Five-Year Review Report
Ramapo Landfill Superfund Site
Rockland County
Town of Ramapo, New York

Prepared by:

United States Environmental Protection Agency
Region 2
New York, New York

December 2004

EXECUTIVE SUMMARY

A second five-year review for the Ramapo Landfill Superfund site, located in the Town of Ramapo, Rockland County, New York, was completed. Currently the landfill remedy is functioning as intended by the decision documents protecting human health and the environment. However, this review has raised a concern about the human health exposure from groundwater contamination which may be reaching drinking water wells. Recommendations contained in this report, if carried out, will clarify these exposures and indicate if additional actions are needed. An addendum to this report will be issued when a site-wide protectiveness determination can be made.

Five-Year Review Summary Form

SITE IDENTIFICATION

Site Name *(from WasteLAN)*: Ramapo Landfill

EPA ID *(from WasteLAN)*: NYD000511493

Region: 2	**State:** NY	**City/County:** Town of Ramapo/Rockland County

SITE STATUS

NPL Status: **O** Final **G** Deleted **G** Other (specify) _____

Remediation Status (choose all that apply): **G** Under Construction **G** Operating **O** Complete

Multiple OUs? **G** YES **O** NO	**Construction completion date:** September 30, 1997

Are portions of the site in use or suitable for reuse? **O** YES **G** NO **G** N/A

REVIEW STATUS

Lead agency: **G** EPA **O** State **G** Tribe **G** Other Federal Agency _____

Author name: George Jacob

Author title: Remedial Project Manager	**Author affiliation:** EPA

Review period:** 12/1999 to 12/2004

Date(s) of site inspection: 11/23/04

Type of review:

G Post-SARA **G** Pre-SARA **G** NPL-Removal only
G Non-NPL Remedial Action Site **G** NPL State/Tribe-lead
G Regional Discretion **G** Policy **O** Statutory

Review number: **G** 1 (first) **O** 2 (second) **G** 3 (third) **G** Other (specify) _____

Triggering action:
G Actual RA Onsite Construction at OU # _ **G** Actual RA Start at OU#__
G Construction Completion **O** Previous Five-Year Review Report
G Other (specify) _____

Triggering action date *(from WasteLAN)*: 12/23/1999

Due date *(five years after triggering action date)*: 12/23/2004

Five-Year Review Summary Form (continued)

Issues, Recommendations, and Follow-Up Actions

The current monitoring well network does not allow for a determination of a groundwater capture zone or give early warning regarding potential contaminant migration to downgradient drinking water wells. In addition, it is unclear whether elevated levels of antimony that has been sporadically detected in downgradient drinking water wells is site-related. Further, because the laboratory's detection limit for antimony is greater than the state standard, it is unknown whether the levels that are present in any of the drinking water wells are protective.

Additional groundwater monitoring wells need to be installed and sampled and a lower laboratory detection limit for antimony needs to be employed.

If it is determined that the site is the source of the antimony detected in the downgradient drinking water wells, the alternate water supply contingency remedy called for in the Record of Decision may need to be implemented and the Town would need to implement institutional controls to restrict the use of off-property groundwater.

Protectiveness Statement

Currently, the landfill remedy is functioning as intended by the decision documents and is protecting human health and the environment on-site. However, this review has raised a concern about the human health exposure from groundwater contamination which may be reaching drinking water wells. Recommendations contained in this report will clarify these exposures and indicate if additional actions are needed. An addendum to this report will be issued when a site-wide protectiveness determination can be made.

I. Introduction

This second five-year review for the Ramapo Landfill site, located in the Town of Ramapo, Rockland County, New York, was conducted by United States Environmental Protection Agency (EPA) Remedial Project Manager (RPM) George Jacob. The review was conducted pursuant to Section 121(c) of the Comprehensive Environmental Response, Compensation, and Liability Act, as amended, 42 U.S.C. §9601 *et seq*. and 40 CFR 300.430(f)(4)(ii) and in accordance with the Comprehensive Five-Year Review Guidance, OSWER Directive 9355.7-03B-P (June 2001). The purpose of five-year reviews is to ensure that implemented remedies protect public health and the environment and that they function as intended by the site decision documents. This report will become part of the site file.

A five-year review is required at this site due to the fact that hazardous substances, pollutants, or contaminants remain at the site above levels that allow for unlimited use and unrestricted exposure**.**

In accordance with Section 1.3.3 of the five-year review guidance, a subsequent statutory five-year review is triggered by the signing date of the previous five-year review report. The first five-year review was signed on December 23, 1999.

This five-year review found that the implemented remedy is functioning as intended and continues to protect human health and the environment.

II. Site Chronology

Table 1 (attached) summarize the site-related events from discovery to construction completion.

III. Background

Site Location

The Ramapo Landfill site is located in the Town of Ramapo, Rockland County, New York, about 35 miles northwest of New York City and 1 mile northeast of the Village of Hillburn, New York. The site is situated at the western base of the Ramapo Mountains off Torne Valley Road east of the New York State Thruway, Route 17, and Route 59.

Physical Characteristics

The landfill is situated on a 96-acre tract. Approximately 60 acres of the site (the landfill portion) are covered with fill material. The landfill portion of the site is mounded into two major lobes (northern and southern), and slopes steeply toward the west with grades ranging from less than one percent to greater than 30 percent. Both landfill lobes consist of mixed refuse. Substances reportedly disposed of in the landfill include industrial sludge and other wastes reportedly from a pharmaceutical company, sewage

sludge, municipal refuse, asbestos, construction and demolition debris, yard debris, paint sludge (presumably from an automotive plant), and liquid wastes reportedly from a paper company.

Utility corridors lie on three sides of the site, high voltage power transmission lines to the east and west, and a high pressure gas line to the south. A power substation is located just north of the site.

