INTERIM RESPONSE WORK PLAN

WESTERN SYSTEM

January 25, 2006

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January 24, 2006

Introduction

Pall Life Sciences (PLS) is providing this Interim Response Work Plan (Plan) at the request of the Michigan Department of Environmental Quality (MDEQ). The Western System is one area of groundwater contamination identified in the Consent Judgment between Gelman Sciences, Inc. (CA No.88-34734-CE) and the MDEQ. Other areas of contamination, including soils and groundwater, have been or are being remediated pursuant to different work plans and programs adopted under the Consent Judgment and subsequent orders from the Washtenaw County Circuit Court.

Location

The Western System is identified in the Consent Judgment as the area of groundwater contamination (i.e., exceeding 85 microgram per liter [µg/L]) northwest, west, or southwest of the Core Area. The Western System area relative to the PLS facility on Wagner Road is shown on Figure 1. Figure 2 depicts further geographic details of the Western System area with well locations.

Overview of Past and Current Uses of Properties

The properties included in the Western System have either been vacant, undeveloped parcels or have light development, including commercial and residential uses. To the extent 1,4-dioxane contamination is present in the Western System, it has migrated to that area, and there are no known sources of soil or groundwater contamination within the Western System itself. Current uses can be determined from Figures 1 and 2.

The known Chemical of Potential Concern (COPC) associated with the Western System is 1,4-dioxane. 1,4-Dioxane is present in both the groundwater and portions of the Honey Creek Tributary, where groundwater vents to the surface water. No other environmental media (soil or air) are affected by the Western System.

The purpose of this Work Plan is to summarize the results of groundwater investigation activities to date, evaluate the human health and environmental risks from releases at the site, and present an interim response activities plan to remediate the groundwater.

History of the Investigations

Investigations of the Western System began in 1986. Significant investigations/events in the Western System area have included:

The installation of 18 monitoring wells and three test borings.

- The collection of hundreds of water samples and water-level measurements from monitoring wells and domestic wells.
- Aquifer performance testing.
- Surface water quality sampling.
- Profiling of surface water sediments.
- Groundwater transport modeling.
- The installation of a groundwater extraction well (Ann Arbor Cleaning Supply Well) and associated groundwater extraction (batch purging) of over 1,000,000 gallons of contaminated groundwater.
- The preparation of a Remedial Action Plan.
- The preparation of numerous work plans and technical reports.

The MDEQ Jackson District Remediation and Redevelopment Division maintains a list of mailings to Information Repositories. The list of mailings related to the Western System from October 1992 to October 2004 is provided as Appendix 1.

Site Description

Zoning and land use in the Western System consists of limited industrial, residential, and moderate density multiple-family residential. Since 1986, when investigations began in the Western System area, there has been a general transition of property from open space/agricultural to its current usage. A plat map showing the Western System property boundaries and zoning classification is provided as Figure 3.

The only property known to have 1,4-dioxane at concentrations above the Part 201 Generic Residential Drinking Water Criterion (GRDWC) of 85 µg/L is Parcel No. 81-08-26-225-013 of Scio Township. Other properties interpreted to be within the Western System plume area are shown on Figure 3.

Hydrogeological Characterization

The geology of the Western System has been described as having approximately 200 to 220 feet of glacial drift on top of the bedrock surface, the Mississippian Coldwater Formation (a regionally extensive shale deposit). Cross Section A-A' (Figure 4) characterizes the stratigraphy of the area drift. Cross section well locations are depicted on the cross section location map included as a Figure 4 inset. The unconsolidated units within the drift sequence are composed of sand and gravels, plus interbedded clay-rich units. The sands and gravel units are interpreted to be associated with outwash deposits, while the clay-rich diamicton units are typically associated with till deposits.

The Upper Regional Aquifer (URA), also referred to as the D_0 Aquifer in the Western System, is illustrated on Cross Section A-A'. Review of the cross section indicates that groundwater in the Western System area is present under both confined and unconfined conditions.

Data from the recently drilled MW-93 and BHMW-92 indicate that the base of the aquifer in the Western System area appears to be lowest in the area of BHMW-92. The aquifer thickness in this area is approximately 110 feet. The unit thickness thins southeastward, toward MW-51 (aquifer thickness of 25 feet), and northward, toward MW-31 (aquifer thickness of 75 feet). An Isopach Map of the URA in the Western System area is provided as Figure 5. Elevation contours of the base of the URA in this area are provided in Figure 6.

