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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 2: Capital Industries Plant 4 Interim Action Work Plan**

Dear Ms. Cannon:

On July 27, 2017, the Washington State Department of Ecology (Ecology) received an Emailed copy of the draft Site Unit 2 *Capital Industries Plant 4 Interim Action Work Plan* from the West of 4th PLPs. This draft version of the Work Plan was submitted in accordance with the PLPs' December 16, 2016, proposed "path forward" letter. On August 16 Ecology provided preliminary comments on the draft Work Plan.

The West of 4th Agreed Order was amended on November 21, 2017, to include requirements and deliverable due dates for the Site Unit 2 Interim Action. In accordance with that amendment the PLPs should revise the draft Work Plan submitted last July to satisfactorily address Ecology's enclosed comments. These comments are based on our preliminary Work Plan comments, provided to the PLPs last August. 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.

The revision of the Interim Action Work Plan is 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

By certified mail: 9171 9690 0935 0169 7331 05
Enclosure

cc: Jeff Kaspar/Peter Jewett, Farallon
William Carroll, PCE
Janet Knox, PGG
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William Beck, Stericycle/PSC
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Central Files
PLPs' W4 repository

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

# ENCLOSURE

## Draft Site Unit 2 Capital Industries Plant 4 Interim Action Work Plan Ecology COMMENTS

General Comment

Proposals included the Interim Action Work Plan, unless otherwise the subject of an Ecology comment below, seem reasonable for this *conceptual* stage of the action's design. As the Work Plan states, after it has been finalized a Field Investigation Work Plan (FIWP) will be prepared that provides more detailed proposals for implementation and monitoring of the action.

Specific Comments

1. Page 1-2, Section 1.1. The third interim action objective states that the PLPs intend to reduce – to the "extent practicable" – the "risk" of Plant 4 soils and/or shallow groundwater "recontamination" due to "upgradient sources off the CI property...". If the PLPs believe that a source of contamination upgradient of the Capital Industries property is located below the Pacific Food Systems' property, the Work Plan should provide more information about this source and its expected contributions to Water Table zone groundwater contamination in the southern portion of the West of 4th site.[1] More importantly, it should describe how the proposed interim action, once completed, will minimize future Plant 4 soil/groundwater contamination from this source.

2. Page 1-2, Section 1.1. The Work Plan states that it will be followed by a more "detailed" Field Investigation Work Plan (FIWP), which will include a SAP, QAPP, and H&SP. Ecology agrees that a more detailed and comprehensive RD/RA document should be submitted prior to initiating the interim action. This can be the proposed FIWP. Please see Comment #25 below.

3. Pages 4-1 through 4-3, Section 4. In general, Ecology agrees with this section's (section 4.2's) hydrogeology summary. However, the corresponding lithologic units referenced at the beginning of Section 4.2 are not summarized in Section 4.1. Instead, only the lithologic units of the vadose zone and Water Table Interval are described in Section 4.1, "Geology." Either the first sentence of Section 4.2 should be revised or Section 4.1 should be expanded to reflect the connections between lithology and the hydrogeologic units discussed in Section 4.2

4. Page 5-1. Section 5.1. The PLPs propose to inject potassium permanganate (KMnO4) via DP methods. But the Work Plan does not explain why potassium permanganate, instead

[1] Beyond the concern of an upgradient source re-contaminating the Plant 4 area, and resulting in future PCUL exceedances, is the more short-term problem of accounting for these contributions during interim action effectiveness-assessment. How do the PLPs intend to differentiate CVOC rebound (due to incomplete interim action treatment) from any increasing CVOC levels caused by upgradient contributions?

of sodium permanganate, has been selected.[2] Nor does it explain why – in other than general terms – a 3% injectant concentration is likely to be "sufficient to achieve the PCULs…". Although 3% is within the (high end of the) site literature range, the percentage of KMnO4 in the injected solution should be based on the desired vadose zone and saturated zone KMnO4 concentrations expected to be needed to reduce CVOC levels to target concentrations within the treatment zone (given a number of assumptions regarding: the number of pore volumes that should be targeted; the expected distribution of delivered oxidant and injection points; injection flowrates, pressures, and volumes per point; natural/soil oxidant demand in saturated and unsaturated zones within the Plant 4 area; etc.).

