FEASIBILITY EVALUATION

OF

ALTERNATIVE GREEN REMEDIATION APPLICATIONS

Former GM Delco Plant 5 (Kokomo)

March 2010

INTRODUCTION

Toxicological & Environmental Associates, Inc. (TEA) reviewed the Motors Liquidation Company (MLC) site portfolio to determine if there are candidates for Alternative Green Remedial approaches, either solely or in combination with other remedies previously identified for those sites. Alternative Green Remedial approaches were defined in a memorandum submitted on October 2, 2009, entitled "Site Selection Criteria for the Identification of Candidate Sites for Alternative Green Remediation" and included, but were not limited to, phytoremediation, source area reduction of dense non-aqueous phase liquid (DNAPL), and various in-situ technologies. Eight sites from the MLC portfolio were identified for conceptual development. These eight sites included:

1. Former Delco Chassis Plant (Livonia)
2. Willow Run Company Vehicle Operations
3. GMPT Bay City
4. Danville Central Foundry
5. Stamping - Grand Rapids
6. Buick City
7. Former GM Delco Plant 5 (Kokomo)
8. Delphi - Moraine

In addition to these sites, GMPT Massena (New York), Buick City and others were targeted for feasibility evaluation of an emerging polychlorinated biphenyl (PCB) abatement technology for paints, soils, sediment, sludge, and light non-aqueous phase liquid (LNAPL) treatment for oils containing PCBs.

TEA prepared "Conceptual Design and Preliminary Cost" reports for these sites which were uploaded to the IDEA database in October 2009. Based on subsequent discussions among the remedial and planning team members, TEA evaluated these sites in further detail to assess the practical feasibility of incorporating alternative green technologies into remedial plans for those specific sites. Assessments of potential cost impacts were also evaluated during the current assignment.

The limited information and data available for TEA's "Conceptual Design and Preliminary Cost" reports were expanded to generate this document. The feasibility evaluations presented herein are based solely on data available on the IDEA database and telephone discussions with site project managers.

The objectives of this submittal are to evaluate practical, logistical, technical, regulatory, and financial issues related to these sites in which alternative green remedies may be considered within the course of proposed remediation schemes. Considered during the evaluations were implementability, effectiveness, cost, and green sustainable principles and practices. Estimates of capital costs, O&M costs, and monitoring costs were refined for the alternative green remedies proposed for each site. The results of the evaluation are presented succinctly using the following general outline:

I. Problem Statement
   - compounds/contaminants
   - media
   - saturated/unsaturated zones
   - landfill, etc.

II. Site Characteristics
   - Hydrogeology
     a. depth to groundwater
     b. groundwater flow direction
     c. hydraulic conductivity, groundwater velocity, etc.
   - Extent of contaminant plume
   - Potential receptors

III. Proposed Alternative Green Remedy
   - Purpose and objectives
   - Description of alternative green remedial technology
   - Sustainability
   - Analysis of Green and Sustainable Remediation
   - Monitoring program
   - Term of operation
   - Advantages and disadvantages

IV. Regulatory Outlook
   - Existing order
   - Regulatory agency
   - Potential obstacles

V. Green and Sustainable Remediation (GSR) Comparison

VI. Costs

- Capital/O&M/Monitoring
- Assumptions
- Potential savings

VII. Conclusions

Estimated costs for the proposed alternative green remedies proposed in this submittal were refined based on all information and data gathered by TEA to date. At this time, costs are not necessarily intended to modify overall remediation estimates necessary for these sites. These estimates are mostly intended for consideration during future planning and design of site remediation as proven, implementable, sustainable, and effective cost-saving measures.

Former GM Delco Plant 5, Kokomo, IN
MLC # 1288

I. Problem Statement

The on-site environmental issue within the former General Motors Delco Plant 5 consists of soils impacted from tetrachloroethene (PCE), trichloroethene (TCE) and groundwater impacted from TCE and its degradation breakdown products cis-1,2-dichloroethene (cDCE) and vinyl chloride (VC). No active remediation system is currently operating to reduce on-site contaminants.

The planned remedial solution is a combination of electrical resistivity heating (ERH) for "source area" soils and groundwater and *in-situ* chemical oxidation (ISCO) for off-site groundwater in the upper sand and gravel unit (S1) and the intermediate sand and gravel unit (S2) water bearing intervals. The proposed remedial strategy will not treat impacted groundwater down gradient of the "source area" addressed by the ERH system. ISCO will treat groundwater that flows into its extents; however the chemical oxidant may not remain activated long enough within the subsurface to treat all groundwater that may migrate off-site once the source material is treated by the ERH system.

