REVISED COMPREHENSIVE CORRECTIVE ACTION PLAN ADDRESSING THE SOLVENT RELEASE FROM THE EGYPTIAN LACQUER MANUFACTURING COMPANY IN FRANKLIN, TENNESSEE

TriAD Project Number 07-ELM01-01

Prepared for:

EGYPTIAN LACQUER MANUFACTURING COMPANY
113 FORT GRANGER DRIVE
FRANKLIN, TENNESSEE 37064

Prepared by:

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JUNE 23, 2008

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1.0 INTRODUCTION

On behalf of the Egyptian Lacquer Manufacturing Company (“ELMCO”), and through its attorneys Stites & Harbison PLLC, this *Revised Comprehensive Corrective Action Plan* (“RCCAP”) has been prepared by TriAD Environmental Consultants, Inc. (“TriAD”) to address an accidental release of volatile organic solvents that occurred at the ELMCO manufacturing facility located at 113 Fort Granger Drive (the “Site”). More specifically, this RCCAP has been developed to address the contaminated soils and groundwater that remain at and around the Site as a result of a 2007-discovered solvent release from leaking underground pipes that transferred solvents from an aboveground Tank Farm to the manufacturing building at the Site. While the solvent release was immediately stopped upon its discovery in February 2007, and the underground pipelines have since been decommissioned and partly removed, and the aboveground tanks completely removed, the solvents that had been released continue to migrate with groundwater toward and into nearby streams.

ELMCO began voluntarily working with TDEC (through the State Remediation Program within its Division of Solid Waste Management) in early February 2007 to investigate the source of aromatic and ketone solvents that had been found discharging into Liberty Creek and the Harpeth River west and south of the Site, respectively. After discovering on March 2, 2007, that unprotected subsurface elbows in the underground piping on the west side of the former Tank Farm had corroded and leaked, ELMCO promptly assumed responsibility for both investigating and remediating that solvent release source area and for the response actions that TDEC had initiated to manage the solvent releases into the Harpeth River and, especially, Liberty Creek. On June 1, 2007, ELMCO entered into a Consent Agreement and Order (the “Order”, Case No. 07-R0134) with TDEC to address the release. The Order required ELMCO to prepare and submit to TDEC corrective action plans to address the contaminated source area soils, the contaminated groundwater, and contaminated soils that TDEC contractors had stockpiled during their initial efforts to excavate and interceptor trench near Liberty Creek. In compliance with the Order, ELMCO developed and submitted the required corrective action plans and, following or in advance of TDEC approval, implemented them. Of necessity, the corrective action plans have involved additional investigations and monitoring, and these efforts have generated further information concerning the nature, extent, and effects of the contaminants in soil, groundwater, and air which must be factored into the corrective action efforts.

The most substantive work plan prepared and submitted by ELMCO pursuant to the Order was the *Groundwater Corrective Action Plan* ("GCAP"), dated August 28, 2007. Following extensive public review and comment, TDEC issued on November 20, 2007, a Notice of Deficiency ("NOD") to ELMCO that identified several deficiencies in the GCAP and the course of action that ELMCO must take to correct those deficiencies. Pursuant to that NOD, ELMCO submitted to TDEC an air monitoring plan (prepared by EnSafe and dated December 14, 2007) to evaluate the contaminant levels in ambient air to which the persons living, working, or otherwise occupying structures near the solvent seep discharges into Liberty Creek and the Harpeth River might have long-term exposure. Also pursuant to the NOD, ELMCO submitted to TDEC an Investigative Workplan (prepared by TriAD and dated December 20, 2007) that described (1) additional groundwater investigations to further delineate groundwater contamination, (2) confirmation subsurface soil sampling in the known source area at the south end of the former Tank Farm to determine the effectiveness of previous *in situ* soil treatment, (3) confirmation subsurface soil sampling under the former Tank Farm to determine the presence or absence of additional soil source areas, and (4) further site characterization to demonstrate that natural attenuation processes are occurring as suggested in the GCAP. While implementation of both of these work plans was delayed by property access issues, both were subsequently implemented. ELMCO's implementation of items (1) and (4) from the December 20, 2007, Investigative Workplan was reported in TriAD's March 25, 2008, letter "Report of Additional Solvent Release Investigations". Then, following the April 2008 removal of the solvents and aboveground tanks that were in the Tank Farm, ELMCO implemented the efforts described in items (2) and (3) above. The performance and results of these confirmation subsurface soil investigations were reported in two TriAD letter reports – an initial report dated May 30, 2008, and a final report dated June 10, 2008.

The NOD also required ELMCO to submit "a revised Corrective Action Plan" to TDEC within 30 days from the submittal date of the "Site Investigation Report" that reported the results from implementation of the Investigative Workplan. This due date was interpreted to be April 24, 2008, 30 days from the March 25, 2008 letter "Report of Additional Solvent Release Investigations". However, ELMCO requested – in an April 23, 2008, letter from Stites & Harbison PLLC – that the due date for the revised CAP be extended until June 23, 2008. This request was verbally granted on April 24, 2008, and the schedule extension was documented in a May 7, 2008, letter from TDEC to Stites & Harbison PLLC.

Pursuant to the November 20, 2007, NOD, the revised CAP was to include the following items: (1) Corrective Measures Study, (2) Proposed remedy, (3) Time line for site remediation, (4) Contingency provisions, and (5) Long-term groundwater monitoring plan. In Stites & Harbison's April 23, 2008, letter, ELMCO requested the 60-day extension to try to ensure time to:

1. Address not only the contaminated groundwater but also any remaining contaminated soils in the source area at the former Tank Farm, the operation and ultimate closure of the Interceptor Trench near Liberty Creek, the management of the piles of excavated soil and rock that are staged south of (and originate from) the Interceptor Trench, and any residual soil contamination that exists in the soils in the Liberty Creek floodplain area – It was particularly noted that the confirmation subsurface soil investigations in the treated source area and under the Tank Farm were scheduled for May 2008.

2. Include a more thorough assessment of the risks to which persons may be exposed to the contaminated soil, groundwater, and surface water, and especially to

breathable vapors that may be created from such contaminated soil and water – It was noted that the risks have to be clearly identified because the purpose of corrective action is to ameliorate such risks. It was also noted that the long-term air monitoring plan that had just been implemented was going to collect some key information in this area.

3. Allow for a more thorough assessment of the groundwater monitoring and other data that had been collected and reported in the March 25, 2008, letter "Report of Additional Solvent Release Investigations" – It was also noted that the quarterly groundwater monitoring that was scheduled for May 2008 would provide valuable additional information to be factored into the planned risk assessment and corrective action planning efforts.

4. Consider in the corrective action planning effort the improved access to the interceptor trench and soil pile area to be provided by the culvert crossing of Liberty Creek that TDEC was planning to install.

Subsequent discussions with TDEC officials also convinced ELMCO that a formal assessment of both human health and ecological risks needed to be performed and the results factored into the corrective action planning effort.

It is important to remember that this RCCAP is based on available data and related assumptions. As described in Section 4.0, there are data gaps and investigative efforts that have yet to be accomplished. Also, as described in Sections 8.0 and 9.0, some additional data-gathering steps and/or pilot tests are needed to "flesh out" the recommended corrective measures. Further, it is possible that the routine, ongoing groundwater, seep/surface water, and air monitoring efforts may provide results that will require a change in these planned corrective actions.

2.0 BACKGROUND

The "regulatory" background for ELMCO's solvent release response is described in Section 1.0. The following sections provide a more physical description of the Site setting, geology, and the release of solvent from the underground pipes at the former tank farm.

2.1 Site Setting

The ELMCO facility, located at 113 Fort Granger Drive in Franklin, Tennessee, is a manufacturer of specialty paints and lacquers, primarily for the pencil industry. These paints and lacquers must be very fast drying to meet industry requirements, and solvent-based paints have been, and still are, the primary means of meeting the fast-drying standards. Since the beginning of operations at their current location in 1978, ELMCO has used a variety of VOC solvents in their manufactured paints and lacquers. These solvents were principally stored in twelve aboveground storage tanks located in the western portion of ELMCO's property. The twelve tanks, which were removed from the Site in April 2008, were placed on a concrete pad and surrounded by low, concrete-block secondary containment walls. The tanks were connected to the manufacturing building via twelve underground pipelines, which were abandoned and partially removed in February and March 2007. The tank farm was located approximately 350 feet west of the building, at an elevation of approximately 665 feet above mean sea level (MSL). A Site Map, showing the location of the former tank farm, the manufacturing building, and other area features, is presented as Figure 1. [Note: This map identifies the "Site" as the larger area impacted by the solvent release rather than as simply the ELMCO facility.]

For the purposes of this CAP, the geographic features of the land south (to the Harpeth River) and west-northwest (to Liberty Creek) are important. The locations of these features are shown on Figure 1. The topographic relationships between these features are shown on Figures 2 and 3, which are TriAD-generated west-to-east and north-to-south cross sections showing elevations of the ground surface and other relevant features.

