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Five-Year Review Report

Second Five-Year Review Report
for
The Central Landfill Superfund Site
Johnston
Providence County, Rhode Island 02919

September 2008

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LIST OF ACRONYMS AND ABBREVIATIONS

ACRONYM	DEFINITION
AOC	Area of Containment
ARAR	Applicable or Relevant and Appropriate Requirement
C&P	Cardboard and Paper
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COPC	Contaminant of Potential Concern
EMP	Environmental Monitoring Plan
ERA	Ecological Risk Assessment
FAWQC	Federal Ambient Water Quality Criteria
FS	Feasibility Study
HHRA	Human Health Risk Assessment
MCL	Maximum Contaminant Level
MNA	Monitored Natural Attenuation
NCP	National Contingency Plan
NPL	National Priorities List
O&M	Operation and Maintenance
OU1	Operable Unit 1
OU2	Operable Unit 2
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
RA	Remedial Action
RAC	Remedial Action Contract
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
RIDEM	Rhode Island Department of Environmental Management

ACRONYM	DEFINITION
RIRRC	Rhode Island Resource Recovery Corporation
RISWMC	Rhode Island Solid Waste Management Corporation
RD	Remedial Design
ROD	Record of Decision
SVOC	Semivolatile Organic Compound
TSDF	Transportation Storage and Disposal Facilities
VOC	Volatile Organic Compound
USEPA	United States Environmental Protection Agency

EXECUTIVE SUMMARY

The Central Landfill Superfund Site (the Site), located in Johnston, Rhode Island, consists of two operable units, Operable Unit 1 (OU1) and Operable Unit 2 (OU2). The Site is a 154-acre licensed landfill in the central portion of a 1,200-acre parcel owned by the Rhode Island Resource Recovery Corporation (RIRRC). OU1 addresses source control of contamination at the Site and OU2 addresses off-Site migration of contamination.

The human health risk assessment conducted as part of the OU1 investigations determined that site conditions presented a risk to human health from ingestion of and dermal contact with groundwater. The selected source control remedy identified in the Record of Decision (ROD) for OU1 includes construction of a multi-layer RCRA C cap; hydraulic containment and treatment of "Hot Spot" groundwater; implementation of deed restrictions on groundwater use and land development within the RIRRC property; long-term sampling of groundwater, surface water, and air; a detailed evaluation of the existing landfill gas collection and combustion system; and installation of a chain link fence to prevent access.

The human health and ecological risk assessments conducted as part of the OU2 investigations did not show any risks that warrant action under Superfund. The OU2 ROD concluded that no further actions were necessary other than those required by the OU1 ROD.

The trigger for this statutory review is the start of actual remedial action (RA) on-Site construction at OU1 on August 31, 1998. This review is required by statute because the selected remedy for OU1 results in hazardous substances remaining on-Site above health based levels.

Sediment data analyzed as part of this review has shown that the concentrations of lead in Upper Simmons Reservoir sediment during the last three years have exceeded the consensus-based Threshold Effects Concentration and Probable Effects Concentration sediment quality guidelines for lead and therefore present a long-term ecological risk. Also, the current detection limits for metals in surface waters needs to be lowered to verify that the metals at this Site are not presenting a long-term ecological risk.

This review concludes that: the remedy is protective of human health; the remedy is protective of the environment in the short-term; and the remedy may not be protective of the environment in the long-term since the sediment lead levels in the Upper Simmons Reservoir are currently presenting a long-term ecological risk. In addition, the current detection limits for metals in surface waters needs to be lowered to verify that the metals at this Site are not presenting a long-term ecological risk.

Five-Year Review Summary Form

SITE IDENTIFICATION		
Site name: Central Landfill		
EPA ID: RID980520183		
Region: 01	**State:** RI	**City/County**: Johnston/Providence County
SITE STATUS		
NPL status: Final		
Remediation status: Operating		
Multiple OUs? YES	**Construction completion date:** September 28, 2006	
Has Site been put into reuse? No		
REVIEW STATUS		
Lead agency: EPA		
Author name: James M Brown		
Author title: Remedial Project Manager	**Author affiliation:** U.S. EPA, Region 1 - New England	
Review period: September 2003 to September 2008		
Date(s) of Site inspection: August 5, 2008		
Type of review: Post-SARA		
Review number: second		
Triggering action: Previous Five-Year Review Report		
Triggering action date *(from WasteLAN)*: September 26, 2003		
/Due date *(five years after triggering action date)*: September 26, 2008		

Five-Year Review Summary Form, Continued

Issues:

1. Phase VI landfill expansion.
2. Replacement wells for the long-term groundwater compliance monitoring network.
3. Need lower detection limits for metals analysis in surface waters.
4. The sediment monitoring data for lead in Upper Simmons Reservoir indicates that there is probability of ecological effects from concentrations of sediment lead that are increasing above the consensus-based PEC of 128 mg/kg lead.

Recommendations and Follow-up Actions:

1. RIRRC to evaluate Phase VI impacts to the OU1 source control remedy and propose a plan for minimizing those impacts.
2. RIRRC to propose an update to the long-term groundwater compliance monitoring network.
3. RIRRC to amend the Environmental Monitoring Program to provide lower detection limits.
4. RIRRC to propose a study to determine the cause for the increase in sediment lead concentrations in the Upper Simmons Reservoir.

Protectiveness Statement(s):

OU1 Statement:

The OU1 source control remedy required construction of a cap over the Phase I landfill area and the construction of a hot spot groundwater containment system along with long-term monitoring of groundwater, surface water, sediment and air. At this time the data indicates that groundwater quality is stable or improving. Institutional controls are in place preventing exposure to the contaminated groundwater. To date, no VOCs have been detected in the air at the landfill above levels that are considered protective of on-site workers and area residents. Surface water quality data does not indicate a current ecological risk, however, there is some uncertainty in the long-term effects because the existing detection limits for metals are too high when compared to the state and federal ambient water quality criteria. Sediment data has shown that the concentrations of lead in Upper Simmons Reservoir sediment during the last three years have exceeded the consensus-based Threshold Effects Concentration and Probable Effects Concentration sediment quality guidelines for lead and therefore may present a long-term ecological risk. It is also noted that copper concentrations are rising but as yet do not pose an ecological risk. In addition, the current detection limits for metals in surface waters needs to be lowered to verify that the metals at this Site are not presenting a long-term ecological risk.

The OU1 remedy is protective of human health. The OU1 remedy is protective of the environment in the short-term but may not be in the long-term.

OU2 Statement:

The OU2 studies involved a human health and ecological risk assessment for groundwater beyond the Facility and surface water, sediment and soils within the OU2 study area which included the Upper Simmons Reservoir. The OU2 remedy did not call for any remedial actions beyond that called for in the OU1 remedy. As discussed above, sediment lead levels in Upper Simmons Reservoir may currently be presenting a long-term ecological risk. It is also noted that copper concentrations are rising but as yet do not pose an ecological risk. In addition, the current detection limits for metals in surface waters needs to be lowered to verify that the metals at this Site are not presenting a long-term ecological risk.

The OU2 remedy is protective of human health. The OU2 remedy is protective of the environment in the short-term but may not be in the long-term.

Site-Wide Protectiveness Statement:

The OU1 and OU2 remedy are protective of human health. The OU1 and OU2 remedy are protective of the environment in the short-term. However, the OU1 and OU2 remedy may not be protective of the environment in the long-term since the sediment lead levels in the Upper Simmons Reservoir may present a long-term ecological risk. In addition, the current detection limits for metals in surface waters needs to be lowered to verify that the metals at this Site are not presenting a long-term ecological risk.

Other Comments:

None

SECTION 1.0 - INTRODUCTION

This document is a comprehensive and interpretive report on the five-year review conducted for the Central Landfill Superfund Site (the Site) in Johnston, Rhode Island. This work was conducted by the EPA with the assistance of GZA GeoEnvironmental, Inc. (GZA) under direct contract to the Rhode Island Resource Recovery Corporation (RIRRC).

The purpose of this second five-year review is to evaluate the ongoing effectiveness of the remedy for the Central Landfill Site with respect to the protection of human health and the environment. The methods, findings, and conclusions of this review are documented in this second Five-Year Review report. In addition, this Five-Year Review report identifies issues found during the review and recommendations to address them.

EPA Region I has conducted this five-year review pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National Contingency Plan (NCP). CERCLA §121 states:

> *If the President selects a remedial action that results in any hazardous substances, pollutants, or contaminants remaining at the site, the President shall review such remedial action no less often than each five years after the initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented. In addition, if upon such review it is the judgment of the President that action is appropriate at such site in accordance with section [104] or [106], the President shall take or require such action. The President shall report to the Congress a list of facilities for which such review is required, the results of all such reviews, and any actions taken as a result of such reviews.*

The NCP 300.430(f)(4)(ii) of the Code of Federal Regulations (CFR) states:

> *If a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure, the lead agency shall review such action no less often than every five years after the initiation of the selected remedial action.*

The Central Landfill Site consists of two operable units, Operable Unit 1 (OU1) and Operable Unit 2 (OU2), however, OU2 investigations did not identify any risks beyond those identified in the OU1 investigations and no action was required. Therefore, this five-year review addresses OU1 and to the extent it is relevant, OU2.

This is the second five-year review for the Central Landfill Site. The first is dated September 26, 2003. This review is required by statute because the selected remedy results in hazardous substances, pollutants, or contaminants remaining on-Site above health-based levels that would allow for unlimited use and unrestricted exposure. The triggering action date for this statutory review is the date of the last Five-Year Review, September 26, 2003.

SECTION 2.0 - SITE CHRONOLOGY

The chronology of the Site, including all significant Site events and dates is included in Table 1.

Table 1: Chronology of Site Events

Event	Date
Part of Site used as sand and gravel quarry/stone operation	1952 through 1955
Site operated as a refuse burning dump	1955 through 1962
Large volumes of liquid industrial wastes disposed of in "Hot Spot" area	mid to late 1970s
The Rhode Island Solid Waste Management Corporation (RISWMC), now the Rhode Island Resource Recovery Corporation (RIRRC) Purchased the Site from the Silvestri Brothers	June 1980
EPA issued RISWMC an Administrative Order to produce a proposal for monitoring, sampling, testing, analysis, and reporting at the Central Landfill	June 1984
RIDEM and RISWMC enter into Consent Agreements to remedy violations of state Rules and Regulations for Solid Waste Management Facilities	August 1984
Final listing on EPA National Priorities List (#269)	June 1986
EPA Issues Consent Order to the RISWMC for Performance of the OU1 RI/FS	April 1987
Completion of Remedial Investigation for OU1	March 1993
Completion of Feasibility Study for OU1	December 1993
OU1 Record of Decision is signed	June 1994
Consent Decree entered by Federal Court for OU1	May 1996
100% Final Cap Design approved by EPA	November 1997
Start of on-Site construction at OU1 (date that triggers a five-year review)	August 1998
Completion of Remedial Investigation for OU2	March 2001
OU2 Record of Decision is signed	September 2002
Explanation of Significant Difference (ESD) issued for OU1	September 2005

Table 1 Continued	
Event	**Date**
OU1 Cap Construction Completed	November 2005
Pre-Final Inspection of OU1 Cap by EPA	November 2005
100% Hydraulic Containment and Groundwater Treatment System Design Approved by EPA, with Comments	September 2006
Operation of Hydraulic Containment and Groundwater Treatment System Begins	September 2006
Pre-Final Inspection of Hydraulic Containment and Groundwater Treatment System Design by EPA	September 2006
Preliminary Closeout Report Issued by EPA	September 2006

SECTION 3.0 - BACKGROUND

3.1 PHYSICAL CHARACTERISTICS AND LAND AND RESOURCE USE

The Central Landfill Superfund Site (the Site) is a 154-acre licensed landfill (Phase 1, 2 and 3) in the central portion of a 1,200-acre parcel at 65 Shun Pike, Johnston, Rhode Island, Providence County (see Figure 1, provided in Attachment 1 of this Report). The Central Landfill is an active waste disposal facility and is the largest waste disposal facility in Rhode Island, servicing the majority of communities in the state. Central Landfill is owned by the Rhode Island Resource Recovery Corporation (RIRRC) [formerly known as the Rhode Island Solid Waste Management Corporation (RISWMC)].

The Central Landfill Superfund Site consists of two operable units, Operable Unit 1 (OU1) and Operable Unit 2 (OU2). OU1 deals with source control of contamination at the Site and OU2 addresses off-site migration of contamination.

For OU1 purposes, the Site is comprised of two areas: a 121-acre area known as the Phase 1 Landfill area and a 33-acre expansion area known as the Phase 2 and 3 Landfill areas. The RIRRC has also expanded into a 44-acre expansion area known as Phase 4 Landfill, which is located south of the Phase 2 and 3 areas and a 32-acre expansion area known as the Phase 5 Landfill, which is located at the southeast interface of Phase 1 and Phase 4. The Phase 4 and 5 expansions required the relocation of Cedar Swamp Brook. A 153-acre (including piggyback area over Phase 1) expansion known as Phase 6 is currently in the permitting stage. It is proposed to the east of Phase 1, and will overlap its eastern slope by approximately 50 acres. See Figure 1, provided in Attachment 1 of this report for details. The Phase 1 Landfill (121 acre cell) is unlined; however, the remaining cells use a double or double composite engineered baseliner and integral leachate collection systems.

The OU2 Study Area consisted of a 1,333-acre area that surrounds, but does not include the OU1 Site, refer to Figure 1. Areas surrounding the Site are either undeveloped, residential, or commercial/industrial. RIRRC operations at the property other than landfilling are located primarily east-southeast of the Site and include administration offices, a vehicle maintenance facility, materials recycling facility, tipping facility, construction and demolition debris (C&D) processing facility, a wastewater pretreatment plant, and a landfill gas-to-energy plant. Former operations/businesses, not owned by RIRRC, within the OU2 Study Area, include a screw machine products manufacturer, a commercial welder, a demolition contractor, vehicle repair shop, refuse transfer station, cardboard and paper (C&P) recycling operation, refuse hauling company, and a former hazardous waste/oil Transportation Storage and Disposal Facilities (TSDF) business. Residential properties within 2,000 feet of the Site were acquired by RIRRC. This property acquisition was primarily to the north and east along Bishop Hill Road, Central Avenue, and Scituate Avenue. Homes within the acquisition area along Simmons Lake Drive (hydro-geologically downgradient of the Site) have all been purchased by RIRRC and demolished (USEPA, 2002).

RIRRC purchased most of the property along Shun Pike adjacent to RIRRC's operations building (south of the main entrance) in which businesses were located as well as land to the south east of the main Central Landfill Property known as the A.Macera Property. This area is being developed as an industrial park. Florida Power and Light (FPL) purchased land south of Shun Pike between the Upper Simmons Reservoir and the A.Mecera property where they developed a power plant.

The Upper and Lower Simmons Reservoirs are located southeast of the Site and were also part of the OU2 Study Area. The Almy Reservoir, located northeast of the Site, was also included as part of the OU2 Study Area. These reservoirs are designated as Class B surface waters by the Rhode Island Department of Environmental Management (RIDEM), which means that they are designated for fish and wildlife habitat and recreational activities and are not used as drinking water supplies. The majority of the groundwater within the OU2 Study Area has been federally classified as Class II aquifer which is suitable for current or potential drinking water. Under the state groundwater classification scheme, RIDEM has classified this area as GA (suitable for drinking water without treatment) or GA-NA (non-attainment), with the groundwater below the Site classified as GC - suitable for certain waste disposal purposes (USEPA, 2002). RIDEM has also established a GB buffer around the waste disposal areas that extends 100 feet upgradient and 500 feet or the nearest receiving water body downgradient of a landfill. GB aquifer areas are defined as groundwater resources designated by the Director which may not be suitable for public or private drinking water use without treatment due to known or presumed degradation. The federal Class II groundwater classification is, however, more stringent for groundwater at and beyond the edge of the waste management area.

The approximately 1,200-acre property owned by RIRRC is partially fenced and vehicular entry is limited to secured roadways. Security guards patrol the property 24 hours/day (USEPA, 2002).

Future land uses within the RIRRC-owned property is not likely to change significantly.

3.2 HISTORY OF CONTAMINATION

The Central Landfill has been owned and operated by the RIRRC since 1980. Prior to 1980, the Site was owned by the Silvestri Brothers. From 1952 to 1955, a portion of the Site was used as a combination sand and gravel/quarry stone operation. From 1955 to 1962, the Site was operated as a refuse burning dump. The Site has been used as a solid waste disposal area since 1962 (USEPA, 2002). Waste filling records and historical estimates show that the five Phases of the Central Landfill currently contain on the order of 20 million tons of waste.

During the mid to late 1970s, an approximate 1 acre area, located within the unlined Phase I Landfill, was used for disposal of large volumes of liquid industrial waste by the Silvestri Brothers. This area is referred to as the Hot Spot (USEPA, 2002).

According to RIDEM waste manifests, industrial wastes were accepted and disposed of in the Hot Spot during the period of December 3, 1976 through May 30, 1979. Between January 1978 and May 1979, Industrial Waste Manifests were submitted to RIDEM. The manifests indicate

that wastes disposed of at the Site include aqueous solutions of latex waste, acid waste, corrosive waste, water soluble oils, and waste solvents such as methylene chloride, toluene, 1,1,1-trichloroethane, and tetrachloroethylene. Limited information was available concerning the types and quantities of wastes that were disposed of prior to January 1978 because neither federal nor state hazardous waste regulations were in effect at that time (USEPA, 2002).

Between May 1979 and February 1981, approximately 10 acres in the northeast portion of the Site received large volumes of untreated liquid sewerage sludge. That area was subsequently covered with about fifteen feet of landfill debris and daily soil cover. Since 1980, the waste stream has been as high as 6,000 tons per day. In 1991, solid waste disposal averaged approximately 2,500 tons per day (USEPA, 2002). Today waste volumes are typically 5,000 tons/day and the state predicts that disposal rates will remain on the order of 1.25 million tons/year for the life of the Phase V and Phase VI landfills.

On August 10, 1984, and again on August 28, 1984, RIDEM and RISWMC entered into Consent Agreements to remedy violations of the state Rules and Regulations for Solid Waste Management Facilities. The August 10 agreement addressed several solid waste violations including the need for a closure plan for the entire Site. The August 28 agreement addressed the concerns of the November 9, 1983 Notice of Violation.

In 1984, the Site was proposed for inclusion on EPA's National Priorities List (NPL). In June 1984, EPA issued an Administrative Order to RISWMC pursuant to the authority granted EPA under Section 3013 of the Resource Conservation and Recovery Act (RCRA). The Order required RISWMC to produce a proposal for monitoring, sampling, testing, analysis, and reporting at the Central Landfill. The Order was based on EPA's determination that the landfill may have presented a substantial hazard to human health and the environment. The Site was added to the NPL in June 1986 as #269 making it one of the 13 superfund sites in Rhode Island.

3.3 INITIAL RESPONSE

In 1986, RIRRC (formerly the RISWMC), in conjunction with the RIDEM and the Town of Johnston initiated a project to provide public drinking water to area residents. The project was completed in 1990. A 12-megawatt (MW) landfill gas to electricity facility was constructed at the Site and has been in operation since 1990. This facility has been expanded in stages since 1990 and now includes 15 engine generator sets producing a combined 20 MWs of electricity. RIRRC expended approximately $23,000,000 acquiring residentially zoned property located within 1,000 feet of the licensed landfill area and offered residents within the next 1,000 feet the option of selling their property to the RIRRC. This property acquisition was mandated by the Rhode Island State Legislature.

