03.01-04/08/96-00271

TERRA VAC

REPORT
FINAL VERSION OF RESPONSE TO EPA'S LETTER OF JULY 27, 1995
TOW WAY FUEL FACILITY
ROOSEVELT ROADS NAVAL STATION
PROJECT NO. 11-0234

April 8, 1996

Prepared for:

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Technical Review Report

The Technical Review is five sections titled Introduction, Methodology, General Overview, Detailed Technical Evaluation and Recommendations. The following responds to each section based on the available data.

1. Introduction

This section raises no issues or comments, but references to two Terra Vac reports for different dates and the same report number. Both the April 17, 1995 (TVR-3) and the May 25, 1995 (TVR-4) reports are Free Product Removal Report 95-01; the May report should be Report 95-02.

2. Methodology

EPAs contractor "review focused on performance information that specifically related to product (petroleum fuel) recovery, corrective action, and the site characterization performed previously at the Tow Way Fuel Facility (p.2). Under Terra Vacs contract with the Navy, the performance of the product recovery system was initially limited to installation and operation of free product recovery systems. The operations where conducted only as an interim measure on the wells present, in response to the Puerto Rico Underground Storage Tank (UST) regulation of the EQB, while others independently performed site characterization.

Accordingly, while the methodology selected for the review is proper for a comprehensive remediation program, it may create overreaching expectations with respect to the 4 selected monthly reports reviewed in this case. However, this is a good opportunity to take a look at the big picture, especially in light of the complex dynamic information gathered to date, in response to EPAs review and presented in the Multi-Phase Report, and enhance product recovery operations in a manner that is most cost effective for the overall cleanup of the site.

3. General Overview

There is a consensus that the four monthly reports present only a fraction of the data needed to evaluate the performance and efficiency of the VAR system. However, the basic assumption used by the EPAs contractor performance evaluation is beyond the scope of the contract. The review "assumes the existence of an O & M Plan [Operations and Maintenance Plan]. The performance of the VAR system is compared in the four monthly reports to the product recovery system in terms of the parameters of concern from the contract perspective, that is, product removal rates and product thickness in operating wells.

The overview further considers the "need to relate the data which are collected during each reporting period to designed and/or predicated performance ranges contained in the O & M Plan." Again, these conditions would be typical for a priori design which is "built to specifications." However, such a design did not exist during reporting period due the constraints of the contracting mechanisms of producing "build to specifications." Furthermore, the time allowed for installation of the recovery system was characteristic with an emergency response approach--that is, do the best with what we have at the time.

In respect to the limitations of the contracting mechanisms and initial objectives of the product removal system, the VAR system is an obvious improvement over the other four product removal systems compared in the four reports and the Multi-Phase Recovery Report. The review suggests that data collected should "serve as criteria for identifying when the VAR system no longer provides remediation benefit in excess of unassisted passive skimming It is obvious from the reports the benefit of the VAR system is more beneficial than the passive skimming system since the product recovery rate is always greater with the VAR system. Furthermore, additional remediation benefits are gained at no extra cost as the soils and groundwater are remediated simultaneously.

The review also suggests "time series charts and graphics that allow rapid analysis of performance trends. There are over 50 such charts and graphics presented in the Multi-Phase Report. Charts and graphs not provided in previous reports are not within scope of the original product recovery contract.

The review further suggests that data be collected to allow determination "if the system is effectively removing product at a rate which justifies the expenses and if system modification/adjustment is necessary." Data is presented as a cost and benefit analysis in Terra Vacs reports for January 1995 showing the VAR System is 42% more cost effective in recovering free product ($1.65/gallon) versus the skimmer pumps ($2.34/gallon).

Shortage of abundant monitoring points used to calculate the radius of effective influence of the VAR system is a concern in the review. This was again due to the limitations of the contract mechanism available and the previous well system only has one pair of wells close enough to evaluate. This deficiency is overcome in the Multi-Phase report, where more than 50 well combinations are evaluated for radius of influence.

The review expressed concern for operating conditions which would limit the smearing of product upward with vacuum effects or downward with lowering of the water table. The Multi-Phase report confronts these operating conditions in detail. Furthermore, the Multi-Phase report shows the VAR system does not smear the

product further than already exists due to natural conditions. The Multi-Phase reports confirms the VAR system to clean up the previously smeared product by 1) removing product above the mobile free product layer through vaporization and enhanced biodegradation, 2) faster, more efficient product recovery over a larger radius of influence than skimmer pumps and 3) cleanup of the contaminated groundwater which has been previously exposed to residual saturation of hydrocarbons.

4.0 Detailed Technical Evaluation

1. TVR-1, Page 3, Phase One Operations: Steady State

According to the review, product recovery will eventually coincide with a reduction in product level, however, in reports (TVR-2, -3, -4), the reductions in product levels have not shown a steady decrease. The VAR system operated from January 4 through February 6, 1995, when the skimming pump system returned to service for a day. The system was shut down on February 7, as instructed by the Navy Contracting Officer. Comparing approximately one month productivity of the VAR system at 345 gallons per day (gpd) with restarting of the skimmer pump at 33 gpd before shut down, further proves the performance of the VAR system.