The PLPs may propose 3% potassium permanganate in the revised Work Plan, but the document should then additionally discuss the rationale for selecting this particular oxidant and oxidant strength (3%). It should also describe how the "final" KMnO4 % will be calculated and established in the draft FIWP.[3]

5. Page 5-1. Section 5.1. Because Water Table zone groundwater in this area is "aerobic to anoxic" and there have been no "visible organic materials" in Plant 4 soils, the PLPs assume the natural oxidant demand will be relatively low. The Work Plan acknowledges, however, that substantiating oxidant demand requires bench-scale testing.

   Although Ecology agrees that Stage 1 monitoring results may enable us to infer the approximate degree of oxidant demand, the Work Plan does not adequately explain why bench-scale testing to estimate this demand should not be performed prior to initiating Stage 1 (and before the FIWP is finalized). This is a standard pre-injection ISCO RD task.[4]

   As we discussed on September 27, 2017, however, there may be good reasons – including the potential for the bench-scale results to have minimal utility (due to variations between field and bench-scale test conditions), and cost considerations – for not conducting a bench-scale evaluation of natural oxidant demand during this particular project. But the rationale should then be included in the document.

6. Page 5-2, Section 5.1. Stage 1 results will be used to estimate *achieved*-ROI, but the Work Plan assumes the ROI will be between 5 to 20 feet. Later it appears that an ROI of 20 feet has been assumed for the purposes of estimating injection point and monitoring-boring densities.

   Ecology agrees that the Work Plan can state that an ROI range of 5-20' is probably to be expected, but it should then additionally:

   - state that this estimate is based on best professional judgment and/or the relevant – cited – site literature,

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[2] Ecology assumes that the PLPs prefer permanganate to persulfate because of the former's longer persistence.

[3] Citations from the literature are helpful if the cited studies are associated with site conditions similar to those expected beneath Plant 4.

[4] Stericycle estimated oxidant demand via bench-scale testing for areas of contamination east of 4th Ave. S. GE also performed bench-scale demand tests prior to performing an ISCO pilot study. Ecology suggests that the PLPs review these data prior to drafting the FIWP. The PLPs should additionally consider whether the collection of soil samples for a bench-scale NOD study would be a good opportunity to measure Plant 4 soils for "redox-sensitive metals" (unless vadose zone metals data were previously obtained from Plant 4 during earlier phases of the RI/FS).

- note that the draft FIWP will describe how, specifically, the PLPs will use Stage 1 and Stage 2 data/observations to estimate achieved-ROI, and
- explain whether this anticipated ROI range holds for Plant 4 soils as well as groundwater.

In addition, in the same paragraph the Work Plan states that Stage 1 results will be used to determine the optimally-effective KMnO4 concentration for full-scale ISCO implementation. Ecology agrees that Stage 1 results should be reviewed before establishing a final KMnO4 concentration for the injected solution. But as discussed in Comment #4 above, the Work Plan should clearly differentiate between the likely percentage of KMnO4 in the delivery solution and the target MnO4- concentrations in soils and groundwater the action is expected to achieve. It should be clear that the former has been chosen to produce the latter.

7. Page 5-2, Section 5.2. Project-related "baseline" groundwater monitoring is proposed for CI Water Table wells 6 and 7. The Work Plan states that well samples will be analyzed for CVOCs and the usual field parameters (including DO, pH, ORP, and specific conductance).

Ecology agrees, but additional geochemical parameters (major cations/anions and TDS), redox-sensitive metals (such Cr, Fe, and perhaps As), and Mn+2 should also be "baseline" analytes.[5] As discussed on September 27, we do not expect metals concentrations in groundwater to increase other than temporarily and locally, but monitoring should be designed to verify that this has indeed occurred.

