DEPARTMENT OF THE NAVY
NAVAL FACILITIES ENGINEERING COMMAND SOUTHWEST
1220 PACIFIC HIGHWAY
SAN DIEGO, CA 92132-5190

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Ser OPAE.TM/076
February 28, 2014

Ms. Beatrice Griffey
California Environmental Protection Agency
California Regional Water Quality Control Board
Mitigation & Cleanup Unit
2375 Northside Drive, Suite 100
San Diego, CA 92108

Mr. Tayseer Mahmoud
California Environmental Protection Agency
Department of Toxic Substances Control
Brownfields and Environmental Restoration Program
5796 Corporate Avenue
Cypress, CA 90630

Mr. Martin Hausladen
U. S. Environmental Protection Agency
Region IX, Code SFD-8-3
75 Hawthorne Street
San Francisco, CA 94105-3901

SUBJECT: FINAL RECORD OF DECISION FOR 22/23 AREA GROUNDWATER, MARINE CORPS BASE CAMP PENDLETON

Dear Ms. Griffey, Mr. Mahmoud, Mr. Hausladen:

Enclosed is the final Record of Decision for 22/23 Area Groundwater. Please call Ms. Theresa Morley at (619) 532-1502 if you have any questions.

Sincerely,

GASTON C. BORDENAVE, JR
By direction

Copy to: CG, MCB Camp Pendleton (Attn: ACOS, Environmental Security - Mr. Luis Ledesma)

FINAL

RECORD OF DECISION

FOR

22/23 AREA GROUNDWATER

MARINE CORPS BASE CAMP PENDLETON, CALIFORNIA

February 2014

NAVAL FACILITIES ENGINEERING COMMAND SOUTHWEST
1220 Pacific Highway, San Diego, CA 92132-5190

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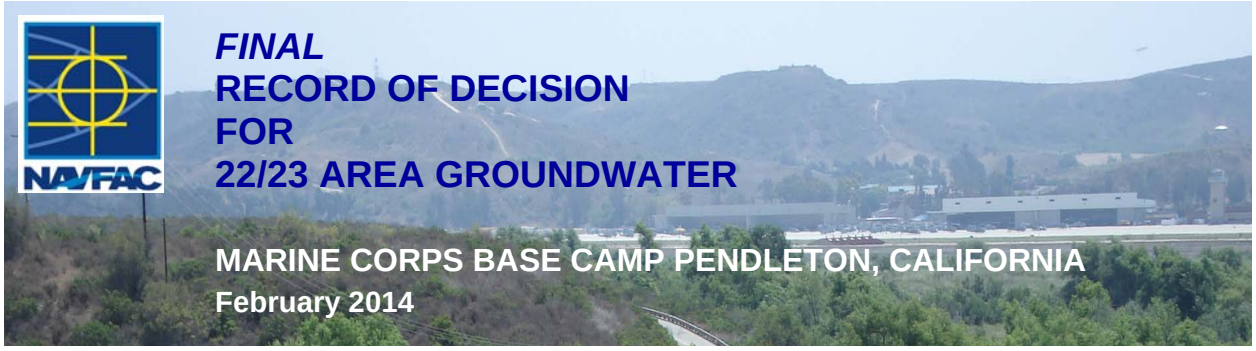

FINAL RECORD OF DECISION FOR 22/23 AREA GROUNDWATER

MARINE CORPS BASE CAMP PENDLETON, CALIFORNIA

February 2014

DECLARATION

This Record of Decision (ROD) presents the selected remedies for groundwater at the 22/23 Area Groundwater site at Marine Corps Base (MCB or Base) Camp Pendleton, California. The site is also adjacent to the Marine Corps Air Station (MCAS), which is located within the boundaries of MCB Camp Pendleton. The remedies were selected in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980 as amended by the Superfund Amendments and Reauthorization Act of 1986, Title 42 United States Code Sections (§) 9601 et seq., and in accordance with the National Contingency Plan, 40 Code of Federal Regulations 5 300, et seq. The decisions are based on information contained in the administrative record files for this site. There is information about this site that is not summarized in this ROD but is contained in the **administrative record**[1]. All site information in this ROD and the administrative record is relevant to the selection of the remedy at 22/23 Area groundwater.

The Base was placed on the National Priority List in 1989 (USEPA ID CA2170023533). The Federal Facility Agreement for MCB Camp Pendleton, which was signed in October 1990, documents how the Navy and Marine Corps intend to meet and implement CERCLA in partnership with the United States Environmental Protection Agency (USEPA), the Department of Toxic Substances Control (DTSC), and the Regional Water Quality Control Board (RWQCB).

The U.S. Department of the Navy is the lead agency for CERCLA response actions and provides funding for site cleanups at MCB Camp Pendleton. The Navy, Marine Corps, and the USEPA Region 9 jointly selected the remedies with the concurrence of the California Environmental Protection Agency, which includes the California DTSC and the California RWQCB, San Diego Region. **Responses to Comments**[2] from the agencies are included as Attachment 1. The schedule for CERCLA cleanup activities is updated every four months when the Department of the Navy meets with the regulatory agencies.

MCB Camp Pendleton was established in early 1942 to provide training facilities, logistical support, and administrative support to Fleet Marine Force Units. The Marine Corps Air Station was designated as an auxiliary landing field at the same time. Both were dedicated by President Roosevelt in September 1942 and were designated permanent bases in October 1944. The Base has a daytime population of approximately 70,000 military and civilian personnel; approximately 38,000 military family members occupy Base housing complexes. Located 38 miles north of downtown San Diego, the Base occupies approximately 125,000 acres of land and is the Marine Corps' primary amphibious training center. The Base encompasses 17 miles of relatively undisturbed coastline along the Pacific Ocean (Figure 1). Rolling hills and valleys range inland an average of 10 to 12 miles. Land use consists of airfield operations, maneuver and impact areas, troop and family housing, recreation areas, and out-leased areas used by various entities. There are over 450 species of wildlife, including birds, fish, reptiles, and mammals. Base Environmental also provides special management for 12

federally endangered and four federally threatened species. Most of the land is open and undeveloped and directly supports the training mission of the Base. Developed areas are isolated from one another by large areas of essentially undeveloped land used for training and maneuvers.

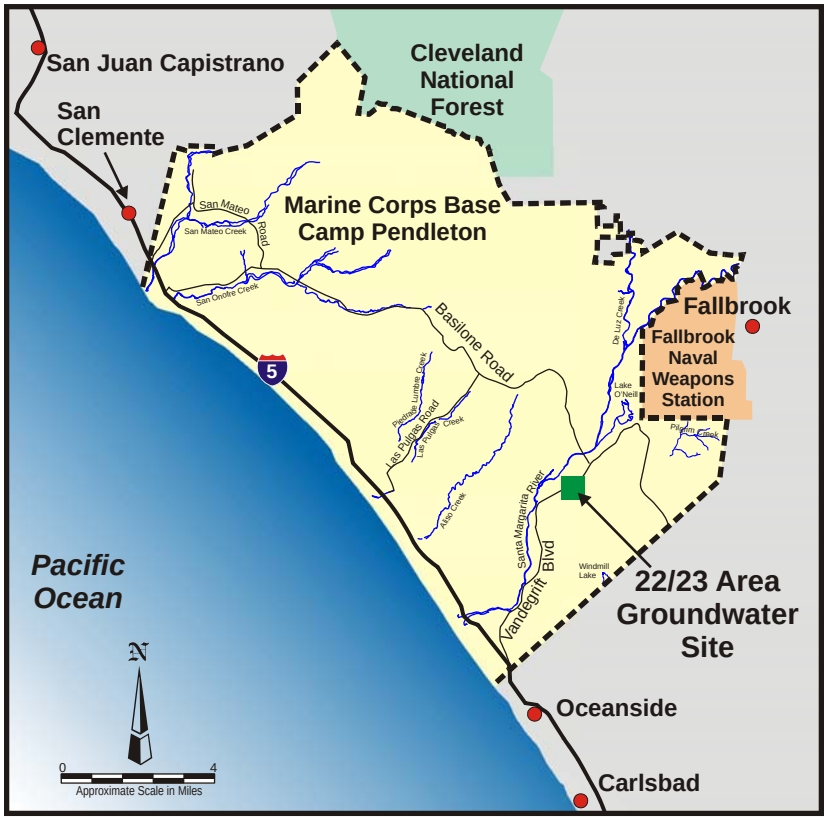

Figure 1 Base Location Map

The 22/23 Area Groundwater site consists only of the groundwater medium, not the overlying soils. The 22/23 Area site soils were analyzed and evaluated previously, as discussed in Section 1.2. The remedial actions and No Further Action decisions for the soil are documented in the RODs for Operable Units (OUs) 1, 2, 3, and 5. The OU 1 ROD was signed in December 1995, OU 2 was signed in September 1997, OU 3 was signed in January 1999, and OU 5 was signed in February 2008. This ROD documents the final response actions for the 22/23 Area Groundwater site that are necessary to protect the public health, welfare, and environment from actual or threatened releases of contaminants.

Selected Remedy

At the site, there is contamination in a former drinking water well and in an upgradient area, with the potential for contamination to migrate into current drinking water wells. The chemicals of concern (COCs) in site groundwater are the volatile organic compounds (VOCs) detected above maximum contaminant levels including 1,2-dichloroethane (1,2-DCA), *cis*-1,2-dichloroethene (*cis*-1,2-DCE), 1,1-DCE, trichloroethene (TCE), and vinyl chloride. The VOCs 1,2,3-trichloropropane (1,2,3-TCP) and 1,4-dioxane are also COCs because they were detected above their state notification levels in groundwater at the site. The COCs are discussed in more detatil in Section 1.1.

The selected remedy for the 22/23 Area Groundwater site consists of the following components:

- Land use controls and long-term monitoring to prevent the use of contaminated water and monitor the potential movement of groundwater contamination;
- Source area treatment via in situ technologies to reduce contaminant concentrations in the source areas and reduce the potential for migration of contamination; and
- Identification of an alternate water supply well location to replace the water supply well that was removed from service, and install a new water supply well at the approval of the Base Commanding General.

The selected remedy meets the statutory requirements of CERCLA and is protective of human health and the environment, complies with Federal and State regulations that are applicable or relevant and appropriate to the remedial actions, is cost-effective, and uses permanent solutions and alternative treatment technologies to the maximum extent practicable.

Because this remedy results in hazardous substances, pollutants, or contaminants remaining on site above levels that allow for unlimited uses and unrestricted exposure for an extended period, a five-year review is required. Therefore, the site will be included in five-year reviews to document the status of the remedial action and ensure that the remedy remains protective.

Data Certification Checklist

The information included in the Decision Summary for this site is contained in the following sections as outlined below.

- Chemicals of concern and their respective concentrations (Section 1.1);
- Risk represented by the chemicals of concern (Section 1.5);
- Cleanup levels established for chemicals of concern and the basis for these levels (Section 1.7);
- How source materials constituting principal threats are addressed (Section 1.6);
- Current and reasonably anticipated future land-use assumptions used in the risk assessment (Section 1.4);
- Potential land and groundwater use that will be available at the sites as a result of the selected remedy (Section 1.9);
- Estimated capital, annual operation and maintenance, and total present worth costs; discount rate; and the number of years over which the remedy cost estimates are projected (Section 1.8); and
- Key factors that led to selecting the remedy (i.e., a description of how the selected remedy provides the best balance of tradeoffs with respct to the balancing and modifying criteria, highlighting criteria key to the decision) (Sections 1.8 and 1.9).

Additional information can be found in the administrative record file for this site. If contamination posing an unacceptable risk to human health or the environment is discovered after execution of this ROD, the Navy will undertake the necessary actions to ensure continued protection of human health and the environment.

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Authorizing Signatures

For the United States Department of the Navy, Marine Corps Base Camp Pendleton,

Signature: _____ Date: 8-19-13

Vincent A. Coglianese, Brigadier General, United States Marine Corps,
Commanding General, Marine Corps Installations West-
Marine Corps Base Camp Pendleton

For the United States Environmental Protection Agency,

Signature: _____ Date: 12/16/13

Michael M. Montgomery, Chief
Federal Facilities and Site Cleanup Branch, USEPA, Region 9

For the California Environmental Protection Agency,

Signature: _____ Date: Jan. 14, 2014

John E. Scandura, Branch Chief
Brownfields and Environmental Restoration Program
Department of Toxic Substances Control

Signature: _____ Date: 18 February 2014

David W. Gibson, Executive Officer
California Regional Water Quality Control Board, San Diego Region

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1.0 22/23 AREA GROUNDWATER DECISION SUMMARY

1.1 Site Description and History

Description: The 22/23 Area Groundwater site is near the southern boundary of the Base, along both sides of Vandegrift Boulevard (**Figure 2**[3]). Facilities within this area include various industrial warehouses, office buildings, and the 488-acre MCAS. The 22/23 Area is expected to remain a developed area as long as the Base and Station remain active facilities. The term "22/23 Area Groundwater" is used to denote the groundwater underlying this industrial operations area, which includes approximately 425 acres. There are currently four open underground storage tank (UST) cases (Sites 2264, 22141, 22187, and the Marine Corps exchange [MCX] Gas Station) and six closed UST cases (Sites 2296, 22048, 22141-3&4, 22150, 22151, and 22831) located in the 22 Area.

