



City of Bothell™

Public Works Department

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Bothell, WA 98011

LETTER OF TRANSMITTAL

Phone (425) 486-2768
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Date: January 27, 2016

Company: Department of Ecology
Attn: Sunny Becker NWRO Toxics
Address: Cleanup Program 3190 - 160th SE
Bellevue, WA 98008

From: Nduta Mbutia, Capital Projects Division

Attached please find: Electronic copy of:-

1) Letter Report (1/26/2016) - In Situ Bioremediation Supplemental Injections for Ultra Custom Care Cleaners IAWP No.2

- | | |
|---|---|
| <input type="checkbox"/> For your information/files | <input type="checkbox"/> For your action |
| <input checked="" type="checkbox"/> At your request | <input type="checkbox"/> Approved as noted |
| <input type="checkbox"/> Returned for correction | <input type="checkbox"/> Please return all copies |
| <input type="checkbox"/> Other: | |

Comments:



January 26, 2016
HWA Project No. 2007-098

Washington State Department of Ecology
3190 160th Ave SE
Bellevue, WA 98008

Attention: Sunny Becker

Subject: **Ultra Custom Care Cleaners Site
In Situ Bioremediation, Supplemental Injections, Second Round Plan
Bothell, Washington**

Dear Ms. Becker:

This letter describes HWA Geosciences recommendations for a second round of in-situ bioremediation at the Ultra Custom Care Cleaners site (the Site).

Introduction and Background

Initial in-situ bioremediation injections were completed in January 2015. Interim action cleanup and monitoring of the Site is being performed in accordance with Agreed Order DE9704 between the City of Bothell and the Washington Department of Ecology (Ecology). As part of the approved scope of work for Interim Action No. 2 (*Ultra Custom Cleaners, Interim Action Work Plan No. 2*, November 7, 2014), enhanced in-situ bioremediation materials were injected into subsurface soil and ground water in four areas to stimulate biological activity and accelerate degradation of PCE and its degradation products (TCE, DCE, and vinyl chloride, or VC) at the source area and down-gradient plume. Injection locations are shown on Figure 1.

Three quarters of ground water monitoring following the in-situ bioremediation were completed in April, August, and October 2015; with a fourth round planned for late January 2016. Details of the cleanup, ground water monitoring results to date, and recommended actions can be found in the *Ultra Custom Care Cleaners Site Ground Water Monitoring Report, Third Quarter After Bioremediation*, Dated November 30, 2015 (Appendix A, excerpt attached “Summary & Recommendations”).

Ground Water Monitoring Results

Ground water monitoring results indicate results of the initial injections are encouraging, with active treatment observed in many wells, as evidenced by decreasing PCE, increased daughter products, and anoxic/reducing conditions. Treatment has been effective in the source area, which is the most important element of the cleanup. Some or most of the HVOC concentrations in downgradient areas are primarily the result of migration from the source area, as opposed to local sorption from

soils. In this case, HVOCs may decrease in downgradient areas over time without active bioremediation in the downgradient areas, although additional localized injections should accelerate the process.

Areas where treatment is not progressing due to insufficient influence of treatment chemicals include:

- Source area – the easternmost, and farthest downgradient wells UCCMW-21 and UCCMW-5, appear to have not received any treatment, and HVOC concentrations, albeit initially low, remain unchanged. Additional localized injections upgradient of these wells are recommended.
- First injection row – Both downgradient wells UCCMW-7 and UCCMW-25 appear unaffected by treatment. Additional localized injections upgradient of these wells are recommended. Monitoring results suggest the initial injections in Row one may have “set up” (oil binds to soil) downgradient of these wells. For example, ORP decreased UCCMW-8 (below Row 2) about 6 weeks after injection, and that injection row was almost three times as far away from UCCMW-8 as Row 1 is to UCCMW-7 and 25 (where soils are even more permeable). ORP decrease in BI-3 was measured around seven weeks after injections, which also suggests faster than anticipated travel times. If the injected oil at Row 1 arrived at wells UCCMW-7 and UCCMW-25 in around two weeks, that may have been too soon for it to stabilize in the soil (‘set up’). Additionally, ground water direction may be more westerly than anticipated. Treatment from Row 1 injections is occurring but cannot be monitored at UCCMW-7 and 25.
- Second injection row – BB-2 and UCCMW-8 are not maintaining geochemical conditions indicative of treatment chemicals, although PCE concentrations in these wells are decreasing, indicating some positive effects, possibly from upgradient treated areas. Additional localized injections upgradient of these wells are recommended.
- Third injection row – UCCMW-27 is not responding to treatment. Additional localized injections upgradient of UCCMW-27 are recommended.

Additional Explorations

In order to test the theory that injections in Row one may have “set up” downgradient of UCCMW-7 and 25, two direct push boring will be advanced and sampled downgradient of these wells, and sampled for total organic carbon and ground water field parameters (an indicator of the oil). The second round, first row injection locations may then be moved accordingly. Figure 1 show the proposed locations.

