



# Geochemical Fixation of Hexavalent Chromium Site Resulting in Expedited Remediation and Significant Reduction in Liability and Cost Savings

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## SITE BACKGROUND

The subject site is an inactive nickel and chrome plating facility in southern, New Jersey that is located in an area consisting of mixed commercial/industrial and residential neighborhoods. Several hundred single and multi-family residential buildings, commercial buildings, and industrial facilities are located within a two-mile radius of the site. The Delaware River is located approximately 0.25 mile west of the site. Due to the complexity of the site, EPA divided the site into two (2) OUs during the Site Investigation phase. OU-1 involved the investigation and remediation of the site-wide hexavalent chromium contaminated groundwater. OU-2 is defined by the NJDEP 70 micrograms per liter (µg/L) total chromium groundwater quality criteria iso-concentration contour line. OU-2 focused on the investigation and remediation of unsaturated zone soil sources to the Cr<sup>6+</sup> contaminated groundwater plume. Wastewater discharged from the former plating operation and water from a firefighting event during a building fire reportedly contaminated the site and adjacent properties through surface run-off.

After discovery and investigation of groundwater contamination at the downgradient municipal supply wells, EPA completed initial RI activities to define the extent of soil contamination in OU-2. The RI/RD/RA for OU-2 was conducted in multiple expedited stages with Panther Technologies, Inc. (Panther) serving as the lead contractor for the design/implementation of the remedy along with a supporting team of subcontracted environmental professionals and consultants with specialties in specific areas of need for the project. What initially started as a possible EPA led implementation of the ROD was flipped to an Responsible Party (RP) led implementation whereby the client elected to contract with Panther as prime for the project, given our team's technical competence and focus on an expeditious implementation.

Based upon results from initial EPA RI activities, Cr<sup>6+</sup> contamination was detected in an estimated 119,000 tons of soil from the surface to approximately 40-foot bgs on the Site, along with exceedances on the two (2) adjacent properties including an abandoned steel manufacturing facility and an operating asphalt batch plant. While the RI did not complete delineation activities to the NJDEP standard, impacts above the 20-mg/kg Cr<sup>6+</sup> criteria were detected as high as 8,500 mg/kg Cr<sup>6+</sup> and resulted in an estimated 2.5 acres requiring remediation to meet the CD SOW Remedial Action Objectives (RAOs). Once Panther was retained, the RI was expeditiously completed in addition to other concurrent tasks such as pre-design investigations for the selected remedy along with treatability work to document the selected remedies recipe for treatment.

## RECORD OF DECISION (ROD)

Following finalization of the Remedial Investigation/Feasibility study in 2010 by the EPA and their subcontractors, the Record of Decision (ROD) was lodged in September 2011 and included:

*Geochemical fixation will be used to treat all unsaturated zone soil at the Site (as defined in the CD) which contains hexavalent chromium at a level greater than the cleanup goal of 20 milligrams per kilogram (mg/kg). In addition, if leachate testing fails to demonstrate that any soil having a hexavalent chromium concentration between 2.0 mg/kg and 20 mg/kg is protective of the groundwater standard of 70 parts per billion (ppb) for total chromium, those soils will also be treated using a geochemical fixation reducing agent. The treatment will reduce the hexavalent chromium concentration in soil to a level that is protective of the chromium groundwater standard. Soils with a hexavalent chromium concentration of less than 2.0 mg/kg, regardless of leachate testing results, will not be treated.*

*The RA must achieve, and the Settling Defendants must demonstrate that the RA has achieved compliance with the Performance Standards. The Performance Standards shall be met and the objectives of the RA shall be achieved when both of the following occur: a) all soil located above the saturated zone has a hexavalent concentration less than or equal to 20 mg/kg and b) when Synthetic Precipitation Leaching Procedure (SPLP) results analyzed, indicate that soils with hexavalent concentrations less than 20 mg/kg but greater than 2 mg/kg are protective of the 70 ppb groundwater standard for chromium.*

While innovative in nature compared to typical presumptive excavation and offsite disposal remedies historically included within RODs, the ROD estimated ~\$22 million in remedial costs, not including past groundwater remediation costs and possible natural resource damage claims, and the site owner faced a significant financial impact as remedial costs for just this one site alone were significant.