8. Page 5-3, Section 5.4. Ecology agrees with the proposals in this section. But for a number of reasons it would be wise to perform this geophysical survey before submitting the draft FIWP.[6] When injections are performed at shallow depths, and especially when solutions are injected under pressure, there are "daylighting" (surfacing) concerns that must be addressed in both the injection and monitoring designs. Even if the subsurface area targeted for injections at Plant 4 is overlain by a slab without penetrations, there are nearby areas just beyond the Plant 4 footprint that are unlikely to be "capped" to the same degree. This includes properties to the immediate east and northeast of Plant 4.

Utility conduit contamination can occur during injections due to significant rising of the local water table's elevation. A shallower water table, even though a temporary condition, may then intercept those utility conduits that would otherwise be above the saturated zone.

Pressurized injections can also lead to the surfacing of injectant or treated groundwater if preferential subsurface pathways are present due to utilities (e.g., sewer and storm water lines and utility-corridor gravel beddings), or poorly-sealed wells, direct-push points, or historical sampling points. This "daylighting" can occur some distance from the injection location. Even the static pressure from an elevated injection-reagent tank (e.g., on a truck

[5] The PLPs have 2016 MW7 groundwater data for Fe+2 and Mn+2, but apparently not from samples collected at MW6.

[6] As we discussed on September 27, the PLPs already have some good utility-location data for this area. The survey performed in advance of the interim action should be designed to supplement this information. Ecology assumes it will employ standard utility-locate techniques, such as GPR and EM.

bed) may be high enough to cause "daylighting" of the injected solution, and added pumping pressure makes this, and any preferential pathways caused by soil fracturing, more likely. The pressure needed for DP point injection should therefore, in our opinion, be applied slowly and cautiously.

The draft FIWP should contain sections devoted to:

a) discussions of how the injection Design minimizes the potential for daylighting and utility line and conduit contamination;

b) a description of how the project's monitoring program has been designed to provide early indications of the possibility for such undesirable injection-related consequences; and

c) describing the actions the PLPs will take in the event of surfacing or other undesirable distributions of the injected oxidant. For example, the FIWP should identify those monitoring conditions that will trigger (temporary) discontinuation of injection and a re-thinking of delivery parameters (P, Q, V) and injection locations. It should also describe what materials will be on hand to contain/ control any surface releases of groundwater mixed with the injected solution.

9. Page 5-3, Section 5.5. Commonly, injection of "clean water" precedes the first injection of oxidant. This preliminary step provides an opportunity to test the relationship between injection flowrate and pressure while monitoring nearby points for increases in groundwater water table elevation and the potential for (or occurrence of) "daylighting." During these tests it may become evident that design values selected for injection volumes and/or injection rate cannot be achieved. The test can also be used to determine if gravity-fed injection is feasible. If gravity-fed injection is shown to not be feasible, the "clean water" test can then be used to help select minimum injection pressures and provide a *dry run* experience for the fieldteam in adjusting and maintaining desired pressures and flowrates.

   During discussions on September 27, Ecology re-iterated our belief that it would be prudent to perform a pre-Stage 1 injection of clean water. We asked that the PLPs consider those actions – such as a pre-Stage 1 water injection – that could be taken prior to ISCO injections to better understand hydraulic properties in the treatment area, optimize the selection of oxidant-injection flowrates, and collect this information while minimizing the potential for distribution of oxidant-containing water to locations other than the target areas/zones.

   On November 6, following discussions with their injection contractor, the PLPs sent Ecology a follow-up email. The PLPs believe the first oxidant injections, if preceded by a pre-Stage 1 clean water injection, will have to overcome the added pore pressure of that earlier injection. This, in their view, should be avoided. If the subsurface is altered following the clean water injection, new pathways may be created which will affect the distribution of the oxidant during Stage-1 injection. In addition, the PLPs contend that for this project the benefits associated with a pre-Stage 1 clean water injection are in any case outweighed by its cost and level of effort.

Ecology does not know how much a pre-Stage 1 water injection is likely to add to the interim action's cost. Perhaps the PLPs have estimated this additional cost and have concluded it would be significant. Regardless of the cost, however, we are hesitant to insist upon an activity the PLPs believe may impair attainment of the project's objectives.[7] If, at the time the draft FIWP is prepared, the PLPs continue to feel that a clean water injection test will likely compromise the intended distribution of the oxidant injected during Stage-1, and the information obtained from such a preliminary step can be cost-effectively acquired later, during Stage 1, this should be stated in the document.

