

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL VALLEY REGION

ORDER NO. R5-2007-0025

WASTE DISCHARGE REQUIREMENTS

FOR
THE UNITED STATES AIR FORCE
BEALE AIR FORCE BASE
IN-SITU CHEMICAL OXIDATION TREATABILITY STUDY FOR REMEDIATION OF
VOLATILE ORGANIC CONSTITUENTS AT SITE 32
YUBA COUNTY

The California Regional Water Quality Control Board, Central Valley Region (hereinafter the Regional Water Board), finds that:

1. The United States Air Force (hereafter Discharger), submitted a *Draft Design Workplan for Site 32 Remedial Action* (Draft Work Plan), on 6 January 2007 for the design and operation of an in-situ chemical oxidation (ISCO) system as a full-scale treatability study. The treatability study will assess the efficacy of the ISCO system in providing remediation of polluted groundwater at Beale Air Force Base in Yuba County. The Draft Work Plan provides the information required in a Report of Waste Discharge.
2. The project area is in Section 16, T5E, R15N, MDB&M and is shown in Attachment A, which is attached hereto and made part of this Order by reference. The project area is known as Environmental Restoration Program (ERP) Site 32 and the proposed remediation is being conducted as part of a performance based contract between the Discharger and CH2MHill. CH2MHill will construct and operate the ISCO system. The Draft Work Plan provides the necessary information for preparation of these waste discharge requirements (WDRs).
3. Clean up of sites that have groundwater polluted by Volatile Organic Constituents (VOCs) can be complex and difficult. Traditional pump and treat or vapor extraction systems may not work effectively in complex geologic conditions or at sites with low permeability soils. If properly designed and managed, the addition of treatment enhancing substances (TES) such as those used in the ISCO system can be an effective treatment technology capable of enhancing the bioremediation of VOCs in groundwater and reducing cleanup times. The operation of an ISCO treatment system within the area of a groundwater plume is intended to provide an environmentally beneficial and efficient cleanup. The discharge of TES to groundwater must be conducted in a manner that improves corrective action treatment capabilities but also minimizes any additional degradation of groundwater quality with constituents of TES.
4. The Discharger proposes the TES potassium permanganate (KMnO_4) as an oxidant for in-situ chemical oxidation to treat groundwater pollution at ERP Site 32. Findings

17 through 22 describe how the Discharger will implement a full-scale treatability study for in situ chemical oxidation at ERP Site 32. The Discharger operated a pilot-scale treatability study, described in Findings 9 through 16, using KMnO_4 . KMnO_4 is a chemical that is injected into subsurface groundwater pollution source zones where upon reaction with the KMnO_4 , chlorinated VOCs are broken down into inert constituents such as carbon dioxide, hydrogen, chloride, and water.

5. Groundwater beneath Beale Air Force Base contains VOCs, primarily trichloroethene (TCE) and tetrachloroethene (PCE) and their degradation products. TCE and PCE are solvents that were used primarily in cleaning operations and have Primary Drinking Water Standards (MCLs), of 5 micrograms per liter (ug/L). In addition, the California Office of Environmental Health Hazard Assessment has established Public Health Goals for TCE and PCE in water of 0.8 ug/L and 0.06 ug/L, respectively.

BACKGROUND

6. Site 32 is within the flightline area of Beale AFB and is comprised of several VOC groundwater pollution source areas near Building 1086. These areas include an industrial waste line, several former USTs, washracks and oil water separators, which have all been identified to varying degrees as source areas for groundwater pollution. Operations at Building 1086, within Site 32, included assembly of Titan missiles and maintenance of equipment used on B-52 bombers.
7. The Air Force has constructed approximately eighty monitoring wells in the flightline area at Beale AFB and has identified two primary water bearing zones (shallow and deep) which consist of coarse grained alluvial layers. The groundwater flow direction in these water-bearing zones is primarily to the west and southwest. The water bearing zones become thicker and also become more permeable west of Site 32. Water elevation measurements from the two water bearing zones suggest that an upward vertical groundwater gradient exists between these zones. An upward vertical gradient in the treatment areas may have a potential benefit of reducing the KMnO_4 demand in groundwater and enhancing the remedial activities within the treatment areas.
8. The maximum historical concentration of TCE in groundwater beneath Site 32 is 5179 ug/L. The concentrations detected in monitoring wells located at Site 32 have shown both increasing and decreasing trends, which may be a function of changing groundwater flow conditions and/or soil cleanup activities. A Soil Vapor Extraction System, which has been in operation at Site 32 since 1998 and was optimized and expanded several times, has removed over 1700 pounds of VOCs from the vadose zone. Water elevations have risen by approximately 25 feet over the last 15 years in the flightline area and other areas of the Base. The rising water table observed in the flightline area is a function of: reduced off-site agricultural usage of groundwater; increased usage of surface water for agricultural purposes in areas surrounding the western side of the Beale AFB; and, normal rainfall events. These factors have contributed to changing groundwater flow conditions on the Base. The rising water

table has made it difficult to identify preferred pathways for groundwater contamination at Site 32 and has caused the Discharger to focus the source area cleanup activities on relatively small areas within the TCE plume boundary shown in Attachment B, which is attached hereto and made part of this Order by reference.

SITE 32 PILOT-SCALE TREATABILITY STUDY

9. The Discharger performed a pilot-scale treatability study for Site 32 using KMnO_4 in one of the source areas within the Site 32 area that contained concentrations of TCE above 1000 ug/L. The Discharger started the pilot-scale treatability study in September 2005 and has provided monitoring data and other information necessary to support the design and operation of a full-scale treatability study in the Site 32 area.
10. The pilot-scale treatability study evaluated the cost/benefit of implementing a full-scale ISCO remedial action using KMnO_4 at Site 32. The factors evaluated included the appropriate dosage of KMnO_4 , number of injections necessary to achieve complete breakdown of TCE, and construction and location of injection points.
11. The pilot-scale treatability study included specific capacity testing, calculation of hydraulic gradients, groundwater flow modeling to predict hydraulic response and collection of baseline field parameters. The Discharger collected baseline field parameters for specific conductance, pH, oxidation-reduction potential (ORP), dissolved oxygen, water temperature and turbidity. Observation wells within the treatability study area were also sampled for VOCs and metals (including hexavalent chromium).
12. The discharger injected about 15,540 gallons of KMnO_4 solution in one injection well (about a 1 percent solution of KMnO_4) over a 3-day period in early September 2005. The injection rate ranged from 11 to 19 gallons per minute (gpm).
13. In early November 2005, the discharger performed a hydropunch investigation near the injection well and observation wells. The purpose of the hydropunch investigation was to evaluate the initial oxidant radius of influence and also identify the distribution of VOCs and metals in the treatability study area. The hydropunch investigation confirmed the presence of elevated TCE near the injection well. The hydropunch data was also useful in providing additional data for developing baseline concentrations for metals.
14. Analytical sampling performed for the observation wells and the injection wells in the treatability study prior to KMnO_4 injection indicated TCE concentrations ranged from 1050 to 1090 ug/L. Post-injection sampling indicated TCE concentrations were below detection limits in the injection well and 0.24 ug/L in one observation well (downgradient of the injection well). One observation well, located upgradient of injection well, showed a slight increase in TCE concentrations from 994 to 1030 ug/L.

TCE daughter products, commonly produced during bioremediation, were not detected in the treatability study area

15. The pre-injection baseline groundwater data from August 2005 and post-injection groundwater data collected from the observation wells and the injection well between December 2005 and November 2006 suggest that KMnO_4 provided successful removal of VOCs from groundwater in the area downgradient of the injection well (15 foot radius from the injection well). Concentrations of several constituents (manganese, chromium, hexavalent chromium, chloride and selenium) that were initially detected below respective secondary and primary MCLs, were detected above baseline concentrations after injection of KMnO_4 . However, groundwater data collected in November 2006 shows that the concentrations of manganese, chromium, hexavalent chromium, selenium and chloride reduced to baseline concentrations. The Discharger stated that this data suggests elevated metals concentrations induced by KMnO_4 are a temporary condition.
16. Under aerobic conditions manganese is typically present in groundwater zone as relatively insoluble oxides or hydroxides. During injection of KMnO_4 , manganese is injected as part of the KMnO_4 . When the oxidized permanganate reacts with TCE, manganese oxide is formed. Manganese oxide is relatively insoluble and not very mobile. Chromium in the aquifer is oxidized with the addition of KMnO_4 to form hexavalent chromium. Hexavalent chromium is a known carcinogen. Chromium and manganese that are mobilized and formed by the oxidation process are quickly immobilized when the groundwater returns to normal redox conditions.