II. Site Characteristics

The contamination impacted geologic intervals identified for remediation are the S1, S2, and the limestone and dolomite bedrock unit, identified as B1. The site is underlain by three water units. The first water bearing unit, identified as S1, is under confined conditions and is located approximately 10 to 25 feet bgs. This is followed by hard clay till ranging in thickness between 10 to 40 feet. Underlying the clay till is the second water unit, identified as S2, located at 50 to 55 ft bgs. This unit is fully saturated and is also under confined conditions. This unit also pinches out south of the facility. The B1 unit is located beneath the S3 water bearing unit at approximately 85 ft bgs in the northern part of the site, 60 ft bgs south of the facility.

Soil impacts are limited to within the site boundary and mostly between 8 and 20 ft bgs. Previous site assessments have identified an on-site soil "source area" to be addressed as part of the corrective measures. The foot print of this "source area" is approximated at 10,000 square

feet. Groundwater impacts to be addressed by a green remedial technology have been identified within the S1 unit starting beneath the on-site "source area" and extending southeast in the direction of groundwater flow within this geologic unit.

III. Proposed Alternative Green Remedy

Purpose and Objective

The purpose of the remedial solution proposed herein is to provide an alternative green remedy for on-site environmental issues that will reduce the overall costs for meeting the long-term requirements. This objective can most readily be met by revisiting site remediation strategies to utilize *ENGINEERED_PHYTOREMEDIATION*℠ and emulsified zero valent iron (EZVI) to treat impacted soil and groundwater and mitigate further off-site migration of contaminants within the S1 water bearing unit.

Description of Technology

ENGINEERED_PHYTOREMEDIATION℠ is very well suited for treating, controlling, and capturing groundwater flow. "Source area" treatment effectiveness can be improved by combining EZVI technology with phytoremediation. This combined technology strategy in the "source area" will stimulate biodegradation and abiotically break down site contaminants to drive TCE through all degradation breakdown components and ultimately to non-toxic end products. Furthermore, the footprint of the residual contaminant plume can be treated using *ENGINEERED_PHYTOREMEDIATION*℠ to remediate site contaminants and control off-site migration by degrading remaining contamination before migrating off-site.

"Source area" remedial strategy using phytoremediation and EZVI could be implemented as follows:

- 100 *TreeWell*® units two feet in diameter can be installed on 10 foot centers within the 10,000 square foot area as follows:
    - A hole is augered to 20 to 25 ft bgs;
    - Up to 3 gallons of EZVI would be added to the bottom of each hole to enhance groundwater contaminant reduction
    - A root sleeve liner is installed in the hole to a depth of 15 to 20 ft bgs with a root aeration tube;
    - The hole is then filled to the surface with a mixture of auger cuttings and planting mix;

- An 8 to 10 ft bare-root tree is then planted at the surface and the root sleeve closed around the tree and aeration tube.

- 1,500 holes (2-3 holes between *TreeWell*® units) two foot (or greater) in diameter can be augered to mix EZVI into as follows:

  - Auger to 7-8 ft bgs and excavate;
  - Auger down to 15-16 ft bgs while mixing in EZVI at a rate of one gallon per foot augered;
  - Withdraw auger flights without excavating soils mixed with EZVI; and
  - Replace previously excavated soils back into hole.

Utilizing excavated soils and mixing EZVI with site soils will eliminate the necessity to dispose of any soils and treat the "source area" as intensively as possible.

An extended area downgradient of groundwater flow can be planted to treat site contaminants and control off-site migration as follows:

- 450 *TreeWell*® units two feet in diameter can be installed on 15 foot centers within a 2.5 acre area; and

- 200 *TreeWell*® units two feet in diameter can be installed on 15 foot centers near the southern end of the facility to control continuing off-site migration of site contaminants

- The same planting methodology as the "source area" can be utilized.

Description of Monitoring Program

The monitoring requirements for the phytoremediation/EZVI remedy consist of a standard groundwater monitoring program (hydraulic and quality) with limited additional assessments of tree health during the initial years of implementation.

Term of Operation

Although trees will begin using water during the initial growing season in which they are planted, full hydraulic effects of the trees are expected 3 to 5 years after planting. The phytoremediation plantation should be allow to run its course for ten years before evaluation of removing tree is considered unless treatment requirements have been met before such time has elapsed.

Advantages and Disadvantages

Advantages

- No external energy inputs required during operation;
- Low maintenance requirements;
- Effectiveness of technology has been demonstrated at many environmental sites under many conditions by many different agencies;
- Hydraulic control of off-site migration;
- In addition to hydraulic effects, has the potential to reduce contamination *in-situ*;
- Cost effective;
- Treatment of source and residual contaminant plume; and
- Aggressive treatment of source material directly with EZVI.