Cross Section A-A' also depicts the vertical distribution of 1,4-dioxane in the Western System plume. In the area where 1,4-dioxane concentrations are above 85 µg/L, the aquifer is unconfined.

Groundwater in the Western System interacts with the Honey Creek Tributary. Previous investigations have interpreted the Honey Creek Tributary to generally be a "gaining stream." In a localized area around Little Lake, the tributary has the potential to be under losing conditions.

The groundwater flow direction in the Western System, presented herein, is based on static water levels measured at monitoring wells completed in the URA aquifer on September 13, 2005. The resulting potentiometric surface map of the Unit D0 aquifer is provided as Figure 7. The direction of groundwater flow in the Western System area is generally northward, toward Honey Creek. East and northeast from the MW-53 nested wells, the groundwater flow direction is generally northeastward. In the area of the Western System plume, the groundwater flow direction is northwest. Water and groundwater elevation data are provided along with available water quality data in Appendix 2.

An aquifer performance test was conducted in the Western Plume area in June 1993 (Alpha Geosciences, Inc., 1993). The purpose of the test was to evaluate the transmissivity/storativity of the URA in a centralized portion of the Western Plume area. Test well PTW was located north of Park Road, near MW-31. This 4-inch-diameter test well was pumped at a constant rate of 60 gallons per minute for a period of 19.5 hours. Water levels were monitored in the test well and nearby observation wells during the pump test and also during the 19-hour recovery period.

Based on the aquifer test results, the aquifer in this area was determined to be a leaky artesian aquifer with a transmissivity (T) of approximately 5,810 ft^2/day and a storativity (S) of approximately 0.0012. An average hydraulic conductivity (K) of the aquifer material calculated at approximately 75 ft/day. This finding is consistent with hydraulic conductivity values for sandy outwash material (Fetter, 2001).

Using an average K value of 75 feet/day, an assumed effective porosity (n_e) of 0.20, and the specified 0.0017 ft/ft for *dh/dl* (based on historical data), the average linear velocity of groundwater flow calculates as approximately 0.637 ft/day: $[(K)(dh/dl)]/n_e$ = (75 feet/day) (0.0017 ft/ft) / 0.20 = 0.637 ft/day (or 233 feet/year).

Estimated travel times for groundwater from the Ann Arbor Cleaning Supply Well area to selected wells are as follows: 1,500 feet from the Ann Arbor Cleaning Supply Well to MW-31 yields 6.45 years travel time, 675 feet from the Ann Arbor Cleaning Supply Well to MW-61 yields 2.90 years travel time, 300 feet from the Ann Arbor Cleaning Supply Well to MW-93 yields 1.29 years travel time.

Groundwater Quality Characterization

PLS has been collecting water quality data and monitoring 1,4-dioxane concentrations in the Western System area since 1986. Water quality data for the Western System are provided in Appendix 2. Graphs of these data are provided in Appendix 3. Figure 8 shows the 1,4-dioxane is concentration contours for April through May 2005. A summary of water quality data for samples collected from Western System wells, along with a trend analysis of these data, is provided in Table 1. Copies of laboratory reports and field notes are available upon request.

Groundwater quality data indicate that 1,4-dioxane has been detected in the Western System at concentrations as high as 185 µg/L (4401 Park Road, November 9, 1987). Recent data indicate the highest concentrations of 1,4-dioxane in the Western Plume are approximately 120 µg/L (Ann Arbor Cleaning Supply Well, January 2006). Although the highest known concentration of 1,4-dioxanes have not changed over this 18-year period, the distribution of 1,4-dioxane has decreased considerably. Figure 9 shows the plume boundary as defined by the 85 µg/L isoconcentration contour for the years 1988 and 2005. Over the approximate 18-year monitoring period (since 1986), the portion of the plume exceeding the 85 µg/L GRDWC has reduced in size by approximately 97%. At present, the Western Plume covers an area of approximately 100,741 $feet^2$. Using a plume thickness of 20 feet yields a calculated approximate aquifer volume of 2,014,820 $feet^3$ within the plume area. Applying an assumed porosity of 20%, the volume of water in the plume is approximately 3,014,170 gallons (2,014,820 $feet^3$ x 0.20 x 7.48 gallons/$feet^3$). Assuming an average 1,4-dioxane concentration of 150 µg/L in the Western System, the approximate mass of the Western System groundwater plume is less than 5 pounds.