We agree that monthly reports need to present additional data to prove the general effectiveness of the VAR system. Much of the data requested, such as recovery rates, air and groundwater flow rates, vacuums radii, and treatment zone radii are presented in the Multi-Phase Report in graphical format as requested. However, design criteria and specifications are not available to compare, as the data was generated to test an alternative to the skimmer system rather than because of a separate design objective. During the contract period in question, the only objective available was to maximize product recovery for the lowest cost. As noted in the report TVR-1, a 42% reduction in costs per gallon removed with the VAR system in its initial testing with similar results reproduced in the Multi-Phase test.

2. TVR-1, Page 4, Steady State

We agree that VAR system should run a longer time to judge its long term effectiveness. However, the effectiveness of the VAR system over the skimmer system was demonstrated twice. The first time is January 1995 where product recovery increased over 600% (from 33 gpd to 285 gpd) and more recently in October 1995 increasing 800% (from 15 gpd to 135 gpd).

To further address the concern for reduced product recovery and recharge to the wells there are comparisons made in the Multi-Phase report. Due to limited time and budget, comparisons of essentially four different systems were made in short duration.

However, operations were conducted on a basis to yield data that is as comparative as possible. The present system and monitoring well network at the site, make it possible to address long term product recharge rates as it relates to VAR system performance.

The performance of the skimming system can be further reviewed with the January, February, and March 1996 monthly report data, included as reference in Appendix C. Long term production rates is very closely tied to product recharge in a well with a properly situated pump. The current skimmer system has been reduced to a product recovery rate of 5.10 gpd. The effectiveness of skimmer system has been shown to be quite limited when compared to the VAR system in terms of recovery rates and radius of influence as shown in the Multi-Phase report.

3. TVR-1, page 4, Radius of Influence

Several concerns expressed are addressed in the Multi-Phase Report with the radius of influence testing reported for six different wells and more than 30 measurements. The time constraints to complete the other comparative objectives restricted the development time of the radius of influence. Radius of influence observed in the Multi-Phase testing is consistent with our previously reported radius of influence of approximately 15 feet.

The pneumatic radius (pressure function) compared to the zone of treatment (flow based) is closely related at the low vacuums used in the Multi-Phase test. In a long term operation a higher vacuum would further develop the vapor flow zone in these low permeability soils and overcome some of the effects of extreme heterogeneity's at the site.

The data in the Multi-Phase Report is both graphical and tabular and is provided for further evaluation. However, the reference to predicted design parameters is beyond the scope of the approach taken here.

4. TVR-1, p4. Radius of Influence.

A concern was raised regarding the vacuum effect causing product levels to rise and smearing product onto the soils. Special considerations in the Multi-Phase Test were made to carefully monitor the levels of product and water in the monitoring wells while under vacuum. The impact is assessed in the changes to the piezometric surface. The vacuum applied in the Multi-Phase test was low, so not to create a large rise in the product levels. Concerns of raising or lowering of residual product from the vacuum influence or drawdowns created by the VAR system is small compared to the previously existing smear zone. The existence of this previous smear zone, which is more than eight feet, is shown by the TPH analysis report results from soil sampling undertaken before the Multi-Phase Test. The natural water table fluctuation

is three to five feet at the site, and the vacuum measured at monitoring points several feet from the extraction wells have a limited effect of raising product levels of only a few inches. Furthermore, any residual hydrocarbons exposed to the vacuum system in the vadose zone (above the product and water saturated zone) will be subject to further remediation by the VAR system by volatilization and bioremediation, thus, eliminating any concern for residual oil saturation due to vacuum induced upswelling. Similarly drawdowns are controlled by the VAR system so that maximum product recovery is achieved with minimal drawdown.

The estimated volume of product rendered immobile from the causes of vacuum lift and hydraulic drawdown is zero, since immobile residual product is present at levels below the maximum drawdown and above the levels of the maximum uplift observed at the site.

5. TVR-1, Page 6, Evaluation

A question is raised over whether the cost effectiveness reported for the VAR system at 42% greater than the skimmer pumps included maintenance costs. There is a presumption that appreciable maintenance was required after the pilot test. In fact, the next report states that the VAR system was replaced with the original skimmer system at the request of the Contracting officer on February 6 after the one month pilot test. The reinstallation of the original skimmer system is the origin of the appreciable maintenance, not the VAR system. The next day the operation was shut down due to contract requirements.

Cost effectiveness is determined by an all inclusive cost per gallon of recovered product since optimizing the product recovery rate was the primary objective at the time. Costs for water treatment are considered nil since the marginal cost of treating these small volumes in the waste water treatment system are insignificant.

