Hoist equipment up to work surface after ascending. Use proper lifting techniques. • Employ air monitoring per below	Sampling Technician
3	Air Monitoring of the breathing zones - PID, Colorimetric tubes, and LEL/O_2 monitor	Contaminant exposure; slip/trip/hit/fall	• Perform air monitoring in accordance with the HASP and the Air Monitoring Plan table below. • Colorimetric tubes to be pulled for Vinyl Chloride if PID readings exceed 1-ppm. • Upgrade PPE as necessary based on air monitoring results	Sampling Technician
4	Prepare to collect samples	Back strain; Pinch points; Cuts; Punctures; Sample misidentification	• Use proper lifting techniques and buddy system if needed. • Avoid placing hands/fingers in pinch point locations. • Use proper tools when opening container packaging. Do not use fixed open blade knives when opening boxes or containers. • Ensure the sample id label matches sample location with site plan/CRA Site Supervisor/subcontractor.	Sampling Technician
5	Sample collection	Contaminant exposure; Cuts from container breakage; Sample misidentification	• Wear nitrile gloves and replace between samples. • Inspect glass bottles for breaks/cracks. Do not attempt to use any suspect containers. Close glass sample containers carefully to avoid breakage. • Check sample labels for accuracy prior to placing in cooler.	Sampling Technician

JOB STEPS [1]	TASK ACTIVITY	POTENTIAL HAZARD(S) [2]	CORRECTIVE MEASURE(S)[3]	Person Responsible
6	Packing samples in cooler(s)	Bottle breakage; Contaminant exposure; Cuts; Pinch points; Back strain; Lost time due to incorrect sample packaging or hold time exceedances	• Wear nitrile gloves when handling sample containers. Pack glass containers in bubble wrap. Check COC against sample labels and SSOW for accuracy before shipping. • Avoid placing hands/fingers in pinch point locations (e.g. between cooler and lid). • Use proper lifting techniques and buddy system if needed. • Ensure equipment and supplies are loaded correctly and do not shift during transport.	Sampling Technician
7	Investigation derived waste (IDW) management	Contaminant exposure; Heavy lifting; Pinch points; Slips/trips/falls; Mislabeled waste	• Wear nitrile gloves when handling IDW. • Use proper lifting techniques to transport/dispose of IDW into drums and use buddy system if needed. • Avoid placing hands/fingers in pinch point locations. • Maintain awareness of walking surfaces. • Label IDW with generator, a contact number, identification of contents, and site location. Specify IDW as either hazardous or non-hazardous material.	Sampling Technician

[1] Each Job or Task consists of a set of steps. Be sure to list all the steps in the sequence that they are performed. Specify the equipment or other details to set the basis for the potential (associated) hazards.

[2] A hazard is a potential danger. What can go wrong? How can someone get hurt? Consider, but do not limit, the analysis to: **Contact** - victim is struck by or strikes an object; **Caught** - victim is caught on, caught in or caught between objects; **Fall** - victim falls to ground or lower level (includes slips and trips); **Exertion** - excessive strain or stress / ergonomics / lifting techniques; **Exposure** - inhalation/skin hazards. Specify the hazards and do not limit the description to a single word such as "Caught"

[3] Aligning with the Job Steps, Task Activity Description, and Potential Hazard columns, describe what actions or procedures are necessary to eliminate or minimize the hazards. Be clear, concise and specific. Use objective, observable and quantified terms. Avoid subjective general statements such as, "be careful" or "use as appropriate".

AIR MONITORING PLAN

INSTRUMENT	MONITORING FREQUENCY	ACTION LEVELS		
		MODIFIED LEVEL D	UPGRADE TO LEVEL C	CEASE OPERATIONS
PID	Continuous during tank opening and sampling activities	Less than 1 ppm	1 ppm - 10 ppm	Greater than 10 ppm
Colorimetric Tubes - Vinyl Chloride	If PID levels greater than 1 ppm are discovered, hourly thereafter	Less than 1 ppm	NA	Vinyl Chloride greater than 1 ppm
LEL/O_2 monitor	Continuous during tank opening and sampling activities	NA	NA	Greater than 10% LEL
LEL/O_2 monitor	Continuous during tank opening and sampling activities	NA	NA	Less than 19.5% O_2 or greater than 23.5% O_2

Notes:

- All work for this task to be initiated in Modified Level D
- All monitoring will be conducted in the breathing zone at the frequency noted
- To the extent practicable, gas powered equipment (generators, backhoe, geo-probe, etc.) will be placed such that exhaust and fumes are downwind of the breathing zone/work zone.

Job Safety Analysis (JSA)

JSA Filename: Clearance of Unexploded Ordinance (UXO)

Safety Means Awareness Responsibility Teamwork

Field staff must review job-specific work plan and coordinate with project manager to verify that all up-front logistics are completed prior to starting work including, but not limited to, permitting, access agreements and notification to required contacts (e.g., site managers, inspectors, clients, subcontractors, etc.). Additionally, a tailgate safety meeting must be performed and documented at the beginning of each workday. **Stop, Think, Act, Review (STAR)** must be used prior to any activity. All personnel must possess the appropriate training prior to initiating scheduled tasks. Also consider weather conditions. CRA personnel have the authority and responsibility to use **Stop Work Authority.**

Date Issued/Revised	January 30, 2008	**JSA Type**	Construction
Work Type	Remediation	**Client**	ATK
Work Activity	Clearance of areas potentially containing unexploded ordinance		
Work Site	RTI Superfund Site, 108 Lake Denmark Road, Rockaway Township, New Jersey		
Key Equipment	Magnetometer, stakes, flagging tape, marking paint		
Task-specific Training	Work to be performed by a qualified UXO contractor specializing in this kind of work		

MINIMUM REQUIRED PERSONAL PROTECTIVE EQUIPMENT (SEE JOB STEPS FOR TASK-SPECIFIC REQUIREMENTS)			
☒ REFLECTIVE VEST*	☐ GOGGLES	☐ APR: _____*	☒ GLOVES*
☒ HARD HAT	☐ FACE SHIELD*	☐ SUPPLIED AIR RESPIRATOR*	☐ COVERALLS*
☐ LIFELINE / HARNESS*	☐ HEARING PROTECTION*	☐ PPE CLOTHING*	☐ OTHER* _____
☒ SAFETY GLASSES	☒ STEEL TOED BOOTS	☐ OTHER* _____	☐ OTHER* _____
ADDITIONAL PPE: * Provide specific type(s) or descriptions of this item below			
Leather work gloves to avoid splinters, etc. while installing stakes/lathe			

Development Team	**Position/Title**	**Reviewed By**	**Position/Title**	**Date**
Tom Hobday	Engineer	Robert Martin	Project Manager	1/30/08

Job Safety Analysis (JSA)

JSA Filename: Clearance of Unexploded Ordinance (UXO)

Safety Means Awareness Responsibility Teamwork

JOB STEPS [1]	TASK ACTIVITY	POTENTIAL HAZARD(S) [2]	CORRECTIVE MEASURE(S)[3]	Person Responsible
1	Inspect and calibrate magnetometer	Loss of equipment or personnel due to malfunctioning equipment	• Ensure equipment is in proper working order daily • Calibrate equipment to manufacturer's requirements daily • Document calibrations and inspections	UXO contractor
2	Map out areas to be cleared including access and egress and required size of pathways based on equipment needs - To be performed prior to clearance activities	None	NA	UXO contractor CRA site supervisor
3	UXO surface avoidance activities and marking of safe passageways to test pit and sampling locations	Slip/Trip/Hit/Fall Biological Hazards UXOs Hand injury during stake installs	• Walk carefully, visually inspect areas for potential slip/trip/fall hazards, and eliminate as possible • Where necessary clothing and insect sprays to minimize potential biological hazards • Follow instructions of HASP for clearance of UXO free pathways. Conspicuously mark potential UXOs with stakes and flagging in red. Mark safe passageways with green stakes and flagging. • Take care while pounding in stakes and lathe to insure hands or body parts are not caught in between • Map out cleared pathways and provide to CRA SS	UXO contractor
4	UXO surface avoidance of test pit and sampling locations. Area cleared shall be adequate in size to allow all required equipment to safely maneuver at the location	Slip/Trip/Hit/Fall Biological Hazards UXOs Hand injury during stake installs	• Walk carefully, visually inspect areas for potential slip/trip/fall hazards, and eliminate as possible • Where necessary clothing and insect sprays to minimize potential biological hazards • Follow instructions of HASP for clearance of UXO free areas. Conspicuously mark potential UXOs with stakes and flagging in red. Mark safe passageways with green stakes and flagging. Mark cleared borehole locations with orange staking • Take care while pounding in stakes and lathe to insure hands or body parts are not caught in between • Map out cleared pathways and drilling/sampling locations to CRA SS	UXO contractor
5	Subsurface UXO clearance during test pitting in areas of potential UXOs.	Proximity to heavy equipment Pinch points Slip/Trip/Hit/Fall UXOs	• Stay clear of moving parts on excavator/heavy equipment. • Keep hands/equipment out of potential pinch points • Conspicuously mark any potential subsurface UXOs found with red tape/stakes • Maintain housekeeping, be aware of ground conditions in area	UXO contractor

[1] Each Job or Task consists of a set of steps. Be sure to list all the steps in the sequence that they are performed. Specify the equipment or other details to set the basis for the potential (associated) hazards.

[2] A hazard is a potential danger. What can go wrong? How can someone get hurt? Consider, but do not limit, the analysis to: **Contact** - victim is struck by or strikes an object; **Caught** - victim is caught on, caught in or caught between objects; **Fall** - victim falls to ground or lower level (includes slips and trips); **Exertion** - excessive strain or stress / ergonomics / lifting techniques; **Exposure** - inhalation/skin hazards. Specify the hazards and do not limit the description to a single word such as "Caught"

[3] Aligning with the Job Steps, Task Activity Description, and Potential Hazard columns, describe what actions or procedures are necessary to eliminate or minimize the hazards. Be clear, concise and specific. Use objective, observable and quantified terms. Avoid subjective general statements such as, "be careful" or "use as appropriate".

APPENDIX C

MATERIAL SAFETY DATA SHEETS

ALCONOX MSDS

Section 1 : MANUFACTURER INFORMATION

Product name: Alconox

Supplier: Same as manufacturer.

Manufacturer: Alconox, Inc.
30 Glenn St.
Suite 309
White Plains, NY 10603.

Manufacturer emergency phone number: 800-255-3924.
813-248-0585 (outside of the United States).

Manufacturer: Alconox, Inc.
30 Glenn St.
Suite 309
White Plains, NY 10603.

Supplier MSDS date: 2005/03/09

D.O.T. Classification: Not regulated.

Section 2 : HAZARDOUS INGREDIENTS

C.A.S.	CONCENTRATION %	Ingredient Name	T.L.V.	LD/50	LC/50
25155-30-0	10-30	SODIUM DODECYLBENZENESULFONATE	NOT AVAILABLE	438 MG/KG RAT ORAL 1330 MG/KG MOUSE ORAL	NOT AVAILABLE
497-19-8	7-13	SODIUM CARBONATE	NOT AVAILABLE	4090 MG/KG RAT ORAL 6600 MG/KG MOUSE ORAL	2300 MG/M3/2H RAT INHALATION 1200 MG/M3/2H MOUSE INHALATION
7722-88-5	10-30	TETRASODIUM PYROPHOSPHATE	5 MG/M3	4000 MG/KG RAT ORAL 2980 MG/KG MOUSE ORAL	NOT AVAILABLE
7758-29-4	10-30	SODIUM PHOSPHATE	NOT AVAILABLE	3120 MG/KG RAT ORAL 3100 MG/KG MOUSE ORAL >4640 MG/KG RABBIT DERMAL	NOT AVAILABLE

Section 2A : ADDITIONAL INGREDIENT INFORMATION

Note: (supplier).
CAS# 497-19-8: LD50 4020 mg/kg - rat oral.
CAS# 7758-29-4: LD50 3100 mg/kg - rat oral.

Section 3 : PHYSICAL / CHEMICAL CHARACTERISTICS

Physical state: Solid

Appearance & odor: Almost odourless.
White granular powder.

Odor threshold (ppm): Not available.

Vapour pressure (mmHg): Not applicable.

Vapour density (air=1): Not applicable.

By weight: Not available.

Evaporation rate (butyl acetate = 1): Not applicable.

Boiling point (°C): Not applicable.

Freezing point (°C): Not applicable.

pH: (1% aqueous solution).
9.5

Specific gravity @ 20 °C: (water = 1).
0.85 - 1.10

Solubility in water (%): 100 - > 10% w/w

Coefficient of water\oil dist.: Not available.

VOC: None

Section 4 : FIRE AND EXPLOSION HAZARD DATA

Flammability: Not flammable.

Conditions of flammability: Surrounding fire.

Extinguishing media: Carbon dioxide, dry chemical, foam.
Water
Water fog.

Special procedures: Self-contained breathing apparatus required.
Firefighters should wear the usual protective gear.

Auto-ignition temperature: Not available.

Flash point (°C), method: None

Lower flammability limit (% vol): Not applicable.

Upper flammability limit (% vol): Not applicable.

Not available.

Sensitivity to mechanical impact: Not applicable.

Hazardous combustion products: Oxides of carbon (COx).
Hydrocarbons.

Rate of burning: Not available.

Explosive power: None

Section 5 : REACTIVITY DATA

Chemical stability: Stable under normal conditions.

Conditions of instability: None known.

Hazardous polymerization: Will not occur.

Incompatible substances: Strong acids.
Strong oxidizers.

Hazardous decomposition products: See hazardous combustion products.

Section 6 : HEALTH HAZARD DATA

Route of entry: Skin contact, eye contact, inhalation and ingestion.

Effects of Acute Exposure

Eye contact: May cause irritation.

Skin contact: Prolonged contact may cause irritation.

Inhalation: Airborne particles may cause irritation.

Ingestion: May cause vomiting and diarrhea.
May cause abdominal pain.
May cause gastric distress.

Effects of chronic exposure: Contains an ingredient which may be corrosive.

LD50 of product, species & route: > 5000 mg/kg rat oral.

LC50 of product, species & route: Not available for mixture, see the ingredients section.

Exposure limit of material: Not available for mixture, see the ingredients section.

Sensitization to product: Not available.

Carcinogenic effects: Not listed as a carcinogen.

Reproductive effects: Not available.

Teratogenicity: Not available.

Mutagenicity: Not available.

Synergistic materials: Not available.

Medical conditions aggravated by exposure: Not available.

First Aid

Skin contact: Remove contaminated clothing.
Wash thoroughly with soap and water.
Seek medical attention if irritation persists.

Eye contact: Check for and remove contact lenses.
Flush eyes with clear, running water for 15 minutes while holding eyelids open: if irritation persists, consult a physician.

Inhalation: Remove victim to fresh air.
Seek medical attention if symptoms persist.

Ingestion: Dilute with two glasses of water.
Never give anything by mouth to an unconscious person.
Do not induce vomiting, seek immediate medical attention.

Section 7 : PRECAUTIONS FOR SAFE HANDLING AND USE

Leak / Spill: Contain the spill.
Recover uncontaminated material for re-use.
Wear appropriate protective equipment.
Contaminated material should be swept or shoveled into appropriate waste container for disposal.

Waste disposal: In accordance with municipal, provincial and federal regulations.

Handling procedures and equipment: Protect against physical damage.
Avoid breathing dust.
Wash thoroughly after handling.
Keep out of reach of children.
Avoid contact with skin, eyes and clothing.
Launder contaminated clothing prior to reuse.

Storage requirements: Keep containers closed when not in use.
Store away from strong acids or oxidizers.
Store in a cool, dry and well ventilated area.

Section 8 : CONTROL MEASURES

Precautionary Measures

Gloves / Type:

Neoprene or rubber gloves.

Respiratory / Type:

If exposure limit is exceeded, wear a NIOSH approved respirator.

Eye / Type:

Safety glasses with side-shields.

Footwear / Type: Safety shoes per local regulations.

Clothing / Type: As required to prevent skin contact.

Other / Type: Eye wash facility should be in close proximity.
Emergency shower should be in close proximity.

Ventilation requirements: Local exhaust at points of emission.

Material Safety Data Sheet

SECTION 1 PRODUCT AND COMPANY IDENTIFICATION

CHEVRON REGULAR UNLEADED GASOLINE

Product Number(s): CPS201000 [See Section 16 for Additional Product Numbers]
Synonyms: Calco Regular Unleaded Gasoline

Company Identification
Chevron Products Company
Marketing, MSDS Coordinator
6001 Bollinger Canyon Road
San Ramon, CA 94583
United States of America

Transportation Emergency Response
CHEMTREC: (800) 424-9300 or (703) 527-3887
Health Emergency
ChevronTexaco Emergency Information Center: Located in the USA. International collect calls accepted. (800) 231-0623 or (510) 231-0623
Product Information
Technical Information: (510) 242-5357

SPECIAL NOTES: This MSDS applies to: Federal Reformulated Gasoline, California Reformulated Gasoline, Wintertime Oxygenated Gasoline, Low RVP Gasoline and Conventional Gasoline.

SECTION 2 COMPOSITION/ INFORMATION ON INGREDIENTS

COMPONENTS	CAS NUMBER	AMOUNT
Gasoline	86290-81-5	100 %volume
Benzene	71-43-2	0.1 - 4.9 %volume
Ethyl benzene	100-41-4	0.1 - 3 %volume
Naphthalene	91-20-3	0.1 - 2 %volume
Ethanol	64-17-5	0 - 10 %volume
Methyl tert-butyl ether (MTBE)	1634-04-4	0 - 15 %volume
Tertiary amyl methyl ether (TAME)	994-05-8	0 - 17 %volume
Ethyl tert-butyl ether (ETBE)	637-92-3	0 - 18 %volume

Motor gasoline is considered a mixture by EPA under the Toxic Substances Control Act (TSCA). The refinery streams used to blend motor gasoline are all on the TSCA Chemical Substances Inventory. The appropriate CAS number for refinery blended motor gasoline is 86290-81-5. The product specifications of motor gasoline sold in your area will depend on applicable Federal and State regulations.

SECTION 3 HAZARDS IDENTIFICATION

****

EMERGENCY OVERVIEW

- EXTREMELY FLAMMABLE LIQUID AND VAPOR. VAPOR MAY CAUSE FLASH FIRE
- HARMFUL OR FATAL IF SWALLOWED - MAY CAUSE LUNG DAMAGE IF SWALLOWED
- VAPOR HARMFUL
- CAUSES SKIN IRRITATION
- CAUSES EYE IRRITATION
- LONG-TERM EXPOSURE TO VAPOR HAS CAUSED CANCER IN LABORATORY ANIMALS
- KEEP OUT OF REACH OF CHILDREN
- TOXIC TO AQUATIC ORGANISMS

****

IMMEDIATE HEALTH EFFECTS
Eye: Contact with the eyes causes irritation. Symptoms may include pain, tearing, reddening, swelling and impaired vision.
Skin: Contact with the skin causes irritation. Skin contact may cause drying or defatting of the skin. Symptoms may include pain, itching, discoloration, swelling, and blistering. Contact with the skin is not expected to cause an allergic skin response. Not expected to be harmful to internal organs if absorbed through the skin.
Ingestion: Because of its low viscosity, this material can directly enter the lungs, if swallowed, or if subsequently vomited. Once in the lungs it is very difficult to remove and can cause severe injury or death.
Inhalation: The vapor or fumes from this material may cause respiratory irritation. Symptoms of respiratory irritation may include coughing and difficulty breathing. Breathing this material at concentrations above the recommended exposure limits may cause central nervous system effects. Central nervous system effects may include headache, dizziness, nausea, vomiting, weakness, loss of coordination, blurred vision, drowsiness, confusion, or disorientation. At extreme exposures, central nervous system effects may include respiratory depression, tremors or convulsions, loss of consciousness, coma or death.

DELAYED OR OTHER HEALTH EFFECTS:
Reproduction and Birth Defects: This material is not expected to cause birth defects or other harm to the developing fetus based on animal data.
Cancer: Prolonged or repeated exposure to this material may cause cancer. Gasoline has been classified as a Group 2B carcinogen (possibly carcinogenic to humans) by the International Agency for Research on Cancer (IARC).

Contains benzene, which has been classified as a carcinogen by the National Toxicology Program (NTP) and a Group 1 carcinogen (carcinogenic to humans) by the International Agency for Research on Cancer (IARC).
Contains ethylbenzene which has been classified as a Group 2B carcinogen (possibly carcinogenic to humans) by the International Agency for Research on Cancer (IARC).
Contains naphthalene, which has been classified as a Group 2B carcinogen (possibly carcinogenic to humans) by the International Agency for Research on Cancer (IARC).

Whole gasoline exhaust has been classified as a Group 2B carcinogen (possibly carcinogenic to humans) by the International Agency for Research on Cancer (IARC).

Risk depends on duration and level of exposure. See Section 11 for additional information.

SECTION 4 FIRST AID MEASURES

Eye: Flush eyes with water immediately while holding the eyelids open. Remove contact lenses, if worn, after initial flushing, and continue flushing for at least 15 minutes. Get medical attention if irritation persists.
Skin: Wash skin with water immediately and remove contaminated clothing and shoes. Get medical attention if any symptoms develop. To remove the material from skin, use soap and water. Discard contaminated clothing and shoes or thoroughly clean before reuse.
Ingestion: If swallowed, get immediate medical attention. Do not induce vomiting. Never give anything by mouth to an unconscious person.
Inhalation: Move the exposed person to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention if breathing difficulties continue.
Note to Physicians: Ingestion of this product or subsequent vomiting may result in aspiration of light hydrocarbon liquid, which may cause pneumonitis.

SECTION 5 FIRE FIGHTING MEASURES

See Section 7 for proper handling and storage.

FIRE CLASSIFICATION:
OSHA Classification (29 CFR 1910.1200): Flammable liquid.

NFPA RATINGS: Health: 1 Flammability: 3 Reactivity: 0

FLAMMABLE PROPERTIES:
Flashpoint: (Tagliabue Closed Cup) < -45 °C (< -49 °F)
Autoignition: > 280 °C (> 536 °F)
Flammability (Explosive) Limits (% by volume in air): Lower: 1.4 Upper: 7.6

EXTINGUISHING MEDIA: Dry Chemical, CO2, AFFF Foam or alcohol resistant foam if >15% volume polar solvents (oxygenates).

PROTECTION OF FIRE FIGHTERS:
Fire Fighting Instructions: Use water spray to cool fire-exposed containers and to protect personnel. For fires involving this material, do not enter any enclosed or confined fire space without proper protective equipment, including self-contained breathing apparatus.
Combustion Products: Highly dependent on combustion conditions. A complex mixture of airborne solids, liquids, and gases including carbon monoxide, carbon dioxide, and unidentified organic compounds will be evolved when this material undergoes combustion.

SECTION 6 ACCIDENTAL RELEASE MEASURES

Protective Measures: Eliminate all sources of ignition in the vicinity of the spill or released vapor. If this material is released into the work area, evacuate the area immediately. Monitor area with combustible gas indicator.
Spill Management: Stop the source of the release if you can do it without risk. Contain release to prevent further contamination of soil, surface water or groundwater. Clean up spill as soon as possible, observing precautions in Exposure Controls/Personal Protection. Use appropriate techniques such as applying non-combustible absorbent materials or pumping. All equipment used when handling the product must be grounded. A vapor suppressing foam may be used to reduce vapors. Use clean non-sparking tools to collect absorbed material. Where feasible and appropriate, remove contaminated soil. Place contaminated materials in disposable containers and dispose of in a manner consistent with applicable regulations.
Reporting: Report spills to local authorities and/or the U.S. Coast Guard's National Response Center at (800) 424-8802 as appropriate or required. This material is covered by EPA's Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) Petroleum Exclusion. Therefore, releases to the environment may not be reportable under CERCLA.

SECTION 7 HANDLING AND STORAGE

Precautionary Measures: READ AND OBSERVE ALL PRECAUTIONS ON PRODUCT LABEL. This product presents an extreme fire hazard. Liquid very quickly evaporates, even at low temperatures, and forms vapor (fumes) which can catch fire and burn with explosive violence. Invisible vapor spreads easily and can be set on fire by many sources such as pilot lights, welding equipment, and electrical motors and switches. Never siphon gasoline by mouth.
Use only as a motor fuel. Do not use for cleaning, pressure appliance fuel, or any other such use. Do not store in open or unlabeled containers. Do not get in eyes, on skin, or on clothing. Do not taste or swallow. Do not breathe vapor or fumes. Wash thoroughly after handling. Keep out of the reach of children.
Unusual Handling Hazards: WARNING! Do not use as portable heater or appliance fuel. Toxic fumes may accumulate and cause death.
General Handling Information: Avoid contaminating soil or releasing this material into sewage and drainage systems and bodies of water.
Static Hazard: Electrostatic charge may accumulate and create a hazardous condition when handling this material. To minimize this hazard, bonding and grounding may be necessary but may not, by themselves, be sufficient. Review all operations which have the potential of generating an accumulation of electrostatic charge and/or a flammable atmosphere (including tank and container filling, splash filling, tank cleaning, sampling, gauging, switch loading, filtering, mixing, agitation, and vacuum truck operations) and use appropriate mitigating procedures. For more information, refer to OSHA Standard 29 CFR 1910.106, 'Flammable and Combustible Liquids', National Fire Protection Association (NFPA 77, 'Recommended Practice on Static Electricity', and/or the American Petroleum Institute (API) Recommended Practice 2003, 'Protection Against Ignitions Arising Out of Static, Lightning, and Stray Currents'. Improper filling of portable gasoline containers creates danger of fire. Only dispense gasoline into approved and properly labeled gasoline containers. Always place portable containers on the ground. Be sure pump nozzle is in contact with the container while filling. Do not use a nozzle's lock-open device. Do not fill portable containers that are inside a vehicle or truck/trailer bed.

General Storage Information: DO NOT USE OR STORE near heat, sparks or open flames. USE AND STORE ONLY IN WELL VENTILATED AREA. Keep container closed when not in use.
Container Warnings: Container is not designed to contain pressure. Do not use pressure to empty container or it may rupture with explosive force. Empty containers retain product residue (solid, liquid, and/or vapor) and can be dangerous. Do not pressurize, cut, weld, braze, solder, drill, grind, or expose such containers to heat, flame, sparks, static electricity, or other sources of ignition. They may explode and cause injury or death. Empty containers should be completely drained, properly closed, and promptly returned to a drum reconditioner or disposed of properly.

SECTION 8 EXPOSURE CONTROLS/PERSONAL PROTECTION

GENERAL CONSIDERATIONS:
Consider the potential hazards of this material (see Section 3), applicable exposure limits, job activities, and other substances in the work place when designing engineering controls and selecting personal protective equipment. If engineering controls or work practices are not adequate to prevent exposure to harmful levels of this material, the personal protective equipment listed below is recommended. The user should read and understand all instructions and limitations supplied with the equipment since protection is usually provided for a limited time or under certain circumstances.

ENGINEERING CONTROLS:
Use process enclosures, local exhaust ventilation, or other engineering controls to control airborne levels below the recommended exposure limits.

PERSONAL PROTECTIVE EQUIPMENT
Eye/Face Protection: No special eye protection is normally required. Where splashing is possible, wear safety glasses with side shields as a good safety practice.
Skin Protection: No special protective clothing is normally required. Where splashing is possible, select protective clothing depending on operations conducted, physical requirements and other substances in the workplace. Suggested materials for protective gloves include: Chlorinated Polyethylene (or Chlorosulfonated Polyethylene), Nitrile Rubber, Polyurethane, Viton.
Respiratory Protection: Determine if airborne concentrations are below the recommended exposure limits. If not, wear an approved respirator that provides adequate protection from measured concentrations of this

material, such as: Air-Purifying Respirator for Organic Vapors.
When used as a fuel, this material can produce carbon monoxide in the exhaust. Determine if airborne concentrations are below the occupational exposure limit for carbon monoxide. If not, wear an approved positive-pressure air-supplying respirator.
Use a positive pressure air-supplying respirator in circumstances where air-purifying respirators may not provide adequate protection.

