# 2.12 Selected Remedies

The remedies selected for specific groundwater sites at Travis AFB are as follows:

- **Alternative 1 – No Further Action:** Site SS041
- **Alternative 2 – MNA:** Sites FT004 and LF006, Subareas LF007B and LF007D, and Sites LF008, ST027B, SD031, SD033, SS035, and SD043
- **Alternative 3 – GET:** Site FT005, Subarea LF007C, and Sites SS029 and SS030
- **Alternative 4 – Bioreactor and GET:** Site SS016
- **Alternative 5 – EVO and EA:** Sites SS015, SD036, and SD037
- **Alternative 6 – Bioreactor, Phytoremediation, EVO PRB, and EA:** Site DP039
- **Alternative 7 – Passive Skimming and EA:** Site SD034

The primary indicators of remedial action performance will be satisfying the RAOs for groundwater at Travis AFB and protecting human health and the environment. Performance measures are defined herein as the RAOs (see Section 2.8) plus the required actions to achieve the objectives, as defined in this section. It is anticipated that successful implementation, operation, maintenance, and completion of the performance measures will achieve protective and legally compliant remedies for groundwater at Travis AFB.

The AF is responsible for implementing, maintaining, and monitoring the remedial actions identified herein for the duration of the remedies selected in this ROD. The AF will exercise this responsibility in accordance with CERCLA and the NCP. Concurrence by EPA, the California DTSC, and San Francisco Bay Regional Water Board is required for any modification of the remedy inconsistent with the objectives of this ROD.

## 2.12.1 Summary of the Rationale for the Selected Remedies

The AF, EPA, California DTSC, and the San Francisco Bay Regional Water Board believe that the selected remedy for a site meets the threshold criteria and provides the best balance of tradeoffs among the other alternatives with respect to the balancing and modifying criteria (including sustainability). The selected remedies are expected to reduce concentrations of COCs in groundwater, achieve cleanup levels based on federal and more stringent State of California MCLs and cleanup levels for protection of indoor air that were established to achieve RAOs, as well as include LUCs to prevent access or use of groundwater, including development of on-base water wells, to restrict soil disturbances in circumstances where contaminated groundwater or vapors might be encountered, maintain the integrity of current and future remedial and monitoring systems, and to restrict land use to industrial purposes only until the concentrations of COCs are at such levels to allow for designated beneficial uses of groundwater (domestic, municipal, agricultural, and industrial supply) as well as unlimited use and unrestricted exposure (refer to Table 2.8-1), and as well as limit exposure to VOCs emanating from groundwater to indoor air until concentrations of volatile COCs in groundwater posing a potential indoor air risk are at such levels that VOCs emanating from groundwater to indoor air do not pose unacceptable risk to human

health (refer to Table 2.8-2). An alternative was selected over other alternatives evaluated for a site because it ranked highest or equally ranked highest in the threshold and primary balancing criteria and represents the most reasonable value for the money (see Tables 2.10-1 through 2.10-20). The costs are proportional to the effectiveness of the remedy by achieving long-term effectiveness and permanence within a reasonable time. The preference for treatment will be met at Site FT005, Subarea LF007C, and Sites SS015, SS016, SS029, SS030, SD034, SD036, SD037, and DP039.

## 2.12.2 Descriptions of the Selected Remedies

Except Alternative 1 – No Further Action, all of the remedies include the common components of groundwater monitoring and LUCs. The key distinguishing feature between Alternatives 2 through 7 is treatment. Alternatives 3 through 7 include treatment, with Alternatives 3 and 4 including ex situ treatment and Alternatives 4, 5, and 6 including in situ treatment. Alternative 7 includes physical removal of Stoddard solvent floating on the groundwater table and treatment or recycling of the recovered product by an EPA-approved off-base vendor.

Alternatives 2, 5, and 7 use natural physical, chemical, and biological processes to remediate COCs in groundwater. Alternative 2 includes MNA, which was successfully demonstrated by long-term interim MNA assessments, positive results of contaminant rebound studies, and positive results of an aerobic chlorinated cometabolism enzyme study. In addition to treatment or passive skimming, Alternatives 5 and 7 include EA, which will remediate COCs in downgradient groundwater by the reduced influx of contaminants following treatment of the portions of the plumes with the highest concentrations.

Descriptions of the components for each of the remedies are provided in the following subsections. A layout of the remedies is shown on Figure 2.12-1. LUC boundaries for groundwater and soil vapor emanating from groundwater are shown on Figures 2.12-12 through 2.12-14.

Changes, if they occur, to the remedies described in this ROD will be documented using a technical memorandum in the Administrative Record, an ESD, or ROD amendment.

The following subsections describe each of the selected remedies. A site-by-site summary of the remedies is also provided in Table 2.12-1 – Basis for Remedy Summary. This table provides a summary of the COCs, concentrations, and plume dimensions, as well as the status of the interim remedy, the selected remedy, RAOs, and the basis for remedy selection at each site.

### 2.12.2.1 Alternative 1 – No Further Action

No Further Action is the selected remedy for Site SS041.

Site SS041 had pesticide contaminants in its surface soil and groundwater. A 2003 soil remedial action cleaned up surface soil and achieved residential cleanup levels. An interim groundwater remedial action cleaned up the Site SS041 groundwater contaminant (heptachlor epoxide) to below its interim cleanup goal (0.01 µg/L) and its practical quantitation limit (0.01 µg/L). The NFRAP status for Site SS041 is documented in a December 14, 2005, consensus statement that was signed by the representatives of the lead and regulatory agencies (Travis AFB, 2005a).

#### 2.12.2.2 Alternative 2 – Monitored Natural Attenuation

Alternative 2 uses natural physical, chemical, and/or biological processes at Sites FT004 and LF006, Subareas LF007B and LF007D, and Sites LF008, ST027B, SD031, SD033, SS035, and SD043 to achieve RAOs. The groundwater at Subarea LF007B and Site SS035 has already achieved cleanup levels; however, additional groundwater monitoring is required. In accordance with regulatory agencies requirements, at least 2 additional years of monitoring will be conducted at each site to confirm that cleanup levels have been achieved.

This alternative also discontinues the operation of existing IRA GET systems at Sites FT004, LF008, SD031, SD033, and SD043. When groundwater cleanup levels for all COCs are achieved within the monitoring network for a site, and confirmed by 2 years of annual LTM, the RAOs will be considered satisfied for the site, and the groundwater remedial action will be considered complete. Groundwater monitoring will stop, and the completion of the remedial action and a plan to decommission all remedy infrastructure as part of the site closure process will be documented in the annual GRISR.

In the event that plume migration or increasing concentrations are observed at Sites FT004 and LF006, Subareas LF007B and LF007D, and Sites ST027B, SD031, SD033, SS035, and SD043, then GET system operations could be resumed. However, resuming GET system operation at Site LF008 is not considered a viable action because groundwater pumping was demonstrated to agitate the aquifer and mobilize fine soil particles with sorbed contaminants (CH2M HILL, 2012d). The AF will keep the Site LF008 GET system in place in the highly unlikely event that the migration of contaminants away from the site is discovered by future monitoring and a resumption of pumping is required for hydraulic containment of the contaminants.

In some cases, an alternative remedial approach, such as combining EVO injections and EA, could be implemented to treat portions of plumes with elevated concentrations of VOCs, if determined by the AF to be technically and economically feasible. This treatment would be conducted mainly to accelerate site cleanup.

#### 2.12.2.3 Alternative 3 – GET

Alternative 3 entails active groundwater remediation using the GET systems previously installed as part of the IRA at Site FT005, Subarea LF007C, and Sites SS029 and SS030. Contaminated groundwater would continue to be extracted using horizontal and/or vertical extraction wells, treated at the NGWTP (Site FT005 and Subarea LF007C) and SBBGWTP (Sites SS029 and SS030), and the treated water discharged to the stormwater drainage system.

After a period of active remediation under Alternative 3, continued progress toward RAOs at Site FT005, Subarea LF007C, and Sites SS029and SS030 may be achieved by transitioning from the active GET remedy to an effective program of MNA under Alternative 2. This potential remedy transition will be based on the performance monitoring data and cost data obtained during the period of LTO. Over long-term GET system operation, it is possible that the plume contaminant concentrations will decline at an ever decreasing rate and the cost-effectiveness of the remedy will become relatively low. That is, high costs will be incurred to achieve increasingly modest reductions in the plume concentrations above cleanup levels. In this event, site-specific contaminant rebound studies will be conducted to demonstrate plume

stability and continued reductions in concentrations towards cleanup levels using natural physical, chemical, and biological processes. The AF will prepare an ESD to document the change of the remedy from Alternative 3 – GET to Alternative 2 – MNA.

In the event that plume migration or increasing concentrations are observed at a GET site, then optimization of the GET system will be evaluated. Potential optimization actions could include increasing the pumping rates in individual extraction wells or adding new extraction and/or monitoring wells. In some cases, an alternative remedial approach, such as combining EVO injections and EA, could be implemented, if determined by the AF to be technically and economically feasible. In the future, if groundwater in the off-base portions of the plumes at Sites FT005 and SS030 meets cleanup levels, an in situ treatment system, such as an EVO PRB, may be installed at Site SS029, and the GET system will be shut down to lower energy requirements and GHG emissions. The in situ treatment system would be designed to treat the entirety of the Site SS029 plume and all the contaminant mass migrating hydraulically downgradient from Site SS016.

**GET at Site FT005.** Under Alternative 3, optimized groundwater extraction, treatment at the SBBGWTP, and discharge of treated water into the stormwater drainage system would continue at Site FT005 until RAOs are achieved. A conceptual design of Alternative 3 at Site FT005 is shown on Figure 2.12-3.

The GET system at Site FT005 has been effective at controlling the migration of groundwater contamination, reducing the plume size, and reducing contaminant concentrations (CH2M HILL, 2008a, 2011a). No fundamental changes to the current GET system are required, although optimization of the groundwater extraction well network to improve system performance will be continually evaluated. Extracted groundwater would continue to be conveyed to the existing SBBGWTP for treatment using LGAC. The treated water would then be discharged to the Main Branch of Union Creek at the existing outfall.

**GET at Subarea LF007C.** A conceptual design of Alternative 3 at Subarea LF007C is shown on Figure 2.12-2.

A data gaps investigation was conducted during 2011–2012 to more fully characterize the off-base portion of the plume. Following evaluation of the characterization data, additional extraction wells may be installed to improve hydraulic capture and removal of TCE from the off-base portion of the plume.

During the times of year when a vernal pool at the site is dry, extracted groundwater would be conveyed to a small skid-mounted treatment unit and treated using LGAC. The LGAC unit would be located at the NGWTP, or other nearby on-base location, but treatment of groundwater using the NGWTP air stripper would be discontinued. The AF would beneficially reuse the treated water by pumping it to the Duck Pond via the existing conveyance system.

During the wet season, GET system operation at Subarea LF007C is discontinued in accordance with USFWS requirements to prevent potential adverse impacts to the vernal pool (USFWS, 2002).

**GET at Site SS029.** A conceptual design of Alternative 3 at Site SS029 is shown on Figure 2.12-3.

The GET system at Site SS029 has been effective at controlling the migration of groundwater contamination (CH2M HILL, 2008a, 2011b). No changes to the current GET system are required. Extracted groundwater would continue to be conveyed to the existing SBBGWTP for treatment using LGAC. The treated water would then be discharged to the Main Branch of Union Creek at the existing outfall.

**GET at Site SS030.** A conceptual design of Alternative 3 at Site SS030 is shown on Figure 2.12-3.

Operation of the Site SS030 interim GET system was modified in 2011 to improve the hydraulic capture of the off-base plume. As described in Section 8.3 of the 2011 Annual RPO Report (CH2M HILL, 2012d), operational changes (i.e., RPO) to the existing GET system were made to maintain hydraulic capture for the entirety of the plume by increasing the rate of groundwater extraction. Groundwater monitoring data obtained under the GSAP and GRIP demonstrated that hydraulic capture of the plume was achieved and that TCE concentrations within the eastern side of the plume are declining (CH2M HILL, 2012d). Further optimization of the GET system involves the installation of an additional extraction well to further improve hydraulic capture of the off-base plume and reduce the wear on the existing extraction well pumps resulting from sustained high-speed operation.

The ability of the Site SS030 GET system to maintain progress toward RAOs and achieve cleanup levels for the entirety of the plume will be verified prior to and during the RD phase under the Travis AFB GRIP and reported in annual GRISRs. If groundwater performance monitoring during the period of LTO indicates that hydraulic capture is not being maintained (e.g., increasing well concentrations), then further investigation of the eastern side of the plume will be conducted to verify hydraulic capture and remediation of that portion of the plume. Following evaluation of the characterization data, operation of the existing extraction wells may be modified and/or additional extraction wells may be installed to more fully achieve hydraulic capture of the off-base portion of the plume. All such optimizations will be incorporated into Alternative 3 as RPO activities. Extracted groundwater will continue to be conveyed to the existing SBBGWTP for treatment using LGAC. The treated water will then be discharged to the Main Branch of Union Creek at the existing outfall.

#### 2.12.2.4 Alternative 4 – Bioreactor and GET

Alternative 4 combines the following two (2) components to remediate the Site SS016 plume:

- Bioreactor
- GET

A conceptual design of Alternative 4 at Site SS016 is shown on Figures 2.12-4 and 2.12-5. The Site SS016 and Site SS029 plumes are connected and are most effectively addressed together. Untreated groundwater COCs originating from Site SS016, primarily from the OSA, will eventually migrate to Site SS029. Therefore, the plumes will be treated as one (1) plume and eventually closed together.

In 2010, a bioreactor was constructed at Site SS016 within the OSA portion of the plume as a demonstration of in situ treatment (refer to Section 2.2.3.1). The bioreactor uses ERD processes to break down chlorinated VOCs within the portion of the plume with the highest concentrations of contaminants. Contaminated groundwater from existing horizontal extraction well EW003x16 is circulated through the bioreactor using a solar-powered pump. As a result of these actions, the continuing source of TCE contamination into the hydraulically downgradient portions of the Site SS016 plume has been and will continue to be reduced. Residual contamination from the OSA will be addressed by existing vertical groundwater extraction wells EW605x16 and EW610x16. A conceptual cross section of a bioreactor is shown on Figure 2.12-6.

Groundwater extraction within the TARA portion of Site SS016 will continue under Alternative 4 using the two (2) existing horizontal extraction wells (EW001x16 and EW002x16).

Extracted groundwater will be treated using LGAC at the CGWTP and then discharged into the stormwater drainage system.

After a period of active remediation under Alternative 4, continued progress toward RAOs at Site SS016 may be achieved by transitioning from the active Bioreactor and GET remedy to an effective program of MNA under Alternative 2. This potential remedy transition will be based on the performance monitoring data and cost data obtained during the period of LTO. Over long-term Bioreactor and GET system operation, it is possible that the plume contaminant concentrations will decline at an ever decreasing rate and the cost-effectiveness of the remedy will become relatively low. That is, high costs will be incurred to achieve only modest reductions in the plume concentrations above cleanup levels. In this event, a site-specific contaminant rebound study will be conducted to demonstrate plume stability and continued reductions in concentrations toward cleanup levels using natural physical, chemical, and biological processes. The AF will prepare an ESD to document the change of the remedy from Alternative 4 – Bioreactor and GET to Alternative 2 – MNA.