PROPOSED REMEDIATION PROJECT

17. Layout and operation of the Full-Scale Treatability Study system at Site 32 that will be operated under these waste discharge requirements is designed to provide treatment of the uppermost water-bearing zone, which is 60 to 80 feet below ground surface. The KMnO_4 treatment area, shown in Attachment C, which is attached hereto and made part of this Order by reference, overlays the 1000 $\mu\text{g/L}$ TCE plume area. The treatability study will include the installation of up to 31 injection points aligned in a grid over the 1000 $\mu\text{g/L}$ TCE plume area. The location of the injection wells will be modified as necessary to assure treatment of the 1000 $\mu\text{g/L}$ TCE plume area and could also be modified to provide cleanup of the 500 $\mu\text{g/L}$ TCE plume area, if shown to be technically and economically feasible.
18. The area treated by KMnO_4 is divided into a treatment zone area and a transition zone area as shown in Attachment D, which is attached hereto and made part of the Order by reference. The treatment zone area includes injection wells that deliver amendments to provide degradation of VOCs. The transition zone area surrounds the treatment zone area and is the area where extremely aerobic conditions, created by the KMnO_4 , will return to natural aerobic conditions. Within the transition zone area it is expected that the oxidized metals mobilized in the treatment zone will be reduced and precipitate, becoming immobile. It is expected that residual concentrations of

KMnO₄, potentially migrating from the treatment zone, will be completely consumed in the transition zone.

19. The Discharger proposes to perform the injections of KMnO₄ in two phases within the 1000 µg/L plume area. The first injection phase of the project will provide additional data to better define the distribution of VOCs and evaluate if other potential source areas should be addressed during step out injections from the initial treatment areas within the treatment zone shown in Attachment D. Also, this phased approach is necessary to assure that uncertainties (hydraulic properties) are considered and the KMnO₄ is properly distributed. The first phase of the project is planned in April 2007 with the second phase occurring 6 to 12 months later. The Discharger anticipates that it may require up to one year following the final injection of KMnO₄ to achieve sufficient reduction in TCE mass that would allow the Discharger to achieve aquifer cleanup goals within the treatment zone. Attachment D shows the proposed layout of injection points as well as monitoring wells, which will evaluate the cleanup activities.
20. A groundwater flow model that was previously included in the Site 32 Feasibility Study was updated and included in the Draft Work Plan. The groundwater flow model was used to evaluate the impacts of the planned KMnO₄ on the regional flow field. The model was run under steady-state conditions using the heads generated by the January 2002 flow field as the initial condition. Using the model generated flow field, flow lines were started at the perimeter of the anticipated treatment zone and tracked forward for 2 years. The area covered by these flow lines represented the transition zone. Additional hydraulic data will be collected from the injection wells to be constructed for the KMnO₄ injection and, additional groundwater modeling will be conducted to confirm the configuration of these wells is adequate to provide adequate distribution of KMnO₄ within the treatment zone. The modeling will also be updated to evaluate if the location of the compliance monitoring well network is adequate to show compliance with this Order.
21. The installation of the ISCO treatment system at Site 32 includes a field investigation upgradient of the areas shown in Attachment D, which will address concerns by Regional Board staff that additional VOC source areas may exist upgradient of the treatment area. The scope of the field investigation will include drilling cone penetrometer test borings and the installation of monitoring wells to evaluate other potential source areas. If necessary, the Discharger will expand the treatment areas, shown in Attachment D, to include remediation of other high concentration source areas at Site 32.
22. Performance of the KMnO₄ will be assessed by monitoring the decline of VOC concentrations coupled with the increases in ORP and permanganate in the monitoring wells. The consumption of KMnO₄ by soil and groundwater and the reduction of TCE concentrations will provide estimates of TCE mass removal.

OTHER

23. The ISCO project proposed in these WDRs has the potential to cause an increase in concentration of some dissolved metals and other indicator constituents inside the treatment zone and transition zone that are above baseline conditions. It is reasonable and appropriate that groundwater monitoring be conducted by the Discharger to demonstrate that metals and other indicator constituents return to baseline concentrations within these treatment areas
24. These proposed cleanup activities will also be referenced in an Interim Record of Decision that the Discharger is preparing. This Interim Record of Decision does not address the distal portion of the VOC plume at Site 32. The Discharger will address the distal portion of the VOC plume with a different remedial approach, which may include monitored natural attenuation. A Final Record of Decision (ROD) for groundwater remediation at Beale Air Force Base will include, in part, the selected remedy for all of Site 32 – the area covered by this treatability study and the areas upgradient and downgradient from the treatability study. Thus, the ROD will address residual pollutants within the treatability study area.

BASELINE SAMPLING

25. The Discharger will collect groundwater samples to assess site condition baseline concentration ranges for pollutants, ions, metals, and other by-products, at least one week prior to the first phase of KMnO_4 injection. The baseline groundwater samples will be collected from the compliance monitoring wells and monitoring wells within the treatment and transition zone, as defined in Findings No. 17 and 18. Baseline sample analyses will include all constituents and associated analytical methods listed in MRP No. R5-2006-0025. The sampling data will be used to determine baseline concentrations for these constituents, as appropriate, using EPA and Regional Board staff approved statistical methods to define the 95% upper confidence limit for a specified constituent based on the analytical results from all the samples collected at all the sample locations. Baseline concentrations are defined as those values contained within the 95% confidence interval. Immediately before baseline sampling begins, groundwater elevation levels will be measured at each baseline monitoring well location.

CONTINGENCY PLAN

26. The Discharger has submitted a contingency plan, which was provided in the Draft Work Plan and would address potential violations of this Order. The Discharger proposes to implement the contingency plan in the event potassium permanganate, dissolved chromium, hexavalent chromium or dissolved manganese are detected above baseline concentrations in any of the downgradient compliance monitoring wells. If groundwater monitoring data indicate that any of these constituents are above baseline concentrations, the Discharger would conduct confirmation sampling within 7 days of receiving these results and would also notify Regional Board staff if

any of these constituents are detected above baseline concentrations. The Discharger believes, based on the groundwater flow velocity estimates for the site, that the soonest dissolved manganese, dissolved chromium or potassium permanganate would be expected to reach downgradient compliance monitoring wells about 2 years after injection of KMnO_4 . Provision D.4 describes how the contingency plan would be implemented by the Discharger. Provision D.3 identifies the compliance monitoring network for this treatability study.

27. The Contingency Plan, and any approved revisions thereto, includes provisions to install additional monitoring wells to confirm the exceedance of baseline conditions. If exceedance of baseline conditions is confirmed, then pursuant to the Contingency Plan, the Discharger will install and operate an Enhanced Bioremediation System using sodium thiosulfate, sodium lactate, emulsified oil, and/or cheese whey. The installation and operation of an Enhanced Bioremediation System would require submittal of a Corrective Action Work Plan, describing the Enhanced Bioremediation project. Prior to implementation, the Corrective Action Work Plan would require approval by the Executive Officer. These Waste Discharge Requirements, including the Monitoring and Reporting Program, would be revised, as necessary, to reflect the operation of the new project and evaluate the adequacy of the VOC treatment and the reduction of dissolved metals concentrations and other pollutants to pre-treatment conditions.

REGULATORY CONSIDERATIONS

28. *The Water Quality Control Plan, Fourth Edition, for the Sacramento and San Joaquin River Basins, Fourth Edition*, (hereafter Basin Plan) designates beneficial uses, establishes water quality objectives (WQOs), contains implementation plans and policies for protecting waters of the basin, and incorporates by reference plans and policies adopted by the State Water Resources Control Board (State Board). Pursuant to ¶ 13263(a) of the California Water Code (CWC), waste discharge requirements must implement the Basin Plan.
29. The designated beneficial uses of underlying groundwater include:
 - a. Municipal and domestic water supply (MUN);
 - b. Agricultural water supply (AGR);
 - c. Industrial service supply (IND); and
 - d. Industrial process supply (PRO).
30. State Board Resolution No. 92-49 (hereafter Resolution No. 92-49) requires the Regional Board to require actions for cleanup and abatement of discharges that cause or threaten to cause pollution or nuisance to conform to the provisions of State Board Resolution No. 68-16 (hereafter Resolution No. 68-16) and the Basin Plan. Pursuant to Resolution No. 92-49, the Regional Board shall ensure that dischargers are required to clean up and abate the effects of discharges in a manner that promotes attainment of either background water quality, or if background levels of

water quality cannot be restored, the best water quality which is reasonable and which complies with the Basin Plan including applicable WQOs.

