de maximis, inc.
200 Day Hill Road
Suite 200
Windsor, CT 06095
(860) 298-0541
(860) 298-0561 FAX

July 20, 2009

Mr. George Jacob
U.S. Environmental Protection Agency, Region II
Emergency and Remedial Response Division
Central New York Remediation Section
290 Broadway, 20th Floor
New York, NY 10007-1866

Subject: **EHC® Injection Work Plan**
York Oil Superfund Site
Moira, New York

Dear Mr. Jacobs:

Attached for your review is the EHC® Injection Work Plan prepared by Adventus America, Inc. on behalf of Alcoa, Inc. for the York Oil Superfund Site. This Work Plan discusses the implementation of EHC®, a patented combination of controlled-release carbon and zero valent iron (ZVI) particles, using *in situ* chemical reduction (ISCR) technology to treat chlorinated volatile organic compounds (cVOCs), primarily *cis* 1,2-dichloroethene (cDCE) in the groundwater.
.
While the Operable Unit 1 (OU1) pump and treat system has been adequately designed and has operated essentially continuously since May 2002, continued extraction of water is unlikely to improve ground-water quality for the foreseeable future as long as the oily material continues to provide a source of cDCE. Oily material is located under the solidified mass of material that makes up the landfill, and this material cannot be directly accessed.

Previous analysis of MNA data has identified lack of electron donor as a limiting factor for successful biological degradation of cDCE. Full-scale ISCR using EHC® has been successfully applied at a number of sites, suggesting that installing a line of injection wells and injecting EHC®, would successfully stimulate complete anaerobic biodegradation of residual cDCE emanating from OU 1 and provide a replacement for the pump and treat system.

In addition, implementing this in-situ technology will provide a secondary positive environmental benefit. Replacing the pump and treat system will:

- End the need to dispose of iron-hydroxide sludge off-site, 5.3 tons of iron have been removed from the ground and disposed of off-site to date.
- Significantly reduce greenhouse gas emissions which have amounted to 45 tons of CO_2 emissions to date for both electrical usage and O&M staff travel.

Please contact me if you have any questions.

Sincerely,

Bruce Thompson

Enclosure

cc: Mr. Greg Handley – NYSDEC
Mr. Larry McShea – Alcoa Remediation
Mr. Bruce Cook – Alcoa Remediation
Mr. Peter Swallow – Alcoa Remediation
Mr. Andrzej Przepiora – Adventus America, Inc.

EHC INJECTION WORKPLAN

York Oil Superfund Site
Moira, NY

Prepared for:

ALCOA

Prepared by:

ADVENTUS AMERICAS, INC.

Project No. AAI8-509

July 20, 2009

2871 W. Forest Road, Suite 2 • Freeport, IL 61032 • Tel: 815.235.3503 • Fax: 815.235.3506
www.AdventusGroup.com

1.0 INTRODUCTION

On behalf of ALCOA, Adventus America, Inc. (Adventus) has prepared this work plan for implementation of EHC® *in situ* chemical reduction (ISCR) technology to treat chlorinated volatile organic compounds (cVOCs), primarily *cis* 1,2-dichloroethene (cDCE), in groundwater at the York Oil Superfund Site in Moira, NY (Site).

A focused feasibility study was performed by ***de maximis, inc.*** (de maximis) to identify an *in situ* remedial approach for controlling a cVOC plume emanating from a landfill and an impoundment area at Operable Unit 1 (OU1) and migrating into Operable Unit 2 (OU2), that could replace the currently operating pump-and-treat system (P&T). The objectives of an alternative groundwater remedial approach are:

- Lower operations and maintenance (O&M) costs and other associated burdens (CO_2 footprint, site visit frequency, offsite disposal, etc.) related to the existing P&T.
- Maintain or further reduce groundwater cVOC concentrations in the downgradient aquifer.

Based on the remedial alternatives evaluation, EHC® was identified as a preferred in-situ, passive remedial option for OU1 groundwater. EHC® is a patented combination of controlled-release carbon and zero valent iron (ZVI) particles used for stimulating *in situ* chemical reduction (ISCR) of otherwise persistent organic compounds in groundwater. Variations of these materials have been used to treat over 5,000,000 tons of soil/sediment impacted by recalcitrant compounds as part of the company's DARAMEND® bioremediation technology. Both EHC® and DARAMEND® are proven, established technologies that have been used at hundreds of field sites to date throughout the world and accepted by many Federal, State, and regional regulatory authorities within the USA, Canada, Europe and Asia.