Occupational Exposure Limits:

Component	Limit	TWA	STEL	Ceiling	Notation
Benzene	ACGIH_TLV	.5 ppm	2.5 ppm		Skin A1
Benzene	OSHA_PEL	1 ppm	5 ppm		
Benzene	OSHA_Z2	10 ppm		25 ppm	
Ethanol	ACGIH_TLV	1000 ppm			A4
Ethanol	OSHA_PEL	1000 ppm			
Ethyl benzene	ACGIH_TLV	100 ppm	125 ppm		A3
Ethyl benzene	OSHA_PEL	100 ppm	125 ppm		
Ethyl tert-butyl ether (ETBE)	ACGIH_TLV	5 ppm			
Gasoline	ACGIH_TLV	300 ppm	500 ppm		A3
Gasoline	OSHA_PEL	300 ppm	500 ppm		
Methyl tert-butyl ether (MTBE)	ACGIH_TLV	50 ppm			A3
Naphthalene	ACGIH_TLV	10 ppm	15 ppm		Skin A4
Naphthalene	OSHA_PEL	10 ppm	15 ppm		
Tertiary amyl methyl ether (TAME)	CHEVRON		50 ppm		

Refer to the OSHA Benzene Standard (29 CFR 1910.1028) and Table Z-2 for detailed training, exposure monitoring, respiratory protection and medical surveillance requirements before using this product.

SECTION 9 PHYSICAL AND CHEMICAL PROPERTIES

Attention: the data below are typical values and do not constitute a specification.

Color: Colorless to yellow
Physical State: Liquid
Odor: Petroleum odor
pH: NA
Vapor Pressure: 5 psi - 15 psi (Typical) @ 37.8°C (100°F)
Vapor Density (Air = 1): 3 - 4 (Typical)
Boiling Point: 37.8°C (100°F) - 204.4°C (400°F) (Typical)
Solubility: Insoluble in water; miscible with most organic solvents.
Freezing Point: NA
Melting Point: NA
Specific Gravity: 0.7 g/ml - 0.8 g/ml @ 15.6°C (60.1°F)
Viscosity: <1 SUS @ 37.8°C (100°F)

SECTION 10 STABILITY AND REACTIVITY

Chemical Stability: This material is considered stable under normal ambient and anticipated storage and handling conditions of temperature and pressure.
Incompatibility With Other Materials: May react with strong oxidizing agents, such as chlorates, nitrates, peroxides, etc.
Hazardous Decomposition Products: None known (None expected)
Hazardous Polymerization: Hazardous polymerization will not occur.

SECTION 11 TOXICOLOGICAL INFORMATION

IMMEDIATE HEALTH EFFECTS
Eye Irritation: The Draize eye irritation mean score in rabbits for a 24-hour exposure was: 0/110.
Skin Irritation: For a 4-hour exposure, the Primary Irritation Index (PII) in rabbits is: 4.8/8.0.
Skin Sensitization: This material did not cause sensitization reactions in a Modified Buehler guinea pig test.
Acute Dermal Toxicity: 24 hour(s) LD50: >3.75g/kg (rabbit).
Acute Oral Toxicity: LD50: >5 ml/kg (rat)
Acute Inhalation Toxicity: 4 hour(s) LD50: >2000ppm (rat).

ADDITIONAL TOXICOLOGY INFORMATION:
Gasolines are highly volatile and can produce significant concentrations of vapor at ambient temperatures. Gasoline vapor is heavier than air and at high concentrations may accumulate in confined spaces to present both safety and heath hazards. When vapor exposures are low, or short duration and infrequent, such as during refuelling and tanker loading/unloading, neither total hydrocarbon nor components such as benzene are likely to result in any adverse health effects. In situations such as accidents or spills where exposure to gasoline vapor is potentially high, attention should be paid to potential toxic effects of specific components. Information about specific components in gasoline can be found in Sections 2, 8 and 15 of this MSDS. More detailed information on the health hazard of specific gasoline components can be obtained calling the Chevron Emergency Information Center (see Section 1 for phone numbers).

NEUROTOXICITY: Pathological misuse of solvents and gasoline, involving repeated and prolonged exposure to high concentrations of vapor is a significant exposure on which there are many reports in the medical literature. As with other solvents, persistent abuse involving repeated and prolonged exposures to high concentrations of vapor has been reported to result in central nervous system damage and eventually, death. In a study in which ten human volunteers were exposed for 30 minutes to approximately 200, 500 or 1000 ppm concentrations of gasoline vapor, irritation of the eyes was the only significant effect observed, based on both subjective and objective assessments. In an inhalation study, groups of 6 Fischer rats (3 male. 3 female) were exposed to 2056 ppm of wholy vaporized unleaded gasoline for 6 hours perday, 5 day per week for up to 18 months. Histopathology of the peripheral nervous system and spinal cord revealed no distal axonal neuropthy of the type associated with exposure to n-hexane even though gasoline contained 1.9% n-hexane. The authors concluded that gasoline treatment may have amplified the incidence and prominence of some naturally occurring age-related (subclinical) in the nervous system. BIRTH DEFECTS AND REPRODUCTIVE TOXICITY: An inhalation study with rats exposed to 0, 400 and 1600 ppm of wholly vaporized unleaded gasoline, 6 hours per day on day 6 through 16 of gestation, showed no teratogenic effects nor indication of toxicity to either the mother

or the fetus. Another inhalation study in rats exposed to 3000, 6000, or 9000 ppm of gasoline vapor, 6 hours per day on day 6 through 20 of gestation, also showed no teratogenic effects nor indications of toxicity to either the mother or the fetus.

CHRONIC TOXICITY/CANCER: Wholly vaporized unleaded gasoline was used in a 3 month inhalation study. Groups of 40 rats (20 males, 20 female) and 8 squirrel monkeys (4 male, 4 female) were exposed 6 hours per day and 5 days per week for 13 weeks to 384 or 1552 ppm gasoline. One group of each species served as unexposed controls. The initial conclusion of this study was that inhalation of gasoline at airborne concentrations of up to 1522 ppm caused no toxicity in rats or monkeys. However, further histopathological examination of male rat kidneys on the highest dose group revealed an increased incidence and severity of regenerative epithelium and dilated tubules containing proteinaceous deposits. Lifetime inhalation of wholly vaporized unleaded gasoline at 2056 ppm has caused increased liver tumors in female mice. The mechanism of this response is still being investigated but it is thought to be an epigenetic process unique to the female mouse.

This exposure also caused kidney damage and eventually kidney cancer in male rats. No other animal model studied has shown these adverse kidney effects and there is no physiological reason to believe that they would occur in man. EPA has concluded that mechanism by which wholly vaporzied unleaded gasoline causes kidney damage is unque to the male rat. The effects in that species (kidney damage and cancer) should not be used in human risk assesment. In their 1988 review of carcinogenic risk from gasoline, The International Agency for Research on Cancer (IARC) noted that, because published epidemiology studies did not include any exposure data, only occupations where gasoline exposure may have ocurred were reviewed. These included gasoline service station attendants and automobile mechanics. IARC also noted that there was no opportunity to separate effects of combustion products from those of gasoline itself. Although IARC allocated gasoline a final overall classification of Group 2B, i.e. possibly carcinogenic to humans, this was based on limited evidence in experimental animals plus supporting evidence including the presence in gasoline of benzene and 1, 3-butadiene. The actual evidence for carcinogenicity in humans was considered inadequate.

MUTAGENICITY: Gasoline was not mutagenic, with or without activation, in the Ames assay (Salmonella typhimurium), Saccharamyces cerevisesae, or mouse lymphoma assays. In addition, point mutations were not induced in human lymphocytes. Gasoline was not mutagenic when tested in the mouse dominant lethal assay. Administration of gasoline to rats did not cause chomosomal aberrations in their bone marrow cells. EPIDEMIOLOGY: To explore the health effects of workers potentially exposed to gasoline vapors in the marketing and distribution sectors of the petroleum industry, the American Petroleum Institute sponsored a cohort mortality study (Publication 4555), a nested case-control study (Publication 4551), and an exposure assessment study (Publication 4552). Histories of exposure to gasoline were reconstructed for cohort of more than 18,000 employees from four companies for the time period between 1946 and 1985. The results of the cohort mortality study indicated that there was no increased mortality from either kidney cancer or leukemia among marketing and marine distribution employees who were exposed to gasoline in the petroleum industry, when compared to the general population. More importantly, based on internal comparisons, there was no association between mortality from kidney cancer or leukemia and various indices of gasoline exposure. In particular, neither duration of employment, duration of exposure, age at first exposure, year of first exposure, job category, cumulative exposure, frequency of peak exposure, nor average intensity of exposure had any effect on kidney cancer or leukemia mortality. The results of the nested case-control study confirmed the findings of the original cohort study. That is, exposure to gasoline at the levels experienced by this cohort of distribution workers is not a significant risk factor for leukemia (all cell types), acute myeloid leukemia, kidney cancer or multiple myeloma.

SECTION 12 ECOLOGICAL INFORMATION

ECOTOXICITY
The 96 hour(s) LC50 for rainbow trout (Oncorhynchus mykiss) is 2.7 mg/l.
The 48 hour(s) LC50 for water flea (Daphnia magna) is 3.0 mg/l.
The 96 hour(s) LC50 for sheepshead minnow (Cyprinodon variegatus) is 8.3 mg/l.
The 96 hour(s) LC50 for mysid shrimp (Mysidopsis bahia) is 1.8 mg/l.
This material is expected to be toxic to aquatic organisms. Gasoline studies have been conducted in the laboratory under a variety of test conditions with a range of fish and invertebrate species. An even more extensive database is available on the aquatic toxicity of individual aromatic constituents. The majority of published studies do not identify the type of gasoline evaluated, or even provide distinguishing characteristics such as aromatic content or presence of lead alkyls. As a result, comparison of results among studies using open

and closed vessels, different ages and species of test animals and different gasoline types, is difficult.

The bulk of the available literature on gasoline relates to the environmental impact of monoaromatic (BTEX) and diaromatic (naphthalene, methylnaphthalenes) constituents. In general, non-oxygenated gasoline exhibits some short-term toxicity to freshwater and marine organisms, especially under closed vessel or flow-through exposure conditions in the laboratory. The components which are the most prominent in the water soluble fraction and cause aquatic toxicity, are also highly volatile and can be readily biodegraded by microorganisms.

ENVIRONMENTAL FATE
This material is expected to be readily biodegradable. Following spillage, the more volatile components of gasoline will be rapidly lost, with concurrent dissolution of these and other constituents into the water. Factors such as local environmental conditions (temperature, wind, mixing or wave action, soil type, etc), photo-oxidation, biodegradation and adsorption onto suspended sediments, can contribute to the weathering of spilled gasoline.

The aqueous solubility of non-oxygenated unleaded gasoline, based on analysis of benzene, toluene, ethylbenzene+xylenes and naphthalene, is reported to be 112 mg/l. Solubility data on individual gasoline constituents also available.

SECTION 13 DISPOSAL CONSIDERATIONS

Use material for its intended purpose or recycle if possible. This material, if it must be discarded, may meet the criteria of a hazardous waste as defined by US EPA under RCRA (40 CFR 261) or other State and local regulations. Measurement of certain physical properties and analysis for regulated components may be necessary to make a correct determination. If this material is classified as a hazardous waste, federal law requires disposal at a licensed hazardous waste disposal facility.

SECTION 14 TRANSPORT INFORMATION

The description shown may not apply to all shipping situations. Consult 49CFR, or appropriate Dangerous Goods Regulations, for additional description requirements (e.g., technical name) and mode-specific or quantity-specific shipping requirements.

DOT Shipping Name: GASOLINE
DOT Hazard Class: 3 (Flammable Liquid)
DOT Identification Number: UN1203
DOT Packing Group: II

SECTION 15 REGULATORY INFORMATION

SARA 311/312 CATEGORIES:

1. Immediate (Acute) Health Effects: YES
2. Delayed (Chronic) Health Effects: YES
3. Fire Hazard: YES
4. Sudden Release of Pressure Hazard: NO
5. Reactivity Hazard: NO

REGULATORY LISTS SEARCHED:

4_I1=IARC Group 1 15=SARA Section 313

4_I2A=IARC Group 2A

4_I2B=IARC Group 2B

05=NTP Carcinogen

06=OSHA Carcinogen

09=TSCA 12(b)

16=CA Proposition 65

17=MA RTK

18=NJ RTK

19=DOT Marine Pollutant

20=PA RTK

The following components of this material are found on the regulatory lists indicated.

Benzene	15, 16, 17, 18, 20, 4_I1, 5, 6
Ethanol	17, 18, 20
Ethyl benzene	15, 17, 18, 20, 4_I2B
Gasoline	17, 18, 20
Methyl tert-butyl ether (MTBE)	15, 17, 18, 20, 9
Naphthalene	15, 16, 17, 18, 20, 4_I2B
Tertiary amyl methyl ether (TAME)	9

CERCLA REPORTABLE QUANTITIES(RQ)/SARA 302 THRESHOLD PLANNING QUANTITIES(TPQ):

Component	Component RQ	Component TPQ	Product RQ
Benzene	10 lbs	None	186 lbs
Ethanol	100 lbs	None	1961 lbs
Ethyl benzene	1000 lbs	None	34964 lbs
Methyl tert-butyl ether (MTBE)	1000 lbs	None	7513 lbs
Naphthalene	100 lbs	None	4000 lbs

CHEMICAL INVENTORIES:
CANADA: All the components of this material are on the Canadian DSL or have been notified under the New Substance Notification Regulations, but have not yet been published in the Canada Gazette.
UNITED STATES: All of the components of this material are on the Toxic Substances Control Act (TSCA) Chemical Inventory.

WHMIS CLASSIFICATION:
Class B, Division 2: Flammable Liquids
Class D, Division 2, Subdivision A: Very Toxic Material - Carcinogenicity
Class D, Division 2, Subdivision B: Toxic Material - Skin or Eye Irritation

SECTION 16 OTHER INFORMATION

NFPA RATINGS: Health: 1 Flammability: 3 Reactivity: 0

(0-Least, 1-Slight, 2-Moderate, 3-High, 4-Extreme, PPE:- Personal Protection Equipment Index recommendation, *- Chronic Effect Indicator). These values are obtained using the guidelines or published evaluations prepared by the National Fire Protection Association (NFPA) or the National Paint and Coating Association (for HMIS ratings).

Additional Product Number(s): CPS201023, CPS201054, CPS201055, CPS201075, CPS201090, CPS201105, CPS201106, CPS201120, CPS201121, CPS201122, CPS201126, CPS201128, CPS201131, CPS201136, CPS201141, CPS201142, CPS201148, CPS201153, CPS201158, CPS201161, CPS201162, CPS201168, CPS201181, CPS201185, CPS201186, CPS201188, CPS201216, CPS201217, CPS201218, CPS201236, CPS201237, CPS201238, CPS201266, CPS201267, CPS201268, CPS201277, CPS201278, CPS201279, CPS201286, CPS201287, CPS201289, CPS201296, CPS201297, CPS201298, CPS201849, CPS201850, CPS201855, CPS201856, CPS201857, CPS204000, CPS204001, CPS204002, CPS204003, CPS204010, CPS204011, CPS204022, CPS204023, CPS204046, CPS204047, CPS204070, CPS204071, CPS204088, CPS204089, CPS204104, CPS204105, CPS204116, CPS204117, CPS204140, CPS204141, CPS204164, CPS204165, CPS204188, CPS204189, CPS204200, CPS204201, CPS204212, CPS204213, CPS204224, CPS204225, CPS204248, CPS204249, CPS204272, CPS204273, CPS204290, CPS204291, CPS204322, CPS204323, CPS204324, CPS204350, CPS204352, CPS204354, CPS204356, CPS204358, CPS204359, CPS204364, CPS204365, CPS204370, CPS204371, CPS204376, CPS204377, CPS204382, CPS204383, CPS204388, CPS204389, CPS204394, CPS204395, CPS204400, CPS204401, CPS204406, CPS204407, CPS204412, CPS204413, CPS204418, CPS204419, CPS204424, CPS204425, CPS204430, CPS204431, CPS204436, CPS204437, CPS204442, CPS204446, CPS204450, CPS204454, CPS204458, CPS204462, CPS204466, CPS204467, CPS204484, CPS204485, CPS204502, CPS204503, CPS204520, CPS204521, CPS204538, CPS204539, CPS204556, CPS204557, CPS204574, CPS204575, CPS204592, CPS204593, CPS204610, CPS204611, CPS204628, CPS204629, CPS204646, CPS204647, CPS204664, CPS204665, CPS204682, CPS204690, CPS204691, CPS204696, CPS204697, CPS204702, CPS204703, CPS204708, CPS204709, CPS204721, CPS204722, CPS204727, CPS204728, CPS241765

REVISION STATEMENT: This revision updates the following sections of this Material Safety Data Sheet: Section 1 (Product Codes). This Material Safety Data Sheet has been prepared using the ProSteward MSDS system.

ABBREVIATIONS THAT MAY HAVE BEEN USED IN THIS DOCUMENT:

TLV	-	Threshold Limit Value	TWA	-	Time Weighted Average
STEL	-	Short-term Exposure Limit	PEL	-	Permissible Exposure Limit
			CAS	-	Chemical Abstract Service Number
NDA	-	No Data Available	NA	-	Not Applicable
<=	-	Less Than or Equal To	>=	-	Greater Than or Equal To

Prepared according to the OSHA Hazard Communication Standard (29 CFR 1910.1200) and the ANSI MSDS Standard (Z400.1) by the ChevronTexaco Energy Research & Technology Company, 100 Chevron Way, Richmond, California 94802.

The above information is based on the data of which we are aware and is believed to be correct as of the date hereof. Since this information may be applied under conditions beyond our control and with which we may be unfamiliar and since data made available subsequent to the date hereof may suggest modifications of the information, we do not assume any responsibility for the results of its use. This information is furnished upon condition that the person receiving it shall make his own determination of the suitability of the material for his particular purpose.

APPENDIX D

UXO BACKGROUND INFORMATION

PICATINNY UXO BACKGROUND

Based on ATK's review of the Stakeholder Draft Site Inspection (SI) Report, Picatinny Arsenal, New Jersey (Malcolm Pirnie, Inc., November 2007), the potential for UXO on the RTI site results from munitions firing and discarded UXO following the 1926 Lake Denmark Powder Depot explosion.

In 2007, Picatinny conducted a visual survey of 4.75-acres at the RTI site. According to the SI report, no munitions and explosives of concern (MEC) or munitions debris were observed. A map of the SI field activities and findings is attached as Figure 1.

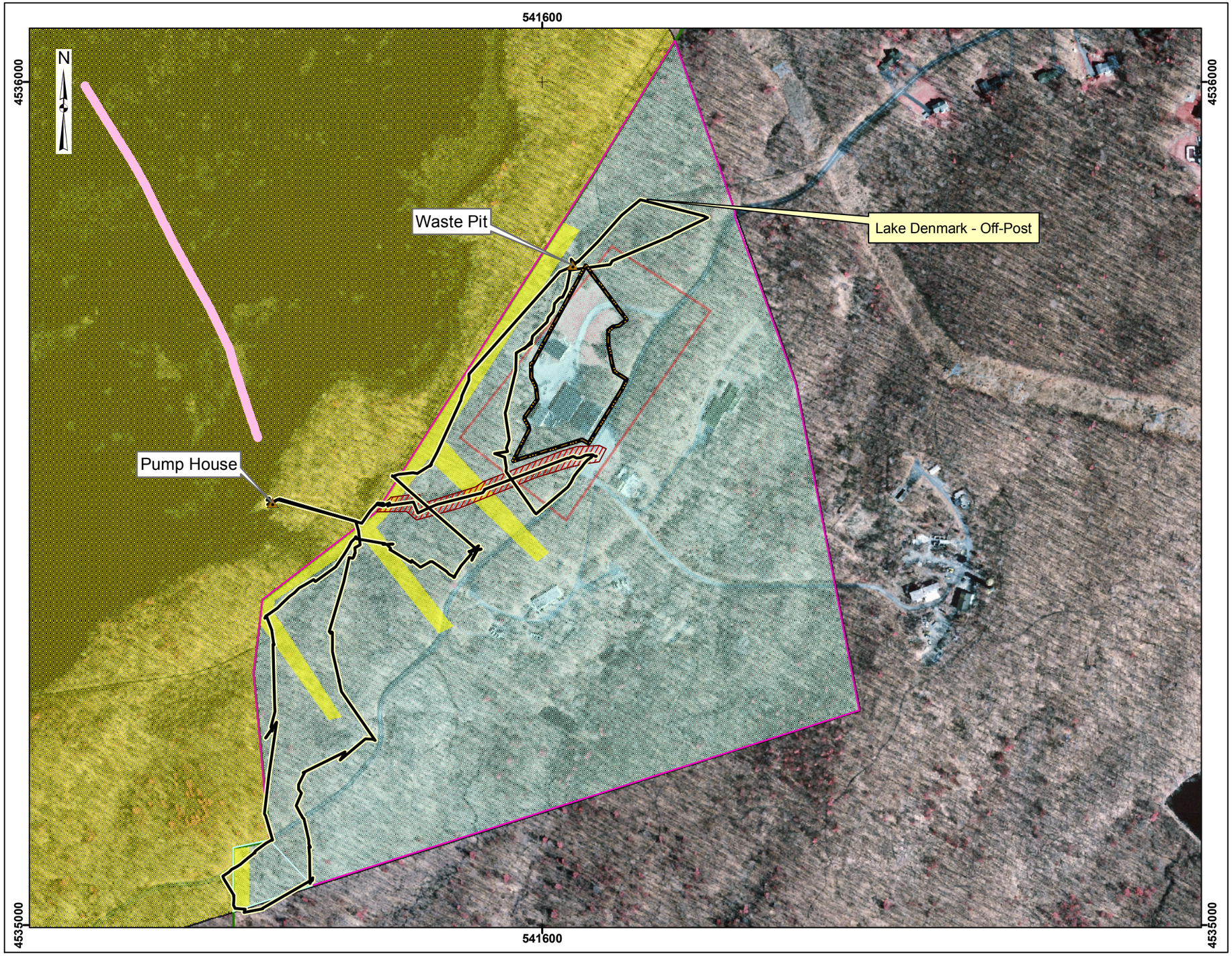
The following table provides a summary of the potential and actual munitions debris and MEC for the RTI Site (a.k.a. Lake Denmark – Off-Post)

Munitions Debris/MEC Observed During SI Field Activities	Munitions Debris/MEC Identified during Historical Records Review	Primary Release Mechanism
None	• Mortars: 60-mm, 81-mm, 4.2-inch inert • 20-mm cannons • Primary and secondary explosives • Pyrotechnics • Experimental munitions	• Munitions firing and testing • Discarded UXO following the 1926 Lake Denmark Powder Depot explosion

According to the USACE's Ordnance and Explosives Response Manual (EM1110-1-4009), June 2000, the maximum probable penetration depth for a 4.2-inch mortar is 5.4 feet. According to the SI report, no MEC was observed on the surface during the SI visual survey; therefore, the MEC density at the site is unknown.

PICATINNY CONTACT INFORMATION

In the event an anomaly is detected during the UXO clearing activities, the Picatinny Police Department (973-724-6666) and Paul Greene of USACE (410-962-6741) will be contacted to investigate, and if necessary, remove the UXO. ATK's UXO contractor will not be responsible for conducting UXO removal activities.



Site Inspection
Picatinny Arsenal, NJ

MALCOLM PIRNIE

Map 4-5
SI Field Activities and Findings
Lake Denmark - Off-Post

Legend

- Installation Boundary
- Site Survey
- Approximate Furthest Extent of Mortar Impact Area
- SI Work Plan Proposed Area for Visual Survey
- Radiation Technology Superfund Site
- Berm
- Fenced Area

Military Range Area

- Lakes Site
- Lake Denmark - Off-Post

Off-Post Owners*

- Rockaway Township
- Radiation Technology, Inc

*Notes: 1) Off-Post Owners areas are approximate
2) Transects for the visual survey were not conducted in straight lines because of sporadic GIS satellite coverage, site topography and dense vegetation. GIS interference was caused by overhead tree canopy.

0 90 180 360 Meters

Data Source: Aerials: NJDEP, CIR Orthoimagery, 2002
CTT Data: AEC, CTT Range Inventory, 2005

Coordinate System: UTM Zone 18N
Datum: NAD 83
Units: Meters

Contract: W912DR-05-D-0004
Edition: Draft SI Report
Date: November 2007

300562

APPENDIX E

WRITTEN SAFETY PROGRAMS

Hazard Communication Program
Fall Protection Program
Respiratory Protection Program

Hazard Communication Program

CONESTOGA-ROVERS & ASSOCIATES

HAZARD COMMUNICATION PROGRAM

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1.0 PURPOSE

The purpose of this hazard communication (HAZCOM) program is to provide guidance and information to Conestoga-Rovers & Associates (CRA) employees on the physical and/or health hazards of hazardous chemicals they may encounter or use in the workplace.

2.0 SCOPE

This document establishes the HAZCOM program for the CRA family of companies. The guidelines and requirements of this program apply to any employee, subcontractor or any other individual falling under CRA responsibility, who will handle or work with hazardous chemicals in the workplace. It is policy that all employees shall have access to information regarding hazardous chemicals in their workplace.

CRA will maintain and implement a HAZCOM program in accordance with OSHA 29 CFR 1910.1200. The implementation of this program includes the following:

- Assess the potential exposure to employees while using workplace chemicals.
- Assemble a list of the hazardous materials and/or substances in the workplace.
- Label all chemicals.
- Provide employees with access to the Material Safety Data Sheets (MSDSs).
- Provide training and education to employees.
- Employees shall receive applicable training and information regarding the safe use and handling of hazardous materials in the workplace.

3.0 REGULATORY BACKGROUND

On November 25, 1983, Occupational Safety and Health Administration (OSHA) published its final rule on the Hazard Communication Standard (HAZCOM) also known as the "Right-To-Know" Rule as referenced in OSHA 29 CFR 1910.1200. The standard requires employers to communicate the hazards associated with workplace chemicals to all employees, by giving them greater access to information on the physical and health hazards present in the workplace, safe handling precautions, and emergency and first-aid procedures. The standard covers manufacturing and non-manufacturing establishments and is a performance-oriented rule.

The following materials are exempt from the requirements of the HAZCOM standard and this program:

- Any hazardous waste which is subject to the regulations of the U.S. Environmental Protection Agency (EPA).
- Substances generally available to the public that are used in the workplace in the same form, volume, concentration, and manner as consumer goods.
- Tobacco or tobacco products.
- Wood or wood products.
- Articles.
- Food, drugs, or cosmetics for personal consumption used by employees in the workplace.

3.1 STATE REGULATIONS

The U.S. federal regulation is the template that is used in most state right-to-know laws. However, some states have regulations that supplement the federal regulation, particularly in the area of community requirements.

4.0 DEFINITIONS

The following definitions are applicable to this program:

Combustible Liquid is a liquid having a flashpoint between 100°F and 200°F.

Consumer Product Chemical is a chemical purchased from a retail or hardware store, which is commercially available.

Engineering Controls means controls that isolate or remove the chemical hazard from the workplace.

Exposure occurs when an employee is **potentially** or actually subjected to a hazardous chemical, through any route of entry.

Flammable Liquid is a liquid having a flashpoint below 100°F.

Flashpoint is the minimum temperature at which a liquid releases vapor in a sufficient concentration to ignite with any source of energy (e.g., spark).

Hazard Warning is any group of words, pictures, symbols, or combination thereof, appearing on a label or other appropriate form of warning which convey the hazards of the chemical(s) in the container(s).

Hazardous Chemical is a chemical for which there is significant evidence of a physical or health hazards, based on at least one study conducted in accordance with established procedures.

Health Hazard is a hazard from a chemical for which statistically significant scientific evidence shows that acute or chronic health effects may occur in overexposed employees. This includes carcinogens, corrosives, irritants, sensitizers, toxic or highly toxic agents and other categories listed in 29 CFR 1910.1200.

Label is any written, printed, or graphic material displayed on or affixed to containers of hazardous materials.

MSDS means Material Safety Data Sheet.

NFPA is the abbreviation for the National Fire Protection Association.

Personal Protective Equipment (PPE) are items such as safety glasses, gloves, respirators, hard hats and other such equipment which are used specifically for providing protection from physical or chemical hazards to the individual wearing the equipment.

Physical Hazard is a hazard from a chemical that is a combustible liquid, compressed gas, explosive, flammable, organic peroxide, oxidizer, reactive or pyrophoric substance.

Work Area is a workplace where hazardous chemicals may be used.

5.0 PROGRAM ADMINISTRATION

The CRA Corporate Safety and Health Manager (CSHM) will serve as the overall administrator of this program. The CRA Regional Safety and Health Managers (RSHMs) will have a regional responsibility for the administration of the program. In addition, the project manager and/or supervisor for each CRA project will ensure the following:

- The HAZCOM program is properly developed and implemented.
- Conduct periodic reviews to ensure compliance with the program.
- Employee are provided proper information and training.
- MSDSs are current, available, and accessible to employees.
- A location has been selected where the MSDSs shall be maintained and made accessible to all employees.
- A chemical inventory has been established.