It is likely that the OSA bioreactor will reach the limits of effective treatment well before the RAOs are achieved by the GET system for the remainder of the plume. At that time, the bioreactor will be decommissioned, and GET system operation will continue. When all RAOs are achieved, groundwater extraction and monitoring will stop, and the completion of the remedial action and a plan to decommission all remedy infrastructure as part of the site closure process will be documented in the annual GRISR.

Treatment residuals following complete degradation of chlorinated VOCs through the ERD processes using the bioreactor include non-regulated end-products such as ethene and ethane. Incomplete ERD, resulting from the stalling of these processes, has the potential to create intermediate treatment residuals such as cis-1,2-DCE and/or vinyl chloride. Vinyl chloride is the most toxic potential treatment residual resulting from incomplete ERD treatment. Within the anaerobic treatment zone created by installation of the bioreactor, creation of vinyl chloride is expected as part of normal ERD processes. Based on analytical results obtained during the OSA bioreactor treatment demonstration, full degradation of vinyl chloride within the treatment zone is expected as those processes continue through completion to form ethane, ethene, and methane (refer to Section 2.2.3). Outside of the treatment zone, the aquifer is aerobic. Vinyl chloride readily degrades under aerobic conditions, so any vinyl chloride

that migrates beyond the bioreactor treatment zone will degrade aerobically shortly after entering the downgradient portion of the aquifer (CH2M HILL, 2012d).

If performance monitoring identifies any unanticipated or adverse outcomes from installation of the bioreactor, then the AF will evaluate and carry out performance enhancement measures to correct the deficiencies. The end result of these measures will be a return of the bioreactor's ability to remediate contaminated groundwater, a transition to a more effective remedial alternative, or the application of an additional remedial alternative in a downgradient location. Potential adverse outcomes could include the following:

- Incomplete reductive dechlorination or transformation that stalls at cis-1,2-DCE and/or vinyl chloride
- Increases in concentrations of VOCs immediately downgradient of the bioreactor treatment zone
- Migration of contaminant plume/lack of plume stability

Potential performance enhancement measures for one (1) or more of these outcomes include the following, listed in ascending order of field effort:

- Increased monitoring
- Installation of additional monitoring wells
- Boosting dissolved organic carbon levels in the bioreactor recirculation water (e.g., adding vegetable oil or high fructose corn syrup into the existing distribution manifold)
- Bioaugmentation of the water circulated through the bioreactor (i.e., supplement native microbes with a proprietary microbial consortium [e.g., KB-1®] if the native microbes prove incapable of complete degradation of TCE through cis-1,2-DCE to non-toxic ethene)
- Expansion and restart of the OSA GET system
- Implementation of another remedial technology

The AF and the regulatory agencies will base the selection of the appropriate performance enhancement measure(s) on the type and severity of the adverse outcome.

In the event that plume migration or increasing concentrations are observed downgradient of the GET component of the remedy, then optimization of the GET system will be evaluated. Potential optimization actions could include increasing the pumping rates in individual extraction wells or adding new extraction and/or monitoring wells.

The land use at Site SS016 consists primarily of active military airfield operations, including aircraft parking ramps, taxiways, and runways. Access to the great majority of the site is restricted. Implementation of any remedial action or optimization measure will be constrained by these access restrictions and the requirement to avoid adverse impacts to the military mission of Travis AFB.

#### 2.12.2.5 Alternative 5 – EVO and EA

Alternative 5 combines the following two (2) components to remediate the Site SS015, SD036, and SD037 plumes:

- **EVO Injection –** Edible oil substrates are injected into the portions of the plumes with the highest concentrations of contaminants to facilitate anaerobic degradation of chlorinated VOCs. These high concentration portions of the plume are a continuing source of contamination into the hydraulically downgradient portions of the plume.
- **EA –** In conjunction with ERD treatment of the portions of the plumes with the highest concentrations of contaminants, physical, chemical, and/or biological processes of natural attenuation will reduce the mass, toxicity, volume, or concentration of contaminants in the remaining portions of the plume.

Treatment using EVO injections will be continued until COC concentrations are less than 1,000 µg/L. Then, EA monitoring will be conducted for the entirety of the plume until cleanup levels are achieved. It is likely that the injected EVO will reach the limits of effective treatment well before the RAOs are achieved by attenuation processes within the remainder of the plume. At that time, in situ treatment using EVO injections will be discontinued and EA monitoring will continue. When groundwater cleanup levels for all COCs are achieved within the monitoring network for the site, and confirmed by 2 years of annual LTM, the RAOs will be considered satisfied for the sites. Groundwater monitoring will stop, and the completion of the remedial action and a plan to decommission all remedy infrastructure as part of the site closure process will be documented in the annual GRISR. This alternative discontinues the operation of the Site SD036 and Site SD037 GET systems. In the event that plume migration or increasing concentrations are observed at either site, then active remediation using these systems can be readily resumed or an alternative technology could be implemented.

Treatment residuals following complete degradation of chlorinated VOCs through the ERD processes facilitated by EVO injection include non-regulated end-products such as ethene and ethane. Incomplete ERD, resulting from the stalling of these processes, has the potential to create intermediate treatment residuals such as cis-1,2-DCE and/or vinyl chloride. Vinyl chloride is the most toxic potential treatment residual resulting from incomplete ERD treatment. Within the anaerobic treatment zone created by EVO injection, creation of vinyl chloride is expected as part of normal ERD processes. Based on analytical results obtained during the EVO treatment demonstrations, full degradation of vinyl chloride within the treatment zones is expected as those processes continue through completion to form ethane, ethene, and methane (refer to Section 2.2.3). Outside of the treatment zones, the aquifer is aerobic. Vinyl chloride readily degrades under aerobic conditions, so any vinyl chloride that migrates beyond the ERD treatment zone will degrade aerobically shortly after entering the downgradient portion of the aquifer (CH2M HILL, 2012d).

If performance monitoring of the remedy identifies any unanticipated or adverse outcomes from injection of EVO, then the AF will evaluate and carry out enhancement measures to correct the deficiencies. The end result of these measures will either be a return of the EVO's ability to remediate contaminated groundwater, a transition to a more effective remedial

alternative, or the application of an additional remedial alternative in a hydraulically downgradient location. Potential adverse outcomes could include the following:

- Incomplete reductive dechlorination or transformation that stalls at cis-1,2-DCE and/or vinyl chloride
- Increases in concentrations of VOCs immediately downgradient of the EVO treatment zone
- Migration of contaminant plume/lack of plume stability

Potential performance enhancement measures for one (1) or more of these outcomes include the following, listed in ascending order of field effort:

- Increased monitoring
- Installation of additional monitoring wells
- Sustaining high dissolved organic carbon levels within the EVO treatment zone (e.g., injecting high fructose corn syrup)
- Bioaugmentation of the EVO solution injected into the treatment zone (i.e., supplement native microbes with a proprietary microbial consortium [e.g., KB-1®] if the native microbes prove incapable of complete degradation of TCE through vinyl chloride to non-toxic ethene)
- Expansion and restart of the GET systems
- Implementation of another remedial technology

The AF and the regulatory agencies will base the selection of the appropriate performance enhancement measure(s) on the type and severity of the adverse outcome.

**EVO and EA at Site SS015.** A conceptual design of Alternative 5 at Site SS015 is shown on Figure 2.12-7.

There is no GET system associated with Site SS015. In the unlikely event that plume migration or increasing concentrations are observed at this site, a contingency remedy would have to be designed and carried out, taking into account the considerable restrictions posed by the presence of a fuel truck parking area and maintenance facility above the plume.

**EVO and EA at Site SD036.** A conceptual design of Alternative 5 at Site SD036 is shown on Figure 2.12-9.

This alternative continues the performance monitoring of the EVO injections. Groundwater monitoring for natural attenuation will continue within the untreated portions of the overall WIOU plume, including the distal portions of Site SD036.

**EVO and EA at Site SD037.** A conceptual design of Alternative 5 at Site SD037 is shown on Figure 2.12-10.

This alternative continues the performance monitoring of the EVO injections. Groundwater monitoring for natural attenuation will continue within the untreated portions of the overall WIOU plume, including the distal portions of Site SD037.

#### 2.12.2.6 Alternative 6 – Bioreactor, Phytoremediation, EVO PRB, and EA

Alternative 6 combines the following three (3) in situ bioremediation technology processes and monitored EA to remediate the Site DP039 plume:

- **In Situ Bioremediation**
  - **Bioreactor –** The bioreactor installed in December 2008 as a technology demonstration project actively treats the portion of the plume with the highest concentrations by circulating extracted groundwater through an organic mulch mixture to reduce contaminant mass and volume via ERD processes. Contaminated groundwater from an extraction well is pumped through a pipe system onto the mulch column. The water then trickles through the mulch column and into the aquifer before being captured and recirculated by an extraction well. A sustainable source of electric power to the extraction well pump is provided by solar panels (CH2M HILL, 2009b).
  - **Phytoremediation –** A phytoremediation zone is downgradient of the bioreactor and consists of a grove of engineer-planted eucalyptus trees. The trees take in contaminated groundwater and either absorb the contaminants or transpire them, providing additional reduction of contaminant mass and volume. Root growth also contributes to the breakdown of contaminants into harmless compounds (Parsons, 2010).
  - **EVO PRB –** A demonstration PRB of edible vegetable oil was installed in 2010 using injection wells in the portion of the aquifer downgradient of the phytoremediation zone. Injection of EVO across the leading edge of the 500-µg/L portion of the plume anaerobically degrades the higher concentrations of TCE and other chlorinated VOCs. This portion of the plume is a continuing source of contamination into the hydraulically downgradient area of EA. The injected EVO is expected to provide effective treatment for approximately 2 to 3 years. Supplemental injection of EVO will be conducted using the injection wells, if required, to maintain the treatment process.
- **EA –** Physical, chemical, and/or biological processes will remediate the residual contaminants in the distal portion of the Site DP039 plume. The effectiveness of natural attenuation in the lower concentration distal portions of the plume is now enhanced, because contaminant migration into this part of the plume from the higher concentration portion of the plume is greatly reduced. The existing site monitoring wells will be incorporated into the implementation of EA.

Alternative 6 discontinues the operation of the Site DP039 GET system. A conceptual design of the implementation of Alternative 6 is shown on Figure 2.12-11. The land use at Site DP039 is mostly open space. Building 755 was demolished in 2009, and there are currently no office facilities or other buildings at the site.

Treatment using the bioreactor will continue until groundwater influent COC concentrations into the bioreactor are at cleanup levels. The hydraulically downgradient area of phytoremediation will be maintained until cleanup levels are achieved in the underlying groundwater being treated by the trees. Further downgradient, treatment using the EVO PRB will continue until groundwater COC concentrations entering the PRB treatment zone are less than or equal to cleanup levels. Then, EA monitoring will be

conducted for the entirety of the plume until cleanup levels are achieved. When groundwater cleanup levels for all COCs are achieved within the monitoring network for the site, and confirmed by 2 years of annual LTM, the RAOs will be considered satisfied. Groundwater monitoring will stop, and the completion of the remedial action and a plan to decommission all remedy infrastructure as part of the site closure process will be documented in the annual GRISR.

Treatment residuals following complete degradation of chlorinated VOCs through the ERD processes facilitated by EVO injection and installation of the bioreactor include non-regulated end-products such as ethene and ethane. Incomplete ERD, resulting from stalling of these processes, has the potential to create intermediate treatment residuals such as cis-1,2-DCE and/or vinyl chloride. Vinyl chloride is the most toxic potential treatment residual resulting from incomplete ERD treatment. Within the anaerobic treatment zone created by EVO injection and the bioreactor, creation of vinyl chloride is expected as part of normal ERD processes. Based on analytical results obtained during the EVO injection and bioreactor treatment demonstrations, full degradation of vinyl chloride within the treatment zones is expected as those processes continue through completion to form ethane, ethene, and methane (refer to Section 2.2.3). Outside of the treatment zones, the aquifer is aerobic. Vinyl chloride readily degrades under aerobic conditions, so any vinyl chloride that migrates beyond the ERD treatment zones will degrade aerobically shortly after entering the downgradient portion of the aquifer (CH2M HILL, 2012d).

**Bioreactor Performance Enhancement Measures.** If performance monitoring identifies any unanticipated or adverse outcomes from installation of the bioreactor, then the AF will evaluate and carry out performance enhancement measures to correct the deficiencies. The end result of these measures will be a return of the bioreactor's ability to remediate contaminated groundwater, a transition to a more effective remedial alternative, or the application of an additional remedial alternative in a downgradient location. Potential adverse outcomes could include the following:

- Incomplete reductive dechlorination or transformation that stalls at cis-1,2-DCE and/or vinyl chloride
- Increases in concentrations of VOCs immediately downgradient of the bioreactor treatment zone
- Migration of contaminant plume/lack of plume stability

Potential performance enhancement measures for one (1) or more of these outcomes include the following, listed in ascending order of field effort:

- Increased monitoring
- Installation of additional monitoring wells
- Boosting dissolved organic carbon levels in the bioreactor recirculation water (e.g., adding vegetable oil or high fructose corn syrup into the existing distribution manifold)
- Bioaugmentation of the water circulated through the bioreactor (i.e., supplement native microbes with a proprietary microbial consortium [e.g., KB-1®] if the native microbes prove incapable of complete degradation of TCE through cis-1,2-DCE to non-toxic ethene)

- Expansion and restart of the Site DP039 GET system
- Implementation of another remedial technology

The AF and the regulatory agencies will base the selection of the appropriate performance enhancement measure(s) on the type and severity of the adverse outcome.

**Phytoremediation Performance Enhancement Measures.** If performance monitoring identifies any unanticipated or adverse outcomes from installation of the tree stand, then the AF will evaluate and carry out performance enhancement measures to correct the deficiencies. The end result of these measures will be a return of the tree stand's ability to remediate contaminated groundwater, a transition to a more effective remedial alternative, or the application of an additional remedial alternative in a downgradient location. Potential adverse outcomes could include the following:

- Increases in concentrations of VOCs immediately downgradient of the tree stand
- Migration of contaminant plume/lack of plume stability
- Releases of VOCs into the atmosphere from the transpiration processes of the tree stand

Potential performance enhancement measures for one (1) or more of these outcomes include the following, listed in ascending order of field effort:

- Increased monitoring
- Installation of additional monitoring wells
- Expansion of the tree planting area
- Conducting a simple air study to assess releases of VOCs from the tree stand
- Implementation of another remedial technology

The AF and the regulatory agencies will base the selection of the appropriate performance enhancement measure(s) on the type and severity of the adverse outcome.