Just west of the former ELMCO tank farm and down a short slope is an abandoned railroad spur siding and, just to its west, the main line of the CSX railroad, which serves downtown Franklin. The abandoned rail spur was owned partly by local landowners and partly by CSX. The CSX-owned portion of the right-of-way ends 140 feet from the former switch points. The railroad main line is approximately 175 feet west of the former tank farm and at about 645 feet above MSL (roughly 20 feet lower than the tank farm).

West of the railroad is found the residential development along Daniels Drive. The single-family homes and duplexes are arranged along both sides of the street and around the cul-de-sac that forms the southern end of Daniels Drive. The nearest residence to the tank farm (124 Daniels Drive) is located approximately 250 feet west. The elevation of Daniels Drive at its high point (near 120 Daniels Drive) is about 650 feet above MSL (roughly 15 feet lower than the former tank farm). The elevation of Daniels Drive at monitoring well MW-5, located at 110 Daniels Drive, and at the cul-de-sac is approximately 640 feet above MSL (roughly 25 feet lower than the former tank farm). The residences at the south end of Daniels Drive, nearest the Harpeth River, are at an elevation of about 630 feet above MSL, or roughly 35 feet lower than the former tank farm.

West of the Daniels Drive residential area, the land slopes down into the valley of Liberty Creek. The valley floor elevation is about 620 feet above MSL. Liberty Creek itself is approximately 750 feet west of the tank farm at an elevation of 611 feet above MSL (measured at the main seep described in Section 3, roughly 55 feet lower than the former tank farm).

To the west of Liberty Creek the land rises out of the creek valley to an elevation of about 635 feet above MSL. Battle Ground Academy Lower School (elementary) is located here, about 850 feet west of the tank farm.

At its nearest point to the tank farm, the Harpeth River is located about 340 feet south-southwest. At that point, the water-level elevation of the river (which varies significantly in response to rain events) has been measured at about 605 feet above MSL (roughly 50 feet lower than the tank farm).

Several underground utility lines serve the area. Water lines are located parallel to Fort Granger Drive and Daniels Drive, although they are not shown on the maps or cross sections included with the CAP. A private sewer line serving ELMCO and the property adjacent to the north runs parallel to and on the east side of the rail spur and CSX line. The private sewer line connects with the municipal sewer near the CSX railroad bridge over the Harpeth River. The private line is located roughly 6 feet underground and is not shown on the maps or cross sections included with this CAP. Municipal sanitary sewer lines are located along Daniels Drive, the Harpeth River, and Liberty Creek. These sewer lines are shown on Figure 1 and, in the case of the line along Liberty Creek, on Figure 2.

Land use in the vicinity of the Site is primarily light industrial and commercial east of the railroad, residential west of the railroad, and undeveloped park land south of the Harpeth River. Fort Granger Park, a municipal park incorporating a Civil War fort, is located adjacent to ELMCO on the south, on the higher ground between ELMCO and the Harpeth River.

2.2 Summary of Solvent Release

VOCs entered the groundwater at the Site as a result of a solvent release from the underground pipelines that connected the former above-ground tank farm to the manufacturing building. The following subsections describe the solvent release and the physical properties of the principal chemicals of concern, toluene and acetone.

2.2.1 Release Mechanism

Following the discovery of VOCs in water and air samples collected at the Harpeth River and Liberty Creek, ELMCO had tightness testing performed on its underground solvent pipelines in February 2007. This testing detected a possible leak in the acetone line. A detailed investigation of the underground pipes was therefore performed in February and March 2007 by excavating and inspecting (visually and with an Organic Vapor Meter [OVM]) the piping near the tank farm and at nine test pits spaced at 30- to 40-foot intervals between the tank farm and the manufacturing building. As determined from this inspection of the excavated underground pipelines, the pipes were coated with plastic, their connections were wrapped in plastic, and were in excellent condition except at the 90-degree elbows below where the pipes exited the ground at the tank farm end (similar elbows at the building end of the lines were observed to be wrapped and in excellent condition). At the tank-farm pipe elbows all of the pipes were heavily corroded and two of the pipes, those carrying acetone and toluene, were obviously leaking. No quantitative integrity tests were performed on the elbows. High organic vapor readings were found in the soil surrounding the pipe elbows, and soil samples were collected from this area and analyzed for VOCs by US Environmental Protection Agency (EPA) SW846 Method 8260B. The samples were found to be heavily contaminated with VOCs.

In addition to the visual and OVM inspection of the underground pipelines performed by TriAD in March 2007, soil samples were collected from each of the nine test pits, including directly beneath the pipe elbows at the building end. In each test pit, a soil sample was collected from a depth greater than the piping, as close to under the piping as possible, and the collected samples were analyzed for VOCs using Method 8260B. None of these samples contained VOCs above laboratory detection limits, demonstrating that the underground pipelines were not a source of contamination beyond the leaking elbows at the tank farm. Results of this investigation were reported in TriAD's April 11, 2007, letter "Data Report of Soil Investigation Results".

The discovery of the leaking acetone and toluene pipelines and the large concentrations of those VOCs in the soil samples collected near the leaks matched the principal constituents of water contamination previously documented at groundwater seeps and surface-water sampling points along Liberty Creek and the Harpeth River. It was therefore concluded that releases of solvents from the unprotected, corroded pipe elbows at the tank farm were directly related to the VOCs identified in local surface water. Chemical analysis of the soil and surface water identified toluene and acetone as the principal constituents, with other chemicals (e.g., methyl isobutyl ketone [MIBK], methyl ethyl ketone [MEK], naphthalene, trimethylbenzene, ethylbenzene, xylenes) in minor amounts.

No evidence of other release mechanisms at the ELMCO facility has been found, although such cannot be ruled out with certainty. In October 2006, prior to TriAD's involvement and before the discovery of VOC contamination in Liberty Creek and the Harpeth River, a Phase II environmental site assessment was performed at ELMCO as part of a property transfer due diligence investigation. This investigation, performed by August Mack Environmental of Indianapolis, Indiana, consisted of subsurface soil sampling via 12 soil borings advanced by Geoprobe in several areas of the Site. (A copy of the Phase II report, dated November 2, 2006, was submitted previously to TDEC.) This investigation found significant VOC concentrations only in one soil boring drilled just west of the tank farm in a shallow drainageway (just downgradient of the later-discovered leaking pipe elbows). Although other soil samples collected from other borings contained trace concentrations of VOCs (i.e., less than 0.5 mg/kg total VOCs), the investigation found no evidence of any other release of sufficient quantity to justify further investigation. It is ELMCO's and TriAD's understanding that TDEC has concluded, based on this investigation and TriAD's subsequent efforts, that no further investigations for contaminant releases at the Site are needed.

Prior to ELMCO's ownership of the property, two underground storage tanks were located in the area near the north side of the building. One tank was reportedly used for heating oil (8,500 gallons), one for gasoline (6,500 gallons). The heating oil tank was removed in November 1997, and soil samples collected from the tank pit at that time showed no detectable concentrations of total petroleum hydrocarbons – diesel range organics. A closure report was submitted to TDEC. The gasoline tank was converted by ELMCO to use for process cooling water and is still in place and used for that purpose.

2.2.2 Elimination of Release Mechanism

In February 2007, the solvent pipelines were permanently disconnected from the tank farm by severing the connection from the piping to the tanks at the tank-farm end. In March 2007, the pipes were further separated from the tanks by removing approximately 50 feet of each line from the ground at the tank-farm end. During these operations, the pipes were purged of solvent by vacuuming, nitrogen purging, and water purging. All purged solvent and water was contained and subsequently disposed of off-Site as manifested hazardous waste. Therefore, the source of the solvent release was eliminated as of February and March 2007.

In April 2008, in accordance with TriAD's December 20, 2007, *Investigative Workplan*, the aboveground tanks and remaining aboveground piping were decontaminated, demolished, and removed from the Site. All decontamination fluids were contained and subsequently disposed of off-Site as manifested hazardous waste.

2.2.3 Volume of Release

The volume of solvent released cannot be accurately determined for the following reasons:

1) Inventory controls were inadequate to detect a slow release over time. The solvent tanks were vented to the atmosphere, causing some evaporative loss of

the highly volatile solvent compounds. Because the rate of volatilization is dependent on several atmospheric conditions, including temperature and humidity, only very rough estimates can be made regarding atmospheric losses (which were reported to regulatory agencies as required by the facility's air permits). Further, the volume of solvent in each tank was measured using a calibrated stick, with measurements to the nearest inch. Because the liquid expands and contracts with temperature, calculations of tank volumes were necessarily estimates. Resolving differences between volumes purchased, volumes used in manufacturing, volumes estimated lost through volatilization, and volumes measured in the tanks is problematic and does not have the accuracy needed to detect small losses over time.

2) The timing of the release is unknown. All that can be established is that the pipe elbows at the tank farm end were corroded and leaking when they were inspected in March 2007. There are no federal or state regulatory requirements for routine underground pipeline tightness testing. Therefore, no testing had been performed on the pipelines between their installation in 1978 and 2007.
3) No estimate of the rate of leakage from the pipe elbows can be made. The solvent in the pipes was not under constant pressure, so no accurate calculation can be made of how fast solvent could be "pushed" out of whatever size holes were found in the pipes. The solvent lines were used only occasionally as ELMCO personnel needed solvent for a particular batch of paint or lacquer. When not in use, the solvent pumps were turned off and the pressure on the lines was released. Therefore, any leaks from holes at the pipe elbows would have occurred at variable rates entirely dependent on the pressurization and depressurization of the pipes and the hydrostatic pressure surrounding the pipes.

