

EnviroBlend® has extensive knowledge of the fate and transport of heavy metal contamination, as well as remedial action experience. Our scientists have spent years developing cost-effective chemistries for rendering lead, cadmium, arsenic, hexavalent chromium, zinc and other heavy metal contaminants non-hazardous. This research has resulted in a number of patented products that have been widely applied for heavy metal remediation sites across the country.

Columbia Development Corporation – South Carolina

Remediated over 500 tons of lead-impacted soil at a potential brownfield redevelopment site. Rendered the soil non-hazardous without additional treatment, soil reused on site. Met the client's 2-week timeframe, completing the project prior to implementation of UTS standards. Performed the project at 1/2 the cost of the alternative, which would have been disposing of in a hazardous waste landfill.

Speakman Company Foundry Sand Site - Delaware

Remediated over 5,000 tons of lead-impacted soil *in-situ* at an operating manufacturing facility. Performed work under the voluntary cleanup program (VCP) in Delaware, which required the preparation of a remedial action work plan and documentation report subject to public comment and review. Work was completed on a 0.5-acre site in a mixed residential and commercial area without affecting neighboring properties. The total project cost was over 60% less than the cost of hazardous waste disposal.

Former Herbicide Manufacturer - Missouri

Armour Road site was used for railroad herbicide manufacturing and blending from 1948 to 1986. Powdered arsenic (95% pure), monosodium arsenic, and various other chemicals were part of the herbicide production. Subsurface testing revealed significant arsenic contamination in over 40,000 tons of soil. EnviroBlend personnel formulated site-specific treatment chemistry for the contaminated soil that was effective at low doses, saving the owner considerable off-site disposal costs.

Excerpt from Chowdhury, Ajit K.; Stanforth, Robert R.; and Overby, Ross (2007) "Treating Arsenic-Contaminated Soil At A Former Herbicide Blending Facility," Proceedings of the Annual International Conference on Soils, Sediments, Water and Energy: Vol. 12, Article 5. EnviroBlend HXM was utilized.

| Soil Arsenic Concentration, mg/kg | EnviroBlend® Dosage, weight % |
|-----------------------------------|-------------------------------|
| <2,000 | 1.15 |
| 2,000-5,000 | 1.75 |
| 5,000-15,000 | 2.3 |

Approximately 11,000 cubic yards of soil were initially treated at dosages ranging from 0.75 to 2.3 percent by weight. Table 1 provides a summary of full-scale treatability data on the initial soil stockpiles.

Table 1. Initial Full-scale Treatability Data Summary

| | Dose | Pre Treatment | | Post Treatment |
|--------|---------------|----------------|--------------|----------------|
| | | Total Arsenic | TCLP Arsenic | TCLP Arsenic |
| Range | 0.75% - 2.30% | 1,700 – 10,600 | 1.7 – 63.6 | 0.28 – 2.90 |
| Median | 1.25% | 5,220 | 15.1 | 1.20 |
| Mean | 1.53% | 5,450 | 20.7 | 1.32 |

Former Ashepoo Fertilizer Works – South Carolina

Spills at this former fertilizer plant contaminated the soil and groundwater with acid, arsenic, and lead. Sampling found arsenic as high as 220 mg/L. Over 45,000 cubic yards of saturated affected soil were effectively treated *in-situ* with EnviroBlend to below drinking water standards. The site was located in a tidally-influenced coastal environment, and the project was hailed as a success by both the USEPA and the client, in addition to significant cost savings.

Former Lumber Company Brownfield Site – Wisconsin

Former landowner used the 45-acre site in Taylor County to treat lumber with chromated copper arsenate (CCA). Arsenic levels exceeded 1,000 mg/kg in some areas. EnviroBlend was used to stabilize approximately 2,400 tons of soil contaminated with CCA. Arsenic concentrations in the soil were reduced to less than 0.005 mg/L. Treated material was left on-site.

