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FIVE-YEAR REVIEW REPORT FOR WESTERN SAND AND GRAVEL SUPERFUND SITE PROVIDENCE COUNTY, RHODE ISLAND

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Prepared by

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Region 1
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Date

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EXECUTIVE SUMMARY

The purpose of this five-year review is to determine whether the remedial actions at the Western Sand & Gravel site, located primarily in Burrillville, and partially in North Smithfield, Providence County, Rhode Island (the Site) are protective of human health and the environment and functioning as designed. This five-year review is for the entire Site (OU-I, OU-II and OU-III). The United States Environmental Protection Agency (EPA), Region I, conducted this review pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 122(a), NCP Section 300.400(f)(4)(ii), and OSWER Directive 9355.7-03B-P (June 2001). It is a statutory review. This is the fifth five-year review for the Site covering the years 2008 through 2013.

The Site was a sand and gravel quarry operation from 1953 until 1975. From 1975 to April 1979, a portion of the Site was used for the disposal of liquid wastes including chemicals and septic waste. Unpermitted wastes were disposed of at the Site and over time, some of the wastes penetrated the porous soil and contaminated the groundwater. In 1979, hazardous wastes were no longer accepted at the Site, and in March 1980 EPA conducted a removal action at the Site during which approximately 60,000 gallons of VOC-contaminated liquids were pumped from lagoons. From 1982 to 1989 the Rhode Island Department of Environmental Management (RIDEM) operated a groundwater recirculation system in an effort to control the spread of groundwater contamination. In September 1983, the EPA added the Site to the CERCLA National Priorities List (NPL).

EPA has issued three Records of Decision (ROD) for this Site. Under the first ROD (1984), water filters were installed on private wells until a permanent water supply system was constructed to serve the affected area (approximately 56 parcels) in 1992. The second ROD (1985) addressed contaminated soils at the Site. Contaminated soils were excavated and consolidated in a designated area within the Site. A RCRA Subtitle C cap (the cap) was installed over a two-acre soil disposal area in 1987. An area of approximately six acres was graded (including the area currently occupied by the cap) and it was fenced and posted with warning signs. Post-closure monitoring and inspections of this fenced Site area is ongoing. EPA issued the third ROD in 1991 to address groundwater contamination. The groundwater remedy selected for the Site consists of natural attenuation until interim cleanup levels have been met, Site monitoring and Institutional Controls (ICs). In addition, the 1991 ROD includes a contingency remedy for active remediation, which takes effect in the event that natural attenuation does not occur at the predicted rate or if one or more of three other scenarios, as laid out in the 1992 Consent Decree (CD) occur.

The assessment of this five-year review found that the remedies continue to function as designed. The water supply system is operated and maintained safely. The landfill cap is in excellent condition and is being well maintained. Finally, the groundwater data collected as part of OU-III indicates that natural attenuation is progressing and there is no need to consider active remediation at this time. Because the remedial actions at all the Operable Units (I, II, and III) at the Western Sand and Gravel Site are protective, the Site is protective of human health and the environment.

Five-Year Review Summary Form

SITE IDENTIFICATION		
Site Name: Western Sand & Gravel		
EPA ID: RID009764929		
Region: 1	**State:** RI	**City/County:** Burrillville and N. Smithfield, Providence County

SITE STATUS	
NPL Status: Final	
Multiple OUs? Yes	**Has the site achieved construction completion?** Yes

REVIEW STATUS
Lead agency: EPA
Author name (Federal or State Project Manager): Gerardo Millán-Ramos
Author affiliation: U.S. EPA, Region 1 - New England
Review period: November 14, 2012 - September 25, 2013
Date of site inspection: September 6, 2012.
Type of review: Statutory
Review number: 5
Triggering action date: 09/25/2008
Due date *(five years after triggering action date)*: 09/25/2013

Issues/Recommendations

OU(s) without Issues/Recommendations Identified in the Five-Year Review:
OU-I and OU-II.

Issues and Recommendations Identified in the Five-Year Review:	
OU(s): OU-3	**Issue Category:** Monitoring
	Issue: It is unknown whether or not 1,4-dioxane exists in groundwater at the Site.
	Recommendation: Design and implement a sampling plan to answer: 1. whether 1,4-dioxane is present at the site at levels meeting or exceeding the EPA Federal guideline (0.67 µg/L); 2. whether it is attributable to the site (i.e. whether it should be identified as a COC; and 3. what impact if any will its presence have on the projected timeframe for natural attenuation to be achieved.

Affect Current Protectiveness	Affect Future Protectiveness	Implementing Party	Oversight Party	Milestone Date
No	Yes	PRP	EPA	9/30/2014

Protectiveness Statement(s)

Include each individual OU protectiveness determination and statement. If you need to add more protectiveness determinations and statements for additional OUs, copy and paste the table below as many times as necessary to complete for each OU evaluated in the FYR report.

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
OU-I	Protective	n/a

Protectiveness Statement:
OU-I involved the construction of a water supply system to provide residents in the affected area with a permanent supply of safe drinking water. The water supply system has been in operation since September 1994. The remedy at OU-I is protective of human health and the environment.

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
OU-II	Protective	n/a

Protectiveness Statement:
OU-II involved the consolidation of contaminated soils to the cap area and construction of an impermeable barrier over the consolidated contaminated soils. The OU-II remedy continues to minimize the continued release of contaminants to the groundwater and prevents public exposure to the contaminated soils. The remedy at OU-II is protective of human health and the environment.

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
OU-III	Protective	n/a

Protectiveness Statement:
OU- III relies on natural attenuation of the contaminated groundwater (with a contingency for active remediation), Site monitoring (including groundwater monitoring), and ICs to prevent the use of groundwater in the affected area. As evidenced by the concentration trends of the four indicator compounds and the statistical analysis performed as recently reviewed, natural attenuation is taking place and, at this time, there is no need for active remediation. The remedy at OU-III is expected to be protective upon completion and in the interim, exposure pathways that could result in unacceptable risks are being prevented by ICs and the availability of a public water supply system in the area. Thus, the remedy at OU-III is protective of human health and the environment.

Sitewide Protectiveness Statement (if applicable)

For sites that have achieved construction completion, enter a sitewide protectiveness determination and statement.

Protectiveness Determination:	*Addendum Due Date (if applicable):*
Protective	*n/a*

Protectiveness Statement:
Overall, because the remedial actions at all OUs at the Western Sand and Gravel Site are protective, the Site is protective of human health and the environment.

1.0 INTRODUCTION

The purpose of the five-year review is to determine whether the remedies at a site are protective of human health and the environment. The methods, findings, and conclusions of reviews are documented in Five-Year Review reports. In addition, Five-Year Review reports identify issues found during the review, if any, and identify recommendations to address them.

The Agency is preparing this Five-Year Review report pursuant to the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) §121 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 5 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 Agency interpreted this requirement further in the NCP; 40 CFR §300.430(f)(4)(ii) 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 United States Environmental Protection Agency, Region 1 (EPA), conducted this five-year review of the remedial actions implemented at the Western Sand and Gravel (WS&G) Site (hereinafter referred to as the Site), located on Douglas Pike (also known as Route 7), on the boundary of Burrillville and North Smithfield, in Providence County, Rhode Island. This review was conducted in accordance with OSWER Directive 9355.7-03B-P, "Comprehensive Five-Year Review Guidance" (June 2001); OSWER Memorandum 9200.2-111, and "Clarifying the Use of Protectiveness Determinations for Comprehensive Environmental Response, Compensation, and Liability Act Five Year Reviews" (September 2012).

This is the fifth five-year review for the Site. The triggering action for this statutory review was the approval date of the 2008 Five-Year Review Report. The five-year review is required due to the fact that hazardous substances, pollutants, or contaminants remain at the Site above levels that allow for unlimited use and unrestricted exposure.

2.0 SITE CHRONOLOGY

The chronology of significant Site events and dates is included in Table 1.

Table 1 - Chronology of Site Events

Event	Date
Site operated as a sand and gravel quarry.	1953 to 1979
Approximately 12 acres of the Site used for disposal of liquid wastes.	1975 to 1979
Joint meeting of Burrillville and North Smithfield Town Councils to discuss concerns about Western Sand and Gravel Site.	January 1979
RI Department of Health begins sampling of nearby wells.	February 1979
RIDEM sends Western Sand and Gravel a Notice of Violation for violation of water and air pollution regulations, odors and for failing to prepare complete and accurate industrial waste manifests.	February 1979
RIDEM issues a Cease and Desist Order.	April 24, 1979
Under Consent Agreement with the Rhode Island Department of Environmental Management (RIDEM) six groundwater monitoring wells were installed and sampled. They tested positive for toluene, xylene, chloroform, 1,1,1-trichloroethane, trichloroethene, tetrachloroethene, and dichloromethane.	November 1979
RIDEM issues a Consent Decree (CD), a Show Cause Order on Closure, and a Final Closure Order for pumping chemical wastes from the lagoons.	November 1979
EPA pumps out the lagoons.	March 1980
RIDEM installs a groundwater re-circulation system.	November 1982
Final Listing of the Site on the National Priorities List (NPL).	September 8, 1983
OU-I Remedial Investigation/Feasibility Study (RI/FS) Complete	September 28, 1984
OU-I Final Record of Decision (ROD) (Waterline)	September 28, 1984
OU-II RI/FS Complete.	September 30, 1985
OU-II Final ROD (Capping)	September 30, 1985
Approximately 45 Potential Responsible Parties (PRPs) entered into a CD to pay EPA for the estimated cost of the waterline construction and perform all the other activities required in the OU-I and OU-II RODs.	June 5, 1987
OU-II Remedial Design Complete.	June 12, 1987
OU-I Remedial Design Complete.	March 29, 1989

Event	Date
OU-III RI/FS Complete.	April 16, 1991
OU-III – Final ROD (natural attenuation w/ contingency for active remediation).	April 16, 1991
Five PRPs enter into a CD to perform OU-III remedy.	February 21,1992
Administrative Settlement with one PRP that failed to join the 1992 CD.	August 11, 1992
Preliminary Close-Out Report / Construction Complete Milestone.	December 22,1992
First Five Year Review.	December 23, 1992
OU-III Natural Attenuation Design Complete.	February 1, 1993
OU-I Remedial Action Report	September 1, 1994
OU-I Remedial Action Complete.	September 26, 1994
Second Five Year Review.	July 9, 1998
Prospective Purchaser Agreement with Supreme Mid-Atlantic Corporation.	October 2001
Third Five Year Review.	September 26, 2003
Fourth Five Year Review.	September 26, 2008

3.0 BACKGROUND

3.1 Physical Characteristics

The Site is located on the boundary of Burrillville and North Smithfield, in Providence County, Rhode Island. A map depicting the general location of the Site is provided in the Site vicinity map of Appendix A. The Site consists of approximately 25 acres of land and is located in an area generally described as being semi-rural. The general layout of the Site is shown on the Base Map in **Appendix A**.

The Site is located over the Slatersville Aquifer that has been designated as a drinking water source by the State of Rhode Island. Other potentially environmentally sensitive areas near the Site include Tarkiln Brook and the Slatersville Reservoir, both of which are classified as Class B water bodies. According to the Rhode Island Water Quality Standards, Class B water bodies are suitable for fishing, swimming, and other recreational purposes. There is also a wetland area near the Site that borders Tarkiln Brook. Groundwater flow throughout this five-year review period has been generally to the north, with groundwater ultimately discharging into Tarkiln Brook and the Slatersville Reservoir.

Residential areas are located to the west and north of the Site, with the nearest residence being

approximately 1,000feet northwest of the Site. No residential or commercial structure lies within 100 feet vertically or laterally from the plume of groundwater contamination, thus no vapor intrusion issues are suspected.

3.2 Land and Resource Use

The Site was operated as a sand and gravel quarry from 1953 until 1979. From 1975 to April 1979, a portion of the Site was used for the disposal of liquid wastes including chemicals and septic waste. Contents of tank trucks were emptied directly into open lagoons and pits, none of which were lined with protective materials. Over time, some of the wastes penetrated the porous soil and contaminated the groundwater.

In October 2001, a Prospective Purchaser Agreement between EPA – Region 1 (New England) and Supreme Mid-Atlantic Corporation (Supreme) was signed. Supreme purchased the entire 25-acre Site. Prior to construction of the Mid Atlantic Supreme Assemble Building, test pits were excavated to investigate lagoons which were allegedly located in this area, and a monitoring well was sampled. Dark colored soil was found and the concentrations of organics and inorganics exceeded residential and/or industrial criteria. Also elevated levels of inorganics were found in the monitoring well. The planned layout of the industrial complex, the existing ICs and the language associated with the redevelopment of the site were found sufficient to address these issues.

The use of the fenced portion of the Site (approximately 6 acres), the rest of the Site, and the use of the groundwater within the Site, is limited by the implementation of all necessary ICs. The following is a list of the ICs (for both land and groundwater) currently in place at the Site:

1. Declaration of the Restrictions and Protective Covenants Imposed Upon the So-called Western Sand & Gravel Hazardous Disposal Site. Executed on April 23, 1986, before Notary Public in Providence Rhode Island. This IC prevents the use of or any activity on the Remedial Action Area (the fenced six acres), or on any portion of the Site which shall disturb the integrity or effectiveness of the final cover, liner(s), or any other components of any containment system relating to the Remedial Action Area, or the function of monitoring systems relating to the Remedial Action Area. It also prevents any use of the groundwater under the Site which may adversely affect either the quantity or quality of the permanent water supply that was installed by EPA.
2. Declaration of Groundwater Use Restrictions and Protective Covenants. Executed on March 27, 1991, before Notary Public in Dannellon, Florida. This IC prevents any use of the groundwater or installation of wells at a porion of the site identified as lot 42B, Block 43 in the Town of Burrilville's Tax Assessor's Map.
3. Declaration of Groundwater Use Restrictions and Protective Covenants. Executed on August 23, 1991, before Notary Public in Providence, Rhode Island. This IC prevents any use of the groundwater, installation of groundwater wells, excavation, or installation of structures below the groundwater level which may expose groundwater or alter the

groundwater flow, in the entire Site.

4. Institutional Control Agreement Western Sand and Gravel Superfund Site, Burrilville and North Smithfield, Rhode Island. Executed on September 3, 1991, before Notary Public in New York, New York. This IC prevents the use of the groundwater, installation of groundwater wells, excavation, or installation of structures below the groundwater level which may expose groundwater or alter the groundwater flow, at a portion of a property north of the Site.
5. Declaration of Groundwater Use Restrictions and Protective Covenants. Executed on December 26, 1995 at the Land of Evidence Records for the Towns of North Smithfield and Burrilville, Rhode Island. This IC prevents the use of the groundwater, installation of groundwater wells, excavation, or installation of structures below the groundwater level which may expose groundwater or alter the groundwater flow, at a portion of the Site.
6. Confirmatory Declaration of Groundwater Use Restrictions and Protective Covenants. Executed on June 5, 1996, before Notary Public in Cranston, Rhode Island. This IC is a confirmation of the previous one.

Electronic copies of all the institutional control documents are available at the Superfund Site Profile in EPA's national Superfund website. The following is a link to the webpage: http://www.epa.gov/ictssw07/public/export/01/RID009764929/RID009764929_report.HTM

Hard copies are also available at the Burrillville Town Hall, 105 Harrisville Main Street, Harrisville, RI 02830, and the EPA New England Records Center, 5 Post Office Square, Boston, MA 02109.

The land south of the capped portion of the Site (approximately 19 acres) is currently being operated by Supreme as a truck body assembly plant, and is generally upgradient of the impacted groundwater.

3.3 History of Contamination

From 1975 to April 1979, a portion of the Site (approximately 12 acres) was used for the disposal of liquid wastes including chemicals and septic waste. Contents of tank trucks were emptied directly into open lagoons and pits, none of which were lined with protective materials. Initially the Site was only permitted to accept sewage wastes. Over time, the wastes disposed of at the Site included chemical wastes that eventually penetrated underlying porous soils and contaminated the groundwater. The total volume of materials disposed of at the Site is unknown. RIDEM records indicate that approximately 470,000 gallons of waste were deposited at the Site during its last year of operation.

A fire occurred in one of the chemical pits in March 1977. At that time, local fire officials ordered the Site owner and operator to remove the chemicals from the waste pit. Reportedly, the Site owner responded by burying the contents from the waste pit on-site. It was also during 1977

that nearby residents began complaining about odors from the Site. During February 1979, due to concerns regarding local water supplies, nearby wells were sampled by the Rhode Island Department of Health (RIDOH).

3.4 Initial Response

In 1979, the Rhode Island Department of Environmental Management (RIDEM) issued a Cease and Desist Order for violations of water and air pollution regulations at the Site.

In 1980, approximately 60,000 gallons of VOC-contaminated liquids were pumped and removed from the lagoons by EPA. This action was taken under the authority of Section 311 of the Clean Water Act, prior to the passage of CERCLA.

The Site was proposed for listing on the NPL in October 1981, with final listing on the NPL in September 1983.

In 1982, RIDEM as the lead Agency began a groundwater recirculation system in an effort to control the spread of groundwater contamination. RIDEM and EPA conducted RI/FS studies at the Site from 1982 to 1985 for OUs I and II.

3.5 Basis for Taking Action

In September 1984, RIDEM completed the first RI/FS for the Site under a cooperative agreement with EPA. The conclusions of the RI were as follows:

- Organic chemicals had infiltrated through highly permeable soil into the groundwater.
- Organic chemicals had migrated from the Site through the upper fractured bedrock and residential wells down gradient from the Site were contaminated.
- Contamination had migrated to and had affected the quality of drinking water in nearby residential wells.
- Contaminated groundwater had discharged into nearby Tarkiln Brook and Slatersville Reservoir.
- Contaminated soil and sludge existed in various locations on the Site.
- Hazardous air emissions were not detected at the Site.

Action was taken at the Site, in accordance with the 1984 OU-I ROD and the 1985 OU-II ROD, since both human and environmental receptors existed and could potentially be exposed to contaminants occurring at concentrations in excess of state and Federal standards. The primary exposure to Site contamination would be through direct contact and/or ingestion of soils, sludge, and sediments in waste basins/lagoons and areas immediately adjacent to the waste basins/lagoons; direct contact and/or ingestion of surface water; and ingestion of contaminated groundwater.

In addition, the 1991 ROD for OU-III identifies Site Contaminants of Concern (COCs), including, but not limited to:

Organics
benzene; chlorobenzene; toluene; xylenes; 1,1,1-trichloroethane; trichloroethene; tetrachloroethene; 1,2-dichloroethane; 1,1-dichloroethane; and vinyl chloride.

Inorganics

arsenic; chromium; and lead.

For a complete list of all the COCs listed in the ROD for OU-III and their respective Groundwater Interim Cleanup Levels, please see **Appendix G**.

4.0 REMEDIAL ACTIONS

4.1 Operable Unit I Remedy Selection/Implementation

In September 1984, EPA issued the first ROD for the Site with the following remedial objectives:

- To provide residents in the affected area with a permanent supply of safe drinking water.
- Abate local sources of contamination at the Site.
- Minimize future public health risks by restricting site access.

To achieve these objectives the ROD specified:

- The installation of water filters as an Initial Remedial Measure (IRM) to provide protection for homes where contaminants were identified in their wells, until the permanent alternate water supply became functional.
- The installation of a permanent alternate water supply to service approximately 56 parcels of land.

Starting in August 1984, Olin Hunt Specialty Products, Inc. (Olin), a potentially responsible party (PRP) at the Site, installed water filters in private homes with contaminated wells and in homes that might become contaminated. EPA began construction of the permanent water supply system in April 1990. The water supply system became operational and functional in September 1994. The water supply system ownership was transferred to the State on September 16, 1992, and subsequently transferred to a privately owned water utility, the Nasonville Water District. The Rhode Island Department of Health (RIDOH) is responsible for ensuring that the water supply system is being operated and maintained properly and remains protective of human health. Olin is currently doing business as Olin Corporation and it is in effect the PRP responsible for the ongoing remedy.

4.2 Operable Unit II Remedy Selection/Implementation

In September 1985, EPA issued a second ROD for the site with the following additional remedial objectives:

- Contain or remove sources of contamination at the Site to minimize the continued release of contaminants to the groundwater and future public exposure and health impacts.
- Mitigate the environmental impact of contaminated groundwater.

To achieve these objectives the ROD specified:

- The grading of contaminated soil to the cap area.
- The installation of an impermeable cap consistent with Resource Conservation and Recovery Act (RCRA) provisions.
- The phasing out of the groundwater recirculation system, and the removal and disposal of the associated equipment.
- The final grading of the Site with loam and the seeding of the cap and surrounding surface.
- The securing of the Site with a fence and posting of the Site.

This ROD also required the following operation and maintenance activities:

- The inspection and maintenance of the cap, fence, and postings consistent with RCRA provisions.
- Continued groundwater monitoring consistent with RCRA post-closure provisions.

Construction activities for OU-II were complete by March 1989. All contaminated soils were excavated and consolidated under approximately 2-acres of a RCRA C impermeable cap. The entire Site was graded and the cap plus its surrounding areas were fenced and posted with warning signs. The fenced area comprises approximately 6-acres of the 25 acre Site. Post-closure monitoring and inspections of this fenced area is ongoing.

4.3 Operable Unit III Remedy Selection/Implementation

In April 1991, EPA issued the third and final ROD for the Site with the following remedial objectives:

- Restore contaminated groundwater in the overburden aquifer, from the boundary of the existing cap to the outer boundary of the contaminant plume, to state and federal ARARs, including drinking water standards, and to a level that is protective of human health and the environment as soon as practicable.
- Restore contaminated groundwater in the bedrock system, to state and federal ARARs,

including drinking water standards, and to a level that is protective of human health and the environment as soon as practicable unless EPA determines, based on additional information, that contamination in the bedrock does not exceed protective levels.

- Protect uncontaminated groundwater and surface water for current and future use.
- Prevent human and animal exposure to contaminated groundwater.
- Protect environmental receptors.

To achieve these objectives the 1991 ROD specified:

- Reliance on natural attenuation of contaminated groundwater with a contingency to perform active restoration. According to the hydro-geologic models, groundwater was expected to be restored to the interim cleanup levels in approximately 24 to 28 years from the date of the OU-III ROD (04/16/1991). Active restoration, for which a work plan has been developed, will be implemented, according to the ROD, if natural attenuation is not restoring the groundwater at a rate predicted by modeling or faster.

- Utilization of ICs to reduce the risk to public health from consumption of groundwater.
- Implementation of a Site monitoring program to include long term monitoring of the groundwater.

The interim cleanup levels for four indicator compounds were established for the Site to determine if natural attenuation was working as predicted by the model or faster, using the non-parametric Wilcoxon signed rank test. These four indicator compounds and their respective interim cleanup levels are presented below:

benzene	5 micrograms per liter (μg/L)
tetrachloroethene	5 μg/L
trichloroethene	5 μg/L
vinyl chloride	2 μg/L

Specifications for performance of periodic evaluations of the natural attenuation remedy were initially identified in the 1993 Site Monitoring Plan. Submittal of the first evaluation was completed in accordance with the Site Monitoring Plan and the CD Statement of Work and was presented in Appendix E to the 1994 Data Report, dated February 1995. The evaluation showed that the statistical test passed without considering outliers for the indicator compounds tetrachloroethene, trichloroethene, and vinyl chloride. The report made recommendations regarding treatment of outliers for the indicator compound benzene and a further recommendation regarding modification of the benzene theoretical curve based on new information derived from a recent review of the groundwater modeling assumptions and modeling parameters reported in the literature.

Following submission of the 1994 Data Report, three consecutive quarters of groundwater monitoring showed benzene maximum concentrations to be at or below the theoretical curve. However, for the period December 1995 through December 1996, three of the five quarters showed benzene maximum concentrations to be above the theoretical curve. As a result, and consistent with the CD Statement of Work, another periodic evaluation and data report was completed and submitted to EPA in April 1997. That evaluation identified proposed changes to the Wilcoxon statistical test.

The 1997 proposal for modification of the statistical test received EPA concurrence in the course of the development of the second Five-Year Review in 1998. With this modification, active remediation would be implemented only if both of the following conditions are met for any of the four indicator compounds:

- In applying the Wilcoxon Signed Rank Test, the null hypothesis is rejected in favor of the alternative hypothesis that attenuation is occurring at a rate slower than predicted by the theoretical curve. This will occur if $T^{+} \geq t(\alpha, n)$, and

- Least squares regression fails to identify a statistically significant negative slope at the 95 percent confidence level.

Implementation and monitoring of the remedy under OU-III – natural attenuation – has continued to be performed on a biannual basis since 2001.

4.4 System Operations/Operation and Maintenance (O&M)

The water supply system (implemented in accordance with the OU-I ROD) is operated and maintained by a privately owned water utility (Nasonville Water District). The Rhode Island Department of Health (RIDOH) is responsible for ensuring that the water supply system is being operated and maintained properly and remains protective of human health.

The PRPs have continued to conduct routine system operations/O&M that have consisted of Site inspections and general maintenance of the grounds and the landfill cap. In addition, the PRPs continue to monitor the performance of the remedy based on groundwater sampling events. Quarterly progress reports and annual data reports have been submitted to the EPA and RIDEM for the years cited below. All O&M activities during the five-year review period were conducted during the regular sampling events as noted below:

2008	**2009**	**2010**	**2011**	**2012**
March 2008	April 2009	July 2010	March 2011	March 2012
September 2008	October 2009	September 2010	September 2011	September 2012

Since the remedy relies on natural attenuation of contaminated groundwater to achieve the goals set forth in the ROD, an annual data review is also conducted to assess whether the remedy performance standards are being satisfied.

5.0 PROGRESS SINCE THE LAST REVIEW

In the fourth Five-Year Review, dated September 2008, EPA certified that the remedy selected for this Site remains protective of human health and the environment. Since the concentrations of the four indicator compounds were decreasing at the rate predicted by the theoretical curve, or faster, it was recommended that the natural attenuation remedy be allowed to continue. The 2008 Five-Year Review also identified three issues and provided concrete recommendations to address those. The identified issues and their respective recommendations were:

Issue #1: *The OU-III ROD requires a statistical trend analysis for only four indicator compounds rather than for all groundwater contaminants with ICLs that are currently being detected.* Recommendation #1: *An evaluation of all detected groundwater contaminants with site-specific ICLs is needed.*

In response to Issue #1, EPA decided to evaluate the data from the 2008 and 2009 annual reports, and the results of the field audit performed on October 27, 2009. The data evaluation revealed consistent downward trends for three of the four indicator compounds. The field audit of Olin's sampling efforts showed that poor QA/QC practices and other errors of the field staff were causing the anomalous results that were previously observed. After discovering these errors, EPA asked Olin to correct the procedures in the field. After taking these steps and considering that the statistical analysis of the data was being reviewed, EPA determined it was no longer necessary to implement this recommendation.

Issue #2: *On April 2007, the maximum concentration for PCE was extremely high (49 µg/L) from a split sample for well C4S. It is unclear whether this was in fact an accurate measurement or an error associated with field and/or analytical procedures.*
Recommendation #(2)(a): *Additional attention is needed to sampling and analytical QA/QC procedures for all groundwater monitoring wells, but in particular, well C4S.*
Recommendation #(2)(b): *Perform field audits during the next several sampling rounds to determine if more frequent sampling is needed.*

In response to Issue #2, a field audit was performed on October 27, 2009. Errors were observed in the field and reported to the PRPs via letter. The objective of the audit was to determine if the anomalous PCE concentration (49 µg/L) observed at Well 4CS was due to the field practices performed by Olin's contractor at the time of sampling and/or analytical practices at the laboratory. The conclusion of the field audit was that Olin's contractor followed the Revised Site Monitoring Plan, October 2009, using Passive Diffusion Bags (PDBs) and the low-flow groundwater sampling procedure. However, it was evident that the samplers had not read the bailer procedure (Site Monitoring Plan, November 1992) because parts of the procedure were not performed until EPA brought them to the attention of the samplers. Also, the audit revealed that the samplers relied on the field instrument rental company for the proper standards to be used in calibrating the field instruments. The samplers were instructed to check the rental company provided standards against the Site Monitoring Plan. For future sampling at the Site, it was recommended that Olin's representative ensure that the samplers have read and understood the sampling procedures as described in the Site Monitoring Plan. After evaluation of the field audit

results and discussion with the field auditor, it was determined that neither an audit of the analytical QA/QC procedures, nor additional audits were necessary because the errors observed in the field explained the high levels of PCE observed in the past.

Issue #3: *Recent guidance generally requires lines of evidence beyond the current statistical approach being used to support the performance of the natural attenuation remedy at this Site.*
Recommendation #3: *The current statistical performance criteria should be reviewed in light of recent guidance on monitoring the performance of natural attenuation remedies.*

In response to Issue #3, and pursuant to Section XIV, page 39, Section 37 of the 1992 CD, EPA Region 1 requested technical assistance from the EPA Emergency Response Team (ERT) in Las Vegas, Nevada. Specifically the services of a statistician and other professionals were requested to review the statistical analysis that Olin had applied to the Site's groundwater data since March 1991. After numerous discussions with ERT experts, EPA Region 1 shared with Olin, on February 22, 2012, a copy of the Data Analysis and Conclusions that it received from ERT, and requested that Olin perform three adjustments to the statistical analysis:

1. *Adjust the theoretical degradation rates for the other three indicator chemicals: Tetrachloroethene (PCE), Trichloroethene (TCE), and Vinyl Chloride (VC), in the same fashion it was adjusted for Benzene, given the increase in organic matter measured at the site.*

2. *For all four indicator contaminants, perform a time series trend analysis using a non-parametric method such as the Sen Method. Non-parametric methods make no assumptions about the underlying distribution of the data residuals and are outlier resistant. If no trend is observed, conclude that no attenuation is occurring for that particular contaminant.*

3. *Perform the Wilcoxon Signed Rank test, only for those indicator contaminants for which a downward trend exists; i.e., significant negative slope.*

After discussing these requests further, in August 2012, Olin submitted to EPA a document (*Modification to the Statistical Approach for assessing remedy performance at the Western Sand and Gravel Site in Burrilville, Rhode Island)* that generally responded to all the requests EPA laid out in February 2012. Olin revised the theoretical degradation rates for tetrachloroethene (PCE), trichloroethene (TCE), and vinyl chloride (VC) in the same fashion it had adjusted for benzene back in 1995, given the increase in organic matter measured at the Site. The application of revised theoretical degradation rates to PCE, the indicator compound with the greatest retardation factor, revealed that the predicted time for PCE to reach its Maximum Contaminant Level (MCL), 5 ppb, is approximately 5.2 years longer than originally predicted (33.2 years instead of 28) in 1991.

The document also presented an analysis of potential outliers for PCE, TCE and VC using four different approaches. All analyses revealed a limited number of outliers and there did not seem to be any circumstances warranting the exclusion of most of the potential outliers.

A time series trend analysis using a non-parametric method (Man-Kendall Test) was performed on all the PCE, TCE, and VC data sets through 2011, and a significant trend was observed for all of them, even at the 95% confidence level. This analysis was also performed with potential outliers replaced with best fits or entirely removed, and it made no difference in the outcome. The analysis was not applied to benzene since its MCL (5μg/l) had been met for 20 consecutive sampling events.

The document however did not include the application of the Wilcoxon Signed Rank Test. Subsequently EPA received the 2011 Data Report which included the application of this test to the four indicator compounds; all indicator compounds passed the test except VC. Nonetheless at that time a downward trend for VC was shown by the least squares regression test and later on such downward trend was confirmed with the application of the Man Kendall test. Therefore since applied statistical tests were passed, no active remediation measures were necessary.