The main surface waters in the vicinity of the site are the Ramapo River, Torne Brook, and Candle Brook. The Ramapo River, located approximately 300 feet from the southwest corner of the site, is a New York State Department of Environmental Conservation (NYSDEC) Class "A" waters, which may be used as a source of water supply for drinking, culinary, or food-processing purposes. Torne Brook, which flows near the western boundary of the site, and Candle Brook, a tributary of Torne Brook, are NYSDEC Class "B" waters, suitable for primary contact recreation and any other use, except as a source of water supply for drinking, culinary, or food-processing purposes.

The United States Geological Survey has identified an area of less than ten acres near the headwaters of Candle Brook as a wetland.

Site Geology/Hydrogeology

The site is underlain by a sequence of glacially derived unconsolidated sediments that overly bedrock, which is comprised of granitic and biotite gneiss. The bedrock geology is structurally complex with numerous fault systems in the area. A fracture trace analysis identified a number of lineaments in the vicinity of the site, the most obvious one being the Ramapo fault (approximately 1.25 miles southeast of the site), which strikes northeast and dips steeply southeast. Two other lineaments observed within the immediate area of the landfill include one that lies adjacent to the west side of the landfill and trends northeast. This lineament may represent faulting or other subsurface structures controlling deflections in Torne Brook. The second lineament trends east-west and appears to cross the central portion of the landfill.

The shallow aquifer is comprised of permeable sediments consisting of a grey to brown, very loose to loose sand or sandy gravel with some silt with a hydraulic conductivity on the order of 1×10^{-4} cm/sec and a medium-dense to very dense silty sand or gravelly sand with abundant bolders and cobbles with hydraulic conductivity values ranging from 5.1×10^{-5} to 1.4×10^{-4} cm/sec. Below these sand units is a thin weathered rock zone ranging in thickness from a few inches to nearly five feet with hydraulic conductivity values ranging from 4×10^{-5} to 1.5×10^{-3} cm/sec. Underlying the weathered rock zone is a granitic and biotite gneiss bedrock aquifer. In some locations, highly fractured zones were found within the bedrock suggesting faulting. Hydraulic conductivity values for the bedrock aquifer ranged from 8.9×10^{-5} to 1×10^{-2} cm/sec.

Past investigations found that shallow groundwater generally flows toward Torne Brook and the Ramapo River with Torne Brook acting as the discharge area for the water table aquifer and that groundwater in the bedrock aquifer likely flows beneath Torne Brook. Vertical flow measurements indicated that groundwater generally flows downward.

Land and Resource Use

The Town subdivided the property north of the limit of waste and sold it to the Rockland County Solid Waste Management Authority in August 1998. The Rockland County Solid Waste Management Authority currently operates a garbage transfer facility at this location.

A pistol range utilized by the Town of Ramapo Police Department is located in the northeastern area of the site.

Groundwater is withdrawn from the area south and west of the site for residential use. Ten water supply wells, operated by the Spring Valley Water Supply Company and serving a population of over 200,000, are located along the Ramapo River both upstream and downstream of the site. Four of these wells are located within 1,500 feet of the landfill. The closest of these wells lies approximately 500 feet west of the site on the west bank of the Ramapo River. Torne Brook Estate, a residential apartment complex of 25 units, has a water well 450 feet from the landfill. A 2-unit apartment building maintains a water well about 1,200 feet from the landfill.

History of Contamination

Prior to landfill operations in the 1950s and 1960s, portions of the site were excavated as a source of gravel. In 1971, the Rockland County Department of Health granted a permit to the Town of Ramapo for the operation of the sanitary landfill. At that time, the site was owned by the Ramapo Land Company and the contract-operator was the Torne Mountain Sand and Gravel Co., Inc.

In 1976, a contract was awarded to Carmine Franco of Sorgine Construction Services of New York, Inc., for the operation and maintenance of the landfill. The contract was terminated by the Town of Ramapo in 1979, when the Town began operating the landfill directly. Municipal waste was accepted in the landfill until 1984. The Town of Ramapo continued to accept construction and demolition debris at the landfill until 1989.

A leachate collection system was constructed along the downgradient edge of the landfill from 1984 to 1985. The collected leachate was conveyed to a wastewater treatment pond in the site's southwest corner. After aeration and settling in the pond, the water was discharged to the Ramapo River. Beginning in November 1990, the collected leachate was discharged to the Village of Suffern Wastewater Treatment Plant via a 7,900-foot sewer line.

Initial Response

In September 1983, the Ramapo Landfill site was placed on the Superfund National Priorities List.
From June 1980 through October 1986, NYSDEC and the Town of Ramapo entered into three Orders on Consent related to phasing out the operation of the landfill, determining the extent of leachate movement and the feasibility of leachate collection, and constructing a surface-water and groundwater-diversion system, leachate-collection system, and a system capable of transporting or treating the collected leachate.

On February 1, 1988, the Town entered into its fourth and current Order on Consent (Index No. W3-0083-8707) with NYSDEC. This Order required that a remedial investigation and feasibility study (RI/FS) be performed for the site and that the design and construction of the remedy that was to be ultimately selected be undertaken. The Town also received a Title 3, Environmental Bond Act grant to assist it in performing the remedial activities called for by the Order.

Basis for Taking Action

The results of the RI revealed that volatile organic compounds (VOCs) were detected in three waste sample (landfill material and paint sludge) locations, ranging from 0.002 milligrams per kilogram (mg/kg) to 110 (mg/kg); VOCs were not detected in any of the surface soil samples. Semi-volatile compounds, including polycyclic aromatic hydrocarbons, were detected in waste samples and surface soil samples at concentrations ranging from 0.042 mg/kg to 16 mg/kg. Antimony, barium, beryllium, cadmium, calcium, chromium, copper, lead, selenium, and zinc were detected in surface soil and waste samples at concentrations exceeding background by an order of magnitude. NYSDEC Water Quality Standards and Guidance Values (T.O.G.S. 1.1.1) (WQSGV) and/or EPA Maximum Contaminant Levels (MCLs)[1] were exceeded for arsenic, chromium, iron, lead, magnesium, manganese, mercury, sodium, benzene, chlorobenzene, and di-n-octyl phthalate in on-site groundwater monitoring wells. No federal or state drinking water standards were exceeded in groundwater samples collected from the nearby public or private water supply wells during the RI.

