The estimated boundaries of the areas encompassing soil/bedrock impacted with explosive compounds greater than 16 mg/kg are depicted on Figure 6-4. The boundaries were drawn to encompass all sampling locations where explosive compounds were detected, and includes the area where a possible sixth strip may exist. As can be seen on Figure 6-4, the boundaries can be drawn with more certainty in areas where there are control points relatively close to each other. The boundaries are based mostly on analytical results; however, geologic, transport mechanism, and topographic considerations were also employed. No explosive compounds were detected outside the Project Site boundary to the north and east where access was obtained. The northeastern extent of TNT-affected soil beyond the Project Site boundary and between the area of TNT Strip #4 and sample location TNT-R6 has not been defined. This area will be addressed after OE point clearance has occurred (see Table 8-1).

6.2.1.2 Migration Pathways and Transport Mechanisms for Explosive Compounds.

The mechanisms by which the explosive and related compounds could have been transported beyond the TNT Strips are believed to be (1) windblown action particularly near the top of the Ridge, (2) movement of surficial soil downslope, (3) a combination of precipitation infiltration and subsequent migration into deeper soil and weathered bedrock, and in the case of the valley floor (4) spillage along the midway road.

Another transport mechanism considered to be significant within the TNT Strips area is described as follows. As shown on aerial photographs of the Project Site taken since May 1990, numerous vehicle trails (most likely from recreational vehicles such as motorbikes) traverse the TNT Strips area, as well as other portions of the site. The aerial photographs show that the number of trails increased from 1990 to the point where the TNT Strips were obscured significantly in later years. Typically, areas disturbed in this fashion exhibit ruts that are deepened by surface runoff when it rains. The off-road activities apparently persisted until the Project Site was fenced off and access was impeded. Another mechanism to mix and spread explosive-impacted soil in the vicinity of the TNT Strips is the discing of the soil along a firebreak that follows the Project Site boundary fence and crosses TNT Strip #1.

The residual soil/colluvium at the Project Site is typically a fat clay that exhibits dessication cracks during the summer. These cracks may form preferential migration pathways during the first precipitation of the winter, before the fat clay expands and decreases the size of the cracks. This preferential pathway likely resulted in the high concentrations observed within the upper 2 feet bgs along the strips and the lower concentrations observed at greater depth directly beneath the strips.

Explosive compounds in soil have relatively low solubilities. Estimated low concentrations of explosive compounds have been detected in a grab groundwater sample from an undeveloped well (TW-4: TNT [0.9 µg/L "J"] and amDNTs [4.9 µg/L "J"]) downgradient of the Howitzer Test Facility and in a grab groundwater sample (LFP-24: HMX [0.26 µg/L "J"] and 2,4-DNT [0.66 µg/L "J"]) collected from the North Valley Military Landfill, as discussed in Sections 5.6.2 and 5.4. It is likely that these low concentrations are a result of the grab groundwater sampling technique used to collect the samples. In fine-grained soils, similar to those found at the Project Site, this sampling technique can result in collection of samples containing sediment (turbidity). The laboratory analytical testing method for water samples is very sensitive and would be affected by sediment even containing very low concentrations of explosives. This is supported by the fact that no developed groundwater wells have detected explosives, even those directly downgradient of the North Valley Military Landfill.

6.2.2 Howitzer Test Facility (including Stockpile #3)

Based on the data collected during the non-OE RI, it is concluded that the soil at the Howitzer Test Facility appears to be impacted with low levels (less than 100 mg/kg) of non-point-source petroleum hydrocarbons. No PCBs were detected in any of the samples analyzed for these compounds. Isolated detections of TNT and dioxins/furans reported during the remedial investigation were not confirmed during the data gaps investigation at locations adjacent to where they were originally detected. Consequently, these detections are considered to represent isolated, not extensive occurrences, or to be suspect due to the non-repeatability of the initial detections. The reported concentrations of 2-butanone are considered to be a laboratory contaminant, as discussed in Section 5.1. As shown on Figure 5-4, the only other chemicals detected at the Howitzer Test Facility are (1) isolated detections of VOCs commonly associated with petroleum hydrocarbons and lubricants/oils, and (2) inorganic compounds.

The lateral and vertical extent of petroleum hydrocarbons and VOCs are further discussed in Section 6.2.2.1.

Inspection of the inorganic data does not appear to indicate impact with respect to metals in the Howitzer Test Facility area. For those metals exceeding the 95th percentile (Table 6-2), four (copper, iron, nickel, and zinc) showed a statistically significant difference between the Howitzer Test Facility concentrations and ambient concentrations, based on the Wilcoxon results (Table 6-3). Further review of the isoconcentration contour maps and the scatter plots (Appendix E) shows no systematic pattern for these metals in the Howitzer Test Facility area.

6.2.2.1 Lateral and Vertical Extent of Petroleum Hydrocarbons.

Petroleum Hydrocarbons. The estimated lateral extent of petroleum hydrocarbon impact is shown on Figure 6-5. Low levels of petroleum hydrocarbons in the motor oil range, as well as unknown hydrocarbons (possibly representing weathered fuels), were detected in the near-surface soil (less than 1 foot bgs) in the vicinity of the former Test Firing Butts (Building 182) at estimated concentrations ranging from 4.7 mg/kg "J" (HF-3R) to 58 mg/kg "J-" (HF-3). Unknown hydrocarbons in the motor oil range were also detected in the near-surface soil from adjacent boreholes in this area. Petroleum hydrocarbons in the motor oil range were also detected at one location (TW-5) to a depth of 10 feet (6.9 mg/kg "J"). This location is not in close proximity to any buildings, but is adjacent to the road connecting Buildings 540 and 542 to the Ammunition Renovation/Primer Destruction Site.

Low levels of petroleum hydrocarbons in the motor oil range and unknown hydrocarbons in the motor oil range (less than 100 mg/kg) were also detected in the near-surface soil at two locations in close proximity to Midway Road, between the Test Firing Butts and the northeast Project Site boundary. The unknown hydrocarbon detections may represent weathered petroleum hydrocarbons.

An isolated area of soil impacted by petroleum hydrocarbons in the motor oil range has also been identified to a depth of 20 feet (18 mg/kg) at the northeast end of the North Valley Military Landfill (see Section 6.2.3). The source of this impact of the fat clay alluvial deposits is currently unknown.

The detections of the petroleum and the unknown hydrocarbons in the near-surface soils are consistent with a non-point source represented by prior practices of oiling roads and parking areas for dust suppression, as well as from non-uniform, intermittent petroleum hydrocarbon leaks (diesel, motor oil) from parked and moving vehicles. The areas affected by this condition are Midway Road, the parking areas in front of the Test Firing Butts (Building 182) and the Test Firing Tunnels (Building 181), and the road connecting Buildings 540 and 542 to the Ammunition Renovation/Primer Destruction Site. Other factors that may contribute to the distribution of petroleum hydrocarbons in the near-surface soil is the movement of fill material in the North Valley during grading/ construction of the buildings at this site, as well as more recent surficial disturbance during the 1996 initial site preparation activities. The area in the Howitzer Test Facility and along Midway Road to the southeast impacted by petroleum hydrocarbons in the motor oil/diesel range, including the unknown hydrocarbons, is depicted on Figure 6-5. The boundaries of the non-point-source-impacted area have been defined by topography and the historical use as roads and parking areas.

VOCs. Estimated low concentrations of benzene (0.0035 mg/kg "J"), toluene (0.0055 mg/kg "J") and xylenes (0.0022 mg/kg "J") were only detected in subsurface soil at one of the boreholes (HF-7) advanced at the Howitzer Test Facility in the vicinity of Buildings 540 and 542 at 10 feet bgs. Estimated low concentrations of 1,2,3-trichlorobenzene (0.0016 mg/kg) and 1,2,4-trichlorobenzene (0.0012 mg/kg) were also detected in near-surface soil at the same general location (borehole HF-8). An estimated low concentration of benzene (0.0018 mg/kg "J") was detected at 20 feet bgs (HF-9), also in the vicinity of boreholes HF-7 and HF-8. These compounds, commonly associated with petroleum hydrocarbons and hydraulic oils/lubricants, were not detected elsewhere at this site and are considered isolated detections. Since the detections are circumscribed to the immediate area of the former buildings, it is reasonable to conclude that they may be associated to leaks from vehicles parked next to the original buildings during operation of the facility.

The lateral extent of the VOCs is not shown on Figure 6-5 due to the sporadic nature of the detections.

6.2.2.2 Migration Pathways and Transport Mechanism.

Petroleum Hydrocarbons. The potential migration pathways identified for the non-point-source petroleum hydrocarbons are precipitation infiltration into subsurface soils and surface runoff. Non-point-source petroleum hydrocarbons can be expected in areas of former vehicle use where minor leaks from vehicles could be transported by surface runoff to produce low-level impact to near-surface soils.

Data from the Howitzer Test Facility are consistent with a non-point-source release, which can be characterized by: (1) an absence of an area of high concentrations; (2) disseminated and relatively low concentrations of petroleum hydrocarbons in the near-surface soil (i.e., less than 100 mg/kg); (3) limited downward migration in the soil zone; and (4) absence of significant groundwater impact due to insufficient mass.

"Heavy" petroleum hydrocarbons (e.g., diesel, and motor oil) are, in general, relatively immobile in the soil-groundwater system, being limited in their potential for migration by relatively high viscosities, high soil-sorption coefficients, and low water solubilities. Migration via the atmosphere (air) is not considered a viable migration pathway as heavy petroleum hydrocarbons are characterized by low vapor pressures and are, therefore, relatively non-volatile.

In addition to the properties of heavy petroleum hydrocarbons that limit their mobility in the soil-groundwater system, site-specific conditions can be expected to further limit the potential for significant petroleum hydrocarbon migration. Once released to the ground surface or subsurface at the Project Site, petroleum hydrocarbon migration would be limited by the underlying low-permeability soil and bedrock. Mass is another limiting factor as the heavy petroleum hydrocarbons exhibit significant attenuation due to the physicochemical properties described above.

Given the time frame since most of the potential releases occurred (on the order of 40 to 55 years), extensive weathering and natural attenuation of petroleum hydrocarbons would also be expected, and likely accounts for the low concentrations (less than 100 mg/kg) detected and the sporadic nature of some of the detections.

The relatively low concentrations, the low-permeability soil/bedrock that underlies the Project Site, and the general lack of groundwater limits the potential for significant petroleum hydrocarbon impact to groundwater. As shown on Figure 4-20, groundwater in the area of the Howitzer Test Facility (which is situated near the upper reaches of the North Valley) will flow predominantly to the southeast down the North Valley. Estimated concentrations of petroleum hydrocarbons have been sporadically detected in the North Valley groundwater downgradient of the Howitzer Test Facility, as discussed in Section 6.2.5.

VOCs. The potential migration pathways identified for VOCs are precipitation and subsequent infiltration and surface runoff. In general, VOCs are less likely to persist in the soil environment than petroleum hydrocarbons due to their higher volatility and relative solubilities. Isolated estimated low concentrations of VOCs were detected at three of the locations sampled at the Howitzer Test Facility: at the near-surface (HF-8), 10 feet bgs (HF-7), and 20 feet bgs (HF-9). The presence of VOCs in near-surface soil is suspect due to their propensity for volatilization. The concentrations at depth at the other two locations are also suspect, since VOCs were not detected in either the shallower or the deeper samples collected at the same locations or in samples collected from adjacent locations. The lack of these VOCs in the site groundwater downgradient of the Howitzer Test Facility also supports that a significant release of VOCs to the soil-groundwater system has not occurred at the Howitzer Test Facility.

6.2.2.3 Stockpile #3.

Estimated low concentrations of PAHs (ranging from 0.033 mg/kg to 0.11 mg/kg) were detected in the stockpile soil samples (see Figure 5-4). Unknown hydrocarbons in the motor oil range were detected at concentrations ranging from 79 mg/kg "J" to 200 mg/kg "J-". The hydrocarbon data are consistent with the findings in the subsurface native soil since the stockpile contains some surficial soil as a result of the 1996 initial site preparation activities.

The lateral and vertical extent of the stockpile can be represented, at a minimum, by the topographic expression of the stockpiled materials. The stockpile consists of soils and construction debris that were excavated from the surrounding area and pushed to their current location. The stockpiled materials were deposited loosely over the natural alluvial soils of the North Valley drainageway, with no compaction effort applied to them, and were covered for winter 2000-2001 to prevent rainfall infiltration or erosion.

6.2.3 North Valley Military Landfill

Several chemicals were detected at estimated concentrations in the fill and at 2 feet below the underlying alluvial soil, as well as in two grab groundwater samples collected from the test pits excavated through the landfill materials. COIs included unknown hydrocarbons, VOCs, two dioxins/furans, one pesticide, and inorganics. Grab groundwater samples from under the landfill materials detected estimated concentrations of explosives (HMX at 0.26 µg/L. "J" and 2,4-DNT at 0.66 µg/L "J"), unknown hydrocarbons in the diesel and motor oil range

(81 µg/L "J-" to 200 µg/L "J-"), and dioxins (OCDD at 260 pg/L). It is our opinion that these low estimated concentrations of explosives are a result of the grab groundwater sampling technique used to collect the samples. In fine-grained soils, like those found at the Project Site, this sampling technique can result in collection of samples containing sediment (turbidity). The laboratory analytical testing method for water samples is very sensitive and would be affected by sediment even containing very low concentrations of explosives and dioxins/furans. This is supported by the fact that no developed groundwater wells have detected explosives, even those directly downgradient of the North Valley landfill.

Inspection of the inorganic data does not appear to indicate impact with respect to metals in the North Valley Military Landfill area. For those metals exceeding the 95th percentile (Table 6-2), seven (aluminum, beryllium, copper, chromium, iron, nickel, and vanadium) showed a statistically significant difference between the North Valley Military Landfill concentrations and ambient concentrations, based on the Wilcoxon results (Table 6-3). Further review of the isoconcentration contour maps and the scatter plots (Appendix E) shows no systematic contaminant pattern for these metals in the North Valley Military Landfill area.

The extent of the fill material in the North Valley Military Landfill is considered to coincide with the outline of the maximum historical extent depicted on Figure 5-9, the eastern and southwestern limits of which were confirmed during the removal action investigation. The eastern, northern, and southwestern limits of the landfill were confirmed to coincide with the maximum historical extent depicted on Figure 5-9. The western limit could not be confirmed because it extends under stockpile #3. However, the western limit likely coincides with the historical limit, given the close match of the other three sides. As further discussed in Chapter 8.0, the fill material will be excavated in lifts as part of the OE clearance activity and will be placed in the North Valley as engineered fill.

6.2.4 Ammunition Renovation/Primer Destruction Site (including Stockpiles #1 and #2)

As shown on Figure 5-6, the chemicals detected at the Ammunition Renovation/ Primer Destruction Site are petroleum hydrocarbons in the diesel and motor oil ranges, unknown hydrocarbons (likely representing weathered petroleum hydrocarbons), isolated detections of VOCs commonly associated with petroleum hydrocarbons and oils/lubricants, and inorganics. The reported concentrations of 2-butanone are considered a common laboratory contaminant, as discussed in Section 5.3.1. PCBs were analyzed due to their potential associations with oils, lubricants, etc. No PCBs were detected at the Ammunition Renovation/Primer Destruction Site.

Inspection of the inorganic data does not appear to indicate impact with respect to metals in the Ammunition Renovation/Primer Destruction Site area. For those metals exceeding the 95th percentile (Table 6-2), four (copper, cobalt, iron and nickel) showed a statistically significant difference between the Ammunition

Renovation/Primer Destruction Site concentrations and ambient concentrations, based on the Wilcoxon results (Table 6-3). Further review of the isoconcentration contour maps and the scatter plots (Appendix E), shows no systematic contaminant pattern for these metals in the Ammunition Renovation/Primer Destruction Site area.

6.2.4.1 Lateral and Vertical Extent of Petroleum Hydrocarbons.

As shown on Figure 6-5, petroleum hydrocarbons were detected in both the diesel and motor oil range at the Ammunition Renovation/Primer Destruction Site. Low levels of petroleum hydrocarbons in the diesel and motor oil ranges are pervasive in the near-surface (0.5 foot bgs) soil across the majority of the site, typically at concentrations of less than 50 mg/kg (diesel) and 70 mg/kg (motor oil). The near-surface low concentrations of petroleum hydrocarbons are consistent with similar findings in the Howitzer Test Facility. The source of this impact is attributed to the historical practice of spraying unpaved roadways, working areas, and parking areas with petroleum hydrocarbons (diesel, motor oil) as a dust suppressing measure.

Low concentrations (less than 100 mg/kg) of petroleum hydrocarbons in the diesel and motor oil ranges were also detected throughout the soil and bedrock column toward the northwest portion of the site (boreholes AR-1, AR-2, and TW-7) at depths up to 10 feet bgs, and toward the east boundary of the site (borehole AR-4) up to 30 feet bgs. No evident source for these detections has been determined, but it is speculated that leaks from parked vehicles may have contributed to this impact. The estimated extent of soil impacted with petroleum hydrocarbons in the motor oil range up to 10 feet bgs in the northwest portion of the site is shown on Figure 6-5. That figure also depicts the estimated extent of that type of impact around borehole AR-4.

Higher concentrations of petroleum hydrocarbons (including unknown hydrocarbons) were noted in the area toward the southeast corner of the site, in the vicinity of a suspected UST (see Figure 6-5), where near-surface concentrations of unknown hydrocarbons were detected up to 310 mg/kg "J" (borehole AR-7R). The highest concentrations of petroleum hydrocarbons in the diesel range were also detected at depth in the vicinity of the suspected UST (630 mg/kg in borehole AR-3 at 17.5 feet bgs) and south of the wooden building (220 mg/kg in borehole TW-1 at 22 feet bgs). Figure 6-5 shows the extent of the suspected point-source impact extending in a southeasterly direction between boreholes AR-3 and TW-1. Samples collected from borehole AR-10, situated between these boreholes, did not show petroleum hydrocarbon impact to the depth explored of 17 feet bgs. This is interpreted herein as an indication that the borehole may not have been deep enough to reach the deeper petroleum hydrocarbon-affected soil derived from the UST potentially situated in the vicinity of borehole AR-7.

6.2.4.2 *Migration Pathways and Transport Mechanisms.*

The migration pathways for the non-point-source petroleum hydrocarbons are similar to the migration pathways for the Howitzer Test Facility. Point-source petroleum hydrocarbons can be expected in the vicinity of an UST and associated piping where local surface releases, which are subject to infiltration, as well as direct releases to the subsurface soil and bedrock can occur.

Data from the northwest portion of the site are consistent with a non-point-source release, as described for the Howitzer Test Facility, while data from the southeast portion of the site are consistent with a point-source release, which can be characterized by an area with concentrations between 220 mg/kg and 630 mg/kg in the vicinity of a source at the surface and at depth.

The west portion of the Ammunition Renovation/Primer Destruction Site is situated at the groundwater divide. Groundwater under the western portion is likely to flow to the northwest (at times of higher groundwater levels) while groundwater under the majority of the Ammunition Renovation/Primer Destruction Site will flow to the southeast (see Figure 4-20). No petroleum hydrocarbon-impacted groundwater was encountered northwest of the divide.

6.2.4.3 *Stockpiles #1 and #2.*

Unknown hydrocarbons in the diesel and motor oil range were detected in soil samples from Stockpile #1 (up to 1,400 mg/kg "J-") and Stockpile #2 (up to 150 mg/kg "J-") (see Figure 5-6). Low levels of petroleum hydrocarbons in the motor oil range were detected in Stockpile #1 (6.7 mg/kg "J") and Stockpile #2 (160 mg/kg). In terms of the petroleum hydrocarbons, these data are consistent with the findings in the subsurface soil, since the stockpile contains surficial soil as a result of the 1996 initial site preparation activities. Low concentrations of PAHs (ranging from 0.017 mg/kg "J" to 0.054 mg/kg "J"), likely associated with the asphalt observed in the stockpiles, were detected in both stockpiles. A low concentration of TNT (0.67 mg/kg) was detected in Stockpile #1.

The extent of stockpiles is estimated to be represented at a minimum by the topographic expression of the stockpiled materials as depicted on Figure 5-9. The stockpile consists of soils and asphalt debris that were excavated from the surrounding area and pushed to their current locations. The stockpiled materials were deposited in the graded area over fill materials and the underlying alluvial soils of the North Valley drainageway, with no compaction effort applied to them, and were covered for winter 2000-2001 to prevent rainfall infiltration or erosion. As further discussed in Section 8.0, the stockpiles will be removed from the site during the OE clearance activity.

6.2.5 North Valley Groundwater

Groundwater quality in the North Valley was assessed through the sampling of 14 groundwater monitoring wells situated throughout the valley. As discussed in the previous sections, soil/bedrock in the North Valley has been impacted primarily by heavy-petroleum hydrocarbons, and to a much lesser extent by petroleum-related VOCs and PAHs associated with the Howitzer Test Facility and Ammunition Renovation/Primer Destruction Site and metals. Chemicals detected in the grab groundwater samples collected from seeps and test pits are considered suspect due to the sampling technique. In fine-grained soils, similar to those found at the Project Site, this sampling technique can result in collection of samples containing sediment (turbidity). The laboratory analytical testing method for water samples is very sensitive and would be affected by sediment even containing very low concentrations of explosives and dioxins/furans.

As shown on Figure 5-7, no explosive compounds were detected in any of the groundwater samples collected from the North Valley during the most recent data gaps investigation. Estimated low concentrations of TNT (0.17 µg/L "J") and 4amDNT (0.38 µg/L "J") were detected in the grab sample from seep NV-S3 situated along the western boundary of the Howitzer Test Facility. The estimated low concentrations of TNT (0.9 µg/L "J") and amDNTs (4.9 µg/L "J") detected in the grab groundwater sample collected from well MW-4 (TW-4) during the remedial investigation were not confirmed during the groundwater sampling of the data gaps investigation, after well development.

Petroleum hydrocarbons in the kerosene range were detected in the groundwatersample collected from well MW-4A during both data gaps investigation monitoring events (April 2000 and August 2000) at concentrations ranging from 34 µg/L to 210 µg/L "J". It should be noted that no petroleum hydrocarbons in the kerosene range were detected in any of the soil samples collected at either the Ammunition Renovation/Primer Destruction Site or the Howitzer Test Facility. Low levels of petroleum hydrocarbons in the diesel range were detected in the grab groundwater samples collected from wells MW-3 (TW-3) (170 µg/L "J-") and MW-4(TW-4) (79 µg/L "J-") during the remedial investigation, and low levels of petroleum hydrocarbons in the motor oil range were detected in the grab groundwater sample collected from well MW-4(TW-4) (860 µg/L); however, these detections were not confirmed during the data gaps investigation monitoring events (April 2000 and August 2000), after well development. Several VOCs were detected at very low concentrations in the groundwater sample collected during the data gaps investigation in April 2000 from deep well MW-4A as follows: 2-butanone (6.8 µg/L "J"), bromodichloromethane (0.15 µg/L "J"), carbon disulfide (3.7 µg/L), and chloroform (2.9 µg/L). These chemicals are all common laboratory contaminants. Only 2-butanone was detected (14 µg/L "J") in the groundwater sample collected in August 2000 from this well.