Additional inferences from the data were provided such as a summary of mean concentrations, number of sampling events meeting the MCL, and potential outliers, per five year intervals. The data suggested declining concentrations and an increase in the number of sampling events meeting the MCL for TCE and VC. Also, the number of wells in which detected concentrations exceeded the MCL was compiled for each year, where available. The data showed a decrease in both the number of wells with detected indicator compounds and the number of wells with detections above MCLs.

On December 11, 2012, EPA expressed agreement with most of the conclusions and recommendations laid out in the August 2012 document. It also requested that Olin adopt a number of measures in future Annual Reports.[1]

6.0 FIVE-YEAR REVIEW PROCESS

6.1 Administrative Components

The Western Sand & Gravel site's five-year review team was led by Gerardo Millán-Ramos, EPA Region 1 Remedial Project Manager for the Site, with assistance from the following case team members:

- Claire Willscher, EPA Region 1 Risk Assessor;
- Michelle Lauterback, EPA Region 1 Attorney;
- Rudy Brown, EPA Region 1 Community Involvement Coordinator;
- Paul Kulpa, RIDEM Project Manager.

The review components included:

- site inspection;
- review of decision documents;

[1] EPA letter to Olin Corporation. December 11, 2012.

- review of annual data reports;
- review of site inspection reports; and
- development and review of the Five-Year Review Report.

Soon after the review and approval of this Five-Year Review report, a notice will be placed in a local paper announcing that the five-year review report is complete and that it is available to the public at the Site repositories listed below:

Burrillville Town Hall
105 Harrisville Main Street
Harrisville, Rhode Island 02830
Telephone: (401) 568-4300
Fax: (401) 568-0496
E-mail: townclerk@burrillville.org

U.S. Environmental Protection Agency Records Center
5 Post Office Square, Suite 100
Boston, MA 02109-3912
Telephone: (617) 918-1440
Fax: (617) 918-1223
E-mail: r1.records-osrr@epa.gov

6.2 Community Notification and Involvement

During this five-year review period, there were no public hearings or public meetings. Community involvement activities during the five year review period were limited to the submission of the annual data reports to the local and federal repositories listed above (*i.e.*, the Burrillville Town Hall and the EPA New England – Region 1 Records Center).

A public notice was published in The Woonsocket Call, a local newspaper in Woonsocket, Rhode Island, on Friday January 11, 2013. The notice indicated that EPA had begun the fifth Five Year Review of the Site. It summarizes the cleanup measures taken at the Site and provides contact information for the public. For a copy of the public notice please see **Appendix E**.

6.3 Document Review

This five-year review consisted of a review of relevant documents including the three RODs; the 1992, 1998, 2003, and 2008 Five-Year Review Reports; annual data reports, bi-annual site inspection reports, field audit reports and a review of current regulatory guidelines (state and federal) to verify any changes in standards with respect to the remedy.

6.4 Data Review

As part of the OU-I remedial action, any new residential or commercial development in the Site vicinity is required to be connected to the public water supply.

Ongoing tasks associated with OU-II include regular inspection and monitoring of the landfill cap during routine Site monitoring events. During this five-year review period, the integrity of the cap remained intact. Three minor depressions of the surface soils were observed in July 14, 2010, in the south east corner of the fenced area but outside the cap. These areas were observed to be growing in depth and extent. They were replenished with clean fill per RIDEM requirements on May 2011, and no further subsidence has been observed. It is theorized that rotting vegetation (*e.g.* tree stumps) may have created voids in the soils which in turn created the minor depressions.

Tasks for OU-III include ongoing groundwater monitoring for select wells at the Site, site inspections, and annual reporting of results. Groundwater flow throughout this five-year review period has been generally to the north, with groundwater ultimately discharging into Tarkiln Brook and the Slatersville Reservoir. All piezometric contour maps that were generated during the 5-year period are presented in **Appendix D**.

Overall, the four indicator compounds (benzene, tetrachloroethene, trichloroethene, and vinyl chloride) have been assessed since 1998 by applying the following analyses to the groundwater data:

- the Wilcoxon Signed Rank Test, and
- least squares regression.

During the fifth five year review period (2008 – 2013) no changes have been made to the Site's monitoring program. However, five new metrics:

- summary of mean concentrations
- number of sampling events meeting the MCL and its percentage
- number of unusual observations (potential outliers)
- number of wells in which detected concentrations exceeded the MCL
- number of wells impacted by indicator compounds

were incorporated as additional lines of evidence in the evaluation of the natural attenuation's progress for the four indicator compounds. EPA requested via letter on December 11, 2012 that these metrics be reported on an annual basis and every five years prior to the preparation of the CERCLA mandated Five Year Reviews. On March 21, 2013 Olin agreed to this request.

On April 2013, Olin applied these metrics to the historical data as part of the 2012 Annual Report. A summary of mean concentrations, sampling events that met the MCL, and potential outliers (unusual observations) per five-year interval, was presented. These intervals of data suggest declining concentrations for PCE, TCE, and VC. The statistics for PCE do not appear to be improving as smoothly as for TCE and VC, but demonstrate that, except for a few anomalies (whether identified as true outliers or not), there is an overall improvement in Site conditions for PCE. See **Table F-3** in **Appendix F**.

Also, the number of wells in which there was a detection of PCE, TCE, or VC, and the number

of wells in which the detected concentrations were greater than their respective MCL were compiled for each year (1989-1994 and 1998-2012). Note: the data for 1995 through 1997 were not available on a well to well basis. The data clearly show a decrease in the number of wells where indicator compounds were detected and number of wells where detections were above the MCL. In fact, many of the original wells with indicator compounds have become non-detect for these compounds. In current years, only two wells have shown a significant frequency of detection above the MCL, locations C-4S and II-3S. See **Table F-4** in **Appendix F**.

Both **Tables F-3** and **F-4** suggest that natural attenuation has been able to achieve site-wide reduction in the concentrations of indicator compounds, the number of wells in which there are observed detections and the number of detections above MCLs for the indicator compounds.

During the current (fifth) five year review period, some modifications were made to the statistical analysis used to evaluate the progress of the remedy. Olin agreed to perform the following steps for all subsequent annual reports:

1. Identify statistical outliers and exclude such outliers from the statistical comparison of the actual data to the theoretical data (curves showing the estimated decline in concentrations); describe the outlier detection method used (preferably a non-parametric one); identify the outlier values; and if applicable, state the rationale for the selection of the outlier detection method.

2. Revise the theoretical equations of the estimated decline in concentrations for all the other indicator compounds, in the same fashion the benzene theoretical equation was adjusted in 1995, by using a revised value for the fraction organic carbon; and use such revised theoretical attenuation curves in evaluating the progress of natural attenuation for each of the four indicator compounds.

3. Replace the Least Square Regression Test with a non-parametric method (*e.g.*, Mann-Kendal trend test or Sen Method trend test) and apply it to all indicator compounds with a 90% level of confidence.[2]

4. Reverse the order of the statistical tests applied to the data with the stipulation that both tests must fail before consideration is given to active remediation as a contingent remedy. The Mann-Kendall Trend test will be performed first, to determine whether there is a statistically significant downward trend for each of the four indicator compounds. Then, the Wilcoxon Rank Sum Test will be applied in order to determine whether the downward trend is progressing as fast, or faster than as predicted by the theoretical attenuation curves.

As part of the 2012 Annual Report, Olin performed the previous steps to the historical data.

Laboratory analytical results for this five-year review period are summarized below with respect to the four individual indicator compounds of concern. In addition, **Appendix B** contains the

[2] In December 2012 EPA originally requested a 95% level of confidence but upon subsequent discussions with the PRP and RIDEM, a 90% level was deemed acceptable.

analytical results for each of the groundwater monitoring wells tested at the Site; **Appendix F** contains the statistical analysis results for the four indicator compounds from 1989 to present; and additional metrics (*i.e.*, summary of mean concentrations, number of sampling events meeting the MCL and its percentage, number of unusual observations, number of wells in which detected concentrations exceeded the MCL, and number of wells impacted by indicator compound) that have been applied to the historical data and will be incorporated in future annual reports.

Benzene

Benzene actual maximum concentrations did not exceed the theoretical concentration (defined from the 1993 groundwater modeling) of 5 µg/l during this five-year review period. During the first two sampling events for this five year review period (March and September 2008), the maximum benzene concentration detected was 2.0 µg/l. For the remainder of the five year review period (2009 – 2012) benzene was not detected in any groundwater samples, at a detection limit of 1 µg/L. Hence, benzene passed the Wilcoxon Signed Rank Test during this five year review period and so far has met the MCL (5µg/l) for 20 consecutive sampling events.

Tetrachloroethene (PCE)

PCE actual maximum concentrations exceeded the theoretical concentration values four times during this five-year review period (March 2008, July 2010, September 2011, and March 2012). This is one time less than the exceedance frequency observed during the prior five year review. The first exceedance was very slight (1.3 times higher than the corresponding theoretical concentration); the second exceedance was substantially larger (2.6 times higher than the corresponding theoretical concentration); the third exceedance was once again very slight (1.0 times higher than the corresponding theoretical concentration); and the fourth exceedance was relatively high (6.0 times higher than the corresponding theoretical concentration). Nonetheless, according to statistical analyses applied to potential outliers (regression analysis for linear and log-linear models) this last value is a probable extreme statistical outlier. During the 2012 fall sampling event, the PCE maximum concentration (4.6 µg/l) was substantially below the theoretical concentration (11.5 µg/l). Thus, overall, the magnitude of the exceedances to the corresponding theoretical concentrations for PCE seems to exhibit a downward trend during this five year review period. Additionally, PCE continued to pass the Wilcoxon Signed Rank Test during the entire 5 year review period.

Trichloroethene (TCE)

TCE maximum concentrations exceeded the corresponding theoretical concentrations four times during this five-year review period (March 2008, September 2008, October 2009, and March 2012). This is one time less than the frequency of exceedance observed in the prior five year review period. The first exceedance was very large (12.4 times higher than the corresponding theoretical concentration). This value was statistically analyzed to determine if it was an outlier but it was determined to be a valid observation. The second exceedance was very small (3 times higher than the corresponding theoretical concentration); the third exceedance was much lower (1.5 times higher than the corresponding theoretical concentration); and the fourth exceedance

was slightly larger than the second one (4.6 times higher than the corresponding theoretical concentration). At all other sampling events during this five year review period, the maximum concentrations were below the corresponding theoretical concentrations. Hence the magnitude of the exceedances to the corresponding theoretical concentrations for TCE, generally exhibit a downward trend during this five year review period. Additionally, TCE continued to pass the Wilcoxon Signed Rank Test during the entire five year review period.

Vinyl chloride (VC)

VC maximum concentrations exceeded the theoretical concentration (2 μg/l) five times during this five-year review period (March 2008, October 2009, September 2011, March 2012, and September 2012). This is one time less than the frequency of exceedance observed in the prior five year review period. The first exceedance was extremely large (37.5 times the theoretical concentration); the second exceedance was a slight one (2 times the theoretical concentration); the third exceedance was very large (11 times the theoretical concentration); the fourth exceedance showed a decrease in magnitude (3.5 times the theoretical concentration); and the last one showed an even smaller scale (1.7 times the theoretical concentration). Thus there seems to be wide variation in the magnitude of exceedances with a generally declining trend during this five year review period.

In applying the Wilcoxon Signed Rank Test to the VC data, the contaminant failed the test during the first four annual data reporting periods (2008 - 2011) indicating that the concentrations of vinyl chloride were decreasing at a slower rate than what was projected by the theoretical curve established in the 1991 ROD. However, in applying the Mann-Kendall trend test to the vinyl chloride data, a negative slope was evident (see **Table F-2** at **Appendix F**) and the threshold for consideration of active remediation was not exceeded.

During the last annual data reporting period (2012) vinyl chloride did pass the Wilcoxon Signed Rank Test for the two sampling events; indicating that the downward trend line of the VC concentrations fell below the theoretical trend line (*i.e.*, the concentrations of VC decreased at a rate equal or faster than the one predicted by the theoretical curve).

Finally, isoconcentration maps for the years 2008 through 2012 (as presented in the annual reports during this Five-Year Review period) are provided in **Figure F-11** at **Appendix F**. These maps show the concentration contours for total volatile organics based on the single highest total volatile organic concentration detected in each well for all sampling events during the respective years. From these figures, one can see that the plume shape has changed over the past five years as each of the four indicator compounds gradually approaches their respective MCLs.

6.5 Site Inspection

Site inspections were conducted by the PRP's contractor during each of the groundwater sampling events conducted during 2008 (March, and September), 2009 (April, and October), 2010 (July, and September), 2011 (March, and September), and 2012 (March and September). Overall, there were no conditions identified that would compromise the remedy. The general

maintenance activities included: maintenance of vegetation along fence lines; the re-seeding and mulching of sub-areas showing limited vegetation growth; and the replenishment of soils at the minor surface depressions in the southeastern corner of the fenced area, and at small animal burrows in some areas underneath the fence.

On September 6 2012 EPA performed its Site Inspection for the upcoming 5 Year Review. The cap was observed to be well maintained. There were no observed low spots or ponded waters, no erosion damage, and no observed animal burrows in the cap. Also, EPA and RIDEM inspected the residential area and obtained information from the Town of Burrillville and the Nasonville Water District to confirm that all new residential dwellings constructed in the area were connected to the alternative water supply. Based upon the site inspections and the obtained information it was determined that all of the new residential dwellings were connected to the alternative water supply. **Appendix C** includes a photographic summary of general Site conditions as observed during the most recent Site inspection.

6.6 Interviews

There were no interviews conducted during this five-year review period.

7.0 TECHNICAL ASSESSMENT

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

YES. The remedy continues to function as intended by the three Records of Decision for the Site. In particular, the water supply system implemented as part of OU-I is being operated and maintained safely. The landfill cap, installed as part of OU-II, is in excellent condition and is being well maintained. Finally, the groundwater data collected as part of OU-III indicates that natural attenuation is progressing and there is no need to consider active remediation at this time. However, during this five-year review period, the statistical analysis of the groundwater data was carefully reviewed by EPA and recommendations were made to modify it. See Section 6.4 for further details.

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. While the RAOs used at the time of the remedy selection remain valid, there have been changes in the Maximum Contaminant Level/Maximum Contaminant Level Goals (MCL/MCLG) and toxicity data for several compounds included in the OU-III ROD. These changes were identified after a thorough review of the Interim Groundwater Cleanup Levels (IGCLs) identified in the ROD for OU-III (see **Appendix G**), against current MCLs/MCLGs, and the most current toxicity information.

The following paragraphs describe such changes and the potential impact these changes may have on the current and future protectiveness of the selected remedy for the Site.

There are a number of COCs for which the MCL or MCLG as established under EPA's Safe

Drinking Water Program is now **less stringent** than the IGCL value used in the OU-III ROD. The following is a list of those compounds and their respective values.

COC	OU-III ROD IGCL (µg/L)	MCL/ MCLG/SMCL As of August 2013 (µg/L)
1,1,2-trichloroethane	PMCLG=3	MCL = 5/MCLG=3
bis (2-ethylhexyl) phthalate	PMCL=4	MCL=6
1,2,4-trichlorobenzene	PMCLG=9	MCL=70 / MCLG=70
barium	PMCLG=1,000	MCL=2,000/MCLG=2,000
lead	PMCL=5	MCL*=15/MCLG=0
silver	SMCL=90	SMCL=100
* - Treatment Technique at the tap SMCL = Secondary Maximum Contaminant Level		

At the time of the OU-III ROD (April, 1991), several of the IGCLs were noted as being Proposed Maximum Contaminant Level Goals (pMCLGs). The pMCLGs for **chlorobenzene**, **1,2-dichloroethane (cis), ethylbenzene**, and **xylene** have now been promulgated as MCLGs, thus no changes to the IGCL values for these contaminants are warranted at the present time.

In the OU-III ROD, the IGCL for **di-n-butyl phthalate** was a proposed MCL (4 µg/L) and the IGCL for **nickel** was a pMCLG (100 µg/L). EPA's Office of Safe Drinking Water however, has not promulgated MCLs or MCLGs for these compounds. As such, only risk-based values would be appropriate for deriving IGCLs at the present time. In both cases, the concentration corresponding to the more stringent of a non-cancer hazard index of 1 or cancer risk of 10^{-6} for the residential water exposure pathway (670 µg/L for **di-butyl phthalate** and 300 µg/L for **nickel**), is in excess of the OU-III IGCL. Also note that now there is a lifetime health advisory of 100 µg/L for **nickel**, which is the same value as the pMCLG identified in the 1991 ROD.

The OU-III ROD identifies the IGCL for **chloroform** to be 100 µg/L based on the MCL for total trihalomethanes. The current MCL (80 µg/L) and MCLG (70 µg/L) for total trihalomethanes are both more stringent than the IGCL (100 µg/L) identified in the OU-III ROD.

The OU-III ROD identifies the IGCL for **di-n-octyl phthalate** (700 µg/L). Since the time of the ROD the toxicity values for this COC have been revised such that an IGCL based on these updated toxicity values would be more stringent. A concentration of 160 µg/L corresponds to a hazard index of 1, for the residential water exposure pathway.

The OU-III ROD identifies that criteria were not available to establish IGCLs for **acrolein**, **2-methylnaphthalene,** and **cobalt**. There are now toxicity values associated with each of these three contaminants of concern (COCs). A concentration of 0.04 µg/L for **acrolein**, 27 µg/L for **2-methylnaphthalene**, and 4.70 µg/L for **cobalt**, corresponds to the more stringent of a noncancer hazard index of 1 or cancer risk of 10^{-6} for the residential water exposure pathway.

As discussed above, there have been updates to the toxicity values for several COCs such that a concentration corresponding to the more stringent level of a non-cancer hazard index of 1 or cancer risk of 10^{-6} for the residential water exposure pathway, is now lower (more stringent) than the IGCL in the OU-III ROD. However, none of these changes affect- the current protectiveness of the selected remedy for the Site. This is due to the fact that currently there is no use of the groundwater as a water supply and ICs remain in place to preclude use of the groundwater as a water supply. However, future protectiveness may be affected should ICs be removed and the consumption of groundwater as a water supply occur.

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

NO. There have been no changes to the capped portion of the Site or at any of the adjacent properties that would call into question the protectiveness of the remedy. The regulations governing groundwater quality at the Site remain unchanged with the exceptions noted above (see response to Question B).

The land south of the capped portion of the Site is currently being used as a truck body assembly plant. This area is generally upgradient of the impacted groundwater and it encompasses the remaining approximately 19-acres of the Site. The assembly activities do not encroach upon the capped portion of the Site or the groundwater given their upgradient location and the fact that the area is serviced by public water.

However, during this Five Year Review period it was noticed that 1,4-dioxane is not one of the contaminants being monitored. 1,4-dioxane is a compound known to be used both as a solvent and as a stabilizer for other chlorinated solvents, especially 1,1,1-trichloroethane, in industrial degreasing operations. Since 1,1,1-trichloroethane is identified as a COC in the OU-III ROD for the Site, and since the groundwater monitoring data does not include 1,4-dioxane in the analysis, it is unknown whether or not 1,4-dioxane exists in groundwater at the Site.

In order to have a more robust monitoring program for this site and in order to be consistent with the ongoing monitoring at other sites within EPA Region 1, a sampling plan must be designed and implemented so the following questions are answered:

1. whether 1,4-dioxane is present at the site at levels meeting or exceeding the EPA Federal guideline (0.67 μg/L);
2. whether it is attributable to the site (*i.e.*, whether it should be identified as a COC); and
3. what impact, if any, will its presence have on the projected timeframe for natural attenuation to be achieved.

7.1 Technical Assessment Summary

According to the data reviewed for this five-year period and the Site inspections conducted during groundwater sampling events, the remedy is functioning as intended by the three RODs for the Site. There have been some changes in the regulatory statutes relevant to the interim

groundwater cleanup levels, as described in the response to question B of Section 7.0. However none of these changes impact the protectiveness of the remedy as groundwater is not being used as a water supply. Furthermore, institutional and engineering controls preclude the use of the groundwater as such.

Groundwater concentrations continue to decline, as indicated by plots of the overall trends for the four indicator compounds (TCE, PCE, vinyl chloride, and benzene) shown on the figures presented in **Appendix F**.

A review of the statistical analysis being applied to the data, revealed some issues with the theoretical attenuation curves for some of the indicator compounds, the treatment of outlier values, the order of the tests being performed and the fitness of some statistical tests to the data. After addressing all these issues, it was concluded that the projected time for achieving natural attenuation of all four indicator compounds needs to be extended to approximately five more years from the date of the ROD (33.2 as opposed to the 28 years indicated in the 1991 ROD). Also, it was concluded that all indicator compounds except VC are attenuating at a rate as fast or faster than the one predicted by the theoretical curves.[3] However the observed VC concentrations exhibit a downward trend as confirmed by the Man-Kendall test. Thus, confirming that natural attenuation is in progress, and that at this time there is no need to consider active remediation as a contingency.

8.0 ISSUES

Table 2 - Issues

Issues	Affects Current Protectiveness (Y/N)	Affects Future Protectiveness (Y/N)
It is unknown whether or not 1,4-dioxane exists in groundwater at the Site.	N	N

[3] It should be noted that VC did pass the Wilcoxon Rank Sum Test during the evaluation of the 2012 data.

9.0 RECOMMENDATIONS AND FOLLOW-UP ACTIONS

Table 3 – Recommendations and Follow up Actions

Issue	Reccomendation and Follow up Actions	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness (Y/N)	
					Current	Future
It is unknown whether or not 1,4-dioxane exists in groundwater at the Site.	Design and implement a sampling plan to answer: 1. whether 1,4-dioxane is present at the site at levels meeting or exceeding the EPA Federal guideline (0.67 µg/L); 2. whether it is attributable to the site (*i.e.* whether it should be identified as a COC; and 3. what impact if any will its presence have on the projected timeframe for natural attenuation to be achieved.	PRP	EPA	September 30, 2014	N	N

10.0 PROTECTIVENESS STATEMENT

OU-I involved the construction of a water supply system to provide residents in the affected area with a permanent supply of safe drinking water. The water supply system has been in operation since September 1994. The remedy at OU- I is protective of human health and the environment.

OU-II involved the consolidation of contaminated soils into the cap area and construction of an impermeable barrier over the consolidated contaminated soils. The OU-II remedy continues to minimize the continued release of contaminants to the groundwater and prevents public exposure to the contaminated soils. The remedy at OU-II is protective of human health and the environment.

OU- III relies on natural attenuation of the contaminated groundwater (with a contingency for

active remediation), Site monitoring (including groundwater monitoring), and ICs to prevent the use of groundwater in the affected area. As evidenced by the concentration trends of the four indicator compounds and the statistical analysis performed as recently reviewed, natural attenuation is taking place and, at this time, there is no need for active remediation. The remedy at OU-III is expected to be protective upon completion and in the interim, exposure pathways that could result in unacceptable risks are being prevented by ICs and the availability of a public water supply system in the area. Thus, the remedy at OU-III is protective of human health and the environment.

Overall, because the remedial actions at all OUs at the Western Sand and Gravel Site are protective, the Site is protective of human health and the environment.

11.0 NEXT REVIEW

The next five-year review for the Site will be required by September 2018, five years from the approval date of this review.

12.0 APPENDICES

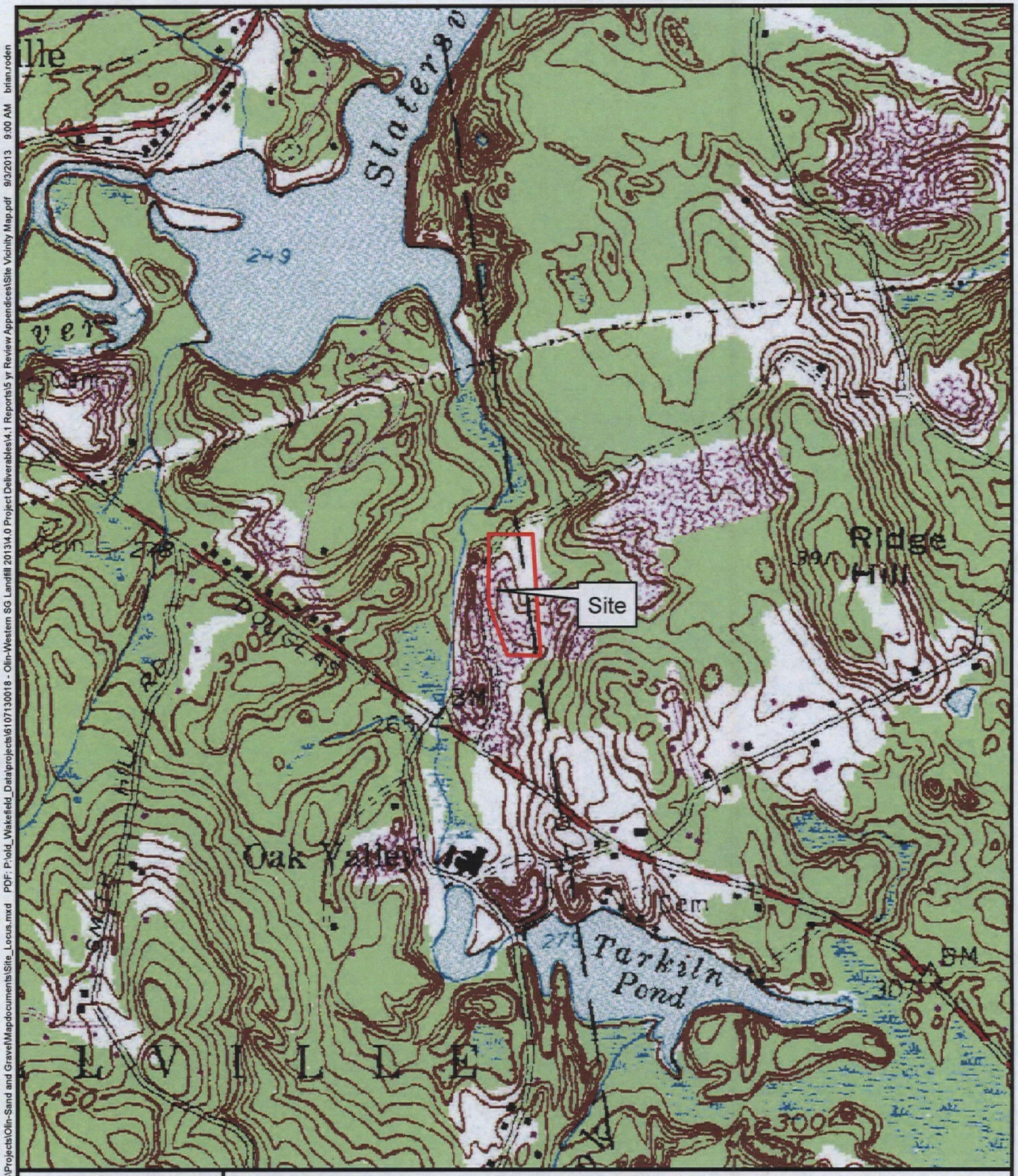
Appendix A	Site Maps
Appendix B	Summary of Data Tables
Appendix C	Site Inspection Report
Appendix D	Piezometric Contour Maps
Appendix E	Public Notice of 5YR Review
Appendix F	Tables and Figures Documenting Remedy Performance
Appendix G	COCs per ROD for OU-III

Appendix A

Site Maps

Site Vicinity Map

Base Map



Source: Rhode Island Geographic Information System
http://www.edc.uri.edu/rigis/data/

N

0 500 1,000 Feet

Prepared by BJR | Checked by CAC

Site Vicinity Map
Western Sand and Gravel Site
Burrillville, Rhode Island

amec

AMEC Environment & Infrastructure
107 Audubon Road Suite 301
Wakefield, MA 01880

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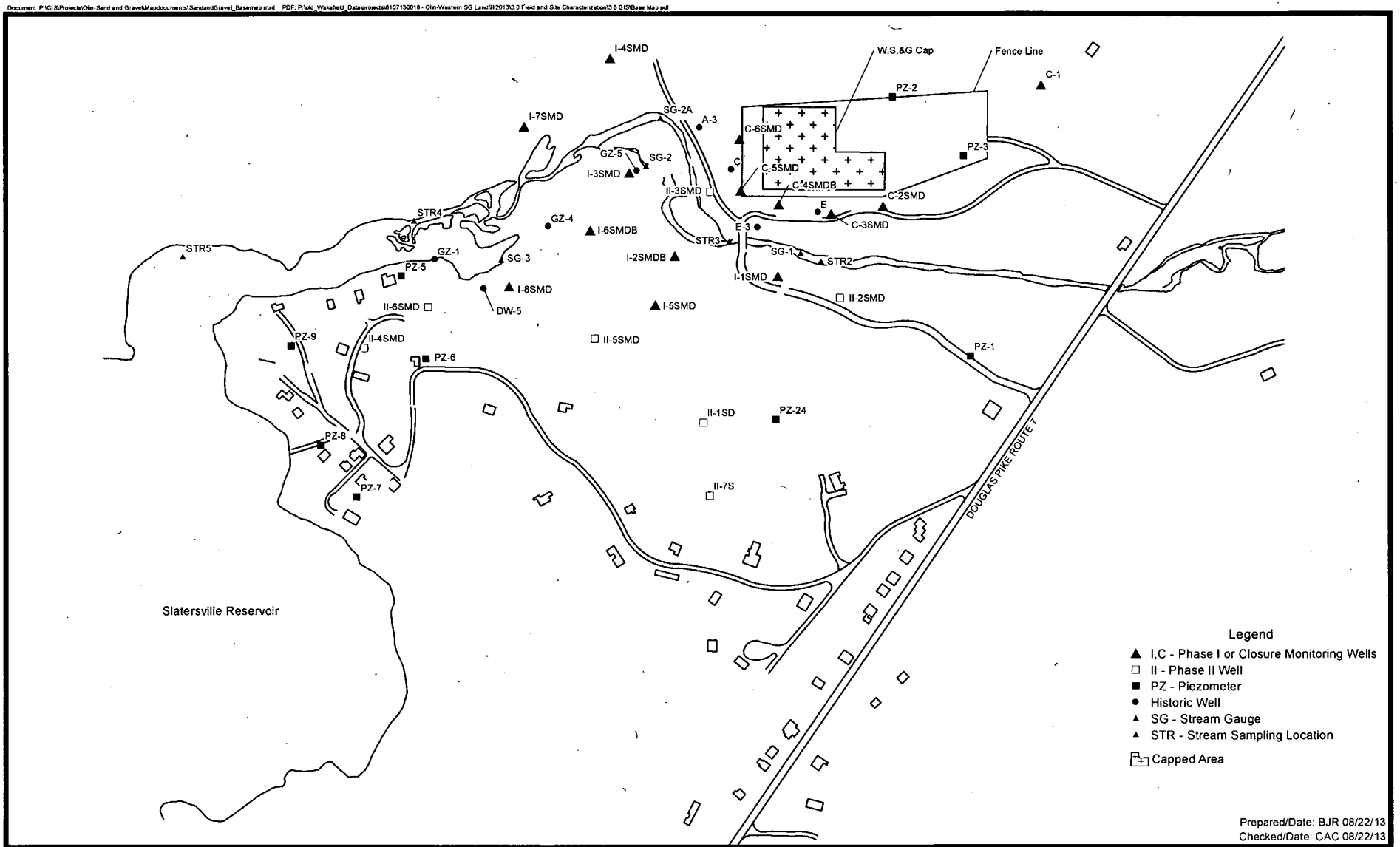
Document: P:\GIS\Projects\Olin-Sand and Gravel\Mapdocuments\SandandGravel_Basemap.mxd PDF: P:\old_Wakefield_Data\projects\6107130018 - Olin-Western SG Landfill 2013\3.0 Field and Site Characterization\3.6 GIS\Base Map.pdf