6.0 DUTIES AND RESPONSIBILITIES

6.1 SUPERVISORS/PROJECT MANAGERS

Supervisors/Project Managers have the following duties and responsibilities with respect to this program:

- Establish the project's chemical inventory.
- Ensure the HAZCOM program guidelines are being followed.
- Employees have been trained.
- MSDSs are current and available.
- Employees are aware of the MSDS location.

6.2 SAFETY CAPTAINS

Safety Captains shall be responsible for the following at CRA office locations:

- Establish the facilities chemical inventory.
- MSDSs are current and available.
- Employees are aware of the MSDS location.

6.3 EMPLOYEES

Employees shall have the following responsibilities with respect to this program:

- Follow safe work practices for the handling, use and storage of hazardous materials.
- Wear appropriate PPE as designated by the program, warning labels, and supervisory instruction.
- Label or re-label containers with the appropriate chemical identification and hazard warning information
- Do not handle or use unlabeled containers.
- Obtain additional information about chemicals in the workplace by referring to the MSDS or ask your supervisor.

7.0 PROGRAM ELEMENTS

7.1 HAZCOM PROGRAM GUIDELINES

Each project/facility location shall implement the CRA HAZCOM program, which will include:

- The use of labels and other forms of warnings.
- MSDSs.
- Employee information and training requirements.
- A list of hazardous chemicals known to be present.
- Methods used to inform employees of the hazards of non-routine tasks.

7.2 CHEMICAL INVENTORY

CRA will establish and maintain a hazardous chemical inventory. The inventory is to be located in each MSDS book for each respective location. The hazardous chemical inventory must contain the identity of the chemicals identified in the MSDS book. The name used on the inventory to identify a chemical does not have to be its scientific chemical name (i.e., common, trade, or product names may be used). However, the name used on the inventory must also reference its corresponding MSDS.

A Chemical Inventory List template can be found in Appendix A. Any new products purchased after the inventory date will be added to this list and any products that have been discontinued will be deleted from the list. CRA shall reaffirm the chemical inventory on an annual basis.

7.3 MATERIAL SAFETY DATA SHEETS

Chemical manufacturers must obtain or develop an MSDS for each hazardous chemical they produce or import.

Each MSDS shall contain the following information:

- Identity of the substance as it appears on the container label.

- The physical and chemical characteristics of the chemical.
- The physical hazards of the chemical.
- The health hazards of the chemical, including signs and symptoms of exposure, and any medical conditions which are recognized as being aggravated by exposure to the chemical.
- The primary routes of entry.
- Information and exposure limits.
- Whether the substance is a potential carcinogen.
- Precautions and safe handling.
- Applicable control measures [engineering controls, work practices, or personal protective equipment (PPE)].
- Emergency first aid procedures.
- The date the MSDS was prepared.
- Name, address, and telephone number of the manufacturer, importer or other responsible party.

MSDSs describe in detail the properties of a chemical substance, their physical and health hazards, and precautions for safe handling and use.

CRA project sites and facilities are required to have an MSDS for each hazardous chemical that is used at that location. Incoming MSDSs should be reviewed for accuracy and completeness and to ensure that the latest MSDS is on file.

CRA will maintain and establish a book of MSDS to include each item listed in the chemical inventory. The MSDS book will be assigned to a specific facility or project location and communicated to employees working at those premises.

Personnel that purchase hazardous materials will ensure that the most current MSDS is forwarded to the facility safety captain or project supervisor.

7.3.1 EMPLOYEE ACCESS TO MSDS

CRA will ensure that MSDSs are readily available in all workplace environments where hazardous material products are stored or used. The location of this information will

also be conveyed to all applicable personnel through training, signs, and verbal instruction.

7.4 LABELS AND OTHER FORMS OF WARNING

Chemical manufacturers, importers, and distributors must label, tag, or mark each container of hazardous chemicals leaving their facility. Most containers of chemical products will already be labeled by the manufacturer, supplier, or distributor to satisfy the OSHA HAZCOM standard requirements. CRA will initially rely on product manufacturers for proper labeling of chemicals that are purchased and received at the facility. However, CRA personnel shall check the adequacy of existing labels as they are received or purchased.

When these containers are accepted by CRA, labels shall be kept clean and legible, shall be prominently displayed on the container, and shall be written in English. Other labels written in other languages may be affixed to the container as long as there is a label in English.

CRA will also ensure that containers of chemicals are labeled with the following information:

- The name of the hazardous chemical/material.
- The name and address of the manufacturer, importer or distributor.
- Appropriate hazard warnings (route of entry into body/affected target organs/first aid).
- Description of the health and/or physical hazards.

The chemical or product name warning can be words, pictures, or symbols, which provide an immediate understanding of the primary health and/or physical hazard(s) of the material. The chemical or product name that is listed on the label must allow cross-referencing to the MSDS and the inventory.

7.4.1 LABEL REPLACEMENT

There are situations where existing labels may need to be replaced or supplemented. Existing labels that do not remain legible over the useful life of the container must be

replaced. For example, weather-resistant labels or tags would be appropriate for containers subjected to outdoor conditions. Some chemicals when splashed or spilled may degrade the marking on the container label. Therefore, label inks and markings should be used that are not soluble in the liquid content of the container.

7.4.2 PORTABLE CONTAINERS

All employees will label portable containers into which hazardous chemicals are transferred from labeled containers. Unless the hazardous chemicals are intended for immediate use, the portable container shall contain the same information as the original container label. CRA will use the NFPA or HMIS system as identified in Appendix B for labeling these containers.

7.4.3 STATIONARY CONTAINERS AND VESSELS

Stationary containers or vessels such as storage tanks must at a minimum, must be labeled with the product or chemical name and appropriate hazard warnings.

The following labeling guidelines will be followed for different size containers:

- Small, portable container — one label
- Vessel<10 feet (3.0 meters) — one label
- 10-20 feet (3-6 meters) — two labels at 180°
- >20 feet (>6.0 meters) — three or four at 90° or 120°
- Horizontal tanks — All four sides

Placards, signs, process sheets, batch tickets, operating procedures, or other such written materials may be used in lieu of labels to mark stationary process containers.

7.4.4 WARNING LABEL SYSTEMS

CRA will be using a combination of the HMIS and NFPA labeling systems. Employees will be educated on both systems. A description of a typical warning label system has been included in Appendix B. CRA employees will also be informed of the DOT signs and labels as these may be used on incoming shipments of products/materials.

8.0 EMPLOYEE INFORMATION AND TRAINING

CRA shall provide employees with effective information and training on hazardous chemicals in their work area at the time of their initial assignment, and whenever a new chemical product is introduced into the workplace. At a minimum, this training shall consist of the following:

- Methods and observations that may be used to detect the presence or release of a hazardous chemical in the work area.
- The physical and health hazards of chemicals in the work area.
- The measures employees can take to protect themselves from these hazards (for example (work practices, emergency procedures and PPE).
- How to identify and interpret hazard symbols and warnings of chemical labels.
- How to read, understand and find information located on an MSDS.

Employees shall also receive information on the following:

- The requirements of 29 CFR 1910.1200.
- Identification of all operations in their work area where hazardous substances are present.
- The location and availability of the written HAZCOM program and MSDSs, including the list of hazardous chemicals and inventory.

Employees that do not read and/or speak English will be provided education in their language to ensure proper understanding of the HAZCOM requirements.

8.1 INITIAL TRAINING

CRA employees currently receive initial HAZCOM training through our own computer based training course. After receipt of this training they are provided additional instruction/orientation by the project manager/supervisor as applicable.

8.2 PERIODIC TRAINING

CRA employees also receive periodic training whenever a new chemical product is introduced into the workplace. This training will be provided orally by their supervisor or a CRA safety professional within the company.

CRA employees who reside in states that require annual training shall receive this training through our computer based course or by lecture style instruction.

9.0 CONTRACTORS

CRA will advise outside contractors of any chemical hazards that may be encountered in the normal course of their work on CRA projects, the labeling system in use, the protective measures to be taken, and the safe handling procedures to be used. In addition, CRA will notify these individuals of the location and availability of MSDSs. Each contractor desiring to bring chemicals on site must provide CRA with the appropriate hazard information on those substances, including the labels used, MSDS and the precautionary measures to be taken while working with these chemicals. Based upon the evaluation of the chemical information approval will either be granted or denied, requiring other proposals.

10.0 PROGRAM EVALUATION AND DOCUMENT CONTROL

This program will be reviewed, and updated as necessary, at a frequency necessary to maintain its effectiveness. The responsibility for maintenance of this program belongs to CRA's Corporate Safety and Health Manager.

APPENDIX A

CHEMICAL INVENTORY LIST

Chemical Product/Trade Name	*Manufacturer*	*Address*	*MSDS Y/N*

Supervisor (Print Name) _____ Signature _____

Date of Assessment: _____

APPENDIX B

WARNING LABEL SYSTEMS

National Fire Protection Association (NFPA) Hazard Code Label System

This system was adopted by the NFPA in 1975 to safeguard the lives of firefighters. It is based on the hazards created by a substance in a fire situation. The label is broken up into 4 diamonds within a larger diamond and are color-coded. The colors stand for the following:

- **Red — Flammable**. Store in an area segregated for flammable reagents.
- **Blue — Health Hazard**. Toxic if inhaled, ingested or absorbed through skin. Store in secure area.
- **Yellow — Reactive and Oxidizing Reagents**. May react violently with air, water or other substance. Store away from flammable and combustible materials.
- **White — Corrosive**. May harm skin, eyes, and mucous membranes. Store away from red, blue and yellow coded reagents above.

The red, blue, and yellow diamonds are then rated by their hazard. The hazard ratings are as follows:

- Extreme Hazard.
- Severe Hazard.
- Moderate Hazard.
- Slight Hazard.
- 0 - No hazard according to present data.

The white diamond is used for special symbols such as radioactivity, corrosivity, and reactivity. An example of the NFPA 704 labeling system is shown below.

The Hazardous Materials Identification System (HMIS)

HMIS® is a system that can be used to assist employers comply with the labeling requirements of the Hazard Communication Standard. The HMIS® label is rectangular in shape and is divided into four color-coded sections as shown below. The first two sections Health (Blue) and Flammability (Red) are the same as the NFPA system definitions. The label also uses a numerical hazard rating system with colored bars to inform workers of chemical hazards of a container's contents. Personal protective equipment information identified by letters and icons is also supplied to give employees information needed to protect themselves from hazardous materials they might encounter on the job. This system was recently revised and updated now called HMIS® III.

Degrees of Hazard The severity of the hazard is identified by a number in the box next to the hazard category.	
4	EXTREME
3	SERIOUS
2	MODERATE
1	SLIGHT
0	MINIMAL

The new HMIS® III provides employees the informational tools to recognize and handle chemicals with a variety of physical hazards. The physical hazard (orange) section replaces the reactivity (yellow) section of the NFPA system. The physical hazard section addresses flammability, compressed gases, explosives, organic peroxides, oxidizers, pyrophorics,

unstable-reactive and water-reactive chemicals. The new HMIS® III not only specifically incorporates each hazard, with specific criteria to evaluate the degree of hazard, but permits employers to identify the hazard present with an icon or symbol.

DOT Placard and Labels

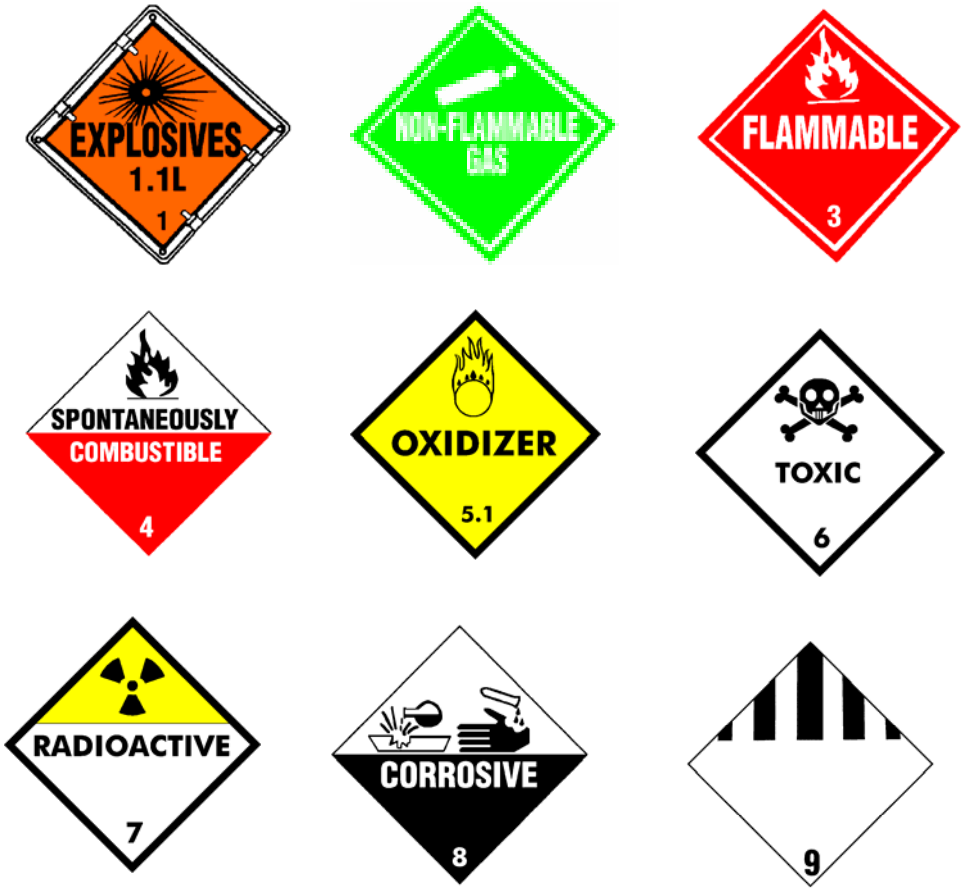
The DOT divides hazardous materials into various classifications. Each class is based on their degree of hazard. They are given a United Nations Hazard Class number from #1 to #9, #1 materials presenting the greatest potential hazard while #9 materials present the least potential hazard during transportation. Some classifications do not have a number.

By law, a DOT placard must be diamond-shaped and of a certain size. The 9 different specific classes each have a:

- Unique color code.
- Unique word code.
- Unique symbol.
- Unique hazard class number code.
- If required, a unique 4-digit number code.

A unique 4-digit number code is required on all large transportation tanks such as a railcar, tank truck, or portable tank. It may appear in the center of a placard or it may appear as a large rectangular orange panel beneath the placard. Placards with word designations are typically used for transport trucks carrying smaller containers of a hazard class.
In addition to placards, shipping labels are also used on containers. These are virtually identical to the placards. They are, of course, smaller and may appear on drums, boxes, or other containers. An example of DOT warning labels are located on the following page. There are a few additional warning signs that are not used as DOT placards. They include the symbol for etiological hazards, irritant hazards, and other regulated materials (ORM).

DOT PLACARDS AND LABELS



Fall Protection Program

FALL PROTECTION
STANDARD OPERATING PROCEDURES

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REF. NO. 400012 (3)
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1.0 INTRODUCTION

The purpose of this Standard Operating Procedure (SOP) is to designate minimum requirements and responsibilities that will be taken to ensure the safety of CRA personnel assigned to work activities with fall hazards at elevations of 6 feet (1.8 m) or more. These precautions are intended to prevent employees from falling off, onto, or through working levels and to protect employees from falling objects.

1.1 SCOPE AND APPLICATION

The requirements of this SOP apply to all work activities performed by CRA employees at heights of 6 feet (1.8 m) or greater in locations without standard guardrails or otherwise not designed for continuous human occupancy. Such locations include, but are not limited to, meteorological station towers, stripping towers, and rooftops with unprotected edges.

1.2 REFERENCES

- American National Standards Institute Z359.1.
- American National Standards Institute A10.14 (Canada).
- Occupational Safety and Health Administration 29 CFR 1926, Subpart M, Fall Protection.
  http://www.osha-slc.gov/OshStd_toc/OSHA_Std_toc_1926_SUBPART_M.html
- Occupational Safety and Health Administration 29 CFR 1910.21-.32, Walking/Working Surfaces.
  http://www.osha-slc.gov/OshStd_toc/OSHA_Std_toc_1910_SUBPART_D.html
- Occupational Safety and Health Administration 29 CFR 1926, Subpart X, Ladders.
  http://www.osha-slc.gov/OshStd_toc/OSHA_Std_toc_1926_SUBPART_X.html
- Occupational Safety and Health Administration, OSHA Directives, CPL 2-1.23 - Inspection Procedures for Enforcing Subpart L, Scaffolds Used in Construction – 29 CFR 1926.450-454.
  http://www.osha-slc.gov/OshDoc/Directive_data/CPL_2-1_23.html

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- OSHA Standards Interpretation and Compliance Letters, 09/28/1999 - Fall Protection, Lifejacket, and Lifesaving Requirements When Working Over or Near Water.
  http://www.osha-slc.gov/OshDoc/Interp_data/I19990928.html

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2.0 DEFINITIONS

Anchorage:	A secure point of attachment for lifelines or lanyards, which is independent from any means of supporting or suspending a work platform.
Fall Protection Systems:	A fall protection system is an assembly of components and subsystems, including the necessary connectors, used to arrest the user in a fall from a working height and suspend the user until rescue can be effected. Climbing protection systems are fall protection systems specially designed for climbing ladders and structures that are designed for climbing. They may be either temporary (portable) or permanent.
Competent person:	OSHA regulations define a competent person in several ways, yet each definition has the same basic meaning. For this program, a competent person is a person who, because of training and experience, is capable of identifying hazardous or dangerous conditions, one who knows how to properly use the equipment and related components, and has the authority to implement corrective action(s).
Connector:	A component used to couple parts of the system together. It may be an independent component of the system (e.g., carabiners), or an integral component of the system (e.g., buckle or dee-ring sewn into body harness, a snap-hook spliced or sewn to a lanyard or self retracting lanyard.)
Full body harness:	A design of straps secured about the employee in a manner to distribute the fall arrest forces over the thighs, pelvis, waist, chest and shoulders with a means for attaching it to other components of a personal fall arrest system. This attachment point on the body harness should be located in the center of the wearer's back, near shoulder level, or above

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the wearer's head. CRA requires the use of a full body harness (no body belts).

Guardrails:	Barriers erected to prevent employees from falling to lower levels. Guardrails may be constructed with pipe, rails, wood, wire, rope, etc.
Hole:	means a gap or void 2 inches (5.1 cm) or more in its least dimension, in a floor, roof, or other walking/working surface.Lanyard —A flexible line of rope, wire rope, or strap, which is used to secure the body harness to a lifeline or anchorage.
Lifeline:	A flexible line used for connection to an anchorage at one end to hang vertically (vertical lifeline), or for connection to an anchorage at both ends to span horizontally (horizontal lifeline). The lifeline serves as a means for connecting other components of a personal fall arrest system to the anchorage. A vertical lifeline usually extends an anchorage point onto which a rope grab is attached.
Self-retracting lanyard:	A device that contains drum-wound line that may be slowly extracted from or retracted onto the drum under slight tension during normal movement of the user. The line has a means for attachment to the fall arrest attachment on the body harness. After onset of a fall, the device automatically locks the drum and arrests the fall.

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3.0 ELEMENTS

3.1 FALL HAZARD CONTROL MEASURES

Activities conducted at elevated heights of 6 feet (1.8 m) or more, or falls that are likely to result in death or serious harm, must employ suitable fall hazard control measures.

Whenever possible, tasks should be planned so that elevated work will not occur. When this is not possible, fall hazards should be minimized by installing fixed platforms with railings, guarding of openings, controlling of access, or by working from equipment designed for the job. Care should be taken so that employees are not required to climb on or stand on piping or other unstable footing in order to accomplish assigned duties. Each jobsite analysis must include the intended work for the potential of falls and address appropriate fall protection measures.

Suitable fall hazard control measures will be taken to protect against the potential exposure of falling into floor openings, permanent or temporary, in elevated walking and working surfaces where a potential fall is likely to result in serious harm. Wall openings from which a potential fall is likely to result in serious harm will be guarded with a barrier or other equally effective system. Stairs having four or more risers will be equipped with stair railings or handrails.

To protect against the potential exposure to falling objects, walking, and working surfaces above a work area will be fitted with toe-boards, screens, nets, or a guardrail system. Additional protection can be obtained by installing a canopy or other protective structure over the work area. If falling objects are still a concern, the area will be barricaded, work stopped, or special work procedures implemented to prevent objects from falling from higher levels.

3.1.1 ADDITIONAL SITE HAZARD CONTROL CONSIDERATIONS

Prior to selecting a harness or other personal protective equipment, the user must make a workplace assessment of hazards and conditions where the equipment is required. Such assessments must, at a minimum, make an effort to identify the presence of objects and conditions that could damage the integrity of the equipment. A Preliminary Site Inspection Checklist and a Daily Inspection Checklist have been included as Appendix A and Appendix B, respectively. These checklists are to be used when conducting a workplace assessment of hazards and conditions. Users of the equipment

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should identify: Hot objects, Spark and Heat-producing operations, Flames, Chemicals, Confined space hazards, Electrical hazards, Environmental contaminants, Sharp objects, Abrasive surfaces, Moving equipment, Moving materials, Unguarded Openings, Climatic/Weather factors, Unstable/Uneven surfaces, and Slippery surfaces.

Foreseeable changes in any of these conditions, individually or collectively, must be identified, evaluated, and controlled. These materials, the construction of harnesses, and associated equipment must be considered in selection so workplace conditions are appropriately addressed. Equipment must match the work situation and workplace environmental factors.

The workplace/job site assessment must identify all paths of intended user movement and all hazards along such paths. The user must identify the required range of mobility in each hazard zone and note the location and distance to all obstructions in potential fall paths. Lateral obstructions that can be contacted by arresting a pendular fall must be noted. An assembly connecting the harness to an anchorage must be selected that will satisfactorily limit total distance and allow for dynamic elongation and activation distance of the assembly. If a harness is to be used for confined space entry operations, the workplace/jobsite assessment must comply with the requirements of OSHA regulation 29 CFR 1910.146 and ANSI Z117.1.

3.1.2 COMPETENT PERSON

A trained and authorized individual will be designated as a competent person or proficient operator for all fall protection control measures.

3.1.3 FALL ARREST SYSTEMS

When fall hazards cannot be eliminated or prevented, personal fall arrest systems will be used. A personal fall arrest system is a system to arrest an employee in a fall from a working level. It consists of an anchorage, connectors, a body harness and may include a lanyard, lifeline, or suitable combinations of these. Personal fall arrest systems should serve as "backup" protection, acting only to arrest a fall when it occurs. No personal fall arrest system will be used without first analyzing the task to be performed, the need for mobility in performing the task, and personnel recovery after fall arrest. Additional

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information regarding fall arrest components can be found in Appendix C, titled, Construction Worksite Project Manager's/Site Safety Personnel Additional Information.

3.1.4 FALL ARREST COMPONENTS

All personal fall arrest systems, subsystems, and components, will conform to American National Standards Institute (ANSI) Standard Z359.1 and must be bear a tag stating conformance. Fall protection systems will not be used for purposes nor undergo stresses beyond the manufacture's specified limitations. Examples of these limitations include: personnel whose weight exceeds the component design limitations, conditions that will alter the integrity of the system, such as chemicals, heat, corrosion, abrasion, normal wear, and subject to an impact force from arresting a fall. Components subject to such conditions should be clearly marked and tagged "UNUSABLE" until they are inspected, destroyed, or repaired. Personal fall arrest components will be rigged so employees can neither free fall more than 6 feet (or 5 feet 1.5 m in Canada), nor contact any lower level.

All anchorage points will be designed to support 5,000 pounds for each personal fall arrest system attached. The anchorage should be located (e.g., located above the employee's head) so as to eliminate the hazards of pendulum type swing falls, and whenever possible, be located above shoulder height.

All lanyards will be equipped with an energy (shock) absorber and a self-closing, self-locking snap hook on each end. The shock absorber and attached devices will be selected to limit the maximum arresting force to 1,800 lbs. (8 Kn). Lanyards ,connectors, and energy (shock) absorber should be kept free of knots. A lanyard should never be wrapped around a structural member and hooked back onto itself as a means of tying off. In some situations, it is necessary to use a tie-off adapter to connect the lanyard to an anchorage. To facilitate fall protection while moving or re-rigging, two lanyards (Y-type) connected to a single shock absorber, should be used so that one lanyard is continuously connected to an anchorage or lifeline.

No more than one personal fall arrest system may be attached to a single vertical lifeline.

No horizontal lifeline will be rigged without consideration to proper engineering design and an evaluation of the hazards encountered when a fall is arrested. The end anchorages of horizontal lifelines should have the same elevation and should be positioned above the waist (preferably above shoulder level) of an average size user. All

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lifelines should be protected from abrasion that may occur from suspension over or along a structural member.

Lanyards or shock-absorbing devices will **not** be connected to self-retracting lanyards.

3.2 GUARDRAILS, COVERS, AND WARNING LINE SYSTEMS

3.2.1 GUARDRAILS

Guardrails will be capable of withstanding, without failure, a force of at least 200 pounds applied at any point, in any outward or downward direction. Guardrails must have a top edge member of 39 to 45 inches high above the walking/working level and an intermediate rail approximately half way between the top rail and the floor. Guardrails will be secured when installed to prevent accidental displacement by wind, equipment, or employees, etc.

Examples of guardrail systems are:

- **Pipe railings**—Assumed to meet the requirements if posts, top rails, and intermediate rails are at least 1½" nominal diameter (i.e., Schedule 40 pipe or equivalent degree of strength) with posts no more than 8 feet apart on center.
- **Structural steel railings**—Assumed to meet the requirements if posts, top rails, and intermediate rails are at least 2-inch x 2-inch x 3/8-inch angles or equivalent degree of strength, with posts no more than 8 feet apart on center.

Where there is a danger, due to falling materials, to personnel working below the floor or wall opening, control measures, such as adding toe plates to the guardrail system or creating a barricaded area on the lower level that prohibits employees from entering the area to which objects could fall, is required.

3.2.2 COVERS

Covers for floor openings or holes will be capable of supporting, without failure, at least twice the weight of employees, equipment, and materials that may be imposed; and secured when installed to prevent accidental displacement by wind, equipment, or employees, etc.

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3.2.3 WARNING LINE SYSTEMS

When floor or wall openings are not eliminated or prevented, employees will be protected with personal fall arrest systems. A warning line system will be erected to warn employees of the unprotected floor or wall opening. A warning line system will consist of a rope, wire, chain, or plastic/vinyl tape or fencing, erected around all sides of the floor or wall opening, not less than 10 feet from the outer perimeter of the opening. If the warning line system consists of rope, wire, or chain, the system will be flagged with high visibility material at not more than 6-foot intervals. Employees entering the area between the opening and the warning line will be protected by personal fall arrest systems.

3.3 SCAFFOLDING

Use of scaffolding should be consistent with the following guidelines:

- No one will erect, move, dismantle, or alter scaffolding, except under the supervision of a competent person. A competent person may recommend changes or alterations of the scaffolding that are as stringent or even stricter than regulations to protect employees.
- Scaffolds will **not** be altered or moved horizontally while they are in use or occupied.
- Scaffolds will **not** be loaded in excess of the working load they are designed to hold.
- Footing or anchorage for scaffolds will be sound, rigid, and capable of carrying the maximum intended load without settling or displacement.
- Scaffolds and their components are to be maintained in a safe condition. Any broken, bent, excessively rusted, altered, or otherwise structurally damaged frames or accessories will be taken out of service.
- Scaffolds and their components will be inspected before each work shift and after any incident that could affect the structure of the scaffold.
- Scaffolds should be tied to or securely braced against the structure horizontally and/or vertically as required for support.
- Scaffolds will be constructed to support at least four times the maximum intended loads.

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- Scaffold platforms should be equipped with standard guardrails and mid-rails, be completely decked with safety planks or scaffold decking, and have rigidly secured toe-boards on sides and ends as determined by the scaffolding competent person.
- Tools and materials on scaffold platforms must be placed in such a manner that they will not create a tripping hazard or become dislodged and fall.
- Tools, materials, and debris should not be allowed to accumulate in quantities to cause a hazard.
- Slippery conditions on scaffolds should be eliminated as soon as possible after they occur.
- Work on scaffolds will be suspended during storms or high winds.
- Windscreens (plastic coverings) will be inspected to ensure the system can accommodate the anticipated wind loads.
- A ladder or stairway must be used for proper access to a scaffold platform.
- Personal fall arrest systems are required when erecting, dismantling, or working on scaffolding, unless the employee is sufficiently guarded from falling by other fall control measures.