Disadvantages

- Average of three year lag time until full hydraulic effects of trees likely to be observed; and
- Options to redevelop the site in the near future are limited where phytoremediation plantations are located due to necessary footprint.

IV. Regulatory Outlook

A March 2006 Performance Based Corrective Action Agreement between General Motors and the US EPA is the driver for remedial action. A RCRA Facility Investigation (RFI) Report has been submitted to the US EPA and a Corrective Measures Plan (CMP) is to be submitted in June 2010.

The potential regulatory obstacles for this proposed alternative green remedy most likely include:

- Inclusion of *ENGINEERED_PHYTOREMEDIATION*^{SM} and EZVI within the CMP; and
- Agency approval for phytoremediation and EZVI.

V. GSR Comparison

	Proposed Remedy	Alternative
Technology	ERH, ISCO, and long-term MNA	*ENGINEERED_PHYTOREMEDIATION*[SM] and EZVI
Energy Inputs		
Materials	High – manufacturing of energy source, well materials, vapor collection system,	Low – growing trees, manufacturing of root sleeve, fertilizer
Installation	High – equipment to capture and treat volatile off-gassing from subsurface,	Moderate
O&M	High – electricity to run system	Low
Waste Generation	minimal	None other than vegetative matter
Effectiveness	Able to maintain hydraulic gradient	Minimize and possibly eliminate off-site migration
CO_2 sequestration	None	Sequesters carbon in trees
Land and Ecosystem Impacts	Neutral compared to existing site condition	Positive impact on ecosystem
Air Emissions	Depends upon power source, necessary to control volatile off-gassing with capture and treatment system	No emissions, positive effect on ambient air quality
Maintenance	High – requires constant O&M and inputs of energy	Low – Once established, system is essentially self-sustaining
Risk Reduction	Risk reduction through off-gassing collection/treatment, and destruction of contaminants	Risk reduction through hydraulic control and destruction of contaminants
Site Reuse	Long-term site land and groundwater use restrictions will apply	Long-term site land and groundwater use restrictions will apply. Phytoremediation trees also provide a natural habitat

Water usage	Does not require additional water inputs	ENGINEERED_PHYTOREMEDIATION℠ and EZVI does not require additional water inputs
Natural Processes Utilization	Does not use natural processes	Utilizes all natural processes
Renewable Resources	Not renewable	Trees are renewable
Reduction/destruction of contaminant mass	Reduces on-site contaminant mass only through off-gassing volatiles	Potential to stimulate *in-situ* degradation of contaminants

VI. Costs

- Capital costs for this solution – The estimate presented herein is based on the planting of 750 trees using an Engineered_Phytoremediationsm system and 8 gallons of EZVI per 1,500 holes within the "source area" as described above. It is assumed that the installed cost per *TreeWell*® unit will be $1,000. Thus the cost for installing the phytoremediation system is estimated to be $750,000. The cost estimate assumes that the materials cost for EZVI will be $30 per gallon thus estimating the total EZVI material cost to $369,000. An additional $100,000 for mixing in the EZVI is assumed. An additional $150,000 for design and project management is assumed, bringing the total capital cost to $1,360,000.

- O&M/Monitoring costs for this solution – The OMM cost for this solution is estimated to be $150,000. It is based upon the assumption that O&M will be necessary to assess and optimize the phytoremediation plantations over five years. After five years, it is assumed that trees are mature enough to require less attention and can be left to continue site remediation and hydraulic control of groundwater. Also limited annual maintenance and agency oversight is included.

- Potential savings – The current remediation cost estimate for this site is estimated at $4,200,000 for corrective measures for soils and 5 years reduced annual cost compared to the estimated cost of this alternative green remedy of $1,519,000. This represents a $2,681,000 monetary savings.

VII. Conclusions

The proposed alternative green remedial technology chosen for the Kokomo, IN site is ENGINEERED_PHYTOREMEDIATION℠ and EZVI. This remedy is implementable, sustainable, provides effective hydraulic control, potential contaminant treatment, and lowers the

long-term cost of ownership. The proposed green technologies are estimated to reduce the overall remediation by at least 5 years. This strategy is estimated to lower the long-term cost of ownership by a total of approximately $2,681,000 over the next 30 years.

There is an opportunity to offer an alternative GSR approach in the June 2010 Corrective Measures Proposal. The current planned approach involves thermal treatment of PCE & TCE contaminated soil and groundwater which could be replaced/supplemented with EZVI and Engineered Phytoremediation.

Currently, there is $4.2 million designated for soil and groundwater corrective action. This cost could be at least cut in half using alternative GSR in these designated applications.

However, no cost changes at this time are recommended as technology will need to be approved by the agency. Path forward involves working with Arcadis and MLC personnel to develop corrective measures proposal.