Prepared/Date: BJR 08/22/13
Checked/Date: CAC 08/22/13

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Western Sand and Gravel
Burrillville, Rhode Island

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Base Map

Appendix B

Summary of Data Tables

Table 1. Summary of Detected Volatile Concentrations in Groundwater (March 2009 – September 2012)

Table 2. Summary of Detected Semivolatile Concentrations in Groundwater (March 2009 – September 2012)

Table 3. Summary of Detected Metals in Groundwater (March 2009 – September 2012)

Table 1
Summary of Detected Volatile Concentrations in Groundwater (March 2008 - Sept 2012)
Western Sand and Gravel Site
Burrillville, Rhode Island

	Sampling Event:	Apr-08	Apr-08-SPLIT	Sep-08	Sep-08-SPLIT	Oct-09	Feb-10	Jul-10	Oct-10	Mar-11	Sep-11	Mar-12	Sep-12
Well	Parameter												
C1D													
	All VOCs	NA	NA	ND	NA	ND	NA	NA	ND	NA	ND	NA	ND
C2S													
	All VOCs	NA	NA	ND	NA	ND	NA	NA	ND	NA	ND	NA	ND
C2M													
	cis-1,2-Dichloroethene	NA	NA	ND	NA	ND	NA	NA	ND	NA	ND	NA	ND
C2D													
	All VOCs	NA	NA	ND	NA	ND	NA	NA	ND	NA	ND	NA	ND
C3S													
	All VOCs	NA	NA	ND	NA	ND	NA	NA	ND	NA	ND	NA	ND
C3M													
	All VOCs	NA	NA	ND	NA	ND	NA	NA	ND	NA	ND	NA	ND
C3D													
	All VOCs	NA	NA	ND	NA	ND	NA	NA	ND	NA	ND	NA	ND
C4S													
	1,1,1-Trichloroethane	94	46	23	3	5	NA	31	13	13	30	52	1.6
	1,1-Dichloroethane	43	21	9	4	5	NA	18	11	6	25	45	2.5
	1,1-Dichloroethene	6	2	0.5J	ND	ND	NA	1	0.5J	ND	5	2	ND
	Benzene	2	ND	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND
	Chlorobenzene	30	ND	ND	ND	ND	NA	ND	ND	ND	5	ND	ND
	Chloroform	1	0.7	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND
	cis-1,2-Dichloroethene	120	36	21	28	27	NA	110	52	5	190	300	16
	Ethylbenzene	46	ND	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND
	Tetrachloroethene	4	3	5	5	2	NA	22	4	ND	8	70	3.9
	Toluene	79	0.3J	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND
	trans-1,2-Dichloroethe	1	ND	ND	ND	ND	NA	ND	ND	ND	1	1.4	ND
	Trichloroethene	6	4	2	1	1	NA	4	1	2	4	23	0.87J
	Trichlorofluoromethane	ND	ND	ND	ND	ND	NA	0.3J	ND	ND	ND	ND	ND
	Vinyl Chloride	75	3	ND	ND	ND	NA	ND	ND	ND	22	0.33J	ND
	Xylenes	120	0.5J	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND

Table 1
Summary of Detected Volatile Concentrations in Groundwater (March 2008 - Sept 2012)
Western Sand and Gravel Site
Burrillville, Rhode Island

	Sampling Event:	Apr-08	Apr-08-SPLIT	Sep-08	Sep-08-SPLIT	Oct-09	Feb-10	Jul-10	Oct-10	Mar-11	Sep-11	Mar-12	Sep-12
Well	**Parameter**												
C4M													
	All VOC	ND	NA	ND	NA	ND	NA	ND	ND	ND	ND	ND	ND
C4D													
	1,1,1-Trichloroethane	ND	0.4J	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND
C5D													
	cis-1,2-Dichloroethene	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	ND	0.29
	Bromomethane	ND	ND	ND	ND	ND	NA	ND	1J	ND	ND	ND	ND
C5M													
	1,1,1-Trichloroethane	ND	ND	ND	0.3J	ND	ND	ND	ND	ND	ND	ND	ND
	1,1-Dichloroethane	ND	ND	4	10	5	ND	ND	ND	ND	ND	ND	ND
	1,1-Dichloroethene	ND	ND	0.6J	0.7J	0.8J	ND	ND	ND	ND	ND	ND	ND
	1,2-Dichlorobenzene	ND	ND	0.9J	2	0.9J	ND	ND	ND	ND	ND	ND	ND
	1,2-Dichloroethane	ND	ND	0.5J	1	ND	ND	ND	ND	ND	ND	ND	ND
	1,4-Dichlorobenzene	ND	ND	ND	0.4J	ND	ND	ND	ND	ND	ND	ND	ND
	Benzene	ND	ND	2	5	2	ND	ND	ND	ND	ND	ND	ND
	Chlorobenzene	ND	ND	14	30	14	ND	ND	ND	ND	ND	ND	ND
	Chloromethane	ND	ND	ND	ND	ND	ND	0.4JB	ND	ND	ND	ND	ND
	cis-1,2-Dichloroethene	ND	ND	11	30	13	ND	ND	0.2J	0.5J	ND	ND	0.34
	Ethylbenzene	ND	ND	10	19	2	ND	ND	ND	ND	ND	ND	ND
	Toluene	ND	ND	7	8	4	ND	ND	ND	ND	ND	ND	ND
	Trichloroethene	ND	ND	ND	1	ND	ND	ND	ND	ND	ND	ND	ND
	Vinyl Chloride	ND	ND	0.5J	1	0.6J	ND	ND	ND	ND	ND	ND	ND
	Xylene, o	NA	NA	NA	NA	2	ND	ND	ND	ND	ND	ND	ND
	Xylenes, (m&p)	NA	NA	NA	NA	2	ND	ND	ND	ND	ND	ND	ND
	Xylenes, Total	ND	ND	15	25	5	ND	ND	ND	ND	ND	ND	ND
C5S													
	1,1,1-Trichloroethane	11	1	22	21	27	NA	5	21	ND	6	2.7	32
	1,1-Dichloroethane	8	0.6	10	9	17	NA	2	17	ND	2	ND	29
	1,1-Dichloroethene	0.4	ND	ND	ND	0.9J	NA	ND	1	ND	0.5J	ND	1.3
	Chloroethane	ND	ND	ND	ND	1J	NA	ND	0.6J	ND	ND	ND	ND
	Chloroform	ND	ND	ND	ND	0.4J	NA	ND	0.4J	ND	ND	ND	0.55J
	Chloromethane	0.4	ND	ND	ND	ND	NA	0.4JB	ND	ND	ND	ND	ND
	cis-1,2-Dichloroethene	44	4	41	33	75	NA	10	110	ND	7	0.71J	100
	Tetrachloroethene	ND	2	1	1	1	NA	ND	2J	ND	ND	ND	1.5
	Toluene	ND	ND	ND	ND	0.4J	NA	ND	ND	ND	ND	ND	ND
	trans-1,2-Dichloroethene	ND	ND	0.6J	0.6J	1	NA	ND	1	ND	ND	ND	1.2
	Trichloroethene	0.9J	ND	1	1	1	NA	0.3J	2	ND	ND	ND	1.9
	Vinyl Chloride	ND	ND	ND	ND	ND	NA	ND	0.5J	ND	ND	ND	ND

Table 1
Summary of Detected Volatile Concentrations in Groundwater (March 2008 - Sept 2012)
Western Sand and Gravel Site
Burrillville, Rhode Island

	Sampling Event:	Apr-08	Apr-08-SPLIT	Sep-08	Sep-08-SPLIT	Oct-09	Feb-10	Jul-10	Oct-10	Mar-11	Sep-11	Mar-12	Sep-12
Well	**Parameter**												
C6D													
	Chloromethane	ND	ND	ND	ND	0.5J	NA	0.7JB	ND	ND	ND	ND	ND
C6M													
	All VOCs	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND
C6S													
	All VOCs	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND
I1D													
	All VOCs	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA
I2D													
	All VOCs	NA	NA	ND	NA	ND	NA	NA	ND	NA	ND	NA	ND
I2M													
	All VOCs	NA	NA	ND	NA	ND	NA	NA	ND	NA	ND	NA	ND
I2S													
	All VOCs	NA	NA	ND	NA	ND	NA	NA	ND	NA	ND	NA	ND
I3D													
	1,1-Dichloroethane	NA	NA	0.7J	NA	0.7J	NA	NA	0.8J	NA	0.6J	NA	0.46J
	Chloromethane	NA	NA	0.6J	NA	ND	NA	NA	ND	NA	ND	NA	ND
	cis-1,2-Dichloroethene	NA	NA	NA	NA	0.7J	NA	NA	0.8J	NA	0.6J	NA	0.52J
	Trichloroethene	NA	NA	1J	NA	0.9J	NA	NA	1	NA	0.8J	NA	0.72J
I3M													
	All VOCs	NA	NA	ND	NA	ND	NA	NA	ND	NA	ND	NA	ND
I3S													
	Chloromethane	NA	NA	ND	NA	0.5J	NA	NA	ND	NA	ND	NA	ND
I4D													
	All VOCs	NA	NA	ND	NA	ND	NA	NA	ND	NA	ND	NA	ND

Table 1
Summary of Detected Volatile Concentrations in Groundwater (March 2008 - Sept 2012)
Western Sand and Gravel Site
Burrillville, Rhode Island

	Sampling Event:	Apr-08	Apr-08-SPLIT	Sep-08	Sep-08-SPLIT	Oct-09	Feb-10	Jul-10	Oct-10	Mar-11	Sep-11	Mar-12	Sep-12
Well	Parameter												
I4M													
	All VOCs	NA	NA	ND	NA	ND	NA	NA	ND	NA	ND	NA	ND
I4S													
	All VOCs	NA	NA	ND	NA	ND	NA	NA	ND	NA	ND	NA	ND
I6D													
	All VOCs	NA	NA	ND	NA	ND	NA	NA	NA	NA	ND	NA	ND
I6M													
	All VOCs	NA	NA	ND	NA	ND	NA	NA	ND	NA	ND	NA	ND
I6S													
	All VOCs	NA	NA	ND	NA	ND	NA	NA	ND	NA	ND	NA	ND
I7D													
	All VOCs	NA	NA	ND	NA	ND	NA	NA	ND	NA	ND	NA	ND
I7M													
	cis-1,2-Dichloroethene	NA	NA	ND	NA	0.6J	NA	NA	ND	NA	ND	NA	ND
I7S													
	All VOCs	NA	NA	ND	NA	ND	NA	NA	ND	NA	ND	NA	ND
II2M													
	All VOCs	NA	NA	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA
II2D													
	All VOCs	NA	NA	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA
II3D													
	1,1-Dichloroethane	0.4J	ND	ND	0.6J	0.3J	NA	NA	ND	ND	ND	ND	ND
	Chlorobenzene	ND	ND	ND	0.6J	ND	NA	NA	ND	ND	ND	ND	ND
	Toluene	ND	ND	ND	ND	0.6J	NA	NA	ND	ND	ND	ND	ND

Table 1
Summary of Detected Volatile Concentrations in Groundwater (March 2008 - Sept 2012)
Western Sand and Gravel Site
Burrillville, Rhode Island

	Sampling Event:	Apr-08	Apr-08-SPLIT	Sep-08	Sep-08-SPLIT	Oct-09	Feb-10	Jul-10	Oct-10	Mar-11	Sep-11	Mar-12	Sep-12
Well	**Parameter**												
II3M													
	1,1,1-Trichloroethane	ND	0.7J	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND
	1,1-Dichloroethane	ND	4	ND	0.6J	0.4J	NA	1	2	ND	1	1.6	ND
	Bromomethane	NA	NA	NA	NA	ND	ND	ND	0.9J	ND	ND	ND	ND
	Chlorobenzene	ND	ND	ND	1	2	NA	1	3	ND	ND	ND	ND
	cis-1,2-Dichloroethene	ND	ND	0.5J	ND	ND	NA	0.5J	0.3J	ND	ND	ND	ND
	Toluene	ND	ND	ND	ND	1	NA	ND	ND	ND	ND	ND	ND
	Trichloroethene	ND	ND	ND	ND	ND	NA	ND	0.4J	ND	ND	0.34J	ND
	Vinyl Chloride	ND	1	ND	ND	ND	NA	0.7J	0.6J	ND	ND	0.8J	ND
II3S													
	1,1,1-Trichloroethane	10	4	0.2J	0.3J	17	NA	31	26	4	20	48	3.9
	1,1-Dichloroethane	10	3	12	17	15	NA	23	35	3	26	35	7.2
	1,1-Dichloroethene	ND	ND	0.4J	0.9J	0.5J	NA	0.7J	1	ND	2	1.6	ND
	Benzene	0.4J	ND	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND
	Chlorobenzene	1	ND	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND
	Chloroethane	ND	ND	5	7	ND	NA	ND	ND	ND	ND	0.75J	ND
	Chloroform	ND	ND	ND	ND	ND	NA	0.7J	0.5J	ND	0.7J	0.85J	ND
	Chloromethane	ND	ND	ND	0.7J	ND	NA	ND	ND	ND	ND	ND	ND
	cis-1,2-Dichloroethene	20	15	30	44	65	NA	180	130	6	150	150	27
	Ethylbenzene	10	ND	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND
	Tetrachloroethene	14	2	2	3	6	NA	1J	6J	ND	4	0.69J	4.6
	Toluene	14	ND	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND
	trans-1,2-Dichloroethene	ND	ND	0.4J	ND	0.4J	NA	1J	0.6J	ND	2	1.3	ND
	Trichloroethene	ND	ND	21	30	3	NA	1	2	ND	1	1.1	1.3
	Vinyl Chloride	16	ND	0.3J	1	7	NA	ND	0.7J	ND	0.9J	6.9	3.3
	Xylenes	8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Notes:
J = value is estimated
NA = Not Analyzed
ND = Not Detected
Units are in micrograms per liter (ug/L)

Table 2
Summary of Detected Semivolatile Concentrations in Groundwater (March 2008 - Sept 2012)
Western Sand and Gravel Site
Burrillville, Rhode Island

	Sampling Event:	Apr-08	Apr-08-SPLIT	Sep-08	Sep-08-SPLIT	Oct-09	Feb-10	Jul-10	Oct-10	Mar-11	Sep-11	Mar-12	Sep-12
Location:	Parameter												
C1D													
	All SVOCs	NA	NA	NA	NA	ND	NA	NA	NA	NA	ND	NA	NA
C2S													
	All SVOCs	NA	NA	NA	NA	ND	NA	NA	NA	NA	ND	NA	NA
C2M													
	Dibenzofuran	NA	NA	NA	NA	ND	NA	NA	NA	NA	3J	NA	NA
C2D													
	All SVOCs	NA	NA	NA	NA	ND	NA	NA	NA	NA	ND	NA	NA
C3S													
	All SVOCs	NA	NA	NA	NA	ND	NA	NA	NA	NA	ND	NA	NA
C3M													
	Dibenzofuran	NA	NA	NA	NA	ND	NA	NA	NA	NA	2J	NA	NA
C3D													
	bis(2-ethylhexyl)phthalate	NA	NA	NA	NA	5J	NA	NA	NA	NA	ND	NA	NA
	Dibenzofuran	NA	NA	NA	NA	ND	NA	NA	NA	NA	2J	NA	NA
C4S													
	Dibenzofuran	NA	NA	NA	NA	ND	NA	NA	NA	NA	3J	NA	NA
C4M													
	Dibenzofuran	NA	NA	NA	NA	ND	NA	NA	NA	NA	3J	NA	NA

Table 12

Summary of Detected Semivolatile Concentrations in Groundwater (March 2008 - Sept 2012)
Western Sand and Gravel Site
Burrillville, Rhode Island

	Sampling Event:	Apr-08	Apr-08-SPLIT	Sep-08	Sep-08-SPLIT	Oct-09	Feb-10	Jul-10	Oct-10	Mar-11	Sep-11	Mar-12	Sep-12
C4D													
	All SVOCs	NA	NA	NA	NA	ND	NA	NA	NA	NA	ND	NA	NA
C5S													
	All SVOCs	NA	NA	NA	NA	ND	NA	NA	NA	NA	ND	NA	NA
C5M													
	bis(2-ethylhexyl)phthalate	NA	NA	NA	NA	8J	NA	NA	NA	NA	ND	NA	NA
	Dibenzofuran	NA	NA	NA	NA	ND	NA	NA	NA	NA	2J	NA	NA
C5D													
	All SVOCs	NA	NA	NA	NA	ND	NA	NA	NA	NA	ND	NA	NA
C6S													
	Caproloactam	NA	NA	NA	NA	9J	NA	NA	NA	NA	ND	NA	NA
C6M													
	All SVOCs	NA	NA	NA	NA	ND	NA	NA	NA	NA	ND	NA	NA
C6D													
	bis(2-Chloroisopropyl)ether	NA	NA	NA	NA	ND	NA	NA	NA	NA	3J	NA	NA
I2S													
	All SVOCs	NA	NA	NA	NA	ND	NA	NA	NA	NA	ND	NA	NA
I2M													
	All SVOCs	NA	NA	NA	NA	ND	NA	NA	NA	NA	ND	NA	NA
I2D													
	All SVOCs	NA	NA	NA	NA	ND	NA	NA	NA	NA	ND	NA	NA

Table 2
Summary of Detected Semivolatile Concentrations in Groundwater (March 2008 - Sept 2012)
Western Sand and Gravel Site
Burrillville, Rhode Island

	Sampling Event:	Apr-08	Apr-08-SPLIT	Sep-08	Sep-08-SPLIT	Oct-09	Feb-10	Jul-10	Oct-10	Mar-11	Sep-11	Mar-12	Sep-12
Location:	Parameter												
C1D													
	All SVOCs	NA	NA	NA	NA	ND	NA	NA	NA	NA	ND	NA	NA
C2S													
	All SVOCs	NA	NA	NA	NA	ND	NA	NA	NA	NA	ND	NA	NA
C2M													
	Dibenzofuran	NA	NA	NA	NA	ND	NA	NA	NA	NA	3J	NA	NA
C2D													
	All SVOCs	NA	NA	NA	NA	ND	NA	NA	NA	NA	ND	NA	NA
C3S													
	All SVOCs	NA	NA	NA	NA	ND	NA	NA	NA	NA	ND	NA	NA
C3M													
	Dibenzofuran	NA	NA	NA	NA	ND	NA	NA	NA	NA	2J	NA	NA
C3D													
	bis(2-ethylhexyl)phthalate	NA	NA	NA	NA	5J	NA	NA	NA	NA	ND	NA	NA
	Dibenzofuran	NA	NA	NA	NA	ND	NA	NA	NA	NA	2J	NA	NA
C4S													
	Dibenzofuran	NA	NA	NA	NA	ND	NA	NA	NA	NA	3J	NA	NA
C4M													
	Dibenzofuran	NA	NA	NA	NA	ND	NA	NA	NA	NA	3J	NA	NA

Table 2
Summary of Detected Semivolatile Concentrations in Groundwater (March 2008 - Sept 2012)
Western Sand and Gravel Site
Burrillville, Rhode Island

	Sampling Event:	Apr-08	Apr-08-SPLIT	Sep-08	Sep-08-SPLIT	Oct-09	Feb-10	Jul-10	Oct-10	Mar-11	Sep-11	Mar-12	Sep-12
C4D													
	All SVOCs	NA	NA	NA	NA	ND	NA	NA	NA	NA	ND	NA	NA
C5S													
	All SVOCs	NA	NA	NA	NA	ND	NA	NA	NA	NA	ND	NA	NA
C5M													
	bis(2-ethylhexyl)phthalate	NA	NA	NA	NA	8J	NA	NA	NA	NA	ND	NA	NA
	Dibenzofuran	NA	NA	NA	NA	ND	NA	NA	NA	NA	2J	NA	NA
C5D													
	All SVOCs	NA	NA	NA	NA	ND	NA	NA	NA	NA	ND	NA	NA
C6S													
	Caprolactam	NA	NA	NA	NA	9J	NA	NA	NA	NA	ND	NA	NA
C6M													
	All SVOCs	NA	NA	NA	NA	ND	NA	NA	NA	NA	ND	NA	NA
C6D													
	bis(2-Chloroisopropyl)ether	NA	NA	NA	NA	ND	NA	NA	NA	NA	3J	NA	NA
I2S													
	All SVOCs	NA	NA	NA	NA	ND	NA	NA	NA	NA	ND	NA	NA
I2M													
	All SVOCs	NA	NA	NA	NA	ND	NA	NA	NA	NA	ND	NA	NA
I2D													
	All SVOCs	NA	NA	NA	NA	ND	NA	NA	NA	NA	ND	NA	NA

Table 2
Summary of Detected Semivolatile Concentrations in Groundwater (March 2008 - Sept 2012)
Western Sand and Gravel Site
Burrillville, Rhode Island

	Sampling Event:	Apr-08	Apr-08-SPLIT	Sep-08	Sep-08-SPLIT	Oct-09	Feb-10	Jul-10	Oct-10	Mar-11	Sep-11	Mar-12	Sep-12
I3S													
	All SVOCs	NA	NA	NA	NA	ND	NA	NA	NA	NA	ND	NA	NA
I3M													
	All SVOCs	NA	NA	NA	NA	ND	NA	NA	NA	NA	ND	NA	NA
I3D													
	All SVOCs	NA	NA	NA	NA	ND	NA	NA	NA	NA	ND	NA	NA
I4D													
	All SVOCs	NA	NA	NA	NA	ND	NA	NA	NA	NA	ND	NA	NA
I4M													
	All SVOCs	NA	NA	NA	NA	ND	NA	NA	NA	NA	ND	NA	NA
I4S													
	Diethylphthalate	NA	NA	NA	NA	ND	NA	NA	NA	NA	2J	NA	NA
I6D													
	All SVOCs	NA	NA	NA	NA	ND	NA	NA	NA	NA	ND	NA	NA
I6M													
	All SVOCs	NA	NA	NA	NA	ND	NA	NA	NA	NA	ND	NA	NA
I6S													
	All SVOCs	NA	NA	NA	NA	ND	NA	NA	NA	NA	ND	NA	NA
I7D													
	All SVOCs	NA	NA	NA	NA	ND	NA	NA	NA	NA	ND	NA	NA

Table 2
Summary of Detected Semivolatile Concentrations in Groundwater (March 2008 - Sept 2012)
Western Sand and Gravel Site
Burrillville, Rhode Island

	Sampling Event:	Apr-08	Apr-08-SPLIT	Sep-08	Sep-08-SPLIT	Oct-09	Feb-10	Jul-10	Oct-10	Mar-11	Sep-11	Mar-12	Sep-12
I7M													
	All SVOCs	NA	NA	NA	NA	ND	NA	NA	NA	NA	ND	NA	NA
I7S													
	All SVOCs	NA	NA	NA	NA	ND	NA	NA	NA	NA	ND	NA	NA
II3S													
	All SVOCs	NA	NA	NA	NA	ND	NA	NA	NA	NA	ND	NA	NA
II3M													
	Caproloactam	NA	NA	NA	NA	3J	NA	NA	NA	NA	ND	NA	NA
	Diethylphthalate	NA	NA	NA	NA	ND	NA	NA	NA	NA	2J	NA	NA
II3D													
	All SVOCs	NA	NA	NA	NA	ND	NA	NA	NA	NA	ND	NA	NA

Notes:
J = value is estimated
NA = Not Analyzed
ND = Not Detected
Units are in micrograms per liter (ug/L)

Table 3
Summary of Detected Metals Concentrations in Groundwater (March 2008 - Sept 2012)
Western Sand and Gravel Site
Burrillville, Rhode Island

October 2009

	Loc Name:	C-1D	C-2D	C-2M	C-2M DUP	C-2S	C-3D	C-3D DUP	C-3M	C-3S	C-4D	C-4M	C-4S	C-5D	C-5M	C-5S	C-6D	C-6D	C-6D	C-6M
Analyte	Units	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result
Aluminum	UG/L	565	111	62.2	77.6	74.8	42.2	45.6	56.2	78.5	110	41.1	78.5	37.7	95.6	35.8	74.1	ND	ND	ND
Barium	UG/L	30.6	36.1	36.4	33.6	46.4	34.7	35.4	34.8	45.8	40	33	46.5	10.4	58.8	41.2	44.4	ND	10.6	9.6
Cobalt	UG/L	8.3	ND	ND	ND	ND	ND	ND	ND	ND	0.84	ND	ND	ND	9.3	ND	ND	2.5	ND	ND
Copper	UG/L	5.2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	5.5	ND	ND	ND	ND	0.57	ND	ND
Lead	UG/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nickel	UG/L	1.2	ND	ND	ND	ND	ND	ND	ND	ND	7	ND	1.7	ND	ND	ND	ND	ND	ND	ND
Zinc	UG/L	37.4	2.7	1.3	1	1.7	ND	ND	ND	1.9	12.6	ND	6.7	1.7	112	ND	1.8	ND	1.1	1.9

October 2009 (Continued)

	Loc Name:	C-6S	I-2D	I-2M	I-2S	I-3D	I-3M	I-3S	I-4D	I-4M	I-4S	I-6D	I-6M	I-6S	I-7D	I-7M	I-7S	II-3D	II-3M	II-3S
Analyte	Units	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result
Aluminum	UG/L	ND	60.5	62.6	110	23.1	136	222	ND	ND	ND	ND	ND	393	540	ND	ND	ND	25.7	ND
Barium	UG/L	17.2	24.1	27.6	24.8	6.6	13.7	13.9	ND	5.1	9.2	35.4	34.7	23	11.2	3.5	5.6	5	17.3	46.3
Cobalt	UG/L	1.6	ND	ND	ND	ND	ND	1.4	2.7	ND	ND	0.73	0.56	ND	ND	ND	ND	1.4	ND	1.6
Copper	UG/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	5.7	ND	ND	ND	ND	ND
Lead	UG/L	4.3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nickel	UG/L	4.7	0.51	ND	ND	ND	0.51	1	ND	ND	ND	ND	ND	ND	ND	ND	ND	34.5	ND	ND
Zinc	UG/L	7.4	3.4	1.5	1.1	2.8	2.3	3	ND	ND	ND	ND	ND	1.2	ND	ND	ND	7.7	ND	10.1

September 2011

	Loc Name:	C-1D	C-2D	C-2M	C-2S	C-3D	C-3M	C-3S	C-3S DUP	C-4D	C-4M	C-4S	C-4S DUP	C-5D	C-5M	C-5S	C-6D	C-6M	C-6S	I-2D
Analyte	Units	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result
Aluminum	UG/L	545	66.2	ND	ND	ND	118	47.1	23	45.8	ND	54.3	65.7	ND	188	ND	ND	ND	ND	119
Barium	UG/L	19.2	33.4	34.4	35.1	34.3	36.6	32.1	32.3	39.6	36	29.3	28.4	5.6	22.3	40.8	5.9	3.9	25.5	20.2
Cobalt	UG/L	7.9	ND	ND	ND	ND	ND	ND	ND	1.4	ND	ND	ND	ND	3.3	0.24	ND	ND	0.3	ND
Lead	UG/L	3.8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nickel	UG/L	2.6	ND	ND	ND	ND	ND	ND	ND	3.2	ND	ND	ND	ND	2.4	3.4	ND	ND	12.7	ND
Zinc	UG/L	25.7	ND	ND	ND	ND	ND	ND	ND	12.5	ND	5.2	ND	2.4	88.9	4.2	ND	ND	5.8	ND

September 2011 (Continued)

	Loc Name:	I-2M	I-2S DUP	I-2S	I-3D	I-3M	I-3S	I-4D	I-4M	I-4S	I-4S DUP	I-6D	I-6M	I-6S	I-7D	I-7M	I-7S	II-3D	II-3M	II-3S
Analyte	Units	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result
Aluminum	UG/L	ND	ND	ND	ND	ND	118	ND	27.2	30.1	ND	ND	116	410	ND	ND	ND	ND	ND	ND
Barium	UG/L	25.2	20.4	20.1	3.6	8.9	8.3	ND	5.3	9.5	9	29.4	33.6	25.4	5.2	7.3	5.6	4	11.3	18.7
Cobalt	UG/L	ND	ND	ND	ND	ND	0.64	2.6	ND	ND	ND	ND	0.47	ND	ND	ND	ND	2.6	1.4	1
Lead	UG/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nickel	UG/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	3.1	ND	ND
Zinc	UG/L	1.6	ND	1.4	1.5	ND	1.3	ND	ND	ND	ND	2.9	ND	2.7	ND	ND	ND	7.3	5.6	ND

Notes:
ND = Not detected
UG/L = micrograms per liter

Appendix C

Site Inspection Report

Five Year Review Site Inspection Checklist

Five Year Review Site Inspection Photographs

Site Inspection Checklist

I. SITE INFORMATION	
Site name: Western Sand and Gravel Superfund Site	**Date of inspection:** September 6, 2012
Location and Region: Towns of Burrillville and North Smithfield, Providence County, Rhode Island	**EPA ID:** RID009764929
Agency, office, or company leading the five-year review: EPA New England – Region 1, Office of Site Remediation and Restoration	**Weather/temperature:** Cloudy / 76°F

Remedy Includes: (Check all that apply)

- ■ Landfill cover/containment
- ■ Access controls
- ■ Institutional controls
- Groundwater pump and treatment
- Surface water collection and treatment
- ■ Other Groundwater Monitoring and natural attenuation
- Monitored natural attenuation
- Groundwater containment
- Vertical barrier walls

Attachments: Inspection team roster attached Site map attached

II. INTERVIEWS (Check all that apply)

1. **O&M site manager** _____ _____ _____
   Name Title Date
   Interviewed ☐ at site ☐ at office ☐ by phone Phone no. _____
   Problems, suggestions; ☐ Report attached _____
   _____

2. **O&M staff** _____ _____ _____
   Name Title Date
   Interviewed ☐ at site ☐ at office ☐ by phone Phone no. _____
   Problems, suggestions; ☐ Report attached _____
   _____

3. **Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply.

Agency RIDEM
Contact Paul Kulpa (Name) Project Manager (Title) September 6, 2012 (Date) 401 222 2797 ext. 7111 (Phone no.)
Problems; suggestions; Report attached _____

Agency _____
Contact _____ (Name) _____ (Title) _____ (Date) _____ (Phone no.)
Problems; suggestions; ☐ Report attached _____

Agency _____
Contact _____ (Name) _____ (Title) _____ (Date) _____ (Phone no.)
Problems; suggestions; ☐ Report attached _____

Agency _____
Contact _____ (Name) _____ (Title) _____ (Date) _____ (Phone no.)
Problems; suggestions; ☐ Report attached _____

4. **Other interviews** (optional) ☐ Report attached.

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)				
1.	**O&M Documents**			
	O&M manual	Readily available	Up to date	■ N/A
	As-built drawings	Readily available	Up to date	■ N/A
	Maintenance logs	Readily available	Up to date	■ N/A
	Remarks			
2.	**Site-Specific Health and Safety Plan**	Readily available	■ Up to date	N/A
	Contingency plan/emergency response plan	Readily available	Up to date	■ N/A
	Remarks			
3.	**O&M and OSHA Training Records**	Readily available	■ Up to date	N/A
	Remarks			
4.	**Permits and Service Agreements**			
	Air discharge permit	Readily available	Up to date	■ N/A
	Effluent discharge	Readily available	Up to date	■ N/A
	Waste disposal, POTW	Readily available	Up to date	■ N/A
	Other permits	Readily available	Up to date	■ N/A
	Remarks			
5.	**Gas Generation Records**	Readily available	Up to date	■ N/A
	Remarks			
6.	**Settlement Monument Records**	Readily available	Up to date	■ N/A
	Remarks			
7.	**Groundwater Monitoring Records**	Readily available	■ Up to date	N/A
	Remarks			
8.	**Leachate Extraction Records**	Readily available	Up to date	■ N/A
	Remarks			
9.	**Discharge Compliance Records**			
	Air	Readily available	Up to date	■ N/A
	Water (effluent)	Readily available	Up to date	■ N/A
	Remarks			
10.	**Daily Access/Security Logs**	Readily available	■ Up to date	N/A
	Remarks Entry to the site's fenced area is recorded in the quarterly site inspection reports.			