As discussed in Comment #8, both Ecology and the PLPs want the injected oxidant to go into Plant 4 soils (and/or shallow groundwater), and be distributed ≈ radially, at targeted depths. We do not want it to go elsewhere. *Elsewhere* includes: locations above ground surface (daylighting due to vertical migration), and non-targeted subsurface areas where vulnerable subsurface utilities or other buried cables/structures are located. A consequence of unintended oxidant distribution could certainly be compromised treatment efficiency, but could additionally include safety-related hazards and/or the destruction of private/public property that the PLPs would be liable for. A pre-Stage 1 water injection should therefore be considered one approach for providing an early indication of the likelihood of unintended distribution – before oxidant is actually introduced.

10. Page 5-3, Section 5.5. During Stage 1 the distribution and persistence of the injected oxidant will be determined by drilling "performance borings" and making (visual) observations at varying step-out distances. Section 5.6 states that three borings will be advanced per injection point, located 5', 10', and 15' away (in a triangular configuration) from those points. The borings will be advanced to the same depth as the injections.

    The Work Plan does not appear to state whether the oxidant observations will include any measurement of oxidant distribution/presence other than simply the eyeballing of cores and groundwater samples for (a purplish) color. This should be clarified in the Work Plan and – more importantly – the FIWP. As we discussed on September 27, the permanganate solution has a distinctive purplish color, but field colorimeters (like the DR/890) offer a more quantifiable indication of presence and have been used for these purposes at other sites. The devices seem suitable for application during the SU2 ISCO action.

11. Page 5-4, Section 5.5.1. During Stage 1 the Work Plan proposes to inject oxidant at three locations (B3, F5, and E5). It states that the purpose of these injections, and the follow-up examination of soil cores, is to "evaluate the ROI" in the upper portion of the vadose zone (near B3), at depths of 1-6' in the vadose zone (near F5), and in the Water Table zone and deeper vadose zone (at E5). Ecology agrees with these proposals, but it is unclear to us if the PLPs intend to inject oxidant only at the depths referred to in the Work Plan's three bullets, or plan to inject throughout the vadose zone depth interval and into the Water Table zone at all three locations.

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[7] Ecology's recommendation for a preliminary "clean water injection test" has been based on the assumption that the follow-up Stage 1 injection would not need to overcome the added pore pressure of the pre-Stage 1 water injection. That is, our expectation has been that the subsurface will return to near-equilibrium pressure conditions within a few days of injection completion.

Figure 5 seems to suggest that oxidant will be delivered from 0 to 25' bgs at locations F5 and E5, but not B3. Is there a good reason to limit the Stage 1 injection depth to the vadose zone at location B3 (and/or F5)?

12. Page 5-4, Section 5.5.1. The last paragraph of this sub-section states that after Stage 1 is "completed," "performance borings" will be advanced to assess the effectiveness of three "scenarios." The clarity of this proposal could be improved in the revised Work Plan by stating that when the Stage 1 injections have been completed, borings will be used to estimate the distribution of oxidant (ROI), injected-oxidant lifespan, and its effect on contaminant levels, near the three injection locations.

13. Page 5-4, Section 5.5.1. As discussed in Comment #6, the FIWP should identify the desired (target) oxidant concentrations in soils and groundwater near the injection points and at distances 10 to 20 feet away from those points (i.e., within the target treatment zone). It should also anticipate the likely/desirable post-injection groundwater geochemical conditions (pH, ORP, etc.) within the treatment zone (ROI).

14. Page 5-4, Section 5.5.1. In the last sentence of this sub-section the Work Plan notes that groundwater sampling data will help determine the potential for CVOC rebound. However, sub-section 5.6.1 appears to propose only a single Stage 1 groundwater sampling event, to be conducted within two weeks of the injections (the groundwater sampling locations are not identified in this paragraph of 5.6.1, but Ecology has assumed the PLPs intend to sample CI Water Table wells 6 and 7).