31. Resolution No. 68-16 requires the Board in regulating discharges to maintain high quality waters of the state until it is demonstrated that any change in quality will be consistent with maximum benefit to the people of the State, will not unreasonably affect present and potential beneficial uses, and will not result in water quality less than that described in plans and policies (e.g., quality that exceeds WQOs). Temporal degradation of groundwater may occur at this site within the defined treatment zone and transition zone due to the amended groundwater injection. The temporary degradation allowed by this Order is consistent with Resolution No. 68-16 since (1) the purpose is to accelerate and enhance remediation of groundwater pollution and such remediation will benefit the people of the state; (2) the discharge facilitates a project to evaluate the effectiveness of cleanup technology in accord with Resolution No. 92-49; (3) the degradation is limited in scope and duration; (4) best practicable treatment and control, including adequate monitoring and hydraulic control to assure protection of water quality, are required; and (5) the discharge will not cause WQOs to be exceeded beyond the treatment zone and transition zones. A slight residual increase in salts (primarily chloride and potassium concentrations above baseline concentrations) will likely occur. However, those concentrations will return to baseline following inflow of groundwater from upgradient of the treatability study area.
32. As described in the Basin Plan, groundwater cleanup goals range between background concentrations to the water quality objectives (WQO), unless background for naturally occurring constituents is higher than the WQO, in which case the cleanup goals are the background concentrations. For this site, the background concentrations for VOCs are the detection limits, since these compounds are not known to be present upgradient of the site. For some pollutants, ions, metals, and other by-products associated with the injection of potassium permanganate, background concentrations may need to be developed or may be represented by baseline concentrations. The applicable WQO is the narrative toxicity objective. Numerical limits in this Order implement the narrative objective. The following are the WQOs for VOCs present at this site:

Constituent	WQO	Reference
Cis-1,2 dichloroethene	6.0 µg/l	California Department of Health Services Primary MCL ¹
Trichloroethene	0.8 µg/l	California Public Health Goal in Drinking Water
Tetrachloroethene	0.06 µg/l	California Public Health Goal in Drinking Water

¹MCL Maximum Contaminant Level

33. The action to adopt these Waste Discharge Requirements for the United States Air Force is exempt from the provisions of the California Environmental Quality Act (Public Resources Code Section 21000, et seq.) (CEQA) because it: (1) authorizes

activity that will result in a minor modification to land pursuant to Title 14, California Code of Regulations, Section 15304; (2) consists of an action by a regulatory agency authorizing actions for the protection of the environment pursuant to Title 14, California Code of Regulations, Section 15308; and (3) authorizes minor cleanup actions costing \$1.5 million or less that are taken to prevent, minimize, stabilize, mitigate, or eliminate the release or threat of release of a hazardous waste or substance pursuant to Title 14, California Code of Regulations, Section 15330.

34. The discharge is exempt from the requirements of *Consolidated Regulations for Treatment, Storage, Processing, or Disposal of Solid Waste*, set forth in the Title 27, California Code of Regulations (CCR), section 20005 *et seq.* (hereafter Title 27), which allows a conditional exemption from some or all of the provisions of Title 27. The exemption, pursuant to Title 27 CCR Section 20090(b), is based on the following:

- a. The Regional Water Board is issuing waste discharge requirements.
- b. The discharge is in compliance with the applicable Basin Plan.
- c. The wastewater does not need to be managed according to Title 22CCR, Division 4.5 and Chapter 11 as a hazardous waste.

Section 20090(d) allows exemption for a project to cleanup a condition of pollution that resulted from an unauthorized release of waste based on the following:

- d. The discharge of potassium permanganate to groundwater is at the direction of the Regional Water Board to cleanup and abate conditions of pollution or nuisance resulting from the unauthorized release of pollutants.
- e. Wastes removed from the immediate place of release will be discharged according to the Title 27 regulations; and
- f. The remedial actions intended to contain wastes at the place of release shall implement the Title 27 regulations to the extent feasible.

35. Section 13267(b) of the California Water Code provides that:

“In conducting an investigation specified in subdivision (a), the Regional Board may require that any person who has discharged, discharges, or is suspected of having discharged or discharging, or who proposes to discharge within its region, or any citizen or domiciliary, or political agency or entity of this state who has discharged, discharges, or is suspected of having discharged or discharging, or who proposes to discharge waste outside of its region that could affect the quality of the waters of the state within its region shall furnish under penalty of perjury, technical or monitoring program reports which the Regional Board requires. The burden, including costs of these reports, shall bear a reasonable relationship to the need for the reports and the benefits to be obtained from the reports. In requiring these reports, the Regional Board shall provide the person with a written explanation with regard to the need for

the reports, and shall identify the evidence that supports requiring that person to provide the reports.”

The technical reports required by this Order and the attached MRP No. R5-2007-0025 are necessary to assure compliance with these WDRs. The Discharger operates the facility that discharges the waste subject to this Order.

36. The California Department of Water Resources sets standards for the construction and destruction of groundwater wells, as described in *California Well Standards Bulletin No. 74-90* (June 1991) and *Water Well Standards: State of California Bulletin No. 94-81* (December 1981). These standards, and any more stringent standards implemented by the Regional Water Board or adopted by the Yuba County pursuant to California Water Code Section 13801 apply to all monitoring and injection wells.
37. Section 3020(b)(2) of the Resource Conservation and Recovery Act (RCRA) states that prior to injection into or above an underground source of drinking water, contaminated groundwater shall be “...treated to substantially reduce hazardous constituents prior to such injection.” In a letter dated 10 December 1999, the United States Environmental Protection Agency, Office of Solid Waste and Emergency Response (OSWER) states, “if extracted groundwater is amended at the surface (i.e., “treated”) before reinjection, and the subsequent in-situ bioremediation achieves a substantial reduction of hazardous constituents the remedy would satisfy Section 3020(b)(2).” Therefore, the injection of groundwater within the treatment zone at this site, with or without the treatment for VOCs, complies with Section 3020(2)(b) of RCRA.
38. The Regional Water Board has notified the Discharger and interested agencies and persons of its intent to prescribe waste discharge requirements for the in-situ treatment technology discussed in this Order, and has provided them with an opportunity to submit their written comments and recommendations.
39. Pursuant to California Water Code Section 13263(g), discharge is a privilege, not a right, and adoption of this Order does not create a vested right to continue the discharge.
40. All the above and the supplemental data and information and details in the attached Information Sheet, which is incorporated by reference herein, were considered in establishing the following conditions of discharge.
41. The Discharger and interested agencies and persons were notified of the intent to prescribe WDRs for this discharge and provided with an opportunity for a public hearing and an opportunity to submit written views and recommendations.
42. In a public meeting, all comments pertaining to these Waste Discharge Requirements were heard and considered.

IT IS HEREBY ORDERED that, pursuant to Sections 13263 and 13267 of the California Water Code, the United States Air Force, its agents, successors, and assigns, in order to meet the provisions contained in Division 7 of the California Water Code, and regulations and guidelines adopted thereunder, shall comply with the following while conducting the above described cleanup activities:

[Note: Other prohibitions, conditions, definitions, and some methods of determining compliance are contained in the attached "Standard Provisions and Reporting Requirements for Waste Discharge Requirements" dated 1 March 1991, incorporated herein.]

A. Discharge Prohibitions

1. Discharge of wastes or any pollutant to surface waters or surface water drainage courses is prohibited.
2. Discharge of waste classified as 'hazardous' under Title 23 CCR Section 2521 or 'designated' as defined in California Water Code Section 13173 is prohibited.
3. The discharge/injection of potassium permanganate, sodium thiosulfate, sodium lactate, emulsified oil, and/or cheese whey by the Discharger at a location or in a manner different from that described in Findings 17 through 22 or the Contingency Plan provided in the Draft Work Plan, or any approved revisions thereto, is prohibited.
4. Creation of a pollution, contamination, or nuisance, as defined by Section 13050 of the California Water Code (CWC), attributable to operation of the ISCO system is prohibited.

B. Discharge Specifications

1. The discharge of potassium permanganate, sodium thiosulfate, sodium lactate, emulsified oil, and/or cheese whey shall be limited to the minimum necessary for effective in-situ treatment of groundwater and remain within the project areas as shown in Attachment D. The Discharger shall not add more than twenty times the stoichiometric derived demand for potassium permanganate in the treatment zone area.
2. The Discharger shall implement the Contingency Plan contained in the Draft Work Plan, and any Regional Board staff approved amendments thereto, to address any violation, or potential violation, of this Order including, but not limited to; conditions of soil, groundwater or air quality pollution, contamination, or nuisance created by the discharge of potassium permanganate, possible breakdown products from the application of potassium permanganate, inadequate oxidant distribution, lower-than-

expected mass reduction rates, excessive contaminant migration, fugitive emissions or aquifer clogging.

3. The Discharger shall maintain the ability to implement the Contingency Plan within the transition zone area shown in Attachment D and provide hydraulic control within a 250 foot radius from the downgradient edge of the transition zone of any groundwater pollutants, amendments, and breakdown products either injected or created by the full-scale treatability study. The Discharger shall maintain the ability for hydraulic control within a 250 foot radius downgradient of the transition zone area and until the aquifer has recovered to pre-injection conditions, or until the Discharger can demonstrate that any parameters that exceed baseline concentrations as a result of potassium permanganate, sodium thiosulfate, sodium lactate, emulsified oil, and/or cheese whey injection show a decreasing trend. The ability to provide hydraulic control shall be maintained until discontinuance is approved by the Executive Officer.
4. The groundwater shall not be amended with materials other than potassium permanganate. However, if the Contingency Plan is implemented, the groundwater shall not be amended with materials other than sodium thiosulfate, sodium lactate, emulsified oil, and/or cheese whey.
5. The Discharger shall not cause the permeability of the aquifer, either inside or outside of the treatment areas, to be affected to such a degree that the Discharger is unable to effectively operate extraction wells for the purpose of containing the injected material and or its byproducts.
6. Objectionable odor originating at the treatment zone area using potassium permanganate shall not be perceivable beyond the limits of the Site.