**EVO PRB Performance Enhancement Measures.** Similarly, if performance monitoring identifies any unanticipated or adverse outcomes from installation of the EVO PRB, then the AF will evaluate and carry out performance enhancement measures to correct the deficiencies. The end result of these measures will either be a return of the PRB's ability to remediate contaminated groundwater, a transition to a more effective remedial alternative, or the application of an additional remedial alternative in a downgradient location.

Potential outcomes could include the following:

- Increases in concentrations of VOCs immediately downgradient of the EVO PRB treatment zone
- Decrease in the permeability of the EVO PRB treatment zone, resulting in an upgradient pooling of contaminated groundwater
- Migration of contaminant plume/lack of plume stability
- Incomplete reductive dechlorination or transformation that stalls at cis-1,2-DCE or vinyl chloride

Potential performance enhancement measures for one (1) or more of these outcomes include the following, listed in ascending order of field effort:

- Increased monitoring
- Installation of additional monitoring wells
- Supplemental injection of EVO using existing PRB injection wells
- Installation of additional PRB injection wells
- Bioaugmentation (i.e., supplement native microbes with a proprietary microbial consortium [e.g., KB-1®] if the native microbes prove incapable of complete degradation of TCE through cis-1,2-DCE to non-toxic ethene)
- Installation of recirculation loops to allow additional residence time of contaminants within the PRB treatment zone; the recirculation system could potentially be extended to include the area of phytoremediation located hydraulically upgradient of the PRB
- Extending the existing PRB to better intercept the migrating plume
- Installing an additional PRB at another location (e.g., at the toe of the plume)
- Expanding and restarting the Site DP039 GET system

Travis AFB will base the selection of the appropriate performance enhancement measure(s) on the type and severity of the adverse outcome.

#### 2.12.2.7 Alternative 7 – Passive Skimming and EA

Alternative 7 includes the following two (2) components to remediate the Site SD034 plume:

- **Passive skimmer –** Floating free-phase Stoddard solvent, containing dissolved COCs, will be removed using the passive skimmers previously installed in the existing network of vertical extraction wells. This action minimizes the dissolution of COCs from the nonaqueous Stoddard solvent medium into the underlying groundwater and minimizes the spread of contamination into previously uncontaminated zones by using recovery and disposal techniques appropriate to the hydrogeologic conditions at the site. The presence of free-phase Stoddard solvent is limited to the original release area and is not migrating (CH2M HILL, 2011b).
- **EA –** In the distal portions of the plume, natural attenuation will be monitored to address low concentration dissolved-phase contamination. The existing Site SD034 monitoring wells will be incorporated into the monitoring of EA within the overall WIOU plume. The effectiveness of EA in the untreated portion of the plume will be enhanced by continuing to conduct passive skimming to remove the ongoing source of COCs dissolving into the groundwater from the free-phase Stoddard solvent.

Stoddard solvent, containing dissolved COCs, floating on the groundwater table will be physically removed using previously installed passive skimmers and recycled by an EPA-approved off-base vendor until a maximum thickness of 0.01 foot is achieved at every compliance point (monitoring wells), or to the maximum extent practicable. When removal of free-phase Stoddard solvent (NAPL) floating on the groundwater table is considered complete

(i.e., maximum thickness of 0.01 foot is achieved), then passive skimming will be discontinued. The low concentrations of dissolved COCs at Site SD034 do not warrant an active treatment component for the remedy. As reported in the 2010-2011 Annual GSAP Report, the COCs dissolved in the groundwater at Site SD034 include TCE and vinyl chloride at maximum concentrations of 5.8 and 2.1 µg/L (MW02x34). Therefore, groundwater monitoring will continue throughout the WIOU plume, including Site SD034, as part of the EA component of the remedy. When groundwater cleanup levels for all COCs are achieved within the monitoring network for the site and are confirmed by 2 years of annual LTM, the RAOs will be considered satisfied for the site. At that time, groundwater monitoring will stop, and the completion of the remedial action and a plan to decommission all remedy infrastructure as part of the site closure process will be documented in the annual GRISR report.

Resuming GET system operation is not considered a viable alternative technology. The interim GET system operated for almost a decade and did not remove all the Stoddard solvent. No improvement in free product removal performance is expected by resuming GET system operations, and such a system would have a relatively large carbon footprint. Also, expansion of the GET system would be constrained by the proximity of active aircraft maintenance activities in Building 811. In the event that plume migration or increasing concentrations are observed within the EA portion of the plume, then GET system operations could be resumed in those areas. An alternative remedial approach, such as combining EVO and EA, could possibly be implemented in some portions of the plume, if determined by the AF to be technically and economically feasible.

#### 2.12.2.8 Land Use Controls

**Resource Uses and Risk Exposure Assumptions for LUCs.** California has designated all groundwater of the state as potential drinking water. While Travis AFB currently does not use the aquifer under the main base as potable drinking water, and does not plan to do so in the future, as it obtains its drinking water from the City of Vallejo and/or drinking water wells at the off-base golf course, to assess the need for LUCs, contamination at these groundwater sites was assessed for risk under a potable water use scenario.

The need for LUCs to address risk posed by volatile COCs emanating from groundwater to indoor air was also assessed for industrial worker and hypothetical future resident scenarios.

**Risks Necessitating LUCs.** The groundwater plumes at these groundwater sites, both on- and off-base, are not safe for drinking water. Accordingly, the base must impose LUCs and monitor and enforce its off-base access easements over the plumes to ensure groundwater is not used for potable purposes until it is remediated to MCLs that allow for unlimited use and unrestricted exposure.

Groundwater contamination at portions of Sites FT004, SS015, SS016, SS029, and DP039 poses an indoor air vapor intrusion risk to industrial workers. Risks are also posed to potential future residents at these sites and at Subarea LF007C and Sites SS030, SD033, SS035, SD036, and SD037. Accordingly, the base must impose LUCs to restrict residential and industrial land uses until concentrations of volatile COCs in groundwater posing a potential indoor air risk are at such levels that VOCs emanating from groundwater to indoor air do not pose unacceptable risk to human health.

**Performance Objectives.** The performance objective of LUCs for groundwater is to prevent access or use of groundwater, including development of on-base water wells, until groundwater cleanup levels are met that allow for unlimited use and unrestricted exposure. They will restrict soil excavation and other subsurface work in circumstances where workers might encounter contaminated groundwater or vapors. The LUCs will also maintain the integrity of current and future remedial and monitoring systems, such as monitoring and extraction wells. They will restrict land use over contaminated groundwater plumes to industrial purposes only.

The performance objective of LUCs for vapor intrusion is to restrict industrial building construction on portions of Sites FT004, SS015, SS016, SS029, and DP039 (see Figure 2.12-13) unless vapor barriers and passive venting systems are included. The LUCs will be maintained until concentrations of volatile COCs in groundwater posing a potential indoor air risk are at such levels that VOCs emanating from groundwater to indoor air do not pose unacceptable risk to human health.

**Location of LUCs.** Maps showing the boundaries of groundwater LUCs (Figure 2.12-12) and groundwater-to-indoor air LUCs (Figures 2.12-13 and 2.12-14) and associated data fields will be included in the Base General Plan. The boundaries of the off-base LUCs at Site FT005, Subarea LF007C, and Site SS030 are within the boundaries of the easements already purchased by the AF from the private landowners.

**Duration of LUCs.** LUCs for groundwater will be maintained on groundwater sites and use restricted until cleanup levels are achieved that allow for unlimited use and unrestricted exposure (refer to Table 2.8-1).

LUCs for vapor intrusion will be maintained until concentrations of volatile COCs in groundwater posing a potential indoor air risk are at such levels that the VOCs emanating from groundwater to indoor air are at levels that allow for unlimited use of and unrestricted exposure to indoor air (refer to Table 2.8-2).

**Mechanisms for Achieving LUC Performance Objectives.** The internal procedures that Travis AFB will use to implement the LUCs include but are not limited to the following:

- **Base Civil Engineer Work Requests –** One (1) tool for achieving the LUC performance objectives is the AF Form 332 (AF332) or Base Civil Engineer Work Request. This form must be submitted and approved before the start of any construction project at Travis AFB. One (1) step in the approval process for this form is a comparison of the construction site with all constraints that are described in the Base General Plan. The AF332 serves as the document for communicating any construction constraints to the appropriate offices. Any constraints at the site result in the disapproval of the form unless the requester makes appropriate modifications to the construction plans.
- **Excavation Permits –** Travis AFB also uses the 60th Air Mobility Wing Form 55 or Excavation Permit to enforce soil and sediment disturbance restrictions. The requester submits the permit to the Civil Engineer Squadron for any project that involves mechanical soil or sediment excavation, such as trench digging for underground utilities or soil excavation for building foundations. If constraints involving soil disturbance or worker safety exist at the excavation area, the permit describes the appropriate

procedures that workers must implement before the start of excavation to prevent unknowing exposure to contamination.

- **The Base Environmental Impact Analysis Process (EIAP) –** EIAP is conducted pursuant to the National Environmental Policy Act, as promulgated for the AF in 32 CFR 989, et. seq., to assess the potential environmental impact of any federal action initiated by or involving Travis AFB. An AF Form 813 (AF813) initiates the EIAP. Both AF332s and excavation permits are subject to an evaluation under the EIAP. The proponent of a proposed action is required to submit the AF332 or excavation permit with AF813 so that the appropriate environmental analysis of the proposed action and alternatives to the proposed action is accomplished prior to any construction activities. The EIAP works to ensure proposed construction sites take into account the constraints that are described in the Base General Plan and known to the AFCEC Environmental Restoration Installation Support Team (IST). The EIAP also ensures that all environmental factors, such as LUCs, are considered in the selection of locations for construction projects.

- **Travis AFB General Plan –** The Base General Plan is a long-range planning tool that provides a framework for selecting the locations of future facilities needed to carry out the Base mission (Travis AFB, 2002). The Base General Plan describes the specific LUCs for each site, the reasons for the controls, and the areas where the controls are applied. For a LUC to remain protective, Base personnel must have access to information concerning its existence, purpose, and maintenance requirements. The Base General Plan provides the important information management to ensure that LUC management takes place and that the LUC's presence is effectively communicated.

- **Base Well Permitting System –** All Travis AFB ERP groundwater monitoring, extraction, and injection wells are managed under the GRIP. Approval of the construction of new wells is received during the regulatory review and acceptance of work plans for groundwater remedial actions and technology demonstration projects. Approval of the decommissioning of old wells is received during the regulatory review and acceptance of the annual GRISR. All modifications to the Travis AFB well network receive Base approval through the submission and approval of the AF Form 332 and the 60AMW Form 55, as described above.

The AF will notify EPA in advance of any changes to internal procedures associated with the selected remedy that might affect the LUCs.

The AF is responsible for implementing, maintaining, monitoring, reporting, and enforcing LUCs. The AF has an obligation to inform, monitor, enforce, and bind, where appropriate, authorized lessees, tenants, contractors, and other authorized occupants of the groundwater sites of LUCs impacting the sites. Although the AF may later transfer these procedural responsibilities to another party by contract, property transfer agreement, or through other means, the AF shall retain ultimate responsibility for remedy integrity.

Whenever the AF transfers real property that is subject to institutional controls and resource use restrictions to another federal agency, the transfer documents shall require that the federal transferee include the institutional controls, and applicable resource use restrictions, in its resource use plan or equivalent resource use mechanism. The AF shall advise the recipient federal agency of all obligations contained in the ROD, including the obligation

that a State Land Use Covenant will be executed and recorded pursuant to 22 CCR Section 67391.1 in the event the federal agency transfers the property to a non-federal entity.

Whenever the AF proposes to transfer real property subject to resource use restrictions and institutional controls to a non-federal entity, it will provide information to that entity in the draft deed and transfer documents regarding necessary resource use restrictions and institutional controls, including the obligation that a State Land Use Covenant will be executed and recorded pursuant to 22 CCR Section 67391.1. The signed deed will include institutional controls and resource restrictions equivalent to those contained in the State Land Use Covenant and this ROD.

The AF will provide notice to EPA and the State at least six (6) months prior to any transfer or sale of Travis AFB so that EPA and the State can be involved in discussions to ensure that appropriate provisions are included in the transfer terms or conveyance documents to maintain effective institutional controls. If it is not possible for the facility to notify EPA and the State at least 6 months prior to any transfer or sale, then the facility will notify EPA and the State as soon as possible but no later than 60 days prior to the transfer or sale of any property subject to institutional controls. In addition to the land transfer notice and discussion provisions above, the AF further agrees to provide EPA and the State with similar notice, within the same time frames, as to federal-to-federal transfer of property. The AF shall provide a copy of the executed deed or transfer assembly to EPA and the State.

The AF shall notify EPA and state 45 days in advance of any proposed land use changes that are inconsistent with land use control objectives or the selected remedy.

Any activity that is inconsistent with the LUC objectives or use restrictions or any other action that may interfere with the effectiveness of the LUCs will be addressed by the AF as soon as practicable, but in no case will the process be initiated later than ten days after the AF becomes aware of the breach. The AF will notify EPA and the state as soon as practicable, but no longer than ten days after discovery of any activity that is inconsistent with the LUC objectives or use restrictions, or any other action that may interfere with the effectiveness of the LUCs. The AF will notify EPA and the state regarding how the AF has addressed or will address the breach within ten days of sending the EPA and state notification of the breach. For corrective measures taken after the notification, the AF shall notify EPA and the state when the measures are complete.

Monitoring of the environmental use restrictions and controls will be conducted annually by the AF. The monitoring results will be included in a separate report or as a section of another environmental report, if appropriate, and provided to EPA and the State. The annual monitoring reports will be used in preparation of the Five-year Review to evaluate the effectiveness of the remedy. The annual monitoring report, submitted to the regulatory agencies by the AF, will evaluate the status of the LUCs and how any LUC deficiencies or inconsistent uses have been addressed. The annual evaluation will address whether the use restrictions and controls referenced above were communicated in the deed(s), whether the owners and state and local agencies were notified of the use restrictions and controls affecting the property, and whether use of the property has conformed to such restrictions and controls.

Travis AFB shall not modify or terminate LUCs, implementation actions, or land use that are associated with the selected remedy without the approval of EPA and the opportunity

for concurrence by the State. Travis AFB shall seek prior concurrence of EPA and the State before any anticipated action that may disrupt the effectiveness of the LUCs or any action that may alter or negate the need for LUCs.

Three (3) solvent plumes have migrated off-base. These plumes are associated with Subarea LF007C and Sites FT005 and SS030 and lie beneath private property. To manage the groundwater IRAs for these sites, Travis AFB purchased long-term easements that grant access rights to the United States, its representatives, agents, and contractors for the purpose of conducting environment responses on the properties. The easements contain enforceable restrictions that prevent the landowners from interfering or abridging the exercise of the government's rights under the easements and prevent landowners from engaging in water development or soil disturbing activities that could interfere with cleanup activities. The AF would view any residential development and any well drilling on the properties covered by the easements as interfering with the government's easement and would take appropriate action to prevent interference with its rights under the easements.