Surface water samples were collected from Torne Brook, the Ramapo River near the confluence of Torne Brook, a drainage swale on an adjacent property, and two leachate seeps emanating from the landfill. At all surface water locations that were sampled, New York State surface water standards were exceeded for one or more of the following contaminants: vinyl chloride, antimony, arsenic, iron, manganese, mercury, nickel, zinc, ammonia, sulfide, copper, and lead. The highest frequency of the detections above the standards occurred near the confluence of Torne Brook and the Ramapo River, where water from the on-site leachate holding pond was being discharged to the Ramapo River. Three semi-volatile compounds were detected in a sediment sample collected in Torne Brook at concentrations below NYSDEC sediment cleanup criteria. Inorganic compounds detected in sediments which exceeded background concentrations by at least an order of magnitude included antimony, calcium, manganese, and thallium.

IV. Remedial Actions

Remedy Selection

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[1] WQSGVs and MCLs are the highest level of contaminant that is allowed in drinking water. They are promulgated standards that apply to public water systems and are intended to protect human health by limiting the levels of contaminants in drinking water.

Based upon the results of the RI/FS, in March 1992, EPA signed a ROD for the site, calling for, among other things:

- Installation of a cap on the top of the landfill using a multimedia system, including layers of fill material, a gas-venting system and an impermeable membrane. The landfill side slopes would be capped using a multimedia system without an impermeable membrane if confirmatory studies demonstrated that this approach met the remedial action objectives. Should the confirmatory studies indicate that the overall remedy's effectiveness would be significantly reduced by not including an impermeable barrier in the multimedia cap on the sideslopes, then an impermeable barrier was to be included in the cap on some or all of the side slopes of the landfill;

- Installation of a perimeter drain around the sections of the cap containing the impermeable membrane to collect and divert surface water runoff;

- Installation of groundwater extraction wells to contain the groundwater contamination;

- Collection and diversion of leachate seeps to the existing leachate collection system;

- Conveyance of the collected leachate and contaminated groundwater via the sewer system to a local wastewater treatment facility;

- Imposition of property deed restrictions which would include measures to prevent the installation of drinking water wells at the site, and restrict activities which could affect the integrity of the cap;

- Performance of a maintenance and sampling program upon completion of closure activities. The monitoring program will provide data to evaluate the effectiveness of the remedial effort. Additional monitoring points would be established as needed to detect any future movement of site contaminants toward drinking water sources off-site;

- Development of a contingency plan for rapid implementation of additional measures to protect nearby residents and users of groundwater if those measures are determined to be necessary.

Remedy Implementation

The Town of Ramapo retained URS Consultants, Inc. of Buffalo, New York to conduct the remedial design (RD), solicit and obtain bids for the landfill closure, and provide construction administration and resident engineering.

As was noted above, the ROD stated that an impermeable barrier would be placed on the landfill's side slopes if confirmatory studies indicated that the remedy's overall effectiveness would be significantly enhanced. The confirmatory studies indicated that the exclusion of an impermeable barrier from the landfill cap on the side slopes would result in increased infiltration of rainfall through the cap. This would cause the generation of greater quantities of contaminated groundwater, which would result in greater operational costs to collect and treat a larger volume of contaminated groundwater and leachate. In addition, it was determined that either a thicker soil cover or an impermeable barrier would be needed on the side slopes to provide adequate control of landfill gases. The impermeable barrier was found to be the less costly of the two options. Therefore, based upon the results of the confirmatory studies, it was concluded that a cap with an impermeable barrier on the landfill's side slopes would be more protective and more cost-effective than a cap without an impermeable barrier on the side slopes. An Explanation of Significant Differences (ESD) was issued in November 26, 1997 to document these findings.

The RD, which was prepared by URS Greiner Inc., was approved by NYSDEC in 1992. The RD not only included the plans and specifications for the construction of the landfill cap and expanding the leachate collection system, but also included a preliminary design (contingency plan) for the connection of nearby residents to the Pothat Water Company water line should groundwater monitoring data indicate that groundwater standards are being contravened.

A construction contract was awarded to Geo-Con Inc. in 1993. Construction of the site remedy began on December 26, 1994 and was substantially completed on May 30, 1997.

The construction effort involved the construction of a landfill cap (a gas venting layer, a textured 40- mil high density polyethylene geomembrane liner, a 12-inch barrier protection layer, and a 6-inch topsoil layer) and the expansion of the existing leachate collection system to enhance its recovery of contaminated groundwater.

Institutional Controls Implementation

Although the ROD required the implementation of institutional controls to restrict the use of on-site groundwater and to protect the integrity of the cap, since the site property is municipally-owned, NYSDEC did not require the Town to obtain property deed restrictions to prevent the installation of drinking water wells at the site and restrict activities which could affect the integrity of the cap. The Town has, however, prepared the appropriate language for restrictions to be incorporated into the deed in the event that there is any change anticipated in the ownership/operation of the property.

If the recommended groundwater investigation (see Table 8) determines that the site is a source or potential source of contamination to downgradient areas, the Town would need to implement institutional controls to restrict the use of off-property groundwater.

System Operations/Operation and Maintenance

An Operation and Maintenance Manual, covering post-landfill cap construction inspection and maintenance procedures, was submitted and approved by NYSDEC as part of the RD. During the first year following the landfill cap construction, the site was inspected quarterly and following heavy storm events. For the subsequent years, the site has been inspected on a quarterly basis as follows:

- The site is inspected for debris, litter and/or waste.
- The landfill cap is inspected for vegetation loss due to erosion or poor grass growth. Annual ground inspections at the beginning of each summer also note the status of woody plant species on the landfill surface and side slopes.
- The landfill cap is inspected for settlement, ponding, and animal borrows.
- The gas venting pipes are inspected for damage.
- The site access gate and fence are inspected for operational locks and vandalism.
- The culverts, drainage ditches, and level spreaders are inspected for sediment buildup or erosion.
- The groundwater monitoring wells are inspected for operational locks, damage, and vandalism.