Acenaphthylene, a compound often associated with petroleum hydrocarbons, was detected at low concentrations in the groundwater sample collected from well

MW- 13 (0.38 µg/L "J") and in two of the North Valley grab seep samples (NV-S2A [5.8 µg/L] and NV-S3 [0.84 µg/L "J"]).

Other compounds detected in the North Valley grab seep samples include: low concentrations of one VOC (p-cymene [p-isopropyltoluene] at 0.61 µg/L "J"), and one pesticide (p'p'-DDD at 0.0077 µg/L "J") detected in the seep sample NV-S2; and trace concentrations of explosive compounds (TNT and 4amDNTs) detected in seep sample NV-S3; however, these compounds have not been found in the developed wells and are considered suspect due to the sampling technique.

Site groundwater monitoring wells (except MW-5) were analyzed for the full suite of metals (CAM 17 plus aluminum, calcium, iron, manganese, magnesium, potassium, and sodium) plus total phosphorus and nitrate/nitrite. Comparison of filtered metals results and nitrate results to primary Maximum Contaminant Levels (MCLs) indicates two instances where a North Valley groundwater sample exceeded an MCL: aluminum at well MW-6 and thallium at well MW-7. The aluminum result for well MW-6 (9.7 mg/L) suggests a problem with the filtering procedure and is, therefore, not likely representative of actual dissolved aluminum in groundwater. This interpretation is based on the observations that a relatively high iron concentration accompanied the aluminum value (iron and aluminum are the two metals typically most sensitive to clay mineral content [i.e., turbidity]) and that other metal species do not exhibit similar increases in concentrations. The thallium result for MW-7 (0.0058 mg/L "J") is an estimated result and, therefore, may not accurately represent dissolved thallium in groundwater.

Organic analytical results were also compared to the MCLs. Only one of the compounds detected has a listed MCL (bromodichloromethane at 100 µg/L). The concentration of bromodichloromethane detected at well MW-4A is well below the MCL.

It is concluded that the North Valley groundwater has not been significantly impacted and that there is no significant impact from subsurface groundwater migration through the soil and underlying bedrock (via precipitation/surface runoff infiltration) from the TNT Strips, Howitzer Test Facility, North Valley Military Landfill, and Ammunition Renovation/Primer Destruction Site.

6.2.6 North Valley Soils

Soil samples were collected outside of the areas of interest in the North Valley during installation of various boreholes. TNT at 17 mg/kg or less has been detected in soil/bedrock along the floor of the North Valley. Low concentrations of unknown hydrocarbons (21 mg/kg "J" or less) were detected in near surface soil samples. Other explosive compounds were detected in one or more samples at concentrations of 0.83 mg/kg or less. Inspection of the inorganic data does not appear to indicate impact with respect to metals in these "miscellaneous" North Valley soil samples. For those metals exceeding the 95th percentile (Table 6-2), three (beryllium, iron, and nickel) showed a statistically significant difference between the miscellaneous North Valley soil concentrations and ambient concentrations, based on the Wilcoxon results (Table 6-3). Further review of the isoconcentration contour maps, and the scatter plots (Appendix E) shows no systematic contaminant pattern for these metals in the North Valley.

6.3 NATURE AND EXTENT, RIDGE

6.3.1 Dynamite Burn Site

The original source of potentially impacted soils was at the ground surface and has been removed. Soil and bedrock at a significant distance beyond the Dynamite Burn Site have also been removed. Therefore, no impact would be expected in the samples collected 20 feet to 40 feet below the original ground surface. Sample results from the exposed excavated surface did not detect explosives and supports this theory. Additional downgradient soil sampling is being proposed after OE point clearance to verify the downgradient soil and bedrock have not been impacted (see Table 8-1).

6.4 NATURE AND EXTENT, SOUTH VALLEY AREAS OF INTEREST

6.4.1 Flare Site

As shown on Figure 5-9 and isoconcentration contour maps (Appendix E), inorganics and dioxins/furans were detected in the soil at the Flare Site. No explosives or PAHs were detected in any of the soil samples collected from the Flare Site. Of the chemicals detected, metals are considered to be most characteristic of DOD-related activities at the Flare Site. For those metals exceeding the 95th percentile (Table 6-2), four (copper, iron, nickel, and zinc) showed a statistically significant difference between the Flare Site concentrations and ambient concentrations, based on the Wilcoxon results (Table 6-3). Further review of the isoconcentration contour maps and the scatter plots (Appendix E) shows a consistent pattern for copper and zinc in the Flare Site area. Additionally, other sample locations in the Flare site (i.e., FA3 and FA6) indicate clearly elevated concentrations of antimony, barium, and lead based on review of the scatter plots and Table 6-2.

In addition to the metals, dioxins/furans were also detected in the two samples collected from the center of the Flare Site. Since only a limited number of dioxin/furan samples were collected, the metals concentrations have been used to conservatively delineate the nature and extent of soil impact at the Flare Site, based on their mobility relative to the mobility of dioxins (i.e., it is unlikely that the dioxins/furans extend beyond the area of metals impact).

6.4.1.1 Lateral and Vertical Extent of Metals and Dioxin/furans.

The lateral extent of the metals impact at the Flare Site has been estimated in the northern and eastern directions. For purposes of the following discussion, the evaluation of lateral and vertical extent of metals in the Flare Site is conducted, in part, within the context of the remedial goals set for the COIs at the Flare Site.

The estimated extent of metals impact is shown on Figure 6-6. As presented in Table 8-1, additional definition of metal concentrations is proposed in the southern and western directions. The highest concentrations of metals above their remedial action levels occur in the vicinity of boreholes FA-3 and FA-6. No metals above their respective remedial goal were detected in the soil samples collected from boreholes FA-1 and FA-5, situated approximately 20 feet to the east and 30 feet north of the boreholes FA-3 and FA-6, respectively. Copper and zinc were detected slightly above their remedial goal in both samples collected from borehole FA-2, situated approximately 20 feet to the west of boreholes FA-3 and FA-6. The fact that only two metals were detected at this location above their remedial goal suggests that borehole FA-2 is likely close to the western limit of metals impact. Multiple metals were detected above their remedial goal in borehole FA-4, approximately 20 feet upslope of boreholes FA-3 and FA-6, but at significantly lower concentrations relative to FA-3 and FA-6. The limit of metals impact upslope of borehole FA-4 is estimated to be in the order of approximately 20 feet, based on the relative immobility of metals in the soil environment.

The vertical extent of the metals above their respective remedial goal is not as well defined due to the safety hazards involved with advancing boreholes at the center of this site, which precluded the use of a drill rig, thus limiting the depth of borehole advancement. Data from the two deepest boreholes (FA-4 and FA-6) indicate that the number of metals above ambient concentrations is significantly lower beyond 1 foot bgs. Given the general lack of mobility of the trace metals such as antimony, copper, lead, and zinc, it is unlikely that the metals impact will extend much beyond 3 feet to 5 feet bgs.

Two soil samples from the Flare Site were analyzed for dioxins/furans. A number of dioxins/furans were detected at low concentrations (up to 490 pg/g) in the near surface samples collected at boreholes FA-3 and FA-6 (see Figure 6-6); however, at 1 foot bgs, the number of the dioxins/furans and their respective concentrations was considerably lower (up to 10 pg/g). Dioxins/furans are even less mobile than the metals in the soil environment and are unlikely to migrate vertically beyond the limit of the metals impact. The dioxins/furans will therefore be addressed as part of any remedial action alternative(s) considered for the metals at the Flare Site. Additional dioxin/furan sampling will be conducted to define lateral and vertical extent (See Table 8-1).

6.4.1.2 Migration Pathways.

Based on the data, no extensive surface migration (surface precipitation runoff and transport of surficial soil via gravity downslope) or subsurface migration (precipitation infiltration into subsurface soil/bedrock and groundwater) has occurred in relation to the Flare Site. This observation is consistent with the relative immobility of metals and dioxins/furans in the soil environment.

6.4.2 Demolition Site #1

As shown on Figure 5-9 and isoconcentration contour maps (Appendix E) with the exception of inorganics, no chemicals were detected in any of the four soil samples collected from Demolition Site #1. No investigation of the upper portion of Demolition Site #1 was conducted due to a safety concern from the presence of a significant geophysical anomaly in this area. This area will be further characterized during the non-OE investigation (See Table 8-1).

Inspection of the inorganic data does not appear to indicate impact with respect to metals in the Demolition Site #1 area. For those metals exceeding the 95th percentile (Table 6-2), two (copper and iron) showed a statistically significant difference between the Demolition Site #1 concentrations and ambient concentrations, based on the Wilcoxon results (Table 6-3). Further review of the isoconcentration contour maps and the scatter plots (Appendix E) shows no systematic contaminant pattern for these metals in the Demolition Site #1 area.

6.4.3 Demolition Site #2

As shown on Figure 5-9 and isoconcentration contour maps (Appendix E) with the exception of inorganics, no chemicals were detected in either of the two soil samples collected from Demolition Site #2. Since no physical evidence (i.e., scrap ordnance, magnetic anomalies) or ordnance-related activities have been found at Demolition Site #2, the site was eliminated from further investigation after the completion of the interim investigation.

Metals results from Demolition Site #2 that are above ambient concentrations are listed in Table 6-2. For those metals exceeding the 95th percentile, two (iron and nickel) showed a statistically significant difference between the Demolition Site #2 concentrations and ambient concentrations, based on the Wilcoxon results (Table 6-3). Further review of the contour maps and the scatter plots (Appendix E) shows no systematic contaminant pattern for these metals in the Demolition Site #2 area.

6.4.4 Demolition Site #3

As shown on Figure 5-9 and isoconcentration contour maps (Appendix E), with the exception of inorganics, no chemicals were detected in any soil samples collected from Demolition Site #3. Metals results from Demolition Site #3 that are above ambient concentrations are listed in Table 6-2. For those metals exceeding the 95^{th} percentile, two (iron and vanadium) showed a statistical significance between the Demolition Site #3 area and ambient concentrations based on the Wilcoxon results (Table 6-3). Further review of the isoconcentration contour maps and the scatter plots (Appendix E) shows no systematic contaminant pattern for these metals in the Demolition Site #3 area. However, samples collected at location DA3 show elevated concentrations of mercury (see Table 2 and scatter plot for mercury [Appendix E]).

6.4.4.1 *Lateral and Vertical Extent of Mercury in Demolition Site # 3.*

Based on sample results, Demolition Site #3 appears to have been impacted by mercury. For purposes of the following discussion, the evaluation of lateral and vertical extent of metals in Demolition Site # 3 area is conducted, in part, within the context of the remedial goal set for mercury (see Section 7.3.3). In addition, mercury results from screening-level samples collected by SECOR (SS-25, SS-27, and SS-31) were used to help define the lateral and vertical extent of mercury.

It should be noted that the soil samples collected toward the center of the site were advanced primarily through recent fill material, to a depth of approximately 6 feet bgs. The lateral and vertical extent of the metals impact at Demolition Site #3 is relatively well understood such that the lateral and vertical bounds can be drawn or estimated. Concentrations of mercury above the remedial goal are present near the upslope periphery of Demolition Site #3 (DA3-1) and extending upslope as far as SS-31, and beyond the site boundary to the west (SS-25), beyond the site boundary to the south (WET-4), and to the southeast (WET-7).

Figure 6-7 shows the approximate lateral extent of mercury-impacted soil/sediment based on the likely radial distribution if the wetland has been impacted by Demolition Site #3. Several of the sediment samples were also analyzed for methyl mercury, which is formed in the environment by sulfate-reducing bacteria under anaerobic conditions. The methyl mercury results are also shown on Figure 6-7.

Mercury values were below the remedial goal for six screening-level samples (SS 26, SS-28, SS-29, SS-30, SS-32, and SS-33). Based on the above results, the extent of mercury-impacted soil was established half-way between samples above and below the remedial goal. It is estimated that: (1) the northern limit of mercury impact extends as far as approximately 180 feet north of the northern site boundary, just beyond SS-31; (2) the western limit of mercury impact extends approximately 90 feet west of the western site boundary; (3) the southern limit of mercury impact extends approximately 120 feet south of the southern site boundary in soil including a portion of the South Valley wetland area; and (4) the eastern limit of impact extends no further than 50 feet to the east but extends toward the southeast as far as approximately 150 feet in soil and approximately another 50 feet into the South Valley wetland area (as indicated by the mercury result from samples WET-7).

Most of the mercury detections above the remedial goal were from samples collected from depths of 2 feet bgs or less. At the one borehole location (DA3-6) where mercury was detected in excess of its remedial goal at 5.5 feet bgs, it was not detected at 10.5 feet bgs. At this location it is probable that mixing of surficial and deeper soil occurred as a result of excavating and backfilling during DOD-related activities at the site. Thus, given the relative immobility of mercury in the soil environment, it is estimated that mercury-impacted soil is limited to the upper 2 feet to 3 feet of native soil.

6.4.4.2 Migration Pathways.

Based on the data, no extensive surface migration (surface precipitation runoff and transport of surficial soil via gravity downslope) or subsurface migration (precipitation infiltration into subsurface soil/bedrock and groundwater) has occurred in relation to the Demolition Site #3. This observation is consistent with the relative immobility of metals in the soil environment. The surficial nature and larger estimated radial extent is based on the airborne distribution associated with the type of activities conducted at Demolition Site #3; however, surface migration via surface runoff or transport of surficial soil via gravity downslope may have contributed to the impact particularly in the wetland.

6.4.5 South Valley Wetland Sediment and Surface Water

6.4.5.1 Sediment.

As noted above, impact with respect to mercury is apparent in sediment downslope of Demolition Site #3 (Figure 6-7). In upgradient sediment sample WET-1, no organic COIs were detected, however, with respect to metals, magnesium, sodium, and zinc concentrations were above ambient levels.

An estimated concentration of one explosive compound (TNT at 1.5 mg/kg "J-") was detected in the downgradient sediment sample (WET-2) collected during the remedial investigation; however, the result was not confirmed in the duplicate sample (WET-2A) taken from the same location during the same sampling event. Similarly, a low concentration of one PAH (benzo[b]fluoranthene at 0.094 mg/kg) was detected in WET-2, but was not detected in the duplicate sample (WET-2A). In addition, it should be noted that these two compounds were not detected in any of the soil samples collected from the South Valley. Therefore, it is concluded that the sediments are not impacted by explosive compounds. Dioxins/furans were not detected in the sample (WET-2R) collected downgradient of the Flare Site.

It appears that DOD activities at Demolition Site #3 may have impacted a small portion of the wetland area, immediately downslope and southeast of the site, as a result of detonation activities and possible surface migration via precipitation runoff or transport of surficial soil via gravity downslope. Based on the non-repeatability of the low explosive and PAH concentrations detected in the downgradient sediment samples, it is concluded that the South Valley wetland sediment has not been impacted by these compounds.

6.4.5.2 Surface Water.

As shown on Figure 5-10, an estimated concentration of one explosive compound (TNT at 2.2 mg/kg "J") was detected in the downgradient surface water sample (SW-2) collected during the remedial investigation; however, the result was not confirmed in the resample (SW-2R) taken from the same location during the data gaps investigation. It was detected in the sediment sample collected from the same location during the remedial investigation but, the sediment result was not confirmed in the duplicate sediment sample collected during the same sampling event. Therefore, it is concluded that no impact from explosive compounds is evident in the surface water of the South Valley. No other COIs, with the exception of metals, were detected in any of the surface water samples from the South Valley. Comparison of filtered metals results to primary MCLs indicates that there are no instances where South Valley surface water exceeds an MCL.

Based on the above observations, it is concluded that the South Valley wetland surface water has not been adversely impacted by site activities.

6.4.6 South Valley Groundwater

Groundwater quality in the South Valley was assessed through the sampling of three groundwater monitoring wells. As shown on Figure 5-7, an estimated concentration of 3-nitrotoluene (0.59 µg/L "J") was detected in the groundwater sample collected in April 2000 from well MW-12(TW-12). This compound had not been detected in the grab groundwater sample collected during the remedial investigation, but was detected after well development. This compound was not detected during the August 2000 monitoring event.

The detection of 3-nitrotoluene is questionable since this compound was not detected in any of the soil/sediment samples collected from the areas of interest in the South Valley, including those soil samples collected at the toe of the land bridge (see Section 6.5.2), where it is believed soil from the Dynamite Burn Site was placed. It is concluded that the South Valley groundwater has not been significantly impacted by site activities and that there is no significant impact from subsurface groundwater migration through the soil and underlying bedrock (via precipitation/surface runoff infiltration) from Demolition Site #3 and the Flare Site. The low level sporadic detection of 3-nitrotoluene does not warrant further action.

One PAH, acenaphthylene, was detected at an estimated concentration of 1.1 µg/L "J" in a sample from well MW-10 during the August 2000 monitoring event.

No COIs (with the exception of selected metals and nitrate addressed below) were detected in the one South Valley grab seep sample.

Comparison of filtered metals results and nitrate results to primary MCLs indicates one instance where a South Valley groundwater sample exceeds an MCL: aluminum at well MW-11. The aluminum result for well MW-11 (3.9 mg/L) suggests a problem with the filtering procedure and is, therefore, not considered representative of actual dissolved aluminum in groundwater. This interpretation is based on the observations that a relatively high iron concentration accompanied the aluminum value (iron and aluminum are the two metals typically most sensitive to clay mineral content [i.e., turbidity]) and that other metal species less sensitive to turbidity do not exhibit similar increases in concentrations.

6.5 NATURE AND EXTENT, OTHER AREAS OF INVESTIGATION

6.5.1 Ridge Stockpiles #1-#9

The nine Ridge stockpiles consist of a mixture of concrete rubble, asphalt debris, soil and other inert construction demolition materials. The stockpiles cover the areas shown on Figure 5-8. The stockpiles have an average thickness of about 5 feet. These materials were reportedly transported from off-site sources for storage on the excavated Ridge cut area. The stockpiles were analyzed for the following COIs to determine eventual disposition of the stockpiled material: explosive compounds, TEPHs, and metals.

No explosives were detected in any of the soil samples collected from the Ridge stockpiles. Petroleum hydrocarbons in the diesel range (7.7 mg/kg "J-") and in the motor oil range (7.7 mg/kg "J" to 53 mg/kg "J-") were detected in soil samples collected from the stockpiles.

Inspection of the inorganic data does not appear to indicate impact with respect to metals in the Ridge stockpiles. For those metals exceeding the 95th percentile (Table 6-2), none showed a statistical significance between the Ridge stockpiles and ambient concentrations based on the Wilcoxon results (Table 6-3). These data are not presented on the scatter plots (Appendix E) or the isoconcentration contour maps, because they are not in situ samples.

The migration pathways for chemicals detected at the Ridge stockpiles include preferential precipitation infiltration, surface runoff, and wind erosion.

At the request of DTSC, additional characterization of VOCs is proposed for the stockpiles (See Table 8-1).

6.5.2 McAllister Drive Land Bridge

The McAllister Drive Land Bridge appears to have been constructed from soil excavated from a portion of the Ridge area which included the former Dynamite Burn Site (see Section 6.3.1). This factor was the basis for analysis of the following COIs during the remedial investigation: nitroglycerin and PETN, along with nitrate due to its potential presence as a degradation product of nitroglycerin. No explosive compounds were detected in any of the land bridge soil samples. Nitrate was detected in four of the soil samples collected from the upgradient and downgradient toe of the land bridge at concentrations ranging from 0.44 mg/kg "J" to 1.2 mg/kg. As shown in Table 6-2, cobalt and nickel were detected at concentrations above their respective 95^{th} percentile ambient concentrations. A Wilcoxon test could not be conducted for this area because there is only one sample location for which metals data were analyzed. However, review of scatter plots (Appendix E) indicates that metals concentrations for the soil sample are not anomalous and, therefore, do not indicate impact.

7.0 RISK ASSESSMENT

This chapter presents an assessment of the potential risks to human health and the environment associated with chemicals at the Project Site based on current site conditions. The screening-level human health and ecological risk assessments presented herein are based on the data collected during the RI. The results of the human health screening assessment are presented in Section 7.1. Section 7.2 summarizes the ecological conditions at the Project Site and presents the findings of the ecological screening assessment. The results of the screening assessments are used to help identify the chemicals that will be remediated. The proposed remediation goals for the Project Site, which are protective of human health and ecological impacts, are presented in Section 7.3. During and following remedial efforts at the Site, additional data will be collected to confirm that the proposed remediation goals were met. A post-remediation human health and ecological risk assessment will be conducted to evaluate data from confirmation samples and non-remediated areas. Section 7.4 presents the scope of the post-remediation human health and ecological risk assessment.

7.1 HUMAN HEALTH SCREENING ASSESSMENT

Potential human health risks associated with exposure to chemicals detected at the Project Site were evaluated on a screening-level basis by comparing maximum detected concentrations to readily available regulatory screening criteria. The screening risk estimates represent potential health risks to hypothetical residential populations, assuming current site conditions. This evaluation was conducted for each area of interest at the Project Site (i.e., TNT Strips, Howitzer Test Facility, North Valley Military Landfill, Ammunition Renovation/Primer Destruction Site, McAllister Drive Land Bridge, Miscellaneous North Valley, Flare Site, Demolition Sites #1 and #3, and Miscellaneous South Valley for soil and North Valley and South Valley for groundwater and surface water), and entailed calculating screening-level estimates of potential noncancer hazard indices and theoretical lifetime excess cancer risks based on maximum detected concentrations, regardless of depth, within each area. The process used to complete this assessment consisted of the following steps: data evaluation, exposure assessment, selection of screening criteria, and health risk estimate calculations. Each of these steps, and the results and the interpretation of the evaluation, are described in the following sections.

7.1.1 Data Evaluation

Data evaluation is the process of analyzing site characteristics and analytical data to identify data of sufficient quality for inclusion in a risk assessment, and based on these data, to identify chemicals to be evaluated in the risk assessment. Detailed discussions of site characteristics and available analytical data in each of the areas of interest at the Project Site are presented in previous chapters of this document. As discussed in Section 5.1 and Appendix C, the analytical data were reviewed and validated as part of the overall quality assurance program for the site investigation. The results of this process indicate that, with few exceptions, the data collected during the non-OE RI met the project objectives. In cases where data for specific samples were rejected, additional samples were collected, or the rejected data were not considered critical to the overall project objectives.

For the purposes of this screening-level assessment, all chemicals detected in validated soil, groundwater, and surface water samples collected at the Project Site are evaluated in the risk assessment, except as noted below.