Additionally, Solano County Ordinance, Chapter 13.10, makes it a misdemeanor to construct a well without a Solano County permit and requires the permit requester to notify the County of all wells within a 100-foot radius of the proposed well site. Given the number of monitoring and extraction wells that the government is operating on the easements, this ordinance ensures that Travis AFB will be notified of a landowner's well drilling plans. Additionally, Travis AFB's wells are frequently monitored, and any landowner actions potentially interfering with the easements would be observed. The landowner would be contacted to rectify the situation. To date, no such activities have been observed, and there are no known drinking water wells that draw water from the plumes, as confirmed by the frequent presence of base and contractor personnel in the off-base area as part of conducting the interim remedies. The AF will purchase additional easements in the event the off-base plumes remain contaminated at the expiration of the terms of the existing easements. Thus, throughout their duration, the easements restrict development of new wells and incompatible use of the water below the property.

#### 2.12.2.9 Performance Monitoring

For each of the remedies, except Alternative 1 – No Further Action, a period of LTO will be conducted after the remedial action has been installed and the remedy is fully in-place. Monitoring data obtained during the period of LTO will be used to assess whether the remedy is performing as intended. The LTO monitoring will continue until groundwater cleanup levels have been achieved for the entirety of a site plume. When that is achieved, the response will be complete and then a period of LTM will begin. The LTM will be conducted semiannually for an additional 2 years to verify that the concentrations of contaminants have been permanently reduced to cleanup levels or below. At the conclusion of the period of LTM, a site closeout report will be developed to document that cleanup levels have been achieved. Estimates for the periods of LTO and LTM for each site are summarized in Table 2.12-2 – Summary of Performance Monitoring.

Performance monitoring will be conducted under the Travis AFB GRIP and in accordance with applicable EPA guidance documents, including the *Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater* (EPA, 1998) and *Performance Monitoring of MNA Remedies for VOCs in Groundwater* (EPA, 2004a). Existing Travis AFB documents, groundwater data, and assessments of IRA performance will also be used in the

development of the sampling requirements identified in the GRIP and GRISRs. Laboratory analyses of samples will be conducted in accordance with the RD/RA QAPP (CH2M HILL, 2009a). Monitoring results will be provided in annual GRISRs.

As remediation of the contaminant plumes progresses under each site remedy, it is expected that the distribution of groundwater contamination will change over time. Different portions of some plumes will achieve cleanup levels more rapidly than others. For example, under Alternative 5 – EVO and EA, the portions of the plumes at Sites SS015, SD036, and SD037 undergoing active ERD treatment will likely achieve cleanup levels more quickly than the portions of the plumes where the processes of natural attenuation are employed. A summary of the estimated cleanup times for the site plumes is provided in Table 2.12-2 – Summary of Performance Monitoring.

The performance monitoring well network for each site and remedy will be initially developed during the RD phase. However, as the plumes change over time, the monitoring networks will evolve appropriately for the future conditions. As the plumes change in shape and concentration, some monitoring wells may no longer be necessary and/or new wells may be required to adequately monitor the progress of remediation. It is also possible that the frequency of monitoring may increase or decrease under future conditions or that the required list of analytes may increase or decrease. Corrective actions to remedies potentially resulting from deficiencies identified in five-year reviews may also trigger changes to the monitoring schemes. Potential changes to the performance monitoring will be specified in the annual GRISRs and implemented under the GRIP.

### 2.12.3 Summary of Estimated Remedy Costs

This section provides breakdowns of the estimated costs associated with implementing and maintaining each remedial alternative. Cost estimates are provided in Appendix D.

The information in these cost estimate summary tables is based on the best available information regarding the anticipated scope of the remedial alternatives. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternatives. Major changes may be documented in the form of a memorandum in the Administrative Record file, an ESD, or a ROD amendment. These are order-of-magnitude engineering cost estimates that are expected to be within +50 to -30 percent of the actual project costs.

### 2.12.4 Expected Outcomes of Selected Remedy

The expected outcome of each selected remedy is the reduction of concentrations of COCs in groundwater to the lowest of either the state or federal MCLs and to allow for designated beneficial uses of groundwater (domestic, municipal, agricultural, and industrial supply) as well as unlimited use and unrestricted exposure (refer to Table 2.8-1). The selected remedies, including implementing all previously described LUCs, will allow Travis AFB to continue its designated existing mix of land uses.

Land use that would result in human exposure to contaminants in indoor air based on an industrial risk scenario is restricted until concentrations of volatile COCs in groundwater posing a potential indoor air risk are at such levels that VOCs emanating from groundwater to indoor air do not pose unacceptable risk to human health at Sites FT004, SS015, SS016,

SS029, and DP039 (refer to Table 2.8-2). Under a hypothetical residential scenario, land use that would result in human exposure to indoor air contaminants is restricted until concentrations of volatile COCs in groundwater posing a potential indoor air risk are at such levels that VOCs emanating from groundwater to indoor air do not pose unacceptable risk to human health at Site FT004, Subarea LF007C, and Sites SS015, SS016, SS029, SS030, SD033, SS035, SD036, SD037, and DP039 (refer to Table 2.8-2).

Land overlying plumes originating from Sites FT005, LF006, LF008, ST027B, SD031, SD034, SS041, and SD043 is currently considered suitable for continued industrial use or potential future residential use. The vapor intrusion pathway is not a potential future concern under either a residential or industrial exposure scenario at these sites. Withdrawal or use of groundwater that would result in human exposures to contaminants is restricted until the groundwater cleanup levels are met at each site. On the basis of available data, the total RTFs for the remedies at each site are estimated as follows:

- Site FT004: 35 years
- Site FT005: 10 years
- Site LF006: 5 years
- Subarea LF007B: 0 years
- Subarea LF007C: 26 years
- Subarea LF007D: 23 to 49 years
- Site LF008: 100 to 110 years
- Site SS015: 70 years
- Site SS016: 62 years
- Site ST027B: 50 years
- Site SS029: 62 years
- Site SS030: 22 years
- Site SD031: 15 years
- Site SS033: 60 years
- Site SD034: 60 years
- Site SS035: 60 years
- Site SD036: 60 years
- Site SD037: 60 years
- Site SD039: 58 years
- Site SS041: 0 years
- Site SD043: 60 years

The contaminated groundwater from Sites SD033, SD034, SS035, SD036, SD037, and SD043 has merged, so Travis AFB is addressing groundwater from all of these sites as a part of a single plume (i.e., the WIOU plume). Groundwater at Site SS035 has achieved cleanup goals. Groundwater monitoring will be performed at this site for 2 years prior to evaluating the site for closure.

Continued monitoring and evaluation of site conditions and CERCLA Five-year Reviews will be conducted to ensure the remedies are functioning optimally. Site data will be evaluated periodically to determine the progress in achieving the RAOs with the selected remedies. Implementing alternative remedies or new treatment technologies that might reduce costs, accelerate site cleanup, or provide additional protection to human health or the environment will be considered if a remedy selected for a site no longer effectively provides for protection of human health and the environment.

**TABLE 2.12-1**
Basis for Remedy Summary
*Groundwater Record of Decision, Travis Air Force Base, California*

| Site | COCs | Concentration (µg/L)[a,b] | Plume Size[c] | Interim Remedy/Status | Selected Remedy | Selected Remedy: RAOs | Selected Remedy: Description | Basis for Remedy Selection |
|---|---|---|---|---|---|---|---|---|
| FT004 | TCE<br>cis-1,2-DCE<br>1,2-DCA<br>Chloroform<br>Bromodichloromethane<br>1,1-DCE<br>Vinyl chloride<br>1,4-DCB | **204 J-**<br>**12.6 J+**<br>ND<br>3.8<br>0.73 J-<br>0.77<br>**14.8**<br>ND | TCE plume approximate dimensions:<br>Length: 950 feet<br>Width: 250 feet<br>Thickness: 30 feet<br>Area: 250,893 $ft^2$<br>Volume: 1,455,170 $ft^3$ | <u>GET and MNA Assessment</u><br>Plume size and concentrations of COCs have been reduced by approximately 10 years interim remediation (GET combined with MNA Assessment), but remain above cleanup levels. Monitoring data do not indicate significant plume migration.<br>A contaminant rebound study began in December 2007 and included the shutdown of selected extraction wells. In February 2009, the remaining extraction wells were shut down. Data obtained during the rebound study do not indicate significant increases in plume concentrations or plume migration after GET system operations were discontinued. | Alternative 2 – MNA | Restrict human ingestion and direct dermal contact with contaminated groundwater and reduce concentrations of COCs in groundwater to restore designated beneficial uses, to the maximum extent practicable.<br>Restrict inhalation of COCs that are volatilizing from groundwater into indoor air until those levels do not pose unacceptable risk to human health.<br>Prevent or minimize further migration of the contaminant plume. | Naturally occurring physical, chemical, and biological processes remediate COCs in groundwater. Operation of the GET system is discontinued.<br>LUCs restrict groundwater access and use and residential and industrial land uses.<br>Groundwater-to-indoor-air LUCs enforced when risk-based groundwater-to-indoor-air concentrations are exceeded. | Alternative 2 – MNA will achieve the RAOs and best satisfies the threshold and primary balancing evaluation criteria and represents the most reasonable value for the money. Costs are proportional to the effectiveness of the remedy by achieving long-term effectiveness and permanence within a reasonable time (35 years). The main factors supporting selection of the remedy include the following: the monitoring well components of MNA have already been implemented, the processes of natural attenuation have been demonstrated to be effective at remediating the entirety of the site plume, and the capital costs for the MNA monitoring well network have already been incurred.<br>Implementation of ROD Alternative 2 – MNA follows approximately a decade of successful interim GET system operation within the higher concentration portion of the plume combined with MNA Assessment in the lower concentration portion of the plume located hydraulically downgradient of the GET system. The GET system part of the IRA has been shut down for a contaminant rebound study since 2007. Plume concentrations under long-term GET operation had declined at an ever-decreasing rate and had become cost-ineffective. Natural attenuation processes have since been evaluated for the entirety of the plume (CH2M HILL, 2010b). Assessments of MNA during the period of interim remediation and during the period of the rebound study indicate that natural physical, chemical, and biological processes are viable for plume remediation under the site conditions (refer to Section 2.2.5.1). |
| FT005 | TCE<br>1,2-DCA<br>cis-1,2-DCE<br>Chloroform<br>Bromodichloromethane | **5.6 J-**<br>**5.8**<br>0.48 J-<br>0.29 J-<br>ND | 1,2-DCA plume approximate dimensions:<br>Length: 600 feet<br>Width: 400 feet<br>Thickness: 25 to 30 feet<br>Area: 1,258,142 $ft^2$<br>Volume: 11,323,278 $ft^3$<br>The majority of the contaminant plume extends to off-base privately owned property. | <u>GET</u><br>Plume size and concentrations of COCs have been reduced by approximately 10 years of interim remediation, but remain above cleanup levels in some wells.<br>A contaminant rebound study began in December 2007, and the majority of the GET system has been shut down. Groundwater extraction has been resumed at selected wells when localized increases in the concentrations of COCs are observed during monitoring events. | Alternative 3 – GET | Restrict human ingestion and direct dermal contact with contaminated groundwater and reduce concentrations of COCs in groundwater to restore designated beneficial uses, to the maximum extent practicable.<br>Prevent or minimize further migration of the contaminant plume. | Pumps extract contaminated groundwater from the aquifer and provide hydraulic containment of the plume. Extracted groundwater is treated using LGAC at a centralized treatment plant. Treated groundwater is discharged to the stormwater drainage system.<br>LUCs restrict groundwater access and use and residential and industrial land uses. | Alternative 3 – GET will achieve the RAOs and best satisfies the threshold and primary balancing evaluation criteria and represents the most reasonable value for the money. Costs are proportional to the effectiveness of the remedy by achieving long-term effectiveness and permanence within a reasonable time (10 years). The main factors supporting selection of the remedy include the following: the GET remedy components have already been implemented, GET has been demonstrated to be effective at remediating the entirety of the site plume, and the GET system capital costs have already been incurred. Treatment of contaminant-laden LGAC by an off-base EPA-approved vendor will also satisfy the statutory preference for treatment.<br>Implementation of ROD Alternative 3 – GET at Site FT005 represents a continuation of approximately a decade of successful interim GET system operation (refer to Section 2.2.5.2). |