To produce an estimate of the dissolved contaminant mass in the affected area as of February 2008, the then most recent contaminant distribution, a potentiometric map, and estimated porosities were used. The methodology and results are described in detail in the *Report of Additional Solvent Release Investigations*, dated March 25, 2008. The resulting total dissolved contaminant masses of the principal constituents were:

Toluene	1,857 pounds (255 gallons)
Acetone	4,767 pounds (726 gallons)

These rough estimates do not include the toluene free product or other VOCs that occur in dissolved phase throughout the plume. The toluene and acetone account for the overwhelming majority of contaminants and are the principal target of any remedial activities performed at the site. Estimates of free-product toluene would be dependent on understanding the specific geometry of the conduits and fractures that allow accumulation of product on a free surface – geometry that is unknown. Further, recent groundwater sampling and work at the interceptor trench near Liberty Creek have failed to find evidence of free product.

An estimate of the contaminant mass in soil at the source area (former tank farm) was calculated based on data collected from Geoprobe investigations of the source area performed in March 2007 and May 2008. Cross sections of the impacted soil are presented as Figures 4 and 5. These calculations resulted in the following estimates of contaminant mass of the two principal constituents:

Toluene	1,234 pounds (170 gallons)
Acetone	21,840 pounds (3,330 gallons)

Combining the totals from the aquifer and from the source area soils yields a mass of 3,091 pounds (425 gallons) of toluene and 26,607 pounds (4,056 gallons) of acetone remaining in the subsurface.

2.2.4 Constituents of Concern

As previously noted in this and other reports, toluene and acetone are by far the most prevalent constituents in the contaminant plume. However, they are not the only constituents. Other constituents detected at the Site, in soil, surface water, and groundwater samples include:

Benzene
Di-isopropyl ether
Ethylbenzene
Isopropylbenzene (cumene)
Isopropyl alcohol
Methyl ethyl ketone (MEK)
Methyl isobutyl ketone (MIBK, 4-methyl-2-pentanone))
n-Propylbenzene
1,2,3-Trimethylbenzene
1,2,4-Trimethylbenzene
1,3,5-Trimethylbenzene
Xylenes
cis-1,2-Dichloroethane
Tetrachloroethene
Methylene chloride
Naphthalene
1-Methylnaphthalene
2-Methylnaphthalene

Although detected in samples from time to time, most of these ancillary compounds have been detected sporadically. Some (e.g., naphthalene) have been detected in one medium (e.g., soil) and not in others. Some (e.g., cis-1,2-dichloroethane and tetrachloroethene) were detected only once. The methylnaphthalenes (the only semi-volatile organic compounds on the list), which were detected at trace levels in some groundwater samples, may represent naturally occurring compounds (bedrock formations in the area are known to be minimally petroliferous, i.e., containing small amounts of petroleum).

The source of most of the listed VOCs could be attributed to the variety of solvents stored at the tank farm at ELMCO over the years. ELMCO used not only toluene and acetone but also blended solvents consisting of several different volatile organics. Over time, different tanks held different products. Although ELMCO specifically and deliberately did not use solvents containing chlorinated compounds or benzene (based on the manufacturer's material safety data sheet), benzene is a common contaminant in shipments of toluene and may have entered the solvent stock without ELMCO's knowledge. Where benzene and toluene are detected together at the Site, benzene is typically present at a concentration of 1 percent or less of the toluene concentration, which would be consistent with the possibility that benzene is a contaminant of the toluene used by ELMCO.

Regardless of the origin of any individual compound, the principal chemicals of concern at and in the vicinity of the Site are toluene and acetone. Any consideration of corrective action must therefore focus on these two VOCs. Other solvent constituents, present in minor concentrations, are also VOCs and it may be presumed that any remedial action taken to address the toluene and acetone will also remediate these associated VOCs.

Toluene is a highly volatile organic compound that is largely insoluble in water. Its water solubility at room temperature is about 535 mg/L. The vapor density of toluene is 3.14, or roughly three times heavier than air. The half-life of toluene in surface water at 25º C is reported to be approximately 2.9 to 5.7 hours (EPA Technical Fact Sheet on: Toluene).

Acetone is a volatile organic compound that is completely soluble in water (water solubility is infinite). The vapor density of acetone is 2.0, or roughly two times heavier than air. The half-life of acetone in surface water at 25º C is reported to be approximately 20 hours (Department of Energy Risk Assessment Information System). Acetone in water in high concentrations may act as a solvent for the toluene, slightly increasing the solubility of toluene.

Neither acetone nor toluene is considered a human carcinogen. In fact, both are considered to be of relatively low toxicity, although toluene is more toxic than acetone. US EPA has recently established revised risk-based exposure concentrations for human populations (Regional Screening Levels [RSLs], May 2008). These RSLs are used by TDEC in screening sites for contamination. The acetone RSL for tap water is 22 mg/L. US EPA has not set a drinking water maximum contaminant level (MCL) for acetone. The toluene RSL for tap water is 2.3 mg/L, with an MCL of 1.0 mg/L.

Benzene is the only human carcinogen that has been consistently detected in water samples from the Site (it has not been detected in soil or air samples at concentrations exceeding detection limits for those media). Benzene's vapor density is 2.8, or heavier than air. The half-life of benzene in flowing surface water is reported to be 2.7 hrs at 20º C (U.S. EPA Technical Fact Sheet on: Benzene). The benzene RSL for tap water is 0.00041 mg/L, with an MCL of 0.005 mg/L.

2.3 Site Geology and Hydrogeology

Based on a review of the published geologic map of the Franklin quadrangle (Geologic Map of the Franklin, Tennessee Quadrangle, Tennessee Division of Geology, 1963) and on data collected during the soil and groundwater investigations at the Site, the following description of Site geology has been assembled. Geologic information is presented on the cross sections in Figures 2 and 3.

Overburden at the Site consists of residual silty, sandy clay derived from weathering of the underlying bedrock. Layers of higher sand or clay content reflect lithologic differences in the bedrock parent material. The overburden ranges from 10 to 35 feet thick at the ELMCO facility, and may be completely absent in areas along the Harpeth River and Liberty Creek, which flow on or near bedrock. Drilling at the ELMCO facility has shown there is no significant groundwater in the overburden; where it occurs at all, groundwater in the overburden is limited to a thin zone at the top of rock, predominantly in bedrock depressions or "cutters."

The uppermost bedrock unit at the ELMCO facility is the Bigby-Cannon Limestone, particularly the Bigby facies, which is the lowest facies in the formation. The Bigby ranges from 5 to 40 feet thick at ELMCO, thickening to the east. To the west, the Bigby thins gradually, disappearing completely in the valley of Liberty Creek. To the south, the Bigby does not thin, but ends in bluffs along the Harpeth River. The Bigby is a coarse-grained, cross-bedded phosphatic limestone that weathers into an irregular surface known as "cutter and pinnacle" topography. Cutters are linear depressions in the surface of the bedrock, formed by weathering along fractures. Because it readily forms solution features, the Bigby-Cannon Limestone is generally considered a good water-producer, although no water has been encountered in the Bigby at ELMCO, other than minor perched zones at the top of rock.

Beneath the Bigby-Cannon, at a mapped elevation of approximately 630 feet above MSL, is the Hermitage Formation. The Hermitage is a shaly limestone less prone to solution development than the Bigby-Cannon, and as a result is a poor water producer. Boreholes drilled at ELMCO have encountered water flowing along bedding planes in the Hermitage, but there is generally little water, and monitoring wells set in the formation are very low yielding. Liberty Creek and the Harpeth River both flow on the Hermitage.

Based on the geologic map, the limestone formations in the vicinity of the Site dip slightly to the southwest, which is expected based on the Site's position in the southern portion of the Nashville Dome, a broad regional uplift. Examination of the bedrock outcrop along the Harpeth River south of ELMCO indicates a slight dip to the northwest, with a strike to the northeast. While some local variation in dip is likely, the overall degree of dip is low, with near-horizontal conditions predominating.

The bedrock surface at and in the vicinity of the Site is irregular. Data from Geoprobe and air-rotary drilling at ELMCO have indicated a cutter located near the south side of the tank farm that trends east-west, sloping to the west-northwest. The upper bedrock within the cutter is heavily weathered, while the bedrock surface outside of the cutter has exhibited only minor weathering. The position and orientation of bedrock surface irregularities, including cutters, are controlled by fractures. Fractures in the Site vicinity can be observed at small scale in the outcrops of bedrock along the Harpeth River, in the orientation of the bedrock cutter near the former tank farm, and in the orientation of segments of streams, including the Harpeth River. Indeed, the north-northwest orientation of the segment of the Harpeth River nearest the Site roughly mimics the inferred trend of the cutter and fracture system which apparently directs flow of contaminants from ELMCO to Liberty Creek.