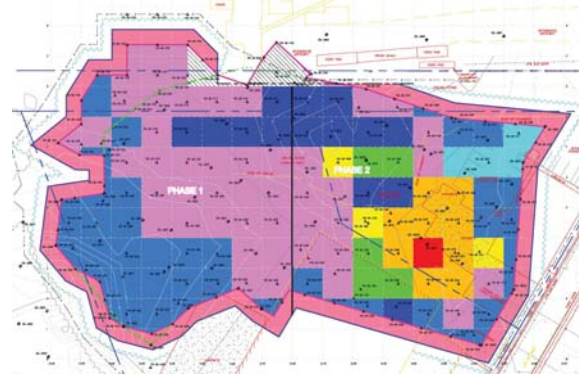
## APPLICATION OF THE TRIAD APPROACH AND SYSTEMATIC PLANNING DURING RD/RA ACTIVITIES

The EPA Brownfields initiative defines the Triad approach as: "Use of real-time measurements, including real-time measurement technologies, combined with a rigorous planning process to understand and control sources of uncertainty, is inherent to the Triad approach and helps stakeholders improve the reliability of risk-related decisions."

In early 2012, the RP contracted Panther to provide strategic management and regulatory agency negotiation as a member of the team that included Panther as the RA implementation contractor, the RP, RP outside counsel, EPA and the Department of Justice during the CD negotiation process. Negotiations at this stage centered on completing the project in an expedited timeframe with limited RD iterations and an immediate transition to RA implementation upon RD completion. To support development of an expedited RD/RA program for treatment of OU-2 soils, Panther subcontracted the development of select design and workplan elements to a national consultant with significant experience in Region 2 CERCLA RD programs, retained an experienced professional geologist to conduct all field sampling efforts, and retained a regional modeling expert who was instrumental in the development of soil cleanup standards for chrome in New Jersey to provide support and model site specific data for determination of leaching models. This strategy allowed Panther to focus on the broad RA implementation strategy and its inherent complexities, while the consulting component focused on prescriptive CERCLA RD requirements where their expertise allowed for a more efficient completion.

Following lodging of the Consent Decree in April 2014, Panther and select subcontracted consultants immediately developed a Remedial Design Work Plan (RDWP) that consolidated all previous investigation results while establishing a Pre-Design Investigation (PDI) program aimed towards completing delineation of the estimated 119,000 tons of soil to the 20-mg/kg Cr<sup>6+</sup> standard, completing a bench scale treatability study and setting the stage for a rapid RD phase. Following RDWP approval, delineation including 158 soil borings and collection, logging and analysis of nearly 400 soil samples was completed in a 6-week timeframe with Cr<sup>6+</sup> analysis on 24-hour turnaround times (TAT). This expedited TAT allowed nearly real-time data analysis and additional sampling to be conducted, if necessary, on step-out basis while still mobilized. This expedited evaluation timeframe allowed decision making as data was reported and resulted in completion of delineation activities in a compressed 6-week timeframe.

In parallel with the onsite delineation program, a lab-based Treatability Study (TS) commenced in accordance with the approved RDWP. The RDWP Treatability Study Work Plan (TSWP) proposed an evaluation of four (4) chemical reductants to determine their effectiveness in reducing Cr<sup>6+</sup> to <20-mg/kg and through SPLP analysis and modeling, resulted in total Cr concentrations that are protective of the 70-ug/l NJDEP groundwater quality standard.