Several petroleum hydrocarbon mixtures have been detected in soil samples collected at the Project Site (e.g., TEPH). Such measurements represent mixtures of chemicals that, because of their highly variable composition, do not have descriptive health criteria. Therefore, the toxicity of these mixtures is best described by the aggregate toxicity of key individual chemicals in the mixture, such as benzene, toluene, ethylbenzene, and xylene (BTEX); and PAHs. For the purposes of this risk assessment, and as is the practice in California (California Environmental Protection Agency, Department of Toxic Substances Control, 1994a), a quantitative evaluation of TEPH measurements was not conducted in this study; rather, individual measured constituents of the TEPH mixtures were evaluated.

With regard to inorganic chemicals, site-specific ambient samples were collected at the Project Site and analyzed for several naturally occurring metals (see Section 5.2). As shown in Tables 7-1 through 7-10, the maximum-detected inorganic concentration was compared to the 95th percentile of the site-specific ambient samples for each area of interest. If the maximum detected concentration was below the ambient value, the chemical was not evaluated further in the screening assessment for that area. This practice is consistent with DTSC guidance (California Environmental Protection Agency, Department of Toxic Substances Control, 1997). Four other inorganic chemicals (calcium, magnesium, potassium, and sodium) also were not further evaluated in any of the areas of interest, because these chemicals are not considered to be of human health concern at environmental concentrations.

7.1.2 Exposure Assessment

Exposure assessment is the process of measuring or estimating the intensity, frequency, and duration of human exposure to the COIs. Exposure assessment is conducted within the context of a Conceptual Site Model, which describes what is known about chemical sources, likely migration pathways, exposure routes, and possible exposure scenarios, under current and future conditions. The Conceptual Site Model developed for this site is presented on Figure 7-1.

Potential for exposure to site chemicals depends on current and future uses of the site. The Project Site is currently undeveloped. Future development plans call for the Ridge and North Valley areas of the site to be used for residential purposes; the remainder of the site will be maintained as open space. In addition, after OE and non-OE remediation of site soil, clean fill will be placed in the residential areas (14 feet in most areas, 4 feet minimum), which will substantially limit, if not prevent, future exposure to any residual levels of chemicals in site soil. Nevertheless, for purposes of this screening-level assessment, it was assumed that future residents would have frequent, long-term exposure to soil based on current conditions.

Under this assumption, future on-site residents could be exposed to chemicals detected in soil via incidental ingestion, dermal contact, and inhalation of vapors or resuspended particulates (i.e., dust). All of these pathways were considered in the screening assessment. Another possible exposure pathway for non-volatile compounds is ingestion of homegrown produce. There is considerable uncertainty associated with evaluating potential health risks from this exposure pathway, primarily due to the scientific community's limited understanding of the transport of chemicals in soil into plants. Given this considerable uncertainty, and the fact that a minimum of 4 feet of clean fill will be placed in the residential areas prior to redevelopment, ingestion of homegrown produce was not evaluated in this screening assessment. The exclusion of this pathway may underestimate the estimated potential noncancer hazard indices or excess cancer risks for some chemicals.

Shallow groundwater at the Project Site is not currently used for any purpose, and is not expected to be used in the foreseeable future due to limited groundwater occurrence and low formation permeability that does not yield sufficient quantities of water for drinking or irrigation purposes (see Section 4.4). Domestic water will be supplied to the future residential development from other sources. Surface water at the site is limited to the wetland in the South Valley, which is outside of the area to be developed for residential use. (Intermittent seeps are discussed within the context of groundwater samples.) Nevertheless, for purposes of this screening-level assessment, it was assumed that future residents would use either groundwater or surface water for domestic purposes at some time in the future. Under this assumption, future on-site residents could be exposed to chemicals detected in groundwater or surface water via ingestion, dermal contact, and inhalation of vapors (see Figure 7-1).

In addition to the future on-site residents described above, recreational users of the portions of the Project Site that will remain as open space may also be exposed to residual chemicals in soil via incidental ingestion, dermal contact, and inhalation of vapors or particulates, and residual chemicals in surface water via dermal contact and inhalation of vapors (see Figure 7-1). However, the extent of exposure to recreational users would be significantly less than that assumed for future on-site residents. Therefore, recreational users are not included in the quantitative portion of this screening assessment.

7.1.3 Selection of Screening Criteria

EPA Region IX PRGs for residential soil or tap water (U.S. Environmental Protection Agency, 2000a) were used to screen chemicals detected in soil or groundwater and surface water, respectively. PRGs combine current EPA toxicity values with standard exposure factors to estimate concentrations in environmental media (e.g., soil) that are protective of human health over a lifetime. The specific exposure factors used to calculate the PRGs for this evaluation are provided in Exhibit 4-1 of the PRG documentation issued by EPA Region IX in 1999 (U.S. Environmental Protection Agency, 1999a). Examples of these factors include a child soil ingestion rate of 200 mg per day, adult drinking water ingestion rate of 2 liters per day, exposure frequency of 50 days per year, and exposure duration of 30 years (6 years as a child, 24 years as an adult). PRGs are based on either noncancer or cancer effects; the lowest value is chosen as the final PRG for chemicals that may cause both types of effects.

The residential soil PRGs are appropriate for evaluating chemicals detected in soil in this assessment, because they assume continuous and long-term exposure to chemicals in soil via the same exposure pathways as identified in the Conceptual Site Model (i.e., ingestion, dermal contact, and inhalation of vapors or resuspended soil particulates [dust]). With regard to evaluating chemicals in groundwater and surface water, tap-water PRGs assume long-term exposure to chemicals in water via ingestion of drinking water at a rate of 2 liters per day and inhalation of vapors for volatile chemicals. The tap-water PRGs do not include potential exposure via dermal contact. Nevertheless, the tap-water PRGs are considered sufficiently conservative for purposes of this screening-level assessment. Using tap-water PRGs to evaluate surface water is very conservative, in that it assumes a person drinks 2 liters per day of surface water. This is an unrealistic assumption because surface water is limited to the wetland in the South Valley.

It should be noted that PRGs have not been developed for a number of chemicals detected in one or more areas of interest at the Project Site. For two chemicals (2,6-DNT and tetryl), PRGs were calculated according to EPA Region IX methodology using toxicity criteria from Cal/EPA (1994b). For the majority of the remaining chemicals, sufficient information was available to identify a surrogate PRG based on similarities in chemical, physical, and toxicological characteristics. Those chemicals for which insufficient information was available to identify a surrogate PRG were evaluated qualitatively in conjunction with the quantitative analysis for the other chemicals.

Finally, the PRGs for some of the inorganic chemicals lie near or below the estimated ambient concentrations for the Project Site. For example, the arsenic residential PRG of 0.39 mg/kg is significantly below the 95th percentile of the site ambient data of 18.2 mg/kg (see Section 6.1). Similarly, the 95th percentile of the site ambient data for iron in soil is 43,805 mg/kg, while the residential PRG is 23,000 mg/kg. Finally, the residential PRG for manganese of 1,800 mg/kg is only slightly greater than the 95th percentile of the site ambient data of 1,645 mg/kg. In these instances, it is often appropriate to modify the PRG to consider the ambient concentrations (Environmental Protection Agency, 2000a). However, for this assessment, the screening risk calculations were based on the residential PRG values without consideration of the ambient concentrations. When appropriate, calculations are presented both with and without the arsenic, iron, and/or manganese results. A more detailed evaluation of arsenic, iron, and manganese concentrations detected at the Project Site is provided in Appendix E and is discussed further in Section 7.1.4.11.

7.1.4 Screening-Level Health Risk Estimates for Soil

Screening-level estimates of potential human health risks associated with exposure to the chemicals detected in soil were calculated using the maximum detected concentration, regardless of depth, in each area of interest at the Project Site, along with residential PRGs.

Human health risk estimates were calculated in terms of noncancer hazard indices (HIs) for chemicals with PRGs based on noncancer effects, and in terms of theoretical lifetime excess cancer risks for chemicals with PRGs based on cancer effects. As described by EPA Region IX, these estimates were calculated according to the following equations:

Noncancer Hazard Index

$$HI = \frac{\max conc_a}{PRG_a} + \frac{\max conc_b}{PRG_b} + ... + \frac{\max conc_n}{PRG_n}$$

Excess Cancer Risk (ECR)

$$\text{ECR} = [(\frac{\max conc_a}{PRG_a}) + (\frac{\max conc_b}{PRG_b}) + ... + (\frac{\max conc_c}{PRG_c})]x10^{-6}$$

The results of this assessment for each area are summarized in Tables 7-1 through 7-10; the major findings for each area of interest are summarized below.

7.1.4.1 TNT Strips.

The estimated screening-level total excess cancer risk for the TNT Strips is 2x10-2, primarily due to TNT and 2,4-DNT (see Table 7-1). Other chemicals that contribute to the total excess cancer risk include arsenic, 2,6-DNT, TNT breakdown products (2-amino-4,6-dinitrotoluene, 2-amino-2,6-dinitrotoluene, or a combination of the two [reported as amDNTs]), and RDX. The estimated total excess cancer risk, excluding arsenic, is 2x10-2.

The estimated screening-level total noncancer HI for the TNT Strips is 7, primarily due to iron and manganese and, to a lesser extent, 2,3-dinitrobenzene. The estimated total noncancer HI, excluding iron and manganese, is 2.

Total phosphorus was detected at the TNT Strips at a maximum concentration of 485 mg/kg. A PRG has not been developed for this chemical; however, this value is only slightly greater than the 95th percentile of the site ambient data of 458 mg/kg. A more detailed evaluation of the distribution of total phosphorus in soil at the TNT Strips indicates that site soils have not been impacted by total phosphorus (see Section 6.2.1).

7.1.4.2 Howitzer Test Facility.

The estimated screening-level total excess cancer risk for the Howitzer Test Facility is 7x10-5, primarily due to arsenic and, to a lesser extent, dibenz(a,h)anthracene (see Table 7-2). The estimated total excess cancer risk, excluding arsenic, is 3x10-6.

The estimated screening-level total noncancer HI for the Howitzer Test Facility is 5, primarily due to iron and manganese. The estimated total noncancer HI, excluding iron and manganese, is 1.

Total phosphorus was detected at the Howitzer Test Facility at a maximum concentration of 1,470 mg/kg. A PRG has not been developed for this chemical, and this value is greater than the 95th percentile of the site ambient data of 458 mg/kg. However, as discussed in Section 6.2.2, a more detailed evaluation of the distribution of total phosphorus in soil at the Howitzer Test Facility indicates that site soils have not been impacted by total phosphorus.

7.1.4.3 North Valley Military Landfill.

The estimated screening-level total excess cancer risk for the North Valley Military Landfill is 6x10-5, primarily due to arsenic (see Table 7-3). The estimated total excess cancer risk, excluding arsenic, is 2x10-6.

The estimated screening-level total noncancer HI for the North Valley Military Landfill is 4, primarily due to iron and manganese. The estimated total noncancer HI, excluding iron and manganese, is 0.9.

2-hexanone was detected in one sample at the North Valley Military Landfill at a concentration of 0.018 mg/kg. A PRG has not been developed for this chemical; however, given that it was detected in only one sample at such a low concentration, 2-hexanone is not expected to contribute significantly to the overall heath risk estimated for this area.

7.1.4.4 Ammunition Renovation/Primer Destruction Site.

The estimated screening-level total excess cancer risk for the Ammunition Renovation/Primer Destruction Site is 7x10-5, primarily due to arsenic and, to a lesser extent, benzo(a)pyrene (see Table 7-4). The estimated total excess cancer risk, excluding arsenic, is 4x10-6.

The estimated screening-level total noncancer HI for the Ammunition Renovation/Primer Destruction Site is 6, primarily due to iron and manganese. The estimated total noncancer HI, excluding iron and manganese, is 1.

P-cymene (p-isopropyltoluene) was detected in one sample from the Ammunition Renovation/Primer Destruction Site at a concentration of 0.0037 mg/kg. A PRG has not been developed for p-cymene; however, given that it was detected in only one sample at such a low concentration, p-cymene is not expected to contribute significantly to the overall health risk estimated for this area.

7.1.4.5 Miscellaneous North Valley.

The estimated screening-level total excess cancer risk for the North Valley outside of the previously identified areas of interest is 1x10-4, primarily due to arsenic (see Table 7-5). The estimated total excess cancer risk, excluding arsenic, is 2x10-6.

The estimated screening-level total noncancer HI for the North Valley outside of the previously identified areas of interest is 2, primarily due to iron. The estimated total noncancer HI, excluding iron, is 0.04.

7.1.4.6 Flare Site.

The estimated screening-level total excess cancer risk for the Flare Site is 1x10-4, primarily due to arsenic and, to a lesser extent, dioxins (including dioxin and furan congeners) (see Table 7-6). The estimated total excess cancer risk, excluding arsenic, is 9x10-6.

The estimated screening-level total noncancer HI for the Flare Site is 40, primarily due to antimony, barium, copper, iron, lead, and manganese. The estimated total noncancer HI, excluding iron and manganese, is 30.

Total phosphorus was detected at the Flare Site at a maximum concentration of 614 mg/kg. A PRG has not been developed for this chemical; however, this value is only slightly greater than the 95th percentile of the site ambient data of 458 mg/kg, and a more detailed evaluation of the distribution of total phosphorus in soil at the Flare Site indicates that site soils have not been impacted by total phosphorus (see Section 6.4.1).

7.1.4.7 Demolition Site #1.

None of the PRGs for chemicals evaluated in the Demolition Site #1 are based on a cancer endpoint; therefore, no estimated screening-level excess cancer risk was calculated for this area. The estimated screening-level total noncancer HI for Demolition Site #1 is 2, primarily due to iron (see Table 7-7). The estimated total noncancer HI, excluding iron, is 0.05.

7.1.4.8 Demolition Site #3.

The estimated screening-level total excess cancer risk for Demolition Site #3 is 6x10-5, which is due entirely to arsenic (Table 7-8). Because arsenic is the only chemical evaluated in Demolition Site #3 with a PRG based on a cancer endpoint, an estimated total excess cancer risk, excluding arsenic, cannot be calculated for this area.

The estimated screening-level total noncancer HI for Demolition Site #3 is 4, primarily due to iron and manganese. The estimated total noncancer HI, excluding iron and manganese, is 0.5.

7.1.4.9 Miscellaneous South Valley.

None of the PRGs for chemicals evaluated in the South Valley outside of the previously identified areas of interest are based on a cancer endpoint; therefore, no estimated screening-level excess cancer risk was calculated for this area. The estimated screening-level total noncancer HI for the South Valley outside of the previously identified areas of interest is 0.5 (see Table 7-9).

7.1.4.10 McAllister Drive Land Bridge.

The estimated screening-level total excess cancer risk for the McAllister Drive Land Bridge is 5x10-7 (see Table 7-10). The estimated screening-level total noncancer HI for the McAllister Drive Land Bridge is 0.009.

7.1.4.11 Interpretation of Risk Estimates for Soil.

The significance of the screening risk estimates presented above must be evaluated within the context of the screening-level nature of this assessment. For example, the screening risk estimates are based on a hypothetical resident under current site conditions, and do not take into account that several areas of interest will never be used for residential purposes, and that much of the future residential area will be constructed on top of clean, imported fill material. Additionally, the screening risk estimates are based on the maximum detected concentrations within each area, regardless of depth. The format of this assessment is different than a typical baseline risk assessment because the purpose was to rapidly screen detected chemicals against risk-based criteria to identify chemicals for which remediation goals will be developed.

Within this context, several explosive compounds in the TNT Strips area; benzo(a)pyrene and dibenz(a,h)anthracene) in stockpiles in the Ammunition Renovation/Primer Destruction site or Howitzer Test Facility; and dioxins and furans, antimony, barium, copper, lead, and zinc in the Flare Site contributed most significantly to the screening risk estimates. Remediation goals are proposed for these chemicals in Section 7.3.

Arsenic, iron, and manganese also contributed significantly to the screening risk estimates in several areas of interest. Screening risk estimates for these chemicals in soil will be near or greater than common regulatory benchmarks (i.e., a noncancer HI of 1 or a theoretical lifetime excess cancer risk of 1x10–6), even if the detected concentrations are within the range of expected ambient concentrations. Therefore, it is important to determine whether on-site concentrations of these compounds are truly elevated or simply represent ambient conditions. A more detailed evaluation of arsenic, iron, and manganese concentrations detected at the Project Site is provided in Appendix E. Based on a weight-of-evidence approach, which included further statistical analysis, cumulative probability plots, comparison to background literature values, and an evaluation of spatial distribution, site soils do not appear to have been impacted by arsenic, iron, or manganese. Therefore, no remediation of soils containing arsenic, iron, or manganese is proposed at the Project Site.

7.1.5 Calculation of Screening-Level Health Risk Estimates for Groundwater and Surface Water

Screening-level estimates of potential human health risks associated with exposure to the chemicals detected in groundwater and surface water were calculated using the maximum detected filtered and unfiltered concentration in the North Valley or South Valley, along with EPA Region IX tap-water PRGs. For groundwater in the North Valley, data for samples collected from permanent monitoring wells were used in this assessment when available (see Section 5.6). The exception to this is the North Valley Military Landfill area, in which only grab groundwater samples were collected. As a result, the grab groundwater samples from the North Valley Military Landfill may not be representative of groundwater conditions in this area of the site. Data for intermittent seeps in the North Valley were also included in this evaluation. All of the seep samples collected from the North Valley were filtered prior to analysis for metals; therefore, the results for these samples may underestimate the concentration of metals in unfiltered samples. For groundwater in the South Valley, data for samples collected from permanent water wells and from an intermittent seep were used in this evaluation. For surface water, grab surface water samples from the South Valley wetland were used.

The results of this assessment for each area are summarized in Tables 7-11 through 7-13; the major findings are summarized below.

7.1.5.1 North Valley Groundwater.

The estimated screening-level total excess cancer risk for North Valley groundwater is 3x10-4 based on filtered samples and 4x10-4 based on unfiltered samples, primarily due to arsenic, and to a lesser extent, chloroform and 2,4-DNT (see Table 7-11). The presence of arsenic in these samples is likely associated with naturally occurring arsenic in soil (see Appendix E). Chloroform was detected in only one sample from monitoring well MW-4A during the April 2000 monitoring event, at a concentration of 2.9 µg/L chloroform was not detected in the sample collected from this well during the August 2000 monitoring event (PQL of 1 µg/l). In addition, 2,4-DNT was detected only in a grab groundwater sample collected from the North Valley Military Landfill; it was not detected in the well immediately downgradient of the landfill. Therefore, the presence of this chemical in this grab groundwater sample may not be representative of groundwater conditions at the Project Site (see Section 5.6.2).

The estimated screening-level total noncancer HI for North Valley groundwater is 7 based on filtered samples and 10 based on unfiltered samples, primarily due to thallium (filtered samples only), iron, and manganese. The presence of iron and manganese in these samples is likely associated with naturally occurring concentrations of these metals in soil (see Appendix E). Thallium was detected in only two filtered groundwater samples from the North Valley at concentrations of 3.1 and 5.8 µg/L. These values are only slightly greater than the PQL of 3 µg/L, and were qualified by the analytical laboratory as estimated values.

7.1.5.2 South Valley Groundwater.

The estimated screening-level total excess cancer risk for South Valley groundwater is 2x10-4 based on unfiltered samples, primarily due to arsenic; no carcinogenic chemicals were detected in the filtered samples (see Table 7-12). The presence of arsenic in these samples is likely associated with naturally occurring arsenic in soils (see Appendix E).

The estimated screening-level total noncancer HI is 3 based on filtered samples and 4 based on unfiltered samples, primarily due to thallium (filtered samples) or iron (unfiltered samples). As discussed previously, the presence of iron in these samples is likely associated with naturally occurring concentrations of iron in soil (see Appendix E). Thallium was detected in only one groundwater sample from the South Valley at a concentration of 3.1 µg/L. This value is only slightly greater than the PQL of 3 µg/L and was qualified as an estimated value by the analytical laboratory.

7.1.5.3 South Valley Surface Water.

The estimated screening-level total excess cancer risk for South Valley surface water is 1x10-6 based on either filtered or unfiltered samples (see Table 7-13). The estimated screening-level noncancer HI for South Valley surface water is 0.2 based on filtered samples and 0.8 based on unfiltered samples.

7.1.5.4 Interpretation of Risk Estimates for Groundwater and Surface Water.

As with the results of the screening assessment for chemicals detected in soil, the significance of the screening risk estimates presented above must be evaluated in context. Particularly important is the fact that shallow groundwater at the Project Site is not currently used for any purpose, and is not expected to be used in the foreseeable future, due to limited groundwater occurrence and low formation permeability that does not yield sufficient quantities of water for drinking or irrigation purposes. In addition, domestic water will be supplied to the residential development from other sources. Finally, surface water at the Project Site is limited to intermittent seeps and the wetland in the South Valley, which is outside the area to be developed for residential use. Use of the PRGs to evaluate the surface water pathway is very conservative because it assumes that a person drinks 2 liters per day of the surface water from the intermittent seeps and wetland.

Within this context, several chemicals in groundwater in the North Valley or South Valley, and in surface water seeps in the North Valley, contribute most significantly to the screening risk estimates. The majority of these chemicals are metals that may be attributable to ambient conditions. The other chemicals were detected infrequently or only in grab groundwater samples, and their presence in these samples may not be representative of groundwater conditions at the Project Site (see Section 5.6.2).

Based on these results, residual chemicals in groundwater and surface water do not appear to be of human health concern. General water quality will continue to be evaluated at the Site through a focused groundwater monitoring program. However, no further action with regard to the groundwater is required for protection of human health.

7.2 Ecological Screening Assessment

Potential ecological impacts associated with exposure to chemicals detected at the Project Site were evaluated through use of a screening assessment. This assessment was conducted in four steps: (1) wildlife habitats were identified that will remain on-site following post-grading and redevelopment activities (the areas of current and future habitat); (2) the chemicals measured in these habitats were identified; (3) risk-based criteria were developed for ecological receptors in the form of reference concentrations in soil, sediment or water that are protective of wildlife (for those chemicals for which toxicity data are available); and (4) maximum concentrations of the chemicals detected in the habitat areas of interest were compared to risk-based criteria for ecological receptors and other available data to identify chemicals for which ecological remediation goals are to be developed.

This screening-level ecological risk assessment was conducted using methods consistent with the Guidance for Ecological Risk Assessment at Hazardous Waste Sites and Permitted Facilities (California Environmental Protection Agency, 1996a). The format of this assessment is different than a typical ecological risk assessment because the purpose is to rapidly screen detected chemicals against risk-based criteria to identify chemicals for which remediation goals will be developed. The assessment is therefore chemical-specific, and multiple chemical exposures are not evaluated. As discussed in Section 7.4, a post-remediation risk assessment will be conducted that will address cumulative ecological impacts of residual chemicals at the Site.