Former Fertilizer Manufacturing Site – New Jersey

This client needed to remediate 37,000 tons of soil in tidal areas impacted with lead (up to 136,000 mg/kg) and arsenic (54,000 mg/kg). The soil was in a low pH environment and was located at depths of 8-16 feet. The project was performed during winter. Soil was rendered non-hazardous by the application of EnviroBlend and was reused on the site, saving the client approximately \$1 million.

Chrome Plating/Automobile Parts Manufacturing – Indiana

Remediated approximately 9,000 tons of chromium-impacted soil adjacent to building foundation *in-situ*. Chromium was no longer detectable in groundwater after approximately 150 days of treatment. Resulting in cost savings of approximately \$600,000 compared to traditional dig and haul alternatives.

Wausau Battery Site – Wisconsin

Remediated 55,000 cubic yards of battery reclaiming residue *in-situ*. Conventional construction equipment was used to mix materials, including some material below the water table. Monitoring confirmed treatment chemicals have not affected groundwater. Reduced costs by approximately 55% by utilizing the approved field screening method and a mobile lab for determining lead and treatment additive concentrations. Avoided RCRA hazardous waste permitting requirements. Reduced overall remediation costs by \$10 to \$15 million compared to dig and haul alternative.

GNB Technologies, Inc. – Illinois

Remediated 30,000 tons of soil, initially *ex-situ* with a pugmill, with subsequent phases treated *in-situ*. Reused stabilized soil on-site through IEPA's Pre-Notice program. Used the treated material to construct a surface water diversion berm, saving time and the expense of hauling the treated material to a Subtitle D landfill. After the Illinois DOT identified impacted soil at another area of the facility due to a right-of-way expansion project, also treated this area *in-situ* with IEPA and IDOT approval. Saved the client approximately \$600,000.

Former Firing Range – Pennsylvania

Treated over 500 tons of lead-affected soil from a former police pistol range, rendered soil non-hazardous. Treated soil was placed on-site under the direction of the PADEP under Act II guidelines. Placed soil 20 feet below parking lot surface of newly constructed Home Depot at the property, saving transportation and disposal costs.

East Penn Manufacturing – Pennsylvania

Managed construction activities, including excavation, EnviroBlend stabilization, placement, and structural compaction of over 30,000 tons of lead-contaminated soil and battery casings at an acid battery manufacturing plant. Managed remedial closure of two solid waste units. Placed stabilized soil and battery casings into the former ore pit and structurally compacted the material to accommodate future upgrades to the facility. This saved the expense and liability of disposing of these materials off-site.

Property Development Corporation – Rhode Island

Treated 750 tons of arsenic-impacted soil using conventional construction equipment. Treated material was used for the on-site backfill.

Industrial Waste Disposal NPL Site – South Carolina

Stabilization/solidification of more than 57,000 cubic yards of soil impacted by arsenic, cadmium, chromium, lead, mercury, and nickel. The site is surrounded by extensive residential development. Used advanced geostatistics and XRF analysis to focus the site excavation and treat and handle only affected soil. Constructively reused treated soil, sludge, and water. Treated soil was used as internal berms within the on-site landfill. Significantly reduced treatment of additional material by attributing the existing chromium to background sources. Performed project for a final cost of \$7 million versus the preliminary cost estimated at \$12-\$25 million based on USEPA data.

Privately Held Firing Range – Minnesota

Treated approximately 2,000 cubic yards of soil in stockpiles *ex-situ* with backhoes. The material was left on-site.

Former Mill - Montana

EnviroBlend was used to treat 3,000 tons of mill tailings *ex-situ* at a former mill. Waste was contaminated with lead, arsenic, and cadmium. The remediated soil was leave-in-place at the site.

Former Conoco Fertilizer Manufacturing Facility – South Carolina

EnviroBlend® was used to treat 90,000 cubic yards of soil and groundwater from a former fertilizer manufacturing facility. The soil was treated in-place and up to depths of 30 feet.

Fairmont Battery Site – Kansas

Conducted a time-critical removal action to clean up a site purchased as part of a residential relocation program. Provided construction management for in-situ treatment and stabilization of 3,700 cubic yards of soil impacted with lead from crushed batteries. Removed impacted soil to an off-site landfill and backfilled excavations with general fill. Completed the project within 1 month of authorization, and the client met the regulatory deadline.

