Table 3. Identification and Screening of Remedial Technologies
Feasibility Study, OUCTP RI/FS, Former Fort Ord, California

General Response Action for Groundwater	Remedial Technology Type/ Process Option	Description	Effectiveness	Implementability	Relative Cost	Selected for Remedial Alternative Development
NO ACTION WITH MONITORED NATURAL ATTENUATION	None	No remedial action other than monitoring of groundwater wells for COCs and natural attenuation parameters. Natural attenuation can reduce contaminant concentrations over time through degradation and dispersion processes within the aquifers.	Natural attenuation has been demonstrated to be occurring within these aquifers and would eventually achieve ACLs over time. There is no longer a source of VOCs within the aquifers, and the widespread extent of the plumes within three sandy aquifers could be technically or economically impractical to capture or contain and actively remediate.	Easily implemented from a technical perspective. Groundwater monitoring for COCs and natural attenuation parameters is already occurring under existing programs. May be difficult to implement from an administrative perspective at the outset without pairing it with some form of active remediation. COCs occur above ACLs within all aquifers, including the Lower 180-Foot drinking water aquifer. Could be implemented under a phased approach in the future for portions of plumes demonstrated to be impractical to remediate below ACLs using other remedial technologies.	Low	Yes: All aquifers
CONTAINMENT	Vertical barriers (grout curtain, slurry walls, sheet piling)	Impermeable barriers installed belowground to cutoff or redirect the horizontal flow of groundwater and prevent migration of contaminants or redirect groundwater into specific treatment zones (funnel-and-gate technology).	Potentially effective for redirecting groundwater flow, but would not be effective in cutting off groundwater flow due to high flow conditions within these aquifers and would not remediate COCs.	Difficult to install within the deep aquifers and across wide plumes. Could only be considered for installation within the uppermost A-Aquifer.	High	No
IN SITU TREATMENT	Permeable reactive barriers	Scrap iron metal or other reactive media is placed within permeable barriers below ground surface to intersect groundwater flow and reductively dehalogenate chlorinated VOCs in situ.	Potentially effective for remediating groundwater in portions of the plume downgradient of the barrier. Would require pilot study to evaluate site-specific effectiveness and longevity. High flow conditions within these aquifers would require thick barriers be constructed to provide adequate residence time for degradation below ACLs. Nano-scale iron could also be injected in slurry form in discrete locations to target source removal in upgradient or other portions of the plume.	Difficult to install within the deep aquifers and across wide plumes with high flow conditions; could only be considered for installation within the uppermost A-Aquifer. Would require specialized installation equipment. Other technology or remedial approach be implemented in portions of the plume not captured and treated by downgradient barrier. Would not require long term operations and maintenance. May need to be reinstalled due to reduced effectiveness over time if ACLs have not been achieved after 20 years.	High	Yes: A-Aquifer

Table 3. Identification and Screening of Remedial Technologies
Feasibility Study, OUCTP RI/FS, Former Fort Ord, California