7.2.1 Habitat Assessment

Previous assessments of habitat are described in Section 2.2.7. In addition, a recent reconnaissance of the Project Site was conducted to evaluate potential habitat areas that will remain following post-grading and redevelopment activities. Two habitat types were identified that will not be modified by the planned development activities and that have been investigated for possible site impact. These are the North Valley grassland areas and the freshwater marsh wetland area in the South Valley. The remainder of the site is either outside the area of the site investigation or covered by the planned development residential structures. It is these wildlife habitats of interest that were evaluated in this ecological screening assessment.

Previous investigations found no Federal or California listed special status species on the Project Site (Section 2.2.7.2). As discussed in the following sections, the ecological receptors of interest are the plant, invertebrate, bird, and mammal species commonly found in the habitats on the Project Site.

7.2.1.1 North Valley Grassland.

The hillside on the north slope of the North Valley of the Project Site is covered with non-native grassland vegetation. This non-native grassland habitat is dominated by introduced plant species such as wild oats, ripgut brome, red brome, foxtail barley, wild radish, and fennel (see Section 2.2.7.1). This habitat supports mammals and birds that feed on these plants, and other mammals, birds, and reptiles that feed on the invertebrates associated with soil and plants. It also supports the mammals, birds, and reptiles that prey on these species. Some of the species that compose the food web in this non-native grassland habitat are listed in Section 2.2.7.2. These include the pocket gopher, lesser goldfinch, and mule deer that feed on plants, and the coyote and red-tailed hawk, mammalian and avian predators, that might forage on small animal prey in this non-native grassland habitat. It is this type of food web and these types of species that are the focus of the ecological screening assessment for this non-native grassland habitat on the Project Site.

The TNT strips are the highly affected areas in this habitat. The strips make up a small portion (approximately 1 hectare) of the non-native grassland habitat on the Project Site and are not sufficiently large to constitute wildlife habitat themselves, or to substantially affect wildlife resources. However, these strips and the areas immediately surrounding the strips are the areas where some plant, soil invertebrate, and animal exposures to chemicals could potentially occur.

7.2.1.2 Freshwater Marsh Wetland and Surrounding Upland South Valley.

The unnamed creek in the South Valley of the Project Site supports willow riparian vegetation and a freshwater marsh. This wetland habitat consists mainly of freshwater marsh species such as cattail, bulrush, and tule (see Section2.2.7.1). The wetland likely supports fish and aquatic invertebrates, and mammalian and avian predators, such as raccoon and egrets that forage in this type of habitat. It is these types of species in the freshwater wetland food web that are the focus of the ecological screening assessment for this habitat. There are, however, areas of interest situated upslope of the wetland that are potential sources of chemicals to the wetland and these are described below.

The upland grassland on the hillside slopes surrounding the freshwater wetland provides habitat similar to that found on the north slope of the North Valley. This area is presumed to support a food web and species similar to those described for the North Valley non-native grassland habitat. This area of non-native grassland habitat contains three small areas of interest: the Flare Site, Demolition Site #1, and Demolition Site #3. Because each of these areas is small relative to general requirements for wildlife, their impact on wildlife resources is limited. However, as stated above, these areas are points of potential plant, invertebrate, and wildlife exposures.

7.2.2 Chemicals Evaluated

Four areas of interest were identified in the non-native grassland habitat in the North Valley and South Valley of the Project Site. These are the TNT Strips, Flare Site, Demolition Site #1, and Demolition Site #3. The chemicals evaluated in the ecological screening assessment for the grassland habitat were those detected in soil samples from these four areas, with the exception of calcium, magnesium, potassium, and sodium, which are essential elements and toxic to plants and animals only at relatively high levels. Also, petroleum mixtures, for which there are no appropriate toxicity criteria and for which individual constituents were screened, were not evaluated. Therefore, the list of chemicals evaluated consisted of all detected chemicals from the four areas, with the above-noted exceptions, and the screening concentrations were the maximum measured concentrations from samples in each of the four areas.

The chemicals evaluated in the freshwater wetland habitat were the chemicals detected in water and sediment in this habitat, with the same exceptions as noted above for soil. The screening values were the maximum measured concentrations of the chemicals in water and surface sediment samples.

7.2.3 Ecological Screening Criteria

As a basis for screening risks to ecological receptors, risk-based criteria were developed for chemicals in soil in the non-native grassland habitat, and water and sediment in the freshwater wetland habitat. Criteria were developed as reference concentrations of the chemicals in media (soil, water, or sediment) that are protective of ecological receptors that commonly come into contact with that medium or feed on biota that live in or on that medium. The criteria for soil were derived separately for four groups of ecological receptors: plants, soil invertebrates, mammals, and birds. As discussed further below, one of these four values was chosen for purposes of evaluating potential risks to terrestrial organisms. The criteria for water and sediment were derived separately for water-column and sediment-dwelling aquatic organisms. Finally, sediment criteria for birds were also derived for potentially bioaccumulative chemicals. The process used to develop these criteria is based on that described in the U.S. Environmental Protection Agency draft "Ecological Soil Screening Level Guidance" (U.S. Environmental Protection Agency, 2000b).

7.2.3.1 Soil Screening Criteria for Plants.

Plant protection screening criteria were taken from the "Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants: 1997 Revision" (Efroymson et al., 1997a). These criteria are based on data from toxicity studies in the field, or more commonly, in a greenhouse or growth chamber setting. In most cases, the concentrations reported from toxicity studies are nominal concentrations of a soluble form of the chemical added to the soil, or of the more soluble fraction of the chemical extracted from soil. In contrast, these criteria concentrations are generally compared to the "total" concentration of the chemical extracted with the most rigorous methods from soil collected at chemically affected sites.

Because of the great variety of soils, plant species, chemical forms, and test procedures, it is not possible to estimate concentrations that constitute thresholds of toxic effects in plant communities at specific sites from unrelated toxicity studies. Therefore, these criteria represent either the lowest observed effect concentration (LOEC), if 10 or fewer study values were available, or the 10th percentile LOEC value, if more than 10 values were available. The plant protection criteria available for the COIs in non-native grassland soils are shown in Appendix F, Table F-1.

These criteria concentrations were used to screen the risk of chemical exposures to plants. Soil and plant characteristics, and chemical form, greatly influence the toxicity of chemicals to plants and the difference in conditions between the toxicity studies and the site, if known, should be considered in interpreting comparisons of criteria and site soil concentrations. "If chemical concentrations reported in field soils that support vigorous and diverse plant communities exceed one or more of the benchmarks presented in this report or if a benchmark is exceeded by ambient concentrations, it is generally safe to assume that the benchmark is a poor measure of risk to the plant community at the site" (Efroymson et al., 1997a).

7.2.3.2 *Soil Screening Criteria for Invertebrates.*

The soil invertebrate screening criteria were taken from the "Toxicological Benchmarks for Contaminants of Potential concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process: 1997 Revision" (Efroymson et al., 1997b). The soil invertebrate screening criteria are based primarily on data from laboratory toxicity studies and sometimes field studies. As with the plant studies, the soil invertebrate screening criteria are generally based on nominal concentrations of the soluble form of the chemical, and these concentrations are compared to the "total" quantities of the chemical extracted from soil samples from the site.

Because of the diversity of soil invertebrate species, chemical forms, and test procedures, it is impossible to estimate concentrations that would represent thresholds for toxic effects on the invertebrate communities at a particular site from published toxicity data unrelated to that site. These criteria were derived from LOEC values in the same manner as described above for plants. Available criteria for chemicals in non-native grassland soils are presented in Appendix F, Table F-1.

These criteria are appropriate for screening purposes only. If chemical concentrations reported in soils that support many invertebrates exceed one or more screening criteria, or if a benchmark is exceeded by ambient soil concentrations, it is safe to assume that the screening criterion is a poor measure of risk to invertebrates at the site.

7.2.3.3 *Soil Screening Criteria for Mammals and Birds.*

Soil screening criteria for mammals and birds were calculated based on the approach and equations described in the EPA's draft "Ecological Soil Screening Level Guidance" (U.S. Environmental Protection Agency, 2000b). The screening criteria were back-calculated from a hazard quotient of 1.0, where the estimated exposure dose and dose associated with no adverse effects are equal. Generic food-chain models were used to estimate the relationship between the concentration of the COI in soil and the dose for the receptor (mg per kg body weight per day). The toxicity reference value (TRV) represents a receptor-class-specific estimate of a no-observed-adverse-effect level (NOAEL) as a dose of the chemical. For some chemicals, such as nitrite and total phosphorus, EPA has not established a TRV, because these compounds are not considered toxic to terrestrial animals. No published studies have been found where these chemicals have been evaluated in soils to assess toxicity to wildlife.

The equation used to back-calculate soil screening criteria concentrations is as follows:

$$Cs = TRV/[FIR \times (Ps + BAFs\text{-}b) \times (AUF)]$$

where:

Cs	=	Criteria chemical concentration in soil (mg/kg dry weight)
TRV	=	Toxicity reference value for chemical (mg/kg body weight[wet weight]/day])
FIR	=	Food ingestion rate (kg food dry weight/kg body weight [wet weight]
Ps	=	Soil ingestion as proportion of diet (unitless)
BAFs-b	=	Soil-to-biota bioaccumulation factor for the chemical and biota type (unitless).
AUF	=	Area use factor (unitless)

Soil screening criteria were calculated for a mammal species, the mule deer, that feeds primarily on plants and is commonly found at the Project Site. Screening criteria were also calculated for a bird species, the red-tailed hawk. This hawk species is a predator that feeds on small mammals, has been observed foraging at the Project Site, and is a species identified in the Ecological Soil Screening Level Guidance. The selected species are commonly found on the Project Site, and they represent feeding strategies common to the grassland animal community (grazing on plants and preying on small mammals); they also represent two different trophic levels of the grassland food web.

The TRVs and exposure parameters used in the above equation for the deer and hawk were taken from published sources. The TRVs are primarily from the "Toxicological Benchmarks for Wildlife: 1996 Revision (Sample et al., 1996) and "Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities" Peer Review Draft (U.S. Environmental Protection Agency, 1999b). These TRVs were developed prior to a recent request to consider Biological Technical Assistance Group (BTAG) TRVs (California Environmental Protection Agency, 2000). A comparison of the TRVs used in this assessment to the BTAG values is presented in Appendix F, Table F-2. As shown in the table, the only difference that would arise from using the BTAG TLVs would be the identification of manganese as a chemical to be evaluated for soil. However, as discussed in Appendix E, site soils do not appear to have been impacted by manganese. The FIR for the deer is from an allometric equation in the EPA (1999b). The FIR for the hawk is from "Ecological Soil Screening Level Guidance" Draft (U.S. Environmental Protection Agency, 2000b). Ps and BAF values are from the EPA (1999b and 2000b). The AUF was set to 1 for back-calculating screening criteria, based on a conservative assumption that all foraging is in the affected area. Specific input values, calculation spreadsheet and soil screening criteria values for mammals and birds are provided in Appendix F, Tables F-3 and F-4, respectively.

7.2.3.4 Water Screening Criteria for Freshwater Organisms.

Screening criteria for the protection of freshwater organisms were taken primarily from the "National Recommended Water Quality Criteria- Correction" (U.S. Environmental Protection Agency, 2000c). The criteria have been adopted by the State of California (U.S. Environmental Protection Agency, 2000c). The Continuous Chronic Concentration (CCC) is an estimate of the highest concentration of a material in surface water to which an aquatic community can be exposed indefinitely without resulting in an unacceptable effect. These criteria are generally compared to the dissolved chemical concentrations measured in site surface water samples. The screening criteria for water for chemicals detected in surface water samples in the freshwater wetland are shown in Appendix F, Table F-5.

7.2.3.5 Sediment Screening Criteria for Sediment-Dwelling Organisms.

The screening criteria for sediment-dwelling organisms were taken from a compilation of sediment quality benchmarks for freshwater sediments in "Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Sediment-Associated Biota: 1997 Revision (Jones et al., 1997). The specific screening criteria are from the Assessment and Remediation of Contaminated Sediment (ARCS) Project (U.S. Environmental Protection Agency, 1996a) threshold effect concentration (TEC) and the Ontario Ministry of the Environment low-effect level (Low) (Persaud et al., 1993). The TEC values were calculated from laboratory data on the toxicity of chemicals in 62 sediment samples and represent the highest no-effect concentrations for the chemicals, with a minimum requirement that the percent false negatives be less than 25 percent. The Low is a lowest-effect level and represents the 5th percentile of the screening-level concentrations. The sediment screening criteria for chemicals detected in surface sediment samples in the freshwater wetland are shown in Appendix F, Table F-6.

7.2.3.6 Sediment Screening Criteria for Birds.

For those chemicals in sediment that are potentially bioaccumulative [benzo(b)fluoranthene, methyl mercury, and TNT], screening criteria were developed for birds that feed on sediment-dwelling invertebrates if sufficient toxicity information was available. Invertivorous birds are likely the most highly exposed group foraging in wetlands because they consume both sediment and the organisms that live in sediment when feeding. There are no data on species feeding on invertebrates in the South Valley wetlands on the Project Site. Therefore, the spotted sandpiper, a species common to the region and often evaluated in risk assessments, was selected to represent birds that forage in sediment.

The equation used to back-calculate sediment screening criteria is the same as that described previously for developing soil screening criteria for birds and mammals (Section 7.2.3.3). The data for the sandpiper were taken from the "Wildlife Exposure Factors Handbook" (U.S. Environmental Protection Agency, 1993c) and the "Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities" (U.S. Environmental Protection Agency, 1999b). The TRVs for birds were also taken from the EPA (1999b). The sediment screening criteria for chemicals detected in surface sediment samples in the freshwater wetland are shown in Appendix F, Table F-7.

7.2.3.7 Selection of Final Screening Criteria.

When appropriate data were available, soil reference concentrations were developed for plants, soil invertebrates, and representative mammal and bird species. For some chemicals, there are no appropriate criteria, while for others, there are one to four values for ecological receptors that could be applied in the screening assessment. In addition, because criteria are developed largely from laboratory studies of unknown relevance to the Project Site, and because many of the chemicals detected are natural constituents in soil, a comparison of the screening criteria concentrations with ambient concentrations is necessary to identify unrepresentative values. The most relevant criterion for each chemical was identified using the evaluation process described in Figure 7-2. If the chemical is not a natural constituent of soil and no ambient data are available, then the minimum criterion (lowest concentration) was identified as the screening criterion. If Project Site ambient data were available, then the screening criteria for each receptor were compared to the ambient concentrations, and the lowest criterion above the ambient concentration was selected as the screening criterion for ecological receptors. If none of the criteria were above the ambient concentration, then the ambient concentration was identified as the screening criterion. If no relevant criteria were found for a chemical, then it was evaluated qualitatively to determine whether it should be considered further in this screening assessment.

Only a single criterion for aquatic organisms was identified for water and sediment, respectively. The identified criteria for water and sediment for aquatic organisms were applied in the screening evaluation. With regard to sediment criteria for birds, only a screening criterion for methyl mercury was developed. No relevant toxicity data were available for the other bioaccumulative chemicals detected in sediment at the site. These chemicals were evaluated for aquatic organisms as described below.

7.2.4 Comparison of Site Chemical Concentrations with Ecological Screening Criteria

The maximum concentrations of chemicals detected in soil (regardless of depth), surface water (filtered samples), and sediment (0 to 1 feet bgs) were compared to their respective screening criteria. If the maximum detected concentration exceeded the screening criterion, then the chemical was identified as one to be considered in developing remediation goals for ecological receptors. If the maximum detected concentration was less than the criterion, then the chemical was eliminated from the evaluation. Finally, chemical concentration patterns, co-occurrence with other selected chemicals, and source information were evaluated prior to selecting chemicals for which ecological remediation goals are to be developed. Chemicals for which no screening criteria could be identified were not included in the quantitative screening evaluation, but were assessed qualitatively to determine whether they should be evaluated further. The results of the screening assessment are presented in the following sections, by medium and area of interest.

7.2.4.1 TNT Strips.

For the TNT Strips, concentrations of 1,3-dinitrobenzene, 2,4,6-trinitrotoluene (TNT), and 2,4-dinitrotoluene exceeded criteria for ecological receptors based on the screening evaluation and were retained for development of remediation goals, 2,6-dinitrotoluene, 2-amino-4,6-dinitrotoluene, hexahydro-1,3,5-trinitro-1,3,5,7-tetraocine, nitrobenzene, and tertyl were eliminated from further consideration (Table 7-14). The remaining explosive compounds for which no screening criteria were found were selected as chemicals to be evaluated further for ecological receptors. However, these chemicals were found with TNT and in relatively low concentrations compared to TNT, and therefore do not require the development of quantitative targets to guide remediation of explosive compounds. Because TNT is generally found jointly with the other detected explosive chemicals, and at much higher concentrations, TNT was selected as the representative explosive chemical for which a remediation goal will be established.

No PAH compounds were identified for further consideration as a result of the screening. The PAH compounds for which no criteria were found were detected at low levels and below the most stringent criterion for a compound in this class. The PAH compounds were therefore eliminated from further consideration.

The only inorganic chemical that exceeded its respective screening criterion is aluminum. For this chemical, all screening criteria were below the ambient concentration; therefore the ambient concentration was identified as the screening criterion and the maximum aluminum concentration exceeded the ambient concentration. This situation occurs frequently in these types of evaluations. Aluminum is the most common metallic element in the earth's crust, and the concentrations of aluminum in soils vary widely from 10,000 to 300,000 mg/kg (Dragun, 1988). Total aluminum is not correlated with toxicity to plants or soil invertebrates. The Ecological Soil Screening Level Guidance indicates that aluminum should be identified as a chemical for evaluation only for those soils with soil pH values less than 5.5 (U.S. Environmental Protection Agency, 2000b). Therefore, aluminum was not considered for further evaluation at this Site, where the soil pH is expected to be in the neutral range.

There are no ecological screening criteria for iron or total phosphorus. Iron is another common constituent in soil that is found at percent levels that vary widely for different soils. As with aluminum, iron is not very bioavailable in neutral and basic pH soils (U.S. Environmental Protection Agency, 2000b), and therefore, it was not selected for further evaluation. Finally, phosphorus is an essential nutrient for plants, and phosphorus as phosphate in soil is generally not considered toxic to terrestrial animals in risk assessments. Therefore, total phosphorus also was eliminated from further consideration.

7.2.4.2 Flare Site.

Eight metals had concentrations that exceeded screening criteria at the Flare Site based on the evaluation (Table 7-15): aluminum, antimony, barium, copper, lead, molybdenum, mercury, and zinc. Aluminum was discussed in the previous section and was eliminated from further consideration based on EPA guidance (U.S. Environmental Protection Agency, 2000b). Of the remaining metals, there are two, mercury and molybdenum, for which the maximum measured concentrations were only slightly higher than their respective ecological screening criteria (0.59 to 0.3 mg/kg for mercury and 4.5 to 2.0 mg/kg for molybdenum). The 95 percent upper confidence limit of the mean mercury concentration in Flare Site soils was 0.14 mg/kg. This value is below the lowest ecological screening criterion (for plants) and more than 1000 times below the screening criteria for mammals and birds. Therefore, mercury was not selected for further evaluation in Flare Site soil. Similarly, the maximum reported concentration for molybdenum, 4.5 mg/kg, appeared to be anomalous and was the only value greater than the minimum ecological criterion, which is for the protection of plants. As discussed in Section 6.4.1, there was no statistically significant difference between molybdenum concentrations detected in the Flare Site soils and the ambient samples. Therefore, molybdenum also was eliminated from further consideration.

No criteria were found for iron or total phosphorus, as noted in the discussion for the TNT Strips, and for the reasons previously presented, iron and total phosphorus were eliminated from further consideration. Similarly, no criteria were found for nitrite. The maximum measured concentration of nitrite was very low (0.23 mg/kg); therefore, this compound also was eliminated from further consideration.

Based on the evaluation for the Flare Site, antimony, barium, copper, lead, and zinc were selected as chemicals for which a remediation goal will be established.

7.2.4.3 Demolition Site #1.

No chemicals in soil in Demolition Site #1 were identified that require further ecological evaluation (Table 7-16). As with the TNT Strips and the Flare Site, the maximum concentration of iron exceeded the ambient concentration; however, as stated above, iron is not very bioavailable in neutral-pH soils and therefore was not considered further in this evaluation. Similarly, nitrite was detected at very low concentrations (maximum of 0.17 mg/kg) that do not warrant further evaluation.

7.2.4.4 Demolition Site #3.

Mercury was the only chemical to exceed the screening criterion in Demolition Site #3 and was selected as a chemical for which a remediation goal will be established (Table 7-17). Again, iron could not be screened because of a lack of appropriate ecological criteria, but for the previously stated reasons, iron was eliminated from further consideration.

7.2.4.5 Surface Water.

The screening evaluation identified concentrations of aluminum in surface water above the water quality criterion (Table 7-18). As noted above for soil, aluminum poses a threat to aquatic organisms only in low-pH and low-hardness waters. The screening criterion for aluminum is from a toxicity study performed at low pH and hardness. The wetland water is believed to have a neutral pH (based on measurements of site groundwater that showed pH of between 7 and 8) and hardness of approximately 400 mg/L as CaCO3 (based on measurements of calcium and magnesium in surface water). Therefore, aluminum was not selected for further evaluation. No screening criteria were found for barium, manganese, and vanadium. These chemicals occur naturally in surface waters and do not appear to be at elevated levels in the wetland water or soils in areas of interest surrounding the wetland. Therefore, these chemicals were not considered for further evaluation.

No chemicals detected in surface water were selected as chemicals for which remediation goals will be established.

7.2.4.6 Sediment.

The screening evaluation identified copper, iron, manganese, and mercury as having concentrations above sediment quality criteria for sediment-dwelling organisms (Table 7-19); however, the exceedance of a screening criterion in sediment is insufficient evidence by itself to warrant remediation. For example, the maximum detected concentration of copper in sediment (51.7 mg/kg) is less than the ambient soil concentration (71.7 mg/kg), suggesting that sediment has not been impacted by copper. Iron was eliminated from further evaluation for the same reasons as described previously for iron in soil (i.e., iron normally occurs in percent levels and is generally only bioavailable [and potentially toxic] under acidic [low pH] conditions). For manganese, the maximum detected concentration in sediment is essentially equivalent to its sediment quality criterion; other sediment samples contained manganese at concentrations well below the screening criterion. With regard to mercury, only three of ten surface sediment samples had concentrations that exceeded the screening criterion of 0.2 mg/kg. The average mercury concentration in these samples is approximately 0.3 mg/kg, which is only slightly greater than the screening criterion. In addition, mercury was selected as a chemical for which a remediation goal will be established for affected soil upland of the South Valley wetland. Therefore, remediation of mercury in sediment is not proposed. Finally, the inorganic chemicals detected for which no sediment criteria were found appeared to be at relatively low levels in sediment, were not selected for evaluation in adjacent soil and therefore, were not selected for further evaluation in sediment.