After the Site was listed on the NPL, the EPA and RIRRC entered into a Consent Order to perform a remedial investigation and feasibility study (RI/FS) in April 1987. Field work for the OU1 RI began in January 1986 and was completed in November 1991. The RI was completed in March 1993. During the field investigations, the project was divided into Operable Units 1 and 2. The FS for OU1 was completed in December 1993.

Field work for the OU2 RI was conducted between June 1992 and July 1998 and also in December 2000. The OU2 RI, including the baseline risk assessment report, was completed in March 2001.

3.4 BASIS FOR TAKING ACTION

The following summarizes the contaminants detected as part of the OU1 RI at the Site:

Groundwater. Several volatile organic compounds (VOCs), semi volatile organic compounds (SVOCs), and inorganics were detected in groundwater samples collected around the perimeter of the landfill area. Groundwater in the vicinity of the Hot Spot area contained much higher levels of VOCs and SVOCs. Groundwater samples from wells close to the 1200-acre property line contained only slightly elevated levels of a few VOCs, SVOCs, and inorganics.

Soil. VOCs, SVOCs, pesticides, and metals were detected in locations downgradient of the Site. Compounds that were considered contaminants of potential concern (COPCs) for the human health risk assessment included several polycyclic aromatic hydrocarbons (PAHs) and metals.

Sediment. VOCs, SVOCs, pesticides, polychlorinated biphenyls (PCBs), and metals were detected in samples from locations in the Almy and Upper Simmons Reservoirs, Cedar Swamp Brook, Quarry Stream, associated wetlands areas, and the four on-Site landfill Sedimentation Ponds. Compounds that were considered COPCs included several PAHs and metals.

Surface Water. VOCs, SVOCs, pesticides, PCBs, and metals were detected in one or more samples from locations in the Almy and Upper Simmons Reservoirs, Cedar Swamp Brook, Quarry Stream, associated wetland areas, and four landfill Sedimentation Ponds. Compounds that were considered COPCs included one VOC, one pesticide, and several metals.

OU1 Risk Evaluation. A human health risk assessment (HHRA) was performed for the Site in 1993 by CDM Federal Programs Corporation (CDM FPC, 1993). The risk assessment concluded that there were no complete exposure pathways for human receptors under present Site conditions but there were under hypothetical future use conditions. The OU1 HHRA concluded that there were no significant risks associated with exposure to estimated future concentrations in the surface waters of the Upper Simmons and Almy Reservoirs. However, the HHRA indicated that there was insufficient data to completely characterize the human health risks associated with recreational use of these two water bodies. The OU1 HHRA also concluded that there is potential future risk to human health from ingestion and dermal contact with groundwater beyond the toe of the landfill but within the RIRRC-owned property. The source of this groundwater contamination was determined to be the 121-acre Phase I Landfill area of the Central Landfill. These conclusions formed the basis of the selected remedy for OU1 which focused on capping the solid and industrial hazardous wastes and controlling the source of groundwater contamination.

OU2 Risk Evaluations. The HHRA for OU2 concluded that contaminants present in soil, surface water, and sediment within the 1,333-acre OU2 Study Area and groundwater outside of the RIRRC-owned property do not pose a significant risk to human health. The HHRA assumed that residents downgradient of the Site were not and will not be using groundwater as a drinking water source, relying on institutional controls that were required as part of the OU1 remedy to prohibit use of the groundwater. The Ecological Risk Assessment (ERA) performed for OU2 concluded that there is no significant risk to aquatic biota including fish, planktonic and epiphytic organisms, and benthic organisms in the Upper and Lower Simmons Reservoirs from contaminants present in surface water and sediments. Also, there are no significant indirect impacts to fish and wildlife, which depend on those species for food. These determinations were the basis of the no further remedial action decision for OU2.

SECTION 4.0 - REMEDIAL ACTIONS

4.1 REMEDY SELECTION

This section outlines the selected remedy for Operable Unit 1 and the basis for the no action decision for Operable Unit 2.

4.1.1 Operable Unit 1

The EPA Record of Decision (ROD) for Central Landfill OU1 was signed on June 17, 1994. The remedial action objectives (RAOs) listed in the ROD are:

- Minimize the effects of landfill contaminants on groundwater quality; specifically, reduce to a minimum the amount of precipitation allowed to leak through the waste column and infiltrate to the groundwater;

- Eliminate future risks to human health through direct contact with landfill contaminants by maintaining a physical barrier;

- Minimize migration of contaminants in groundwater so that groundwater is not injurious to the aquatic ecological system of receiving water bodies (Upper Simmons Reservoir, Cedar Swamp Brook, and Almy Reservoir);

- Minimize risks to human health associated with potential future consumption of and direct contact with groundwater;

- Comply with state and federal applicable or relevant and appropriate requirements (ARARs); and

- Minimize potential impacts of implementing the selected source control alternative on adjacent surface waters and wetlands.

The selected source control remedy for Central Landfill OU1, as identified in the ROD, consisted of the following components:

- Constructing a multi-layer RCRA C cap over the existing 121-acre Phase I area and incorporating the existing 32 acres of RIDEM approved cap on the side slopes;

- Hydraulic containment and treatment of groundwater in the Hot Spot area of the landfill and discharging the treated groundwater to either on-site surface water or the Cranston Waste Water Treatment Plant;

- Implementing deed restrictions on groundwater use and land development within property owned by the RIRRC ;

- Initiating a long-term program of sampling and analysis of groundwater, surface water, and air;
- Conducting a detailed evaluation of the existing landfill gas collection and combustion system;
- Installing a chain link fence to prevent access; and
- Conducting five year reviews.

4.1.2 Operable Unit 2

A no action ROD for Central Landfill OU2 was issued by EPA on September 26, 2002. The no action determination was based on the baseline risk assessments for OU2 which revealed that the only potential pathway for an unacceptable risk to human health or the environment was associated with the consumption of groundwater within a limited and defined portion of the OU2 Study Area. Because the RIRRC had made public water available to that area prior to the issuance of the OU2 ROD and because institutional controls precluding the installation and use of water supply wells in that area were in place, exposure to groundwater in this area was not considered to be a complete pathway and no human or ecological risks existed in the OU2 study area.

4.2 REMEDY IMPLEMENTATION

In a Consent Decree entered on May 16, 1996, the RIRRC agreed to perform and pay for the Remedial Design/Remedial Action (RD/RA) and operation and maintenance for the Central Landfill Site.

The design and implementation of the remedial actions for OU1 are discussed below, by component, as identified in the ROD. The remedial actions have been completed and a Preliminary Close-Out Report was issued for the Site by EPA in September 2006.

4.2.1 Construction of the Landfill Cap

Four preliminary investigations were conducted to obtain supplementary information needed for the landfill cap design including a site survey, verification of Record Drawings for the existing cap, geotechnical investigation, and mapping of leachate seeps. Following the completion of the investigations, RIRRC conducted the design of the landfill cap in 1996 and 1997. The 100% Final Cap Design Report was submitted on August 1, 1997 and was approved by EPA on November 3, 1997. A 100% Cap Design Addendum was approved by EPA on November 11, 1997 (USEPA, 2002).

The Phase I cap consisted of approximately 88 acres of new capping. The capping project was comprised of five areas (areas 3, 4, 5, 6 & 7). Areas 1 and 2 (33 acres total) were capped with a RIDEM approved cap that was incorporated into the new cap.

Landfill cap construction activities conducted prior to 2003 are discussed in the first five year review, dated September 2003. The capping of Phase I Areas 3 and 4 were completed during that time and all "punch list" items for Area 4 as described in the first 5 year report were completed. From September 2003 through November 2005, the RIRRC completed placement of the RCRA cap in Areas 5, 6 and 7 (approximately 54 acres) of the Phase I area completing the OU1 cap. A pre-final inspection was performed for the cap in November of 2005.

4.2.2 Hydraulic Containment and Groundwater Treatment System for the Hot Spot Area

As discussed in the first Five-Year Review, a revised remedial design work plan for the hot spot groundwater containment and treatment system was prepared by GZA, in June 2002. This report outlined activities to be performed to ensure that the groundwater containment system was designed in a manner that effectively contains the groundwater and is consistent with the requirements of the ROD. Activities to be performed included the installation of six additional monitoring stations upgradient of, and along the flow path that passes through, the Hot Spot to the Phase I toe of slope and a single round of comprehensive groundwater screening and analytical testing. The six boreholes were installed and borehole geophysical testing was conducted during July and August 2003. Packer testing and groundwater sampling of discrete packer test zones were completed in November of 2003.

The rationale for the location of the multi-level well screen intervals was presented in GZA's Technical Memorandum dated December 9, 2003. EPA and RIDEM concurred with the recommendations with minor modifications as noted in GZA's January 7, 2004, "Revised Recommended Monitoring Well Installation Zones for Hot Spot Evaluation Wells". Single zone wells were installed in two boreholes and Solinst Waterloo System multi-level wells were installed in three boreholes. One well, MW03-ML11, was left open for use as the remedial system extraction well. Well installation was completed in April, 2004. Two aquifer pump tests were performed, the first in December 2003 and the second in September and October of 2004, using MW03-ML-11 as the extraction well. A temporary remediation system, consisting of pumping groundwater from the extraction well through activated carbon, was installed in September of 2004 (GZA 2005).

The results of the above described field study are presented in the 30% Hot Spot Remedial Design Report, submitted to EPA in March 2005. EPA and RIDEM comments to the 30% Design Report generally focused on issues related to the short time frame, minimal pumping response and severe weather events during the first (December 2003) pump test, and the analytical method used for estimation of the extent of the groundwater capture zone of the pumping well MW03-ML11. Subsequent to the submission of the 30% Design much longer stretches of continuous pumping were completed (October 2004 pump test) and resulting drawdowns recorded and evaluated. These pumping events are documented in the Calibrated MODFLOW Groundwater Model report submitted to EPA and RIDEM on June 13, 2006. A fractured media groundwater flow model was also prepared to evaluate the extent of capture of well MW03-ML11 subsequent to the 30% Remedial Design Report. These later submittals, in conjunction with the September 30, 2005 Comment Response Summary, addressed all review agency comments to the 30% Design Report (GZA 2006).

Additionally, the OU1 ROD required that the RIRRC undertake bench and/or pilot scale tests to verify the suitability of an Ultraviolet Oxidation (UVox) system for the treatment of Hot Spot groundwater. A bench scale test of an UVox system (Calgon's Rayox System) was completed by GZA in conjunction with Calgon Corporation in the spring of 2005. The results of this testing were submitted to EPA and RIDEM on July 19, 2005 and demonstrated that there were significant technical issues (e.g., loss of 50% of target VOCs during pre-treatment, interferences by non-target compounds resulting in reduced efficiency of the peroxide and UV energy, lack of flexibility in treatment flow rates) and cost limitations (i.e., more than $250,000 per 55-gallon drum of solvent removed) associated with the implementation of UVox at Central Landfill (GZA 2006).

Due to the technical problems associated with UVox and in accordance with the ROD, RIRRC completed an evaluation of the direct discharge of Hot Spot groundwater to the on-site wastewater pretreatment system/Cranston POTW. As described in the July 2005 POTW Discharge Assessment/ESD Support Evaluation, the POTW option addressed both the organics (VOCs and SVOCs) and metals that were identified as the primary risk drivers for the OU1 Superfund Site. Based on this evaluation, EPA determined that direct discharge of the extracted hot spot groundwater to the existing City of Cranston Waste Water Treatment Plant was an acceptable alternative to on-site treatment as long as the RIRRC's leachate pre-treatment system remains in operation. EPA issued an Explanation of Significant Difference in September 2005 to remove the requirement to treat the extracted Hot Spot groundwater using an on-site UVox system (GZA 2006).

The 100% Hot Spot Remedial Design Report was submitted to EPA in July 2006. The remedial system consists of four primary components: 1) an extraction well (currently consisting of MW03-ML11) and pneumatically operated groundwater pumping system; 2) a conveyance pipeline to transfer extracted groundwater from the Hot Spot approximately 2,400 feet to RIRRC's leachate pre-treatment facility and ultimately to the City of Cranston's Publicly Owned Treatment Works (POTW); 3) groundwater treatment units consisting of the on-site leachate pre-treatment facility and the City of Cranston's POTW; and 4) a contingency treatment system (consisting of an air stripper) to be used when total flows to RIRRC's final pump station wet-well fall below 160,000 gallons/day (inclusive of a factor of safety, 145,000 GPD actual) (GZA 2006).

In a letter to RIRRC dated September 18, 2006, EPA approved the remedial design described above, with comments. The main comment was to address omissions in the Demonstration of Compliance Plan (DOCP). As of April 2008, a revised DOCP was in preparation by RIRRC but has not yet been submitted.

Construction of the final conveyance pipeline to the existing Central Landfill leachate pre-treatment system was completed in September 2006. The contingency treatment system was placed online on September 28, 2006. A pre-final inspection for the Hot Spot hydraulic containment system was performed by EPA and RIDEM on September 21, 2006. Currently the system is operational and all the extracted water is treated by an air stripper and polished with activated carbon as a condition of the City of Cranston's interim approval of the discharge. If total flows to RIRRC's final pump station wet-well are above 160,000 GPD, extracted

groundwater is to be discharged directly to the leachate pretreatment system. If total flows drop below 160,000 GPD, extracted groundwater is to be run through the contingency treatment system and discharged to the leachate pretreatment system.

The impending Phase VI expansion of the landfill will overlap the current locations for the hot spot extraction well and treatment system. Further evaluation will be necessary to determine if a new location for the extraction well can be equally effective and to find a new location for the treatment system.

4.2.3 Institutional Controls and Installation of Chain Link Fence To Prevent Access

The institutional controls and access controls for the Site are currently in place as described below.

RIRRC filed a Declaration of Covenants and Environmental Protection/Conservation Easement on August 16, 2001 on property it owns (Assessor's Map 43, Lots 402, 176, 60, and 59). The Covenant prohibits the use of groundwater except for remediation purposes, prohibits the installation of groundwater wells or the use of existing groundwater wells and prohibits the alteration of the groundwater flow in any way. The Covenant also prohibits any activity which will disturb any of the remedial measures implemented at OU1, unless otherwise provided for in the 1996 Consent Decree. The area subject to this deed restriction is shown on Figure 1 in Attachment 1.

In addition, the Town of Johnston adopted a Town ordinance on February 10, 2003 that, among other things, prohibits the use of groundwater wells and prohibits the Building Inspector from issuing permits for the construction of groundwater wells in any location where access to Town public water is available; where the well or proposed well is located in certain described areas including where groundwater has been classified by the State as GAA non-attainment, GA non-attainment, GB, GB non-attainment or GC; and where it is located in the OU2 areas recommended for institutional controls. The latter area is designated the OU2 Groundwater Buffer Zone and is depicted on Figure 1 in Attachment 1. The Town ordinance also requires written notice to the RIDEM and U.S. EPA upon repeal or modification of the ordinance or any judicial decisions that repeals or modifies the ordinance.

The 1,200-acre property owned by RIRRC is partially fenced (key access and egress points) and vehicular entry is limited to secured roadways. Security guards patrol the property 24 hours/day.

4.2.4 Long-Term Groundwater, Surface Water, and Air Monitoring

Long-term monitoring of groundwater and surface water is currently being conducted in accordance with the Revised Environmental Monitoring Plan (EMP) which was prepared by GZA GeoEnvironmental in March 2004 (GZA, 2004). This revised plan supersedes the Environmental Monitoring Plan prepared by GZA GeoEnvironmental in May 1997. The plan was developed to address OU1 current and post-closure groundwater, surface water, sediment and air monitoring requirements in addition to several other regulatory requirements. The revised EMP was implemented beginning in May 2004. Groundwater and surface water and

sediment sampling are conducted on a quarterly basis. An expanded annual monitoring round is conducted during August of each year.

All remedial actions were implemented as of September 2006 and quarterly monitoring will continue to be performed during operation of the remedial actions for a period of five years, ending in 2011. At that time, a review of 10 years worth of data will be conducted, and if no statistically significant increase in contaminant concentrations are observed since implementation of the remedial actions, the monitoring frequency may be reduced to semi-annually.

Long-term monitoring of air is also currently being conducted in accordance with the Revised EMP (GZA, 2004). Quarterly sampling of ambient air for VOCs is conducted at a minimum of four locations: one upwind of the Phase 1, 2, 3, 4, and 5 Landfill areas and three downwind, relative to the active face of the landfill on the day of sample collection. If more than one face of the landfill is active, additional air monitoring is conducted. In addition to VOC sampling, concurrent hydrogen sulfide monitoring is conducted at the VOC sampling locations and around the circumference of the Phase 1, 2, 3, 4, and 5 Landfill areas using a field portable instrument.

Refer to Section 5.3 for a review of groundwater, surface water, sediment, and air monitoring data with respect to compliance criteria and trends.

4.2.5 Evaluation of the Existing Landfill Gas Collection and Combustion System

The performance standards for emissions to air, specified in the 1996 Consent Decree requires the RIRRC to demonstrate that the landfill gas collection and combustion system, which collects and treats gas from the Phase I area of the landfill, does not result in an unacceptable human health risk and complies with all federal and state ARARs.

The evaluation of the existing landfill gas collection and combustion system was completed in 2005. The evaluation concluded that the gas collection and combustion system is in compliance with state and federal regulations and the air risk assessment performed as part of this evaluation concluded that the air emissions for the combustion facility presented no risks to human health. The demonstration of compliance plan, which lists and provides copies of all relevant documents pertaining to the evaluation is substantially complete and will be submitted to EPA in the summer/fall of 2008.

4.3 SYSTEM OPERATIONS/O&M

With construction complete, long-term monitoring, and operations and maintenance (O&M) activities are conducted by the RIRRC in accordance with the Revised Environmental Monitoring Plan and the OU1 Cap Operations and Maintenance Plan prepared pursuant to the 1996 Consent Decree and the OU1 ROD. The Operations and Maintenance Plan for the Hot Spot hydrodynamic containment system is currently in preparation but has not been submitted.

The long-term monitoring activities have been discussed throughout this report. The routine cap maintenance activities include: cutting of vegetative growth on the slopes; removal of plant growth from the stormwater runoff system (riprap benches, downchutes, perimeter channels) as needed; and removal of accumulated sediment in the stormwater runoff system and stormwater culverts as needed.

A regular schedule of inspection and maintenance is required to insure adequate functioning of the Hot Spot Hydrodynamic Containment System (HSCS) system. These procedures can be categorized by frequency of occurrence:

- Daily to Weekly inspection and maintenance
- Monthly to Quarterly inspection and maintenance
- Annual inspection and maintenance

These activities are briefly described below. Maintenance activities are documented in a log book which is kept in the Hot Spot GTS Building and are reported in the monthly progress reports.