General Response Action	Remedial Technology Type/ Process Option	Description	Effectiveness	Implementability	Relative Cost	Selected for Remedial Alternative Development
IN SITU TREATMENT	Enhanced biodegradation (Injection of methane or other gases; or liquids such as lactate, oil emulsions, molasses, hydrogen release compound [HRC®], or other compounds)	Injection of a gaseous or liquid food source into aquifer to stimulate the growth of microorganisms that consume contaminants, to enhance naturally occurring biodegradation processes.	Potentially effective for remediating groundwater throughout the plume. Site-specific bench- and pilot-scale studies have already been conducted using lactate and it was demonstrated as effective in anaerobically biodegrading COCs. High flow conditions and large plume size within these aquifers would require large grid of injection points and reinjection of food source periodically to maintain long-term biodegradation and achieve ACLs. Could also be injected in discrete locations to target source removal in other portions of the plume in combination with other remedial approaches.	Moderately difficult to install due to large number of injection points that would be required to remediate entire plume; could only be considered for installation within the uppermost A-Aquifer. Would not require specialized installation equipment. Would require long term operations and maintenance (reinjection and system monitoring), and assessment of potential fouling of aquifer due to anaerobic (non-oxygenated) conditions it creates in order to degrade COCs. May require re-oxygenation via air sparging or other technology downgradient to address potential fouling.	Moderate	Yes: A-Aquifer
COLLECTION, RECIRCULATION, AND DISPOSAL	Extraction, recirculation, reinjection, and disposal of groundwater as components of ex situ treatment (pump & treat) or in situ treatment (recirculation of injected treatment media)	Collection: Vertical extraction wells, horizontal extraction wells, drains, trenches Recirculation: Vertical extraction, reinjection/ recirculation, and air sparging wells Disposal: Reinjection/ recirculation wells, discharge to sewer or storm drain	Collection: Vertical and horizontal extraction wells are proven effective in collecting groundwater for aboveground treatment at former Fort Ord. Drains and trenches would not be effective for these high-flow, deep aquifers. Recirculation: Vertical extraction, reinjection/ recirculation, and air sparging wells would be effective in creating vertical flow of groundwater to distribute injected biological enhancements within the aquifer or stimulate flow of groundwater. Disposal: Reinjection/ recirculation wells would be effective as described above. Discharge to sewer or storm drain would also be effective for disposal of treated groundwater.	Collection: Vertical extraction wells are relatively easy to install and operate within the sandy aquifers at former Fort Ord. Horizontal extraction wells are difficult to install and would only be considered for inaccessible areas. Drains and trenches would be relatively easy to install but difficult to maintain because they are prone to lose their capacity for infiltration and become clogged and inoperable at former Fort Ord. Recirculation: Vertical extraction, reinjection/ recirculation, and air sparging wells would be relatively easy to install and operate within the sandy aquifers at former Fort Ord. However, it may be difficult to maintain large vertical recirculation zones within deeper portions of the aquifer and over extensive plumes. Disposal: Reinjection/ recirculation wells would be relatively easy to install and operate as described above. Discharge to sewer or storm drain is not anticipated to be implementable from a capacity perspective for such large volumes of groundwater from these high-flow aquifers.	Low	Yes: A-Aquifer Vertical, horizontal, reinjection, and recirculation wells will be considered. Upper and Lower 180-Foot Aquifers Vertical extraction and reinjection wells will be considered.

Table 3. Identification and Screening of Remedial Technologies
Feasibility Study, OUCTP RI/FS, Former Fort Ord, California

General Response Action	Remedial Technology Type/ Process Option	Description	Effectiveness	Implementability	Relative Cost	Selected for Remedial Alternative Development
EX SITU TREATMENT	Activated carbon adsorption	Removes VOCs from water or vapor streams by adsorption, the attraction and accumulation of one substance on the surface of another. Typically installed with two or more vessels in series so that as the first vessel (lead adsorber) nears its breakthrough capacity, there is reserve adsorption capacity maintained in the second vessel (polishing adsorber).	Effective for remediating COCs below ACLs/discharge levels. High flow conditions within these aquifers would require large carbon vessels and frequent changeout/regeneration of spent carbon in order to achieve ACLs/discharge levels in system effluent prior to reinjection into the aquifer.	Moderately difficult to construct due to extensive piping conveyance and large capacity central processing unit. Would not require specialized installation equipment and carbon vessels are readily available. Would require long term operations and maintenance (influent/effluent sampling, carbon changeout, reinjection and system monitoring). Could also be implemented using modular wellhead treatment units in discrete locations to target source removal at wells not easily tied into the piping conveyance in other portions of the plume, in combination with other remedial approaches.	High	Yes: All Aquifers
EX SITU TREATMENT	Air stripping	Packed or tray towers designed so that water enters the top of the treatment vessel while air is injected from the bottom, creating a countercurrent flow that volatilizes and remove VOCs from groundwater.	Effective for remediating COCs below ACLs/discharge levels. High flow conditions within these aquifers would require frequent cleaning of trays in order to achieve ACLs/discharge levels in system effluent prior to reinjection into the aquifer. Vapor phase carbon adsorption polishing may be required to treat air flow prior to discharge to atmosphere in order to meet the substantive requirements of air permitting.	Moderately difficult to construct due to extensive piping conveyance and large capacity central processing unit. Would not require specialized installation equipment and air strippers are readily available. Would require long term operations and maintenance (influent/effluent sampling, tray cleaning, reinjection and system monitoring). Could also be implemented within extraction or recirculation wells (air sparging or in-well stripping), but is not considered feasible for implementation for the deep depths and/or large lateral extents of the plumes. Could also be implemented using modular wellhead treatment units in discrete locations to target source removal at wells not easily tied into the piping conveyance in other portions of the plume, in combination with other remedial approaches.	Moderate	Yes: All Aquifers

Checked: MS

Approved: EJ