The inspections, maintenance, sampling, monitoring, data evaluation and reporting costs are approximately $135,000 on an annual basis; these costs are broken down in Table 2 (attached).

V. Progress Since the Last Five-Year Report

The first five-year review for this site was approved on December 23, 1999.

At the time of the first five-year review, two downchutes had been damaged by storms in the Summer of 1999, and the damage was exacerbated by impacts from Hurricane Floyd in September 1999. Damage to one downchute was minimal, but damage to the other downchute (1,000-foot long and rip-rap-lined, located between the north and south lobes) was more significant. Also, the soil cover had eroded in some locations and geocomposite was exposed and/or severely damaged.

Since only two years of on-site groundwater data has been generated following the construction of the cap, the 1999 five-year review could not draw any conclusions about the effectiveness of the cap or establish whether groundwater contaminant levels were being reduced.

The 1999 five-year review concluded that, while measures needed to be undertaken to remedy the storm damage, the implemented remedy was protective of human health and the environment. NYSDEC and EPA would continue to monitor groundwater data to determine if groundwater contaminant levels decrease

as expected, and if any additional measures are needed to protect nearby residents and users of groundwater as specified in the ROD.

The recommendations and follow-up actions identified in the previous five-year review were related to the needed repairs to the cap. Subsequently, the Town redesigned some of the surficial drainage management features to meet 100-year flood criteria, repaired the damaged geocomposite, and replaced the lost soil and vegetative cover. The Town obtained a grant from the Federal Emergency Management Agency to perform the work; the effort was completed in late 2001.

VI. Five-Year Review Process

Administrative Components

The five-year review team consisted of George Jacob (RPM), Diana Cutt (Hydrogeologist), Julie McPherson (Human Health Risk Assessor), and Chris Stitt (Ecological Risk Assessor, Biological Technical Assistance Group).

Community Involvement

The EPA Community Involvement Coordinator for the Sidney Landfill site, Cecilia Echols, published a notice in the *Journal Newspaper*, a local newspaper, on December 16, 2004, notifying the community of the initiation of the five-year review process. The notice indicated that EPA would be conducting a five-year review of the site to ensure that the site is protective of public health and the environment and that the implemented components of the remedy are functioning as designed. It was also indicated that once the five-year review is completed, the results will be made available in the local site repository. In addition, the notice included the RPM's address and telephone number for questions related to the five-year review process or the Ramapo Landfill site. A similar notice will be published when the review is completed.

Document Review

The documents, data, and information which were reviewed in completing the five-year review are summarized in Table 3 (attached).

Data Review

In the previous five-year review, it was noted that some water standards were sporadically exceeded for ammonia, antimony, iron, lead, manganese, sodium, xylene, and zinc in samples collected from nearby public (United Water New York) and private drinking water supply wells. The exceedances of lead, sodium, xylene, and zinc in the drinking water wells were not believed to be site-related[2]. Antimony was

[2] Xylene and zinc were not detected above groundwater standards in on-site groundwater. Lead was detected above groundwater standards in on-site groundwater, but was detected at higher levels and at a greater frequency in drinking water samples. Sodium has historically been detected at elevated

detected in one United Water New York supply well sample collected in December 1995 and in private well samples collected in June 1998 and September 1998.

Groundwater monitoring during this five-year review period shows exceedances of WQSGVs and/or MCLs for a number of contaminants in on-site groundwater monitoring wells (see Table 4).

The closest downgradient drinking water wells show sporadic exceedances of antimony, iron, lead, manganese and thallium (see Table 5). Since lead exceeded the action level once within the last five years in a private well at 81.9 micrograms per liter (µg/l), which exceeded the maximum detected concentration in the on-site monitoring well (41.1 µg/l), this suggests that the concentration detected at the off-site location is not site-related. Although arsenic exceeded its Preliminary Remediation Goals (PRGs)[3], the maximum detected concentration is within EPA's cancer risk range and has not exceeded its MCL. Iron and manganese exceeded their respective MCLs; however, these values are secondary drinking water standards[4], which are not enforceable guidelines (it should be noted, however, that the maximum detected concentrations of iron and manganese did not exceed their respective PRGs).

During the review period, elevated levels of antimony were detected in all of the drinking water wells during the October 2003 sampling event and sporadically other times (see Table 6). It is unclear, however, whether the elevated concentrations of antimony detected in these wells are site-related or related to the analytical procedures. There is an inadequate network of wells between the site extraction wells and the drinking water wells, which could confirm that site-related contaminants are migrating off-site. It is also apparent that the laboratory detection limits for antimony was too high.

Interviews

Interviews were conducted on November 23, 2004 with Edward Dzurinko and Edward Moran of Town of Ramapo for this review.

Site Inspection

On November 23, 2004, a 5-year review-related site inspection was conducted by EPA Personnel, George Jacob, Diana Cutt, Julie McPherson, and Christopher Stitt. Also present at the site inspection were Edward Dzurinko and Edward Moran of Town of Ramapo, and Sabian Endra Mahamooth, NYSDEC project manager.

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levels in upgradient,as well as,downgradient groundwater samples.

[3] PRGs are a human health risk-based value that is equivalent to a cancer risk (CR) of 1×10^{-6} or a hazard index (HI) of 1.

[4] Secondary standards affect the aesthetic qualities of drinking water (*i.e.*, taste, odor, staining of fixtures), rather than pose a health risk.

