Public Health Assessment for

CROWN VANTAGE LANDFILL SITE
ALEXANDRIA TOWNSHIP, HUNTERDON COUNTY, NEW JERSEY
EPA FACILITY ID: NJN000204492
JULY 5, 2006

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
Agency for Toxic Substances and Disease Registry

THE ATSDR PUBLIC HEALTH ASSESSMENT: A NOTE OF EXPLANATION

This Public Health Assessment was prepared by ATSDR pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund) section 104 (i)(6) (42 U.S.C. 9604 (i)(6)), and in accordance with our implementing regulations (42 C.F.R. Part 90). In preparing this document, ATSDR has collected relevant health data, environmental data, and community health concerns from the Environmental Protection Agency (EPA), state and local health and environmental agencies, the community, and potentially responsible parties, where appropriate.

In addition, this document has previously been provided to EPA and the affected states in an initial release, as required by CERCLA section 104 (i)(6)(H) for their information and review. The revised document was released for a 30-day public comment period. Subsequent to the public comment period, ATSDR addressed all public comments and revised or appended the document as appropriate. The public health assessment has now been reissued. This concludes the public health assessment process for this site, unless additional information is obtained by ATSDR which, in the agency's opinion, indicates a need to revise or append the conclusions previously issued.

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PUBLIC HEALTH ASSESSMENT

CROWN VANTAGE LANDFILL SITE
ALEXANDRIA TOWNSHIP, HUNTERDON COUNTY, NEW JERSEY

EPA FACILITY ID: NJN000204492

Prepared by:

New Jersey Department of Health and Senior Services
Public Health Services Branch
Consumer and Environmental Health Services
Hazardous Site Health Evaluation Program

Under a Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

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Summary

The Crown Vantage Landfill site is an inactive industrial landfill located off Milford-Frenchtown Road (County Route 619) in Alexandria Township, Hunterdon County, New Jersey. Waste deposition activities at the landfill began in the late 1930s and continued until the early 1970s, and the landfill has been inactive since that time. Based on the flood plain data, the entire site is situated within the 50-year flood plain of the Delaware River. Waste materials deposited at the landfill included those generated at mills that operated in the area. These paper mill-related wastes included flyash, drums containing press room wastes, rolls of paper and aluminum foil-laminated paper, and paper fiber sludge. Additionally, steel and fiber barrels and pallets, construction and demolition debris, machinery parts, and household garbage were also deposited in the landfill. Reportedly, the landfill was set on fire frequently, usually as a result of the deposition of the boiler ash which contained hot embers.

Surface soil samples contain semi-volatile organic compounds, polychlorinated biphenyls, and metals (including barium, chromium, and lead) at elevated concentrations. Flyash samples contained elevated concentrations of semi-volatile organic compounds, including polycyclic aromatic hydrocarbons and metals (including lead and barium). Based on November 2003 United States Environmental Protection Agency sampling results as well as results from previous sampling events, the site was added to the National Priorities List on April 27, 2005.

There is a completed exposure pathway via the incidental ingestion of contaminated flyash, surface soil and sediment. The exposed population includes individuals accessing the site (including children), and recreational users of adjoining parklands and the Delaware River. Access to the site remains available since the fence on the Delaware River side is only partial due to the river's impact. Based on the maximum chromium, 2-methyl-4-chlorophenoxyacetic acid, and vanadium concentration detected in flyash and surface soil, a potential for chronic non-cancer adverse health effects was found for children only and was determined to be low. For polycyclic aromatic hydrocarbons, the highest child exposure doses were unlikely to cause chronic non-cancer adverse health effects. The maximum lead concentration detected in flyash and surface soil at the site is cause for concern, particularly among the children. For cancer health effects, lifetime excess cancer risks were calculated based on maximum and average contaminant concentrations. Adult lifetime excess cancer risks (using maximum contaminant concentrations) from ingestion of contaminated flyash and surface soil indicated excess cancer risks of approximately two excess cancer cases per 1,000 individuals and approximately seven excess cancer cases per 10,000 individuals, respectively. At the mean flyash and soil contaminant concentration, a risk of approximately eight excess cancer cases per 10,000 individuals and approximately three excess cancer cases per 100,000 individuals was determined, respectively (the more likely exposure scenario). As such, the site currently poses a ***Public Health Hazard***.

Limitations in identifying an exposed population for the Crown Vantage Landfill site make evaluation of health outcome data unfeasible. Recommendations include placement of more prominent signs along the Delaware River, measures to reduce migration of on-site contaminants into the Delaware River, and the implementation of air monitoring during remedial activities to safeguard potentially exposed populations. Although the local health department

and the United States Environmental Protection Agency do not indicate any community concerns on record, a public availability session to gather community concerns and comments was held during the public comment period.

Statement of Issues

On September 23, 2004, the United States Environmental Protection Agency proposed to add the Crown Vantage Landfill site, Alexandria Township, Hunterdon County, New Jersey, to the National Priorities List (NPL). The site was added to the NPL on April 27, 2005. Pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and the Superfund Amendments and Reauthorization Act (SARA) of 1986, the federal Agency for Toxic Substances and Disease Registry (ATSDR) is required to conduct public health assessments of sites listed or proposed to be added to the National Priorities List (NPL). The New Jersey Department of Health and Senior Services (NJDHSS), in cooperation with the Agency for Toxic Substances and Disease Registry (ATSDR), prepared the following public health assessment to review environmental data obtained from the site, evaluate potential human exposure to contaminants, and to determine whether the exposures are of public health concern.

Background

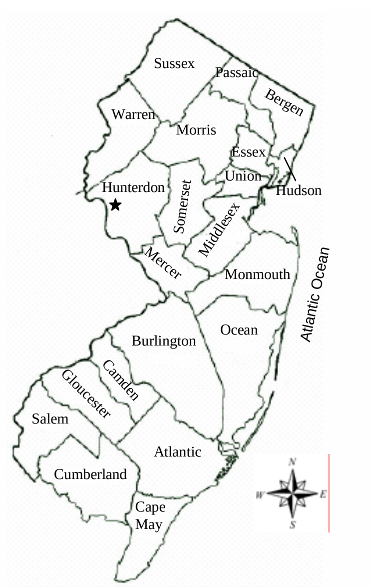

Figure 1: Location of Crown Vantage Landfill Site

The Crown Vantage Landfill site is an inactive landfill located off Milford-Frenchtown Road (County Route 619) in Alexandria Township, Hunterdon County, New Jersey (see Figure 1). The current owner of the landfill is the Crown Paper Liquidating Trust (USEPA 2004a). The site is bounded by the former James River Corporation paper mill plant property to the north and the plant's sewage disposal pond to the northeast; an abandoned railroad right-of-way to the east; New Jersey State park land to the south; and the Delaware River to the west. The former James River Corporation paper mill is located approximately 0.5 mile north of the landfill.

Waste deposition activities at the landfill began in the late 1930s and continued until the early 1970s. The landfill has been inactive since that time (WCC 1991). Waste materials deposited at the landfill included those generated at the former James River Corporation paper mill, as well as other mills that operated in the area. These paper mill-related wastes included flyash from coal burning and drums containing press room wastes (varnish, shellac, methyl ethyl ketone, toluene, inks, and dyes), rolls of paper and aluminum foil-laminated paper, and paper fiber sludge from wastewater treatment plant operations. Additionally, steel and fiber barrels and pallets, construction and demolition debris such as concrete, duct work, piping, and machinery parts and household garbage and rubbish including appliances and furniture were also deposited in the landfill. The landfill area was used by previous owners for the deposition of wastes which were covered without compaction (WCC 1992). Reportedly, the landfill was set on fire frequently, usually as a result of the deposition of the boiler ash which contained hot embers. Background information indicates that burning was a routine method for reducing waste volume (WCC 1992).

The fill material in the landfill is approximately 20 to 25 feet thick at its maximum. The majority of the fill is flyash with degraded drums and debris mixed in (USEPA 2005b). A reported review of aerial photographs from selected time periods spanning from 1930 through 1979 confirm the presence of flyash present over majority of the site (WCC 1991).

The land use in the area is mixed agricultural, residential, and recreational. Based upon the 2000 United States Census, population demographics indicate that there are approximately 980 individuals residing within a one-mile radius of the site (see Figure 2). The closest residences are situated approximately 0.3 miles north of the site. Presently, vegetation on the uncapped landfill surface consists of a mixture of young and mature hardwood trees, shrubs, and grasses (USEPA 2004a). Although the facility is currently fenced on the east, south and north boundaries, access may be obtained along the western side from the Delaware River (USEPA 2005a).

Site Geology and Hydrogeology

The site slopes from east to west toward the Delaware River, which forms the western boundary (see Figure 3). The topography of the site is gently sloping except for an estimated 25-foot drop along the river. Based on the flood plain data, the entire site is situated within the 50-year flood plain of the Delaware River (USEPA 2005b). A 10-year flood would inundate most of the western face of the landfill. Historic and current observations made at the site indicate that the western face of the landfill is periodically scoured by the river during flooding. There are no flood containment measures or liners present at the site, and the site is uncapped.

Groundwater flow direction is west-southwest, toward the Delaware River (WCC 1995). Depth to groundwater at the landfill ranges from five to approximately 21 feet deep (NJDEP 1990). There is a drinking water intake (Point Pleasant Pumping Station) serving approximately 96,226 people located on the Pennsylvania side of the Delaware River, approximately 9.5 miles downstream of the site. This pumping station is an interbasin transfer facility that withdraws water from the Delaware River and transfers it to numerous water purveyors for distribution as drinking water (USEPA 2004a). Another surface water intake used for drinking water purposes is from the Delaware and Raritan Canal in Lambertville, New Jersey, which is approximately 20 miles south of the site. The Delaware River feeds the canal at Bulls Island State Park. United Water, which supplies an estimated 3,400 persons in Lambertville, uses the intake only for emergency purposes. Consequently the public are not affected by the potential contaminants in this portion of the Delaware River (USEPA 2005b).

Groundwater is the source for drinking water within a four-mile radius of the site. A portion of the New Jersey population within four miles of the site receives their water from municipal wells. The Milford Water Department and the Frenchtown Water Department serve Milford and Frenchtown, respectively. The two municipal wells in Milford are located approximately one mile from the site, to the northwest, and service approximately 2,000 persons. The two municipal wells in Frenchtown are located 1.5 to 3.5 miles from the site, to the southeast, and service approximately 1,500 persons (see Figure 4). The water from these wells is blended. It is estimated that nearly 400 persons utilize private wells within one mile of the site.

It is believed that all of the drinking water wells (municipal and private) near the site are located upgradient from the area of suspected contamination (USEPA 2005b).

Previous Investigations

In December 1991 and January 1992, a Surface Remedial Activity on the Crown Vantage Landfill was performed on behalf of the former owner, the James River Corporation (WCC 1992). The purpose of the activity was to remove waste material from the surface of the landfill as part of a response action. The materials removed included rusted drums, off-specification paper (mostly foil-backed), rubber tires (less than 20), and general refuse (e.g., bottles and newspapers). A total of 69 partially-filled drums and 450 rusted empty drums were removed. During the course of the investigation, drum contents were sampled for volatile organic compounds (VOCs) and metals.

In 1994, eight groundwater monitoring wells were installed around the landfill and were sampled for VOCs and metals (WCC 1995). Analytical results of the groundwater samples indicated non-detect values for all VOCs except for low, estimated concentrations of toluene.

In 2001, NJDEP was awarded funds from Crown Vantage Paper Company's bankruptcy estate to conduct remedial work at the landfill. Subsequently, NJDEP removed drums and some contaminated soil, fenced the site, and conducted limited soil sampling (USEPA 2004a).

On April 25, 2003, the NJDEP collected surface soil samples from the site. The samples collected from the exposed face of the landfill alongside the river showed exceedences of both the state residential and nonresidential standards for metals and semivolatile organic compounds (SVOCs) in many of the samples (NJDEP 2003)

In November 2003, the USEPA collected flyash, surface soil, sediment and surface water samples in and around the site (USEPA 2004a).

<u>Previous Site Inspections</u>

During a May 31, 2001 inspection of the site by the NJDEP and paper mill representatives, deteriorating 55-gallon drums were observed protruding from the landfill all along the Delaware River. The drums were reported to be empty and no odors were detected. This inspection occurred approximately ten years after the former owner of the paper mill had removed drums and other materials from the surface of the landfill (NJDEP 2001). Also observed during the May 2001 inspection were old tires, smaller metal drums, metal duct work, paper debris, aluminum foil laminated paper, and other assorted debris. It was reported that the majority of drums were observed along the southern reaches of the edge of the landfill. Several paths traversing the site were documented in this inspection. One path through the center of the landfill was wide enough for vehicular traffic. Another path, which led from the river up the western side of the landfill, was composed mainly of coal ash. It was noted that the paths/roads were maintained prior to March 1, 2001 by the paper mill for the recreational uses by the nearby residents. During the course of inspection, two workers on break from the mill and three mountain bikers were encountered. The presence of well maintained paths indicated that the landfill was actively utilized for recreational purposes. Pathways that existed through the landfill provided easy access to the site by kayakers, bird watchers, and other recreational users of the Delaware River. A barbeque pit was present in an area at the top of the landfill (USEPA 2005b).

Several site visits were conducted by the USEPA between June 2003 and November 2003. The initial site visit was conducted on June 25, 2003. During the visit, pigment waste was observed on the surface of the landfill, solvent odors were identified emanating from cracks, and at least ten badly degraded, partially buried drums of waste were observed near the surface (USEPA 2005b). During the period June 2003 through January 2004, the Delaware River's monthly average flow rates were approximately 300% above historical norms. Flood waters had overflowed the western toe of the landfill and scoured the face, revealing buried drums. During the site visits conducted by the USEPA, it was also noted that a fence installed around the site by the NJDEP had been severely damaged along the river due to the elevated water and flow levels, and from impact by large fallen trees that routinely flow down the Delaware River (USEPA 2005b). The damage to the fence required that most of the portion along the river bank be removed. Some of the posts were replaced by the NJDEP and strands of wire and signs were placed to mark the landfill.

The USEPA conducted another site visit on September 20, 2004 after the remnants of Hurricane Ivan resulted in the Delaware River rising well above flood stage. It was noted that the river had earlier crested above the face of the landfill (USEPA 2005b). While observing an area of the landfill face that appeared to have experienced some erosion due to the flood waters, USEPA personnel watched a portion of the landfill slough off into the Delaware River. The material was a black ash that had been sampled previously and indicated the presence of elevated levels of polyaromatic hydrocarbons (PAHs), heavy metals, polychlorinated biphenyls (PCBs) and pesticides. On September 23, 2004, an emergency removal action was initiated by the USEPA to stabilize the site in the areas along the landfill face that were severely impacted by the flooding by the use of riprap. The existing landfill pathways were improved and some vegetation was cleared to support this effort and improve access. The fence along the northern and southern boundaries of the site was repaired, and additional warning signs were posted along the fence and the river bank (USEPA 2005b).

The USEPA stabilized specific areas of the landfill in November 2004, after the bank of the landfill was substantially damaged by flood waters. In addition to shoring up areas where the banks collapsed, the USEPA placed warning signs along the perimeter. Two spring rainstorms in March and April 2005, combined with snowmelt caused major flooding in the Delaware River basin. As a point of comparison, this flood event resulted in the Delaware River crest over two feet higher than the flooding that resulted from Hurricane Ivan in September 2004 (USEPA 2005c). Site visits by the USEPA, conducted on April 5 and April 12, 2005, noted that the flood waters had nearly reached the office trailer in the support zone. Sloughing of the fly ash was observed along the landfill face and two depressions (several feet in depth) were noted on a path at the top of the landfill. Fence damage on the southern edge was reported and evidence of trespassing was noted during the site visits (USEPA 2005c).

Prior ATSDR Involvement

In response to a request by the USEPA to determine whether radioactivity levels in fly ash at the Crown Vantage Landfill site posed a threat to human health, the NJDHSS prepared a Health Consultation for the site (ATSDR 2004). Exposure scenarios evaluated were for full-time site remediation workers, intermittent workers (occasional site visits), and trespassers based on the results of two surface soil samples with the highest measured radioactivity levels. The report concluded that there was ***No Apparent Public Health Hazard*** to full-time site remediation workers, intermittent workers, or trespassers from the radioactivity levels in fly ash at the Crown Vantage Landfill.

Site Visits

<u>October 26, 2004 Site Visit</u>

On October 26, 2004, staff performed a site visit of the Crown Vantage Landfill site. Present were Steve Miller, Julie Petix, and Somia Aluwalia of the NJDHSS; Leah Escobar of the ATSDR; a representative of the NJDEP; representatives from the United States Coastal Guard; and representatives of the USEPA. Level C protection was donned for the site visit, including tyvek suits, rubber booties, gloves and hard hats. The site was fenced and gated on the eastern side. The temporary pathway was covered with large loose stones to create roadways to bring heavy machinery onto site as part of emergency response related actions. It was noted that areas not covered with stones were covered with fly ash. The site was heavily wooded. Half buried 55 gallon drums were observed at various locations along the tour (see Photographs 7 and 8 in Appendix). Wax and paper were also observed on the ground and attached to tree branches (see Photographs 5 and 6 in Appendix). Debris from the September 2004 flooding event was observed along the shoreline of the Delaware River that borders the western portion of the site; the flood waters had encroached roughly 200 feet into the site (see Photographs 1 and 2 in Appendix). The NJDEP representative indicated that in the past, he had seen stone rings with beverage cans scattered around, presumably used by hunters and trespassers. Two weeks prior to the site visit, the same representative stated that he came across two women who were walking their dogs on a hiking trail that runs adjacent to the eastern boundary of the site. He commented that prior to the installation of the fence the site was easily accessible to trespassers. The NJDHSS staff viewed the site from across the river on the Pennsylvania side and noted the presence of a public boat launch ramp one mile upstream of the site.

<u>August 11, 2005 Site Visit</u>

On August 11, 2005, staff performed a site visit of the Crown Vantage Landfill site. Present were Tariq Ahmed, Glenn Pulliam, and Somia Aluwalia of the NJDHSS; a representative from the NJDEP; representatives from the USEPA; and representatives from the Hunterdon County Health Department. Steel-toed safety shoes were worn by all representatives.

The environmental agency representatives pointed out the location of a large portion of the landfill area along the northwestern landfill area was lost due to flood erosion in 2004. This area was secured from future erosion by installing riprap for ground stability over the eroded portion of the landfill. The riprap was in good condition and appeared to be effectively maintaining the integrity of the northwestern slope of the landfill during the site visit (see Photograph 3 in Appendix).

Debris from the flooding event in March 2005 was observed along the shoreline of the Delaware River that borders the western portion of the site. The flooding event nearly covered the entire site area and reached the USEPA trailer located on the south-eastern portion of the landfill. The USEPA and NJDEP maintain "No Trespassing" signs at frequent intervals along the shoreline area where the fence was formerly located to deter unauthorized access (see Photographs 9 and 10 in Appendix). There was no indication that the fence along the shoreline would be replaced in the future. The USEPA and NJDEP personnel mentioned the presence of trespassers on the site year-round for activities such as hiking, dirt-riding and camping. There is a hiking trail that ends at the gate on the eastern portion of the site. Two shoes (one adult and one child) were noted on the northern and southern portions of the site (see Photographs 13 and 14 in Appendix). The adult shoe was noted along the northern portion within an area subject to the fluctuating levels of the Delaware River and, therefore, may have been washed up onto the site area. Approximately one hour following the site visit, a NJDHSS staff member noticed his shoes felt "uneven." Upon inspection, it was observed that the bottom soles of both shoes had disintegrated (see Photograph 15). The shoes were placed in a protective bag to prevent any exposure.

Pictures from the site visits are catalogued in Appendix A.

Community Concerns

In order to gather information on community health concerns at the Crown Vantage site, the NJDHSS spoke with the Health Officer, Hunterdon County Department of Health. The local health department has reported no community concerns regarding the site (J. Beckley Health Officer, Hunterdon County Department of Health, personal communication, 2004). The USEPA do not indicate any community concerns on record. The NJDEP has received calls from local residents regarding the landfill affecting their drinking water and these have been addressed by the NJDEP.

During the afternoon, the NJDHSS met with the Mayor of Milford, an adjoining township, to discuss redevelopment proposals that have been received for the former paper mill, located 0.5 miles north of the landfill. Some of these proposals include plans to redevelop the land, adjacent to the landfill, for residential housing. The Mayor has not made a decision to date with regard to the redevelopment proposals. The NJDHSS spoke to an area resident and discussed access issues related to the Crown Vantage Landfill site. The resident spoke of a trail used by hikers and mountain bikers that originates in Frenchtown, runs through Alexandria Township (and the Crown Vantage site) and ends in Milford. The trail runs right next to the Delaware River but in certain places makes sharp turns into land adjacent to the shoreline. She has been on the trail on her mountain bike frequently in the past and mentioned that local children frequently utilize this trail. She also mentioned the dirt mounds on the site which are used by dirt riders. The trail is utilized by people walking their dogs as well.

Environmental Contamination

An evaluation of site-related environmental contamination consists of a two tiered approach: a screening analysis and a more in-depth analysis to determine the public health implications of site-specific exposures. First, maximum concentrations of detected substances are compared to media specific comparison values (known as environmental guideline comparison values). If substance concentrations exceed the comparison value, these substances, known as Contaminants of Concern (COC), are selected for further evaluation. This evaluation is conducted by comparing estimated exposure doses, derived from site-specific exposure conditions, to dose-based comparison values (known as health guideline comparison values).

Environmental Guideline Comparison

A compilation of environmental sample results for the Crown Vantage Landfill site is provided in the following section. Media reviewed included flyash, soil, sediment, groundwater and surface water. These data were organized by the NJDHSS as on-site (Crown Vantage Landfill) versus off-site (Delaware River; area northeast and southeast of the landfill). The chronic ATSDR Environmental Media Evaluation Guide (EMEG), Reference Dose Media Evaluation Guide (RMEG) and Cancer Risk Evaluation Guide (CREG) were selected as the environmental guideline comparison values (CVs). EMEGs are estimated contaminant concentrations that are not expected to result in adverse non-carcinogenic health effects. ATSDR derives RMEGs from USEPA's oral reference doses, which are developed based on USEPA toxicological evaluations. RMEGs represent the concentration in water or soil at which daily human exposure is unlikely to result in adverse non-carcinogenic effects. CREGs are media-specific comparison values that are used to identify concentrations of cancer-causing substances that are likely to result in an increase of cancer rates in an exposed population. Where the ATSDR CVs were unavailable, USEPA Region 3 Risk Based Concentrations (RBCs) or NJDEP Residential Direct Contact Soil Cleanup Criteria (RDCSCC) were used for comparison purposes. RBCs are chemical concentrations corresponding to a fixed level of risk (i.e., a Hazard Index of 1, or lifetime excess cancer risk of one in one million, whichever results in a lower concentration) in water, air, biota, and soil. Based on site utilization and potential future use considerations, New Jersey RDCSCC were used as CVs. They are primarily based on human health impacts but also consider natural background concentrations, analytical detection limits and ecological effects.