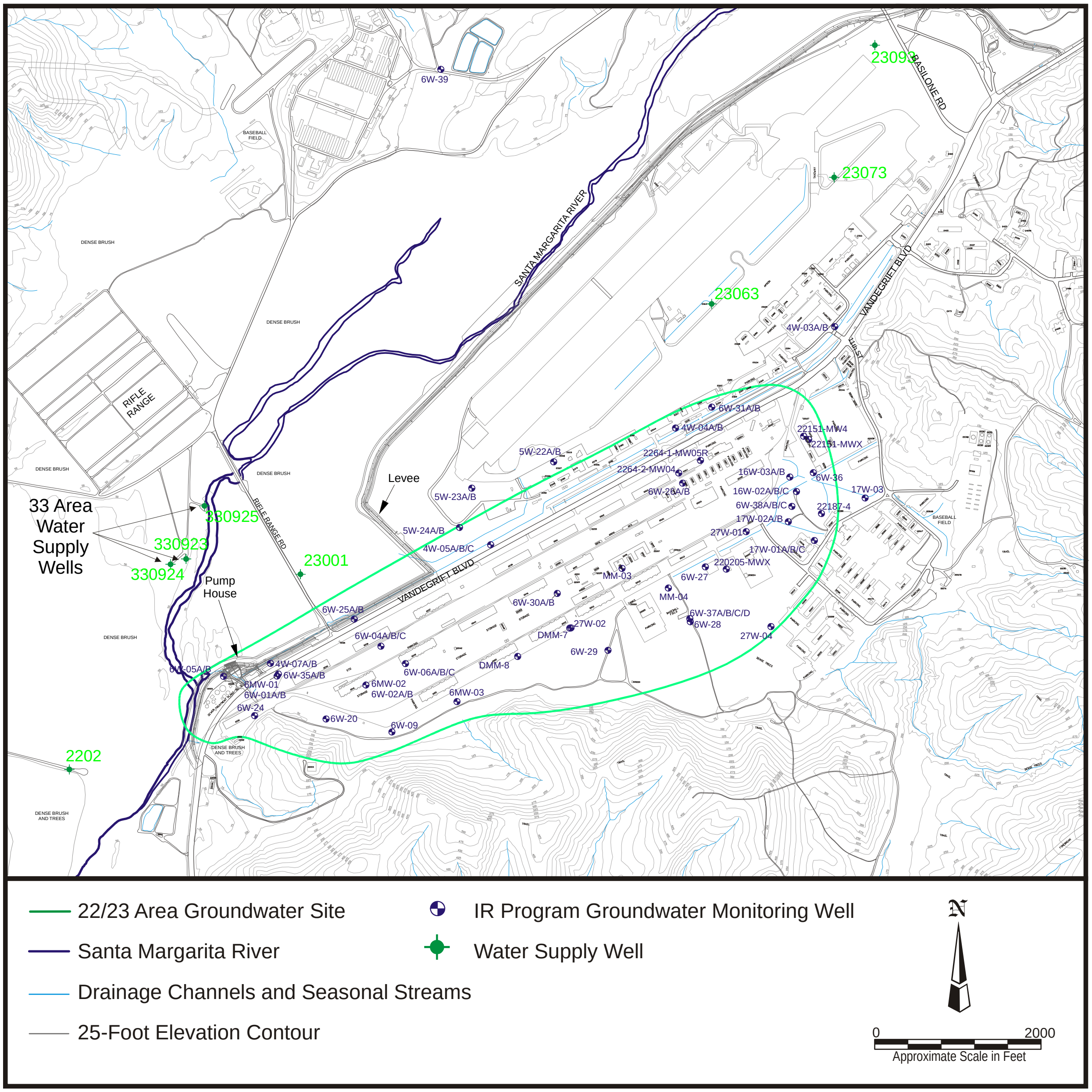

Figure 2 22/23 Area Groundwater Location Map

History: The 22/23 Area Groundwater site consists of the groundwater medium underlying former Installation Restoration (IR) **Sites 4, 4A, 5, 6, 6A, 16, 17, and 27**[4]. These former Installation Restoration sites are discussed in more detail in Section 1.2, Previous Investigations, and the locations are shown on **Figure 3**[5]. The remedial actions and No Further Action decisions for the soil at these sites are documented in the Record of Decisions (RODs) for Operable Units 1, 2, 3, and 5.

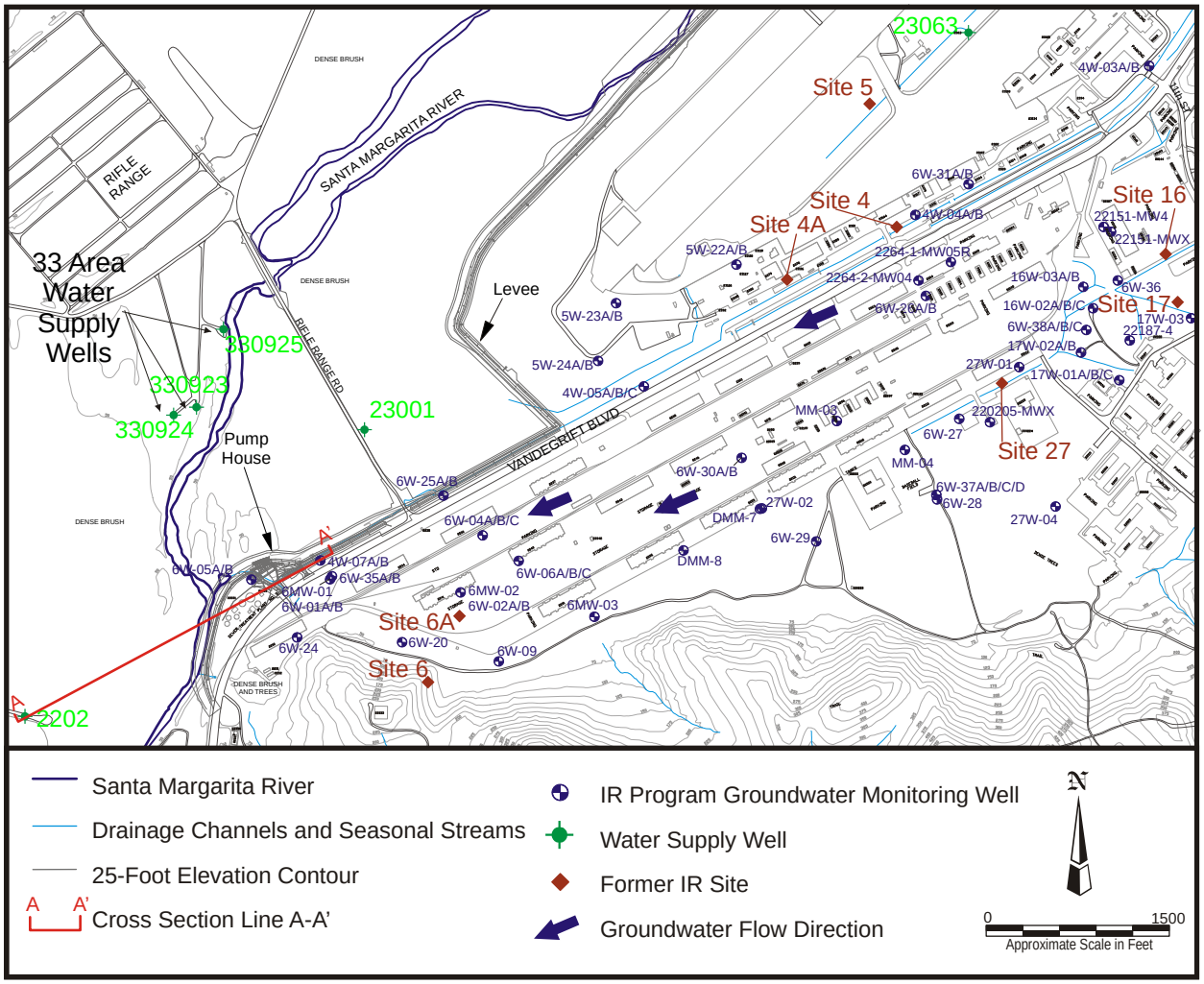

Figure 3 22/23 Area Groundwater with Former IR Sites

The chemicals of concern (COCs) in site groundwater are volatile organic compounds (VOCs) detected above maximum contaminant levels including 1,2-dichloroethane (1,2-DCA), *cis*-1,2-dichloroethene (*cis*-1,2-DCE), 1,1-DCE, trichloroethene (TCE), and vinyl chloride. The compounds 1,2,3-trichloropropane (1,2,3-TCP) and 1,4-dioxane were detected above their state notification levels in groundwater at the site. The California Department of Health Services has established a notification level and a response level for 1,2,3-TCP and 1,4-dioxane. The notification level is a health-based advisory level, and the response level is the level at which the California Department of Health Services recommends that a water supply source be taken out of service. Base water supply well 2202 was taken out of service when 1,2,3-TCP was detected in water from this well. The detections of 1,2,3-TCP in this well were above the state notification level of 0.005 micrograms per liter (µg/L) but below the response level of 0.5 µg/L.

The Base decided to remove the well from service, even though this was not required by State or Federal regulations. The Base policy is to exercise extra protection of the water supplies.

Characteristics: **Subsurface geology**[6] consists primarily of stream-deposited alluvium of the Santa Margarita River watershed overlying bedrock. The alluvium consists of unconsolidated sand and silts with lesser amounts of clay and gravel (**Figure 4**[7]). The bedrock is the Santiago Formation, which broadly consists of inter-bedded sandstone, siltstone, and mudstone. The water table is relatively shallow, ranging from approximately 5 to 15 feet below ground surface (bgs), and **groundwater**[8] flows generally toward the southwest.

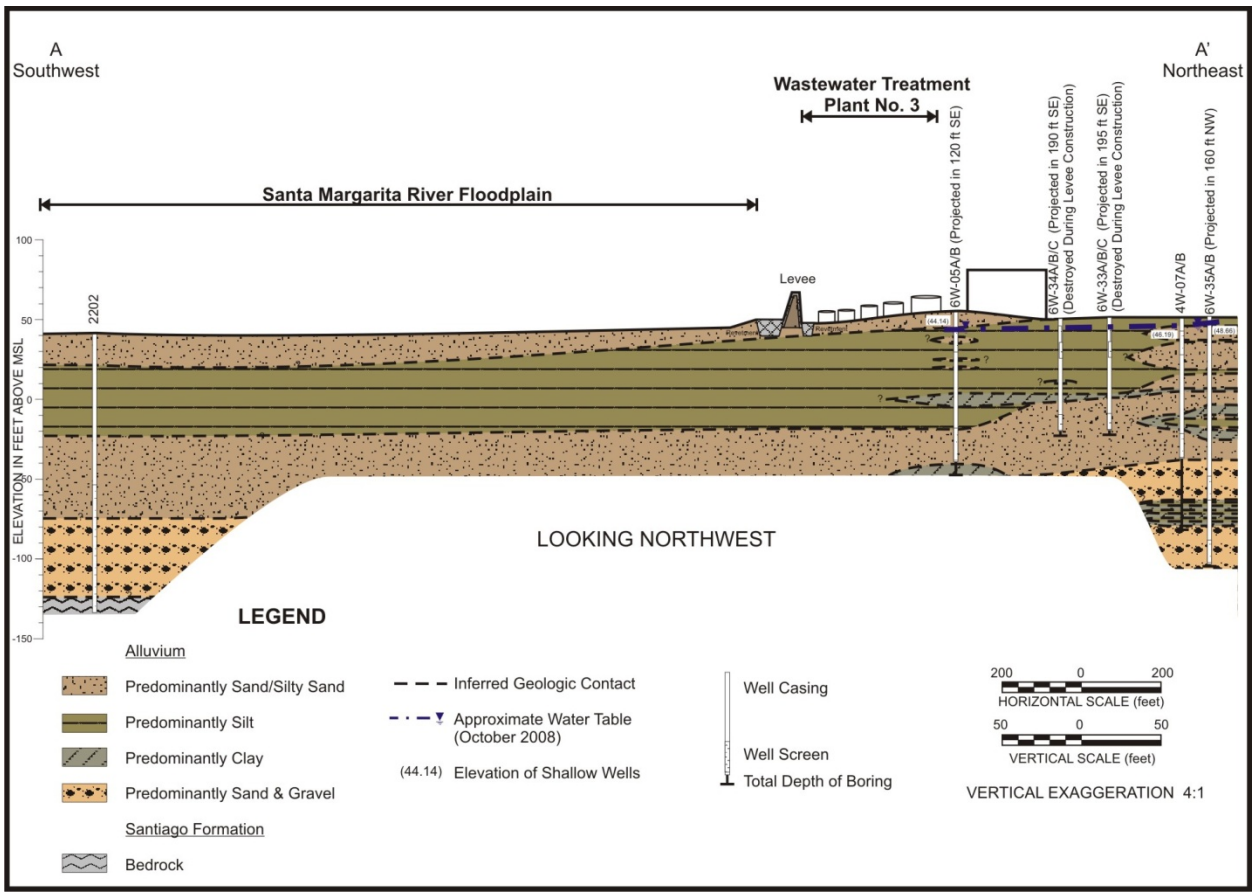

Figure 4 Generalized Cross Section A-A'

Site groundwater discussed above is in the alluvial aquifer within the Chappo subbasin of the Santa Margarita River watershed. This alluvial aquifer is considered the principal water bearing deposit and is the primary water source for the southwestern portion of the Base. This aquifer consists of upper deposits of unconsolidated sand and silt with lesser amounts of clay and gravel; the underlying lower deposit has more sand and gravel, and less fine grained sediments. The maximum thickness of the alluvial deposits in the site area is approximately 180 to 190 feet, with the maximum thickness of the upper alluvial deposits approximately 80 feet.