Institutional Controls Verification

Although the ROD required the implementation of institutional controls to restrict the use of on-site groundwater and to protect the integrity of the cap, since the site property is municipally-owned, NYSDEC did not require the Town to obtain property deed restrictions to prevent the installation of drinking water wells at the site and restrict activities which could affect the integrity of the cap. The Town has, however, prepared the appropriate language for restrictions to be incorporated into the deed in the event that there is any change anticipated in the ownership/operation of the property. New York State now requires annual certifications that institutional controls that are required by RODs are in place and that remedy-related O&M is being performed. To comply with this requirement, on an annual basis, the site will need to be inspected to determine whether any intrusive activities have been performed at the site and the building and property records will need to be reviewed to ascertain whether or not any filings had been made for such activities. The annual O&M report that is currently submitted by the Town should include a summary of the findings of the above-noted activities, along with certifications that remedy-related O&M is being performed.

Other Comments on Operation, Maintenance, Monitoring, and Institutional Controls

Table 7 (attached) summarizes several observations and offers suggestions to resolve the issues.

VI. Technical Assessment

Question A: Is the remedy functioning as intended by the decision documents?

The ROD, as modified by the ESD, called for, among other things, the installation of a cap with an impermeable barrier and groundwater and leachate collection and treatment. The purpose of the response action was to reduce the risk to human health and the environment due to contaminants leaching from the landfill mound. The capping of the landfill was to minimize the infiltration of rainfall and snowmelt into the landfill, thereby reducing the potential for contaminants leaching from the landfill and negatively impacting the wetlands habitat and groundwater quality. Capping was to also prevent direct contact exposure to contaminated soils. Pumping and treating the contaminated groundwater was to contain the groundwater contamination within the site boundary to ensure that groundwater beyond the site boundary meets Applicable or Relevant and Appropriate Requirements (ARARs) for groundwater.

The groundwater remedy (extraction and treatment) has not yet resulted in restoration of groundwater to meet ARARs. The success of the groundwater extraction system in containing and remediating the contaminant plume as intended by the decision documents is difficult to determine at this time. Typically, the success of a groundwater remedy is measured by analysis of groundwater elevations demonstrating consistent plume capture over time, decreasing concentrations in groundwater over time, and data from groundwater extraction wells demonstrating that the wells are consistently operational and are extracting contaminated groundwater.

The monitoring well network is comprised of well clusters aligned in a general northeast to southwest direction along the west side of the landfill, generally parallel to the groundwater extraction wells. With the exception of one well cluster (MW-9), there are no wells radiating from the landfill that would aid in the determination of a capture zone.

In the absence of adequate groundwater elevation data, the second line of evidence in demonstrating the success of the groundwater remedy would be decreasing contaminant concentrations in groundwater over time. The groundwater monitoring data for the site shows continuing MCL exceedances for constituents, such as chromium, antimony, arsenic, and cadmium (see Tables 4 and 5) in monitoring wells. The data does not demonstrate decreasing concentrations over time. Rather, concentrations in certain wells (MW-1OS, MW-1R, MW-3OS, MW-3R, MW-7OS) show an increase over time. Chromium concentrations in MW-3OS, for example, show a general increase from 257 µg/l in March 2002, to 1,400 µg/l in October 2002, to 4,250 µg/l in April 2003. Additionally concentrations in other wells (*i.e.*, 2-OS) are erratic and show no pattern.

Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives used at the time of the remedy still valid?

The majority of the exposure pathways and the receptor populations identified in the 1991 Baseline Human Health Risk Assessment are still valid. Although some exposure assumptions have changed and several exposure pathways were not evaluated, it is not expected to effect the remedy.

The toxicity values for several contaminants of potential concern (COPCs) have changed since the RI. In order to account for changes in toxicity values since the RI, the maximum detected concentrations of COPCs in monitoring wells during the review period were compared to their respective residential groundwater WQSGV, PRGs, and MCLs. As can be seen in Table 4, aluminum, antimony, arsenic, barium, beryllium, cadmium, chromium, iron, manganese, nickel and thallium exceeded their respective WQSGV, MCL and/or PRG on-site. Currently, there are no institutional controls on-site to restrict groundwater use, since the site property is currently owned by the Town of Ramapo. Since, NYSDEC did not require deed restrictions to be implemented on-site, it is reasonable to assume that wells may be installed downgradient for potable use.

The closest downgradient residential wells (PW-1 and PW-2) and the water supply wells (SWVC 93-96) are currently being monitored as part of the monitoring program three times a year. During the review period, various compounds appeared to exceed their respective WQSGV. MCL and/or PRG (CR = 1 x 10^{-6} or HI = 1) in these wells (Table 5). As was noted in the "Data Review" section, above, antimony is the only contaminant that was more consistently detected above its MCL in potable supply wells during the review period.

The remedial action objectives established in the ROD are still valid.

Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

A portion of the site is currently being utilized as a shooting range by the Ramapo Police Department. The shooting range was constructed so that the ammunition fired would enter a berm constructed for the purposes of the shooting range. In accordance with best management practices of outdoor shooting ranges, berms should be covered by a roof to prevent erosion of the berm and increased lead mobility. During the five-year review site inspection, it was observed that a roof was not present and expended bullets were present and accumulating on the ground. Potential human exposure to lead exists at the site through various exposure pathways as a result of the lack of management practices conducted at the shooting range. The primary exposure of lead to humans as a result of shooting range activities is through incidental ingestion of lead contaminated soil. An additional exposure pathway that individuals may be exposed to lead from shooting range activities is by lead bullets or lead particles moving via storm water runoff into the downgradient surface water areas (Torne Brook, Ramapo River and the adjacent wetland). The Torne Brook and Ramapo River are used for recreational purposes, which include swimming and fishing. Dissolved lead may also migrate through soils and leach into the groundwater. However, since an impermeable cap is placed on the landfill, it is expected that any lead on the surface of the landfill would not infiltrate the cap, but rather move via storm water runoff into the downgradient surface water areas. Human health as well as ecological risks at the site could potentially increase due to the activities conducted at this shooting range facility. Waterfowl, such as the Canadian geese observed on the landfill during the site visit are highly susceptible to lead ingestion. These animals often ingest shots, mistaken it for food, which may lead to increased mortality. This potential contributing source of lead contamination at the landfill may be attributable to the shooting range activities. It is recommended that the shooting range be properly maintained and best management practices be implemented to ensure that activities conducted at the shooting range do not impact human health and the environment.