IV. O&M COSTS

1. **O&M Organization**

State in-house — Contractor for State
PRP in-house — ■ Contractor for PRP
Federal Facility in-house — Contractor for Federal Facility
Other_____

2. **O&M Cost Records**

Readily available ■ Up to date
■ Funding mechanism/agreement in place
Original O&M cost estimate_____ Breakdown attached

Total annual cost by year for review period if available

From_____ To_____ _____ Breakdown attached
Date Date Total cost
From_____ To_____ _____ Breakdown attached
Date Date Total cost
From_____ To_____ _____ Breakdown attached
Date Date Total cost
From_____ To_____ _____ Breakdown attached
Date Date Total cost
From_____ To_____ _____ Breakdown attached
Date Date Total cost

3. **Unanticipated or Unusually High O&M Costs During Review Period**

Describe costs and reasons: _____

V. ACCESS AND INSTITUTIONAL CONTROLS ■ Applicable N/A

A. Fencing

1. **Fencing damaged** Location shown on site map ■ Gates secured N/A
Remarks Fence and gates and locks were in good repair.

B. Other Access Restrictions

1. **Signs and other security measures** Location shown on site map N/A
Remarks_____

C. Institutional Controls (ICs)

1. **Implementation and enforcement**

Site conditions imply ICs not properly implemented — Yes ■ No N/A
Site conditions imply ICs not being fully enforced — Yes ■ No N/A

Type of monitoring (*e.g.*, self-reporting, drive by) _____
Frequency _____
Responsible party/agency Olin Corporation
Contact James Cashwell (Name) Sr. Associate Specialist-Env. Remediation (Title) September 6, 2012 (Date) 423-336-4012 (Phone no.)

Reporting is up-to-date — ☐ Yes ☐ No ☐ N/A
Reports are verified by the lead agency — ☐ Yes ☐ No ☐ N/A

Specific requirements in deed or decision documents have been met — ☐ Yes ☐ No ☐ N/A
Violations have been reported — ☐ Yes ☐ No ☐ N/A
Other problems or suggestions: ☐ Report attached

2. **Adequacy** ■ ICs are adequate ☐ ICs are inadequate ☐ N/A
Remarks _____

D. General

1. **Vandalism/trespassing** Location shown on site map ■ No vandalism evident
Remarks _____

2. **Land use changes on site** ■ N/A
Remarks _____

3. **Land use changes off site** ■ N/A
Remarks _____

VI. GENERAL SITE CONDITIONS

A. Roads ■ Applicable N/A

1. **Roads damaged** Location shown on site map ■ Roads adequate N/A
Remarks _____

B. Other Site Conditions

Remarks _____

_____

_____

_____

_____

_____

VII. LANDFILL COVERS ■ Applicable N/A

A. Landfill Surface

1. **Settlement** (Low spots) Location shown on site map ■Settlement not evident
   Areal extent_____ Depth_____
   Remarks Areas that have previously shown settlement were replenished with clean fill that was tested according to RIDEM requirements. The areas seemed stable at the time of inspection.

2. **Cracks** Location shown on site map ■ Cracking not evident
   Lengths_____ Widths_____ Depths_____
   Remarks_____

3. **Erosion** Location shown on site map ■ Erosion not evident
   Areal extent_____ Depth_____
   Remarks_____

4. **Holes** Location shown on site map ■ Holes not evident
   Areal extent_____ Depth_____
   Remarks_____

5. **Vegetative Cover** ■ Grass ■ Cover properly established ■ No signs of stress
   Trees/Shrubs (indicate size and locations on a diagram)
   Remarks_____

6. **Alternative Cover (armored rock, concrete, etc.)** ■ N/A
   Remarks_____

7. **Bulges** Location shown on site map ■ Bulges not evident
   Areal extent_____ Height_____
   Remarks_____

8. **Wet Areas/Water Damage** ■ Wet areas/water damage not evident
   Wet areas Location shown on site map Areal extent_____
   Ponding Location shown on site map Areal extent_____
   Seeps Location shown on site map Areal extent_____
   Soft subgrade Location shown on site map Areal extent_____
   Remarks_____

9.	**Slope Instability**	Slides	Location shown on site map	■ No evidence of slope instability
	Areal extent_____			
	Remarks_____			
B. Benches		Applicable	■ N/A	
	(Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)			
1.	**Flows Bypass Bench**		Location shown on site map	■ N/A or okay
	Remarks_____			
2.	**Bench Breached**		Location shown on site map	■ N/A or okay
	Remarks_____			
3.	**Bench Overtopped**		Location shown on site map	■ N/A or okay
	Remarks_____			
C. Letdown Channels		■ Applicable	N/A	
	(Channel lined with erosion control mats, riprap, grout bags, or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies.)			
1.	**Settlement**		Location shown on site map	■ No evidence of settlement
	Areal extent_____		Depth_____	
	Remarks_____			
2.	**Material Degradation**		Location shown on site map	■ No evidence of degradation
	Material type_____		Areal extent_____	
	Remarks_____			
3.	**Erosion**		Location shown on site map	■ No evidence of erosion
	Areal extent_____		Depth_____	
	Remarks_____			

4. **Undercutting** Location shown on site map ■ No evidence of undercutting
Areal extent_____ Depth_____
Remarks_____

5. **Obstructions** Type_____ ■No obstructions
Location shown on site map Areal extent_____ Size_____
Remarks_____

6. **Excessive Vegetative Growth** Type_____
■ No evidence of excessive growth
Vegetation in channels does not obstruct flow
Location shown on site map Areal extent_____
Remarks_____

D. Cover Penetrations Applicable ■ N/A

1. **Gas Vents** Active Passive
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance
■ N/A
Remarks_____

2. **Gas Monitoring Probes**
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance ■ N/A
Remarks_____

3. **Monitoring Wells** (within surface area of landfill)
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance ■ N/A
Remarks_____

4. **Leachate Extraction Wells**
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance ■ N/A
Remarks_____

5. **Settlement Monuments** ■ Located ☐ Routinely surveyed ☐ N/A
Remarks_____

E. Gas Collection and Treatment Applicable ■ N/A

1. **Gas Treatment Facilities**
   Flaring Thermal destruction Collection for reuse
   Good condition Needs Maintenance
   Remarks_____

2. **Gas Collection Wells, Manifolds and Piping**
   Good condition Needs Maintenance
   Remarks_____

3. **Gas Monitoring Facilities** (*e.g.*, gas monitoring of adjacent homes or buildings)
   Good condition Needs Maintenance
   Remarks_____

F. Cover Drainage Layer ■ Applicable ☐ N/A

1. **Outlet Pipes Inspected** ☐ Functioning ■ N/A
   Remarks_____

2. **Outlet Rock Inspected** ■ Functioning ☐ N/A
   Remarks_____

G. Detention/Sedimentation Ponds Applicable ■ N/A

1. **Siltation** Areal extent_____ Depth_____ ■ N/A
   Siltation not evident
   Remarks_____

2. **Erosion** Areal extent_____ Depth_____
   Erosion not evident
   Remarks_____

3. **Outlet Works** Functioning ■N/A
   Remarks_____

4. **Dam** Functioning ■ N/A
   Remarks_____

H. Retaining Walls Applicable ■ N/A

1. **Deformations** Location shown on site map Deformation not evident
   Horizontal displacement_____ Vertical displacement_____
   Rotational displacement_____
   Remarks_____

2. **Degradation** Location shown on site map Degradation not evident
   Remarks_____

I. Perimeter Ditches/Off-Site Discharge ☐ Applicable ■ N/A

1. **Siltation** ☐ Location shown on site map ☐ Siltation not evident
   Areal extent_____ Depth_____
   Remarks_____

2. **Vegetative Growth** ☐ Location shown on site map ☐ N/A
   ☐ Vegetation does not impede flow
   Areal extent_____ Type_____
   Remarks_____

3. **Erosion** ☐ Location shown on site map ☐ Erosion not evident
   Areal extent_____ Depth_____
   Remarks_____

4. **Discharge Structure** ☐ Functioning ☐ N/A
   Remarks_____

VIII. VERTICAL BARRIER WALLS Applicable ■ N/A

1. **Settlement** Location shown on site map Settlement not evident
   Areal extent_____ Depth_____
   Remarks_____

2. **Performance Monitoring** Type of monitoring_____
   Performance not monitored
   Frequency_____ Evidence of breaching
   Head differential_____
   Remarks_____

C. Treatment System	Applicable	■ N/A

1. **Treatment Train** (Check components that apply).
   Metals removal Oil/water separation Bioremediation
   Air stripping Carbon adsorbers
   Filters_____
   Additive (*e.g.*, chelation agent, flocculent)_____
   Others_____
   Good condition Needs Maintenance
   Sampling ports properly marked and functional
   Sampling/maintenance log displayed and up to date
   Equipment properly identified
   Quantity of groundwater treated annually_____
   Quantity of surface water treated annually_____
   Remarks_____

2. **Electrical Enclosures and Panels** (properly rated and functional)
   ■ N/A Good condition Needs Maintenance
   Remarks_____

3. **Tanks, Vaults, Storage Vessels**
   ■ N/A Good condition Proper secondary containment Needs Maintenance
   Remarks_____

4. **Discharge Structure and Appurtenances**
   ■ N/A Good condition Needs Maintenance
   Remarks_____

5. **Treatment Building(s)**
   ■ N/A Good condition (esp. roof and doorways) Needs repair
   Chemicals and equipment properly stored
   Remarks_____

6. **Monitoring Wells** (pump and treatment remedy)
   Properly secured/locked Functioning Routinely sampled Good condition
   All required wells located Needs Maintenance ■ N/A
   Remarks_____

D. Monitoring Data

1. Monitoring Data
   ■ Is routinely submitted on time ■ Is of acceptable quality

2. Monitoring data suggests:
   ■ Groundwater plume is effectively contained ■ Contaminant concentrations are declining

D. Monitored Natural Attenuation

1. **Monitoring Wells** (natural attenuation remedy)
■ Properly secured/locked ■ Functioning ■ Routinely sampled ■ Good condition
■ All required wells located Needs Maintenance N/A
Remarks Technically the remedy is not considered Monitored Natural Attenuation (MNA) since it was established well before the MNA remedy concept was formally accepted by EPA. The remedy for this site is natural attenuation plus site monitoring.

X. OTHER REMEDIES

If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.).

The remedy for OU-1was designed to provide residents in the affected area with a permanent supply of safe drinking water, to abate local sources of contamination at the Site, and to minimize future public health risks by restricting site acess. All of these objectives have been achieved, initially with the installation of water filters at homes where contaminants were identified in their wells (August 1984); followed by the installation of a permanent alternate water supply serving approximately 56 parcels (September1994). This inspection and other field inspections corroborated that the alternate water supply system is still effectively serving all residents in the vicinity of the Site.

The remedy for OU-2 was designed to contain or remove sources of contamination at the Site, in order to minimize the continued release of contaminants to the groundwater, future public exposure and health impacts; and to mitigate the environmental impact of contaminated groundwater. All of these objectives have been achieved by the excavation and consolidation of contaminated soils under approximately 2 acres of a RCRA C impermeable cap; the grading of the Site; the installation of a fence with warning signs around the cap and surrounding graded areas (approximately 6 acres within the total 25 acres of the Site); and the ongoing post-closure monitoring and inspections of the cap and graded areas, since March 1989. This inspection and other site inspections confirmed that the cap and graded areas within the fence are in good working conditions, and secured by by a fence without any evidence of trespassing.

The remedy for OU-3 was designed to restore contaminated groundwater in the overburden aquifer, from the boundary of the existing cap to the outer boundary of the contaminated plume, to state and federal Applicable and Relevant or Appropriate Requirements (ARARs), including drinking water standards, and to a level that is protective of human health and the environment as soon as practicable; to restore contaminated groundwater in the bedrock system, to state and federal ARARs, including drinking water standards, and to a level protective of human health and the environment as soon as practicable unless EPA determines, based on additional information, that contamination in the bedrock does not exceed protective levels; to protect uncontaminated groundwater and surface water for current and future use; to prevent human and animal exposure to contaminated groundwater; and to protect environmental receptors.

All of these objectives have been achieved by reliance on natural attenuation of contaminated groundwater with a contingency to perform active remediation; the use of institutional controls to reduce the risk to public health from consumption of groundwater, and the implementation of a Site monitoring program to include long term monitoring to the groundwater. This and other inspections have shown the network of monitoring wells to be intact and well secured. During this inspection the regulatory agencies were able to confirm that all Institutional Controls are effectively in place and that no residents are being exposed to the groundwater. Also via this and other inspections, the regulatory agencies have been able to audit and observe some of the groundwater monitoring activities of the overall Site monitoring program, further attesting the ongoing status of the remedy.

B. Adequacy of O&M

Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy.

The permanent alternate drinking water supply by the Nasonville Water District is still operational and it is ensuring that no one is exposed to the contaminated groundwater while the remedy progresses. The Nasonville Water District and the Town of Burrilveille have a good record-keeping and permit system in place which allowed us to confirm that all residents in the vicinity are connected to the Nasonville Water District water supply. The ability to track connections to the system helps ensure the short and long term protectiveness of the remedy for OU-I of the Site.

The fence and cap were observed to be in good operating condition, which is indicative of adequate adherence to the O&M procedures indicated in the 1992 Consent Decree. This in turn, ensures the short-term effectiveness of the OU-II remedy. The long-term protectiveness of OU-II is contingent upon good operation and maintenance of these two structures.

C. Early Indicators of Potential Remedy Problems

Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs, that suggest that the protectiveness of the remedy may be compromised in the future.

None such issues were observed.

D. Opportunities for Optimization

Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.

N/A.

WESTERN SAND AND GRAVEL SUPERFUND SITE
PHOTOGRAPHS FROM THE FIVE YEAR REVIEW INSPECTION
September 6 2012

Figure 1. View of the Site's front gate (south to north).

Figure 2. View of the minor depression (covered with clean fill) located at the south east corner of the fenced area.

Figure 3. View of cluster of monitoring wells north of the site.

Figure 4. View of sign at the entrance gates of the fenced area.

Figure 5. Groundwater sampling at the wells immediately north of the fenced area.

Figure 6. Collecting a sample from a passive diffusion bag.

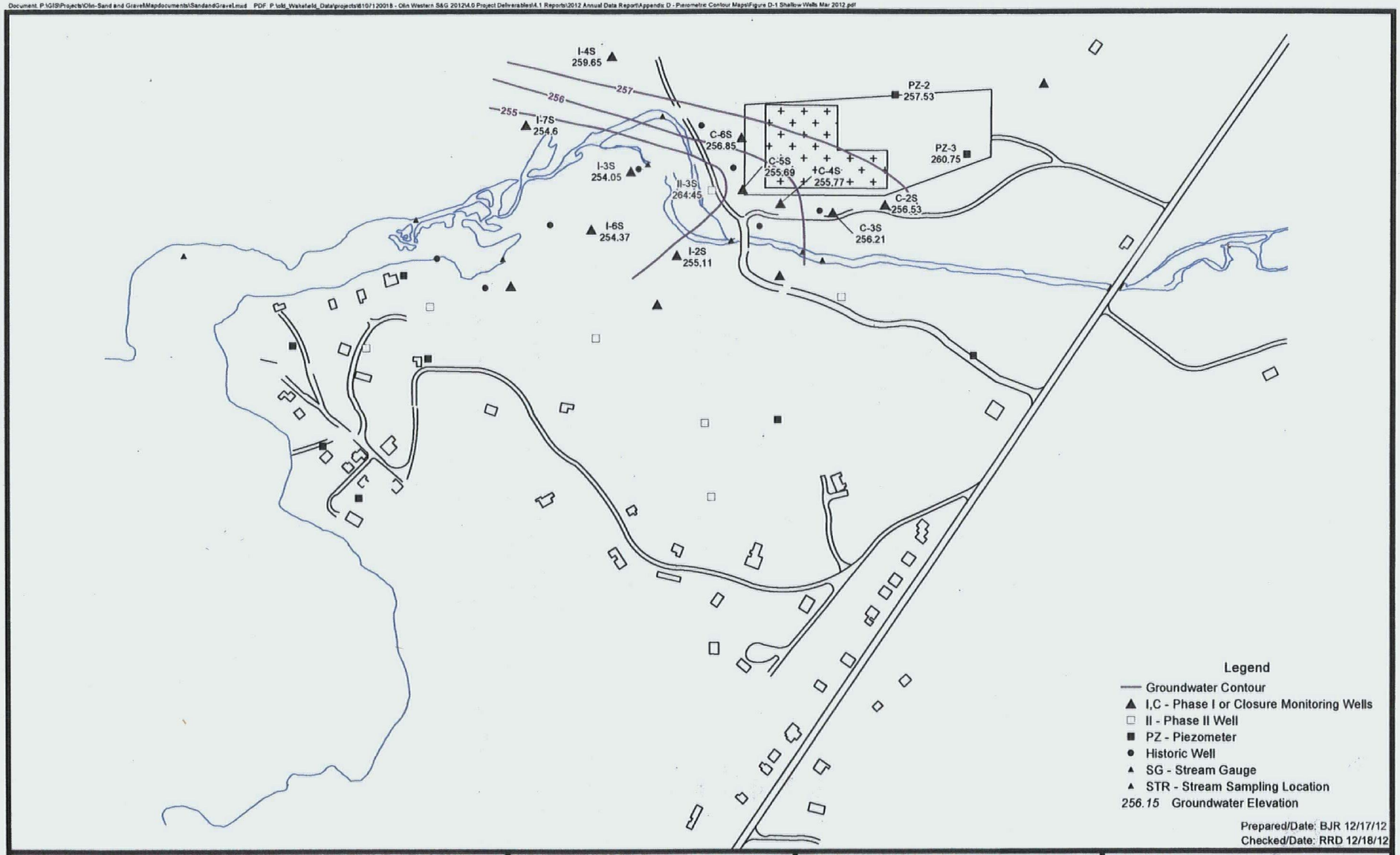
Figure 7. Surface water level gauge north of the site at Tarkiln Brook.

Appendix D

Piezometric Contour Maps

Figure D-1 Piezometric Contours for Shallow Wells Measured 03 / 2012
Figure D-2 Piezometric Contours for Shallow Wells Measured 09 / 2012
Figure D-3 Piezometric Contours for Medium Wells Measured 03 / 2012
Figure D-4 Piezometric Contours for Medium Wells Measured 09 / 2012
Figure D-5 Piezometric Contours for Medium Wells and Stream Gauges Measured 03 / 2012
Figure D-6 Piezometric Contours for Medium Wells and Stream Gauges Measured 09 / 2012
Figure D-7 Piezometric Contours for Deep Wells Measured 03 / 2012
Figure D-8 Piezometric Contours for Deep Wells Measured 09 / 2012
Figure D-9 Piezometric Contours for DeepWells and Stream Gauges Measured 03 / 2012
Figure D-10 Piezometric Contours for Deep Wells and Stream Gauges Measured 09 / 2012

Document: P:\GIS\Projects\Olin-Sand and Gravel\Mapdocuments\SandandGravel.mxd PDF: P:\olt_Wakefield_Data\projects\610712001B - Olin Western S&G 2012\4.0 Project Deliverables\4.1 Reports\2012 Annual Data Report\Appendix D - Piezometric Contour Maps\Figure D-1 Shallow Wells Mar 2012.pdf



Western Sand and Gravel
Burrillville, Rhode Island

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Figure D-1
Piezometric Contours for Shallow Wells
Measured March 2012

Document: P:\GIS\Projects\Olin-Sand and Gravel\Mapdocuments\SandandGravel.mxd PDF: P:\old_Wakefield_Data\projects\6107120018 - Olin Western S&G 2012\4.0 Project Deliverables\4.1 Reports\2012 Annual Data Report\Appendix D - Pierometric Contour Maps\Figure D-1 Shallow Wells Mar 2012.pdf

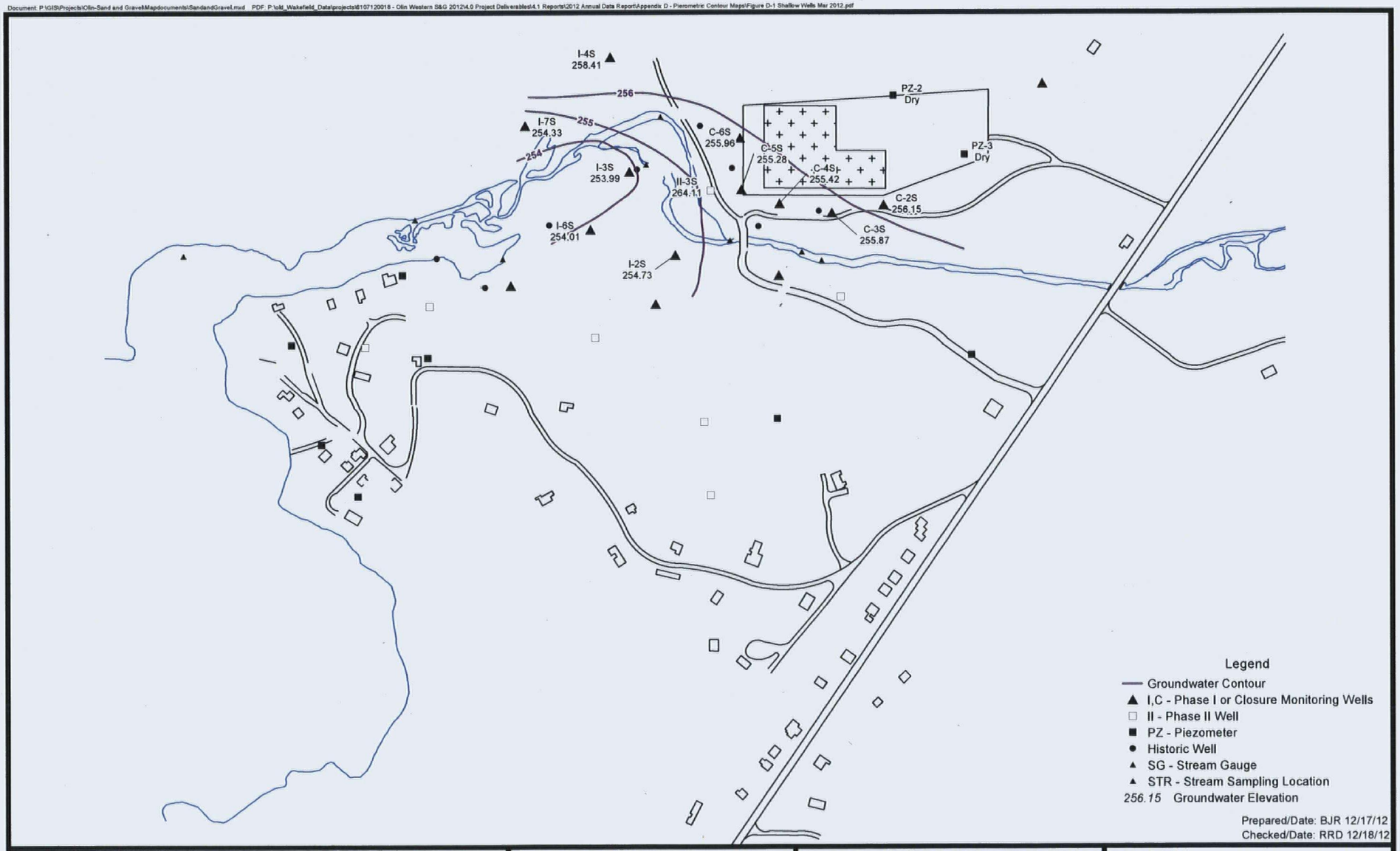

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Figure D-2
Piezometric Contours for Shallow Wells
Measured September 2012

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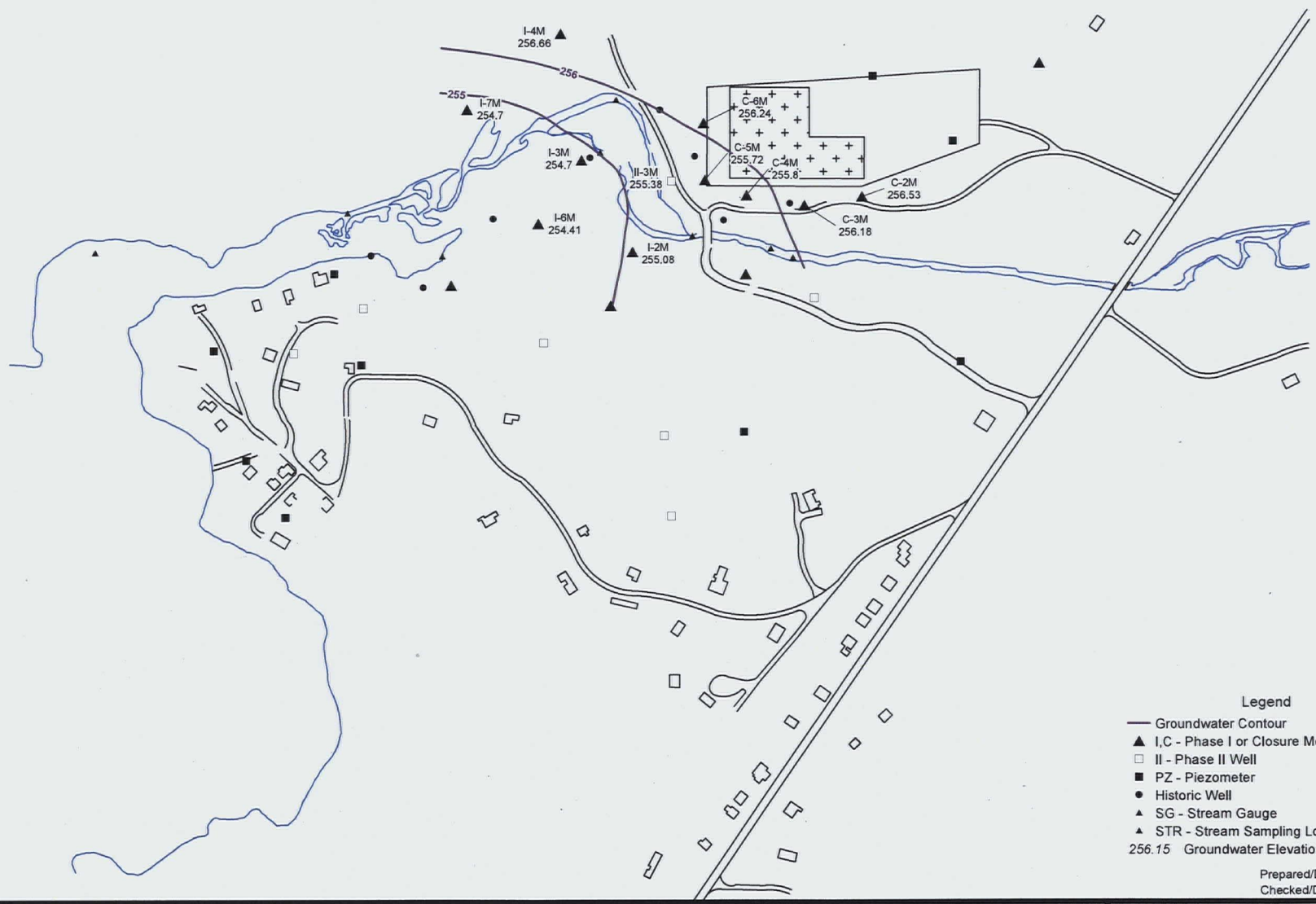

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Figure D-3
Piezometric Contours for Medium Wells
Measured March 2012

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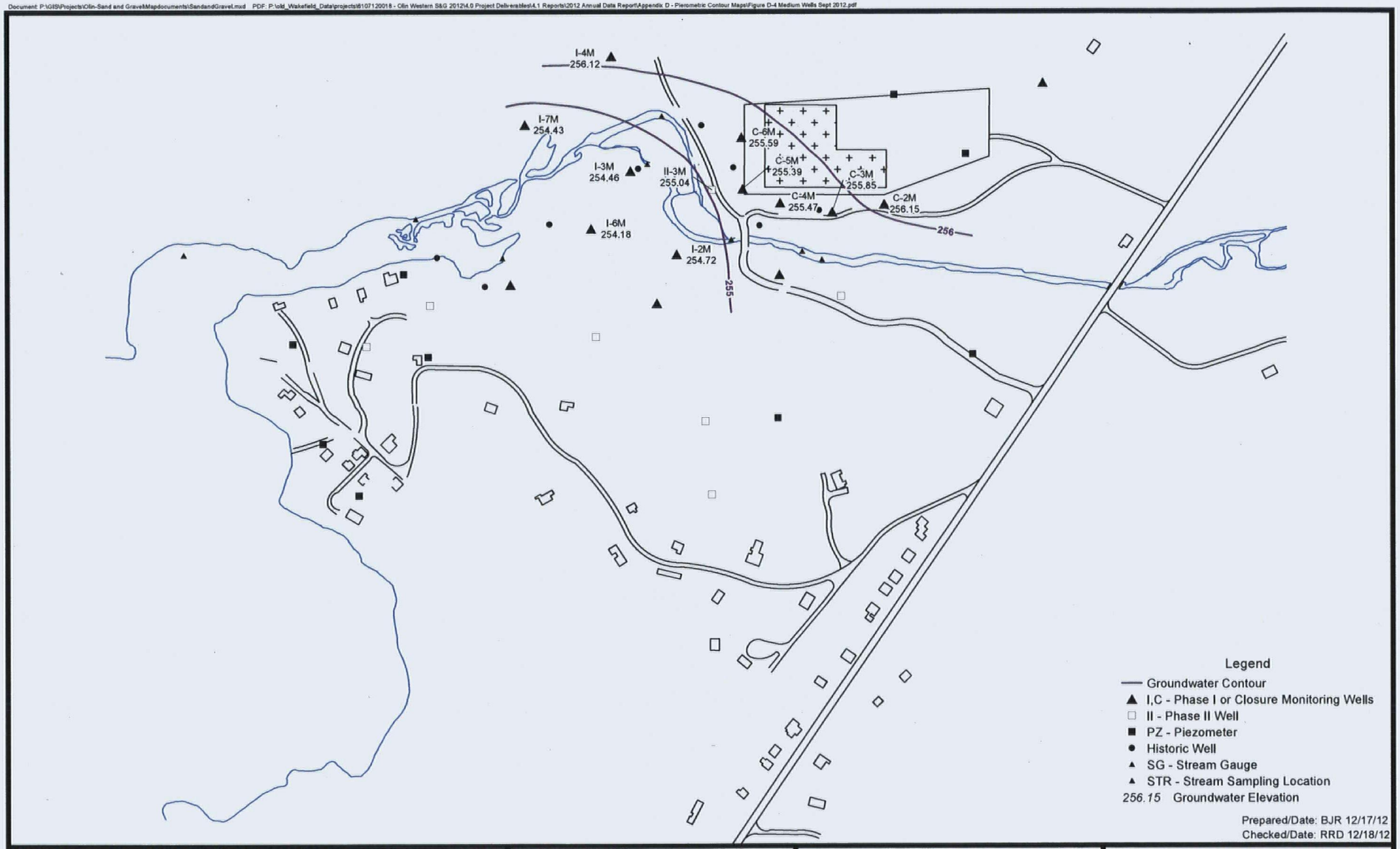