    As we discussed on September 27, if Stage 1 groundwater sampling is limited to a single event, shortly after injections, the sampling data are unlikely to provide a useful estimate of the potential for CVOC rebound.[8] Therefore, several semi-permanent monitoring wells with pre-packed well screens and sand pack should be installed in the general upgradient direction from CI-MW-7 using a direct-push (DP) rig. The construction details and locations of these semi-permanent wells should be presented in the revised Work Plan or draft FIWP.

15. Pages 5-4 and 5-5, Section 5.5.2. The Work Plan proposes 23 Stage 2 injection points, assuming an effective ROI per point of 20 feet. It also states that Stage 2's injection plan "details" will be informed by Stage 1 results, and the plan may therefore be somewhat different from the proposed design in the Work Plan and FIWP.

    Ecology agrees that the FIWP should include a more detailed full-scale injection and monitoring RD (remedial design). We also agree that these designs may need to be altered based on what is learned during Stage 1. In terms of the Work Plan's Stage 2 conceptual injection design, however, it is unclear:

[8] If the PLPs intent in Section 5.5.1 is to state that groundwater sampling two weeks after Stage 1 injections, coupled with future sampling events at the same wells, will provide indications of expected rebound, this should be explained in the Work Plan text. It should also be noted if groundwater samples will be collected from points other than just the MW6 and 7 locations (via temporary wells).

- whether the three Stage 1 points will be re-injected during Stage 2 (the Work Plan refers to 23 points),[9]
- what depths (shallower than 25' bgs) will be targeted for injection at the ten more western and northern locations identified in Figure 5? And,
- how much ROI overlap is (or will be) assumed in the injection spacing design.

This should be clarified in the revised Work Plan.

In addition, the Work Plan does not propose to inject oxidant at any locations south of the Plant 4 building (such as in areas near historic sampling points PB-10 through -14). This is consistent with SU2 FS Alternative #1, and the interim action may be limited to areas north of these points. But the Work Plan should then discuss why attainment of the interim action's objectives does not require oxidant injections into the contaminated vadose zone and/or groundwater areas immediately south of Plant 4 (and, in particular, near PB-14) – even if these injections would be relatively easy and inexpensive to perform if conducted at the same time the PLPs have mobilized for Stage 2 injections.

16. Pages 5-5 through 5-9, Section 5.6. It would be helpful if the FIWP differentiated between project "process" monitoring and "performance monitoring. The former activities occur during implementation of the action (injection) and typically include a number of injectant pressure, flowrate, and volume measurements. Often they also include measurements of groundwater levels and other monitoring tasks designed to indicate the onset of unintended implementation consequences (such as "daylighting," increases in soil gas CVOC levels, etc.).

    In addition, post-injection soil and groundwater samples routinely need to be "quenched" before being transported to the lab for CVOC analyses. See EPA's August 2012 *Groundwater Issue* (EPA/600/R-12/049). The FIWP must include the PLPs' proposed quenching SOP, and identify those samples which will and will not be subjected to the procedure. For QA/AQC purposes, for example, the PLPs may choose to collect certain samples in duplicate, quenching one but not the other.

17. Pages 5-5 through 5-7, Sections 5.6 and 5.6.1. During Stage 1 the PLPs propose to assess the physical distribution of the oxidant via post-injection borings. Visual observations from the Stage 1 performance borings will be used to adjust full-scale (Stage 2) injection spacing, injection volume(s), and perhaps the method of oxidant delivery. Please see Comment #10 above regarding the use of semi-quantitative instruments such as colorimeters.

    In addition, the measurement of conventional field parameters such as conductivity and DO/ORP may also help identify reagent distribution. Conservative tracers such as bromide, used with a bromide field probe, could additionally be helpful in confirming reagent breakthrough and distribution. These supplemental approaches to visual observations should be evaluated during preparation of the FIWP.

18. Page 5-6, Section 5.6. Point of clarification: the Work Plan states that during Stage 2 monitoring soil cores will be collected from 0-25'. Soil samples from these cores will be

[9] Following submittal of the Work Plan the PLPs clarified, via Email, that the Stage 1 injection points will be re-injected during Stage 2.

collected at intervals corresponding to historical sampling results that indicated PCUL exceedances. The Work Plan should clarify whether all full-scale monitoring-related borings will be advanced to 25' bgs, or just those monitoring-related borings nearby injection locations where the full depth of the vadose zone (and/or shallow groundwater) was targeted.