Cedar Rapids Firing Range – Iowa

The site is an active firing range in Cedar Rapids, IA for police officer training. The backstop berm area was reconstructed to address environmental concerns with high-lead concentrations in the soil and to provide additional protection for neighboring properties. The remedial objectives at this site were to stabilize the lead-impacted soil to meet the Toxicity Characteristic Leaching Procedure (TCLP) criteria for lead, recycle lead bullets, and restore the berm for future use.

Prior to screening lead from the berm soil at the gun range, the soil was stabilized using EnviroBlend®, a dry, coarse chemical delivered to the site in dump trucks. EnviroBlend was applied superficially to site areas requiring treatment, then mechanically blended into the soil using a tracked excavator. The soil was blended until a homogenous mixture was achieved. In-situ treatment of the soil prior to excavation allowed the material to be rendered non-hazardous prior to further management, avoiding generation of an unpermitted hazardous waste pile. Following treatment of the soil, two samples were collected for Toxicity Characteristic Leaching Procedure (TCLP) – lead analysis. The TCLP results demonstrated lead concentrations below 5 mg/L in the stabilized material.

After the soil was treated and confirmed to be non-hazardous, the contractor screened lead bullets from the soil using a MKII PowerScreen with a 3-inch upper deck and a ¼ -inch lower deck. Soil was fed into the hopper on the screen, and three material piles were generated:

- Material retained on the 3-inch screen – typically large soil clods, debris, and rocks
- Material retained on the ¼ -inch screen – expected to be lead material
- Material passing through both screens – fine soil particles

Lead recovered from the soil was to be transported to the Doe Run Resource Recovery Facility in Boss, MO for recycling. Analysis of the lead-containing material screened from the soil indicated it was approximately 50% lead by weight and not suitable for recycling. EnviroBlend stabilizes soil, and the treated material is stable over a wide range of conditions and is protective of leaching to groundwater. Because of this quality, the screened and stabilized material could be used as a backfill for reconstructing the core of the backstop berm. The total project cost for EnviroBlend stabilization and screening was \$45,000 which provided significant savings over hazardous waste disposal.

Army Ammunitions Plant – EPA Region V

In-situ remediation at Army Ammunitions Plant treated approximately 5,000 tons of soil contaminated with lead, arsenic, and barium.

Seymour Johnson AFB – North Carolina

In summer 2011, A&D Environmental Services, Inc. (A&D Environmental) was contracted by the engineering firm MMG to remediate this former small arms firing range in Goldsboro, NC. In addition to small-arms bullets and debris, the site was screened for munitions and explosives of concern (MEC) including unexploded ordnance (UXO). MMG managed the site and supplied UXO technicians throughout the project duration. A&D Environmental has completed many similar sites and while the base initially assumed that all materials would be managed as RCRA hazardous waste for TCLP lead levels, the state regulators agreed that an on-site treatment step would be allowable.

A&D Environmental excavated and screened over 4,000 tons of lead-impacted soils. The soils were mixed in-situ in 100-ton batches utilizing a 3% admix of EnviroBlend® 90/10 Coarse. Samples were collected for every 200 cubic yards generated. On the first treatment pass, 100% of the soils were rendered RCRA non-hazardous. The resulting effect to the project bottom line was a savings of over \$600,000 to the customer by eliminating the RCRA hazardous characteristic. Following removal of the impacted soils, A&D demolished the range concrete retaining walls and graded the former soil mound to match surrounding grades.

Former Tomco Wood-Preserving Site – Indiana

From 1980 to the fall of 1993, Tomco Wood-Preserving used the property to pressure-treat wood products intended for exterior construction. In 1999 the presence of arsenic and chromium impacts in surface and subsurface soils were identified. In 2000, on-site buildings were demolished and a fence was erected around the facility. The Voluntary Remediation Program (VRP) accepted the Tomco application in May 2001. The remediation consisted of excavation along with in-situ EnviroBlend® remediation. A total of 2,872 tons of arsenic-and-chromium-containing soil and 116 tons of debris were excavated as part of the source removal operation. After groundwater was sampled for four (4) consecutive quarters, it was determined that arsenic did not exceed acceptable risk levels, and subsequently, VRP issued formal closure to the site.