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Western Sand and Gravel
Burrillville, Rhode Island

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Figure D-4
Piezometric Contours for Medium Wells
Measured September 2012

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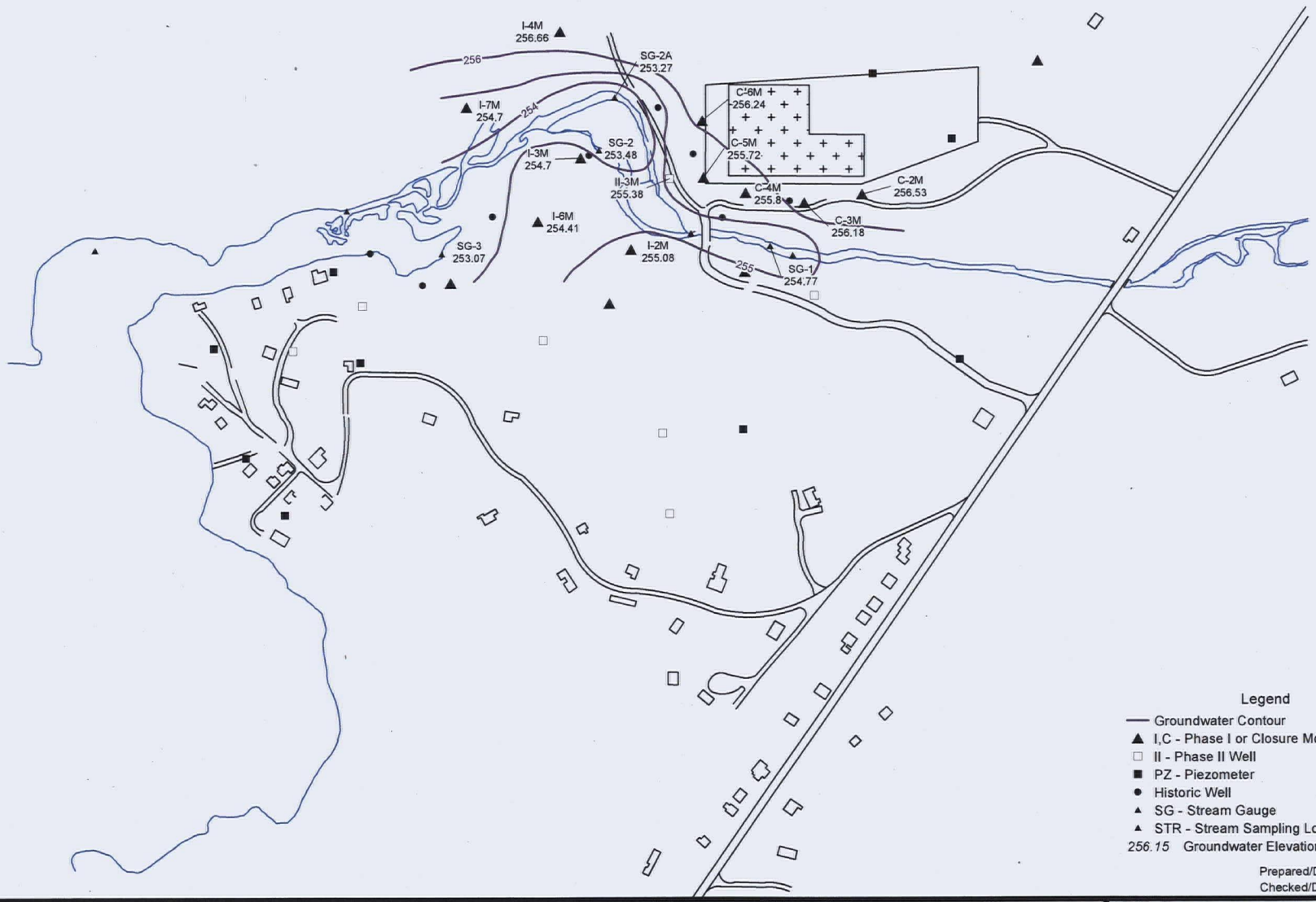

Prepared/Date: BJR 12/17/12
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Burrillville, Rhode Island

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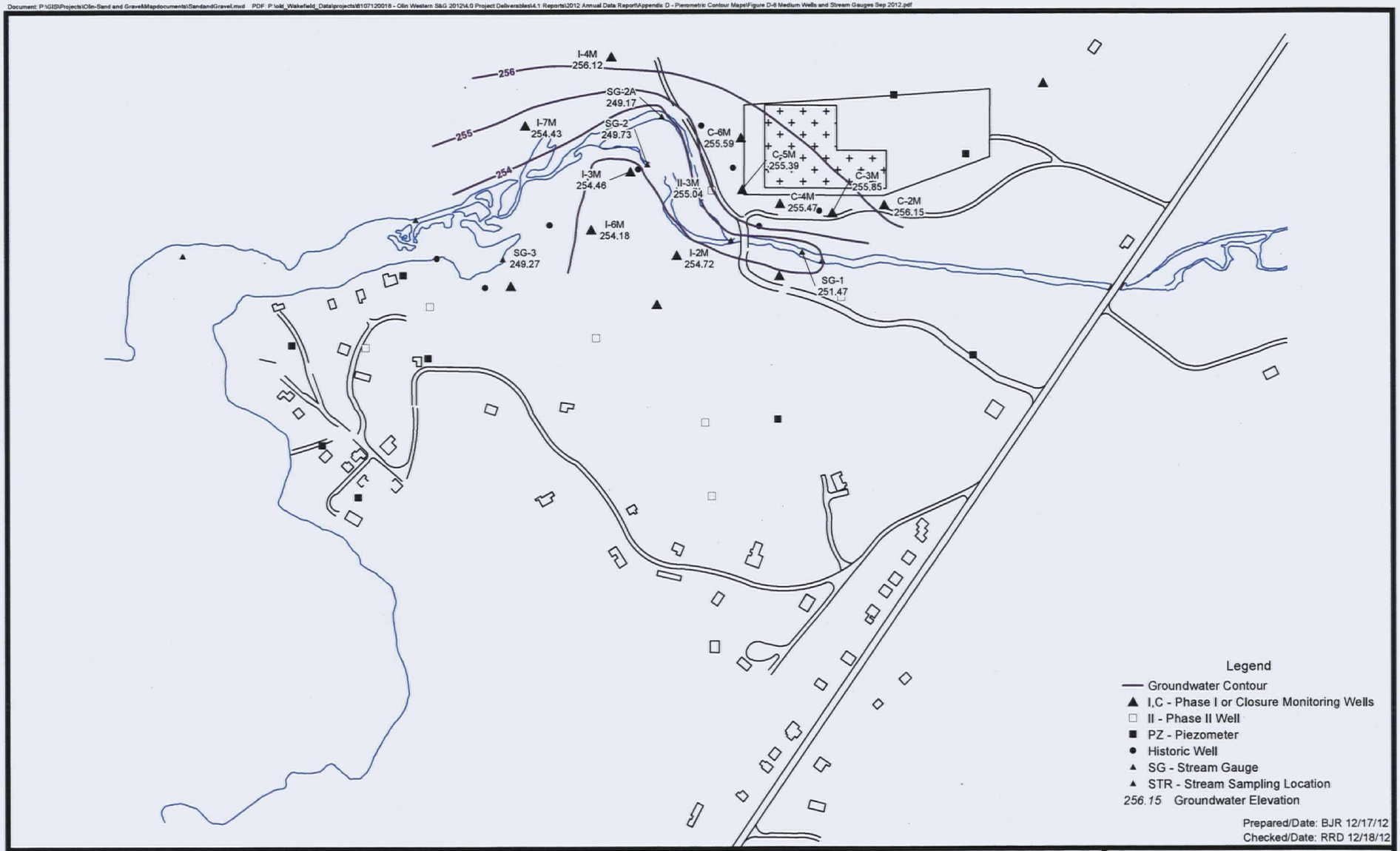
Figure D-5
Piezometric Contours for Medium Wells and Stream Gauges Measured March 2012

Document: P:\GIS\Projects\Olin-Sand and Gravel\Mapdocuments\SandandGravel.mxd PDF: P:\old_Wakefield_Data\projects\6107120018 - Olin Western S&G 2012\4.0 Project Deliverables\4.1 Reports\2012 Annual Data Report\Appendix D - Pierometric Contour Maps\Figure D-6 Medium Wells and Stream Gauges Sep 2012.pdf



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Western Sand and Gravel
Burrillville, Rhode Island

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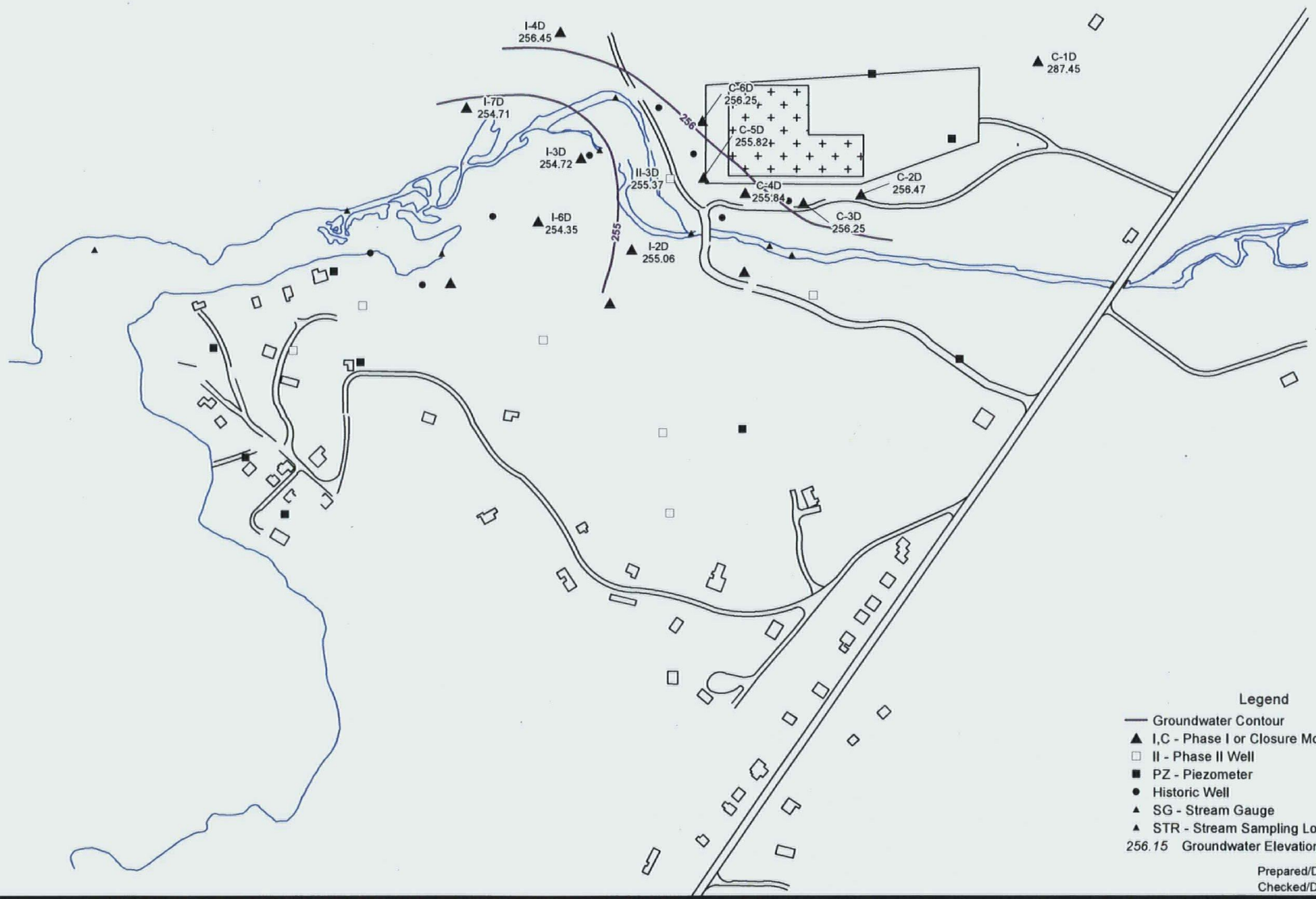
Figure D-6
Piezometric Contours for Medium Wells and Stream Gauges Measured September 2012

Document: P:\GIS\Projects\Olin-Sand and Gravel\Mapdocuments\SandandGravel.mxd PDF: P:\old_Wakefield_Data\projects\6107120018 - Olin Western S&G 2012\4.0 Project Deliverables\4.1 Reports\2012 Annual Data Report\Appendix D - Pierometric Contour Maps\Figure D-6 Medium Wells and Stream Gauges Sep 2012.pdf



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Burrillville, Rhode Island

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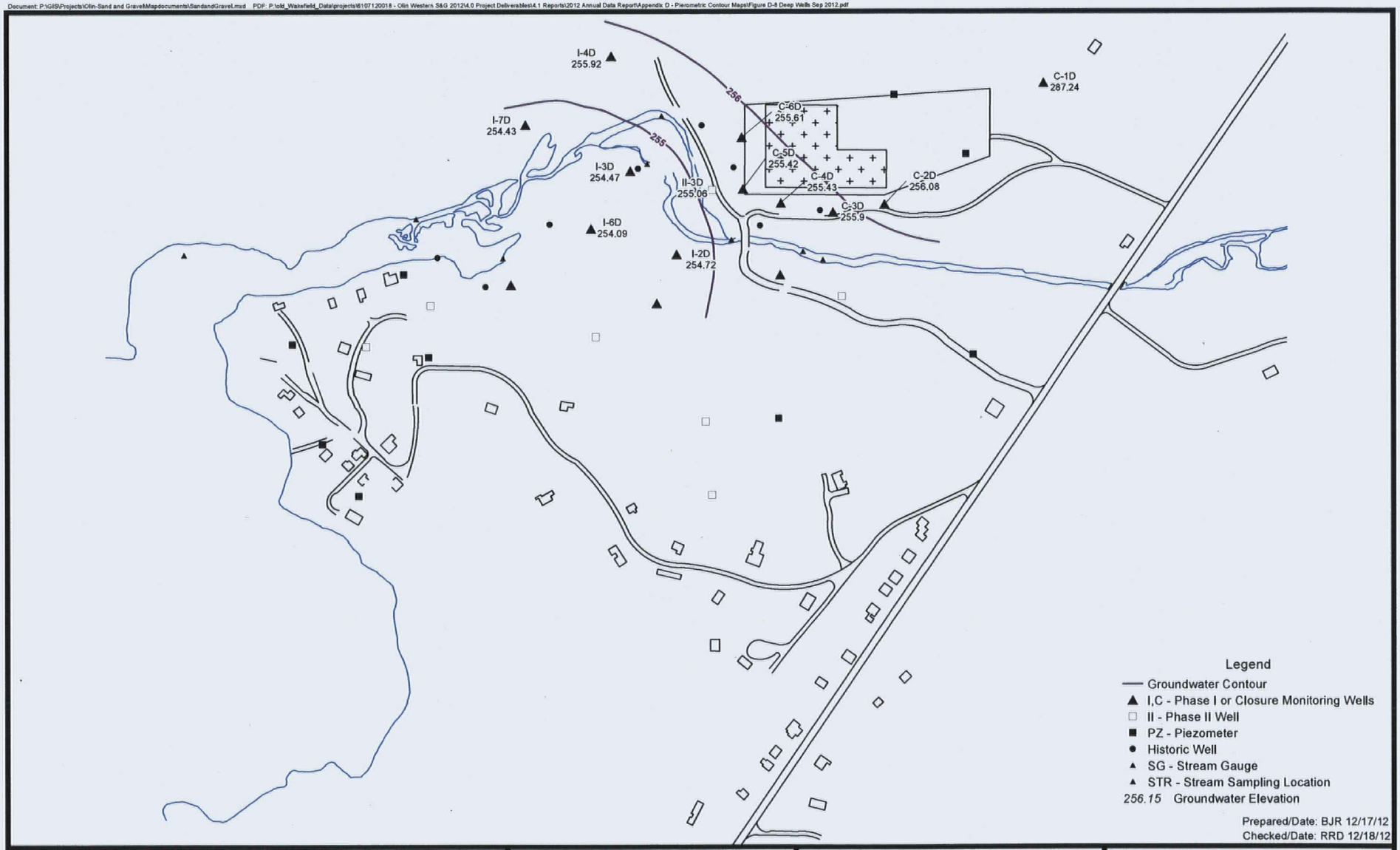
Figure D-7
Piezometric Contours for Deep Wells
Measured March 2012

Document: P:\GIS\Projects\Olin-Sand and Gravel\Mapdocuments\SandandGravel.mxd PDF: P:\old_Wakefield_Data\projects\6107120018 - Olin Western S&G 2012\4.0 Project Deliverables\4.1 Reports\2012 Annual Data Report\Appendix D - Piezometric Contour Maps\Figure D-8 Deep Wells Sep 2012.pdf



Western Sand and Gravel
Burrillville, Rhode Island

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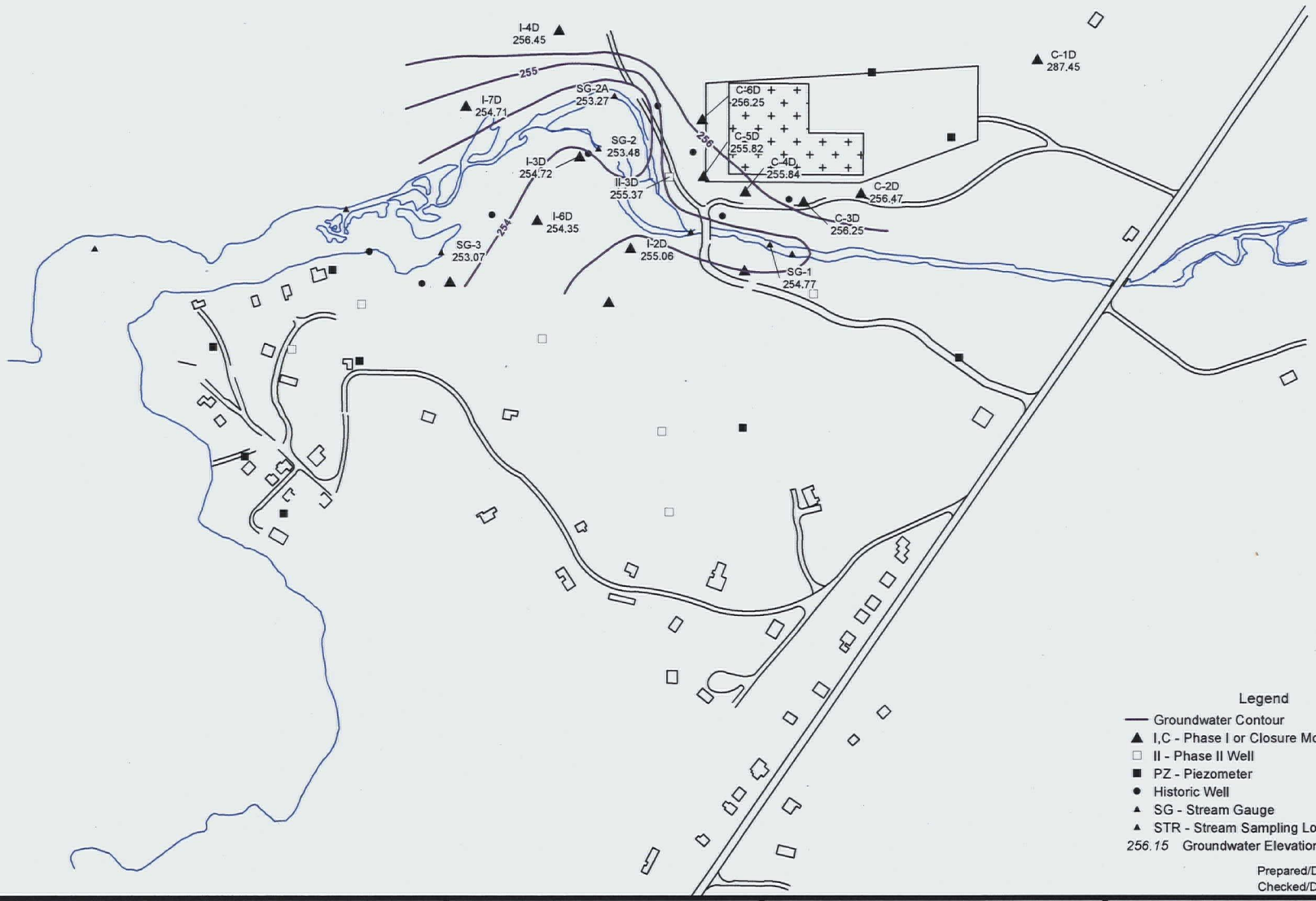
Figure D-8
Piezometric Contours for Deep Wells
Measured September 2012

Document: P:\GIS\Projects\Olin-Sand and Gravel\Mapdocuments\SandandGravel.mxd PDF: P:\old_Wakefield_Data\projects\6107120018 - Olin Western S&G 2012\4.0 Project Deliverables\4.1 Reports\2012 Annual Data Report\Appendix D - Pierometric Contour Maps\Figure D-9 Deep Wells and Stream Gauges March 2012.pdf



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Western Sand and Gravel
Burrillville, Rhode Island

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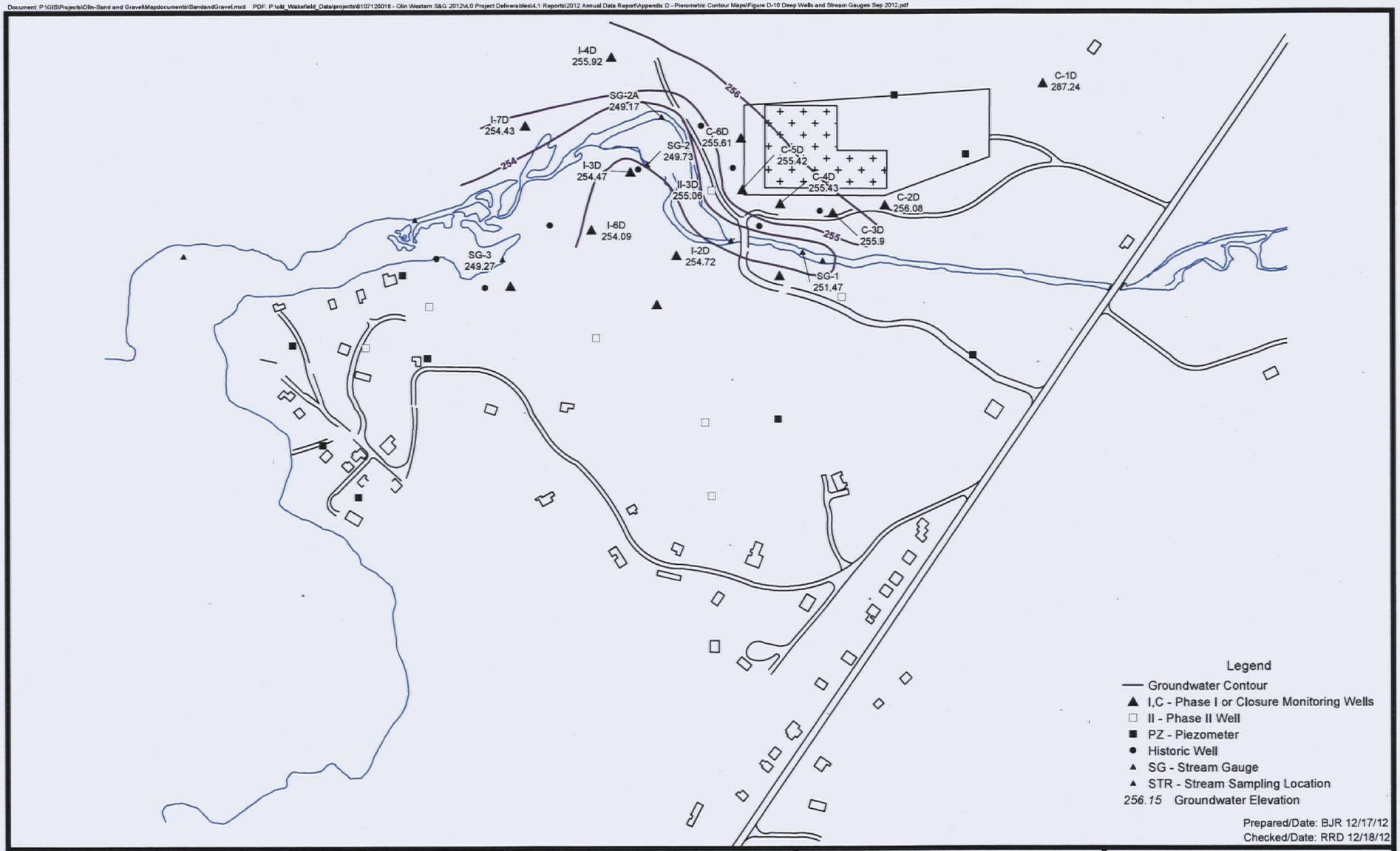
Figure D-9
Piezometric Contours for Deep Wells and Stream Gauges Measured March 2012

Document: P:\GIS\Projects\Olin-Sand and Gravel\Mapdocuments\SandandGravel.mxd PDF: P:\old_Wakefield_Data\projects\6107120018 - Olin Western S&G 2012\4.0 Project Deliverables\4.1 Reports\2012 Annual Data Report\Appendix D - Piezometric Contour Maps\Figure D-10 Deep Wells and Stream Gauges Sep 2012.pdf



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Western Sand and Gravel
Burrillville, Rhode Island

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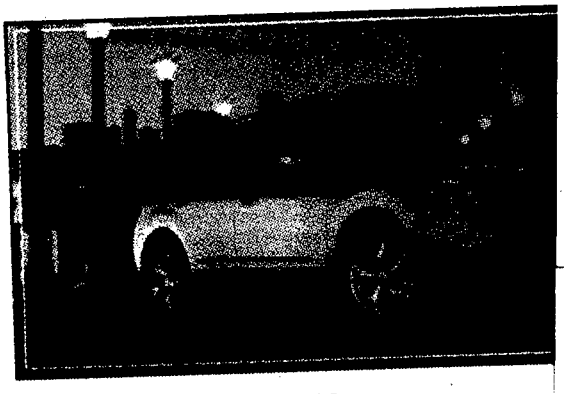
Figure D-10
Piezometric Contours for Deep Wells and Stream Gauges Measured September 2012

Appendix E

Public Notice of 5YR Review



Friday, January 11, 2013

How to calculate the force of a car crash

Q: How can I calculate the impact force of a car crashing into a tree or wall? I want to give a talk to a group of high school students and be able to show them how dangerous collisions really are. Is there a good way to show this without making them glaze over with disinterest?

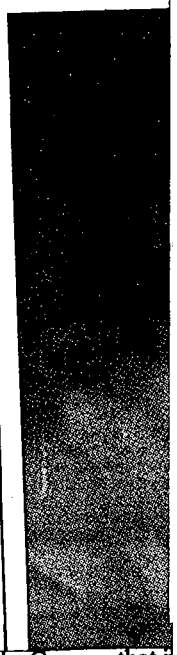
— Megan in Columbus, Ohio

A: The simplest equation

always overpriced. These will hide scratches for a short time, but I'd steer clear of them, as I recommend doing for any product heavily advertised on infomercials.

Most multi-step scratch removers are effective, as they contain some form of clear-coat finish that can be buffed out after it cures. These only work if the scratch isn't deep enough to get into the color layer of the paint. If that's the case, you need to touch up the color before doing any scratch repairs.

If the scratches on your car show white, it's likely that



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THE CALL Cla

To learn more about independent contractor opportunities please call Jorge at 401-617-8089 or Bill at 781-858-3294 to arrange an interview.

THE CALL

EPA Starts Five-Year Review of Western Sand & Gravel Superfund Site

The U.S. Environmental Protection Agency (EPA) has begun its fifth Five-Year Review of the Western Sand Superfund Site, Burrillville, RI. Five-Year Reviews are required by law and occur every five years. The reviews determine if the cleanup is protective of human health and the environment. This Five-Year Review will be completed by September 2013 and the results will be publicly available.

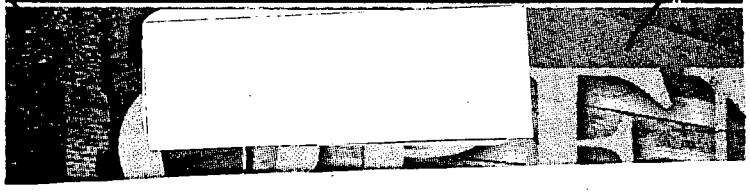
The Western Sand & Gravel Site cleanup plan included installing a groundwater recirculation system, building a permanent alternate water supply, installing a 2-acre cap over the areas of contaminated soil and sludge, grading the site to promote run-off and drainage, and fencing. Additional measures included cleanup of groundwater through natural attenuation.

Contaminants at the site included Volatile Organic Compounds in groundwater and soil. Cleanup actions have removed 60,000 gallons of liquid chemical and septic waste, installed a groundwater recirculation system and alternate water supply, and installed a cap. Groundwater cleanup through natural attenuation continues.

More information about the cleanup can be found on-line at www.epa.gov/ne/superfund/sites/wsg or at the Burrillville Town Hall, 105 Harrisville Main Street, Harrisville, RI 02830.

EPA
United States Environmental Protection Agency New England

For more information, contact:
Gerardo Millán-Ramos
Toll Free 1-888-372-7341, ext.81377 millan-ramos.gerardo@epa.gov
www.epa.gov/ne/superfund/sites/wsg



APPENDIX F

Tables and Figures Documenting Remedy Performance

Table F-1	Outlier Identification; Regression Outputs
Table F-2	Outputs from Mann Kendall Trend Test
Table F-3	Summary of Data per 5-Year Time Increment
Table F-4	Number of Wells by Indicator Compounds and Number Greater than MCLs (1989-2012)
Figure F-1	Wilcoxon Signed Rank Test Output for Tetrachloroethene (PCE)
Figure F-2	Wilcoxon Signed Rank Test Output for Tricholorethene (TCE)
Figure F-3	Wilcoxon Signed Rank Test Output for Vinyl Chloride (VC)
Figure F-3A	Wilcoxon Signed Rank Test Output for Benzene
Figure F-4	Theoretical Attenuation vs Actual Concentrations, Tetrachloroethene (PCE)
Figure F-5	Theoretical Attenuation vs Actual Concentrations, Tricholorethene (TCE)
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Figure F-8	Volatile Iso-Concentration Map 2011
Figure F-9	Volatile Iso-Concentration Map 2010
Figure F-10	Volatile Iso-Concentration Map 2009
Figure F-11	Historical Iso-Concentration Maps (1998 through 2008) as Reported in the 2008 Data Report by ATC Associates Inc.