The reductants that were evaluated at a 1x, 2x and 3x the stoichiometric Cr<sup>6+</sup> demand included sodium bisulfite, ferrous sulfate heptahydrate, Ferroblack<sup>®</sup> and calcium polysulfide. At the three stoichiometric demands tested and with Baseline Cr<sup>6+</sup> concentrations ranging from 38.1 mg/kg to 782 mg/kg Cr<sup>6+</sup> during TS testing, only calcium polysulfide consistently reduced Cr<sup>6+</sup> to <20 mg/kg, and following SPLP modeling in accordance with new November 2013 NJDEP Guidance documents, reduced the total Cr SPLP to a level that was protective of the 70-ug/l total Cr groundwater quality standard.

Because of the real time decision making from expedited turnaround times on data, utilizing known chemistries successful at reducing Cr<sup>6+</sup> to the more stable Cr+3 valence states and incorporating systematic planning with significant flexibility and known endpoints for both phases of work, both the PDI boring program and Treatability Study activities commenced in December 2013 and were completed by March 2014. Within this expedited timeframe, all Remedial Action Objectives (RAOs) of the CD and QA/QC goals of the RDWP were met and volumes requiring remediation were reduced from approximately 119,000-tons to approximately 94,000 tons, or a 21% reduction from estimated FS soil volumes requiring remediation.

In late 2014, Panther mobilized following preparation and approval of 30%, 60%, and 100% Remedial Design (RD) documents to complete the RA phase which included demolition, site setup and soil treatment plant assembly involving on-site soil screening, mixing of over a million pounds of calcium polysulfide, and subsequent stabilization prior to backfill. In February 2015, excavation, ex-situ soil treatment, post-treatment soil sampling and analysis, and backfill activities were initiated and completed in 13 months. Off-site soils near an existing asphalt plant were addressed using precision excavation techniques using trench boxes, sheet piling, and installation of helical piles to support the silo of the plant prior to micro-tunneling under the silo to remove a discrete, impacted bog iron layer. Panther's aggressive remedial program fully complied with the ROD, where we completed the remedial program two years ahead of schedule, eliminated the hexavalent chromium source of groundwater contamination in the soil by removing and ultimately treating over 107,500 tons of impacted soils, while also reducing remedial costs by 40% over the ROD estimates.

## REGULATORY CHANGES DURING COURSE OF PROJECT

One significant hurdle encountered during implementation of the RDWP and the subsequent development of the RD/RA strategy revolved around the varying and voluminous NJDEP Guidance Documents, and the EPA and NJDEP's lack of promulgated Cr<sup>6+</sup> standards. In May 2012, the majority of the NJDEP Technical Requirements were repealed and replaced with an outline of a new Licensed Site Remediation Program (LSRP). The LSRP program was originally conceived to reduce the backlog of remedial cases in the NJDEP and streamline closure of the large case inventory in the Site Remediation program. Numerous promulgated regulations were essentially eliminated in favor of Guidance Documents that were consistently being revised during the initial phases of the LSRP program's implementation, which coincided with the development of the RD program at the Site.

Promulgation of new Cr<sup>6+</sup> standards were deferred by the NJDEP during development of the Guidance Documents and previous criteria from 2007 for Industrial and Residential Soil Cleanup Criteria recommendations were adopted as interim remedial standards. No Impact to Groundwater Soil Remediation Standards (IGWSRS) were adopted and methods for its development were revised to a site-specific standard utilizing the SPLP pathway. Prior to this project, this new approach has not been implemented in an onsite treatment and backfill RA in New Jersey, hence, the application of the Guidance Documents to this type of RA was a groundbreaking application of the new regulations. To ensure compliance with fluid regulatory environment, Panther elected to subcontract a second national consulting company and co-author of the SPLP Guidance Documents to complete modeling activities and develop the site specific IGWSRS in compliance with NJDEP Guidance. Although the NJDEP Guidance Documents were in a consistently dynamic state of flux (including a November 2013 revision to the SPLP Guidance), NJDEP Regulations were identified as a chemical specific applicable or relevant and appropriate regulation and formed the basis of the RAOs due to no promulgated USEPA Cr<sup>6+</sup> regulations. As such, the ever-changing Guidance Documents had to be incorporated in their most updated form to comply with the CD SOW Performance Standards.