It is possible that the Western System plume extends further downgradient than interpreted. The maximum downgradient extent of the plume lies somewhere between the MW-53i area and the MW-61 well cluster. MW-61s, MW-61d, and MW-93 are located downgradient of the only well with concentrations above 85 µg/L, the Ann Arbor Cleaning Supply extraction Well. MW-61s/d was installed in September 2000. The first sample of groundwater from MW-61 on September

12, 2000, had a 1,4-dioxane concentration of 32 µg/L. The maximum concentration observed occurred on February 20, 2003, at 49 µg/L. Since then, the values have oscillated up and down to the most recent sample concentration of 33 µg/L on October 8, 2004. Since sampling at MW-61s began, 1,4-dioxane concentrations have ranged between 17 and 49 µg/L. 1,4-Dioxane concentrations at MW-61d have ranged from <1 to 7 µg/L (occurring on October 23, 2000). 1,4-Dioxane concentrations have shown a decreasing trend since October 2000 and have remained at <1 µg/L since January 2002.

Site-Specific Conditions

Currently, there are no completed exposure pathways at the site. The only potential exposure pathway is residential drinking water. Actual site conditions impact the severity of risks posed by contamination and the potential that a pathway may be completed. Those conditions important to the evaluation of the potential risks posed by 1,4-dioxane are listed below.

Drinking water in the Western System area is supplied by the Scio Township municipal supply, which purchases its water from the City of Ann Arbor. Many drinking water wells were replaced with the municipal supply after the discovery of the Western System. There are domestic wells located west of the plume in the Park Road, Myrtle, Burton, and Luella Streets areas and north of the plume in the West Delhi Road area. Water quality data collected in these areas for approximately 18 years indicate the plume has not migrated into these regions. Should the plume migrate into these regions, the concentrations of 1,4-dioxane will be at levels below 85 µg/L GRDWC.

The Western System is not in, or proximate to, any MDEQ-designated wellhead protection areas.

The existing Scio Township Water Ordinance, adopted December 17, 1985, amended July 15, 1997, prohibits the installation of water supply wells in the Western System area. The MDEQ has concluded that, as drafted, the restriction does not fully meet the statutory requirements to constitute an approvable institutional control.

Washtenaw County Rules and Regulations for the Protection of Groundwater, adopted February 4, 2004, Res. No. 04-0029, reliably restricts the installation of new water supply wells in the zone of protection (zone). Under those rules and regulations: (1) no one can construct or drill any well (including a drinking water well) without first obtaining a permit from the County Health Office (Section 2:1); (2) no municipality within the county may issue a building permit where a well is necessary or allow construction to commence on any land where an approved public or private water supply is not available until issuance of a permit by the Health Officer (Section 2:4); (3) no permit can be issued by the Health Officer if it is not in compliance with the Rules or if it would create a dangerous or unsafe condition (Section 2:5); (4) it is unlawful for any person to occupy or permit to be occupied any premise in Washtenaw County not equipped with an adequate supply of potable water as determined by the Health Officer (Section 6:1); (5) the rules apply to all noncommunity and private groundwater supplies within Washtenaw County (Section 6:2); (6) water supplies intended for human consumption that are not "potable" must either be abandoned, identified at the outlet as unfit for human consumption, or treated by methods

approved by the MDEQ or County Health Officer so as to make the water potable; (7) newly drilled wells cannot be used for human consumption until approved by the Health Officer and after it has been tested for bacteriological or chemical contaminants (Section 6:6); and (8) no well can be located within at least 100 feet from a source of contamination, or at such increased distance as determined necessary by the Health Officer (Section 6:7). "Potable" water is defined as water that is free of contaminants in concentrations that may cause disease or harmful physiological effects, is safe for human consumption, and meets the state drinking water standards set forth in the Michigan Safe Drinking Water Act.

Under the existing county ordinance, unacceptable exposures would be prohibited within the zone subject to the waiver and, indeed, throughout the rest of the county. Wells could not be installed within the zone because it would be a "new well" that would require a permit, and no permit could be issued because the water would not meet the definition of potable, the isolation requirements could not be met, and the wells could not be used until tested.