Daily to Weekly Inspection and Maintenance

The following maintenance activities are performed on a daily to weekly basis:

- Air pressure reading at air compressor and extraction well MW03-ML11.
- Flow rate readings at: (1) influent to treatment building (target is approximately 3 gpm); (2) through the air stripper; and (3) after the carbon filtration system.
- Flow rate totalizer reading after carbon filtration system.
- Air stripper backpressure reading.
- Water pressure reading before and after bag filters for air stripper.
- Water pressure readings before bag filter for carbon system and at the carbon vessels.
- Water pressure readings after transfer pump at equalization tank and after transfer pump at manhole MH-1.
- Check defoamer solution level for air stripper and fill as needed with 10% solution.
- Empty condensate from air compressor and refrigerated compressed air dryer into the equalization tank.

Monthly to Quarterly Inspection and Maintenance

The following maintenance activities should be performed on a monthly to quarterly basis:

- Collect an influent flow sample for water quality analysis from the system on a monthly basis and analyze the water sample for VOCs, SVOCs, arsenic, beryllium, chromium, iron, lead, manganese, mercury, nickel, vanadium, cyanide, nitrate, total suspended solids, total dissolved solids, pH, temperature, dissolved oxygen, and ORP.
- Collect an effluent sample from the air stripper and analyze the sample for VOCs.
- Download the water level pressure transducer data installed in extraction well MW03-ML11 on a monthly basis.
- Download the flow rate data from the LPF on a monthly basis.
- Clean the trays in the QED air stripper every month.
- Change the oil in the air compressor every month.
- Clean the paddle wheel flow meter (influent to system) every month.
- Purge oil and particulates from the two compressed air filters every month.
- Visually inspect piping system on a monthly basis. For the underground piping, open the manholes and access vaults and inspect for sediment accumulation.
- Clean sump pump in manhole MH-1 with a dilute acid wash every 6 weeks.
- Clean backflow preventer flapper valve (after the air stripper) every 2 months.
- Remove AP-3 extraction pump from well, and clean/rebuild pump and check/foot valves (as necessary) following the pump manufacturers maintenance procedure (every 3 months).
- Visually inspect interior 1-inch stainless steel pump discharge line inside well MW03-ML11 and 2-inch PVC discharge line from MW03-ML11 to Hot Spot GTS for sedimentation/buildup of particulates (every 3 months).
- Test high water shutdown switch in manhole MH-1 and the equalization tank every 3 months.
- Clean interior of the bag filter housings every 3 months.

Annual Inspection and Maintenance

The following maintenance activities should be performed on an approximately yearly basis:

- Vacuum removal of accumulated sediment from manholes (as needed based on visual inspections).
- Cleaning and removal of sediment from equalization tank (as needed based on visual inspections).
- Clean and calibrate the electromagnetic flow meters.
- Jet clean of pipelines (as necessary based on visual inspections).

A summary of the annual O&M costs are provided in Table 2:

TABLE 2
Operation and Maintenance Cost Operable Unit 1
Central Landfill, Johnston, RI

Environmental Monitoring for OU1/Phase I Landfill	**Annual Cost**
Sampling and Analysis Wells and Surface Water Locations	**$60,000**
Data Validation, Data Entry and Quality Control	**$20,000**
Monthly Groundwater Elevation Survey	**$6,000**
Data Management and Evaluation and Reporting	**$40,000**
SUB-TOTAL	**$126,000**
O & M of Hot Spot Hydrodynamic Containment System	
Labor	**$182,000**
Carbon Purchase and Disposal	**$25,000**
Analytical Subcontractor Costs	**$11,000**
Electrical Subcontractor Cost	**$9,000**
Routine Pump Removal and Replacement Support	**$5,000**
Other Subcontractors	**$18,000**
SUB-TOTAL	**$250,000**
Cap Maintenance	
Cap Maintenance, Mowing and Erosion Repairs	**$60,000**
SUB-TOTAL	**$60,000**
TOTAL	**$436,000**

Note: Environmental monitoring cost includes the demonstration of compliance monitoring as well as the OU-1 portion of the site-wide Environmental Monitoring Plan.

SECTION 5.0 – PROGRESS SINCE THE LAST REVIEW

In the first Five-Year Review dated September 2003, EPA certified that the selected remedial actions for the site are expected to be protective of human health and the environment once completed, and in the interim, exposure pathways that could result in unacceptable risks are being controlled. Institutional controls and access restrictions are in place and are successfully preventing exposure.

At the time of the last Five-Year Review (September 2003) construction of the remedial action was still underway. As of September 2006, all the physical components of the remedial action have been completed. EPA issued a Preliminary Close Out Report for the Site in September 2006. Additional details regarding the construction activities since the last Review can be found in Section 4 of this Report.

The last Five-Year Review identified three issues that required follow-up actions. Those issues and the actions taken since the last Review are discussed below.

5.1 STATUS OF ISSUES THAT REQUIRED FOLLOW-UP ACTIONS FROM LAST REVIEW

Issue 1: The deadline for submittal of the 30% design for the Hot Spot Groundwater Containment and Treatment System on July 16, 2002 was not met.

The 30% design for the Hot Spot Groundwater Containment and Treatment System was submitted to EPA in March 2005. The 100% design was submitted to EPA in July 2006 and approved on September 18, 2006. A pre-final inspection for the Hot Spot Groundwater Containment and Treatment System was performed by EPA and RIDEM on September 21, 2006. Additional information can be found in Section 4.2.2 of this Report.

Issue 2: The Area 3, and Area 4, Interim Cap punch list items have not been completed.

All of the punch list items for Areas 3 and 4 have been completed. In addition, in September 2003, RIRRC entered into a contract with J.H. Lynch & Sons (Lynch) to complete placement of the RCRA cap in Areas 5, 6 and 7 (approximately 54 acres) of the Phase I area. Construction activities commenced in September 2003 and capping of Area 7 was completed in June 2004. J.H. Lynch & Sons then commenced with capping of Areas 5 and 6, completing this work in November 2005, thus completing the required OU1 capping. A pre-final inspection was performed for the cap in November of 2005. Additional information can be found in Section 4.2.1 of this Report.

Issue 3: The evaluation of the landfill gas collection and combustion system was not complete.

The evaluation of the existing landfill gas collection and combustion system and human health risk assessment for air was submitted to the EPA and RIDEM for review in February 2006. The EPA and RIDEM approved the air risk assessment in April 2006. The evaluation concluded that the gas collection and combustion system is in compliance with state and federal regulations and the air risk assessment performed as part of this evaluation concluded that the air emissions for the combustion facility presented no risks to human health.

SECTION 6.0 - FIVE-YEAR REVIEW PROCESS

This section describes the activities performed during the Five-Year Review process and provides a summary of findings.

6.1 COMMUNITY NOTIFICATION AND INVOLVEMENT

A summary of the most significant community involvement over the past five years is provided below:

In December 2006, EPA released a Community Update on the status of Central Landfill. The update described the selected remedial activities and stated that all remedial construction activities for OU1 had been completed, and operations and maintenance activities related to the OU1 remedies had been implemented.

In March 2008, EPA placed an advertisement in a local newspaper announcing the start of the second Five-Year Review for the Site. Soon after the review and approval of this Five-Year Review Report, a notice will be placed in a local newspaper announcing that the second Five-Year Review Report is complete and that it is available to the public at the following Site repositories:

Marion J. Mohr Memorial Public Library
1 Memorial Drive
Johnston, RI 02919

EPA – Region 1 (New England) Records Center
One Congress Street
Boston, Massachusetts 02114-2023

Rhode Island Department of Environmental Management
235 Promenade Street
Providence, RI 02908
(Note: Please call 401-22-2797 Ext. 7307 to set up an appointment to review site documents)

6.2 DOCUMENT REVIEW

This five-year review consisted of a review of relevant documents for both Operable Units including the RODs, ESD for OU1, Consent Decree for OU1, design documents and a detailed review of the past five years of analytical data from the required environmental monitoring programs for groundwater, surface water, sediment and air. The results of this evaluation are presented below. See Attachment 2 for a list of documents that were reviewed.

6.3 DATA REVIEW

6.3.1 Groundwater Monitoring

Groundwater monitoring has been conducted on an approximately quarterly basis since 1980. This results in approximately 128 rounds and more than 400,000 parameters being analyzed. The current monitoring program, described in a document titled Revised Environmental Monitoring Program, Central Landfill, Johnston, RI (GZA, 2004), was designed to satisfy the requirements of the OU1 Consent Decree Scope of Work (October 1, 1996). The objectives of the groundwater monitoring are to: 1) measure the effect of capping and the hot spot hydrodynamic containment system on the concentrations of contaminants migrating beyond the compliance boundary; and 2) ensure that those concentrations are not increasing or adversely affecting human health or the environment.

Pursuant to the OU1 Groundwater Monitoring Plan (the Plan), 27 locations are sampled and analyzed for a variety of common contaminants each quarter. During the summer (typically August) sampling round, an additional 6 locations are sampled and tested. The locations that are sampled quarterly include one sample from the west side leachate collection system (WSLCS), which serves as an underdrain for the lined Phase 2/3 Landfills, and intercepts groundwater migrating (in the westerly direction) from the Phase 1 Landfill below the Phase 2/3 Landfills liner. Most of the monitored wells are screened in the shallow bedrock, since that is the zone in which the highest concentrations of contaminants have typically been detected at multi-level wells and well clusters. The other monitored wells are screened in the overburden or deeper bedrock zones. Due to occasional landfill operational issues (e.g., modifications, maintenance activities and mishaps) that impact certain wells, not all wells have been sampled during each monitoring event.

Monitoring results are evaluated on a regular basis, and quarterly and annual monitoring reports are prepared. As required by the Plan, the reports include comparisons between contaminant concentrations and Federal Safe Drinking Water Maximum Contaminant Levels (MCLs) as well as evaluation of trends in contaminant concentrations.

Similar evaluations were conducted for this Five-Year Review, employing two computer database programs. This evaluation of data covers the monitoring period from January 2003 to present. Note, the majority of the data was collected after pumping started in the Hot Spot in September 2004. The Central Landfill employs the Environmental Quality Information System (EQuIS) database, developed by Earthsoft, Inc. of Concord, Massachusetts, for data storage. GZA, on behalf of the RIRRC, employed the Compliance, Assessment and Remediation Statistics (CARStat) program developed by Discerning Systems Inc. of Burnaby, British Columbia, Canada to store and statistically evaluate the data. The following section describes both the comparison of contaminant concentrations to MCLs as well as data trend analysis for samples collected from select locations up-gradient, around and down-gradient of the Central Landfill Hot Spot.

Site-Wide MCL and Contaminant Trend Evaluation

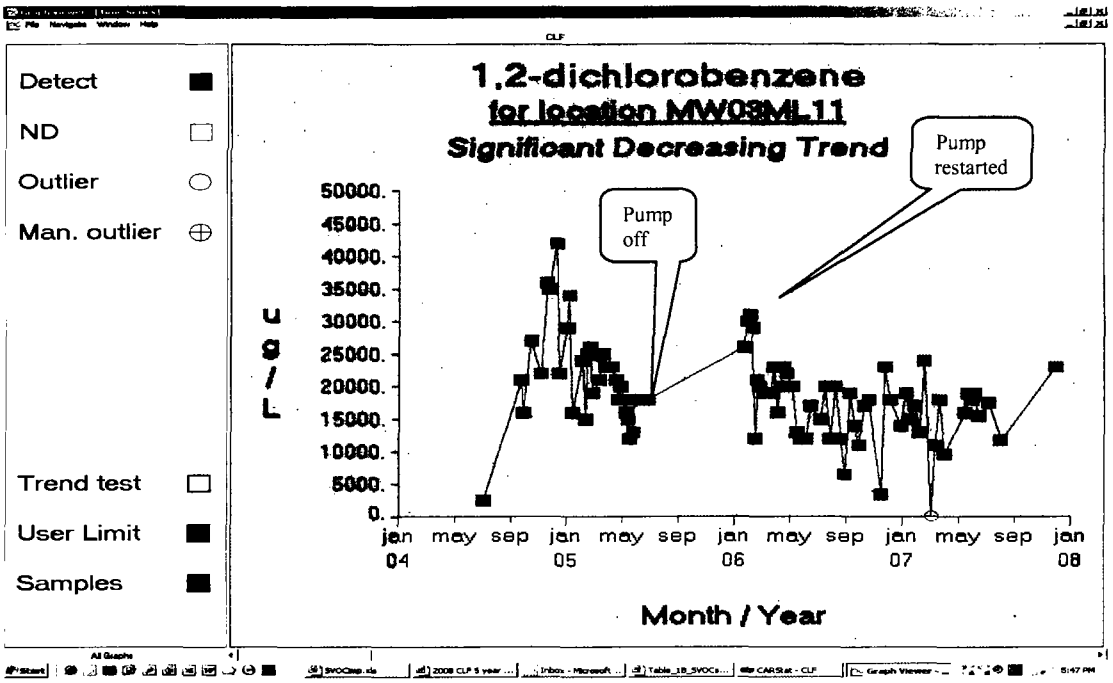
MCL Evaluation

Thirty analytes out of a potential 84 exceeded their MCLs at one or more locations site-wide. This resulted in 202 observed MCL exceedances for monitoring conducted over the five year period of this review. Each exceedance was evaluated statistically by calculating the lower confidence limit (LCL) for the five-year data set (i.e., January 2003 through January 2008) at a 95% confidence level and comparing that directly to the MCL. Of the 202 MCL exceedances 78 were shown to be statistically significant based on the combination of the detected concentrations and their frequency of detection. Seventy of the 78 statistically significant exceedances occurred in samples collected within the landfill itself (plume centerline) and eight occurred outside the footprint of the current licensed landfill (refer to Table 4, Attachment 3 and Figure 2 for their locations).

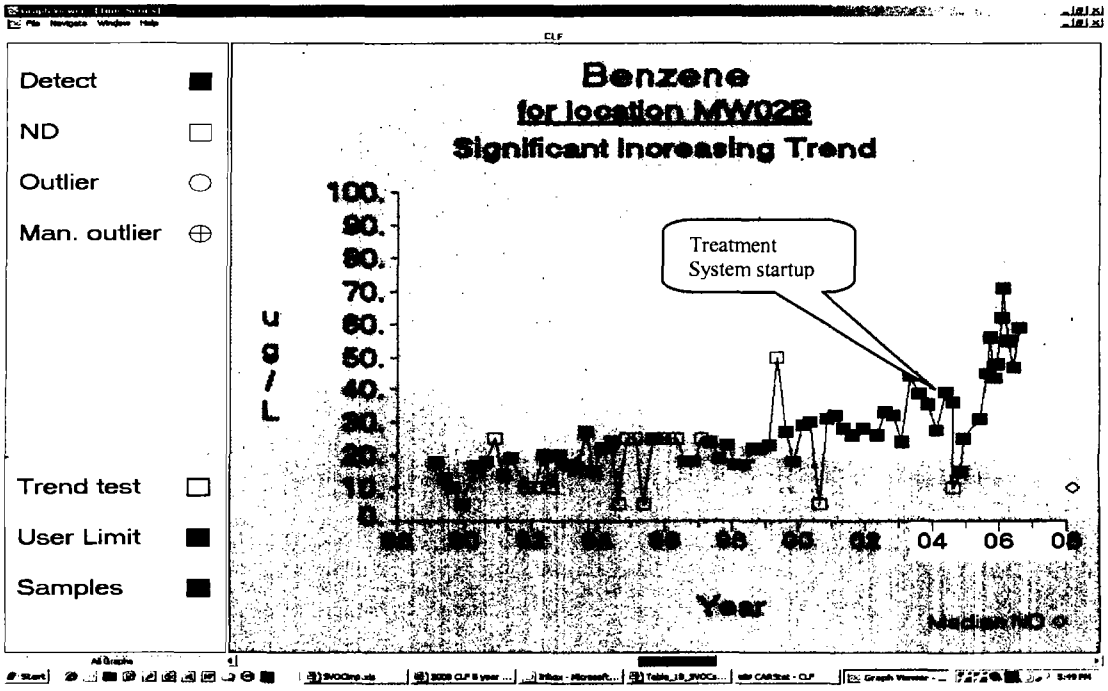
Trend Evaluation

Trends in contaminant concentrations with respect to time were evaluated using CARStat. CARStat employs Sen's Test for Trends to evaluate data. Trend analyses were run at a 95% confidence level and were evaluated over the same five year window as described above (January 2003 to January 2008). All groundwater time series plots are included in Attachment 4. Time series plots are segregated by location with respect to the Hot Spot and the unlined Phase I Landfill as described above.

There were a total of 2,404 time series plots generated and analyzed for trends. Time series plot selection was based on parameters detected at all locations during the five year period of evaluation. Of the 2,404 time series plots, 65 contaminants/locations showed statistically significant trends, less than 3%. As shown on the following page, downward trending in 1,2-dichlorobenzene contaminant concentrations within the source area indicates attenuation of the primary COCs. The second example graph displays down-gradient locations MW02-B. This graph shows a statistically significant increasing trend in what is believed to be daughter products (i.e., benzene) of chlorinated benzene decomposition. This could support the supposition that reductive dehalogenation may be taking place within the landfill.



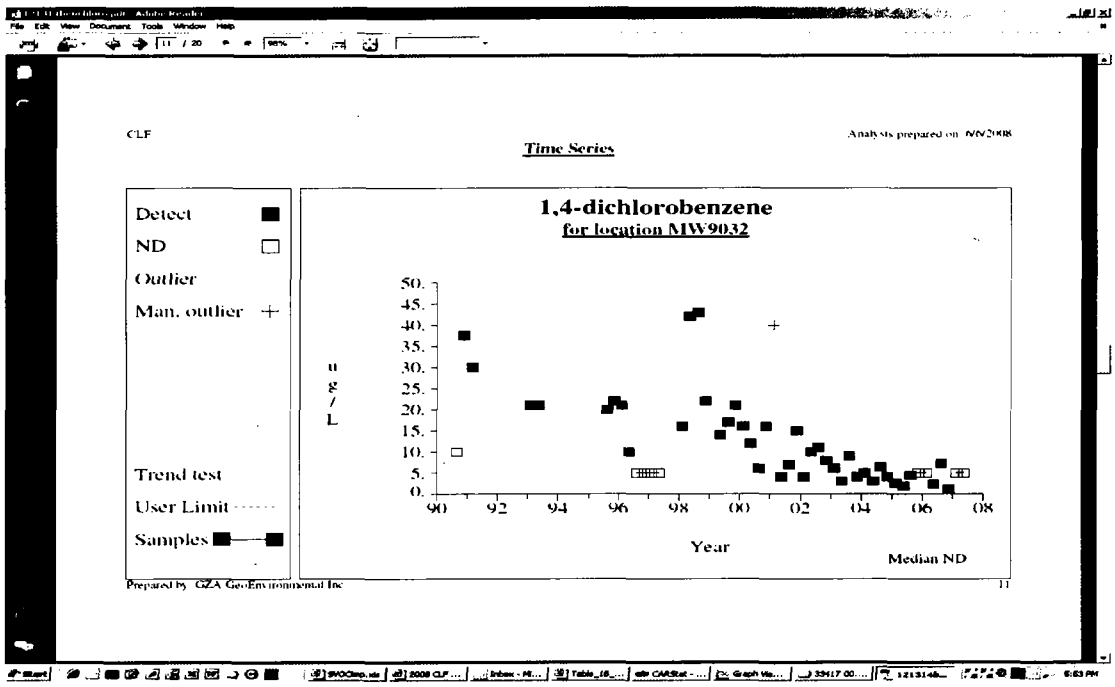
Significantly decreasing trend for 1,2-dichlorobenzene in the Hot Spot pumping well.