Groundwater flow at the Site is primarily through weathered and fractured zones in the top of rock (particularly in the cutter near the tank farm) and through fractures and/or bedding planes (likely enlarged by weathering) in the bedrock. Hydraulic conductivities in the bedrock aquifer have been estimated using data collected from single-well slug tests as described in the *Report of Additional Solvent Release Investigations* (March 25, 2008). These estimates ranged from 6.4×10^{-7} ft/sec at MW-3 to 4.8×10^{-3} ft/sec at MW-1.

A potentiometric map generated from water-level data collected during June 2008 is presented as Figure 6. As shown on the map, water levels are highest in the area near the solvent release point, which is near the eastern end of a cutter/weathered bedrock feature in which the major portion of the contaminant plume is migrating to Liberty Creek. From this high point, groundwater moves to the west through the soil and fractured rock of the cutter as well as outward in all directions into the bedrock aquifer, working its way along both bedding plane and vertical fractures, where the contaminant plume is dominated by dissolved phase VOCs. Free product solvent has previously been identified in well MW-3, demonstrating that some free product worked its way into fractures in the vicinity of the cutter. No free product has been observed in well MW-3 since it was removed by absorbent booms in March 2008. Well MW-2 is impacted by dissolved-phase contaminants, and February sampling data indicate dissolved-phase contaminants may be impacting MW-1 and MW-5. It is therefore apparent that the cutter is acting as a linear recharge zone for groundwater in the wider bedrock aquifer, which discharges into Liberty Creek and the Harpeth River.

Based on the estimated hydraulic conductivities and the hydraulic gradients shown on the potentiometric map, groundwater flow velocities at the Site are quite variable, ranging from 6×10^{-7} ft/sec to 1.2×10^{-2} ft/sec (roughly 0.05 ft/day to 1,000 ft/day). This wide range is typical of fracture and karst aquifers in which groundwater flow is dominated by secondary porosity. These values are averages and may not represent the maximum and minimum velocities that could be encountered at any given point in the aquifer. For example, the velocity calculated for the weathered rock and soil in the cutter does not account for the presence of fracture/conduit flow observed during construction of the interceptor trench. A more realistic approach would be to assume that the higher velocity calculated for the fractured bedrock (1.2×10^{-2} ft/sec) is also more representative of the faster velocities expected in the weathered rock/cutter zone. It is also important to note that although high velocities may be encountered at any given point, these points may or may not be interconnected in a continuous pathway between the source area and the creek or river that would allow such velocities to be maintained over the entire distance.

3.0 SUMMARY OF RESPONSE ACTIONS PERFORMED

A variety of actions have been taken by ELMCO to investigate and remediate the release of solvent constituents. The following sections describe the principal actions.

3.1 Solvent Capture at Liberty Creek

Beginning February 8, 2007, immediately upon discovery of free-product solvent (primarily toluene) entering Liberty Creek at the main seep, ELMCO responded with efforts to contain the product using absorbent booms and pads. The effort was then taken over by TDEC until March 2, 2007, when ELMCO resumed responsibility. During TDEC's operation, an attempt was made to dig an interception trench on the east side of Liberty Creek. Although this trench succeeded in recovering a small amount of free product, it was not effective at preventing product from entering the creek.

During the spring and summer of 2007, ELMCO's contractor, Ops Contracting Services (OCS) continued collecting free-product using absorbent booms and pads that were changed out as they became saturated with solvent, often on a daily basis. These efforts prevented free product or sheens from migrating down Liberty Creek to the Harpeth River, and continued until late summer 2007, after construction of the second interceptor trench. All recovered product was transported back to ELMCO for classification and then transported and disposed off-site as manifested hazardous waste.

A second interception/recovery trench was constructed in the valley of Liberty Creek during the period July 27 to August 24, 2007. The first trench, constructed under TDEC supervision, was backfilled and the second trench was excavated using trackhoe and hoe-ram equipment in the approximate location shown on Figure 1. A cross section of the trench is presented as Figure 7. The trench is approximately 140 feet long and ranges from approximately 11 to 17 feet deep. Its length and depth were designed to intercept the free-product flow that had been discharging into Liberty Creek. It was excavated into bedrock and, as shown on the cross section, a 1- to 5-foot thick layer of weathered rock was encountered, thinning to the south. The bottom elevation of the trench ranges from about 611 feet above MSL at the north end to about 607 feet above MSL at the south end. As noted previously, the elevation of the Main Seep in Liberty Creek is approximately 611 feet above MSL, when the stream is flowing (which it was not doing during construction of the trench).

During trench construction, four locations were encountered where groundwater flowed into the excavation. At approximately 20 feet from the north end, a small flow of water entered the trench from the east side at an elevation of about 611 feet above MSL. This water, though apparently contaminated (based on PID and olfactory evidence), did not contain measurable free product. At approximately 87 and 89 feet from the north end, flows of water entered the trench from the east side at elevations of approximately 609 feet and 608 feet above MSL, respectively. Both flows of water were accompanied by free-product toluene. An additional flow of mixed water and free product was encountered at approximately 102 feet from the north end of the trench at an elevation of approximately 607 feet above MSL. No additional free product was encountered in the remaining 38 feet of trench.

As the water level rose in the trench (apparently because of semi-confined conditions in the water-bearing zones), the free-product flows were reduced or eliminated, as had happened at well RW-1 near the tank farm. To facilitate recovery of the free product, at least under the drought conditions experienced in August 2007, it was necessary to keep the water level artificially lowered in the section of trench into which the product could flow. For this reason, dams were constructed across the trench to the north and south of the three product seeps. These dams allowed water to be pumped from the product-generating middle section of the trench to either the northern or southern sections. This water was pumped via an intrinsically safe pump (to eliminate the danger of ignition of the free product toluene) and via a submerged inlet (to eliminate the risk of pumping product with the water). Absorbent booms were also used in the northern trench to capture any entrained free-phase product that might have been discharged.

The pumped water, which contained dissolved-phase acetone and toluene, was then allowed to infiltrate the ground through the sides and bottom of the north or south sections of the trench, to either continue on to Liberty Creek or to return to the central portion of the trench from where it could again be pumped. This intermittent pumping allowed the flow of free product into the trench, where it was separated from the water by means of absorbent booms. The booms were recovered and transported to an authorized hazardous waste management facility for reclamation.

Very soon after operation of the trench began there was a noticeable decrease in free product entering Liberty Creek. Small amounts of product or sheen were intermittently observed during the fall and early winter of 2007, with some occasionally being trapped on the absorbent booms that are, to the date of this report, being maintained in place around the main seep at Liberty Creek. By late winter and early spring of 2008, free product was no longer being observed or trapped in booms at Liberty Creek.

Operation of the trench continued through the fall of 2007. During the winter of 2008 access issues with the property owner arose that resulted in delays in trench operation, and increased rainfall caused significant water-level increases in the trench. Also during the winter, some slumping of the east wall of the central portion of the trench occurred in an area where free product had been observed entering the trench. As water levels declined and TDEC brought in their contractor, periodic trench pumping resumed in April 2008 and continued again with OCS when ELMCO made access arrangements with the property owners. It quickly became evident that the trench, at least with the slumped portion of the east wall, was not producing free product, nor was free product being observed in the creek. After several weeks of intermittent pumping, trench operations were suspended until repairs could be effected. A work plan for such repairs is described in Section 4 of this report. During the suspension of trench operations, crews continue to inspect the booms in place in Liberty Creek and to check for free product accumulation in the trench and creek.

Routine sampling of the groundwater entering the trench has not been performed. However, in November 2007 two samples were collected, one from the central portion and one from the northern portion. These samples showed 320 mg/L toluene and 540 mg/L acetone in the central trench, and 100 mg/L toluene and 240 mg/L acetone in the northern trench.

3.2 Soil Investigation and Remediation at ELMCO

Soil investigation has occurred in phases and has been reported by TriAD in the following documents:

Data Report of Soil Investigation Results, April 11, 2007 (initial tank farm Geoprobe and test pit investigation)

Initial report of Confirmation Soil Investigations Under Former Tank Farm and in BIOX Treatment Area at ELMCO Facility, May 30, 2008 (Geoprobe investigation with boring logs)

Final Report of Confirmation Soil Investigations Under Former Tank Farm and in BIOX Treatment Area at ELMCO Facility, June 10, 2008 (Geoprobe investigation with cross sections)

Additional information regarding soil investigation was presented in the *Groundwater Corrective Action Plan* dated August 28, 2007. Based on the 2007 investigation, which defined the extent of soil contamination at the ELMCO facility and confirmed that the leak from the underground pipe elbows at the Tank Farm was the source of the VOC impact to Liberty Creek, an in-situ soil remediation was designed and implemented. This treatment consisted of injection of a chemical oxidant and biological nutrients. In early June 2007, Geoprobe technology was used to inject into the contaminated soil column a liquid treatment reagent produced by BioManagement Services, Inc. Known as BIOX, the solution included solid peroxides, pH buffers, and nutrients to enhance biological activity. A total of 3,249 gallons of BIOX formulation was injected into the contaminated soil column through 33 injection points spaced roughly 4 feet apart. The injection was performed pursuant to a TDEC-issued Class V Injection permit. A report of this remedial action was submitted to TDEC in the letter report *Source Area Soils CAP Implementation Report 1*, dated June 22, 2007.