19. Page 5-7, Section 5.6.1. No more than two weeks after the first set of core samples are collected from Stage 1 performance borings, a second set of performance borings will be advanced. Again, visual observations will be made of the cores to determine KMnO4 presence. Where KMnO4 no longer "persists" in soils, the PLPs will collect soil samples at depths where historical sampling has indicated contamination. Samples will be analyzed for CVOCs, and the PLPs will use the data to – among other things – decide if 3% is the correct oxidant injectant concentration.

Ecology agrees that soil samples in the vicinity of the three Stage 1 "pilot study" injection points should be analyzed for CVOC concentrations. However, the Work Plan is not clear about where the second set of samples will be collected (i.e., where this set of borings will be advanced). Do the PLPs plan to advance three more borings per injection point, at the same locations as the first set?

In addition, it would be beneficial to also analyze those saturated soil samples being collected and analyzed for CVOCs for $MnO_2$, a product of the CVOC-oxidation reaction. If oxidant injections are resulting in a saturated zone that is permanently less permeable than it was prior to the interim action, these analyses should provide an indication of this. The costs and benefits of $MnO_2$ analysis should therefore be evaluated during the PLPs' preparation of the draft FIWP.

20. Page 5-7, Section 5.6.1. Within two weeks of Stage 1 injections the Work Plan proposes to collect groundwater samples from the Water Table zone. Samples will be analyzed for CVOCs. This paragraph of the sub-section does not, however, indicate where the Water Table zone samples will be collected.

Ecology assumes that the PLPs plan to collect samples from CI monitoring wells 6 and 7. MW-6 is located very close to, and downgradient of, point E5 (~10', according to Figure 5). It therefore seems suitably positioned to provide data representative of near-term post-injection impacts to groundwater quality and contaminant level changes. MW-7, on the other hand, is installed in the Fidalgo St ROW. Based on the positions depicted in Figure 5, it appears to be a little less than 40' southwest of F5. Samples collected from this well within two weeks of injections will only provide data representative of post-injection groundwater changes if affected groundwater can reach Fidalgo St in less than 14 days. Is this the PLPs' expectation?

It is reasonable to monitor indications of groundwater quality from the two wells shortly after injections, and then occasionally thereafter until the PLPs can estimate geochemical peaks and tail-off. But as noted above, MW-7 appears to be some 40 feet southwest of the closest Stage 1 injection point. As we discussed on September 27, the Work Plan should therefore include the collection of groundwater samples at additional locations (collected via 1-inch semi-permanent wells with pre-packed well screens and sand packs installed via direct-push).

21. Page 5-7, Section 5.6.1. Within two weeks of Stage 1 injections Water Table zone groundwater samples will be collected and analyzed for CVOCs. These samples should also be analyzed for selected inorganics (such as Mn+2, Fe, and Cr+3/+6).

22. Page 5-8, Section 5.6.2. Stage 2 (full-scale) monitoring is discussed in this portion of the Work Plan. Once the oxidant from full-scale injections has been "expended," DP sampling will be performed. A Plant 4 grid will be created, based on the assumed ROI. One boring will be associated with each grid cell. The PLPs will obtain soil cores and then collect samples at 1, 3, 5, 7, and 10' from each core. Samples will be analyzed for CVOCs. Initially, only six grid cells (in the SE corner of Plant 4) will be targeted.

    Ecology understands that the "details" related to Stage 2 post-injection sampling will be included in the FIWP. However, at this "conceptual" stage the Work Plan should consider and discuss how the FIWP's sampling grid will differ from the Stage 2 injection grid, and which boring locations will be chosen to closely align with injection points and which will be selected to represent sub-slab areas maximally distant from injections.

    In addition, samples collected from portions of the core at and below the Water Table:
    a) should additionally be analyzed for the same parameters/analytes we have requested for groundwater monitoring (certain metals and major cation/anions), and
    b) may be beneficially analyzed for $MnO_2$. As noted in Comment #19 above, the PLPs should evaluate the costs and benefits of $MnO_2$ analysis during preparation of the draft FIWP.