Substances exceeding applicable environmental guideline CVs were identified as COCs and evaluated further to determine whether these contaminants pose a health threat to exposed or potentially exposed receptor populations. If environmental guideline CVs are unavailable, these substances are also selected for further evaluation.

On-site Contamination

In December 1991 and January 1992, a Surface Remedial Activity was performed by Environmental Services Incorporated, a contractor for the James River Corporation (WCC 1992). Volatile organic chemical analysis of drum contents indicated the presence of petroleum hydrocarbons (benzene, toluene, ethylbenzene, xylenes), organic solvents (acetone, methyl isobutyl ketone, methylene chloride, 1,2-dichloroethene, trichloroethylene) and styrene (WCC 1992). Four metals were detected at concentrations above method detection limits, including chromium, lead, copper and zinc. Toxicity Characteristic Leaching Procedure (TCLP) of drum contents was conducted to classify the hazardous waste for disposal purposes. Of these, only lead (at 18.4 milligrams per liter or mg/L) exceeded the TCLP regulatory levels (5 parts per million or ppm). TCLP analyses of composite drum samples indicated the presence of benzene (138 mg/L), trichloroethylene (8,945 mg/L), tetrachloroethylene (21,129 mg/L), 2-butanone (1,430 mg/L) and heptachlor (0.156 mg/L) (WCC 1991).

Following is a summary of sampling conducted by the NJDEP and the USEPA in 2003. The NJDEP soil samples were analyzed for Full Target Compound List (TCL) Organic Compounds, Target Analyte List (TAL) Metals, Cyanide, Herbicides, Pesticides/Polychlorinated Biphenlyls Organic Analysis. The USEPA flyash, soil, sediment and surface water samples were analyzed for Full TCL Organic Compounds, TAL Metals, Cyanide, Herbicides and Full TCLP.

Flyash

On November 12 and 13, 2003, the USEPA collected six surface flyash samples (including one field duplicate) at locations along the exposed face of the landfill facing the Delaware River (USEPA 2004b).

Analytical results of the flyash samples indicated non-detect values for VOCs (see Table 1). Levels of polycyclic aromatic hydrocarbons, also known as PAHs, (benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo [k]fluoranthene, benzo[g,h,i]perylene, carbazole chrysene, dibenzo[a,h]anthracene, dibenzofuran, fluoranthene, indeno[1,2,3-cd]pyrene, naphthalene, phenanthrene and pyrene), herbicides (2-methyl-4-chlorophenoxyacetic acid or MCPA and 2-(2-methyl-4-chlorophenoxy) propionic acid or MCPP) and metals (antimony, barium, beryllium, chromium, copper, iron, lead, nickel and thallium) were present above their respective environmental guideline CVs.

Surface Soil

In April 2003, the NJDEP collected 22 surface (0-6 inches depth) soil samples from the exposed face of the landfill adjacent to the Delaware River. The samples were analyzed for SVOCs, pesticides/PCBs, chlorinated herbicides, and metals (NJDEP 2003). In November 2003, the USEPA collected nine surface soil samples (0-6 inches) at locations between the landfill and the Delaware River (USEPA 2004b). Table 2 presents the combined analytical results from the NJDEP and USEPA sampling events; the range and mean of contaminant concentrations detected are provided.

Analytical results indicated the presence of PAHs (acenaphthene, benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[g,h,i]perylene, benzo[k]fluoranthene, chrysene, dibenzo[a,h]anthracene, indeno[1,2,3-c,d]pyrene and phenanthrene), as well as other SVOCs (bis(2-ethylhexyl)phthalate and PCBs), and pesticides/herbicides (alpha-chlordane, 4,4'-DDT, dieldrin and MCPA) above their respective environmental guideline CVs. Elevated levels of metals detected in the soil samples included antimony, cadmium, chromium, copper, iron, lead, nickel, thallium, vanadium, and zinc (see Table 2).

Sediment

In November 2003, the USEPA collected eleven sediment samples (including one duplicate) along the Delaware River bank within one foot of the water's edge, adjacent to the site (USEPA 2004b). Analyses of the sediment samples indicated non-detect values for VOCs, except for the trace levels of acetone. A summary of the analytical data is presented in Table 3. There are no human health-based guidelines available for sediment. As such, the sediment sampling results were compared to New Jersey RDCSCC. Levels of PAHs (acenaphthylene, benzo[a]pyrene, benzo[g,h,i]perylene, dibenzo[a,h]anthracene and phenanthrene), as well as metals (beryllium, cadmium, iron, thallium, and zinc) were present above their environmental guideline CVs.

Groundwater

From April 1986 to October 1989, samples from four on-site shallow groundwater monitoring wells and one deep groundwater monitoring well were analyzed for metals and VOCs (NJDEP 1990). VOCs such as chlorobenzene, methylene chloride, tetrachloroethylene (PCE), trichloroethane, and trichloroethylene (TCE) and SVOCs (phenols) and metals such as arsenic, barium, cadmium, iron, lead, manganese and zinc were elevated above their respective environmental guideline CVs (see Table 4a).

In June 1991, Woodward-Clyde Consultants (WCC) collected shallow groundwater and soil gas samples as part of a Preliminary Site Investigation of the landfill (WCC 1991). Groundwater sampling indicated the presence of toluene and naphthalene in one of six samples (see Table 4b). In 1994, eight monitoring wells were installed around the landfill and were sampled for VOCs and metals (WCC 1995). Analytical results of the ground water samples indicated non-detect values for all VOCs except for low, estimated concentrations of toluene (i.e., below the NJDEP Groundwater Quality Standard). Concentrations of arsenic, beryllium and lead exceeded the NJDEP Groundwater Quality Standards (see Table 4b).

Air/Soil Gas

During a July 2003 site visit, the USEPA conducted air monitoring throughout the site using a using a portable organic vapor analyzer equipped with a photoionization detector (PID), oxygen meter, carbon monoxide meter, hydrogen sulfide meter, and combustible gas indicator (CGI) (USEPA 2005b). Areas were identified off of the main pathway at the site, near the center of the landfill, where odors typical of organic solvents were identified. These areas were near subsidences that had occurred where test pits had been previously excavated by the NJDEP. Monitoring at these locations with the PID indicated breathing zone readings ranging from 5 to 15 units above background. At one of the locations directly above the ground surface, PID readings peaked at 1,500 units above background; oxygen levels dropped to13%, and the CGI peaked at 20% of the lower explosive limit.

As part of the Preliminary Site Investigation in 1991, soil gas samples were collected throughout the site (WCC 1991). As presented in Table 5, soil gas analytical results indicated the presence of chlorinated and non-chlorinated volatile organic compounds (VOCs), including PCE, trichloroethane, TCE, benzene, toluene, and xylenes, in the soil gas beneath the site (see Table 5).

Off-site Contamination

Surface Soil

Limited sampling, consisting of two surface soil samples was conducted at southeast and northeast off-site locations (USEPA 2004b). A summary of the analytical data is presented in Table 6. PAHs (benzo[a]pyrene, benzo[g,h,i]perylene and phenanthrene), and iron were elevated above their respective environmental guideline CVs.

Sediment

Two sediment samples were collected upstream and downstream of the site. A summary of the upstream and downstream sediment data is presented in Table 7a and Table 7b, respectively. PAHs (benzo[a]pyrene, benzo[g,h,i]perylene and phenanthrene)and metals (beryllium, cadmium, iron and thallium) were elevated above the environmental guideline CVs for the upstream sediment samples. The same contaminants, with the exception of beryllium, were elevated above the comparison values for the downstream sediment samples.

Surface Water

Five surface water samples (including one field duplicate) were collected directly at the Delaware River surface as close to the river bank as possible. Three samples were downstream of the site, one was adjacent to the site and one sample was upstream of the site (just south of the paper mill). The results indicated non-detect values for all VOCs except for 10 ug/L of acetone in one of the downstream samples. Low estimated concentrations of SVOCs (bis(2-ethylhexyl)phthalate and naphthalene) were detected in both upstream and downstream samples (USEPA 2004b).

Summary of Contaminants of Concern (COC)

The COC are those contaminants that are present at levels higher than the media-specific standards/criteria or the environmental comparison values. The COC present in flyash, soil, sediment and groundwater are as follows:

Contaminants of Concern at the Crown Vantage Landfill site			
Media	**VOCs/SVOCs Pesticides/Herbicides**	**PAHs**	**Metals**
Flyash	MCPA, MCPP	Benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo [k]fluoranthene, benzo[g,h,i]perylene, carbazole chrysene, dibenzo[a,h]anthracene, dibenzofuran, fluoranthene, indeno[1,2,3-cd]pyrene, naphthalene, phenanthrene, pyrene,	Antimony, barium, beryllium, chromium, copper, iron, lead, nickel, thallium
Soil	Bis(2-ethylhexyl)phthalate, PCBs, chlordane, DDT, dieldrin, MCPA	Acenapthylene, benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[k]fluoranthene, benzo[g,h,i]perylene, chrysene, dibenzo[a,h]anthracene, indeno[1,2,3-cd]pyrene, phenanthrene	Antimony, cadmium, chromium, copper, iron, lead, nickel, thallium, vanadium, zinc
Sediment		Acenapthylene, benzo[a]pyrene, benzo[g,h,i]perylene, dibenzo[a,h]anthracene, phenanthrene	Beryllium, cadmium, iron, thallium, zinc
Groundwater	Chlorobenzene, methylene Chloride, PCE, trichloroethane, TCE, phenols		Arsenic, barium, beryllium, cadmium, iron, lead, manganese, zinc

Discussion

Exposure Pathway Analysis

An exposure pathway is a series of steps starting with the release of a contaminant in a media and ending at the interface with the human body. A completed exposure pathway consists of five elements:

1. source of contamination;
2. environmental media and transport mechanisms;
3. point of exposure;
4. route of exposure; and
5. a receptor population.

Generally, the ATSDR considers three exposure categories: 1) completed exposure pathways, that is, all five elements of a pathway are present; 2) potential exposure pathways, that is, one or more of the elements may not be present, but information is insufficient to eliminate or exclude the element; and 3) eliminated exposure pathways, that is, one or more of the elements is absent.

Completed Pathways

Incidental ingestion of contaminated flyash, soil and sediment are the completed exposure pathways for Crown Vantage Landfill site (see Table 8). Flyash on the western portion of the site is contaminated with PAHs, pesticides, and metals. Surface soils on the site are contaminated with PAHs, SVOCs (including pesticides and herbicides), and metals. The sediment on the site boundary on the western portion of the site is contaminated with PAHs and metals. The site is currently fenced on three sides but the western portion of the site is accessible via the Delaware River. Individuals, including children, may be exposed to contaminants while engaging in outdoor recreational activities near the site. Trespassing occurs year-round (as evidenced by the presence of hiking trails and signs of camping), although the extent and frequency is unknown. Flyash, surface soils and sediment may be incidentally ingested through hand-to-mouth activity to hikers, campers, dirt-riders, and recreational users of the Delaware River.

Potential Pathways

Potential exposure pathways for the Crown Vantage Landfill site were identified as follows (also summarized in Table 8):

<u>Inhalation of contaminated air</u>. Analytical results of soil gas samples collected in 1991 indicated the presence of VOCs and SVOCs. During a July 22, 2003 site visit, areas were identified off of the main pathway at the site, near the center of the landfill, where extremely elevated levels of organic vapors present at near explosive levels were determined. The concentration, extent, and migration pathway of these vapors in the subsurface is not known. The presence of vapor levels at 20% of the lower explosive limit is an indication that there may

be a potential for a fire or explosion should an ignition source such as a brush or camp fire be present in those areas.

Ingestion of contaminated biota from the Delaware River. Biota (e.g., fish, plants) in the Delaware River continue to be exposed to contaminated sediment. Since naphthalene and toluene exhibit moderate tendencies to bioconcentrate in the fatty tissues of aquatic animals, contaminants of concern may have been introduced into the aquatic food chain (ATSDR 2003). The Delaware River is considered a fishery and supports populations of blueback herring; small-mouth bass, American shad, hickory shad, river herring, and channel catfish. An advisory is in effect for the Delaware River regarding the consumption of striped bass, channel catfish, white sucker, largemouth bass, smallmouth bass and American eel due to PCB, dioxin and mercury contamination (NJDEP 2006; USEPA 2003). Information obtained from a professional fishing guide indicates that this area is "heavily fished," and fishing trips are conducted along the segment of the Delaware River adjacent to the site. Statements made by local residents on the Pennsylvania side of the river document that the segment of the Delaware River adjacent to the site is fished for consumption (USEPA 2004a). The USEPA observed fishing activity across the river from and adjacent to site in May 2004 (Weston Solutions 2004). Hazardous contaminants, such as PAHs, heavy metals, and PCBs have been identified at the site, although contamination of the Delaware River cannot be solely attributable to the Crown Vantage Landfill site. Additionally, sampling events at the landfill have not analyzed for dioxin which is formed by burning chlorine-based chemical compounds with hydrocarbons. Dioxin pollution is also affiliated with paper mills which use chlorine bleaching in their process. Given that waste materials deposited at the landfill included those generated at the former James River paper mill, and that the landfill had frequent fires, there is a potential for presence of dioxin-contaminated media on-site. These contaminants have the potential to enter the food chain; as such, this pathway remains a potential pathway of concern.

Ingestion of Surface Water. There is a drinking water intake (Point Pleasant Pumping Station) serving approximately 96,226 people located on the Pennsylvania side of the Delaware River, approximately 9.5 miles downstream of the site. This pumping station is an interbasin transfer facility that withdraws water from the Delaware River and transfers it to numerous water purveyors for distribution as drinking water (USEPA 2004a). Another surface water intake used for drinking water purposes is from the Delaware and Raritan Canal in Lambertville, New Jersey, which is approximately 20 miles south of the site. The Delaware River feeds the canal at Bulls Island State Park. United Water, which supplies an estimated 3,400 persons in Lambertville, uses the intake only for emergency purposes (USEPA 2005b). The water purveyors for both the intakes employ routine water treatment facilities prior to distribution. Although the possibility of the water intakes to be adversely impacted is minimal, it can not be completely discounted based on the observations that the Delaware River is scouring the surface of the landfill during flooding events, increasing the concentration of contaminants in the water. In addition, pieces of the landfill in the past have broken off into the river. Limited surface water samples (under varying conditions such as flood-level, low-level) make it difficult to estimate the impact on the river. Data is unavailable for all potential contaminants, such as dioxin. Although utilities are required to monitor the water quality, the contaminants in the landfill are not primary drinking water contaminants. The western portion of the site is situated within the 10-year floodplain. Historical and current observations made at the site indicate that the western face of the landfill is periodically scoured by the river during flooding, exposing previously buried waste. It is currently unknown if the release of hazardous substances from the site has impacted the Delaware River, based on limited surface water sampling data. The segment of the Delaware River adjacent to the site is a federally designated recreational river. Activities such as canoeing, tubing, and jet-skiing may result in potential exposures via incidental ingestion to the recreational users of the river. Based on limited data and uncertainties associated with exposures, this was designated as a potential pathway of exposure. Although there is the possibility of contaminated water entering the drinking water intakes, the likelihood of appreciable exposures is low.

Eliminated Pathway

Ingestion of drinking water from public/private wells. Groundwater flow in the surficial deposits and the upper bedrock aquifer in the vicinity of the site is to the west-southwest toward the Delaware River (USEPA 2004b). Hydropunch samples collected in 1991 indicated the presence of toluene and naphthalene at concentrations below federal drinking water standards in one sample. Additional groundwater sampling in 1994 from monitoring wells installed in the surficial deposits immediately above bedrock indicated that the landfill was not negatively impacting the shallow aquifer. Arsenic and lead were present at higher levels on the upgradient side of the landfill.

Groundwater is the source for drinking water within a four-mile radius of the site. Four public supply wells in Milford and Frenchtown service approximately 2,000 and 1,500 persons, respectively. It is estimated that nearly 400 persons utilize private wells within one mile of the site. Public and private wells are believed to be situated upgradient of the area of contamination. Therefore, it is unlikely that the drinking water is impacted by the site and, therefore, is eliminated at the present time.

Public Health Implications of Completed Pathways

Health Guideline Comparison – Non-Cancer Health Effects

To assess the public health implications of site-specific exposures, estimated exposure doses, derived from site-specific exposure conditions, are compared to dose-based comparison values. To assess non-cancer health effects, ATSDR has developed Minimal Risk Levels (MRLs) for contaminants that are commonly found at hazardous waste sites. An MRL is an estimate of the daily human exposure to a hazardous substance at or below which that substance is unlikely to pose a measurable risk of adverse, non-cancer health effects. MRLs are developed for a route of exposure, i.e., ingestion or inhalation, over a specified time period, e.g., acute (less than 14 days); intermediate (15-364 days); and chronic (365 days or more). MRLs are based largely on toxicological studies in animals and on reports of human occupational (workplace) exposures. MRLs are usually extrapolated doses from observed effect levels in animal toxicological studies or occupational studies, and are adjusted by a series of uncertainty (or safety) factors or through the use of statistical models. In toxicological literature, observed effect levels include:

- no-observed-adverse-effect level (NOAEL); and
- lowest-observed-adverse-effect level (LOAEL).

NOAEL is the highest tested dose of a substance that has been reported to have no harmful (adverse) health effects on people or animals. LOAEL is the lowest tested dose of a substance that has been reported to cause harmful (adverse) health effects in people or animals.
If site-specific exposure dose estimates exceed the health guideline CV, this dose is compared to the NOAEL or LOAEL. If the site-specific exposures are well below a NOAEL that is based on a human study, the likelihood for adverse health effects in the exposed population would be low. If, however, the NOAEL is based on an animal study, exposure doses near the NOAEL could be of concern because of uncertainty in the relative sensitivity of animals as compared to humans. In the instance where the MRL is derived from a LOAEL, the likelihood of adverse health effects increases as site-specific exposures approach a LOAEL derived from either a human or animal study. For this analysis, relevant literature values and professional judgment is used in weighing what is known and unknown, including uncertainties and data limitations.

To ensure that MRLs are sufficiently protective, the extrapolated values can be several hundred times lower than the observed effect levels in experimental studies. When MRLs for specific contaminants are unavailable, other health based comparison values such as USEPA Reference Dose (RfD). The RfD is an estimate of a daily oral exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime.

Exposure doses were not calculated for off-site COCs because there is insufficient data to characterize off-site exposure.

Ingestion of On-Site Contaminated Flyash, Soil and Sediment

Local residents and tourists reportedly use the site for recreational purposes (i.e., canoeing, camping, hiking and fishing along the on-site portion of site). Exposures are based on ingestion of contaminated media; non-cancer exposure doses were calculated using the following formula:

$$\textit{Exposure Dose (mg/kg/day)} = \frac{C \times IR \times EF}{BW}$$

where, mg/kg/day = milligrams of contaminant per kilogram of body weight per day;
C = concentration of contaminant in soil (mg/kg);
IR = soil ingestion rate (kg/day);
EF = exposure factor; and,
BW = body weight (kg)

whereas exposure factor =

$$\frac{\text{number of days of exposure per year } x \text{ the number of years of exposure}}{\text{days per year } x \text{ number of years exposed}}$$

Based on the USEPA Exposure Factors (USEPA 1997) and site-specific conditions, the following assumptions were used to calculate exposure doses for children and adults:

<table>
<tr><th>Media</th><th>Receptor Population</th><th>Ingestion Rate (mg/day)</th><th>No. of Days of Exposure Per Year</th><th>Body Weight (kg)</th></tr>
<tr><td>Flyash</td><td rowspan="2">Child</td><td rowspan="2">200</td><td rowspan="4">26 days (1 day per week, 6 months per year)</td><td rowspan="2">21</td></tr>
<tr><td rowspan="2">Soil</td></tr>
<tr><td rowspan="2">Adult</td><td rowspan="2">100</td><td rowspan="2">70</td></tr>
<tr><td>Sediment</td></tr>
</table>

Tables 9 through 14 present calculated doses, expressed in scientific notation, which is simply a method for expressing either very large or very small numbers. For example, 1,000,000 can be expressed in scientific notation as 1×10^{6}; and 0.001 can be expressed as 1×10^{-3}, respectively.

Flyash

As presented in Table 9, maximum and mean exposure doses of flyash COCs were compared with the corresponding chronic health guideline CVs. Health guideline CVs are unavailable for lead. For PAH's, the exposure doses were compared to available LOAELs.

Based on maximum concentrations of MCPP, antimony, barium, beryllium, copper, iron, nickel and thallium detected in the flyash, chronic exposure doses calculated for children and adults were lower than the corresponding health guideline CVs. As such, exposures to these COCs are unlikely to cause non-cancer adverse health effects.

Based on maximum concentrations of MCPA and chromium detected in the flyash, chronic exposure doses calculated for children were higher than the corresponding health guideline CVs. For MCPA, chromium, PAHs and lead, a brief evaluation of non-cancer health implications is presented below.

MCPA. A chronic oral MRL is unavailable for MCPA. The chronic oral RfD (0.0005 mg/kg/day) is based on kidney and liver toxicity in dogs (USEPA 2005d). An uncertainty factor of 300 and a NOAEL of 0.15 mg/kg/day were used to calculate the MRL. Maximum exposure doses calculated for children (i.e., 0.000599) was about 250 times lower than the oral chronic NOAEL. As such, the potential for non-cancer adverse health effects in children from exposures to MCPA in the flyash is low.

Chromium. A chronic oral MRL is unavailable for chromium. The chronic oral RfD for hexavalent chromium (0.003 mg/kg/day) is based decreased water consumption in rats (USEPA 2005e). An uncertainty factor of 900 and a NOAEL of 2.5 mg/kg/day were used to calculate the RfD. Maximum exposure doses calculated for children (i.e., 0.00871) was about 200 times lower than the oral chronic NOAEL. However, the percent of hexavalent chromium present in total chromium measured in the flyash is unknown. Therefore, the likelihood of non-cancer adverse health effects in children is low. Additionally, the mean exposure dose for children (0.00147) is lower than the chronic oral RfD (see Table 9).