C. Groundwater Limitations

1. The release, injection, discharge or addition of constituents from a remediation system shall not cause or contribute to exceedance of any water quality objective outside of the treatment and transition zones, as delineated in Attachment D, during the project. Compliance with this Limitation is assessed at the Points of Compliance defined in Monitoring and Reporting Program No. R5-2007-0025.
2. Following completion of the project, the concentrations of pollutants in groundwater shall not exceed background concentrations. Exceptions to this Limitation are concentrations of potassium and chloride, which will be released during the operation of project. The concentration of potassium and chloride at the Points of Compliance defined in Monitoring and Reporting Program No. R5-2007-0025 shall not exceed 20% over their respective background concentrations.
3. During operation of the project, the Discharger shall not cause an increase in the concentration of amendments or redox sensitive metals outside of the treatment and

transition zones. Compliance with this Limitation is assessed at the Points of Compliance defined in Monitoring and Reporting Program No. R5-2007-0025.

4. The Discharger shall not cause the groundwater outside of the treatment and transition zones to contain taste and odor producing substances in concentrations that cause nuisance or adversely affect beneficial uses.
5. The Discharger shall not cause the permeability of the aquifer, either inside or outside the treatment zone, to be affected to such a degree that the Discharger is unable to provide any necessary hydraulic control of the treatment and transition zones.

D. Provisions

1. The Discharger shall comply with all applicable "Standard provisions and Reporting Requirements for Waste Discharge Requirements", dated 1 March 1991, which are attached hereto and by reference a part of this Order. This attachment and its individual paragraphs are commonly referenced as "Standard Provision(s)".
2. The Discharger will be required to submit technical and monitoring reports pursuant to California Water Code Section 13267 as directed by the Executive Officer. The technical reports required by this Order are necessary to assure compliance with this Order. In accordance with California Business and Professions Code sections 6735, 7835 and 7835.1, engineering and geologic evaluations and judgments shall be performed by or under the direction of registered professionals competent and proficient in the fields pertinent to the required activities. All technical reports specified herein that contain work plans for, that describe the conduct of investigations and studies, or that contain technical conclusions and recommendations concerning engineering and geology shall be prepared by or under the direction of appropriately qualified professional(s), even if not explicitly stated. To demonstrate compliance with Title 16,CCR, Sections 415 and 3065, all technical reports must contain a statement of qualifications of the responsible registered professional(s) as well as the professional's signature and/or stamp of the seal. Violations may result in enforcement action as allowed in the Water Code
 - a. The Discharger shall submit a Baseline Summary Report due not later than **90 days** after startup of the first phase of the potassium permanganate injection. The Baseline Summary Report shall evaluate the natural variation and propose baseline concentrations for the amendments and byproducts in the ambient groundwater outside of the treatment area. The Baseline Summary Report shall be used by Regional Board staff to establish baseline concentrations of constituents in groundwater as required by MRP R5-2007-0025.
 - b. The Discharger shall submit an Implementation/Phase I Evaluation Report no later than **90 days** after completion of the first phase of injection. The

Implementation/Phase I Evaluation Report shall include a description of the injection and a summary of analytical results, an evaluation of injection effectiveness and shall include any changes to the Draft Work Plan. A second Evaluation Report for Phase II of the full-scale treatability study shall be submitted no later than **1 year** after implementation of the second phase of the full-scale treatability study.

3. If groundwater samples from any of the downgradient Points of Compliance, as defined in Monitoring and Reporting Program R5-2007-0025, are above baseline concentrations for potassium permanganate, dissolved chromium, or dissolved manganese, the Discharger shall immediately notify Regional Board staff of the exceedance(s) and obtain confirmation samples within **7 days** of receiving the results. Within **48 hours** of receiving the confirmation sample results, the Discharger shall notify Regional Board staff of the results followed by written notification within **7 days**.
4. **Within 90 days** of confirming that baseline concentrations have been exceeded in any of the compliance monitoring wells and it has been determined by Regional Board staff that potassium permanganate injection is not providing adequate treatment of VOCs or the amendments and/or by-products are migrating outside of the transition zone, the Discharger shall submit a Corrective Action Workplan for approval by the Executive Officer. The Corrective Action Workplan shall describe which specific corrective measures, as provided in the Contingency Plan to address violations of this Order, will be implemented, along with a time schedule for implementation. The Corrective Action Workplan must also describe which measures will be taken in the event groundwater elevation maps and/or groundwater sampling indicate that the compliance monitoring well network cannot adequately monitor the effectiveness of the Enhanced Bioremediation System. These WDRs will be modified, as necessary, to address the Enhanced Bioremediation System.
5. The Discharger shall provide a water supply replacement evaluation report within **30 days** if the full-scale KMnO_4 treatability study or any corrective action measure taken in response to implementation of the Contingency Plan adversely affects any water supply wells. The Report shall identify immediate and long-term water replacement options.
6. A copy of this Order shall be maintained at the project site and be available at all times to operating personnel. Key operating personnel shall be familiar with its contents.
7. While this Order is in effect, and prior to any change in ownership of the Site or management of this operation, the Discharger shall transmit a copy of this Order to the succeeding Owner/Operator, and forward a copy of the transmittal letter and proof of transmittal to the Regional Board. Transfer of privileges granted under this Order are subject to the discretion of the Executive Officer.

8. The Discharger shall comply with the attached MRP No. R5-2007-0025, which is part of this Order, and any revisions thereto as ordered by the Executive Officer. Modifications to the MRP No. R5-2007-0025 may be made to continue process monitoring if any parameter does not return to pre-injection conditions. Chemical, bacteriological, and bioassay analyses must be conducted at a laboratory certified for such analyses by the State Department of Health Services.
9. Should evaluation of the ISCO treatment reveal adverse effects on groundwater quality that were not anticipated, the Discharger shall notify Regional Board staff within 24 hours of detection of the adverse effect, followed by a written summary within 2 weeks. The Discharger shall cleanup and abate these effects pursuant to an abatement plan approved by Regional Board staff.
10. The Discharger shall comply with all conditions of this Order, including timely submittal of technical and monitoring reports as directed by the Executive Officer. Violations may result in enforcement action, including Regional Board or court order requiring corrective action or imposing civil monetary liability, or a revision or rescission of this Order.
11. Provisions of these WDRs are severable. If any provision of these requirements is found invalid, the remainder of these requirements shall not be affected.
12. The Discharger shall maintain in good working order and operate as efficiently as possible any facility or control system installed by the Discharger to achieve compliance with the WDRs.
13. This Order does not convey any property rights of any sort or any exclusive privileges. The requirements prescribed herein do not authorize the commission of any act causing injury to persons or property, not protect the discharger from his liability under Federal, State, or Local laws, nor create a vested right for the Discharger to continue the waste discharge.
14. In the event the discharger is unable to comply with any of the conditions of this Order due to:
 - a. breakdown of any facility or control system or monitoring equipment installed by the Discharger to achieve compliance with this Order;
 - b. migration or application of potassium permanganate, pollutants or byproducts outside the specified treatment area;
 - c. accidents caused by human error or negligence; or
 - d. other causes such as acts of nature;

the Discharger shall notify the Regional Water Board by telephone as soon as he or his agents have knowledge of the incident and confirm this notification in writing within two weeks of the telephone notification. The written notification shall include pertinent information explaining reasons for the noncompliance and shall indicate the steps taken to correct the problem and the dates thereof, and the steps being taken to prevent the problem from recurring. The reporting of migration or application of potassium permanganate, pollutants, breakdown products or byproducts outside the transition zone, as show in Attachment D, shall include an assessment of and schedule for implementation of the Contingency Plan included in the *Draft Design Workplan for Site 32 Remedial Action*, dated 5 January 2007 and developed in accordance with this Order. The Discharger shall provide a Corrective Action Status Summary Report no later than **60 days** after implementation of the Contingency Plan detailing activities that were implemented and described in the Corrective Action Workplan.

15. The Regional Water Board may review this Order periodically and will revise these requirements when necessary.

I, Pamela C. Creedon, Executive Officer, do hereby certify that the foregoing is a full, true, and correct copy of an Order adopted by the California Regional Water Quality Control Board, Central Valley Region, on 16 March 2007.

