# CASE STUDY

**TYPE: In Situ Bioremediation (Hexavalent Chromium)**
**COMPONENTS: ISD Equipment and Amendments**

## AGGRESSIVE HEXAVALENT CHROMIUM REMEDIATION USING A 10-GPM IN SITU DELIVERY (ISD™) SYSTEM
## Agricultural Facility, Walla Walla, WA

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| **Type of Project:** | Pilot-scale demonstration |
| **Contaminants Treated:** | $Cr^{+6}$ (hexavalent chromium) |
| **Concentration:** | Maximum of >60,000 µg/L hexavalent chromium observed |
| **Technology Applied:** | Anaerobic Reduction to Trivalent Chromium |
| **Geology:** | Fractured Bedrock and Overburden |
| **Treatment Interval:** | 20 to 40 ft bgs |
| **Average % Reduction:** | >90% reduction of $Cr^{+6}$ in full-scale area |
| **Timeframe:** | 6 months of active GW recirculation w/ 1 year of additional slug injections |

### DESCRIPTION

A trailer-mounted 10-gpm In Situ Delivery (ISD™) system was used at a former agricultural facility (chrome plating) in Walla Walla, Washington to treat $Cr^{+6}$-contaminated soil and groundwater that was a result of a leaking UST. This pilot-scale action was based on the results obtained from a bench-scale demonstration that was conducted using site groundwater, which indicated microbial growth could be stimulated under high $Cr^{+6}$ conditions using a simple nutrient-amended substrate. The treatment location is the source area with dimensions of 80 feet wide by 120 feet long, and a saturated thickness of 30 feet. Saturated zone lithology is fractured bedrock (basalt) and overburden.

The ISD™ system was fabricated and installed by ETEC, and was able to re-circulate over 70,000 gallons of groundwater during a 6 month timeframe (~0.5 gpm rate). A total of 10,000 lbs of CarBstrate™ was used. Groundwater was extracted from 11 extraction wells, automatically amended with CarBstrate™, and distributed into the subsurface via 20 injection wells.

Groundwater conditions were very aerobic and oxidized due to the presence of the $Cr^{+6}$ and a nearby creek that seasonally communicated with the saturated zone (losing creek). CarBstrate™ was selected as the electron donor due to its high solubility and low cost, as well as the fact that it poses no risk to human health.

ETEC trained a local contractor to operate the ISD™ system. We also provided the appropriate substrate feed rate, which was based on the concentration of $Cr^{+6}$, the volume of groundwater to be treated, the mass of the terminal electron acceptors, and the total groundwater extraction rate. Existing monitoring wells were used as performance monitoring wells to assess the effectiveness of the approach. Groundwater samples were analyzed for $Cr^{+6}$, $Cr^{+3}$, total Cr, terminal electron acceptors (iron, manganese, nitrate, and sulfate), TOC, and water quality parameters (pH, DO, ORP, and conductivity). Samples were collected prior to startup, during, and after the 6-month recirculation event.

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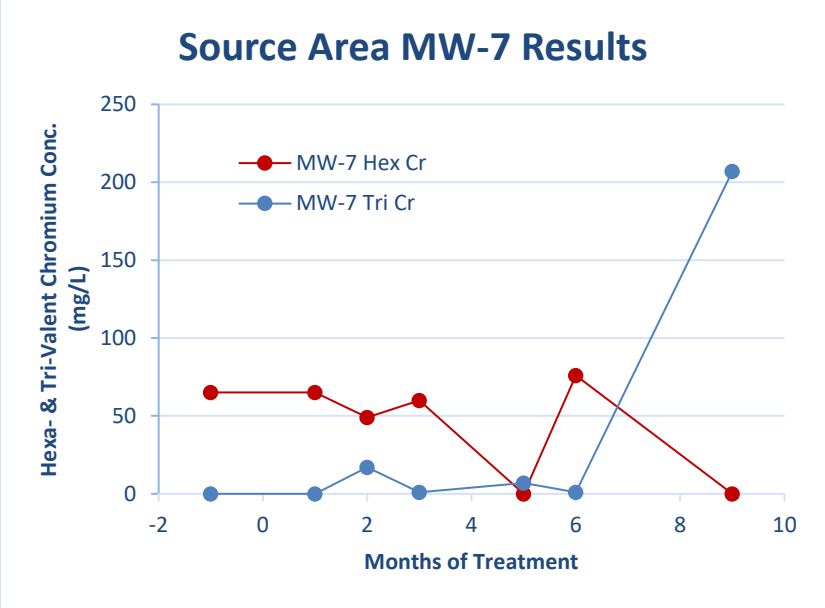
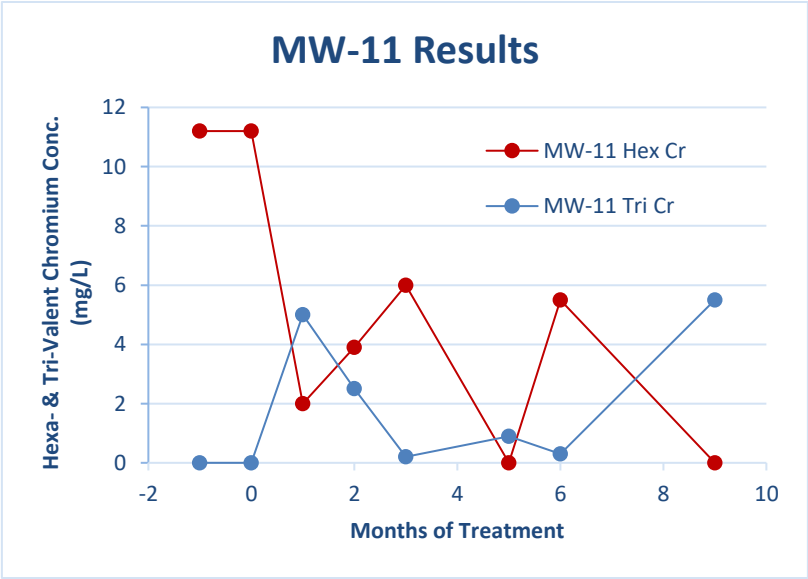
## RESULTS & DISCUSSION

Results and observations from the pilot-scale implementation include the following:




- The source area MW-7 groundwater concentrations were as high as 58 mg/L, showing rapid transformation to $Cr^{+3}$ after 6 months, as shown by the 207 mg/L $Cr^{+3}$ result near the end of the project.
- MW-7 was the last location to show $Cr^{+3}$ formation due to the highly oxidized state of the soil/GW in the UST area.
- Significantly more substrate was required to overcome the highly oxidized subsurface conditions compared to the rest of the treatment zone.




- All other monitoring locations showed a more rapid transformation immediately after recirculation and substrate addition began. Once recirculation ceased, the $Cr^{+3}$ was stable and did not convert back to $Cr^{+6}$.
- Additional slug injections were conducted maintain anaerobic conditions in the target zone throughout the next year after reciruclation ceased.

**The results demonstrate that aggressive short-term groundwater recirculation can achieve effective electron donor delivery that promotes complete $Cr^{+6}$ transformation within months.**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