PAHs. PAHs are a class of over 100 different compounds that are found in and formed during incomplete combustion of coal, oil, wood, or other organic substances. More commonly they are found in petroleum based products such as coal tar, asphalt, creosote, and roofing tar (ATSDR 2003). In the environment, PAHs are found as complex mixtures of compounds, rarely as single compounds alone.

No acute, or chronic oral MRLs were derived for PAHs because there are no adequate human or animal dose-response data available that identify threshold levels for appropriate noncancer health effects.

As shown in Table 9, PAH exposure dose ranges calculated for children and adults are 10^{-3} to 10^{-5} mg/kg/day and 10^{-4} to 10^{-6} mg/kg/day, respectively. In the absence of chronic oral MRLs, chronic oral RfDs were used for comparison. The highest child exposure dose calculated for fluoranthene (3.54×10^{-3} mg/kg/day) is one order of magnitude lower than its RfD (4×10^{-2} mg/kg/day). Since the remaining exposure doses are less than that calculated for fluoranthene, ingestion of flyash containing benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[k]fluoranthene, carbazole, chrysene, dibenzo[a,h]anthracene, indeno[1,2,3-c,d]anthracene, and pyrene are not expected to cause non-cancer adverse health effects. This determination takes into account that PAHs have similar physical, chemical, and toxicological characteristics.

Lead. As previously indicated, the maximum concentration of lead (77,100 ppm) detected in the flyash exceeded the New Jersey RDCSCC (400 ppm). No MRL or RfD is available for lead. Accumulation of lead in the body can cause damage to the nervous or gastrointestinal system, kidneys, or red blood cells (ATSDR 1999). Children, infants, and fetuses are the most sensitive populations. Lead may cause learning difficulties and stunted growth, or may endanger fetal development. Health effects associated with lead exposure, particularly changes in children's neurobehavioral development, may occur at blood lead levels so low as to be essentially without a threshold (i.e., no NOAEL or LOAEL is available). As such, lead exposures to children assessing the Crown Vantage Landfill site were evaluated and are presented in the Child Health Considerations section.

Soil

As presented in Table 10, maximum and mean exposure doses of on-site surface soil COCs were compared with the corresponding chronic health guideline CVs. Health guideline CVs are unavailable for lead. For PAH’s, the exposure doses were compared to available LOAELs.

Based on maximum concentrations of bis(2-ethylhexyl)phthalate, PCBs, alpha-chlordane, 4,4'-DDT, dieldrin, MCPA, antimony, cadmium, copper, iron, nickel, thallium, and zinc detected in surface soil, chronic exposure doses calculated for children and adults were lower than the corresponding health guideline CVs. As such, exposures to these COCs are unlikely to cause non-cancer adverse health effects.

Based on maximum concentrations of chromium and vanadium detected in surface soil, chronic exposure doses calculated for children were higher than the corresponding health guideline CVs. For chromium, vanadium, PAHs, and lead, a brief evaluation of non-cancer health implications is presented below.

Chromium. A chronic oral MRL is unavailable for chromium. The chronic oral RfD for hexavalent chromium (0.003 mg/kg/day) is based decreased water consumption in rats (USEPA 2005e). An uncertainty factor of 900 and a NOAEL of 2.5 mg/kg/day were used to calculate the MRL. A maximum exposure dose calculated for children (i.e., 0.00374) was about 670 times lower than the oral chronic NOAEL. However, the percent of hexavalent chromium present in total chromium measured in the surface soil is unknown. Therefore, the likelihood of non-cancer adverse health effects in children is low. Additionally, the mean exposure dose for children (0.000186) is lower than the chronic oral RfD (see Table 10).

Vanadium. Exposure to high levels of vanadium can cause harmful health effects. The major effects from breathing high levels of vanadium result in lung irritation, coughing, wheezing, chest pain, runny nose, and a sore throat. The human health effects from ingestion of vanadium are unknown. A chronic oral MRL is unavailable. An intermediate oral MRL value of 0.003 mg/kg/day was derived from a NOAEL of 3 mg/kg/day (ATSDR 1992). This was based on a study in rats and all treated groups showed changes in kidneys, lungs and spleen. A maximum exposure dose calculated for children (i.e., 0.0038 mg/kg/day) was about 1,000 times lower than the oral intermediate NOAEL. As such, the likelihood of non-cancer adverse health effects in children is low. Additionally, the mean concentration of vanadium detected in the surface soil was below the New Jersey RDCSCC (see Table 2).

PAHs. As shown in Table 10, PAH exposure doses calculated for children and adults are 10^{-4} mg/kg/day and 10^{-5} mg/kg/day, respectively. Chronic MRLs and/or RfDs are unavailable for the PAHs listed in Table 10. Benzo[a]pyrene is considered the most toxic and has an intermediate oral LOAEL, based on increased liver weight in a mouse study (ATSDR 1995). The calculated child oral exposure dose for benzo[a]pyrene (4.76×10^{-4}mg/kg/day) is six orders of magnitude lower than the corresponding LOAEL (120 mg/kg/day). Since the remaining exposure doses are the same order of magnitude as that calculated for benzo[a]pyrene, ingestion of soil containing benzo[a]anthracene, benzo[b]fluoranthene, benzo[g,h,i]perylene, benzo[k]fluoranthene, chrysene, dibenzo[a,h]anthracene and indeno[1,2,3-c,d]anthracene are not expected to cause non-cancer adverse health effects. This determination takes into account that PAHs have similar physical, chemical, and toxicological characteristics.

Lead. The maximum concentration of lead (34,400 ppm) detected in the soil exceeded the New Jersey RDCSCC (400 ppm). Please refer to the related discussion in the previous section under Flyash.

Sediment

As presented in Table 11, maximum and mean concentrations of on-site sediment COCs were compared with the corresponding chronic health guideline CVs. For PAH's, the exposure doses were compared to available LOAELs.

Based on maximum concentrations of beryllium, cadmium, iron, thallium and zinc detected in on-site sediment, chronic exposure doses calculated for children and adults were lower than the corresponding health guideline CVs. As such, exposures to these COCs are unlikely to cause non-cancer adverse health effects.

PAHs. As shown in Table 11, PAH exposure dose ranges calculated for children and adults are 10^{-7} to 10^{-8} mg/kg/day and 10^{-8} to 10^{-9} mg/kg/day, respectively. The highest child exposure dose calculated for benzo[a]pyrene (4.76 x 10^{-4}mg/kg/day) is six orders of magnitude lower than the corresponding intermediate oral LOAEL (120 mg/kg/day). Since the remaining exposure doses are less than that calculated for benzo[a]pyrene, ingestion of sediment containing acenaphthylene, benzo[g,h,i]perylene, dibenzo[a,h]anthracene and phenanthrene are not expected to cause non-cancer adverse health effects. This determination takes into account that PAHs have similar physical, chemical, and toxicological characteristics.

Evaluation of Acute Non-Cancer Adverse Health Effects

For the COCs which had potential for chronic adverse health effects as identified in the section above, the likelihood of acute adverse health effects was also evaluated. This evaluation was done to quantify an exposure scenario wherein a trespasser contacts contaminated on-site flyash, soil and sediment as a once in a lifetime event. The calculated exposure doses for these contaminants were lower than the corresponding acute health guideline CVs. Therefore, As such, exposures to these contaminants are unlikely to cause acute non-cancer adverse health effects.

Health Guideline Comparison – Cancer Health Effects

Site-specific lifetime excess cancer risk (LECR) indicates the cancer potential of contaminants and are usually expressed in terms of excess cancer cases in an exposed population. LECR for children and adults are calculated by multiplying the exposure dose by the cancer slope factor. The cancer slope factor is defined as the slope of the dose-response curve obtained from animal and/or human cancer studies and is expressed as the inverse of the daily exposure dose, i.e., $(mg/kg/day)^{-1}$.

The United States Department of Health and Human Services (USDHHS) cancer class for Crown Vantage Landfill site contaminants is presented in Tables 12 - 14. The cancer classes are defined as follows:

1 = Known human carcinogen
2 = Reasonably anticipated to be a carcinogen
3 = Not classified

Ingestion of Contaminated Flyash, Soil and Sediment

Exposure doses were calculated using the following formula:

$$\textit{Exposure Dose (mg/kg/day)} = \frac{C \times IR \times EF}{BW}$$

where, mg/kg/day = milligrams of contaminant per kilogram of body weight per day;
C = concentration of contaminant in soil (mg/kg);
IR = soil ingestion rate (kg/day);
EF = exposure factor;
BW = body weight (kg); and

$$\text{whereas, EF} = \frac{\text{number of days of exposure per year } x \text{ the number of years of exposure}}{\text{days per year } x \text{ 70 years}}$$

Based on the USEPA Exposure Factors (USEPA 1997) and site-specific conditions, the following assumptions were used to calculate the exposure doses and the corresponding LECRs for children and adults:

Media	Receptor Population	Ingestion Rate (mg/day)	No. of Days of Exposure Per Year	Years Exposed	Body Weight (kg)
Flyash Soil Sediment	Child	200	26 days (1 day per week, 6 months per year)	10	21
	Adult	100		30	70

The USEPA has developed a relative potency estimate approach for PAHs (USEPA 1993). Using this approach, the cancer potency of carcinogenic PAHs can be estimated based on their relative potency with reference to benzo[a]pyrene. For each of the carcinogenic PAHs, the benzo[a]pyrene equivalence was calculated by multiplying the maximum concentration detected with the cancer potency factor. The total benzo[a]pyrene equivalence was then obtained by summing each of the individual benzo[a]pyrene equivalences (see Tables 12 - 14).

LECRs based on maximum contaminant concentrations detected in the three media (flyash, soil and sediment) are presented in Tables 12 - 14; LECR values in parentheses are based on mean contaminant concentrations. Although considered human carcinogens, LECRs for beryllium and cadmium could not be calculated since cancer slope factors are unavailable (USEPA 2004). Cancer slope factors for chromium and vanadium are also currently unavailable.

Based on maximum PAHs, PCBs, SVOCs and metals concentrations detected in the three media, the resulting LECR for each contaminant was graphed (see Figure 5). The highest risks in all media were associated with PAHs. In soil, the cancer risks posed by PCBs, chlordane, bis(2-ethylhexyl)phthalate, 4,4'-DDT and dieldrin were less then half the risks posed by the PAHs. For PAHs, the risk for individuals in contact with flyash was approximately two excess cancer cases per 1,000 individuals. A risk of approximately seven excess cancer cases per 10,000 individuals was determined for these individuals when exposed to on-site surface soil. At the mean flyash and soil contaminant concentration, a risk of approximately eight excess cancer cases per 10,000 individuals and approximately three excess cancer cases per 100,000 individuals was determined, respectively (see Figure 6). This is the more likely exposure scenario. As previously indicated, the LECRs presented in this report are based on site-specific assumptions that may not be representative of actual individual exposures.

Child Health Considerations

The NJDHSS and ATSDR recognize that the unique vulnerabilities of infants and children demand special emphasis in communities faced with contamination in their environment. Children are at greater risk than adults from certain types of exposures to hazardous substances. Their lower body weight and higher intake rate results in a greater dose of hazardous substance per unit of body weight. The developing body systems of children can sustain permanent damage if toxic exposures occur during critical growth stages. Most important, children depend completely on adults for risk identification and management decisions, housing decisions, and access to medical care.

The maximum concentrations of lead detected in the flyash and surface soil (77,100 and 34,400 ppm, respectively) considerably exceeded the New Jersey RDCSCC (400 ppm). Although no MRL or RfD is available for lead, these levels are of concern. Environmental exposure to lead has long been recognized as a public health problem particularly among children. Excessive concentration of lead in soil has been shown to increase blood lead levels in young children (ATSDR 1999). Some of the health effects of lead exposure on various organ systems are permanent or latent and may appear after exposure has ceased. Signs and symptoms associated with lead toxicity include decreased learning and memory, lowered Intelligence Quotient (IQ), speech and hearing impairment, fatigue, and lethargy. The Centers for Disease Control and Prevention (CDC) action level for children up to 84 months of age is 10 micrograms of lead per deciliter of blood or 10 µg/dL (ATSDR 1999). In other words, CDC considers children to have an elevated level of lead if the amount of lead in the blood is at least 10 µg/dL.

The USEPA Integrated Exposure Uptake Biokinetic (IEUBK) model was used to calculate the geometric mean of lead in blood in children, aged up to 84 months (USEPA 1994a). The model also provides the probability estimate (expressed as P_{10}) that a typical child will have a blood lead level greater or equal to the level associated with adverse health effects (set at 10 µg/dL). This P_{10} estimate should be at or below a protection level of five percent, i.e., $P_{10} \leq 5$

percent, as recommended by the USEPA Office of Solid Waste and Emergency Response (USEPA 1994b).

Lead exposures associated with the recreational (i.e., intermittent) use of the Crown Vantage Landfill site by children was evaluated using the IEUBK model (USEPA 2003). The lead concentration in the flyash is higher than in soil and the flyash is present over majority of the site. Therefore, the average lead concentration in flyash (12,981 ppm; see Table 1) was used as an input value to calculate expected children's blood lead levels. The assumptions for the recreational exposure scenario for children aged up to 84 months are as follows:

1. Children are exposed to site soil each time the site is visited. The site visit frequency was one day per week over six months of the year; the model assumes that the exposure during the remaining days of the week is at the residence.
2. The default lead concentration of the residential soil is 200 ppm (USEPA 2002).
3. IEUBK model default values were used for all other variables (USEPA 2002).

The predicted geometric mean blood lead levels and the probability of blood lead levels exceeding 10 µg/dL (P_{10}) for children are shown in the following table:

Age (months)	Exposure scenario			
	Zero visits per week[1]		One site visit per week[2]	
	Blood Lead Level[3] (µg/dL)	P_{10} (%)[4]	Blood Lead Level (µg/dL)	P_{10} (%)
6 -12	3.8	1.98	11.5	61.7
12 - 24	4.2	3.10	13.2	72.5
24 - 36	3.9	2.25	12.5	68.2
36 - 48	3.7	1.70	12.1	65.5
48 - 60	3.1	0.677	10.1	51.1
60 - 72	2.7	0.295	8.6	37.5
72 - 84	2.5	0.165	7.6	28.4

[1]Soil lead concentration (residence only) = 200 ppm
[2]Weighted soil lead concentration (includes site and residence) = 2,025 ppm. Calculated as follows: (12,981 ppm x 1 day/7 days) + (200 ppm x 6 days/7 days) = 2,025 ppm
[3]Geometric mean as calculated by the IEUBK model
[4]Probability of blood lead level > 10 µg/dL

The mean flyash concentration at the site was time-weighted since exposures are assumed to have occur only one day per week; however, this was not annualized as the IEUBK model treats such weighted values as applying to a full year exposure duration.

For the exposure scenario of zero site visits per week, the blood lead levels for all age groups are below the action level (10 µg/dL). Additionally, for all age groups up to 84 months, the P_{10} value was below the recommended protection level of five percent. For the recreational exposure scenario of one site visit per week, the blood lead levels for the age ranges 6 – 60 months are elevated above 10 µg/dL. Furthermore, the P_{10} value for children aged up to 84 months ranged from 28 to 73 percent, approximately, significantly elevated above the protection level of five percent. Even though the blood lead levels for children aged 60 – 84 month are below the action level, the P_{10} estimates (38 and 28 percent, approximately) are still above the recommended protection level. Therefore, it can be concluded that children (aged up to 84 months) who are exposed to flyash at the Crown Vantage Landfill site, once day per week over six months of the year, would have blood lead levels elevated over the established 10 µg/dL action level.

It is important to note that the IEUBK model should not be relied upon to accurately predict blood lead levels above 30 µg/dL since the model was not empirically validated. Additionally, the model should not be used for exposure periods of less than three months, or in which a higher exposure occurs less than once per week or varies irregularly.

The potential health effects associated with exposure to other site-related contaminants were also evaluated. Based on maximum MCPA concentration detected in flyash, the exposure dose calculated for children exceeded the chronic health guideline comparison value. As such, the potential for chronic non-cancer adverse health effects in children from exposures to MCPA in the flyash was determined to be low.

Based on the maximum chromium concentration detected in flyash and surface soil, and maximum vanadium concentration detected in surface soil, the exposure dose calculated for children exceeded the chronic health guideline comparison value. The likelihood of chronic non-cancer adverse health effects was determined to be low.

With respect to cancer risks using maximum concentrations of PAHs detected, the risk for children exposed to flyash was approximately four excess cancer cases per 1,000 children (see Figure 7). A risk of approximately two excess cancer cases per 1,000 children was determined for these children when exposed to on-site surface soil (see Figure 7). At the mean flyash and soil contaminant concentration, a risk of approximately two excess cancer cases per 1,000 individuals and approximately seven excess cancer cases per 100,000 children was determined, respectively. This is the more likely exposure scenario (see Figure 8).

Health Outcome Data

Based in a review of data available from the USEPA and NJDEP, completed exposure pathways exist for the Crown Vantage Landfill site. These pathways are from on-site exposure to individuals such as hikers, campers, dirt riders and recreational users of the river. Since the completed exposure pathways are from on-site exposure (i.e., the exposure does not extend into residential locations), identification of an exposed population is difficult as this population may not necessarily reside in a community in close proximity to the site. Consequently, because of these limitations in identifying an exposed population, evaluation of health outcome data would not be feasible and therefore was not conducted.

Public Comment

The public health assessment was released for public comment from March 8 through May 26, 2006. Responses to written public comments are in Appendix B.

On May 12, 2006, a joint availability/public meeting was held in Alexandria Township to gather community concerns and to present results from the public health assessment prepared for the site. Informal and formal presentations were made by Somia Aluwalia and Sharon Kubiak from NJDHSS; Leah Escobar from ATSDR; and the site case manager and community relations staff member from the NJDEP. The meeting was attended by a dozen residents. A primary concern for the residents was the accessibility to the site from the Delaware River and from hiking trails around the site. The lack of signage was another issue of concern for the meeting attendees. Suggestions included more signs on the eastern, southern and northern parts of the site that are already fenced, indicating the presence of a Superfund site behind the fenced area. Residents commented that it was vital that signs be present in a prominent fashion on the western shore, adjacent to the Delaware River. Residents noted that the recreational use of the Delaware River occurs most heavily between Memorial Day and Labor Day. Due to lack of prominent signage on the shore-line of the site, it was suggested that the canoe and tubing liveries be informed of the presence of the site prior to the Memorial Day weekend. One resident mentioned that the children from areas local to the site were utilizing the trials for biking. Another resident noted that as an area fisherman, he knew of individuals who retained fish caught from the Delaware River, presumably to be used for consumption. Although the risks to biota from the site have not been determined, copies of the most recent New Jersey Fish Consumption Advisories were provided. Several concerns centered on remediation actions at the landfill site. It was noted that while the residents were satisfied with USEPA's shore stabilization efforts, they were particularly interested in the timeline for active remediation on-site. One resident was concerned about stagnation and subsequent mosquito issues at a retention pond (associated with the former paper mill) located north of the site. Another resident expressed concern about water quality in his private drinking water well, located to the north of the site and at approximately 350 feet depth. It was recommended to this individual that he get his well tested as per NJDEP's Private Well Testing Act. Some residents also expressed concerns about the Milford municipal water supply, specifying malodors and staining of fabrics from the tap water. They were advised to contact the Hunterdon County health department.

Conclusions

There is a completed exposure pathway via the incidental ingestion of contaminated flyash, surface soil and sediment. The exposed population includes individuals accessing the site (including children), recreational users of adjoining parklands and the Delaware River. Access to the site remains available since the fence on the Delaware River side is only partial due to the river's impact. Direct observations made during the recent USEPA removal action indicate persons continue to access the site from along the river bank or directly via the river. Pathways that existed through the landfill made for easier access to the site and were reportedly used as a short cut-by kayakers, bird watchers, and other recreational users of the Delaware River due to its proximity and location adjacent to state park lands. A barbeque pit is present in an area at the top of the landfill. Persons accessing the site could come into direct contact with the exposed waste material. As noted in the site visit section, the bottom shoe soles of a NJDHSS staff member had disintegrated shortly following the site visit.

Based on the maximum chromium, MCPA and vanadium concentration detected in flyash and surface soil, a potential for chronic non-cancer adverse health effects was found for children only and was determined to be low. For PAHs, the highest child exposure doses in each media were compared to available LOAELs and were unlikely to cause chronic non-cancer adverse health effects. The maximum lead concentration detected in flyash and surface soil at the site is cause for concern, particularly among the children. Using the mean lead concentrations detected in the flyash, the results of the IEUBK lead model indicated that for children exposed to flyash at the Crown Vantage Landfill site, once day per week over six months of the year, the blood lead levels would be elevated over the level of concern. It should be noted that blood lead levels in this report are estimates based on site specific assumptions and IEUBK model default values for air and water lead concentrations and dietary lead levels.

For cancer health effects, LECRs were calculated based on maximum and average contaminant concentrations. Adult LECRs (using maximum contaminant concentrations) from ingestion of contaminated flyash and surface soil indicated excess cancer risks of approximately two excess cancer cases per 1,000 individuals and approximately seven excess cancer cases per 10,000 individuals, respectively. At the mean flyash and soil contaminant concentration, a risk of approximately eight excess cancer cases per 10,000 individuals and approximately three excess cancer cases per 100,000 individuals was determined, respectively. For hazardous waste site cleanups, the USEPA indicates that actions are warranted for excess cancer risks greater than one case in 10,000 individuals and actions may be taken for risks between one in 10,000 and one in 1,000,000 individuals (USEPA 2005f). As such, the site currently poses a ***Public Health Hazard***.

It should be noted that the assumptions used for calculation of the exposure doses are conservative due to the uncertainties associated with frequency of individuals accessing the site. Actual exposures are probably less frequent and to lower concentrations.

The physical/explosion hazards at the site are not fully characterized. Elevated levels of organic vapors have been detected in the subsurface of the landfill and in areas of subsidence at the upper portion of the landfill at near-explosive levels. The threat of fire or explosion exists should an ignition source such as a brush or camp fire be present in those areas. Ambient air sampling data is not known to exist with regard to the Crown Vantage Landfill site.