2.0 BASIS FOR EHC TECHNOLOGY SELECTION

Prior analysis of MNA data has identified a lack of electron donor in groundwater as the primary limiting factor for the complete biological degradation of site chlorinated solvents at this site. It is not uncommon that biological dechlorination of tetrachloroethene and trichloroethene stops at cDCE because more highly reducing conditions and greater biological activity is generally necessary for complete mineralization. Since the implementation of the P&T at this site, in-situ bioremediation approaches, and, in particular the EHC® ISCR technology have been successfully applied at a number of sites to treat contaminated groundwater. In addition, ZVI contained in EHC® has been widely shown to aid both in establishing reducing conditions and in the direct abiotic dechlorination of cVOCs. This new information suggested that installing a permeable reactive barrier (PRB) with a combination of an organic carbon-based electron donor and ZVI could successfully stimulate complete anaerobic biodegradation of residual cDCE emanating from OU1 and support decommissioning of the P&T system.

Following placement of EHC® into the subsurface environment, a number of physical, chemical and microbiological processes combine to create very strong reducing conditions that stimulate rapid and complete dechlorination of organic solvents and other recalcitrant compounds. First, the organic component of EHC® (fibrous organic material) is nutrient rich, hydrophilic and has high surface area; thus, it is an ideal support for growth of bacteria in the groundwater environment. As they grow on EHC® particle surfaces, indigenous heterotrophic bacteria consume dissolved oxygen thereby reducing the redox potential in groundwater. In addition, as the bacteria grow on the organic particles, they ferment carbon and release a variety of volatile fatty acids (acetic, propionic, butyric) which diffuse from the site of fermentation into the groundwater plume and serve as electron donors for other bacteria, including dehalogenators and halorespiring species. Finally, the small ZVI particles (<5 to 45 μm) provide substantial reactive surface area that stimulates direct chemical dechlorination and an additional drop in the redox potential of the groundwater via chemical oxygen scavenging.

These physical, chemical and biological processes combine to create an extremely reduced environment that stimulates chemical and microbiological dechlorination of otherwise persistent compounds. Redox potentials as low as –550 mV are commonly observed in groundwater after EHC® application. At these Eh levels, many organic constituents of interest (COI) are thermodynamically unstable and they will readily degrade via pathways more typical of physical destruction processes (minimum production and no accumulation of typically recognized biodegradation intermediates such as DCE for TCE). Hence, the ISCR technology is microbiologically based in that it relies on indigenous microbes to biodegrade the EHC® carbon (refined plant materials), but it does not require the presence or activity of special or otherwise unique bacteria for complete and effective remediation.

3.0 DESIGN BASIS FOR EHC® PERMEABLE REACTIBE BARRIER

Based on historical Site information, a 200 ft long EHC®-amended PRB zone was developed (Figure 1). This length of the EHC® PRB is expected to be sufficient to intercept the plume of contaminated groundwater at this location after the existing P&T system is turned off. Some of the factors considered in selecting the location and length of the PRB were as follows:

- The YO-12 well cluster did not have significant cVOC impacts before the P&T system installation.
- The source of cVOCs appears to be from the body of the former oil lagoon, not stained soils to the west.
- Pre-pumping groundwater flow was mounded over the lagoon, but will re-establish in a SSE direction after the P&T system is shut-off.
- The low levels of cVOC detected in YO-110 will naturally attenuate before they migrate to OU2.

The targeted depth for EHC® treatment is from 6 ft below ground surface (bgs) to 35 ft bgs at the location of well EW-2 (Figure 2). This corresponds to an elevation interval from 372 ft above mean sea level (amsl) to 343 ft amsl. The top of the EHC® zone corresponds to an average static groundwater table elevation along the EHC® PRB alignment. The bottom of the EHC® zone will be placed at the top of the basal till. The vertical depth and thickness of the PRB as well as the length and placement of the PRB is based on recommendations by de maximis and Alcoa.