**TABLE 2.12-1**
Basis for Remedy Summary
*Groundwater Record of Decision, Travis Air Force Base, California*

| Site | COCs | Concentration (µg/L)[a,b] | Plume Size[c] | Interim Remedy/Status | Selected Remedy | Selected Remedy: RAOs | Selected Remedy: Description | Basis for Remedy Selection |
|---|---|---|---|---|---|---|---|---|
| LF006 | TCE<br>1,1-DCE | **6.9**<br>ND | TCE plume approximate dimensions:<br>Length: 400 feet<br>Width: 350 feet<br>Thickness: 25 to 30 feet<br>Area: 110,447 $ft^2$<br>Volume: 662,680 $ft^3$ | MNA<br>Plume size and concentrations of COCs have been reduced by approximately 10 years of interim remediation, but remain above cleanup levels. Monitoring data have not indicated significant plume migration. | Alternative 2 – MNA | Restrict human ingestion and direct dermal contact with contaminated groundwater and reduce concentrations of COCs in groundwater to restore designated beneficial uses, to the maximum extent practicable.<br>Prevent or minimize further migration of the contaminant plume. | Naturally occurring physical, chemical, and biological processes remediate COCs in groundwater.<br>LUCs restrict groundwater access and use and residential and industrial land uses. | Alternative 2 – MNA will achieve the RAOs and best satisfies the threshold and primary balancing evaluation criteria and represents the most reasonable value for the money. Costs are proportional to the effectiveness of the remedy by achieving long-term effectiveness and permanence within a reasonable time (5 years). The main factors supporting selection of the remedy include the following: the MNA remedy components have already been implemented, the processes of natural attenuation have been demonstrated to be effective at remediating the entirety of the site plume, and the capital costs for the MNA monitoring well network have already been incurred.<br>Implementation of Alternative 2 – MNA at Site LF006 is a continuation of approximately a decade of successful MNA during the period of interim remediation (refer to Section 2.2.5.3). |
| LF007B Subarea | Benzene<br>1,4-DCB<br>Chlorobenzene | ND<br>ND<br>ND | No plume dimensions. Contaminant concentrations already less than cleanup levels.<br>Area: 0 $ft^2$<br>Volume: 0 $ft^3$ | MNA Assessment<br>Plume size and concentrations of COCs have been reduced to below cleanup levels by interim remediation. Monitoring data over approximately 10 years of MNA assessment did not indicate significant plume migration. | Alternative 2 – MNA | Prevent or minimize further migration of the contaminant plume. | Naturally occurring physical, chemical, and biological processes remediate COCs in groundwater. | Alternative 2 – MNA will achieve the RAOs and best satisfies the threshold and primary balancing evaluation criteria and represents the most reasonable value for the money. Groundwater cleanup levels were achieved by natural attenuation processes during the period of interim remediation. Verification of the cleanup levels will be conducted under Alternative 2. Other main factors supporting selection of the remedy include the following: the MNA remedy components have already been implemented, the processes of natural attenuation have been demonstrated to be effective at remediating the entirety of the subarea plume, and the capital costs for the MNA monitoring well network have already been incurred.<br>Implementation of ROD Alternative 2 – MNA at Site LF007B represents a transition from approximately a decade of successful MNA Assessment (CH2M HILL, 2010b) (refer to Section 2.2.5.4). |
| LF007C Subarea | TCE<br>Vinyl chloride<br>1,1-DCE<br>1,2-DCA<br>1,2-Dichloropropane | **10.3**<br>ND<br>ND<br>ND<br>0.3 J | TCE plume approximate dimensions:<br>Length: 620 feet<br>Width: 220 feet<br>Thickness: 25 feet<br>Area: 110,330 $ft^2$<br>Volume: 485,452 $ft^3$<br>The majority of the contaminant plume extends to off-base privately owned property. | GET<br>Plume is stable. Monitoring data over approximately 10 years of interim GET system operation did not indicate significant reductions in plume size or concentrations of COCs. Therefore, GET system optimization will be conducted during 2013 to improve the extent of hydraulic capture and increase the rate of contaminant mass removal. | Alternative 3 – GET | Restrict human ingestion and direct dermal contact with contaminated groundwater and reduce concentrations of COCs in groundwater to restore designated beneficial uses, to the maximum extent practicable.<br>Restrict inhalation of COCs that are volatilizing from groundwater into indoor air until those levels do not pose unacceptable risk to human health.<br>Prevent or minimize further migration of the contaminant plume. | Solar-powered pumps extract contaminated groundwater from the aquifer and provide hydraulic containment of the plume. Extracted groundwater is treated using LGAC at a centralized treatment plant. Treated groundwater is beneficially reused at the on-base Duck Pond recreation area.<br>LUCs restrict groundwater access and use and residential and industrial land uses.<br>Groundwater-to-indoor-air LUCs enforced when risk-based groundwater-to-indoor-air concentrations are exceeded. | Alternative 3 – GET will achieve the RAOs and best satisfies the threshold and primary balancing evaluation criteria and represents the most reasonable value for the money. Costs are proportional to the effectiveness of the remedy by achieving long-term effectiveness and permanence within a reasonable time (26 years). The main factors supporting selection of the remedy include the following: the GET remedy components have already been mostly implemented. GET system optimizations will take place during 2013 that will result in increased groundwater pumping rates, improved hydraulic capture of the plume, and an increased rate of contaminant mass removal. The optimized interim GET system will be more effective at remediating the site plume. Following the completion of the 2013 optimization activities, the GET system capital costs will be largely incurred. Treatment of contaminant-laden LGAC by an off-base EPA-approved vendor will also satisfy the statutory preference for treatment. The use of solar-powered groundwater extraction pumps and beneficial reuse of treated groundwater in the on-base Duck Pond provides aspects of GSR.<br>Implementation of ROD Alternative 3 – GET at Subarea LF007C represents a continuation of approximately a decade of interim GET system operation (refer to Section 2.2.2.1). |

**TABLE 2.12-1**
Basis for Remedy Summary
*Groundwater Record of Decision, Travis Air Force Base, California*

| Site | COCs | Concentration (µg/L)[a,b] | Plume Size[c] | Interim Remedy/Status | Selected Remedy | Selected Remedy: RAOs | Selected Remedy: Description | Basis for Remedy Selection |
|---|---|---|---|---|---|---|---|---|
| LF007D Subarea | Benzene<br>Vinyl chloride<br>1,4-DCB<br>1,1-DCE<br>Chlorobenzene | **2.2**<br>ND<br>**12.6**<br>ND<br>30.2 | Plume is limited to a small area in the vicinity of MW261x07.<br>Area: 31,000 $ft^{2}$ [d]<br>Volume: 248,000 $ft^{3}$ [d] | MNA Assessment<br>Plume is stable. Monitoring data over approximately 10 years of MNA assessment indicated decreasing concentrations and did not indicate significant plume migration. | Alternative 2 – MNA | Restrict human ingestion and direct dermal contact with contaminated groundwater and reduce concentrations of COCs in groundwater to restore designated beneficial uses, to the maximum extent practicable.<br>Prevent or minimize further migration of the contaminant plume. | Naturally occurring physical, chemical, and biological processes remediate COCs in groundwater.<br>LUCs restrict groundwater access and use and residential and industrial land uses. | Alternative 2 – MNA will achieve the RAOs and best satisfies the threshold and primary balancing evaluation criteria and represents the most reasonable value for the money. Costs are proportional to the effectiveness of the remedy by achieving long-term effectiveness and permanence within a reasonable time (23 to 49 years). The main factors supporting selection of the remedy include the following: the MNA remedy components have already been implemented, the processes of natural attenuation have been demonstrated to be effective at remediating the entirety of the site plume, and the capital costs for the MNA monitoring well network have already been incurred.<br>Implementation of ROD Alternative 2 – MNA at Subarea LF007D represents a transition from approximately a decade of successful MNA Assessment (refer to Section 2.2.5.5). |
| LF008 | Alpha-chlordane<br>Heptachlor<br>Heptachlor epoxide | **0.43**<br>ND<br>**0.017 J-** | Alpha-chlordane plume approximate dimensions:<br>Length: 195 feet<br>Width: 112 feet<br>Thickness: 35 feet<br>Area: 33,368 $ft^{2}$<br>Volume: 233,576 $ft^{3}$ | GET<br>Plume is stable and was hydraulically captured by IRA GET system during approximately 10 years of interim remediation. Plume size and concentrations of COCs remained stable and above cleanup levels.<br>GET system operations were discontinued in December 2008 to conduct a contaminant rebound study. Data obtained during the rebound study did not indicate significant increases in concentrations of COCs or plume migration after GET system operations were discontinued. | Alternative 2 – MNA | Restrict human ingestion and direct dermal contact with contaminated groundwater and reduce concentrations of COCs in groundwater to restore designated beneficial uses, to the maximum extent practicable.<br>Prevent or minimize further migration of the contaminant plume. | Naturally occurring physical, chemical, and biological processes remediate COCs in groundwater. Operation of the GET system is discontinued.<br>LUCs restrict groundwater access and use and residential and industrial land uses. | Alternative 2 – MNA will achieve the RAOs and best satisfies the threshold and primary balancing evaluation criteria and represents the most reasonable value for the money. Costs are proportional to the effectiveness of the remedy by achieving long-term effectiveness and permanence within a reasonable time (100 to 110 years). The main factors supporting selection of the remedy include the following: the MNA remedy components have already been implemented, the processes of MNA will be effective because the site plume has been stable or contracting, and the capital costs for the MNA monitoring well network have already been incurred.<br>Implementation of ROD Alternative 2 – MNA at Site LF008 represents a transition from approximately a decade of mostly ineffective interim GET system operation. Pesticide contaminant concentrations were stable during the period of active GET. The interim GET system was shut down for a contaminant rebound study in 2008. No significant change in contaminant concentrations has been observed since discontinuing GET system operations. Filtered and non-filtered sample data indicate that residual pesticides contaminants are strongly sorbed to soil particles and not dissolved in the groundwater. Therefore, MNA is a viable remedy under these site conditions (refer to Section 2.2.5.6). |

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| Site | COCs | Concentration (µg/L)[a,b] | Plume Size[c] | Interim Remedy/Status | Selected Remedy | Selected Remedy: RAOs | Selected Remedy: Description | Basis for Remedy Selection |
|---|---|---|---|---|---|---|---|---|
| SS015 | TCE<br>cis-1,2-DCE<br>Vinyl chloride<br>1,2-DCA<br>PCE | **226**<br>**598**<br>**70.6**<br>0.3 J<br>3.1 | cis-1,2-DCE plume approximate dimensions:<br>Length: 360 feet<br>Width: 160 feet<br>Thickness:10 to 15 feet<br>Area: 55,994 $ft^2$<br>Volume: 78,392 $ft^3$ | <u>MNA Assessment</u><br>Plume concentrations remain above cleanup levels. Monitoring data over approximately 10 years of MNA assessment indicated increases in concentrations of some COCs (primarily cis-1,2-DCE and vinyl chloride). These increases probably resulted from incomplete anaerobic degradation of TCE following an abbreviated vegetable oil treatability study conducted in 2000-2001.<br>Additional site characterization conducted in 2010 indicated local plume migration in the direction of local groundwater flow along the southwest-northeast axis of the plume.<br>A successful demonstration of ERD treatment via EVO injection within the highest concentration portion of the plume began in 2010. This demonstration followed the abbreviated vegetable oil injection treatability study conducted during 2000-2001 within the same area. | Alternative 5 – EVO and EA | Restrict human ingestion and direct dermal contact with contaminated groundwater and reduce concentrations of COCs in groundwater to restore designated beneficial uses, to the maximum extent practicable.<br>Prevent or minimize further migration of contaminants from principal threat wastes and the highest concentrations of the plume into hydraulically downgradient groundwater. Includes cleanup of groundwater, to the extent practicable, within the highest concentration portions of the plume followed by natural attenuation.<br>Prevent or minimize further migration of the contaminant plume.<br>Restrict inhalation of COCs that are volatilizing from groundwater into indoor air until those levels do not pose unacceptable risk to human health. | In situ treatment with EVO in the highest concentration portion of the plume and EA within the hydraulically downgradient and lower concentration portion of the plume. An edible oil substrate (i.e., EVO) is injected into the higher concentration portion of the plume to facilitate ERD treatment processes and anaerobically degrade chlorinated VOCs. In the lower concentration portion of the plume, naturally occurring physical, chemical, and biological processes remediate COCs, which will be enhanced by the reduced influx of contaminants from the treated portion of the plume.<br>LUCs restrict groundwater access and use and residential and industrial land uses.<br>Groundwater-to-indoor-air LUCs enforced when risk-based groundwater-to-indoor-air concentrations are exceeded. | Alternative 5 – EVO and EA will achieve the RAOs and best satisfies the threshold and primary balancing evaluation criteria and represents the most reasonable value for the money. Costs are proportional to the effectiveness of the remedy by achieving long-term effectiveness and permanence within a reasonable time (70 years). The main factors supporting selection of the remedy include the following: the EVO injection well components of the remedy have already been mostly implemented during the ERD treatment demonstration and the EA monitoring well components have already been implemented, the effectiveness of ERD treatment via EVO injection to address residual DNAP principal threat wastes and the higher concentration portion of the plume has been successfully demonstrated, the processes of natural attenuation are assessed as likely to be effective at remediating the lower concentration portion of the plume when combined with the EVO injection component (refer to Section 2.2.5.7), and the capital costs of EVO injection wells and EA monitoring wells have already been largely incurred. Use of EVO injection to facilitate ERD under Alternative 5 will also satisfy the statutory preference for treatment. Use of food-grade EVO to facilitate in situ ERD treatment processes provides an aspect of GSR.<br>Implementation of ROD Alternative 5 – EVO and EA at Site SS015 represents a transition from approximately a decade of an ultimately unsuccessful MNA Assessment for the entirety of the site plume (refer to Section 2.2.5.7) to a more effective strategy of active ERD treatment for the principal threat wastes and highest concentration portion of the plume taken in combination with natural attenuation processes in the lower concentration portion of the plume. ERD treatment using EVO injection has been demonstrated to be effective at remediating the principal threat wastes and the highest concentration portion of the plume (refer to Section 2.2.3.2). Natural attenuation processes within the lower concentration portion of the plume will be more effective after the ongoing source of contamination is greatly reduced by the ERD treatment component of the remedy (refer to Section 2.2.5.7). |

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| Site | COCs | Concentration (µg/L)[a,b] | Plume Size[c] | Interim Remedy/Status | Selected Remedy | Selected Remedy: RAOs | Selected Remedy: Description | Basis for Remedy Selection |
|---|---|---|---|---|---|---|---|---|
| SS016 and SS029 | TCE<br>cis-1,2-DCE<br>Vinyl chloride<br>Benzene<br>Chloroform<br>1,4-DCB<br>Bromodichloromethane<br>1,2-DCA<br>1,1-DCE<br>PCE | **40,200**<br>**8,230**<br>**812**<br>ND<br>0.42 J<br>**710**<br>ND<br>**13.4 J**<br>**50.2 J**<br>**108** | Sites SS016 and SS029 TCE plume approximate dimensions:<br>Length: 5,700 feet<br>Width: 1,400 feet<br>Thickness: 25 to 40 feet<br>Area: 7,112,191 $ft^2$<br>Volume: 41,250,708 $ft^3$ | <u>GET</u><br>Plume concentrations remain above cleanup levels. The combined Sites SS016 and SS029 plumes were hydraulically captured by the combined site-specific IRA GET systems over approximately 10 years of interim remediation. Monitoring data indicated that some migration of the Site SS016 plume into the hydraulically downgradient Site SS029 plume was occurring. However, combined IRA GET system operations are continuing to maintain hydraulic capture and reduce contaminant concentrations for the combined plume.<br>A successful demonstration of ERD treatment via an in situ bioreactor at Site SS016 began in 2010. | Alternative 4 – Bioreactor and GET (Site SS016)<br>Alternative 3 – GET (Site SS029) | Restrict human ingestion and direct dermal contact with contaminated groundwater and reduce concentrations of COCs in groundwater to restore designated beneficial uses, to the maximum extent practicable.<br>Prevent or minimize further migration of contaminants from principal threat wastes and the highest concentrations of the plume into hydraulically downgradient groundwater. Includes cleanup of groundwater, to the extent practicable, within the highest concentration portions of the plume followed by natural attenuation.<br>Prevent or minimize further migration of the contaminant plume.<br>Restrict inhalation of COCs that are volatilizing from groundwater into indoor air until those levels do not pose unacceptable risk to human health. | For Site SS016, Alternative 4 involves treatment of COCs in groundwater with an in situ bioreactor and extraction and ex situ treatment with a GET system. An in situ bioreactor installed within the highest concentration portion of the plume facilitates ERD treatment processes to anaerobically degrade chlorinated VOCs. Groundwater within the hydraulically downgradient portions of the plume will continue to be extracted and treated ex situ with LGAC.<br>LUCs restrict groundwater access and use and residential and industrial land uses.<br>Groundwater-to-indoor-air LUCs enforced when risk-based groundwater-to-indoor-air concentrations are exceeded.<br>For Site SS029, Alternative 3 involves continued groundwater extraction and ex situ treatment of COCs in groundwater with LGAC. Hydraulic containment of plumes will be continued using the existing GET system.<br>LUCs restrict groundwater access and use and residential and industrial land uses.<br>Groundwater-to-indoor-air LUCs enforced when risk-based groundwater-to-indoor-air concentrations are exceeded. | Alternative 4 – Bioreactor and GET at Site SS016 will achieve the RAOs and best satisfies the threshold and primary balancing evaluation criteria and represents the most reasonable value for the money. Costs are proportional to the effectiveness of the remedy by achieving long-term effectiveness and permanence within a reasonable time (62 years). The main factors include the following: the bioreactor and GET system components of the Site SS016 remedy have already been implemented within an area of restricted access and ongoing military flightline operations. ERD treatment via a bioreactor was successfully demonstrated as being effective for addressing the residual DNAPL principal threat wastes and the highest concentration portions of the Site SS016 plume, and GET system operation has been demonstrated to be effective at remediating the remainder of the higher concentration plume. The capital costs for both the bioreactor and GET system components of the remedy have already been largely incurred. Use of an in situ bioreactor under Alternative 4 will satisfy the statutory preference for treatment. Treatment of contaminant-laden LGAC by an off-base EPA-approved vendor will also satisfy the statutory preference for treatment. Use of organic mulch to facilitate in situ ERD treatment processes in the bioreactor provides an aspect of GSR.<br>Implementation of ROD Alternative 4 at Site SS016 follows approximately a decade of interim GET system operation. Operation of the GET system within the highest concentration portion of the plume had become increasingly cost-ineffective as contaminant concentrations were being reduced at an ever-decreasing rate. As a result, the GET system within this portion of the plume was shut down in 2010 for a successful ERD treatment demonstration via the bioreactor to address the principal threat wastes and the highest concentration portion of the plume (refer to Section 2.2.3.1). The remainder of the GET system remained in operation and continues to operate successfully within a high concentration portion of the plume (refer to Section 2.2.2.2). The lower concentration portion of the plume that is not hydraulically captured by the Site SS016 GET system is intercepted and hydraulically captured by the downgradient Site SS029 GET system.<br>Alternative 3 – GET at Site SS029 will achieve the RAOs and best satisfies the threshold and primary balancing evaluation criteria and represents the most reasonable value for the money. Costs are proportional to the effectiveness of the remedy by achieving long-term effectiveness and permanence within a reasonable time (62 years). The main factors include the following: the components of the Site SS029 GET system have already been implemented within an area of restricted access and ongoing military flightline operations. Long-term interim GET system operation has been demonstrated to be effective at remediating the combined Sites SS016 and SS029 plumes and preventing plume migration. The capital costs for the Site SS029 GET system have already been incurred. Treatment of contaminant-laden LGAC by an off-base EPA-approved vendor will also satisfy the statutory preference for treatment.<br>Implementation of Alternative 3 at Site SS029 follows approximately a decade of successful interim GET system operation. |