Three of the chemicals in sediment were considered to be potentially bioaccumulative (benzo([b]fluoranthene, methyl mercury, and 2,4,6-TNT). These chemicals were evaluated for birds foraging in sediment (Appendix F, Table F-7). No relevant toxicity data were available for TNT and benzo(b)fluoranthene; however, these chemicals were found at low concentrations in sediment and below screening criteria for aquatic organisms. The maximum concentration of methyl mercury was below its screening criterion, indicating that the risk of bioaccumulation from sediment is negligible (see Table 7-19). No bioaccumulative chemicals in sediment were selected as chemicals for which remediation goals will be established.

7.3 SOIL REMEDIATION GOALS

As presented in Section 7.1, some current concentrations of several explosive compounds in soil in the TNT Strips area; benzo(a)pyrene and dibenz(a,h)anthracene) in soil stockpiles in the Ammunition Renovation/Primer Destruction Site or Howitzer Test Facility; and dioxins/furans, antimony, barium, copper, lead, and zinc in soil in the Flare Site may pose a potential human health risk under the conservative baseline residential conditions. In addition, some current concentrations of several explosive compounds in soil in the TNT Strips area; antimony, copper, lead, mercury, and zinc in soil in the Flare Site, and mercury in soil in the Demolition Site #3 area may pose a potential risk to ecological receptors using conservative ecological screening criteria (see Section 7.2). Based on the results of these screening-level assessments, soil remediation goals are proposed for these chemicals to ensure protection of human health and the environment, as described in the following sections. The proposed soil remediation goals for metals, non-explosive organic compounds, and explosives compounds are presented in Sections 7.3.1, 7.3.2, and 7.3.3, respectively.

7.3.1 Soil Remediation Goals for Metals

The proposed soil remediation goals for the metals detected at concentrations greater than human health and/or ecological screening criteria will be the calculated upper tolerance limit (UTL) of the ambient soil samples, as presented in Appendix E. As shown below, these calculated UTL values are significantly below the EPA Region IX PRGs for residential soil, assuming exposure pathways relevant to future development of the site (i.e., incidental soil ingestion, dermal contact, and inhalation of dusts).

Metal	Estimated UTL of Ambient Samples[a] (mg/kg)	Residential PRG (mg/kg)
Antimony	4.5	31 nc
Barium	642	5,400 nc
Copper	101	2,900 nc
Lead	148	400 nc
Mercury	0.77	23 nc
Zinc	142	23,000 nc

Note: (a) See Appendix E.
mg/kg = milligrams per kilogram
nc = PRG based on noncancer effects
PRG = preliminary remediation goal
UTL = Upper Tolerance Limit

These UTLs are also significantly below the screening criteria for ecological receptors for antimony, copper, lead, and zinc, and are clearly also protective of ecological receptors. The UTLs for barium and mercury are slightly above the screening criteria for these metals (642 to 500 mg/kg for barium, and 0.77 to 0.3 mg/kg for mercury). The lowest screening criteria for these metals are from plant studies. The applicability of these generic screening criteria to the Project Site is unknown, but there is substantial vegetation covering both the Flare Site and Demolition Site #3. The other available screening criterion for barium is 3489 mg/kg, which is based on birds, and the other available screening criteria for mercury are 534 mg/kg and 238 mg/kg, which are based on birds and mammals, respectively. These criteria are well above the UTLs, indicating that the proposed remediation goals are protective of these ecological receptors. The small difference between plant criteria and the UTLs, and the large margin of protection that the UTLs afford mammals and birds, suggests that the proposed soil remediation goals for these metals are sufficiently protective for ecological receptors.

The remediation goals will be applied by comparing individual sample results of excavation confirmatory samples to the proposed remediation goals.

7.3.2 Soil Remediation Goals for Non-Explosive Organic Compounds

Benzo(a)pyrene and dibenz(a,h)anthracene were detected above their respective PRGs in the stockpiled soil situated in the Ammunition Renovation/Primer Destruction Site and Howitzer Test Facility, respectively. These stockpiles will be removed as part of the planned remediation and remediated to non-detect concentrations. Neither of these chemicals were identified as being of potential concern for ecological receptors.

Dioxins and furans were detected above PRGs only at the Flare Site; dioxins and furans in this area will be remediated to ambient levels. Dioxins and furans were not identified as being of potential concern for ecological receptors in any of the areas of interest at the Project Site. Results of numerous environmental studies indicate that virtually all areas in the western world have measurable concentrations of dioxins in soil. Even areas that are not considered to be affected by human activities show some levels of dioxins (U.S. Environmental Protection Agency, 2000d). EPA reported background soil concentrations for dioxins (in terms of 2,3,7,8-TCDD toxicity equivalents [TEQ] and the 1998 World Health Organization [WHO] TEFs) ranging from 1 pg/g to 6 pg/g (0.000001 mg/kg to 0.000006 mg/kg) for rural areas, and 7 pg/g to 20 pg/g (0.000007 mg/kg to 0.00002 mg/kg) for urban areas (U.S. Environmental Protection Agency, 2000e). The estimated mean values were approximately 4 pg/g (0.000004 mg/kg) and 12 pg/g (0.000012 mg/kg) for rural and urban areas, respectively (U.S. Environmental Protection Agency, 2000d). Based on this information, and given that the site is situated in an urban area, the soil remediation goal for dioxins is 12 pg/g (0.000012 mg/kg). This value will be applied by comparing individual sample results (in terms of 2,3,7,8-TCDD TEQ) of excavation confirmatory samples to the proposed remediation goal.

As stated previously, individual petroleum hydrocarbon constituents were evaluated in the screening-level assessment presented in Section 7.1, rather than aggregate measurements of petroleum hydrocarbon mixtures. Although health-based remediation goals cannot be estimated for the various TEPH mixtures detected at the Project Site, the San Francisco Bay RWQCB is currently using a screening value for TEPHs (as diesel, motor oil, or gasoline) of 500 mg/kg for residential land use for exposed soil. Only two soil samples collected at the Project Site contained petroleum hydrocarbons at concentrations greater than 500 mg/kg. The higher of these values is 1,400 mg/kg (quantified as unknown extractable hydrocarbons) in a composite soil sample (SP1-R2) from Stockpile #1 in the Ammunition Renovation/Primer Destruction Site. As stated previously, this soil stockpile will be removed as part of the planned development of the site. The other value is 630 mg/kg (quantified as diesel) in a sample from a borehole (AR-3) in the Ammunition Renovation/Primer Destruction Site collected from 17.5 feet bgs. Petroleum hydrocarbons in the diesel range were not detected in other samples collected from this location, nor were petroleum hydrocarbons in the diesel, motor oil, or kerosene ranges detected in groundwater samples collected from wells MW-1 and MW-7 in the vicinity of the Ammunition Renovation/Primer Destruction Site. Although no specific remediation goal for petroleum hydrocarbons is necessary due to the limited presence of petroleum hydrocarbons in the diesel range above 500 mg/kg in Project Site soil, and the lack of impact in surrounding groundwater, a soil remediation goal of 500 mg/kg for TEPH is proposed. The remediation goal will be applied by comparing individual sample results from the post-point clearance investigation to the proposed remediation goal.

7.3.3 Soil Remediation Goals for Explosive Compounds

7.3.3.1 Residential Remediation Goals.

A variety of explosive compounds have been detected above their respective PRGs in the TNT Strip area. Of these compounds, TNT was detected most frequently and at the highest concentrations (up to percent levels immediately along the TNT Strips). A remediation goal of 16 mg/kg is proposed for TNT, based on standard residential default exposure parameters (U.S. Environmental Protection Agency, 2000a), assuming exposure via incidental ingestion, dermal contact, and inhalation of particulates. This value is equal to the EPA Region IX PRG for residential soil (U.S. Environmental Protection Agency, 2000a). In addition, soil will be remediated to non-detect for 2,6-DNT, because the health-based remediation goal for this chemical (0.02 mg/kg), which was calculated based on Cal/EPA's recommended toxicity criterion and EPA's standard residential default exposure parameters, is below the analytical PQL. The calculation of these values is shown in Table 7-20. The remediation goals will be applied by comparing individual sample results from excavation confirmatory samples to the proposed remediation goals.

Individual remediation goals for all other remaining explosive compounds are not recommended at this time. As described below, an assessment of residual risks, assuming that removal of TNT greater than 16 mg/kg and removal of detectable levels of 2,6-DNT indicates that the cumulative risk from all explosive compounds is likely to be below de minimus risk levels. Therefore, it is appropriate to focus the remediation effort based on the remediation goals of 16 mg/kg for TNT and non-detect for 2,6-DNT.

Existing data for explosive compounds in the TNT Strips area were used to estimate potential cumulative health risks, assuming that the proposed remediation targets of 16 mg/kg for TNT and non-detect for 2,6-DNT are achieved. This assessment was based on estimates of post-remediation representative concentrations and EPA Region IX PRGs for residential soil (U.S. Environmental Protection Agency, 2000a). Estimates of post-remediation representative concentrations were based on the 95 percent upper confidence limit (UCL) of the arithmetic mean for soil that would remain following remediation (U.S. Environmental Protection Agency, 1992b). If the 95 percent UCL of the mean was greater than the maximum detected concentration, then the maximum detected concentration was used. A value of one-half the reporting limited was used for non-detect results (California Environmental Protection Agency, 1992; U.S. Environmental Protection Agency, 1992b). It is important to note that revised estimates of post-remediation representative concentrations will be calculated for purposes of the post-remediation risk assessment (see Section 7.4).

Estimates of cumulative post-remediation risks were calculated in terms of noncancer HI indices for explosive compounds with PRGs based on noncancer effects, and in terms of theoretical lifetime excess cancer risks for explosive compounds, with PRGs based on cancer effects. Chemicals that may cause both noncancer and cancer effects were included in both cumulative risk estimates. As discussed previously, PRGs have not been developed for several of the explosive compounds. For two of these compounds (2,6-DNT and tetryl), PRGs were calculated according to EPA Region IX's methodology using toxicity criteria developed by Cal/EPA (1994b). For the remaining compounds, surrogate PRGs were identified based on similarities in chemical, physical, and toxicological characteristics. As shown in Table 7-21, the estimated cumulative post-remediation noncancer HI is 0.6, and the estimated cumulative post-remediation excess cancer risk is 2x10-6. These results suggest that the cumulative risks from all explosive compounds after remediation of site soil to target remediation goals are not likely to be of concern

7.3.3.2 Recreational Remediation Goals.

The planned development calls for an open hillside in the area of former TNT Strips #1 through #3; the backyards of some of the homes will border this area. As described above, the TNT Strips that overlie areas to be developed for residential use will be remediated to 16 mg/kg for TNT and to non-detect for 2,6-DNT. In locations away from the immediate area of the TNT Strips (e.g., the top of the hillside ridge), a remediation goal of 53 mg/kg is proposed for TNT. This value is based on recreational rather than residential exposure parameters, assuming exposure via the same pathways as the residential scenario (i.e., incidental ingestion, dermal contact, and inhalation of soil particulates). Both an adolescent recreation scenario (i.e., a 5- to 17-year-old adolescent with a soil ingestion rate of 120 mg/day, exposed skin area of 3300 cm^2, an exposure frequency of 260 days/year, exposure duration of 12 years, and body weight of 36 kg) and an adult recreation scenario (standard adult exposure assumptions with a frequency of one day per week for 52 weeks per year) were evaluated. The lower of the two values, which is associated with the adolescent scenario, was chosen as the remediation goal. The recreational remediation goal for 2,6-DNT is also non-detect, because the calculated value of 0.066 mg/kg is below the analytical PQL. Although it is possible that future adult residents living adjacent to the open hillside may use this area more frequently than one day per week, the resulting remediation goal would still be higher than for the youth recreational scenario. The calculation of the recreational remediation goals is presented in Table 7-22. The remediation goals will be applied by comparing individual sample results from excavation confirmatory samples to the proposed remediation goals.

7.3.4 Ecological Remediation Goals

Based on the screening evaluation, the most sensitive receptors to TNT exposure are mammals. This screening evaluation suggested that a deer population that foraged solely on the TNT Strips should not be exposed to a reference concentration greater than 10 mg/kg. Assuming that all foraging is on vegetation from the TNT strips is unrealistic, because most herbivorous mammal populations forage over much larger areas. The home range for deer has been estimated to be from 59 to 520 hectares (Sample and Suter, 1994). If the TNT-impacted area on the Project Site were from 1 to 2 hectares, then a conservative area use factor for deer would be 30 (59 hectares range/2 hectares on site). Applying the area use factor of 30 to the screening criterion of 10 mg/kg gives a representative remediation target for mammals of 300 mg/kg.

The screening criterion for TNT and plants is 30 mg/kg. However, as stated previously, soil and plant characteristics greatly influence the toxicity of chemicals to plants. Therefore, a site-specific evaluation of plants in the TNT Strips area was conducted by Wetlands Research Associates, Inc. in May 2001. The results of this evaluation are summarized in their report, which is included in Appendix F, Attachment F-1. As described in their report, the purpose of this analysis was to compare characteristics of vegetation at locations with varying TNT concentrations. Quantitative measurements of vegetative characteristics, including plant species composition, plant height, and areal cover, were made to identify variations in growing conditions that result from TNT concentrations. The results of this evaluation indicate that a site-specific remediation target for plants would be 1000 mg/kg, because plants are unaffected by TNT concentrations up to this level (see Appendix F).

The screening criterion for TNT and soil invertebrates is 140 mg/kg. There are currently no evaluations of the applicability of this generic criterion to the Project Site. If this generic criterion is assumed to be representative, then 140 mg/kg is the lowest applicable ecological criterion, and this value could be used as the soil remediation goal that would be protective of ecological receptors. However, because the soil remediation goals derived for protection of human health are lower than the ecological remediation goal, the human health goals will be applied to the site.

7.4 POST-REMEDIATION RISK ASSESSMENT

A post-remediation risk assessment will be conducted to ensure that the residual chemical concentrations are protective of human health and the environment. The post-remediation risk assessment will be based on data collected from confirmation samples and in areas that were not remediated, and will be completed in accordance with standard state and federal guidance for baseline risk assessments.

The post-remediation risk assessment will differ from the screening-level assessments presented herein in several important ways. For example, post-remediation chemical concentrations used to evaluate residual risks to human health will be based on the 95 th percent upper confidence limit of the arithmetic mean, rather than the maximum detected concentration (U.S. Environmental Protection Agency, 1992b), taking into account the size of the potential exposure area (e.g., the size of residential lots in the future residential area). In addition, areas of the site that will remain as open space, as specified through institutional controls, will be evaluated based on a recreational scenario rather than a residential scenario. With regard to ecological receptors, the post-remediation risk assessment also will be based on average rather than maximum concentrations, and will take into account the other site-specific issues such as home range. The assessment will evaluate cumulative human health and ecological risk from all complete exposure pathways.

The post-remediation risk assessment will be used to help identify any additional areas requiring evaluation, if necessary, and to identify the final clean-up levels for the Project Site that are protective of human health and ecological impacts.

8.0 NON-OE REMEDIAL INVESTIGATION CONCLUSIONS

The objective of the non-OE RI was to evaluate, to the extent practicable using ordnance avoidance techniques in most areas, the nature and extent of COIs (excluding OE) that may have affected the soil, sediment, surface water, and/or groundwater as a result of activities at the Project Site so that appropriate remedial action alternatives could be evaluated in the FS. The ultimate goal is to remediate portions of the Project Site to levels acceptable for residential land use and the remainder of the Project Site for open space use. This objective has been achieved using the following RI process, as presented in detail in this report.

- Regional and Project Site information, including environmental setting, geology, hydrology, hydrogeology, history of DOD-related and other activities at the Project Site, and past grading activities were researched and documented.

- Data from previous environmental, geotechnical, and geological investigations were compiled and evaluated.

- COIs and areas of interest were identified, and a Conceptual Source and Transport Model was developed accordingly, including the definition of transport pathways.

- An iterative sampling and analysis program was developed and implemented for the areas of interest, as well as for other areas of investigation; the COIs, location, and/or dimensions of the areas of interest, and Conceptual Site Model were refined, as necessary, between each investigative phase.

- The analytical results of the sampling and analysis program were compiled in a database, reviewed for quality, summarized on figures and tables, and described.

- The analytical data developed by the non-OE RI were evaluated in the context of the Conceptual Source and Transport Model for the areas of interest and areas of investigation to delineate the horizontal and vertical extent of the COIs in soil, sediment, surface water, and groundwater, to the extent necessary to evaluate health risks and remedial action alternatives.

Human health and ecological screening level risk assessments were performed based on current site conditions assuming a residential scenario in all areas of interest. Associated human health risk estimates were calculated based on the maximum detected concentration within each area, and an ecological screening assessment was performed. Results of the human health and ecological screening assessment were used to identify chemicals to be remediated. With regard to the human health screening assessment, chemicals contributing to risk screening estimates greater than benchmark levels of 1 x 10-6 or an HI of 1 were generally selected for remediation. Exceptions to this as a general rule are arsenic, iron, and manganese, for which it is commonly acknowledged that even at naturally occurring ambient concentrations, screening assessment risk estimates and HI values will be above benchmark levels. The analysis in Appendix E indicates that concentrations of these metals detected at the site represent naturally occurring levels. With regard to the ecological screening assessment, chemicals exceeding screening criteria and found to warrant further consideration were selected for remediation. Remediation goals were proposed for these chemicals that are protective of both human and ecological receptors.

The above process has allowed a delineation of the nature and extent of DOD-related and other impacts at the Project Site such that appropriate remedial action alternatives could be evaluated in the FS. Certain areas of interest still lack full definition with regard to the extent of the COIs as a result of the use of ordnance avoidance techniques for field investigation activities. Therefore, additional investigations are planned after the sitewide OE point clearance (see Table 8-1).

The following specific conclusions are presented, which are based on the non-OE RI data, with respect to the nature and extent of impact for each area of interest and other areas of investigation defined in this report.

8.1 NORTH VALLEY

8.1.1 TNT Strips

Explosive compounds were detected in the soil at the TNT Strips area. Other COIs identified at the TNT Strips include TNT breakdown products (i.e., explosives, unknown hydrocarbons) and combustion by-products (i.e., PAHs and dioxins/furans). TNT has been detected in the upper 2 feet of soil along the axis of the strips at concentrations exceeding 100,000 mg/kg (i.e., 10 percent by weight) in three samples at two locations. TNT concentrations in other locations along the strips in the upper 2 feet are also high, but are generally less than 50,000 mg/kg (5 percent by weight). Soil affected with TNT at a concentration of 10 percent or greater is classified as OE. At a depth of approximately 10 feet bgs, TNT concentrations are typically non-detect or less than 16 mg/kg, the proposed cleanup level for TNT in residential areas. TNT concentrations also decrease significantly away from the axis of the strips. At a distance greater than 20-feet in the downslope direction and 10 feet in the upslope direction, TNT in soil within the upper 4 feet are non-detect or less than 16 mg/kg.

Other compounds associated with the COIs, such as unknown hydrocarbons, PAHs, and dioxins/furans, are found with the TNT and, therefore, will be addressed as part of any remedial action alternative(s) considered for the explosive compounds at the TNT Strips. Concentrations of TNT at less than 200 mg/kg have been detected in surficial soil northwest of the TNT Strips (see Figure 7-4).

Concentrations of TNT less than 100 mg/kg have been detected in the surficial soil within the Project Site north and east of the TNT Strips area.

Sampling completed to define the lateral extent of the TNT outside the Project Site boundary, north and east of the TNT Strips area, has shown that explosive compounds have not migrated off the Project Site in the areas sampled.

Detected concentrations of TNT and associated explosive compounds were found to exceed human and ecological screening criteria. Soil remediation goals generated for explosive compounds in Chapter 7.0 will be used to guide remediation in this area.

8.1.2 Howitzer Test Facility and Stockpile #3

DOD-related activities within the area of the Howitzer Test Facility have affected the native soil with trace concentrations of non-point-source petroleum hydrocarbons (i.e., motor oil and unknown hydrocarbons typical of weathered fuels) and isolated trace concentrations of fuel-related VOCs. The estimated lateral extent of the affected soils is delineated on Figure 7-5. The detected VOCs do not exceed human health screening criteria. This area of the site was not included in the ecological screening assessment because no wildlife habitats will remain following post-grading and redevelopment activities.

Soil from Stockpile #3 is affected with low levels of PAHs and moderate levels of petroleum hydrocarbons (up to 200 mg/kg) and unknown hydrocarbons, likely weathered fuels. It is planned to remove the stockpiled material from the site for appropriate disposal at an off-site facility. The detected levels of dibenz(a,h)anthracene exceeded human health screening criteria.

With the exception of removal and disposal of material comprising Stockpile #3, no further action is recommended. Confirmation sampling beneath Stockpile #3 will be conducted following removal to confirm that all affected soil has been removed.

8.1.3 North Valley Military Landfill

Wood crates, pallet and packing materials, a crushed metallic structure, and OE scrap were found in this disposal area. No systematic distribution of COIs was identified at the North Valley Military Landfill. Unknown hydrocarbons, VOCs, two dioxins/furans, and one pesticide were detected in various soil samples in the fill material and at 2 feet below in the underlying soil. No impact with respect to metals, nitrate, or phosphorus was identified. Chemicals detected in the North Valley Military Landfill do not exceed human health screening criteria, and the screening-level risk estimates were more or below benchmark levels. This area of the site was not included in the ecological screening assessment for the same reason described above for the Howitzer Test Facility. Accordingly, no future action is recommended in this area.

8.1.4 Ammunition Renovation/Primer Destruction Site and Stockpiles #1 and #2

DOD-related activities within the area of the Ammunition Renovation/Primer Destruction Site have affected the native soil with low levels (less than 650 mg/kg) of point-source petroleum hydrocarbons (i.e., diesel), possibly from a suspected UST identified through geophysical methods. In addition, non-point-source petroleum hydrocarbons (i.e., motor oil and unknown hydrocarbons typical of weathered fuels) have affected soils at the site from applications of petroleum products to roads, work surfaces, and parking areas most likely to suppress dust, and from intermittent irregularly distributed vehicle leaks. The estimated lateral extent of the affected soils is delineated on Figure 6-5.

Other COIs (trace concentrations of VOCs commonly associated with petroleum hydrocarbons and oils) were also detected at isolated locations. A trace concentration of one PCB (Arochlor) was detected in one sample at the Ammunition Renovation/Primer Destruction Site. No other PCBs were detected. The detected VOCs and PCBs do not exceed human screening criteria. This area was also not included in the ecological screening assessment.

Soils from Stockpiles #1 and #2 are affected with low levels of PAHs and moderate levels of petroleum hydrocarbons (up to 1,400 mg/kg). The detected levels of dibenz(a,h)anthracene exceeded human health screening criteria. It is planned to remove the stockpiled material from the site for appropriate disposal at an off-site facility.

The possibility of a UST at this site will be further evaluated after sitewide OE point clearance. If a UST is found at the site, it will be removed in accordance with RWQCB guidelines (Tri-Regional Board Staff, 1990).

With the exception of removal and disposal of material comprising Stockpiles #1 and #2, no further action is recommended. Confirmation sampling beneath stockpiles will be conducted following removal to confirm that all affected soil has been removed.