Significantly increasing concentration trend in benzene at down gradient location (Cedar Swamp Brook relocation time frame shown in yellow on time line axis).

A review of the graphs in Attachment 4 demonstrates that while not yet "statistically significant", a number of additional contaminant trends, primarily downward, are evident, an example of which is shown below. The graph below shows the 1,4-dichlorobenzene

concentration over time in samples collected from monitoring well MW90-32, a side-gradient location. There is a visually apparent trend in the data when evaluated over the entire data record, however, there is not a statistically significant trend based on the trend test evaluation. This is likely because of the limited date range evaluated (most recent five years of data). Graphs 1, 2 and 3 (Graphs Section) show chlorobenzene, 1,2-dichlorobenzene and benzene concentrations in samples collected from the Hot Spot, within the contaminant plume, and in samples collected from other down-gradient receptors. In general there appears to be downward trending from the time in which the Hot Spot pump and treat system became operational. Other select example graphs have been expanded for the sake of discussion and are provided in the Graph section of this report.



The majority of the trending, both statistically determined and visually apparent, is taking place in samples collected from monitoring wells located in close proximity to the pumping well. The decreasing trends are likely a result of the combination of capping of the Phase I Landfill and the operation of the Hot Spot Hydrodynamic Containment System. Based on the observed breakdown of some contaminants, natural attenuation mechanisms may also be acting to reduce contaminant concentrations. Graph 4 in the Graph section depicts chlorobenzene concentrations in samples collected from MW90-34B over time. This data set was identified as a statistically significant decreasing trend over the date range evaluated (January 2003 to January 2008). Prior to the installation and operation of the pump and treat system in the Hot Spot, there appears to be seasonality in the data. Graph 4, as well the others in the Graph section of this report, depicts contaminant concentrations with respect to time as well as important milestones (e.g., the start of the Hot Spot Hydrodynamic Containment System operation, landfill capping completion dates, and Cedar Swamp Brook relocation).

Cross-referencing the list of statistically significant MCL exceedances with the statistically significant trends, 1,2-dichlorobenzene, beryllium and chlorobenzene in samples from well MW90-34B and beryllium in samples from well MW95-51 were all identified as statistically significant exceedances of MCLs. However, trend tests for these locations/contaminants show statistically significant decreasing concentrations with respect to time for each of these contaminants/locations. Samples from MW02-B[1] also statistically exceeded the MCL for benzene. Trend tests indicate that benzene concentrations show a statistically significant increase (increasing trend at this location). Benzene and chloride are breakdown products of the primary site COCs of dichlorobenzenes and chlorobenzene; therefore, their presence in samples at increasing concentrations down-gradient may suggest that reductive dehalogenation of the parent products is occurring. Note, chloride is also present in leachate from the unlined and lined landfills, and chloride containing agents used by RIRRC for occasional road deicing may contribute to the chloride levels observed in groundwater at the site.

As part of the Phase 5 Landfill expansion, a number of monitoring wells located along the southern toe of slope (designated MW02-B, MW02-B1, WE87-ML4, MW95-47, MW95-47S, MW95-48, MW95-48S, MW95-ML9 and MW95-53) were decommissioned or destroyed during the landfill sub-grade preparation and liner installation between March 2003 and August 2006. MW02-B, one of the wells mentioned above, was one of three locations that had the statistically significant increases in contaminant concentration for an organic contaminant with respect to time. New monitoring wells may be needed to continue to evaluate the effectiveness of the OU1 remedy. The EPA will be evaluating this issue and will direct the replacement of monitoring wells as needed.

Area Specific MCL and Trending Evaluation

Groundwater sample locations were evaluated by location with respect to the Hot Spot and the unlined Phase 1 Landfill (i.e. up-gradient, side-gradient/cross-gradient, down-gradient and groundwater samples collected from beneath the landfill along the presumed Hot Spot plume). Groundwater sample results were compared to MCLs. Refer to Table 4 and Attachment 3 for a complete list of parameters and locations where MCL exceedances occurred, and Figure 2 for their sample locations.

Up-gradient Wells

Monitoring wells considered to be hydraulically up-gradient with respect to the Hot Spot include: MW-M, WE85-16, WE85-18, MW02-30, MW90-31A, MW95-51, MW95-52 and MW03055.

[1] Down-gradient monitoring locations MW-B and MW-B1 have been replaced with MW02-B and MW02-B1. Well location and construction are identical and the data from the old and new wells have been combined for an extended data record.

MCL Evaluation

Five metals (antimony, beryllium, cadmium, lead and thallium) and one VOC (benzene) had exceedances of MCLs in samples collected from up-gradient locations; refer to the tables in the up-gradient section of Attachment 3. Of the six parameters, only the metal beryllium statistically exceeded its MCL, in the sample results from MW95-51. Beryllium, although a Superfund contaminant of concern (COC), is generally considered to be naturally occurring at the Site in that it is sourced by the native soils and bedrock; however, the strong anoxic reducing environment created by the solid waste decay may preferentially leach beryllium from Site soils and bedrock.

Trend Evaluation

Seven sets of parameter data were identified as statistically significant trends. Beryllium, iron, and zinc showed statistically significant decreasing trends in sample data from locations MW95-51, MW90-30 and MW90-31A, respectively. Data from three locations had statistically significant decreasing trends for three water quality parameters, nitrate and total dissolved solids (TDS) and total organic carbon (TOC). These locations were MW90-31A, MW95-51 and MW03-55. For a complete list of tends refer to Table 5 and Attachment 4.

Side-gradient Wells

Monitoring wells considered to be "side-gradient" (not up-gradient or directly within the down-gradient flow path) with respect to the flow path consist of; MW-O, WEO204, WE85-6B, WE02-8, MW90-32, MW90-33, MW90-34B, MW95-50, WE87-ML1 (A&E) AND WE87-ML3 (B, D and E).

MCL Evaluation

The side-gradient or cross-gradient evaluation incorporates MW90-34B, one of the most impacted wells not drilled through the landfill. Eight VOCs, seven metals and one water quality parameter exceeded MCLs in this group. Seven of the eight VOCs and four of the seven metals exceeded MCLs in the samples from MW90-34B. Only two of the eight VOCs, 1,2-dichlorobenzene and chlorobenzene were identified as statically significant exceedances, and both were identified within groundwater sample results from MW90-34B, refer to the side-gradient section of Attachment 3.

Similar to the up-gradient well samples, metals concentrations showed exceedances of MCLs at various locations and for a number of different metals, however; only cadmium in samples from MW90-33 and beryllium in samples from MW90-33, MW90-34B, MW95-50, WE02-4[2] (WE87-4), WE85-6B, WE87-ML1A and WE87-ML1E were statistically significant based on the LCL evaluation. As noted above, beryllium is naturally occurring at the Site; however, the strong

[2] WE02-4 is a replacement well for WE87-4. Well construction and location are identical to the original well and therefore the data from both well designations have been combined for the sake of statistical and trend evaluation.

anoxic reducing environment created by the solid waste decay may preferentially leach beryllium from Site soils and bedrock.

Trend Evaluation

There were 20 statistically significant trends identified in side/cross-gradient data sets. Fourteen of the 20 were statistically significant decreasing trends. Most notably two organic contaminants of concern (1,2-dichlorobenzene and 1,4-dichlorobenzene) both had statistically significant downward tends in concentration in the samples collected from MW90-34B. Six statistically significant increasing trends were identified for one metal and three water quality parameters (zinc, chloride, sulfate and TDS). For a complete list of tends refer to Table 5 and Attachment 4.

Down-gradient Wells

Wells that lie down-gradient with respect to the Hot Spot consist of: MW02-B, MW02-B1, MWP5-1 (A&B), MWP5-2 (A&B), MW9928BR, MW99-29BR, MW95-47S, MW95-48S, MW95-48, WE87-ML4B AND MW95-ML9 (A&C).

MCL Evaluation

Sample results from down-gradient locations had exceedances of MCLs for 14 organics and five metals. Contaminants that were found to have statistically significant exceedances consist of five VOCs 1,2-dibromo-3-chloropropane, 1,2-dibromoethane, benzene, chlorobenzene and vinyl chloride; and the metal beryllium. As would be expected, groundwater quality in the samples collected from down-gradient locations reflects greater impacts than both the up- and cross-gradient locations.

Trend Evaluation

Down-gradient locations had only three statistically significant decreasing trends and 18 increasing trends. Most notable increases were for potential daughter products of reductive dehalogenation of chlorinated benzenes (benzene and chloride). Note, benzene and chloride may also be present in Site groundwater from other sources such as gasoline releases and road deicing activities. Refer to Table 5 and Attachment 4 for a complete list of trends as well as individual time series plots[3].

Plume Centerline Wells

Wells considered to lie along the centerline of the Hot Spot contaminant plume consist of: MW03-56, MW03-ML11, MW03-ML12 (A to E), MW03-ML 14 (A to G).

[3] Down-gradient monitoring locations MW-B and MW-B1 have been replaced with MW02-B and MW02-B1. As with the previous footnote, location and construction are identical and the data from the old and new wells have been combined for an extended data record.

MCL Evaluation

Groundwater samples collected from monitoring wells installed through the landfill and in the vicinity of the Hot Spot and associated contaminant plume (i.e. MW03-56, MW03-ML11 [remedial pumping well] and MW03-ML12 through MW03-ML14) were also evaluated for MCL exceedances. There were a total of 19 organics and six metals that exceeded MCLs in one or more samples, refer to Table 4 and Attachment 3. Metals analyses, until recently, have not been part of the sampling program associated with the evaluation of the hydrodynamic containment system, and therefore, statistical analysis of these exceedances is not possible (i.e., insufficient data currently exists). The metals data record will be evaluated as part of the next Five-Year Review. A statistical evaluation of organic MCL exceedances showed that 20 of the 26 MCL exceedances in samples collected from MW03-56 (well installed through Hot Spot) and MW03-ML11 (remedial pumping well) were statistically significant. Thirty seven of the 54 MCL exceedances detected in plume centerline wells MW03-ML12 (A through E) and MW03-ML14 (A through G) were also statistically significant. A complete list of contaminants and locations is available in Table 4 and Attachment 3.

Trend Evaluation

Trend evaluation of contaminant concentrations from samples collected along the presumed centerline of the plume shows four statistically significant increasing and 15 statistically significant decreasing trends, refer to Table 5 and Attachment 4.

Groundwater Evaluation Conclusions

Our major conclusions for this evaluation of information collected during the various environmental monitoring projects at the Central Landfill are:

1. Groundwater quality at the Central Landfill continues to improve with time due to a combination of factors including the Hot Spot pump and treat system, landfill capping and possibly natural attenuation.

2. The affects of capping and the installation of the groundwater pump and treat system (hydrodynamic containment) currently seems most evident in samples from groundwater monitoring wells located in close proximity to the Hot Spot (see example shown on Graph 4).

3. Consistent with prior findings, the groundwater samples collected at wells around the periphery of the landfill (down-gradient and side-gradient) show significantly lower levels of contamination than those collected in close proximity to the Hot Spot as can be seen in Graph 1 and 2, attached.

4. Time series plots were evaluated for trends over the entire data record (big picture) as shown in Attachment 4. There were 142 statistically significant trends in data Site-

wide, 83 decreasing and 59 increasing trends with respect to time. Twenty eight of the 83 decreasing and seven of the 59 increasing trends were for organic COCs.

5. Groundwater flows to the east of the Phase 1 Landfill (side-gradient) may be seasonally affected causing samples from wells in the area to be more directly down-gradient of the Phase 1 Landfill Hot Spot at times. This seasonality can be seen in Graph 4.

6. Samples from on-site down-gradient locations MWP5-1A and -1B continue to show elevated concentrations of COC (refer to Graph 6A). This is likely due to the large distance of the wells from the pumping well. Continued operation and containment of contaminated groundwater at the Hot Spot is expected to have a positive impact on downgradient groundwater quality with time. Continued monitoring of groundwater will help in the evaluation of trends in contaminant concentrations.

6.3.2 Surface Water Monitoring

The current surface water monitoring program, described in a document titled Revised Environmental Monitoring Program, Central Landfill, Johnston, RI (GZA, 2004), was designed to satisfy the requirements of the OU1 Consent Decree Scope of Work (October 1, 1996). The objectives of the surface water monitoring are to: 1) measure the effects of capping the landfill and operation of the Hot Spot Hydrodynamic Containment System on the concentrations of contaminants migrating from the Phase I Landfill and Hot Spot area to surface water locations; and 2) ensure that those concentrations are not increasing with time or adversely affecting human health or the environment.

Surface water samples are collected at nine locations each quarter. Two are upstream locations; one near the headwaters of the Quarry Stream designated SW-1A, and the second on Cedar Swamp Brook at the outlet from a water body known as the "swimming hole" designated SW-1B. The other seven monitoring points consist of four downstream locations on Cedar Swamp Brook (three mid-stream designated SW-A, SW-B and SW-C, and one prior to the brook running off site SW-7), one downgradient location at the outlet of the Phase 5 Landfill stone trench underdrain (designated SW-4) one at the outlet from Pond 2 (designated SW-5), and one down-gradient location at the outlet from Pond 3 (designated SW-6). Refer to Figure 2, Attachment 1, for the sampling locations.

As part of the Phase 5 Landfill expansion, the southern leg of Cedar Swamp Brook was diverted and separated from Pond 2; refer to Figure 2 in Attachment 1. As described in detail in the Proposed Phase 5 Geohydrologic Report, the former Cedar Swamp Brook channel continues to act as a sink for groundwater flow from both the unlined Phase 1 Landfill to the north and from the south below the newly constructed, lined Phase 5 Landfill. Thus, the samples collected from SW-4 post-relocation of the Cedar Swamp Brook (after May 2003) represent a mix of groundwater from the unlined Phase 1 Landfill and groundwater that flows below the Phase 5 Landfill from the south (i.e., the area of the Vinagro and NEED facilities). Because samples from SW-4 now represent a groundwater discharge to an engineered water treatment

impoundment (i.e., Sedimentation Pond #2), we have removed SW-4 from the surface water quality discussion and describe conditions at this location in detail in Section 6.3.3, below.

Note, in accordance with the methods presented in the Revised EMP, surface water samples for the analyses of metals, except for iron, were filtered with a 0.45 micron filter prior to analysis. Since some locations go dry on a seasonal basis, not all locations are sampled during each monitoring event.

Quarterly and annual monitoring reports that include the results from the surface water sampling are prepared and submitted to both EPA and RIDEM. As required by the Revised EMP, the reports include comparisons between contaminant concentrations and the Federal Ambient Water Quality Criteria (FAWQC) as well as the state ambient water quality criteria (RIAWQC); statistical evaluation (Lower Confidence Limit - LCL) of parameters that exceed FAWQC/RIAWQC; evaluation of time series plots for statistical trending in contaminant concentrations using Sen's Test for trends; and an evaluation of seasonality and outliers.

Comparison to Surface Water Quality Standards

For the preparation of this Five-Year Review, surface water sample results were evaluated with respect to both the FAWQC and RI AWQC. Surface water samples from the eight onsite surface water sampling location had exceedances of RI AWQC for one volatile organic compound (VOC - chlorobenzene), one water quality parameter (ammonia as N), and 11 metals (aluminum, antimony, beryllium, copper, iron, lead, nickel, selenium, silver, thallium, and zinc). Refer to Table 6 and Attachment 5. Only five metals (i.e., copper, lead, selenium silver and zinc) were found to have exceeded a FAWQC at some point in the past five years of sampling and analysis.

Chlorobenzene was detected in one sample collected at downstream location SW-5 on February 7, 2005, at a concentration of 19 ug/L. The RIAWQC for chlorobenzene is 18 ug/L. This location is hydraulically downgradient of the Phase I Landfill Hot Spot at the discharge from Sedimentation Pond 2 which has been shown to receive groundwater from the unlined Phase I Landfill Hot Spot. As shown on Graph 7 (Graphs Section), this contaminant is detected consistently in samples from SW-5 at low concentrations ranging from ND (not detected) up to19 µg/L. Note, also that chlorobenzene concentrations have varied more significantly since the brook was relocated out of Pond 2. It also appears that concentrations may be declining in general since brook relocation/underdrain installation except for an annual spike in concentrations during the February 2005 round. This recurring spike may be due to a decrease in volatilization as well as a reduction in stormwater inputs during the colder months.

The FAWQC for chlorobenzene in surface water is 100 µg/L; however, this is based on consumption of surface water by humans and not impact to aquatic organisms. Chlorobenzene concentrations at the discharge from Pond 2 have never approached this concentration and are frequently non-detected (ND). Additionally, as stated in the Ecological Risk Assessment that was completed as part of the Final Remedial Investigation & Risk Assessment Report Central Landfill Operable Unit 2 Johnston, RI (March 2001), Sedimentation Pond 2 is a manmade storm water retention basin/engineered structure. The sedimentation ponds were designed to detain

storm water and remove contaminants from the water column before the water flows off-site and into waters of the State. As such, the sedimentation ponds were evaluated in the OU2 risk assessment as man-made impoundments, engineered and actively maintained for a purpose.

Ammonia and seven of the 11 metals detected at concentrations in excess of the RIAWQC benchmark were demonstrated to have statistically significant exceedances (for the 5 year evaluation period from January 2003 to January 2008) based on the LCL comparison described above. These parameters are shown on Table 6. Note, only two parameters (copper and lead) were shown to exceed the FAWQC at a statistically significant frequency and concentration. Copper was observed at a statistically elevated level in the upstream location samples from SW-1A as well as two sedimentation pond discharges (SW-5/Pond 2 and SW-6/Pond 3).

As shown on the Graph 8 (Graphs Section), the majority of the copper and lead test results are non-detects; however, the reporting detection limit (RDL) is high with respect to the water quality criteria and when ½ the RDL is used in the calculation it erroneously elevates the LCL. The single detection for lead in samples from SW-5 was flagged as an outlier because at 0.14 mg/L it was an order of magnitude higher than any previously detected level, and had been non-detected immediately before and after the one elevated reading.

Contaminant Trend Evaluation

A trend evaluation was performed on surface water sample results, similar to that done for groundwater, using Sen's test for trends on just the last five years of water testing results from 2003 to the present. Time series plots were developed for all parameters detected in surface water samples. A total of 448 time series plots out of a potential 975 were developed.

Only two of the 448 test, or 0.2% of all analytes evaluated, showed statistically significant trending in contaminant concentration with respect to time. Specific conductance and sulfate concentrations in samples collected from SW-6 showed statistically significant increasing trend. Neither specific conductance nor sulfates are Superfund COC at the Site. Their presence in Sedimentation Pond 3 (SW-6) may be related to the processing of construction and demolition debris containing gypsum wall board at the RecoverMat facility which is located within the Pond 3 drainage area. Identified trends and times series plots are presented in Table 7 and Attachment 6, respectively.

Surface Water Evaluation Conclusions

Surface water samples were collected and analyzed from eight locations for VOCs, Metals and Water Quality Parameters. The results for the entire data record at these locations were evaluated with a focus on the most recent fives years. The data review has shown that:

1. Surface water quality is not changing significantly with time, however, there is uncertainty with this conclusion because the detection limits currently being used for the metals analyses are too high.

