216166

FIVE-YEAR REVIEW REPORT
NL INDUSTRIES, INCORPRATED SUPERFUND SITE
PEDRICKTOWN, OLDMANS TOWNSHIP, SALEM COUNTY
NEW JERSEY

Prepared by

U.S. Environmental Protection Agency
Region II
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Approved:

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Date

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EXECUTIVE SUMMARY

This is the fourth five-year review for the NL Industries, Inc. Superfund Site. The Site is located in Pedricktown, Salem County, New Jersey. The Site is being addressed in phases or operable units (OUs) as specified in the 1991 (OU2) and 1994 (OU1) Records of Decision (ROD) and the 2011 ROD Amendment. OU2 addressed slag and lead oxide piles, debris and contaminated surfaces, and standing water which were found to be significant and continual sources of contaminant migration from the Site. The OU2 remedial action was completed in 1995.

OU1 addresses contaminated groundwater, soils and stream sediments at the Site. The soil and stream sediment portion of the remedy was completed in 2003; however, post excavation biological sampling over the next few years showed increasing levels of lead in the sediments. Additional excavation of stream sediments began in August 2011 and is ongoing.

The original OU1 groundwater remedy required construction and operation of a groundwater extraction and treatment system. In September 2011, a ROD Amendment was issued which changed the groundwater remedy to include (1) in-situ pH adjustment and reagent injection for the unconfined aquifer, (2) monitoring of groundwater and (3) creation of institutional controls to restrict the use of groundwater until cleanup goals have been achieved. The groundwater remedy, as modified by the 2011 ROD Amendment, is being designed.

This five-year review finds that the OU2 remedy is protective of human health and the environment.

The OU1 remedy is under construction and is expected to be protective of human health and the environment upon completion.

Five-Year Review Summary Form

SITE IDENTIFICATION		
Site Name: NL Industries		
EPA ID: NJD061843249		
Region: 2	**State:** NJ	**City/County:** Pedricktown/Salem County

SITE STATUS	
NPL Status: Final	
Multiple OUs? Yes	**Has the site achieved construction completion?** No

REVIEW STATUS
Lead agency: EPA
Author name (Federal or State Project Manager): Renee Gelblat
Author affiliation: EPA
Review period: 09/05/08 – 6/30/2013
Date of site inspection: April 11, 2013
Type of review: Policy
Review number: 4
Triggering action date: 09/04/2008
Due date *(five years after triggering action date)*: 09/04/2013

Issues/Recommendations
OU(s) without Issues/Recommendations Identified in the Five-Year Review:
OU1 – remediation of soils and sediments, and groundwater **OU2 – removal of slag and lead oxide piles, contaminated surfaces and debris, and contaminated standing water**

Five-Year Review Summary Form (continued)

Issues and Recommendations Identified in the Five-Year Review:				
OU(s): 1 and 2	**Issue Category: No Issue**			
	Issue: N/A			
	Recommendation: N/A			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
N/A	N/A	N/A	N/A	N/A

Protectiveness Statement(s)

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
OU1 – Soils, Sediments and Groundwater	Will be Protective	N/A
Protectiveness Statement: The OU1 remedy is expected to be protective of human health and the environment upon completion. In the interim, remedial activities completed to date have adequately addressed all exposure pathways that could result in unacceptable risks.		

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
OU2 – Lead bearing wastes.	Protective	N/A
Protectiveness Statement: The OU 2 remedy is protective of human health and the environment.		

I. Introduction

This fourth five-year review for the NL Industries Superfund Site (Site) located in Pedricktown, Salem County, New Jersey, was conducted by Renee Gelblat, the U.S. Environmental Protection Agency (EPA) remedial project manager (RPM) for the Site. This five-year review was conducted pursuant to Section 121 (c) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended, 42 U.S.C. '9601 et seq. and 40 CFR '300.430(f)(4)(ii), and in accordance with the Comprehensive Five-Year Review Guidance, OSWER Directive 9355.7-03B-P (June 2001). The purpose of a five-year review is to ensure that the remedial actions remain protective of public health and the environment and are functioning as intended by the decision documents. This document will become part of the Site file.

This Site is being addressed under two operable units. OU2 addressed slag and lead oxide piles, contaminated surfaces and debris, and contaminated standing water. OU2 activities were initiated in 1992 and included off-site reclamation of lead-containing materials, solidification/stabilization and off-site disposal of slag and other materials, decontamination of building floors and surfaces, off-site treatment and disposal of contaminated standing water, building demolition, and environmental monitoring. The OU2 activities were completed in September 1995.

OU1 addressed the remediation of soil, groundwater, surface water, and stream sediment. OU1 activities for the soil and stream sediment were initiated in January 2000. Cleanup activities included the excavation of soil and sediment containing greater than 500 parts per million (ppm) of lead. The excavation of soil and sediment was completed in July 2003. Post excavation biological sampling over the next few years showed increasing levels of lead in the sediments. Additional excavation of stream sediments began in August 2011 and is ongoing.

The groundwater component of OU1 requires the restoration of contaminated groundwater to meet drinking water standards. The groundwater remedy selected in the 1994 OU1 ROD included the extraction and treatment of the contaminated groundwater. This action was not implemented, and the selected groundwater remedy was amended in the 2011 ROD. The amended remedy includes pH adjustment by reagent injection to reduce contaminant levels in the groundwater. The design for this remedy is underway.

II. Site Chronology

Table 1 (attached) summarizes Site-related events from discovery to present activities.

III. Background

Physical Characteristics

The Site is situated on 44 acres of land in Pedricktown, Oldmans Township, Salem County, New Jersey. Active industrial and commercial facilities are located to the north, east and west of the

Site. Pennsgrove-Pedricktown Road is located adjacent to the southern border of the Site. The nearest home is less than 1,000 feet from the Site property line. An active railroad bisects the Site. Approximately 16 acres of the Site are located north of the railroad tracks, including a closed 5.6-acre landfill. This landfill is being addressed under a state regulatory program and is not part of the CERCLA Site. The southern 28 acres contain the industrial area and landfill access road. The West and East Streams, parts of which are intermittent tributaries of the Delaware River, border and receive surface runoff from the Site. There are two large surface water bodies located between the residential and commercial properties along Route 130 and the landfill. (Figure 1, Site Map)

Land and Resource Use

From 1972 to 1984, NL Industries Inc. (NL), and subsequently National Smelting of New Jersey (NSNJ), recycled lead from spent batteries and other lead-bearing waste at the Site. The facility has been inactive since January 1984. The Site is currently zoned for industrial use and is expected to remain so into the future. The Site is currently surrounded by industrial, commercial and residential land uses.

The groundwater aquifer underlying the Site is classified as a Class IIA groundwater aquifer (potable water source) by the State of New Jersey, and is used for potable purposes in the vicinity of the Site.

History of Contamination

Between 1972 and 1983, NL recycled lead from spent batteries and other lead-bearing waste at the Site. The batteries were drained of sulfuric acid, crushed and then processed for lead recovery at the smelting facility. The plastic and rubber waste materials resulting from the battery-crushing operation were disposed of in the on-site landfill, along with slag from the smelting process.

In February 1983, NL sold the facility to NSNJ who resumed secondary lead smelting operations at the Site. NSNJ ceased operation of the facility in January 1984 and filed for bankruptcy in March 1984.When the facility ceased operating, surface contamination was left behind in the form of slag waste and lead oxide piles, drums and debris, contaminated building surfaces, and contaminated surface water and sediments in basements, pits and sumps.