PAMELA C. CREEDON, Executive Officer

RRR/RDB: 23 March 2007

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL VALLEY REGION

MONITORING AND REPORTING PROGRAM NO. R5-2007-0025
FOR
UNITED STATES AIR FORCE
BEALE AIR FORCE BASE
IN-SITU CHEMICAL OXIDATION TREATABILITY STUDY FOR REMEDIATION OF
VOLATILE ORGANIC CONSTITUENTS AT SITE 32
YUBA COUNTY

This Monitoring and Reporting Program (MRP) incorporates requirements for monitoring the progress of a full-scale in-situ chemical oxidation (ISCO) treatability study project using potassium permanganate as an oxidant to treat groundwater pollution at Site 32 at Beale Air Force Base. Waste Discharge Order R5-2007-0025 (Order) covers the activities for Phase I and Phase II of the ISCO full-scale treatability study. This MRP may need to be updated if the Discharger violates the Order. If the Regional Board finds that the Order has been violated, the Discharger is required to implement a Contingency Plan, which includes operating an in-situ bioremediation system. The in-situ bioremediation system may include the use of sodium thiosulfate, sodium lactate, and/or emulsified oil, or cheese whey in a recirculation loop. The MRP would be revised to include additional monitoring parameters and, if necessary, additional monitoring wells to evaluate the effectiveness of corrective action. The Discharger shall not implement any changes to this MRP unless and until a revised MRP is issued by the Executive Officer.

All samples shall be representative of the volume and the nature of the discharge and matrix of the sampled medium. The time, date, and location of each grab sample shall be recorded on the sample chain of custody form.

Compliance with this Monitoring and Reporting Program, and with the companion Standard Provisions and Reporting Requirements, is ordered by Waste Discharge Requirements Order No R5-2007-0025. Failure to comply with this Program, or with the Standard Provisions and Reporting Requirements dated 1 March 1991, constitutes noncompliance with the WDRs and with the Water Code, which can result in further enforcement actions as allowed in the Water Code

A. REPORTING

The Discharger shall report monitoring data and information as required in this Monitoring and Reporting Program and as required in the Standard Provisions and Reporting Requirements. Reports, which do not comply with the required format will be **REJECTED** and the Discharger shall be deemed to be in noncompliance with the WDRs.

Groundwater monitoring data collected in accordance with this MRP shall be included with technical reports required by the Order. That is, available Quarterly and Semi-annual Groundwater monitoring data, shall be submitted with the **Baseline Summary**

Report, Implementation/ Phase I Report and the **Phase II Evaluation Report** required by Order No. R5-2007-0025. Thereafter, the Discharger is required to submit semi-annual groundwater monitoring reports due on 15 March and 15 September of each calendar year for a period of three years following start-up of the second phase of the treatability study. At a minimum, the reports shall include:

1. A narrative description of all preparatory, monitoring, sampling, and analytical testing activities for the groundwater monitoring. The narrative shall be sufficiently detailed to verify compliance with the WDR, this MRP, and the Standard Provisions and Reporting Requirements. The narrative shall be supported by field logs for each well documenting depth to groundwater; parameters measured before, during, and after purging; calculation of casing volume; total volume of water purged, etc.;
2. Copies of all laboratory analytical report(s);
3. Cumulative data tables containing the water quality analytical results and depth to groundwater;
4. An evaluation of the performance of the full-scale treatability study including an analysis of its effectiveness in destroying the pollutants, and a discussion of the potential for field scale application;
5. A discussion of compliance and the corrective action taken, if any, as well as any planned or proposed actions needed to bring the discharge into full compliance with the waste discharge requirements; and
6. A discussion of any data gaps, potential deficiencies/redundancies in the monitoring system or reporting program and the anticipated date for an effectiveness evaluation of the pilot study.

B. REQUIRED MONITORING REPORTS AND SUBMITTAL DATES

1. Semiannual Groundwater Monitoring Reports

All Semiannual monitoring reports shall include all water quality data and observations collected during the reporting period and submitted per the **Reporting Due Dates** in Section B.3 of this Monitoring and Reporting Program. At a minimum the sampling and data collection in Section C or Tables 1 and 2 of this Monitoring and Reporting Program and Waste Discharge Requirements shall be reported. The Semiannual monitoring reports should incorporate available sampling data from other monitoring wells that are in proximity with the treatability study area.

A letter transmitting the self-monitoring reports shall accompany each report. Such a letter shall include a discussion of requirement violations found during the reporting period, and actions taken or planned for correcting noted violations, such as operation or facility modifications. If the Discharger has previously submitted a report describing

corrective actions and/or a time schedule for implementing the corrective actions, reference to the previous correspondence will be satisfactory. The transmittal letter shall contain the penalty of perjury statement by the Discharger, or by the Discharger's authorized agent, as described in the Standard Provisions General Reporting Requirements Section B.3.

2. Response to a Release (Corrective Action Workplan)

If the Discharger determines that the baseline concentrations have been exceeded in any compliance monitoring wells for any constituent of concern or monitoring parameter listed in the Tables 1 and 2, the Discharger shall immediately notify the Regional Board verbally as to the Monitoring Point(s) and constituent(s) or parameter(s) involved, shall provide written notification by certified mail within seven days of such determination. If the Discharger confirms that baseline concentrations have been exceeded in any of the compliance monitoring wells and it has been determined by Regional Board staff that potassium permanganate injection is not providing adequate remediation of VOCs or the amendments and/or by products are migrating outside of the transition zone, the Discharger shall submit a Corrective Action Workplan for approval by the Executive Officer and implement response actions as required in Order No. R5-2007-0025.

3. Submittal Dates Semiannual Groundwater Monitoring Reports

Reporting Type	Sampling Frequency and Data Reported	Reporting Period	Report Date Due
Semi-annual	Quarterly, Semi-annual, Annual	1 August – 31 January 1 February – 31 July	15 March 15 September

C. GROUNDWATER MONITORING

Monitoring of the ISCO treatability study shall consist of collecting groundwater samples from monitoring wells designated as treatment zone, transition zone and compliance monitoring wells during both Phase I and Phase II of the ISCO treatability study project. The treatment zone monitoring wells are as follows: 05C002MW, 32C025MW, 32C004MW, 32C024MW, 32C042MW, 32C040MW, 32C038MW, 32C037MW, 32C039MW, 32C036MW, 32M001MW and 32M002MW. The transition zone monitoring wells are as follows: 05L001MW, 32C041MW, 32M003MW and 05C005MW. The compliance monitoring wells are as follows: 05R001MW, 32C026IW, 32R002MW and 32027EW.

Baseline Sampling

In order to obtain an accurate representation of baseline groundwater conditions at Site 32 groundwater monitoring wells in the treatment and transition zones and the compliance monitoring wells, shall I be sampled according to Table 1.

Table 1 – Baseline Groundwater Monitoring		
<u>Parameters</u>	<u>Units</u>	<u>Frequency</u>
<u>Field Parameters</u>		
Temperature	°C	once ¹
Specific Conductance	µmhos/cm	once
ORP	millivolts	once
pH	pH number	once
<u>Monitoring Parameters</u>		
<u>Total Dissolved Solids</u> ²	mg/L	once
Volatile Organic Compounds ³	µg/L	once
Dissolved Chromium ⁴	mg/L	once
Dissolved Manganese ⁵	mg/L	once
Potassium ⁶	mg/L	once
Chlorides ⁷	mg/L	once
Dissolved Selenium ⁸	mg/L	once

¹ Samples shall be collected once prior to injection of potassium permanganate, at least one week prior to injection.

² Total Dissolved Solids by EPA Method 160.2, or equivalent.

³ Volatile Organic Compounds by EPA Method 8260, or equivalent, with a Practical Quantitation Limit no greater than 0.5 µg/L.

⁴ Dissolved Chromium by EPA Method 6010B, or equivalent, with a Practical Quantitation Limit no greater than 10 µg/L.

⁵ Dissolved Manganese by EPA Method 6010B, or equivalent, with a Practical Quantitation Limit no greater than 10 µg/L.

⁶ Total Potassium EPA Method 6010B, or equivalent, with a Practical Quantitation Limit no greater than 1000 µg/L.

⁷ Total Chlorides by EPA Method E300.1, or equivalent, with a Practical Quantitation Limit no greater than 5 µg/L.

⁸ Dissolved Selenium by EPA Method 6010B, or equivalent, with a Practical Quantitation Limit no greater than 5 µg/L.

Phase I and II Treatability Study

Monitoring well samples shall be analyzed according to Table 2 during Phase I and II of the ISCO treatability study. The following ISCO treatability study monitoring wells 05C002MW, 32C025MW, 32C042MW, 32C040MW, 32C038MW, 32C037MW, 32C039MW, 32C036MW, 32M001MW, 05L001MW, 32C041MW, 32M003MW, 05C005MW; and compliance monitoring wells 05R001MW, 32C026IW, 32R002MW, 05R002MW and 32027EW should be sampled as described below. The samples will be analyzed for total chromium except as noted below. All chromium present is expected to be in the hexavalent state.