3.4 LADDERS

3.4.1 CLIMBING LADDERS

Climbing ladders will be done with the free use of both hands and feet, to allow three-points of control at all times. The body will be facing the ladder and centered between the ladder's side rails when climbing.

Materials or tools will **not** be carried in the hands while ascending or descending ladders.

Climbing must be carefully evaluated when fixed ladders are not equipped with cages or ladder safety devices. If the ladder is not routinely used, the method of alternately connecting one of two lanyards to individual ladder rungs is acceptable. This method may provide adequate protection where the ladder support and rungs are capable of supporting twice the anticipated arrest forces. If this method is used, lanyards must be kept as short as possible, and rigged to limit free fall distance to 2 feet or less.

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The lanyard length should be less than 3 feet, limiting the free fall distance to less than 6 feet (or 1.5 m in Canada), when climbing with a ladder safety device (i.e., a vertical rail system or vertical lifeline system) where the fall arrester is pulled upward by the lanyard.

Caged ladders may be ascended or descended without fall protection.

3.4.2 FIXED LADDERS

A fixed ladder is a ladder permanently attached to a structure, building, or equipment. Fixed ladders will **not** be loaded beyond the maximum intended load for which they were built or beyond their manufacturer's rated load capacity.

All permanent or temporary fixed ladders placed for repeated access and egress to elevations exceeding 20 feet will be equipped with cages or ladder safety devices.

3.4.3 PORTABLE LADDERS

Use of portable ladders will be limited to tasks requiring access to an elevated task that is performed infrequently, or when the pre-job safety analysis indicates that redesigning the job or providing work platforms is not feasible.

Portable ladders will **not** be loaded beyond the maximum intended load for which they were built or beyond their manufacturer's rated load capacity.

Portable ladder use will be in accordance with the rules below.

- Ladders will be maintained free of oil, grease, and other slipping hazards.
- Ladders will be maintained in good usable condition.
- Ladders will be inspected before climbing or after the ladder is involved in a tip over. Defects should be marked and the ladder taken out of service until repairs can be made.
- The ladder base will be placed with a secure footing to prevent slipping, or it will be lashed, or held in position.

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- Non-self-supporting ladders will be placed at an angle such that the base is located a distance from the vertical wall equal to one-fourth the working length of the ladder (i.e., the base of a 12-foot ladder should be placed 3 feet from the structure needing to be climbed).
- When portable ladders are used to access an upper landing surface, the ladder side rails must extend at least 3 feet above the upper landing surface.
- The top of the ladder will be placed with the two rails supported, unless equipped with a single support attachment, and secured (tied off) as close to the top as possible.

3.5 PERSONNEL PLATFORMS

3.5.1 GENERAL

A personnel platform refers to any powered platform, manlift, vehicle-mounted platform, and aerial lift or man basket used by employees during work on site. A personnel platform must be capable of supporting its own weight and at least five times the maximum intended load.

A proficient operator will be identified and documented in the site safety plan or in the site project notebook by the supervisor or on-site manager prior to operation of the equipment.

3.5.2 CRANE SUSPENDED WORK PLATFORMS OR BASKETS

Crane or derrick suspended work platforms or baskets should only be used when conventional means (e.g., ladders, scaffolds, etc.) for reaching the work area would be more dangerous or is not possible due to structural considerations.

General items to be aware of or follow when using crane suspended work platforms or baskets are listed below:

- Hoisting of basket will be slow, controlled, and in a cautious manner, with no sudden movements.
- Load lines will be capable of supporting seven times the maximum intended load.

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- Load and boom hoist brakes, swing brakes, and locking devices will be engaged when the occupied basket is in a stationary position.
- Cranes will be level with outriggers, fully deployed, and following the manufacturer's specifications.
- A positive acting device will be used to prevent contact between the load block and boom tip, or a system that deactivates the hoisting action should be engaged before damage occurs.
- The load line hoist drum must have a system or device on the power train, other than the load hoist brake, that regulates the lowering rate of speed of the hoist mechanism.
- Free fall will be prohibited.
- Trial lifts should be performed with an unoccupied basket prior to the manned lift.

Work platforms or baskets will be OSHA-approved or designed by a qualified engineer and be capable of holding five times the maximum intended load. The suspension system will be designed to minimize tipping of the platform due to movement of employees. The platform will have guard rails, grab rails, employee headroom, and a posted load rating plate. Access gates when installed must swing outward.

3.5.3 WORK PRACTICES

Safe work practices for working from baskets or personal platforms include:

- Employees must keep all body parts inside the platform during raising, lowering, or positioning.
- Employees being hoisted should remain in sight of and in direct communications with the operator or signal person.
- Tag lines should be used, unless they create an unsafe condition.
- The crane or derrick operator must remain at the controls while the engine is running and the platform is manned.
- Work will be discontinued upon indications of dangerous weather conditions or other impending danger.
- Fall protection, including a full body harness with lanyard attached to an approved anchorage, will be used while in the basket or on the platform.

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3.5.4 AERIAL LIFTS

An aerial device is any vehicle-mounted device, telescoping, or articulating, which is used to position personnel. Aerial lifts include the following: extendible boom platforms; aerial ladders; articulating boom platforms; vertical towers; and a combination of the above.

The following will be considered when using aerial lifts:

- Lift controls will be tested each day prior to use to verify they are in a safe working condition.
- Only proficient operators will operate an aerial lift.
- Personal fall protection (e.g., harness and lanyard) will be worn and attached to an appropriate anchorage while in the aerial lift basket.
- Employees must always stand firmly on the floor of the basket.
- Boom and load limits specified by the manufacturer will **not** be exceeded.
- Vehicle brakes, outriggers, and wheel chocks should be used when required and/or available.
- The aerial lift truck will **not** be moved when the boom is elevated with people in the basket unless the aerial lift is designed to do so (i.e., controls to move truck are located in and may be operated while in the basket). In these cases, the movement of the lift truck will be for work positioning only and not for movement from one work location to another.

3.5.5 DESCENT CONTROL EQUIPMENT

Descent control equipment (e.g., sky genies, boatswain's chairs, etc.) will be used in accordance with the instructions, warnings, and design limitations set by the manufacturers or distributors and with the following procedures and precautions:

- Employees will be trained in the use of the equipment.
- Equipment will be inspected each day before use.
- Emergency rescue will be planned to assure that employees can be promptly rescued or can rescue themselves should a fall occur.

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- Employees must utilize proper rigging and anchorage. All lines, knots, splices will be capable of sustaining a minimum tensile load of 5,000 pounds, and ropes are padded where they contact edges or surfaces that might cut or weaken the rope.
- Employees must utilize a separate fall arrest system. Harness, lanyard, anchorage, etc., must be independent of the descent control equipment, so that any failure in a descent control device will not affect the ability of the fall arrest system to operate and stop the employee's fall.

3.5.6 PROFICIENT OPERATOR

A proficient operator is specifically required in the powered platform, manlifts, and vehicle-mounted platform standard of OSHA. This standard states, "working platforms will be operated only by persons who are proficient in the operation, safe use, and inspection of the particular working platform to be operated." This means that trained and knowledgeable individuals will be selected to operate work platforms.

To become a proficient operator for a powered platform, manlift, or vehicle-mounted platform, the individual must understand the following concepts:

- operating parameters of the device;
- weight limitations;
- maximum boom length in the fully extended position;
- maximum slope allowed for safe operation;
- safe operating distances from overhead obstructions, including electrical lines; and
- operation of the outriggers and their load limits.

3.6 INSPECTIONS

Personal fall arrest systems and equipment will be visually inspected by the user before each use for signs of mildew, wear, damage, or other deterioration, and defective components. Additional inspection of equipment (e.g., self-retracting lanyards) may be required by the manufacturer at suggested intervals. Any component of a personal fall arrest system that may be adversely affected in strength or function must be tagged "UNUSABLE" and removed from service.

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Any personal fall protection component(s) will be tagged "UNUSABLE" and removed from service after being subjected to impact loading, and will **not** be used again until inspected by a competent person and determined to be undamaged and suitable for reuse. A formal checklist has been included as Appendix D – Equipment Manager Formal Inspection Checklist. This checklist is to be used by those managing the construction site/facility fall protection components and/or systems to ensure that the necessary inspections are conducted. Appendix E - Formal Inspection Log will be used to document the results of all inspections.

Powered platforms, manlifts, or vehicle-mounted platforms and their components will be inspected for visible defects before every use and after any occurrence that could affect the platform's structural integrity. A maintenance inspection or test will be conducted following the procedures established by the manufacturer of the equipment. Inspections will be conducted and documented by the use of a Manlift Daily Equipment Checklist which is provided as Appendix F.

Rental equipment (platforms and manlifts) will undergo a visual inspection at time of delivery, before each use, and after any occurrence which will affect structural integrity. An example of a manlift checklist is provided as Appendix F. Maintenance inspections will be conducted on rental equipment or requested of equipment owner if the equipment is kept on site for extended use.

3.7 EMERGENCY RESCUE PLANS

When personal fall arrest systems are used, emergency rescue will be planned to assure that employees can be promptly rescued or can rescue themselves should a fall occur. The availability of rescue personnel, ladders, or other rescue equipment must be evaluated.

Each job safety analysis will cover specific rescue plans (i.e., self-rescue, use of rescue personnel, rescue equipment, etc.). This information will be presented during the pre-job or tailgate safety meeting.

Contractors may provide their own rescue services when hired to perform elevated work. The pre-job safety meeting is the appropriate location to share the contractors' rescue plans.

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4.0 RESPONSIBILITIES

4.1 PROJECT MANAGER

It is the project manager's responsibility to ensure that the fall protection requirements of this SOP are adhered to for each of the projects under their direction and control.

4.2 SITE SUPERVISOR

It is the responsibility of the site supervisor to ensure implementation of this SOP which include the following components:

- appropriate fall protection equipment is available for use;
- fall protection equipment has been inspected prior to use;
- provide and/or ensure that all personnel have received the required training in the use and the need for fall protection devices (proper fit, proper use, and proper inspection procedures); and
- a pre-job safety meeting is conducted at the start of the project.

4.3 EMPLOYEES

Employees are required to adhere to the requirements of this SOP as applicable to their specific project duties.

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5.0 TRAINING

All personnel performing work must receive training in the relative aspects of this SOP. The effectiveness of the training will be verified by successful completion of the subject matter quiz.

5.1 TRAINING PROVIDER

Personnel providing this training shall have a thorough knowledge of the relevant SOPs, regulations and the Standard, be proficient in fall hazard control measures, understand the specific application of the Standard to the training audience, and be an effective communicator.

5.2 TRAINING FREQUENCY

Training will be provided prior to initial assignment to any task with potential fall hazards.

Refresher training will be provided on a semi-annual basis, or more frequently, when the following situations occur:

- Changes in the workplace or the type of operations render previous training obselete.
- Inadequacies in the employee's knowledge or adherence to procedures indicate that the employee has not retained the requisite understanding or skill.
- Regulatory requirements have changed.

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APPENDIX A

CRA FALL PROTECTION – CONSTRUCTION SITES
PRELIMINARY SITE INSPECTION CHECKLIST

Site: _____ Project No.: _____

Inspected by: _____ Date: _____

Elevated Work Activity – Construction sites (Check Appropriate Box)

Yes/True[1]	*No/False*	
☐	☐	No work will be preformed greater than 6 ft. or a free fall of 1.5 m (Canada) above a adjacent surface. If "True", no fall protection is required.
☐	☐	Elevated work will be relocated and performed on the ground. If "True", no fall protectio is required.
☐	☐	There will be no required climbing or standing on unstable footing.
☐	☐	The potential for falling in trenches, through floor openings (permanent or temporary) an skylights in elevated walking/working surfaces have been evaluated and abated.
☐	☐	Wall openings from which a fall can result in serious harm are guarded with a barrier o other effective system.
☐	☐	Stairs having four or more risers are equipped with stair railings or handrails.
☐	☐	All open-sided floors or platforms four or more feet above the ground have standard railings, except where there is an entrance.
☐	☐	Potential exposure to falling objects, walking/working surfaces above work areas are fitte with toe-boards, screens, nets, or guardrail systems. See SOP for additional protectio options.

[1] If any answer is "No/False", action is required.

Section 2: ***Safety Checklist: Additional site hazard control considerations (Check Appropriate Box)***

Identification of objects/conditions potentially damaging to fall protection equipment.

Yes	*No*[2]		*Yes*	*No*[2]	
☐	☐	Hot objects?	☐	☐	Heat-producing operations?
☐	☐	Spark-producing operations?	☐	☐	Flames?
☐	☐	Chemicals?	☐	☐	Confined space hazards?
☐	☐	Electrical hazards?	☐	☐	Environmental Contaminants?
☐	☐	Sharp objects?	☐	☐	Abrasive surfaces?
☐	☐	Unguarded Openings?	☐	☐	Unstable/Uneven surfaces?
☐	☐	Climatic/Weather factors?	☐	☐	Slippery?
☐	☐	Moving equipment through the area where a falling person or objects create a hazard?			
☐	☐	Materials are moving through the area where persons/objects might fall?			

[2] If any answer is "Yes", action is required.

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APPENDIX B

CRA FALL PROTECTION – CONSTRUCTION SITES
DAILY INSPECTION CHECKLIST

Site: _____ Project No.: _____

Inspected by: _____ Date: _____

Section 1: Daily Construction Site Safety Checklist (Check Appropriate Box)

Identification of changes in objects and conditions at the site.

Yes/True[1]	*No/False*	
☐	☐	Employees have been informed of the nature of any new fall hazards in the work area.
☐	☐	No new work is planned or will be preformed greater than 6 ft. (5 ft. Canada) above any adjacent surface, including equipment.
☐	☐	Elevated work will be relocated and performed on the ground.
☐	☐	Climbing or standing on unstable footing has been eliminated.
☐	☐	The potential for falling in trenches, through floor openings (permanent or temporary) and skylights in elevated walking/working surfaces have been eliminated.
☐	☐	Wall openings are guarded with a barrier or other effective systems.
☐	☐	Stairs having four or more risers are equipped with stair railings or handrails.
☐	☐	All open-sided floors or platforms four or more feet above the ground have standard railings, except where there is an entrance.
☐	☐	Potential exposure to falling objects, walking/working surfaces above a work area are fitted with toe-boards, screens, nets, or guardrail systems. See SOP for additional protection options.

[1] If any answer is "No/False", action is required.

Section 2: Daily Safety Checklist (Check Appropriate Box)

Additional site hazard control considerations

Yes	*No*[2]		*Yes*	*No*[2]	
☐	☐	Hot objects?	☐	☐	Heat-producing operations?
☐	☐	Spark-producing operations?	☐	☐	Flames?
☐	☐	Chemicals?	☐	☐	Confined space hazards?
☐	☐	Electrical hazards?	☐	☐	Environmental Contaminants?
☐	☐	Sharp objects?	☐	☐	Abrasive surfaces?
☐	☐	Unguarded Openings?	☐	☐	Unstable/Uneven surfaces?
☐	☐	Climatic/Weather factors?	☐	☐	Slippery?
☐	☐	Moving equipment through the area where a falling person or objects create a hazard?			
☐	☐	Materials are moving through the area where persons/objects might fall			

[2] If any answer is "Yes," action is required.

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APPENDIX C

CRA FALL PROTECTION
CONSTRUCTION WORKSITE
PROJECT MANAGER'S / SITE SAFETY PERSONNEL
ADDITIONAL INFORMATION

All harness and fall protection equipment will be inspected prior to use. All persons using the equipment will be trained and competent in the equipment's use. Personnel trained with the equipment should be able to produce a training certificate.

Each piece of CRA equipment should have a unique serial number, should be cataloged, and permanent maintenance records kept by the supplying site equipment manager.

The site safety officer will be trained specifically on fall protection device use and inspections before jobsite employees are allowed to utilize fall protection equipment.

Stress to the equipment, such as a fall , abrasion, exposure to chemicals, heat, or broken threads will be reported immediately to the jobsite health and safety officer. The site health and safety officer or the site supervisor will evaluate the equipment and determine if it should be taken out of service. Any device taken out of service will be tagged or otherwise labeled "UNUSABLE." Unquestionably unusable devices will be either physically destroyed/perminantly rendered ususable by any means at the site by the site health and safety officer, or returned promptly to the factory for repairs. No unusable equipment is to leave the jobsite except to be returned to the supplying site's facility equipment manager, directly to the manufacturer, or mulated and discarded in such a way as to not allow site personnel to remove it for future use as fall protection. Information regarding such equipment that is either unusable, questionably usable, destroyed, or returned to the manufacturer should be documented and a copy of the documentation sent to the supplying site's facility equipment manager. Document date, time, and reason for removal from service. The facility equipment manager will document the information in the equipment inspection log.

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APPENDIX D

CRA FALL PROTECTION EQUIPMENT MANAGER FORMAL INSPECTION CHECKLIST

All fall protection equipment will be inspected prior to use. All persons using the equipment will be trained and competent in the equipment's use.

HARNESS INSPECTION PROCEDURE

1) All harnesses are to be inspected the greater of intervals specified by the manufacurer or every 6 months. If a greater time has elapsed, this procedure will suffice as a "formal inspection".

2) Inspect labels to verify they are present and legible. Check manufacturer's guide for the placement of the labels on the specific harness and for the labels that should be present and the infomation contained on them. The "inspection grid" showing when the harness was last formally inspected should be part of this label pack. If the label pack, or any of its components are missing, the harness is "UNUSABLE" and will be tagged as such.

3) Inspect all webbing (straps) and stitching for cuts, fraying, pulled or broken threads, abrasion, excessive wear, altered or missing straps, burns, and heat and chemical exposures.

4) Inspect all metallic parts (i.e., back D-ring, oval rings, buckles, adjusters, and grommets) for deformation, fractures, cracks, corrosion, deep pitting, burrs, sharp edges, cuts, deep nicks, missing or loose parts, improper function, and evidence of excessive heat or chemical exposures.

   Inspect all plastic parts (i.e., back D-ring locator, strap collars, labels, too belt support clips) for cut, broken, excessivly work, missing, and loose parts. (Labels are to be additionally checked in accordance with Step 2 above.) Inspect for evidence burns and excessive heat or chemical exposures.

5) Inspect each component and subsystem of the complete system in acordance with the associated manufacuter's instructions.

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LANYARD INSPECTION PROCEDURE

1) All lanyards are to be inspected the greater of intervals specified by the manufacurer or every six months. If a greater time has elapsed, this procedure will suffice as a "formal inspection".

2) Inspect labels to verify they are present and legible. Check manufacturer's guide for the labels that should be present and the infomation contained on them. The "inspection grid" showing when the harness was last formally inspected should be part of this label pack. If the label pack, or any of its components are missing, the harness is "UNUSABLE" and will be tagged as such.

3) Inspect deceleration device is intact. If supplied with a cover, verify that both ends are sealed and all tapes and stitching are intact.

4) Inspect all webbing (straps) and stitching for cuts, fraying, pulled or broken threads, abrasion, excessive wear, altered or missing straps, burns, and heat and chemical exposures.

5) Inspect all fiber ropes for cuts, bulled or broken fibers, abrasion, excessive wear or aging, excessive elongation, reduction of rope diameter, altered or missing rope segments, hockling (unlaying and kinking of strands), burns, and damage from heat or chemicals. Inspect knot, loosening or unbraiding of splices, excessive fuzziness of fibers, and for very soft condition that easily allows the rope to unlay (unwind).

6) Inspect all metallic parts for defects, damage, alteratino, and missing parts: a) For snaphooks, carabiners, adjusters, and swaged fittings and metal thimbles on wire rope, inspect for deformation, fractures, cracks, corrowion deep pitting, burrs, sharp edges, cuts, deep nicks, loose parts and evidence of excessive heat or chemical exposures. Inspect snaphook and carabiner function by cycling their functinos. Gates must automatically close and snugly seat against the nose. The locking mechanism must tetain the gate tip within 1/8 inch or the nose within finger pressure is firmly applied to the gate in any direction. Inspect for weak springs, loose rivets and binding of the gate or lock. b) For wire rope, inspect for broken wires, kinks, unlaying of strands, corrosion, diameter changes, loosening of thimbles or swagged fittings, and evidence of damage from heat or chemical attack.

7) Inspect all plastic parts (i.e., rope himbles, labels, and vinyl cover of the wire rope) for cuts, broken parts, alteration, excessive wear, missing, and loose parts.

OTHER DEVICES

See manufacturer's instructions.

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CORRECTIVE ACTION

When inspection in accordance with the procedure above indicates signs of inadequate maintenance, the fall protection device must be immediately removed from service and marked as "UNUSABLE" until destroyed or subjected to maintenance by CRA or an authorized CRA representative in accordance with this SOP. Defects, damage, excessive wear, and/or aging are not considered repairable. If detected, immediately remove the harness form use and mark it as "UNUSABLE", until destroyed. For final disposition, submit the harness to a competent person who is authorized to perform this procedure. If there is any question as to repairablility, contact the manufacurer in writing before further use of the fall protection device.

RECORDKEEPING

Each fall protection device/piece of equipment has a unique serial number, will be cataloged and permanent maintenance records kept by the supplying site equipment manager. After a formal inspection, the inspection performance will be recorded in a "Formal Inspection Log" and retained for reference. (Example in Appendix E. See manufacturer Instruction booklet for more detailed inspection forms. Some manufacturers will supply blank forms upon request.) If a fall protection device passes formal inspection, the inspector should punch the date (month/year) of the inpection on the grid supplied in the label packet. Users should never punch this grid, but it should be checked before use to ensure the device has been inspected within the manufacture's specified time limits or within the last 6 months.

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APPENDIX E

CRA FALL PROTECTION
FORMAL INSPECTION LOG

Harness No: _____ Site: _____
Model No: _____ Inspected by: _____
Mfg. date: _____ Inspection Date: _____
Disposition (Circle): PASS / FAIL_____

DESCRIPTION	COMPONENT CONDITION	COMMENTS
FABRIC PARTS		
WEBBING (STRAPS)		
Shoulder		
Shoulder strap retainer		
Shoulder ring strap		
Thigh		
Sub-pelvic		
Tool belt support		
STITCHING		
Shoulder ring strap		
Shoulder strap tip		
Shoulder strap reatiner		
Shoulder strap reinforce		
Buckle strap		
Thigh strap		
Thigh strap edges		
Sub-pelvic strap		
METALLIC PARTS		
D-RINGS/OTHER RINGS		
Back		
Hip		
Chest		
Shoulder		
BUCKELS/ADJUSTERS/ GROMETS		
Adjuster, torso sizing		
Buckle tongue		
Buckle		
Grommets, thigh strap		
PLASTIC PARTS		
Back D-ring locator		
Strap collar		
Labels		
Tool belt support clips		

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APPENDIX E

CRA FALL PROTECTION
FORMAL INSPECTION LOG

Lanyard No: _____ Site: _____
Model No: _____ Inspected by: _____
Mfg. date: _____ Inspection Date: _____
Disposition (Circle): PASS / FAIL_____

DESCRIPTION	COMPONENT CONDITION	COMMENTS
FABRIC PARTS		
WEBBING (STRAPS)		
Lanyard leg (single)		
Lanyard legs (double)		
Sewn 9" Loop		
STITCHING		
Lanyard leg (single, fxd)		
Lanyard leg (single, adj)		
Lanyard legs (twin)		
9" loop		
9" loop joint		
BREAK or Deceleration Device		
Webbing, loop (single)		
Webbing, loop (twin)		
Stitching, strap loops		
Stitching, cover		
Binding Tape		
Cover		
FIBER ROPE		
Lanyard leg		
Splices		
METALLIC PARTS		
Lanyard leg (wire rope)		
Snaphooks, single		
Snaphooks, double		
Large-throat opening snaphook (twin)		
Large-throat opening snaphook		
Adjuster (single)		
Adjuster (twin)		
Swaged fitting		
Thimble		
Hog ring		
PLASTIC PARTS		
Labels		
Thimble		
Vinyl coating, wire rope		
Vinyl coating, 9" loop		

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APPENDIX F

CRA FALL PROTECTION
MANLIFT DAILY EQUIPMENT CHECKLIST

Equipment/Vehicle # _____ Week Beginning: _____

1) Check that all functions of the equipment are operating properly. (Forward, Reverse, Up, Down, Horn, etc.)

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday

Note any problems found during check below:

2) Check all hardware for looseness. (Hose reels, guard rails, doors, covers, etc.)

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday

Note any problems found during check below:

3) Check for hydraulic line leaks, worn hoses or lines, crimped lines or lines in danger of being damaged:

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday

Note any problems found during check below:

4) Check battery water level, gauge, leads and charger connector.

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday

Note any problems found during check below:

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Respiratory Protection Program

CONESTOGA-ROVERS & ASSOCIATES

RESPIRATORY PROTECTION PROGRAM

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1.0 PURPOSE

It is the policy of Conestoga-Rovers & Associates (CRA) to provide safe and healthful working conditions for its employees and to comply with both state and Federal Occupational Safety and Health Administration (OSHA) requirements. As part of this policy, this written respiratory protection program has been developed to ensure proper administration of the CRA Respiratory Protection Program, adherence to regulatory and contractual requirements, and preservation of the health and well being of CRA employees.

It must always be kept in mind that the use of any kind of a respirator is the **last** choice in employee protection. CRA will investigate all feasible engineering and administrative controls to control airborne contaminates prior to use of respirators to minimize the reliance on respiratory protective devices.

2.0 SCOPE

This program establishes the Respiratory Protection Program for CRA. All CRA employees, subcontractors, or any other individuals falling under CRA responsibility are required to adhere to the guidelines and requirements of this program.

3.0 REGULATORY BACKGROUND

This program has been prepared to comply with the requirements of Title 29, Section 1910.134 of the Code of Federal Regulations (29 CFR 1910.134), the Respiratory Protection Standard. This program contains CRA's policies and procedures for the following:

- Respirator selection;
- Medical evaluations;
- Fit testing procedures;
- Proper use of respirators;
- Inspection, cleaning, and storage of respirators;
- Air quality, quantity, and flow for supplied air respirators; and
- Training.

4.0 PROGRAM ADMINISTRATION

The Respiratory Protection Standard (29 CFR 1910.134(c)(3)) requires "The employer shall designate a program administrator who is qualified by appropriate training or experience that is commensurate with the complexity of the program to administer or oversee the respiratory protection program and conduct the required evaluations of program effectiveness."

The Corporate Safety and Health Manager (CSHM) will serve as the overall administrator of this program. In addition, the Safety Supervisors (SS) for each project under their responsibility will ensure the following:

- Verify that CRA employees have received the proper training in respiratory protection;
- Ensure that employees have been provided appropriate respiratory devices;
- Ensure that employees, when leaving the work area, wash and change out cartridges at the end of shifts, at break time and if break-through has occurred;
- Ensure that employees have been fit tested with respiratory devices; and
- Ensure that employees have proper medical clearance to wear respiratory devices.

The cost for administering this program will be paid for solely by CRA. This includes the cost of all respirators, respiratory protection supplies, training and medical evaluations.

5.0 DUTIES AND RESPONSIBILITIES

5.1 SUPERVISORS AND PROJECT MANAGERS

Due to the varying nature of CRA projects and work locations, it is project management's responsibility (through consultation with the SS) to coordinate the requirements of CRA's Respiratory Protection Program as applicable to their project(s).

Supervisors and project managers have the following duties and responsibilities with respect to this program:

- Ensure that respiratory protective devices are available to employees for their use against harmful vapors and oxygen deficient atmospheres;
- Ensure that employees are wearing respiratory protective devices as appropriate; and
- Ensure that employees are provided annual training, medical evaluations and fit tests.

5.2 EMPLOYEES

Employees are responsible for the following:

- Wearing proper respiratory protective devices as applicable;
- Using engineering controls to reduce airborne exposure when possible;
- Participating and assisting in employee exposure assessment studies; and
- Complying with the CRA Respiratory Protection Program requirements.

6.0 PROGRAM ELEMENTS

6.1 SELECTION PROCEDURES

A number of factors must be considered in the selection of the appropriate respiratory protection device. This section outlines these factors.