Operations at the Site resulted in the contamination of soil, surface water, sediment, and groundwater. Soil at the Site was contaminated with metals, primarily lead. In addition, elevated levels of lead, copper and zinc were detected in stream sediment and surface water. Groundwater contamination detected at the Site consists primarily of lead and cadmium, with a localized area where elevated levels of volatile organic compounds (VOCs) were detected.

Geology/Hydrogeology

The Site is underlain by three hydrogeologic units: the unconfined (uppermost and water table) aquifer; the first confined aquifer; and the second confined aquifer. The unconfined aquifer is part of the Cape May Formation and averages approximately 20 feet in thickness. The unconfined and first confined aquifers are separated by a clay layer ranging in thickness from about 5 to 20 feet. The first confined aquifer exists approximately 50 to 70 feet below grade and is part of the Raritan

Formation. The second confined aquifer is also part of the Raritan Formation. The first and second confined aquifers are separated by a clay layer of approximately 30 feet in thickness.

Groundwater sampling has confirmed that contamination is currently limited to the unconfined aquifer. The unconfined aquifer has historically been subdivided into two zones; the shallow and deep zones. The shallow zone generally ranges from 5 feet below ground surface (bgs) to 25 feet bgs. The deep zone generally ranges from 25 feet bgs to 50 feet bgs. The terms shallow and deep relate to screened intervals of wells and not to geologic materials. Screen depths for monitoring wells in these zones range from approximately 5 feet below grade in the shallow zone to approximately 50 feet below grade in the deeper zone.

Groundwater flow direction in the unconfined aquifer, as inferred based on groundwater elevation data, is primarily west across the Site towards the West Stream. The groundwater flow rate is approximately 27.5 feet per year; however, the total mass of contaminants flow at a lesser rate due to natural processes, such as precipitation and adsorption reactions, that remove contaminants from groundwater and bind them to aquifer soils, thereby limiting their mobility.

Initial Response

Between 1973 and 1980, the New Jersey Department of Environmental Protection (NJDEP) noticed NL with numerous violations of state air and water regulations. Water pollution violations were directed toward the battery storage area and the on-site landfill. NJDEP conducted an air-monitoring program in 1980 that detected airborne quantities of lead, cadmium, antimony and ferrous sulfate produced by the smelting process, at levels exceeding the facility's operating permits. NL ceased smelting operations in May 1982.

In October 1982, NL entered into an administrative order on consent (AOC) with NJDEP to conduct a remedial program to address contamination of some site soil, paved areas, surface water runoff, the on-site landfill, and groundwater. The Site was proposed for inclusion on the National Priorities List (NPL) in December 1982 and finalized on the NPL in September 1983. The on-site landfill is not within the boundaries of the Site. It is currently closed and is maintained by NL under an agreement with NJDEP.

In February 1983, NL sold the facility to NSNJ who resumed secondary lead smelting operations at the Site. NSNJ subsequently entered into an amended AOC with NJDEP, ceased operation of the facility in January 1984 and filed for bankruptcy in March 1984.

In March 1989, EPA initiated a multi-phased removal action at the Site to address several conditions that presented a serious risk to public health and the environment. Phase I of the removal action (RA) was conducted in March and April of 1989 and consisted of construction of a chain-link fence to enclose the smelting facility and encapsulation of slag piles to provide temporary protection from wind and rain erosion. Phase II began in November 1989 and consisted of additional encapsulation of the slag piles, securing the entrances to the contaminated buildings, and removal of over 40,000 pounds of the most toxic and reactive materials, including red phosphorus and metallic sodium, from the Site. Phase III began in March 1991. During this phase, damage to the perimeter fence was repaired, a new entrance gate was installed and the contents of all containers stored in the open were consolidated to reduce the potential for discharge. Phase IV

began in July 1992 during which the slag bin retaining walls, which were in danger of collapse, were reinforced. Phase V began in the Fall of 1993 and involved the removal of the most highly contaminated sediments from the West Stream.

Groundwater monitoring was initially conducted during the sitewide remedial investigation in 1988 and 1989. Most of the contamination was from lead and cadmium, though VOCs, arsenic and radiological parameters were also detected in localized areas. Arsenic was later determined to be related to landfill leachate. Improvements to the landfill eliminated the seeps and the arsenic detections.

Basis for Taking Action

The results of the EPA and NJDEP investigations showed elevated concentrations of metals at the Site. Although metals such as zinc were detected in site soils, lead and cadmium are the most prevalent and are the primary contaminants of concern. Metals were also found in the unconfined aquifer beneath the Site. The plume was comprised primarily of lead and cadmium, and also contains elevated levels of beryllium, chromium, copper, nickel and zinc. The surface water and sediments in the East and West Streams, and the drainage channel north of Route 130 contained elevated levels of lead, copper and zinc.

A localized area of elevated volatile organic compounds was found in the vicinity of two monitoring wells in the vicinity of the process buildings. Volatile compounds detected include 1,1,1 trichloroethane, 1,1 dichloroethane, 1,1 dichloroethylene, tetrachloroethene and vinyl chloride.

The baseline risk assessment considered current land use to be industrial and future land use was characterized as either industrial or residential. Receptors included off-site residents (child and adult) and off-site workers. Future receptors included on-site residents (child and adult), off-site residents (child and adult), on-site workers and off-site workers. Results of the quantitative risk assessment concluded that there was an unacceptable risk for the potential future receptors due to exposure to contaminated groundwater via ingestion.

The results of the 1992 ecological risk assessment showed that the stream sediment and wetland soils posed a potential risk to ecological receptors. Groundwater was not found to be a significant ecological risk.

IV. Remedial Actions

OU2 Remedy Selection

The OU2 ROD was issued on September 27, 1991. The remedial action objectives (RAOs) for the OU2 remedy focus on preventing future release and migration of hazardous materials and eliminating the areas which could become sources of future contamination and exposure on and off-site. The major components of the remedy selected in the OU2 ROD include:

- Solidification/stabilization and on-site placement of the slag and lead oxide piles;

- Decontamination and off-site treatment and disposal of debris and contaminated surfaces;
- Off-site treatment and disposal of standing water and sediments; and
- Appropriate environmental monitoring to ensure the effectiveness of the remedy.

In March 1992, EPA issued an Explanation of Significant Difference (ESD) which revised the OU2 remedy to permit off-site disposal of the slag and lead oxide piles, after treatment.

OU2 Remedy Implementation

In March 1992, EPA issued a unilateral administrative order (UAO) to 31 potentially responsible parties (PRPs) for design and implementation of the OU2 remedial action. On October 19, 1992, a contractor for the PRPs began slag stabilization activities. Stabilization of all of the slag piles was completed in June 1993. Off-site disposal of the treated slag was completed in July 1993.

During February 1993, another contractor for the PRPs began decontamination and demolition of the facility. On-site structures dismantled included the rotary kiln, baghouses, decasing and slag crushing buildings, battery crusher, truck lift, crushed battery conveyor, above-ground fuel tanks, refining building, office building, soda ash silo and underground storage tanks. Demolition of on-site structures was completed by December 2003. Contaminated sediments and wash water collected at the Site during these activities were shipped off-site for treatment and disposal. On-site non-hazardous concrete was used to backfill the building basements, left in place or sent off-site for recycling. Final grading and backfilling of the former industrial area was completed in August 1994.