The alluvial deposits are very heterogeneous because of many erosional and depositional cycles in response to sea level changes. Groundwater flow occurs primarily in sand layers, but these sand layers are interbedded with finer layers, so that the groundwater flow does not occur along a uniform, direct path within a laterally continuous layer. The majority of water flowing into Base supply wells occurs in thin layers of the alluvial deposits. Layers as thin as 10 feet

contributed up to 60 percent of the water flowing into some wells, which demonstrates the heterogeneity of the deposits.

Eight Chappo subbasin groundwater water supply wells are located upgradient (23073 and 23093), downgradient (former water supply well 2202), and cross gradient (330923, 330924, 330925, 23001, and 23063) of the site (**Figure 2**[3]).

The ground surface in the developed area of the site is generally flat and includes various buildings, roads, drainage swales, and unpaved areas. Overall, the ground surface generally slopes toward the west, with an average elevation of approximately 60 feet above mean sea level (amsl), although ground surface elevations vary from about 50 to 70 feet amsl. The hill elevations range from 400 to 475 feet amsl in the surrounding areas to the south, southeast, and east. The Santa Margarita River bed, which is located northwest of the site, occupies a relatively large, flat channel, at an average elevation of approximately 50 feet amsl in this area.

A portion of the 22/23 Area Groundwater site is within the Santa Margarita River floodplain (Figure 2). However, a flood control levee separates the 22/23 Area from the floodplain and its riparian **habitats**[9]. Because buildings, asphalt roads, and asphalt parking lots cover much of the site, the site is poor quality habitat and does not support significant plant or animal communities. The exposed soils, largely limited to the southern margin of the site, are dominated by upland habitats, including sage, coyote brush, ripgut brome, and wild oats. Soil, sediment, surface water, and biota (plants and aquatic invertebrates) samples collected at the site indicated a low risk to ecological receptors.

Transport Pathways: There are several possible pathways for contaminants in groundwater to reach human or ecological receptors. One of these pathways is the movement of chemicals of concern in the aquifer to a water supply well, and then into the water that is extracted from the aquifer by the supply well. People could then be exposed to this water by drinking it (ingestion), direct contact with it during bathing (dermal contact), and/or breathing (inhalation) of volatile organic compounds emitted during the use of the water, such as during showering. However, there is no actual significant risk to people drinking the water from this site because the Base only allows water that meets regulatory standards into the drinking water system, as noted in Section 1.4.1.

For ecological receptors, if contaminated groundwater were to reach the ground surface, plants or animals could absorb or ingest the water. An additional potential pathway may be complete if an industrial or construction worker were to be exposed to contaminated groundwater while digging. Another potential pathway would be if the contaminants in groundwater were to volatilize, migrate through the vadose zone (the unsaturated zone between the groundwater and the ground surface), and migrate into the indoor air of buildings where people work or live. Actual current risks to humans and ecological receptors are not significant, as discussed in Section 1.4.1, although there are potential significant risks that need to be mitigated because of the presence of contaminants in groundwater.

The movement of chemicals in groundwater is controlled by many factors, including precipitation, infiltration, the presence of continuing sources of contamination, and the nature of the soils making up the aquifer. Precipitation is limited from infiltrating to groundwater through the soil because most of the site is paved or covered by buildings. Infiltration would primarily occur in the area of exposed soils along the southern margin of the site. Former Installation Restoration sites were addressed in prior Operable Units and phases of work, and there are not believed to be any continuing sources of COCs to the underlying groundwater from site soils. Groundwater generally flows southwest towards the Santa Margarita River. **Figure 5**[10] shows the conceptual site model, illustrating the location of COC plumes and geology relative to the area features.

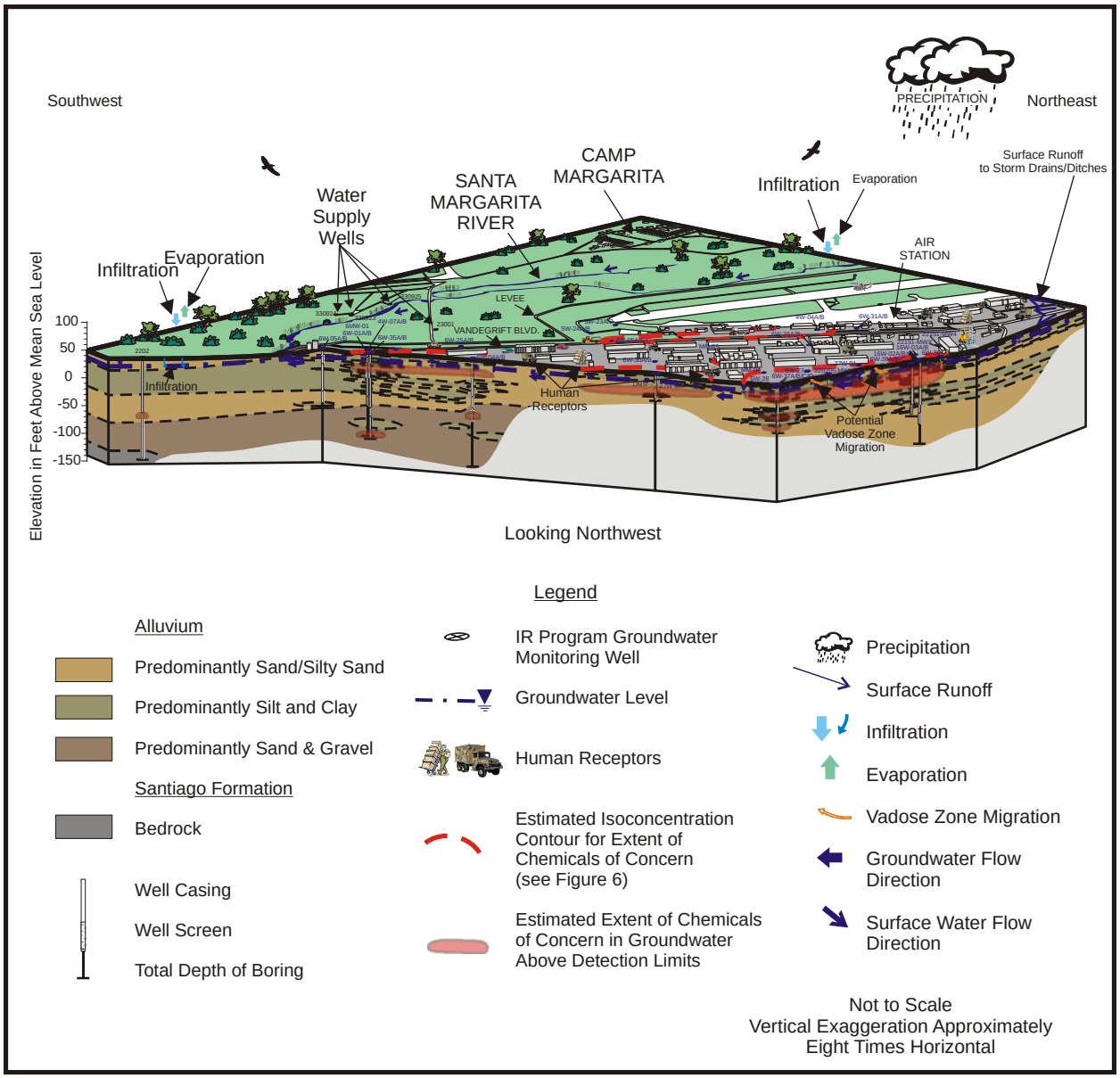

Figure 5 Transport Pathways

The available data indicate that COC concentrations in groundwater have been slowly and steadily declining over time, with the exception of 1,2,3-TCP, for which insufficient data exist to establish a temporal trend. The **extent of the plumes has decreased**[11] in size and concentrations between 25 and 40 percent since the mid-1990s. However, COCs in groundwater are likely to persist above regulatory thresholds for many decades if left untreated. The reduction in lateral extent of the COCs in groundwater over the last 15 years of monitoring, coupled with the lack of COC detections at the plume's most down-gradient well 6W-05A/B, indicates that natural attenuation processes have been effectively controlling the migration of COCs (with the exception of 1,2,3-TCP). Natural attenuation processes include both biological transformation reactions and physical dispersion and diffusion processes.

Groundwater and soil gas data collected in this investigation were used to assess potential exposures to human receptors at the 22/23 Area. The summary of potential risks to human health and the environment is provided in Section 1.5.

1.2 Scope and Role of Response Action

Suspected waste sites at MCB Camp Pendleton have been grouped into several Operable Units (OUs) based on geographical location, type of media contaminated (soil or groundwater), and schedule. There are currently five OUs at MCB Camp Pendleton. Sites that are grouped into OUs are ultimately addressed in a Record of Decision (ROD) for cleanup and closure of all sites. The 22/23 Area Groundwater site is part of OU 5.

The 22/23 Area site soils were analyzed and evaluated previously, as discussed in Section 1.3. The remedial actions and No Further Action decisions for the soil are documented in the RODs for OUs 1, 2, 3, and 5. The OU 1 ROD was signed in December 1995, OU 2 was signed in September 1997, OU 3 was signed in January 1999, and OU 5 was signed in February 2008.

This ROD addresses the contamination in groundwater underlying the former IR sites. The risk assessment found that chemicals in groundwater represent a potential risk to human health based on possible domestic groundwater use. However, there is no actual significant risk to people drinking the water from this area because the Base only allows water that meets regulatory standards into the drinking water system. This ROD documents the final response actions for the 22/23 Area Groundwater site that are necessary to protect the public health, welfare, and the environment from actual or threatened releases of contaminants.

1.3 Previous Investigations

Eight former IR sites (4, 4A, 5, 6, 6A, 16, 17, and 27) were investigated in the past. A further data review was conducted at other Base facilities, including current and former UST program sites, to determine if there might have been additional potential sources in the Santa Margarita River Valley, other than the previously known IR sites noted above. Available data were reviewed from wells in proximity to the Rifle Range, IR Site 28, and Camp Margarita. There is no evidence that these areas contributed to observed groundwater contamination based on the data review. It is also possible that groundwater contamination was caused by small isolated releases to the ground surface at various discharge points within the 22/23 Area site.

No specific source or release point has been identified to account for the observed contamination in the site groundwater. However, the term “source areas” is used in this document to describe areas having the highest COC concentrations in groundwater. Investigations conducted at the site since 1992 at the former IR sites and the 22/23 Groundwater site are summarized in Table 1.

Table 1 Previous Studies and Investigations

IR Site	Previous Study / Investigation*	Report Date	Investigation Activities
Former Soil Sites			
Sites 4 and 4A	Remedial Investigation Report, Group A	1993	**Sites 4 and 4A**[12] consisted of a drainage ditch reportedly used for disposal of liquid wastes from flight line operations and a concrete-lined surface impoundment reportedly used to catch discharge from hangar deluge systems. Surface and subsurface soil samples, sediment, surface water, and groundwater samples were collected and analyzed for metals, VOCs, semivolatile organic compounds (SVOCs), petroleum hydrocarbons, pesticides and polychlorinated biphenyls (PCBs). No chemicals of concern in sediment or surface water were detected above regulatory criteria. Based on human health and ecological risk assessments, the petroleum constituents and pesticides detected in soil did not pose a significant threat to human or ecological receptors. VOCs in groundwater exceeded drinking water criteria, and it was determined to investigate groundwater further as part of the widespread plume suspected in the 22 Area.
	Final Record of Decision, OU 1	1995	The decision that No Further Action was required for soil, sediment, and surface water at Sites 4 and 4A was documented in the **OU 1 ROD**[13].
Site 5	Remedial Investigation Report, Group A	1993	**Site 5**[14] was a former area used to train firefighters in the suppression of fuel and oil fires from the 1940s or 1950s to 1981. Surface and subsurface soils samples, sediment, and groundwater samples were collected and analyzed for metals, VOCs, SVOCs, petroleum hydrocarbons, pesticides, and PCBs. Soil samples were also analyzed for dioxins/furans. Elevated concentrations of total petroleum hydrocarbon (TPH-) gasoline and -diesel and associated polynuclear aromatic hydrocarbons (PAHs) were detected in soil samples from 20 borings, and TCE was detected in one sample. Benzene and 1,2-DCA were detected in groundwater at concentrations just above drinking water criteria. It was recommended that the soil be remediated to prevent further contamination of groundwater.
	Engineering Evaluation/Cost Analysis (EE/CA)	1994	The EE/CA provided an evaluation of potential remedial alternatives for soil.
	Action Memorandum	1994	The preferred remedy documented in the Action Memorandum was excavation of contaminated soil followed by stabilization/solidification and disposal at the Box Canyon Landfill.
	Non-time Critical Removal Action, Group A, Site 5	1996	Documented the clean-up activities and results at Site 5, and recommended no further remedial action for the site.
	Final ROD, OU 2	1997	The decision that No Further Action was required for soil and groundwater at Site 5 was documented in the **OU 2 ROD**[15].