Once the need for a respirator has been identified, the basic steps for selecting a respirator are:

1. Choose only approved respirators.
2. Evaluate the anticipated respiratory hazards such as:
   - 2.1 Physical state (vapor or particulate).
   - 2.2 Contaminant type and concentration.
   - 2.3 Oxygen levels.
3. Determine if the atmosphere is Immediately Dangerous to Life and Health (IDLH):
   - 3.1 If IDLH, you must use the most protective supplied-air devices.
   - 3.2 If not IDLH, you may use equipment other that the most protective supplied-air devices provided they are appropriate for the contaminant and concentration in question.

6.2 RESPIRATOR APPROVAL

Only respirators certified by the National Institute of Occupational Safety and Health (NIOSH) shall be used by CRA employees (29 CFR 1910.134(d)(1)(i)). The certification must include the exact style of mask used, and approval of the cartridge type for air purifying respirators.

6.3 TYPES OF RESPIRATORS

When respirators are used, the predominate type employed by CRA is the air-purifying device. Infrequently, CRA utilizes air-supplied respirators. These devices are used when United States Environmental Protection Agency (USEPA) Level B is specified in a

health and safety plan (HASP). However, it is CRA's policy **NOT** to use compressors for the purpose of supplying breathing air.

6.3.1 AIR-PURIFYING RESPIRATORS

These respirators remove air contaminants by filtering, absorbing, adsorbing, or chemical reaction with the contaminants as they pass through the respirator canister or cartridge. This respirator is to be used only where adequate oxygen (19.5 to 23.5 percent by volume) is available. Air-purifying respirators can be classified as follows:

- Particulate removing respirators, which filter out dusts, fibers, fumes, and mists. These respirators may be single-use disposable respirators or respirators with replaceable filters;
- Gas- and vapor-removing respirators, which remove specific individual contaminants or a combination of contaminants by absorption, adsorption, or by chemical reaction. Gas masks and chemical-cartridge respirators are examples of gas- and vapor-removing respirators; and
- Combination particulate/gas- and vapor-removing respirators, which combine the respirator characteristics of both kinds of air-purifying respirators.

6.3.2 SUPPLIED-AIR RESPIRATORS

These respirators provide breathing air independent of the environment. Such respirators are to be used when the contaminant has insufficient odor, taste, or irritating warning properties, or when the contaminant is of such high concentration or toxicity that an air-purifying respirator is inadequate. Supplied-air respirators, also called air-line respirators, are classified as follows:

- Demand - This respirator supplies air to the user on demand (inhalation) which creates a negative pressure within the facepiece. Leakage into the facepiece may occur if there is a poor seal between the respirator and the user's face. CRA does not own or use this type of device;
- Pressure-Demand - This respirator maintains a continuous positive pressure within the facepiece, thus preventing leakage into the facepiece; and

- Continuous Flow - This respirator maintains a continuous flow of air through the facepiece and prevents leakage into the facepiece.

6.3.3 SELF-CONTAINED BREATHING APPARATUS

This type of respirator allows the user complete independence from a fixed source of air and offers the greatest degree of protection but is also the most complex. Training and practice in its use and maintenance is essential. This type of device will be used in emergency situations or where United States Environmental Protection Agency (USEPA) Level A or B protection is required.

6.4 AIR QUALITY FOR SUPPLIED-AIR RESPIRATORS

When any form of supplied-air respirator is used, the breathing air supply shall meet or exceed the American National Standard Institute (ANSI)/Compressed Gas Association (CGA-G7.1-1989) Standards for Grade D breathing air. This air quality must be verified with the air supplier for quality control purposes. This is accomplished by reviewing the paperwork from each supplier to make sure that the breathing air has been approved as Grade D. Copies of this paperwork are maintained with the Equipment Manager in each CRA office that utilizes breathing air.

6.5 HAZARD EVALUATION

The selection of the appropriate respirator to use must be appropriate for the respiratory hazards to which the employee is exposed (29 CFR 1910.134(d)(1)(i)). This involves conducting a workplace assessment and selecting a respirator based on the hazards identified.

At a minimum, the following data must be determined or reasonably estimated:

- Oxygen concentration;
- Presence and concentration of airborne contaminants; and
- Physical form of airborne contaminants; either gasses, vapors, mists, or particulates.

6.5.1 IDLH ATMOSPHERES

An IDLH atmosphere is an atmosphere that poses an immediate threat to life, would cause irreversible adverse health effects, or would impair an individual's ability to escape from a dangerous atmosphere (29 CFR 1910.134(b)).

Oxygen Deficiency

Air Purifying Respirators (APRs) cannot be used at oxygen concentrations below 19.5 percent; a Supplied Air Respirator (SAR) must be used. The atmosphere is considered to be IDLH if the oxygen content is or may fall below the limits shown in Table 621 (29 CFR 1910.134(d)(2)(iii)).

TABLE 6-1 OXYGEN DEFICIENT IDLH LEVELS

Altitude (feet)	*Any Type of SAR*	*Atmosphere Considered IDLH**
Less than 3,001[A]	19.5%	16.0%
3,001 - 4,000	19.5%	16.4%
4,001 - 5,000	19.5%	17.1%
5,001 - 6,000	19.5%	17.8%
6,001 - 7,000	19.5%	18.5%
7,001 - 8,000	19.5%	19.3%
Over 8,000	19.5%	19.5%
Over 14,000	19.5%; breathing air that is enriched in oxygen must be supplied	

* IDLH requires positive pressure SCBA or airline respirator with and escape bottle.

6.5.2 NON-IDLH ATMOSPHERES

The respirator chosen for protection against airborne contaminants in a non-IDLH setting must protect the health of the employee under routine and reasonably foreseeable emergency conditions (29 CFR 1910.134(d)(3)(i)). To properly select a respirator in this situation, the contaminant, the concentration, and physical form of contaminant must be known.

Concentration

Respirators work by reducing, not eliminating, the concentration of contaminants in the worker's breathing zone. The measure of how efficient a given respirator is in any situation is dependent on many variables, including the breathing rate and volume of the user, the fit of the respirator, and the efficiency of the cartridge. Most practitioners use the concept of Assigned Protection Factors (APFs) to estimate how efficient a respirator is. An APF is the measure of how efficient a particular respirator is in reducing worker exposure to an inhalation hazard. For example, if the concentration of substance outside the respirator was 90 parts per million (ppm), and the respirator reduced the levels to 9 ppm, the respirator would have an APF of 10.

OSHA, in the revisions to the Respiratory Protection Standard, reserved references to APFs for a future rulemaking. In the interim, OSHA "...expects employers to take the best available information into account in selecting respirators. OSHA itself will continue to refer to the NIOSH APFs..." (Federal Register Volume 63, No. 5, page 1204).

NIOSH considers half-face APRs to have an APF of 10 and full face respirators to have an APF of 50. Therefore, half-face APRs cannot be used in situations where the concentration exceeds ten times the permissible level, and full-face APRs cannot be used in atmospheres over 50 times this concentration.

Physical Form

APRs work by filtering contaminants out of the air breathed by the user. This is why they cannot be used in areas of oxygen deficiency. If an APR can be used, the selection of the correct cartridge to use on an APR depends on the form of the contaminant. Contaminants can either be gasses, like carbon monoxide or hydrogen sulfide, or particulates such as lead dust or asbestos.

For protection against gasses and vapors, the following types of respirators may be used at CRA:

- An APR that meets the following conditions:
  - The APR is equipped with an End of Service Life Indicator (ESLI) certified by NIOSH for the contaminant; or

- A cartridge change-out policy (Section 3.5) has been developed and implemented.

For protection against dusts, fumes, and mists, the following types of respirators may be used:

- An air purifying respirator with a filter certified by NIOSH as a High Efficiency Particulate Air (HEPA) filter.

6.6 RESPIRATOR USE GUIDELINES

The following sections contain minimum requirements for the safe and effective use of respirators.

Respirator Sealing Problems

CRA employees may not use tight-fitting respirators when certain conditions prevent achieving a satisfactory seal (29 CFR 1910.134(g)(1)):

- Any facial hair that comes between the sealing surface of the facepiece and the face or that interferes with valve function;
- The wearing of a spectacle, a goggle, a face shield, a welding helmet, or other eye and face protective device that interferes with the seal; and
- Scars, hollow temples, excessively protruding cheekbones, deep creases in facial skin, the absence of teeth or dentures, or unusual facial configurations that prevent sealing a respirator facepiece to a wearer's face.

Respirator Sealing Tests

CRA employees who plan to use a respirator equipped with a tight-fitting facepiece must check the seal of the respirator using a positive or negative pressure seal check, or equivalent means recommended by the manufacturer, before entering the potentially hazardous work area (29 CFR 1910.134(g)(1)(iii)). Procedures for the seal check are included in Appendix D.

Facepiece Seal Protection

The following minimum procedures must be followed to ensure that respirator seals are not compromised.

- Employees with facial hair, scars, or any other condition that might interfere with the seal may not use a tight fitting respirator facepiece;
- Corrective glasses or protective equipment cannot interfere with the respirator seal or function; and
- If the seal should break in a hazardous area, the user shall exit the area to re-don the respirator and check the seal. If the user experiences frequent seal breaks the respirator does not fit and the user must select and be fit tested for another.

Evacuation Requirements

Employees using respirators will return to an area of known clean air in the following conditions:

- If the seal should break in a hazardous area, the user shall exit the area to re-don the respirator and check the seal. If the user experiences frequent seal breaks the respirator does not fit and the user must select and be fit tested for another;
- To wash their faces and respirator facepieces as necessary to prevent skin or eye irritation;
- If vapor or gas breakthrough occurs, or changes in breathing resistance are noted, or signs of exposure are observed;
- Monitoring instruments document changes in contamination concentrations that result in the need to upgrade protective equipment; and
- Any sign of respirator damage or malfunction is noted.

If breakthrough, damage, or malfunction has occurred, the employee cannot reenter the hazardous area without first servicing, repairing, or replacing, the respirator.

Work In IDLH Atmospheres

CRA will not be permitted to work in IDLH atmospheres.

6.6.1 CARTRIDGE CHANGE-OUT

Manufacturers provide APR cartridges to protect against a variety of typical airborne contaminants. The types most often used at CRA are organic vapor cartridges, either alone or in combination with an acid gas cartridge, and HEPA cartridges.

OSHA requires (29 CFR 1910.134(d)(3)(iii)(B)(2)) "If there is no ESLI appropriate for conditions in the employer's workplace, the employer implements a change schedule for canisters and cartridges that is based on objective information or data that will ensure that canisters and cartridges are changed before the end of their service life."

The purpose of the cartridge change out policy is to prevent breakthrough or saturation of the cartridge absorbent or filter from occurring.

CRA Cartridge Change-out Policy

CRA will use the following procedures for cartridge changes:

- The cartridge has exceeded the ESLI for the contaminant;
- Cartridges have become damaged or defective; and
- Cartridges will be changed/replaced in accordance with the site-specific HASP.

Ultimately, the cartridge manufacturer has to be consulted to calculate/predict cartridge change-out procedures based on the chemicals of concern and the variable factors listed above. This potentially will differ with each brand of respirator used at CRA.

6.7 MEDICAL SURVEILLANCE

CRA personnel required to wear a respirator will be evaluated prior to initial use of respirators and then annually thereafter to determine their capability to wear a respirator. The evaluation will be conducted by a physician or other licensed health care physician (PLHCP).

Medical Clearance

CRA 's consulting PLHCP reviews the clinical data and any other required data and issues an opinion as to the employee's suitability to use a respirator.

Additional Medical Evaluations

Employees are provided with additional evaluations (29 CFR 1910.134(e)(7)) if:

- The employee reports medical signs or symptoms that are related to ability to use a respirator;
- Information from the Respiratory Protection Program, including observations made during fit tests and program evaluation, indicates a need for reevaluation; and
- A change in workplace conditions that may result in a substantial increase in the physiological burden placed on an employee.

6.8 RECORD KEEPING

A qualitative or quantitative fit test (QLFT or QNFT) must be used to determine the ability of employees to obtain a satisfactory fit with any tight-fitting facepiece prior to assignment (29 CFR 1910.134(f)). The results of fit tests will then be used to select specific types, makes, and models of respirators appropriate for the wearers. Employees may not use any tight-fitting facepiece without passing a fit test for that exact make and model of facepiece.

Appendix C contains the OSHA required QLFT and QNFT protocols.

Frequency of Testing

Employees will be fit tested prior to initial use of a respirator, whenever a different size, style, make or model of facepiece is used, and at least annually thereafter (29 CFR 1910.134(f)(2)).

Additional fit testing will be performed (29 CFR 1910.134(f)(3)) whenever the employee, the employee's supervisor, or the program administrator observes changes to the

employee's physical condition (scarring, facial hair, dental changes, significant weight changes, etc.) that might affect the fit of the respirator.

If, subsequent to a successful fit test, the employee later determines the fit of the respirator to be unacceptable, the employee will be provided with a reasonable opportunity to select another respirator (29 CFR 1910.134(f)(4)).

Qualitative Respirator Fit Tests

A QLFT test determines the *quality* of the fit of a facepiece - either good or bad. It cannot determine the actual protection factor of the equipment. OSHA (29 CFR 1910.134(f)(6)) only allows QLFT testing for situations where a respirator fit factor of 100 or less is required. The Protection Factor for a respirator is determined by dividing the fit factor by a safety margin of 10, so passing a QLFT qualifies a person as having a Protection Factor of 10 for that respirator.

Therefore, any tight-fitting facepiece may be tested to an Assigned Protection Factor of 10 using QLFT. If a tight-fitting supplied air respirator is tested with a QLFT protocol, the respirator cannot be used in atmospheres over 10 times the permissible exposure level, and cannot be used in IDLH atmospheres, regardless of the type of respirator.

Irritant Smoke Test

The irritant smoke test can be used for both air-purifying respirators and atmosphere-supplying respirators. When an air-purifying respirator is tested, it should be equipped with a HEPA filter. The irritant smoke is produced by air flowing through a commercially available smoke tube normally used to check the performance of ventilation systems.

Isoamyl Acetate Test

The odorous vapor test can be used for both air-purifying respirators and atmosphere-supplying respirators. When an air-purifying respirator is tested, it should be equipped with an organic vapor cartridge. The person being fit tested will smell the banana-like odor of the isoamyl acetate if the fit of the respirator is unsatisfactory and report same to the test administrator.

Quantitative Respirator Fitting Test

For a QNFT, the individual wears a respirator in an atmosphere containing a test agent in the form of an aerosol, vapor, or gas. Instrumentation, which samples the test atmosphere and the air inside the respirator, is used to measure the penetration of the test agent into the respirator. This method of testing determines the exact fit factor of the respirator on the person being tested. For example, if the instruments measure a concentration of 1,000 ppm outside the facepiece and 1 ppm inside, that facepiece on that individual has a fit factor of 1,000.

Any QNFT documenting a fit factor of 500 or greater may be used to validate the equipment to its maximum use concentration. For example, NIOSH assigns an airline respirator without an escape bottle, operated in positive pressure mode, a Protection Factor of 1,000. Any QNFT that documents the wearer exceeding a fit factor of 500 would allow use of this respirator up to the 1,000 times the action level.

Facial Hair

OSHA mandates (29 CFR 1910.134 Appendix A) that fit testing cannot be done if there is any hair growth between the skin and the sealing surface of the respirator. This includes stubble, beards, mustaches, or sideburns.

Fit Test Procedures

The following procedures must be followed when providing any QLFT of QNFT (Appendix A to 29 CFR 1910.134). The test specific procedures are provided in Appendix C.

1. The employee will be allowed to select a facepiece from a sufficient array of size, makes, and models of NIOSH certified respirators to ensure a correctly fitting and acceptable respirator. The employee will be asked to select the facepiece with the most acceptable fit.
2. The tester will then review respirator donning and doffing procedures with the employee. A mirror is recommended to assist the employee in evaluating the fit of the respirator.

3. The employee will wear the facepiece for at least 5 minutes. The employee will be furnished with written instructions for the exercise regimen during this period.
4. If the respirator is a model unfamiliar to the employee, the tester will assist the employee in donning and doffing the facepiece several times to familiarize them with the unit.
5. The tester and employee will check the following items for fit and comfort: Position and fit of mask on the nose; room for eye protection; room to talk; position of mask on face and cheeks; chin properly placed; appropriate strap tension; and slipping tendency.
6. Employee will then conduct negative and positive pressure seal checks (Appendix D). For a negative check, cover the inhalation valves and breathe in; the facepiece should collapse slightly. For the positive check, cover the exhalation valve and breath out slightly (normally); the mask should bulge outward. The employee should not feel any air escaping or entering the mask.
7. If the employee routinely uses any safety equipment that might interfere with respirator fit (such as safety glasses with half-face respirators), it must be worn during the fit testing.
8. The following test exercises will be conducted for 1 minute while standing, except for the grimace exercise that is conducted for 15 seconds:
   - Normal breathing;
   - Deep breathing;
   - Turn head slowly side to side;
   - Nod head slowly up and down; inhale when looking upwards;
   - Talk slowly and loudly enough to be heard by the instructor. The employee can recite a story, count backwards from 100, read the 'rainbow passage' or another prepared script, etc.;
   - Grimace (smile or frown). (NOTE: OSHA states that this is required only for QNFT testing);
   - If possible, bend over from the waist. Jogging in place may be used if the test conditions prevent bending; and
   - Normal breathing.
9. If, at any time during the test the employee reports exposure to the challenge substance or the computerized QNFT test indicates failure, the test is to be

stopped, and the employee will be offered the opportunity to adjust the respirator or select a different one.

Respirator Fit Test Records

CRA will maintain records of respirator fit tests until the next test is taken (see Appendix F for form). The following information will be documented during the fit test:

- Name of employee being tested;
- Type of fit test used;
- Specific make, model, style, and size of respirator tested;
- Date of test; and
- Pass/Fail test results for QLFTs, or the fit factor and strip charts or other record for QNFTs.

7.0 RESPIRATOR MAINTENANCE

CRA employees will be responsible for cleaning and maintaining their personally assigned respirators.

Cleaning and Sanitizing

Employees shall clean and sanitize personally assigned respirators in accordance with the procedures outlined in Appendix E. Non-personally assigned respirators shall be cleaned after each use by the user.

Respirators used in fit testing shall be cleaned and sanitized between each use.

Storage

Respirators must be stored in a manner that will protect them against damage, contamination, dust, sunlight, extreme temperatures, excessive moisture, or damaging chemicals. Respirators should also be stored to prevent distortion of rubber or other elastomeric parts. Respirators must not be stored in such places as lockers and toolboxes unless they are protected as stated above.

Inspection

Each respirator must be inspected before each use and during cleaning to ensure it is in proper working condition. These inspections are documented on the Inspection Record Form that is provided in Appendix G.

A respirator inspection must include a check for respirator function; connection tightness; for the condition of the respiratory inlet covering, head harness, valves, connecting tubes, harness assemblies, filters, cartridges, canisters, ESLI, and shelf life date(s); and for the proper function of regulators, alarms, and other warning systems.

Each rubber or other elastomeric part must be inspected for pliability and signs of deterioration.

Part Replacement and Repair

Parts replacement may be performed by the employee to whom the respirator is assigned in accordance with the manufacturer's procedures. Replacement parts must be only those designed for the specific respirator being repaired.

Respirator repair, beyond user-serviceable parts, will be performed by trained and authorized third parties. Reducing or admission valves must be returned to the manufacturer or to a trained technician for repair or adjustment. Instrumentation for valve tests must be approved by the manufacturer.

8.0 EMPLOYEE TRAINING

CRA will provide training to all employees participating in the Respiratory Protection Program. This training will be provided at:

- The time of initial employment;
- Annually;
- Whenever changes in respiratory protective equipment or respiratory hazards in the workplace occur;
- Whenever inadequate employee knowledge or use of the respirator indicates that the employee has not retained the requisite understanding or skills required to wear respiratory protection equipment; and
- Whenever any other situation in which retraining appears necessary to ensure safe respirator usage.

The training program shall include the following elements:

- The basic elements of the CRA Respiratory Protection Program;
- Responsibilities of managers and employees;
- The criteria for selecting respirators;
- Proper inspection procedures for respirators;
- Maintenance and storage of respirators;
- Regulations concerning respirator use, including a review of 29 CFR 1910.134;
- A review of forms to be used for respirator fit tests, training records, and respirator inspection records;
- The reason(s) respiratory protection is required on the work sites;
- The general nature, extent, and effects of respiratory hazards to which the person may be exposed;
- A discussion of possible engineering controls as they relate to the types of work sites with which CRA employees are involved;
- An explanation of the operation, capabilities, and limitations of the respirator selected; and
- Instruction in donning, checking the fit of, wearing, and use of respirators.

The successful completion of the training program shall be documented and kept on file.

9.0 PROGRAM EVALUATION AND DOCUMENT CONTROL

Evaluations of our workplaces are conducted periodically to ensure compliance with CRA's Respiratory Protection Program and its effectiveness. Employees are questioned about fitting, selection, use and maintenance of the respirators that they wear. This program will be reviewed and updated as necessary, at a frequency necessary to maintain its effectiveness. The responsibility for maintenance of this program belongs to the Corporate Safety and Health Manager.

APPENDIX A –DEFINITIONS AND ABBREVIATIONS

ACGIH	American Conference of Governmental Industrial Hygienists
Aerodynamic diameter	The diameter of a unit density sphere having the same settling velocity as the particle in question, whatever the shape and density.
Aerosol	A system consisting of particles, solid or liquid, suspended in air.
Air-regulating valve	An adjustable valve used to regulate, but which cannot completely shut off, the airflow to the facepiece, helmet, hood, or suit of an air-line respirator.
Air-supply device	A hand- or motor-operated blower for the hose mask, or a compressor or other source of respirable air for the air-line respirator.
Anesthetic	A substance that causes loss of feeling and sensation with unconsciousness and death possible (for example: nitrous oxide, hydrocarbons, and ethers). Some anesthetics injure body organs (for example: Carbon tetrachloride (liver and kidneys), chloroform (liver and heart), benzene (bone marrow), and carbon disulfide (nervous system)).
ANSI	American National Standards Institute
Approved	Tested and listed as satisfactory by the National Institute of Occupational Safety and Health (NIOSH) of the U.S. Department of Health and Human Services
Asphyxiant	A substance that interferes with utilization of oxygen in the body.
Asphyxiant - chemical	A substance that in low concentrations interferes with supply or utilization of oxygen in the body (for example: carbon monoxide, hydrogen cyanide, cyanogen, and nitriles).
Asphyxiant - simple	A physiologically inert substance that dilutes oxygen in the air (for example: nitrogen, hydrogen, helium, and methane).
Breathing tube	A tube through which air or oxygen flows to the facepiece, mouthpiece, helmet, hood, or suit.
Canister (air-purifying)	A container with a filter, sorbent, or catalyst, or any combination thereof, that removes specific contaminants from the air drawn through it.

Carcinogen	A substance known to produce cancer in some individuals following a latent period (for example: Asbestos, chromates, or radioactive particulates).
Cartridge	A small, air-purifying, canister.
Catalyst	In respirator use, a substance that converts a toxic gas (or vapor) into a less toxic gas (or vapor).
Ceiling concentration	The concentration of an airborne substance that must not be exceeded.
Confined space	Any space with limited means of egress subject to toxic or flammable contaminant accumulation or to an oxygen deficient atmosphere. Confined spaces include but are not limited to storage tanks, process vessels, bins, boilers, ventilation or exhaust ducts, sewers, underground utility vaults, tunnels, pipelines and open top spaces more than 4 feet deep, such as pits, tubes, vaults and vessels.
Contaminant	A harmful, irritating, or nuisance material that is foreign to the normal atmosphere.
Demand	A type of self-contained breathing apparatus or air-line respirator that functions due to negative pressure created by inhalation (i.e., air flow into the facepiece on "demand").
DOP	Dioctyl phthalate, a particulate with a fairly uniform size of about 0.3 micrometers and used in testing HEPA filters.
Dust	A solid particle suspended in air, generated by handling, drilling, crushing, grinding, rapid impact, detonation, or decrepitation of organic or inorganic materials such as rock, ore, metal, coal, wood, grain, and etc.
Emergency respirator	A respirator available to be worn when a hazardous atmosphere suddenly occurs that requires immediate use of a respirator either for escape from the hazardous atmosphere or for entry into the hazardous atmosphere.
Exhalation valve	A device that allows exhaled air to leave a respirator and prevents outside air from entering through the valve.
Eyepiece	A gas-tight, transparent window(s) in a full facepiece, helmet, hood, or suit, through which the wearer may see.
Face shield	A device worn in front of the eyes and a portion of, or all of, the face, whose predominant function is protection of the eyes and the face.

Facepiece	That portion of a respirator that covers the wearer's nose and mouth in quarter-mask (above the chin) or half-mask (under the chin) facepiece or that covers the nose, mouth, and eyes in a full facepiece. It is designed to make a gas-tight or particle-tight fit with the face and includes the headbands, exhalation valve(s), and connections for an air-purifying device or respirable gas source, or both.
Fibrosis (producing dust)	Dust that, when inhaled, deposited, and retained in the lungs, may result in fibrotic growth that may cause reduced pulmonary function.
Filter	A media component used in respirators to remove solid or liquid particles from inspired air.
Fog	A mist of sufficient concentration to perceptibly obscure vision.
Fume	Solid particles suspended in air, generated by condensation from the gaseous state, generally after volatilization from molten metals, etc., and often accompanied by a chemical reaction such as oxidation.
Gas	An aeriform fluid that is in the gaseous state at ordinary temperature and pressure.
Goggle	A device with contour-shaped eyecups and glass or plastic lenses worn over eyes and held in place by a headband or other suitable means for protection of the eyes and eye sockets.
Hazardous atmosphere	Any atmosphere, either immediately or not immediately dangerous to life or health, which is oxygen deficient or contains a toxic or disease-producing contaminant.
Head harness	That part of a facepiece assembly that secures the facepiece to the wearer.
Helmet	That portion of a respirator that shields the eyes, face, neck, and other parts of the head.
HEPA	High-efficiency particulate air filter
HEPA	High efficiency particulate air filter that removes 99.97 percent or more of monodisperse dioctyl phthalate (DOP) particles with a mean particle diameter of 0.3 micrometer from air.
Hood	That portion of a respirator that completely covers the head, neck, and portions of the shoulders.
HSM	Area Health and Safety Manager

IDLH	Immediately dangerous to life or health
IDLH	Immediately dangerous to life or health. Any atmosphere that poses an immediate hazard to life or produces immediate irreversible debilitating effects on health.
Inhalation valve	A device that allows respirable air to enter a respirator and prevents exhaled air from leaving the respirator through the valve.
Irrespirable	Unfit for breathing.
Irritant	Corrosive in action. May cause irritation and inflammation of parts of the respiratory system (also skin and eyes) and pulmonary edema.
Maximum use limit	Refers to filters, cartridges, or canisters. The maximum concentration of a contaminant for which an air-purifying filter, cartridge, or canister is approved for use.
Mist	Liquid droplets suspended in air, generated by condensation from the gaseous to the liquid state or by breaking up a liquid into a dispersed state, such as by splashing, foaming, or atomizing.
Mouthpiece	That portion of a respirator that is held in the wearer's mouth and is connected to an air-purifying device or respirable gas source, or both. It is designed to make a gas-tight or particle-tight fit with the mouth.
MPCa	Maximum permissible air-borne concentration. These concentrations are set by the National Committee on Radiation Protection. They are recommended maximum average concentrations of radionuclides to which a worker may be exposed, assuming that he/she works 8 hours a day, 5 days a week, and 50 weeks a year.
MSHA	Mines Safety and Health Administration
Negative pressure respirator	A respirator in which the air pressure inside the respiratory inlet covering is positive during exhalation in relation to the air pressure of the outside atmosphere and negative during inhalation in relation to the air pressure of the outside atmosphere.
NIOSH	National Institute of Occupational Safety & Health
Nonroutine respirator use	Wearing a respirator when carrying out a special task that occurs infrequently.
Nose clamp	A device used to close the nostrils of a worker wearing a respirator equipped with a mouthpiece (sometimes called a nose clip).

