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MOFFETT FIELD
SSIC NO. 5090.3.A.

California Regional Water Quality Control Board

San Francisco Bay Region

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Winston H. Hickox
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April 20, 1999

Commanding Officer
Engineering Field Activity, West
Naval Facilities Engineering Command
Attn: Mr. Stephen Chao
900 Commodore Drive
San Bruno, CA 94066-2402

Dear Mr. Chao:

Subject: In Situ Abiotic Redox Manipulation (ISRM) Phase I Draft Technical Memorandum, Moffett Federal Airfield

The San Francisco Bay Regional Water Quality Control Board (RWQCB) has reviewed the subject report and prepared the following comments for your consideration. RWQCB is pleased to see the bench scale test results (Phase I) and concurs with the Navy to conduct a field pilot study (Phase II) at Moffett Federal Airfield. Please incorporate the enclosed comments in the final Technical Memorandum.

If you have any questions on these comments, please contact me at (510) 622-2334.

Sincerely,

C. Joseph Chou
Remedial Project Manager
San Francisco Bay Regional Water Quality Control Board

Enclosure

cc:
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GENERAL COMMENTS

1. The ISRM bench-scale study has shown that using sodium dithionite to create a reducing environment to remediate trichloroethene (TCE) in groundwater is a promising technique. However, the abiotic in situ oxidation studies also indicated favorable results (McKay and Hewitt, 1998; Tratnyek et al., 1998). In addition, biological reductive dechlorination processes have been more widely studied in recent years. Please explain the rationale for choosing the ISRM among other in-situ techniques for MFA.

2. Please clarify if the injected material will be intercepted by the West-Side Groundwater Aquifer Treatment System?

SPECIFIC COMMENTS

1. Page ES-1, 2nd Paragraph; Executive Summary

It is important to clearly define the "reducible iron". Please explain how to determine the reducible iron content is 1.1 percent at MFA. How can you determine that 0.05 percent of iron will be the minimum criterion to complete the chlorinated solvent degradation process? Can the various Fe-bearing minerals and chemical environment change the percentage of the minimal available iron content?

2. Page ES-1, 2nd Paragraph; Executive Summary

Please clarify if multi-injections of the reducing agent will be needed to maintain the reducing environment. The statement in this section seems different from Section 1.0.

3. Page 1, 2nd Paragraph; Section 1.0

In order to understand TCE and other chlorinated volatile organic compounds (CVOCs) behavior in aqueous phase, it is proper to select the most permeable area at Moffett Field to conduct the ISRM pilot study. But the CVOCs absorbed in a clayey, less permeable aquitard may act differently and should be evaluated.

4. Page 1, 3rd Paragraph; Section 1.0

The text states that trenching costs increase exponentially at depths below 40 feet (A-2 aquifer); therefore, the ISRM may be more cost effective to remediate the chlorinated solvent plume in deeper aquifer. Even without cost analysis information, we probably can assume that a cost

saving may also happen by using ISRM in A-1 aquifer. If so, the Navy may consider replace the permeable zero valence iron wall system with ISRM in the A-1 aquifer as well.

5. Page 5, 2nd Paragraph; Section 3.0

Please clarify if the A-2 aquifer is a reduced or oxidized environment. In addition, please provide detailed mineral composition data, especially for iron rich minerals, to understand the solubility and redox reactions of iron in soils.

6. Page 5, 2nd Paragraph; Section 3.0

Several terms are introduced in this section such as aquifer materials, available iron, structural iron, and fixed reducing zone. All these terms should be clearly defined to avoid unnecessary confusion. For instances, it is not clear to us if the "aquifer materials" include both dissolved and undissolved phases? Are the terms "available iron" and "structural iron in aquifer material" interchangeable? How do you form a "fixed" reducing zone?

7. Page 5, 3rd Paragraph; Section 3.0

Please identify the mineral species that has effectively reduced structural Fe(III) to Fe(II) by sodium dithionite. If the ferric/ferrous iron transformation plays an important role in the ISRM process, more quantitative data should be provided in the report.

8. Page 6, 2nd Paragraph; Section 3.1.1

Please explain how to decide that reaction (1) can be described by a third-order rate law? In general, the rate law can only be determined by experimental data or by analogy to the reactivity of compounds of related structures. We have the same rate law question for some other reactions mentioned in Section 3.1.

