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November 22, 2017

Ms. Dana Cannon
West of 4th Project Coordinator
Aspect Consulting
401 2nd Ave S, Suite 201
Seattle, WA 98104

Re: **West of 4th Site - Agreed Order #DE 10402**
Site Unit 1, In Situ Metals Immobilization Pilot Testing Work Plan

Dear Ms. Cannon:

On April 17, 2017, the Washington State Department of Ecology (Ecology) received an emailed copy of the draft Site Unit 1, *In Situ Metals Immobilization Pilot Testing Work Plan* from the West of 4th PLPs. The draft Work Plan was submitted in accordance with the PLPs' December 16, 2016, proposed "path forward" letter and schedule.[1]

On November 21, 2017, the West of 4th Agreed Order was amended to include requirements and deliverable due dates for the Site Unit 1 Metals Immobilization Pilot Study. In accordance with that amendment the PLPs should revise the draft Work Plan submitted last April to satisfactorily address Ecology's enclosed comments. At that time the document's schedule should also be updated. These revisions of the document are due to Ecology within thirty (30) days of receipt of today's letter.

If you have any questions, or would like to schedule a meeting or conference call to discuss Ecology's comments, please contact me at (425) 649-4449 or ejon461@ecy.wa.gov.

Sincerely,

Ed Jones
Environmental Engineer
Hazardous Waste and Toxics Reduction Program

Enclosure
By certified mail: 9171 9690 0935 0169 7331 12

[1] On December 19, 2016, Ecology approved the PLPs' proposed due dates for the: (1) draft Site Unit 1 CVOC pilot-study work plan; (2) draft Site Unit 1 "plating-metals" pilot-study work plan; and, (3) draft Site Unit 2 CVOC pilot-study work plan.

cc: William Joyce, SJZ
William Carroll, PCE
Janet Knox, PGG
Jeff Kaspar/Peter Jewett, Farallon
Ronald Taylor, CI
Donald Verfurth, G&R
Marlys Palumbo, VNF
William Beck, Stericycle/PSC
Laura Castrilli, EPA R10
Central Files
PLPs' W4 repository

ecc: Tong Li, GWS
Peter Hapke, ALG
Nels Johnson, AAG
Patty Foley/Sherell Ehlers, GTCC

ENCLOSURE

In Situ Metals Immobilization Pilot Test Work Plan COMMENTS

General Comment

Proposals included Section 4, unless otherwise the subject of an Ecology comment below, seem reasonable for this stage of the study's design. As the PLPs state, once Phases I and II have been completed, a Field Investigation Work Plan (FIWP) will provide more detailed proposals for Phase III. Ecology agrees with the proposed content of the FIWP provided at the bottom of page 11 and top of page 12, as well as the more comprehensive description on page 14. However, as discussed on June 22, 2017, we also expect the document to include a comprehensive study Sampling and Analysis Plan (SAP).[2]

Specific Comments

1. Page 7, Section 4.1.1, and Figure 12. In the second bullet the Work Plan proposes two new monitoring wells, PSW-4 and -5. The first is a DR well; the second is a "downgradient" monitoring well. Existing well MW-3 will also be used as a DR well. Ecology agrees with the two proposed downgradient DR wells (PSW-4 and MW-3), and we also agree with the location of the PLPs' proposed downgradient performance monitoring well, PSW-5. However, as discussed on June 22, an additional Water Table (WT) zone, DR monitoring well should be added to the Final Work Plan. This well will be installed to the northwest of IW-1 at the targeted radius of influence (ROI).

2. Page 8, Section 4.1.2. Point of clarification: one of the three 6-inch sample cores will apparently be measured for pH in the field. Ecology understands that the other two 6-inch cores will be capped and tape-sealed for delivery to Anchor QEA's EGL. Please clarify in the Work Plan that core lithology observations will be described and recorded in the well log and field logbook.

3. Pages 9 and 10, Section 4.2.1. The Work Plan states that selected cores for bench scale testing will be opened and homogenized into four batches per boring when soil sample processing is initiated. Later it states that two soil batches from each boring will be analyzed for metals. The two (of the four) from each boring with the lowest pH will also be analyzed for sulfide, carbon, and sulfur. Once the results have been evaluated, the PLPs will select sample batches for titration sampling.

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[2] The comprehensive Sampling and Analysis Plan (SAP) for the field study may be based on the discussion in Section 4.3 and related tables (Tables 2 and 5), revised – as the PLPs propose – as needed to account for Phase I and II results. The QAPPs and SOPs previously prepared for the West of 4th site should have applicability to a number of data-gathering activities proposed for the field study. However, in addition to the QA/QC needs associated with tracer testing, there are needs related to the type of remediation agent to be injected and its monitoring that are not anticipated by previous QAPPs and SOPs. The PLPs should therefore plan to supplement the draft FIWP with a study-specific QAPP. The QAPP can refer to older documents that Ecology has approved, but should be focused on the data quality needs/objectives and QA/QC pertaining specifically to the plating-metals field study.

On November 15 the PLPs emailed revisions to Sections 4.1.2 and 4.2.1, noting that they now intend to create one homogenate from each boring (IW-1 and IW-2) using collected cores from 10 to 17.5 feet. This will not include the 6-inch core segments used for field characterization (one from each 18-inch drive). The revised Work Plan should incorporate the 11/15 proposed changes, as qualified by the PLPs' November 20 email to Ecology (regarding the number of core segments archived).