Based on existing site information in the vicinity of the proposed EHC® system, the anticipated cDCE concentrations are about 200 µg/L. Based on the detailed groundwater chemical characterization data for the overburden aquifer zone, the pH is circum-neutral, Eh values are below 100 mV, DO levels are below 1.0 mg/L and concentrations of sulfate, the major terminal electron acceptor (TEA) in the site groundwater, ranges from 10 to 50 mg/L. Appreciable concentrations of methane and ethene detected in most of the shallow wells indicate that the aquifer is anaerobic and amenable to bioremediation approaches (i.e.; bioaugmentation is not likely required). The reported groundwater velocity is about 60 ft/yr.

On the basis of groundwater chemistry and flow conditions, Adventus recommended an application of 0.3% EHC® by weight of dry soil mass within a 15 ft wide EHC®-amended barrier. This EHC® application rate was developed using an electron acceptor-donor balance calculation, based on the anticipated mass fluxes of TEAs and a known electron donor capacity of EHC®. The resulting total mass of EHC® to be injected is 30,050 lb (Table 1). The width of the EHC® PRB may be modified, depending on the injection method used. However, an equivalent amount of EHC® (5.2 lbs/ft^2) must be placed across the face of the PRB to provide the requisite amount of material along the groundwater flow path.

Table 1: EHC® Mass Requirements and Injection Details.

EHC PRB dimensions:	**Value**	**Unit**
PRB length	200	ft
PRB width [a]	15	ft
Depth to top of plume	6	ft bgs
Depth to bottom of plume	35	ft bgs
PRB thickness	29.0	ft
PRB volume	87,000	ft^3
Mass of soil in PRB	5,003	U.S. tons
Estimated porosity	30%	
Volume pore space	26,524	ft^3
EHC® mass calculations:		
Percentage EHC® by soil mass	0.30%	
Linear groundwater velocity	0.16	ft/day
Contact time	94	days
Contact time * application rate multiplier	28	days*%EHC
Mass of EHC® required	30,050	lbs
Mass of EHC® required per sq ft of face area	5.2	lbs/ft^2
Preparation of EHC® Slurry [b]:		
Percent solids in slurry	29%	
Volume water required	9,010	U.S. gallons
Slurry volume	10,947	U.S. gallons

[a] The width of the PRB may be modified, depending on the injection method used. However, an equivalent amount of EHC® (5.2 lbs/ft^2) must be placed across the face of the PRB.
[b] Typical slurry used for injections, may be adjusted for a specific equipment used by the selected injection contractor.

4.0 INSTALLATION

Adventus has performed a review of existing boring logs and site lithology in the context of EHC® placement. In particular, the presence of seams containing cobbles within the glacial till zones may pose a drilling and injection challenge (Figure 2). Based on these considerations and previous experience at similar sites, Adventus has considered two potential EHC® injection methods at the site:

- Direct Push Technology (DPT):
  DPT has been used at numerous sites for EHC® injections in unconsolidated aquifers and this method was considered in our initial evaluation. However, based on the discussions with a DPT contractor familiar with the site, ZEBRA, viability of this method at the site for amendment placement below 20 ft bgs is questionable, due to the presence of cobble layers in the glacial till zones. Therefore, if DPT is used at the site it may have to be aided by an additional drilling technique to reach the targeted depth of 35 ft bgs

- Hydraulic and pneumatic fracturing injection methods:
  These methods have been used for EHC® injections in difficult lithology, including cobble layers as well as in fractured bedrock. These methods rely on access points created by a suitable drilling method and use their proprietary fracturing equipment for injections. One advantage of fracturing methods, compared to DPT, is a relatively large radius of influence, therefore less points could be used to inject the amount EHC® material required

Based on an initial communication with contractors who specialize in the placement methods listed above, the following injection companies, all experienced in EHC® injections, will be invited to provide construction bids to implement the proposed EHC® PRB:

- ARS Technologies, Inc. (pneumatic fracturing);
- FRx, Inc. (hydraulic fracturing); and
- Frac Rite Environmental, Ltd. (hydraulic fracturing).

Because the type of injection tooling and procedure is different among those fracturing methods, the number of injection points has not been specified. However, a specified amount of EHC® placed across the face of the PRB will be requested. Each contractor’s bid will be evaluated by Adventus, de maximis and Alcoa based on their proposed injection procedure to select the most suitable method for implementation of an effective EHC® PRB at the Site.