Not IDLH	Not immediately dangerous to life or health. Any hazardous atmosphere that may produce physical discomfort immediately, chronic poisoning after repeated exposure, or acute adverse physiological symptoms after prolonged exposure.
Odor threshold limit	The lowest concentration of a contaminant in air that can be detected by the olfactory sense.
OSHA	Occupational Safety and Health Administration
Oxygen deficiency-not IDLH	An atmosphere having an oxygen concentration below the minimum legal requirement of 19.5 percent by volume for respirable air at sea-level conditions, but above that which is immediately dangerous to life or health.
PAPR	Powered air purifying respirator
Particulate matter	A suspension of fine solid or liquid particles in air, for example: Dust, fog, fume, mist, smoke, or spray. Particulate matter suspended in air is commonly known as an aerosol.
PEL	Permissible exposure limit
Permissible exposure limit (PEL)	The legally established time-weighted average (TWA) concentration or ceiling concentration of a contaminant that shall not be exceeded.
Pneumoconiosis-producing dust	Dust that, when inhaled, deposited, and retained in the lungs, may produce signs, symptoms, and findings of pulmonary disease.
Positive-pressure respirator	A respirator in which the air pressure inside the respiratory inlet covering is positive in relation to the air pressure of the outside atmosphere during exhalation and inhalation.
Pressure demand	Similar to a demand-type respirator but designed to maintain positive pressure in the facepiece at all times.
Protection factor	The ratio of the ambient concentration of an airborne substance to the concentration of the substance inside the respirator at the breathing zone of the wearer. The protection factor is a measure of the degree of protection provided to the wearer by a respirator.
Resistance	Opposition to the flow of air, as through a canister, cartridge, particulate filter, orifice, valve, or hose.
Respirable	Suitable for breathing.

Respirator	A device designed to protect the wearer from the inhalation of harmful atmospheres.
Respiratory inlet covering	That portion of a respirator that connects the wearer's respiratory tract to an air-purifying device or respirable gas source, or both. It may be a facepiece, helmet, hood, suit, or mouthpiece/nose clamp.
Routine respirator use	Wearing a respirator as a normal procedure when carrying out a regular and frequently repeated task.
Sanitization	The removal of dirt and the inhibiting of the action of agents that cause infection or disease.
SAR	Supplied air respirators
SCBA	Self-contained breathing apparatus
Sensitizers	Substances that cause increased probability of physiological reactions (for example, isocyanates or epoxy resins systems).
Service life	The period of time that a respirator provides adequate protection to the wearer - for example, the period of time that an air-purifying device is effective for removing a harmful substance from inspired air.
Smoke	A system that includes the products of combustion, pyrolysis, or chemical reaction of substances in the form of visible and invisible solid and liquid particles and gaseous products in air. Smoke is usually of sufficient concentration to perceptibly obscure vision.
Sorbent	A material contained in cartridge or canister that removes toxic gases and vapors from the inhaled air.
Spray	A liquid, mechanically produced, particle with sizes generally in the visible or macroscopic range.
STEL	A STEL is defined as a 15-minute time-weighted average exposure that should not be exceeded at any time during a work day even if the 8-hour time-weighted average is within the TLV. Exposures at the STEL should not be longer than 15 minutes and should not be repeated more than four times per day. There should be at least 60 minutes between successive exposures at the STEL.
Supplied-air suit	A suit impermeable to most particulate and gaseous contaminants and provided with an adequate supply of respirable air.

Systemic poisons	Substances that damage organs and systems in the body (for example: Mercury (nervous system and various organs), phosphorus (bone), hydrogen sulfide (respiratory paralysis), and arsine (red blood cells and liver).
Time-weighted average	The average concentration of a contaminant in air during a specific time period.
TLV	Threshold limit value
TLV	Threshold Limit Value. Refers to the airborne concentration of a substance and represents conditions to which it is believed nearly all workers may be repeatedly exposed day after day without adverse effect. Due to the wide variation in individual susceptibility, usually a small percentage of workers may experience discomfort from some substances at or below the threshold limit.
TLV-C	Threshold limit value - ceiling
TLV-c	A listed value bearing a "c" designation refers to a "ceiling" value that should NOT be exceeded without appropriate respiratory protection. ALL values should fluctuate below this listed value. This, in effect, makes the "c" designation a maximum allowable concentration.
TLV-STEL	Threshold limit value - short term exposure limit
TLV-STEL	Threshold limit value - short-term exposure limit. The concentration to which workers can be exposed continuously for a short period of time without suffering from 1) irritation, 2) chronic or irreversible tissue damage, or 3) narcosis of sufficient degree to increase the likelihood of accidental injury, impair self-rescue, or materially reduce work efficiency, and provided that the daily TLV-TWA is not exceeded.
TLV-TWA	Threshold limit value - time weighted average
TLV-TWA	Threshold limit value - time weighted average. The time-weighted average concentration for a normal 8-hour workday and a 40-hour work week to which nearly all workers may be repeatedly exposed, day after day, without adverse effect.
Valve	A device that controls the pressure, direction, or rate of flow of air or oxygen.
Vapor	The gaseous state of a substance that is solid or liquid at ordinary temperature and pressure.

Welding helmet	A device designed to provide protection for the eyes and face against intense radiant energy and molten metal splatter encountered in the welding and cutting of metals.
Window indicator	A device on a cartridge or canister that visually denotes the service life of the cartridge or canister.

APPENDIX B – OSHA RESPIRATORY PROTECTION PROGRAM REGULATIONS

29 CFR 1910.134 Respiratory Protection.

[Added at 63 FR 1270, Jan. 8, 1998]

This section applies to General Industry (part 1910), Shipyards (part 1915), Marine Terminals (part 1917), Longshoring (part 1918), and Construction (part 1926).

(a) *Permissible practice.*

(1) In the control of those occupational diseases caused by breathing air contaminated with harmful dusts, fogs, fumes, mists, gases, smokes, sprays, or vapors, the primary objective shall be to prevent atmospheric contamination. This shall be accomplished as far as feasible by accepted engineering control measures (for example, enclosure or confinement of the operation, general and local ventilation, and substitution of less toxic materials). When effective engineering controls are not feasible, or while they are being instituted, appropriate respirators shall be used pursuant to this section.

(2) Respirators shall be provided by the employer when such equipment is necessary to protect the health of the employee. The employer shall provide the respirators which are applicable and suitable for the purpose intended. The employer shall be responsible for the establishment and maintenance of a respiratory protection program which shall include the requirements outlined in paragraph (c) of this section.

(b) *Definitions.* The following definitions are important terms used in the respiratory protection standard in this section.

Air-purifying respirator means a respirator with an air-purifying filter, cartridge, or canister that removes specific air contaminants by passing ambient air through the air-purifying element.

Assigned protection factor (APF) [Reserved]

Atmosphere-supplying respirator means a respirator that supplies the respirator user with breathing air from a source independent of the ambient atmosphere, and includes supplied-air respirators (SARs) and self-contained breathing apparatus (SCBA) units.

Canister or cartridge means a container with a filter, sorbent, or catalyst, or combination of these items, which removes specific contaminants from the air passed through the container.

Demand respirator means an atmosphere-supplying respirator that admits breathing air to the facepiece only when a negative pressure is created inside the facepiece by inhalation.

Emergency situation means any occurrence such as, but not limited to, equipment failure, rupture of containers, or failure of control equipment that may or does result in an uncontrolled significant release of an airborne contaminant.

Employee exposure means exposure to a concentration of an airborne contaminant that would occur if the employee were not using respiratory protection.

End-of-service-life indicator (ESLI) means a system that warns the respirator user of the approach of the end of adequate respiratory protection, for example, that the sorbent is approaching saturation or is no longer effective.

Escape-only respirator means a respirator intended to be used only for emergency exit.

Filter or air purifying element means a component used in respirators to remove solid or liquid aerosols from the inspired air.

Filtering facepiece (dust mask) means a negative pressure particulate respirator with a filter as an integral part of the facepiece or with the entire facepiece composed of the filtering medium.

Fit factor means a quantitative estimate of the fit of a particular respirator to a specific individual, and typically estimates the ratio of the concentration of a substance in ambient air to its concentration inside the respirator when worn.

Fit test means the use of a protocol to qualitatively or quantitatively evaluate the fit of a respirator on an individual. (See also Qualitative fit test QLFT and Quantitative fit test QNFT.)

Helmet means a rigid respiratory inlet covering that also provides head protection against impact and penetration.

High efficiency particulate air (HEPA) filter means a filter that is at least 99.97% efficient in removing monodisperse particles of 0.3 micrometers in diameter. The equivalent NIOSH 42 CFR 84 particulate filters are the N100, R100, and P100 filters.

Hood means a respiratory inlet covering that completely covers the head and neck and may also cover portions of the shoulders and torso.

Immediately dangerous to life or health (IDLH) means an atmosphere that poses an immediate threat to life, would cause irreversible adverse health effects, or would impair an individual's ability to escape from a dangerous atmosphere.

Interior structural firefighting means the physical activity of fire suppression, rescue or both, inside of buildings or enclosed structures which are involved in a fire situation beyond the incipient stage. (See 29 CFR 1910.155)

Loose-fitting facepiece means a respiratory inlet covering that is designed to form a partial seal with the face.

Maximum use concentration (MUC) [Reserved].

Negative pressure respirator (tight fitting) means a respirator in which the air pressure inside the facepiece is negative during inhalation with respect to the ambient air pressure outside the respirator.

Oxygen deficient atmosphere means an atmosphere with an oxygen content below 19.5% by volume.

Physician or other licensed health care professional (PLHCP) means an individual whose legally permitted scope of practice (*i.e.,* license, registration, or certification) allows him or her to independently provide, or be delegated the responsibility to provide, some or all of the health care services required by paragraph (e) of this section.

Positive pressure respirator means a respirator in which the pressure inside the respiratory inlet covering exceeds the ambient air pressure outside the respirator.

Powered air-purifying respirator (PAPR) means an air-purifying respirator that uses a blower to force the ambient air through air-purifying elements to the inlet covering.

Pressure demand respirator means a positive pressure atmosphere-supplying respirator that admits breathing air to the facepiece when the positive pressure is reduced inside the facepiece by inhalation.

Qualitative fit test (QLFT) means a pass/fail fit test to assess the adequacy of respirator fit that relies on the individual's response to the test agent.

Quantitative fit test (QNFT) means an assessment of the adequacy of respirator fit by numerically measuring the amount of leakage into the respirator.

Respiratory inlet covering means that portion of a respirator that forms the protective barrier between the user's respiratory tract and an air-purifying device or breathing air source, or both. It may be a facepiece, helmet, hood, suit, or a mouthpiece respirator with nose clamp.

Self-contained breathing apparatus (SCBA) means an atmosphere-supplying respirator for which the breathing air source is designed to be carried by the user.

Service life means the period of time that a respirator, filter or sorbent, or other respiratory equipment provides adequate protection to the wearer.

Supplied-air respirator (SAR) or airline respirator means an atmosphere-supplying respirator for which the source of breathing air is not designed to be carried by the user.

This section means this respiratory protection standard.

Tight-fitting facepiece means a respiratory inlet covering that forms a complete seal with the face.

User seal check means an action conducted by the respirator user to determine if the respirator is properly seated to the face.

(c) *Respiratory protection program.* This paragraph requires the employer to develop and implement a written respiratory protection program with required worksite-specific procedures and elements for required respirator use. The program must be administered by a suitably trained program administrator. In addition, certain program elements may be required for voluntary use to prevent potential hazards associated with the use of the respirator. The Small Entity Compliance Guide contains criteria for the selection of a program administrator and a

sample program that meets the requirements of this paragraph. Copies of the Small Entity Compliance Guide will be available on or about April 8, 1998 from the Occupational Safety and Health Administration's Office of Publications, Room N 3101, 200 Constitution Avenue, NW, Washington, DC, 20210 (202-219-4667).

(1) In any workplace where respirators are necessary to protect the health of the employee or whenever respirators are required by the employer, the employer shall establish and implement a written respiratory protection program with worksite-specific procedures. The program shall be updated as necessary to reflect those changes in workplace conditions that affect respirator use. The employer shall include in the program the following provisions of this section, as applicable:

(i) Procedures for selecting respirators for use in the workplace;

(ii) Medical evaluations of employees required to use respirators;

(iii) Fit testing procedures for tight-fitting respirators;

(iv) Procedures for proper use of respirators in routine and reasonably foreseeable emergency situations;

(v) Procedures and schedules for cleaning, disinfecting, storing, inspecting, repairing, discarding, and otherwise maintaining respirators;

(vi) Procedures to ensure adequate air quality, quantity, and flow of breathing air for atmosphere-supplying respirators;

(vii) Training of employees in the respiratory hazards to which they are potentially exposed during routine and emergency situations;

(viii) Training of employees in the proper use of respirators, including putting on and removing them, any limitations on their use, and their maintenance; and

(ix) Procedures for regularly evaluating the effectiveness of the program.

(2) Where respirator use is not required:

(i) An employer may provide respirators at the request of employees or permit employees to use their own respirators, if the employer determines that such respirator use will not in itself create a hazard. If the employer determines that any voluntary respirator use is permissible, the employer shall provide the respirator users with the information contained in Appendix D to this section ("Information for Employees Using Respirators When Not Required Under the Standard"); and

(ii) In addition, the employer must establish and implement those elements of a written respiratory protection program necessary to ensure that any employee using a respirator voluntarily is medically able to use that respirator, and that the respirator is cleaned, stored, and maintained so that its use does not present a health hazard to the user. Exception: Employers

are not required to include in a written respiratory protection program those employees whose only use of respirators involves the voluntary use of filtering facepieces (dust masks).

(3) The employer shall designate a program administrator who is qualified by appropriate training or experience that is commensurate with the complexity of the program to administer or oversee the respiratory protection program and conduct the required evaluations of program effectiveness.

(4) The employer shall provide respirators, training, and medical evaluations at no cost to the employee.

(d) *Selection of respirators.* This paragraph requires the employer to evaluate respiratory hazard(s) in the workplace, identify relevant workplace and user factors, and base respirator selection on these factors. The paragraph also specifies appropriately protective respirators for use in IDLH atmospheres, and limits the selection and use of air-purifying respirators.

(1) *General requirements.*

(i) The employer shall select and provide an appropriate respirator based on the respiratory hazard(s) to which the worker is exposed and workplace and user factors that affect respirator performance and reliability.

(ii) The employer shall select a NIOSH-certified respirator. The respirator shall be used in compliance with the conditions of its certification.

(iii) The employer shall identify and evaluate the respiratory hazard(s) in the workplace; this evaluation shall include a reasonable estimate of employee exposures to respiratory hazard(s) and an identification of the contaminant's chemical state and physical form. Where the employer cannot identify or reasonably estimate the employee exposure, the employer shall consider the atmosphere to be IDLH.

(iv) The employer shall select respirators from a sufficient number of respirator models and sizes so that the respirator is acceptable to, and correctly fits, the user.

(2) *Respirators for IDLH atmospheres.*

(i) The employer shall provide the following respirators for employee use in IDLH atmospheres:

(A) A full facepiece pressure demand SCBA certified by NIOSH for a minimum service life of thirty minutes, or

(B) A combination full facepiece pressure demand supplied-air respirator (SAR) with auxiliary self-contained air supply.

(ii) Respirators provided only for escape from IDLH atmospheres shall be NIOSH-certified for escape from the atmosphere in which they will be used.

(iii) All oxygen-deficient atmospheres shall be considered IDLH. Exception: If the employer demonstrates that, under all foreseeable conditions, the oxygen concentration can be

maintained within the ranges specified in Table II of this section (i.e., for the altitudes set out in the table), then any atmosphere-supplying respirator may be used.

(3) *Respirators for atmospheres that are not IDLH.*

(i) The employer shall provide a respirator that is adequate to protect the health of the employee and ensure compliance with all other OSHA statutory and regulatory requirements, under routine and reasonably foreseeable emergency situations.

(A) *Assigned Protection Factors (APFs)* [Reserved]

(B) *Maximum Use Concentration (MUC)* [Reserved]

(ii) The respirator selected shall be appropriate for the chemical state and physical form of the contaminant.

(iii) For protection against gases and vapors, the employer shall provide:

(A) An atmosphere-supplying respirator, or

(B) An air-purifying respirator, provided that:

Table II

Altitude (ft.)	Oxygen deficient Atmospheres (%0_2) for which the employer may rely on atmosphere-supplying respirators
Less than 3,001	16.0 - 19.5
3,001 - 4,000	16.4 - 19.5
4,001 - 5,000	17.1 - 19.5
5,001 - 6,000	17.8 - 19.5
6,001 - 7,000	18.5 - 19.5
7,001-8,000[1]	19.3 - 19.5

(1) The respirator is equipped with an end-of-service-life indicator (ESLI) certified by NIOSH for the contaminant; or

(2) If there is no ESLI appropriate for conditions in the employer's workplace, the employer implements a change schedule for canisters and cartridges that is based on objective information or data that will ensure that canisters and cartridges are changed before the end of their service life. The employer shall describe in the respirator program the information and data relied upon and the basis for the canister and cartridge change schedule and the basis for reliance on the data.

(iv) For protection against particulates, the employer shall provide:

(A) An atmosphere-supplying respirator; or

(B) An air-purifying respirator equipped with a filter certified by NIOSH under 30 CFR part 11 as a high efficiency particulate air (HEPA) filter, or an air-purifying respirator equipped with a filter certified for particulates by NIOSH under 42 CFR part 84; or

(C) For contaminants consisting primarily of particles with mass median aerodynamic diameters (MMAD) of at least 2 micrometers, an air-purifying respirator equipped with any filter certified for particulates by NIOSH.

TABLE I.—ASSIGNED PROTECTION FACTORS [Reserved]

[1] Above 8,000 feet the exception does not apply. Oxygen-enriched breathing air must be supplied above 14,000 feet.

(e) *Medical evaluation.* Using a respirator may place a physiological burden on employees that varies with the type of respirator worn, the job and workplace conditions in which the respirator is used, and the medical status of the employee. Accordingly, this paragraph specifies the minimum requirements for medical evaluation that employers must implement to determine the employee's ability to use a respirator.

(1) *General.* The employer shall provide a medical evaluation to determine the employee's ability to use a respirator, before the employee is fit tested or required to use the respirator in the workplace. The employer may discontinue an employee's medical evaluations when the employee is no longer required to use a respirator.

(2) *Medical evaluation procedures.*

(i) The employer shall identify a physician or other licensed health care professional (PLHCP) to perform medical evaluations using a medical questionnaire or an initial medical examination that obtains the same information as the medical questionnaire.

(ii) The medical evaluation shall obtain the information requested by the questionnaire in Sections 1 and 2, Part A of Appendix C of this section.

(3) *Follow-up medical examination.*

(i) The employer shall ensure that a follow-up medical examination is provided for an employee who gives a positive response to any question among questions 1 through 8 in Section 2, Part A of Appendix C or whose initial medical examination demonstrates the need for a follow-up medical examination.

(ii) The follow-up medical examination shall include any medical tests, consultations, or diagnostic procedures that the PLHCP deems necessary to make a final determination.

(4) *Administration of the medical questionnaire and examinations.*

(i) The medical questionnaire and examinations shall be administered confidentially during the employee's normal working hours or at a time and place convenient to the employee. The

medical questionnaire shall be administered in a manner that ensures that the employee understands its content.

(ii) The employer shall provide the employee with an opportunity to discuss the questionnaire and examination results with the PLHCP.

(5) *Supplemental information for the PLHCP.*

(i) The following information must be provided to the PLHCP before the PLHCP makes a recommendation concerning an employee's ability to use a respirator:

(A) The type and weight of the respirator to be used by the employee;

(B) The duration and frequency of respirator use (including use for rescue and escape);

(C) The expected physical work effort;

(D) Additional protective clothing and equipment to be worn; and

(E) Temperature and humidity extremes that may be encountered.

(ii) Any supplemental information provided previously to the PLHCP regarding an employee need not be provided for a subsequent medical evaluation if the information and the PLHCP remain the same.

(iii) The employer shall provide the PLHCP with a copy of the written respiratory protection program and a copy of this section.

Note to Paragraph (e)(5)(iii): When the employer replaces a PLHCP, the employer must ensure that the new PLHCP obtains this information, either by providing the documents directly to the PLHCP or having the documents transferred from the former PLHCP to the new PLHCP. However, OSHA does not expect employers to have employees medically reevaluated solely because a new PLHCP has been selected.

(6) *Medical determination.* In determining the employee's ability to use a respirator, the employer shall:

(i) Obtain a written recommendation regarding the employee's ability to use the respirator from the PLHCP. The recommendation shall provide only the following information:

(A) Any limitations on respirator use related to the medical condition of the employee, or relating to the workplace conditions in which the respirator will be used, including whether or not the employee is medically able to use the respirator;

(B) The need, if any, for follow-up medical evaluations; and

(C) A statement that the PLHCP has provided the employee with a copy of the PLHCP's written recommendation.

(ii) If the respirator is a negative pressure respirator and the PLHCP finds a medical condition that may place the employee's health at increased risk if the respirator is used, the employer

shall provide a PAPR if the PLHCP's medical evaluation finds that the employee can use such a respirator; if a subsequent medical evaluation finds that the employee is medically able to use a negative pressure respirator, then the employer is no longer required to provide a PAPR.

(7) *Additional medical evaluations.* At a minimum, the employer shall provide additional medical evaluations that comply with the requirements of this section if:

(i) An employee reports medical signs or symptoms that are related to ability to use a respirator;

(ii) A PLHCP, supervisor, or the respirator program administrator informs the employer that an employee needs to be reevaluated;

(iii) Information from the respiratory protection program, including observations made during fit testing and program evaluation, indicates a need for employee reevaluation; or

(iv) A change occurs in workplace conditions (e.g., physical work effort, protective clothing, temperature) that may result in a substantial increase in the physiological burden placed on an employee.

(f) *Fit testing.* This paragraph requires that, before an employee may be required to use any respirator with a negative or positive pressure tight-fitting facepiece, the employee must be fit tested with the same make, model, style, and size of respirator that will be used. This paragraph specifies the kinds of fit tests allowed, the procedures for conducting them, and how the results of the fit tests must be used.

(1) The employer shall ensure that employees using a tight-fitting facepiece respirator pass an appropriate qualitative fit test (QLFT) or quantitative fit test (QNFT) as stated in this paragraph.

(2) The employer shall ensure that an employee using a tight-fitting facepiece respirator is fit tested prior to initial use of the respirator, whenever a different respirator facepiece (size, style, model or make) is used, and at least annually thereafter.

(3) The employer shall conduct an additional fit test whenever the employee reports, or the employer, PLHCP, supervisor, or program administrator makes visual observations of, changes in the employee's physical condition that could affect respirator fit. Such conditions include, but are not limited to, facial scarring, dental changes, cosmetic surgery, or an obvious change in body weight.

(4) If after passing a QLFT or QNFT, the employee subsequently notifies the employer, program administrator, supervisor, or PLHCP that the fit of the respirator is unacceptable, the employee shall be given a reasonable opportunity to select a different respirator facepiece and to be retested.

(5) The fit test shall be administered using an OSHA-accepted QLFT or QNFT protocol. The OSHA-accepted QLFT and QNFT protocols and procedures are contained in Appendix A of this section.

(6) QLFT may only be used to fit test negative pressure air-purifying respirators that must achieve a fit factor of 100 or less.

(7) If the fit factor, as determined through an OSHA-accepted QNFT protocol, is equal to or greater than 100 for tight-fitting half facepieces, or equal to or greater than 500 for tight-fitting full facepieces, the QNFT has been passed with that respirator.

(8) Fit testing of tight-fitting atmosphere-supplying respirators and tight-fitting powered air-purifying respirators shall be accomplished by performing quantitative or qualitative fit testing in the negative pressure mode, regardless of the mode of operation (negative or positive pressure) that is used for respiratory protection.

(i) Qualitative fit testing of these respirators shall be accomplished by temporarily converting the respirator user's actual facepiece into a negative pressure respirator with appropriate filters, or by using an identical negative pressure air-purifying respirator facepiece with the same sealing surfaces as a surrogate for the atmosphere-supplying or powered air-purifying respirator facepiece.

(ii) Quantitative fit testing of these respirators shall be accomplished by modifying the facepiece to allow sampling inside the facepiece in the breathing zone of the user, midway between the nose and mouth. This requirement shall be accomplished by installing a permanent sampling probe onto a surrogate facepiece, or by using a sampling adapter designed to temporarily provide a means of sampling air from inside the facepiece.

(iii) Any modifications to the respirator facepiece for fit testing shall be completely removed, and the facepiece restored to NIOSH-approved configuration, before that facepiece can be used in the workplace.

(g) *Use of respirators.* This paragraph requires employers to establish and implement procedures for the proper use of respirators. These requirements include prohibiting conditions that may result in facepiece seal leakage, preventing employees from removing respirators in hazardous environments, taking actions to ensure continued effective respirator operation throughout the work shift, and establishing procedures for the use of respirators in IDLH atmospheres or in interior structural firefighting situations.

(1) *Facepiece seal protection.*

(i) The employer shall not permit respirators with tight-fitting facepieces to be worn by employees who have:

(A) Facial hair that comes between the sealing surface of the facepiece and the face or that interferes with valve function; or

(B) Any condition that interferes with the face-to-facepiece seal or valve function.

(ii) If an employee wears corrective glasses or goggles or other personal protective equipment, the employer shall ensure that such equipment is worn in a manner that does not interfere with the seal of the facepiece to the face of the user.

(iii) For all tight-fitting respirators, the employer shall ensure that employees perform a user seal check each time they put on the respirator using the procedures in Appendix B-1 or

procedures recommended by the respirator manufacturer that the employer demonstrates are as effective as those in Appendix B-1 of this section.

(2) *Continuing respirator effectiveness.*

(i) Appropriate surveillance shall be maintained of work area conditions and degree of employee exposure or stress. When there is a change in work area conditions or degree of employee exposure or stress that may affect respirator effectiveness, the employer shall reevaluate the continued effectiveness of the respirator.

(ii) The employer shall ensure that employees leave the respirator use area:

(A) To wash their faces and respirator facepieces as necessary to prevent eye or skin irritation associated with respirator use; or

(B) If they detect vapor or gas breakthrough, changes in breathing resistance, or leakage of the facepiece; or

(C) To replace the respirator or the filter, cartridge, or canister elements.

(iii) If the employee detects vapor or gas breakthrough, changes in breathing resistance, or leakage of the facepiece, the employer must replace or repair the respirator before allowing the employee to return to the work area.

(3) *Procedures for IDLH atmospheres.* For all IDLH atmospheres, the employer shall ensure that:

(i) One employee or, when needed, more than one employee is located outside the IDLH atmosphere;

(ii) Visual, voice, or signal line communication is maintained between the employee(s) in the IDLH atmosphere and the employee(s) located outside the IDLH atmosphere;

(iii) The employee(s) located outside the IDLH atmosphere are trained and equipped to provide effective emergency rescue;

(iv) The employer or designee is notified before the employee(s) located outside the IDLH atmosphere enter the IDLH atmosphere to provide emergency rescue;

(v) The employer or designee authorized to do so by the employer, once notified, provides necessary assistance appropriate to the situation;

(vi) Employee(s) located outside the IDLH atmospheres are equipped with:

(A) Pressure demand or other positive pressure SCBAs, or a pressure demand or other positive pressure supplied-air respirator with auxiliary SCBA; and either

(B) Appropriate retrieval equipment for removing the employee(s) who enter(s) these hazardous atmospheres where retrieval equipment would contribute to the rescue of the employee(s) and would not increase the overall risk resulting from entry; or

(C) Equivalent means for rescue where retrieval equipment is not required under paragraph (g)(3)(vi)(B).

(4) *Procedures for interior structural firefighting.* In addition to the requirements set forth under paragraph (g)(3), in interior structural fires, the employer shall ensure that:

(i) At least two employees enter the IDLH atmosphere and remain in visual or voice contact with one another at all times;

(ii) At least two employees are located outside the IDLH atmosphere; and

(iii) All employees engaged in interior structural firefighting use SCBAs.

Note 1 to paragraph (g): One of the two individuals located outside the IDLH atmosphere may be assigned to an additional role, such as incident commander in charge of the emergency or safety officer, so long as this individual is able to perform assistance or rescue activities without jeopardizing the safety or health of any firefighter working at the incident.

Note 2 to paragraph (g): Nothing in this section is meant to preclude firefighters from performing emergency rescue activities before an entire team has assembled.

(h) *Maintenance and care of respirators.* This paragraph requires the employer to provide for the cleaning and disinfecting, storage, inspection, and repair of respirators used by employees.

(1) *Cleaning and disinfecting.* The employer shall provide each respirator user with a respirator that is clean, sanitary, and in good working order. The employer shall ensure that respirators are cleaned and disinfected using the procedures in Appendix B-2 of this section, or procedures recommended by the respirator manufacturer, provided that such procedures are of equivalent effectiveness. The respirators shall be cleaned and disinfected at the following intervals:

(i) Respirators issued for the exclusive use of an employee shall be cleaned and disinfected as often as necessary to be maintained in a sanitary condition;

(ii) Respirators issued to more than one employee shall be cleaned and disinfected before being worn by different individuals;

(iii) Respirators maintained for emergency use shall be cleaned and disinfected after each use; and

(iv) Respirators used in fit testing and training shall be cleaned and disinfected after each use.