In October 1994, the PRPs mobilized to the Site to remove lead-contaminated acid-resistant brick from the battery breaking yard. The remaining brick was subsequently sampled and additional acid-resistant brick was excavated in January 1995. The excavated brick was disposed of off-site in June 1995. The final inspection to ensure completion of the OU2 RA was conducted by representatives of EPA and NJDEP on July 24, 1995. The OU2 RA Report, which documented completion of the OU2 RA, was approved by EPA on September 26, 1995.

During the OU2 RA, material was disposed of or recycled in the following manner: 13,149.76 tons of slag were treated and disposed of off-site as non-hazardous waste; 1,914.8 tons of scrap metal were recycled; 1,592.2 tons of lead-bearing material were sent to a secondary lead smelter for recycling; 1,486 tons of clean concrete were removed for crushing and beneficial use; 52.35 tons of asbestos-containing materials from the on-site buildings were disposed of at an approved non-hazardous landfill; 1,992.8 tons of materials were disposed of at a hazardous landfill; and over 764,000 gallons of contaminated standing water and wash water were sent offsite for treatment.

OU1 Remedy Selection

Original ROD

The OUI ROD for the Site was issued on July 8, 1994. The RAOs for the OUI remedy are as follows:

- To leave no greater than 500 parts per million (ppm) of lead remaining in Site soils and stream sediments; and

- To restore the contaminated unconfined aquifer to drinking water standards for all contaminants.

The major components of the remedy selected in the OU1 ROD include the following:

- Excavation of all soils contaminated with lead above the remedial action objective of 500 ppm, treatment via solidification/stabilization of those soils classified as hazardous under the Resource Conservation and Recovery Act, and disposal of the treated soils along with non-hazardous soils in a landfill to be constructed on the Site;

- Removal of contaminated stream sediments above 500 ppm of lead from the West Stream and drainage channel north of Route 130 and treatment/disposal of the sediments in a manner similar to that described for soils above;

- Extraction and treatment of contaminated groundwater with direct discharge of the treated groundwater to the Delaware River; and

- Appropriate environmental monitoring to ensure the effectiveness of the remedy.

In June 1999, EPA issued an ESD which provided an explanation of a change which EPA made to a portion of the OU1 remedy. The 1999 ESD revised the OU1 remedy to permit appropriate off-site disposal of all excavated soil and sediment, after treatment. Excavated areas were restored and graded. The OU2 remedy does not require further actions such as operation and maintenance.

OU1 Remedy Implementation

In June 1996, EPA entered into an AOC with five PRPs for remedial design (RD) of the OU1 remedy. On January 13, 1997, the 1996 AOC was modified to additionally require that the PRPs install and maintain silt fencing along the West Stream and on the north and west sides of the former plant area of the Site in order to mitigate off-site migration of site-related contamination. On April 5, 1999, a Consent Decree for RA was entered by the Federal Court in order to implement the designed remedy. In order to expedite OU1 activities, EPA decided to begin design and implement the soil and sediment components of the remedy while conducting additional groundwater investigations.

Soil and Sediments:

Remediation of soils and sediment

In September and October 1997, the PRPs conducted a pre-design investigation for soil and sediment to determine the approximate geographic limits of the soil and sediment contamination. The Design Report for Soil and Sediment was approved by EPA in January 2000.

The PRPs mobilized to the Site in June 2000 to begin the soil and sediment RA. During the RA, 150,928 tons of contaminated soil and sediment were excavated, treated and disposed of at appropriate off-site disposal facilities; 10,887 tons of concrete were demolished, decontaminated and shipped to an off-site facility for recycling; and 182 tons of scrap metal and steel rebar were decontaminated and shipped to an off-site facility for recycling.

As part of the soil and sediment RA, the PRPs were required to collect and analyze soil and sediment confirmation samples to demonstrate that the 500 ppm cleanup for lead was achieved. In order to accomplish this, the PRPs established a 100 foot by 100 foot grid at the Site and collected confirmation samples from two grid nodes for each grid. The results of this confirmation sampling demonstrated that soil and sediment containing lead at concentrations greater than 500 ppm does not remain at the Site. As noted in the second five-year review (September 2003), the average concentration of lead remaining in soil and sediment in remediated areas was less than 400 ppm.

A final inspection was conducted by EPA and the NJDEP on May 29, 2003. With the exception of the need to apply mulch to a portion of the Site, no deficiencies were noted. The OU1 RA report was approved by EPA on July 31, 2003

Post Remediation Sampling

The Biological Monitoring Plan was approved by EPA on May 4, 2000. Post-remedial biological monitoring events took place in 2002, 2003 and 2004 to ensure that the lead levels in the stream soil and sediments remained below 500 ppm. Biological monitoring included tests to evaluate whether the levels of lead in the sediments were expected to impact aquatic receptors and whether lead levels in surface water, sediment and aquatic life were potential hazards to wildlife.

Results of the 2003 and 2004 biological monitoring events showed several areas where the sediment lead levels were greater than 500 ppm. As a result, additional sediment sampling was performed to delineate the extent of elevated lead contamination in the West Stream and both stream banks between Pennsgrove-Pedricktown Road to Route 130. In April 2008, approximately 380 sediment samples were collected from approximately 175 sample locations. Sample analysis showed areas of elevated lead levels and the PRP Group agreed to conduct the necessary remedial activities to address the sediment contamination.

Subsequent remediation of soil and sediment

Additional stream soil and sediment removal activities began in August 2011. This work entails removing sediments and soils with greater than 500 ppm of lead from the West Stream and the West Stream's banks. As of the spring of 2013, lead contaminated sediment has been removed from the area south of Pennsgrove-Pedricktown Road until Route 130. These areas were backfilled with certified clean fill and revegitated. Currently work continues along the West Stream northwest of Route 130.

Lead-bearing soils were also removed from residential properties along the West Stream. Post-excavation sampling on the residential properties showed that remaining soils are below the NJDEP residential standard of 400 ppm.

To date 11,100 cubic yards (or approximately 15,034 tons) of stream soil and sediment have been removed and disposed off-site. During the spring/summer of 2013, the PRPs will continue to remove lead contaminated soils and sediment from the West Stream northwest of Route 130 until the cleanup goals are met. (Figure 2)

Following the completion of the excavation activities (approximately one year) biomonitoring data will be collected one, two and four years later to confirm that lead concentrations in exceedance of the cleanup value have been appropriately addressed.

As noted earlier in this section, the average lead level in the soil and sediment, except in the areas where current removal activities are taking place, is below 400 ppm. The lead levels in soils on the residential properties where soils were recently removed are also below 400 ppm. This is below the NJDEP residential standard and Institutional Controls are not necessary.

Groundwater:

As part of the remedial design for the OU1 groundwater remedy, two phases of groundwater evaluations were conducted in the late 1990s. Phase I took place in 1997 when twenty groundwater samples were collected and analyzed for VOCs, semi-volatile organic compounds (SVOCs), total and dissolved metals, cyanide and radiological parameters. Water quality parameters, such as pH and oxidation-reduction potential, were also measured. This sampling event showed a relationship between pH and metal solubility in groundwater. Areas of low pH (high acidity) correlated with high concentrations of lead and cadmium. This sampling also showed that overall; concentrations of lead and cadmium in groundwater at the Site had decreased since RI sampling in 1988 and 1989.

The Phase II groundwater evaluation began in 1998. It included installation of additional monitoring wells, sampling of potable groundwater from residential wells along Route 130, evaluation of Site subsurface soils to determine adsorption capacity of metal ions, a radionuclide study, pump tests, and groundwater flow and transport modeling.