## EXPEDITED ADAPTIVE SITE MANAGEMENT APPROACH

With the scope of the RDWP completed (TS testing complete, delineation of all impacted soils to 20 mg/kg Cr<sup>6+</sup> and SPLP modelling completed in accordance with the Guidance Documents), the Preliminary RD was developed to comply with the intent of meeting the requirements set forth in the CD SOW. Major elements of the RD that were incorporated included:

- Site specific IGWSRS of 38.7 mg/kg that is protective of the 70 ug/l GWQS; therefore 20 mg/kg is the site wide Cr<sup>6+</sup> standard;
- Site preparation including demolition of two structures, one containing significant transite and friable asbestos construction materials;
- 200 linear feet of steel sheet piling with tiebacks 35-feet deep to protect the adjacent operating asphalt plant silo and scale operation;
- Clearing and grubbing of approximately 2-acres of forested uplands;
- Excavation, ex-situ chemical reduction with calcium polysulfide of 94,000 tons of impacted soil to a maximum of 40-feet bgs;
- Post treatment sampling every 100-cubic yard to confirm compliance with the 20 mg/kg Cr+6 standard;
- Backfill of treated soil with 5-foot "clean" soil buffer and topsoil/grass surface cap;
- In-situ treatment of approximately 2,100 tons of impacted soil due to their proximity adjacent to and beneath the operating asphalt plant silos.

Submission and EPA approval of the final RDWP occurred in November 2013. PDI activities outlined within the RDWP were completed in a 4-month timeframe and the Preliminary RD was submitted in April 2014, only 5 months following RDWP approval, with comments received in May 2014 to allow for a June 2014 field project start. The reason an expedited review was achieved was based on early and honest discussions with the regulatory team regarding our project goals, a client that was willing and able to respond to all concerns, and a competent EPA and Army Corp Review team that understood the framework and technical aspects of the ROD and our compliance with its merits. After that, all that was required was to deliver competent technical work that complied with technical requirements. When challenges in the field presented themselves, our team immediately communicated impacts to our client who authorized approvals to negotiate with our regulatory team using an adaptive site management approach. In conjunction with the EPA and ACOE, who desired similar expedited closure of the project, our team was able to achieve success in reducing the liability associated with the site using a design-build approach to Superfund cleanup where the project coordinating firm also served as the approved field contractor for the project.

## OUTCOME OF COMPRESSED PDI/RD/RA PROGRAMS

A team consisting of a remedial construction contractor, various national consultants, the RP, legal counsel and regulators joined forces in a collaborative environment to develop and implement an expedited solution to unsaturated hexavalent chromium soil contamination at a high-profile site in New Jersey. With an evolving regulatory landscape due to a recently enacted LSRP program by the NJDEP and a lack of promulgated state and federal Cr<sup>6+</sup> remedial standards, the team negotiated an agreement, developed an approach, and verified it was protective of all potential receptors. The innovative solution was developed, pending full-scale construction implementation, including:

- Onsite treatment and backfill of impacted soil that eliminates offsite transportation and disposal of over 94,000 tons of impacted soil;
- Abatement of existing hazards onsite including abandoned facilities containing significant quantities and friable and non-friable asbestos;
- Completion without interfering with operating businesses immediately adjacent to and on top of impacted soil;
- Implementation in a compressed timeframe to eliminate source flux to groundwater expedite ongoing remediation of OU-1 by the USEPA;
- A reduction in total project costs from an FS estimated \$22M to less than \$12.5M or a savings of \$10M while still meeting all RAOs.