There is an actual or potential exposure to nearby animals from contaminants present on-site in drums or other bulk storage containers. As the river further erodes the face of the landfill, drums containing hazardous substances may be exposed and their contents released into the environment. Hazardous contaminants, such as PAHs, heavy metals, and PCBs have been identified at the site, although contamination of the Delaware River cannot be solely attributable to the Crown Vantage Landfill site. These contaminants have the potential to enter the food chain; as such, this pathway remains a potential pathway of concern. Although an advisory is in effect for the Delaware River regarding the consumption of striped bass, channel catfish, and

American eel due to PCB/dioxin contamination, statements made by local residents' document that the segment of the Delaware River adjacent to the site is fished for consumption. Sampling events at the landfill have not analyzed for dioxin which is formed by burning chlorine-based chemical compounds with hydrocarbons. Dioxin pollution is also affiliated with paper mills which use chlorine bleaching in their process. Given that waste materials deposited at the landfill included those generated at the former James River paper mill, and that the landfill was reportedly set on fire frequently, there is a potential for presence of dioxin-contaminated media on-site.

The landfill is not capped and the western face of the landfill is unsecured. During the period June 2003 through January 2004, the Delaware River's monthly average flow rates were approximately 300% above historic norms. The remnants of Hurricane Ivan in September 2004 resulted in the Delaware River cresting above the face of the landfill. Furthermore, two spring rainstorms in March and April 2005, combined with snowmelt caused major flooding in the Delaware River basin. If these hydrologic conditions recur, the releases would potentially increase as the landfill face is further eroded. Materials released could impact persons using the river. The Delaware River is utilized by families for seasonal recreational activities such as kayaking, canoeing and the use of personal water crafts (i.e., jet skiing). There are other independent recreational users of the Delaware River, including charter companies and canoe/kayak clubs. The recreational uses of the Delaware River are infrequent and therefore the likelihood of frequent significant exposures via ingestion of river sediment/surface water pathway is unlikely.

Recommendations

1. The USEPA should consider posting prominent signs to better inform the community that the Crown Vantage Landfill site is a designated Superfund site.

2. The USEPA and/or potential responsible party(ies) should consider implementing remedial measures to reduce migration of onsite contaminants to the Delaware River. The Crown Vantage Landfill site is not capped, and the western face of the landfill is impacting the Delaware River. Should no action be taken, or the planned action delayed, further erosion of and damage to the landfill face can be expected during elevated river levels. This would result in the continued release of hazardous substances into the Delaware River, particularly during significant flood events.

3. The USEPA and/or potential responsible party(ies)should consider implementing air monitoring during remedial activities to determine the potential health impact of airborne contaminants to potentially exposed populations and to evaluate the potential for an explosion hazard. There are elevated levels of organic vapors present at near explosive levels, at the surface, near the center of the landfill and the concentration, extent, and migration pathway of these vapors in the subsurface is not known.

4. The USEPA and/or potential responsible party(ies) should conduct a full characterization of the on-site and off-site soil and sediment contamination at the site, including the

determination of whether dioxin is present. The Delaware River is considered a fishery. Hazardous substances, such as PAHs, heavy metals, and PCBs have been identified at the site. These substances could impact the fish and have the potential to enter the food chain and be consumed by persons fishing in the area of the site.

Public Health Action Plan (PHAP)

The purpose of a PHAP is to ensure that this health assessment not only identifies public health hazards, but also provides a plan of action designed to mitigate and prevent adverse human health effects resulting from exposure to hazardous substances in the environment. Included is a commitment on the part of ATSDR and NJDHSS to follow up on this plan to ensure that it is implemented. The public health actions to be implemented by the NJDHSS and the ATSDR are as follows:

Public Health Actions Undertaken by NJDHSS and ATSDR

1. The NJDHSS and ATSDR evaluated whether radioactivity levels in fly ash at the Crown Vantage Landfill site posed a threat to human health (ATSDR 2004).

2. The NJDHSS and ATSDR reviewed available environmental data and other relevant information for the Crown Vantage Landfill site to determine human exposure pathways and public health issues.

3. The NJDHSS and ATSDR conducted two site visits and met with local health and public officials to identify community concerns.

Public Health Actions Planned by NJDHSS and ATSDR

1. The NJDHSS, ATSDR and the USEPA will identify organizations, groups and businesses that may plan activities on or near the site for recreational, environmental or conservation activities. These organizations will be contacted to schedule educational outreach in order to inform them of the potential health risks associated with the site.

2. Copies of this public health assessment will be provided to local health, public officials and other interested parties in the vicinity of the site. Copies will also be available at the township library and/or the Internet.

3. The ATSDR and the NJDHSS will review and evaluate any community health concerns that may arise with the commencement of site remediation. A public availability session to gather community concerns and comments will be held in the future during the public comment period.

4. New environmental, toxicological, or health outcome data, or the results of implementing the recommendation and proposed actions, may determine the need for additional actions at this site. The ATSDR and the NJDHSS will reevaluate and expand the PHAP as warranted.

5. As site conditions change, public health implications and the potential for completed human exposure pathways will be reevaluated and the current designated hazard category will be reconsidered.

6. The NJDHSS and the ATSDR will coordinate with the NJDEP and the USEPA to implement appropriate intervention to minimize exposures to site-related contaminants.

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CERTIFICATION

The public health assessment for the Crown Vantage Landfill site, Hunterdon County, New Jersey was prepared by the New Jersey Department of Health and Senior Services under a cooperative agreement with the Agency for Toxic Substances and Disease Registry. It is in accordance with approved methodology and procedures existing at the time the public health assessment was initiated. Editorial review was completed by the cooperative agreement partner.

Gregory V. Ulirsch, MS, PhD
Technical Project Officer, CAT, SPAB, DHAC
Agency for Toxic Substances and Disease Registry

The Division of Health Assessment and Consultation (DHAC), ATSDR, has reviewed this public health assessment and concurs with its findings.

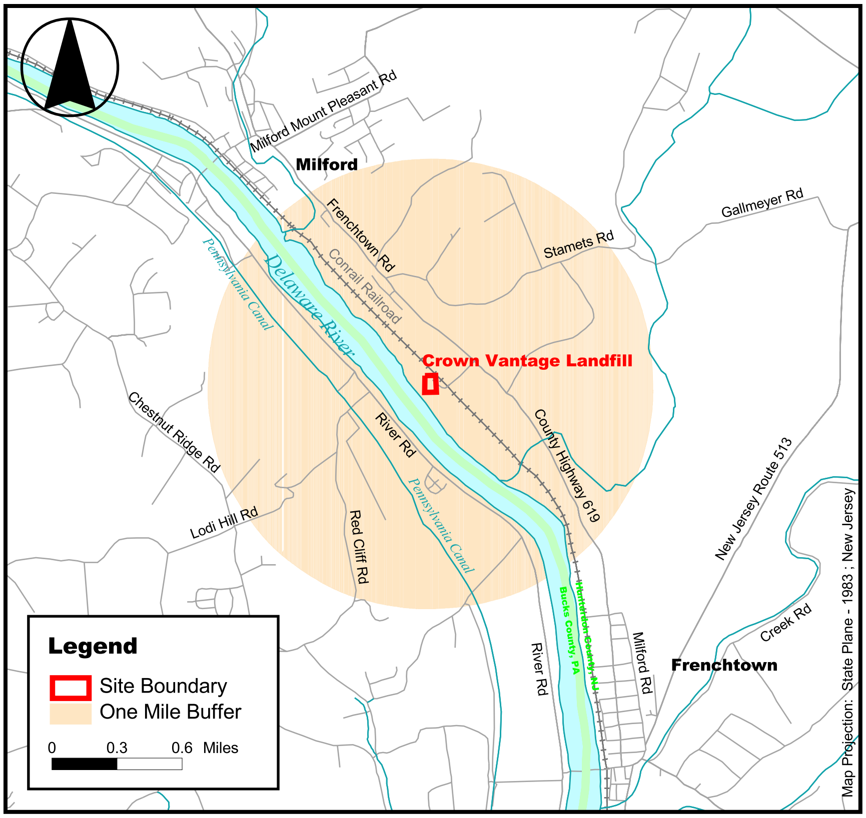
Alan Yarbrough
Team Leader, CAT, SPAB, DHAC
Agency for Toxic Substances and Disease Registry

Crown Vantage Landfill

INTRO MAP

AlexandriaTownship, New Jersey

EPA Facility ID NJN000204492



Base Map Source: 1995 TIGER/Line Files

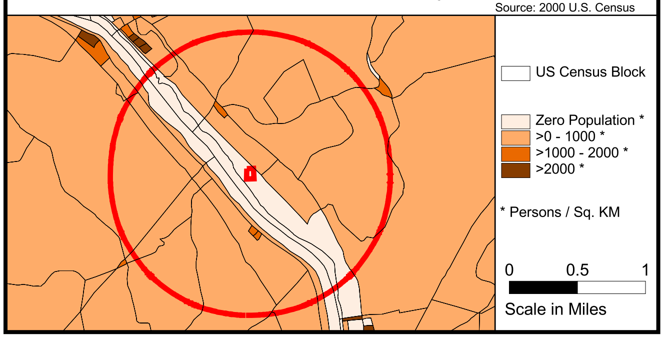
Hunterdon County, New Jersey

Demographic Statistics Within Specified Distance*	.5mi	1mi
Total Population	273	979
White alone	265	958
Black alone	4	5
Am. Indian & Alaska Native alone	0	0
Asian alone	0	2
Native Hawaiian and Other Pacific Islander alone	0	0
Some other race alone	0	1
Two or More races	3	13
Hispanic or Latino	6	13
Children Aged 6 & Younger	17	80
Adults Aged 65 & Older	46	132
Females Aged 15 - 44	47	174
Total Housing Units	118	393

Demographics Statistics Source: 2000 Census
*Calculated using an area-proportion spatial analysis technique

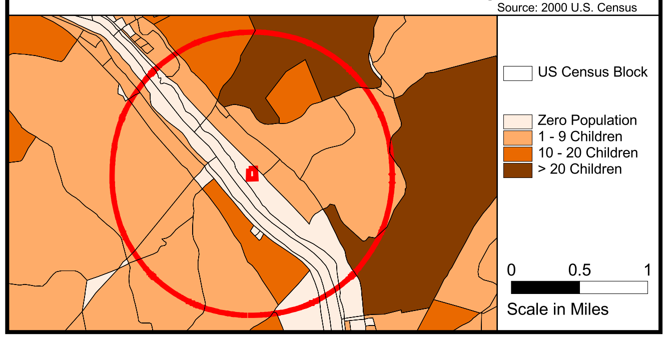
Population Density

Source: 2000 U.S. Census



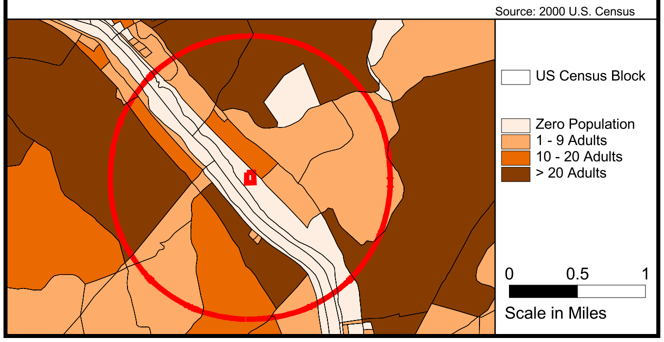
Children 6 Years and Younger

Source: 2000 U.S. Census



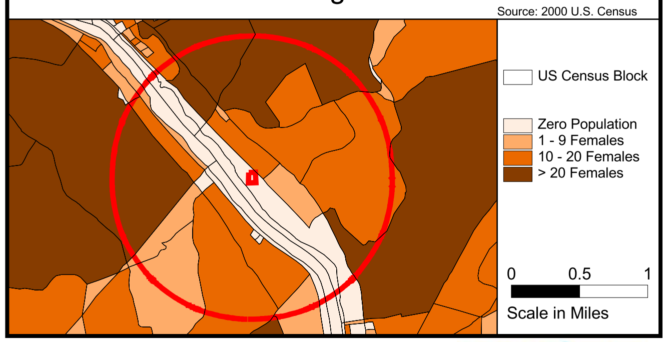
Adults 65 Years and Older

Source: 2000 U.S. Census



Females Aged 15 - 44

Source: 2000 U.S. Census



JVA102104

GRASP

Figure 2: Demographic Information of the Crown Vantage Landfill site based on 2000 U.S. Census

Figure 3: Location of the Crown Vantage Landfill site

Figure 4: Location of the Crown Vantage Landfill site and four public supply wells (indicated by red stars)

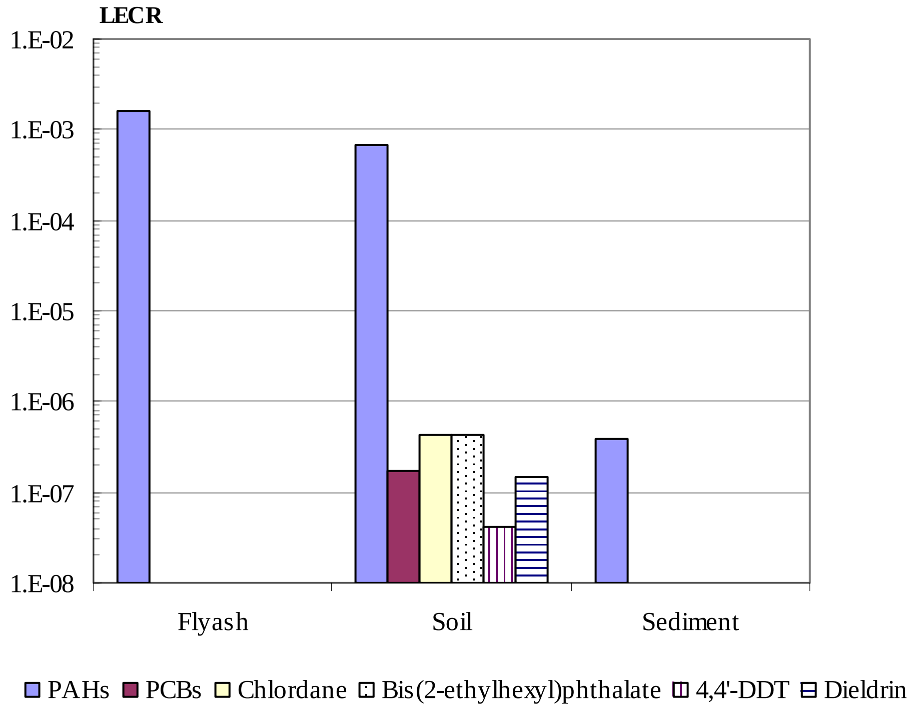


Figure 5: Adult LECR associated with PAHs and SVOCs based on Maximum Concentration of Contaminants

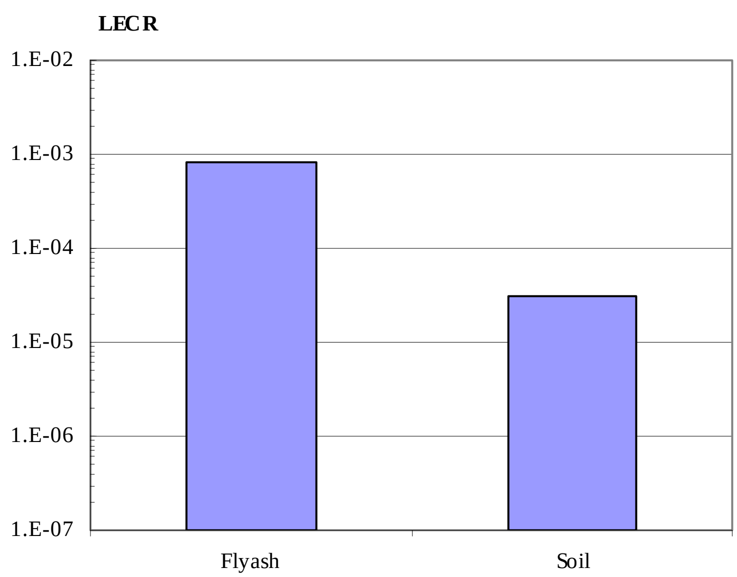


Figure 6: Adult LECR associated with PAHs based on Mean Concentrations

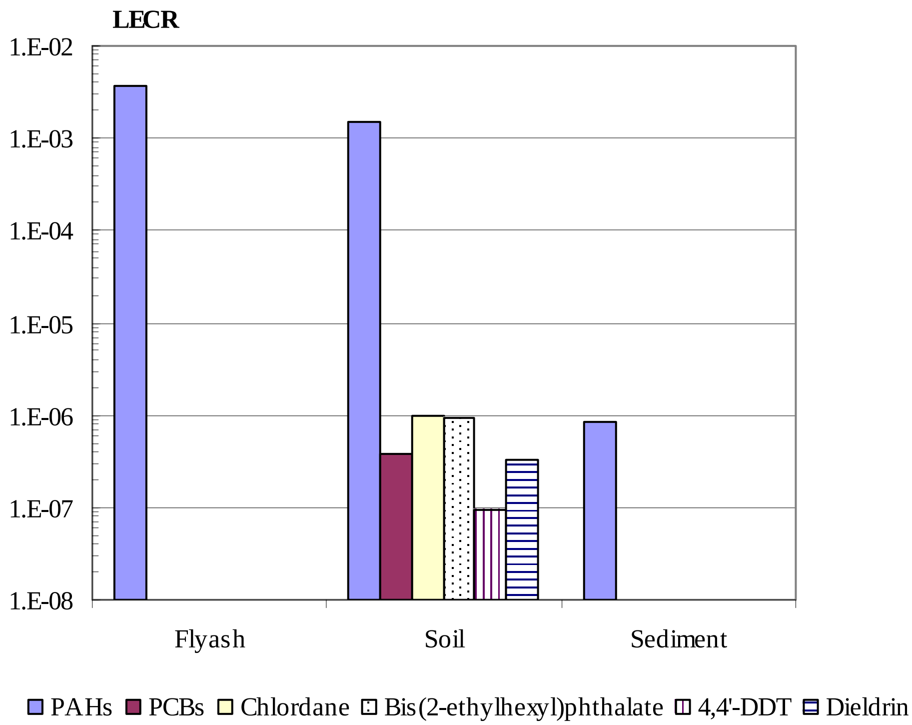


Figure 7: Child LECR associated with PAHs and SVOCs based on Maximum Concentrations of Contaminants

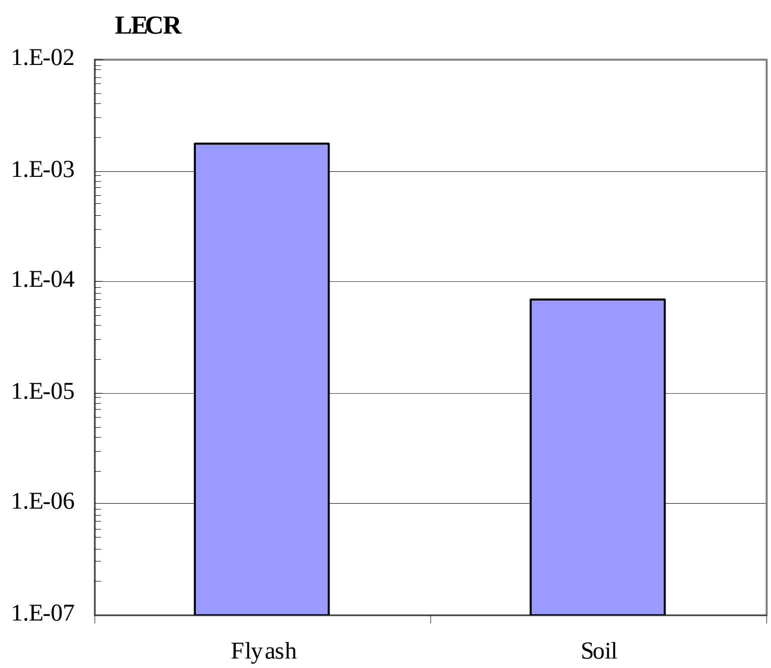


Figure 8: Child LECR associated with PAHs based on Mean Concentrations

Table 1: Contaminant Concentration in Flyash samples (USEPA sampling event, November 2003) from the Crown Vantage Landfill site

Contaminant	No. of Samples	No. of Detections	Concentration (ppm)			Environmental Guideline Comparison Value (ppm)	New Jersey RDCSCC[1] (ppm)	Retained for Further Evaluation
			Minimum	Maximum	Average			
Volatile Organic Compounds								
Methylene Chloride	6	5	0.003	0.005	0.004	90 (CREG)[2]	49	No
Semi-Volatile Organic Compounds								
Bis(2-ethylhexyl)phthalate	6	1	0.19	0.19	0.19	50 (CREG)	49	No
Di-n-butylphthalate	6	3	0.16	1,400	467	5,000 (RMEG)	5,700	No
Semi-Volatile Organic Compounds (Polycyclic Aromatic Hydrocarbons)								
Acenaphthene	6	2	310	400	355	1,000 (EMEG)[3]	3,400	No
Anthracene	6	4	0.15	840	373	20,000 (EMEG)	10,000	No
Acetophenone	6	1	0.32	0.32	0.32	5,000 (RMEG)[4]	NA[5]	No
Benzaldehyde	6	1	0.15	0.15	0.15	5,000 (RMEG)	NA	No
Benzo[a]pyrene	6	4	0.38	2,000	950	0.1 (CREG)	0.66	**Yes**
Benzo[a]anthracene	6	4	0.47	2,500	1,150	3.9 (RBC)C[6]	0.9	**Yes**
Benzo[b]fluoranthene	6	4	0.43	2,200	950	3.9 (RBC)C	0.9	**Yes**
Benzo[k]fluoranthene	6	4	0.41	760	310	8.7 (RBC)N	0.9	**Yes**
Benzo[g,h,i]perylene	6	4	0.22	880	365	NA	NA	**Yes**
Carbazole	6	4	0.099	330	135	32 (RBC) C	NA	**Yes**
Chrysene	6	4	0.51	2,500	1,125	390 (RBC)C	9	**Yes**
Dibenzo[a,h]anthracene	6	3	0.14	480	253	0.087 (RBC)C	0.66	**Yes**
Dibenzofuran	6	2	140	190	165	160 (RBC)N	NA	**Yes**
Fluoranthene	6	4	0.99	5,200	2,350	800 (EMEG)	2,300	**Yes**
Fluorene	6	2	250	350	300	800 (EMEG)	2,300	No

Table 1: (Cont'd)