5.0 PROPOSED PERFORMANCE MONITORING

The effects of shutting down the existing pump and treat system will have to be factored in while evaluating the performance of the EHC® PRB. Therefore, baseline sampling will be performed after the P&T shut down and before the EHC® installation, allowing for establishment of a static water table (August 2009). We propose the existing monitoring wells, YO-14X, YO-14ALX, MW-1, YO-12AX, and YO-12ALX be used for performance monitoring of the EHC® system (Figure 1). We propose the following sampling schedule:

- Baseline data will be collected from YO-14X, YO-14ALX, MW-1, YO-12AX, and YO-12ALX. These samples will be collected using a low-flow sampling method.
- Monthly sampling will be collected from YO-14X and YO-14ALX for six months.
- Quarterly sampling will be collected fromYO-14X and YO-14ALX, for one year starting in March 2010. Wells YO-12RX and YO-12AX will be sampled in the first quarter to confirm plume capture on the west end. If cDCE is present, YO-12RX and YO-12AX will be included in the subsequent sampling events.
- In March 2011, sampling will revert back to semi-annually.

The following analytical data will be collected from the monitoring locations listed above:

- Field analyses: pH, Redox Potential, Electrical Conductivity, Dissolved Oxygen, Temperature.
- Laboratory analyses:
  - Metals Scan (iron, calcium, magnesium, manganese included);
  - Anion Scan (chloride, sulfate, and nitrate included);
  - Total Organic Carbon (TOC) and carbonate alkalinity; and
  - Volatile Organic Compounds (VOCs).
- Quarterly samples will also be analyzed for:
  - Volatile fatty acids (VFAs); and
  - Dissolved gases (ethene, ethane, methane, hydrogen).

All sampling will be conducted in accordance with approved Site-Specific Plans. A table describing the laboratory methodology is provided below:

Analytes	***Methodology***
cVOCs	8260B
Calcium	EPA200.7 and SM3030D (ICP-OES)
Iron	
Magnesium	
Manganese	
Nitrate	EPA9056 (IC)
Chloride	
Sulfate	
Alkalinity (mg CaCO3/L)	SM2320 B (titration)
Total Organic Carbon (TOC)	EPA415.1
VFAs	SW846 VFA
Dissolved gases (ethene, ethane, methane, hydrogen)	RSK-175