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|---|---|---|---|---|---|---|---|---|
| ST027B | TCE[e]<br>Vinyl chloride[e]<br>cis-1,2-DCE[e]<br>Benzene<br>Toluene | **435**<br>**7.1**<br>**338**<br>0.32 J<br>ND | TCE plume approximate dimensions:<br>Length: 650 feet<br>Width: 400 feet<br>Thickness: 30 to 35 feet<br>Area: 183,134 $ft^{2e}$<br>Volume: 1,281,938 $ft^{3e}$<br>Formerly managed under the POCO program. Chlorinated VOCs were detected after the IROD was finalized and IRAs implemented. | MNA[e]<br>Plume is stable at concentrations above cleanup levels. Monitoring data obtained during periods of POCO and ERP program management did not indicate significant increases in COC concentrations and did not indicate plume migration. | Alternative 2 – MNA | Restrict human ingestion and direct dermal contact with contaminated groundwater and reduce concentrations of COCs in groundwater to restore designated beneficial uses, to the maximum extent practicable.<br>Prevent or minimize further migration of the contaminant plume. | Naturally occurring physical, chemical, and biological processes remediate COCs in groundwater.<br>LUCs restrict groundwater access and use and residential and industrial land uses. | Alternative 2 – MNA will achieve the RAOs and best satisfies the threshold and primary balancing evaluation criteria and represents the most reasonable value for the money. Costs are proportional to the effectiveness of the remedy by achieving long-term effectiveness and permanence within a reasonable time (50 years). The main factors supporting selection of the remedy include the following: the MNA remedy components have already been implemented, the processes of natural attenuation have been demonstrated to be effective at remediating the site plume, and the capital costs for the MNA monitoring well network have already been incurred.<br>Implementation of ROD Alternative 2 – MNA at Site ST027B represents a transition from MNA as the POCO program presumptive remedy for the site and the period of MNA assessment after CERCLA contaminants were detected in 1999. Site ST027B was not included in the Groundwater IROD for the NEWIOU, and MNA Assessment was not formally selected as the interim remedy. However, long-term groundwater monitoring of the site was conducted under the Travis AFB GSAP. The data were obtained by the GSAP monitoring support using natural attenuation processes to remediate the plume (refer to Section 2.2.5.8). |
| SS030 | TCE<br>Chloroform<br>Bromodichloromethane<br>1,2-DCA | **48.8**<br>7.4<br>ND<br>ND | TCE plume approximate dimensions:<br>Length: 1,400 feet<br>Width: 400 feet<br>Thickness: 20 to 40 feet<br>Area: 455,647 $ft^2$<br>Volume: 1,822,588 $ft^3$<br>The majority of the contaminant plume extends onto off-base privately owned property. | GET<br>Plume size and concentrations of COCs have been reduced by interim remediation but remain above cleanup levels. The plume was hydraulically captured by the interim GET system over approximately 10 years of interim remediation. GET system operations continue to maintain hydraulic capture of the plume and reduce contaminant concentrations.<br>In 2010-2011, additional investigation was conducted to further characterize the distribution of COCs and possible plume migration. The rate of groundwater extraction was then increased to more fully capture the plume. Additional GET system optimization will be conducted during 2013 by installing an additional extraction well to further improve hydraulic capture of the plume and increase the rate of contaminant mass removal. | Alternative 3 – GET | Restrict human ingestion and direct dermal contact with contaminated groundwater and reduce concentrations of COCs in groundwater to restore designated beneficial uses, to the maximum extent practicable.<br>Prevent or minimize further migration of the contaminant plume.<br>Restrict inhalation of COCs that are volatilizing from groundwater into indoor air until those levels do not pose unacceptable risk to human health. | Pumps extract contaminated groundwater from the aquifer and provide hydraulic containment of the plume. Extracted groundwater is treated using LGAC at a centralized treatment plant. Treated groundwater is discharged to the stormwater drainage system.<br>LUCs restrict groundwater access and use and residential and industrial land uses.<br>Groundwater-to-indoor-air LUCs enforced when risk-based groundwater-to-indoor-air concentrations are exceeded. | Alternative 3 – GET will achieve the RAOs and best satisfies the threshold and primary balancing evaluation criteria and represents the most reasonable value for the money. Costs are proportional to the effectiveness of the remedy by achieving long-term effectiveness and permanence within a reasonable time (22 years). The main factors supporting selection of the remedy include the following: the GET remedy components have already been mostly implemented and have been demonstrated to be effective at remediating the site plume, and the GET system capital costs have already been incurred. Treatment of contaminant-laden LGAC by an off-base EPA-approved vendor will also satisfy the statutory preference for treatment. GET system optimizations will take place during 2013 that will result in improved hydraulic capture of the plume and an increased rate of contaminant mass removal.<br>Implementation of Alternative 3 – GET at Site SS030 represents a continuation from approximately a decade of successful interim GET system operation (refer to Section 2.2.1). |

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|---|---|---|---|---|---|---|---|---|
| SD031 | TCE<br>Benzene<br>1,1-DCE<br>cis-1,2-DCE<br>Carbon tetrachloride<br>Chloroform<br>1,2-DCA<br>Vinyl chloride | **7.1 J-**<br>ND<br>**56.7**<br>0.78 J-<br>ND<br>0.17 J<br>ND<br>ND | 1,1-DCE plume approximate dimensions:<br>Length: 300 feet<br>Width: 150 feet<br>Thickness: 25 to 30 feet<br>Area: 54,255 $ft^2$<br>Volume: 260,424 $ft^3$ | <u>GET and MNA Assessment</u><br>Plume size and concentrations of COCs have been reduced by interim remediation but remain above cleanup levels. Monitoring data obtained over approximately 10 years of interim remediation did not indicate significant plume migration.<br>The interim GET system was shut down for a contaminant rebound study in December 2007. Data obtained during the rebound study did not indicate significant increases in concentrations of COCs or plume migration after GET system operations were discontinued. | Alternative 2 – MNA | Restrict human ingestion and direct dermal contact with contaminated groundwater and reduce concentrations of COCs in groundwater to restore designated beneficial uses, to the maximum extent practicable.<br>Prevent or minimize further migration of the contaminant plume. | Naturally occurring physical, chemical, and biological processes remediate COCs in groundwater. Operation of the GET system is discontinued.<br>LUCs restrict groundwater access and use and residential and industrial land uses. | Alternative 2 – MNA will achieve the RAOs and best satisfies the threshold and primary balancing evaluation criteria and represents the most reasonable value for the money. Costs are proportional to the effectiveness of the remedy by achieving long-term effectiveness and permanence within a reasonable time (15 years). The main factors supporting selection of the remedy include the following: the monitoring well components of MNA have already been implemented, the processes of natural attenuation have been demonstrated to be effective at remediating the site plume, and the capital costs have already been incurred.<br>Implementation of ROD Alternative 2 – MNA at Site SD031 follows approximately a decade of successful interim GET system operation within the higher concentration portion of the plume combined with MNA Assessment in the lower concentration portion of the plume located hydraulically downgradient of the GET system. Plume concentrations under long-term interim GET operation had declined at an ever-decreasing rate and had become cost-ineffective. After shutdown of the GET system, natural attenuation processes were evaluated for the entirety of the plume (CH2M HILL, 2010b). Assessments of MNA during the period of interim remediation and during the period of the rebound study indicate that natural physical, chemical, and biological processes are viable for plume remediation under the site conditions (refer to Section 2.2.5.1). |
| SD033 (component of WIOU) | TCE<br>1,1-DCE<br>1,2-DCA<br>cis-1,2-DCE | **99.2**<br>ND<br>ND<br>**50** | Site contamination is within the overall WIOU plume.[f] | <u>GET and MNA Assessment</u><br>Plume size and concentrations of COCs have been reduced by interim remediation but remain above cleanup levels. Monitoring data obtained over approximately 10 years of interim remediation indicated declining plume concentrations and did not indicate significant plume migration.<br>The interim GET system was shut down for a contaminant rebound study in April 2010. Data obtained during the rebound study have not indicated significant increases in concentrations of COCs or plume migration after GET system operations were discontinued. | Alternative 2 – MNA | Restrict human ingestion and direct dermal contact with contaminated groundwater and reduce concentrations of COCs in groundwater to restore designated beneficial uses, to the maximum extent practicable.<br>Prevent or minimize further migration of the contaminant plume.<br>Restrict inhalation of COCs that are volatilizing from groundwater into indoor air until those levels do not pose unacceptable risk to human health. | Naturally occurring physical, chemical, and biological processes remediate COCs in groundwater. Operation of the GET system is discontinued.<br>LUCs restrict groundwater access and use and residential and industrial land uses.<br>Groundwater-to-indoor-air LUCs enforced when risk-based groundwater-to-indoor-air concentrations are exceeded. | Alternative 2 – MNA will achieve the RAOs and best satisfies the threshold and primary balancing evaluation criteria and represents the most reasonable value for the money. Costs are proportional to the effectiveness of the remedy by achieving long-term effectiveness and permanence within a reasonable time (60 years). The main factors supporting selection of the remedy include the following: the monitoring well components of MNA have already been implemented, the processes of natural attenuation have been demonstrated to be effective at remediating the site plume, and the capital costs have already been incurred.<br>Implementation of ROD Alternative 2 – MNA at Site SD033 follows approximately a decade of successful interim GET system operation within the higher concentration portion of the plume combined with MNA Assessment in the lower concentration portion of the plume located hydraulically downgradient of the GET system. The GET system part of the IRA has been shut down for a contaminant rebound study since 2010. Plume concentrations under long-term GET operation had declined at an ever-decreasing rate and had become cost-ineffective. Natural attenuation processes have since been evaluated for the entirety of the WIOU plume, including Site SD033 (CH2M HILL, 2010b). Assessments of MNA during the period of interim remediation and during the period of the rebound study indicate that natural physical, chemical, and biological processes are viable for plume remediation under the site conditions (refer to Section 2.2.5.9). |

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|---|---|---|---|---|---|---|---|---|
| SD034 (component of WIOU) | TCE<br>Vinyl chloride<br>1,1-DCE<br>Benzene<br>cis-1,2-DCE<br>PCE | **5.8**<br>**2.1**<br>ND<br>0.21 J<br>5.7<br>ND | Free-phase Stoddard solvent intermittently measured floating on groundwater table.<br>Site contamination is within the overall WIOU plume.[f] | <u>GET with Free Product Removal</u><br>Plume size and concentrations of COCs have been reduced by interim remediation but remain above cleanup levels. Monitoring data obtained over approximately 10 years of interim remediation indicated declining plume concentrations and did not indicate significant plume migration.<br>The interim GET system was shut down for a contaminant rebound study in April 2010. Data obtained during the rebound study have not indicated significant increases in concentrations of COCs or plume migration after GET system operations were discontinued.<br>Free-phase Stoddard solvent containing dissolved COCs continues to be intermittently detected floating on the groundwater table. | Alternative 7 – Passive Skimming and EA | Restrict human ingestion and direct dermal contact with contaminated groundwater and reduce concentrations of COCs in groundwater to restore designated beneficial uses, to the maximum extent practicable.<br>Remove free-phase Stoddard solvent containing dissolved COCs floating on the groundwater table and potentially impacting designated beneficial uses to the maximum extent practicable.<br>Prevent or minimize further migration of the contaminant plume. | Stoddard solvent floating on the groundwater table and containing dissolved COCs is physically removed using passive skimmers. Removal of the free-phase Stoddard solvent providing an ongoing source of contamination then supports natural physical, chemical, and biological processes in remediating COCs dissolved in groundwater. Operation of the GET system is discontinued.<br>LUCs restrict groundwater access and use and residential and industrial land uses. | Alternative 7 – Passive Skimming and EA will achieve the RAOs and best satisfies the threshold and primary balancing evaluation criteria and represents the most reasonable value for the money. Costs are proportional to the effectiveness of the remedy by achieving long-term effectiveness and permanence within a reasonable time (60 years). The main factors supporting selection of the remedy include the following: the passive skimming and monitoring well components of the remedy have already been implemented, the processes of passive skimming and natural attenuation have been demonstrated to be effective at removing the residual LNAPL principal threat waste (i.e., free-phase Stoddard solvent containing dissolved COCs) and remediating the dissolved site plume, and the capital costs of passive skimming and monitoring have already been incurred.<br>Implementation of ROD Alternative 7 – Passive Skimming and EA at Site SD034 follows approximately a decade of successful passive skimming of free-phase Stoddard solvent and interim GET system operation within the higher concentration portion of the plume combined with MNA Assessment in the lower concentration portion of the plume located hydraulically downgradient of the passive skimming and GET systems. Passive skimming has removed Stoddard solvent to the point that it is only intermittently measured, and the GET system component of the IRA has been shut down for a contaminant rebound study since 2010. Plume concentrations under long-term GET operation had declined at an ever-decreasing rate and had become cost-ineffective. Natural attenuation processes have since been evaluated for the entirety of the WIOU plume, including Site SD034 (CH2M HILL, 2010b). Assessments of MNA during the period of interim remediation and during the period of the rebound study indicate that natural physical, chemical, and biological processes are viable for plume remediation under the site conditions (refer to Section 2.2.5.9). |