Table 1 Previous Studies and Investigations

IR Site	Previous Study / Investigation*	Report Date	Investigation Activities
Site 6	Remedial Investigation Technical Memorandum, Group A	1993	**Site 6**[16] was a former scrap yard, unpaved with buildings, hardscape, and large expanses of paved storage, operated from 1950s to 1979. Soil, sediment, and groundwater samples were collected and analyzed for metals, VOCs, SVOCs, petroleum hydrocarbons, pesticides, and PCBs. Soil and sediment samples exceeded the regulatory limits for chlorinated solvents, PAHs, pesticides, PCBs, and metals in the low-lying area south of the site. Additional sampling was recommended to delineate the contaminated soil. VOCs in groundwater exceeded drinking water criteria, and it was determined to investigate groundwater further as part of the widespread plume suspected in the 22 Area.
	EE/CA	1995	The EE/CA provided an evaluation of potential remedial alternatives to address the low-lying area south of the site.
	Action Memorandum	1996	The preferred remedy was excavation of contaminated soil in the low-lying area south of the site, followed by stabilization/solidification and disposal at the Box Canyon Landfill.
	Remedial Investigation Technical Addendum, Group B	1996	Soil samples were collected and analyzed to define the extent of contamination further in soil in the low-lying area south of the site prior to removal.
	Non-time Critical Removal Action, Group A, Site 6	1997	Documented the clean-up activities and results at Site 6 and recommended no further remedial action for the site.
	Final ROD, OU 2	1997	The decision that No Further Action was required for soil, sediment, and surface water at Site 6 was documented in the **OU 2 ROD**[15].
Site 6A	Remedial Investigation Report, OU 5	2004	**Site 6A**[17] was part of a former paved storage yard that operated from 1950s to 1979. Surface and subsurface soil samples were collected and analyzed for metals and dioxins/furans. Because it was determined that soil contaminants do not pose a potential threat to human health and the environment, no further action was recommended for soil at Site 6A.
	Final Record of Decision, OU 5	2008	The decision that No Further Action was required for soil at Site 6A was documented in the **OU 5 ROD**[18].
Site 16	Remedial Investigation Report, Group C	1996	**Site 16**[19] is a natural drainage ditch that may have received hazardous materials from various Base operations. Soil and groundwater samples were collected and analyzed for metals, VOCs, SVOCs, petroleum hydrocarbons, pesticides, and PCBs. Soil contamination was determined to be non-CERCLA constituents. It was determined to investigate groundwater further as part of the widespread plume suspected in the 22 Area.
	Final Record of Decision, OU 3	1999	The decision that No Further Action was required for soil at Site 16 was documented in the **OU 3 ROD**[20]

Table 1 Previous Studies and Investigations

IR Site	Previous Study / Investigation*	Report Date	Investigation Activities
Site 17	Remedial Investigation Report, Group C	1996	**Site 17**[21] is a natural drainage ditch that may have received hazardous materials from various Base operations. Soil and groundwater samples were collected and analyzed for metals, VOCs, SVOCs, petroleum hydrocarbons, pesticides, and PCBs. Soil contamination was determined to be non-CERCLA constituents. It was determined to investigate groundwater further as part of the widespread plume suspected in the 22 Area.
	FFA Amendment, CERCLA Petroleum Exclusion	1996	Soil investigation moved to UST program.
	Remedial Investigation Report, Group D	1997	Sediment and surface water samples collected at Site 17. Human health and ecological risk assessments determined there were no complete pathways to receptors and no further action was recommended.
	Final Record of Decision, OU 3	1999	The decision that No Further Action was required for sediment and surface water at Site 17 was documented in the **OU 3 ROD**[20]
Site 27	Remedial Investigation Report, Group C	1996	**Site 27**[22] is a natural drainage ditch that may have received hazardous materials from various Base operations. Soil and groundwater samples were collected and analyzed for metals, VOCs, SVOCs, petroleum hydrocarbons, pesticides, and PCBs. Soil contamination was determined to be non-CERCLA constituents. It was determined to investigate groundwater further as part of the widespread plume suspected in the 22 Area. Sediment, surface water, and groundwater samples were collected and analyzed. Sediment samples contained some VOCs, pesticides, and metals. Surface water samples contained some VOCs, total petroleum hydrocarbons as diesel (TPH-diesel), and metals. It was determined to investigate groundwater further as part of the widespread plume suspected in the 22 Area.
	Remedial Investigation Report, Group D	1997	Human health and ecological risk assessments determined there were no complete pathways to receptors and no further action was recommended.
	Final Record of Decision, OU 3	1999	The decision that No Further Action was required for soil at Site 27 was documented in the **OU 3 ROD**[20].
Combined Groundwater Site			
22/23 Area Groundwater	Remedial Investigation and Supplemental Feasibility Study, OU 2	1996	The Remedial Investigation (RI) presented groundwater sampling results and the nature and extent of contamination with data from 1992 through 1996 that included groundwater from Sites 4, 4A, 6, 16, 17, and 27. The Feasibility Study (FS) provided an evaluation of remedial alternatives, including no action, institutional controls, in-well striping with institutional controls, hydraulic control with institutional controls, and pump and treat/reinjection and institutional controls.

Table 1 Previous Studies and Investigations

IR Site	Previous Study / Investigation*	Report Date	Investigation Activities
	Remedial Investigation and Supplemental Feasibility Study, OU 4	1999	The RI updated the nature and extent of groundwater contamination with data through 1998. The FS provided an evaluation of remedial alternatives, including no action, institutional controls, enhanced in situ bioremediation with institutional controls, and localized groundwater extraction with institutional controls.
	Supplemental Feasibility Study, OU 4	2002	The FS updated the nature and extent of groundwater contamination with data through 2001. The FS provided an evaluation of remedial alternatives, including no action, institutional controls with monitored natural attenuation, and plume treatment via air sparging/soil vapor extraction.
	Remedial Investigation and Feasibility Study, 22/23 Area Groundwater	2011	The RI updated nature and extent of groundwater contamination with **data through 2009**[23]. The FS provided an evaluation of remedial alternatives, including no action, institutional controls with groundwater monitoring, alternate water supply, source area treatment via in situ technologies, ex situ wellhead treatment at Base supply well, and ex situ wellhead treatment at Base supply well and reinjection of treated water. Following completion of the FS, the preferred remedy was selected. The preferred remedy is combining an alternate water supply and source area treatment via in situ technologies, both of which include the provisions of land use controls and long-term monitoring.
	Proposed Plan	2011	The Navy invited the public to comment on the proposed cleanup. A public notice was published in the North County Times newspaper and in the online Base newspaper, the Scout, announcing the public meeting and where the Proposed Plan could be obtained or viewed. In addition, the MCB Camp Pendleton IR website announced the public meeting and provided a link to the Proposed Plan.

*The documents listed are available in the **Administrative Record**[1] and provide detailed information used to support the remedy selection at the 22/23 Area Groundwater site.

The nature and extent of contamination was defined by chemical concentrations in groundwater exceeding regulatory guidance. There are five plumes of groundwater contamination consisting of dissolved phase contaminants that have proven to be persistent since groundwater monitoring started in 1992.

- **Area around well 4W-04A:** the COC plume consists of TCE, *cis*-1,2-DCE, 1,1-DCE, and vinyl chloride;
- **Area around well 220205-MWX:** the COC plume is located in the southeast portion of the site and consist primarily of 1,2,3-TCP with 1,2-DCA ;
- **Area around well MM-03:** where vinyl chloride was detected above the MCL;
- **Area around well DMM-7:** the COC plume consists of TCE (below the MCL), *cis*-1,2-DCE, and 1,2,3-TCP; and

- **Area around well 6W-04A/B/C:** in the vicinity of the former Site 6, the COC plume consists of TCE (below the MCL), *cis*-1,2-DCE, 1,1-DCE, and 1,4-dioxane in shallow wells, and 1,2,3-TCP detected in deeper wells (6W-04C and 6W-35B).

The boundaries for the five plume areas are shown on **Figure 6**[24].

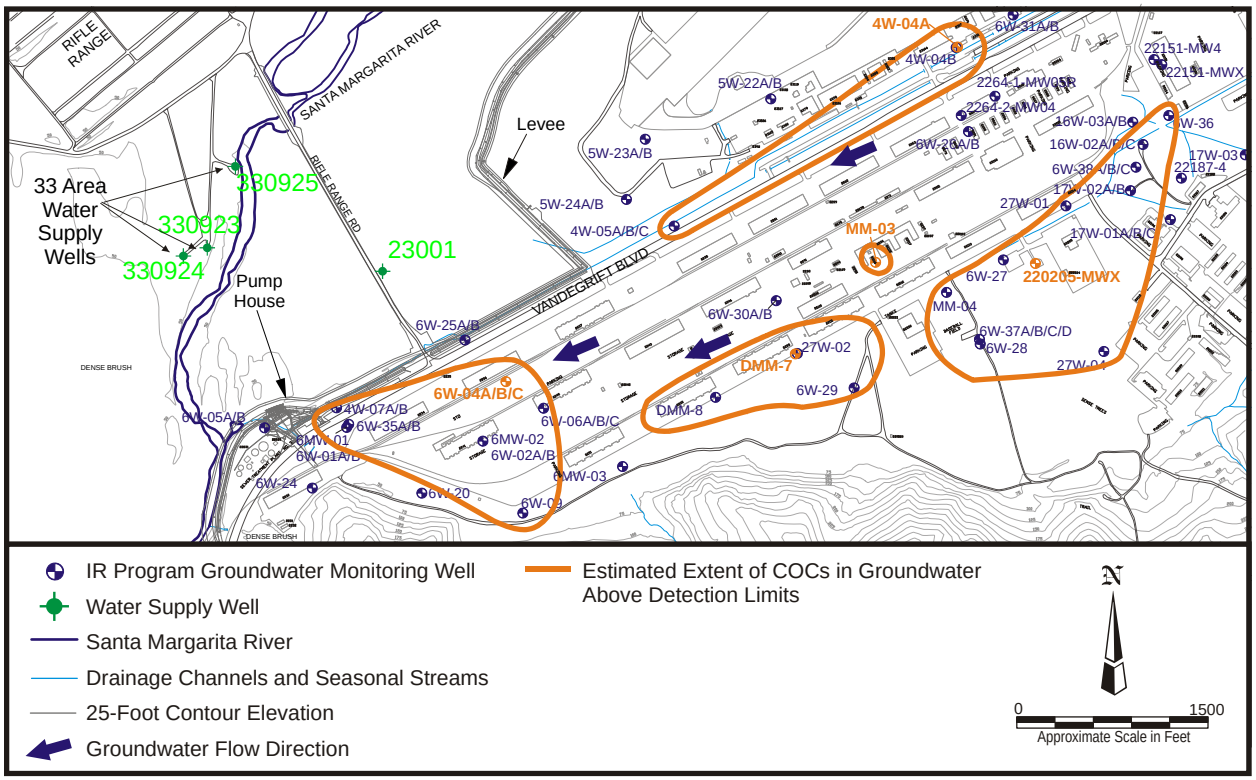

Figure 6 22/23 Area Groundwater Plume Areas

1.4 Current and Potential Future Site and Resource Uses

The 22/23 Area consists mainly of barracks, industrial buildings, an air station complex, and warehouses. Almost all of the site is covered by buildings, asphalt roads, or asphalt parking lots. The future land use will likely remain largely the same with the possible addition of more troop housing. Thus, the current and reasonably foreseeable land use of the 22/23 Area is industrial and residential.

Camp Pendleton is the only amphibious Marine Corps Base on the west coast suitable for combat training on land, sea, and air. It is vitally important to military security and Navy/Marine Corps operational readiness. Because of this, the DON has no plans to close or transfer the Base in the foreseeable future. However, in the unlikely event that the DON may transfer these procedural responsibilities to another party by contract, property transfer agreement, or through other means, the DON shall retain ultimate responsibility for remedy integrity.

The site is located within the Santa Margarita River watershed. The alluvial aquifer underlying the river valley is the primary drinking water source for the southwestern portion of the Base. Eight groundwater water supply wells are located within 6,000 feet of the site. One of these wells (2202) is no longer in service due to detections of 1,2,3-TCP. As noted previously, 1,2,3-TCP was detected above the state notification level but below the response level.

1.5 Summary of Site Risks and Hazards

1.5.1 Human Health Risk Assessment

A quantitative **Human Health Risk Assessment**[25] was completed for the 22/23 Area Groundwater site for exposure to groundwater. Groundwater and soil gas data were used to assess potential exposures to human receptors at the 22/23 Area. The receptors evaluated at the site include hypothetical residents, industrial workers, and construction workers. The human health risk assessment examines two types of negative or adverse health risk: cancer risk and noncancer hazard.

First, cancer risk is expressed in terms of the probability that an individual or a particular group of individuals would have an increased chance of contracting cancer over a lifetime period of 70 years. For example, a risk of 1 in a million means that an exposed person could have an increased likelihood of 1 in a million to develop cancer. If the increased cancer risk posed by a site is greater than 1 in a million, but less than 1 in 10,000, then the site falls within the range that the USEPA refers to as a risk management range, where various factors are taken into consideration to determine if remedial action is necessary. If the site risk is greater than 1 in 10,000, then remedial action is generally warranted at a contaminated site.

Second, noncancer health effects are evaluated in terms of a hazard index (HI) that determines negative health effects caused by specific chemicals. If the HI is above 1, then there is a possibility that there might be negative health concerns caused by the site.

The risk assessment found that chemicals in groundwater represent a potential risk to human health based on possible domestic groundwater use. However, there is no actual significant risk to people drinking the water from this area because the Base only allows water that meets regulatory standards into the drinking water system. If groundwater with the highest contaminant concentrations were consumed by people, the estimated cancer risk to human health is greater than 1 in a million, and greater than 1 in 10,000 near wells 6W-04A, DMM-7, and 220205-MWX. Possible dermal contact with contaminated groundwater, for example, in a trench, also results in risk estimates that exceed 1 in a million.