(2) *Storage.* The employer shall ensure that respirators are stored as follows:

(i) All respirators shall be stored to protect them from damage, contamination, dust, sunlight, extreme temperatures, excessive moisture, and damaging chemicals, and they shall be packed or stored to prevent deformation of the facepiece and exhalation valve.

(ii) In addition to the requirements of paragraph (h)(2)(i) of this section, emergency respirators shall be:

(A) Kept accessible to the work area;

(B) Stored in compartments or in covers that are clearly marked as containing emergency respirators; and

(C) Stored in accordance with any applicable manufacturer instructions.

(3) *Inspection.*

(i) The employer shall ensure that respirators are inspected as follows:

(A) All respirators used in routine situations shall be inspected before each use and during cleaning;

(B) All respirators maintained for use in emergency situations shall be inspected at least monthly and in accordance with the manufacturer's recommendations, and shall be checked for proper function before and after each use; and

(C) Emergency escape-only respirators shall be inspected before being carried into the workplace for use.

(ii) The employer shall ensure that respirator inspections include the following:

(A) A check of respirator function, tightness of connections, and the condition of the various parts including, but not limited to, the facepiece, head straps, valves, connecting tube, and cartridges, canisters or filters; and

(B) A check of elastomeric parts for pliability and signs of deterioration.

(iii) In addition to the requirements of paragraphs (h)(3)(i) and (ii) of this section, self-contained breathing apparatus shall be inspected monthly. Air and oxygen cylinders shall be maintained in a fully charged state and shall be recharged when the pressure falls to 90% of the manufacturer's recommended pressure level. The employer shall determine that the regulator and warning devices function properly.

(iv) For respirators maintained for emergency use, the employer shall:

(A) Certify the respirator by documenting the date the inspection was performed, the name (or signature) of the person who made the inspection, the findings, required remedial action, and a serial number or other means of identifying the inspected respirator; and

(B) Provide this information on a tag or label that is attached to the storage compartment for the respirator, is kept with the respirator, or is included in inspection reports stored as paper or electronic files. This information shall be maintained until replaced following a subsequent certification.

(4) *Repairs.* The employer shall ensure that respirators that fail an inspection or are otherwise found to be defective are removed from service, and are discarded or repaired or adjusted in accordance with the following procedures:

(i) Repairs or adjustments to respirators are to be made only by persons appropriately trained to perform such operations and shall use only the respirator manufacturer's NIOSH-approved parts designed for the respirator;

(ii) Repairs shall be made according to the manufacturer's recommendations and specifications for the type and extent of repairs to be performed; and

(iii) Reducing and admission valves, regulators, and alarms shall be adjusted or repaired only by the manufacturer or a technician trained by the manufacturer.

(i) *Breathing air quality and use.* This paragraph requires the employer to provide employees using atmosphere-supplying respirators (supplied-air and SCBA) with breathing gases of high purity.

(1) The employer shall ensure that compressed air, compressed oxygen, liquid air, and liquid oxygen used for respiration accords with the following specifications:

(i) Compressed and liquid oxygen shall meet the United States Pharmacopoeia requirements for medical or breathing oxygen; and

(ii) Compressed breathing air shall meet at least the requirements for Grade D breathing air described in ANSI Compressed Gas Association Commodity Specification for Air, G-7.1-1989, to include:

[1910.134(i)(1)(ii) corrected at 63 FR 20098, April 23, 1998]

(A) Oxygen content (vv) of 19.5- 23.5%;

(B) Hydrocarbon (condensed) content of 5 milligrams per cubic meter of air or less;

(C) Carbon monoxide (CO) content of 10 ppm or less;

(D) Carbon dioxide content of 1,000 ppm or less; and

(E) Lack of noticeable odor.

(2) The employer shall ensure that compressed oxygen is not used in atmosphere-supplying respirators that have previously used compressed air.

(3) The employer shall ensure that oxygen concentrations greater than 23.5% are used only in equipment designed for oxygen service or distribution.

(4) The employer shall ensure that cylinders used to supply breathing air to respirators meet the following requirements:

(i) Cylinders are tested and maintained as prescribed in the Shipping Container Specification Regulations of the Department of Transportation (49 CFR part 173 and part 178);

(ii) Cylinders of purchased breathing air have a certificate of analysis from the supplier that the breathing air meets the requirements for Grade D breathing air; and

[1910.134(i)(4)(ii) corrected at 63 FR 20098, April 23, 1998]

(iii) The moisture content in the cylinder does not exceed a dew point of -50° F (-45.6° C) at 1 atmosphere pressure.

(5) The employer shall ensure that compressors used to supply breathing air to respirators are constructed and situated so as to:

(i) Prevent entry of contaminated air into the air-supply system;

(ii) Minimize moisture content so that the dew point at 1 atmosphere pressure is 10 degrees F (5.56° C) below the ambient temperature;

(iii) Have suitable in-line air-purifying sorbent beds and filters to further ensure breathing air quality. Sorbent beds and filters shall be maintained and replaced or refurbished periodically following the manufacturer's instructions.

(iv) Have a tag containing the most recent change date and the signature of the person authorized by the employer to perform the change. The tag shall be maintained at the compressor.

(6) For compressors that are not oil-lubricated, the employer shall ensure that carbon monoxide levels in the breathing air do not exceed 10 ppm.

(7) For oil-lubricated compressors, the employer shall use a high-temperature or carbon monoxide alarm, or both, to monitor carbon monoxide levels. If only high-temperature alarms are used, the air supply shall be monitored at intervals sufficient to prevent carbon monoxide in the breathing air from exceeding 10 ppm.

(8) The employer shall ensure that breathing air couplings are incompatible with outlets for nonrespirable worksite air or other gas systems. No asphyxiating substance shall be introduced into breathing air lines.

(9) The employer shall use breathing gas containers marked in accordance with the NIOSH respirator certification standard, 42 CFR part 84.

(j) *Identification of filters, cartridges, and canisters.* The employer shall ensure that all filters, cartridges and canisters used in the workplace are labeled and color coded with the NIOSH approval label and that the label is not removed and remains legible.

(k) *Training and information.* This paragraph requires the employer to provide effective training to employees who are required to use respirators. The training must be comprehensive, understandable, and recur annually, and more often if necessary. This paragraph also requires the employer to provide the basic information on respirators in Appendix D of this section to employees who wear respirators when not required by this section or by the employer to do so.

(1) The employer shall ensure that each employee can demonstrate knowledge of at least the following:

(i) Why the respirator is necessary and how improper fit, usage, or maintenance can compromise the protective effect of the respirator;

(ii) What the limitations and capabilities of the respirator are;

(iii) How to use the respirator effectively in emergency situations, including situations in which the respirator malfunctions;

(iv) How to inspect, put on and remove, use, and check the seals of the respirator;

(v) What the procedures are for maintenance and storage of the respirator;

(vi) How to recognize medical signs and symptoms that may limit or prevent the effective use of respirators; and

(vii) The general requirements of this section.

(2) The training shall be conducted in a manner that is understandable to the employee.

(3) The employer shall provide the training prior to requiring the employee to use a respirator in the workplace.

(4) An employer who is able to demonstrate that a new employee has received training within the last 12 months that addresses the elements specified in paragraph (k)(1)(i) through (vii)is not required to repeat such training provided that, as required by paragraph (k)(1), the employee can demonstrate knowledge of those element(s). Previous training not repeated initially by the employer must be provided no later than 12 months from the date of the previous training.

(5) Retraining shall be administered annually, and when the following situations occur:

(i) Changes in the workplace or the type of respirator render previous training obsolete;

(ii) Inadequacies in the employee's knowledge or use of the respirator indicate that the employee has not retained the requisite understanding or skill; or

(iii) Any other situation arises in which retraining appears necessary to ensure safe respirator use.

(6) The basic advisory information on respirators, as presented in Appendix D of this section, shall be provided by the employer in any written or oral format, to employees who wear respirators when such use is not required by this section or by the employer.

(l) *Program evaluation.* This section requires the employer to conduct evaluations of the workplace to ensure that the written respiratory protection program is being properly implemented, and to consult employees to ensure that they are using the respirators properly.

(1) The employer shall conduct evaluations of the workplace as necessary to ensure that the provisions of the current written program are being effectively implemented and that it continues to be effective.

(2) The employer shall regularly consult employees required to use respirators to assess the employees' views on program effectiveness and to identify any problems. Any problems that are identified during this assessment shall be corrected. Factors to be assessed include, but are not limited to:

(i) Respirator fit (including the ability to use the respirator without interfering with effective workplace performance);

(ii) Appropriate respirator selection for the hazards to which the employee is exposed;

(iii) Proper respirator use under the workplace conditions the employee encounters; and

(iv) Proper respirator maintenance.

(m) *Recordkeeping.* This section requires the employer to establish and retain written information regarding medical evaluations, fit testing, and the respirator program. This information will facilitate employee involvement in the respirator program, assist the employer in auditing the adequacy of the program, and provide a record for compliance determinations by OSHA.

(1) *Medical evaluation.* Records of medical evaluations required by this section must be retained and made available in accordance with 29 CFR 1910.1020.

(2) *Fit testing.*

(i) The employer shall establish a record of the qualitative and quantitative fit tests administered to an employee including:

(A) The name or identification of the employee tested;

(B) Type of fit test performed;

(C) Specific make, model, style, and size of respirator tested;

(D) Date of test; and

(E) The pass/fail results for QLFTs or the fit factor and strip chart recording or other recording of the test results for QNFTs.

(ii) Fit test records shall be retained for respirator users until the next fit test is administered.

(3) A written copy of the current respirator program shall be retained by the employer.

(4) Written materials required to be retained under this paragraph shall be made available upon request to affected employees and to the Assistant Secretary or designee for examination and copying.

(n) *Dates.*

(1) *Effective date.* This section is effective April 8, 1998. The obligations imposed by this section commence on the effective date unless otherwise noted in this paragraph. Compliance with

obligations that do not commence on the effective date shall occur no later than the applicable start-up date.

(2) *Compliance dates.* All obligations of this section commence on the effective date except as follows:

(i) The determination that respirator use is required (paragraph (a)) shall be completed no later than September 8, 1998.

(ii) Compliance with provisions of this section for all other provisions shall be completed no later than October 5, 1998.

(3) The provisions of 29 CFR 1910.134 and 29 CFR 1926.103, contained in the 29 CFR parts 1900 to 1910.99 and the 29 CFR part 1926 editions, revised as of July 1, 1997, are in effect and enforceable until October 5, 1998, or during any administrative or judicial stay of the provisions of this section.

[1910.134(n)(3) corrected at 63 FR 20098, April 23, 1998]

(4) *Existing Respiratory Protection Programs.* If, in the 12 month period preceding April 8, 1998, the employer has conducted annual respirator training, fit testing, respirator program evaluation, or medical evaluations, the employer may use the results of those activities to comply with the corresponding provisions of this section, providing that these activities were conducted in a manner that meets the requirements of this section.

(o) *Appendices.*

(1) Compliance with Appendix A, Appendix B-1, Appendix B-2, and Appendix C of this section is mandatory.

(2) Appendix D of this section is non-mandatory and is not intended to create any additional obligations not otherwise imposed or to detract from any existing obligations.

APPENDIX C - OSHA FIT TESTING PROCEDURES

APPENDIX A TO §1910.134: FIT TESTING PROCEDURES (Mandatory)

Part I. OSHA-Accepted Fit Test Protocols

A. Fit Testing Procedures – General Requirements

The employer shall conduct fit testing using the following procedures. The requirements in this appendix apply to all OSHA-accepted fit test methods, both QLFT and QNFT.

1. The test subject shall be allowed to pick the most acceptable respirator from a sufficient number of respirator models and sizes so that the respirator is acceptable to, and correctly fits, the user.

2. Prior to the selection process, the test subject shall be shown how to put on a respirator, how it should be positioned on the face, how to set strap tension and how to determine an acceptable fit. A mirror shall be available to assist the subject in evaluating the fit and positioning of the respirator. This instruction may not constitute the subject's formal training on respirator use, because it is only a review.

3. The test subject shall be informed that he/she is being asked to select the respirator that provides the most acceptable fit. Each respirator represents a different size and shape, and if fitted and used properly, will provide adequate protection.

4. The test subject shall be instructed to hold each chosen facepiece up to the face and eliminate those that obviously do not give an acceptable fit.

5. The more acceptable facepieces are noted in case the one selected proves unacceptable; the most comfortable mask is donned and worn at least five minutes to assess comfort. Assistance in assessing comfort can be given by discussing the points in the following item A.6. If the test subject is not familiar with using a particular respirator, the test subject shall be directed to don the mask several times and to adjust the straps each time to become adept at setting proper tension on the straps.

6. Assessment of comfort shall include a review of the following points with the test subject and allowing the test subject adequate time to determine the comfort of the respirator:

(a) Position of the mask on the nose

(b) Room for eye protection

(c) Room to talk

(d) Position of mask on face and cheeks

7. The following criteria shall be used to help determine the adequacy of the respirator fit:

(a) Chin properly placed;

(b) Adequate strap tension, not overly tightened;

(c) Fit across nose bridge;

(d) Respirator of proper size to span distance from nose to chin;

(e) Tendency of respirator to slip;

(f) Self-observation in mirror to evaluate fit and respirator position.

8. The test subject shall conduct a user seal check, either the negative and positive pressure seal checks described in Appendix B-1 of this section or those recommended by the respirator manufacturer which provide equivalent protection to the procedures in Appendix B-1. Before conducting the negative and positive pressure checks, the subject shall be told to seat the mask on the face by moving the head from side-to-side and up and down slowly while taking in a few slow deep breaths. Another facepiece shall be selected and retested if the test subject fails the user seal check tests.

9. The test shall not be conducted if there is any hair growth between the skin and the facepiece sealing surface, such as stubble beard growth, beard, mustache or sideburns which cross the respirator sealing surface. Any type of apparel which interferes with a satisfactory fit shall be altered or removed.

10. If a test subject exhibits difficulty in breathing during the tests, she or he shall be referred to a physician or other licensed health care professional, as appropriate, to determine whether the test subject can wear a respirator while performing her or his duties.

11. If the employee finds the fit of the respirator unacceptable, the test subject shall be given the opportunity to select a different respirator and to be retested.

12. Exercise regimen. Prior to the commencement of the fit test, the test subject shall be given a description of the fit test and the test subject's responsibilities during the test procedure. The description of the process shall include a description of the test exercises that the subject will be performing. The respirator to be tested shall be worn for at least 5 minutes before the start of the fit test.

13. The fit test shall be performed while the test subject is wearing any applicable safety equipment that may be worn during actual respirator use which could interfere with respirator fit.

14. Test Exercises.

(a) The following test exercises are to be performed for all fit testing methods prescribed in this appendix, except for the CNP method. A separate fit testing exercise regimen is contained in the CNP protocol. The test subject shall perform exercises, in the test environment, in the following manner:

(1) Normal breathing. In a normal standing position, without talking, the subject shall breathe normally.

(2) Deep breathing. In a normal standing position, the subject shall breathe slowly and deeply, taking caution so as not to hyperventilate.

(3) Turning head side to side. Standing in place, the subject shall slowly turn his/her head from side to side between the extreme positions on each side. The head shall be held at each extreme momentarily so the subject can inhale at each side.

(4) Moving head up and down. Standing in place, the subject shall slowly move his/her head up and down. The subject shall be instructed to inhale in the up position (i.e., when looking toward the ceiling).

(5) Talking. The subject shall talk out loud slowly and loud enough so as to be heard clearly by the test conductor. The subject can read from a prepared text such as the Rainbow Passage, count backward from 100, or recite a memorized poem or song.

Rainbow Passage

When the sunlight strikes raindrops in the air, they act like a prism and form a rainbow. The rainbow is a division of white light into many beautiful colors. These take the shape of a long round arch, with its path high above, and its two ends apparently beyond the horizon. There is, according to legend, a boiling pot of gold at one end. People look, but no one ever finds it. When a man looks for something beyond reach, his friends say he is looking for the pot of gold at the end of the rainbow.

(6) Grimace. The test subject shall grimace by smiling or frowning. (This applies only to QNFT testing; it is not performed for QLFT)

(7) Bending over. The test subject shall bend at the waist as if he/she were to touch his/her toes. Jogging in place shall be substituted for this exercise in those test environments such as shroud type QNFT or QLFT units that do not permit bending over at the waist.

(8) Normal breathing. Same as exercise (1).

(b) Each test exercise shall be performed for one minute except for the grimace exercise which shall be performed for 15 seconds. The test subject shall be questioned by the test conductor regarding the comfort of the respirator upon completion of the protocol. If it has become unacceptable, another model of respirator shall be tried. The respirator shall not be adjusted once the fit test exercises begin. Any adjustment voids the test, and the fit test must be repeated.

B. Qualitative Fit Test (QLFT) Protocols

1. General

(a) The employer shall ensure that persons administering QLFT are able to prepare test solutions, calibrate equipment and perform tests properly, recognize invalid tests, and ensure that test equipment is in proper working order.

(b) The employer shall ensure that QLFT equipment is kept clean and well maintained so as to operate within the parameters for which it was designed.

2. Isoamyl Acetate Protocol

Note: This protocol is not appropriate to use for the fit testing of particulate respirators. If used to fit test particulate respirators, the respirator must be equipped with an organic vapor filter.

(a) Odor Threshold Screening

Odor threshold screening, performed without wearing a respirator, is intended to determine if the individual tested can detect the odor of isoamyl acetate at low levels.

(1) Three 1 liter glass jars with metal lids are required.

(2) Odor-free water (e.g., distilled or spring water) at approximately 25° C (77° F) shall be used for the solutions.

(3) The isoamyl acetate (IAA) (also known at isopentyl acetate) stock solution is prepared by adding 1 ml of pure IAA to 800 ml of odor-free water in a 1 liter jar, closing the lid and shaking for 30 seconds. A new solution shall be prepared at least weekly.

(4) The screening test shall be conducted in a room separate from the room used for actual fit testing. The two rooms shall be well-ventilated to prevent the odor of IAA from becoming evident in the general room air where testing takes place.

(5) The odor test solution is prepared in a second jar by placing 0.4 ml of the stock solution into 500 ml of odor-free water using a clean dropper or pipette. The solution shall be shaken for 30 seconds and allowed to stand for two to three minutes so that the IAA concentration above the liquid may reach equilibrium. This solution shall be used for only one day.

(6) A test blank shall be prepared in a third jar by adding 500 cc of odor-free water.

(7) The odor test and test blank jar lids shall be labeled (e.g., 1 and 2) for jar identification. Labels shall be placed on the lids so that they can be peeled off periodically and switched to maintain the integrity of the test.

(8) The following instruction shall be typed on a card and placed on the table in front of the two test jars (i.e., 1 and 2): "The purpose of this test is to determine if you can smell banana oil at a low concentration. The two bottles in front of you contain water. One of these bottles also contains a small amount of banana oil. Be sure the covers are on tight, then shake each bottle for two seconds. Unscrew the lid of each bottle, one at a time, and sniff at the mouth of the bottle. Indicate to the test conductor which bottle contains banana oil."

(9) The mixtures used in the IAA odor detection test shall be prepared in an area separate from where the test is performed, in order to prevent olfactory fatigue in the subject.

(10) If the test subject is unable to correctly identify the jar containing the odor test solution, the IAA qualitative fit test shall not be performed.

(11) If the test subject correctly identifies the jar containing the odor test solution, the test subject may proceed to respirator selection and fit testing.

(b) Isoamyl Acetate Fit Test

(1) The fit test chamber shall be a clear 55-gallon drum liner suspended inverted over a 2-foot diameter frame so that the top of the chamber is about 6 inches above the test subject's head. If no drum liner is available, a similar chamber shall be constructed using plastic sheeting. The inside top center of the chamber shall have a small hook attached.

(2) Each respirator used for the fitting and fit testing shall be equipped with organic vapor cartridges or offer protection against organic vapors.

(3) After selecting, donning, and properly adjusting a respirator, the test subject shall wear it to the fit testing room. This room shall be separate from the room used for odor threshold screening and respirator selection, and shall be well-ventilated, as by an exhaust fan or lab hood, to prevent general room contamination.

(4) A copy of the test exercises and any prepared text from which the subject is to read shall be taped to the inside of the test chamber.

(5) Upon entering the test chamber, the test subject shall be given a 6-inch by 5-inch piece of paper towel, or other porous, absorbent, single-ply material, folded in half and wetted with 0.75 ml of pure IAA. The test subject shall hang the wet towel on the hook at the top of the chamber. An IAA test swab or ampule may be substituted for the IAA wetted paper towel provided it has been demonstrated that the alternative IAA source will generate an IAA test atmosphere with a concentration equivalent to that generated by the paper towel method.

(6) Allow two minutes for the IAA test concentration to stabilize before starting the fit test exercises. This would be an appropriate time to talk with the test subject; to explain the fit test, the importance of his/her cooperation, and the purpose for the test exercises; or to demonstrate some of the exercises.

(7) If at any time during the test, the subject detects the banana-like odor of IAA, the test is failed. The subject shall quickly exit from the test chamber and leave the test area to avoid olfactory fatigue.

(8) If the test is failed, the subject shall return to the selection room and remove the respirator. The test subject shall repeat the odor sensitivity test, select and put on another respirator, return to the test area and again begin the fit test procedure described in (b) (1) through (7) above. The process continues until a respirator that fits well has been found. Should the odor sensitivity test be failed, the subject shall wait at least 5 minutes before retesting. Odor sensitivity will usually have returned by this time.

(9) If the subject passes the test, the efficiency of the test procedure shall be demonstrated by having the subject break the respirator face seal and take a breath before exiting the chamber.

(10) When the test subject leaves the chamber, the subject shall remove the saturated towel and return it to the person conducting the test, so that there is no significant IAA concentration buildup in the chamber during subsequent tests. The used towels shall be kept in a self-sealing plastic bag to keep the test area from being contaminated.

3. Saccharin Solution Aerosol Protocol

The entire screening and testing procedure shall be explained to the test subject prior to the conduct of the screening test.

(a) Taste threshold screening. The saccharin taste threshold screening, intended to determine whether the individual being tested can detect the taste of saccharin.

(1) During threshold screening as well as during fit testing, subjects shall wear an enclosure about the head and shoulders that is approximately 12 inches in diameter by 14 inches tall with at least the front portion clear and that allows free movements of the head when a respirator is worn. An enclosure substantially similar to the 3M hood assembly, parts # FT 14 and # FT 15 combined, is adequate.

(2) The test enclosure shall have a ¾ -inch (1.9 cm) hole in front of the test subject's nose and mouth area to accommodate the nebulizer nozzle.

(3) The test subject shall don the test enclosure. Throughout the threshold screening test, the test subject shall breathe through his/her slightly open mouth with tongue extended. The subject is instructed to report when he/she detects a sweet taste.

(4) Using a DeVilbiss Model 40 Inhalation Medication Nebulizer or equivalent, the test conductor shall spray the threshold check solution into the enclosure. The nozzle is directed away from the nose and mouth of the person. This nebulizer shall be clearly marked to distinguish it from the fit test solution nebulizer.

(5) The threshold check solution is prepared by dissolving 0.83 gram of sodium saccharin USP in 100 ml of warm water. It can be prepared by putting 1 ml of the fit test solution (see (b)(5) below) in 100 ml of distilled water.

(6) To produce the aerosol, the nebulizer bulb is firmly squeezed so that it collapses completely, then released and allowed to fully expand.

(7) Ten squeezes are repeated rapidly and then the test subject is asked whether the saccharin can be tasted. If the test subject reports tasting the sweet taste during the ten squeezes, the screening test is completed. The taste threshold is noted as ten regardless of the number of squeezes actually completed.

(8) If the first response is negative, ten more squeezes are repeated rapidly and the test subject is again asked whether the saccharin is tasted. If the test subject reports tasting the sweet taste during the second ten squeezes, the screening test is completed. The taste threshold is noted as twenty regardless of the number of squeezes actually completed.

(9) If the second response is negative, ten more squeezes are repeated rapidly and the test subject is again asked whether the saccharin is tasted. If the test subject reports tasting the sweet taste during the third set of ten squeezes, the screening test is completed. The taste threshold is noted as thirty regardless of the number of squeezes actually completed.

(10) The test conductor will take note of the number of squeezes required to solicit a taste response.

(11) If the saccharin is not tasted after 30 squeezes (step 10), the test subject is unable to taste saccharin and may not perform the saccharin fit test.

Note to paragraph 3. (a): If the test subject eats or drinks something sweet before the screening test, he/she may be unable to taste the weak saccharin solution.

(12) If a taste response is elicited, the test subject shall be asked to take note of the taste for reference in the fit test.

(13) Correct use of the nebulizer means that approximately 1 ml of liquid is used at a time in the nebulizer body.

(14) The nebulizer shall be thoroughly rinsed in water, shaken dry, and refilled at least each morning and afternoon or at least every four hours.

(b) Saccharin solution aerosol fit test procedure.

(1) The test subject may not eat, drink (except plain water), smoke, or chew gum for 15 minutes before the test.

(2) The fit test uses the same enclosure described in 3. (a) above.

(3) The test subject shall don the enclosure while wearing the respirator selected in section I. A. of this appendix. The respirator shall be properly adjusted and equipped with a particulate filter(s).

(4) A second DeVilbiss Model 40 Inhalation Medication Nebulizer or equivalent is used to spray the fit test solution into the enclosure. This nebulizer shall be clearly marked to distinguish it from the screening test solution nebulizer.

(5) The fit test solution is prepared by adding 83 grams of sodium saccharin to 100 ml of warm water.

(6) As before, the test subject shall breathe through the slightly open mouth with tongue extended, and report if he/she tastes the sweet taste of saccharin.

(7) The nebulizer is inserted into the hole in the front of the enclosure and an initial concentration of saccharin fit test solution is sprayed into the enclosure using the same number of squeezes (either 10, 20 or 30 squeezes) based on the number of squeezes required to elicit a taste response as noted during the screening test. A minimum of 10 squeezes is required.

(8) After generating the aerosol, the test subject shall be instructed to perform the exercises in section I. A. 14. of this appendix.

(9) Every 30 seconds the aerosol concentration shall be replenished using one half the original number of squeezes used initially (e.g., 5, 10 or 15).

(10) The test subject shall indicate to the test conductor if at any time during the fit test the taste of saccharin is detected. If the test subject does not report tasting the saccharin, the test is passed.

(11) If the taste of saccharin is detected, the fit is deemed unsatisfactory and the test is failed. A different respirator shall be tried and the entire test procedure is repeated (taste threshold screening and fit testing).

(12) Since the nebulizer has a tendency to clog during use, the test operator must make periodic checks of the nebulizer to ensure that it is not clogged. If clogging is found at the end of the test session, the test is invalid.

4. Bitrex™ (Denatonium Benzoate) Solution Aerosol Qualitative Fit Test Protocol

The Bitrex™ (Denatonium benzoate) solution aerosol QLFT protocol uses the published saccharin test protocol because that protocol is widely accepted. Bitrex is routinely used as a taste aversion agent in household liquids which children should not be drinking and is endorsed by the American Medical Association, the National Safety Council, and the American Association of Poison Control Centers. The entire screening and testing procedure shall be explained to the test subject prior to the conduct of the screening test.

(a) Taste Threshold Screening.

The Bitrex taste threshold screening, performed without wearing a respirator, is intended to determine whether the individual being tested can detect the taste of Bitrex.

(1) During threshold screening as well as during fit testing, subjects shall wear an enclosure about the head and shoulders that is approximately 12 inches (30.5 cm) in diameter by 14 inches (35.6 cm) tall. The front portion of the enclosure shall be clear from the respirator and allow free movement of the head when a respirator is worn. An enclosure substantially similar to the 3M hood assembly, parts # FT 14 and # FT 15 combined, is adequate.

[Corrected at 63 FR 20098, April 23, 1998]

(2) The test enclosure shall have a ¾ inch (1.9 cm) hole in front of the test subject's nose and mouth area to accommodate the nebulizer nozzle.

(3) The test subject shall don the test enclosure. Throughout the threshold screening test, the test subject shall breathe through his or her slightly open mouth with tongue extended. The subject is instructed to report when he/she detects a bitter taste.

(4) Using a DeVilbiss Model 40 Inhalation Medication Nebulizer or equivalent, the test conductor shall spray the Threshold Check Solution into the enclosure. This Nebulizer shall be clearly marked to distinguish it from the fit test solution nebulizer.