2. Surface water samples from eight onsite surface water sampling locations had exceedances of RIAWQC for one VOC (chlorobenzene), one water quality parameter (ammonia as N), and 11 metals (aluminum, antimony, beryllium, copper, iron, lead, nickel, selenium, silver, thallium, and zinc). Five metals (copper, lead, selenium, silver and zinc) were found to have exceeded the FAWQC at some point in the last five years. Measured contaminant concentrations are below FAWQC for all Superfund contaminants of concern (COCs) except for lead (based on a single lead detection which was flagged as an outlier).

3. Concentrations of some COCs have become more variable in surface water at the groundwater discharge points (i.e., Sedimentation Pond 2) since the Cedar Swamp Brook was relocated.

6.3.3 Phase V Stone Trench Underdrain (SW-4) Evaluation

The sampling station identified as SW-4 was originally located in Cedar Swamp Brook at the influent point to Sedimentation Pond 2 and represented surface water flow. In 2003 the lower reach of the Cedar Swamp Brook was relocated to make way for the construction of the Phase Landfill (see Figure 2, Attachment 1). At this time a stone fill trench (approximately 20 feet wide and 4 feet thick) was installed within the former brook channel to: 1) maintain groundwater levels beneath the Phase 5 cell at their pre-brook relocation elevations; and 2) and to keep the OU1 contaminant plume within its previously defined boundaries and avoid spreading it further south. As such, it is anticipated that groundwater contaminants from the OU1 Landfill, and more specifically the Hot Spot area, will be observed in the Phase 5 underdrain discharge water. Groundwater and contaminant transport modeling conducted by GZA prior to installation of the stone trench estimated that discharges from the system would not result in a water quality violation at the outfall of Pond 2[4].

Three types of evaluation were conducted on water quality data collected from SW-4. They consisted of: 1) a water quality criteria exceedance evaluation; 2) an evaluation of trends in contaminant concentrations for pre-Cedar Swamp Brook relocation; and 3) an evaluation of trends in contaminant concentrations for post-Cedar Swamp Brook relocation.

Comparison to Water Quality Standards

As described above in Section 6.3.3, SW-4 now represents a groundwater discharge from an underdrain below the newly constructed Phase 5 Landfill that discharges to an engineered water quality treatment basin (Sedimentation Pond 2). Sedimentation Pond 2 is operated and maintained to mitigate the off site migration of particles and particle bound contaminants. Therefore, exposure pathways to ecological receptors is not considered to be complete and comparison of SW-4 data to federal and state water quality criteria is not appropriate. However, comparison to MCLs is appropriate. The results of this comparison are shown on Table 8, attached. Additionally, for illustration purposes, testing results were compared to surface water standards (FAWQC and RIAWQC), also shown on Table 8. This comparison shows that five parameters (benzene, antimony, beryllium, lead and thallium) exceeded an MCL. Benzene,

[4] GZA GeoEnvironmental, Inc., Sedimentation Pond 2 Water Quality Evaluation Report. 31 Oct. 2002

beryllium and lead are Superfund COCs at the Site. Further statistical evaluation of these results, see Attachment 7, shows that none were statistically significant when an LCL evaluation was conducted.

Graphs 9 and 10 (Graphs Section) show the historical benzene, antimony, beryllium, lead and thallium results for this location with time.

As shown on the Graphs 9 and 10, the majority of the metals test results are non-detects; however, sporadic excursions above the water quality benchmarks are observed. Several outliers are also noted for the thallium results in the past several years which calls the one significantly elevated detect into question (this elevated value is identified as a possible outlier as well).

Contaminant Trend Analysis

Time series plots and Sen's Test for trends in contaminant concentrations with respect to time were performed for the first five year period from January 1998 through the relocation of Cedar Swamp Brook in May of 2003 and then for the time period of May 2003 to January 2008 (data available up to January 2008). For the first date range, all detected parameters were evaluated for trending and this resulted in 46 time series plots. No statistically significant trends were identified in the data.

An evaluation of trends in contaminant concentrations with respect to the second time window May 2003 to present was then performed. This evaluation resulted in the creation of 75 times series plots and one statistically significant trend in contaminant concentrations (chlorobenzene) was identified. A plot of this chlorobenzene data is shown in the graph above and the trend analysis is depicted on the time-series plots in Attachment 7.

SW-4 Evaluation Conclusions

The data evaluation described above for the Phase 5 Landfill stone trench underdrain (SW-4) has shown that:

1. The Phase 5 Stone Trench is acting as a discharge point for OU1 derived contaminants.

2. Water quality at the SW-4 monitoring station has declined since the relocation of Cedar Swamp Brook out of this area in May 2003 which significantly reduced the amount of surface water dilution at this location.

3. Testing shows that discharges from the underdrain are generally compliant with groundwater quality standards with the exception of sporadic exceedances by benzene and four heavy metals.

4. Statistical evaluation of these exceedances demonstrates that none are significant with respect to frequency of detection and concentration.

5. With the exception of chlorobenzene concentrations, which were shown to be increasing over the past 5 years, water quality at SW-4 is not changing significantly with time.

6. Discharges from the Phase 5 underdrain are not resulting in water quality violations for Superfund Contaminants of Concern in downgradient waters of the State as monitored at the Pond 2 discharge (SW-5). However, as stated in Section 6.3.2 there is uncertainty with this conclusion because the detection limits currently being used for metals analyses are too high.

6.3.4 Sediment Data

The sediment data is provided as Attachment 9. Chlorobenzene data collected in the Upper Simmons Reservoir since 1999 indicates an overall downward trend in chlorobenzene concentrations at SED17 and no obvious trend at other stations. The maximum concentration detected (100 ug/Kg chlorobenzene) at SED17 in 1999 is one order-of-magnitude less than a sediment effects concentration based on equilibrium partitioning of chlorobenzene between solid phase sediment and the interstitial (pore) water.

The sediment metals data for Upper Simmons Reservoir collected since 1999 indicates a generalized upward trend in sediment lead at SED15, 16 and 17. Sediment copper appears to trend upward at stations SED6 and 17, and possibly others since the monitoring began in 1999.

The past five years of data indicates that Exposure Point Concentrations (EPCs) have increased for sediment lead and copper in the Upper Simmons Reservoir delta. Both lead and copper appear to have an upward trend in concentrations. At its current concentration, lead presents a long-term ecological risk. In particular, sediment lead concentrations at all stations in Upper Simmons Reservoir exceed the consensus-based Threshold Effects Concentration (TEC) of 35.8 mg/kg lead during the past three years, and also exceed the consensus-based PEC of 128 mg/kg lead (MacDonald et al., 2000). Therefore, sediment lead may pose a long term significant risk from direct toxicity and to the food chain as the metal tends to bioaccumulate in the environment. Although copper concentrations appear to be increasing, the current copper levels do not pose an ecological risk.

6.3.5 Air Monitoring

The air monitoring data is provided as Attachment 10. As described in Section 4.2, long-term monitoring of air is conducted in accordance with the Revised EMP (GZA, 2004). Quarterly sampling of ambient air for VOCs and hydrogen sulfide is conducted at a minimum of four locations: one upwind of the Phase 1, 2, 3, 4, and 5 areas and three downwind of these areas. The air monitoring program is designed to characterize the distribution of select volatile organic compounds in the air in the vicinity of Central Landfill. The purpose of this monitoring program is to evaluate workplace exposure to airborne hazards.

Quarterly ambient air monitoring from the July 2003 to December 2007 quarter results for VOCs were reviewed. These air monitoring results were compared to the RIDEM Ambient Air Levels (AALs) as required by the Revised EMP for Central Landfill (GZA 2004) and the Occupational Safety and Health Administration (OSHA) Permissible Exposure Levels (PEL) where applicable. To date, no VOCs have been detected at the landfill above levels that are considered protective of on-site workers.

The quarterly air data for Central Landfill was also compared to risk-based screening levels. The risk based screening levels used are based on residential exposure and toxicity values that follow the EPA hierarchy as described in OSWER Directive 9285.7-53.

The review concluded that there are no levels that pose a public health risk concern. It should also be noted that this comparison is conservative given that the data were collected at the perimeter of the landfill and compared to levels based on residential exposure. At residential properties the air concentration of contaminants emanating from the landfill would be significantly lower.

The tables provided in Attachment 10 include a comparison to Rhode Island criteria and note that there are some instances where the chloroform and benzene concentrations exceed those criteria. There are no exceedances of the risk-based screening levels for annual averages for these two compounds.

6.4 SITE INSPECTION

As described earlier, a pre-final inspection was performed for the OU1 cap in November 2005 and a pre-final inspection was performed for the Hot Spot Hydrodynamic Containment System on September 21, 2006. A Preliminary Closeout Report was issued by the EPA for the Site in September 2006. No outstanding construction items were identified and no additional, substantial construction is anticipated at the Site (EPA, 2006).

As part of this Five-Year Review the U.S. EPA performed a site inspection in August 2008. Overall, the inspection found that the landfill cap and Hot Spot containment system are being adequately maintained and there were no conditions identified that would compromise the integrity of the remedy.

6.5 INTERVIEWS

Site interviews were not performed as part of this five-year review.

SECTION 7.0 - TECHNICAL ASSESSMENT

This section discusses the technical assessment of the remedy and provides answers to the three questions posed in the EPA Guidance (USEPA, 2001).

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

In the short-term yes, but in the long-term no. Construction of the landfill cap and hot spot pump and treat system have been completed. The review of the constructed remedy indicates that the remedy has been constructed in accordance with the ROD. At this time groundwater quality is stable or improving. To date, no VOCs have been detected in the air at the landfill above levels that are considered protective of on-site workers and area residents. Surface water quality does not present a current ecological risk, however, there is some uncertainty in the long-term effects because the current detection limits are too high when compared to the state and federal water quality criteria. The concentrations of lead in Upper Simmons Reservoir sediment during the last three years have exceeded the consensus-based Threshold Effects Concentration and Probable Effects Concentration sediment quality guidelines for lead. The concentrations of copper in Upper Simmons Reservoir sediment are also increasing, however, at this time current copper levels do not pose an ecological risk. Also, this Five-Year Review has concluded that over time surface water quality has not changed significantly and does not present a long-term ecological risk. However, there is some uncertainty with this conclusion because the detection limits currently being used for the metals analyses are too high. The current detection limits for metals in surface waters needs to be lowered to verify that the metals at this Site are not presenting a long-term ecological risk.

The institutional controls and access controls are currently in place. The institutional controls include a Town of Johnston ordinance that prohibits the use of groundwater wells and prohibits the Building Inspector from issuing permits for the construction of groundwater wells in any location where access to Town public water is available and where the well or proposed well is located in certain described areas including where groundwater has been classified by the State as GAA, GA, GB, or GC and where it is located in the OU2 areas recommended for institutional controls identified as the OU2 Groundwater Protection Buffer Zone. Also, RIRRC filed a Declaration of Covenants and Environmental Protection/Conservation Easement on property it owns, which prohibits the use of groundwater except for remediation purposes, prohibits the installation of groundwater wells or the use of existing groundwater wells, prohibits the alteration of the groundwater flow in any way, and prohibits any activities that would interfere with the integrity of the cap. The 1,200-acre property owned by RIRRC is partially fenced, vehicular entry is limited to secured roadways, and security guards patrol the property 24 hours/day.

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

No. The exposure assumptions, cleanup levels, and RAOs are still valid, however, there have been some changes to toxicity data used to evaluate human health risks since the 2003 Five-Year Review. Minor revisions were made to the toxicity values for toluene and 1, 1, 1-trichloroethane from the values used in the OU1 Human Health Risk Assessment conducted in 1993. These changes are summarized in the table below:

Contaminants:	**Toluene**	**1,1,1-Trichloroethane**
Reference Dose (RfD; mg/kg-day)		
Value from Original Risk Assessment	0.2	0.09
Current Value	0.08	2
Reference Concentration (RfC; mg/m^3)		
Value from Original Risk Assessment	0.35	1.01
Current Value	5	5

An increase in an RfD or RfC value would correspond to a decrease in corresponding risk estimates, while a decrease in an RfD or RfC value would correspond to an increase in corresponding risk estimates. The RfD and RfC used in the OU1 Risk Assessment for 1,1,1-trichloroethane were slightly lower than current values. The RfD for toluene used in the OU1 Risk Assessment was slightly higher than current value, and the RfC was slightly lower than the current value. Together, these differences result in a slight overestimate of groundwater risk in 1993 compared to that which would be calculated today. Other differences between historical and current toxicity values tended to be minimal. Since only a small number of toxicity values have changed since the 2001 OU2 risk assessment was finalized, there are no significant impacts to the protectiveness findings of the OU2 risk assessment.

There have also been some changes to the toxicity data used to evaluate ecological risks for chlorobenzene. The new chronic Tier II aquatic life criteria is 47 ug/L chlorobenzene and the new acute criteria is 420 ug/L. Measured chlorobenzene concentrations in surface water are two to four fold less than the chronic (47 ug/L) or 10 fold less than the acute (420 ug/L).

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

Yes. The sediment monitoring data for lead in Upper Simmons Reservoir indicates that there is probability of ecological effects from concentrations of sediment lead that are increasing above the consensus-based PEC of 128 mg/kg lead. Also, the current detection limits for metals in surface waters needs to be lowered to verify that the metals at this Site are not presenting a long-term ecological risk.

SECTION 8.0 - ISSUES

Based on the activities conducted during this Five-Year Review, the issues identified in Table 2 have been noted.

Table 2: Issues

Issues	Affects Current Protectiveness (Y/N)	Affects Future Protectiveness (Y/N)
Phase 6 landfill expansion (see below).	N	Y
Replacement wells for the long-term groundwater compliance monitoring network (see below).	N	N
Need lower detection limits for metals analysis in surface waters.	N	Y
The sediment monitoring data for lead in Upper Simmons Reservoir indicates that there is probability of ecological effects from concentrations of sediment lead that are increasing above the consensus-based PEC of 128 mg/kg lead. Increasing copper levels are also noted.	N	Y

As shown on attached Figures 1 and 2, the RIRRC is in the process of seeking a Permit from the RIDEM for another expansion to the Central Landfill. The new expansion, designated the Phase 6 Landfill, will have a footprint of 103 acres and will piggyback the Phase I/OU1 Landfill by an additional 50 acres. The landfill will be constructed in sub-phases and will have a double composite synthetic and clay liner system with integral leachate collection. The proposed Phase 6 expansion will significantly impact the OU1 remedy. The impacts include the need to relocate the landfill gas to electricity facility, the Hot Spot groundwater treatment system, and possibly relocating the Hot Spot extraction well (MW03-ML11). As the Phase 6 landfill expansion plans unfold through the next 5-year review period, further evaluation will be necessary to determine if a new location for the extraction well can be equally effective, to find a new location for the Hot Spot treatment system and to ensure that the gas to electricity facility which currently burns gas collected from the Phase I Area is relocated in a manner which does not result in an unacceptable increase in air emissions.

Past landfill expansions (Phase 4 and 5) and the planned Phase 6 expansion have and will result in the loss of long-term groundwater monitoring wells. During the next 5-year review period it will be necessary to reevaluate the current groundwater monitoring network and replace lost wells as needed.

SECTION 9.0 - RECOMMENDATIONS AND FOLLOW-UP ACTIONS

In response to the issues noted above, it is recommended that the actions listed in Table 3 be taken:

Table 3: Recommendations and Follow-up Actions

Issue	Recommendations and Follow-up Actions	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness	
					Current	Future
Phase 6 landfill expansion.	RIRRC to evaluate Phase 6 impacts to the OU1 remedy and propose a plan for minimizing those impacts.	RIRRC	USEPA	9/1/10	N	Y
Replacement wells for the long-term groundwater compliance monitoring network.	RIRRC to propose an update to the long-term monitoring network.	RIRRC	USEPA	9/1/09	N	Y
Need lower detection limits for metals analysis in surface waters.	RIRRC to amend the Environmental Monitoring Program to provide lower detection limits.	RIRRC	USEPA	9/1/09	N	Y
The sediment monitoring data for lead in Upper Simmons Reservoir indicates that there is probability of ecological effects from concentrations of sediment lead that are increasing above the consensus-based PEC of 128 mg/kg lead. Increasing copper levels are also noted	RIRRC to propose a study to determine the cause for the increase in sediment lead concentrations in the Upper Simmons Reservoir and continue to monitor copper levels.	RIRRC	USEPA	9/1/09	N	Y

SECTION 10.0 - PROTECTIVENESS STATEMENTS

OU1 Protectiveness Statement:

The OU1 source control remedy required construction of a cap over the Phase I landfill area and the construction of a Hot Spot groundwater containment system along with long-term monitoring of groundwater, surface water, sediment and air. At this time the data indicates that groundwater quality is stable or improving. Institutional controls are in place preventing exposure to the contaminated groundwater. To date, no VOCs have been detected in the air at the landfill above levels that are considered protective of on-site workers and area residents. Surface water quality data does not indicate a current ecological risk, however, there is some uncertainty in the long-term effects because the existing detection limits for metals are too high when compared to the state and federal ambient water quality criteria. Sediment data have shown that the concentrations of lead in Upper Simmons Reservoir sediment during the last three years have exceeded the consensus-based Threshold Effects Concentration and Probable Effects Concentration sediment quality guidelines for lead and therefore may present a long-term ecological risk. It is also noted that copper concentrations are rising but as yet do not pose an ecological risk. In addition, the current detection limits for metals in surface waters needs to be lowered to verify that the metals at this Site are not presenting a long-term ecological risk.

The OU1 remedy is protective of human health. The OU1 remedy is protective of the environment in the short-term but may not be in the long-term.

OU2 Protectiveness Statement:

The OU2 studies involved a human health and ecological risk assessment for groundwater beyond the Facility and surface water, sediment and soils within the OU2 study area which included the Upper Simmons Reservoir. The OU2 remedy did not call for any remedial actions beyond that called for in the OU1 remedy. As discussed above, sediment lead levels in Upper Simmons Reservoir may be currently presenting a long-term ecological risk. It is also noted that copper concentrations are rising but as yet do not pose an ecological risk. In addition, the current detection limits for metals in surface waters needs to be lowered to verify that the metals at this Site are not presenting a long-term ecological risk.

The OU2 remedy is protective of human health. The OU2 remedy is protective of the environment in the short-term but may not be in the long-term.