9. Page 6, 3rd Paragraph; Section 3.1.1

Is there any experimental data to support that reaction (2) did occur in a slower rate? Please provide references and results of mentioned "other studies".

10. Page 7, 2nd Paragraph; Section 3.1.2

Please discuss the roles of siderite, ferric hydroxide in TCE degradation process.

11. Page 8; Section 3.1.3

In most abiotic multi-electron redox reactions, the actual electron transfer occurs by a sequence of one electron transfer steps, and there are intermediates formed which are often very reactive. This phenomenon, if it exists, cannot be omitted for TCE degradation because those intermediates may pose potential risks to the public and environment.

12. Page 9, 2nd Paragraph; Section 3.1.3

Should we consider different forms of iron (II) as an electron transfer mediator or acceptor?

13. Page 9, 2nd Paragraph; Section 3.1.3

Please discuss why the reductive elimination, not hydrogenolysis, is the major pathway for TCE degradation.

14. Page 19, 4th Paragraph; Section 6.2

Please provide X-ray diffraction (XRD) analysis results (or summary) in the subject report. XRD analysis is useful in identifying clay minerals structure, composition, properties and occurrences. However, it is very difficult to quantify iron content by using XRD method alone.

15. Page 25, 1st Paragraph; Section 7.1

Please, clarify whether the mentioned batch reduction experiment was conducted on the aquitard or aquifer materials at MFA. Also show how to calculate the reducible iron mass by using the batch reduction modeling.

16. Page 25, 1st Paragraph; Section 7.1

How do we know the rapid decrease of dithionite was first caused by reduction alone (0 to 3 hours) and then followed by disproportionation (3 to 50 hours)? How do we know the lines shown in Figure 5 represent a "fast third order reduction reaction"? The assumption that dithionite redox reactions involved a third order reduction, a slow reaction and disporportionation reaction, should be verified by analytical results or previous studies. Numerical model fitting may not be sufficient to prove that reactions 1, 2 and 4 are the specific reactions that occurred.

17. Page 30, 3rd Paragraph; Section 7.2

The measurement of chloroacetylene, acetylene, and ethylene is critical to confirm that the reaction pathway assumption is correctly made. It should be included in the Phase II study.

18. Page 31, 1st Paragraph; Section 7.2

The statement that 60 percent of TCE would be adsorbed by clay minerals, and only a portion of TCE removal was due to dechlorination process, should be confirmed by analytical data.

19. Page 31, 1st Paragraph; Section 7.2

A similar study has been conducted by Thornton and others (1998), their results show TCE degraded with a half-life of about 40 hours which is about four times longer than the results from MFA. Please discuss the difference between these two tests and possible cause of shorter TCE half-life discovered in the subject report.

20. Page 39-40; Section 9.1

Please provide a table to list the estimated cost for the pilot field test and the full scale implementation. According to the text, the total scale ratio between the pilot field work and full-scale installation is about 1 to 60, but the cost is $280,000 to $1,700,000 which seems low compare to the scale ratio.

REFERENCES

McKay, D., A. Hewitt, S. Reitsma, J. LaChance, and R. Baker. 1998. In Situ Oxidation of Trichloroethylene Using Potassium Permanganate: Part 2. Pilot Study. Physical, Chemical, and Thermal Technologies, Remediation of Chlorinated and Recalcitrant Compounds. Battelle Press. Columbus, Ohio. pp. 377-382.

Thorton, E., J.E. Szecsody, K.J. Cantrell, C.J. Thompson, J.C. Evans, J.S. Fruchter, and A.V. Mitroshkov. 1998. Reductive Dechlorination of TCE by Dithionite-Treated Sediment. Physical, Chemical, and Thermal Technologies, Remediation of Chlorinated and Recalcitrant Compounds. Battelle Press. Columbus, Ohio. pp. 335-340.

Tratnyek, P.G., T.L. Johnson, S.D. Warner, H.S. Clarke and J.A. Baker. 1998. In Situ Treatment of Organics by Sequential Reduction and Oxidation. Physical, Chemical, and Thermal Technologies, Remediation of Chlorinated and Recalcitrant Compounds. Battelle Press. Columbus, Ohio. pp. 371-376..