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|---|---|---|---|---|---|---|---|---|
| | | | | | | RAOs | Description | |
| SS035 (component of WIOU) | TCE | ND | Site contamination is within the overall WIOU plume.[f] | GET and MNA Assessment<br>Plume size and concentrations of COCs have been reduced to below cleanup levels by interim remediation. Monitoring data obtained over approximately 10 years of interim remediation indicated declining plume concentrations and did not indicate significant plume migration.<br>The interim GET system was shut down for a contaminant rebound study in April 2010. Data obtained during the rebound study have not indicated significant increases in concentrations of COCs or plume migration after GET system operations were discontinued. | Alternative 2 – MNA | Restrict human ingestion and direct dermal contact with contaminated groundwater and reduce concentrations of COCs in groundwater to restore designated beneficial uses, to the maximum extent practicable.<br>Prevent or minimize further migration of the contaminant plume.<br>Restrict inhalation of COCs that are volatilizing from groundwater into indoor air until those levels do not pose unacceptable risk to human health. | Naturally occurring physical, chemical, and biological processes remediate COCs in groundwater. Operation of the GET system is discontinued.<br>LUCs restrict groundwater access and use and residential and industrial land uses.<br>Groundwater-to-indoor-air LUCs enforced when risk-based groundwater-to-indoor-air concentrations are exceeded. | Alternative 2 – MNA will achieve the RAOs and best satisfies the threshold and primary balancing evaluation criteria and represents the most reasonable value for the money. Groundwater cleanup levels were achieved during the period of interim remediation. Verification of the cleanup levels will be conducted under Alternative 2. Other main factors supporting selection of the remedy include the following: the MNA remedy components have already been implemented, the processes of natural attenuation have been demonstrated to be effective at remediating the entirety of the site plume, and the capital costs for the MNA monitoring well network have already been incurred.<br>Implementation of ROD Alternative 2 – MNA at Site SS035 follows approximately a decade of successful interim GET system operation within the higher concentration portion of the WIOU plume, including Site SS035, combined with MNA Assessment in the lower concentration portion of the plume located hydraulically downgradient of the GET system. The GET system part of the IRA has been shut down for a contaminant rebound study since 2010. Plume concentrations under long-term GET operation had declined at an ever-decreasing rate and had become cost-ineffective. Natural attenuation processes have since been evaluated for the entirety of the WIOU plume, including Site SD034 (CH2M HILL, 2010b). Assessments of MNA during the period of interim remediation and during the period of the rebound study indicate that natural physical, chemical, and biological processes are viable for plume remediation under the site conditions (refer to Section 2.2.5.9). |

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| Site | COCs | Concentration (µg/L)[a,b] | Plume Size[c] | Interim Remedy/Status | Selected Remedy | Selected Remedy: RAOs | Selected Remedy: Description | Basis for Remedy Selection |
|---|---|---|---|---|---|---|---|---|
| SD036 (component of WIOU) | Vinyl chloride<br>TCE<br>1,1-DCE<br>cis-1,2-DCE<br>1,2-DCA<br>Benzene<br>Bromodichloromethane<br>PCE | **1,100**<br>**14,400**<br>**12.5 J-**<br>**3,870**<br>**1.2**<br>0.59<br>ND<br>**13.3 J** | Site contamination is within the overall WIOU plume.[f] | <u>GET and MNA Assessment</u><br>Plume size and concentrations of COCs have been reduced by interim remediation but remain above cleanup levels. Monitoring data obtained over approximately 10 years of interim remediation indicated declining plume concentrations and did not indicate significant plume migration.<br>The interim GET system was shut down for a contaminant rebound study in April 2010. Data obtained during the rebound study have not indicated significant increases in concentrations of COCs or plume migration after GET system operations were discontinued.<br>A successful demonstration of ERD treatment via EVO injection began in 2010. | Alternative 5 – EVO and EA | Restrict human ingestion and direct dermal contact with contaminated groundwater and reduce concentrations of COCs in groundwater to restore designated beneficial uses, to the maximum extent practicable.<br>Prevent or minimize further migration of contaminants from principal threat wastes and the highest concentrations of the plume into hydraulically downgradient groundwater. Includes cleanup of groundwater, to the extent practicable, within the highest concentration portions of the plume followed by natural attenuation.<br>Prevent or minimize further migration of the contaminant plume.<br>Restrict inhalation of COCs that are volatilizing from groundwater into indoor air until those levels do not pose unacceptable risk to human health. | In situ treatment with EVO in the highest concentration portion of the plume and EA within the hydraulically downgradient and lower concentration portion of the plume. An edible oil substrate (i.e., EVO) is injected into the higher concentration portion of the plume to facilitate ERD treatment processes and to anaerobically degrade chlorinated VOCs. In the hydraulically downgradient and lower concentration portion of the plume, naturally occurring physical, chemical, and biological processes remediate COCs, which will be enhanced by the reduced influx of contaminants from the treated portion of the plume. Operation of the GET system is discontinued.<br>LUCs restrict groundwater access and use and residential and industrial land uses.<br>Groundwater-to-indoor-air LUCs enforced when risk-based groundwater-to-indoor-air concentrations are exceeded. | Alternative 5 – EVO and EA will achieve the RAOs and best satisfies the threshold and primary balancing evaluation criteria and represents the most reasonable value for the money. Costs are proportional to the effectiveness of the remedy by achieving long-term effectiveness and permanence within a reasonable time (60 years). The main factors supporting selection of the remedy include the following: the EVO injection component of the remedy has already been mostly implemented during the ERD treatment demonstration, the EA monitoring well components have already been implemented, ERD treatment via EVO injection to address the residual DNAPL principal threat wastes and the higher concentration portion of the plume has been successfully demonstrated (refer to Section 2.2.3.2), the processes of natural attenuation have been demonstrated to be effective at remediating the lower concentration portion of the plume (refer to Section 2.2.5.9), and the capital costs of EVO injection wells and EA monitoring wells have already been largely incurred. Use of EVO injection to facilitate ERD under Alternative 5 will also satisfy the statutory preference for treatment. Use of food-grade EVO to facilitate in situ ERD treatment processes provides an aspect of GSR.<br>Implementation of ROD Alternative 5 – EVO and EA at Site SD036 follows approximately a decade of partially successful interim GET system operation within the higher concentration portion of the WIOU plume combined with MNA Assessment in the lower concentration portion of the plume located hydraulically downgradient of the GET system. Operation of the interim GET system to address principal threat wastes and the highest concentration portion of the plume had become increasingly cost-ineffective as contaminant concentrations were being reduced at an ever-decreasing rate. As a result, the GET system component of the IRA has been shut down for an ERD treatment demonstration and contaminant rebound study since 2010. Natural attenuation processes have since been evaluated for the remainder of the WIOU plume, including Site SD036 (CH2M HILL, 2010b). Assessments of MNA during the period of interim remediation and during the period of the rebound study indicate that natural physical, chemical, and biological processes are viable for remediating the lower concentration portions of the WIOU plume, including the Site SD036 plume component (refer to Section 2.2.5.9). |

**TABLE 2.12-1**
Basis for Remedy Summary
*Groundwater Record of Decision, Travis Air Force Base, California*

| Site | COCs | Concentration (µg/L)[a,b] | Plume Size[c] | Interim Remedy/Status | Selected Remedy | Selected Remedy: RAOs | Selected Remedy: Description | Basis for Remedy Selection |
|---|---|---|---|---|---|---|---|---|
| SD037 (component of WIOU) | 1,1-DCE<br>1,2-DCA<br>Benzene<br>Bromodichloromethane<br>Carbon tetrachloride<br>PCE<br>TCE<br>Vinyl chloride<br>cis-1,2-DCE | 4.6<br>ND<br>**7.6**<br>ND<br>**7.6**<br>**212**<br>**1,720**<br>**26.3**<br>**749** | TCE plume approximate dimensions:<br>Length: 4,650 feet<br>Width: 750 feet<br>Thickness: 20 to 90 feet<br>Area: 1,626,667 $ft^2$<br>Volume: 13,664,003 $ft^3$<br>Site SD037 plume dimensions represent the overall WIOU plume.[f] | <u>GET and MNA Assessment</u><br>Plume size and concentrations of COCs have been reduced by interim remediation but remain above cleanup levels. Monitoring data obtained over approximately 10 years of interim remediation indicated declining plume concentrations and did not indicate significant plume migration.<br>The interim GET system was shut down for a contaminant rebound study in April 2010. Data obtained during the rebound study have not indicated significant increases in concentrations of COCs or plume migration after GET system operations were discontinued.<br>A successful demonstration of ERD treatment via EVO injection began in 2010. | Alternative 5 – EVO and EA | Restrict human ingestion and direct dermal contact with contaminated groundwater and reduce concentrations of COCs in groundwater to restore designated beneficial uses, to the maximum extent practicable.<br>Prevent or minimize further migration of contaminants from principal threat wastes and the highest concentrations of the plume into hydraulically downgradient groundwater. Includes cleanup of groundwater, to the extent practicable, within the highest concentration portions of the plume followed by natural attenuation.<br>Prevent or minimize further migration of the contaminant plume.<br>Restrict inhalation of COCs that are volatilizing from groundwater into indoor air until those levels do not pose unacceptable risk to human health. | In situ treatment with EVO in the highest concentration portion of the plume and EA within the hydraulically downgradient and lower concentration portion of the plume. An edible oil substrate (i.e., EVO) is injected into the higher concentration portion of the plume to facilitate ERD treatment processes and to anaerobically degrade chlorinated VOCs. In the hydraulically downgradient and lower concentration portion of the plume, naturally occurring physical, chemical, and biological processes remediate COCs, which will be enhanced by the reduced influx of contaminants from the treated portion of the plume. Operation of the GET system is discontinued.<br>LUCs restrict groundwater access and use and residential and industrial land uses.<br>Groundwater-to-indoor-air LUCs enforced when risk-based groundwater-to-indoor-air concentrations are exceeded. | Alternative 5 – EVO and EA will achieve the RAOs and best satisfies the threshold and primary balancing evaluation criteria and represents the most reasonable value for the money. Costs are proportional to the effectiveness of the remedy by achieving long-term effectiveness and permanence within a reasonable time (60 years). The main factors supporting selection of the remedy include the following: the EVO injection well components of the remedy have already been mostly implemented during the ERD treatment demonstration, the EA monitoring well components have already been implemented, ERD treatment via EVO injection to address the residual DNAPL principal threat wastes and the higher concentration portion of the plume has been successfully demonstrated (refer to Section 2.2.3.2), the processes of natural attenuation have been demonstrated to be effective at remediating the lower concentration portion of the plume (refer to Section 2.2.5.9), and the capital costs of EVO injection wells and EA monitoring wells have already been largely incurred. Use of EVO injection to facilitate ERD under Alternative 5 will also satisfy the statutory preference for treatment. Use of food-grade EVO to facilitate in situ ERD treatment processes provides an aspect of GSR.<br>Implementation of ROD Alternative 5 – EVO and EA at Site SD037 follows approximately a decade of partially successful interim GET system operation within the higher concentration portion of the WIOU plume combined with MNA Assessment in the lower concentration portion of the plume located hydraulically downgradient of the GET system. Operation of the interim GET system within the highest concentration portion of the plume had become increasingly cost-ineffective as contaminant concentrations were being reduced at an ever-decreasing rate. As a result, the GET system component of the IRA has been shut down for an ERD treatment demonstration and contaminant rebound study since 2010. Natural attenuation processes have since been evaluated for the remainder of the WIOU plume, including Site SD037 (CH2M HILL, 2010b). Assessments of MNA during the period of interim remediation and during the period of the rebound study indicate that natural physical, chemical, and biological processes are viable for remediating the lower concentration portions of the WIOU plume, including the Site SD037 plume component (refer to Section 2.2.5.9). |