Brass Foundry Hazardous Waste Sands

A brass foundry recently found that a switch to EnviroBlend® from calcium silicate cement for waste foundry sands disposal provides cost savings to them in many ways. The amount of EnviroBlend reagent needed to treat in-situ the hazardous waste sands from the sand mold casting, while meeting TCLP regulatory standards was reduced by 40% by weight when compared to the silicate cement-based product at this non-ferrous foundry. The overall weight and cost of the waste disposal were reduced substantially with a switch to EnviroBlend®. This fact, coupled with the upfront reduction of reagent requirements and reduced cost, proved to be an obvious priority for the foundry in such a competitive industry and market.

Power Plant Industrial Wash Water – Florida

In Florida, laboratory treatability studies were conducted to evaluate the nickel-stabilizing capacity of various soil amendments for the purpose of enhancing the attenuation of dissolved nickel from industrial wash water derived from operations at a power plant fired with Number 6 fuel oil. The wash water, containing an average nickel concentration of 10 mg/L, percolated through the base of a holding pond into groundwater. The ambient attenuation capacity of native soil was inadequate to attenuate the nickel concentration to less than the state groundwater protection standard of 0.1 mg/L. Studies were conducted to evaluate approaches to improve the attenuation capacity of the native soil with regard to nickel binding with the intent to modify the percolation pond to allow its operation for wash water disposal while also complying with groundwater quality requirements.

A series of tests were performed to identify and select appropriate metal-binding reagents, evaluate the nickel binding capacity of the selected reagents, and test various mixtures of native soil and the reagent for removing nickel from wash water to below the groundwater standard. Tests were performed in flow-through columns to measure percolation rates and nickel removal under gravity-driven flow with relatively short contact times to simulate in-situ infiltration through the percolation pond.

Results indicated that a relatively small concentration (4% by weight) of EnviroBlend® CS mixed to a depth of 12 inches into the native soil effectively attenuated nickel from the wash water and would continue to be effective for at least 30 wash cycles (up to at least 133 mg/kg of nickel loading) or approximately five years of normal operation. Synthetic Precipitation Leaching Procedure

(SPLP) analyses performed on the amended soil samples exposed to the equivalent of 30 wash cycles of soluble nickel indicated the attenuated (bound) nickel did not leach from the soil at detectable concentrations.

The state regulatory agency approved the addition of the amendment to the soil in the bottom of the pond for the removal of nickel from the facility's industrial wash water. The amendment was spread in the bottom of the pond during renovation and mixed to a

depth of 12 inches. Following the placement of the amendment, wash water was discharged to the pond with no apparent effect on the percolation rate of the pond. The performance of the modified pond bottom with regard to nickel removal is being evaluated through shallow groundwater monitoring. This approach provided an initial cost savings of approximately \$250,000 over other water treatment alternatives and was operated with no ongoing O&M costs.

Leave-in-Place Saves \$2 Million – Connecticut

Approximately 12,000 cubic yards of soil contaminated with lead and arsenic was leaching above hazardous levels in the TCLP test. The soil was treated with EnviroBlend at a 3% mix ratio by weight and left on site to be compacted and capped. Total savings by using EnviroBlend over alternative opt-ins was \$2 million. Once remediated, this Connecticut-restricted-use site has the potential to have a second life as a commercial development.

Airport Firing Range – Ohio

Environmental Remediation Contractor remediated a former firing range which sat on a seven-acre area in the middle of the taxiways and runways of an active airport. The site's constituents of concern were hazardous and non-hazardous lead (Pb), arsenic (As), and PAH-contaminated soils.