Table 2 – Treatability Study Groundwater Monitoring		
<u>Parameters</u>	<u>Units</u>	<u>Frequency</u>
<u>Field Parameters</u>		
Temperature	°C	Quarterly ^{a,b,c}
Specific Conductance	µmhos/cm	Quarterly ^{a,b,c}
ORP	millivolts	Quarterly ^{a,b,c}
pH	pH number	Quarterly ^{a,b,c}
Groundwater Elevation	ft and hundredths.-MSL	Quarterly ^{a,b,c}
Dissolved Oxygen	mg/L	Quarterly ^{a,b,c}
<u>Monitoring Parameters</u>		
Total Dissolved Solids ¹	mg/L	Quarterly ^{a,b,c}
Permanganate ²	mg/L	Quarterly ^{a,b} /Semi-Annual ^c
Volatile Organic Compounds ³	µg/L	Quarterly ^{a,b} /Semi – Annual ^c
Dissolved Chromium ⁴	mg/L	Quarterly ^{a,b,c}
Dissolved Manganese ⁵	mg/L	Quarterly ^{a,b,c}
Total Potassium ⁶	mg/L	Quarterly ^{a,b,c}
Total Chlorides ⁷	mg/L	Quarterly ^{a,b,c}
Dissolved Selenium ⁸	mg/L	Quarterly ^{a,b,c}

^a Treatment zone monitoring wells: 05C002MW, 32C025MW, 32C042MW, 32C040MW, 32C038MW, 32C037MW, 32C039MW, 32C036MW, 32M001MW (Note: All treatment zone monitoring wells to be sampled quarterly except for 05C002MW, which will be sampled annually for Dissolved Chromium and VOCs)

^b Transition zone monitoring wells 05L001MW, 32C041MW, 32M003MW, 05C005MW (Note: All Transition zone monitoring wells to be sampled quarterly/semiannually except 05L001MW to be sampled annually as noted above)

^c Compliance monitoring wells 05R001MW, 05R002MW, 32C026IW and 32027EW and 32R002MW (Note: All compliance monitoring wells to be sampled quarterly except 05R001MW to be sampled annually as noted above)

- ¹ Total Dissolved Solids by EPA Method 160, or equivalent.
- ² Permanganate by colorimetric Ag SOI SOP V1.3.³ Volatile Organic Compounds by EPA Method 8260, or equivalent, with a Practical Quantitation Limit no greater than 0.5 µg/L.
- ⁴ Dissolved Chromium by EPA Method 6010B, or equivalent, with a Practical Quantitation Limit no greater than 10 µg/L.
- ⁵ Dissolved Manganese by EPA Method 6010B, or equivalent, with a Practical Quantitation Limit no greater than 10 µg/L.
- ⁶ Total Potassium EPA Method , or equivalent, with a Practical Quantitation Limit no greater than 1000 µg/L.
- ⁷ Total Chlorides by EPA Method 6010B, or equivalent, with a Practical Quantitation Limit no greater than 5 µg/L.
- ⁸ Dissolved Selenium by EPA Method 6010B, or equivalent, with a Practical Quantitation Limit no greater than 5 µg/L.

Field testing instruments (such as those used to test oxidation-reduction potential and dissolved oxygen) may be used provided that:

1. The operator is trained in proper use and maintenance of the instruments;
2. The instruments are field calibrated prior to each monitoring event;
3. Instruments are serviced and/or calibrated by the manufacturer at the recommended frequency; and
4. Field calibration reports are provided with the appropriate monitoring report.

The Discharger shall implement the above monitoring program as of the date of the Order.

Ordered by: _____
PAMELA C. CREEDON, Executive Officer

RRR
22 March 2007

INFORMATION SHEET

ORDER NO R5-2007-0025
UNITED STATES AIR FORCE
BEALE AIR FORCE BASE
IN-SITU CHEMICAL OXIDATION TREATABILITY STUDY
FOR REMEDIATION OF VOLATILE ORGANIC CONSTITUENTS AT SITE 32
YUBA COUNTY

The United States Air Force (hereafter Discharger) owns and operates Beale Air Force Base in Yuba County. Beale Air Force Base is an active Air Force Base approximately 40 miles north of Sacramento and 10 miles east of Marysville. Site 32, the location of a proposed full-scale in-situ chemical oxidation (ISCO) treatability study, is in the north-western portion of Beale AFB in the Flight Line Area. Site 32 contains several active maintenance buildings, former underground storage tanks (USTs), washracks, an oil water separator and an industrial waste line that have been associated with spills and leaks, which caused groundwater and soil contamination in this area.

Contaminants of concern (COCs) identified in soil and groundwater during the Feasibility Study (FS) include volatile organic compounds (VOCs) and Total Petroleum Hydrocarbons, Diesel Range (TPH-D). The majority of groundwater contamination at Site 32 is in the upper aquifer zone, which extends from approximately 60 to 80 feet below ground surface. The groundwater cleanup project is being conducted as part of a performance based contract between the Discharger and CH2MHill. CH2MHill will construct and operate the treatability study.

The full-scale ISCO treatability study will be conducted in two phases and will utilize potassium permanganate (KMnO_4). KMnO_4 is a treatment enhancing substance, which is intended to provide an environmentally beneficial and efficient cleanup and has the ability to permanently reduce contaminant mass in the subsurface in a much shorter timeframe than traditional groundwater pump-and-treat remediation systems.

The area to be treated by KMnO_4 is divided into a treatment zone area and a transition zone. The treatment zone area includes injection wells that will deliver the amendment (KMnO_4) into the subsurface. The transition zone area is downgradient of the treatment zone area and is the area where extremely aerobic conditions, created by the KMnO_4 , will return to natural aerobic conditions. Injection of KMnO_4 in groundwater may have some secondary effects such as increases in total dissolved solids (primarily increases in potassium and chloride) and manganese. The addition of KMnO_4 may also temporarily mobilize redox sensitive metals. In addition, KMnO_4 contains low concentrations of impurities, including chromium, and is known to oxidize trivalent chromium (Cr(III)) found in soil to the more soluble hexavalent form (Cr(VI)). It is expected that the

ORDER NO R5-2007-0025
UNITED STATES AIR FORCE
BEALE AIR FORCE BASE
IN-SITU CHEMICAL OXIDATION TREATABILITY STUDY
FOR REMEDIATION OF VOLATILE ORGANIC CONSTITUENTS AT SITE 32
YUBA COUNTY

oxidized metals within the transition zone area, including hexavalent chromium, will be reduced and precipitate, thereby becoming immobile.

A pilot-scale treatability study (pilot study) performed at Site 32 by the Discharger in 2005 demonstrated that (KMnO₄) has the ability to provide significant mass reduction of VOCs in groundwater. The pilot study also evaluated the secondary effects on groundwater quality related to the presence of soluble metals during treatment study. Analytical data in the Site 32 pilot test area indicates that TCE concentrations, which ranged from 1050 to 1090 ug/L prior to pilot test, were reduced to below or near detection limits. The data collected during the pilot study provided the Discharger with sufficient data to design the proposed full-scale treatability system. The pilot-scale treatability study for (KMnO₄) showed that some metals increased above baseline concentrations and above the respective primary and secondary maximum contaminant levels (MCLs) for these metals. However, the metals sampling performed in the pilot study area after completion of the study showed that the concentrations of these metals reduced to baseline concentrations. The pilot study data suggest elevated metals concentrations induced by (KMnO₄) are transient in nature. This Order requires that the Discharger monitor for dissolved metals and other pollutants and assure that water quality is not adversely impacted by the ISCO system outside of the treatment areas and that the dissolved metals and other pollutants that are generated by ISCO are reduced to pre-treatment conditions inside of the treatment area

Any adverse byproducts, such as dissolved metals, created by the full-scale treatability study, that are outside of the defined treatment areas are to be addressed by the Discharger's Contingency Plan. The Contingency Plan requires that the Discharger perform corrective action to address any violation of this Order. The Contingency Plan states that the Discharger will operate an Enhanced Bioremediation System. Operation of the Enhanced Bioremediation System may include injection of amendments such as sodium thiosulfate, sodium lactate and/or emulsified oil and cheese whey to achieve reduction of dissolved metals concentrations at the downgradient edge of the treatment area. These Waste Discharge Requirements will be modified, as necessary to address the Enhanced Bioremediation System if the Discharger is required to implement the Contingency Plan.