Technical Assessment Summary

Based upon the results of the five-year review, it has been concluded that:

- the cap and vegetative cover are intact and in good condition;
- the fence around the cap within the site is intact and in good repair;
- it is not clear whether or not the on-site groundwater extraction system and the monitoring are preventing contaminant migration from the site;
- during the review period, monitoring of downgradient drinking water wells was not able to substantiate that the water meets water quality standards or whether or not it is impacted by site contaminants;

- inadequate data exists to determine the effectiveness of the groundwater extraction system; and

- there are no restrictions on the installation of wells downgradient of the site (such restrictions may be necessary if the recommended groundwater investigation determines that the site is the source of the antimony detected in downgradient drinking water wells).

VII. Issues, Recommendations, and Follow-Up Actions

Table 8 (attached) summarizes the recommendations and follow-up actions stemming from this 5-year review.

VIII. Protectiveness Statement

Currently, the landfill remedy is functioning as intended by the decision documents and is protecting human health and the environment on-site. However, this review has raised a concern about the human health exposure from groundwater contamination which may be reaching drinking water wells. Recommendations contained in this report will clarify these exposures and indicate if additional actions are needed. An addendum to this report will be issued when a site-wide protectiveness determination can be made.

IX. Next Review

Since hazardous substances, pollutants or contaminants remain at the Ramapo Landfill site which do not allow for unlimited use or unrestricted exposure, in accordance with 40 CFR 300.430 (f) (4) (ii), the remedial action for the site shall be reviewed no less often than every five years. EPA will conduct another five-year review on or before December 2009.

Approved:

_____ _____

Table 1: Chronology of Site Events	
Event	**Date(s)**
Commencement of operation of the landfill	1950
NYSDEC and Town of Ramapo enter into three Orders on Consent related to phasing out operation of the landfill, determining extent of leachate movement and feasibility of leachate collection, and constructing a surface-water and groundwater-diversion system, leachate-collection system, and system capable of transporting or treating the collected leachate	1980-1986
Site placed on National Priorities List	1983
Town enters into fourth Order on Consent under which a remedial investigation and feasibility study is performed	1988
Record of Decision	1992
Remedial Design	1992-1994
Remedial Action	1994-1997
Explanation of Significant Differences	1997
First Five-Year Review conducted	1999
Preliminary Site Close-Out Report.	2002

Table 2: Annual Operation, Maintenance, and Monitoring Costs	
Activity	**Cost per Year**
Sampling and analysis (quarterly)/data evaluation and reporting	$35,000
Site inspection/maintenance	$100,000
Total estimated cost	*$135,000*

Table 3: Documents, Data, and Information Reviewed in Completing the Five-Year Review	
Document Title, Author	**Submittal Date**
Record of Decision, EPA	1992
Explanation of Significant Differences, EPA	1997
Remedial Investigation/Feasibility Study, URS Consultants, Inc.	1991
Design Analysis Report, URS Greener, Inc.	1994
Preliminary Close-Out Report, EPA	1997
Operation and Maintenance Monitoring Manual, URS Greener, Inc.	1998
Construction Monitoring Report Ramapo Landfill Remediation, URS Greiner, Inc.	1998
Five-Year Review Report, EPA	1999
Post-Closure Annual Groundwater Quality Monitoring Letter Reports, Sterling Environmental Engineering	2000-2004
EPA guidance for conducting five-year reviews and other guidance and regulations to determine if any new Applicable or Relevant and Appropriate Requirements relating to the protectiveness of the remedy have been developed since EPA issued the ROD.	

Table 4 - Comparison of Maximum Detected Concentrations of Contaminants Detected in Monitoring Wells to Their Respective Water Quality Standards and Guidance Values, Human Health Risk Based Screening Criteria (Preliminary Remediation Goal), and/or Primary Drinking Water Standard (Maximum Contaminant Level)

Contaminant	Maximum Detected Concentration (Monitoring Wells) (µg/l)	Water Quality Standards and Guidance Values (µg/l)	Region 9 Preliminary Remediation Goal (µg/l)	Primary Drinking Water Standard (µg/l)	Location of Maximum Detected Concentration	Sample Date
Aluminum	**98800**	--	**36000 (nc)**	**200***	5-OS	3/04
Antimony	**155**	**3**	**15 (nc)**	**6**	3-OS/I	10/03
Arsenic	**91.3**	**25**	**0.045 (c)**	**10**	1-OS	10/02
Barium	**512**	1000	2600 (nc)	**200**	5-OS	3/04
Beryllium	**4.9**	3	73 (nc)	**4**	5-OS	3/04
Cadmium	**9.4**	5	18 (nc)	**5**	9-R	7/00
Chromium	**4250**	50	**110 (nc)**	**100**	3-OS/I	4/03
Cobalt	143	--	730 (nc)		7-OS	3/04
Copper	183	200	1500 (nc)	1300	5-OS	3/04
Iron	**150000**	**300**	**11000 (nc)**	**300***	5-OS	3/04
Lead	**41.1**	**25**	--	**15**	2-OS	4/03
Manganese	**24800**	35000	**880 (nc)**	**50***	3-OS/I	4/03
Nickel	**932**	100	**730 (nc)**		3-OS/I	4/03
Selenium	3.2	10	180 (nc)	50	8-OS	3/04
Silver	39.5	50	180 (nc)	100*	3-OS/I	3/04
Thallium	**5.4**	**0.5**	**2.4 (nc)**	**2**	4-OS	3/04
Vanadium	**231**	--	**36 (nc)**		5-OS	3/04
Zinc	222	2000	11000 (nc)	5000*	5-OS	4/03
Chlorobenzene	2.8	5	110 (nc)	100	8-I	5/00
Benzene	**0.6**	1	**0.34 (c)**	5	8-I	5/00
1,4-Dichlorobenzene	**0.6**	3	**0.5 (c)**	75	8-I	5/00
Vinyl chloride	**2**	5	**0.02 (c)**	2	8-R	10/03
1,1-dichloroethane	1.1	5	810	--	1R	10/01
Chloroethane	1.5	5	4.6	--	8R	3/02

Table 4's legend is on the next page.