Second Round Bioremediation Plan

Additional injections of electron donor (emulsified edible oil with sodium lactate) and micro zero valent iron (mZVI) are planned in the following areas. Figure 1 shows past and planned injection sites. Details of the technology and process to be used can be found in the *Ultra Custom Cleaners, Interim Action Work Plan No. 2* dated November 7, 2014.

- Source area – In order to target the area monitored by wells UCCMW-21 and UCCMW-5, injections will be completed at:
 - The five easternmost, one-inch diameter injections wells (screened 8 -13 feet bgs)
 - Ten new, direct push injections east of the easternmost injection well, at depths of 9-13 and 14-18 feet bgs (injecting in two separate lifts at each location).

- First injection row – In order to target the area monitored by wells UCCMW-7 and UCCMW-25, a line of eight direct push injections north and upgradient of these wells will be completed, , at depths of 8-12 and 13-17 feet bgs (injecting in two separate lifts at each location).

- Second injection row – In order to target the area monitored by wells BB-2 and UCCMW-8, a line of 17 direct push injections east of and overlapping the initial line of injections will be completed, at depths of 8-12 and 13-17 feet bgs (injecting in two separate lifts at each location).

- Third injection row – In order to target the area monitored by UCCMW-26 and UCCMW-27, a line of 25 direct push injections east of and overlapping the initial line of injections will be completed, at depths of 8-12 and 13-17 feet bgs (injecting in two separate lifts at each location).

Injection protocol for each location will include the following elements:

- Mix hydrant water with granular zero-valent iron (ZVI) for approximately 24 hours to remove chlorine and create anoxic water (oxidation/reduction potential [ORP] < - 100 mV, dissolved oxygen [DO] < 0.5 mg/L) in a tank large enough for the next day's injection volume.
- Inject 100 gallons emulsified oil (5% oil:water) with micro ZVI (0.08 lbs/gallon) plus dispersant (500 ml/100lbs mZVI) in anaerobic water
- Inject bioaugmentation culture (approximately 1 liter/ 200 gallons injected at wells, and 1liter/ 150 gallons injected at direct push injection sites)
- Inject remainder of emulsified oil with micro ZVI (approximately 1,060 gallons per well, 442 gallons per DP probe)


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- Flush with 50 gallons anaerobic water



We appreciate the opportunity to provide our services to you on this project. Please feel free to call us if you have any questions or need more information.

Sincerely,
HWA GEOSCIENCES INC.