Site-Wide Protectiveness Statement:

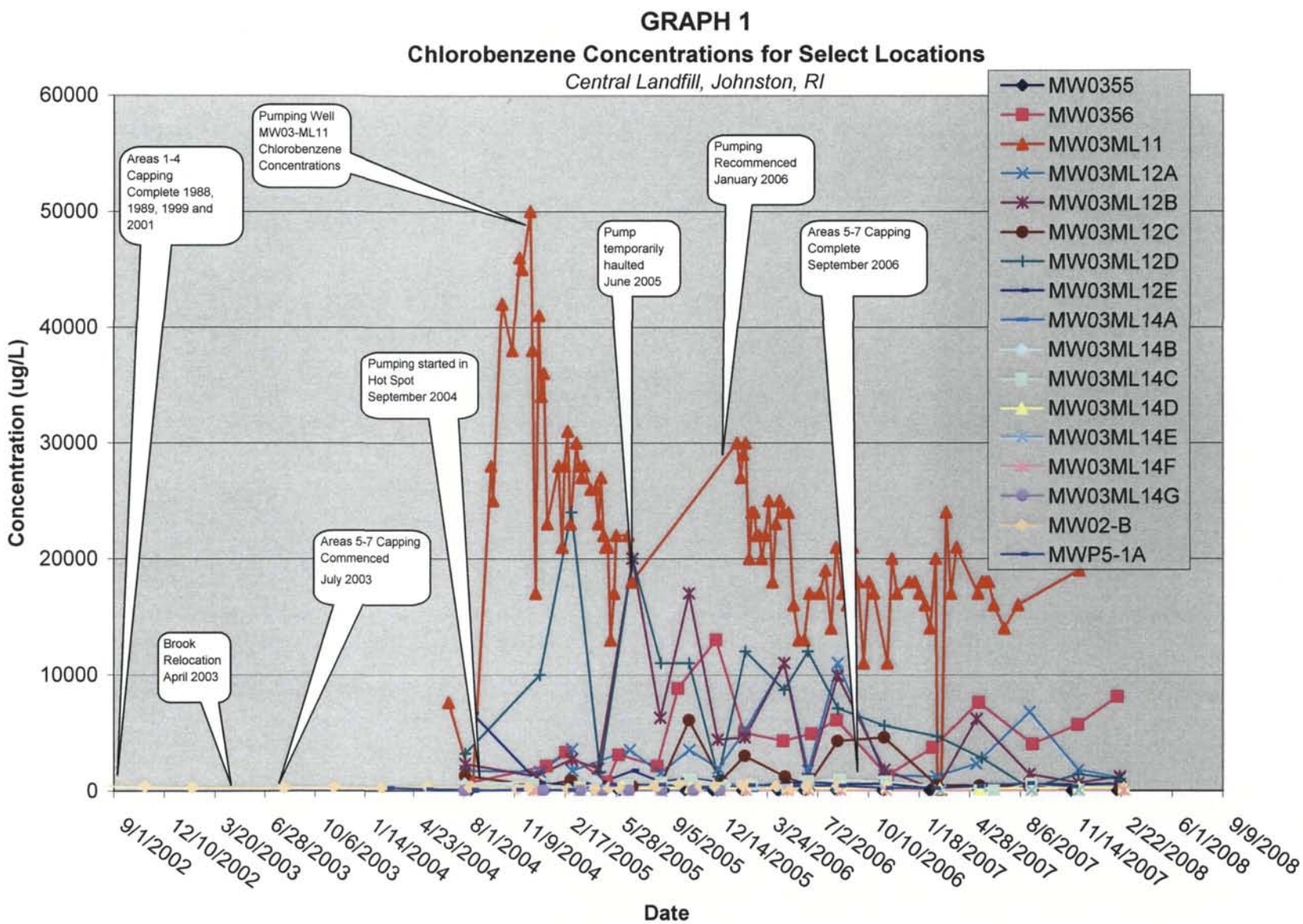
The OU1 and OU2 remedy are protective of human health. The OU1 and OU2 remedy are protective of the environment in the short-term. However, the OU1 and OU2 remedy may not be protective of the environment in the long-term since the sediment lead levels in the Upper Simmons Reservoir may present a long-term ecological risk. In addition, the current detection limits for metals in surface waters needs to be lowered to verify that the metals at this Site are not presenting a long-term ecological risk.

SECTION 11.0 - NEXT REVIEW

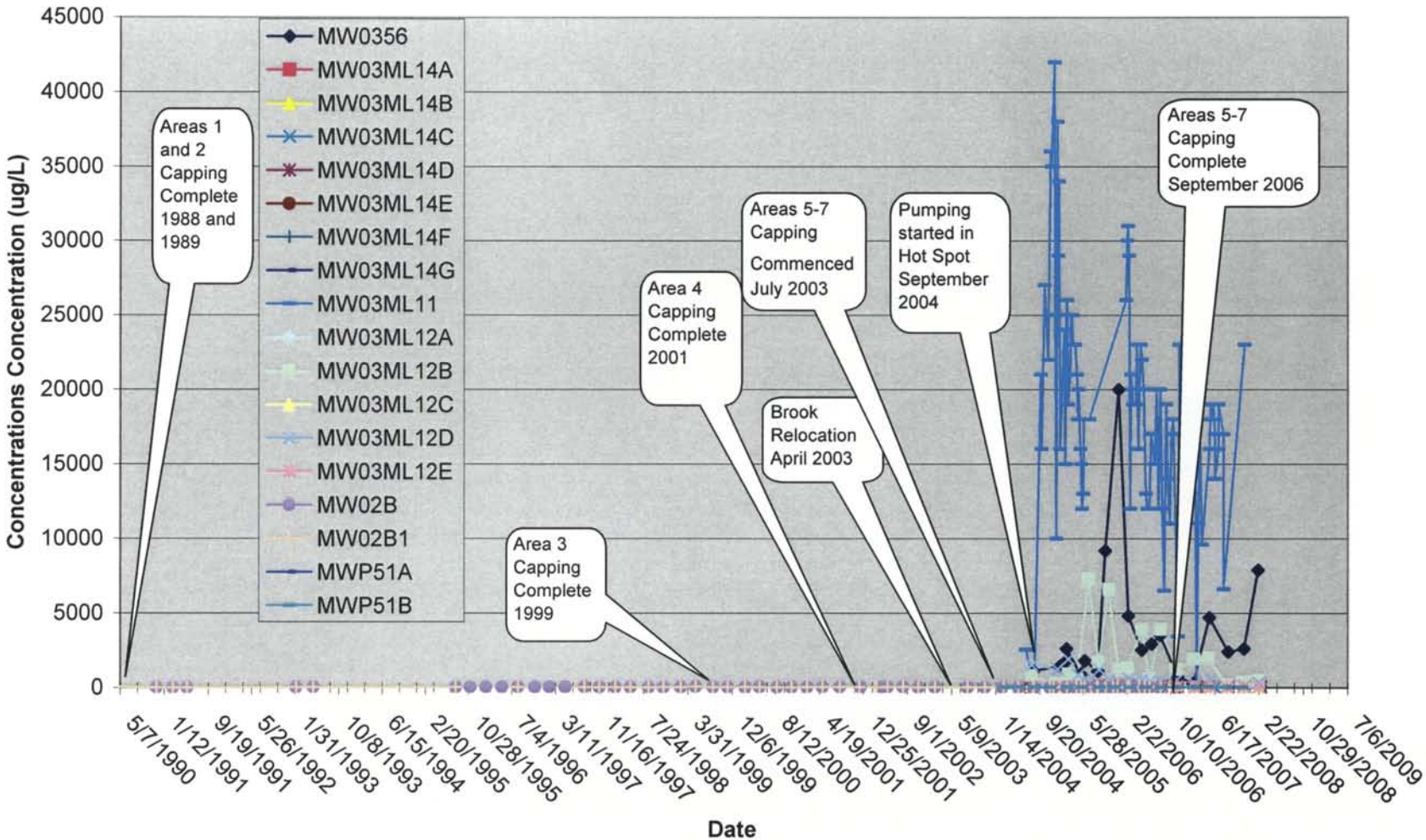
The next Five-Year Review for the Central Landfill Superfund Site is September 2013, five years from the date of this review.

Graphs

SELECT GRAPHS
GRAPHS


GRAPH 1
Chlorobenzene Concentrations for Select Locations
Central Landfill, Johnston, RI
Concentration (ug/L)
60000
50000
40000
30000
20000
10000
0
Areas 1-4 Capping Complete 1988, 1989, 1999 and 2001
Brook Relocation April 2003
Areas 5-7 Capping Commenced July 2003
Pumping started in Hot Spot September 2004
Pumping Well MW03-ML11 Chlorobenzene Concentrations
Pump temporarily haulted June 2005
Pumping Recommenced January 2006
Areas 5-7 Capping Complete September 2006
MW0355
MW0356
MW03ML11
MW03ML12A
MW03ML12B
MW03ML12C
MW03ML12D
MW03ML12E
MW03ML14A
MW03ML14B
MW03ML14C
MW03ML14D
MW03ML14E
MW03ML14F
MW03ML14G
MW02-B
MWP5-1A
9/1/2002
12/10/2002
3/20/2003
6/28/2003
10/6/2003
1/14/2004
4/23/2004
8/1/2004
11/9/2004
2/17/2005
5/28/2005
9/5/2005
12/14/2005
3/24/2006
7/2/2006
10/10/2006
1/18/2007
4/28/2007
8/6/2007
11/14/2007
2/22/2008
6/1/2008
9/9/2008
Date

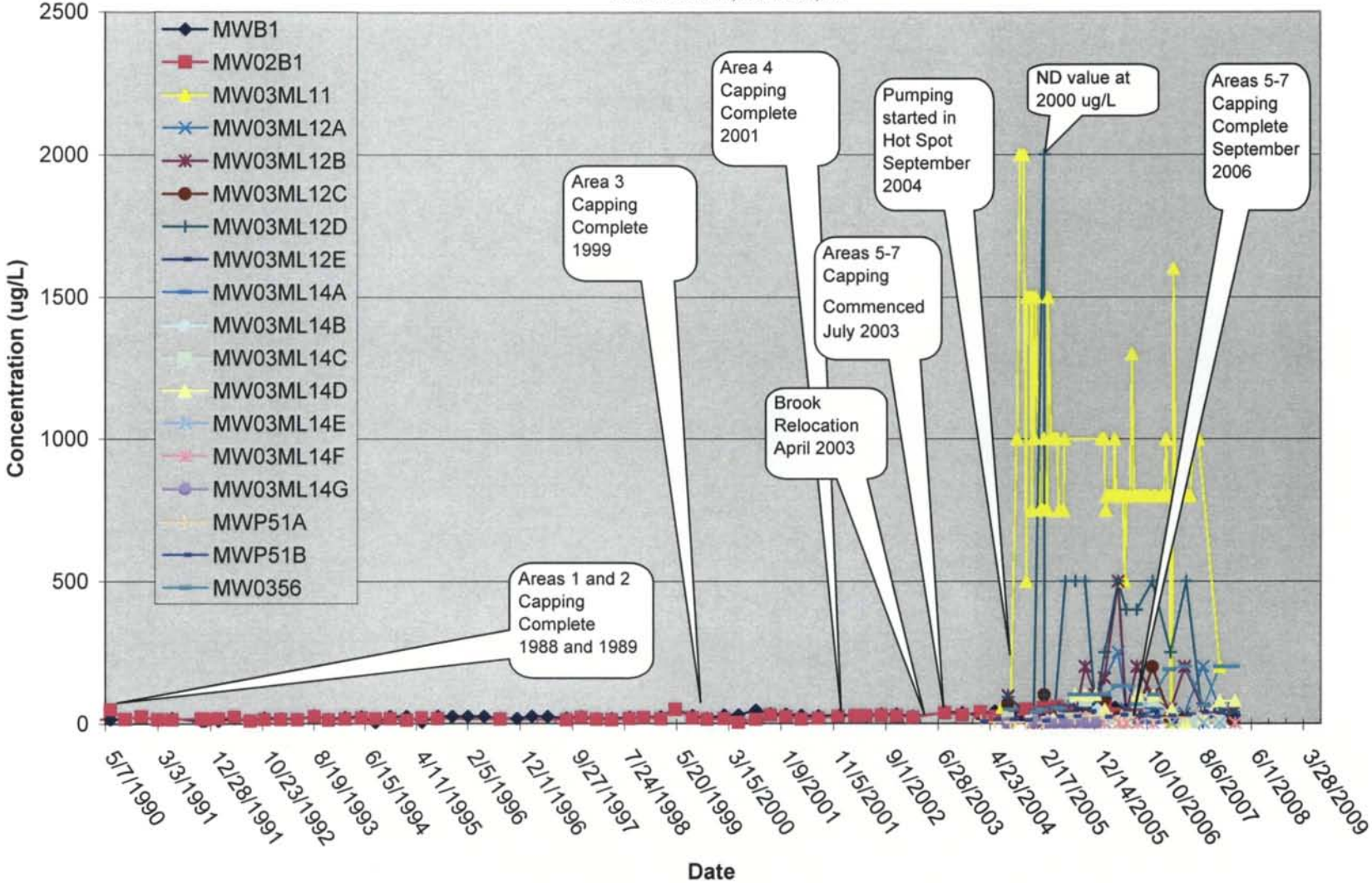
Graph 2
1,2-dichlorobenzene Concentrations for Select Wells
Central Landfill, Johnston, RI