8.1.5 North Valley Soil and Groundwater

8.1.5.1 Soil.

TNT at a concentration of 17 mg/kg or less was detected in the soil/bedrock along the floor of the North Valley. The estimated lateral extent of the affected soils is delineated on Figure 7-4.

8.1.5.2 Groundwater.

Low-level and sporadic detections of petroleum hydrocarbons (34 μg/L to 860 μg/L) and related compounds from grab samples and wells indicate a slight impact to groundwater from the petroleum hydrocarbon-affected soils in the Ammunition Renovation/Primer Destruction Site and Howitzer Test Facility. Isolated low detections of explosive compounds (0.17 µg/L to 4.9 µg/L) may also indicate groundwater impact from explosives-affected soil downgradient of the TNT Strips.

However, it is considered that it is more likely that these low concentrations of explosives are a result of the grab groundwater sampling technique used to collect the samples from boreholes, test pits, and seeps. In fine grained soils, like those found at the Project Site, the grab sampling technique can result in collection of samples containing sediment (turbidity). The laboratory analytical testing method for water samples is very sensitive and would be affected by sediment even containing very low concentrations of explosives. Further supporting evidence is shown in the water sampling results from permanently installed and fully developed monitoring wells in the North Valley in the area of and immediately downgradient of seeps and pits where trace concentrations of explosives were detected. Water samples from these wells have not detected explosives in two rounds of sampling in April and August 2000. Therefore, the results from these wells are considered to be representative of the North Valley groundwater because of the appropriately placed well locations and because of the mature nature of the Project Site (i.e., DOD-related activities occurred 40 to 56 years ago). The wells installed at the Project Site have been designed to reduce turbidity through a sand pack around the well casing and well development techniques.

Extremely low detections of one or more explosive compounds (less than 0.38 µg/L), PAHs (less than 5.8 µg/L), VOCs (0.61 µg/L), and pesticides (0.0077 µg/L) were also identified in grab seep samples from the North Valley. Unknown hydrocarbons (less than 200 µg/L) and extremely low detections of explosives (less than 0.66 µg/L), VOCs (0.67 µg/L), and dioxins (260 pg/L) were identified in grab water samples from beneath the North Valley Military Landfill. Excluding the hydrocarbons, these compounds have not been detected in groundwater samples collected from the developed wells in the North Valley.

Maximum concentrations of seveal chemicals detected in groundwater exceed human health screening criteria, based on the assumption of ingestion of groundwater. The majority of the chemicals that contributed most significantly to the screening risk estimates were metals that may be attributable to ambient conditions. The other chemicals (explosives and chloroform) were detected infrequently or only in grab groundwater samples, and their presence in these samples are not considered to be representative of groundwater conditions at the Project Site.

Groundwater is not currently used for any purpose, and is not expected to be used in the foreseeable future, due to limited groundwater occurrence and low formation permeability that does not yield sufficient quantities of water for drinking or irrigation purposes. In addition, domestic water will be supplied to the residential development from other sources. Accordingly, residual chemicals in groundwater do not appear to be of human health concern. General water quality will continue to be evaluated at the site through a focused groundwater monitoring program. However, no further action with regard to the groundwater is recommended for protection of human health.

8.1.6 Ridge

Dynamite Burn Site

Soils from the Ridge area where the former Dynamite Burn Site was situated, have been excavated and, according to our analysis, have been placed in the McAllister Drive Land Bridge. No impact of COIs to the exposed bedrock, which represents a surface approximately 30 to 40 feet below the original ground surface where dynamite was burned, was identified in this area of interest.

8.2 SOUTH VALLEY

8.2.1 Flare Site

DOD activities within the area of the Flare Site have affected soils with five metals (antimony, barium, copper, lead, and zinc). The lateral extent of metals impact to soil in the northern and eastern directions are relatively well understood and are shown on Figure 6-6. The southern extent, although upslope, is not defined, nor is the western extent. The vertical extent is also not as well understood due to limitations on drilling boreholes in this area, but does not appear to be deeper than 5 feet bgs. Dioxins/furans (up to 490 pg/g) also occur at the surface where burning occurred; however, the concentrations decrease rapidly to less than 10 pg/g at 1 foot bgs and are not likely to extend beyond the limit of the metals-affected soil.

Detected concentrations of antimony, barium, copper, lead, and zinc exceeded human health and/or ecological screening criteria. Antimony, barium, copper, iron, lead, and manganese contributed most significantly to the human health risk estimates. Soil remediation goals generated for these metal compounds in Chapter 7.0 will be used to guide remediation in this area.

8.2.2 Demolition Site #1

No impact to soil from DOD-related activities was identified in this area of interest, based on the sampling performed to date. Investigation of the upper portion of this area of interest could not be performed due to a safety concern from the presence of a geophysical anomaly at the southern end of the site.

Based on sampling to date, detected concentrations of chemicals do not exceed human or ecological screening criteria.

8.2.3 Demolition Site #2

No impact to soil from DOD-related activities was identified in this area of interest; therefore, this site was eliminated.

8.2.4 Demolition Site #3

DOD activities within the area of Demolition Site #3 appear to have affected soils with mercury. The estimated lateral extent of mercury impact to soil is delineated on Figure 6-7. The vertical extent appears to be from the ground surface to an average of 3 feet bgs.

Detected mercury concentrations did not exceed human health screening criteria, but did exceed ecological screening criteria. The soil remediation goal generated for mercury in Chapter 7.0 will be used to guide remediation in this area.

8.2.5 South Valley Wetland Sediment and Surface Water

8.2.5.1 Sediment.

DOD activities related to Demolition Site #3 have impacted a portion of the near-surface wetland sediment with mercury immediately downslope and southeast of Demolition Site #3. The estimated lateral extent of mercury impact to sediment is shown on Figure 6-7.

Some metals were detected in sediment samples at concentrations exceeding ecological screening criteria. However, based on more refined ecological evaluation, remediation of sediment is not proposed. For those chemicals considered to be potentially bioaccumulative (benzo(b)fluoranthene, methyl mercury, and 2,4,6-trinitrotoluene) the risk associated with bioaccumulation from sediment was evaluated and found to be negligible.

8.2.5.2 Surface Water.

No impact to surface water from DOD activities was identified in the wetland. Chemicals detected in South Valley surface water do not exceed human health or ecological screening criteria. No impact with respect to surface water was identified and no further action is recommended.

8.2.6 South Valley Soil and Groundwater/Seeps

8.2.6.1 Soil.

No DOD-related impact to soil samples collected during site screening or installation of monitoring wells was identified.

8.2.6.2 Groundwater/Seeps.

One nitroaromatic compound (3-nitrotoluene) was detected in groundwater from the most downgradient monitoring well at an estimated trace concentration (0.59 Fg/L) during one groundwater sampling event. This well has been sampled three times and explosives were not detected in two of the sampling events. No COIs were detected in the seep sample collected from the South Valley.

Maximum concentrations of three metals detected in groundwater exceeded screening risk estimates, based on the assumption of ingestion of groundwater. These chemicals were attributable to ambient conditions.

Groundwater is not currently used for any purpose, and is not expected to be used in the foreseeable future due to limited groundwater occurrence and low formation permeability that does not yield sufficient quantities of water for drinking or irrigation purposes. In addition, domestic water will be supplied to the residential development from other sources. Accordingly, residual chemicals in groundwater do not appear to be of human health concern. General water quality will continue to be evaluated at the site through a focused groundwater monitoring program. However, no further action with regard to the groundwater is required for protection of human health.

8.3 OTHER AREAS

8.3.1 Ridge Stockpiles

No impact to soil from DOD-related activities was identified in this area of investigation. However, soil stockpiles brought to this location from off-site areas exhibit low-levels of petroleum hydrocarbons (less than 53 mg/kg) that were detected in the stockpiles and are typical of soil that has been handled by heavy earth moving equipment. At the request of DTSC, Ridge stockpiles will be analyzed for VOCs during OE clearance activities using field measurement techniques (Photoionization Detections [PID]). If no VOCs are detected (less than 10 ppm), the material will be used for engineered fill in the North Valley or taken off site to a suitable landfill (if greater than 10 ppm).

8.3.2 McAllister Drive Land Bridge

No impact to soil from DOD-related activities was identified on the slopes in the lower portion of the land bridge during the non-OE RI. However, according to our analysis, soil from the Dynamite Burn Site is in the lower portions of the fill of the land bridge (approximately 100 feet below the roadway surface). It is not known if the soil from the Dynamite Burn Site was chemically affected.

Based on sampling to date, detected concentrations of chemicals do not exceed human health screening criteria. This area of the site also was not included in the ecological screening assessment.

8.4 PROPOSED SUPPLEMENTAL NON-OE INVESTIGATION AFTER SITEWIDE OE POINT CLEARANCE

COIs have been characterized using ordnance avoidance field sampling techniques to evaluate potential remedial action alternatives; however, certain areas of interest still lack full definition with regard to the extent of the COIs; therefore, additional investigations are planned after the sitewide OE point clearance.

Characterization of areas of interest where the extent of impact has not been fully defined can be achieved through further soil and groundwater sampling as part of remediation, and through excavation confirmation sampling to ensure that the remediation goals are met.

Details of the supplemental investigations are presented in the non-OE RDD, which outlines the scope of work and the field sampling and analysis plans. Table 8-1 summarizes those areas of interest where post-OE point clearance supplemental investigations are planned.

8.4.1 Non-OE Remediation Approach

Non-OE remedial actions are integrated with the OE point clearance for several key sites. These sites include the TNT Strips, Stockpiles #1, #2, and #3 in the North Valley, and Demolition Sites #1 and #3 and the Flare Site in the South Valley. Further characterization and confirmation sampling at the sites will occur as soils are removed in lifts as part of the OE clearance activities. For those sites identified in Table 8-1 as requiring further site characterizations, non-OE remediation activities will occur following OE point clearance and prior to areawide OE clearance activities. The general approach planned for these non-OE remedial actions can be generalized into the four-stages listed below

Stage 1. Perform the necessary investigations to determine the lateral and vertical extent of chemically affected soil at each site. These investigations will include sampling along transects that radiate out from the defined site boundaries. On-site laboratories will be used to analyze the samples allowing for a rapid turnaround of sample results.

Stage 2. Remedial actions will be implemented at each site as summarized below.

Stage 3. Confirmation samples will be collected as defined in the non-OE RDD.

Stage 4. Prepare a sitewide, post-remediation human health and ecological risk assessment.

A description summarizing the remedial activities planned under the non-OE RDD process for each site is provided below. Details of how this characterization and remediation process will occur can be found in the non-OE RDD.

TNT Strips. Currently the TNT strips contain explosive compounds in some locations in excess of 100,000 mg/kg and are considered potentially explosive. During OE remediation, the soils within the unvegetated portion of the strips (including the potentially explosive soil areas) will be homogenized and removed. Once the explosive compound levels of the underlying soil are less than 100,000 mg/kg throughout the TNT Strip area, OE remediation will be considered complete. Steps defined in the non-OE RDD document will then be used to characterize the lateral and vertical extent of TNT-affected soil. Lateral and vertical extent characterization will generally be accomplished by collecting soil samples along transects oriented perpendicular to the long axis of the individual strips. Once all TNT-affected soil has been identified, soil with TNT concentrations that exceed the soil remedial goals will be excavated and disposed of at an appropriate off-site landfill. Confirmation samples will be collected from the bottom and sidewalls of the excavation, as defined in the non-OE RDD. Excavation and sampling will continue until all chemically affected soils meet the RAOs.

Howitzer Test Facility/Stockpile #3. Stockpile #3 may require further characterization of the stockpile materials for disposal purposes. Composite samples will be collected from Stockpile #3, as required by the landfill accepting this material. Once Stockpile #3 has been removed, confirmation samples will be collected from soil underlying the former stockpile location to verify that the affected stockpiled soil has been completely removed. The non-OE RDD provides a detailed explanation of the confirmation sampling approach to be used.

Ammunition Renovation/Primer Destruction Site. The geophysical anomaly identified during this RI will be investigated as part of the sitewide OE clearance activities. The area of this geophysical anomaly will be excavated to determine whether the anomaly is a UST. If a UST is encountered, it will be removed in accordance with requirements set forth by the Tri-Regional Water Quality Control Board Staff (1990).

Stockpiles #1 and #2. Stockpiles #1 and #2 will be removed as part of the OE RDD process. As part of the removal process, the soil will be sampled and analyzed based on the requirements set forth by the accepting landfill. Confirmation sampling beneath the former soil stockpile locations will be conducted to verify that the affected stockpiled soil has been completely removed. Analytical parameters in addition to those specified in Table 8-1 may be added based on the results of the disposal characterization samples.

North Valley General. Following OE point clearance, additional soil boreholes will be installed to characterize the lateral extent of non-point-source petroleum hydrocarbon-affected soil. Results of this characterization will be reviewed with the regulatory agencies.

Ridge Area Stockpiles #1 through #9. Construction debris from Ridge Stockpiles 1 through 9 will be disposed of at an appropriate off-site landfill. An OE technician will observe loading of the debris to ensure that no OE items are shipped off site. During OE point clearance, the Ridge stockpiles will be screened for VOC's using field screening techniques. Depending on whether VOCs are detected, the material will either be used as backfill in the North Valley or disposed of at an appropriate off-site landfill.

Dynamite Burn Site. Following sitewide OE point clearance activities, soil samples will be collected from locations downslope of the Dynamite Burn Site, as defined in the non-OE RDD. If this initial characterization phase identifies any soil requiring remediation, the lateral and vertical extent will be defined by additional sampling using step-out sampling procedures defined in the non-OE RDD.

Flare Site. Soil samples will be collected within the depth of the scan following the OE point clearance activities to define the lateral and vertical extent of chemically affected soils. After excavation of the first lift of soil, the excavated surface will be geophysically scanned and point cleared, as specified in the OE RDD. If evidence gathered during excavation suggests the site was also used for demolition, all soil within the Flare Site boundary will be removed to bedrock. If the site is only chemically affected, excavation will continue until all soils containing COIs above RAO levels have been removed. Characterization of the lateral and vertical extent of chemically affected soil will follow the step-out sampling procedures defined in the non-OE RDD. Confirmation samples will be collected from the final excavated surface as established in the non-OE RDD.

Demolition Site #1. Further chemical characterization will be conducted following OE point clearance activities. The history of Demolition Site #1 suggests that OE may be found at depth. Therefore, OE clearance of soils will require that they be removed from within the boundaries of the former demolition site in lifts following protocols established in the OE RDD and non-OE RDD. Excavated soils will be stockpiled until all affected soils have been removed from the site. If soils are not chemically affected, they will be placed back into the excavation. If the soils are affected, additional investigations will occur outside the site boundaries using step-out sampling techniques defined in the non-OE RDD. All chemically affected soil will be removed and disposed of at an appropriate landfill. Once the affected soils have been removed, confirmation samples will be collected from the bottom and sidewalls of the excavation as described in the non-OE RDD.

Demolition Site #3. Further chemical characterization will be conducted during OE clearance activities. The history of Demolition Site #3 suggests that OE may be found at depth. Therefore, OE clearance of soils will require that they be removed from within the boundaries of the former demolition site in lifts as defined in the OE RDD and non-OE RDD. Excavation and scanning in lifts within the site boundaries will continue down to bedrock. Excavated soils will be stockpiled until all soils have been removed from the site. Additional investigations will occur outside the site boundaries to determine the lateral and vertical extent of chemically affected soil. Details of this sampling protocol are defined in the non-OE RDD. All chemically affected soil will be removed and disposed of at an appropriately licensed landfill. Once the site has been determined to be free of OE and chemically affected soil, confirmation samples will be collected from the bottom and sidewalls of the excavation as described in the non-OE RDD.

McAllister Drive Land Bridge. In 1990, the Ridge area was used as a borrow site for construction of the McAllister Drive Land Bridge. Because the former Dynamite Burn Site and a possible communications tower were situated on the Ridge in the past, DTSC has requested that additional investigations be conducted at the McAllister Drive Land Bridge. In response to DTSC's request, additional characterization of the McAllister Drive Land Bridge will be conducted. Soil boreholes are proposed to supplement the existing data presented in this RI. If the soil is found to be chemically affected, the results will be evaluated and discussed with DTSC to assess the need for further action.

1945 Disturbed Area. A disturbed area was identified on a 1945 aerial photograph in the north portion of the Ridge area. DTSC has requested that this area be investigated after OE point clearance activities are completed. Soils in this area may be subject to areawide clearance. If the chemical screening criteria are exceeded, additional investigations will be conducted. Boreholes will be situated in the area identified in the 1945 aerial photograph as the disturbed area (see the non-OE RDD). Soil samples will be collected using hollow-stem auger drilling and split-spoon sampling techniques. If the initial sampling shows the site has been affected, additional sampling will be conducted to determine the vertical and lateral extent of the affected soils. If appropriate, the vertical and lateral extent will be defined using the step-out procedures defined in the non-OE RDD. If the investigation shows that the soils do not contain chemicals above the remediation goals, no remedial activities are proposed.

Unit D-1 Area Stockpiles. The Unit D-1 Area stockpiles have a total estimated volume of approximately 8,000 cy. Concrete, asphalt concrete, and other non-soil debris will be removed from the Unit D-1 Stockpiles. UXO personnel will inspect the debris during loading and prior to removal from the site. Chemically affected soils will be disposed of at an appropriate off-site landfill. If the stockpiled soil contains any COIs above RAOs, samples will be collected below the footprint of the stockpiles following their removal to assess whether all chemically affected soil has been removed. Those stockpiles that are determined not to be chemically affected will be scanned in lifts and temporarily stockpiled on site. This material may be used as engineered fill in the North Valley.

North Valley and South Valley Groundwater/Seeps and Surface Water. After OE point clearance, additional groundwater monitoring wells will be installed outside the construction area to create well pairs that can monitor groundwater from both the alluvium/colluvium and the weathered bedrock. Details on the location of these new wells and the sampling protocol and frequency are defined in the non-OE RDD.

Sitewide. Following the additional characterization and remedial activities, a post-remediation human health and ecological risk assessment will be conducted to verify that the residual chemical concentrations are protective of human health and the environment. The post-remediation risk assessment will be based on data collected from confirmation samples in the remediated areas and using existing analytical results in areas that were not remediated. In addition, this assessment will be completed in accordance with state and federal guidance for conducting risk assessments (see Section 7.4).

9.0 ORDNANCE AND EXPLOSIVES REMEDIAL INVESTIGATION

The OE RI consisted of a review of data obtained from previous OE clearances and investigations conducted at the Project Site, as well as data obtained during the removal action investigation phase of the non-OE RI (investigation of the North Valley Military Landfill). Data reviewed included geophysical data for the Project Site; anomaly excavation logs; daily field logs; and information presented in the *Archives Search Report Findings, Benicia Arsenal, Benicia, Solano County, California* (U.S. Army Corps of Engineers, St. Louis District, 1994a); *Supplement to the March 1994 Archives Search Report for Benicia Arsenal, Benicia, Solano County, California* (U.S. Army Corps of Engineers, St. Louis District, 1997); *Final Benicia Arsenal Records Research Report* (Jacobs Engineering, 1999); and *Final Engineering Evaluation/Cost Analysis [EE/CA], Former Benicia Arsenal, Benicia, California* (Earth Tech, 2000d). The purpose of the EE/CA was to obtain sufficient information to develop a work plan and environmental documents to perform a cleanup of the former Benicia Arsenal, including the Project Site. This chapter includes information concerning OE-related DOD activities at the Project Site and a summary of previous OE investigations and findings.

9.1 DEPARTMENT OF DEFENSE ACTIVITIES AT THE PROJECT SITE

Based on the site inspection, data collected by USACE for the former Benicia Arsenal EE/CA report (Earth Tech, 2000d), review of historical aerial photographs, and review of geophysical data for the Project Site, the potential OE sites have been identified (see Section 2.3.1 and Figure 2-3).

The hillside to the north of the North Valley was used to dispose of 2,4,6-TNT (TNT Strips). Analytical results for several soil samples collected from the TNT Strips indicated concentrations of TNT in excess of 10 percent by weight (see Section 5.2). Soil containing 10 percent or more TNT by weight is considered "explosive soil" and is classified as OE. All TNT-impacted soil has been addressed in the non-OE RI discussion in the preceding chapters, and is not discussed further in this chapter.

Approximately 6 acres in the North Valley were developed with roads and structures where the accuracy of locally manufactured howitzer gun barrels was checked (Howitzer Test Facility), ordnance was inspected and renovated, and primers were destroyed in a "squirrel cage" (Ammunition Renovation/Primer Destruction Site). A disposal area referred to as the "North Valley Military Landfill" was also situated in the North Valley. Part of the Ridge was used to destroy aged, out-of-service dynamite (Dynamite Burn Site).

In the South Valley there was a Flare Site and up to three suspected demolition sites (Demolition Sites #1, #2, and #3). The Flare Site was used to burn old, out-of-service flares. This generally was accomplished by placing a number of flares in a pile and igniting them. Demolition activities generally consisted of placing various amounts of out-of-service munitions in a pit and placing a countercharge on top of the items and detonating them. Often, these areas were used multiple times, resulting in a deep pit or crater.

As discussed in Section 2.3.1.8, Demolition Site #2 was suspected of being a demolition site because it appears disturbed or barren in several of the historical aerial photographs. However, disturbance in this area may have been associated with a landslide/earthflow identified in that area on the 1945 and later photographs. Review of geophysical data for Demolition Site #2 do not indicate a high anomaly count, similar to those of Demolition Sites #1 and #3, nor is there field evidence of OE scrap and OE fragments. Based on these observations, it no longer appears likely that Demolition Site #2 was ever used as a demolition site.

9.2 ORDNANCE AND EXPLOSIVES CLEARANCE ACTIVITIES

DOD conducted OE clearance activities in the South Valley in 1955 (U.S. Army Corps of Engineers, St. Louis District, 1994a) in anticipation of disposal of part of the property. However, during a later inspection of the South Valley in 1955, several live OE items were found, and it was recommended that a second clearance be performed. During this inspection, four hand grenades, two 37mm (HE) projectiles, three 60mm mortars, and one 75mm (HE) projectile are reported to have been found. No record of a possible second clearance could be found. No other DOD-initiated clearance actions were reported in the RRR (Jacobs Engineering, 1999) and ASR Supplement (U.S. Army Corps of Engineers, St. Louis District, 1997).

The next reported OE clearance activity was initiated when a concrete-filled howitzer shell was encountered during preliminary site preparations in mid-1996. On May 3, 1996, Cal/EPA, DTSC, performed a site visit in response to concerns raised by local citizens about possible hazards on the property due to past DOD-related activities. Following that site visit, DTSC recommended that a thorough investigation of the site be performed, including a Preliminary Endangerment Assessment and an OE Waste Assessment. DTSC also recommended that development activities at the site be curtailed pending completion of the investigation of the site. Granite retained OE experts and initiated OE investigations on the Project Site. The work included geophysical mapping and OE removal.