4. Page 10, Section 4.2.2. The Work Plan text indicates that titration tests will be conducted using a slurry comprised of a 1:10 soil-to-groundwater ratio. Table 3, referenced in this section, appears to show that titration tests will also be conducted using 200 ml of groundwater (only). As discussed on June 22, titration tests with groundwater only should be added to the Final Work Plan.

5. Page 10, Section 4.2.2. The alkaline reagents being considered for use in the pilot study are all soluble, and include sodium bicarbonate, hydroxide, and polysulfide. This is generally consistent with the Site Unit (SU) 1 FS Report's identification of sodium bicarbonate and carbonate blends (NuBuff was provided as an example) as likely candidates for pH neutralization. Ecology agrees that the three buffering agents proposed for testing are good selections. However, as we discussed on June 22, the revised Work Plan should also include:

   - a discussion related to the performance of the three buffering agents at other sites with similar contaminant and geochemical conditions, and similar remedial action objectives. This can be primarily a summarization and citation of the literature sources the PLPs utilized in designing the Work Plan; and,
   - the range of available reagent candidates, their likely/potential advantages and disadvantages, and – at least briefly – an explanation for why the PLPs narrowed their candidate list to the three proposed.[3]

   As we additionally discussed on June 22, it is possible that ultimately the administered reagent could be a combination of two of the three candidates (e.g., NaOH and polysulfides) or a mixture of one of the three candidates with a material not planned for bench-scale testing. The benefits of using a combination of reagents should be considered based on the results of testing the individual reagents proposed in the Work Plan. If a particular combination of these reagents is deemed potentially beneficial, the combination should then be evaluated in the laboratory before field pilot testing commences.

6. Page 10, Section 4.2.3. The Work Plan proposes "treatment batch testing" with "soil homogenate." The revised Work Plan should clarify which soils will be used for these tests (i.e., describe how these soils will be selected from among the core samples collected and sent to Anchor).

7. Page 11, Section 4.3. Point of clarification: Ecology agrees with the second bulleted objective, and assumes that the PLPs simply left out "injection pressure" and "injection

[3] For example, sodium carbonate; calcium polysulfide; and, potassium, calcium, and (suspended) magnesium hydroxides have been injected, with varying success, into acidic groundwater at cleanup sites.

flowrate" as parameter values they intend to determine. While it is likely that the reagent will be gravity-fed (based on injection-well design), injection flowrates should be controlled and monitored to achieve the target/optimal ROI and treatment effects.

In addition, Ecology agrees that the reagent solution should be injected under zero or low, non-fracturing pressures, as discussed in the fourth paragraph of this section. However, it should be remembered that a gravity flow "feeding container" will add at least 10 feet of head over the water table. Based on the injection well design (4-inch wells with 10-foot stainless-steel wire-wrapped screens), the injection could achieve a relatively high flowrate under gravity feeding. For this reason, even if the plan is to rely solely on gravity-fed injection, the PLPs should consider adding (if the design does not currently include it) a flow-control valve to regulate injection flow rate.

8. Page 11, Section 4.3. In the fifth paragraph of this section the Work Plan proposes use of a tracer to help account for contributions from upgradient groundwater quality, and any impermanent treatment mechanisms, likely to confound the evaluation of reagent success. Ecology agrees that this is a good plan. The type of tracer the PLPs are considering is not identified in the Work Plan. It will be proposed in the FIWP. The timing is acceptable to Ecology, since the study area injections are a long distance from the Waterway and we do not believe it is critical to seek public comment on tracer selection. However, the PLPs should consider the following:

   - The draft SU1 CVOC pilot study work plan envisages the use of xanthene dyes for tracer testing in an area of groundwater contamination west of East Marginal Way S. Fluorescein, and perhaps other dyes in its class, may be a good choice for this location, but not for the low pH area near the Art Brass Plating facility (see Smart & Laidlaw [1977]).

     Fluorescein, and possibly other xanthene dyes, may also be a poor selection for co-injection with a basic reagent. There have been reports of its incompatibility with some oxidants (see [Saint-fort, 2016]).

   - Depending the type of tracer the PLPs would like to use, it may be worthwhile to add a task to the bench-scale work, testing it's compatibility with the preferred reagent. As we discussed on June 22, the Work Plan should be revised to include the possibility of evaluating tracer in the presence of the selected reagent during laboratory testing, if there are compatibility concerns (e.g., due to elevated pH of the selected reagent solution). This evaluation would consist of adding a measured amount of tracer to the selected reagent solution and analyzing the dissolved tracer concentration. Further, the pilot testing in the field will include measuring tracer concentration in the injection solution so that the actual, applied tracer concentration is known.

   - The draft Work Plan proposes to wait until Month 3 for the collection of samples from upgradient well MW-1. As discussed on June 22, the revised Work Plan should state that MW-1 will be sampled during Week 4, and then Months 3, 6, and 12. Samples will be analyzed for analyte groups #1, 3, and 4.

9. Page 13, Section 5.2. Ecology agrees that a "supplemental" QAPP should be submitted as part of the FIWP. Please see our General Comment above.

10. Page 14, Section 6. Ecology agrees with the 5th bullet on this page, but the FIWP should also describe the conditions likely to trigger a second injection event.

11. Page 14 and Figure 13. The PLPs plan to submit the Completion Report 45 days after "receiving all analytical data." Ecology would prefer that the Report be submitted 45 days after receiving all analytical data *critical to meeting study objectives*. This provides some flexibility for scenarios such as the following:

    (1) the study – and technology – is successful, but we collect enough data to meet our needs in less than a year; or, conversely,

    (2) there are study problems, or poor technology performance, and this is apparent soon after the injections. There may therefore need to be re-thinking of the study and implementation of a "Plan B."