6.0 CLOSING OF EXTRACTION WELLS EW-1 AND EW-2

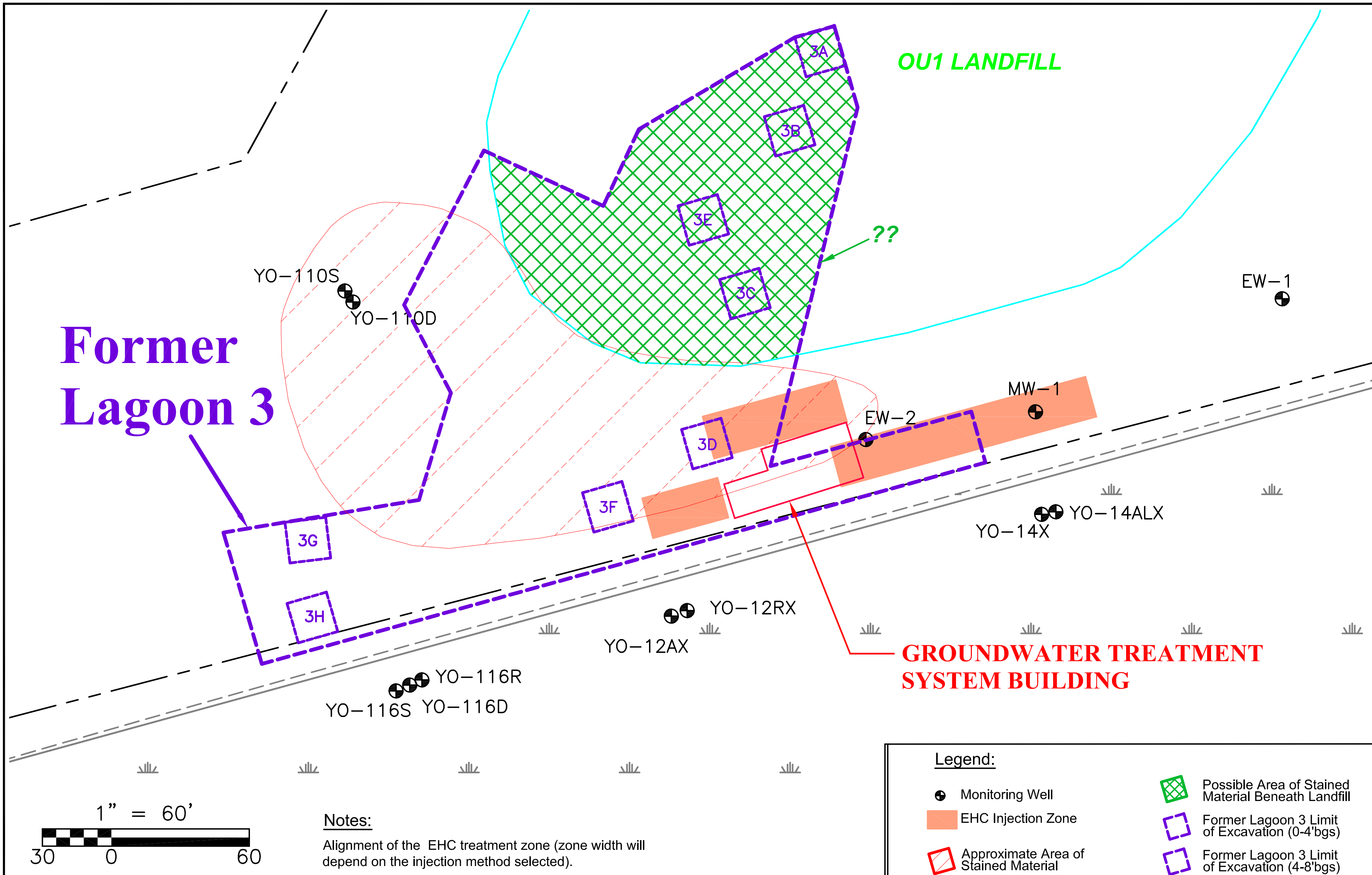
Alcoa proposes to decommission the two extraction wells at OU1, EW-1 and EW-2. The reasons for the proposed well decommissioning are as follows:

- The proposed passive EHC® treatment system will replace the P&T system which is currently using EW-2 and EW-1.
- The two extraction wells are 6” in diameter and are located in the vicinity of the proposed EHC® system, therefore may serve as a conduit for substrate short-circuiting during injections.
- Well MW-1, located near EW-2, will be kept as a monitoring point within the EHC® zone. MW-1 will be temporary packered off during EHC® injection to prevent EHC® slurry from migrating into the screened interval.
- EHC® contains a combination of ZVI and carbon. Injection of EHC® will results in local aqueous chemistry changes (i.e.; reducing conditions, increased dissolved iron concentrations, and high bioactivity). If the extraction wells were operated after injection of EHC®, it is likely that fouling of the wells and treatment system would occur.

Wells EW-1 and EW-2 will be closed by the injection contractor prior to EHC® placement. The decommissioning procedure for these wells will follow the recommendations by the New York State Department of Environmental Conservation (NYSDEC) website (www.dec.ny.gov/lands/5000.html) for monitoring well decommissioning and as discussed with an the Site NYSDEC representative for this specific application. The well disinfection step will be omitted to avoid interference with the proposed bioremediation system.

FIGURES

H:\Adventus Group\York Oil(Moira,NY)\EHC ZONE-FIG.1.dwg, 7/16/2009 4:40:29 PM



Notes:

Alignment of the EHC treatment zone (zone width will depend on the injection method selected).

Legend:

- Monitoring Well
- EHC Injection Zone
- Approximate Area of Stained Material
- Possible Area of Stained Material Beneath Landfill
- Former Lagoon 3 Limit of Excavation (0-4'bgs)
- Former Lagoon 3 Limit of Excavation (4-8'bgs)

de maximis, inc.