The radionuclide study in Phase II did not show a radionuclide source at the Site as there was no clear pattern of radionuclide occurrence in the subsurface. Radiological parameters were only detected in samples obtained from deep-zone wells adjacent to clay layers at the Site. This led to the conclusion that the radiological parameters are naturally occurring and not related to former Site activities. Therefore, no further analysis of radionuclides was required.

Phase II pump tests indicated that constant pumping of the contaminated groundwater would not be highly efficient at removing lead and cadmium. It was calculated that it would take between 50 and 60 years of aggressive pumping to remove enough lead and cadmium from the groundwater to achieve the cleanup standards. Furthermore, evaluation of groundwater contamination levels over time, showed a continuing decrease in the mass of lead and cadmium.

Aquifer testing was also conducted to determine the adsorption capacity of the aquifer material. Testing revealed that there were adequate amounts of iron and manganese oxide/hydroxide coatings on the aquifer soils to provide for adsorption of lead and cadmium ions, if these metals were to precipitate out of solution.

Based on these findings, in January 2000, the PRPs proposed changing the selected groundwater remedy from extraction and treatment to the injection of stabilizing agents into the aquifer to enhance naturally-occurring geochemical reactions. After evaluating this proposal, EPA determined that additional investigations and treatability studies were necessary to determine if the injection of stabilizing agents into the groundwater would be appropriate.

Additional rounds of groundwater sampling took place in 2004, 2007 and 2010. Data generated during groundwater monitoring events indicated that the lead and cadmium concentrations generally continued to decrease and the area of contaminated groundwater shrank over time, although there were still exceedances of the New Jersey Groundwater Quality Standards (NJGWQS) (5 ppb for lead and 4 ppb for cadmium) in some areas. By the 2010 event, the majority of the contaminated groundwater was located beneath and slightly north of the former facility production area. (Figure 3: cadmium in groundwater, Figure 4: lead in groundwater)

Residential Wells:

Residents located west of the West Stream, along Benjamin Green Road were connected to the public water supply system in 1975, while residents located north of the Site along Route 130 have private wells. Residential well sampling was conducted in 2004, 2006, 2007 and 2010. During each of these monitoring events, lead and cadmium concentrations in the residential water samples were either not detected, were significantly below the applicable New Jersey drinking water standards, or had minor detections that were determined not to be Site related.

VOCs:

Groundwater data collected in 2010 show that vinyl chloride and tetrachloroethene are the only site-related VOCs currently above the drinking water standards. These two contaminants have been detected at only three of the twenty-eight groundwater monitoring wells at concentrations exceeding the drinking water standards. Two wells had vinyl chloride concentrations of 7.7 parts per billion (ppb) and 6.9 ppb. One well had a tetrachloroethene concentration of 1.6 ppb. Total VOC concentrations have generally decreased over time and these concentrations are expected to continue to decrease.

Changes over Time

Removal of contaminated source material as a result of OU1 soil/sediment and OU2 remedial activities, contributed to the observed significant decrease in lead and cadmium groundwater concentrations. Equilibrating (less acidic) pH values have also contributed to the continued decrease in lead and cadmium concentrations in groundwater. At low pH, metals are more soluble and tend to stay in solution. At higher pH values, the metals tend to adsorb to the aquifer soils and become immobile. In 1983, groundwater pH values in the contaminated unconfined aquifer mainly ranged from a pH of 3 to a pH of 4. The lowered pH was a result of the battery acids that

were released on-site as a result of the NL Industries, Inc. facility operations. More recent data from 2010 groundwater samples indicates that pH values of the contaminated unconfined aquifer are closer to a pH of 5. The natural pH range for the Site is between 5 and 6. Rising pH values are a result of natural equilibration subsequent to contaminant source removal.

Between 1983 and 2010, the mass of lead in the groundwater decreased from approximately 220 pounds to 2.7 pounds. For cadmium, the mass has decreased from approximately 70 pounds in 1988 to 5.9 pounds in 2010. Even though lead and cadmium have significantly decreased over time, the concentrations remain above NJGWQS levels.

The data from all these monitoring events was used to develop a new focused feasibility study for groundwater (FFS). The PRP Group submitted a draft FFS to EPA in November 2007 in which they evaluated a number of remedial alternatives for groundwater. After several revisions the FFS was approved in June 2011 and an Amended ROD was issued in September 2011.

OU1 ROD Amendment for Groundwater

The OU1 ROD Amendment for the groundwater remedy was issued on September13, 2011. The RAOs for the OUI ROD Amendment are as follows:

- Restore the contaminated unconfined aquifer to drinking water standards for all contaminants;
- Minimize the potential for migration of the contaminants of concern in groundwater; and
- Prevent or minimize potential current and future human exposures; including ingestion of groundwater, that presents a significant risk to public health and the environment.

The major components of the Amended Remedy include the following:

- In-situ pH adjustment and reagent injection for the contaminated unconfined aquifer via injection wells;
- Monitoring of groundwater; and
- Implementation of institutional controls to restrict the use of contaminated groundwater until cleanup goals are achieved.

In addition, all constituents of concern identified in 1994 ROD will continue to be monitored and the remedy selected in the 1994 OU1 ROD: Pump and Treat Plus Institutional Controls will be retained as a contingency remedy.

OU1 ROD Amendment for Groundwater Implementation

Remedial design (RD) activities are taking place under a unilateral administrative order issued by on EPA September 25, 2012. A RD work plan was submitted to EPA in December 2012 as required by the Order.

V. Progress Since the Last Five-Year Review

The third five-year review was completed on September 4, 2008.

Issues and Recommendations from the Third Five-Year Review:

In the third five-year review, the rise in lead levels in the West Stream sediments was noted as an issue and it was recommended that "upon completion of the removal of lead contaminated stream sediments, evaluate the potential need for institutional controls". The removal of stream sediments is ongoing. An evaluation of the need for institutional controls will follow when all removal activities have been completed. Excavations have been completed in residential areas and the post-excavation lead soil levels meet NJDEP's residential standard of 400 ppm.

OU2:

The OU2 remedy was completed in September 1995 and is protective of human health and the environment. Implementation of the OU2 remedy has provided for the protection of public health and the environment through the removal of lead bearing waste from the Site, thereby eliminating the possibility of exposure to this waste. The OU2 remedy does not require any operation and maintenance or institutional controls.

OU1:

Soil and Sediment:

During the previous five-year review period, monitoring revealed lead levels above 500 ppm in the soil and sediments of the West Stream. As a result, of soil and sediment excavation began August 2011. The work entailed extracting sediments and soils containing greater than 500 ppm of lead from the West Stream and the West Stream's banks. The work started in an area south of Pennsgrove-Pedricktown Road, and will eventually go past Route 130. To date, the area up to Route 130 has been remediated, meaning lead contaminated soil has been removed, and the areas backfilled with certified clean fill and revegitated. To date, approximately 11,100 cubic yards (15,034 tons) of material has been excavated and disposed of off-site. It should be noted that in residential areas, the post-excavation lead soil levels meet NJDEP's residential standard of 400 ppm.

Groundwater:

Groundwater studies which took place after issuance of the OU1 ROD showed that the extent of lead and cadmium was decreasing and the pH levels were increasing within the aquifer over time. These studies also showed that a groundwater extraction and treatment system was unlikely to remediate the remaining groundwater contamination in a timely manner. Therefore, the above mentioned OU1 ROD Amendment for groundwater was issued by EPA in September 2011, and an

UAO for RD was issued in September 2012. The draft RD work plan is currently under EPA review.