The MDEQ has taken the position with respect to the Unit E aquifer (a different area of contamination) that the Washtenaw County Ordinance has some gaps in it that make it noncompliant with statutory requirements. These gaps have been addressed by Order of the Washtenaw County Circuit Court with respect to the Unit E plume.

These site-specific conditions significantly minimize the likelihood of the installation of a well on properties affected by the Western Plume.

Source Control

Part 201, Section 18(8) requires remediation of contaminant source areas, whether or not exposure pathways are< or can be reasonably expected to be, completed. Investigations in the Western System have demonstrated there is no association between 1,4-dioxane in the Western System and other portions of the PLS site (the Core Area/Unit C3, the Evergreen System/Unit D2, and/or the Farm Property Area). PLS has previously speculated that the source of 1,4-dioxane to the Western System plume may have been the loss of contaminated surface water from the Honey Creek Tributary and Little Lake to the groundwater during the time 1,4-dioxane was used in manufacturing at the facility (from 1965 to 1986). Even if the stream and lake do lose water to the groundwater, 1,4-dioxane concentrations in the surface waters of Honey Creek Tributary and Little Lake occur at trace levels. Consequently, any continued interaction between this surface water system and the groundwater in the Western System area cannot result in groundwater contamination at concentrations approaching the GRDWC. Based on these findings, as established in previous investigations, no further investigations are needed to evaluate potential source areas.

Interim Response Activities

In the Western System, groundwater monitoring results have documented that (1) the plume has not expanded, (2) 1,4-dioxane concentrations have continued to generally decrease at most Western System wells, and (3) 1,4-dioxane concentrations have remained below drinking water screening levels in all but the extraction well. PLS attributes this behavior in the Western

System to natural attenuation of the plume and active groundwater remediation (periodic batch purging). Data suggest natural attenuation and batch purging will result in a continued reduction in 1,4-dioxane concentrations, and in combination with other exposure control measures, it will meet the remedial objective of preventing exposure to contaminants above the GRDWC.

PLS is unable to estimate the time required to reach the GRDWC in the Western System with specificity. The best indicator as to when GRDWC will be met are observations made at MW-53i and the Ann Arbor Cleaning Supply Well. A graph of the 1,4-dioxane concentrations, complete through January 2006, for groundwater sampled from MW-53i and the Ann Arbor Cleaning Supply extraction well (Figure 10). Review of the graph suggests the 1,4-dioxane concentrations in groundwater sampled from MW-53i have been generally trending downward at a rate consistent with the transport model predictions made by PLS. A sudden increase in concentrations was observed in the latter part of 2002. Purging initiated in February 2003 changed this trend and was effective in reducing the 1,4-dioxane concentrations in groundwater sampled from MW-531 to below 85 µg/L. 1,4-Dioxane concentrations at MW-53i are currently below 85 µg/L. Concentrations at this well went below this criterion level at the April 4, 2003, sampling.

Data from the Ann Arbor Cleaning Supply extraction well suggest a downward trend in 1,4-dioxane concentrations since March 2004. The oscillatory change in concentrations may be related to seasonal recharge and groundwater withdrawal rates/sampling times. PLS will continue to monitor this well and, based on the historic results at MW-53i and the absence of an upgradient source of 1,4-dioxane, a continued general decline in 1,4-dioxane trends is expected.

Monitored Natural Attenuation

Natural attenuation is generally defined as the reduction in mass, concentration, and/or mobility of a compound in groundwater over time and/or distance from the source of contamination due to naturally-occurring physical, chemical, and/or biological processes. Over the approximate 18-year monitoring period (since 1986), the portion of the Western System plume exceeding the 85 µg/L drinking water criteria has reduced in size by approximately 97% (see Figure 8). The significant reduction in area and mass of the Western System plume is consistent with a discontinuous source and a 1,4-dioxane plume subject to natural attenuation (the reduction of mass/concentrations due to naturally-occurring physical, chemical, and biological processes). The dispersion of the plume mass along its migration pathway is the primary process reducing 1,4-dioxane concentrations. However, based on the literature, other processes such as adsorption and biodegradation are also occurring.