The question of an operations and maintenance plan is raised numerous times, however, in context of the pilot testing mode in which the VAR system was operated, an O & M plan was beyond the scope of the project objectives. The operation of the VAR system was originally considered as enhancement to the skimmer pumps and tested for a one month pilot test from January 4 to February 6, 1995. The VAR system was installed again as a comparative test as reported in the Multi-Phase report. Currently, the original skimmer system is operating according to the contract and direction provided by the Navy representatives.

6. TVR-1, Page 6, Sec. 3, Evaluation

To estimate the relative removal area for the VAR system compared to the skimmer system, the estimated radius of influence of the skimmer pump is two fee, since there is essentially no hydraulic

gradient induced by the pump. The two-foot radius of influence is substantiated by the limited product removal before startup of the VAR system and the substantial reduction and continued small or nonexistent product thickness in well UGW-5. Comparatively the area of a 15-ft radius of influence is more than 50 times the area effected by a 2-foot radius.

As a general statement, it has been documented at hundreds of sites and well know that VAR is effective to remove contaminants from above the water table via volatilization and biodegradation. Specific data to support this effect at this site seemed unwarranted and beyond the scope of the pilot test and the Multi-Phase test.

7. TVR-1, Summary of Conclusions

The review contends that "the effectiveness and efficiency of the VAR system seemed to drop substantially (TVR-3, p.3). While it is true that the recovery rates did drop substantially in the periods after the test, it was because the skimming system, as requested by the Navy representatives, was reinstalled after the VAR pilot test was completed on February 6, 1995. Thus, the subsequent reports are about product recovery using only the skimmer system rather than the VAR system. Please refer back to TVR-2, page 2, lines 1-3 which note that the recovery system was changed from the VAR system to the skimmer pumps. The observation in the review is accurate in noting the skimmer pumps were even less effective after the one month VAR system pilot test since productivity dropped 1200% as compared to the VAR system. However, the assumption the VAR system is still operating throughout the four-month period, which it was not, leads the reviewer to some erroneous conclusions regarding the long term effectiveness of the VAR system.

8. TVR-3, Summary of Conclusions

Again, this comment is misdirected at the VAR system effectiveness since during the period of this report, the VAR system was not in operation, instead only the skimmer pump system was operating. The statement about "the well recharge rate is now only being affected by the force of gravity, with no additional forces acting on the free product mass is accurate with respect to the skimmer pumps.

9. TVR-4, page 1, Field Activities

RCRA samples are required by the contract every 1000 gallons of extracted product.

5.0 Recommendations

Five major points are raised in this section:

- The request for time series charts with accompanying graphs for all data collected is met by more than 50 tables and 50 graphs representing the data collection of the Multi-Phase report in response to the EPA review. The Multi-Phase Test was conducted specifically to address performance of the VAR system and others so that the most effective system can be operated at the site to achieve cleanup objectives.

- The system could be expanded on a modular basis or modified as needed following the observational approach so to efficiently treat the contaminated area of the site. Based on the data collected to date, the optimal vacuum is in the range of 8-10 in. Hg.

  Computer models are often quite helpful in making predictions of performance and changes in efficiency and other decisions regarding modifications. However, due to the extreme variability and limitations of existing site characterization data and other complex interactions at the site, the value of sound judgement based on experience in monitoring and adjusting performance according to an observational approach is expected to be more cost effective at this site than modeling.

- Very close attention has been paid to the concern of upswelling causing additional residual saturation in the Multi-Phase Report. Excessive smearing already exists at the site below the water table and in the weathered bedrock to depths of 21 feet and about 10 feet above the water table in the vadose zone. Therefore, it is difficult to envision how the VAR system can cause any more smearing of residual product or reduction in the volume of product removed when it consistently produces 600% to 1200% more product than the existing skimmer pumps. Accordingly, based on presented operational data and regardless of any specific cleanup objectives, it is clear that the VAR system will move faster and more cost effectively toward achieving the remediation goals at the site.

- Numerous tests made in the Multi-Phase Test address the radii of influence from a multiple well, multidirectional approach.

- Criteria can be made to determine when the VAR system is no longer providing any additional remediation benefit. Three primary criteria should be monitored, product recovery rates, water production, and hydrocarbon mass removal (vapor phase and biodegradation to CO_2). Secondary criteria to measure to optimize primary parameters include; Vacuum, depth of water and product, extractor depths, air flow rates, product quality, water/ hydrocarbon concentrations, and soil concentrations when the cleanup objectives are met. These

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criteria would be measured once the VAR system is reinstalled and operating at each well regularly.

We will contact you shortly to discuss any questions you may have.

Very truly yours,

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TOTAL NUMBER OF PAGES INCLUDING COVER SHEET: 29 **DATE: 09 Apr 96**

SUBJ: TOW WAY FUEL FARM (SWMU # 7)

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MESSAGE: Tom, enclosed are copies of the last monthly reports, Jan, Feb, and Mar 96 for your reference. Also, I'm including the final version of Terra Vac's response to the EPA letter we discussed last week. You can throw away the draft copy I gave you. If you have any questions, please let me know.

Copy to:
Art Wells (LANTDIV) Art I'm not sending you the mothly's since you have them. PJR