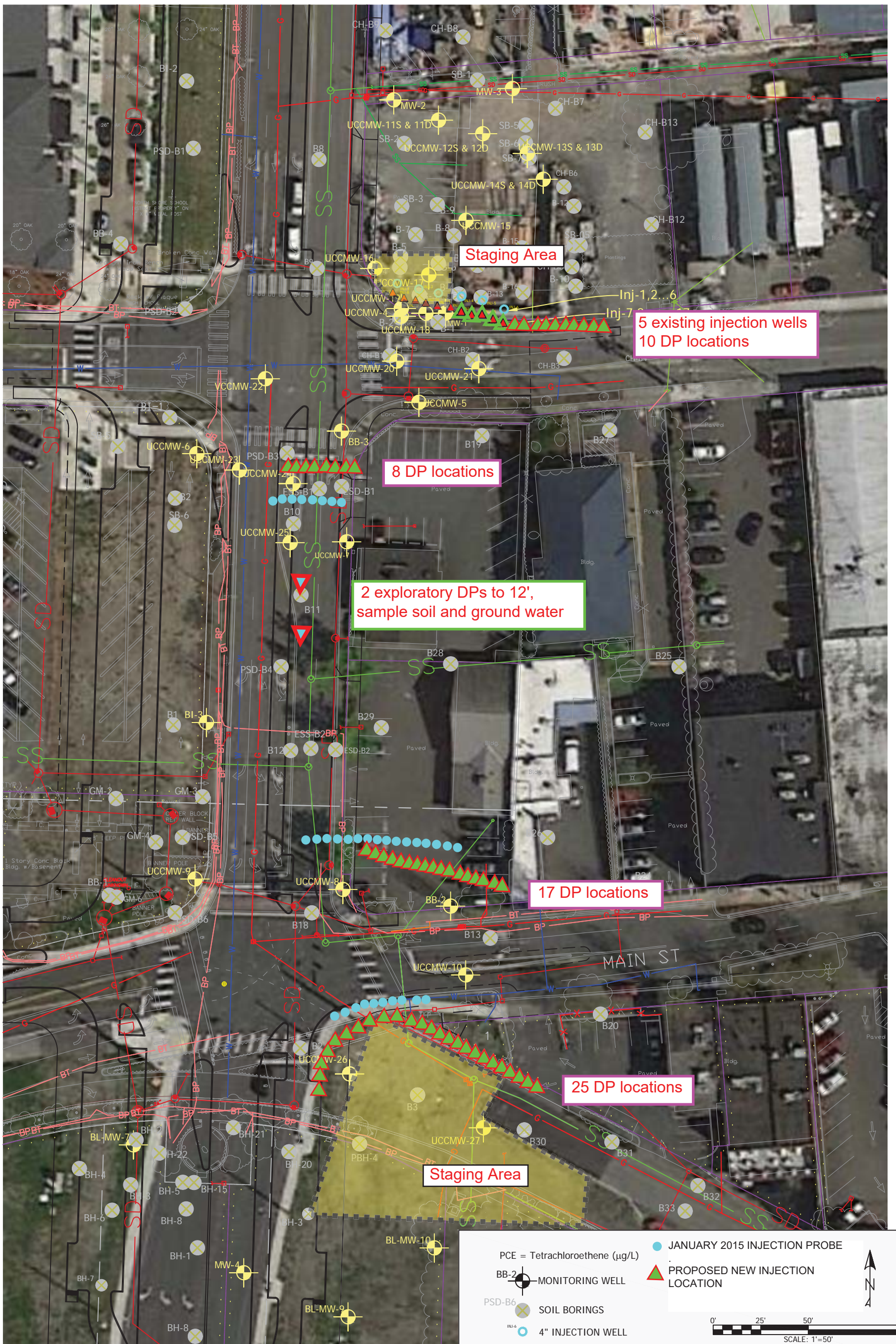


Arnie Sugar, LG, LHG
Principal Hydrogeologist

Attachments:

Figure 1: Planned Second Round Bioremediation Locations
Appendix A - excerpt from: HWA GeoSciences Inc. *Ultra Custom Care Cleaners Site Ground Water Monitoring Report, Third Quarter After Bioremediation*, dated November 30, 2015.

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BASE MAP PROVIDED BY:



HWA GEOSCIENCES INC.

ULTRA CUSTOM CARE CLEANERS SITE
BOTHELL, WASHINGTON

SITE
PLAN

DRAWN BY
EFK
CHECK BY
AS/NN
DATE:
05.20.14

FIGURE #
1
PROJECT #
2007-098-21
T 996

January 26, 2016
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Appendix A

Excerpt from: HWA GeoSciences Inc. *Ultra Custom Care Cleaners Site Ground Water Monitoring Report, Third Quarter After Bioremediation*, dated November 30, 2015

Second injection row – Similar to the previous two rounds of sampling data, PCE concentrations in wells UCCMW-8 and BB-2 decreased; however, redox conditions in UCCMW-8 and UCCMW-10 moved from reducing to oxidative. Negative ORP was temporarily observed at UCCMW-8 previously along with a drop in PCE and the presence of methane; methane is currently present at a higher concentration than observed at that time.

Third injection row – Similar to the previous two rounds of sampling data, PCE concentrations in wells UCCMW-26 and UCCMW-27 decreased; however, only UCCMW-26 has reducing conditions and active dechlorination, as evidenced by increasing DCE, VC, and ethene. This pattern is similar to the second row, in which the western well appears to show better treatment conditions. This may be due to insufficient injection at the eastern edge of the treatment area, more south-westerly ground water flow patterns than anticipated, or preferential flow paths. Since these wells continue to not respond, additional injection in these areas is recommended to reactivate the dechlorination process.

Summary & Recommendations

Overall results are encouraging, with active treatment observed in many wells, as evidenced by decreasing PCE, increased daughter products, and anoxic/reducing conditions. Treatment has been effective in the source area, which is the most important element of the cleanup. Some or most of the HVOC concentrations in downgradient areas may be primarily the result of migration from the source area, as opposed to local sorption from soils. In this case, HVOCs may decrease in downgradient areas over time without active bioremediation in the downgradient areas.

Areas where treatment is not progressing due to insufficient influence of treatment chemicals include:

- Source area – the easternmost, and farthest downgradient wells UCCMW-21 and UCCMW-5, appear to have not received any treatment, and HVOC concentrations, albeit initially low, remain unchanged. Additional localized injections upgradient of these wells are recommended.
- First injection row – Both downgradient wells appear unaffected by treatment. Additional localized injections upgradient of these wells are recommended.
- Second injection row – BB-2 and UCCMW-8 are not maintaining geochemical conditions indicative of treatment chemicals, although PCE concentrations in these wells are decreasing, indicating some positive effects, possibly from upgradient treated areas. Additional localized injections upgradient of these wells are recommended.
- Third injection row – UCCMW-27 is not responding to treatment. Additional localized injections upgradient of UCCMW-27 are recommended.

November 30, 2015
HWA Project No 2007 098

A separate technical memorandum detailing the proposed additional spot injection treatments will be submitted for Ecology's consideration.

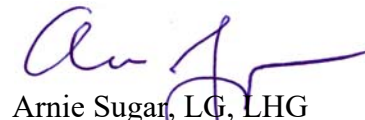


We appreciate the opportunity to provide our services to you on this project. Please feel free to call us if you have any questions or need more information.

Sincerely,
HWA GEOSCIENCES INC.



Jeff Thompson LG, LEG
Environmental Group Manager



Arnie Sugar, LG, LHG
Principal Hydrogeologist

Attachments:

Figure 1: PCE in ground water, October 2015

Figure 2: PCE in ground water, last few rounds

Table 1: Analytical Results for Ground Water Samples