VI. Five-Year Review Process

Administrative Components

The fourth five-year review team consists of Renee Gelblat (EPA, RPM), Michael Scorca (EPA, Hydrogeologist), Julie McPherson (EPA, Risk Assessor for Human Health), and Mindy Pensak (EPA, Ecological Risk Assessor).

Community Involvement

On April 30, 2013, EPA published a notice of the Five Year Review on the local Township web site to notify the community of the initiation of the five-year review process.

The notice informed the community that EPA would be conducting a five-year review of the selected remedies to ensure that the remedies remain protective of public health and are functioning as designed. The notice also includes contact information for the RPM for questions related to the five-year review process for the NL Industries Site and informed the community that the results of the five-year review will be made available in the Site repositories. No concerns or comments regarding the performance of this five-year review have been expressed to EPA.

Document Review

The documents, data, and information which were reviewed in completing this five-year review are summarized in Table 2.

Data Review

Soil and Sediment:

The initial soil and sediment remedial actions took place from June 2000 to July 2003. This was followed by five years of post remediation biological monitoring. Sampling from 2003 and 2004 showed rising lead levels in the sediments. In April 2008, approximately 380 sediment samples were taken from 175 locations. The sampling results showed that lead levels greater than 500 ppm covered a large area along the West Stream from south of Pennsgrove-Pedricktown Road to northwest of Route 130. As a result, a second round of soil and sediment excavation began in August 2011.

As of the spring of 2013, lead contaminated sediment has been removed to below the cleanup goal of 500 ppm from the area south of Pennsgrove-Pedricktown Road up to Route 130. These areas were backfilled with certified clean fill and revegitated. To date 11,100 cubic yards (or approximately 15,034 tons) of soil and sediment have been removed and disposed off-site. Currently, work continues on the lead contaminated sediments the West Stream northwest of Route 130 and will continue until the cleanup goals are met. Post-excavation sampling on the

residential properties along the West Stream showed that the remaining soils on these properties are below the NJDEP residential standard of 400 ppm.

Groundwater:

Groundwater sampling took place under the RI (1988-1989), under the 1994 OU1 ROD (1997 and 1998) and in 2004, 2007, 2010. These data show a general decrease over time in the levels of lead and cadmium in the groundwater and that, at this time, the majority of the contaminated groundwater is located beneath the former facility area (See Figures 3 and 4). Between 1983 and 2010, the mass of lead in the groundwater decreased from approximately 220 pounds to 2.7 pounds. For cadmium, the mass has decreased from approximately 70 pounds in 1988 to 5.9 pounds in 2010. The current volume of groundwater impacted by lead is approximately 1.5 million gallons and 11.8 million gallons for cadmium. Although the groundwater concentrations of lead and cadmium remain above current drinking water standards, there has not been any significant migration of contaminants in recent sampling events. The lack of significant migration and a general decrease in lead and cadmium levels coincide with a general increase in groundwater pH levels. (Figures 3 and 4)

Residential groundwater sampling was also conducted in 2004, 2006, 2007 and 2010 for those residences along Route 130 using private wells. During each of these monitoring events, lead and cadmium concentrations in the residential water samples were either not detected, were significantly below the applicable New Jersey drinking water standards, or had minor detections that were determined not to be Site related.

Vapor Intrusion:

The primary contaminants in groundwater are the metals lead and cadmium which do not form vapors. There are also limited concentrations of VOCs in some wells. The maximum concentration of these VOC compounds was compared to screening groundwater concentrations corresponding to target indoor air concentrations in the EPA Vapor Intrusion Screening Level Calculator.

Only vinyl chloride (detected in MW-12 at 13 μg/L and MW-24 at 4.9 μg/L) was above the screening groundwater concentration of 0.25 μg/L (corresponding to a 10^{-6} cancer risk level). However, this does not indicate that a vapor intrusion problem would occur if a building were to be erected over the area because the concentrations are isolated and results from shallower wells do not show VOC contamination. Additionally, since there are presently no buildings on the site or in the vicinity of the well where VOCs have been found, the exposure pathway is incomplete.

Ecological Assessment:

As biological monitoring determined that residual lead contamination (greater than the cleanup value of 500 ppm) remained in both the West Stream sediment channel and floodplain areas, additional excavation was identified as necessary to achieve the identified cleanup values. Sediment and floodplain soil excavation began in August 2011 and remediation is ongoing.

Baseline biomonitoring data were collected to document body burdens of lead in aquatic biota indigenous to the West Stream. These data indicated that body burdens of lead in aquatic biota collected from all areas of the West Stream were usually higher than lead burdens of the same species (green frogs, spiny-cheek crayfish and bluespotted sunfish) obtained from the reference area. Following the completion of the excavation activities, biomonitoring data will be collected one, two and four years later to confirm that lead concentrations in exceedance of the cleanup value have been appropriately addressed.

Site Inspection

A Site inspection was conducted on April 11, 2013 by Renee Gelblat (RPM) and Jeff Leeds (PRP contractor). The Site inspection consisted of a physical inspection of the former plant area, security fence, monitoring wells, West Stream and surrounding wetland areas, stream culverts and surface water bodies north of the landfill.

The Site is in good condition. The fence surrounding the 44 acres is in good condition as are the groundwater monitoring wells. The concrete remnants of the old buildings have been removed. Currently, there is a deer fence between the property line and the West Stream south of Route 130. This fence was constructed to prevent deer from eating the newly planted vegetation in the remediated areas along the West Stream.

During the Site visit, the area north of Route 130 was being surveyed prior to the next phase of soil and sediment remediation. The stream culverts were clear and in good condition.

Interviews

Renee Gelblat of EPA has discussed ongoing activities at the site with the five-year review team and the PRP Group. EPA also placed a notice of the five-year review on the Township website on April 30, 2013.

EPA did not receive any public comments regarding this five-year review. There were no issues or concerns raised about the protectiveness of the remedies in place at the Site.

VII. Technical Assessment Summary

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

OU2:

The remedy selected for OU2 in 1991 addressed slag and lead oxide piles, debris and contaminated surfaces and standing water and sediments. The remedy included (1) solidification/stabilization and on-site placement of the slag and lead oxide piles, (2) decontamination and off-site treatment and disposal of debris and contaminated surfaces, (3) offsite treatment and disposal of standing water and sediments, and (4) appropriate environmental monitoring to ensure the effectiveness of the remedy. The remedy selected has been implemented and has interrupted the exposure pathway. As

part of the OU2 remedy, 13,149.76 tons of lead-bearing slag, 1,592.2 tons of other lead-bearing materials, and 1,992.8 tons of hazardous material were permanently removed from the Site and either disposed of at a landfill or recycled.

The OU2 remedy was completed in September 1995.

OU1:

The remedy selected for OU1 in the 1994 ROD included: (1) excavation of all soils contaminated with lead above the remedial action objective of 500 ppm, treatment via solidification/stabilization of those soils classified as hazardous under the Resource Conservation and Recovery Act, and disposal of the treated soils along with non-hazardous soils in a landfill constructed on the site (changed to disposal offsite in the 1999 ESD); (2) removal of contaminated stream sediments above 500 ppm of lead from the West Stream and drainage channel north of Route 130 with treatment/disposal in a manner similar to that described for soils above; (3) extraction and treatment of contaminated groundwater prior to discharge to the Delaware River; and (4) appropriate environmental monitoring to ensure the effectiveness of the remedy.