Contaminant	No. of Samples	No. of Detections	Concentration (ppm)			Environmental Guideline Comparison Value (ppm)	New Jersey RDCSCC[1] (ppm)	Retained for Further Evaluation
			Minimum	Maximum	Average			
Indeno[1,2,3-c,d]pyrene	6	4	0.31	1,300	520	3.9 (RBC)C	0.9	**Yes**
Naphthalene	6	3	0.18	48	30.7	40 (EMEG)	230	**Yes**
Phenanthrene	6	4	0.63	3,500	1,575	NA	NA	**Yes**
Pyrene	6	4	0.81	4,300	1,975	2,000 (RMEG)	1,700	**Yes**
Semi-Volatile Organic Compounds (Pesticides/Herbicides)								
Dieldrin	6	1	0.0068	0.0068	0.01	0.04 (CREG)	0.042	No
Endrin	6	3	0.0015	0.036	0.02	20 (EMEG)	17	No
Methoxychlor	6	2	0.023	1.5	0.76	300 (EMEG)	280	No
2-Methylnaphthalene	6	2	28	35	31.5	200 (RMEG)	NA	No
4,4'-DDD	6	1	0.063	0.063	0.06	3 (CREG)	3	No
4,4'-DDE	6	3	0.0022	0.014	0.01	2 (CREG)	2	No
4,4'-DDT	6	3	0.0033	0.07	0.03	2 (CREG)	2	No
Dicamba	6	1	0.36	0.36	0.36	2,000 (RMEG)	NA	No
MCPA	6	3	69	880	586	30 (RMEG)	NA	**Yes**
MCPP	6	1	120	120	120	78 (RBC) N	NA	**Yes**
Pentachlorophenol	6	2	3	3.3	3.15	6 (CREG)	6	No
Metals								
Aluminum	6	6	1,530	21,600	9,168	100,000 (EMEG)	NA	No
Antimony	6	4	0.69	28	7.75	20 (RMEG)	14	**Yes**
Arsenic	6	6	3	10	5	20 (EMEG)	20	No
Barium	6	6	54	2,540	725	5,500 (RBC)N	700	**Yes**
Beryllium	6	6	0.22	2.70	1.15	100 (EMEG)	1	**Yes**
Cadmium	6	5	0.43	0.82	0.64	10 (EMEG)	1	No

Table 1: (Cont'd)

Contaminant	No. of Samples	No. of Detections	Concentration (ppm)			Environmental Guideline Comparison Value (ppm)	New Jersey RDCSCC[1] (ppm)	Retained for Further Evaluation
			Minimum	Maximum	Average			
Chromium	6	6	8.40	12,800	2,161	200 (RMEG)	240	**Yes**
Cobalt	6	6	1.10	5.00	2.80	500 (EMEG)	NA	No
Copper	6	6	25	938	236	500 (EMEG)	600	**Yes**
Iron	6	6	3,320	23,900	10,628	2,300 (RBC)N	NA	**Yes**
Lead	6	6	24	77,100	12,981	NA	400	**Yes**
Manganese	6	6	12	2,470	906	3,000	NA	No
Mercury	6	6	0.09	0.69	0.29	NA	14	No
Nickel	6	6	18	441	135	1,000 (RMEG)	250	**Yes**
Selenium	6	6	0.91	1.80	1.29	300 (EMEG)	63	No
Silver	6	6	0.46	2.30	0.93	300 (RMEG)	110	No
Thallium	6	3	2.50	18	7.83	5.5 (RBC)N	2	**Yes**
Other								
Cyanide	6	5	0.21	75	16	1,000 (RMEG)	1,100	No

[1]Residential Direct Contact Soil Cleanup Criteria; [2]Cancer Risk Evaluation Guide; [3]Environmental Media Evaluation Guide; [4]Reference Media Evaluation Guide; [5]NA - Not Available; [6]USEPA Region 3 Risk-Based Concentrations (N: Non-carcinogenic effects, C: Carcinogenic effects)

Table 2: Contaminant Concentration in On-site Surface Soil (0-6 inches) samples from the Crown Vantage Landfill site (NJDEP April 2003 sampling event and USEPA November 2003 sampling event)

Contaminant	No. of Samples	No. of Detections	Concentration (ppm)			Environmental Guideline Comparison Value (ppm)	New Jersey RDCSCC[1] (ppm)	Retained for Further Evaluation
			Minimum	Maximum	Average			
Semi-Volatile Organic Compounds								
Benzoic Acid	31	6	1	5.8	2.26	200,000 (RMEG)	NA	No
Bis(2-ethylhexyl)phthalate	31	30	0.06	700	24.8	50 (CREG)	49	**Yes**
Butylbenzylphthalate	9	2	0.092	0.26	0.176	10,000 (RMEG)	1,100	No
Di-n-butylphthalate	31	25	0.05	650	34.8	5,000 (RMEG)	5,700	No
Di-n-octylphthalate	31	7	0.34	10	3.95	800 (EMEG)	1,100	No
4-Methylphenol	9	1	0.59	0.59	0.590	390 (RBC)N	2,800	No
Phenol	31	5	0.092	3.4	1.03	20,000 (RMEG)	10,000	No
Semi-Volatile Organic Compounds (Polycyclic Aromatic Hydrocarbons and Polychlorinated Biphenyls)								
Acenaphthene	31	13	0.05	230	11.9	1,000 (EMEG)[2]	3,400	No
Acenaphthylene	31	11	0.06	0.73	0.143	NA[3]	NA	**Yes**
Anthracene	31	17	0.06	460	14.1	20,000 (EMEG)	10,000	No
Benzaldehyde	9	8	0.046	0.2	0.118	5,000 (RMEG)[4]	NA	No
Benzo[a]anthracene	31	28	0.09	820	22.8	3.9 (RBC)C[5]	0.9	**Yes**
Benzo[a]pyrene	31	25	0.09	700	23.2	0.1 (CREG)[6]	0.66	**Yes**
Benzo[b]fluoranthene	31	25	0.11	740	25.2	3.9 (RBC)C	0.9	**Yes**
Benzo[g,h,i]perylene	31	24	0.05	350	12.4	NA	NA	**Yes**
Benzo[k]fluoranthene	31	25	0.1	770	25.7	8.7 (RBC)N	0.9	**Yes**
Carbazole	9	4	0.047	0.22	0.106	32 (RBC)C	NA	No
Chrysene	31	28	0.07	810	22.6	390 (RBC)C	9	**Yes**
Dibenzo[a,h]anthracene	31	11	0.09	220	12.8	0.087 (RBC)C	0.66	**Yes**

Table 2: (Cont'd)

Contaminant	No. of Samples	No. of Detections	Concentration (ppm)			Environmental Guideline Comparison Value (ppm)	New Jersey RDCSCC[1] (ppm)	Retained for Further Evaluation
			Minimum	Maximum	Average			
Dibenzofuran	31	9	0.05	110	8.09	160 (RBC)N	NA	No
Fluoranthene	31	31	0.14	1,600	38.5	800 (EMEG)	2,300	No
Fluorene	30	14	0.046	200	10.4	800 (EMEG)	2,300	No
Indeno[1,2,3-c,d]pyrene	31	24	0.1	370	15.06	3.9 (RBC)C	0.9	**Yes**
2-Methylnaphthalene	9	2	0.057	0.06	0.059	200 (RMEG)	NA	No
Naphthalene	30	14	0.042	33	2.62	40 (EMEG)	230	No
Phenanthrene	31	29	0.1	1,300	34.2	NA	NA	**Yes**
Pyrene	31	20	0.19	1,900	90.1	2,000 (RMEG)	1,700	No
Total PCBs	31	7	0.053	2	0.959	0.32 (RBC)C	0.49	**Yes**
Semi-Volatile Organic Compounds (Pesticides/Herbicides)								
alpha-Chlordane	31	11	0.0008	28.4	2.61	2 (CREG)	NA	**Yes**
gamma-Chlordane	31	12	0.0002	0.03	0.0133	2 (CREG)	NA	No
4,4'-DDD	31	4	0.022	0.122	0.0813	3 (CREG)	3	No
4,4'-DDE	31	8	0.002	0.089	0.0191	2 (CREG)	2	No
4,4'-DDT	31	16	0.009	2.8	0.294	2 (CREG)	2	**Yes**
Dieldrin	31	10	0.0006	0.216	0.0287	0.04 (CREG)	0.042	**Yes**
Endrin	31	4	0.005	0.729	0.132	20 (EMEG)	17	No
Endosulfan II	31	1	0.017	0.017	0.017	100 (EMEG)	340	No
Heptachlor	31	1	0.06	0.06	0.06	0.2 (CREG)	0.15	No
Lindane	31	5	0.002	0.5	0.128	0.5 (EMEG)	0.52	No
2,4'-D	31	20	0.039	1.35	0.254	500 (RMEG)	NA	No
Silvex	31	2	0.001	0.007	0.004	400 (RMEG)	NA	No
MCPA	9	6	53	310	153	30 (RMEG)	NA	**Yes**

Table 2: (Cont'd)

Contaminant	No. of Samples	No. of Detections	Concentration (ppm)			Environmental Guideline Comparison Value (ppm)	New Jersey RDCSCC[1] (ppm)	Retained for Further Evaluation
			Minimum	Maximum	Average			
Metals								
Aluminum	9	9	6,280	10,800	8,253	100,000 (EMEG)	NA	No
Antimony	31	5	0.71	21.2	7.38	20 (RMEG)	14	**Yes**
Arsenic	31	29	1.9	16.1	5.65	20 (EMEG)	20	No
Barium	31	31	34.6	1,011	169.3	5,500 (RBC)N	700	No
Beryllium	31	28	0.45	4.4	1.46	100 (EMEG)	1	No
Cadmium	31	21	0.5	12.3	3.75	10 (EMEG)	1	**Yes**
Chromium	31	31	5.1	5,500	273	200 (RMEG)	240	**Yes**
Cobalt	9	9	5.5	14.7	10.89	500 (EMEG)	NA	No
Copper	31	31	15.7	4,500	215.2	60 (EMEG)	NA	**Yes**
Iron	9	9	12,200	387,000	53,891	2,300 (RBC)N	NA	**Yes**
Lead	31	31	18.2	34,400	1,612	NA	400	**Yes**
Manganese	9	9	375	1,140	715	3,000 (RMEG)	NA	No
Mercury	31	28	0.052	3.3	0.328	NA	14	No
Nickel	31	31	13	1,160	133.4	1,000 (RMEG)	250	**Yes**
Selenium	9	7	2.6	9.8	4.45	300 (EMEG)	63	No
Silver	9	4	0.08	0.18	0.13	300 (EMEG)	110	No
Thallium	9	9	1.7	7.2	3.33	5.5 (RBC)N	2	**Yes**
Vanadium	31	31	16.1	5,590	796	200 (EMEG)	370	**Yes**
Zinc	31	31	17.9	3,820	467	600 (EMEG)	1,500	**Yes**
Other								
Cyanide	9	9	0.22	15	1.85	1,000 (RMEG)	1,100	No

[1]Residential Direct Contact Soil Cleanup Criteria; [2]Environmental Media Evaluation Guide; [3]NA - Not Available; [4]Reference Media Evaluation Guide; [5]USEPA Region 3 Risk-Based Concentrations (N: Non-carcinogenic effects, C: Carcinogenic effects); [6]Cancer Risk Evaluation Guide

Table 3: Contaminant Concentration in On-site Sediment samples (USEPA November 2003 sampling event) from the Crown Vantage Landfill site

Contaminant	No. of Samples	No. of Detections	Concentration (ppm)			Environmental Guideline Comparison Value (ppm)	New Jersey RDCSCC[1] (ppm)	Retained for Further Evaluation
			Minimum	Maximum	Average			
Semi-Volatile Organic Compounds								
Bis(2-ethylhexyl)phthalate	11	10	0.12	0.32	0.187	50 (CREG)	49	No
Di-n-butylphthalate	11	2	0.061	0.086	0.074	5,000 (RMEG)	5,700	No
4-Methylphenol	11	3	0.081	0.45	0.204	390 (RBC)N	2,800	No
4-Nitroaniline	11	1	1.3	1.3	1.3	32 (RBC)C	NA	No
Semi-Volatile Organic Compounds (Polycyclic Aromatic Hydrocarbons and Polychlorinated Biphenyls)								
Acenaphthylene	11	1	0.051	0.051	0.051	NA[2]	NA	**Yes**
Anthracene	11	8	0.076	0.2	0.126	20,000 (EMEG)[3]	10,000	No
Benzaldehyde	11	10	0.067	0.97	0.250	5,000 (RMEG)[4]	NA	No
Benzo[a]anthracene	11	11	0.19	0.65	0.395	3.9 (RBC)C[5]	0.9	No
Benzo[a]pyrene	11	11	0.14	0.62	0.345	0.1 (CREG)[6]	0.66	**Yes**
Benzo[b]fluoranthene	11	11	0.18	0.58	0.397	3.9 (RBC)C	0.9	No
Benzo[g,h,i]perylene	11	7	0.067	0.37	0.204	NA	NA	**Yes**
Benzo[k]fluoranthene	11	11	0.2	0.5	0.359	8.7 (RBC)N	0.9	No
Carbazole	11	4	0.047	0.09	0.069	32 (RBC)C	NA	No
Chrysene	11	11	0.23	0.76	0.479	390 (RBC)C	9	No
Dibenzo[a,h]anthracene	11	1	0.12	0.12	0.12	0.087 (RBC)C	0.66	**Yes**
Fluoranthene	11	11	0.39	1.5	0.807	800 (EMEG)	2,300	No
Fluorene	11	1	0.091	0.091	0.091	800 (EMEG)	2,300	No
Indeno[1,2,3-c,d]pyrene	11	10	0.12	0.37	0.213	3.9 (RBC)C	0.9	No

Table 3: (Cont'd)

Contaminant	No. Samples	No. Detected	Concentration (ppm)			Environmental Guideline Comparison Value (ppm)	New Jersey RDCSCC (ppm)	Retained for Further Evaluation
			Minimum	Maximum	Average			
2-Methylnaphthalene	11	1	0.05	0.05	0.05	200 (RMEG)	NA	No
Naphthalene	11	3	0.057	0.075	0.069	40 (EMEG)	230	No
Phenanthrene	11	11	0.17	0.85	0.428	NA	NA	**Yes**
Pyrene	11	11	0.37	1.3	0.744	2,000 (RMEG)	1,700	No
4,4'-DDE	11	1	0.0048	0.0048	0.005	2 (CREG)	2	No
4,4'-DDT	11	9	0.0059	0.059	0.020	2 (CREG)	2	No
PCB (Aroclor-1260)	11	2	0.068	0.26	0.164	0.32 (RBC)C	0.49	No
Metals								
Aluminum	11	11	5,730	15,700	10,015	100,000 (EMEG)	NA	No
Antimony	11	1	1.7	1.7	1.7	20 (RMEG)	14	No
Arsenic	11	11	1.9	7.6	4.22	20 (EMEG)	20	No
Barium	11	11	52.4	180	110	5,500 (RBC)N	700	No
Beryllium	11	11	0.89	2.6	1.42	100 (EMEG)	1	**Yes**
Cadmium	11	11	0.66	5.6	2.54	10 (EMEG)	1	**Yes**
Chromium	11	11	15.2	47.7	22.5	200 (RMEG)	240	No
Cobalt	11	11	7.8	22.9	13.4	500 (EMEG)	NA	No
Copper	11	11	17.4	52	34.1	60 (EMEG)	NA	No
Iron	11	11	19,700	34,700	25,123	2,300 (RBC)N	NA	**Yes**
Lead	11	11	25.8	80.4	51.8	NA	400	No
Manganese	11	11	238	1,760	740	3,000 (RMEG)	NA	No

Table 3: (Cont'd)

Contaminant	No. Samples	No. Detected	Concentration (ppm)			Environmental Guideline Comparison Value (ppm)	New Jersey RDCSCC (ppm)	Retained for Further Evaluation
			Minimum	Maximum	Average			
Mercury	11	9	0.074	0.21	0.125	NA	14	No
Nickel	11	11	19.1	46.3	27.9	1,000 (RMEG)	250	No
Selenium	11	5	2.7	6	4.5	300 (EMEG)	63	No
Silver	11	9	0.08	0.52	0.28	300 (EMEG)	110	No
Thallium	11	11	1.5	5	2.82	5.5 (RBC)N	2	**Yes**
Vanadium	11	11	12.8	47.5	26.7	200 (EMEG)	370	No
Zinc	11	11	252	620	386	600 (EMEG)	1,500	**Yes**
Other								
Cyanide	11	11	0.18	2.3	0.622	1,000 (RMEG)	1,100	No

[1]Residential Direct Contact Soil Cleanup Criteria; [2]NA - Not Available; [3]Environmental Media Evaluation Guide; [4]Reference Media Evaluation Guide; [5]USEPA Region 3 Risk-Based Concentrations (N: Non-carcinogenic effects, C: Carcinogenic effects); [6]Cancer Risk Evaluation Guide

Table 4a: Contaminants in Monitoring Wells (depth 30-90 feet) sampled from April 1986 - October 1989

Contaminants	No. of Samples	No. of Detections	Concentration (ppb)[1]			Environmental Guideline Comparison Value (ppb)	NJ Groundwater Quality Standards (ppb)	Retained for Further Evaluation
			Minimum	Maximum	Average			
Volatile Organic Compounds								
Chlorobenzene	70	2	5.5	6.4	5.95	200 (EMEG)[2]	4	**Yes**
Methylene Chloride	70	6	5.1	31	13.1	4.1 (RBC)C[3]	2	**Yes**
Tetrachloroethylene	70	3	9	112	49	0.53 (RBC)C	1	**Yes**
Toluene	70	6	0.002	164	142.2	200 (EMEG)	1,000	No
Trichloroethane	70	1	7.6	7.6	7.6	0.19 (RBC)C	NA[4]	**Yes**
Trichloroethylene	70	1	12.3	12.3	12.3	0.026 (RBC)C	1	**Yes**
Semi-Volatile Organic Compounds (including Polychlorinated Biphenyls)								
Phenols	70	64	1	4,300	400	3,000 (RMEG)[5]	4,000	**Yes**
PCBs	70	2	0.005	0.005	0.005	0.2 (EMEG)	0.02	No
Metals								
Arsenic	70	8	5	60	21	0.02 (CREG)[6]	0.02	**Yes**
Barium	70	19	50	850	410	700 (RMEG)	2,000	**Yes**
Cadmium	70	1	10	10	10	2 (EMEG)	4	**Yes**
Copper	70	23	50	230	91.4	300 (EMEG)	NA	No
Iron	70	65	10	105,000	30,030	NA	300	**Yes**
Lead	70	14	2	70	20.1	NA	5	**Yes**
Manganese	70	15	2,000	18,000	6,350	500 (RMEG)	50	**Yes**
Mercury	70	1	1	1	1	NA	2	No
Selenium	70	7	5	9.8	7.98	50 (EMEG)	50	No
Silver	70	7	0.8	49	11.64	50 (RMEG)	NA	No
Zinc	70	18	70	47,000	10,873	2,000 (EMEG)	5,000	**Yes**

[1]parts per billion; [2]Environmental Media Evaluation Guide; [3]USEPA Region 3 Risk-Based Concentrations (N: Non-carcinogenic effects, C: Carcinogenic effects);
[4]Not Applicable; [5]Reference Media Evaluation Guide; [6]Cancer Risk Evaluation Guide

Table 4b: Contaminants in groundwater sampled in 1991 and 1994

Contaminants	No. of Samples	No. of Detections	Concentration (ppb) [1]			Environmental Guideline Comparison Value (ppb)	NJ Groundwater Quality Standards (ppb)	Retained for Further Evaluation
			Minimum	Maximum	Average			
Hydropunch samples (depth 5 - 6 feet)								
Volatile Organic Compounds								
Toluene	6	1	7	7	7	200 (EMEG)[2]	1,000	No
Semi-Volatile Organic Compounds (Polycyclic Aromatic Hydrocarbon)								
Naphthalene	6	1	4	4	4	6.5 (RBC)N[3]	NA[4]	No
Monitoring Well data (depth 11 - 28 feet)								
Metals								
Arsenic	8	6	7.3	13.5	9.88	0.02 (CREG)[5]	0.02	**Yes**
Beryllium	8	1	2.8	2.8	2.8	20 (EMEG)	0.008	**Yes**
Chromium	8	6	5.1	54.8	26.5	NA	100	No
Copper	8	8	5.5	108	34.9	300 (EMEG)	1,300	No
Lead	8	8	4.9	28.5	11.8	NA	5	**Yes**
Nickel	8	3	29.5	82.7	61.7	200 (EMEG)	100	No
Zinc	8	8	30.7	274	114	2,000 (EMEG)	5,000	No

[1]parts per billion; [2]Environmental Media Evaluation Guide; [3]USEPA Region 3 Risk-Based Concentrations (N: Non-carcinogenic effects, C: Carcinogenic effects); [4]Not Applicable; [5]Cancer Risk Evaluation Guide

Table 5: Summary of Soil Gas data for the Crown Vantage Landfill site

Contaminant	No. Stations Detected	Range (ppb)[1]	Mean (ppb)
1,1,1-Trichloroethane	4	0.02 – 0.05	0.04
Trichloroethene	2	0.5 - 6	3
Tetrachloroethene	16	0.001 – 19	1.3
Benzene	2	0.9 – 920	460
Toluene	8	0.2 – 59,000	9,500
Ethylbenzene	0	-	-
Xylenes	1	0.6	0.6
Total Volatile Hydrocarbons	9	3 – 60,000	11,000

[1]parts per billion

Table 6: Contaminant Concentrations in off-site Soil samples (USEPA November 2003 sampling event) from the Crown Vantage Landfill site (No. of samples = 2)