The initial geophysical surveys at the site were limited to the Howitzer Test Facility and limited dispersed data collection areas across the Project Site. An EM61, a high resolution, time-domain metal detector, was used to collect data for the initial surveys. In August 1996, an OE clearance was performed at the Howitzer Test Facility using the EM61 data. The clearance was conducted to support the dismantling of the howitzer tunnels and related structures. In addition, areas at the Ammunition Renovation/Primer Destruction Site and along portions of the northern and eastern Project Site boundaries were investigated and cleared using a magnetometer to detect subsurface magnetic anomalies. No OE items were removed during the August 1996 clearance activities. However, as part of preparing for the Removal Action Investigation, an inventory was taken of the on-site ordnance storage magazines. Two rusted grenade fuzes were stored in the magazine. It is unknown from where these fuzes were recovered. In November 1996, while removing a concrete floor slab from beneath former Building 540, several howitzer dummy 155mm shells and 18 practice land mine fuzes with pins were found. They were inspected by a number of OE specialists and determined to be OE scrap. Table G-1 of Appendix G lists the items recovered during this clearance activity. It should be noted that no OE items were recovered during the August 1996 clearance activities. However, as part of preparing for the Removal Action Investigation, an inventory was taken of the on-site ordnance storage magazine. Two rusted grenade fuzes were stored in the magazine. It is unknown from where these fuzes were recovered. The areas cleared are shown on Figure 9-1.

In fall 1996, NORCAL performed a TMF vertical gradient survey to assess the distribution of OE. This survey consisted of the investigation of contiguous, 200-foot by 200-foot grids utilizing cesium vapor magnetometers arrayed to measure the vertical gradient of the TMF. The magnetometer survey did not include Ridge cut areas where surficial materials had been stripped to bedrock, the west portion of the South Valley, or the wetland in the South Valley. Appendix G summarizes how the geophysical data were collected.

Approximately 8.5 acres of the Project Site was cleared of OE in November and December 1996 using the magnetometer data. The identified magnetic anomalies were investigated by excavating the location of the anomaly until an anomaly source was located. When OE was encountered, it was identified and removed. Six OE items were removed from the Project Site in November and December 1996, including two 37mm high-explosive (HE) rounds, two 40mm anti-aircraft HE rounds, one 60mm HE mortar shell, and one 76mm armor-piercing HE round. The OE clearance was suspended pending further investigation of the former Benicia Arsenal by USACE. The location of the OE items recovered and the area cleared are shown on Figure 9-1. Table 9-2 lists the depth, location, quantity, and number of anomalies investigated during this clearance activity.

9.3 ENGINEERING EVALUATION/COST ANALYSIS INVESTIGATION

USACE conducted an EE/CA investigation for the entire former Benicia Arsenal, including the majority of the Project Site. Portions of the Project Site and adjacent property were geophysically mapped, and subsurface anomalies that were identified were sampled to determine the presence or absence of OE. Two OE items were encountered within the Project Site (one 75mm unfuzed shrapnel projectile and one 37mm fuzed projectile) during the EE/CA field investigation. These items were disposed of by demolition (Earth Tech, 2000d). The locations of these items are also shown on Figure 9-1. No OE or OE scrap was recovered from property immediately adjacent to the north of the Project Site during the

EE/CA investigation. Table 9-3 lists the depth, location, quantity and number of anomalies investigated.

9.3.1 Geophysical Investigation

Twenty-one 100-foot by 100-foot grids (4.82 acres) on the Project Site were investigated using magnetometer data previously collected by NORCAL. For areas where previously collected magnetometer data were not available, and to assess the quality of the magnetometer data previously collected, a Geonics EM61 high-sensitivity metal detector was used to detect and map the location of subsurface anomalies and record the geophysical character. A total of 12 grids (2.75 acres) within the Project Site and an additional 7 grids (1.61 acres) immediately adjacent to the Project Site were geophysically mapped using the EM61 (see Figure 9-1).

9.3.1.1 Performance Criteria.

Prior to deployment of the EM61 or use of the magnetometer data, the instruments were evaluated by means of a test plot with seeded metallic items simulating OE items expected to be encountered during the field investigation.

The performance criteria and results of the equipment test are discussed briefly below. The results of the geophysical equipment test demonstrated that the detection capabilities of the instrumentation (Geonics EM61) used to map the locations of potential OE-caused anomalies met or exceeded the performance criteria defined by:

$$D_d = 3.28 \times 10^{(1.002\log(dia)-1.961)}$$

D_d = Depth of detection (in feet),

and

Dia = the diameter of the OE (in millimeters)

The above performance criteria are required by USACE for any geophysical OE investigation and/or removal when using EM instrumentation. This criterion illustrates the physical measurement constraint that the size of the target must increase with increasing depth in order to be detectable. The specific detection performance for the EE/CA investigation provided mapping depth capabilities better than the minima required by the above function. The change in electromagnetic (EM) response with respect to distance (depth) is a well known physical property. Extrapolation of the performance curve generated by the test plot results indicates that under characteristic site conditions, as represented by geophysical test plot, OE types listed in Table 9-4 would have been detected to the corresponding depths presented in the table.

USACE has established minimum performance criteria for geophysical methods for the detection of ordnance. This performance criteria is based on the historical performance developed for various geophysical instruments as demonstrated at other ordnance sites and specific programs established to test state-of-the-art geophysical instrumentation. Comparison of the size and depth of recovered OE with the required performance criteria showed that the DQOs for the geophysical investigation were achieved and exceeded.

9.3.1.2 Data Collection.

Data collection was accomplished following the specific procedures detailed in the Final EE/CA Work Plan (Earth Tech, 1998) and in Appendix G. The quality of mapping data was assured by continuous tracking, adjustment, and visualization of the field data. Data quality was further assured by adherence to the QA/QC requirements also specified in the Final EE/CA Work Plan (Earth Tech, 1998) and in Appendix G.

The EM61 was used for subsurface geophysical survey recording and anomaly detection for selected grids within the Project Site. Three grids that were previously surveyed with the magnetometer were geophysically mapped during the EE/CA field investigation using the EM61. The EM61 results were directly compared to magnetometer data results. The direct comparison indicated that the EM61 did detect more targets, as expected. However, review of the OE sampling results indicated that additional targets identified by the EM61 were smaller than the smallest OE item of concern, a 37mm projectile. All items with dimensions greater than 37mm were detected by the EM61 and identified in the magnetometer data. Therefore, the data were determined to be valid and acceptable.

9.3.1.3 Data Processing.

Digital geophysical data (amplitude and position) were periodically downloaded each day to avoid possible data loss or corruption. All data collected were reviewed for the DQOs described in the Final EE/CA Work Plan (Earth Tech, 1998). The data were then processed to identify potential OE-related anomalies. Processed geophysical data detailing anomaly locations were used to prepare dig maps for the OE sampling crews.

9.3.1.4 Data Quality.

Earth Tech performed an independent analysis of all geophysical mapping data to verify the geophysical reasonableness of the collected field data and the geophysical data analyses. This independent analysis was performed by Earth Tech's geophysical personnel. Data were audited by processing discretely bounded survey lane segments using the GeoSoft Mapping and Processing System and the Unexploded Ordnance (UXO) Target Analysis. This processing was independent of the data analysis performed by the geophysical subcontractor to the extent that only the position-corrected field data were jointly used. Personnel, processing, and interpretive software were not replicated. The results of the independent analysis were used to determine whether the DQOs were met and if a grid needed to be remapped or the data reprocessed. Parallel processing in this fashion resulted in the identification of similar anomalies. As a result of this analysis, it was concluded that all DQOs, as outlined in the Final EE/CA Work Plan (Earth Tech, 1998), were met.

9.3.2 Ordnance and Explosives Field Sampling Procedures

The OE sampling conducted at the Project Site consisted of intrusively investigating 33 randomly and strategically selected 100-foot by 100-foot grids. The 33 sampling grids included 999 known subsurface anomalies.

Geophysical anomaly locations were identified using a geophysical data analysis process. These locations were provided to the site surveyor in California State Plane coordinates. Anomaly sampling locations within each grid were recovered by the surveyor using a total station optical laser survey system. Each sampling location was marked with a plastic flag. A "dig map" showing relative anomaly locations (see Figure 9-2) within the grids and a sampling data form were provided to the OE dig teams. Where grids had 20 or fewer anomalies identified, each anomaly location was staked and sampled. Where grids contained more than 20 identified anomalies, approximately 40 percent of the anomalies (or 20, whichever was greater) were selected at random and staked.

The OE Dig Team identified the center of the staked target anomaly by traversing a Foerster Mk-26 magnetometer over the surveyed location. This was performed in order to ensure personnel safety during the process of excavating the anomaly. An area 6 feet in diameter originating from the pin flag placed at the original anomaly location was searched. The location of the anomaly center was noted relative to the original staked location.

The exploration progressed in concentric circles of increasing radius and depth originating at the anomaly location staked to identify the centroid of the EM anomaly. The intrusive exploration continued until a suitable anomaly source was identified or an exploratory pit 2 feet in diameter and 2 feet bgs had been excavated. If an anomaly source was present deeper than 2 feet, the excavation continued until the source was found. The dig teams utilized a fluxgate gradiometer (Schonstedt or Foerster) as a screening aid to ensure personnel safety during the progress of the excavation.

The exploratory excavations were left open until the UXO Supervisor had verified the absence of additional metal sources within the perimeter of the excavated pit. Verification that the anomaly source had been removed was accomplished using a Foerster Mk-26 fluxgate magnetic gradiometer.

The QA/QC process involved the review of all recovered items in order to ensure that the geophysical response signal for the anomaly was representative of the recovered item. All DQOs, as outlined in the Final EE/CA Work Plan (Earth Tech, 1998), were met.

9.3.3 Former Benicia Arsenal Ordnance and Explosives Clearance

As a result of the former Benicia Arsenal EE/CA investigation, USACE is currently conducting an OE clearance for several areas within the former Benicia Arsenal including property adjacent to the Project Site referred to as the "Gonsalves property." The Gonsalves property is situated east of the Project Site in the portion of the South Valley east of the McAllister Drive Land Bridge. The remedy selected by USACE for the Gonsalves property is to conduct a surface clearance of OE along the valley walls and to clear OE to depth of detection along the valley floor.

9.4 REMOVAL ACTION INVESTIGATION

The removal action investigation phase of the Non-OE RI included clearing anomalies from proposed excavation locations at the North Valley Military Landfill to facilitate the non-OE characterization of soil beneath the landfill. Geophysical techniques were utilized to locate subsurface anomalies within the North Valley Military Landfill. Anomalies identified in the footprint of a proposed exploratory test pit location were intrusively investigated to determine the source of the anomaly and to clear any OE encountered. OE scrap was encountered in approximately half of the excavations, though no OE was recovered from the North Valley Military Landfill. Table 9-5 lists the depth, quantity, and anomalies investigated during this removal action.

9.4.1 Geophysical Characterization

A Geonics EM61 high-sensitivity metal detector was used to detect and map the location of subsurface anomalies and record the geophysical character. A total of 0.26 acres within the North Valley Military Landfill were geophysically mapped using the EM61. Figure 9-2 depicts the processed EM data collected during this investigation.

9.4.1.1 Performance Criteria.

Prior to deployment of the EM61, the instrument was evaluated by means of a test plot with seeded metallic items simulating OE items expected to be encountered during the field investigation.

The test plot construction, performance criteria, and results are discussed briefly below. The results of the geophysical equipment test demonstrated that the detection capabilities of the instrumentation (Geonics EM61) used to map the locations of potential OE-caused anomalies met or exceeded the following criteria:

-

- Detect all targets buried at 12 inches bgs or less
- Horizontal Accuracy: 90 percent of all excavated items must lie within a 0.5-meter radius of their mapped surface location as identified during real-time mapping tests.

A test plot measuring 50 feet in length was constructed on the Project Site in an area that exhibited relatively low background measurements during a background survey using the EM61. Because the smallest OE item of interest at the Project Site is a 37mm projectile, a series of five 1.5-inch by 4.5-inch sections of steel pipe were used to simulate 37mm projectiles and were buried at various depths (3 inches, 9 inches, and 12 inches bgs) and orientations (east-west, north south, and vertical) along the test line. The EM61 data were collected continuously along the test line, and markers were dropped at suspected anomaly locations for real-time analysis of the data. A single line of data was collected along the test plot, with station spacing of less than one foot (Blackhawk Geometrics, 2000).

All five targets were clearly identified in the test line data using a threshold level of 2 millivolts (mV). The horizontal location accuracy along the test line was shown to be within a 0.5-meter radius of the actual location identified using real-time data collection. Follow-up pinpointing of mapped anomalies with a hand-held EM61 system improved the horizontal accuracy. Based on the results of the test line data, it was determined that a 2-mV threshold level would be used for OE target identification during real-time data collection during the removal action investigation of the North Valley Military Landfill (Blackhawk Geometrics, 2000).

9.4.1.2 Data Collection.

Data collection was accomplished following the specific procedures detailed in the RAW (Earth Tech, 2000f) and in Appendix G. The quality of mapping data was assured by continuous tracking, adjustment, and visualization of the field data. Data quality was further assured by adherence to the QA/QC requirements also specified in the RAW (Earth Tech, 2000f) and in Appendix G.

9.4.2 Ordnance and Explosives Subsurface Clearance Procedures

The OE clearance conducted at the North Valley Military Landfill consisted of intrusively investigating 30 exploratory test pits. The maximum depth of the test pits ranged from 3 feet to 10 feet bgs.

Anomaly locations were marked in real-time by the geophysical survey team with a clay "pigeon" (see Volume II, Photograph #30). The OE clearance team confirmed the center of the marked target anomaly by traversing a magnetometer over the marked location (see Volume II, Photograph #31). This was performed in order to ensure personnel safety during the process of excavating the anomaly.

The OE clearance team excavated each marked anomaly location by carefully removing the earth overburden using a hand shovel/trowel. Because the clearance progressed in 1-foot lifts, if an anomaly source had not been recovered within the first 18 inches, investigation of that anomaly halted. Once each anomaly source was identified and removed or determined to be deeper than 18 inches, a 1-foot lift of the "cleared" soil was excavated from the test pit using the track-mounted backhoe. The bottom of the pit was then remapped using the EM61, marking anomaly locations with clay pigeons. The OE clearance team then excavated each marked anomaly as described above. This process of geophysical mapping, OE clearance, and excavation of 1-foot lifts continued until the base of the landfill was reached.

9.5 NATURE AND EXTENT

Background information and extent of OE-affected soils was obtained from historical records, review of previous OE data collected at the site and presented in the former Benicia Arsenal EE/CA report (Earth Tech, 2000d), and data collected during the removal action investigation.

A preliminary, conservative, OE Site Conceptual Model has been developed based on the results of the geophysical investigation to date. This model is based on the very conservative assumption that all soil fill areas on the Project Site would potentially contain OE and that all areas where OE scrap has been located also could potentially contain OE. The preliminary Site Conceptual Model is presented in Figure 9-3.

How OE may be distributed vertically through the soil column is dependent upon how the Project Site was used by DOD, natural processes (e.g., erosion), grading and filling activities, and undocumented activities that may have occurred at the Project Site. As previously described, there are two potential demolition sites and a Flare Site located in the South Valley. There were no artillery range and/or bombing activities at the Project Site. There was a Howitzer Test Facility where inert artillery rounds were fired into test tunnels. Since any OE that may be present at the Project Site, would have been kicked out from demolition activities, OE would be expected to be distributed in the top 2 feet of soil. This assumption is consistent with the data presented in the former Benicia Arsenal EE/CA report (Earth Tech, 2000d) and the distribution of OE found on similar sites throughout the country. Based on this information and discussions with DTSC, there are two basic findings as to the distribution of OE vertically within the soil column. First, that OE outside the defined demolition sites would be expected to be relatively shallowly buried below the surface (i.e., less than 2 feet bgs) and, second, OE could not be present within the bedrock at the Project Site, and therefore, bedrock is assumed to be free of OE.

9.5.1 Results of OE Clearances and Investigations

The items recovered during previous OE clearances, the EE/CA field investigation, and the removal action investigation were classified as OE, OE scrap, or non-OE scrap. OE is defined by USACE as either:

> (1) Ammunition, ammunition components, chemical or biological warfare material or explosives that have been abandoned, expelled from demolition pits or burning pads, lost, discarded, buried, or fired. Such ammunition, ammunition components, and explosives are no longer under accountable record control of any DOD organization or activity; (2) explosive soils (mixtures of explosives in soil, sand, clay, or other solid media at concentrations such that the mixture itself is explosive) (U.S. Army Corps of Engineers, 2000).

The majority of OE-related items recovered from the Project Site during previous OE clearances, the EE/CA investigation, and the removal action investigation were classified as OE scrap. OE scrap includes inert items such as gravel- or plaster-filled howitzer rounds, expended 105mm projectiles, and fragments of demolished ordnance. All non-OE-related items found during the previous clearances and investigations were classified as non-OE scrap. These items include, but are not limited to wooden boxes, wire, banding material, trash, and nails. A listing of OE-related items recovered from the Project Site during the August and December 1996 OE clearances, the EE/CA investigation, and the removal action investigation, is provided in Appendix G, Attachments G-1 through G-4.

During the OE clearance of the Howitzer Test Facility and dispersed areas across the Project Site in August 1996, a total of 180 anomalies were intrusively investigated. A total of 69 anomalies (39 percent) were classified as OE scrap, and 95 anomalies (52 percent) were classified as non-OE scrap (see Table 9-2). There were no OE items recovered from the Project Site during the initial clearance in August 1996. A total of 16 anomalies (9 percent) were classified as "unable to locate." An anomaly was classified as unable to locate when either the OE dig team could not reacquire a magnetic signal at the location specified in the data collected by the geophysical investigation team or when a magnetic signal was reacquired and intrusively investigated, no magnetic source was found.

During the OE clearance conducted in December 1996, a total of 1,182 anomalies were identified at the Project Site and intrusively investigated. A total of 3 anomalies (less than 1 percent) were classified as OE, 842 anomalies (71 percent) were classified as OE scrap, and 337 anomalies (29 percent) were classified as non-OE scrap (see Table 9-3). In addition, three OE items were recovered from the Project Site in November 1996 prior to the December clearance activities. During the RAW investigation, two rusted grenade fuzes were noted in the inventory for the existing on-site magazine. The available dig sheets from previous investigations do not list the fuzes. Most likely, the grenade fuzes were recovered and placed in the magazine during the November/December clearance activities.

During the EE/CA investigation of the former Benicia Arsenal, a total of 999 anomalies were identified at the Project Site, of which 473 (47 percent) were intrusively investigated. Of this number, 2 anomalies (less than 1 percent) were classified as OE, 272 anomalies (58 percent) were classified as OE scrap, and 160 anomalies (34 percent) were classified as non-OE scrap (see Table 9-4). A total of 39 anomalies (8 percent of those sampled) were intrusively investigated and classified as "false-positives." False-positives are those anomalies that when intrusively investigated produced no magnetic source (i.e., nothing was found).

In May 1999, a potentially live expelling charge was encountered in the South Valley during the interim investigation phase of the non-OE RI. The expelling charge was discovered on the surface by a UXO escort that was accompanying the field crew while accessing 1 of 12 proposed test pit locations on the Project Site. The Explosive Ordnance Disposal (EOD) unit from Travis Air Force Base responded and removed the item. No official determination as to whether the expelling charge was live could be made; however, it has been classified as OE for the purpose of this discussion. The location of this item is shown on Figure 9-1.

During the removal action investigation of the North Valley Military Landfill, a total of 335 anomalies were identified, of which 112 (33 percent) were intrusively investigated. Of this number, 59 anomalies (53 percent) were classified as OE scrap and 53 anomalies (47 percent) were classified as non-OE scrap. There were no OE items recovered from the North Valley Military Landfill during the removal action investigation (see Table 9-5).

On August 10, 2000, a Benicia resident reported to local authorities that he had encountered an ordnance-related item on his property. Granite's OE Specialist and USACE have inspected the item and have come to the following conclusions:

- The tail fin is from a mortar.
- The condition of the tail fin indicates that the mortar was destroyed by demolition.
- The mortar had not been fired as evidenced by the unpierced percussion primer at the base of the tail fin.
- Given that no firing ranges have been identified at the former Benicia Arsenal, the likely point of origin for the tail fin was an open burn/open detonation (OB/OD) site.
- The tail fin has been determined to be OE scrap.

- A total of 15 tail fins were found during the EE/CA investigation; 5 of these items were recovered in Sector 3B (a portion of the Project Site) and 10 were recovered in Sector 5 (the Camel Barn area). USACE designated all these items as OE scrap.

- The tail fin is nonhazardous and does not pose a safety risk.

- There is currently no basis to believe that a dangerous condition exists at the residential lot.

- At this time, additional information is needed to assess the likelihood that OE items exist in areas that have previously received fill soils.

The property where the item was encountered is situated between Columbia Circle and Rose Drive. The property is situated across Rose Drive from the Project Site, and is approximately 1,200 feet from the nearest identified demolition site (Demolition Site #1).

A review of the project grading plans indicates that the lot on which this OE scrap was found was a cut-and-fill lot where minimal grading was performed. In the specific area where the item was found, the plans indicate a fill slope with several feet of fill. The area was altered since the lot was graded by the construction of two small terrace retaining walls. The OE scrap item was recovered from the upper terrace. It is unclear where the soil that contained the item from behind the retaining walls came from or how the item got into the soil. The homes in this area have been occupied for 8 or more years. It is understood that this is the only piece of OE scrap that has been reported to have been found in residential property adjacent to the Project Site.

9.5.2 Distribution of Recovered Anomalies

All OE and OE scrap recovered during previous OE clearances, the EE/CA field investigation, and the removal action investigation was either kick-out from demolition pits or buried by human action or natural processes. Typically, OE items associated with kick-out are shallowly buried, as there is little energy available to bury them deeply into the soil.

Of the 274 anomalies intrusively investigated at the Project Site during the EE/CA investigation and determined to be associated with OE or OE scrap, 233 (85 percent) were recovered at depths ranging from 0 to 12 inches (i.e., within the first foot). A total of 36 anomalies (13 percent) were recovered at depths ranging from 12 to 24 inches. A total of four anomalies (1 percent) were recovered from between 24 and 36 inches, and one anomaly (less than one percent) was recovered at a depth of 48 inches (see Appendix G, Table G-3).

The nine OE items recovered from the Project Site were found at depths ranging from 0 to 2 feet bgs. All OE scrap recovered from the Project Site, outside of the demolition pits, were recovered at depths of 2 feet bgs or less, with the following exception. Two grids outside the demolition pits, Grids 0313 and 0311, were found to contain OE scrap at depths up to 3 feet and 4 feet bgs, respectively. These grids were adjacent to areas disturbed by grading activities that may have dumped various amounts of fill over the area. The absence of OE scrap at depths greater than 2 feet bgs, except as noted above and the actual demolition pits, indicates that any OE at the Project Site would be shallowly buried. This depth is consistent with the preliminary Site Conceptual Model and with documented past use of the area.