Soil and Sediment:

The remediation of soils and sediments containing lead levels greater that 500 ppm was completed in 2001. However, a multi-year post-remediation biological monitoring program indicated areas of the West Stream where the lead levels in the sediment exceeded the 500 ppm goal. The extent of these areas of elevated lead levels was defined and further excavation and off-site disposal of those soil and sediments began in August 2011. The second soil and sediment remediation is ongoing.

A portion of the soil and sediment remediation activities took place on residential properties along the West Stream. Recent sampling confirmed that the post remediation lead levels on these residential properties are below the NJDEP residential soil standard of 400 ppm.

Once the current soil and sediment excavation and disposal actions are fully implemented, the soils and sediment are expected to be protective of human health and the environment.

Groundwater:

The OU1 groundwater remedy selected in the 1994 ROD included construction of an extraction and treatment system. After the ROD was issued, subsequent groundwater sampling and analysis of the physical parameters in the aquifers occurred. Modeling of this data showed an extraction and treatment system may not remediate the groundwater in a timely manner. Furthermore, evaluation of groundwater contamination levels over time showed a continuing decrease in the mass of lead and cadmium along with a decrease in the acidity of the soil. As a result, the PRP Group submitted a draft FFS to EPA in November 2007 in which they evaluated a number of remedial alternatives for groundwater. After several revisions, the FFS was approved by EPA in June 2011.

In 2011, a ROD Amendment was issued which changed the remedy to: (1) in-situ pH adjustment and reagent injection for the contaminated unconfined aquifer via injection wells; (2) monitoring of groundwater; and (3) implementation of institutional controls (such as a Classification Exception Area) to restrict the use of contaminated groundwater until cleanup goals are achieved. In addition, all constituents of concern identified in 1994 ROD will continue to be monitored and the remedy selected in the 1994 OU1 ROD; Groundwater Extraction and Treatment will be retained as a contingency remedy.

The amended remedy is currently in design.

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

Soil and Sediment:

The exposure assumptions and toxicity values that were used to estimate potential cancer risks and noncancer hazards in the risk assessments supporting the 1991 and 1994 RODs followed the Superfund risk assessment process at the time and remain valid. The site-specific lead remediation goal for soil and sediment selected for the site in the 1994 ROD was 500 ppm. This goal is lower than the New Jersey Non-Residential Direct Contact Soil Remediation Standard of 800 ppm and is considered protective for current and anticipated future uses of the site.

Although the remediation goal for the site is not designed to be protective of residential exposures, recent sampling confirmed that the post-remediation levels of lead on residential properties along the West Stream are below the NJ Residential Direct Contact Soil Remediation Standard of 400 ppm. Also, as noted in the September 2003 five-year review, the average concentration of lead remaining in soil and sediment in remediated areas on the rest of the Site was determined to be less than 400 ppm. Therefore, Institution Controls for the soils and sediments are not necessary.

Groundwater:

The remedial action objective for groundwater, established in the 2011 OU1 ROD Amendment, is to restore the unconfined aquifer to drinking water standards for all contaminants. Although this RAO has not yet been achieved for lead and cadmium, the RAO remains valid because the drinking water standards for the contaminants of concern have not changed. Additionally, residential wells along Route 130 were sampled in 2004, 2006, 2007 and 2010 and showed no exceedance of the NJDWS for lead and cadmium.

Vapor Intrusion:

Although the primary contaminants in groundwater are lead and cadmium, there are limited concentrations of VOCs in some wells. The maximum concentration of these VOC compounds was compared to screening groundwater concentrations corresponding to target indoor air concentrations in the EPA Vapor Intrusion Screening Level Calculator (available at: http://www.epa.gov/oswer/vaporintrusion/guidance.html#Item6). Only vinyl chloride (detected in

MW-12 at 13.0 µg/L and MW-24 at 4.9 µg/L) was above the screening groundwater concentration of 0.25 µg/L (corresponding to a 10^{-6} cancer risk level). However, this does not indicate that a vapor intrusion problem would occur if a building were to be erected over the area because the concentrations are isolated and results from shallower wells do not show VOC contamination. Additionally, there are presently no buildings on the site. Therefore, the exposure pathway is incomplete. If, in the future, buildings are constructed in this area of the Site, EPA may conduct a vapor intrusion study.

Ecological Assessment:

Although the ecological risk assessment screening and toxicity values used to support the 1994 ROD may not necessarily reflect the current values, the cleanup value of 500 ppm, which is based on the site-specific ecological risk assessment, remains selected is protective. Current sediment and floodplain soil excavation activities should ensure that contaminated media are addressed. Therefore, this remedy will be protective of ecological resources by preventing unacceptable exposure to ecological receptors. Further, wetland areas disturbed by these remedial activities are being mitigated as per the January 18, 2011 Wetland and Riparian Zone Restoration Plan. Under this plan, areas impacted by remediation activities are being restored as are riparian areas previously dominated by invasive species.

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

No other information has come to light that could call into question the protectiveness of the remedy.

VIII. Recommendations and Follow-up Actions

There are no comments, issues, suggestions or recommendations concerning the OU1 or OU2 remedies. Site structures and surface soils have been removed. Access to the Site is restricted by a fence. The OU1 remedy for the sediment and soil is being implemented and the amended remedy for the groundwater is in design. The OU2 remedial action is completed.

IX. Protectiveness Statement

The remedy for OU2 is protective of human health and the environment.

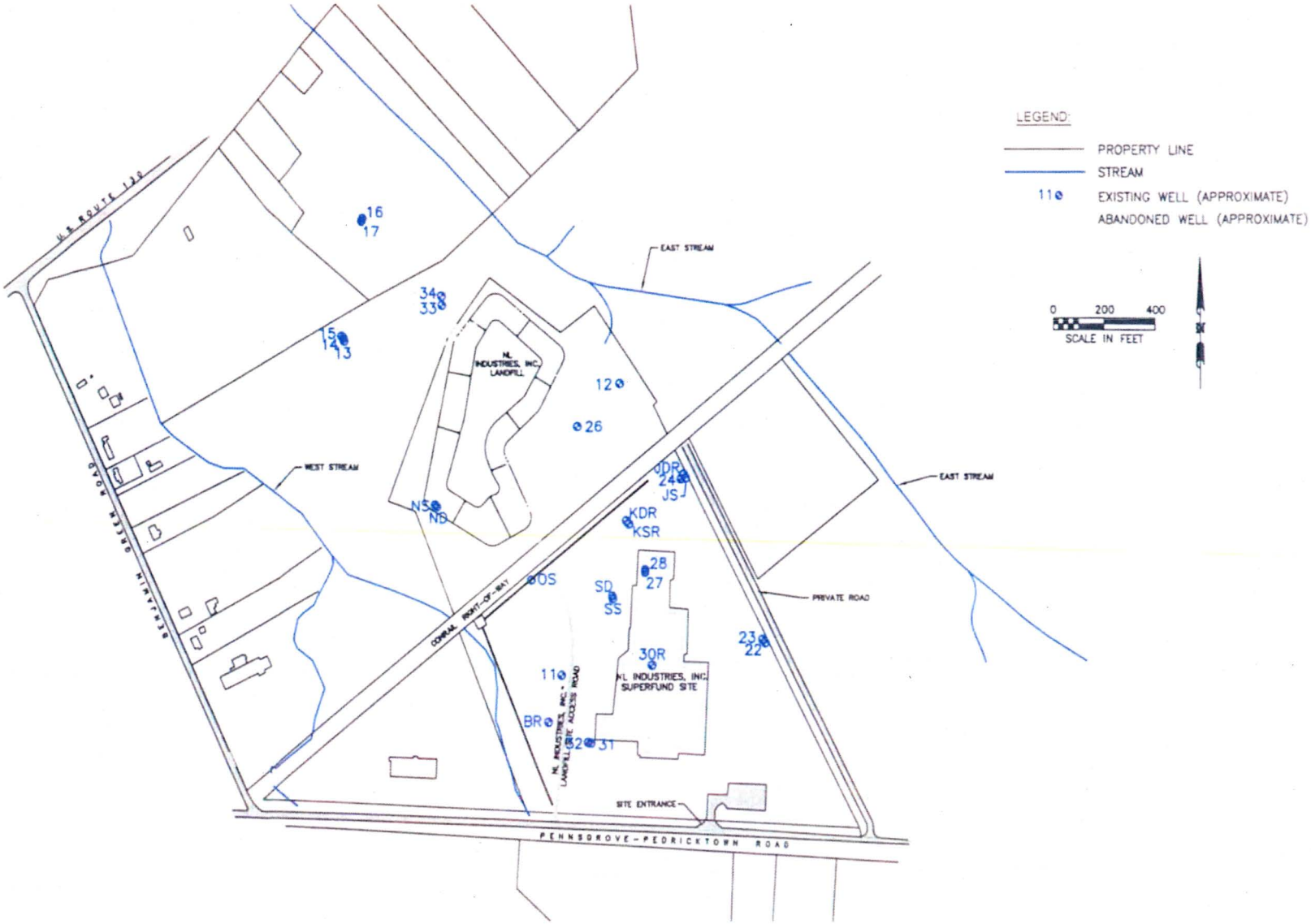
The remedy for OU1 is expected to be protective of human health and the environment upon completion. In the interim, remedial activities completed to date have adequately addressed all exposure pathways that could result in unacceptable risks in these areas.