The 2008 soil investigation was designed to achieve two goals; to determine whether soil under the tank farm concrete pad had been impacted by significant quantities of solvent, and to establish whether the BIOX treatment had been effective. The investigation under the tank pad could not be performed until the tanks had been removed, and TDEC approved a schedule of investigation that was linked to the tank removal, which was completed in April 2008. The May 2008 soil investigation revealed three significant findings:

1) Soil beneath the former tank farm pad was not significantly impacted by solvent constituents, with the exception of an area under the south edge of the pad, directly adjacent to the location of the leaking underground pipe elbows.
2) The BIOX treatment was not effective in significantly reducing the concentration of solvent constituents in the source area.
3) The remaining soil contamination in the source area is capable of leaching solvent constituents to site groundwater.

Figures 4 and 5 show toluene and acetone concentrations on cross sections drawn through the soil source area from east to west and north to south, respectively. These cross sections demonstrate that high concentrations of these solvent constituents are present in a soil column centered on the former location of the leaking underground pipe elbows. The contaminants apparently spread laterally as they migrated downward through the soil, then down the slope of the bedrock surface into the cutter that leads west-northwest from the source area.

3.3 Groundwater Investigations

As with the soil investigation, groundwater investigation has proceeded in phases, with reports in the following TriAD documents:

Summary of Phase I and II Groundwater Investigations, July 27, 2007 (Monitoring wells AR-1, RW-1, MW-1, MW-2, and MW-3)

Groundwater Corrective Action Plan, August 28, 2007

Report of Additional Solvent Release Investigations, March 25, 2008 (Monitoring wells MW-4 and MW-5 and February 2008 quarterly groundwater monitoring event)

Groundwater Monitoring Results – June 2008 Event, June 23, 2008 (summary of all groundwater analytical data to date)

The findings of the groundwater investigations relating to groundwater flow direction and rate have been summarized in Section 2.3 of this report, and in the Potentiometric Map (Figure 6). The extent of groundwater contamination as defined by the toluene concentration above drinking water standards (1.0 mg/L) is presented on Figure 8, Extent of Toluene in Groundwater. The map shows that the highest concentrations of solvent constituents are found in the area near the source and in the seeps along Liberty Creek and the Harpeth River. As expected from the data presented on the potentiometric map, the contaminants have migrated outward in all directions from the source area (south side of the former tank farm). It is also important to note that benzene has been detected above the drinking water standard in two perimeter monitoring wells, MW-1 and MW-5, indicating that the extent of groundwater impact may be somewhat greater to the north and east than that shown on Figure 8. TDEC has directed ELMCO to install additional groundwater monitoring wells to further define the extent of the plume to the north and east (see Section 4.2 for further details).

Table 1 presents a summary of the groundwater analytical results to date. Figure 9 contains a series of graphs showing total VOC concentration in groundwater over time at each groundwater monitoring well. From the table and graphs it can be seen that groundwater sampling data have shown significant declines in total VOC concentrations in MW-2, MW-3, AR-1, and RW-1 since the beginning of sampling. Acetone has virtually disappeared from MW-2, where is had been the dominant contaminant, with a concentration of 360 mg/L in June 2007. Toluene was the dominant contaminant in

MW-3, where it has declined from the saturation limit (free product) to 200 mg/L. Acetone and toluene are down significantly in AR-1 and RW-1 from the time these wells were installed. It is likely that additional analytical data will show some fluctuation in contaminant concentrations over time, as variables such as contaminant plume variations and water-level fluctuations interact to produce higher or lower concentrations at any given point.

Groundwater sampling data show increases in contaminant concentrations in wells MW-1 and MW-5. At MW-1, sampling data from 2007 showed no detectable concentrations of VOCs, while data from 2008 show low concentrations of several VOCs, including benzene and toluene. At MW-5, the two sampling events show a very slight increase in contaminant concentrations, with too few data to confirm the trend.

Two monitoring events at well MW-4, on the BGA property, have shown only toluene detected, both times at concentrations well below the drinking water standard. The analytical data from MW-4 demonstrate that the surface water in the lower reach of Liberty Creek is acting to block any significant contaminant flow further to the west.

3.4 Seep Monitoring

After initial sampling and analysis of samples from Liberty Creek in February 2007 by ELMCO and TDEC a routine seep monitoring program was established beginning in May 2007. Reports are submitted to TDEC on a monthly basis, the most recent being *Seep Monitoring Results – May 2008 Event*, May 23, 2008. This program includes the monthly sampling and analysis of the following locations, which are shown on Figure 1:

LC-PC (Liberty Creek Personnel Crossing)
LC-MS (Liberty Creek Main Seep)
HR-2 (Harpeth River Seep 2)
HR-3 (Harpeth River Seep 3)

In addition, a surface water sampling point was added in November 2007 at the watergate that spans Liberty Creek upstream of the main seep. Table 2 presents a summary of seep sampling results through May 2008. The seep sampling has shown significant reductions in contaminant concentrations since the beginning of monitoring, particularly at locations LC-MS and HR-2, the most contaminated of the seep monitoring locations. (Location LC-PC is in the main channel of Liberty Creek well downstream of the contaminant seep and samples from this point are therefore more affected by precipitation and creek water levels, making it a less reliable indicator of groundwater conditions.) At HR-2, where acetone is the dominant constituent, concentrations of acetone have been reduced from an average of 2,033 mg/L during May through August of 2007 to an average of 553 mg/L since that time. At LC-MS, where toluene is the dominant constituent, concentrations of toluene have been reduced from an average of 377 mg/L during May through August of 2007 to an average of 77 mg/L since that time. Further, free-product solvent has been dramatically reduced at LC-MS since construction of the interception trench in August 2007, being observed only sporadically and in small quantities through the fall and winter, and not at all since early spring 2008.

Although significant reductions in contaminant concentrations have been observed in the seep samples since late summer 2007, variation in seep sample results has been observed and is expected. There are many variables that contribute to these variations, including variations in contaminant concentrations throughout the plume (e.g., presence or absence of pockets of free product), precipitation amounts, creek and river water levels, and pumping of the interception trench.

3.5 Air Monitoring

Several phases and types of air monitoring have been performed at the site since early 2007. EnSafe has performed most of the air monitoring under direction of Mr. Bry Roberson, CIH, with one study performed inside BGA school by Mr. Greg Boothe of EHS Services. There was also some initial work performed by EnSafe as a contractor for TDEC, including real-time air monitoring of crawl spaces and basements of homes along Daniels Drive in February 2007 using an OVM. In addition, TriAD performed daily, real-time monitoring of the area around Liberty Creek and along the Harpeth River using and OVM from March 5 to September 7, 2007. Each phase of air monitoring was performed in accordance with work plans and/or with coordination from TDEC. The following reports have been submitted to TDEC:

Results from Air Monitoring at Residences Near Liberty Creek in Franklin, Tennessee, EnSafe, April 30, 2007.

Updated Data from TriAD's Daily Air Monitoring Around Solvent Seeps into Liberty Creek, TriAD, May 4, 2007

Report on Air Monitoring Near Liberty Creek in Franklin, Tennessee, EnSafe, August 24, 2007.

Updated Table of TriAD Air Monitoring Results for Liberty Creek, email from Dwight Hinch of TriAD to Ashley Holt of TDEC, October 23, 2007.

Report on Supplemental Air Monitoring Near Liberty Creek in Franklin, Tennesee, EnSafe, December 19, 2007

Interim Report on Air Monitoring Near Liberty Creek in Franklin, Tennessee, EnSafe, June 23, 2008.

In the April 2007 monitoring event, air samples were collected and analyzed from the crawl space of 116 Daniels Drive, the basement of 127 Daniels Drive, and the basement of 131 Daniels Drive. The results indicated no vapor intrusion hazard from toluene, acetone, or isopropyl alcohol.

In a July and August 2007 monitoring event, time-integrated monitoring was performed at four locations surrounding Liberty Creek. During the August portion of this event, during which the interceptor trench was being excavated, toluene was detected at concentrations exceeding chronic and, at one sampling location, acute exposure concentrations. Because these results were thought to be skewed by the excavation work near the sampling points, the sampling event was repeated in December 2007, during which no measurable concentrations of acetone or toluene were detected.

Another time-integrated air study was performed, after delays caused by property access issues, over the period April 21 to May 19, 2008, at locations surrounding Liberty Creek and one location near the residence at 131 Daniels Drive. This study found no detectable concentrations of benzene, and concentrations of acetone and toluene were below chronic exposure concentrations at all but one point – the location southwest of the main seep – where the concentration over the four-week monitoring period averaged close to the chronic exposure level.

Time-integrated air monitoring is planned to continue at the locations surrounding Liberty Creek and near 131 Daniels Drive at regular intervals over the next year. A monitoring event is under way as of the date of this report.

Additional details regarding air monitoring results and their implications for human health are provided in Section 6.1 of this report.

4.0 DATA GAPS AND PENDING INVESTIGATIONS

As noted in Section 1.0, there are important data gaps as well as pending investigations that have been planned but are yet to be performed. The major known data gaps and pending investigations are described in this section.