Appendix F
Table F-1
Outlier Identification; Regression Outputs

3/6/2013 4:04:08 AM

```
Welcome to Minitab, press F1 for help.
Retrieving project from file:
'F:\PROJECTS\OLIN\WESTSANDG\STATS_ANALYSIS\WS_AND_G.MPJ_2.MPJ'
```

Regression Analysis: PCE versus t

```
The regression equation is
PCE = 13.8 - 0.0032 t


Predictor       Coef  SE Coef      T      P
Constant      13.807    2.688   5.14  0.000
t           -0.00315  0.02131  -0.15  0.883


S = 12.9165   R-Sq = 0.0%   R-Sq(adj) = 0.0%

PRESS = 11736.1   R-Sq(pred) = 0.00%


Analysis of Variance

Source          DF       SS     MS     F      P
Regression       1      3.7    3.7  0.02  0.883
Residual Error  63  10510.7  166.8
Total           64  10514.3


Unusual Observations

Obs    t    PCE    Fit  SE Fit  Residual  St Resid
  1  -25  64.00  13.89    3.13     50.11    4.00R
 55  193  49.00  13.20    2.53     35.80    2.83R
 64  252  70.00  13.01    3.59     56.99    4.59R

R denotes an observation with a large standardized residual.


Durbin-Watson statistic = 1.61040
```

Regression Analysis: ln_PCE versus t

```
The regression equation is
ln_PCE = 2.43 - 0.00182 t


Predictor        Coef   SE Coef      T      P
Constant       2.4322    0.1816  13.39  0.000
t           -0.001820  0.001440  -1.26  0.211


S = 0.872743   R-Sq = 2.5%   R-Sq(adj) = 0.9%

PRESS = 51.9388   R-Sq(pred) = 0.00%


Analysis of Variance
```

Source	DF	SS	MS	F	P
Regression	1	1.2172	1.2172	1.60	0.211
Residual Error	63	47.9858	0.7617		
Total	64	49.2031			

Unusual Observations

Obs	t	ln_PCE	Fit	SE Fit	Residual	St Resid
13	30	0.262	2.378	0.149	-2.115	-2.46R
34	93	0.470	2.263	0.109	-1.793	-2.07R
55	193	3.892	2.081	0.171	1.811	2.12R
62	240	0.000	1.995	0.227	-1.995	-2.37R
64	252	4.248	1.974	0.242	2.275	2.71R

R denotes an observation with a large standardized residual.

Durbin-Watson statistic = 1.94542

Regression Analysis: TCE versus t

The regression equation is
TCE = 26.0 - 0.123 t

Predictor	Coef	SE Coef	T	P
Constant	26.008	4.979	5.22	0.000
t	-0.12297	0.03947	-3.12	0.003

S = 23.9286 R-Sq = 13.4% R-Sq(adj) = 12.0%

PRESS = 40400.7 R-Sq(pred) = 2.95%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	5558.1	5558.1	9.71	0.003
Residual Error	63	36072.5	572.6		
Total	64	41630.6			

Unusual Observations

Obs	t	TCE	Fit	SE Fit	Residual	St Resid
1	-25	200.00	29.08	5.80	170.92	7.36R

R denotes an observation with a large standardized residual.

Durbin-Watson statistic = 0.772285

Regression Analysis: ln_TCE versus t

The regression equation is
ln_TCE = 2.74 - 0.00697 t

Predictor	Coef	SE Coef	T	P
Constant	2.7362	0.1842	14.85	0.000
t	-0.006974	0.001460	-4.78	0.000

S = 0.885443 R-Sq = 26.6% R-Sq(adj) = 25.4%

PRESS = 53.0671 R-Sq(pred) = 21.11%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	17.879	17.879	22.80	0.000
Residual Error	63	49.393	0.784		
Total	64	67.271			

Unusual Observations

Obs	t	ln_TCE	Fit	SE Fit	Residual	St Resid
1	-25	5.298	2.911	0.215	2.388	2.78R
30	81	0.000	2.171	0.114	-2.171	-2.47R
34	93	-0.693	2.088	0.110	-2.781	-3.17R
52	174	-0.693	1.523	0.153	-2.216	-2.54R
58	210	3.045	1.272	0.193	1.773	2.05R
64	252	3.135	0.979	0.246	2.157	2.54R

R denotes an observation with a large standardized residual.

Durbin-Watson statistic = 1.69526

Regression Analysis: VC versus t

The regression equation is
VC = 58.0 - 0.310 t

Predictor	Coef	SE Coef	T	P
Constant	58.05	11.44	5.08	0.000
t	-0.31045	0.09066	-3.42	0.001

S = 54.9614 R-Sq = 15.7% R-Sq(adj) = 14.4%

PRESS = 211749 R-Sq(pred) = 6.19%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	35424	35424	11.73	0.001
Residual Error	63	190308	3021		
Total	64	225732			

Unusual Observations

Obs	t	VC	Fit	SE Fit	Residual	St Resid
1	-25	430.00	65.81	13.33	364.19	6.83R

R denotes an observation with a large standardized residual.

Durbin-Watson statistic = 0.711789

Regression Analysis: ln_VC versus t

The regression equation is
ln_VC = 3.07 - 0.0102 t

Predictor	Coef	SE Coef	T	P
Constant	3.0703	0.2895	10.60	0.000
t	-0.010167	0.002295	-4.43	0.000

S = 1.39148 R-Sq = 23.8% R-Sq(adj) = 22.5%

PRESS = 130.871 R-Sq(pred) = 18.19%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	37.995	37.995	19.62	0.000
Residual Error	63	121.981	1.936		
Total	64	159.977			

Unusual Observations

Obs	t	ln_VC	Fit	SE Fit	Residual	St Resid
1	-25	6.064	3.325	0.337	2.739	2.03R
57	205	4.317	0.986	0.294	3.331	2.45R

R denotes an observation with a large standardized residual.

Durbin-Watson statistic = 1.81697

Appendix F
Table F-2
Outputs for Mann Kendall Trend Test

```
   Kendall's tau Correlation Test
      US Geological Survey, 2005

Data set:     TCE data as is through 2012

The tau correlation coefficient is -0.404
    S =   -840.
    z =  -4.753
    p =  0.0000
```

```
    Kendall's tau Correlation Test
      US Geological Survey, 2005

Data set:     PCE data as is through 2012

The tau correlation coefficient is -0.164
    S =   -341.
    z =  -1.926
    p =  0.0541
```

```
    Kendall's tau Correlation Test
      US Geological Survey, 2005

Data set:     VC data as is through 2012

The tau correlation coefficient is -0.350
    S =   -729.
    z =  -4.123
    p =  0.0000
```

```
    Kendall's tau Correlation Test
      US Geological Survey, 2005

Data set: PCE data through 2012, remove anomalous March 2012 data point

The tau correlation coefficient is -0.200
    S =   -403.
    z =  -2.330
    p =  0.0198
```

Table F-3
Summary of Data per 5-Year Time Increment

		PCE				TCE				VC			
Period	Number Events	Mean[1,2], ppb	# Events Met MCL	# Unusual Obs	% Events Met MCL or less[3]	Mean[1], ppb	# Events Met MCL	# Unusual Obs	% Events Met MCL or less[3]	Mean[1], ppb	# Events Met MCL	# Unusual Obs	% Events Met MCL or less[3]
1989-1993	14	19.5	2	1	14.3%	33.9	0	0	0.0%	71.8	0	0	0.0%
1994-1998	20	11.3	3	1	15.0%	10.8	7	2	35.0%	24.3	5	0	25.0%
1999-2003	14	8.8	5	0	35.7%	7.2	6	0	42.9%	6.4	2	0	14.3%
2004-2008	10	12.9	3	1	30.0%	6.3	5	2	35.7%	7.1	3	1	30.0%
2009-2012	7	9.32	2	2	28.6%	5.56	6	1	60.0%	2.77	3	1	42.9%

Notes:
1. Arithmetic means for each time interval are calculated deleting the "unusual observation" for that interval
2. The mean for PCE during 2009-2011 on appears to include a local anomalous high of 22 ppb. Without that high value, the average would drop to about 6.2 ppb.
3. Percentage of events meeting MCL or less is computed based on the full set (i.e., no removal of "unusual observations").

Table F-4
Number of Wells Impacted by Indicator Compounds and Number Greater than MCLs
1989-2012

Year	Number of Wells					
	Indicator compounds detected			Indicator compounds > MCL		
	PCE	TCE	VC	PCE	TCE	VC
1989	13	14	7	3	7	6
1990	9	16	7	4	9	3
1991	8	16	5	5	3	4
1992	8	17	7	4	4	3
1993	8	14	6	3	3	4
1994	8	15	5	3	4	3
1998	5	7	4	3	2	3
1999	6	5	5	2	3	4
2000	4	4	3	2	0	2
2001	4	5	3	2	3	2
2002	3	3	2	2	1	1
2003	5	4	1	2	1	1
2004	3	4	1	2	0	1
2005	5	4	2	2	1	1
2006	8	6	4	2	2	4
2007	3	5	5	2	1	1
2008	3	5	4	1	2	2
2009	3	3	2	1	0	1
2010	3	4	3	2	0	0
2011	2	3	2	1	0	1
2012	3	4	2	1	1	1

Notes:
1. Data for 1989 through 1994 from Olin, 1995 letter report; number of wells = 27.
2. Data for 1995 through 1997 unavailable
3. Data for 1998 through 2012 from historic and new data in annual reports; e.g., AMEC, 2011, maximum number of wells = 41.
4. Most recent data (2012) show above MCL concentrations only at wells C-4S and II3-S.

Figure F-1
Wilcoxon Signed Rank Test for Tetrachloroethene

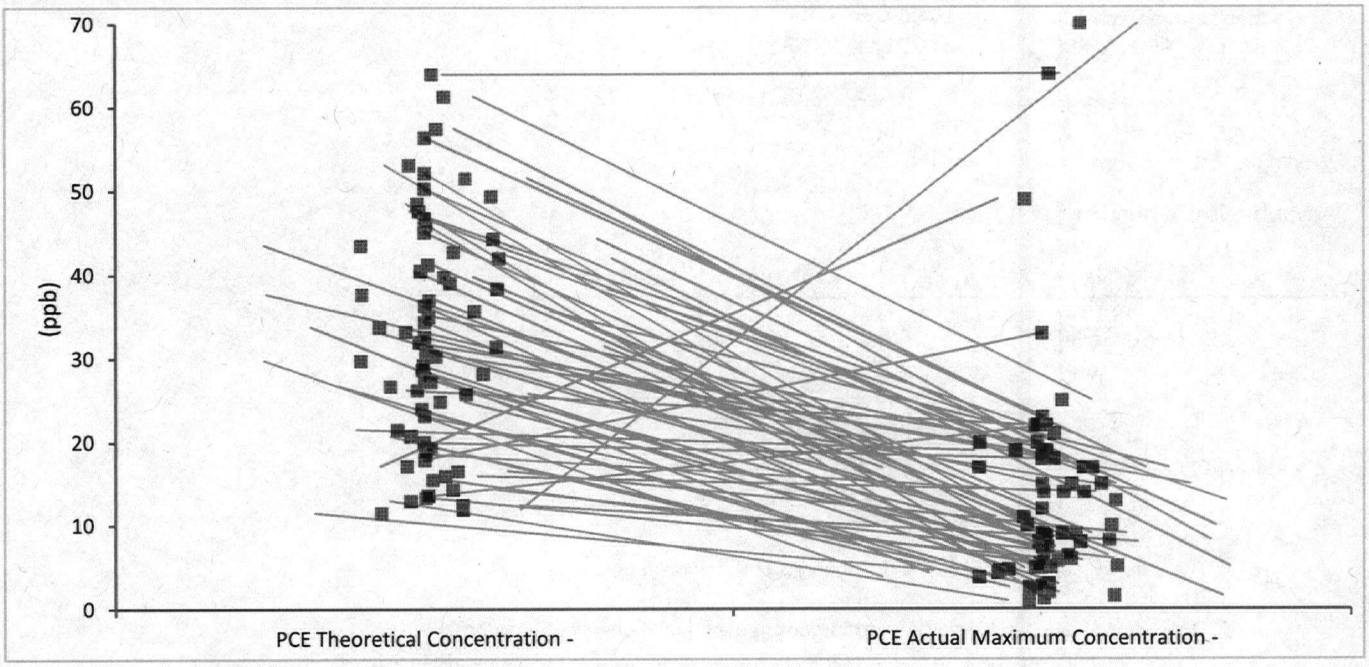
Compare Pairs: PCE Theoretical Concentration -, PCE Actual Maximum Concentration -

Analyse-it v3.10

PCE edited A1:B66

Last updated 20 January 2013 at 12:22 by Mike

Descriptives



N | 65

	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
PCE Theoretical Concentration - (ppb)	11.51	21.268	32.024	43.016	64.00	21.748
PCE Actual Maximum Concentration - (ppb)	1.00	5.167	9.000	18.000	70.00	12.833

Figure F-1
Wilcoxon Signed Rank Test for Tetrachloroethene

Compare Pairs: PCE Theoretical Concentration -, PCE Actual Maximum Concentration -

Analyse-it v3.10

PCE edited A1:B66

Last updated 20 January 2013 at 12:22 by Mike

Location

Hodges-Lehmann shift	-20.969
95.12% CI	-24.791 to -17.331

$F(_{\text{PCE Actual Maximum Concentration -}})=F(_{\text{PCE Theoretical Concentration -}}+\Delta)$

Wilcoxon test

Hypothesized difference	0

Sign	n	Rank sum	Mean rank
Positive	4	139.0	34.75
Negative	60	1941.0	32.35
Zero			

T statistic	139.00
Z approximation	-6.03
p-value	<0.0001[1]

H0: $\Delta = 0$
The shift in location between the distributions of the populations is equal to 0.
H1: $\Delta \neq 0$
The shift in location between the distributions of the populations is not equal to 0.
[1] Reject the null hypothesis in favour of the alternative hypothesis at the 5% significance level.

Figure F-2
Wilcoxon Signed Rank Test for Trichloroethene (TCE)

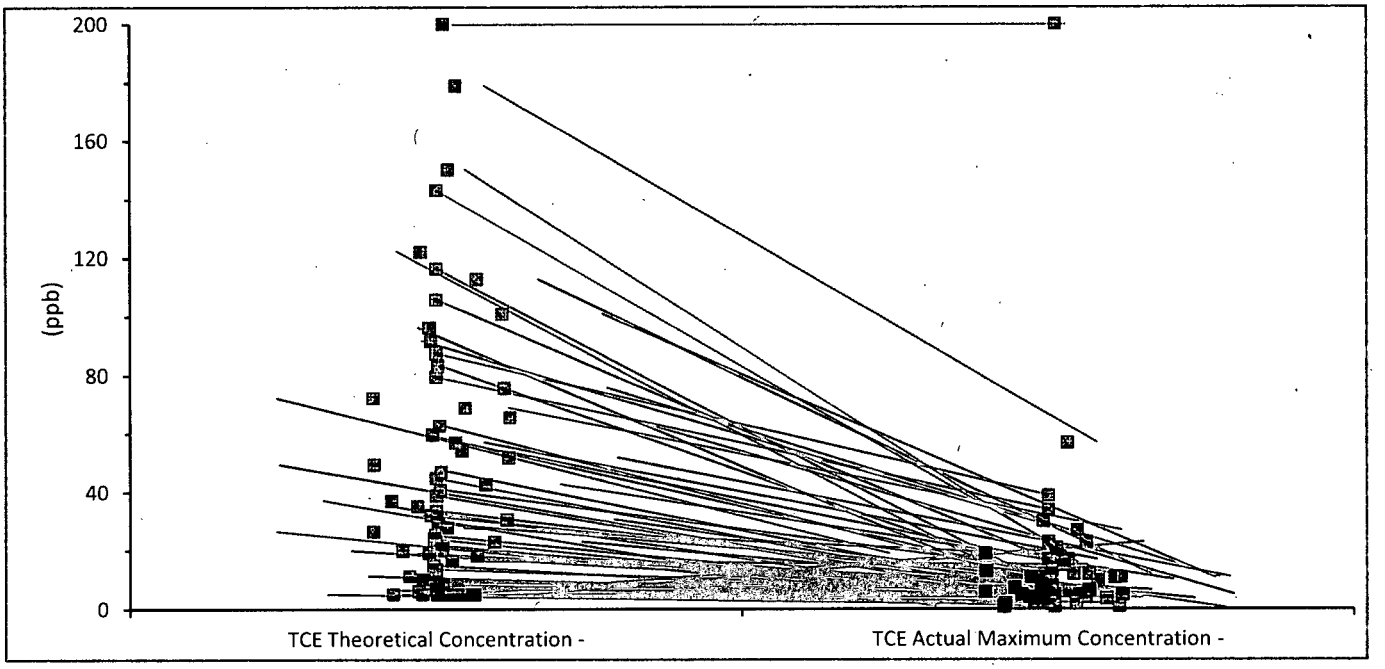
Compare Pairs: TCE Theoretical Concentration -, TCE Actual Maximum Concentration -

Analyse-it v3.10

TCE edited A1:B66

Last updated 20 January 2013 at 12:33 by Mike

Descriptives



N | 65

	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
TCE Theoretical Concentration - (ppb)	5.00	10.962	32.228	70.171	200.00	59.209
TCE Actual Maximum Concentration - (ppb)	0.50	4.100	8.000	13.000	200.00	8.900

Figure F-2
Wilcoxon Signed Rank Test for Trichloroethene (TCE)

Compare Pairs: TCE Theoretical Concentration -, TCE Actual Maximum Concentration -

Analyse-it v3.10

TCE edited A1:B66

Last updated 20 January 2013 at 12:33 by Mike

Location

Hodges-Lehmann shift	-28.460
95.12% CI	-39.055 to -20.998

$F(_{\text{TCE Actual Maximum Concentration -}})=F(_{\text{TCE Theoretical Concentration -}}+\Delta)$

Wilcoxon test

Hypothesized difference	0

Sign	n	Rank sum	Mean rank
Positive	4	63.0	15.75
Negative	59	1953.0	33.10
Zero			

T statistic	63.00
Z approximation	-6.47
p-value	<0.0001[1]

H0: $\Delta = 0$
The shift in location between the distributions of the populations is equal to 0.
H1: $\Delta \neq 0$
The shift in location between the distributions of the populations is not equal to 0.
[1] Reject the null hypothesis in favour of the alternative hypothesis at the 5% significance level.

Figure F-3
Wilcoxon Signed Rank Test for Vinyl Chloride (VC)

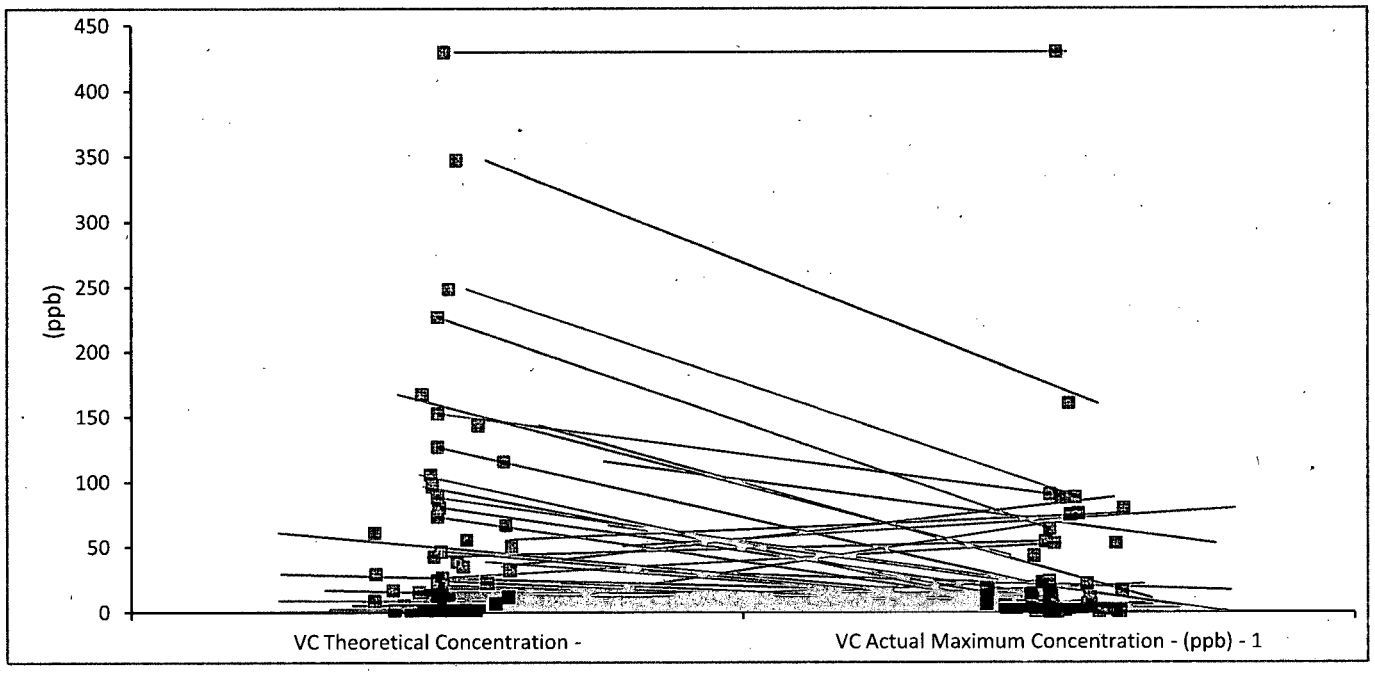
Compare Pairs: VC Theoretical Concentration -, VC Actual Maximum Concentration - (ppb) - 1

Analyse-it v3.10

VinylChloride edited A1:C66

Last updated 20 January 2013 at 13:31 by Mike

Descriptives



N | 65

	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
VC Theoretical Concentration - (ppb)	2.00	2.000	12.912	57.558	430.00	55.558
VC Actual Maximum Concentration - (ppb) - 1 (ppb)	0.50	2.767	6.400	21.333	430.00	18.567

Figure F-3
Wilcoxon Signed Rank Test for Vinyl Chloride (VC)

Compare Pairs: VC Theoretical Concentration -, VC Actual Maximum Concentration - (ppb) - 1

Analyse-it v3.10

VinylChloride edited A1:C66

Last updated 20 January 2013 at 13:31 by Mike

Location

Hodges-Lehmann shift	-8.649
95.12% CI	-27.454 to -2.028

$F(_{\text{VC Actual Maximum Concentration - (ppb) - 1}})=F(_{\text{VC Theoretical Concentration -}}+\Delta)$

Wilcoxon test

Hypothesized difference	0

Sign	n	Rank sum	Mean rank
Positive	21	592.0	28.19
Negative	43	1488.0	34.60
Zero			

T statistic	592.00
Z approximation	-3.00
p-value	0.0027[1]

H0: $\Delta = 0$
The shift in location between the distributions of the populations is equal to 0.
H1: $\Delta \neq 0$
The shift in location between the distributions of the populations is not equal to 0.
[1] Reject the null hypothesis in favour of the alternative hypothesis at the 5% significance level.

TABLE F-3A
WILCOXON SIGNED RANK TEST FOR BENZENE
September 2011 Sampling Event
Target Concentration - 5.0 ppb

Sampling Month	x	Theoretical Concentration (ppb)	Actual Maximum Concentration (ppb)	Y_i (Difference of Theoretical and Actual)	Absolute Value Y_i	R_i (Ranking)	W_i (Value Weight)	$(R_i)(W_i)$	n (No. of Events)
September-89	-18	34.0	34.0	0.0	0	1	0	0	1
August-90	-7	24.8	13.0	-11.8	11.8	58	0	0	2
November-90	-4	22.8	19.0	-3.8	3.8	32	0	0	3
September-91	6	17.2	3.0	-14.2	14.2	60	0	0	4
December-91	9	15.8	28.5	12.7	12.7	59	1	59	5
June-92	15	13.3	5.0	-8.3	8.3	54	0	0	6
September-92	18	12.2	21.0	8.8	8.8	55	1	55	7
December-92	21	11.2	5.5	-5.7	5.7	50	0	0	8
March-93	24	10.3	4.0	-6.3	6.3	52	0	0	9
June-93	27	9.5		-9.5	9.5	56	0	0	10
September-93	30	8.7	1.4	-7.3	7.3	53	0	0	11
December-93	33	8.0	5.2	-2.8	2.8	19	0	0	12
March-94	36	7.3	2.0	-5.3	5.3	49	0	0	13
June-94	39	6.7	23.0	16.3	16.3	61	1	61	14
September-94	42	6.2	6.6	0.4	0.4	6	1	6	15
December-94	45	5.7	5.5	-0.2	0.2	4	0	0	16
March-95	48	5.2	2.8	-2.4	2.4	17	0	0	17
June-95	51	5.0	5.1	0.1	0.1	2	1	2	18
September-95	54	5.0	1.1	-3.9	3.9	33	0	0	19
December-95	57	5.0	9.9	4.9	4.9	47	1	47	20
March-96	60	5.0	1.4	-3.6	3.6	30	0	0	21
June-96	63	5.0	7.4	2.4	2.4	16	1	16	22
September-96	66	5.0	10.0	5.0	5.0	48	1	48	23
December-96	69	5.0	0.3	-4.7	4.7	46	0	0	24
March-97	72	5.0	2.2	-2.8	2.8	18	0	0	25
June-97	75	5.0	2.9	-2.1	2.1	14	0	0	26
September-97	78	5.0	8.1	3.1	3.1	27	1	27	27
December-97	81	5.0	3.2	-1.8	1.8	11	0	0	28
March-98	84	5.0	3.0	-2.0	2.0	12	0	0	29
June-98	87	5.0	1.9	-3.1	3.1	28	0	0	30
September-98	90	5.0	11.0	6.0	6.0	51	1	51	31
December-98	93	5.0	0.5	-4.5	4.5	43	0	0	32
March-99	96	5.0	0.5	-4.5	4.5	43	0	0	33
June-99	99	5.0	16.0	11.0	11.0	57	1	57	34
September-99	102	5.0	8.4	3.4	3.4	29	1	29	35
December-99	105	5.0	2.0	-3.0	3.0	20	0	0	36
March-00	108	5.0	2.0	-3.0	3.0	20	0	0	37
June-00	111	5.0	0.6	-4.4	4.4	42	0	0	38
September-00	114	5.0	4.7	-0.3	0.3	5	0	0	39
December-00	117	5.0	6.0	1.0	1.0	8	1	8	40
March-01	120	5.0	4.9	-0.1	0.1	2	0	0	41
June-01	123	5.0	2.7	-2.3	2.3	15	0	0	42
September-01	126	5.0	5.8	0.8	0.8	7	1	7	43
March-02	132	5.0	4.0	-1.0	1.0	8	0	0	44
September-02	138	5.0	0.5	-4.5	4.5	43	0	0	45
March-03	144	5.0	3.5	-1.5	1.5	10	0	0	46
March-04	156	5.0	1.3	-3.7	3.7	31	0	0	47
September-04	162	5.0	1.0	-4.0	4.0	34	0	0	48
March-05	168	5.0	2.0	-3.0	3.0	20	0	0	49
September-05	174	5.0	2.0	-3.0	3.0	20	0	0	50
March-06	180	5.0	1.0	-4.0	4.0	34	0	0	51
September-06	186	5.0	3.0	-2.0	2.0	12	0	0	52
April-07	193	5.0	1.0	-4.0	4.0	34	0	0	53
October-07	199	5.0	2.0	-3.0	3.0	20	0	0	54
April-08	205	5.0	2.0	-3.0	3.0	20	0	0	55
September-08	210	5.0	2.0	-3.0	3.0	20	0	0	56
October-09	223	5.0	1.0	-4.0	4.0	34	0	0	57
July-10	232	5.0	1.0	-4.0	4.0	34	0	0	58
October-10	235	5.0	1.0	-4.0	4.0	34	0	0	59
March-11	240	5.0	1.0	-4.0	4.0	34	0	0	60
September-11	247	5.0	1.0	-4.0	4.0	34	0	0	61

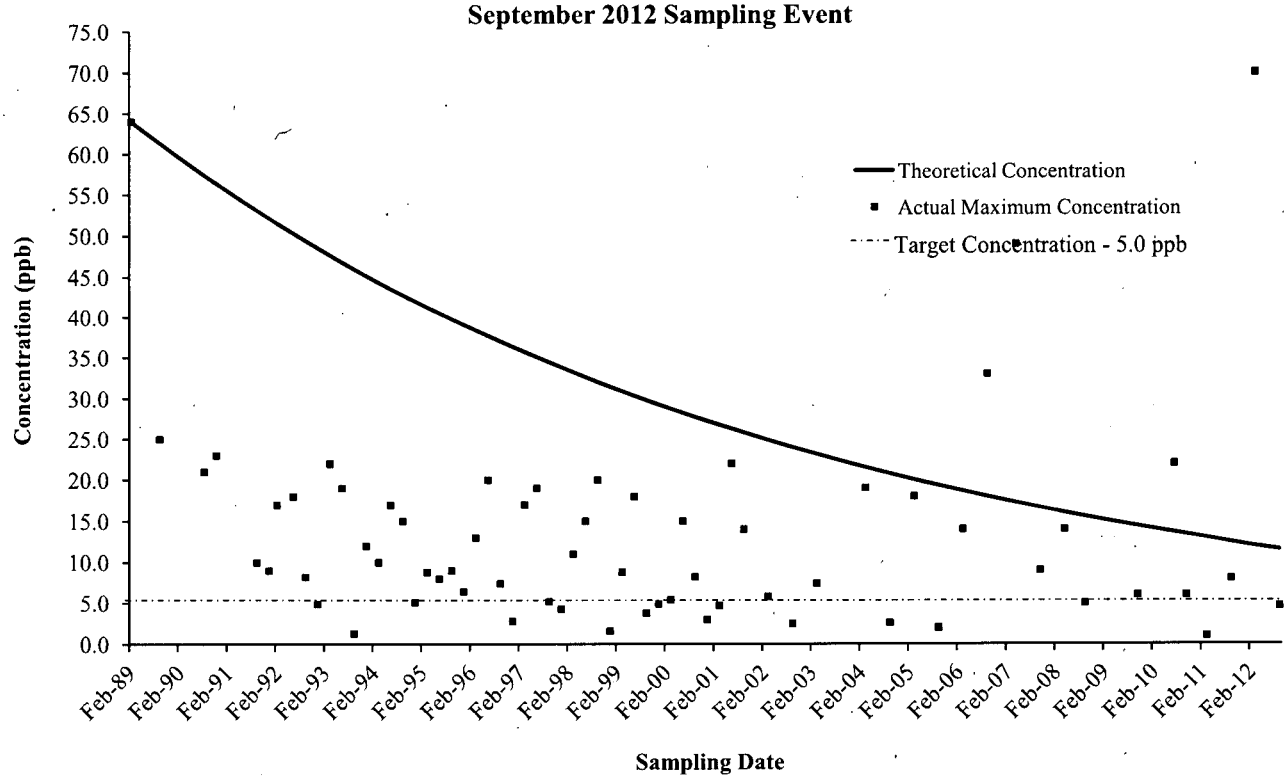
Signed Rank Test Passed Since $T^+ =$ **Sum$(R_i)(W_i)$ = 473**

$T^+ < t(\alpha,n)$ **t(0.05, 58) = 643.03**

mean	7.20	5.52	mean is lower
sdevp	5.38	6.91	
cv	0.75	1.25	
ttest	8.05E-03		
correl	0.685		

Prepared by/ Date: SDM/1/3/12
Checked by/ Date: MJM 1/17/12

Figure F-4. Theoretical Attenuation vs Actual Concentrations
Tetrachloroethene (PCE)
September 2012 Sampling Event