X. Next Review

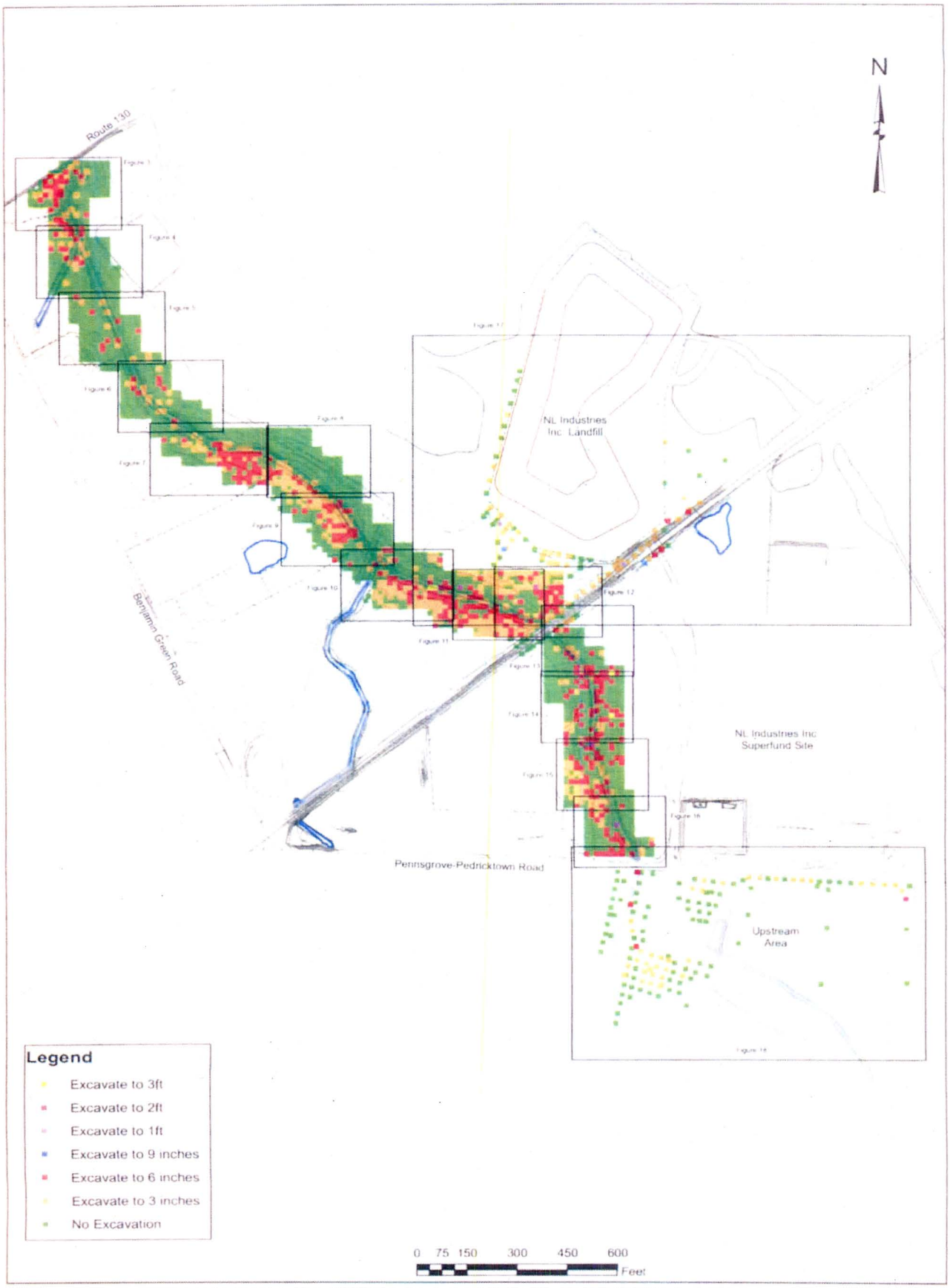
The next five-year review for the NL Industries Company Site should be completed by June 2018

Table 1: Chronology of Site Events	**Date**
Lead Smelting operations by NL Industries	1972-1982
NL cited by NJDEP for violations of state air and water regulations	1973-1980
NL Ceases smelting operations at the Site	5/1982
Lead smelting operations conducted at Site by National Smelting of New Jersey	2/1983-1/1984
Site listed on EPA's National Priorities List	9/1983
Administrative Order on Consent for Site-wide RI/FS by NL Industries	4/1986
RI/FS conducted	1986-1993
Removal Actions conducted by EPA	1988-1996
OU2 ROD issued	9/27/1991
ESD issued for OU2 issued	3/1992
UAO issued to PRPs for OU2 Remedial Design and Remedial Action	3/31/1992
OU2 Remedial Action performed	10/1992-9/1995
OU1 ROD issued	7/8/1994
AOC for performance of OU1 Remedial Design issued	6/10/1996
Remedial Design for OU1 soil and sediment conducted	6/1996-1/2000
First five-year review completed	4/9/1998
Consent Decree for PRP performance of OU1 Remedial Action entered by Federal Court	4/5/1999
OU1 ESD issued	6/21/1999
OU1 Remedial Action for soil and sediment conducted	1/18/2000-731/2003
Second five-year review issued	9/24/2003
Port-remediation biological sampling	2002, 2003, 2004
Wetlands Monitoring	2002-2007
Residential/Commercial water sampling events	2004, 2006, 2007, 2010
Groundwater monitoring events	1997, 1998, 2004, 2006, 2010
Third five-year review issued	9/4/2008
Groundwater Focused Feasibility Study approved	6/2011
Post biological sampling soil and sediment remediation	8/2011 to present
OU1 ROD amendment issued for groundwater remedy	9/13/2011
UAO for Remedial Design issued	9/25/2012