Table 4 Legend

Values in **bold** indicate an exceedance of applicable water quality standards, guidance values, and/or Preliminary Remediation Goals.

(c): Value is based on a Cancer endpoint
(nc): Value is based on a Non-cancer endpoint
*: Values are National Secondary Drinking water regulations, which are non-enforceable guidelines regulating contaminants that may cause cosmetic or aesthetic effects in drinking water.

Source:
Region 9 Preliminary Remediation Goals are human health risk based screening criteria. This values are equivalent to a cancer risk of 1 x 10^{-6} or a hazard index of 1. Refer to: http://www.epa.gov/Region9/waste/sfund/prg/index.htm

National Drinking Water Standards (MCLs) are legally enforceable standards that apply to public water systems. Refer to: http://www.epa.gov/cgi-bin/epaprintonly.cgi

Table 5 - Comparison of the Maximum Detected Concentrations of Contaminants Detected in the Potable Supply Wells Downgradient from the Site to Their Respective Water Quality Standards and Guidance Values, Human Health Risk Based Screening Criteria (Preliminary Remediation Goal), and/or Primary Drinking Water Standard (Maximum Contaminant Level)

Contaminant	Maximum Detected Concentration (Monitoring Wells) (µg/l)	Water Quality Standards and Guidance Values (µg/l)	Region 9 Preliminary Remediation Goal (µg/l)	Primary Drinking Water Standard (µg/l)	Location of Maximum Detected Concentration	Sample Date
Antimony	**19.4**	**3**	**15 (nc)**	**6**	PW-2	10/03
Arsenic	5.6	25	0.045 (c)	10	PW-1	03/04
Barium	17.6	1000	2600 (nc)	2000	SWVC-94	03/04
Beryllium	0.39	3	73 (nc)	4	SWVC-93	07/00
Cadmium	2.4	5	18 (nc)	5	SWVC-94	08/02
Chromium	2.2	50	110 (nc)	100	PW-2	07/03
Copper	131	200	1500 (nc)	1300	PW-1	10/03
Iron	**939**	**300**	11000 (nc)	**300***	SWVC-93	10/02
Lead	**81.9**	**25**	--	**15**	PW-1	10/03
Manganese	**88**	35000	880	**50***	SWVC-95	03/04
Nickel	42.7	100	730	--	SWVC-93	03/04
Selenium	3.1	10	180	50	SWVC-93	03/04
Thallium	**4.1**	**0.5**	**2.4**	**2**	PW-1	04/03
Zinc	70	2000	11000	5000*	PW-2	07/00

Legend

Values in **bold** indicate an exceedance of applicable water quality standards, guidance values, and/or Preliminary Remediation Goals.

(c): Value is based on a Cancer endpoint
(nc): Value is based on a Non-cancer endpoint
*: Values are National Secondary Drinking water regulations, which are non-enforceable guidelines regulating contaminants that may cause cosmetic or aesthetic effects in drinking water.

Source:
Region 9 Preliminary Remediation Goals are human health risk based screening criteria. This values are equivalent to a cancer risk of 1 x 10^{-6} or a hazard index of 1. Refer to: http://www.epa.gov/Region9/waste/sfund/prg/index.htm

National Drinking Water Standards (MCLs) are legally enforceable standards that apply to public water systems. Refer to: http://www.epa.gov/cgi-bin/epaprintonly.cgi

Table 6: Antimony Sample Results for the Review Period						
Sample Date	**Drinking Water Well**					
	PW-1	**PW-2**	**SVWC-93**	**SVWC-94**	**SVWC-95**	**SVWC-96**
Mar 1999	ND	2.8	NA	NA	NA	NA
Jun 1999	ND	ND	ND	ND	ND	ND
Sep 1999	ND	ND	NA	NA	NA	NA
Jul 2000	<3.4	<3.4	<3.4	<3.4	<3.4	<3.4
Sep 2000	<5.5	<5.5	<5.5	<5.5	<5.5	<5.5
Dec 2000	<4.7	<5.5 N	<5.5 N	<5.5 N	<5.5 N	<5.5 N
Mar/Apr 2001	<4.7	<4.7	<4.7	<4.7	<4.7	<4.7
Jul 2001	<4.7	<4.7	<4.7	<4.7	<4.7	<4.7
Oct 2001	<4.7	<4.7	NA	NA	NA	NA
Mar 2002	7.4 U	**9.3 B**	**8 B**	**11.4 B**	7.4 U	7.4 U
Jul/Aug 2002	5.3 U	5.3 U	**8.1 B**	5.3 U	5.3 U	5.3 U
Oct 2002	5.3U,N	5.3U,N	**17.2 B,N**	**5.5 B,N**	5.3 U,N	5.3 U,N
Apr 2003	5 U	**9.3 B**	5 U	5 U	5 U	5 U
Jul 2003	5.5 U	**10.1 B**	5.5 U	5.5 U	5.5 U	**7.1 B**
Oct 2003	**9.5 B**	**19.4 B**	**8.6 B**	**7.1 B**	**13.6 B**	**11.1 B**
Mar 2004	5.8U	5.8U	5.8U	5.8U	5.8U	5.8U

Legend

Values in **bold** indicate an exceedance of applicable water quality standards, guidance values, and/or Preliminary Remediation Goals.
ND= Not detected
NA=Not analyzed
N=Spiked sample recovery not within control limits
U=Denotes that the compound was analyzed for, but not detected at the detection limit listed.
B=The reported value is less than the Contract Required Detection Limit, but greater than the Instrument Detection Limit