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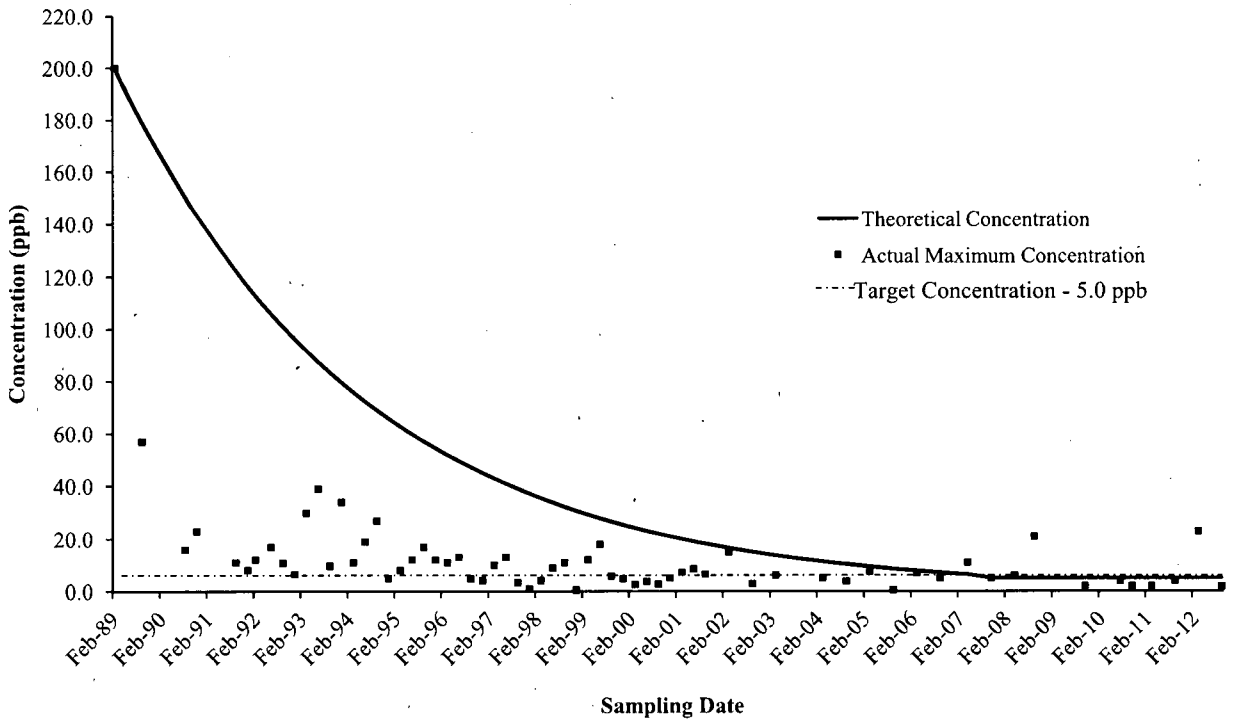
Prepared by/ Date: SDM 1/3/12
Checked by/ Date: SFR 1/12/12

Figure F-5. Theoretical Attenuation vs Actual Concentrations
Trichloroethene (TCE)
September 2012 Sampling Event



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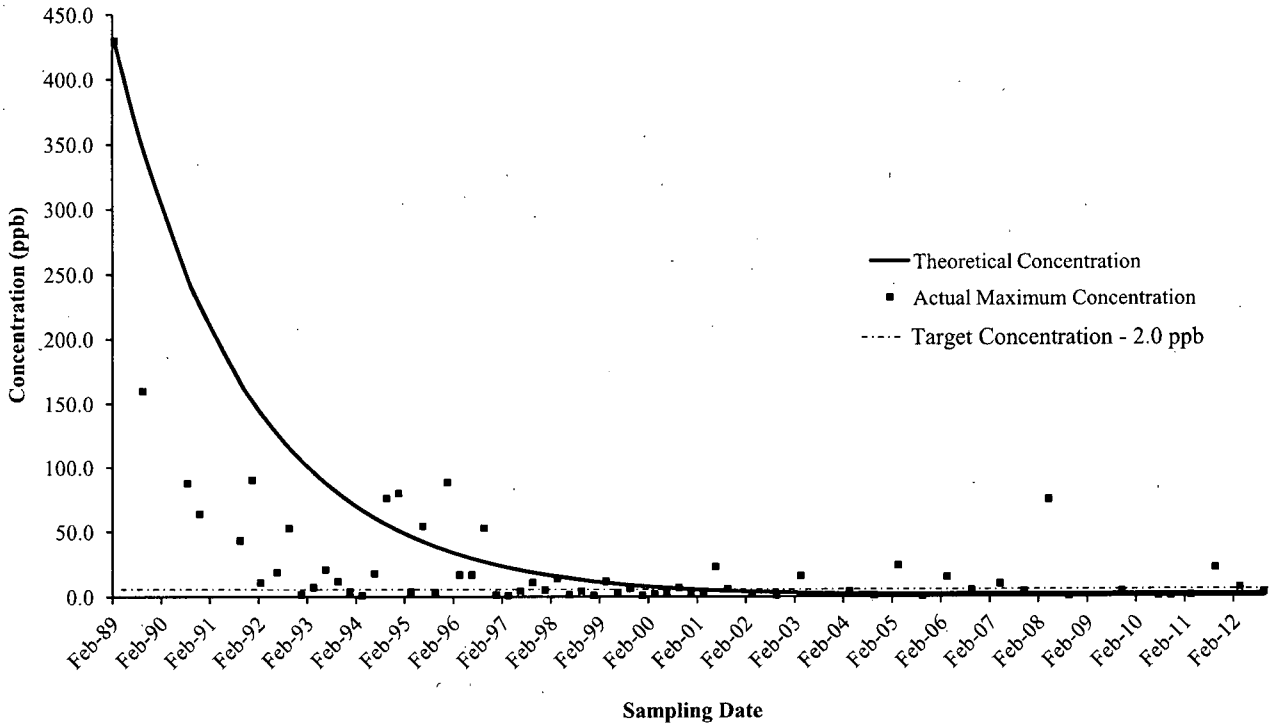
Checked by/ Date: SFR 1/12/12

Figure F-6. Theoretical Attenuation vs Actual Concentrations
Vinyl Chloride
September 2012 Sampling Event



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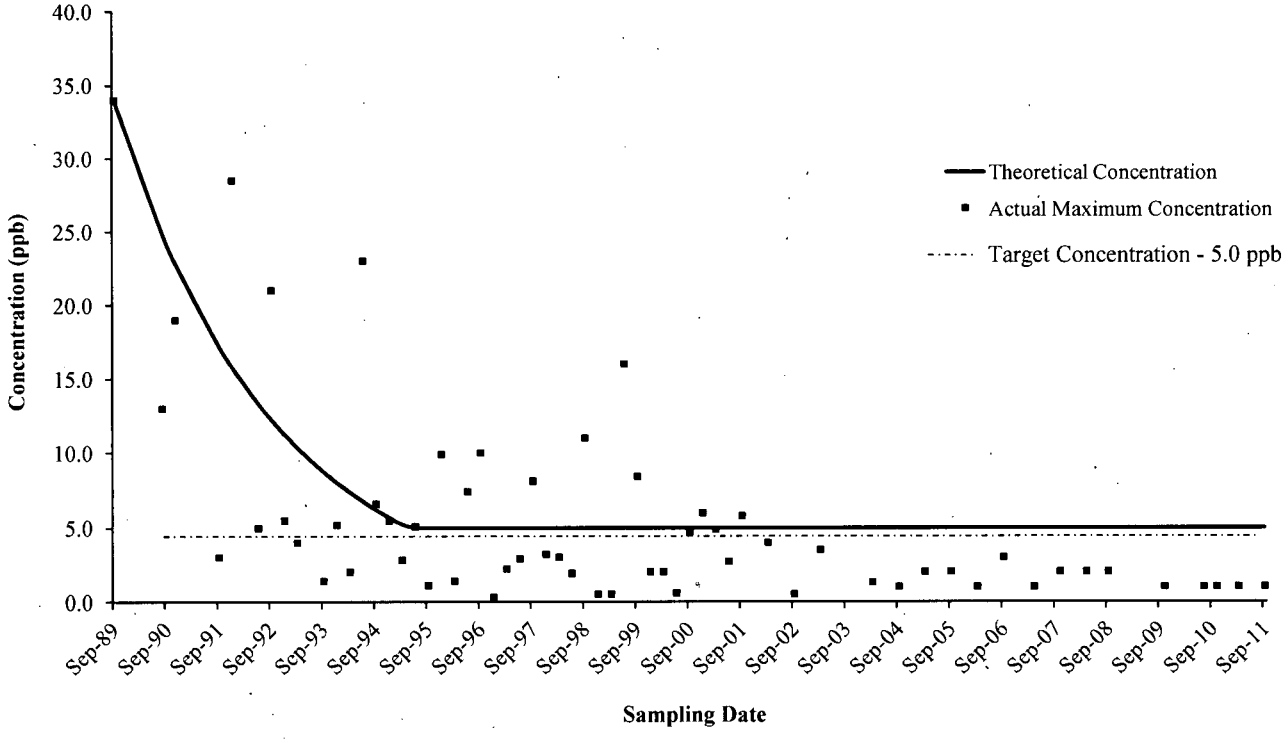
Prepared by/ Date: SDM 1/3/12
Checked by/ Date: SFR 1/12/12

Figure F-6A. Theoretical Attenuation vs Actual Concentrations
Benzene
September 2011 Sampling Event



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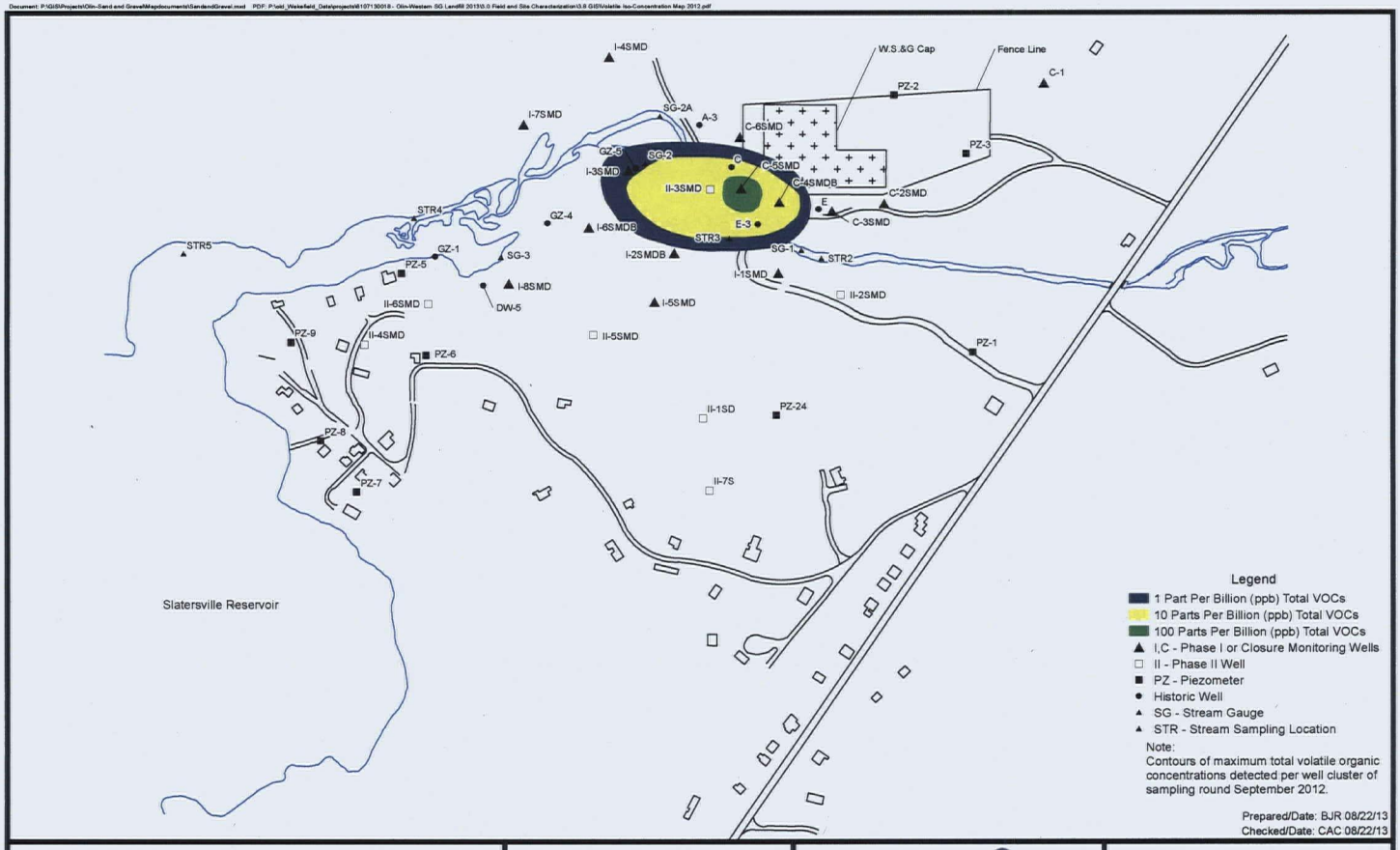
WSG - STATS - October 2011t-test REV.xlsxFigure F-1

Prepared by/ Date: SDM 1/3/12
Checked by/ Date: SFR 1/12/12

Document: P:\GIS\Projects\Olin-Sand and Gravel\Mapdocuments\SandandGravel.mxd PDF: P:\eld_Wakefield_Data\projects\61071300\8 - Olin-Western SG Landfill 2013\0.0 Field and Site Characterization\3.8 GIS\Volatile Iso-Concentration Map 2012.pdf

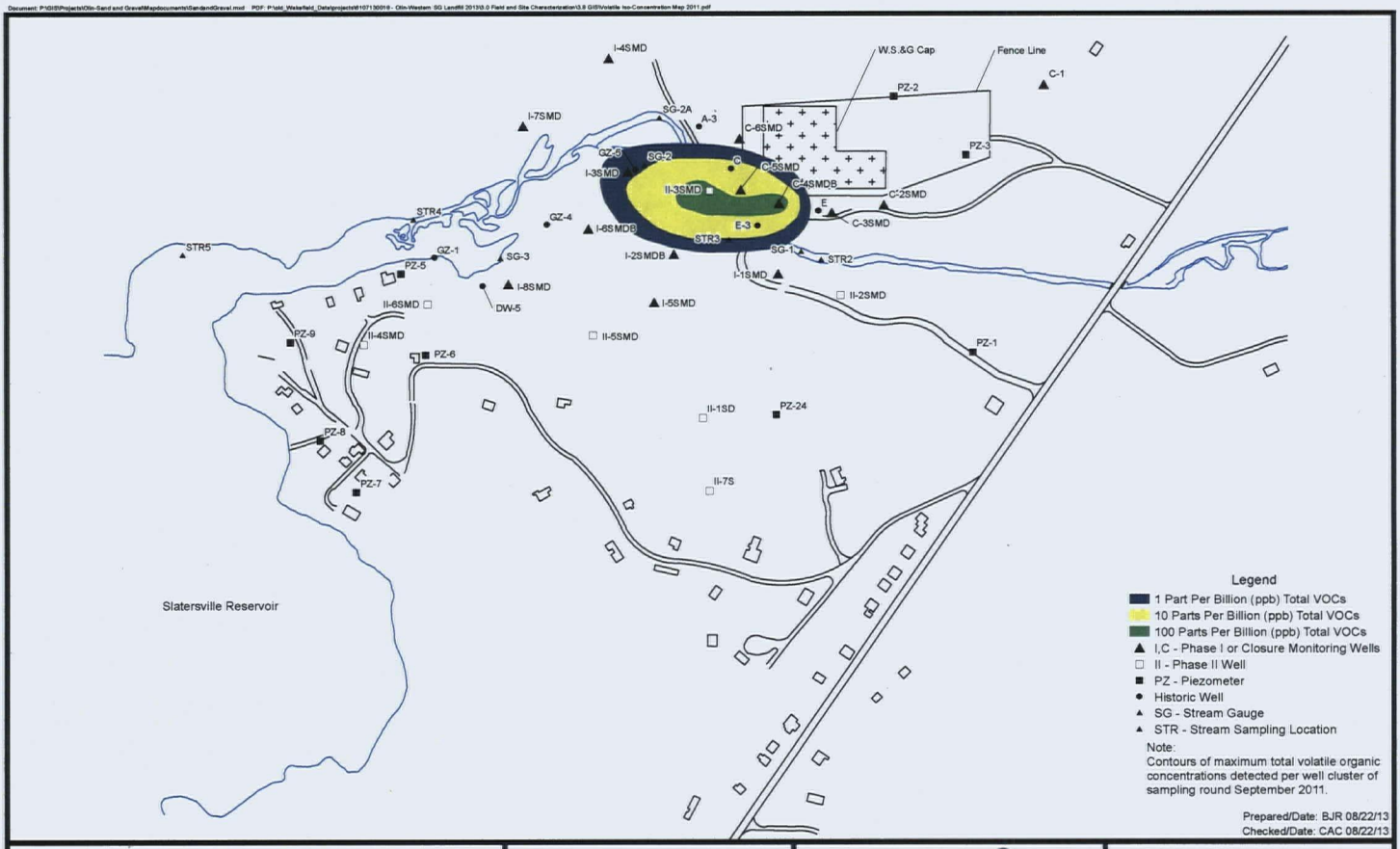


Western Sand and Gravel
Burrillville, Rhode Island

amec

Figure F-7
Volatile Iso-Concentration Map 2012

Document: P:\GIS\Projects\Olin-Sand and Gravel\Mapdocuments\SandandGravel.mxd PDF: P:\old_Westerfield_Data\projects\61071300\6 - Olin-Western SG Landfill 2013\3.0 Field and Site Characterization\3.8 GIS\Volatile Iso-Concentration Map 2011.pdf



Western Sand and Gravel
Burrillville, Rhode Island

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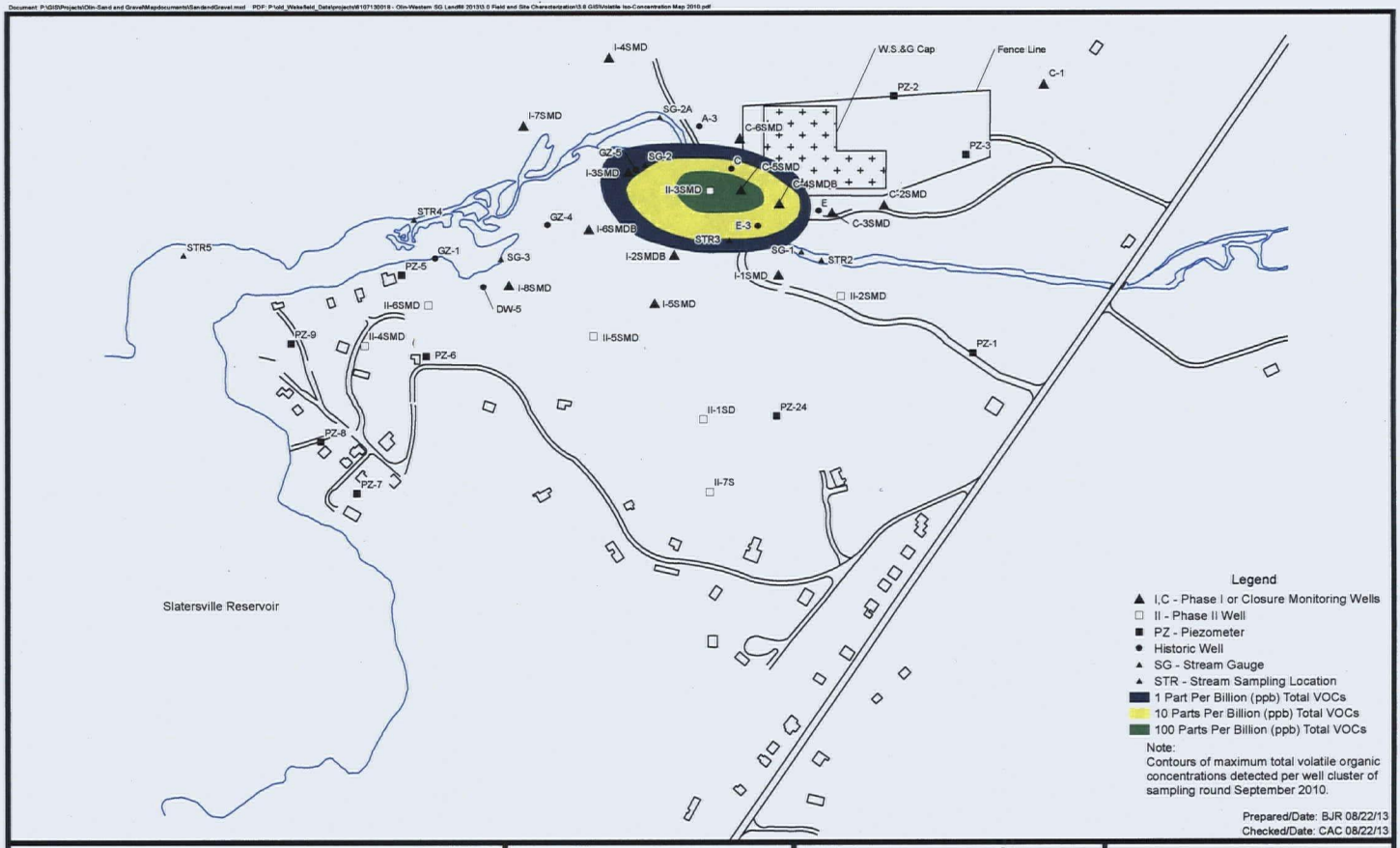
Figure F-8
Volatile Iso-Concentration Map 2011

Document: P:\GIS\Projects\Olin-Sand and Gravel\Mapdocuments\SandandGravel.mxd PDF: P:\old_Wakefield_Data\projects\6107130018 - Olin-Western SG Landfill 2013\3.0 Field and Site Characterization\3.8 GIS\Volatile Iso-Concentration Map 2010.pdf



Western Sand and Gravel
Burrillville, Rhode Island

amec

Figure F-9
Volatile Iso-Concentration Map 2010

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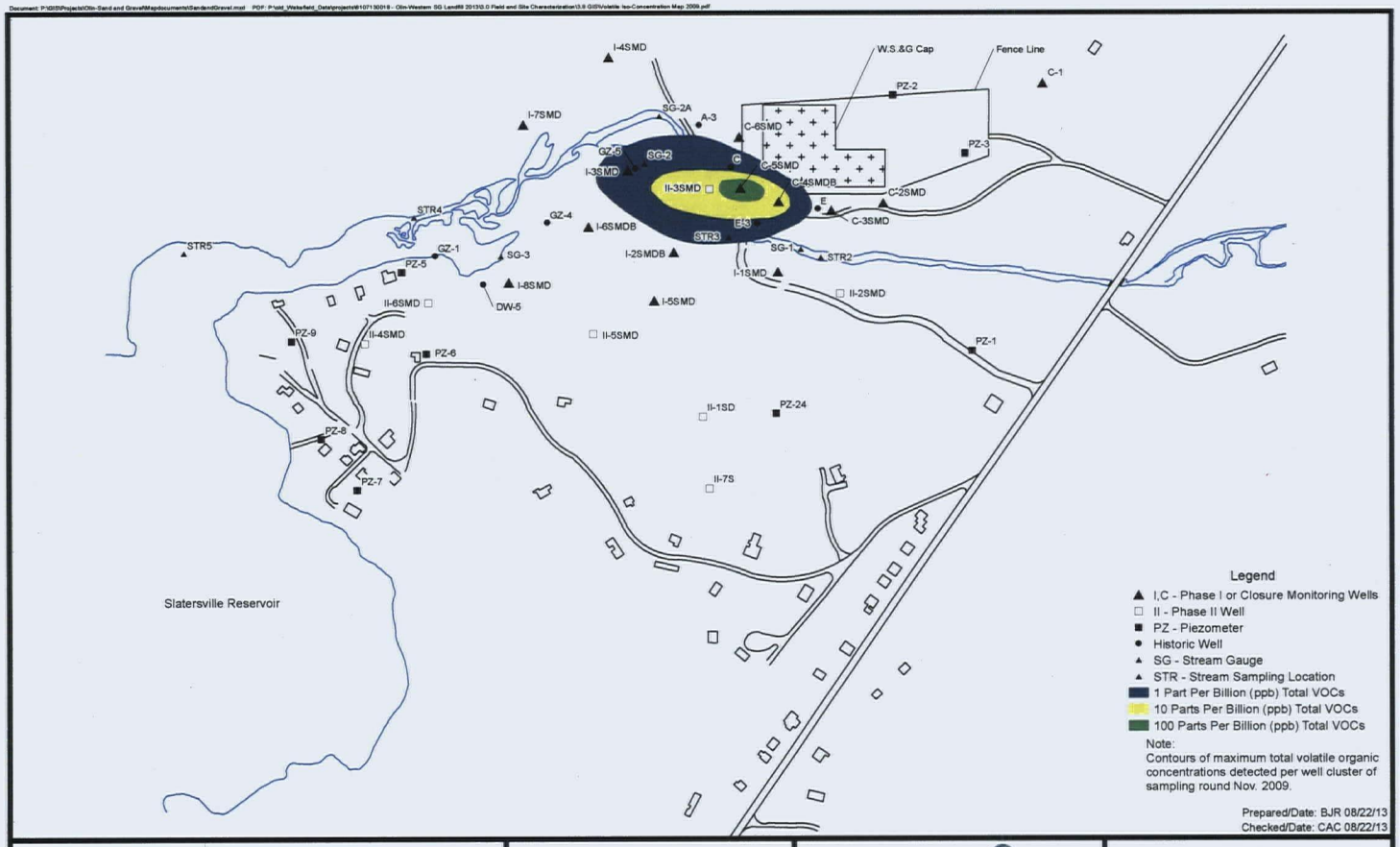


Western Sand and Gravel
Burrillville, Rhode Island

amec

Figure F-10
Volatile Iso-Concentration Map 2009

Figure F-11 - Historical Iso-Concentration Maps (1998 through 2008) as Reported in the 2008 Data Report by ATC Associates Inc.

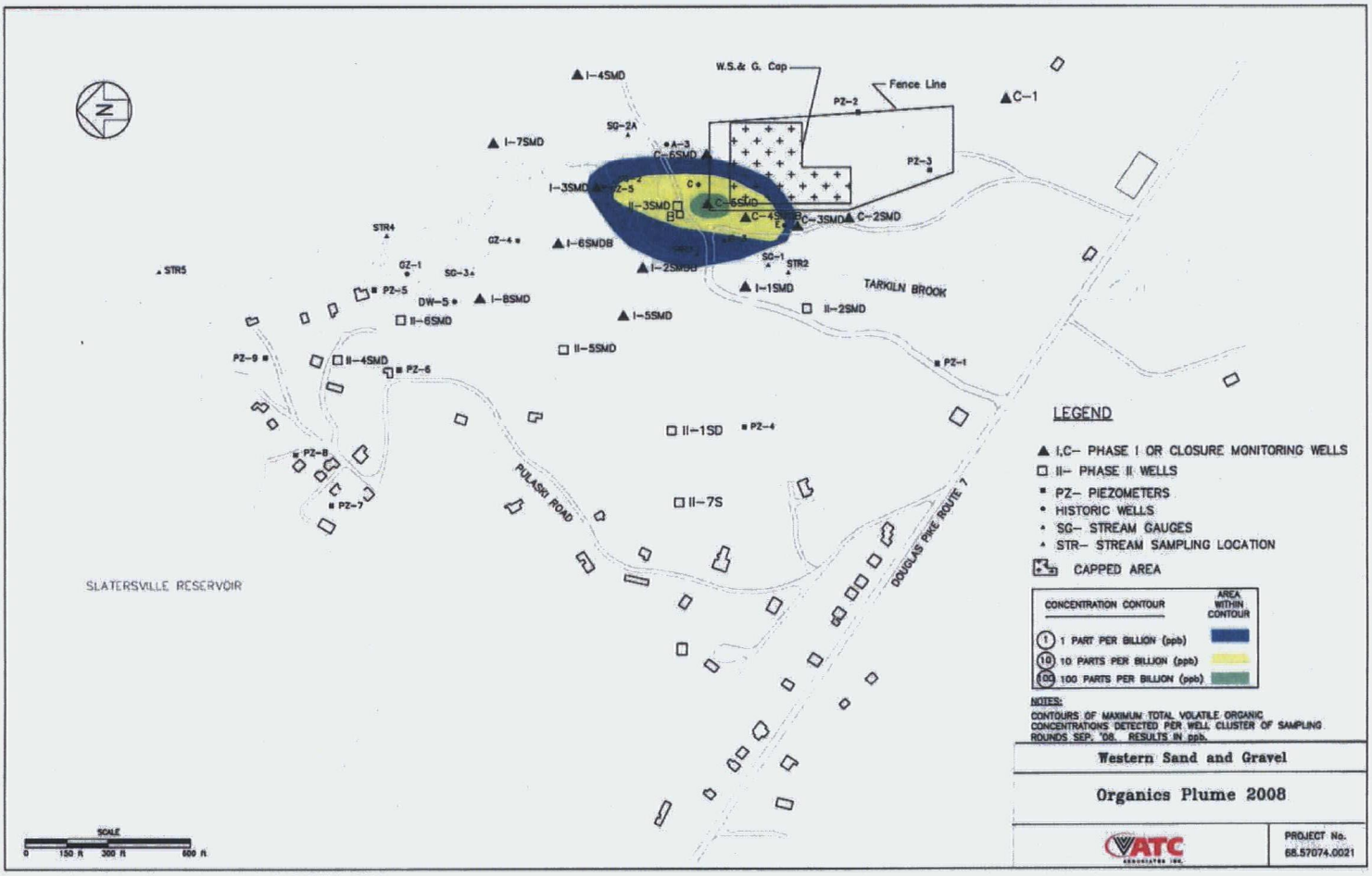


Figure F-11 - Historical Iso-Concentration Maps (1998 through 2008) as Reported in the 2008 Data Report by ATC Associates Inc.