Contaminant	No. of Detections	Concentration (ppm)			Environmental Guideline Comparison Value (ppm)	New Jersey RDCSCC[1] (ppm)	Potential for Health Effects
		Minimum	Maximum	Average			
Volatile Organic Compounds							
Benzaldehyde	2	0.16	0.18	0.17	5,000 (RMEG)[2]	NA[3]	No
Semi-Volatile Organic Compounds (Polycyclic Aromatic Hydrocarbons)							
Benzo[a]anthracene	2	0.13	0.16	0.145	3.9 (RBC)C[4]	0.9	No
Benzo[a]pyrene	2	0.11	0.17	0.14	0.1 (CREG)[5]	0.66	**Yes**
Benzo[b]fluoranthene	2	0.12	0.16	0.14	3.9 (RBC)C	0.9	No
Benzo[g,h,i]perylene	2	0.12	0.44	0.28	NA	NA	**Yes**
Benzo[k]fluoranthene	2	0.11	0.16	0.135	8.7 (RBC)N	0.9	No
Chrysene	2	0.15	0.18	0.165	390 (RBC)C	9	No
Fluoranthene	2	0.28	0.29	0.285	800 (EMEG)[6]	2,300	No
Phenanthrene	2	0.1	0.16	0.13	NA	NA	**Yes**
Pyrene	2	0.29	0.3	0.295	2,000 (RMEG)	1,700	No
Metals							
Aluminum	2	6,280	8,500	7,390	100,000 (EMEG)	NA	No
Arsenic	2	3.3	3.4	3.35	20 (EMEG)	20	No
Barium	2	77.8	87.8	82.8	5,500 (RBC)N	700	No
Beryllium	2	0.45	0.47	0.46	100 (EMEG)	1	No
Cadmium	2	0.5	0.6	0.55	10 (EMEG)	1	No
Chromium	2	9.7	9.9	9.8	200 (RMEG)	240	No
Cobalt	2	5.5	6.3	5.9	500 (EMEG)	NA	No
Copper	2	15.7	17.1	16.4	60 (EMEG)	NA	No

Table 6: (Cont'd)

Contaminant	No. of Detections	Concentration (ppm)			Environmental Guideline Comparison Value (ppm)	New Jersey RDCSCC[1] (ppm)	Potential for Health Effects
		Minimum	Maximum	Average			
Iron	2	12,200	13,900	13,050	2,300 (RBC)N	NA	**Yes**
Lead	2	18.2	29.7	23.95	NA	400	No
Mercury	2	0.059	0.059	0.059	NA	14	No
Nickel	2	13	20.3	16.65	1,000 (RMEG)	250	No
Selenium	2	2.6	2.6	2.6	300 (EMEG)	63	No
Thallium	2	1.8	1.9	1.85	5.5 (RBC)N	2	No
Vanadium	2	16.3	80.3	48.3	200 (EMEG)	370	No
Zinc	2	63.9	99.3	81.6	600 (EMEG)	1,500	No
Other							
Cyanide	2	0.22	0.36	0.29	1,000 (RMEG)	1,100	No

[1]Residential Direct Contact Soil Cleanup Criteria; [2]Reference Media Evaluation Guide; [3]NA - Not Available; [4]USEPA Region 3 Risk-Based Concentrations (N: Non-carcinogenic effects, C: Carcinogenic effects); [5]Cancer Risk Evaluation Guide; [6]Environmental Media Evaluation Guide

Table 7a: Contaminant Concentrations in Off-site upstream Sediment samples (USEPA November 2003 sampling event) from the Crown Vantage Landfill site (No. of samples = 2)

Contaminant	No. of Detections	Concentration (ppm)			Environmental Guideline Comparison Value (ppm)	New Jersey RDCSCC[1] (ppm)	Potential For Health Effects
		Minimum	Maximum	Average			
Volatile Organic Compounds							
Benzaldehyde	2	0.055	0.16	0.1075	5,000 (RMEG)[3]	NA[4]	No
Bis(2-ethylhexyl)phthalate	2	0.22	0.33	0.275	50 (CREG)	49	No
Butylbenzylphthalate	2	0	0.11	0.055	10,000 (RMEG)	1,100	No
4-Methylphenol	2	0	0.33	0.165	390 (RBC)N	2,800	No
Semi-Volatile Organic Compounds (Polycyclic Aromatic Hydrocarbons/Pesticide)							
Anthracene	2	0.079	0.1	0.0895	20,000 (EMEG)[2]	10,000	No
Benzo[a]anthracene	2	0.35	0.47	0.41	3.9 (RBC)C[5]	0.9	No
Benzo[a]pyrene	2	0.36	0.48	0.42	0.1 (CREG)[6]	0.66	**Yes**
Benzo[b]fluoranthene	2	0.39	0.41	0.4	3.9 (RBC)C	0.9	No
Benzo[g,h,i]perylene	2	0.11	0.14	0.125	NA	NA	**Yes**
Benzo[k]fluoranthene	2	0.33	0.51	0.42	8.7 (RBC)N	0.9	No
Chrysene	2	0.43	0.52	0.475	390 (RBC)C	9	No
Dibenzo[a,h]anthracene	2	0.084	0.098	0.091	0.087 (RBC)C	0.66	No
Fluoranthene	2	0.64	0.94	0.79	800 (EMEG)	2,300	No
Indeno[1,2,3-c,d]pyrene	2	0.2	0.22	0.21	3.9 (RBC)C	0.9	No
Naphthalene	2	0	0.073	0.0365	40 (EMEG)	230	No
Phenanthrene	2	0.39	0.45	0.42	NA	NA	**Yes**
Pyrene	2	0.72	0.87	0.795	2,000 (RMEG)	1,700	No
4,4'-DDT	1	0.054	0.054	0.054	2 (CREG)	2	No

Table 7a: (Cont'd)

Contaminant	No. of Detections	Concentration (ppm)			Environmental Guideline Comparison Value (ppm)	New Jersey RDCSCC[1] (ppm)	Potential For Health Effects
		Minimum	Maximum	Average			
Metals							
Aluminum	2	8790	9,890	9340	100,000 (EMEG)	NA	No
Arsenic	2	3.5	4.6	4.05	20 (EMEG)	20	No
Barium	2	99.1	123	111.05	5,500 (RBC)N	700	No
Beryllium	2	1.1	1.4	1.25	100 (EMEG)	1	**Yes**
Cadmium	2	2	2.1	2.05	10 (EMEG)	1	**Yes**
Chromium	2	17.1	30.7	23.9	200 (RMEG)	240	No
Cobalt	2	11.3	15.9	13.6	500 (EMEG)	NA	No
Copper	2	26	33.7	29.85	60 (EMEG)	NA	No
Iron	2	20100	24,600	22350	2,300 (RBC)N	NA	**Yes**
Lead	2	39.6	50.4	45	NA	400	No
Manganese	2	511	906	708.5	3,000 (RMEG)	NA	No
Mercury	2	0.065	0.1	0.0825	NA	14	No
Nickel	2	22.2	32.8	27.5	1,000 (RMEG)	250	No
Silver	2	0.17	0.24	0.205	300 (EMEG)	110	No
Thallium	2	2.2	3	2.6	5.5 (RBC)N	2	**Yes**
Vanadium	2	18.2	20.2	19.2	200 (EMEG)	370	No
Zinc	2	310	429	369.5	600 (EMEG)	1,500	No
Other							
Cyanide	2	0.32	0.69	0.505	1,000 (RMEG)	1,100	No

[1]Residential Direct Contact Soil Cleanup Criteria; [2]Environmental Media Evaluation Guide [3]Reference Media Evaluation Guide; [4]NA - Not Available; [5]USEPA Region 3 Risk-Based Concentrations (N: Non-carcinogenic effects, C: Carcinogenic effects); [6]Cancer Risk Evaluation Guide

Table 7b: Contaminant Concentrations in off-site downstream Sediment samples (USEPA November 2003 sampling event) from the Crown Vantage Landfill site (No. of samples = 3)

Contaminant	No. of Detections	Concentration (ppm)			Environmental Guideline Comparison Value (ppm)	New Jersey RDCSCC[1] (ppm)	Potential for Health Effects
		Minimum	Maximum	Average			
Semi-Volatile Organic Compounds (Polycyclic Aromatic Hydrocarbons)							
Benzo[a]anthracene	2	0.098	0.12	0.11	3.9 (RBC)C[2]	0.9	No
Benzo[a]pyrene	2	0.11	0.11	0.11	0.1 (CREG)[3]	0.66	**Yes**
Benzo[b]fluoranthene	2	0.072	0.11	0.09	3.9 (RBC)C	0.9	No
Benzo[k]fluoranthene	2	0.087	0.14	0.11	8.7 (RBC)N	0.9	No
Chrysene	2	0.11	0.14	0.13	390 (RBC)C	9	No
Fluoranthene	2	0.18	0.21	0.20	800 (EMEG)[4]	2,300	No
Phenanthrene	2	0.056	0.092	0.07	800 (EMEG)	2,300	No
Pyrene	2	0.17	0.2	0.19	2,000 (RMEG)[5]	1,700	No
Metals							
Aluminum	2	5,730	7,440	6,585	100,000 (EMEG)	NA[6]	No
Arsenic	2	2.1	2.1	2.10	20 (EMEG)	20	No
Barium	2	52.4	67	59.7	5,500 (RBC)N	700	No
Beryllium	2	0.98	1.0	0.99	100 (EMEG)	1	No
Cadmium	2	0.66	1.9	1.28	10 (EMEG)	1	**Yes**
Chromium	2	15.9	23.2	19.6	200 (RMEG)	240	No
Cobalt	2	8.4	9.1	8.8	500 (EMEG)	NA	No
Copper	2	17.4	32.9	25.15	60 (EMEG)	NA	No
Iron	2	22,700	31,800	27,250	2,300 (RBC)N	NA	**Yes**

Table 7b: (Cont'd)

Contaminants	No. of Detections	Concentration (ppm)			Environmental Guideline Comparison Value (ppm)	New Jersey RDCSCC[1] (ppm)	Potential for Health Effects
		Minimum	Maximum	Average			
Lead	2	25.8	42.2	34	NA	400	No
Manganese	2	238	385	311.5	3,000 (RMEG)	NA	No
Mercury	1	0.078	0.08	0.078	NA	14	No
Nickel	2	25.5	28	26.8	1,000 (RMEG)	250	No
Silver	1	0.14	0.14	0.140	300 (EMEG)	110	No
Thallium	2	1.5	2.1	1.80	5.5 (RBC)N	2	**Yes**
Vanadium	2	21.8	28.1	25.0	200 (EMEG)	370	No
Zinc	2	262	268	265	600 (EMEG)	1,500	No
Other							
Cyanide	2	0.32	0.54	0.430	1,000 (RMEG)	1,100	No

[1]Residential Direct Contact Soil Cleanup Criteria; [2]USEPA Region 3 Risk-Based Concentrations (N: Non-carcinogenic effects, C: Carcinogenic effects); [3]Cancer Risk Evaluation Guide; [4]Environmental Media Evaluation Guide; [5]Reference Media Evaluation Guide; [6]NA - Not Available

Table 8: Major Exposure Pathways for the Crown Vantage Landfill site

Exposure Pathway Elements					Time Frame	Pathway Classification
Source	**Environmental Medium**	**Point of Exposure**	**Route of Exposure**	**Potentially Exposed Population**		
Crown Vantage Landfill	Air	Air	Inhalation	Workers, local residents, trespassers	Past Present Future	Potential
Crown Vantage Landfill	Soil	Crown Vantage Landfill	Ingestion	Children, local residents, trespassers, recreational users of the adjoining parklands	Past Present Future	Completed
Crown Vantage Landfill	Sediment	Crown Vantage Landfill	Ingestion	Children, local residents, trespassers, recreational users of the adjoining parklands and the Delaware River	Past Present Future	Completed
River water, groundwater, sediment	Food (Biota)	Food	Ingestion	Recreational users of the Delaware River	Past Present Future	Potential

Table 9: Comparison of Exposure Dose resulting from ingestion of Flyash with the Health Guideline CVs

Contaminants of Concern	Max. (mg/kg)	Mean (mg/kg)	Maximum Exposure Dose (mg/kg/day)		Health Guideline CVs (mg/kg/day)			Potential for Non-cancer Health Effects
			Child[a]	Adult[b]	ATSDR MRL[c]	USEPA RfD[d]	USEPA Reg 3 RfDo[e]	
Semi-Volatile Organic Compounds (Polycyclic Aromatic Hydrocarbons)								
Benzo[a]pyrene	2,000	950	1.36×10^{-3}	2.04×10^{-4}	NA[f]	NA	NA	No[g]
Benzo[a]anthracene	2,500	1,150	1.7×10^{-3}	2.55×10^{-4}	NA	NA	NA	No[g]
Benzo[b]fluoranthene	2,200	950	1.5×10^{-3}	2.24×10^{-4}	NA	NA	NA	No[g]
Benzo[k]fluoranthene	760	310	5.17×10^{-4}	7.76×10^{-5}	NA	NA	NA	No[g]
Carbazole	330	135	2.24×10^{-4}	3.37×10^{-5}	NA	NA	NA	No[g]
Chrysene	2,500	1,125	1.7×10^{-3}	2.55×10^{-4}	NA	NA	NA	No[g]
Dibenzo[a,h]anthracene	480	253	3.27×10^{-4}	4.9×10^{-5}	NA	NA	NA	No[g]
Dibenzofuran	190	165	1.29×10^{-4}	1.94×10^{-5}	NA	NA	2×10^{-3}	No
Fluoranthene	5,200	2,350	3.54×10^{-3}	5.31×10^{-4}	NA	4×10^{-2}	NA	No
Indeno[1,2,3-c,d]pyrene	1,300	520	8.84×10^{-4}	1.33×10^{-4}	NA	NA	NA	No[g]
Naphthalene	48	31	3.27×10^{-5}	4.90×10^{-6}	0.6	2×10^{-2}	2×10^{-2}	No
Pyrene	4,300	1,975	2.93×10^{-3}	4.39×10^{-4}	NA	3×10^{-2}	NA	No
Semi-Volatile Organic Compounds (Pesticides/Herbicides)								
MCPA	880	586	5.99×10^{-4} (3.99×10^{-4})[h]	8.98×10^{-5} (5.98×10^{-5})	NA	5×10^{-4}	NA	**Yes**
MCPP	120	120	8.16×10^{-5}	1.22×10^{-5}	NA	1×10^{-3}	NA	No

Table 9: (Cont'd)

Contaminants of Concern	Max. (mg/kg)	Mean (mg/kg)	Maximum Exposure Dose (mg/kg/day)		Health Guideline CVs (mg/kg/day)			Potential for Non-cancer Health Effects
			Child[a]	Adult[b]	ATSDR MRL[c]	USEPA RfD[d]	USEPA Reg 3 RfDo[e]	
Metals								
Antimony	28	7.75	1.90×10^{-5}	2.86×10^{-6}	NA	4×10^{-4}	NA	No
Barium	2,540	725	1.73×10^{-3}	2.59×10^{-4}	NA	7×10^{-2}	NA	No
Beryllium	2.70	1.15	1.84×10^{-6}	2.76×10^{-7}	2.00×10^{-3}	NA	NA	No
Chromium (Total)	12,800	2,161	8.71×10^{-3} (1.47×10^{-3})	1.31×10^{-3} (2.20×10^{-4})	NA	1.5 (III) 0.003(VI)	1.5 0.003	**Yes**
Copper	938	236	6.38×10^{-4}	9.57×10^{-5}	NA	NA	4×10^{-2}	No
Iron	23,900	10,628	1.63×10^{-2}	2.44×10^{-3}	NA	NA	3×10^{-1}	No
Lead	77,100	12,981	- [i]	-	NA	NA	NA	**Yes**
Nickel	441	135	3×10^{-4}	4.50×10^{-5}	NA	2×10^{-2}	NA	No
Thallium	18	7.83	1.20×10^{-5}	1.80×10^{-6}	NA	NA	7×10^{-5}	No

[a]Child exposure scenario: 1 day/week, 6 month/year, 200 mg/day ingestion rate and 21 kg body weight; [b]Adult exposure scenario: 1 days/week, 6 month/year, 100 mg/day ingestion rate and 70 kg body weight;; [c]Minimal Risk Level; [d]Reference Dose; [e]Risk-based Concentrations; [f]Not Available; [g]Based on LOAEL comparison; [h]Exposure Dose in parentheses is based on Mean Concentration; [i]Not Applicable

Table 10: Comparison of Exposure Dose resulting from ingestion of Soil with the Health Guideline CVs

Contaminants of Concern	Max. (mg/kg)	Mean (mg/kg)	Maximum Exposure Dose (mg/kg/day)		Health Guideline CVs (mg/kg/day)			Potential for Non-cancer Health Effects
			Child[a]	Adult[b]	ATSDR MRL[c]	USEPA RfD[d]	USEPA Reg 3 RfDo[e]	
Semi-Volatile Organic Compounds (Polycyclic Aromatic Hydrocarbons)								
Bis(2-ethylhexyl)phthalate	700	24.8	4.76×10^{-4}	7.14×10^{-5}	NA[g]	NA	2.00×10^{-2}	No
Semi-Volatile Organic Compounds (Polycyclic Aromatic Hydrocarbons and Polychlorinated Biphenyls)								
Benzo[a]pyrene	700	23.2	4.76×10^{-4}	7.14×10^{-5}	NA	NA	NA	No[f]
Benzo[a]anthracene	820	22.8	5.58×10^{-4}	8.37×10^{-5}	NA	NA	NA	No[f]
Benzo[b]fluoranthene	740	25.2	5.03×10^{-4}	7.55×10^{-5}	NA	NA	NA	No[f]
Benzo[g,h,i]perylene	350	12.4	2.38×10^{-4}	3.57×10^{-5}	NA	NA	NA	No[f]
Benzo[k]fluoranthene	770	25.7	5.24×10^{-4}	7.86×10^{-5}	NA	NA	NA	No[f]
Chrysene	810	22.6	5.51×10^{-4}	8.27×10^{-5}	NA	NA	NA	No[f]
Dibenzo[a,h]anthracene	220	12.8	1.50×10^{-4}	2.24×10^{-5}	NA	NA	NA	No[f]
Indeno[1,2,3-cd]pyrene	370	15.06	2.52×10^{-4}	3.78×10^{-5}	NA	NA	NA	No[f]
Total PCBs	2	0.959	1.36×10^{-6}	2.04×10^{-7}	2.00×10^{-5}	2.00×10^{-5}	NA	No
Semi-Volatile Organic Compounds (Pesticides/Herbicides)								
alpha-Chlordane	28.4	2.61	1.93×10^{-5}	2.90×10^{-6}	6.00×10^{-4}	5.00×10^{-4}	5.00×10^{-4}	No
4,4'-DDT	2.8	0.294	1.90×10^{-6}	2.86×10^{-7}	5.00×10^{-4}	5.00×10^{-4}	5.00×10^{-4}	No
Dieldrin	0.216	0.0287	1.47×10^{-7}	2.20×10^{-8}	5.00×10^{-5}	5.00×10^{-5}	5.00×10^{-5}	No
MCPA	310	153	2.11×10^{-4}	3.16×10^{-5}	NA	5.00×10^{-4}	NA	No

Table 10: (Cont'd)

Contaminants of Concern	Max. (mg/kg)	Mean (mg/kg)	Maximum Exposure Dose (mg/kg/day)		Health Guideline CVs (mg/kg/day)			Potential for Non-cancer Health Effects
			Child[a]	Adult[b]	ATSDR MRL[c]	USEPA RfD[d]	USEPA Reg 3 RfDo[e]	
Metals								
Antimony	21.2	7.38	1.44×10^{-5}	2.16×10^{-6}	NA	4.00×10^{-4}	NA	No
Cadmium	12.3	3.75	8.37×10^{-6}	1.26×10^{-6}	2.00×10^{-4}	5.00×10^{-4}	NA	No
Chromium (Total)	5,500	273	3.74×10^{-3} (1.86×10^{-4})	5.61×10^{-4} (2.79×10^{-5})	NA	1.5 (III) 0.003(VI)	1.5 0.003	**Yes**
Copper	4,500	215.2	3.06×10^{-3}	4.59×10^{-4}	NA	NA	4×10^{-2}	No
Iron	387,000	53,891	2.63×10^{-1}	3.95×10^{-2}	NA	NA	3.00×10^{-1}	No
Lead	34,400	1,612	-[h]	-	NA	NA	NA	**Yes**
Nickel	1,160	133.4	7.89×10^{-4}	1.18×10^{-4}	NA	2.00×10^{-2}	NA	No
Thallium	7.2	3.33	4.90×10^{-6}	7.35×10^{-7}	NA	NA	7.00×10^{-5}	No
Vanadium	5,590	796	3.80×10^{-3} (5.41×10^{-4})[i]	5.70×10^{-4} (8.12×10^{-5})	3.00×10^{-3}	NA	1.00×10^{-3}	**Yes**
Zinc	3,820	467	2.60×10^{-3}	3.90×10^{-4}	3.00×10^{-1}	3.00×10^{-1}	3.00×10^{-1}	No

[a] Child exposure scenario: 1 day/week, 6 month/year, 200 mg/day ingestion rate and 21 kg body weight; [b]Adult exposure scenario: 1 days/week, 6 month/year, 100 mg/day ingestion rate and 70 kg body weight; [c]Minimal Risk Level; [d]Reference Dose; [e]Risk-based Concentrations; [f]Based on LOAEL comparison; [g]Not Available; [h] –Not Applicable [i]Exposure Dose in parentheses is based on Mean Concentration;

Table 11: Comparison of Exposure Dose resulting from ingestion of Sediment with the Health Guideline CVs

Contaminants of Concern	Max. (mg/kg)	Mean (mg/kg)	Maximum Exposure Dose (mg/kg/day)		Health Guideline CVs (mg/kg/day)			Potential for Non-cancer Health Effects
			Child[a]	Adult[b]	ATSDR MRL[c]	USEPA RfD[d]	USEPA Reg 3 RfDo[e]	
Semi-Volatile Organic Compounds (Polycyclic Aromatic Hydrocarbons)								
Acenaphthylene	0.051	0.051	3.47×10^{-8}	5.20×10^{-9}	NA	NA	NA	No[f]
Benzo[a]pyrene	0.62	0.345	4.22×10^{-7}	6.33×10^{-8}	NA	NA	NA	No[f]
Benzo[g,h,i]perylene	0.37	0.204	2.52×10^{-7}	3.78×10^{-8}	NA	NA	NA	No[f]
Dibenzo[a,h]anthracene	0.12	0.12	8.16×10^{-8}	1.22×10^{-8}	NA	NA	NA	No[f]
Phenanthrene	0.85	0.428	5.78×10^{-7}	8.67×10^{-8}	NA	NA	NA	No[f]
Metals								
Beryllium	2.6	1.42	1.77×10^{-6}	2.65×10^{-7}	2×10^{-3}	2×10^{-3}	2×10^{-3}	No
Cadmium	5.6	2.54	3.81×10^{-6}	5.71×10^{-7}	2.00×10^{-4}	5.00×10^{-4}	NA[g]	No
Iron	34,700	25,123	2.36×10^{-2}	3.54×10^{-3}	NA	NA	3.00×10^{-1}	No
Thallium	5	2.82	3.40×10^{-6}	5.10×10^{-7}	NA	NA	7.00×10^{-5}	No
Zinc	620	386	4.22×10^{-4}	6.33×10^{-5}	3.00×10^{-1}	3.00×10^{-1}	3.00×10^{-1}	No