The cancer risk from potential migration of VOCs from soil gas to indoor air is less than 1 in a million, which indicates that there is no significant risk to indoor air receptors at the site. Much of the calculated risk results from assumed exposures to 1,2,3-TCP. Given the number of wells throughout the state with 1,2,3-TCP detections, the California Department of Public Health believe this chemical should be subject to future regulation (i.e., establishment of a drinking water standard, also known as a maximum contaminant level or MCL).

The estimated risks and hazards for each plume location are summarized in Table 2 below.

Table 2 Human Health Cumulative Risk and Hazard from Groundwater

Plume Location	Receptor	Exposure Pathway	USEPA Toxicity Values		California-Modified Toxicity Values	
			Risk	Hazard Index	Risk	Hazard Index
4W-04A	Resident	Potable Use of Groundwater[1]	2×10^{-5}	0.2	9×10^{-6}	0.2
		Vapor Intrusion[2] from Soil Gas	4×10^{-7}	0.3	1×10^{-6}	0.02
		Vapor Intrusion[2] from Groundwater	2×10^{-6}	0.01	5×10^{-6}	0.02
	Industrial Worker	Vapor Intrusion[2] from Soil Gas	4×10^{-8}	0.03	1×10^{-7}	0.002
		Vapor Intrusion[2] from Groundwater	2×10^{-7}	0.002	5×10^{-7}	0.002

Table 2 Human Health Cumulative Risk and Hazard from Groundwater

Plume Location	Receptor	Exposure Pathway	USEPA Toxicity Values		California-Modified Toxicity Values	
			Risk	Hazard Index	Risk	Hazard Index
4W-04A (continued)	Construction Worker	Groundwater[3]	4×10^{-8}	0.004	4×10^{-8}	0.004
220205-MWX	Resident	Potable Use of Groundwater[1]	5×10^{-3}	0.9	5×10^{-3}	0.8
		Vapor Intrusion[2] from Soil Gas	3×10^{-7}	0.02	3×10^{-7}	0.005
		Vapor Intrusion[2] from Groundwater	6×10^{-7}	0.06	5×10^{-5}	0.06
	Industrial Worker	Vapor Intrusion[2] from Soil Gas	3×10^{-8}	0.003	3×10^{-8}	0.0006
		Vapor Intrusion[2] from Groundwater	6×10^{-8}	0.007	5×10^{-6}	0.007
	Construction Worker	Groundwater[3]	6×10^{-6}	0.01	5×10^{-6}	0.01
MM-03	Resident	Potable Use of Groundwater[1]	3×10^{-5}	0.03	6×10^{-6}	0.03
		Vapor Intrusion[2] from Soil Gas	1×10^{-7}	0.06	2×10^{-7}	0.005
		Vapor Intrusion[2] from Groundwater	9×10^{-7}	0.002	8×10^{-6}	0.002
	Industrial Worker	Vapor Intrusion[2] from Soil Gas	1×10^{-8}	0.007	2×10^{-8}	0.0005
		Vapor Intrusion[2] from Groundwater	4×10^{-8}	0.0003	8×10^{-7}	0.0003
	Construction Worker	Groundwater[3]	1×10^{-8}	0.0003	5×10^{-9}	0.0003
DMM-7	Resident	Potable Use of Groundwater[1]	1×10^{-3}	0.2	1×10^{-3}	0.2
		Vapor Intrusion[2] from Soil Gas	4×10^{-8}	0.002	1×10^{-7}	0.001
		Vapor Intrusion[2] from Groundwater	6×10^{-8}	0.02	1×10^{-5}	0.02
	Industrial Worker	Vapor Intrusion[2] from Soil Gas	4×10^{-9}	0.0002	1×10^{-8}	0.0001
		Vapor Intrusion[2] from Groundwater	6×10^{-9}	0.002	1×10^{-6}	0.002
	Construction Worker	Groundwater[3]	1×10^{-6}	0.004	1×10^{-6}	0.004
6W-04A/B/C	Resident	Potable Use of Groundwater[1]	2×10^{-3}	0.5	2×10^{-3}	0.5
		Vapor Intrusion[2] from Soil Gas	1×10^{-7}	0.004	3×10^{-7}	0.003
		Vapor Intrusion[2] from Groundwater	1×10^{-6}	0.04	3×10^{-5}	0.06
	Industrial Worker	Vapor Intrusion[2] from Soil Gas	1×10^{-8}	0.0005	3×10^{-8}	0.0004
		Vapor Intrusion[2] from Groundwater	6×10^{-8}	0.004	3×10^{-6}	0.007
	Construction Worker	Groundwater[3]	3×10^{-6}	0.008	2×10^{-6}	0.008
Water Supply Well 2202	Resident	Potable Use of Groundwater[1]	4×10^{-5}	0.006	3×10^{-5}	0.006

Potential unacceptable risks are shaded in yellow and risks that exceed the risk management range are shaded in pink.

1 - Potable Use of Groundwater includes dermal contact during showering/bathing, drinking water ingestion, and inhalation during showering.

2 - Vapor Intrusion includes inhalation of volatiles that have migrated to indoor air from soil gas/groundwater via vapor intrusion.

3 - Groundwater includes dermal contact with groundwater, inhalation of volatiles in trench air, and inhalation of volatiles in outdoor air.

1.5.2 Ecological Risk Assessment

The additional groundwater data collected at the 22/23 Area during recent sampling events (2001, 2003, 2007, and 2008) do not alter the results of the previous **Ecological Risk Assessment**[26] conducted by the Navy (1993a, 1996c, and 1997b). The ecological risk is evaluated to determine the potential for negative effects on plants and animals from exposure to site contaminants. Plants and animals are identified that represent the types found at each specific site. Coordination between the Base and regulatory agency staff ensures that any action agrees with the Base's mission and with agency requirements. For example, special-status species ("endangered species") occur near the site, and coordination with the US Fish and Wildlife Service would be appropriate to ensure protection of those species during any remedial action.

Exposure of ecological receptors to chemicals in groundwater was addressed by evaluating surface water (i.e., drainage ditches) where contaminated groundwater may discharge and by testing shallow soil and sediment. Risks to ecological receptors at the 22/23 Area from reported groundwater contamination were determined to be low to negligible.

1.5.3 Basis for Response Action

Because potential human health risks were identified under current land use scenarios from exposure to 1,2-DCA, 1,4-dioxane, TCE, 1,2,3-TCP, and vinyl chloride in groundwater, a response action is necessary to protect public health and welfare from actual or threatened releases.

1.6 Principal Threat Waste

Although a remedial response action is necessary, there are no wastes at 22/23 Area Site that constitute a "principal threat." Per the USEPA **Guide to Principal Threat and Low Level Threat Wastes**[27], a principal threat waste is a source material that is 1) highly toxic and/or highly mobile; 2) generally cannot be reliably contained; and 3) could present substantial threat to human health or the environment if released. For example, liquids in drums, lagoons, or tanks; free product non-aqueous phase liquids over or under groundwater; surface soil with high concentrations of volatiles or dust-associated chemicals of concern; or highly toxic, non-liquid wastes in buried drums or tanks or in soil at high concentrations. Historical records do not indicate the disposal of hazardous or highly toxic source materials at the site. The remaining soil at the site does not pose unacceptable risk as documented in previous RODs. The concentrations of chemicals of concern in groundwater do not indicate an on-going source in groundwater. Therefore, there are no known wastes constituting principal threats at the 22/23 Area Groundwater site.

1.7 Remedial Action Objectives

USEPA defines remedial action objectives as medium-specific (e.g., soil or groundwater specific) goals for protecting human health and the environment. Remedial action objectives serve to focus the remedy selection process and provide context for the overall scope of potential clean-up activities at a site; therefore, they guide the development and assessment of suitable remedial alternatives.

Remedial action objectives are based on the chemicals of concern, the impacted media, fate and transport of those chemicals of concern, the exposure routes, and the potential receptors identified in the conceptual site model. Remedial action objectives provide a clear and concise description of what the remedial action should accomplish at a given site. The following remedial action objectives were developed for the 22/23 Area Groundwater contamination to address the protection of human health and the environment:

- Prevent ingestion, dermal contact, and inhalation of contaminated groundwater containing COCs at concentrations in excess of cleanup levels.
- Preserve and protect the watershed of the lower Santa Margarita River Basin.

Remedial goals were developed to meet these remedial action objectives and are presented in Table 3. The RGs in groundwater are designed to be protective of human health. They were developed by choosing the more stringent of the Federal and State MCLs for the six compounds having MCLs. For 1,4-dioxane, the RG corresponds to a hypothetical risk of 1 x 10^{-5} , and is below the California response level. For 1,2,3-TCP, the RG also corresponds to a hypothetical risk of 1 x 10^{-5}, and is also below the response level. The plume boundaries shown on **Figure 7**[28] illustrate COCs above these remedial goals.

Table 3 Groundwater Remedial Goals and Sources for Unrestricted Land Use

Chemical of Concern	Maximum Detected Conc.	Federal MCL	CA MCL	CA RL	Final RG
Volatile Organic Compounds (µg/L)					
1,1-Dichloroethene	11	7	6	-	6
1,2-Dichloroethane	8.5	5	0.5	-	0.5
1,2,3-Trichloropropane	10	-	-	0.5	0.0065
1,4-Dioxane	41	-	-	35	6.7
cis-1,2-Dichloroethene	23	70	6	-	6
Trichloroethene	35	5	5	-	5
Vinyl chloride	1.5	2	0.5	-	0.5

- = Indicates chemical has no regulatory limit in that category
MCL = Maximum Contaminant Level, Federal or California
CA RL = California Response Level
CA NL = California Notification Level
RG = Remedial Goal

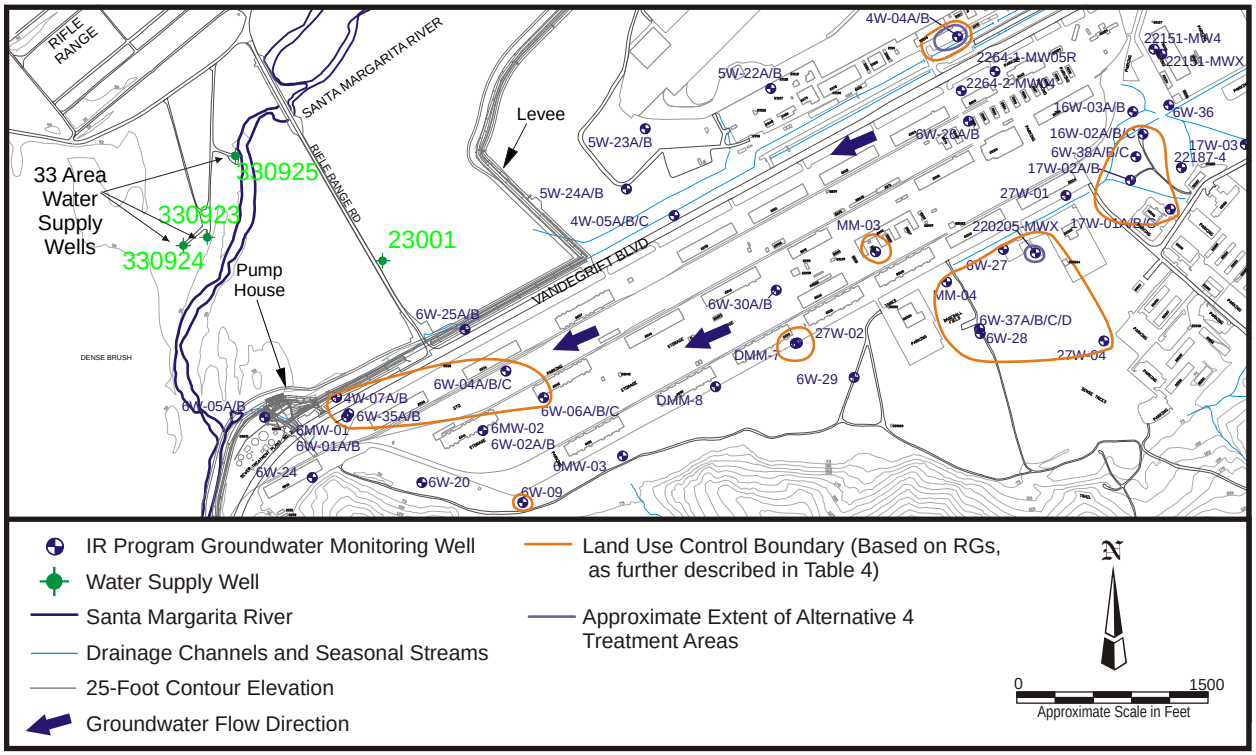

Figure 7 22/23 Area Groundwater Plume Areas Above Remedial Goals

1.8 Description and Evaluation of Remedial Alternatives

To address groundwater contamination at 22/23 Area, a **screening and evaluation of remedial technologies**[29] was completed to refine the remedy selection process. Six groundwater remedial approaches were retained as preliminary process options and were evaluated with respect to implementability, effectiveness, and relative cost (high/moderate/low). All of these were incorporated into the six remedial alternatives for groundwater that were retained for a detailed comparative analysis in accordance with the **National Contingency Plan (NCP)**[30] criteria.

1.8.1 Description of Remedial Alternatives

The six remedial alternatives identified for groundwater at 22/23 Area are presented below in Table 4.