4.1 Status of Free-Product Solvent Flow Toward Liberty Creek

As described in Section 3.1, the interception and capture of the free-product solvent flowing with groundwater along the east-west cutter from the soil source area at the southern end of the former Tank Farm at the ELMCO facility to the seeps into Liberty Creek was a major focus of response actions throughout 2007. In the wet winter months of early 2008, however, the flow of free-product into Liberty Creek and the Interceptor Trench dwindled to nothing, and could not be stimulated by the limited (twice per week) pumping of the Middle Trench Section allowed by ELMCO's access agreement with the property owners. It was not clear whether the free-product solvent flow stopped because the free-product solvent remaining in the hydrogeologic system was insufficient to create such flow, or because wet weather conditions had created a temporary hydraulic barrier that could not be overcome by the limited pumping. It had become clear, however, that the determination as to whether substantive free-product solvent remained in the hydrogeologic “pipeline” between the source area and seeps was a critical factor in planning groundwater corrective actions.

With the onset of the warmer and drier weather in late spring and still no appearance of free-product solvent at the Trench or Liberty Creek seeps, ELMCO began to develop a plan to try to stimulate such flow. On behalf of ELMCO and through its attorneys Stites & Harbison PLLC, TriAD developed a letter “Plan for Additional Non-Routine Work at the Liberty Creek Interceptor Trench and Soil Pile Area”, dated May 20, 2008, which was submitted to both TDEC and the property owners (through their attorney). This plan described, among other things, a plan to try to stimulate free-product solvent flow by “cleaning out” (by excavation) the bottom of the Trench’s Middle Section and then aggressively pumping the water from it into the Trench’s Northern Section. In a June 12, 2008, letter from the property owners’ attorney to ELMCO’s attorney, property access to implement this plan was denied to ELMCO. ELMCO still considers this effort to be critical to the determination as to whether or not substantial free-product solvent might still be present in the hydrogeologic system, and intends to work with TDEC and the property owners to get it implemented.

4.2 Additional Assessment of the Lateral Extent of Groundwater Impacts

In response to ELMCO’s *Report of Additional Solvent Release Investigations*, prepared by TriAD and dated March 25, 2008, TDEC personnel have verbally advised ELMCO representatives that two additional groundwater monitoring wells are needed to adequately define the lateral extent of groundwater contamination. One well would be located east of the solvent release source area in the northeast corner of the ELMCO property on Fort Granger Drive, while the other would be located north and across Liberty Creek from well MW-5 on Daniels Drive. TDEC personnel suggested a specific property for the new northern well, and TriAD personnel have on behalf of ELMCO contacted a representative of the property owner seeking permission to install and periodically sample a monitoring well. Despite repeated contacts, no approval or disapproval of ELMCO's request has as yet been rendered by the property owner. TDEC personnel have also contacted the property owner representative urging that the permission be granted, and a response is expected soon. Once successful access arrangements have been completed with this or another property owner in the area, TriAD will on behalf of ELMCO install, develop, and initiate monitoring of both of these planned new wells.

4.3 Liberty Creek Floodplain Soils

Field monitoring of organic vapors during the August 2007 excavation of the Interceptor Trench in the Liberty Creek floodplain east of Liberty Creek, as well as the results from TriAD's June 2007 collection and analysis of soil samples from the soil pile created by the TDEC contractor's efforts in February 2007, have shown that the overburden soils in a portion of the floodplain have apparently been impacted by ELMCO's solvent release. This includes much if not most of the soils removed during excavation of the Interceptor Trench, which were placed for storage and treatment in a shallow "Biopile" located south of the Trench between the Trench and the Harpeth River. It is believed that the soil contamination – which was observed to extend well above the bedrock, has resulted from "smearing" as free-product solvent and contaminated groundwater rose and fell with water levels in the floodplain soils. The nature and extent of this contamination in both excavated and unexcavated floodplain soils has as yet not been defined.

In the May 20, 2008, letter "Plan for Additional Non-Routine Work at the Liberty Creek Interceptor Trench and Soil Pile Area", TriAD proposed a plan for screening and testing the soils in the existing Biopile, and for reconfiguring the soils into a vegetated stockpile for relatively clean soils and a second Biopile for those soils (if any) where additional treatment by that method might be effective. Property access to implement this portion of that plan was also denied in the June 12, 2008, letter from the property owners' attorney to ELMCO's attorney. TDEC personnel also disapproved this portion of the plan in a June 16, 2008 e-mail to TriAD personnel; however, it is believed that the technical regulatory concerns that TDEC personnel had with the Plan have been resolved. ELMCO intends to somewhat modify the plan and further work with TDEC and the property owners to gain the necessary approvals to implement it to provide the needed interim characterization of contaminant levels in these treated soils.

No plans have as yet been made to assess the nature and extent of solvent contamination in the unexcavated soils of the Liberty Creek floodplain, and it seems fruitless to do so while active remediation efforts (the trench and soil pile) continue in the area and until it has been determined that further free-product solvent flow is unlikely. However, ELMCO acknowledges the need to do so at an appropriate time in the future, and commits to working with TDEC and the property owners to develop and implement an acceptable plan for such soil characterization.

5.0 SITE CONCEPTUAL MODEL

The solvent release occurred as a leak from corroded underground pipe elbows on the south side of the ELMCO tank farm. The solvents migrated downward through the silty, sandy clay of the unsaturated zone, spreading out slightly to form a column, or subsurface "mound" of VOC-impacted soil roughly 75 feet long, 45 feet wide, and 20 to 30 feet deep. Upon encountering the bedrock surface, the solvents followed along the irregular surface, resulting in a larger top-of-rock contaminant footprint, but one still confined to the area immediately south and west of the former tank farm. The majority of the solvent migrated west-northwest along a bedrock cutter that measures roughly 35 feet deep at the Site's western boundary and contains significant weathered bedrock and perched groundwater. Migration rates along the path vary dramatically from point to point, as demonstrated by hydraulic conductivity testing described in Section 2.3 of this report.

As the solvent encountered groundwater, the differing physical properties of the principal contaminants, toluene and acetone, determined their migration characteristics. Toluene, unable to dissolve in water to any significant degree, was largely limited to migration along the phreatic surface of the groundwater, within the cutter and related fractures in a narrow band toward the west-northwest, with some migration outward in to bedding plane fractures along the cutter, as observed at MW-3. It flowed to the surface in the seeps at Liberty Creek, where free-product toluene formed the principal component of the contaminant plume until early 2008. Acetone, being infinitely miscible in water, formed a larger, dissolved-phase plume that migrated with the water along bedding planes and fractures throughout the saturated thickness of the aquifer. This dissolved phase, consisting primarily of acetone with some toluene and other ancillary VOCs, has been encountered at MW-2, the seeps along the Harpeth, and as a component of the plume emerging along Liberty Creek. No free-product solvent has been identified in the Harpeth River seeps or well MW-2. Data from MW-1 and MW-5, at the edge of the dissolved-phase plume, show no detectable concentrations of acetone but have shown other solvent-related VOCs, including toluene and benzene, at different ratios than observed in the main body of the plume closer to the source. These different ratios near the edge of the plume are expected due to the effects of dilution, biological degradation, and differing solubilities of the various constituents.

The exact migration pathways of the free-product and dissolved-phase components of the plume cannot be established with certainty. Such certainty would require large-scale, disruptive investigations along the presumed pathway, including within the residential area along Daniels Drive. However, from the location of points where it has been observed, it may be concluded that the free-product component occurred as a series of pockets and stringers of solvent within a narrow band of weathered, fractured bedrock aligned roughly east-west between the former pipe elbows and the seeps at Liberty Creek, approximately as shown in Figure 8. The current status of the free product – its size or even whether it exists – cannot be determined from existing data. No free product has been observed in the trench or at the main seep for several months, nor has free product been observed at MW-3 since a small quantity was removed in March 2008. An effort to pump water from the trench in such a way as to allow evaluation of whether free product exists near the western end of the plume has been proposed, as described in Section 4 of this report.

The dissolved-phase component of the plume exists within a broad area, from MW-1 to the east, Liberty Creek to the west, the Harpeth River to the south, and MW-5 to the north. The exact limits of the dissolved-phase plume, as defined by drinking-water standards, have not been completely defined to the east or to the north. Additional groundwater investigation is proposed as described in Section 4 of this report.

From data gathered during the Geoprobe and air-rotary drilling investigations, it is apparent that both the free-product and dissolved-phase components of the plume exist at depths exceeding 35 feet just west of the on-Site contaminated soil column. This elevation is, at the highest, approximately 627 feet above MSL. From the measured elevations of the creek and river seeps, it is therefore also apparent that no significant free product exists above this elevation between the Site and Liberty Creek. Given that the elevations of residences along Daniels Drive that are in the path of the free-product component of the plume are approximately 645 to 650 feet above MSL and thus are protected by a thick layer of clay soil overburden, it is unlikely that these residences have been or will be directly affected by the groundwater contamination. Air monitoring in homes along Daniels Drive and in the neighborhood has demonstrated that vapor phase transport from the contaminated water is not affecting the residents of this area (see Section 6 of this report).