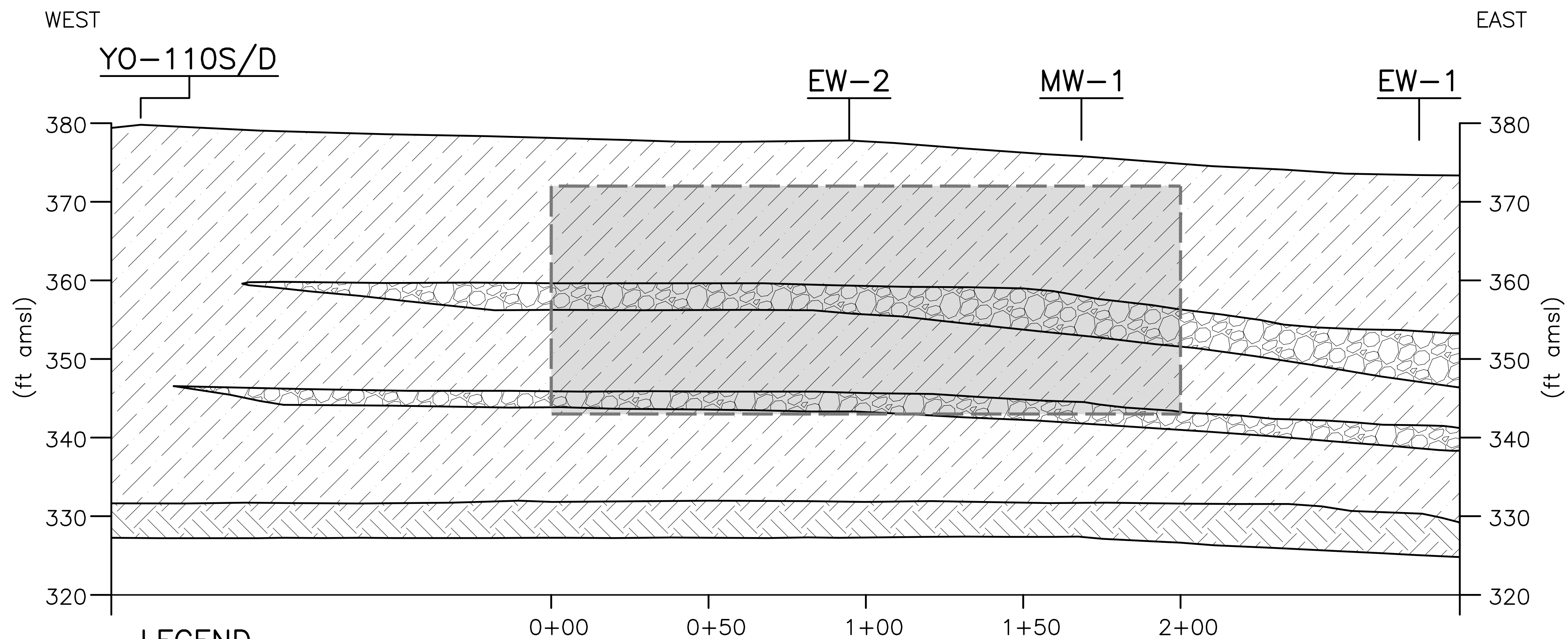
ADVENTUS

DATE	JULY 6, 2009
DWG. NO.	EHC ZONE−FIG.1
DR. BY	ET
CK'D. BY	AP
SCALE	1"=60'
FIG. NO.	1

EHC Injection Work Plan

Alignment of the EHC treatment zone

York Oil Superfund Site - Moira, New York



LEGEND

- FINE TO COARSE SANDS OF REWORKED TILL (UPPER AQUIFER) AND GLACIAL TILL (LOWER AQUIFER)
- SANDSTONE BEDROCK (INFERRED)
- TILL ZONES WITH COBBLES (DIFFICULT DRILLING)
- EHC-TARGETED ZONE

0 25 50 100
HORIZONTAL SCALE (FEET)

0 25 100
VERTICAL SCALE (FEET)

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DATE	JULY 6, 2009
DWG. NO.	CROSS-SECTION-FIG.2
DR. BY	ET
CK'D. BY	AP
SCALE	AS SHOWN
FIG. NO.	2

EHC Injection Work Plan
Simplified lithological cross-section and extend of the EHC zone
York Oil Superfund Site - Moira, New York