Table 4 Remedial Alternatives for 22/23 Area Groundwater

Alternative	Components	Description	Cost
1 No Action	- Existing groundwater	- The NCP (40 Code of Federal Regulations 300.430[e][6]) requires that a no action alternative be evaluated. Under this option, groundwater is left in place and nothing is done to clean up the contamination, prevent use, or limit contaminant movement.	- $0
2 Land Use Controls and Long Term Monitoring	- Land use controls	- The areas where land use controls would be applied are shown on **Figure 7**[28]. The plume contours define the currently estimated extent of land use controls, but the extent may decrease or increase over time based on long-term groundwater monitoring results. The purpose of the land use controls is to prohibit access or use of the contaminated groundwater and prevent interference with site remediation activities, until remedial goals are met. Land use controls would prohibit installation of a drinking water well or any potential construction activities (including schools, offices, housing, etc.) at these specific locations unless specific approval is given through MCB Camp Pendleton's site approval process, which is required for all projects at the Base involving construction, acquisition, or modification. The site approval process can result in actions such as prohibiting a planned well installation or other activity that would result in exposure of residents or workers to groundwater with chemicals at concentrations exceeding the remedial goals. In the event that construction workers may be potentially exposed to chemical concentrations exceeding remedial goals, appropriate safety procedures would be required for the construction project. Land use controls would also include protecting monitoring wells and associated equipment while they are being used for the remedial action. The Navy is responsible for implementing, maintaining, reporting on, and enforcing land use controls. Land use controls would continue until the concentrations of hazardous substances in the groundwater are at such levels to allow for unrestricted use and unrestricted exposure levels.	- Capital Cost: $205,000 - O&M Cost: $3,938,000 - **Total Cost: $4,143,000**[31] - Timeframe: 30 years

Table 4 Remedial Alternatives for 22/23 Area Groundwater

Alternative	Components	Description	Cost
2 Land Use Controls and Long Term Monitoring (Continued)	- Long-term groundwater monitoring	- Conduct a long-term groundwater monitoring program to track chemical concentrations and possible movement, provide early warning of potential impacts to downgradient receptors, and evaluate the attenuation of contamination in and downgradient of the COC plumes. A selected network of groundwater monitoring wells would be sampled to allow a periodic assessment of the groundwater quality, facilitate plume tracking, and permit a periodic evaluation of the need for additional actions. Monitoring would continue until remedial goals are met or it can be demonstrated that the site no longer poses a risk to receptors.	-
3 Alternate Water Supply with Alternative 2	- Design study to evaluate best location for new well - Install new well - Land use controls - Long-term groundwater monitoring	- Conduct a detailed hydrogeologic investigation of the Chappo subbasin to identify specific water-bearing zones and/or geographic areas of the subbasin that would be best suited for placement of a new well that would not be impacted by contamination for many years. In addition, the new well will need to meet Base requirements with respect to water rights, environmental constraints, and connection to Base infrastructure. - Install a replacement water supply well to provide an alternate supply of drinking water. - Implement land use controls and long-term groundwater monitoring of Alternative 2.	- Capital Cost: $4,016,000 - O&M Cost: $0 - Alternative 2 Cost: $4,143,000 - **Total Cost: $8,159,000**[32] - Timeframe: 30 years
4 Source Area Treatment via In Situ Technologies with Alternative 2	- In situ groundwater treatment - Land use controls	- Install and operate in situ remediation systems to destroy contaminant mass in two of the source areas within the 22/23 Area. ▪ Alternative 4A is in situ treatment using zero-valent iron or zero-valent zinc. This technology uses reactive metals (i.e., iron or zinc) injected into the aquifer for chemical reduction of contaminants. This technology will be applied at the plume area around well 220205-MWX (Figure 7) to treat contaminants in groundwater, consisting primarily of 1,2,3-TCP. The 5 µg/L contour line was chosen as the treatment area for 1,2,3-TCP because at lower concentrations the application of reactive metals can be less effective. This is because the contaminants need to come in direct contact with the metal, and at low concentrations, it would be more difficult to ensure that reactive metals distribution would be sufficient to have adequate contact with the limited 1,2,3-TCP molecules available. A design study will be conducted first to evaluate the effectiveness of this technology and to refine the full-scale remedy implementation.	- 4A Capital Cost: $2,487,000 - O&M Cost: $2,881,000 - **Total Cost: $5,368,000**[33]

Table 4 Remedial Alternatives for 22/23 Area Groundwater

Alternative	Components	Description	Cost
4 Source Area Treatment via In Situ Technologies with Alternative 2 (Continued)	- In situ groundwater treatment - Land use controls - Long-term groundwater monitoring	▪ Alternative 4B is in situ enhanced bioremediation. In situ groundwater bioremediation is a technology that encourages growth and reproduction of indigenous microorganisms to enhance biodegradation of organic constituents in the saturated zone. This technology will be applied at the plume area around well 4W-04A (Figure 7) to treat contaminants in groundwater, consisting primarily of TCE. The 20 µg/L TCE contour was chosen as the treatment area because the remedial technology is less effective at low TCE concentrations (less than 20 µg/L). This is due to the inability of dechlorinating microbial populations to compete with other non-dechlorinating microbes in areas where TCE concentrations are too low. A design study will be conducted first to evaluate the effectiveness of this technology and to refine the full-scale remedy implementation. - Implement land use controls and long-term groundwater monitoring previously discussed for Alternative 2. The timeframe for long-term monitoring in close proximity to the treated source areas may be reduced as a result of the in situ treatment. However, the rest of the site would still need to be monitored until remedial goals are met or it can be demonstrated that the site no longer poses a risk to receptors.	- 4B Capital Cost: $1,694,000 - O&M Cost: $2,974,000 - **Total Cost: $4,668,000**[34] - Alternative 2 Cost: $4,143,000 - Total Cost of 2, 4A, and 4B: $14,179,000 - Timeframe: 30 years
5 Ex Situ Wellhead Treatment at Base Supply Well with Alternative 2	- Treat groundwater - Land use controls - Long-term groundwater monitoring	- Extract and treat groundwater using liquid phase activated carbon adsorption from an existing Base supply well for use as drinking water. - Implement land use controls and long-term groundwater monitoring previously discussed for Alternative 2.	- Capital Cost: $2,407,000 - O&M Cost: $10,639,000 - Alternative 2 Cost: $4,143,000 - **Total Cost: $17,189,000**[35] - Timeframe: 30 years
6 Ex Situ Wellhead Treatment at Base Supply Well and Reinjection of Treated Water with Alternative 2	- Treat groundwater - Inject treated groundwater - Land use controls - Long-term groundwater monitoring	- Extract and treat groundwater using liquid phase activated carbon adsorption from an existing Base supply well - Inject treated groundwater into aquifer upgradient of supply wells. - Implement land use controls and long-term groundwater monitoring previously discussed for Alternative 2.	- Capital Cost: $6,747,000 - O&M Cost: $11,654,000 - Alternative 2 Cost: $4,143,000 - **Total Cost: $22,544,000**[36] - Timeframe: 30 years

Table 4 Remedial Alternatives for 22/23 Area Groundwater

Alternative	Components	Description	Cost
Combined Alternatives 2, 3, and 4	- Land use controls - Long-term groundwater monitoring - Design study to evaluate best location for new well - Install new well - In situ groundwater treatment	- Implement land use controls as described under Alternative 2, to restrict future access to the groundwater in the immediate vicinity of the site where chemicals in groundwater may be present above regulatory thresholds. Land use controls would continue until remedial goals are met or it can be demonstrated that the site no longer poses a risk to receptors. - Conduct a long-term groundwater monitoring program as described under Alternative 2, to track chemical concentrations and possible movement, provide early warning of potential impacts to downgradient receptors, and evaluate the attenuation of contamination in and downgradient of the COC plumes. Monitoring would continue until remedial goals are met or it can be demonstrated that the site no longer poses a risk to receptors. - Conduct a detailed hydrogeologic investigation of the Chappo subbasin as described under Alternative 3, to identify specific water-bearing zones and/or geographic areas of the subbasin that would be best suited for placement of a new well that would not be impacted by contamination for many years. In addition, the new well will need to meet Base requirements with respect to water rights, environmental constraints, and connection to Base infrastructure. - Install a replacement water supply well as described under Alternative 3, to provide an alternate supply of drinking water. - Install and operate in situ remediation systems as described under Alternative 4, to destroy contaminant mass in two of the source areas within the 22/23 Area.	- Alternative 2 Capital Cost: $205,000 - Alternative 3 Capital Cost: $4,016,000 - Alternative 4A Capital Cost: $2,487,000 - Alternative 4B Capital Cost: $1,694,000 - **Total Capital Cost: $8,402,000** - Alternative 2 O&M Cost: $3,938,000 - Alternative 3 O&M Cost: $0 - Alternative 4A O&M Cost: $2,881,000 - Alternative 4B O&M Cost: $2,974,000 - **Total O&M Cost: $9,793,000** - **Total Cost: $18,195,000** - Timeframe: 30 years

1.8.2 Comparative Analysis of Alternatives

A **comprehensive analysis of each alternative**[37] with respect to the NCP threshold and balancing criteria is presented in the Final 22/23 Area Groundwater RI/FS. The results of the comparative analysis are summarized below in Table 5 and in the discussion following the table.

Table 5 Summary of Comparative Analysis for 22/23 Area

Criteria	Alternative						
	1 No Action	2 Land Use Controls and Long-Term Monitoring	3 Alternate Water Supply with Alternative 2	4 Source Area Treatment via In Situ Technologies with Alternative 2	5 Ex Situ Wellhead Treatment at Base Supply Well with Alternative 2	6 Ex Situ Wellhead Treatment at Base Supply Well and Reinjection of Treated Water with Alternative 2	Combined Alternatives 2, 3, and 4
Threshold Criteria							
Overall Protection of Human Health and the Environment	No	Yes	Yes	Yes	Yes	Yes	Yes
Compliance with ARARs	No	Yes	Yes	Yes	Yes	Yes	Yes
Balancing Criteria							
Long-Term Effectiveness and Permanence	○	◑	◑ to ●	◑ to ●	◑ to ●	◑ to ●	◑ to ●
Reduction of Toxicity, Mobility, or Volume by Treatment	○	○	○	◑ to ●	○ to ◑	◑	◑ to ●
Short-Term Effectiveness	Not Applicable	●	◑ to ●	◑ to ●	◑ to ●	◑ to ●	◑ to ●
Implementability	Not Applicable	●	◑ to ●	◑	◑	○ to ◑	◑ to ●
Cost ($ millions)	0	4.1	8.2	14.2	17.2	22.5	18.2
Modifying Criteria							
State Acceptance	NR	NR	NR	NR	NR	NR	●
Community Acceptance	NR	NR	NR	NR	NR	NR	C

○ Low ◑ Moderate ● High NR = Not Rated

C = Comments received on proposed plan or during the public meeting and addressed in the Appendix B.

1.8.2.1 Threshold Criteria

Overall Protection of Human Health and the Environment addresses whether each alternative provides adequate protection of human health and the environment and describes how risks posed are eliminated, reduced, or controlled by each alternative. At the 22/23 Area Groundwater site, long-term risk may be reduced as the chemical concentrations naturally attenuate over a very long period of time. As discussed in Section 1.4.2, risks to ecological receptors at the site were determined to be low to negligible; therefore, all of the alternatives are

considered protective of the environment. Alternative 1 is not considered protective of human health because it would not implement any measures to limit potential exposure or monitor the effectiveness of the remedial action. Alternatives 2, 3, 4, 5, and 6 are considered to be protective of human health through continued enforcement of land use restrictions to prevent exposure and long-term groundwater monitoring to evaluate groundwater conditions. Alternative 3 would also protect human health by providing an alternative water supply for domestic use that is not impacted by COCs. Alternative 4 would also protect human health by destroying the chemical mass present in the TCE and 1,2,3-TCP source areas via in situ treatment of the plumes, thereby accelerating plume attenuation. Alternatives 5 and 6 would protect human health by continuously removing the chemical mass from the groundwater via ex situ treatment.

Compliance with Applicable or Relevant and Appropriate Requirements (ARARs) include any federal or state laws and regulations that are applicable or relevant and appropriate to a CERCLA action. A complete discussion of **ARARs**[38] for the selected remedy is presented in Appendix A. Alternative 1 would not meet ARARs because chemical concentrations detected in the groundwater exceed MCLs. Alternative 2 would comply with ARARs, and remedial goals would be attained in groundwater through natural attenuation processes over a very long period of time. Alternative 3 would comply with ARARs by providing an alternate water supply to limit exposure, and achieving remedial goals through natural attenuation. Alternative 4 would comply with ARARs and remedial goals would be attained through chemical mass removal in the source areas via in situ technologies and natural attenuation in the dilute plumes. Alternatives 5 and 6 would comply with ARARs, and remedial goals would be attained through chemical mass removal via ex situ treatment.

1.8.2.2 Primary Balancing Criteria

Long-Term Effectiveness and Permanence is evaluated with respect to the magnitude of residual risk and the adequacy and reliability of controls used to manage the untreated groundwater over the long term. Alternative 1 does not limit long-term exposure and provides no reliable or adequate controls; therefore, this criterion is rated low for this alternative.

Alternative 2 is dependent on continued enforcement of use restrictions to limit exposure to contaminated groundwater and monitoring to evaluate the effectiveness of natural attenuation processes acting on the groundwater contamination. Long-term risk may be reduced as the chemical concentrations naturally attenuate over a very long period of time, and reviews will be required every 5 years until remedial goals are met, or it can be demonstrated that the site no longer poses a risk to receptors. No actions are taken to reduce contamination or provide clean groundwater to receptors with Alternative 2. Therefore, long-term effectiveness and permanence is rated moderate.