[a]Child exposure scenario: 1 day/week, 6 month/year, 200 mg/day ingestion rate and 21 kg body weight; [b]Adult exposure scenario: 1 days/week, 6 month/year, 100 mg/day ingestion rate and 70 kg body weight; [c]Minimal Risk Level; [d]Reference Dose; [e]Risk-based Concentrations; [f]Based on LOAEL comparison; [g]Not Available

Table 12: Calculated LECR associated with the Contaminants detected in the Flyash at the Crown Vantage Landfill

Contaminants of Concern	Max. Conc. (mg/kg)	DHHS[a] Cancer Class	Potency Factor[b]	BaP Equiv. (mg/kg)	Total BaP Equiv. (mg/kg)	Exposure Dose (mg/kg/day) Child[c]	Exposure Dose (mg/kg/day) Adult[d]	CSF[e] (mg/ kg/d)$^{-1}$	LECR[f] Child	LECR[f] Adult
Polycyclic Aromatic Compounds (PAHs)										
Benzo[a]pyrene	2,000	2	1	2,000	5,101	4.96×10^{-4} (2.45×10^{-4})[i]	2.23×10^{-4} (1.10×10^{-4})	7.3	3.62×10^{-3} (1.79×10^{-3})	1.63×10^{-3} (8.05×10^{-4})
Benzo[a] anthracene	2,500	2	0.1	250						
Benzo[b] fluoranthene	2,200	2	0.1	220						
Benzo[k] fluoranthene	760	2	0.1	76						
Benzo[g,h,i] perylene	880	3	NA[g]	-[h]						
Chrysene	2,500	2	0.01	25						
Dibenzo[a,h] anthracene	480	2	5	2,400						
Dibenzofuran	190	NA	NA	-						
Fluoranthene	5,200	3	NA	-						
Indeno[1,2,3-cd]pyrene	1,300	2	0.1	130						
Napthalene	48	3	NA	-						
Phenanthrene	3,500	3	NA	-						
Pyrene	4,300	3	NA	-						
Carbazole	330	3	NA	-						

[a]Department of Health and Human Services Cancer Class: 1 = known human carcinogen; 2 = reasonably anticipated to be a carcinogen; 3 = not classified
[b]Cancer potency factor relative to benzo[a]pyrene (BaP); [c]Child exposure scenario: 1 day/week, 6 months/year, 200 mg/day ingestion rate, 21 kg body weight and 10 year exposure duration; [d]Adult exposure scenario: 1 day/week, 6 months/year, 100 mg/day ingestion rate, 70 kg body weight and 30 year exposure duration; [e]Cancer Slope Factor; [f]Lifetime Excess Cancer Risk; [g]Not Available; [h]Not Applicable; [i]Exposure Dose in parentheses is based on Mean Concentration

Table 13: Calculated LECR associated with the Contaminants detected in Soil at the Crown Vantage Landfill

Contaminants of Concern	Max. Conc. (mg/kg)	DHHS[a] Cancer Class	Potency Factor[b]	BaP Equiv. (mg/kg)	Total BaP Equiv. (mg/kg)	Exposure Dose (mg/kg/day)		CSF[e] (mg/kg/d)$^{-1}$	LECR[f]	
						Child[c]	Adult[d]		Child	Adult
Polycyclic Aromatic Compounds (PAHs)										
Acenaphthylene	0.73	NA[g]	NA	-[h]	2,078	2.02×10^{-4} (9.36×10^{-6})[i]	9.09×10^{-5} (4.21×10^{-6})	7.3	1.47×10^{-3} (6.83×10^{-5})	6.63×10^{-4} (3.07×10^{-5})
Benzo[a] anthracene	820	2	0.1	250						
Benzo[a]pyrene	700	2	1	2,000						
Benzo[b] fluoranthene	740	2	0.1	220						
Benzo[g,h,i] perylene	350	3	NA	-						
Benzo[k] fluoranthene	770	2	0.1	76						
Chrysene	810	2	0.01	25						
Dibenzo[a,h] anthracene	220	2	5	2,400						
Indeno[1,2,3-cd]pyrene	370	2	0.1	130						
Phenanthrene	1,300	3	NA	-						

Table 13: (Cont'd)

Contaminants of Concern	Max. Conc. (mg/kg)	DHHS[a] Cancer Class	Potency Factor[b]	BaP Equiv. (mg/kg)	Total BaP Equiv. (mg/kg)	Exposure Dose (mg/kg/day)		CSF[e] (mg/ kg/d)$^{-1}$	LECR[f]	
						Child[c]	Adult[d]		Child	Adult
Semi-Volatile Organic Compounds										
Bis(2-ethylhexyl)phthalate	700	NA	-	-	-	6.80 x 10^{-5}	3.06 x 10^{-5}	0.014	9.52 x 10^{-7}	4.29 x 10^{-7}
Semi-Volatile Organic Compounds (Pesticides/Herbicides and Polychlorinated Biphenyls)										
alpha-Chlordane	28.4	3	-	-	-	2.76 x 10^{-6}	1.24 x 10^{-6}	0.35	9.66 x 10^{-7}	4.35 x 10^{-7}
4,4'-DDT	2.8	2	-	-	-	2.72 x 10^{-7}	1.22 x 10^{-7}	0.34	9.25 x 10^{-8}	4.16 x 10^{-8}
Dieldrin	0.216	3	-	-	-	2.10 x 10^{-8}	9.45 x 10^{-9}	16	3.36 x 10^{-7}	1.51 x 10^{-7}
Total PCBs	2	2	-	-	-	1.94 x 10^{-7}	8.75 x 10^{-8}	2	3.89 x 10^{-7}	1.75 x 10^{-7}
								Sum=	**1.48 x 10^{-3} (6.87 x 10^{-5})**	**6.65 x 10^{-4} (3.09 x 10^{-5})**

[a]Department of Health and Human Services Cancer Class: 1 = known human carcinogen; 2 = reasonably anticipated to be a carcinogen; 3 = not classified
[b]Cancer potency factor relative to benzo[a]pyrene (BaP); [c]Child exposure scenario: 1 day/week, 6 months/year, 200 mg/day ingestion rate, 21 kg body weight and 10 year exposure duration; [d]Adult exposure scenario: 1 day/week, 6 months/year, 100 mg/day ingestion rate, 70 kg body weight and 30 year exposure duration; [e]Cancer Slope Factor; [f]Lifetime Excess Cancer Risk; [g] Not Available; [h]- Not Applicable; [i]Exposure Dose in parentheses is based on Mean Concentration

Table 14: Calculated LECR associated with the Contaminants detected in Sediment at the Crown Vantage Landfill

Contaminants of Concern	Max. Conc. (mg/kg)	DHHS[a] Cancer Class	Potency Factor[b]	BaP Equiv. (mg/kg)	Total BaP Equiv. (mg/kg)	Exposure Dose (mg/kg/day)		CSF[e] (mg/ kg/d)$^{-1}$	LECR[f]	
						Child[c]	Adult[d]		Child	Adult
Polycyclic Aromatic Compounds (PAHs)										
Acenaphthylene	0.051	NA[g]	NA	- [h]	1.22	1.19×10^{-7}	5.34×10^{-8}	7.3	8.66×10^{-7}	3.89×10^{-7}
Benzo[a]pyrene	0.62	2	1	2,000						
Benzo[g,h,i] perylene	0.37	3	NA	-						
Dibenzo[a,h] anthracene	0.12	2	5	2,400						
Phenanthrene	0.85	3	NA	-						

[a]Department of Health and Human Services Cancer Class: 1 = known human carcinogen; 2 = reasonably anticipated to be a carcinogen; 3 = not classified
[b]Cancer potency factor relative to benzo[a]pyrene (BaP); [c]Child exposure scenario: 1 day/week, 6 months/year, 200 mg/day ingestion rate, 21 kg body weight and 10 year exposure duration; [d]Adult exposure scenario: 1 day/week, 6 months/year, 100 mg/day ingestion rate, 70 kg body weight and 30 year exposure duration; [e]Cancer Slope Factor; [f]Lifetime Excess Cancer Risk; [g] Not Available; [h]- Not Applicable

Appendix B

Summary of Public Comments and Responses
Crown Vantage Landfill public health assessment

This summary presents the comments received from interested parties on the Public Comment Draft of the Crown Vantage Landfill public health assessment, and the subsequent responses of the NJDHSS and the ATSDR. The public comment period occurred from March 8 through May 26, 2006. Comments are presented without personal identifiers.

The NJDHSS are appreciative of the two interested parties who provided their review and input on the public health assessment. Where appropriate, the report was amended to address their comments and concerns.

Both commentators expressed concerns over the current lack of measures present to eliminate access to the site from all four sides. Additionally, they expressed concern over the anticipated time frame for remediation efforts and inadequate signage clearly stating the existence of a Superfund site and associated dangers.

In response to above, the received comments will be forwarded to the state and federal environmental agencies for their consideration so that they are made aware of concerns pertaining to remediation.

Specific comments made by each commentator are detailed below:

Commenter A

Comment 1: *"We believe that The Crown Vantage Landfill Public Health Assessment is a professionally researched and analyzed assessment of potential risks to human health caused by the current condition of the Crown Vantage Landfill…."*

Response 1: NJDHSS appreciate your comment and feedback.

Comment 2: *"…that this paper industry landfill is a substantial public health hazard – could easily have been documented at any time in the last 80 years by local, county, state or federal health agencies."*

Response 2: Under a cooperative agreement with the ATSDR, NJDHSS prepares public health assessments for all sites listed or proposed to be added to the National Priorities List (NPL) in New Jersey as mandated by congressional legislation. The public health assessment for the Crown Vantage Landfill site was initiated when the site was proposed to the NPL in September 2004.

Commenter B

Comment: *"Furthermore, specific groups that may not be a part of Alexandria Township or Milford Borough but still make use of the site…..should be notified through specialized information….."*

Response: The NJDHSS will be working towards providing outreach to organizations and businesses whose operations involve use of the area near the site.

Appendix C

Toxicological Characteristics of Chemicals of Concern

The toxicological summaries provided below are based on ATSDR's ToxFAQs (http://www.atsdr.cdc.gov/toxfaq.html) and the NJDHSS Right to Know Program (http://www.state.nj.us/health/eoh/rtkweb/rtkhsfs.htm#D). Health effects are summarized in this section for some of the chemicals of concern found most frequently above CVs at the Crown Vantage Landfill site.

The health effects described in the toxicological summaries are typically known to occur at levels of exposure much higher than those that occur from environmental contamination. The chance that a health effect will occur is dependent on the amount, frequency and duration of exposure, and the individual susceptibility of exposed persons.

Chromium

Chromium is a naturally occurring element found in rocks, animals, plants, soil, and in volcanic dust and gases. Chromium is present in the environment in several different forms, which are chromium(0), chromium(III), and chromium(VI). No taste or odor is associated with chromium compounds. The metal chromium, which is the chromium(0) form, is used for making steel. Chromium(VI) and chromium(III) are used for chrome plating, dyes and pigments, leather tanning, and wood preserving.

Chromium enters the air, water, and soil mostly in the chromium(III) and chromium(VI) forms. In air, chromium compounds are present mostly as fine dust particles which eventually settle over land and water. Chromium can strongly attach to soil and only a small amount can dissolve in water and move deeper in the soil to underground water. Fish do not accumulate much chromium in their bodies from water.

Breathing high levels of chromium(VI) can cause irritation to the nose, such as runny nose, nosebleeds, and ulcers and holes in the nasal septum. Ingesting large amounts of chromium(VI) can cause stomach upsets and ulcers, convulsions, kidney and liver damage, and even death. Skin contact with certain chromium(VI) compounds can cause skin ulcers. Allergic reactions consisting of severe redness and swelling of the skin have been noted.

Several studies have shown that chromium(VI) compounds can increase the risk of lung cancer. Animal studies have also shown an increased risk of cancer. The World Health Organization (WHO) has determined that chromium(VI) is a human carcinogen.
The US Department of Health and Human Services (DHHS) has determined that certain chromium(VI) compounds are known to cause cancer in humans. The EPA has determined that chromium(VI) in air is a human carcinogen.

It is unknown if exposure to chromium will result in birth defects or other developmental effects in people. Birth defects have been observed in animals exposed to chromium(VI). It is likely that health effects seen in children exposed to high amounts of chromium will be similar to the effects seen in adults.

Vanadium

Vanadium is a compound that occurs in nature as a white-to-gray metal, and is often found as crystals. Vanadium and vanadium compounds can be found in the earth's crust and in rocks, some iron ores, and crude petroleum deposits. Vanadium is mostly combined with other metals to make special metal mixtures called alloys. Most of the vanadium used in the United States is used to make steel. Vanadium is also mixed with iron to make important parts for aircraft engines.

Exposure to high levels of vanadium can cause harmful health effects. The major effects from breathing high levels of vanadium are on the lungs, throat, and eyes. Workers who breathed it for short and long periods sometimes had lung irritation, coughing, wheezing, chest pain, runny nose, and a sore throat. These effects stopped soon after they stopped breathing the contaminated air. Similar effects have been observed in animal studies. No other significant health effects of vanadium have been found in people. Some animals that breathed or ingested vanadium over a long term had minor kidney and liver changes. The Department of Health and Human Services, the International Agency for Research on Cancer, and the Environmental Protection Agency (EPA) have not classified vanadium as to its human carcinogenicity. No human studies are available on the carcinogenicity of vanadium. No increase in tumors was noted in a long-term animal study where the animals were exposed to vanadium in the drinking water.

MCPA : 2-methyl-4-chlorophenoxyacetic acid

MCPA is a systemic post-emergence phenoxy herbicide used to control annual and perennial weeds (including thistle and dock) in cereals, flax, rice, vines, peas, potatoes, grasslands, forestry applications, and on rights-of-way. This compound is a Restricted Use Pesticide (RUP); i.e., it may be purchased and used only by certified applicators. MCPA carries a DANGER signal word on the label even though the acute toxicity of the product indicates that it is only slightly toxic. This is due to its potential to cause severe eye irritation. Symptoms in humans from acute toxic exposure include slurred speech, twitching, jerking and spasms, drooling, low blood pressure, and unconsciousness.

The LD50 (lethal dose that kills 50 percent of the population tested) for MCPA in rats ranges from 700 mg/kg to 1,330 mg/kg and the LD50 of MCPA in the mouse ranges from 550 to 800 mg/kg. The dermal LD50 is 4,800 mg/kg in male rabbits and 3,400 mg/kg in female rabbits. The estimated human lethal oral dose is from 250 to 450 mg/kg.

All of the available cancer evidence on MCPA indicates that the compound does not cause cancer.

Polycyclic Aromatic Hydrocarbons (PAHs)

Polycyclic aromatic hydrocarbons (PAHs) are a group of over 100 different chemicals that are formed during the incomplete burning of coal, oil and gas, garbage, or other organic substances like tobacco or charbroiled meat. PAHs are usually found as a mixture containing two or more of these compounds, such as soot. These include benzo(a)anthracene, benzo(b)fluoranthene, benzo(a)pyrene, benzo(g,h,i)perylene, indeno(1,2,3-cd0pyrene, phenanthrene, and naphthalene

Some PAHs are manufactured. These pure PAHs usually exist as colorless, white, or pale yellow-green solids. PAHs are found in coal tar, crude oil, creosote, and roofing tar, but a few are used in medicines or to make dyes, plastics, and pesticides.

Mice that were fed high levels of one PAH during pregnancy had difficulty reproducing and so did their offspring. These offspring also had higher rates of birth defects and lower body weights. It is not known whether these effects occur in people. Animal studies have also shown that PAHs can cause harmful effects on the skin, body fluids, and ability to fight disease after both short- and long-term exposure. But these effects have not been seen in people.

The US Department of Health and Human Services (DHHS) has determined that some PAHs may reasonably be expected to be carcinogens. Some people who have breathed or touched mixtures of PAHs and other chemicals for long periods of time have developed cancer. Some PAHs have caused cancer in laboratory animals when they breathed air containing them (lung cancer), ingested them in food (stomach cancer), or had them applied to their skin (skin cancer).

Lead

Lead is a naturally occurring metal found in small amounts in the earth's crust. Lead can be found in all parts of our environment. Much of it comes from human activities including burning fossil fuels, mining, and manufacturing. Lead has many different uses. It is used in the production of batteries, ammunition, metal products (solder and pipes), and devices to shield X-rays. Because of health concerns, lead from gasoline, paints and ceramic products, caulking, and pipe solder has been dramatically reduced in recent years. People may be exposed to lead by eating food or drinking water that contains lead, spending time in areas where lead-based paints have been used and are deteriorating, and by working in a job or engaging in a hobby where lead is used. Small children are more likely to be exposed to lead by swallowing house dust or soil that contains lead, eating lead-based paint chips or chewing on objects painted with lead-based paint.

Lead can affect many organs and systems in the body. The most sensitive is the central nervous system, particularly in children. Lead also damages kidneys and the reproductive system. The effects are the same whether it is breathed or swallowed. At high levels, lead may decrease reaction time, cause weakness in fingers, wrists, or ankles, and possibly affect the memory. Lead may cause anemia, a disorder of the blood. It can also damage the male reproductive system. The connection between these effects and exposure to low levels of lead is uncertain.

Children are more vulnerable to lead poisoning than adults. A child who swallows large amounts of lead, for example by eating old paint chips, may develop blood anemia, severe stomachache, muscle weakness, and brain damage. A large amount of lead might get into a child's body if the child ate small pieces of old paint that contained large amounts of lead. If a child swallows smaller amounts of lead, much less severe effects on blood and brain function may occur. Even at much lower levels of exposure, however, lead can affect a child's mental and physical growth. Exposure to lead is more dangerous for young children and fetuses. Fetuses can be exposed to lead through their mothers. Harmful effects include premature births, smaller babies, decreased mental ability in the infant, learning difficulties, and reduced growth in young children. These effects are more common if the mother or baby was exposed to high levels of lead.

The USDHHS has determined that two compounds of lead (lead acetate and lead phosphate) may reasonably be anticipated to be carcinogens based on studies in animals. There is inadequate evidence to clearly determine whether lead can cause cancer in people.

PCB – Arochlor 1260

Polychlorinated biphenyls (PCBs) are mixtures of up to 209 individual chlorinated compounds (known as congeners). There are no known natural sources of PCBs. PCBs are either oily liquids or solids that are colorless to light yellow. PCBs have no known smell or taste. Many commercial PCB mixtures are known in the US by the trade name Arochlor. PCBs have been used as coolants and lubricants in transformers, capacitors, and other electrical equipment because they don't burn easily and are good insulators.

PCBs do not readily break down in the environment and thus may remain there for very long periods of time. PCBs can travel long distances in the air and be deposited in areas far away from where they were released. PCBs are taken up by small organisms and fish in water. They are also taken up by other animals that eat these aquatic animals as food. PCBs accumulate in fish and marine mammals, reaching levels that may be many thousands of times higher than in water.

The most commonly observed health effects in people exposed to large amounts of PCBs are skin conditions such as acne and rashes. Studies in exposed workers have shown changes in blood and urine that may indicate liver damage. PCB exposures in the general population are not likely to result in skin and liver effects. Most of the studies of health effects of PCBs in the general population examined children of mothers who were exposed to PCBs. Animals that ate food containing large amounts of PCBs for short periods of time had mild liver damage and some died. Animals that ate smaller amounts of PCBs in food over several weeks or months developed various kinds of health effects, including anemia; acne-like skin conditions; and liver, stomach, and thyroid gland injuries. Other effects of PCBs in animals include changes in the immune system, behavioral alterations, and impaired reproduction. PCBs are not known to cause birth defects.

Few studies of workers indicate that PCBs were associated with certain kinds of cancer in humans, such as cancer of the liver and biliary tract. Rats that ate food containing high levels of PCBs for two years developed liver cancer. The US Department of Health and Human Services (DHHS) has concluded that PCBs may reasonably be anticipated to be carcinogens. The USEPA and the International Agency for Research on Cancer (IARC) have determined that PCBs are probably carcinogenic to humans.

Women who were exposed to relatively high levels of PCBs in the workplace or ate large amounts of fish contaminated with PCBs had babies that weighed slightly less than babies from women who did not have these exposures. Babies born to women who ate PCB-contaminated fish also showed abnormal responses in tests of infant behavior. Some of these behaviors, such as problems with motor skills and a decrease in short-term memory, lasted for several years. Other studies suggest that the immune system was affected in children born to and nursed by mothers exposed to increased levels of PCBs. There are no reports of structural birth defects caused by exposure to PCBs or of health effects of PCBs in older children. The most likely way infants will be exposed to PCBs is from breast milk. Transplacental transfers of PCBs were also reported. In most cases, the benefits of breast-feeding outweigh any risks from exposure to PCBs in mother's milk.

Appendix D

ATSDR Glossary of Terms

The Agency for Toxic Substances and Disease Registry (ATSDR) is a federal public health agency with headquarters in Atlanta, Georgia, and 10 regional offices in the United States. ATSDR's mission is to serve the public by using the best science, taking responsive public health actions, and providing trusted health information to prevent harmful exposures and diseases related to toxic substances. ATSDR is not a regulatory agency, unlike the U.S. Environmental Protection Agency (EPA), which is the federal agency that develops and enforces environmental laws to protect the environment and human health. This glossary defines words used by ATSDR in communications with the public. It is not a complete dictionary of environmental health terms. If you have questions or comments, call ATSDR's toll-free telephone number, 1-888-42-ATSDR (1-888-422-8737).

General Terms

Absorption
The process of taking in. For a person or an animal, absorption is the process of a substance getting into the body through the eyes, skin, stomach, intestines, or lungs.

Acute
Occurring over a short time [compare with chronic].

Acute exposure
Contact with a substance that occurs once or for only a short time (up to 14 days) [compare with intermediate duration exposure and chronic exposure].

Additive effect
A biologic response to exposure to multiple substances that equals the sum of responses of all the individual substances added together [compare with antagonistic effect and synergistic effect].

Adverse health effect
A change in body function or cell structure that might lead to disease or health problems

Aerobic
Requiring oxygen [compare with anaerobic].