Graph 3

Benzene Concentrations for Select Locations

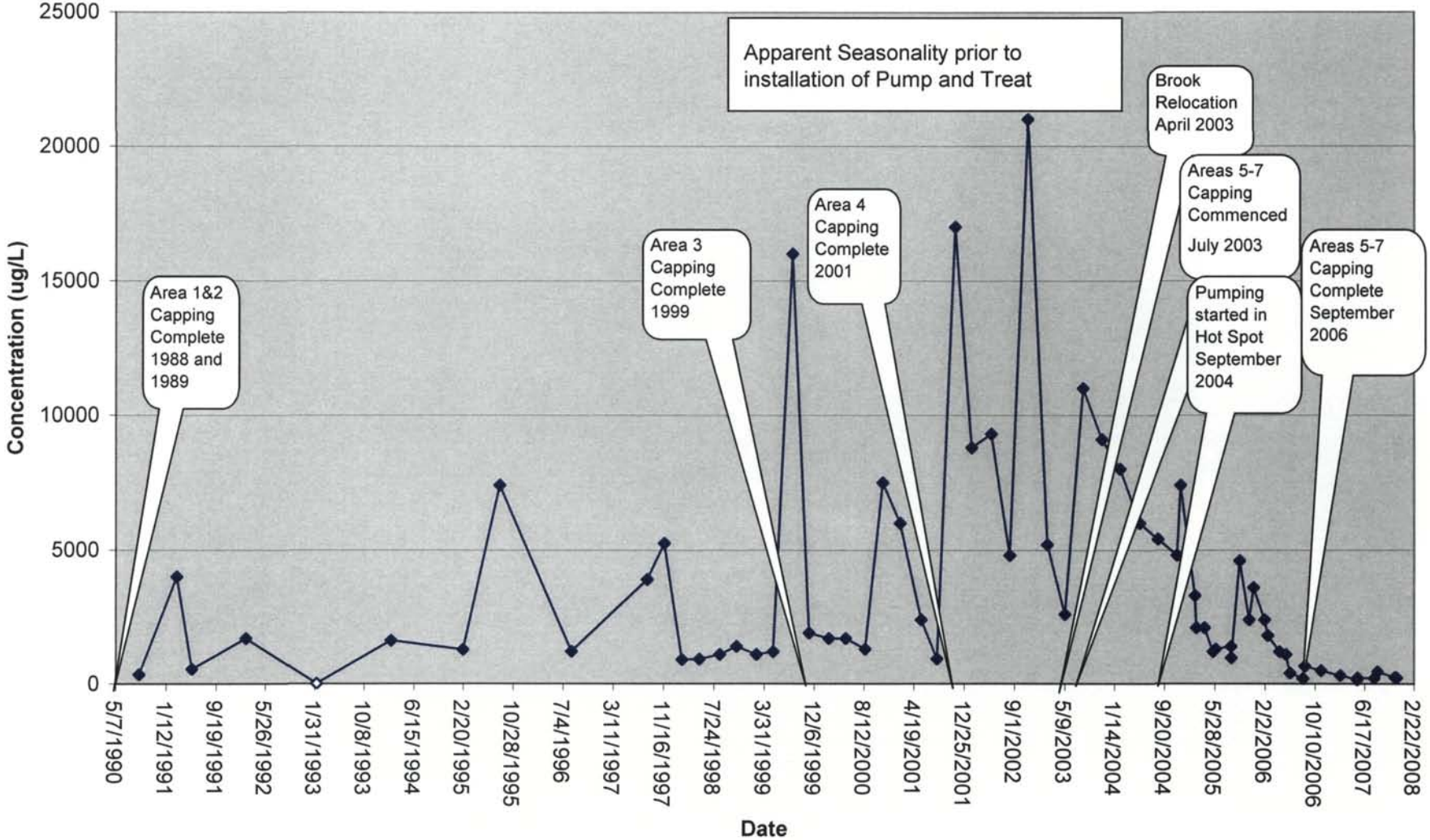
Central Landfill, Johnston, RI



GRAPH 4

Chlorobenzene Concentrations MW90-34B

Central Landfill, Johnston, RI

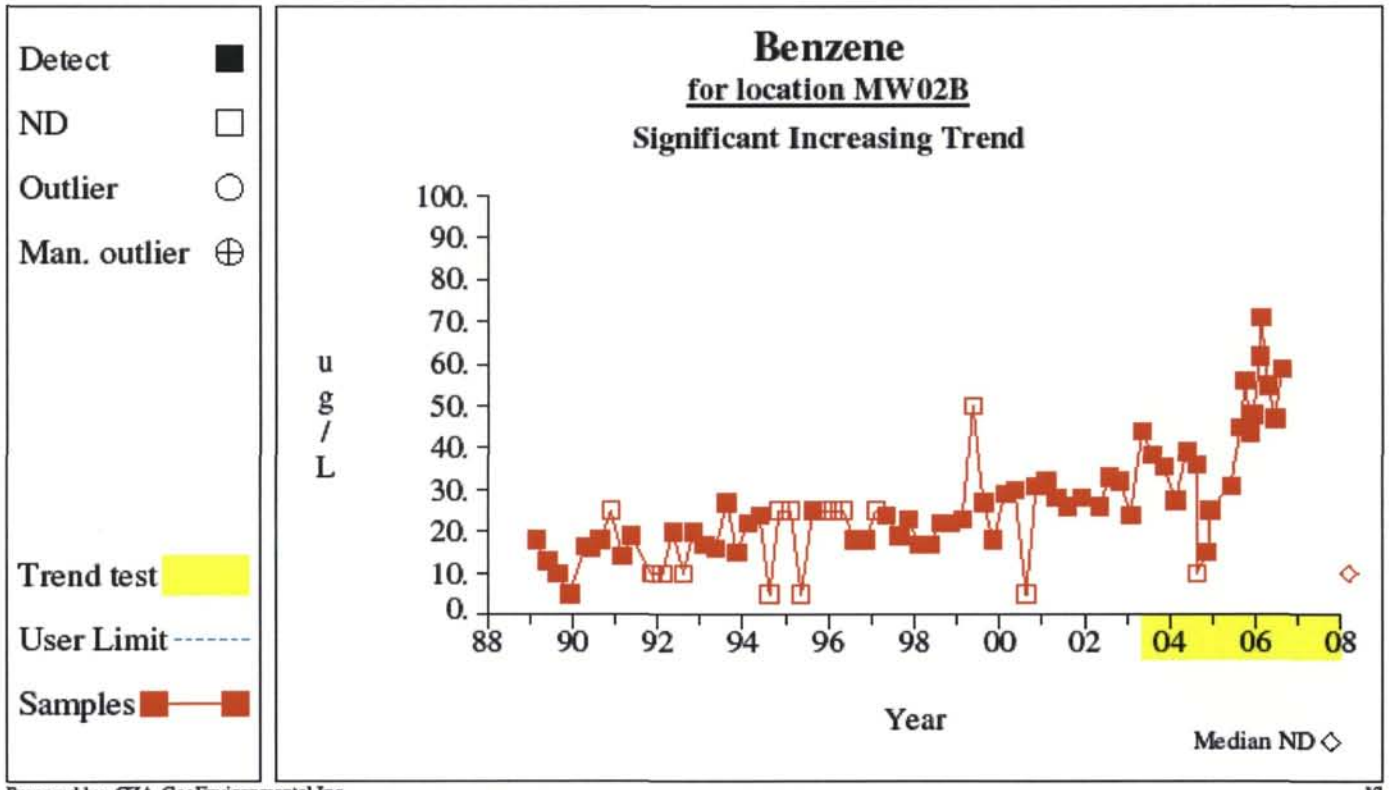


Graph 5
Benzene Concentration MW02-B
Central Landfill, Johnston, RI

CLF

Analysis prepared on: 6/6/2008

Time Series

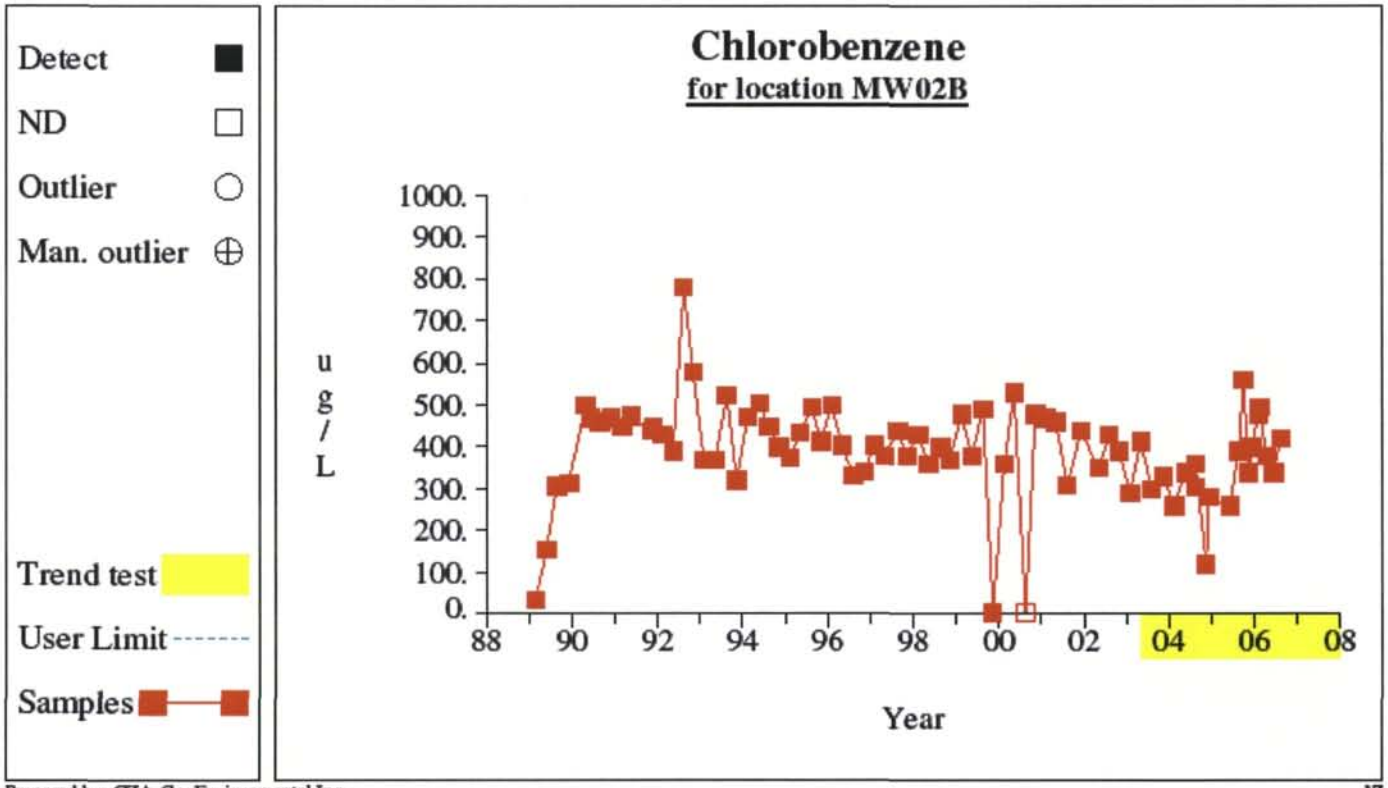


Prepared by: GZA GeoEnvironmental Inc.

CLF

Graph 6
Chlorobenzene Concentration MW02-B
Central Landfill, Johnston, RI

Analysis prepared on: 6/6/2008

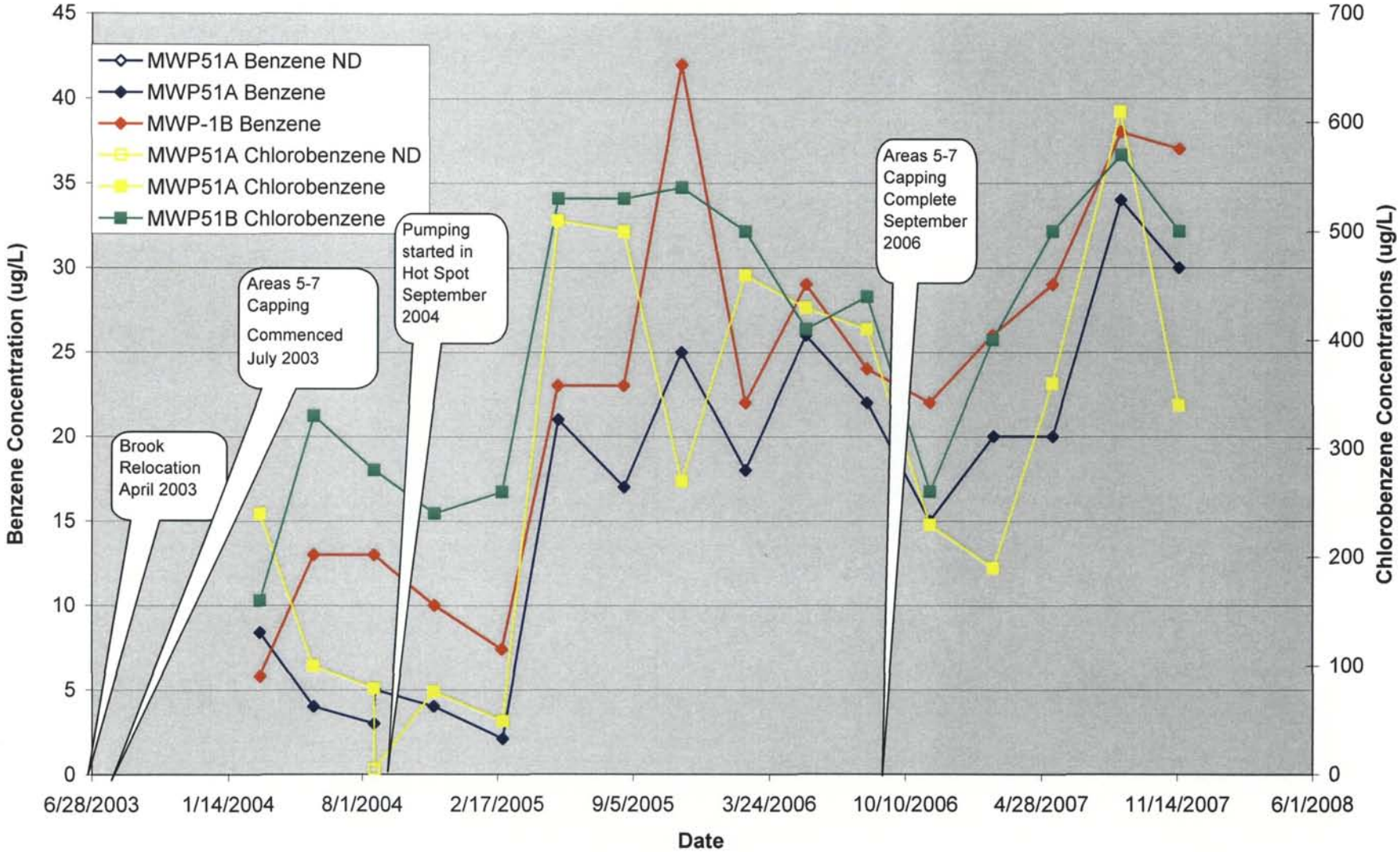


Prepared by: GZA GeoEnvironmental Inc.

Graph 6A

Benzene and Chlorobenzene Concentrations in Select Samples

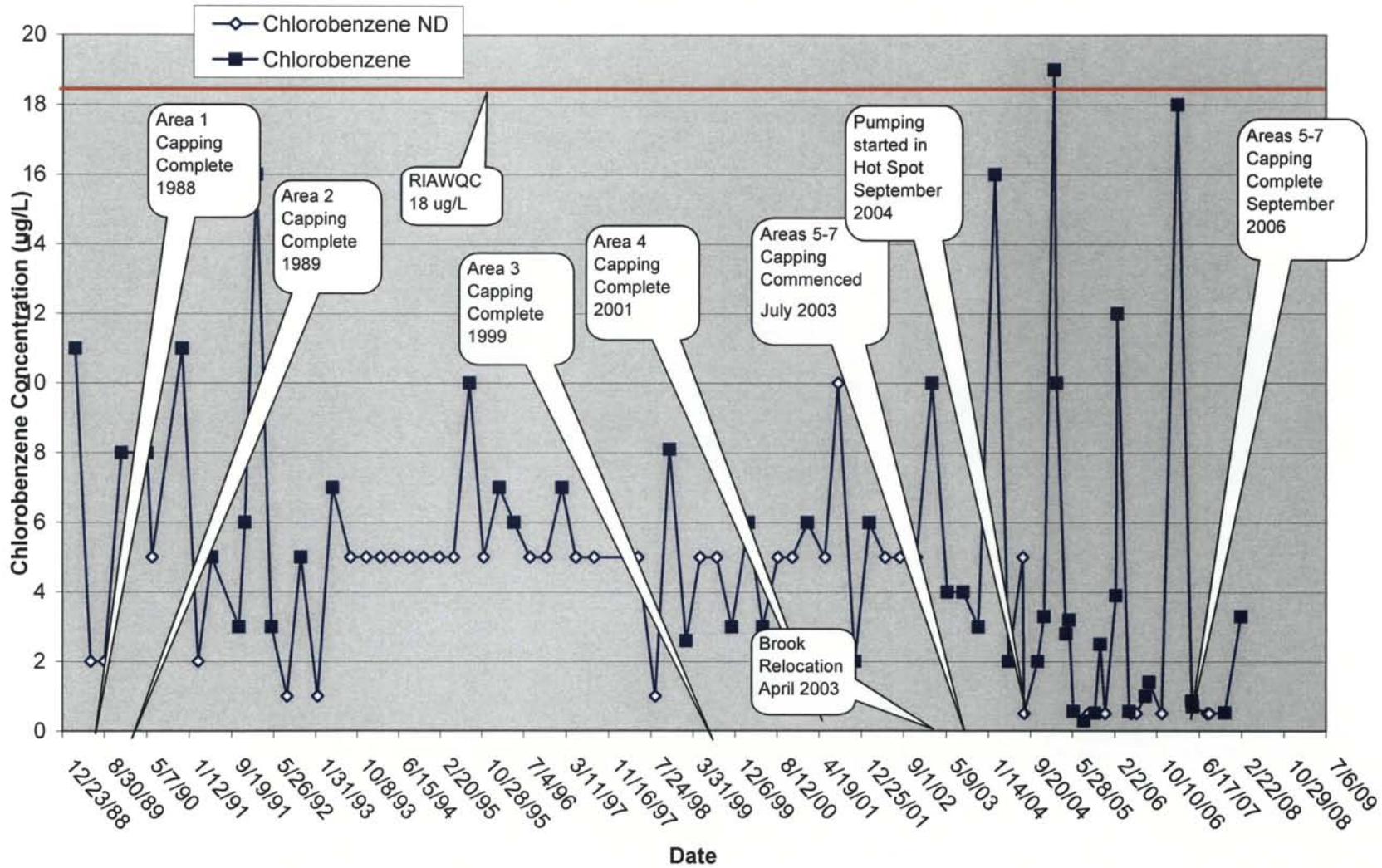
Central Landfill, Johnston, RI



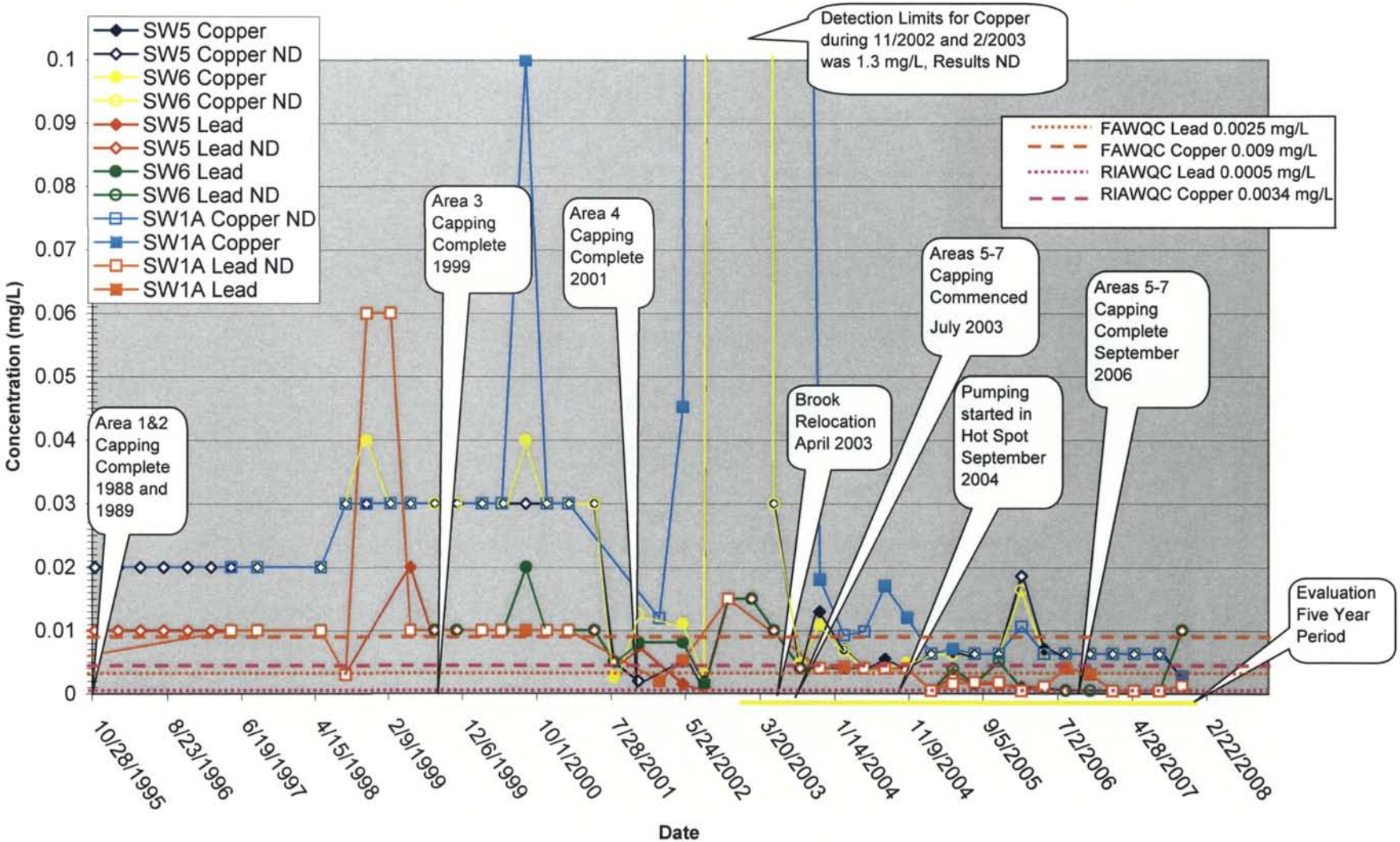
Graph 7

Chlorobenzene Concentrations SW-5

Central Landfill, Johnston, RI



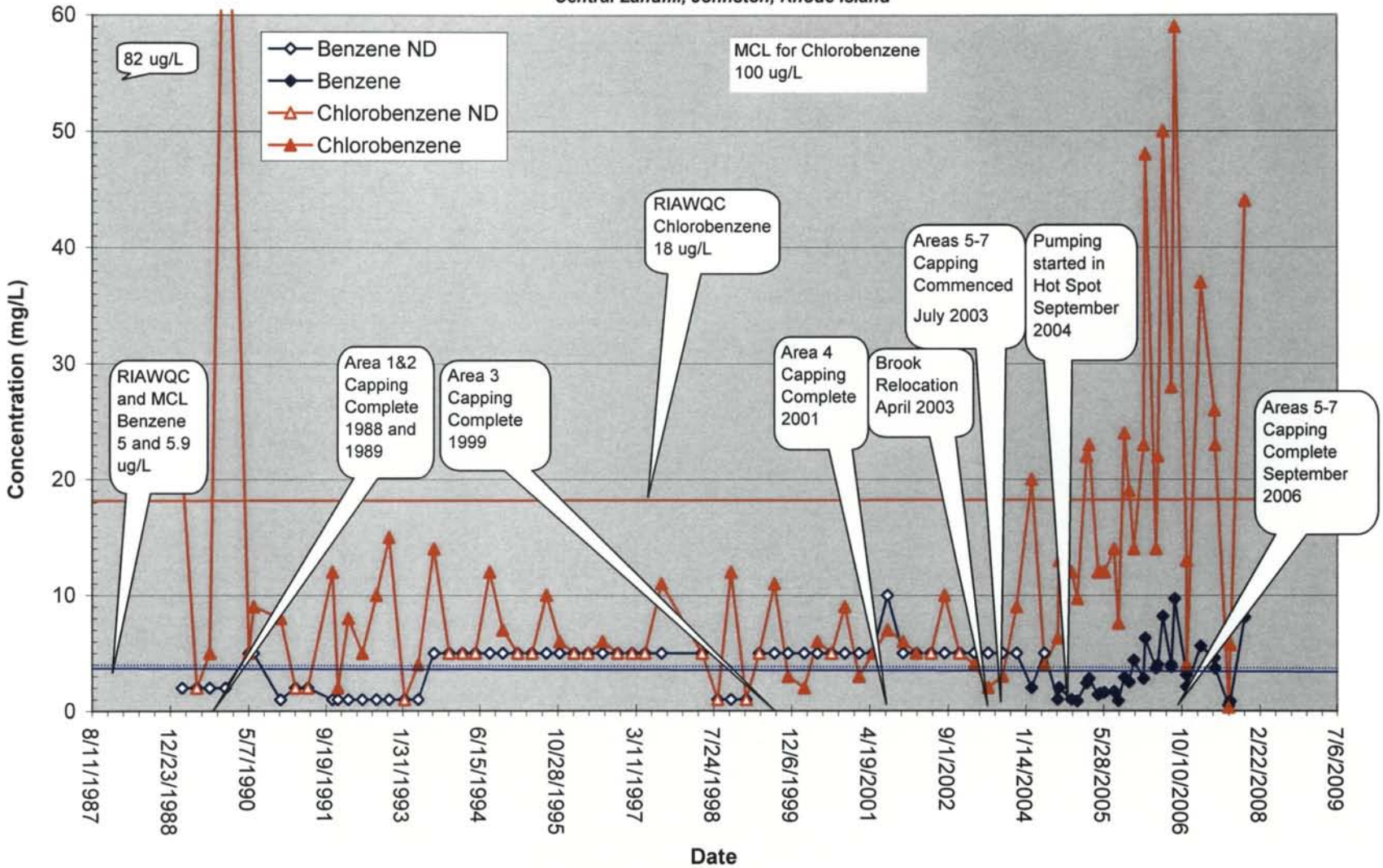
GRAPH 8
Copper and Lead Concentrations for SW-5 and SW-6
Central Landfill, Johnston, RI