Alternative 3 relies on the new alternate water supply well remaining free of contamination over the life span of the well. The investigation component of this alternative will be used to identify specific water-bearing zones and/or geographic areas of the subbasin that would be best suited for a new well that would remain free of contamination. However, no actions are taken to reduce contamination. This alternative would also provide additional long-term effectiveness through the land use controls as described in Alternative 2. Therefore, long-term effectiveness and permanence is rated moderate to high.

Alternative 4 reduces the long-term risk to receptors through the direct treatment of COCs in groundwater via in situ technologies. Active mass removal would also ensure that a continuing source of dissolved chemicals is mitigated, thereby enhancing the permanence of this remedial alternative. However, no actions are taken to provide clean groundwater to receptors in the long-term. Alternative 4 also provides some additional long-term effectiveness by accelerating

remediation periods and providing appropriate land use controls as described in Alternative 2. Therefore, long-term effectiveness and permanence is rated moderate to high.

Alternative 5 reduces the long-term risk to receptors through ex situ treatment using an activated carbon adsorption system to remove the chemical mass from the groundwater. However, groundwater would be treated at an existing supply well, but higher COC concentrations in the source areas would remain. This alternative would also provide additional long-term effectiveness through the land use controls as described in Alternative 2. Therefore, long-term effectiveness and permanence is rated moderate to high.

Alternative 6 reduces the long-term risk to receptors through ex situ treatment of the water from an existing Base supply well and creating a hydraulic barrier to protect other Base wells. Monitoring of plume migration and carbon adsorption effluent water quality will limit the potential for human exposure and risks. While this would protect existing groundwater wells, higher COC concentrations in groundwater in the source areas would remain. This alternative would also provide additional long-term effectiveness through the land use controls as described in Alternative 2. Therefore, long-term effectiveness and permanence is rated moderate to high.

Combining Alternatives 2, 3, and 4 reduces the long-term risk to receptors through the direct treatment of COCs in groundwater and by providing clean groundwater to receptors with a new well. Active mass removal would also ensure that a continuing source of dissolved chemicals is mitigated, thereby enhancing the permanence of this remedial alternative. However, groundwater contamination in untreated areas is likely to remain for a very long time. Therefore, long-term effectiveness and permanence is rated moderate to high.

Reduction of Mobility, Toxicity, or Volume through Treatment refers to the anticipated performance of treatment technologies that are included as part of the alternative. There is no reduction of toxicity, mobility, or volume through active treatment of groundwater for Alternatives 1, 2, and 3. However, remediation via natural attenuation is expected to reduce groundwater chemical levels to the proposed remedial goals over a very long period of time. In addition, Alternatives 1, 2, and 3 do not satisfy the statutory preference for treatment. Therefore, Alternatives 1, 2, and 3 are rated low for this criterion.

The in situ technologies proposed for Alternative 4 would steadily reduce the chemical mass and the volume of contaminated groundwater as treatment proceeds. The first stage of Alternatives 4A and 4B consists of the use of design studies to test and refine the in situ remedies for the two groundwater source areas (near 220205-MWX and 4W-04A), prior to full-scale remedy implementation. Active mass removal would also ensure that a continuing source of dissolved chemicals is mitigated, thereby enhancing the mass removal of this remedial alternative. In addition, Alternative 4 satisfies the statutory preference for treatment. Therefore, Alternative 4 is rated moderate to high for reduction of mobility, toxicity, or volume through treatment.

Alternatives 5 and 6 satisfy the statutory preference for treatment, but only ex situ treatment at one supply well is included, and source area contamination is not addressed. Therefore, Alternative 5 is rated low to moderate. Alternative 6 provides some additional reduction of toxicity because the activated carbon adsorption system and reinjection of clean water back into the aquifer would steadily reduce small amounts of contamination and the volume of contaminated groundwater requiring remediation as treatment proceeds. Therefore, Alternative 6 is rated moderate.

The combined Alternatives 2, 3, and 4 is rated moderate to high because the in situ technologies proposed for Alternative 4 would steadily reduce the chemical mass and the

volume of contaminated groundwater as treatment proceeds. This combined remedy also satisfies the statutory preference for treatment.

Short-Term Effectiveness addresses any adverse impacts to workers, the community, and the environment during the period of time needed to implement the remedy. Short-term effectiveness is not applicable for Alternative 1 because no actions would be taken. Alternatives 2, 3, 4, 5, and 6 pose potential short-term risks to site workers associated with dust emissions and direct contact with contaminated groundwater during implementation. Potential exposure and protection procedures for workers would be addressed in a site health and safety plan to reduce these risks. Alternatives 2, 3, 4, 5, and 6 all include the implementation of land use controls to protect the community by preventing use and contact with contaminated groundwater. The implementation of Alternatives 2, 3, 4, 5, and 6 is not expected to result in any adverse environmental impacts because areas disturbed by would be restored upon completion of the field activities. In addition, environmental imparts would be mitigated by using green and sustainable remediation technologies whenever technically feasible to reduce air emissions and energy consumption.

Short-term effectiveness is ranked high for Alternative 2 because field activities are minimal, limited to well installation and groundwater monitoring. Short-term effectiveness is rated moderate to high for Alternatives 3, 4, 5, and 6 because they include more field activities and pose some additional risk to workers and the environment during implementation and operation and maintenance (O&M). The combination of Alternatives 2, 3, and 4 is also rated moderate to high because of field activities that could affect workers and the environment.

Implementability addresses the technical and administrative feasibility of a remedy through design, construction, and O&M. This criterion is not applicable to Alternative 1 because no actions or controls would be implemented. Alternative 2 includes an administrative process that can be readily implemented because the Base already uses a similar process for all planned construction and land use. In addition, the technology for long term groundwater monitoring is proven and available, and equipment and personnel are readily available. Therefore, this alternative is considered readily implementable, and ranks high for implementability. The activities associated with Alternative 3 include common techniques, and equipment and personnel are readily available; however, the well investigation and installation will be conducted in a heavily vegetated floodplain where access and drilling may be difficult. Therefore, it is ranked moderate to high for implementability. While equipment and personnel are readily available to implement Alternative 4, design studies are needed to test and refine the in situ remedies for the two groundwater source areas (near 220205-MWX and 4W-04A), prior to full-scale remedy implementation. Therefore, Alternative 4 is rated moderate. Although the carbon adsorption system of Alternatives 5 and 6 involves common, proven, and reliable methods and practices, some effort is required to design the treatment system, conduct design testing, and water monitoring. Treatment activities would also require coordination with the Base Office of Water Resources Department. This alternative also requires periodic carbon change out, which requires continuous monitoring and logistics of routine maintenance. Therefore, Alternative 5 is rated moderate. Alternative 6 involves all the same processes and logistics of Alternative 5, but includes additional challenges of drilling and installing an injection well and installing underground piping in a floodplain. Therefore, Alternative 6 is rated low to moderate. The combination of Alternatives 2, 3, and 4 is rated moderate to high because of the issues discussed above for Alternatives 3 and 4.

Cost. No cost is associated with Alternative 1. Alternative 2 would be less expensive than Alternatives 3, 4, 5 or 6, with an estimated cost of approximately $4,143,000 over 30 years. Alternatives 3, 4, 5, and 6 are progressively more expensive, with estimated costs of

approximately $8,159,000, $14,179,000, $17,189,000, and $22,544,000, respectively. The combination of Alternatives 2, 3, and 4 is $18,195,000.

1.8.2.3 Modifying Criteria

State Acceptance. Regulatory involvement has been solicited throughout the CERCLA process. The USEPA and the State of California (the DTSC and the RWQCB) provided in depth review of each of the documents pertaining to the site, including draft and final versions of the Remedial Investigation, the Feasibility Study, and the Proposed Plan. Their input was incorporated into the documents, and their concurrence was obtained before proceeding to each next step in the process. The possible remedies were discussed extensively with the regulatory agencies at periodic meetings in accordance with the Federal Facilities Agreement. The USEPA and the State of California concur with the selected remedy. Therefore, the selected remedy meets this modifying criterion.

Community Acceptance. The proposed plan was issued for public review July 26 to August 26, 2011 and was discussed at a public meeting on August 8, 2011, as discussed in Section 2. No members of the public attended the public meeting. One comment was received from a member of the public, although the comment did not specifically discuss concerns with the proposed remedies outlined for this site. The response to that comment is provided in Appendix B. Because no objections were raised by the public regarding the planned remedy for the site, the selected remedy meets this modifying criterion.

1.9 Selected Remedy

1.9.1 Rationale for Remedy Selection

The selected remedy for 22/23 Area Groundwater site consists of Alternatives 2, 3, and 4, which includes providing an alternate water supply by installation a new supply well, and also in situ treatment of the most contaminated zones of groundwater. In addition, this remedy uses land use controls and long-term monitoring to prevent people from being exposed to groundwater with chemicals above cleanup levels. This remedy was selected because these elements best met the objectives of protecting human health and the environment, and actively reducing contamination in the aquifer. This remedy is more effective than any of these elements on their own, and is the only remedy determined to meet the requirements of the Base, the regulatory agencies, and the Navy.

1.9.2 Description of Selected Remedy

The selected remedy for 22/23 Area Groundwater consists of several components, specifically those described in Alternatives 2, 3, and 4. A description of each of these components is provided below.

One component of the selected remedy consists of developing an alternate supply of water (Alternative 3) to current users of the existing supply wells by installing a new (replacement) water supply well in an area of uncontaminated groundwater within the Chappo subbasin. This alternative would replace Base supply well 2202 that was permanently taken out of service due to concerns over 1,2,3-TCP detections. A new well would be installed in an unimpacted zone of the aquifer to avoid the added cost of wellhead treatment. In addition, the well would be sited with the intention of remaining unimpacted by contamination for the life of the well. This portion of the remedy is consistent with MCB Camp Pendleton's Strategic Water Plan objective of meeting the water supply needs of the Base.

A second component of the selected remedy is the in situ treatment of site groundwater where the highest concentrations of chemicals of concern are present. This component (Alternative 4, Source Area Treatment via In Situ Technologies) involves the installation and operation of in

situ remediation systems to remove contaminant mass in the two source areas identified within the 22/23 Area. Alternative 4A involves in situ remediation using zero-valent iron (ZVI) or zero-valent zinc (ZVZ) and Alternative 4B involves enhanced in situ bioremediation. Alternative 4A will be implemented as an in situ remediation by injecting ZVI or ZVZ to chemically degrade 1,2,3-TCP. Alternative 4A will be applied at the plume area around well 220205-MWX to treat contaminants in groundwater, consisting primarily of 1,2,3-TCP. Prior to full scale implementation, a design study using ZVZ will be conducted to evaluate the effectiveness of this technology and to refine the full-scale remedy implementation. If in situ treatment using ZVZ is found to be ineffective, the design study will be modified to evaluate in situ treatment by ZVI. Alternative 4B will be implemented using enhanced bioremediation by injecting substrates to enhance microbial growth capable of degrading TCE. Alternative 4B will be applied at the plume area around well 4W-04A to treat contaminants in groundwater, consisting primarily of TCE. Prior to full scale implementation, a design study will be conducted using enhanced bioremediation to evaluate the effectiveness of this technology and to refine the full-scale remedy implementation.

The above components include the use of land use controls and a long-term groundwater monitoring program, as described in Alternative 2. Land use controls would ensure that restrictions are placed on the use of groundwater in the areas shown on Figure 7. The land use control restriction prohibits access to the contaminated groundwater until the levels are below the Remedial Goals agreed to in this ROD. The Department of the Navy (DON) will meet the land use controls by assuring that no projects are constructed without going through the MCB Camp Pendleton Site Approval Process. Land use controls would specifically be applied to the areas where COCs in groundwater are above MCLs or Response Levels (RLs) as shown on Figure 7. Land use controls would also include protecting monitoring wells and associated equipment while they are being used for the remedial action. The long-term groundwater monitoring program would be used to track chemical concentrations and possible movement, provide early warning of potential impacts to downgradient receptors, and evaluate the attenuation of contamination in and downgradient of the COC plumes.

A Land Use Control Implementation Plan will be prepared as the land use component of the remedial design. Within 90 days of ROD signature, the DON shall prepare and submit to USEPA for review and approval a land use control remedial design that shall contain implementation and maintenance actions, including periodic inspections.

1.9.3 Estimated Outcomes of the Selected Remedy

Once the selected remedy has been implemented, there will be no significant risk to human health or the environment since there will be no complete exposure pathway to potential receptors. Current non-residential land use is expected to continue for the foreseeable future. Because this remedy results in hazardous substances, pollutants, or contaminants remaining on site above levels that allow for unlimited uses and unrestricted exposure for an extended period of time, land use controls will be used, and a five-year review is required until unlimited uses and unrestricted exposure conditions are achieved. Therefore, land use controls would continue until the concentrations of hazardous substances in the groundwater are at such levels to allow for unrestricted use and unrestricted exposure levels. In the event that contamination is detected in an existing or new supply well that requires action in the future, a decision will be made at that time in consultation with the Base commander regarding the need for action, including possibly removing the well from service, wellhead treatment, or other steps that may be appropriate.

1.9.4 Statutory Determinations

In accordance with the NCP, the selected remedy meets the following statutory determinations.