Ambient
Surrounding (for example, ambient air).

Anaerobic
Requiring the absence of oxygen [compare with aerobic].

Analyte
A substance measured in the laboratory. A chemical for which a sample (such as water, air, or blood) is tested in a laboratory. For example, if the analyte is mercury, the laboratory test will determine the amount of mercury in the sample.

Analytic epidemiologic study
A study that evaluates the association between exposure to hazardous substances and disease by testing scientific hypotheses.

Antagonistic effect
A biologic response to exposure to multiple substances that is less than would be expected if the known effects of the individual substances were added together [compare with additive effect and synergistic effect].

Background level
An average or expected amount of a substance or radioactive material in a specific environment, or typical amounts of substances that occur naturally in an environment.

Biodegradation
Decomposition or breakdown of a substance through the action of microorganisms (such as bacteria or fungi) or other natural physical processes (such as sunlight).

Biologic indicators of exposure study
A study that uses (a) biomedical testing or (b) the measurement of a substance [an analyte], its metabolite, or another marker of exposure in human body fluids or tissues to confirm human exposure to a hazardous substance [also see exposure investigation].

Biologic monitoring
Measuring hazardous substances in biologic materials (such as blood, hair, urine, or breath) to determine whether exposure has occurred. A blood test for lead is an example of biologic monitoring.

Biologic uptake
The transfer of substances from the environment to plants, animals, and humans.

Biomedical testing
Testing of persons to find out whether a change in a body function might have occurred because of exposure to a hazardous substance.

Biota
Plants and animals in an environment. Some of these plants and animals might be sources of food, clothing, or medicines for people.

Body burden
The total amount of a substance in the body. Some substances build up in the body because they are stored in fat or bone or because they leave the body very slowly.

CAP [see Community Assistance Panel.]

Cancer
Any one of a group of diseases that occur when cells in the body become abnormal and grow or multiply out of control.

Cancer risk
A theoretical risk for getting cancer if exposed to a substance every day for 70 years (a lifetime exposure). The true risk might be lower.

Carcinogen
A substance that causes cancer.

Case study
A medical or epidemiologic evaluation of one person or a small group of people to gather information about specific health conditions and past exposures.

Case-control study
A study that compares exposures of people who have a disease or condition (cases) with people who do not have the disease or condition (controls). Exposures that are more common among the cases may be considered as possible risk factors for the disease.

CAS registry number
A unique number assigned to a substance or mixture by the American Chemical Society Abstracts Service.

Central nervous system
The part of the nervous system that consists of the brain and the spinal cord.

CERCLA [see Comprehensive Environmental Response, Compensation, and Liability Act of 1980]

Chronic
Occurring over a long time [compare with acute].

Chronic exposure
Contact with a substance that occurs over a long time (more than 1 year) [compare with acute exposure and intermediate duration exposure]

Cluster investigation
A review of an unusual number, real or perceived, of health events (for example, reports of cancer) grouped together in time and location. Cluster investigations are designed to confirm case reports; determine whether they represent an unusual disease occurrence; and, if possible, explore possible causes and contributing environmental factors.

Community Assistance Panel (CAP)
A group of people from a community and from health and environmental agencies who work with ATSDR to resolve issues and problems related to hazardous substances in the community.

CAP members work with ATSDR to gather and review community health concerns, provide information on how people might have been or might now be exposed to hazardous substances, and inform ATSDR on ways to involve the community in its activities.

Comparison value (CV)
Calculated concentration of a substance in air, water, food, or soil that is unlikely to cause harmful (adverse) health effects in exposed people. The CV is used as a screening level during the public health assessment process. Substances found in amounts greater than their CVs might be selected for further evaluation in the public health assessment process.

Completed exposure pathway [see exposure pathway].

Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)
CERCLA, also known as Superfund, is the federal law that concerns the removal or cleanup of hazardous substances in the environment and at hazardous waste sites. ATSDR, which was created by CERCLA, is responsible for assessing health issues and supporting public health activities related to hazardous waste sites or other environmental releases of hazardous substances. This law was later amended by the Superfund Amendments and Reauthorization Act (SARA).

Concentration
The amount of a substance present in a certain amount of soil, water, air, food, blood, hair, urine, breath, or any other media.

Contaminant
A substance that is either present in an environment where it does not belong or is present at levels that might cause harmful (adverse) health effects.

Delayed health effect
A disease or an injury that happens as a result of exposures that might have occurred in the past.

Dermal
Referring to the skin. For example, dermal absorption means passing through the skin.

Dermal contact
Contact with (touching) the skin [see route of exposure].

Descriptive epidemiology
The study of the amount and distribution of a disease in a specified population by person, place, and time.

Detection limit
The lowest concentration of a chemical that can reliably be distinguished from a zero concentration.

Disease prevention
Measures used to prevent a disease or reduce its severity.

Disease registry
A system of ongoing registration of all cases of a particular disease or health condition in a defined population.

DOD
United States Department of Defense.

DOE
United States Department of Energy.

Dose (for chemicals that are not radioactive)
The amount of a substance to which a person is exposed over some time period. Dose is a measurement of exposure. Dose is often expressed as milligram (amount) per kilogram (a measure of body weight) per day (a measure of time) when people eat or drink contaminated water, food, or soil. In general, the greater the dose, the greater the likelihood of an effect. An "exposure dose" is how much of a substance is encountered in the environment. An "absorbed dose" is the amount of a substance that actually got into the body through the eyes, skin, stomach, intestines, or lungs.

Dose (for radioactive chemicals)
The radiation dose is the amount of energy from radiation that is actually absorbed by the body. This is not the same as measurements of the amount of radiation in the environment.

Dose-response relationship
The relationship between the amount of exposure [dose] to a substance and the resulting changes in body function or health (response).

Environmental media
Soil, water, air, biota (plants and animals), or any other parts of the environment that can contain contaminants.

Environmental media and transport mechanism
Environmental media include water, air, soil, and biota (plants and animals). Transport mechanisms move contaminants from the source to points where human exposure can occur. The environmental media and transport mechanism is the second part of an exposure pathway.

EPA
United States Environmental Protection Agency.

Epidemiologic surveillance [see Public health surveillance].

Epidemiology
The study of the distribution and determinants of disease or health status in a population; the study of the occurrence and causes of health effects in humans.

Exposure
Contact with a substance by swallowing, breathing, or touching the skin or eyes. Exposure may be short-term [acute exposure], of intermediate duration, or long-term [chronic exposure].

Exposure assessment
The process of finding out how people come into contact with a hazardous substance, how often and for how long they are in contact with the substance, and how much of the substance they are in contact with.

Exposure-dose reconstruction
A method of estimating the amount of people's past exposure to hazardous substances. Computer and approximation methods are used when past information is limited, not available, or missing.

Exposure investigation
The collection and analysis of site-specific information and biologic tests (when appropriate) to determine whether people have been exposed to hazardous substances.

Exposure pathway
The route a substance takes from its source (where it began) to its end point (where it ends), and how people can come into contact with (or get exposed to) it. An exposure pathway has five parts: a source of contamination (such as an abandoned business); an environmental media and transport mechanism (such as movement through groundwater); a point of exposure (such as a private well); a route of exposure (eating, drinking, breathing, or touching), and a receptor population (people potentially or actually exposed). When all five parts are present, the exposure pathway is termed a completed exposure pathway.

Exposure registry
A system of ongoing followup of people who have had documented environmental exposures.

Feasibility study
A study by EPA to determine the best way to clean up environmental contamination. A number of factors are considered, including health risk, costs, and what methods will work well.

Geographic information system (GIS)
A mapping system that uses computers to collect, store, manipulate, analyze, and display data. For example, GIS can show the concentration of a contaminant within a community in relation to points of reference such as streets and homes.

Grand rounds
Training sessions for physicians and other health care providers about health topics.

Groundwater
Water beneath the earth's surface in the spaces between soil particles and between rock surfaces [compare with surface water].

Half-life ($t_{1/2}$)
The time it takes for half the original amount of a substance to disappear. In the environment, the half-life is the time it takes for half the original amount of a substance to disappear when it is changed to another chemical by bacteria, fungi, sunlight, or other chemical processes. In the human body, the half-life is the time it takes for half the original amount of the substance to disappear, either by being changed to another substance or by leaving the body. In the case of radioactive material, the half life is the amount of time necessary for one half the initial number of radioactive atoms to change or transform into another atom (that is normally not radioactive). After two half lives, 25% of the original number of radioactive atoms remain.

Hazard
A source of potential harm from past, current, or future exposures.

Hazardous Substance Release and Health Effects Database (HazDat)
The scientific and administrative database system developed by ATSDR to manage data collection, retrieval, and analysis of site-specific information on hazardous substances, community health concerns, and public health activities.

Hazardous waste
Potentially harmful substances that have been released or discarded into the environment.

Health consultation
A review of available information or collection of new data to respond to a specific health question or request for information about a potential environmental hazard. Health consultations are focused on a specific exposure issue. Health consultations are therefore more limited than a public health assessment, which reviews the exposure potential of each pathway and chemical [compare with public health assessment].

Health education
Programs designed with a community to help it know about health risks and how to reduce these risks.

Health investigation
The collection and evaluation of information about the health of community residents. This information is used to describe or count the occurrence of a disease, symptom, or clinical measure and to evaluate the possible association between the occurrence and exposure to hazardous substances.

Health promotion
The process of enabling people to increase control over, and to improve, their health.

Health statistics review
The analysis of existing health information (i.e., from death certificates, birth defects registries, and cancer registries) to determine if there is excess disease in a specific population, geographic area, and time period. A health statistics review is a descriptive epidemiologic study.

Indeterminate public health hazard
The category used in ATSDR's public health assessment documents when a professional judgment about the level of health hazard cannot be made because information critical to such a decision is lacking.

Incidence
The number of new cases of disease in a defined population over a specific time period [contrast with prevalence].

Ingestion
The act of swallowing something through eating, drinking, or mouthing objects. A hazardous substance can enter the body this way [see route of exposure].

Inhalation
The act of breathing. A hazardous substance can enter the body this way [see route of exposure].

Intermediate duration exposure
Contact with a substance that occurs for more than 14 days and less than a year [compare with acute exposure and chronic exposure].

In vitro
In an artificial environment outside a living organism or body. For example, some toxicity testing is done on cell cultures or slices of tissue grown in the laboratory, rather than on a living animal [compare with in vivo].

In vivo
Within a living organism or body. For example, some toxicity testing is done on whole animals, such as rats or mice [compare with in vitro].

Lowest-observed-adverse-effect level (LOAEL)
The lowest tested dose of a substance that has been reported to cause harmful (adverse) health effects in people or animals.

Medical monitoring
A set of medical tests and physical exams specifically designed to evaluate whether an individual's exposure could negatively affect that person's health.

Metabolism
The conversion or breakdown of a substance from one form to another by a living organism.

Metabolite
Any product of metabolism.

mg/kg
Milligram per kilogram.

mg/cm^2
Milligram per square centimeter (of a surface).

mg/m^3
Milligram per cubic meter; a measure of the concentration of a chemical in a known volume (a cubic meter) of air, soil, or water.

Migration
Moving from one location to another.

Minimal risk level (MRL)
An ATSDR estimate of daily human exposure to a hazardous substance at or below which that substance is unlikely to pose a measurable risk of harmful (adverse), noncancerous effects. MRLs are calculated for a route of exposure (inhalation or oral) over a specified time period (acute, intermediate, or chronic). MRLs should not be used as predictors of harmful (adverse) health effects [see reference dose].

Morbidity
State of being ill or diseased. Morbidity is the occurrence of a disease or condition that alters health and quality of life.

Mortality
Death. Usually the cause (a specific disease, a condition, or an injury) is stated.

Mutagen
A substance that causes mutations (genetic damage).

Mutation
A change (damage) to the DNA, genes, or chromosomes of living organisms.

National Priorities List for Uncontrolled Hazardous Waste Sites (National Priorities List or NPL)
EPA's list of the most serious uncontrolled or abandoned hazardous waste sites in the United States. The NPL is updated on a regular basis.

National Toxicology Program (NTP)
Part of the Department of Health and Human Services. NTP develops and carries out tests to predict whether a chemical will cause harm to humans.

No apparent public health hazard
A category used in ATSDR's public health assessments for sites where human exposure to contaminated media might be occurring, might have occurred in the past, or might occur in the future, but where the exposure is not expected to cause any harmful health effects.

No-observed-adverse-effect level (NOAEL)
The highest tested dose of a substance that has been reported to have no harmful (adverse) health effects on people or animals.

No public health hazard
A category used in ATSDR's public health assessment documents for sites where people have never and will never come into contact with harmful amounts of site-related substances.

NPL [see National Priorities List for Uncontrolled Hazardous Waste Sites]

Physiologically based pharmacokinetic model (PBPK model)
A computer model that describes what happens to a chemical in the body. This model describes how the chemical gets into the body, where it goes in the body, how it is changed by the body, and how it leaves the body.

Pica
A craving to eat nonfood items, such as dirt, paint chips, and clay. Some children exhibit pica-related behavior.

Plume
A volume of a substance that moves from its source to places farther away from the source. Plumes can be described by the volume of air or water they occupy and the direction they move. For example, a plume can be a column of smoke from a chimney or a substance moving with groundwater.

Point of exposure
The place where someone can come into contact with a substance present in the environment [see exposure pathway].

Population
A group or number of people living within a specified area or sharing similar characteristics (such as occupation or age).

Potentially responsible party (PRP)
A company, government, or person legally responsible for cleaning up the pollution at a hazardous waste site under Superfund. There may be more than one PRP for a particular site.

ppb
Parts per billion.

ppm
Parts per million.

Prevalence
The number of existing disease cases in a defined population during a specific time period [contrast with incidence].

Prevalence survey
The measure of the current level of disease(s) or symptoms and exposures through a questionnaire that collects self-reported information from a defined population.

Prevention
Actions that reduce exposure or other risks, keep people from getting sick, or keep disease from getting worse.

Public availability session
An informal, drop-by meeting at which community members can meet one-on-one with ATSDR staff members to discuss health and site-related concerns.

Public comment period
An opportunity for the public to comment on agency findings or proposed activities contained in draft reports or documents. The public comment period is a limited time period during which comments will be accepted.

Public health action
A list of steps to protect public health.

Public health advisory
A statement made by ATSDR to EPA or a state regulatory agency that a release of hazardous substances poses an immediate threat to human health. The advisory includes recommended measures to reduce exposure and reduce the threat to human health.

Public health assessment (PHA)
An ATSDR document that examines hazardous substances, health outcomes, and community concerns at a hazardous waste site to determine whether people could be harmed from coming into contact with those substances. The PHA also lists actions that need to be taken to protect public health [compare with health consultation].

Public health hazard
A category used in ATSDR's public health assessments for sites that pose a public health hazard because of long-term exposures (greater than 1 year) to sufficiently high levels of hazardous substances or radionuclides that could result in harmful health effects.

Public health hazard categories
Public health hazard categories are statements about whether people could be harmed by conditions present at the site in the past, present, or future. One or more hazard categories might

be appropriate for each site. The five public health hazard categories are no public health hazard, no apparent public health hazard, indeterminate public health hazard, public health hazard, and urgent public health hazard.

Public health statement
The first chapter of an ATSDR toxicological profile. The public health statement is a summary written in words that are easy to understand. The public health statement explains how people might be exposed to a specific substance and describes the known health effects of that substance.

Public health surveillance
The ongoing, systematic collection, analysis, and interpretation of health data. This activity also involves timely dissemination of the data and use for public health programs.

Public meeting
A public forum with community members for communication about a site.

Radioisotope
An unstable or radioactive isotope (form) of an element that can change into another element by giving off radiation.

Radionuclide
Any radioactive isotope (form) of any element.

RCRA [see Resource Conservation and Recovery Act (1976, 1984)]

Receptor population
People who could come into contact with hazardous substances [see exposure pathway].

Reference dose (RfD)
An EPA estimate, with uncertainty or safety factors built in, of the daily lifetime dose of a substance that is unlikely to cause harm in humans.

Registry
A systematic collection of information on persons exposed to a specific substance or having specific diseases [see exposure registry and disease registry].

Remedial investigation
The CERCLA process of determining the type and extent of hazardous material contamination at a site.

Resource Conservation and Recovery Act (1976, 1984) (RCRA)
This Act regulates management and disposal of hazardous wastes currently generated, treated, stored, disposed of, or distributed.

RFA
RCRA Facility Assessment. An assessment required by RCRA to identify potential and actual releases of hazardous chemicals.

RfD [see reference dose]

Risk
The probability that something will cause injury or harm.

Risk reduction
Actions that can decrease the likelihood that individuals, groups, or communities will experience disease or other health conditions.

Risk communication
The exchange of information to increase understanding of health risks.

Route of exposure
The way people come into contact with a hazardous substance. Three routes of exposure are breathing [inhalation], eating or drinking [ingestion], or contact with the skin [dermal contact].

Safety factor [see uncertainty factor]

SARA [see Superfund Amendments and Reauthorization Act]

Sample
A portion or piece of a whole. A selected subset of a population or subset of whatever is being studied. For example, in a study of people the sample is a number of people chosen from a larger population [see population]. An environmental sample (for example, a small amount of soil or water) might be collected to measure contamination in the environment at a specific location.

Sample size
The number of units chosen from a population or an environment.

Solvent
A liquid capable of dissolving or dispersing another substance (for example, acetone or mineral spirits).

Source of contamination
The place where a hazardous substance comes from, such as a landfill, waste pond, incinerator, storage tank, or drum. A source of contamination is the first part of an exposure pathway.

Special populations
People who might be more sensitive or susceptible to exposure to hazardous substances because of factors such as age, occupation, sex, or behaviors (for example, cigarette smoking). Children, pregnant women, and older people are often considered special populations.

Stakeholder
A person, group, or community who has an interest in activities at a hazardous waste site.

Statistics
A branch of mathematics that deals with collecting, reviewing, summarizing, and interpreting data or information. Statistics are used to determine whether differences between study groups are meaningful.

Substance
A chemical.

Substance-specific applied research
A program of research designed to fill important data needs for specific hazardous substances identified in ATSDR's toxicological profiles. Filling these data needs would allow more accurate assessment of human risks from specific substances contaminating the environment. This research might include human studies or laboratory experiments to determine health effects resulting from exposure to a given hazardous substance.

Superfund [see Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and Superfund Amendments and Reauthorization Act (SARA)

Superfund Amendments and Reauthorization Act (SARA)
In 1986, SARA amended the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and expanded the health-related responsibilities of ATSDR. CERCLA and SARA direct ATSDR to look into the health effects from substance exposures at hazardous waste sites and to perform activities including health education, health studies, surveillance, health consultations, and toxicological profiles.

Surface water
Water on the surface of the earth, such as in lakes, rivers, streams, ponds, and springs [compare with groundwater].

Surveillance [see public health surveillance]

Survey
A systematic collection of information or data. A survey can be conducted to collect information from a group of people or from the environment. Surveys of a group of people can be conducted by telephone, by mail, or in person. Some surveys are done by interviewing a group of people [see prevalence survey].

Synergistic effect
A biologic response to multiple substances where one substance worsens the effect of another substance. The combined effect of the substances acting together is greater than the sum of the effects of the substances acting by themselves [see additive effect and antagonistic effect].

Teratogen
A substance that causes defects in development between conception and birth. A teratogen is a substance that causes a structural or functional birth defect.

Toxic agent
Chemical or physical (for example, radiation, heat, cold, microwaves) agents that, under certain circumstances of exposure, can cause harmful effects to living organisms.

Toxicological profile
An ATSDR document that examines, summarizes, and interprets information about a hazardous substance to determine harmful levels of exposure and associated health effects. A toxicological profile also identifies significant gaps in knowledge on the substance and describes areas where further research is needed.

Toxicology
The study of the harmful effects of substances on humans or animals.

Tumor
An abnormal mass of tissue that results from excessive cell division that is uncontrolled and progressive. Tumors perform no useful body function. Tumors can be either benign (not cancer) or malignant (cancer).

Uncertainty factor
Mathematical adjustments for reasons of safety when knowledge is incomplete. For example, factors used in the calculation of doses that are not harmful (adverse) to people. These factors are applied to the lowest-observed-adverse-effect-level (LOAEL) or the no-observed-adverse-effect-level (NOAEL) to derive a minimal risk level (MRL). Uncertainty factors are used to account for variations in people's sensitivity, for differences between animals and humans, and for differences between a LOAEL and a NOAEL. Scientists use uncertainty factors when they have some, but not all, the information from animal or human studies to decide whether an exposure will cause harm to people [also sometimes called a safety factor].

Urgent public health hazard
A category used in ATSDR's public health assessments for sites where short-term exposures (less than 1 year) to hazardous substances or conditions could result in harmful health effects that require rapid intervention.

Volatile organic compounds (VOCs)
Organic compounds that evaporate readily into the air. VOCs include substances such as benzene, toluene, methylene chloride, and methyl chloroform.

Other glossaries and dictionaries:
Environmental Protection Agency (http://www.epa.gov/OCEPAterms/)

National Center for Environmental Health (CDC)
(http://www.cdc.gov/nceh/dls/report/glossary.htm)

National Library of Medicine (NIH)
(http://www.nlm.nih.gov/medlineplus/mplusdictionary.html)

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Appendix A

Photographs 1 and 2: View of the Delaware River along the western portion of the Crown Vantage Landfill site, August 11, 2005

Photograph 3: Riprap on the western portion of the Crown Vantage Landfill site, October 26, 2004

Photograph 4: Flyash on the Crown Vantage Landfill site, October 26, 2004

Photograph 5: View of fallen fence posts on the western portion of the Crown Vantage Landfill site, August 11, 2005

Photograph 6: Fence with flood debris on the western portion of the Crown Vantage Landfill site, August 11, 2005

Photographs 7 and 8: Half-buried disintegrated drums on the Crown Vantage Landfill site, October 26, 2005

Photographs 9 and 10: Warning signs posted along the western portion of the Crown Vantage Landfill site, August 11, 2005

Photograph 11: Flood debris on the Crown Vantage Landfill site, October 26, 2004

Photograph 12: Fence with flood debris on the western portion of the Crown Vantage Landfill site, August 11, 2005

Photographs 13 and 14: Evidence of adult and child shoe washed ashore on the Crown Vantage Landfill site, August 11, 2005

Photograph 15: NJDHSS staff member's steel-toed safety shoes following the site visit to the Crown Vantage Landfill, August 11, 2005