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ENVIRONMENT

Ms. Jeanette DeBartolomeo
Maryland Department of the Environment
1800 Washington Blvd., Ste. 620
Baltimore, MD 21230

Subject:
Injection Well Status and Response to Comments on Work Plan
Case No. 1986-1205-CE
Former Bayview Station #16-G1R
285 Bayview Road, North East
Cecil County, Maryland
Facility ID No. 2615

Date:
28 August 2013

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Rusty Kahl

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Our ref:
B0085851.0010

Dear Ms. DeBartolomeo:

On behalf of ExxonMobil Environmental Services (EMES), ARCADIS U.S. Inc. (ARCADIS) has prepared this letter in response to two communications from the Maryland Department of the Environment (MDE):

- The 2 July 2013 letter reviewing the 15 April 2013 *Revised Corrective Action Plan* for the above-referenced site.
- Voice mail of 13 August 2013 requesting an update on the gauging of injection wells at the site.

This letter will provide the most recent information regarding gauging of the injection wells.

This letter also includes responses to MDE comments regarding the proposed remediation activities and provides additional information regarding the proposed approach. The remedial approach proposed in the *Revised Corrective Action Plan* was developed to account for the hydrogeologic conditions observed during pilot testing activities in August 2012 and is appropriate for the geologic setting and contaminants. Therefore, ARCADIS is submitting this response, with additional details regarding the injection approach, in lieu of the *Pilot Test Work Plan* requested in the letter dated 2 July 2013.

Injection Well Gauging in 2013

During pilot testing in August 2012, liquid phase hydrocarbon (LPH) was measured in well INJ-2 at a thickness of 0.01 in. LPH was not detected in either injection well INJ-1 or INJ-3. Also, LPH was not detected in any of the site monitoring wells.

Subsequently, injection wells injection wells INJ-1, INJ-2, and INJ-3 were gauged during two monitoring events in February 2013 and August 2013. LPH was not detected in any of the injection wells during either of these monitoring events. Additionally, LPH has not been detected in any of the monitoring wells.

The injection wells will be gauged during future quarterly events to monitoring the potential for LPH to enter the wells.

Response to Comments on Work Plan

Proposed Modifications to Injection Approach

Although the original work plan proposed gravity-feed injection via permanent wells, this was changed to direct-push injection in the April 2013 *Revised CAP* based on the pilot test results. Flow rates achieved during the gravity-feed pilot test in August 2012 were relatively low (approximately 0.4 gallons per minute or less). This change to direct-push injection is anticipated to significantly improve the feasibility of in-situ injection-based remediation options.

Direct-push injection offers several advantages in low-permeability geologic settings compared to gravity-feed injection wells:

- The direct-push approach (essentially injecting through drilling rods advanced to a target depth, with an open or screened interval at the bottom of the drill string) will be used to emplace a smaller overall volume of liquid per point at a higher sulfate concentration.
- More injection points, each with a smaller target radius of influence (ROI), will be used to get an improved distribution of reagent and minimize the potential effects of irregular distribution or preferential flow that may occur through pressure application at a single point.
- The direct-push injection method will involve the application of a limited amount of pressure (typically 5 pounds per square inch or less) to the

injection point in order to promote emplacement of the injection solution in the fine-grained formation.

ARCADIS has successfully used direct-push injection approaches at numerous retail petroleum sites for delivery of various reagents, including sulfate. Based on previous project experience, the most effective delivery approach for sulfate via direct-push injection is via a gypsum slurry. Gypsum (calcium sulfate dihydrate) will be mixed with clean water, in small batches, at a ratio of 10% to 15% gypsum by weight. The gypsum will be kept suspended in a slurry through continuous mixing during injections. Each batch mixed will consist of only the volume needed for one injection interval (approximately 75 gallons, as described in the *Revised Corrective Action Plan*).

In order to make use of the existing injection well infrastructure and maximize the cost-effectiveness of mobilizations for remedial activities, gravity-feed injections will be conducted using existing injection wells, concurrent with the direct-push injection activities, using a solution of Epsom salt (magnesium sulfate heptahydrate). Epsom salt is preferred for injection-well-based delivery because of its solubility. Because achievable flow rates via injection wells are anticipated to be relatively low, this delivery method will be a supplemental method to be completed concurrently with the direct-push injections, which will be the primary delivery method.

Verification/Quality Control during Injections

During the injection activities, samples will be collected from the injected solution and slurry and analyzed for sulfate to verify that the desired dosing and mixing ratios were achieved. Groundwater field parameters at monitoring wells in the area of the injections will be monitored to identify arrival of sulfate solution at a monitoring point (indicated by an increase in specific conductivity). Groundwater samples may also be collected from monitoring wells during or immediately after for sulfate analysis to verify the distribution of sulfate achieved.

Treatment Concept and Monitoring Activities

The overall objective of injection activities is to achieve elevated sulfate ion concentrations in groundwater within the impacted area, taking advantage of the existing anaerobic subsurface environment and supporting anaerobic biological processes capable of degrading hydrocarbons. Both the direct-push and injection-well-based methods will target permeable zones of the geologic formation around the

impacted area, supporting treatment in flow paths where off-site migration of impacts may have previously occurred. Based on previous experience at similar sites, the success of sulfate addition in promoting anaerobic treatment hinges on maintaining sulfate concentrations of 300 to 500 ppm in the targeted treatment area. Post-injection monitoring is proposed to assess the rate of sulfate consumption and washout in the area and evaluate whether additional injections are required to maintain optimal anaerobic conditions.

Post-injection monitoring will consist of collection of groundwater samples from selected wells in the targeted treatment area, including MW-2A, MW-3A, MW-8, and MW-11, for analysis of sulfate and benzene, toluene, ethylbenzene, and xylenes (BTEX), and methyl-tert-butyl ether (MTBE). These events are proposed at initial intervals of 30, 60, and 90 days following the first injection event; this schedule may be revised based on monitoring results.

The post-injection monitoring will be used to guide future timing and implementation of injection activities; however, overall evaluation of the efficacy of treatment in addressing dissolved-phase impacts will be based on quarterly sampling data collected during sitewide monitoring events.

Conclusion

ARCADIS appreciates your review of the additional information presented above, and, on behalf of EMES, respectfully requests approval of the April 2013 *Revised Corrective Action Plan.*

Please contact me with any comments or questions.

Sincerely,

William R Kahl

William R. Kahl, PG
Associate Project Manager

Copies:
Ms. Jewel Cox, ExxonMobil