- Protection of Human Health and the Environment - The selected remedy is needed to protect human health and the environment. Protection will be achieved through restrictions on groundwater use and long-term groundwater monitoring as long as concentrations remain above remedial goals (Alternative 2) and adding an alternate water supply (installation of new well) for domestic use that is not impacted by COCs (Alternative 3). Alternative 4 would also provide additional protection of human health and the environment by treating the contaminants in two COC treatment areas, which would clean the groundwater faster. There are no short-term threats associated with the selected remedy that cannot be controlled. In addition, no adverse cross-media impacts are expected from the remedy.
- Compliance with ARARs – The ARARs include any federal or state standards, requirement, criteria, or limitations that are determined to be legally applicable or relevant and appropriate to a CERCLA site or action. To Be Considered criteria are non-promulgated advisories or guidance issued by federal or state government and do not have the status of potential ARARs but are evaluated along with ARARs. Alternative 2 would comply with ARARs, and remedial goals would be attained in groundwater through natural attenuation processes over a very long period of time. Alternative 3 would comply with ARARs by providing an alternate water supply to limit exposure and achieving remedial goals through natural attenuation over a very long period of time. Alternative 4 would comply with ARARs, and remedial goals would be attained through groundwater treatment. A complete discussion of **ARARs**[38] is presented in Appendix A.
- Cost-Effectiveness - The selected remedy is the most cost-effective and represents the most reasonable value for the money because it satisfies the stakeholders' desire to: 1) protect receptors from the risk of exposure to contaminated groundwater, 2) provide clean drinking water, and 3) reduce the highest concentrations of contaminants in the source areas of the aquifer. Although individually Alternatives 2, 3, and 4 and Alternative 5 are less expensive, none of those alternatives alone satisfy the stakeholders' requirements as well as the combined selected remedy.
- Use of Permanent Solutions and Alternative Treatment Technologies or Resource Recovery Technologies to the Maximum Extent Practicable - The selected remedy provides a moderate to high degree of long-term effectiveness and permanence through contaminant reduction via in situ treatment technologies in the two source areas. Alternative 4A (zero-valent iron or zero-valent zinc) will be applied at the plume around well 220205-MWX to treat contaminants in groundwater, primarily 1,2,3-TCP. Alternative 4B (in situ enhanced bioremediation) will be applied at the plume around well 4W-04A to treat contaminants in groundwater, primarily TCE. Design studies will be conducted first to evaluate the effectiveness of these technologies and to refine the full-scale remedy implementation.
- Preference for Treatment as a Principal Element - The selected remedy involves in situ treatment of the contaminated groundwater using both injectable reactive metals (zero-valent iron or zero-valent zinc) (Alternative 4A) and enhanced bioremediation (Alternative 4B).

- Five-Year Review Requirements - The selected remedy will result in hazardous substances, pollutants, or contaminants remaining on site above levels that allow for unlimited use and unrestricted exposure for a prolonged period of time. Therefore, the site will be included in reviews every five years to document the status of the remedial action, until remedial goals are met or it can be demonstrated that the site no longer poses a risk to receptors.

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2.0 COMMUNITY PARTICIPATION

Community participation at MCB Camp Pendleton includes interviews, public meetings, fact sheets to update current cleanup activities, an information repository to access technical documents, information to local and regional media, and presentations to local groups. During the public review period, public notices were placed in the North County Times, which serves the northern San Diego County area, and in the online Base newspaper, the Scout, announcing the public meeting and where the Proposed Plan could be obtained or viewed. In addition, the MCB Camp Pendleton IR website announced the public meeting and provided a link to the Proposed Plan. A significant and reasonable effort was made to inform the public of the proposed remedies outlined in this ROD. However, as an operational military Base, many members of the MCB/MCAS Camp Pendleton community may be either deployed or preparing for military missions.

The Community Involvement Plan provides detailed information on community participation related to the ongoing environmental investigation and cleanup efforts at MCB Camp Pendleton.

A Proposed Plan was developed to fulfill public participation requirements of Comprehensive Environmental Response, Compensation, and Liability Act Section 117 (a), which specify that the lead Agency (Navy) must publish a plan outlining remedial alternatives evaluated for each site and identify the preferred alternative. Documents pertaining to the investigation conducted at 22/23 Area Groundwater, including the findings and potential remedial approaches, and relevant information relied upon in the remedy selection process, are available for public review in the Administrative Record at the Information Repositories at the following locations:

Administrative Record
Naval Facilities Engineering Command Southwest
1220 Pacific Highway
San Diego, CA 92132-5190
(619) 556-1280

MCB Camp Pendleton Environmental Security Office
Building 22165
MCB Camp Pendleton, CA 92055-5008
(760) 725-9744

Oceanside Public Library
330 N Coast Hwy, Oceanside, CA 92054
(760) 435-5600

The public review period for the 22/23 Area Groundwater Proposed Plan was from 26 July to 26 August 2011. The proposed plan was also sent to the Technical Review Committee on 28 July 2012. A Public Meeting was held on 8 August 2011 at the Pacific View South Mesa Club at MCB Camp Pendleton. All interested parties were encouraged to attend to learn more about the alternative for the site and to submit comments on the Proposed Plan to the Navy.

No members of the public attended the public meeting. One comment was received from a member of the public, although the comment did not specifically discuss concerns with the proposed remedies outlined for this site. This comment is transcribed into the report provided by the court reporter, provided in Appendix B. The response to this comment from MCB Camp Pendleton is provided following the comment in Appendix B.

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3.0 RESPONSIVENESS SUMMARY

The public review period for the 22/23 Area Groundwater Site was July 26, 2011 to August 26, 2011. A public meeting was held on 8 August 2011 at the Pacific View South Mesa Club, Compass Room at MCB Camp Pendleton. One comment was received on the 22/23 Area Groundwater Site Proposed Plan during the public comment period from July 26, 2011 to August 26, 2011 and entered into the record at the public meeting held on 8 August 2011. The **court reporter record**[39] of the public meeting is provided in Appendix B. The response to the public comment received is included in Appendix B and did not affect the remedy selection. As noted in Section 2.0, because MCB Camp Pendleton is an operational military Base and Station, many members of the MCB/MCAS Camp Pendleton community may be either deployed or preparing for military missions.

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4.0 REFERENCES

Item	Reference Phrase in ROD	Location in ROD	Identification of Referenced Document Available in the Administration Record
1	administrative record	Declaration	Administrative Record Index for 22/23 Area Groundwater Site
2	Response to Comments	Declaration	Response to Comments on the Draft 22/23 Area Groundwater ROD
3	Figure 2	Section 1.1	11 x 17 version of Figure 2
4	Sites 4, 4A, 5, 6, 6A, 16, 17, and 27	Section 1.1	Final 22/23 Area Groundwater Remedial Investigation and Feasibility Study, Marine Corps Base Camp Pendleton, California. January 2011. Section 2.1, page 2-1
5	Figure 3	Section 1.1	11 x 17 version of Figure 3
6	Subsurface geology	Section 1.1	Final 22/23 Area Groundwater Remedial Investigation and Feasibility Study, Marine Corps Base Camp Pendleton, California. January 2011. Section 2.2.4, pages 2-3 through 2-7
7	Figure 4	Section 1.1	11 x 17 version of Figure 4
8	groundwater	Section 1.1	Final 22/23 Area Groundwater Remedial Investigation and Feasibility Study, Marine Corps Base Camp Pendleton, California. January 2011. Section 2.2.5, pages 2-7 through 2-12
9	habitats	Section 1.1	Final 22/23 Area Groundwater Remedial Investigation and Feasibility Study, Marine Corps Base Camp Pendleton, California. January 2011. Section 2.2.7, pages 2-12 through 2-13
10	Figure 5	Section 1.1	Plate 1 is an enlarged version of Figure 5.
11	extent of the plumes has decreased	Section 1.1	Final 22/23 Area Groundwater Remedial Investigation and Feasibility Study, Marine Corps Base Camp Pendleton, California. January 2011. Section 2.5, pages 2-21 through 2-27, and Figures 2-21 through 2-24.
12	Sites 4 and 4A	Table 1	Draft Final Remedial Investigation Report for Group A Sites, Marine Corps Base Camp Pendleton, California, 15 October 1993. Section 4.2, pages 4-11 to 4-14, Tables 4-8 through 4-12, and Figures 4-3 and 4-4.

Item	Reference Phrase in ROD	Location in ROD	Identification of Referenced Document Available in the Administration Record
13	OU 1 ROD	Table 1	Final Record of Decision for Operable Unit 1, Marine Corps Base Camp Pendleton, California, signed December 1995. Declaration, pages 1-1 through 1-4
14	Site 5	Table 1	Draft Final Remedial Investigation Report for Group A Sites, Marine Corps Base Camp Pendleton, California, 15 October 1993. Section 4.3, pages 4-14 to 4-16, Tables 4-13 to 4-15, and Figures 4-4 to 4-6.
15	OU 2 ROD	Table 1	Final Operable Unit 2 Record of Decision, Marine Corps Base Camp Pendleton, California, September 1997. Declaration, pages1-1 through 1-6
16	Site 6	Table 1	Remedial Investigation/Feasibility Study Phase 1 RI Technical Memorandum Group C Sites, Marine Corps Base Camp Pendleton, California, 16 August 1995. Section 2.5, pages 2-15 to 2-23, Figures 2-13 to 2-17.
17	Site 6A	Table 1	Draft Operable Unit 5, Remedial Investigation Report for Sites 1A-1, 6A, 21, 1111, and 12 Area, MCB Camp Pendleton, California. February 12, 2004. Sections 3.7 through 3.9, pages 3-16 to 3-19, Tables 3-2 to 3-10, and Figure 3-2.
18	OU 5 ROD	Table 1	Final Operable Unit 5 Record of Decision, Marine Corps Base Camp Pendleton, California, January 2008. Declaration, pages i through v.
19	Site 16	Table 1	Remedial Investigation/Feasibility Study Phase 1 RI Technical Memorandum Group C Sites, Marine Corps Base Camp Pendleton, California, 16 August 1995. Section 2.7, pages 2-28 to 2-33, Figures 2-21 and 2-22.
20	OU 3 ROD	Table 1	Final Operable Unit 3 Record of Decision, Marine Corps Base Camp Pendleton, California, January 1999. Declaration, pages 1-1 through 1-7

Item	Reference Phrase in ROD	Location in ROD	Identification of Referenced Document Available in the Administration Record
21	Site 17	Table 1	Remedial Investigation/Feasibility Study Phase 1 RI Technical Memorandum Group C Sites, Marine Corps Base Camp Pendleton, California, 16 August 1995. Section 2.8, pages 2-33 to 2-37, and Figures 2-24 and 2-25.
22	Site 27	Table 1	Remedial Investigation/Feasibility Study Phase 1 RI Technical Memorandum Group C Sites, Marine Corps Base Camp Pendleton, California, 16 August 1995. Section 2.9, pages 2-38 to 2-41, and Figure 2-27.
23	data through 2009	Table 1	Final 22/23 Area Groundwater Remedial Investigation and Feasibility Study, Marine Corps Base Camp Pendleton, California. January 2011. Tables 2-5 through 2-15.
24	Figure 6	Section 1.3	11 x 17 version of Figure 6
25	human health risk assessment	Section 1.5.1	Final 22/23 Area Groundwater Remedial Investigation and Feasibility Study, Marine Corps Base Camp Pendleton, California. January 2011. Appendix J without the Attachments.
26	Ecological Risk Assessment	Section 1.5.2	Final 22/23 Area Groundwater Remedial Investigation and Feasibility Study, Marine Corps Base Camp Pendleton, California. January 2011. Section 2.7, pages 2-28 and 2-29.
27	Guide to Principal Threat and Low Level Threat Wastes	Section 1.6	Guide to Principal Threat and Low level Threat Wastes. November 1991. USEPA Office of Solid Waste and Emergency Response. OSWER Directive 9380.3-06FS.
28	Figure 7	Section 1.7	11 x 17 version of Figure 7
29	screening and evaluation of remedial technologies	Section 1.8	Final 22/23 Area Groundwater Remedial Investigation and Feasibility Study, Marine Corps Base Camp Pendleton, California. January 2011. Appendix K Figures K-1 and K-2.
30	NCP	Section 1.8	Final Proposed Plan for Cleanup of the 22/23 Area Groundwater at Marine Corps Base Camp Pendleton, California, Figure 3.
31	Total Cost: $4,143,000	Section 1.8.1	ROD cost revisions to FS Tables prepared for Alternative 2, Tables L2 to L4.

Item	Reference Phrase in ROD	Location in ROD	Identification of Referenced Document Available in the Administration Record
32	**Total Cost: $8,159,000**	Section 1.8.1	ROD cost revisions to FS Tables prepared for Alternative 3, Tables L5 to L7.
33	**Total Cost: $5,368,000**	Section 1.8.1	ROD cost revisions to FS Tables prepared for Alternative 4A, Tables L8 to L10.
34	**Total Cost: $4,668,000**	Section 1.8.1	ROD cost revisions to FS Tables prepared for Alternative 4B, Tables L11 to L13.
35	**Total Cost: $17,189,000**	Section 1.8.1	ROD cost revisions to FS Tables prepared for Alternative 5, Tables L14 to L15.
36	**Total Cost: $22,544,000**	Section 1.8.1	ROD cost revisions to FS Tables prepared for Alternative 6, Tables L16 to L17.
37	**comprehensive analysis of each alternative**	Section 1.8.2	Final 22/23 Area Groundwater Remedial Investigation and Feasibility Study, Marine Corps Base Camp Pendleton, California. January 2011. Sections 3.5.3 through 3.6.8, pages 3-18 through 3-31.
38	**ARARs**	Section 1.8.2.1	Appendix A
39	**court reporter record**	Section 3.0	Appendix B