(5) The Threshold Check Solution is prepared by adding 13.5 milligrams of Bitrex to 100 ml of 5% salt (NaCl) solution in distilled water.

(6) To produce the aerosol, the nebulizer bulb is firmly squeezed so that the bulb collapses completely, and is then released and allowed to fully expand.

(7) An initial ten squeezes are repeated rapidly and then the test subject is asked whether the Bitrex can be tasted. If the test subject reports tasting the bitter taste during the ten squeezes, the screening test is completed. The taste threshold is noted as ten regardless of the number of squeezes actually completed.

(8) If the first response is negative, ten more squeezes are repeated rapidly and the test subject is again asked whether the Bitrex is tasted. If the test subject reports tasting the bitter taste during the second ten squeezes, the screening test is completed. The taste threshold is noted as twenty regardless of the number of squeezes actually completed.

(9) If the second response is negative, ten more squeezes are repeated rapidly and the test subject is again asked whether the Bitrex is tasted. If the test subject reports tasting the bitter taste during the third set of ten squeezes, the screening test is completed. The taste threshold is noted as thirty regardless of the number of squeezes actually completed.

(10) The test conductor will take note of the number of squeezes required to solicit a taste response.

(11) If the Bitrex is not tasted after 30 squeezes (step 10), the test subject is unable to taste Bitrex and may not perform the Bitrex fit test.

(12) If a taste response is elicited, the test subject shall be asked to take note of the taste for reference in the fit test.

(13) Correct use of the nebulizer means that approximately 1 ml of liquid is used at a time in the nebulizer body.

(14) The nebulizer shall be thoroughly rinsed in water, shaken to dry, and refilled at least each morning and afternoon or at least every four hours.

(b) Bitrex Solution Aerosol Fit Test Procedure.

(1) The test subject may not eat, drink (except plain water), smoke, or chew gum for 15 minutes before the test.

(2) The fit test uses the same enclosure as that described in 4. (a) above.

(3) The test subject shall don the enclosure while wearing the respirator selected according to section I. A. of this appendix. The respirator shall be properly adjusted and equipped with any type particulate filter(s).

(4) A second DeVilbiss Model 40 Inhalation Medication Nebulizer or equivalent is used to spray the fit test solution into the enclosure. This nebulizer shall be clearly marked to distinguish it from the screening test solution nebulizer.

(5) The fit test solution is prepared by adding 337.5 mg of Bitrex to 200 ml of a 5% salt (NaCl) solution in warm water.

(6) As before, the test subject shall breathe through his or her slightly open mouth with tongue extended, and be instructed to report if he/she tastes the bitter taste of Bitrex.

(7) The nebulizer is inserted into the hole in the front of the enclosure and an initial concentration of the fit test solution is sprayed into the enclosure using the same number of squeezes (either 10, 20 or 30 squeezes) based on the number of squeezes required to elicit a taste response as noted during the screening test.

(8) After generating the aerosol, the test subject shall be instructed to perform the exercises in section I. A. 14. of this appendix.

(9) Every 30 seconds the aerosol concentration shall be replenished using one half the number of squeezes used initially (e.g., 5, 10 or 15).

(10) The test subject shall indicate to the test conductor if at any time during the fit test the taste of Bitrex is detected. If the test subject does not report tasting the Bitrex, the test is passed.

(11) If the taste of Bitrex is detected, the fit is deemed unsatisfactory and the test is failed. A different respirator shall be tried and the entire test procedure is repeated (taste threshold screening and fit testing).

5. Irritant Smoke (Stannic Chloride) Protocol

This qualitative fit test uses a person's response to the irritating chemicals released in the "smoke" produced by a stannic chloride ventilation smoke tube to detect leakage into the respirator.

(a) General Requirements and Precautions

(1) The respirator to be tested shall be equipped with high efficiency particulate air (HEPA) or P100 series filter(s).

(2) Only stannic chloride smoke tubes shall be used for this protocol.

(3) No form of test enclosure or hood for the test subject shall be used.

(4) The smoke can be irritating to the eyes, lungs, and nasal passages. The test conductor shall take precautions to minimize the test subject's exposure to irritant smoke. Sensitivity varies, and certain individuals may respond to a greater degree to irritant smoke. Care shall be taken when performing the sensitivity screening checks that determine whether the test subject can detect irritant smoke to use only the minimum amount of smoke necessary to elicit a response from the test subject.

(5) The fit test shall be performed in an area with adequate ventilation to prevent exposure of the person conducting the fit test or the build-up of irritant smoke in the general atmosphere.

(b) Sensitivity Screening Check

The person to be tested must demonstrate his or her ability to detect a weak concentration of the irritant smoke.

(1) The test operator shall break both ends of a ventilation smoke tube containing stannic chloride, and attach one end of the smoke tube to a low flow air pump set to deliver 200 milliliters per minute, or an aspirator squeeze bulb. The test operator shall cover the other end of the smoke tube with a short piece of tubing to prevent potential injury from the jagged end of the smoke tube.

(2) The test operator shall advise the test subject that the smoke can be irritating to the eyes, lungs, and nasal passages and instruct the subject to keep his/her eyes closed while the test is performed.

(3) The test subject shall be allowed to smell a weak concentration of the irritant smoke before the respirator is donned to become familiar with its irritating properties and to determine if he/she can detect the irritating properties of the smoke. The test operator shall carefully direct a small amount of the irritant smoke in the test subject's direction to determine that he/she can detect it.

(c) Irritant Smoke Fit Test Procedure

(1) The person being fit tested shall don the respirator without assistance, and perform the required user seal check(s).

(2) The test subject shall be instructed to keep his/her eyes closed.

(3) The test operator shall direct the stream of irritant smoke from the smoke tube toward the faceseal area of the test subject, using the low flow pump or the squeeze bulb. The test operator shall begin at least 12 inches from the facepiece and move the smoke stream around the whole perimeter of the mask. The operator shall gradually make two more passes around the perimeter of the mask, moving to within six inches of the respirator.

(4) If the person being tested has not had an involuntary response and/or detected the irritant smoke, proceed with the test exercises.

(5) The exercises identified in section I.A. 14. of this appendix shall be performed by the test subject while the respirator seal is being continually challenged by the smoke, directed around the perimeter of the respirator at a distance of six inches.

(6) If the person being fit tested reports detecting the irritant smoke at any time, the test is failed. The person being retested must repeat the entire sensitivity check and fit test procedure.

(7) Each test subject passing the irritant smoke test without evidence of a response (involuntary cough, irritation) shall be given a second sensitivity screening check, with the smoke from the same smoke tube used during the fit test, once the respirator has been removed, to determine whether he/she still reacts to the smoke. Failure to evoke a response shall void the fit test.

(8) If a response is produced during this second sensitivity check, then the fit test is passed.

C. Quantitative Fit Test (QNFT) Protocols

The following quantitative fit testing procedures have been demonstrated to be acceptable: Quantitative fit testing using a non-hazardous test aerosol (such as corn oil, polyethylene glycol 400 [PEG 400], di-2-ethyl hexyl sebacate [DEHS], or sodium chloride) generated in a test chamber, and employing instrumentation to quantify the fit of the respirator; Quantitative fit testing using ambient aerosol as the test agent and appropriate instrumentation (condensation nuclei counter) to quantify the respirator fit; Quantitative fit testing using controlled negative pressure and appropriate instrumentation to measure the volumetric leak rate of a facepiece to quantify the respirator fit.

1. General

(a) The employer shall ensure that persons administering QNFT are able to calibrate equipment and perform tests properly, recognize invalid tests, calculate fit factors properly and ensure that test equipment is in proper working order.

(b) The employer shall ensure that QNFT equipment is kept clean, and is maintained and calibrated according to the manufacturer's instructions so as to operate at the parameters for which it was designed.

2. Generated Aerosol Quantitative Fit Testing Protocol

(a) Apparatus.

(1) Instrumentation. Aerosol generation, dilution, and measurement systems using particulates (corn oil, polyethylene glycol 400 [PEG 400], di-2-ethyl hexyl sebacate [DEHS] or sodium chloride) as test aerosols shall be used for quantitative fit testing.

(2) Test chamber. The test chamber shall be large enough to permit all test subjects to perform freely all required exercises without disturbing the test agent concentration or the measurement apparatus. The test chamber shall be equipped and constructed so that the test agent is effectively isolated from the ambient air, yet uniform in concentration throughout the chamber.

(3) When testing air-purifying respirators, the normal filter or cartridge element shall be replaced with a high efficiency particulate air (HEPA) or P100 series filter supplied by the same manufacturer.

(4) The sampling instrument shall be selected so that a computer record or strip chart record may be made of the test showing the rise and fall of the test agent concentration with each inspiration and expiration at fit factors of at least 2,000. Integrators or computers that integrate the amount of test agent penetration leakage into the respirator for each exercise may be used provided a record of the readings is made.

(5) The combination of substitute air-purifying elements, test agent and test agent concentration shall be such that the test subject is not exposed in excess of an established exposure limit for the test agent at any time during the testing process, based upon the length of the exposure and the exposure limit duration.

(6) The sampling port on the test specimen respirator shall be placed and constructed so that no leakage occurs around the port (e.g., where the respirator is probed), a free air flow is allowed into the sampling line at all times, and there is no interference with the fit or performance of the respirator. The in-mask sampling device (probe) shall be designed and used so that the air sample is drawn from the breathing zone of the test subject, midway between the nose and mouth and with the probe extending into the facepiece cavity at least 14 inch.

(7) The test setup shall permit the person administering the test to observe the test subject inside the chamber during the test.

(8) The equipment generating the test atmosphere shall maintain the concentration of test agent constant to within a 10 percent variation for the duration of the test.

(9) The time lag (interval between an event and the recording of the event on the strip chart or computer or integrator) shall be kept to a minimum. There shall be a clear association between the occurrence of an event and its being recorded.

(10) The sampling line tubing for the test chamber atmosphere and for the respirator sampling port shall be of equal diameter and of the same material. The length of the two lines shall be equal.

(11) The exhaust flow from the test chamber shall pass through an appropriate filter (i.e., high efficiency particulate filter) before release.

[Corrected at 63 FR 20099, April 23, 1998]

(12) When sodium chloride aerosol is used, the relative humidity inside the test chamber shall not exceed 50 percent.

(13) The limitations of instrument detection shall be taken into account when determining the fit factor.

(14) Test respirators shall be maintained in proper working order and be inspected regularly for deficiencies such as cracks or missing valves and gaskets.

(b) Procedural Requirements.

(1) When performing the initial user seal check using a positive or negative pressure check, the sampling line shall be crimped closed in order to avoid air pressure leakage during either of these pressure checks.

(2) The use of an abbreviated screening QLFT test is optional. Such a test may be utilized in order to quickly identify poor fitting respirators that passed the positive and/or negative pressure test and reduce the amount of QNFT time. The use of the CNC QNFT instrument in the count mode is another optional method to obtain a quick estimate of fit and eliminate poor fitting respirators before going on to perform a full QNFT.

(3) A reasonably stable test agent concentration shall be measured in the test chamber prior to testing. For canopy or shower curtain types of test units, the determination of the test agent's stability may be established after the test subject has entered the test environment.

(4) Immediately after the subject enters the test chamber, the test agent concentration inside the respirator shall be measured to ensure that the peak penetration does not exceed 5 percent for a half mask or 1 percent for a full facepiece respirator.

(5) A stable test agent concentration shall be obtained prior to the actual start of testing.

(6) Respirator restraining straps shall not be over-tightened for testing. The straps shall be adjusted by the wearer without assistance from other persons to give a reasonably comfortable fit typical of normal use. The respirator shall not be adjusted once the fit test exercises begin.

(7) The test shall be terminated whenever any single peak penetration exceeds 5 percent for half masks and 1 percent for full facepiece respirators. The test subject shall be refitted and retested.

(8) Calculation of fit factors.

(i) The fit factor shall be determined for the quantitative fit test by taking the ratio of the average chamber concentration to the concentration measured inside the respirator for each test exercise except the grimace exercise.

(ii) The average test chamber concentration shall be calculated as the arithmetic average of the concentration measured before and after each test (i.e., 7 exercises) or the arithmetic average of the concentration measured before and after each exercise or the true average measured continuously during the respirator sample.

(iii) The concentration of the challenge agent inside the respirator shall be determined by one of the following methods:

(A) Average peak penetration method means the method of determining test agent penetration into the respirator utilizing a strip chart recorder, integrator, or computer. The agent penetration is determined by an average of the peak heights on the graph or by computer integration, for each exercise except the grimace exercise. Integrators or computers that calculate the actual test agent penetration into the respirator for each exercise will also be considered to meet the requirements of the average peak penetration method.

(B) Maximum peak penetration method means the method of determining test agent penetration in the respirator as determined by strip chart recordings of the test. The highest peak penetration for a given exercise is taken to be representative of average penetration into the respirator for that exercise.

(C) Integration by calculation of the area under the individual peak for each exercise except the grimace exercise. This includes computerized integration.

(D) The calculation of the overall fit factor using individual exercise fit factors involves first converting the exercise fit factors to penetration values, determining the average, and then converting that result back to a fit factor. This procedure is described in the following equation:

Overall Fit Factor = (Number of exercises)/$(1/ff_1+1/ff_2+1/ff_3+1/ff_4+...1/ff_n)$

Where ff_1 , ff_2 , ff_3 , etc. are the fit factors for exercises 1, 2, 3, etc.

(9) The test subject shall not be permitted to wear a half mask or quarter facepiece respirator unless a minimum fit factor of 100 is obtained, or a full facepiece respirator unless a minimum fit factor of 500 is obtained.

(10) Filters used for quantitative fit testing shall be replaced whenever increased breathing resistance is encountered, or when the test agent has altered the integrity of the filter media.

3. Ambient aerosol condensation nuclei counter (CNC) quantitative fit testing protocol.

The ambient aerosol condensation nuclei counter (CNC) quantitative fit testing (Portacount™) protocol quantitatively fit tests respirators with the use of a probe. The probed respirator is only used for quantitative fit tests. A probed respirator has a special sampling device, installed on the respirator, that allows the probe to sample the air from inside the mask. A probed respirator is required for each make, style, model, and size that the employer uses and can be obtained from the respirator manufacturer or distributor. The CNC instrument manufacturer, TSI Inc., also provides probe attachments (TSI sampling adapters) that permit fit testing in an employee's own respirator. A minimum fit factor pass level of at least 100 is necessary for a half-mask respirator and a minimum fit factor pass level of at least 500 is required for a full facepiece negative pressure respirator. The entire screening and testing procedure shall be explained to the test subject prior to the conduct of the screening test.

(a) Portacount Fit Test Requirements.

(1) Check the respirator to make sure the sampling probe and line are properly attached to the facepiece and that the respirator is fitted with a particulate filter capable of preventing significant penetration by the ambient particles used for the fit test (e.g., NIOSH 42 CFR 84 series 100, series 99, or series 95 particulate filter) per manufacturer's instruction.

[Revised at 63 FR 20099, April 23, 1998]

(2) Instruct the person to be tested to don the respirator for five minutes before the fit test starts. This purges the ambient particles trapped inside the respirator and permits the wearer to make certain the respirator is comfortable. This individual shall already have been trained on how to wear the respirator properly.

(3) Check the following conditions for the adequacy of the respirator fit: Chin properly placed; Adequate strap tension, not overly tightened; Fit across nose bridge; Respirator of proper size to span distance from nose to chin; Tendency of the respirator to slip; Self-observation in a mirror to evaluate fit and respirator position.

(4) Have the person wearing the respirator do a user seal check. If leakage is detected, determine the cause. If leakage is from a poorly fitting facepiece, try another size of the same model respirator, or another model of respirator.

(5) Follow the manufacturer's instructions for operating the Portacount and proceed with the test.

(6) The test subject shall be instructed to perform the exercises in section I. A. 14. of this appendix.

(7) After the test exercises, the test subject shall be questioned by the test conductor regarding the comfort of the respirator upon completion of the protocol. If it has become unacceptable, another model of respirator shall be tried.

(b) Portacount Test Instrument.

(1) The Portacount will automatically stop and calculate the overall fit factor for the entire set of exercises. The overall fit factor is what counts. The Pass or Fail message will indicate whether or not the test was successful. If the test was a Pass, the fit test is over.

(2) Since the pass or fail criterion of the Portacount is user programmable, the test operator shall ensure that the pass or fail criterion meet the requirements for minimum respirator performance in this Appendix.

(3) A record of the test needs to be kept on file, assuming the fit test was successful. The record must contain the test subject's name; overall fit factor; make, model, style, and size of respirator used; and date tested.

4. Controlled negative pressure (CNP) quantitative fit testing protocol.

The CNP protocol provides an alternative to aerosol fit test methods. The CNP fit test method technology is based on exhausting air from a temporarily sealed respirator facepiece to generate and then maintain a constant negative pressure inside the facepiece. The rate of air exhaust is controlled so that a constant negative pressure is maintained in the respirator during the fit test. The level of pressure is selected to replicate the mean inspiratory pressure that causes leakage into the respirator under normal use conditions. With pressure held constant, air flow out of the respirator is equal to air flow into the respirator. Therefore, measurement of the exhaust stream that is required to hold the pressure in the temporarily sealed respirator constant yields a direct measure of leakage air flow into the respirator. The CNP fit test method measures leak rates through the facepiece as a method for determining the facepiece fit for negative pressure respirators. The CNP instrument manufacturer Dynatech Nevada also provides attachments (sampling manifolds) that replace the filter cartridges to permit fit testing in an employee's own respirator. To perform the test, the test subject closes his or her mouth and holds his/her breath, after which an air pump removes air from the respirator facepiece at a pre-selected constant pressure. The facepiece fit is expressed as the leak rate through the facepiece, expressed as milliliters per minute. The quality and validity of the CNP fit tests are determined by the degree to which the in-mask pressure tracks the test pressure during the system measurement time of approximately five seconds. Instantaneous feedback in the form of a real-time pressure trace of the in-mask pressure is provided and used to determine test validity and quality. A minimum fit factor pass level of 100 is necessary for a half-mask respirator and a minimum fit factor of at

least 500 is required for a full facepiece respirator. The entire screening and testing procedure shall be explained to the test subject prior to the conduct of the screening test.

(a) CNP Fit Test Requirements.

(1) The instrument shall have a non-adjustable test pressure of 15.0 mm water pressure.

(2) The CNP system defaults selected for test pressure shall be set at -15 mm of water (-0.58 inches of water) and the modeled inspiratory flow rate shall be 53.8 liters per minute for performing fit tests.

[Corrected at 63 FR 20099, April 23, 1998]

(**Note:** CNP systems have built-in capability to conduct fit testing that is specific to unique work rate, mask, and gender situations that might apply in a specific workplace. Use of system default values, which were selected to represent respirator wear with medium cartridge resistance at a low-moderate work rate, will allow inter-test comparison of the respirator fit.)

(3) The individual who conducts the CNP fit testing shall be thoroughly trained to perform the test.

(4) The respirator filter or cartridge needs to be replaced with the CNP test manifold. The inhalation valve downstream from the manifold either needs to be temporarily removed or propped open.

(5) The test subject shall be trained to hold his or her breath for at least 20 seconds.

(6) The test subject shall don the test respirator without any assistance from the individual who conducts the CNP fit test.

(7) The QNFT protocol shall be followed according to section I. C. 1. of this appendix with an exception for the CNP test exercises.

(b) CNP Test Exercises.

(1) Normal breathing. In a normal standing position, without talking, the subject shall breathe normally for 1 minute. After the normal breathing exercise, the subject needs to hold head straight ahead and hold his or her breath for 10 seconds during the test measurement.

(2) Deep breathing. In a normal standing position, the subject shall breathe slowly and deeply for 1 minute, being careful not to hyperventilate. After the deep breathing exercise, the subject shall hold his or her head straight ahead and hold his or her breath for 10 seconds during test measurement.

(3) Turning head side to side. Standing in place, the subject shall slowly turn his or her head from side to side between the extreme positions on each side for 1 minute. The head shall be held at each extreme momentarily so the subject can inhale at each side. After the turning head side to side exercise, the subject needs to hold head full left and hold his or her breath for 10 seconds during test measurement. Next, the subject needs to hold head full right and hold his or her breath for 10 seconds during test measurement.

(4) Moving head up and down. Standing in place, the subject shall slowly move his or her head up and down for 1 minute. The subject shall be instructed to inhale in the up position (i.e., when looking toward the ceiling). After the moving head up and down exercise, the subject shall hold his or her head full up and hold his or her breath for 10 seconds during test measurement. Next, the subject shall hold his or her head full down and hold his or her breath for 10 seconds during test measurement.

(5) Talking. The subject shall talk out loud slowly and loud enough so as to be heard clearly by the test conductor. The subject can read from a prepared text such as the Rainbow Passage, count backward from 100, or recite a memorized poem or song for 1 minute. After the talking exercise, the subject shall hold his or her head straight ahead and hold his or her breath for 10 seconds during the test measurement.

(6) Grimace. The test subject shall grimace by smiling or frowning for 15 seconds.

(7) Bending Over. The test subject shall bend at the waist as if he or she were to touch his or her toes for 1 minute. Jogging in place shall be substituted for this exercise in those test environments such as shroud-type QNFT units that prohibit bending at the waist. After the bending over exercise, the subject shall hold his or her head straight ahead and hold his or her breath for 10 seconds during the test measurement.

(8) Normal Breathing. The test subject shall remove and re-don the respirator within a one-minute period. Then, in a normal standing position, without talking, the subject shall breathe normally for 1 minute. After the normal breathing exercise, the subject shall hold his or her head straight ahead and hold his or her breath for 10 seconds during the test measurement. After the test exercises, the test subject shall be questioned by the test conductor regarding the comfort of the respirator upon completion of the protocol. If it has become unacceptable, another model of a respirator shall be tried.

(c) CNP Test Instrument.

(1) The test instrument shall have an effective audio warning device when the test subject fails to hold his or her breath during the test. The test shall be terminated whenever the test subject failed to hold his or her breath. The test subject may be refitted and retested.

(2) A record of the test shall be kept on file, assuming the fit test was successful. The record must contain the test subject's name; overall fit factor; make, model, style and size of respirator used; and date tested.

Part II. New Fit Test Protocols

A. Any person may submit to OSHA an application for approval of a new fit test protocol. If the application meets the following criteria, OSHA will initiate a rulemaking proceeding under section 6(b)(7) of the OSH Act to determine whether to list the new protocol as an approved protocol in this Appendix A.

B. The application must include a detailed description of the proposed new fit test protocol. This application must be supported by either:

1. A test report prepared by an independent government research laboratory (e.g., Lawrence Livermore National Laboratory, Los Alamos National Laboratory, the National Institute for Standards and Technology) stating that the laboratory has tested the protocol and had found it to be accurate and reliable; or

2. An article that has been published in a peer-reviewed industrial hygiene journal describing the protocol and explaining how test data support the protocol's accuracy and reliability.

C. If OSHA determines that additional information is required before the Agency commences a rulemaking proceeding under this section, OSHA will so notify the applicant and afford the applicant the opportunity to submit the supplemental information. Initiation of a rulemaking proceeding will be deferred until OSHA has received and evaluated the supplemental information.

APPENDIX D – OSHA USER SEAL CHECK PROCEDURES

APPENDIX B-1 TO §1910.134: USER SEAL CHECK PROCEDURES (Mandatory)

The individual who uses a tight-fitting respirator is to perform a user seal check to ensure that an adequate seal is achieved each time the respirator is put on. Either the positive and negative pressure checks listed in this appendix, or the respirator manufacturer's recommended user seal check method shall be used. User seal checks are not substitutes for qualitative or quantitative fit tests.

I. Facepiece Positive and/or Negative Pressure Checks

A. *Positive pressure check.* Close off the exhalation valve and exhale gently into the facepiece. The face fit is considered satisfactory if a slight positive pressure can be built up inside the facepiece without any evidence of outward leakage of air at the seal. For most respirators this method of leak testing requires the wearer to first remove the exhalation valve cover before closing off the exhalation valve and then carefully replacing it after the test.

B. *Negative pressure check.* Close off the inlet opening of the canister or cartridge(s) by covering with the palm of the hand(s) or by replacing the filter seal(s), inhale gently so that the facepiece collapses slightly, and hold the breath for ten seconds. The design of the inlet opening of some cartridges cannot be effectively covered with the palm of the hand. The test can be performed by covering the inlet opening of the cartridge with a thin latex or nitrile glove. If the facepiece remains in its slightly collapsed condition and no inward leakage of air is detected, the tightness of the respirator is considered satisfactory.

II. Manufacturer's Recommended User Seal Check Procedures

The respirator manufacturer's recommended procedures for performing a user seal check may be used instead of the positive and/or negative pressure check procedures provided that the employer demonstrates that the manufacturer's procedures are equally effective.

APPENDIX E - OSHA RESPIRATOR CLEANING PROCEDURES

APPENDIX B-2 TO §1910.134: RESPIRATOR CLEANING PROCEDURES (Mandatory)

These procedures are provided for employer use when cleaning respirators. They are general in nature, and the employer as an alternative may use the cleaning recommendations provided by the manufacturer of the respirators used by their employees, provided such procedures are as effective as those listed here in Appendix B-2. Equivalent effectiveness simply means that the procedures used must accomplish the objectives set forth in Appendix B-2, i.e., must ensure that the respirator is properly cleaned and disinfected in a manner that prevents damage to the respirator and does not cause harm to the user.

I. Procedures for Cleaning Respirators

A. Remove filters, cartridges, or canisters. Disassemble facepieces by removing speaking diaphragms, demand and pressure-demand valve assemblies, hoses, or any components recommended by the manufacturer. Discard or repair any defective parts.

B. Wash components in warm (43° C [110° F] maximum) water with a mild detergent or with a cleaner recommended by the manufacturer. A stiff bristle (not wire) brush may be used to facilitate the removal of dirt.

C. Rinse components thoroughly in clean, warm (43° C [110° F] maximum), preferably running water. Drain.

D. When the cleaner used does not contain a disinfecting agent, respirator components should be immersed for two minutes in one of the following:

1. Hypochlorite solution (50 ppm of chlorine) made by adding approximately one milliliter of laundry bleach to one liter of water at 43° C (110° F); or,

2. Aqueous solution of iodine (50 ppm iodine) made by adding approximately 0.8 milliliters of tincture of iodine (6-8 grams ammonium and/or potassium iodide100 cc of 45% alcohol) to one liter of water at 43° C (110° F); or,

3. Other commercially available cleansers of equivalent disinfectant quality when used as directed, if their use is recommended or approved by the respirator manufacturer.

E. Rinse components thoroughly in clean, warm (43° C [110° F] maximum), preferably running water. Drain. The importance of thorough rinsing cannot be overemphasized. Detergents or disinfectants that dry on facepieces may result in dermatitis. In addition, some disinfectants may cause deterioration of rubber or corrosion of metal parts if not completely removed.

F. Components should be hand-dried with a clean lint-free cloth or air-dried.

G. Reassemble facepiece, replacing filters, cartridges, and canisters where necessary.

H. Test the respirator to ensure that all components work properly.

APPENDIX F - FIT TEST RECORD

FIT TEST RECORD

TEST RECIPIENT

Name: _____

Company/Office Location: _____

Test Recipient Signature: _____

RESPIRATOR TESTED

Type: _____

Manufacturer: _____

Size: _____

TEST ADMINISTRATOR

Name: _____

Company: _____

Position: _____

TEST USED

QLFT (Qualitative: Verifies to a Fit Factor of 100)

Isoamyl Acetate Irritant Smoke Bitrex® Other: _____

QNFT (Quantitative: Must achieve a minimum Fit Factor of 500)

Portacount® (attach printout) Other: _____

Measured Fit Factor: _____

CERTIFICATION

Comments: _____

Test Administrator Signature: _____

Date: _____

APPENDIX G - INSPECTION RECORD

INSPECTION RECORD

Each respirator should be inspected during cleaning and sanitizing. This form should be completed and enclosed with the respirator, and should be discarded the next time the respirator is used. In addition, respirators maintained on-site for emergency use to escape toxic atmospheres must be inspected monthly.

Inspected by: _____ Date: _____

Type of Respirator: _____

Part	Not Applicable	Approved	Defective*
ALL RESPIRATORS			
Facepiece			
Inhalation Valve			
Exhalation Valve			
Headbands			
Harness Assembly			
Speaking Diaphragm			
Gaskets			
Connections			
APRs/PAPRs			
Cartridge Holder			
Hose Assembly			
SCBAs or Airline Respirators			
Regulator			
Low Pressure Alarm			
Air Supply			

***Immediately remove any respirator with a Defective finding from service.**