**TABLE 2.12-1**
Basis for Remedy Summary
*Groundwater Record of Decision, Travis Air Force Base, California*

| Site | COCs | Concentration (µg/L)[a,b] | Plume Size[c] | Interim Remedy/Status | Selected Remedy | Selected Remedy: RAOs | Selected Remedy: Description | Basis for Remedy Selection |
|---|---|---|---|---|---|---|---|---|
| DP039 | 1,1-DCE<br>1,2-DCA<br>1,1,1-TCA<br>1,1,2-TCA<br>Bromodichloromethane<br>Methylene chloride<br>PCE<br>TCE<br>Vinyl chloride | **2,210**<br>**5.2**<br>ND<br>ND<br>ND<br>**24**<br>ND<br>**1,740**<br>**48** | TCE plume approximate dimensions:<br>Length: 1,720 feet<br>Width: 820 feet<br>Thickness: 20 to 45 feet<br>Area: 1,144,580 $ft^2$<br>Volume: 9,614,472 $ft^3$ | <u>GET and MNA Assessment</u><br>Plume is stable. Monitoring data obtained over approximately 10 years of interim remediation did not indicate significant plume migration.<br>The interim GET system was shut down for a contaminant rebound study in April 2010. Data obtained during the rebound study have not indicated significant plume migration after GET system operations were discontinued.<br>A successful treatability study of phytoremediation began in 1998. The planted trees continue to mature as an ongoing demonstration of phytoremediation treatment.<br>A successful demonstration of ERD treatment via an in situ bioreactor began in 2008.<br>A successful demonstration of ERD treatment via an injected EVO PRB began in 2010. | Alternative 6 – Bioreactor, Phytoremediation, EVO PRB, and EA | Restrict human ingestion and direct dermal contact with contaminated groundwater and reduce concentrations of COCs in groundwater to restore designated beneficial uses, to the maximum extent practicable.<br>Prevent or minimize further migration of contaminants from principal threat wastes and the highest concentrations of the plume into hydraulically downgradient groundwater. Includes cleanup of groundwater, to the extent practicable, within the highest concentration portions of the plume followed by natural attenuation.<br>Prevent or minimize further migration of the contaminant plume.<br>Restrict inhalation of COCs that are volatilizing from groundwater into indoor air until those levels do not pose unacceptable risk to human health. | In situ treatment of COCs in the higher concentration portions of the plume using the combination of a bioreactor, phytoremediation, and an injected EVO PRB to facilitate biological processes and EA within the remainder of the downgradient plume. Operation of the GET system is discontinued.<br>An in situ bioreactor installed within the highest concentration portion of the plume facilitates ERD treatment processes to anaerobically degrade chlorinated VOCs.<br>A grove of planted eucalyptus trees supplements treatment within a portion of the plume that is hydraulically downgradient of the bioreactor as the plume flows beneath the trees.<br>A PRB of injected edible vegetable oil across the leading edge of the source area (i.e., a biobarrier) continues to treat the portion of the aquifer downgradient of the bioreactor and tree grove.<br>Naturally occurring physical, chemical, and biological processes remediate COCs in downgradient groundwater, which will be enhanced by the reduced influx of contaminants from the treated portions of the plume.<br>LUCs restrict groundwater access and use and residential and industrial land uses.<br>Groundwater-to-indoor-air LUCs enforced when risk-based groundwater-to-indoor-air concentrations are exceeded. | Alternative 6 – Bioreactor, Phytoremediation, EVO PRB, and EA will achieve the RAOs and best satisfies the threshold and primary balancing evaluation criteria and represents the most reasonable value for the money. Costs are proportional to the effectiveness of the remedy by achieving long-term effectiveness and permanence within a reasonable time (58 years). The main factors supporting selection of the remedy include the following: the bioreactor, phytoremediation, EVO PRB, and EA monitoring well components of the remedy have already been implemented; ERD treatment via bioreactor and EVO PRB have been successfully demonstrated as being effective in treating the residual DNAPL principal threat wastes and the higher concentration portions of the plume; biological treatment via phytoremediation has been successfully demonstrated as being effective in treating a portion of the higher concentration plume; and the processes of natural attenuation were assessed as likely to be effective at remediating the lower concentration portion of the plume when combined with the bioreactor, phytoremediation, and EVO PRB remedy components. The capital costs of the bioreactor, area of phytoremediation, EVO PRB, and EA monitoring wells have already been largely incurred. Use of a bioreactor and EVO injection to facilitate ERD and biological treatment using phytoremediation satisfy the statutory preference for treatment. Use of food-grade EVO and planted trees provides aspects of GSR.<br>Implementation of ROD Alternative 6 – Bioreactor, Phytoremediation, EVO PRB, and EA at Site DP039 follows approximately a decade of partially successful interim GET system operation combined with an assessment of MNA in the lower concentration portion of the plume. A successful phytoremediation treatability study was conducted within the higher concentration portion of the site plume located hydraulically downgradient of the GET system. The assessment of MNA was conducted in the lower concentration portion of the plume located hydraulically downgradient of the GET system and area of phytoremediation.<br>Operation of the GET system within the highest concentration portion of the plume had become increasingly cost-ineffective as contaminant concentrations were being reduced at an ever-decreasing rate. As a result, the GET system component of the IRA was shut down in 2008 for a successful ERD treatment demonstration via the bioreactor. Another successful ERD treatment demonstration via an EVO PRB began in 2010 (refer to Section 2.2.3.2). Successful biological treatment using phytoremediation had been ongoing since 1998 (refer to Section 2.2.4).The assessment of MNA during the period of interim remediation indicated that natural physical, chemical, and biological processes alone were not adequate for remediating the distal portion of the plume, and additional measures were needed to reduce the influx of contamination from the hydraulically upgradient and higher concentration portions of the plume (i.e., the bioreactor, area of phytoremediation, and EVO PRB) (refer to Section 2.2.5.10).<br>Use of organic mulch to facilitate in situ ERD treatment processes in the bioreactor provides an aspect of GSR. Also, use of planted trees for in situ biological treatment and food-grade EVO to facilitate in situ ERD treatment processes within the PRB provides additional aspects of GSR. |

**TABLE 2.12-1**
Basis for Remedy Summary
*Groundwater Record of Decision, Travis Air Force Base, California*

| Site | COCs | Concentration (µg/L)[a,b] | Plume Size[c] | Interim Remedy/Status | Selected Remedy | Selected Remedy | | Basis for Remedy Selection |
|---|---|---|---|---|---|---|---|---|
| | | | | | | RAOs | Description | |
| SS041 | Heptachlor epoxide | ND | No plume dimensions. Contaminant concentrations already less than cleanup levels.<br>Area: 0 $ft^2$<br>Volume: 0 $ft^3$ | GET<br>Plume size and concentrations of COCs have been reduced to below cleanup levels by interim remediation. The site has been in NFRAP status since 2005. | Alternative 1 – NFA | Restrict human ingestion and direct dermal contact with contaminated groundwater and reduce concentrations of COCs in groundwater to restore designated beneficial uses, to the maximum extent practicable.<br>Prevent or minimize further migration of the contaminant plume. | No further actions, including no LUC provisions, will occur to remediate or manage COCs in groundwater. Operation of the GET system remains discontinued. | Alternative 1 – NFA will achieve the RAOs and best satisfies the threshold and primary balancing evaluation criteria and represents the most reasonable value for the money. Groundwater cleanup levels were achieved during the period of interim remediation. Site SS041 is currently in NFRAP status under a consensus statement signed by representatives of the AF and regulatory agencies (Travis AFB, 2005a). |
| SD043 (component of WIOU) | TCE | 0.7 | Site contamination is within the overall WIOU plume.[f] | GET<br>Plume size and concentrations of COCs have been reduced to below cleanup levels by interim remediation. Monitoring data obtained over approximately 10 years of interim remediation did not indicate significant plume migration.<br>Data obtained during an ongoing rebound study have not indicated increases in concentrations of COC or plume migration after GET system operations were discontinued in April 2010. | Alternative 2 – MNA | Restrict human ingestion and direct dermal contact with contaminated groundwater and reduce concentrations of COCs in groundwater to restore designated beneficial uses, to the maximum extent practicable.<br>Prevent or minimize further migration of the contaminant plume. | Naturally occurring physical, chemical, and biological processes remediate COCs in groundwater. Operation of the GET system is discontinued.<br>LUCs restrict groundwater access and use and residential and industrial land uses. | Alternative 2 – MNA will achieve the RAOs and best satisfies the threshold and primary balancing evaluation criteria and represents the most reasonable value for the money. Groundwater cleanup levels were achieved during the period of interim remediation. Verification of the cleanup levels will be conducted under Alternative 2. Other main factors supporting selection of the remedy include the following: the MNA remedy components have already been implemented, the processes of natural attenuation have been demonstrated to be effective at remediating the entirety of the site plume, and the capital costs for the MNA monitoring well network have already been incurred. |

[a] **Bolded** concentrations are above the groundwater cleanup level (refer to Table 2.8-1).
[b] Current concentration after approximately a decade of interim remediation. Source: GSAP 2010-2011 Annual Report (CH2M HILL, 2012a).
[c] Estimated based on the groundwater COC with greatest areal extent. Groundwater pore volume estimated from the plume area, saturated thickness, and a porosity of 20 percent.
[d] Contamination is limited to a small area in the vicinity of MW261x07. Plume areas and volumes are based on an approximate 100-foot plume radius around this well.
[e] Portion of Site ST027 formerly managed under the Travis AFB POCO program. Chlorinated VOCs regulated under CERCLA were not detected in the Area B portion of plume (i.e., Site ST027B) until after the NEWIOU Groundwater IROD was finalized.
[f] Included in Site SD037 estimates. The plume areas and volumes for Sites SD033, SD034, SS035, SD036, SD037, and SD043 comprise the overall WIOU plume. These site contaminant plumes are inseparably commingled and are addressed as a single WIOU plume. Site SD037 is selected as representative of the WIOU plume because the ERP site boundary has the greatest geographic extent of the component sites.

**TABLE 2.12-2**
Summary of Performance Monitoring
*Groundwater Record of Decision, Travis Air Force Base, California*

| Site | Remedy Component | Portion of Plume Addressed by Remedy Component | Duration of LTO[a] (years) | Duration of LTM[b] (years) | Duration of LTO and LTM (years) | Comment |
|---|---|---|---|---|---|---|
| FT004 | Alternative 2 – MNA | Entirety of plume | 35 | 2 | 37 | Plume remediated during period of LTO by natural physical, chemical, and biological processes. |
| FT005 | Alternative 3 – GET | Entirety of plume | 10 | 2 | 12 | Plume remediated during period of LTO by physical removal of contaminants using groundwater pumping. Majority of plume is located off-base. |
| LF006 | Alternative 2 – MNA | Entirety of plume | 5 | 2 | 7 | Plume remediated during period of LTO by natural physical, chemical, and biological processes. |
| LF007B | Alternative 2 – MNA | Entirety of plume | 0 | 2 | 2 | Cleanup levels already achieved by natural attenuation processes during the period of interim remediation. |
| LF007C | Alternative 3 – GET | Entirety of plume | 26 | 2 | 28 | Plume remediated during period of LTO by physical removal of contaminants using groundwater pumping. Majority of plume is located off-base. |
| LF007D | Alternative 2 – MNA | Entirety of plume | 23 to 49 | 2 | 25 to 51 | Plume remediated during period of LTO by natural physical, chemical, and biological processes. |
| LF008 | Alternative 2 – MNA | Entirety of plume | 100 to 110 | 2 | 102 to 112 | Organochlorine pesticides sorbed to fine soil particles and not detected in filtered groundwater samples. |
| SS015 | Alternative 5 – EVO | Highest concentration portion of plume | 5 to 10 | --[b] | --[b] | Portion of plume being actively treated using ERD processes via injection of EVO. |
| | Alternative 5 – EA | Lower concentration portion of plume | 70 | 2 | 72 | Portion of plume located hydraulically downgradient of the EVO remedy component. |

**TABLE 2.12-2**
Summary of Performance Monitoring
*Groundwater Record of Decision, Travis Air Force Base, California*

| Site | Remedy Component | Portion of Plume Addressed by Remedy Component | Duration of LTO[a] (years) | Duration of LTM[b] (years) | Duration of LTO and LTM (years) | Comment |
|---|---|---|---|---|---|---|
| SS016 | Alternative 4 – Bioreactor | Highest concentration portion of plume | 5 to 10 | --[b] | --[b] | Portion of plume being actively treated using ERD processes. |
| | Alternative 4 – GET | Low to moderate concentration portion of plume | 62 | 2 | 64 | Component of treatment train. |
| ST027B | Alternative 2 – MNA | Entirety of plume | 50 | 2 | 52 | Plume remediated during period of LTO by natural physical, chemical, and biological processes. |
| SS029 | Alternative 3 – GET | Entirety of plume | 62 | 2 | 64 | Plume remediated during period of LTO by physical removal of contaminants using groundwater pumping. COCs likely migrating to site from the hydraulically upgradient Site SS016 plume. |
| SS030 | Alternative 3 – GET | Entirety of plume | 22 | 2 | 24 | Plume remediated during period of LTO by physical removal of contaminants using groundwater pumping. Majority of plume is located off-base. |
| SD031 | Alternative 2 – MNA | Entirety of plume | 15 | 2 | 17 | Plume remediated during period of LTO by natural physical, chemical, and biological processes. |
| SD033 | Alternative 2 – MNA | Entirety of plume | 60 | 2 | 62 | Plume remediated during period of LTO by natural physical, chemical, and biological processes. Component of overall WIOU plume. |
| SD034 | Alternative 7 – Passive Skimming | Portion of plume with free-phase Stoddard solvent (LNAPL) | 5 to 10 | 2 | 7 to 12 | Portion of plume with localized free-phase Stoddard solvent (containing dissolved COCs). |
| | Alternative 7 – EA | Remainder of plume | 60 | 2 | 62 | Portion of plume with only dissolved contamination. Component of overall WIOU plume. |

**TABLE 2.12-2**
Summary of Performance Monitoring
*Groundwater Record of Decision, Travis Air Force Base, California*

| Site | Remedy Component | Portion of Plume Addressed by Remedy Component | Duration of LTO[a] (years) | Duration of LTM[b] (years) | Duration of LTO and LTM (years) | Comment |
|---|---|---|---|---|---|---|
| SS035 | Alternative 2 – MNA | Entirety of plume | 60 | 2 | 62 | Component site within the overall WIOU plume. Cleanup levels within the Site SS035 administrative boundaries were achieved during the period of interim remediation. Duration of LTO and LTM given for the entirety of the WIOU plume. |
| SD036 | Alternative 5 – EVO | Highest concentration portion of plume | 5 to 10 | --[b] | --[b] | Portion of plume being actively treated using ERD processes via injection of EVO. |
| | Alternative 5 – EA | Lower concentration portion of plume | 60 | 2 | 62 | Portion of plume located hydraulically downgradient of the EVO remedy component. Component of overall WIOU plume. |
| SD037 | Alternative 5 – EVO | Highest concentration portion of plume | 5 to 10 | --[b] | --[b] | Portion of plume being actively treated using ERD processes via injection of EVO. |
| | Alternative 5 – EA | Lower concentration portion of plume | 60 | 2 | 62 | Portion of plume located hydraulically downgradient of the EVO remedy component. Component of overall WIOU plume. |
| DP039 | Alternative 6 – Bioreactor | Highest concentration portion of plume | 5 to 10 | --[b] | --[b] | Portion of plume actively treated using ERD processes using an organic mulch bioreactor. Component of treatment train. |
| | Alternative 6 – Phytoremediation | High concentration and shallow portion of plume | --[a] | --[b] | --[b] | Portion of plume actively treated using biological processes. Component of treatment train. |
| | Alternative 6 – EVO PRB | High concentration portion of plume | --[a] | --[b] | --[b] | Portion of plume actively treated using ERD processes via injection of EVO. Component of treatment train. |
| | Alternative 6 – EA | Lower concentration portion of plume | 58 | 2 | 60 | Portion of plume located hydraulically downgradient of the bioreactor, area of phytoremediation, and EVO PRB remedy components. |

**TABLE 2.12-2**
Summary of Performance Monitoring
*Groundwater Record of Decision, Travis Air Force Base, California*

| Site | Remedy Component | Portion of Plume Addressed by Remedy Component | Duration of LTO[a] (years) | Duration of LTM[b] (years) | Duration of LTO and LTM (years) | Comment |
|---|---|---|---|---|---|---|
| SS041 | Alternative 1 – NFA | Entirety of plume | 0 | 0 | 0 | Cleanup levels achieved during the period of interim remediation. Site SS041 in NFRAP status (Travis AFB, 2005a). |
| SD043 | Alternative 2 – MNA | Entirety of plume | 60 | 2 | 62 | Component site within the overall WIOU plume. Cleanup levels within the Site SD043 administrative boundaries were achieved during the period of interim remediation. Duration of LTO and LTM given for the entirety of the WIOU plume. |

[a] Performance monitoring during the period of LTO is conducted until cleanup levels are achieved for the entirety of the plume.
[b] Monitoring during the period of LTM is to ensure that cleanup levels have been achieved for the entirety of the plume. Includes the higher concentration portion of a plume undergoing active treatment (including the highest concentration portion of the plume at Sites SS015, SS016, SD036, SD037, and DP039) and the lower concentration portion of a plume being remediated by natural physical, chemical, and biological processes.