Table 7: Other Comments on Operation, Maintenance, Monitoring, and Institutional Controls	
Comment	**Suggestion**
Contaminant concentrations and flow rates (including downtime) for the groundwater extraction wells are needed to adequately assess the effectiveness of the contaminated groundwater/leachate collection system.	Contaminant concentrations and flow rates for the groundwater extraction wells should be provided to EPA, if possible (it is unclear if the extraction wells have sampling ports or flow meters where this data could be obtained).
In accordance with best management practices of outdoor shooting ranges, berms should be covered by a roof to prevent erosion of the berm and increased lead mobility. During the five-year review site inspection, it was observed that a roof was not present and expended bullets were present and accumulating on the ground.	The berm should be covered with a roof.
MW-7R has been damaged and has not been sampled since March 2002 (it is likely that this well needs to be replaced) and one of the wells in the MW-3 well cluster requires a new locking cap.	Monitoring well MR-7R needs to be restored to proper working condition and a locking cap needs to be installed for one of the wells in the MW-3 well cluster.
Groundwater contaminant concentrations have increased in some on-site monitoring wells.	An evaluation of potential causes of rises in groundwater contaminant concentrations needs to be performed. It is possible that extraction wells cycling or not properly operating are the cause of the increasing concentrations.
New York State now requires annual certifications that institutional controls that are required by RODs are in place and that remedy-related O&M is being performed.	On an annual basis, the site will need to be inspected to determine whether any intrusive activities have been performed at the site and the building and property records will need to be reviewed to ascertain whether or not any filings had been made for such activities. The annual O&M report that is currently submitted by the Performing Party should include a summary of the findings of the above-noted activities, along with certifications that the institutional controls are in place and that remedy-related O&M is being performed.

Table 8: Recommendations and Follow-Up Actions

Issue	Recommendations and Follow-Up Actions	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness (Y/N)	
					Current	Future
The current monitoring well network does not allow for a determination of a groundwater capture zone nor give early warning regarding potential contaminant migration to downgradient drinking water wells.	Additional monitoring wells need to be installed and sampled and a conceptual or analytical model of the site groundwater contaminants needs to be developed.	PRP	NYSDEC	5/05	N	N
The laboratory's detection limit for antimony is greater than the state standard. Therefore, it is unknown whether the levels of antimony that are present in any of the drinking water wells are protective.	An alternative analytical method for antimony needs to be employed for all subsequent sample analyses.	PRP	NYSDEC	3/05	N	N
If it is determined that the level of antimony detected in the downgradient drinking water wells exceeds drinking water standards, appropriate actions need to be taken.	The alternate water supply contingency remedy may need to be implemented and institutional controls to restrict the withdrawal or use of off-site groundwater.	PRP	NYSDEC	TBD	N	N

Table 9: Acronyms Used in this Document	
ARAR	Applicable or Relevant and Appropriate Requirements
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COPC	Contaminants of Potential Concern
EPA	United States Environmental Protection Agency
ESD	Explanation of Significant Differences
MCLs	Maximum Contaminant Levels
Mg/kg	Milligrams per Kilogram
µg/l	Micrograms per Liter
NYSDEC	New York State Department of Environmental Protection
PRGs	Preliminary Remediation Goals
RA	Remedial Action
RD	Remedial Design
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
RPM	Remedial Project Manager
VOCs	Volatile Organic Compounds

Five-Year Review Report
Addendum
Ramapo Landfill Superfund Site
Rockland County
Town of Ramapo, New York

Prepared by:

United States Environmental Protection Agency
Region 2
New York, New York

August 2005

EXECUTIVE SUMMARY

A five-year review for the Ramapo Landfill Superfund site, located in the Town of Ramapo, Rockland County, New York, was completed in December 2004. This review raised a concern regarding elevated levels of antimony in downgradient drinking water wells. Based upon the collection of new samples and using a lower laboratory detection limit, it has been concluded that antimony is not present in downgradient drinking water wells. The remedy is functioning as intended by the decision documents and protects human health and the environment.

I. Five-Year Review Process

A second five year review for the Ramapo Landfill Superfund site, located in the Town of Ramapo, Rockland County, New York, was completed in December 2004. A review of sample results for the review period (1999-2004) indicated the presence of elevated levels of antimony in drinking water wells during an October 2003 sampling event and sporadically at other times. It was, however, unclear whether the elevated concentrations of antimony detected in these wells were site-related or were due to the analytical procedures. This was due to the fact that the laboratory's detection limit for antimony as greater than the state standard of 3 micrograms per liter (µg/l)[1].

In May 2005, 11 of the drinking water wells were resampled and a lower laboratory detection limit (0.4 µg/1) was used. Antimony was not detected in any of the samples (see Table 1).

There were three recommendations contained in Table 8 of the December 2004 five-year review report. The first recommendation suggested that additional monitoring wells be installed and a conceptual or analytical model of the site groundwater contaminants be developed. The second recommendation pertained to collecting additional groundwater samples and analyzing them using a lower laboratory detection limit for antimony. The third recommendation identified follow up actions that would be taken should it be determined that the drinking water standard for antimony is exceeded. Since the levels of antimony detected in the downgradient drinking water wells are below the drinking water standard, the second and third recommendations no longer apply. Therefore, Table 8 of the December 2004 five-year review is being replaced by the attached Table 2. The observations and suggestions to resolve the issues contained in Table 7 of the December 2004 review remain and are unchanged by this addendum.

II. Protectiveness Statement

The implemented remedy for the Ramapo Landfill Superfund site protects human health and the environment. There are no exposure pathways that could result in unacceptable risks and none are expected, as long as the site use does not change and the implemented engineered, institutional, and access controls that are currently in place continue to be properly operated, monitored, and maintained.

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1 NYSDC Water Quality Standards and Guidance Value (T.O.G.S. 1.1.1) (WQSGV). WQSGVs are the highest level of contaminant that is allowed in drinking water. They are promulgated standard that apply to public water systems and are intended to protect human health by limiting the levels of contaminants in drinking water.

III. Next Review

The next five year review for the Ramapo Landfill Superfund site is required by December 2009, five years from the original five-year review report's approval date.

Approved:

William McCabe, Deputy Director
Emergency and Remedial Response Division

8/19/05
Date