23. Pages 5-8 and 5-9, Section 5.6.2. The Work Plan states that if soils sampled in the southeast corner of Plant 4 are clean (< PCULs), the PLPs will proceed to sample other grid cells – i.e., beyond those in the SE corner – to confirm the interim action's complete effectiveness. These samples will also be analyzed for CVOCs. If, however, the first soil samples contain PCUL exceedances, we may need to consider another (follow-up) injection event.

    Using sampling results from the more highly contaminated area to decide whether samples should or should not be immediately collected from cleaner areas is reasonable, and Ecology appreciates the Work Plan's proposal to include us in the decision-making process. However, the Work Plan does not seem to propose much in the way of groundwater "dose response" monitoring, other than: a) the observations of those portions of soil cores coinciding with saturated conditions, and b) sampling groundwater at MW-6, which is close to injection points. We suggest that the FIWP identify likely DP groundwater (grab) locations where samples can be collected and field-tested (via probe [conductivity and other parameters] and colorimeter) to indicate dose-response.

24. Page 5-9, Section 5.6.3. One month following full-scale injections the PLPs will collect groundwater samples from MW-6 and MW-7. Sampling will be conducted monthly for three months, and then quarterly for at least nine more months. Groundwater samples will be analyzed for CVOCs.

It seems unlikely that we will see many interim action-related changes to groundwater quality at MW-7 from injections performed near A3 through E3, or A4 through D4, or A5 through D5 (much less, B2 through F2). Likewise, it seems doubtful that interim action-related changes in groundwater quality due to the injections at B2 through F2, A3 through E3, A5 through C5, F5, or A4 through D4, will be picked-up from sampling MW-6. Interim action groundwater monitoring at the two wells should therefore be supplemented with monitoring at an additional well or via DP sampling. Ecology suggests a location outside of the southwest corner of the Plant 4 Building (5-10 feet south of cell F1), which should be downgradient of most injection points.

In addition, the analyte list for interim action groundwater monitoring should be expanded beyond CVOCs. At a minimum, besides CVOCs, samples should be analyzed for major cations and anions, TDS, chromium, iron, and manganese.

25. Pages 6-1 and 6-2, Section 6.1. The Work Plan states that the FIWP will contain:

- final injection locations
- final injection "design criteria"
- detailed proposals for performance monitoring
- criteria for evaluating interim action effectiveness
- reporting requirements
- a project SAP (with SOPs)
- a QAPP
- a H&SP

Ecology agrees. Basically, the FIWP will serve as the RD and RA Work Plan for the interim action. Besides the FIWP content proposed in the draft Work Plan, then, the revised document should additionally include the applicable information required by WAC 173-340-400(4). For example, it should include:

(1) the goals of the interim action, and specific performance expectations. Typically for ISCO projects this includes the identification of treatment endpoints (as interim goals) and the criteria that will be used to demonstrate that the oxidant has been delivered and distributed per Design specifications;

(2) an updated project schedule for (any) final design-related activities, construction/implementation, and performance monitoring;

(3) a description of the processes required to implement the action;

(4) Engineering justification for design and operation parameters, including: a) Design criteria, assumptions and calculations for all components of the action; b) expected treatment efficiencies; c) a detailed plan describing how that degree of effectiveness will be determined; and, d) citations from guidance or the scientific literature that support the proposed design and operation parameters;

(5) relevant pilot or treatability test data, and results from similar actions performed under similar conditions (or citations from the scientific literature that provide these data/results);

(6) Design features for controlling hazardous materials spills and accidental discharges (e.g., secondary-containment elements of the action);

(7) Design features to assure the safety of the local public during implementation of the action. This includes any protect-related soil gas and/or indoor air monitoring to ensure that the action has not resulted in an exacerbated potential for vapor intrusion or ambient air contamination;

(8) a discussion of methods for managing and disposing of any treatment-related residuals (sludges, e.g.) or other project (injection or monitoring) derived waste materials;