As noted in earlier sections of this CAP, there are underground private and municipal sewer lines in the area. The elevation of the private sewer line along the east side of the railroad spur track is well above the 627-foot maximum elevation of the contaminated groundwater and cannot therefore be acting as a migration pathway. The same may be said for the municipal sewer line along Daniels Drive. It is likely, however, that the municipal sewer lines along Liberty Creek and the Harpeth River are acting as migration pathways, if only secondarily through flooding during wet seasons. The elevation of the Main Seep at Liberty Creek was measured at approximately 611 feet above MSL. The elevation of the sewer invert 40 feet east is approximately 613 feet above MSL. It is therefore possible that contaminated groundwater could enter the backfill around the sewer line during high-water events and migrate downgradient through the backfill (i.e., toward the Harpeth River). Indeed, contaminants have been detected in water samples collected at HR-1, a seep that is apparently related to the backup of water along the sewer line that crosses under the Harpeth River at that location. A similar situation could exist in the municipal sewer line along the Harpeth River between Liberty Creek and the railroad bridge, although the invert elevations of this sewer line are unknown. In either case the contaminated water would migrate along the sewer line backfill downgradient into areas already affected by the dissolved-phase component of the plume and do not introduce additional migration risks.

Microbiological and chemical sampling and analysis performed on surface water and groundwater samples in February 2008 indicated a variety of microbiological strains and chemical conditions that are favorable to the degradation of acetone and toluene, as well as the ancillary VOCs. As documented in the Report of Additional Solvent Release Investigations (March 25, 2008) Microbe Inotech laboratories (MiL) identified a total of 19 strains (some of which were variants of single strains), many of which were rated as good or excellent degraders. A later edition of the MiL report (June 16, 2008, attached as Appendix 3), stated that in the absence of free product the dissolved toluene contaminant plume in groundwater (ranging in concentration from 525 mg/L to less than detect and consisting of 842.6 kg total mass) would be degraded to less than 10 mg/kg in 8.4 months. A later email amendment to the report stated that the drinking water standard of 1 mg/L toluene would be achieved in 9.8 months. These estimates are based on the number and type of microbial degraders, the total mass of contaminants (including acetone) present across the plume, the nutrient levels measured in February 2008, and the removal of the free product from the system. As noted above, the present amount of free product in the system is unknown. MiL stated that augmentation of the system with nutrients was unnecessary to achieve remediation in the time frames cited.

6.0 RISK ASSESSMENT FINDINGS

Mr. Mark Bowers of Secaps Environmental, Inc., was retained to perform a screening level risk assessment for both human and ecological receptors in the vicinity of the ELMCO facility and the affected portions of the Harpeth River and Liberty Creek. The purpose of the risk assessment was to aid in directing remedial action to those areas and conditions that pose significant risk to human health or the environment, and was performed in accordance with U.S. EPA guidance. The risk assessment report is included in Appendix 2.

6.1 Human Health

Both residential and recreational receptor scenarios were assessed to determine what level of risk would result to the public if no further action were to be taken with regard to contamination at the site. (Note: The risk assessment evaluated conditions as they existed at the site on June 1, 2008.) Conservative assumptions of reasonable maximum exposure were used to ensure that the findings would be reflective of the worst-case conditions. The conclusion of the human health risk assessment was that site conditions as they currently exist pose no significant risk to local populations and that no action is required to protect human health.

6.2 Ecological

Exposure to ecological receptors in both the Harpeth River and Liberty Creek was assessed to determine what level of risk would result to the environment if no further action were to be taken with regard to contamination at the site. (Note: The risk assessment evaluated conditions as they existed at the site on June 1, 2008.)

The assessment for the Harpeth River confirmed previous TDEC findings that the contamination entering the river poses no significant risk to aquatic organisms. Low dissolved oxygen effects on the benthic organisms in isolated areas immediately adjacent to the seeps are not expected to have a quantifiable effect on the overall river ecosystem.

The assessment for Liberty Creek found that fish and benthic organisms in the lower 600-foot reach of the creek are potentially at risk due to the presence of VOCs in surface water. Chronic toxicity impacts may exist, and episodic low dissolved oxygen periods are reportedly possible where contaminants induce eutrophic conditions that could affect resident organisms. Some 90% of this toxicity is due to toluene.

7.0 ASSESSMENT OF CORRECTIVE ACTION NEEDS

In this section, each area of contaminated media is evaluated to determine what if any corrective actions need to be taken to lower contaminant concentrations and reduce risks.

7.1 Source Area Soils

The confirmation subsurface soil investigations performed in May 2008 in the BIOX-treated source area and under the former Tank Farm (see Section 3.2) have demonstrated that substantial soil contamination still exists in the source area, extending under the southern edge of the tank farm pad, and that these soils appear to be capable of continuing to release solvent constituents to the underlying groundwater. The contamination is at depth and would not appear to pose a significant risk to normal industrial or construction workers. However, the risk to the groundwater itself, and potentially to ecological receptors in Liberty Creek via the groundwater pathway, is sufficient to warrant corrective actions targeted to reducing the amount of volatile organic contaminants that are available to migrate into the groundwater pathway.

7.2 Surface Water in Lower Liberty Creek

As described in Section 6.2 and Appendix 2, the presence of volatile solvent constituents in surface water in the lower reaches of Liberty Creek (at least at and downstream of the point – the "watergate" – where the east-west cross-fence installed by ELMCO crosses the stream) pose a potential risk to fish and benthic organisms because of their potential chronic toxicity and because of their potential to induce eutrophic conditions that could result in episodic low dissolved oxygen periods. Such episodes are more likely to occur at low flow conditions. The risk is sufficient to warrant consideration of corrective actions that either reduce the groundwater discharge of solvent constituents to the stream or increase dissolved oxygen concentrations at low flow conditions.

7.3 Groundwater

Because it is not used and resides relatively deeply in the bedrock except at the lower elevations where it discharges into Liberty Creek and the Harpeth River, the groundwater that has been contaminated by ELMCO's solvent release does not pose a risk to human health. Layers of clay soil and generally tight limestone bedrock provide effective barriers against the potential upward migration of organic vapors. The contaminated shallow aquifer typically has very low yield and is thus not suitable for domestic water supply use. Further, municipal water is readily available in the potentially impacted area. Therefore, there seems little likelihood that anyone in the near future would pursue development of a water well in the potentially impacted area. However, ELMCO is working with City of Franklin officials to restrict development of water production wells in the area. Should groundwater usage change in the future, the risks would have to be re-evaluated using then-current groundwater concentrations of the quite degradable solvent constituents of concern.

The contaminated groundwater that discharges into Liberty Creek, however, does cause the concentrations of volatile solvent constituents that create the risk to fish and benthic organisms described in Section 7.2 above. As described in that section, corrective actions that would reduce the groundwater discharge of solvent constituents to the stream should be considered, especially through the “cutter” flow path that has been identified as apparently the primary discharge pathway. This would certainly include the already planned efforts to induce the flow of any remaining free-product solvent in the hydrogeologic system into the Interceptor Trench where it can be captured and removed, as well as any efforts to remediate the source area soils as described in Section 7.1 above.

7.4 Harpeth River

As described in Section 6.2 and Appendix 2, the discharges of solvent constituents into the Harpeth River via the seeps of contaminated groundwater or Liberty Creek itself are not sufficient to pose a significant risk to human health or fish and aquatic life. No corrective actions are therefore needed to protect the river. However, the discharges into the Harpeth River will ultimately be reduced by any corrective actions taken to address source area soils (see Section 7.1 above) and the unacceptable concentrations of solvent constituents in surface water in the lower reaches of Liberty Creek.

7.5 Liberty Creek Floodplain Soils

As described in Section 4.3 and in Appendix 2, there does not yet exist any data on solvent constituent concentrations in the excavated and unexcavated Liberty Creek floodplain soils, and thus the risks posed by such concentrations and the need for corrective actions cannot as yet be assessed. Once the active remediation efforts at the trench and soil pile have been completed, it is expected that soil sampling and analysis efforts will be performed to gather the necessary data, and that ELMCO will work with TDEC and the property owners to determine appropriate soil cleanup level(s) based on the risks associated with the planned and allowable uses of the property. Any necessary corrective actions would then be designed and implemented.

8.0 CORRECTIVE MEASURES STUDY FOR SOURCE AREA SOILS

As described in Section 7.1 above, corrective measures for source area soils are needed in order to reduce the potential for solvent constituents to migrate from the soils into the underlying groundwater. In this section, some potential corrective measures are evaluated and a recommended course of action is presented.

8.1 Evaluation of Potential Corrective Measures

Because of the high potential for significant migration of solvent constituents into the underlying groundwater and the limited mechanisms available for natural degradation of soil contamination at such depths, natural attenuation is not a feasible alternative. In addition, the very limited success demonstrated by the 2007 BIOX treatment efforts demonstrates that it is very difficult to distribute in the subsurface the reagents needed to enhance natural attenuation mechanisms.