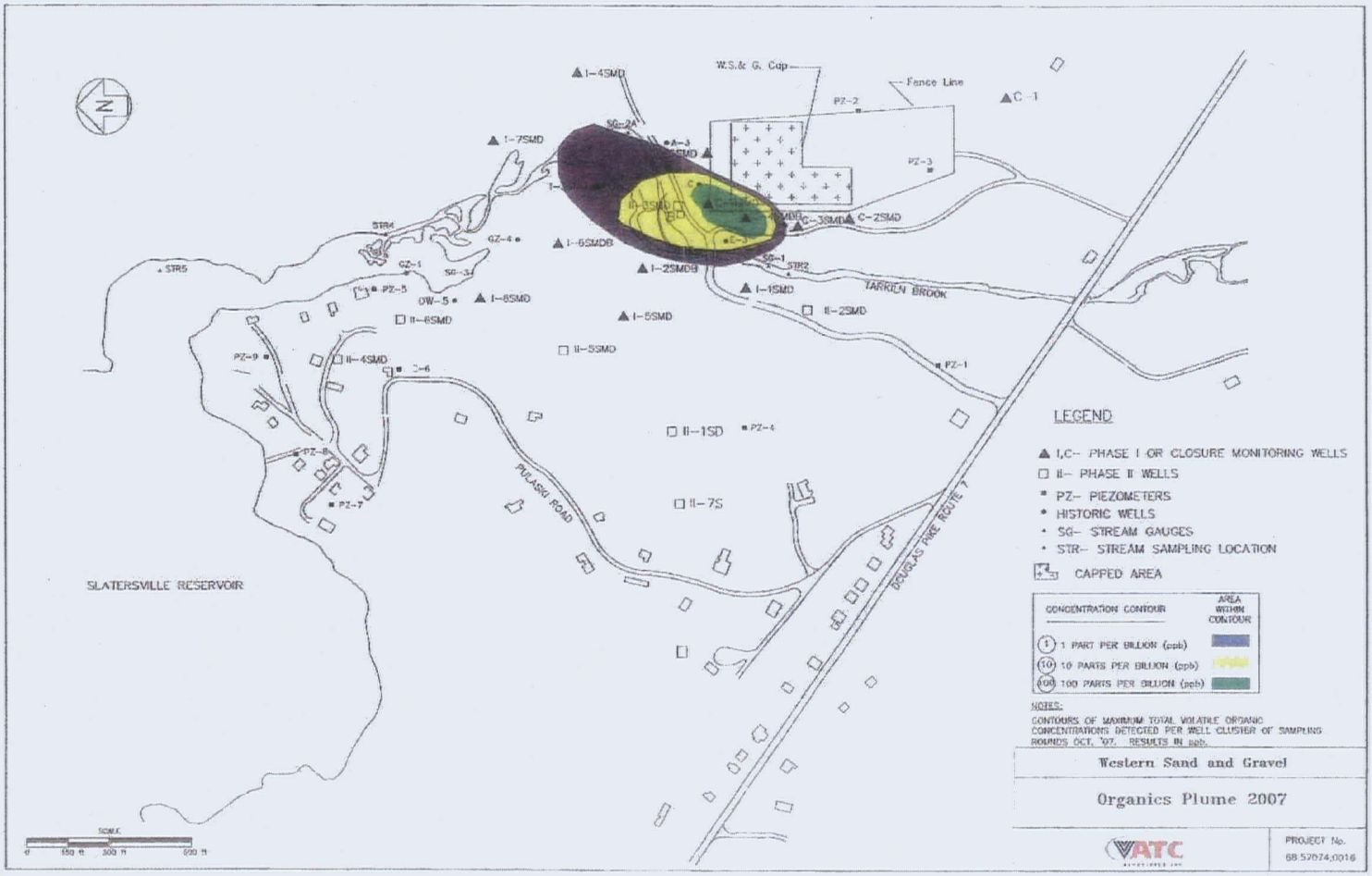
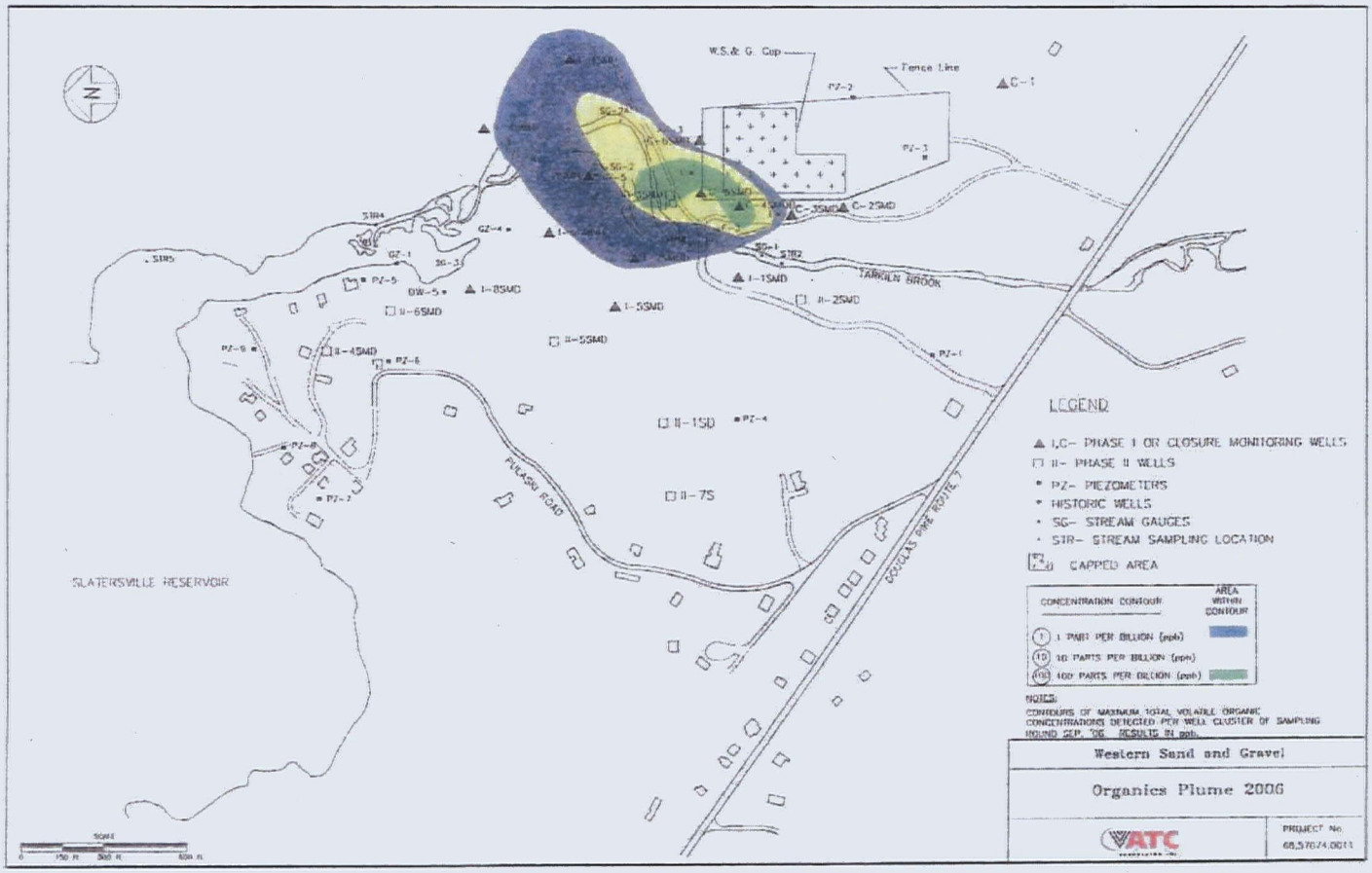


Figure F-11 - Historical Iso-Concentration Maps (1998 through 2008) as Reported in the 2008 Data Report by ATC Associates Inc.



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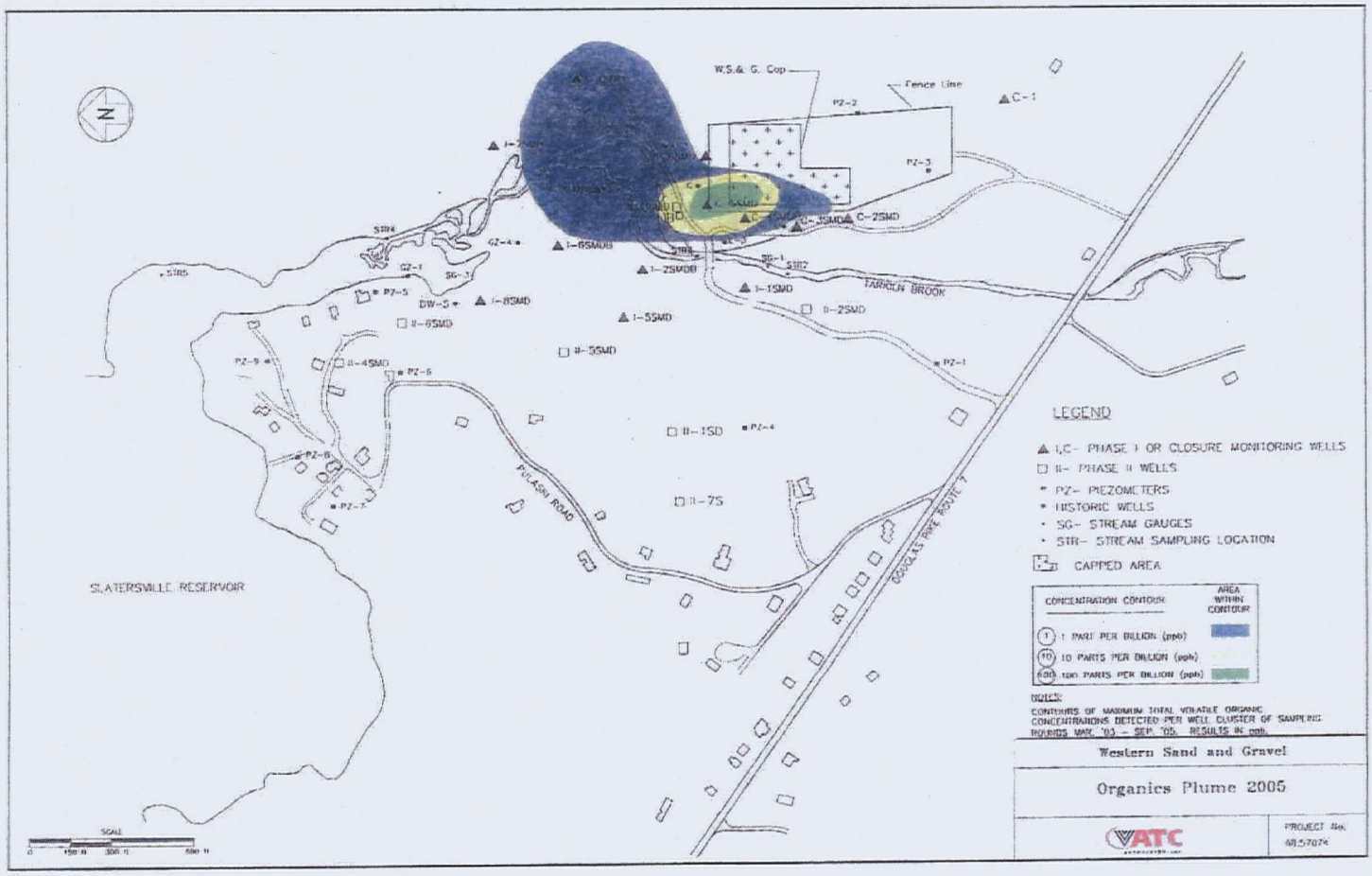

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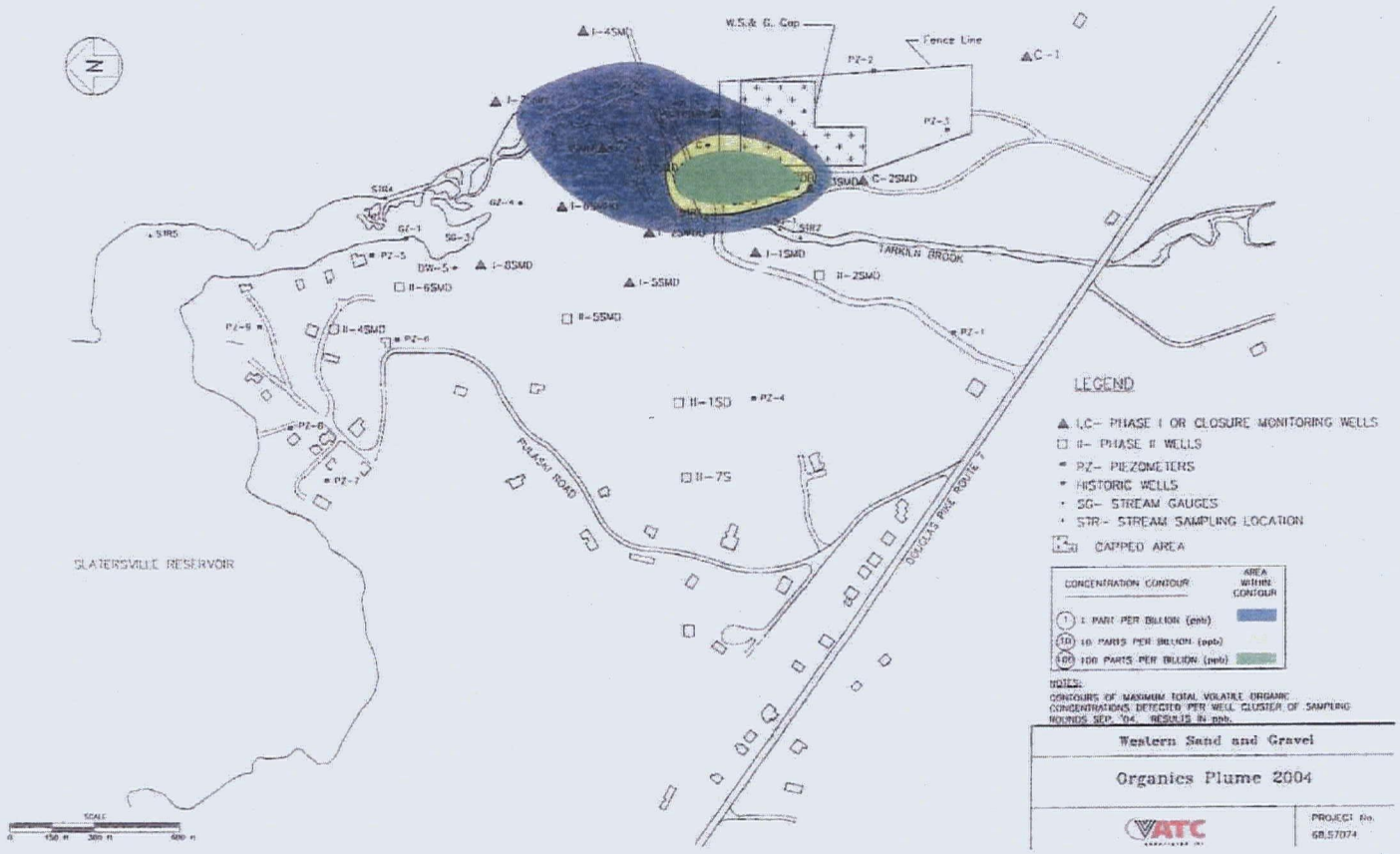


Figure F-11 - Historical Iso-Concentration Maps (1998 through 2008) as Reported in the 2008 Data Report by ATC Associates Inc.

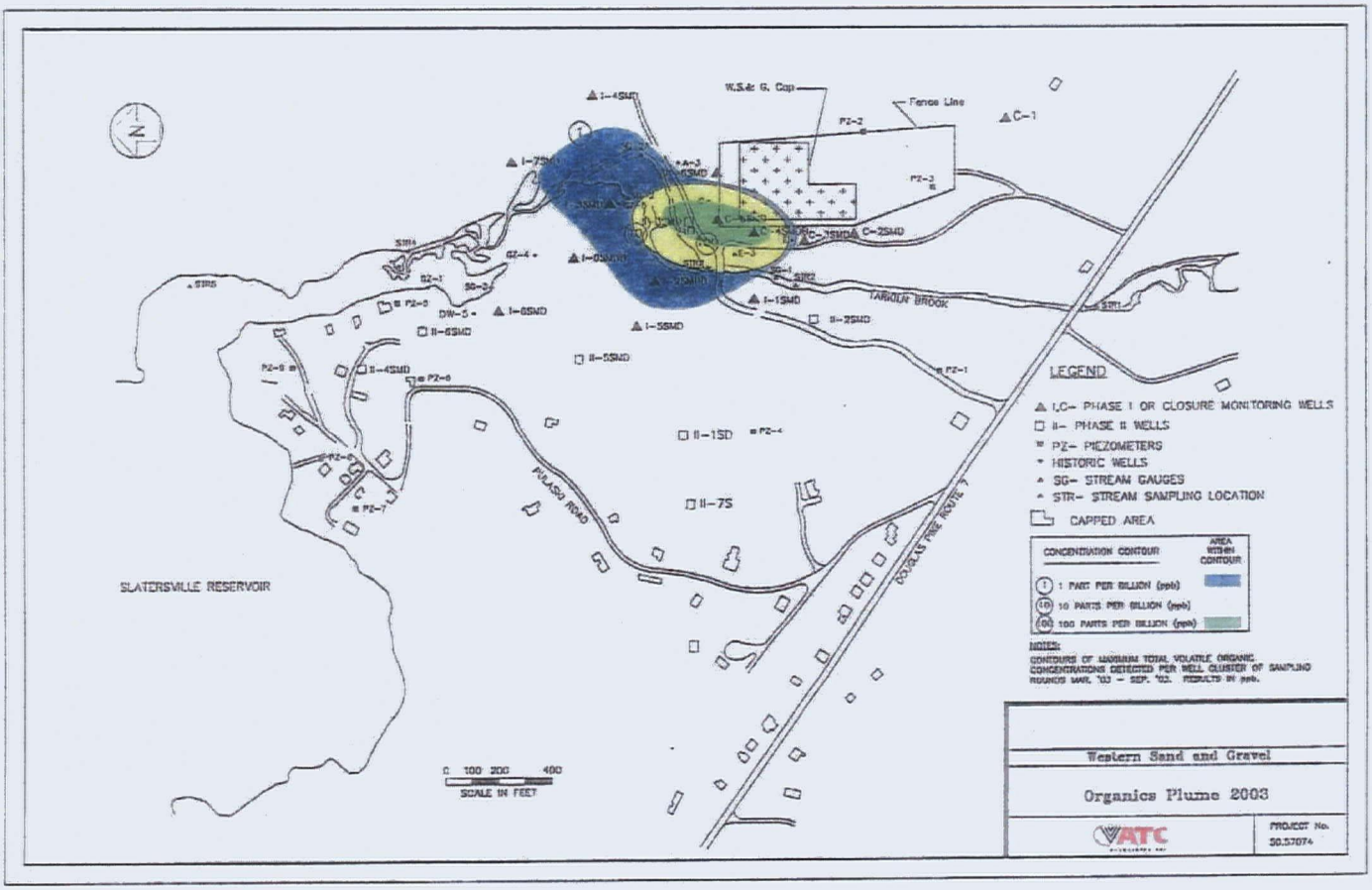
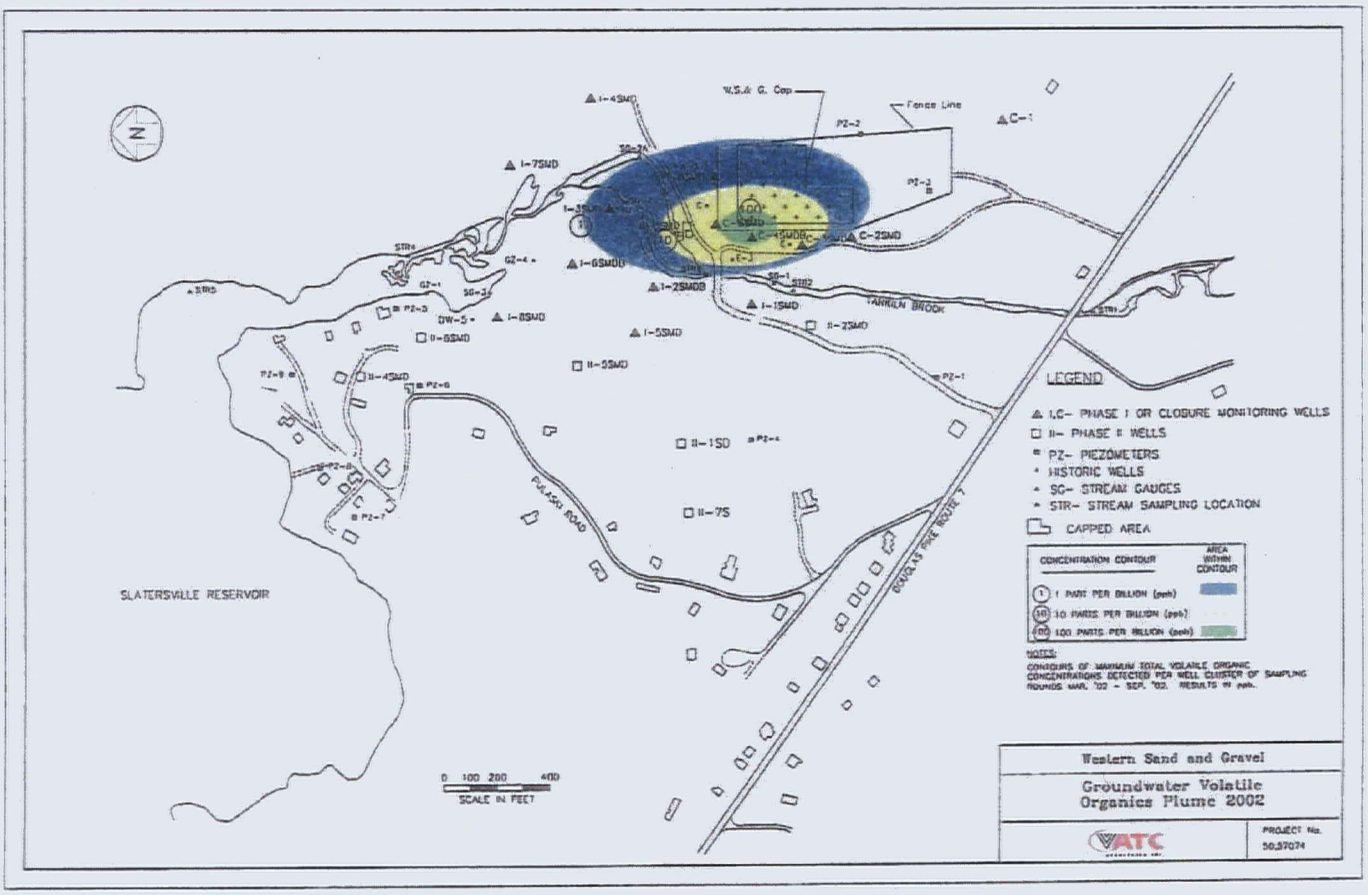


Figure F-11 - Historical Iso-Concentration Maps (1998 through 2008) as Reported in the 2008 Data Report by ATC Associates Inc.



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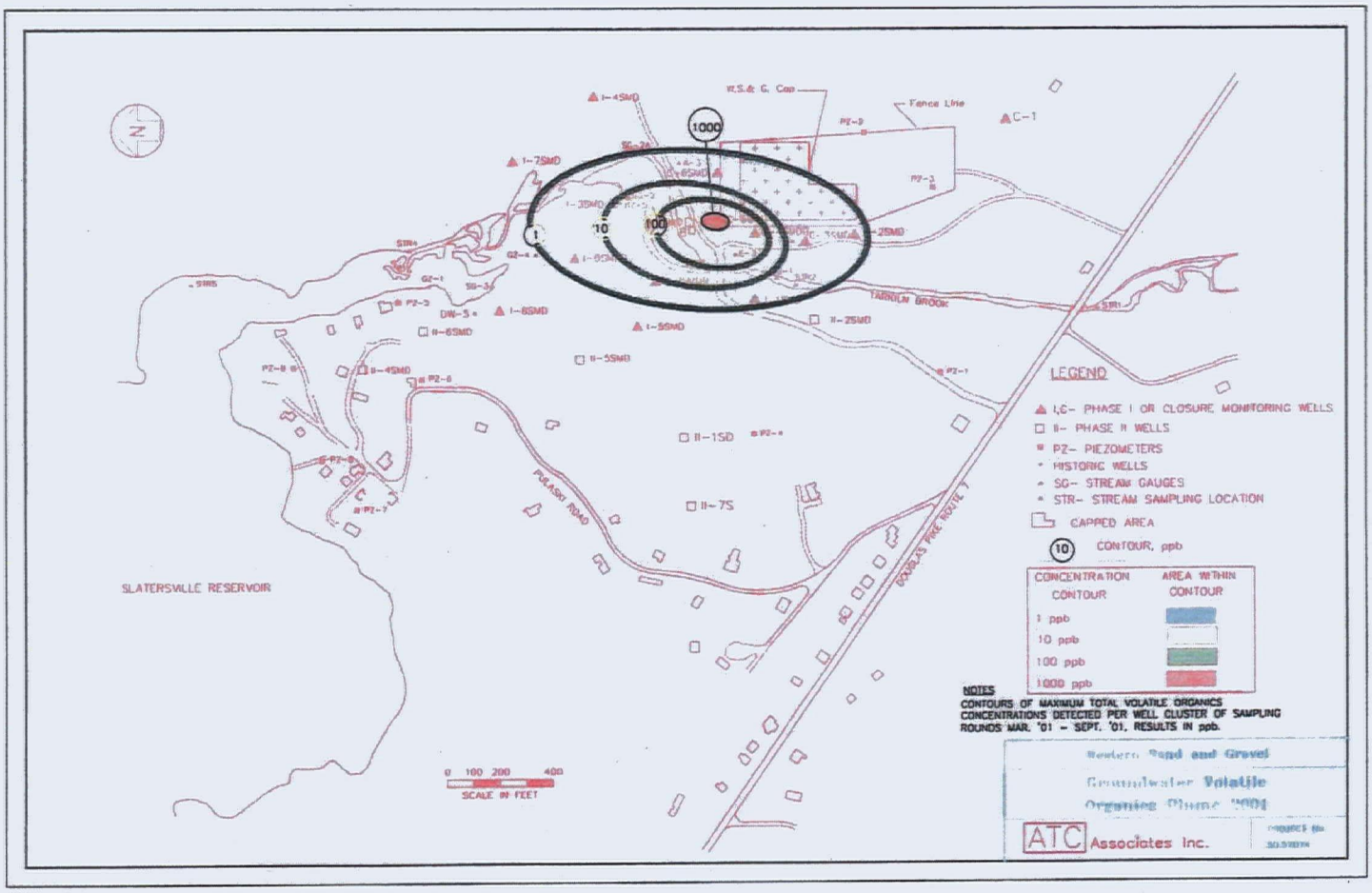

Appendix G

COCs per ROD for OU-III

TABLE 15
WESTERN SAND & GRAVEL SITE
SELECTED GROUNDWATER INTERIM CLEANUP LEVELS

Chemical	Reference Dose(oral) (mg/kg/day)	Carc. Potency Factor(oral) (mg/kg/day)-1	Int Cleanup Level (mg/L)	Basis	Cancer Risk Level	Noncancer Hazard Index	Noncancer Target Endpoint
(Volatile Organics)							
Acetone	1.0E-01	-	3.5E+00	HB	-	1.0E+00	liver, kidney
Benzene	-	2.9E-02	5.0E-03	MCL	4.2E-06	-	
2-Butanone	5.0E-02	-	1.8E+00	HB	-	1.0E+00	fetotoxicity
Chlorobenzene	2.0E-02	-	1.0E-01	PMCLG	-	1.5E-01	liver, kidney
Chloroform*	1.0E-02	6.1E-03	1.0E-01	MCL	1.8E-05	2.9E-01	liver
Chloromethane	-	1.3E-02	3.0E-03	RB	1.1E-06	-	
1,1-Dichloroethane	1.0E-01	-	3.5E+00	HB	-	1.0E+00	none
1,2-Dichloroethane		9.1E-02	5.0E-03	MCL	1.3E-05	-	
1,1-Dichloroethene	9.0E-03	6.0E-01	7.0E-03	MCL	1.2E-04	2.3E-02	liver
1,2-Dichloroethene (1)	2.0E-02	-	7.0E-02	PMCLG	-	1.0E-01	blood
Ethylbenzene	1.0E-01	-	7.0E-01	PMCLG	-	2.0E-01	liver, kidney
Methylene Chloride	6.0E-02	7.5E-03	5.0E-03	MCL	1.1E-06	2.4E-03	liver
4-Methyl-2-pentanone	5.0E-02	-	1.8E+00	HB	-	1.0E+00	liver, kidney
Tetrachloroethene	1.0E-02	5.1E-02	5.0E-03	MCL	7.4E-06	1.5E-02	liver
Toluene	2.0E-01	-	1.0E+00	MCL	-	1.5E-01	organ weight
trans-1,3-Dichloropropene	3.0E-04	1.8E-01	5.0E-03	DL	2.6E-05	4.8E-01	organ weight
1,1,1-Trichloroethane	9.0E-02	-	2.0E-01	MCLG	-	6.4E-02	liver
1,1,2-Trichloroethane	4.0E-03	5.7E-02	3.0E-03	PMCLG	5.0E-06	2.2E-02	clinical chem.
Trichloroethene	-	1.1E-02	5.0E-03	MCL	1.6E-06	-	
Xylene	2.0E+00	-	1.0E+01	PMCLG	-	1.5E-01	body weight, mortality
Vinyl chloride	-	1.9E+00	2.0E-03	MCL	1.1E-04	-	
Bromomethane	1.4E-03	-	3.5E-02	HB	-	7.3E-01	stomach
1,1,2,2-Tetrachloroethane	-	2.0E-01	1.0E-03	DL	-	-	
Chloroethane	-	-	1.4E+01	HB*	-	1.0E+00	blood, CNS
Acrolein	-	-	-	CNA	-	-	
Trichlorofluromethane	3.0E-01	-	1.0E+01	HB	-	9.7E-01	mortality

TABLE 15 - CONTINUED
WESTERN SAND & GRAVEL SITE
SELECTED GROUNDWATER INTERIM CLEANUP LEVELS

Chemical	Reference Dose(oral) (mg/kg/day)	Carc. Potency Factor(oral) (mg/kg/day)-1	Int Cleanup Level (mg/L)	Basis	Cancer Risk Level	Noncancer Hazard Index	Noncancer Target Endpoint
(Semivolatiles)							
Benzoic acid	4.0E+00	-	1.4E+02	HB	-	1.0E+00	irritation, malais
bis(2-ethylhexyl)phthalate	2.0E-02	1.4E-02	4.0E-03	PMCL	1.6E-06	5.8E-03	liver
Isophorone	2.0E-01	4.1E-03	8.4E-03	RB	1.0E-06	1.2E-03	kidney
2-Methylnaphthalene	-	-	-	CNA	-	-	
4-Methylphenol	5.0E-02	-	1.8E-01	HB	-	1.0E-01	neurotoxicity
Napthalene	4.0E-03	-	1.4E-01	HB	-	1.0E+00	body weight
N-nitrosodiphenylamine	-	4.9E-03	1.0E-02	DL	1.4E-06	-	
1,2,4-Trichlorobenzene	1.3E-03	-	9.0E-03	PMCLG	-	2.0E-01	blood
1,2-Dichlorobenzene	9.0E-02	-	6.0E-01	PMCLG	-	1.9E-01	liver
1,4-Dichlorobenzene	-	2.4E-02	7.5E-02	MCLG	5.2E-05	-	
Di-n-octyl phthalate	2.0E-02	-	7.0E-01	HB	-	1.0E+00	liver, kidney
Di-n-butyl phthalate	1.0E-01	-	4.0E-03	PMCL	-	1.2E-03	mortality
(Metals)							
Aluminum	-	-	5.0E-02	SMCL	-	-	
Barium	7.0E-02	-	1.0E+00	PMCLG	-	4.1E-01	blood pressure
Cobalt	-	-	-	CNA	-	-	
Lead	-	-	5.0E-03	PMCL	-	-	
Nickel	2.0E-02	-	1.0E-01	PMCLG	-	1.5E-01	body, organ weight
Silver	3.0E-03	-	9.0E-02	SMCL	-	8.7E-01	argyria-skin
Zinc	2.0E-01	-	5.0E+00	SMCL	-	7.3E-01	blood
				Total	3.7E-04	Weight Change: 6.1E+00 Liver: 4.1E+00 Kidney: 2.5E+00 Blood: 2.4E+00 Mortality: 1.1E+00	

TABLE 15 - CONTINUED
WESTERN SAND & GRAVEL SITE
SELECTED GROUNDWATER INTERIM CLEANUP LEVELS

NOTES

MCL - Maximum Contaminant Level
PMCL - Proposed Maximum Contaminant Level
MCLG - Maximum Contaminant Level Goal
PMCLG - Proposed Maximum Contaminant Level Goal
SMCL - Secondary Maximum Contaminant Level
RB - Risk Based (carcinogens)
HB - Hazard Based (noncarcinogens)
HB* - The clean-up level for chloroethane is based on the RfD for chlorobutane.
A structural similarity is assumed.
CNA - Criteria Not Available
RSD - Risk Specific Dose
DL - Detection Limit
Chloroform* - The MCL for total trihalomethanes was used for chloroform.

(1) Since the specific 1,2-Dichlorothene isomer was not identified in the RI Report, the MCL for the cis" isomer is cited. The cleanup level may be overprotective if the isomer detected is the "trans" isomer.