(9) a general description of testing that will be used to demonstrate adequate quality control during action implementation. Note: the PLPs have proposed submitting a QAPP with the FIWP, and Ecology agrees. However, QAPPs are commonly focused on ensuring adequate data quality. The FIWP needs to also contain the substantive content included in a Construction Quality Control Plan, at least for elements of the action related to injections and monitoring-borings;

(10) construction plans, specifications, and figures describing and detailing the actions to be performed. Specifications should be included for all aboveground pumps, tanks, auxiliary equipment, and measuring devices (such as pressure gauges, flowmeters, flow totalizers, etc.). These specifications should ensure chemical compatibility between the project's materials and the proposed oxidant (and oxidant strength).[10]

Figures in the FIWP should depict the target treatment target zone, both vertically and laterally. A Process and Instrumentation Diagram should indicate schematically the aboveground injection and process-monitoring apparatus; and,

(11) a description of notifications to Ecology and nearby property owners that the PLPs will deliver during critical stages of the proposed fieldwork (injections, e.g.). This description should explain how, when, and why the notifications will be made.

26. Page 6-2, Section 6.1.3. A Completion Report will be submitted "following the conclusion of the interim action…". It will summarize interim action results and present conclusions regarding the effectiveness of the action. If needed, it will also discuss further (follow-up) actions that should be considered in order to achieve the action's core objectives.

Ecology agrees. However,

- please see Comment #27 below concerning the draft Completion Report's due date; and,
- the FIWP should include more specific proposals concerning the Completion Report's content. An outline of the proposed contents, e.g., would be helpful.

[10] Besides the materials chosen and used during the project, the PLPs will need to ensure chemical compatibility between the injectant and any belowground man-made features (such as utility lines) that may possibly come into contact with the oxidant solution.

27. Pages 7-1 and 7-2. The project schedule is proposed in this section of the Work Plan. Ecology agrees with many of the PLPs' proposals here, but has the following questions and comments:

- There is no mention of a revised Plant 4 Interim Action Work Plan. While a number of Ecology's comments on the draft Work Plan may be addressed in the draft FIWP, it is our expectation that the PLPs will revise the Work Plan and submit it for Ecology approval following the AO Amendment public comment period.
- The draft FIWP is scheduled to be submitted 45 days after Ecology's approval of the proposed "approach" in the July Work Plan. We agree with the 45-day timeframe proposed here, but expect that this timeframe will begin after the public comment period, and following Ecology's approval of the revised Plant 4 Interim Action Work Plan.
- The Work Plan does not appear to consider the need for FIWP revisions, either before Stage 1 (to address Ecology comments on the draft FIWP) or afterwards (to make changes based on the Stage 1 results). It is likely that the draft FIWP will require at least one revision.
- The Completion Report is proposed for submittal 30 days after the PLPs' receipt of "final performance groundwater monitoring sampling event results…" This is a reasonable proposal, but Ecology would prefer that the Report be submitted 30 to 45 days after receiving all analytical data critical to meeting – at least near-term – interim action objectives. This provides some flexibility for scenarios such as the following:
  - (1) the interim action appears to be successful, but we collect enough data to meet our needs in less than a year; or, conversely,
  - (2) there are problems, or poor treatment performance, and this is apparent soon after the first injections. There may therefore need to be re-thinking of the action's Design and consideration of a "Plan B."
- Stage 1 injections will be performed after Ecology has approved the FIWP, needed permits have been obtained, and baseline groundwater data have been reviewed. Ecology agrees, but it is unclear to us why this pre-Stage 1 review of baseline data is needed. If the PLPs believe that changes could be made to the interim action's injection or monitoring Design based on these data, the FIWP should discuss this more fully, explaining the PLPs' rationale.
- Stage 2 injections appear to be scheduled for a time two weeks after: (1) review of Stage 1 data/observations, and (2) consideration of Ecology's comments on Stage 1 implications for Stage 2, full-scale Design. Ecology agrees, but the PLPs' should assume that Stage 2 will not be implemented until we concur with any PLP-proposed changes to the approved FIWP's Stage 2 Design.

28. Figure 5. Please see Comments #11 and 15 above.