Groundwater Extraction (Batch Purging)

Groundwater investigations by PLS indicate the Western System is a localized area with limited horizontal and vertical extent and mass. Such small plumes can be addressed by strategic remedial methods targeted at the plume centers. As a contingency plan to address MDEQ concerns relating to a PLS April 2002 report and groundwater model for the Western System, PLS installed and began periodic purging from the Ann Arbor Cleaning Supply Well. This well was installed next to MW-53i, the only Western System well at the time known to have 1,4-

dioxane concentrations in excess of 85 µg/L. PLS began batch purging from the well in February 2003 and, to date, has purged approximately 1,223,600 gallons of water from the Western System.

The impact of the batch purging is evident by a review of water quality data from MW-53i. The historic monitoring data during this period show that the concentration of 1,4-dioxane in MW-53i had slowly decreased to the 110 µg/L range until fall 2002, when concentrations increased to the 150 µg/L range. PLS then implemented its contingency plan of batch purging from the extraction well in February 2003. Concentrations in MW-53i have been in general decline since that time to 57 µg/L in May 2005.

1,4-Dioxane concentrations in the Ann Arbor Cleaning Supply Well increased nominally from 139 µg/L in May 2003 to 182 µg/L in March 2004. Since that time, there has been a general decrease in 1,4-dioxane concentrations at this location.

PLS proposes to continue periodic batch purging until Generic Residential Cleanup Criteria are met within the Western System, as determined by the monitoring points proposed in the Monitoring Plan. PLS proposes to batch purge on a quarterly frequency. This frequency may be adjusted based on the water quality response observed. For each event, a minimum of 20,000 gallons of water will be batch purged, unless site conditions prevent or interfere with trucking. PLS will continue to monitor water quality at MW-53i and the Ann Arbor Cleaning Supply Well on a monthly frequency.

Proposed Groundwater Monitoring Plan

Performance monitoring will continue on a quarterly schedule. The objectives of the groundwater monitoring are:

- Verify that contaminant concentrations in groundwater do not pose a human health risk to downgradient properties.

- Establish that the plume is stable or diminishing.

Groundwater samples will be analyzed for 1,4-dioxane. The wells to be monitored, and proposed sampling frequencies are listed in Table 3 and shown on Figure 11. Groundwater will be sampled from the wells using a low-flow/minimal drawdown method and/or other techniques approved by the MDEQ and consistent with other PLS groundwater monitoring procedures.

PLS is proposing no further investigations to delineate the downgradient extent of 1,4-dioxane in the Western System. MDEQ has recently requested the installation of two monitoring wells, one on property referred to as the Huron Valley Swim Club, and another on the Sunward Co-housing property. PLS provides the following regarding our position on the need for these wells:

- Huron Valley Swim Club Area - PLS has presented extensive data to the MDEQ which demonstrates the Western Plume has considerably reduced in size. Data from former supply

wells on the Huron Valley Swim club indicate 1,4-dioxane concentrations on this property have reduced considerably over time since, and are now less than 5 ug/L. Only one of the two wells at this location had 1,4-dioxane concentrations that exceeded 85 ug/L. PLS believes the data are clear that 1,4-dioxane concentrations on this property have reduced considerably over the 18 years of monitoring. One could argue that the wells were not completed at the depths representing the highest concentrations in the aquifer. PLS suggests that these wells are (1) positioned at depths representative of where the plume would migrate and (2) had concentrations that were consistent with other locations in the plume. PLS does not believe that installing another well on this property to show that the concentrations are below 85 ug/L is necessary. As such, PLS disagrees with the MDEQ's request for a well on this property.

- Sunward Co-Housing Area - The MDEQ has requested a well in the area west of MW-53s, i.d., PLS recognizes that it is possible that a move in any direction from the Ann Arbor Cleaning Supply well could result in a slight increase or decrease in 1,4-dioxane concentrations. However, PLS believes that MW-53i and the Ann Arbor Clean Supply well are located on or very near the longitudinal axis of the Western Plume. A slight refinement in the definition of the plume extent would provide little benefit to the existing monitoring well network and to the understanding of the Western System. Furthermore, access to the most logical downgradient monitoring locations is very difficult (would result in damage to a sensitive area and/or would result in the unnecessary disruption of property use). As such, PLS disagrees with the MDEQ's request for a well on this property.

Implementation Schedule

This Plan can be implemented immediately upon MDEQ approval.