3/22/2007 RRR

Site 32

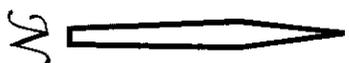
DOOLITTLE GATE

MILLER LAKE

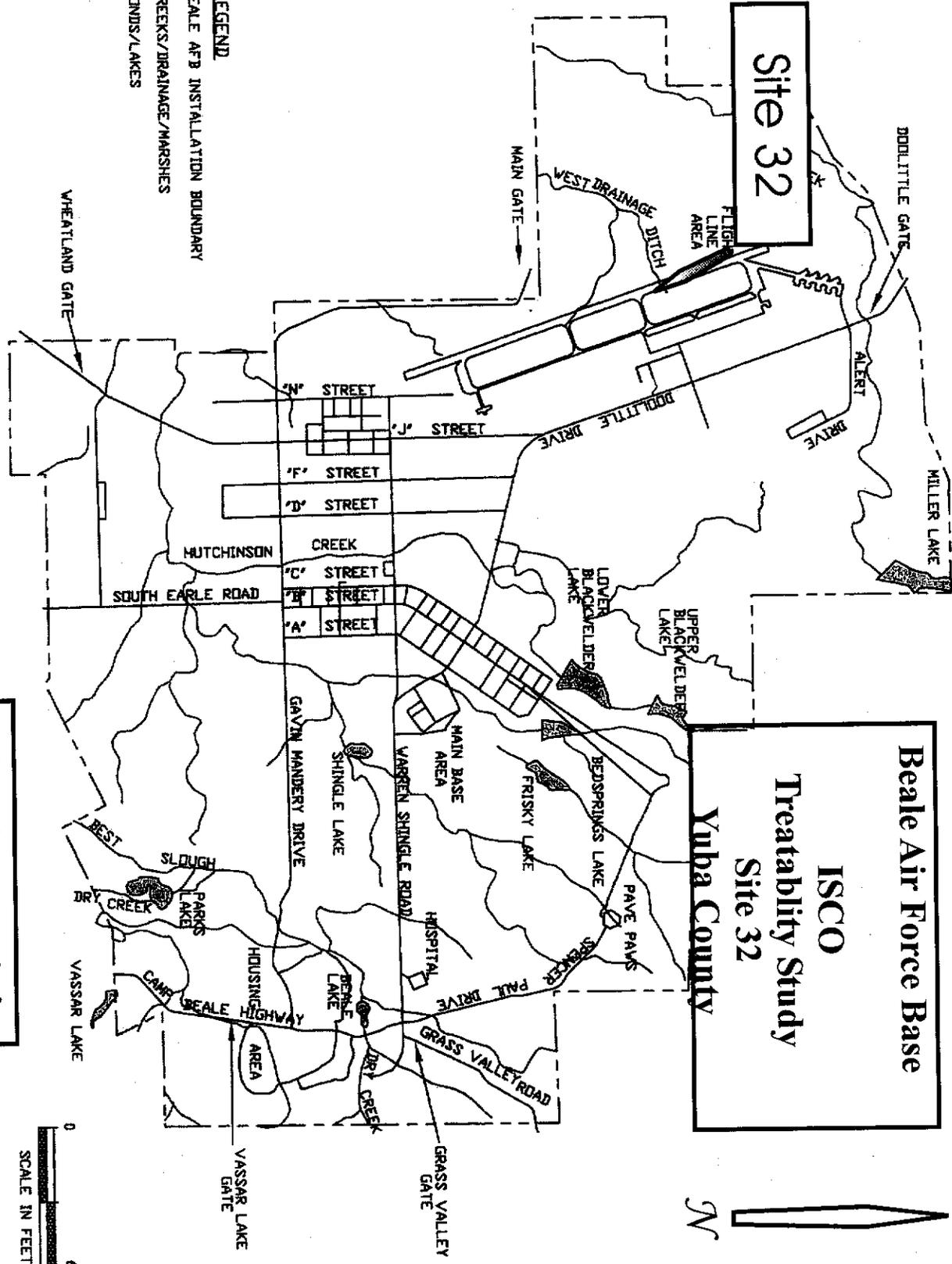
Beale Air Force Base

ISCO
Treatability Study
Site 32

Yuba County



- LEGEND**
- BEALE AFB INSTALLATION BOUNDARY
 - ~ CREEKS/DRAINAGE/MARSHES
 - POND/LAKES



Attachment A

LEGEND

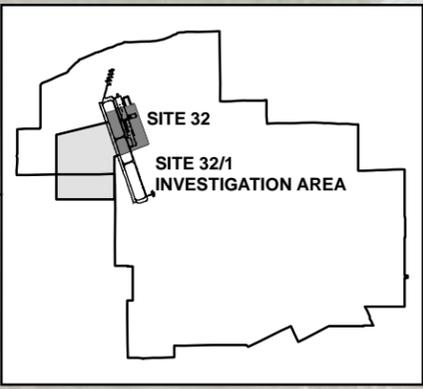
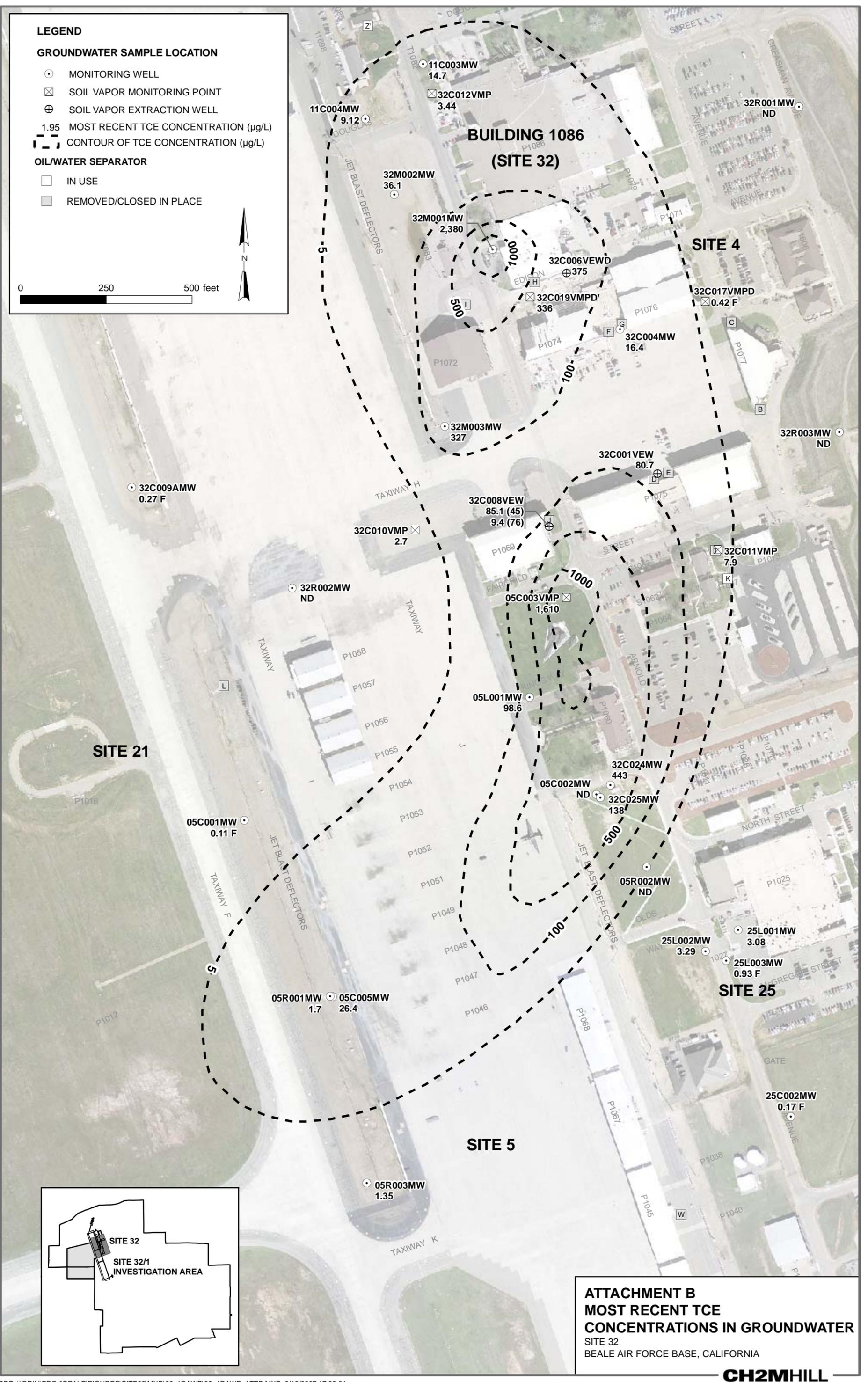
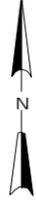
GROUNDWATER SAMPLE LOCATION

- MONITORING WELL
- ⊠ SOIL VAPOR MONITORING POINT
- ⊕ SOIL VAPOR EXTRACTION WELL
- 1.95 MOST RECENT TCE CONCENTRATION (µg/L)
- CONTOUR OF TCE CONCENTRATION (µg/L)

OIL/WATER SEPARATOR

- IN USE
- REMOVED/CLOSED IN PLACE

0 250 500 feet



ATTACHMENT B
MOST RECENT TCE
CONCENTRATIONS IN GROUNDWATER
 SITE 32
 BEALE AIR FORCE BASE, CALIFORNIA

LEGEND

COMPONENTS OF ISCO TREATMENT SYSTEM:

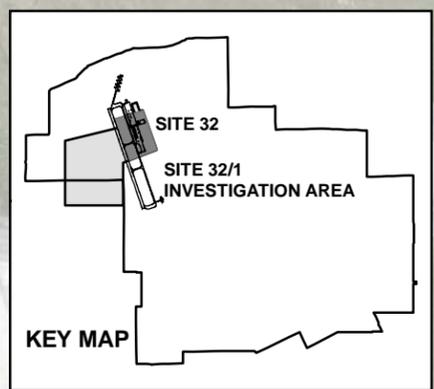
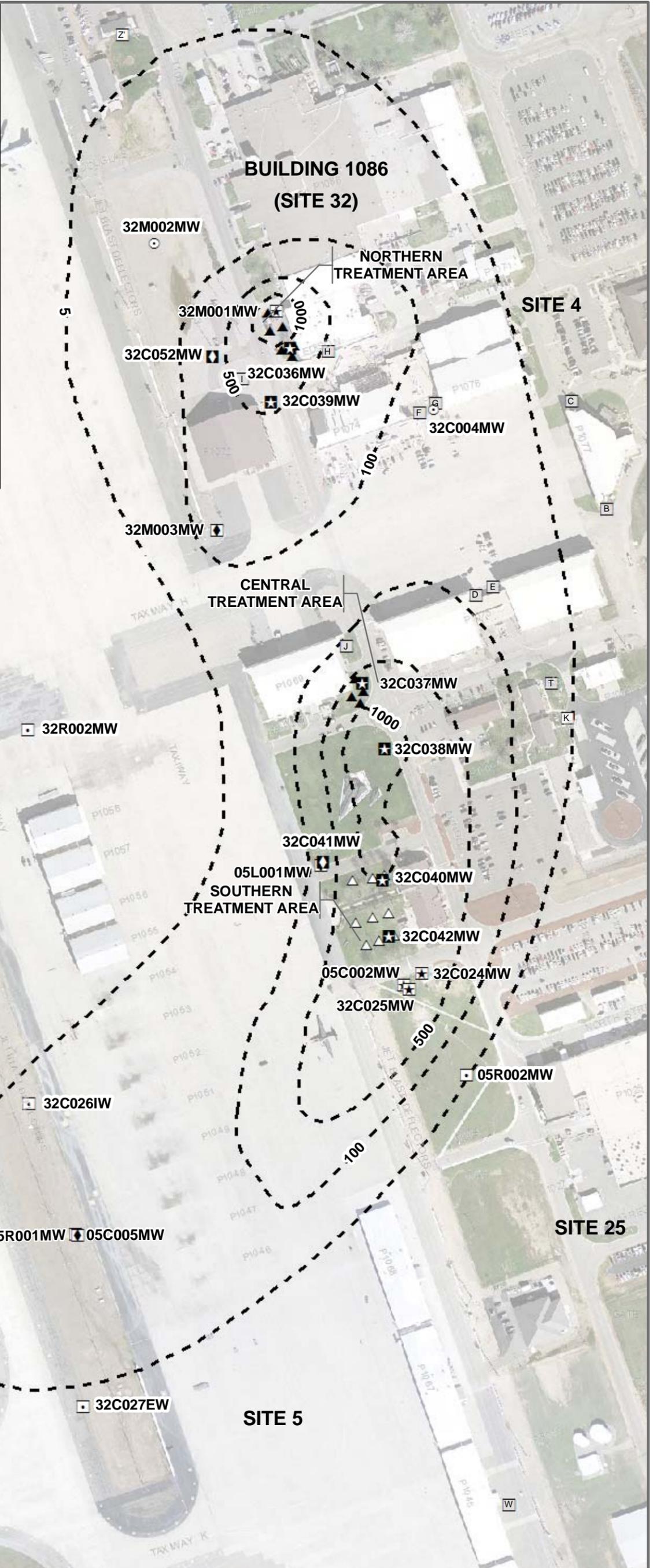
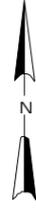
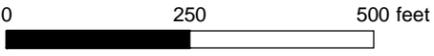
- TREATMENT ZONE MONITORING WELL
- ▣ TRANSITION ZONE MONITORING WELL
- ▲ PROPOSED ISCO INJECTION POINT (PHASE 1)
- △ PROPOSED ISCO INJECTION POINT (PHASE 2)

EXISTING WELLS

- ★ TREATMENT ZONE MONITORING WELL (EXISTING)
- ◆ TRANSITION ZONE MONITORING WELL (EXISTING)
- PERFORMANCE MONITORING WELL (EXISTING)
- ◻ COMPLIANCE MONITORING POINT (EXISTING)
- MONITORING WELL

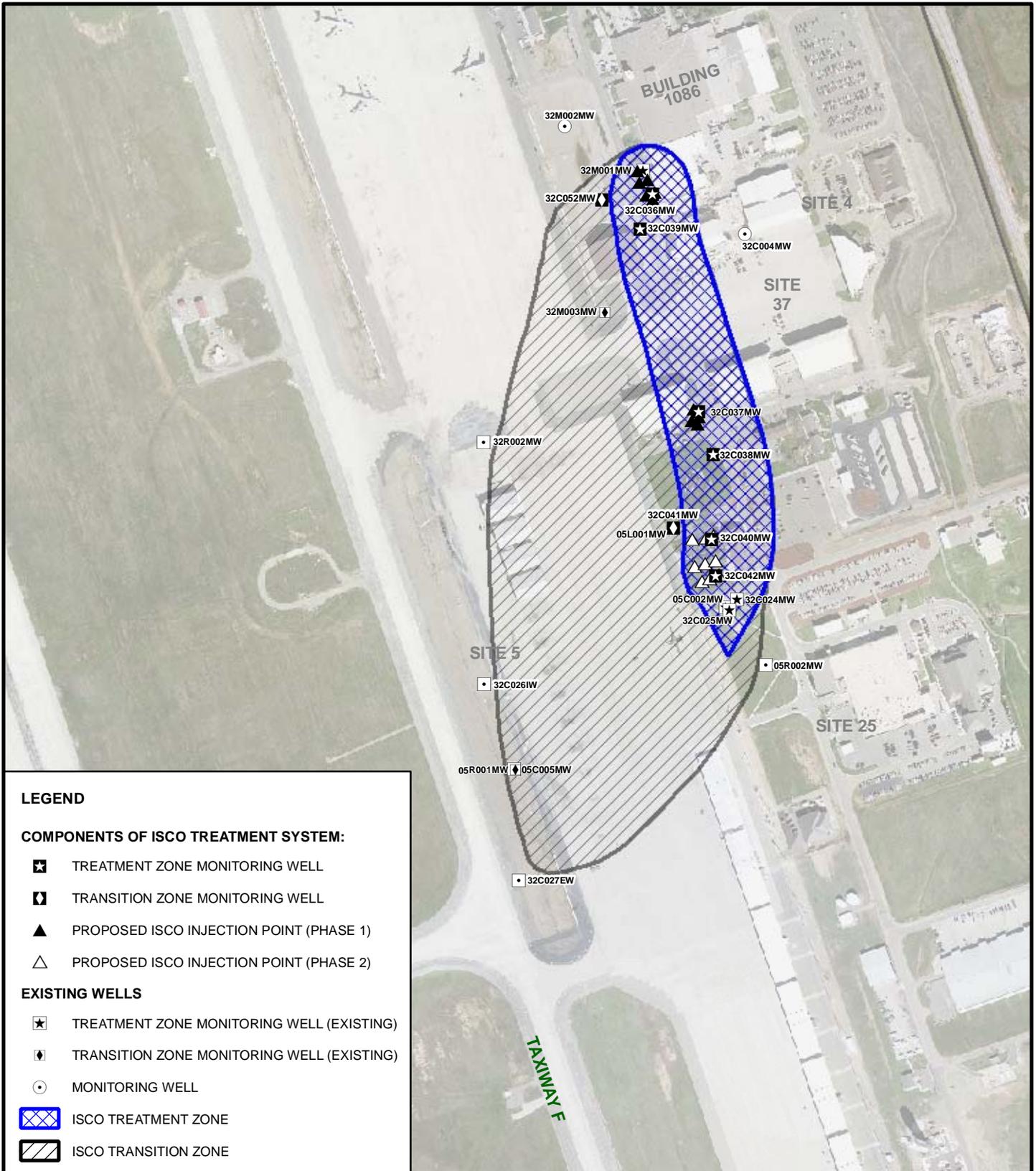
OIL/WATER SEPARATOR

- IN USE
- REMOVED/CLOSED IN PLACE
- - - CONTOUR OF TCE CONCENTRATION (µg/L)



**ATTACHMENT C
PROPOSED PHASE 1 AND 2
ISCO INJECTIONS**
SITE 32
BEALE AIR FORCE BASE, CALIFORNIA





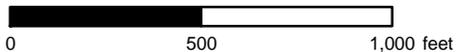
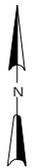
LEGEND

COMPONENTS OF ISCO TREATMENT SYSTEM:

- ★ TREATMENT ZONE MONITORING WELL
- ▼ TRANSITION ZONE MONITORING WELL
- ▲ PROPOSED ISCO INJECTION POINT (PHASE 1)
- △ PROPOSED ISCO INJECTION POINT (PHASE 2)

EXISTING WELLS

- ★ TREATMENT ZONE MONITORING WELL (EXISTING)
- ▼ TRANSITION ZONE MONITORING WELL (EXISTING)
- MONITORING WELL
- ▨ ISCO TREATMENT ZONE
- ▧ ISCO TRANSITION ZONE



**ATTACHMENT D
PROPOSED ISCO TREATMENT AND
TRANSITION ZONES**

SITE 32
BEALE AIR FORCE BASE, CALIFORNIA