Table 2: Documents, Data, and Information Used in Completing Five-Year Review
! Third Five Year Review for NL Industries, EPA, September, 2008
! Progress Reports under the Consent Decree, Leed Environmental, Inc., #108-present
! Progress Reports under the Administrative Order on Consent for Remedial Design, Leed Environmental, Inc., #144-present
! Groundwater Monitoring Plan, CSI Environmental, LLC, November 2010
! Residential Water Supply Well Sampling Plans, CSI Environmental, LLC, November 2010
! December 2010 Groundwater Monitoring Report, CSI Environmental LLC, February 2011
! Residential Well Sampling Report, CSI Environmental, LLC, February 2011
! Scope of Work West Stream Sediment Remediation, Pedricktown Site Group, June 2011
! West Stream Excavation Progress Reports, CSI Environmental, LLC, # 1-6
! Final Groundwater Focused Feasibility Study, CSI Environmental, LLC, June 2011
! OU1 ROD Amendment for the Groundwater Remedy, EPA, September 2011
! Unilateral Administrative Order for Remedial Design of the Amended Groundwater Remedy (CERCLA-02-2012-2018), EPA, September, 2012
! Draft Remedial Design Work Plan for the Amended Groundwater Remedy, CSI Environmental, LCC, December 2012
! Progress Reports under the Unilateral Administrative Order (Remedial Design of the Groundwater Reagent Injection Remedy), Lead Environmental, Inc., #1-present
! Comments from Julie McPherson, EPA Risk Assessor, May, 2013
! Comments from Chloe Metz, EPA Risk Assessor, May 2013
! Comments from Mindy Pensak, EPA Ecological Risk Assessor, May 2013



CSI Environmental, LLC 918 Chesapeake Ave Annapolis, MD 21403 410-268-2785	Drafter: M. Ballantine Approved By: J.D. Ferris Prepared: 2/1/2011	SITE OVERVIEW NL Industries, Inc. Superfund Site Pedricktown, New Jersey	FIGURE 1



CSI Environmental, LLC
918 Chesapeake Ave
Annapolis, MD 21403
410-268-2765

Excavation Figure Key
NL Industries, Inc. Superfund Site
Pedricktown, NJ

Figure 2

N

0 200 400
SCALE IN FEET

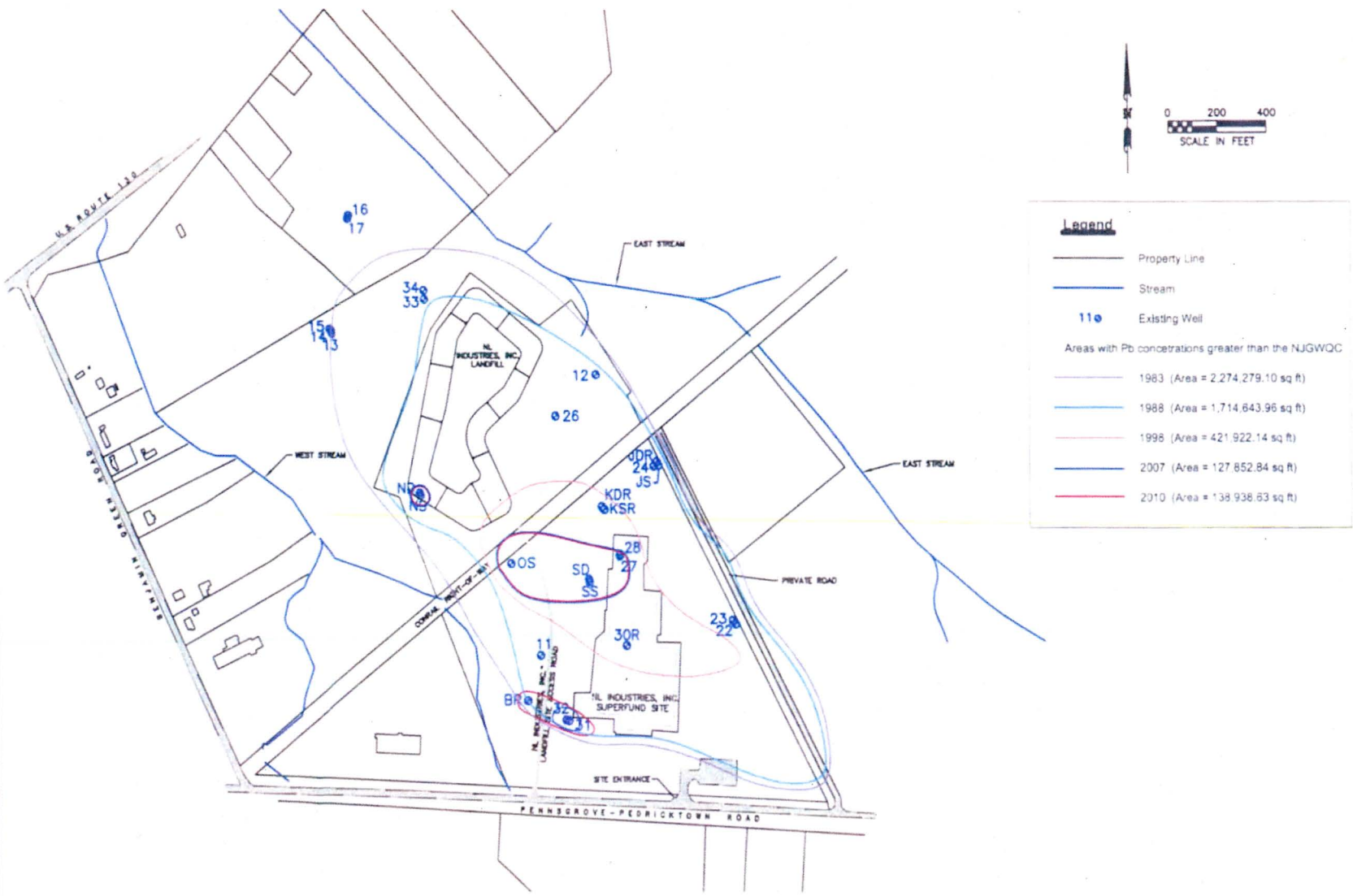
Legend

- Property Line
- Stream
- 11 Existing Well

Areas with Cd concetrations greater than the NJGWQC

- 1988 (Area = 1,231,268.12 sq ft)
- 1998 (Area = 833,701.64 sq ft)
- 2007 (Area = 731,651.89 sq ft)
- 2010 (Area = 742,912.73 sq ft)

CSI Environmental, LLC 918 Chesapeake Ave. Annapolis, MD 21403 410-268-2765	Drafter: M. Hickey Approved By: J.D. Ferris Prepared: 2/10/2011	HISTORICAL EXTENT OF CADMIUM CONCENTRATIONS ABOVE THE GROUNDWATER QUALITY STANDARD NL Industries, Inc. Superfund Site Pedricktown, NJ	FIGURE 3



CSI Environmental, LLC 918 Chesapeake Ave Annapolis, MD 21403 410-268-2765	Drafter: M. Hickey Approved By: J.D. Ferris Prepared: 2/10/2011	HISTORICAL EXTENT OF LEAD CONCENTRATIONS ABOVE THE GROUNDWATER QUALITY STANDARD NL Industries, Inc. Superfund Site Pedricktown, NJ	FIGURE 4