BioManagement Services, Inc. ("BMS"), the vendor of the BIOX technology, has offered to re-treat a portion of the source area for free, but would not be able to do so for several weeks. They have also acknowledged that acetone contamination can be hard to treat by chemical oxidation processes. ELMCO continues to evaluate this offer, but has decided to focus primarily on other alternatives. The offer for free re-treatment does not seem to extend to the full area where it appears that corrective action is needed, and the lack of success of the initial treatment seems to argue against further attempts. In fact, that lack of success seems to argue against any technology which involves pressure injection of reagents into the clay soil subsurface.

One generally sure way of removing a soil source area is via excavation followed by either on-site treatment of the removed soils or off-site shipment of the soils to a suitable commercial facility for treatment and/or disposal. In this case, however, the excavation option is fraught with difficulties. Although the soil source area is fairly well defined by the investigations that have been performed, its shape will require the removal and handling of an even larger amount of "clean" soil to get at the large amount of “dirty” soil that needs to be remediated. It is also not clear to what soil concentrations of the solvent constituents of concern that soil would have to be removed. The SPLP data from the May 2008 soil investigations indicate that the solvent constituents are surprisingly mobile in water, although the SPLP method would be expected to be much more aggressive at such mobilization than would be expected to occur in the in-place environment. TriAD has roughly estimated that there are 1,000 cubic yards of “dirty” soil that need to be removed for treatment or off-site disposal, and that getting at this soil will require “benching” and the removal and handling of 2,000 cubic yards of “clean” soil and the replacement of most if not all of the removed “dirty” soil with imported “clean” soil.. Such excavation would almost certainly require that the equipment operators and other personnel be supplied with at least Level C breathing protection and probably Level B supplied air for improved work efficiency. TriAD and OCS have estimated the costs of simply excavating and handling this amount of soil to be in excess of $70,000. That total does not include implementation of methods to effectively control VOC emissions from the open excavation – assuming such effective methods exist. The contaminated soils contain high concentrations of highly volatile organic solvent constituents, and organic vapor emissions would be difficult and costly to control. There is always also the potential for a rain event during the excavation effort that might cause a huge release of the contaminants into the underlying groundwater.

When the contaminated soils are removed, then something will have to be done with them. Such soils will be a listed hazardous waste that would have to be extensively treated before they could be placed back into the on-site excavation, and the manpower, equipment, and materials to perform that treatment on-site at the ELMCO facility would likely be quite expensive. Unless the excavation and soil treatment are performed gradually in smaller, more manageable quantities (which would likely increase the time and costs), simply finding adequate space at the ELMCO facility for the excavation and treatment activities might also be a limiting factor. There would also be the continuing problem of controlling organic vapor emissions.

TriAD has contacted Waste Management for potential prices for off-site treatment and disposal of the excavated “dirty” soils. WM personnel suggest that incineration of the soils may be necessary in order to achieve the RCRA LDR treatment standards necessary for the soils to be ultimately disposed by landfill. Costs for transportation and commercial incineration of the excavated soils would be expected to easily exceed $1,000,000.

One option that has been briefly explored is *in situ* soil mixing by which specialized heavy equipment would be mobilized to the site to provide for the physical mixing of the “dirty” soils in place with a suitable reagent material. While this option would seemingly provide for much more effective control of organic vapor emissions, the costs of mobilizing the heavy equipment needed (likely $50,000 or more), and its limited availability, would argue against such an option. TriAD was unable to obtain a serious proposal from such vendors.

Another corrective measures option for the source area soils is *in situ* multi-phase vacuum extraction, potentially enhanced with chemical oxidant injection. Under this option, a number of wells would be installed and screened only within the contaminated subsurface zones, and then a strong vacuum would be applied to the wells in a designed pattern to remove liquids and vapors. This option effectively utilizes the high volatility of the solvent constituents of concern, and by its very nature provides for effective control of organic vapor emissions. While TriAD personnel have some concerns about the permeability of the tight clay subsurface soils to even air or vapor movement, the vendor personnel contacted from EcoVac Services seemed confident in its potential effectiveness in even this environment. Considering that there is some heterogeneity in the subsurface stratigraphy, and that water/solvent movement is likely to be along the same pathways available to vapor movement, this technology seems particularly capable of relatively rapidly removing from the subsurface soils the contamination that is most likely to migrate into the underlying groundwater. This technology is proven and reliable, and the vendor has been successfully implementing it for several years. Costs for this *in situ* option also appear to be much more reasonable.

8.2 Proposed Remedy

ELMCO intends to promptly pursue a pilot test of the EcoVac Services Enhanced Fluid Recovery (EFR®) process in the soil source area. A copy of the proposal from EcoVac Services is included as Appendix 3. A minimum of 4 wells will be installed by TriAD within the soil overburden and screened across the appropriate depths, and then EcoVac Systems will perform the pilot testing described in Appendix 3. The pilot testing results will then be evaluated by EcoVac Services, TriAD, and ELMCO for potential additional application of EcoVac technologies as described.

9.0 CORRECTIVE MEASURES FOR LIBERTY CREEK

As described in Section 7.2 above, corrective measures are needed to address the unacceptably high concentrations of solvent constituents – principally toluene – in the lower reaches of Liberty Creek. In this section, some potential corrective measures are identified and evaluated, and a course of action is recommended. It must also be remembered that any action that reduces contaminant concentrations in groundwater, including the recommended remedy for the source area soils described above, will also act to reduce solvent concentrations in Liberty Creek.

One obvious and necessary component of corrective measures for Liberty Creek is the capture and removal of free-product solvent discharges. To that end, implementation of the trench cleaning and aggressive pumping described in TriAD's May 20, 2008, letter "Plan for Additional Non-Routine Work at the Liberty Creek Interceptor Trench and Soil Pile Area", which is designed to induce free-product flow into the trench where it can be captured and removed, is vital to determining if a free-product discharge hazard to Liberty Creek still exists. If a free-product solvent discharge can be induced by the planned efforts, then some form of continued trench operations will be necessary.

These operations have proven successful in the past, and no other more-effective means of managing the migrating free-product solvent has been identified.

If the planned trench efforts are not successful at inducing free-product flow into the trench, then it can probably be concluded that insufficient free-product solvent exists in the cutter "flow-path" to pose a significant threat of discharge into Liberty Creek. In such case, ELMCO proposes to create a permeable reactive barrier across the cutter flow path by backfilling the bottom portion of the trench with a mixture of sand and reagent material such as the "BOS 2000" material described in Appendix 4. This material would provide a long-term, passive means of treating the contaminated groundwater – including the chance globules of free-product solvent – that migrate toward the creek through this cutter flow path.

In addition to these efforts at removing contamination from the groundwater that flows into Liberty Creek, ELMCO intends to explore with TDEC, the property owners, City officials, and other stakeholders the potential for reforming the channel of lower Liberty Creek to provide for increased aeration at low-flow conditions. Aeration would readily strip the toluene – which causes 90% of the aquatic toxicity – from the creek water, and would add oxygen. ELMCO acknowledges that such an effort would require various approvals and permits from TDEC, the property owners, and other agencies. However, if TDEC and the property owners consider such a feasible remedial measure, ELMCO intends to promptly pursue a topographic survey of the Liberty Creek stream channel from the Harpeth River to the watergate at the cross-fence so as to provide the necessary data for design of the channel improvements.

10.0 CONTINGENCY PROVISIONS

Implementation of each of the proposed corrective measures described in Sections 8.0 and 9.0 above will involve periodic inspections and monitoring to determine their effectiveness. Should they prove ineffective over time, then the changed conditions will be re-evaluated through a similar process of risk assessment and identification and evaluation of potential corrective measures. New corrective measures will then be attempted as deemed appropriate.

12.0 CONTINUED MONITORING

As part of ongoing corrective action, both groundwater and seep locations will be monitored as described in the following sections. All samples collected will be analyzed for the standard list of VOCs by U.S. EPA SW846 Method 8260B by a qualified commercial laboratory. All samples will be collected into individually labeled, laboratory-supplied containers, preserved as required, and transported to the laboratory under chain-of-custody procedures. Trip blanks will be included in each cooler containing samples to be analyzed for VOCs.

12.1 Groundwater

All groundwater monitoring wells will be monitored on a quarterly basis until approval is granted by TDEC to reduce either the number of wells sampled or the sampling frequency. Reports will be submitted quarterly, within 30 days of receipt of laboratory reports. Sampling will be performed using low-flow purge techniques, with purging via a bladder pump discharging through a flow-through cell until readings of pH, conductivity, and, if possible, temperature are stable (10 percent for conductivity and temperature and 0.1 standard pH units for pH). Temperature readings may not be stable within 10 percent due to heating or cooling effects of the purged water in the flow-through cell; the low yield of some of the wells increases residence times in the tubing and flow-through cell. The bladder in the pump will be a new, disposable bladder that will not be reused. The tubing will be dedicated to the well. The pump will be disassembled and decontaminated between sampling locations. Samples will be collected by directing the pump discharge directly to the laboratory-supplied containers.

12.2 Seeps and Surface Water

Seeps and surface water will continue to be sampled monthly in accordance with the TDEC-approved *Revised Plan for Collection and Analysis of Water Samples Related to*

Selected Seeps in to Liberty Creek and the Harpeth River, dated May 25, 2007. Reports will be submitted monthly, within 30 days of receipt of the laboratory report. Sampling locations and frequency will be adjusted as approved by TDEC.