- Worked closely with city officials, onsite consultants, and airport management to maintain compliance with all regulatory and FAA rules
- Performed in-situ treatment and soil fixation of over 11,000 tons of hazardous lead-contaminated soil using Enviromag dosages ranging from 1% to 3% weight to weight
- Excavated and loaded over 20,000 tons of treated and non-treated non-hazardous, contaminated soils to an approved off-site disposal facility

Services:

- Dig and Haul
- Soil Treatment and Stabilization
- Landfill/Earthmoving

Secondary Aluminum Smelter

A secondary aluminum smelter in the US has found the use of EnviroBlend[®] for *in-situ* treatment of heavy metal wastes has allowed them to save cost on raw material inputs via the use of lower value scrap while still maintaining the metallurgical properties demanded by their customers.

The high cost of hazardous heavy metal waste disposal associated with the use of lower value aluminum scrap had been a disincentive for the smelter. Higher purity scrap had been the alternative until EnviroBlend use was investigated. EnviroBlend utilization with *in-situ* heavy metal treatment of furnace dust allowed for the use of less pure scrap without the added cost of hazardous waste generation and disposal. This allowed the smelter to dispose of the now non-hazardous waste in a local landfill thereby greatly reducing the costs of tipping fees.

The bulking of the waste stream with reagent addition was minimal. The cost of the minimally bulked waste disposal in a non-hazardous landfill was favored over the elimination of a costly hazardous waste alternative and the liabilities associated with its disposal in hazardous materials landfills.

Former Steel Mill – Illinois

Treatability study confirmed the cost-effectiveness of EnviroBlend[®] when compared to competing chemistries and mechanical disposal alternatives. A total of 20,000 tons of lead-contaminated soil was treated on this site.

Former US Army Firing Range/Basic Training – Alabama

Treatment at the former Fort McClellan Range 30 site in Anniston, AL was completed in July 2021. Treatment was provided for 3,000 tons of lead-contaminated soil, up to 8,200 ppm total Pb. The soil was treated *in-situ*. EnviroBlend[®] was used at a dosage rate of 2% to 3% by weight. Prior to EnviroBlend treatment, TCLP levels were >5 mg/L to 28 mg/L. The soil was disposed of off-site after treatment.

The estimated total savings for this project was roughly \$350,000 between transporting materials to landfills and disposal costs.

With treatment of the soil completed, this space will now be home to an industrial conservation district and open space wildlife habitat.

Former Industrial Operations Site – Mid Atlantic

A 21-acre parcel in the Mid-Atlantic United States hosted several industrial operations from 1907 to 1982. Groundwater at a pH of 5 SU and containing as much as 30 mg/L of zinc discharges to a small stream on one edge of the facility. The site surface was remediated and redeveloped into an apartment complex. Groundwater remediation to a goal of 2.0 mg/L zinc was deferred until after the apartment complex was built. In-situ stabilization technologies that could be applied with minimal interference with site use were evaluated and implemented to achieve the remediation goal.

The remediation had to reduce aqueous zinc concentrations using reagents that were amenable to injection. Two approaches were considered:

1. Zinc Hydroxide: Zinc sequestration as a hydroxide [Zn(OH)₂] can achieve the necessary concentration reductions with an increase of pH from the acidic site conditions to pH values in the range of 8 to 10 SU. EnviroBlend AQ was selected as a pH buffer for zinc stabilization.
2. Zinc Sulfide: Zinc can also be sequestered as a zinc sulfide mineral [ZnS] to low aqueous concentrations. Sulfide application is commonly used in wastewater treatment systems as calcium polysulfides [CaS_x]. The material has a very high pH and has the potential to create hydrogen sulfide odors. A slurry consisting of native sulfur and a pH buffer that would produce polysulfides after injection (and thereby mitigate potential odor issues) was also evaluated.

A pilot test was completed to demonstrate the in-field application of the injection process and the efficacy of the remedy. Zinc concentrations in groundwater downgradient of the injections fell from 21.2 mg/L to less than 1.0 mg/L within 7 months following the injections.



In-Situ Experience

A total of 45,000 gallons of EnviroBlend AQ was injected into 63 borings to form treatment barriers along the downgradient side of the site. Approximately 3 weeks were required to complete the injections. Downgradient monitoring wells will be sampled periodically to assess the full-scale performance of the remedy.