GRAPH 9

Benzene and Chlorobenzene Concentrations for SW-4

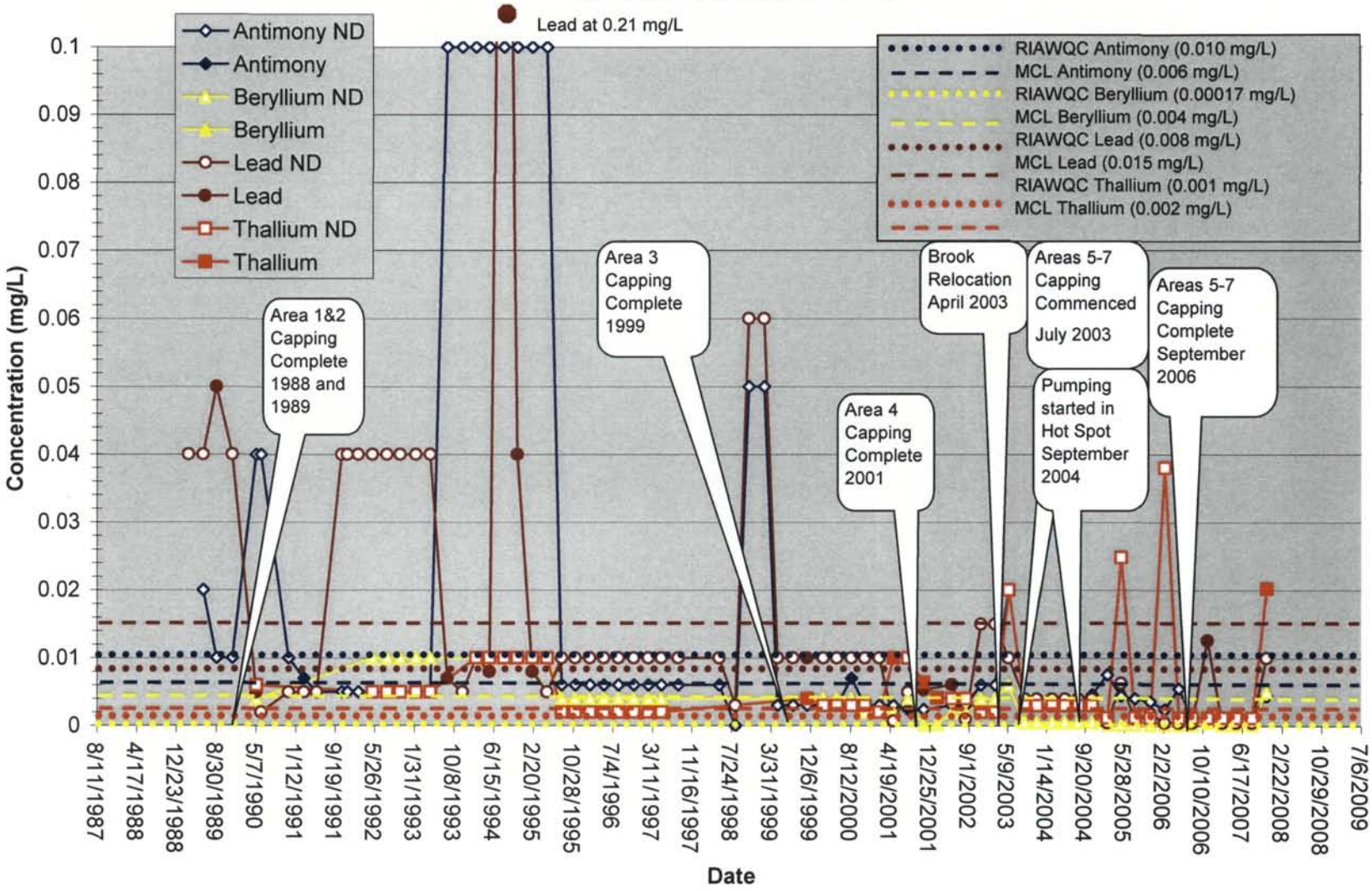
Central Landfill, Johnston, Rhode Island



GRAPH 10

Concentrations of Antimony, Beryllium, Lead and Thallium for SW-4

Central Landfill, Johnston, Rhode Island



TABLES

TABLE 4

Statistical Exceedances of Groundwater Quality Standards
Five-Year Review Report

Central Landfill, Johnston, RI

Parameter	Downgradient Locations										
Metals	**MW-O**	**MWP5-1A**	**MWP5-1B**	**MWP5-2A**	**MWP5-2B**	**MW95-47S**	**MW95-48**	**MW95-48S**	**MW02-B**	**MW02-B1**	**WE87-ML4B**
Antimony	X	X	X	X							
Arsenic (As)*											
Beryllium*	X					X	X				
Cadmium*	X	X	X			X					
Chromium*											
Lead*		X	X			X			X	X	
Thallium	X	X	X	X	X		X	X	X	X	X
Volatile Organic Compounds											
1,1,1-Trichloroethane											
1,1,2-Trichloroethane		X	X								
1,1-Dichloroethene		X	X								
1,2-Dibromo-3-chloropropane		X	X								
1,2-Dibromoethane		X	X								
1,2-Dichlorobenzene*											
1,2-Dichloroethane		X	X								
1,2-Dichloropropane		X	X								
1,4-Dichlorobenzene*											
Benzene*		X	X	X		X	X	X	X	X	
Benzo(a)pyrene											
Carbon tetrachloride*		X	X								
Chlorobenzene*		X	X					X	X	X	
Cis-1,2-dichloroethene											
Ethyl benzene											
Heptachlor epoxide		X	X								
Methylene chloride*		X	X						X	X	
Pentachlorophenol											
Styrene											
Tetrachloroethene*		X	X								
Trichloroethene*		X	X								
Vinyl chloride*		X	X								
Water Quality Parameter											
Nitrate as N											

Notes: **Red X indicates a statistically significant exceedance of federal safe drinking water maximum contaminant level (MCL).**
The * identifies contaminants of concern (COC's).

TABLE 4

Statistical Exceedances of Groundwater Quality Standards
Five-Year Review Report

Central Landfill, Johnston, RI

Parameter	Sidegradient Locations							
Metals	**MW90-31A**	**MW90-32**	**MW90-34B**	**MW95-50**	**WE02-4**	**WE87-8**	**MW02-30**	**MW90-33**
Antimony	X				X		X	
Arsenic (As)*						X		
Beryllium*	X	X	X	X	X			X
Cadmium*			X	X	X	X	X	X
Chromium*		X						
Lead*		X	X	X	X		X	
Thallium	X	X	X	X	X		X	
Volatile Organic Compounds								
1,1,1-Trichloroethane								
1,1,2-Trichloroethane								
1,1-Dichloroethene								
1,2-Dibromo-3-chloropropane								
1,2-Dibromoethane								
1,2-Dichlorobenzene*			X					
1,2-Dichloroethane								
1,2-Dichloropropane								
1,4-Dichlorobenzene*			X					
Benzene*		X	X					
Benzo(a)pyrene								
Carbon tetrachloride*								
Chlorobenzene*			X					
Cis-1,2-dichloroethene								
Ethyl benzene								
Heptachlor epoxide								
Methylene chloride*			X					
Pentachlorophenol								
Styrene								
Tetrachloroethene*			X					
Trichloroethene*			X					
Vinyl chloride*					X			
Water Quality Parameter								
Nitrate as N					X			

Notes: **Red X indicates a statistically significant exceedance of federal safe drinking water maximum contaminant level (MCL).**
The * identifies contaminants of concern (COC's).

TABLE 4

Statistical Exceedances of Groundwater Quality Standards
Five-Year Review Report

Central Landfill, Johnston, RI

Parameter	Upgradient Locations										
Metals	**MW95-51**	**MW95-52**	**MW-M**	**WE85-6B**	**WE85-16**	**WE85-18**	**WE87-ML1A**	**WE87-ML1E**	**WE87-ML3B**	**WE87-ML3D**	**WE87-ML3E**
Antimony		X									
Arsenic (As)*											
Beryllium*	X		X	X	X		X	X			
Cadmium*											
Chromium*											
Lead*						X	X	X			
Thallium	X		X	X		X	X	X	X	X	X
Volatile Organic Compounds											
1,1,1-Trichloroethane											
1,1,2-Trichloroethane											
1,1-Dichloroethene											
1,2-Dibromo-3-chloropropane											
1,2-Dibromoethane											
1,2-Dichlorobenzene*											
1,2-Dichloroethane											
1,2-Dichloropropane											
1,4-Dichlorobenzene*											
Benzene*											
Benzo(a)pyrene											
Carbon tetrachloride*											
Chlorobenzene*											
Cis-1,2-dichloroethene											
Ethyl benzene											
Heptachlor epoxide											
Methylene chloride*											
Pentachlorophenol											
Styrene											
Tetrachloroethene*											
Trichloroethene*											
Vinyl chloride*											
Water Quality Parameter											
Nitrate as N											

Notes: **Red X indicates a statistically significant exceedance of federal safe drinking water maximum contaminant level (MCL).**
The * identifies contaminants of concern (COC's).

TABLE 4

Statistical Exceedances of Groundwater Quality Standards
Five-Year Review Report

Central Landfill, Johnston, RI

Parameter	Plume Centerline Locations									
Metals	MW03-55	MW03-56	MW03-ML11	MW03-ML12A	MW03-ML12B	MW03-ML12C	MW03-ML12D	MW03-ML12E	MW03-ML13D	MW03-ML14B
Antimony										
Arsenic (As)*										
Beryllium*										
Cadmium*										
Chromium*										
Lead*										
Thallium										
Volatile Organic Compounds										
1,1,1-Trichloroethane		X								
1,1,2-Trichloroethane		X								
1,1-Dichloroethene		X								
1,2-Dibromo-3-chloropropane										
1,2-Dibromoethane		X								
1,2-Dichlorobenzene*		X	X		X					
1,2-Dichloroethane			X							
1,2-Dichloropropane		X								
1,4-Dichlorobenzene*		X	X	X	X					
Benzene*	X	X	X	X	X	X		X		X
Benzo(a)pyrene									X	
Carbon tetrachloride*										
Chlorobenzene*		X	X	X	X	X	X	X	X	X
Cis-1,2-dichloroethene		X					X			X
Ethyl benzene		X								
Heptachlor epoxide										
Methylene chloride*		X	X	X		X	X	X		
Pentachlorophenol		X			X					
Styrene		X								
Tetrachloroethene*		X	X		X		X			
Trichloroethene*		X	X				X			X
Vinyl chloride*			X		X		X			X
Water Quality Parameter										
Nitrate as N										

TABLE 4

Statistical Exceedances of Groundwater Quality Standards
Five-Year Review Report

Central Landfill, Johnston, RI

Parameter	Plume Centerline Locations				
Metals	**MW03-ML14C**	**MW03-ML14D**	**MW03-ML14E**	**MW03-ML14F**	**MW03-ML14G**
Antimony					
Arsenic (As)*					
Beryllium*					
Cadmium*					
Chromium*					
Lead*					
Thallium					
Volatile Organic Compounds					
1,1,1-Trichloroethane					
1,1,2-Trichloroethane					
1,1-Dichloroethene		X			
1,2-Dibromo-3-chloropropane					
1,2-Dibromoethane					
1,2-Dichlorobenzene*					
1,2-Dichloroethane					
1,2-Dichloropropane					
1,4-Dichlorobenzene*					
Benzene*	X	X		X	
Benzo(a)pyrene					
Carbon tetrachloride*					
Chlorobenzene*	X	X		X	
Cis-1,2-dichloroethene	X	X	X	X	X
Ethyl benzene					
Heptachlor epoxide					
Methylene chloride*	X	X			
Pentachlorophenol					
Styrene					
Tetrachloroethene*					
Trichloroethene*	X	X	X	X	X
Vinyl chloride*	X	X	X	X	X
Water Quality Parameter					
Nitrate as N					

TABLE 5

Groundwater Trend Tests for Statistically Significant Exceedances
Five-Year Review Report
Central Landfill, Johnston, RI

	Significantly Decreasing Trend																	
	Plume Centerline						Downgradient				Sidegradient					Upgradient		
Parameter	MW03-ML11	MW03-ML12B	MW03-ML12C	MW03-ML12D	MW03-ML12E	MW03-ML14C	MW95-47S	MW95-48S	MWP5-1B	MW99-29BR	MW90-31A	MW90-32	MW90-34B	MW-O	WE02-4	MW03-55	MW90-30	MW95-51
1,2-Dichlorobenzene	x												x					
1,4-Dichlorobenzene	x									x			x					
Benzene																		
Chlorobenzene	x									x			x					
Naphthalene		x	x	x	x								x					
2-Chlorophenol		x		x														
2-Methylnaphthene				x														
Phenanthrene																		
Beryllium													x					x
Iron	x								x								x	
Manganese						x	x											
Zinc											x				x			
Ammonia												x		x				
Chemical Oxygen Demand (COD)													x					
Chloride								x					x		x			
Nitrate											x				x			x
Specific Conductance																		
Sulfate																		
Total Dissolved Solids (TDS)																		
Total Organic Carbon (TOC)		x		x							x		x		x	x		x

Note: A total of 2,404 Time Series Plots were evaluated.

TABLE 5

Groundwater Trend Tests for Statistically Significant Exceedances
Five-Year Review Report
Central Landfill, Johnston, RI

	Significantly Increasing Trend														
	Plume Centerline			Downgradient								Sidegradient			
Parameter	MW03-56	MW03-ML14A	MW03-ML14D	MW02-B	MW02-B1	WE87-ML4B	MW95-ML9A	MWP5-1A	MWP5-1B	MWP5-2A	MW95-48	MW90-32	WE85-6B	MW90-34B	MW-O
1,2-Dichlorobenzene															
1,4-Dichlorobenzene															
Benzene				x					x						
Chlorobenzene										x					
Naphthalene	x														
2-Chlorophenol															
2-Methylnaphthene															
Phenanthrene		x													
Beryllium															
Iron					x										
Manganese			x			x									
Zinc												x	x		
Ammonia									x						
Chemical Oxygen Demand (COD)								x	x						
Chloride							x	x	x		x		x		x
Nitrate															
Specific Conductance			x												
Sulfate														x	
Total Dissolved Solids (TDS)															
Total Organic Carbon (TOC)								x	x						x

Note: A total of 2,404 Time Series Plots were evaluated.

TABLE 6

Surface Water Exceedances of FAWQC and RIAWQC
Five-Year Review Report
Central Landfill, Johnston, RI

Location	Surfacewater - Exceedances of FAWQC/RIAWQC									
	VOC		WQP		Inorganic Parameters					
	Chlorobenzene		Ammonia as N		Aluminum		Antimony		Beryllium	
Regulatory Standard	RIAWQC	FAWQC	RIAWQC	FAWQC	RIAWQC	FAWQC	RIAWQC	FAWQC	RIAWQC	FAWQC
SW-1A					x		x		x	
SW-1B									x	
SW-5	x		x		x				x	
SW-6										
SW-7									x	
SW-A									x	
SW-B									x	
SW-C									x	

1. **Red X indicates a Statically Significant exceedance of Regulatory Criteria as Identified by CARStat.**
2. RIAWQC is the Rhode Island Ambient Water Quality Criteria
3. FAWQC is the Federal Ambient Water Quality Criteria

TABLE 6

Surface Water Exceedances of FAWQC and RIAWQC
Five-Year Review Report
Central Landfill, Johnston, RI

Location	Surfacewater - Exceedances of FAWQC/RIAWQC															
	Inorganic Parameters															
	Copper		Iron		Lead		Nickel		Selenium		Silver		Thallium		Zinc	
Regulatory Standard	RIAWQC	FAWQC	RIAWQC	FAWQC	RIAWQC	FAWQC	RIAWQC	FAWQC	RIAWQC	FAWQC	RIAWQC	FAWQC	RIAWQC	FAWQC	RIAWQC	FAWQC
SW-1A	x	x			x	x	x				x					
SW-1B	x		x		x	x										
SW-5	x	x	x		x	x			x	x	x	x	x		x	x
SW-6	x	x	x								x		x		x	
SW-7	x				x	x					x					
SW-A	x		x		x											
SW-B	x		x		x						x					
SW-C	x		x		x											

1. Red X indicates a Statically Signifi
2. RIAWQC is the Rhode Island Ambie
3. FAWQC is the Federal Ambient Wat

TABLE 7

Surfacewater Trend Test Results for Statistically Significant Exceedances of FAWQC
Five-Year Review Report
Central Landfill, Johnston, RI

Parameter	Significantly Decreasing Trend	Significantly Increasing Trend
Chemical Oxygen Demand	NONE	SW-6
Sulfate	NONE	SW-6

Note: A total of 448 Time Series Plots were evaluated.

TABLE 8

PHASE V STONE TRENCH DISCHARGE (SW-4)
WATER QUALITY DATA STATISTICS

Central Landfill Johnston, RI

		Federal Safe Drinking Water Standard		State and Federal Water Quality Criteria (Aquatic Life)			
Class	Parameter	MCL (ug/L)	Exceedance	RIAWQC (ug/L)	Exceedance	FAWQC (ug/L)	Exceedance
VOCs	1,2-Dichlorobenzene*	600		1.8	X	-	
	1,4-Dichlorobenzene*	75		1.2	X	-	
	Benzene*	5	X	10	X	-	
	Chlorobenzene*	100		5.9	X	-	
	Napthalene*	-		0.17	X	-	
Metals	Antimony	6	X	0.369	X	-	
	Aluminium	-		0.79	X	-	
	Beryllium*	4	X	2.6	X	-	
	Cadmium*	5		87	X	0.25	X
	Copper	1300		2.7	X	9.0	X
	Iron	-		1	X	-	
	Lead*	15	X	0.54	X	2.5	X
	Mercury*	2		0.0122	X	0.77	
	Nickel*	-		48	X	52	X
	Selenium	5		5	X	5.0	X
	Silver	-		0.32	X	-	X
	Thallium	2	X	1	X	-	
	Zinc	-		32.3	X	120	X
WQPs	Ammonia as N	2		36.1	X	-	

Notes:
1. Of the 220 sampled constituents, these 19 parameters exceeded one or more of the indicated criteria.
2. * indicated OU1 constituent of concern.
3. X indicates a statistically significant exceedances.
4. MCL indicates Maximum Contaminant Level.
5. RIAWQC refers to the Rhode Island Ambient Water Quality Criteria.
6. FAWQC refers to the Federal Ambient Water Quality Criteria.

Attachments for this Five-Year Review are available by placing a request using the Customized CERCLIS/RODS Report Order Form.

http://www.epa.gov/superfund/sites/phonefax/rods.htm