9.5.3 OE and OE Scrap Disposal Procedures during EE/CA Investigation

All OE or potential OE recovered during the EE/CA field investigation were disposed of on site by a UXO demolition crew. The method of disposal was to blow in place all suspected OE items. In some cases (such as with an M21 practice grenade recovered in the South Valley), items initially suspected as OE were re-categorized as OE scrap after post-investigation of the disposal site revealed the item was inert (did not contain an explosive filler). All OE scrap recovered during the EE/CA field investigation was inspected, vented/ demilitarized (i.e., inert grenades and projectiles), certified by the Senior UXO Supervisor as free of hazardous materials. These items and debris from detonations were inspected and turned over to a local scrap yard (Benicia Fabrications) as scrap metal.

9.6 ORDNANCE AND EXPLOSIVES DATA EVALUATION

OE and OE scrap data collected during past OE clearance activities, the data that are currently being collected by USACE for the Gonzalves property, and the data that will be collected by Granite during surface and point clearance of the Project Site will be input into a database, and a series of presentation maps and tables will be prepared. USACE, DTSC, Granite, and the remediation contractor will review the maps and tables. Based on this review, the preliminary Site Conceptual Model will be revised as appropriate. The final Site Conceptual Model will be used to select the areas that require further scanning and OE clearance in lifts (areawide clearance), and will be used by DTSC, USACE, and Granite to assess the likelihood that OE items were moved off site during the 1990 grading of portions of the Project Site. Discussions have occurred between DTSC, USACE, and Granite concerning future activities that are appropriate to address the off-site issue. The following three points have resulted from these discussions:

- During the clearance work to be conducted at the Project Site and the former Benicia Arsenal (the Gonzalves property), additional information regarding potential source areas and the distribution of OE and OE scrap will be obtained. This information, combined with existing information, will be evaluated by DTSC, USACE, and Granite and will be used to determine if further action is warranted.

- USACE is currently developing a Community OE Safety Program. The program focuses on educating the City of Benicia emergency staff on ordnance recognition, proper safety procedures and notification, community education through workshops for adults and children, fact sheets, and newsletters.

- The final site conceptual model will be based on data collected during the point clearance phase of the OE investigation and remediation at the Project Site, which is scheduled to begin in late fall 2001, and during the work at the former Benicia Arsenal, which began in May 2001. Evaluation of the data may be available in the first quarter of fiscal year 2002. Based on the final site conceptual model and consistent with USACE procedure, if DTSC determines that OE was distributed to residential areas outside the Project Site boundary and as a result there is risk that OE items can be encountered in a manner presenting a significant risk of injury or death, then concurrent with the areawide clearance phase of work activities, a plan will be developed in accordance with an order or agreement to identify and address these off-site areas. This plan will be presented to the public. If required, the plan will include an analysis of response alternatives for these areas. Response alternatives may include the development of a Community Awareness Plan to educate the public, institutional controls, surface clearance of OE, and/or detection and clearance of OE to depth.

10.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

This FS has been focused to evaluate a range of alternatives to remediate the Project Site to levels acceptable for residential land use development. The alternatives address both OE remediation and non-OE remediation. This FS has been prepared in accordance with the EPA's October 1988 *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA*.

10.1 INTRODUCTION

Identification of remediation goals and screening and evaluation of potentially applicable technologies and process options are key steps in the FS process. The primary objective of this phase of the FS is to develop an appropriate range of remedial technologies and process options that will be developed into preliminary remedial alternatives. The criteria for identifying potentially applicable technologies are provided in EPA guidance (U.S. Environmental Protection Agency, 1988) and in the NCP (U.S. Environmental Protection Agency, 1990). There is strong statutory preference for remedies that will result in a permanent solution; a significant decrease in toxicity, mobility, or volume; and provide long-term protection as identified in Section 121 of CERCLA, as amended. The primary requirements for the final remedy are that it be both protective of human health and the environment, and comply with applicable or relevant and appropriate requirements (ARARs). This section discusses the development and screening of the technologies and process options used to assemble the remedial action alternatives for the Project Site. The technology screening process consists of a series of analytical steps that involve making successively more specific definitions of potential remedial activities. The steps include the following:

- Identification of RAOs and remediation goals
- Identification of Project Site areas requiring remediation
- Identification of general response actions (GRAs)
- Identification and screening of remedial technologies and process options
- Evaluation and selection of process options.

The information in this chapter is presented in a format consistent with EPA RI/FS guidance (U.S. Environmental Protection Agency, 1988). Section 10.2 of this chapter presents the remediation goals for the media of interest at the Project Site. Section 10.3 identifies the GRAs that could meet the remediation goals and the areas potentially to be remediated. Section 10.4 identifies and screens a range of potentially applicable technologies and associated process options for the Project Site. These options are initially screened based upon technical feasibility. Technologies and process options that pass the initial screening are evaluated against the criteria of effectiveness, implementability, and cost to select representative options for alternatives.

10.2 SOIL REMEDIATION GOALS

Soil remediation goals are site-specific goals that define the objectives for remediating the Project Site. Soil remediation goals typically specify the constituents and media of interest, potential exposure route(s) and receptor(s); and an acceptable constituent level or range of levels for each exposure route, where applicable. Because remediation goals for protecting environmental receptors typically seek to preserve or restore a resource (e.g., groundwater, surface soil), they are expressed in terms of the medium of interest (e.g., soil, groundwater) and target cleanup levels whenever possible (U.S. Environmental Protection Agency, 1988). Remediation goals include both an exposure pathway and a constituent concentration in a given medium because protectiveness may be achieved in two ways: (1) limiting or eliminating the exposure pathway, or (2) reducing constituent concentrations. This FS evaluates remedial alternatives for both approaches.

Specific remedial goals for the Project Site were developed from (1) information obtained during remedial investigations at the Project Site, and (2) risk management decisions based on the anticipated future use of the Project Site. In addition, a review of pertinent laws, regulations, and other criteria for the Project Site was performed to identify ARARs and other criteria "to be considered" (TBC), as described below.

10.2.1 Regulatory Requirements

The Superfund Amendments and Reauthorization Act (SARA) requires that remedial actions at federal Superfund sites achieve a cleanup level that protects health and the environment. In addition, cleanups must attain legally ARARs that are promulgated under federal or state law, unless a waiver is warranted. Although the Project Site is not a Superfund site, the concept of ARARs has been used to evaluate and select final remedial actions for the proposed future residential use of the Project Site.

The following local, state, and federal agencies may have jurisdiction over remedial activities at the Project Site:

- DTSC is the lead regulatory agency for investigation and cleanup of the Project Site
- USACE

- U.S. Fish and Wildlife Service (USFWS)
- California Department of Fish and Game (CDFG)
- Bay Area Air Quality Management District (BAAQMD) has responsibility for protection of air quality; California Occupational Safety and Health Administration (Cal/OSHA) has oversight authority for worker protection during removal activities
- California RWQCB has responsibility for protection of groundwater and surface water quality; the City of Benicia has authority to issue grading permits for the Project Site
- Solano County DEM.

10.2.1.1 *Applicable or Relevant and Appropriate Requirements.*

As defined in the NCP, an "applicable" requirement is a promulgated federal or state standard that specifically addresses a hazardous constituent, remedial action, location, or other circumstance.

As defined in the NCP, a "relevant and appropriate" requirement is a promulgated federal or state requirement that addresses problems or situations sufficiently similar to those encountered, even though the requirement is not legally applicable. A requirement may be relevant but not appropriate given site-specific circumstances; such a requirement would not be an ARAR. If only part of a requirement is relevant and appropriate, then only that portion needs to be addressed.

ARARs may be chemical-specific, action-specific, or location-specific. Chemical-specific ARARs are health- or risk-based concentration limits, such as federal or state drinking water standards for specific chemicals. Action-specific ARARs are technology-based requirements that are triggered by the specific remedial actions. An example of action-specific ARARs is the National Pollutant Discharge Elimination System (NODES) requirements, which regulate the discharge of pollutants to surface water. Location-specific ARARs impose restrictions, based on site characteristics, on certain types of activities. Examples of location-specific ARARs include possible requirements associated with remedial activities in areas designated as wetlands, flood plains, or historic sites.

The proposed ARARs for the Project Site, including more detailed information on the regulatory requirements, is included as Attachment H-1 of Appendix H, TBC Criteria. Non-promulgated advisories or guidance are referred to as "to be considered" criteria (TBC) that may also be incorporated into the evaluation of potential remedies. Superfund remedies are not required to meet TBCs, but they may be used in the selection of remedies in the absence of ARARs. TBC criteria may be considered when determining the degree of remediation necessary to protect human health and the environment. For example, the Department of the Army has adopted the criterion of 10-percent explosive content as a measure of the potential reactivity of soil containing explosives such as TNT. This TBC criterion has been utilized at the Project Site to characterize OE-affected soil, and develop appropriate remedial alternatives.

10.2.2 Development of Remediation Goals

Pursuant to the NCP, site-specific remediation goals should consider (1) federal and state ARARs, if any, that specify concentration standards for COIs (independent of site conditions), and (2) risk-based concentrations that are protective of human health and the environment, considering site-specific factors. No federal or state requirements (i.e., ARARs) have been promulgated that prescribe remediation levels in soil. Therefore, remediation goals have been conservatively developed to allow unrestricted development of the planned residential areas of the Project Site.

10.2.2.1 Soil.

Soils at the Project Site are potentially affected by both OE and non-OE substances, including TNT and related compounds, other explosives, metals, PAHs, TEPHs, and dioxins/furans.

The RI portion of this report evaluates the nature and extent of non-OE-affected media. Background information and the extent of OE-affected soils were obtained from historical records, review of previous OE data collected at the site, and information presented in the former Benicia Arsenal EE/CA (Earth Tech, 2000d).

In order to develop soil remediation goals for OE at the Project Site, it is important to understand how OE may be distributed both laterally and vertically in the soil based on previous DOD-related activities at the Project Site.

USACE uses a 1,250-foot radius around potential demolition sites as a standard distance within which OE and OE scrap would most likely be encountered. OE experts generally agree that live OE items would most likely not be kicked out more than 300 to 500 feet from a given demolition site. However, fragments of inert OE can be expelled much greater distances. This estimated kick-out distance is consistent with the data presented in the final Benicia EE/CA report and the distribution of OE items recovered from the site.

How OE may be distributed vertically through the soil column is dependent upon how the site was used by DOD, natural processes (e.g., erosion), grading and filling activities, and undocumented activities that may have occurred at the Project Site. As described in Chapter 2.0, there are two demolition sites and a Flare Site situated in the South Valley. There were no artillery range and/or bombing activities at the site. There was a Howitzer Test Facility where inert artillery rounds were fired into test tunnels. Since any OE that may be present at the site would have been kick-out from demolition activities, OE would be expected to be distributed at shallow soil depths. This assumption is consistent with the data presented in the final Benicia EE/CA report (Earth Tech, 2000d), and the distribution of OE found on other similar sites throughout the country. Based on this information, two basic conclusions as to the distribution of OE vertically within the soil column have been drawn: (1) that OE outside the defined demolition sites would be relatively shallowly buried below the surface (i.e. less than 2 feet bgs); and (2) that OE could not be present within the bedrock at the site, and, therefore, bedrock is considered to be free of OE.

While analysis of site background information indicates several areas of the site where OE is most likely to be found (i.e., near the Demolition Site), for the purposes of a conservative remedial approach, it has been assumed that all areas of the Project Site have the potential to be affected by OE. Therefore, the entire Project Site will be screened for the presence of OE.

Remediation goals for soil include:

- Remove all OE detected at the Project Site, restoring the planned residential areas of the Project Site to conditions suitable for residential land use without restrictions.

- Remediate all non-OE COIs in soils to levels that will allow residential land use without restriction. A risk-based cleanup goal has been developed for TNT, as described in Chapter 7.0 and Appendix F. Other non-OE COIs will be remediated in accordance with the specific remediation goals presented in Section 7.3.1. In the absence of a risk-based remediation goal, organic compounds will be remediated to non-detect (less than the PQL).

The individual areas of interest of the Project Site are shown in Figure 2-3. These locations include the TNT Strips, the North Valley floor, the Flare Site, Demolition Site #3, and Stockpiles #1, #2, and #3.

10.2.2.2 Wetlands/Surface Water.

Surface water present at the Project Site includes surface water in the South Valley wetlands and several small seeps on slopes along the South Valley. Approximately 5 acres of jurisdictional wetlands have been delineated in the South Valley area (see Figure 2-3) and 0.09 acre has been delineated in the North Valley. DOD-related activities related to Demolition Site #3 appear to have impacted wetland sediment in a localized area immediately downslope of Demolition Site #3. In this location, sediments contain mercury at concentrations above ambient values for the site. However, methyl mercury concentrations (the form of mercury that is of greatest potential environmental concern) are consistent with background concentrations across the United States. These data indicate that neither mercury nor methyl mercury pose a significant environmental risk. Since the activities that put mercury into the soil occurred some 50 years ago, the ratio of methyl mercury to mercury is in a steady state, and existing sample results are considered representative of site conditions. No other COIs have been detected in wetland areas at concentrations warranting remediation. Therefore, soil remediation goals have been proposed to address OE and the future migration of non-OE chemicals to wetland areas.

Remediation goals for wetland/surface water include:

- Remove OE, if any are detected within the wetlands.
- Remediate non-OE COIs in soils in order to prevent their release or migration to surface water at concentrations that would exceed National Ambient Water Quality Criteria.

10.2.2.3 Groundwater.

As discussed in Chapter 7.0 (the Non-OE Health Risk Evaluation) and Chapter 8.0 (Non-OE Remedial Investigation Conclusions), groundwater at the Project Site has not been determined to be significantly affected by non-OE constituents. Additionally, ingestion of groundwater is not considered a complete exposure pathway since groundwater at the Project Site is not a viable source for drinking water. Therefore, no remediation goals are proposed for groundwater at this time. However, groundwater quality will be further assessed following implementation of remedial alternatives for OE and soil containing COIs. If future monitoring results indicate the presence of COIs in groundwater at concentrations that are of potential concern to health or the environment, then additional remedial activities will be considered for this medium.

10.3 GENERAL RESPONSE ACTIONS

GRAs describe basic actions that could be used to satisfy the remediation goals. GRAs include no action, institutional actions, containment, removal, treatment, and disposal as follows:

No-Action. The no-action alternative is retained throughout the FS process as required by the NCP (40 CFR Part 300.430[e][6]). The No-Action Alternative provides a comparative baseline against which other alternatives can be evaluated. Under this alternative, no remedial action will be taken. In the No-Action Alternative, the materials are considered to be left "as is," without implementation of any institutional action or containment, removal, treatment, or other mitigating actions.

Institutional Action. Institutional action applies various access controls and/or covenants to restrict use of property to reduce or eliminate direct exposure pathways. The volume, mobility, and toxicity of the constituents would not be reduced through the application of institutional actions.

Containment. Another method of reducing potential health and environmental risks is through waste containment. This GRA uses engineering controls such as capping to eliminate exposure pathways and the potential migration of COIs in affected media.

Removal. Technologies under the removal response action category are used to move waste or affected media from its present location to be treated and/or disposed of elsewhere. Removal process options are generally combined with treatment and/or disposal process options to develop complete alternatives.

Treatment. Treatment response actions include both in situ and ex situ treatment process options. These process options are designed to reduce the toxicity, volume, or mobility of the constituents present. Ex situ treatment process options are used with removal and disposal process options to develop alternatives.

Disposal. Disposal response actions include waste transportation, on-property disposal, and off-site disposal. The disposal process options are used in concert with removal options and possibly treatment options to develop comprehensive alternatives.

The following discussion summarizes the medium-specific GRAs consistent with the soil remediation goals for the Project Site, and describes the estimation of areas or volumes requiring remediation.

10.4 IDENTIFICATION AND SCREENING OF TECHNOLOGY TYPES AND PROCESS OPTIONS

Viable remedial action alternatives for the Project Site are developed by identifying remedial technologies and viable process options within these technologies that may be applied to the various media to be remediated at the site. The technologies considered in selecting remedial action alternatives include those identified in 40 CFR Part 300. Additional technologies were considered based on experience and information gained through remedial action planning and implementation at similar sites. The range of available technology types and process options were screened for applicability to the site in accordance with EPA guidance (U.S. Environmental Protection Agency, 1988). This section presents an evaluation of the remaining process options to select representative process options that may be used to develop comprehensive remedial action alternatives in Chapter 11.0.

10.4.1 Identification and Screening of Technologies

The initial screening of remedial technologies and process options is designed to identify applicable technologies and process options for further evaluation and to assemble them into potential remedial alternatives as set forth in the NCP.

Based on available information, media-specific remedial technologies and process options were identified for each of the GRAs. The technologies and associated process options were compiled using information available in various EPA documents, as well as other references. Each process option was screened for technical implementability. When no viable process option was left from a technology family, the technology was also screened. The screening process reduces the variety of possible process options for a given technology family to a smaller and more manageable number of options that were considered appropriate for the various media. In this step, both technologies and process options could be eliminated based on technical implementability criteria. In addition, site description and constituent characterization and concentration information was used to eliminate various technologies and process options that would not apply or could not be effectively implemented at the site.

Table 10-1 summarizes the GRAs, remedial technologies, and associated process options considered for the Project Site. Table 10-1 further summarizes the applicability of the various process options to the Project Site and presents the results of the initial screening process. All process options that are retained at this stage of the process may not be incorporated into proposed alternatives. Rather, a process option that is considered representative of the technology may be carried forward for subsequent analysis. The following discussion summarizes the identification and screening of technologies and process options. The GRAs identified as potentially applicable to the Project Site include no action, institutional controls, containment, removal, disposal, ex-situ treatment, and in-situ treatment. These actions encompass a broad range of options from "no action" to substantial measures to treat and eliminate OE and non-OE compounds in site soils.

The GRAs, remedial technologies, and process options selected for analysis are discussed below and shown in Table 10-1, along with the results of the effectiveness, implementability, and relative cost evaluations.

10.4.1.1 No-Action.

The no-action response does not include remediation, maintenance, or security activities at the Project Site to limit risk to public health and the environment and allow the site to be developed for the currently planned residential use. The no-action GRA is retained as a baseline for comparison to other remediation alternatives as required by the NCP.

Table 10-1. Identification and Evaluation of Process Options

General Response Action	Remedial Technology Type	Process Option	Preliminary Screening Based on Technical Feasibility: Soil	Surface Water/ Wetland	Groundwater	Evaluation and Selection of Representative Technologies: Effectiveness	Implementability	Cost
No Action	None	Not Applicable	Yes	Yes	Yes	Not Effective	Implementable but not for residential use	None
Institutional Controls	Monitoring	Groundwater Monitoring	NA	NA	Yes	Effective in assessing occurence of compounds and effectiveness of remedial alternatives	Implementable	Low
		Surface Water/Sediment Monitoring	NA	Yes	NA	Effective in assessing occurence of compounds and effectiveness of remedial alternatives	Implementable	Low
	Access Control	Physical Barriers	Yes	Yes	NA	Can mitigate potential exposures by restricting access	Implementable	Low
		Administrative Controls	Yes	Yes	NA	Can be effective in reducing contact between affected media and receptors	Implementable	Low to Moderate
Containment	Capping	Asphalt or Concrete-Based	No	No	NA	Effective	Not Implementable	High
		Earthen-Based	Yes	No	NA	Can be effective barrier if sufficiently thick	Implementable	Moderate
	Run-Off/Run-On Control Technologies	Diversion/Collection	Yes	Yes	NA	Effective at controlling erosion and directing surface runoff	Implementable	Moderate
		Grading	Yes	Yes	NA	Highly effective at controlling site drainage	Implementable	Moderate
		Revegetation	Yes	Yes	NA	Effective at controlling erosion, stabilization	Implementable	Low
Removal	Mechanical Removal	Excavation	Yes	Yes	NA	Effective for soil	Implementable	Low to Moderate
		Point Clearance (OE)	Yes	Yes	NA	Effective for soil	Implementable	High
OE Detection	Surface	Airborne imaging	Yes	Yes	NA	Not effective in discriminating individual anomalies	Implementable	High
		Visual searching	Yes	Yes	NA	Effective in finding surface OE	Implementable	Low
	Subsurface	Mine detector	Yes	Yes	NA	Effective in finding near surface	Implementable	Low
		Inductive EM instruments	Yes	Yes	NA	Effective	Implementable	High
		Magnetic field sensors	Yes	Yes	NA	Effective	Implementable	High
		Ground penetrating radio wave detection and ranging	Yes	Yes	NA	Not effective in clayey soils	Implementable	High
Treatment	In-Situ Biological	Enhanced Biodegradation	Yes	NA	NA	Effective for remediating low level residual contamination in conjunction with source removal.	Implementable	Low to Moderate
		Natural Attenuation	Yes	NA	NA	Effective for remediating fuel hydrocarbons	Implementable	Low
	Ex-Situ Biological	Biopiles	No	No	NA	Effective at remediating biodegradable compounds.	Implementable	Moderate
		Composting	Yes	No	NA	Effective at remediating biodegradable organic compounds	Implementable	High
		Fungal Biodegradation	No	No	NA	Limited effectiveness for TNT	Difficult to implement	Moderate
		Landfarming	No	No	NA	Effective at remediating biodegradable organic compounds	Implementable	Moderate
		Constructed Wetlands	No	Yes	NA	Moderately effective	Could be difficult to implement	Moderate
	Ex-Situ Physical/Chemical	Soil Washing	No	No	NA	Limited effectiveness	Difficult to implement	High
		Soil Sieving	No	No	NA	Not feasible to sieve clayey soils	Difficult to implement	High
		UV Oxidation	No	No	NA	Limited effectiveness	Difficult to implement	High
	Ex-Situ Physical/Thermal	Hot Gas Decontamination	No	No	NA	Effective for volatile compounds	Difficult to implement	High
		Incineration	No	No	NA	Effective for organic compounds	Difficult to implement	High
		Open Burn/Detonation (OE)	Yes	No	NA	Effective for "safe to move" OE	Implementable for on-site treatment: substantial space requirements. Off-site OB/OD very difficult to implemement	Moderate
		On-Site Blast Chamber	Yes	No	NA	Effective for "safe to move" OE	Implementable	Moderate to High
		Render Safe (OE)	No	No	NA	Effective for "not safe to move" OE	Not Implementable	Moderate to High
		Blow in Place	Yes	No	NA	Effective for "not safe to move" OE	Implementable: substantial space requirements	Moderate
Disposal	Off-Property Disposal	Transport to Class I Landfill	Yes	No	NA	Effective	Implementable	Moderate to High
		Transport to Class II/III Landfill	Yes	No	NA	Effective	Implementable	Low to Moderate

Note:
N/A = Not Applicable

10.4.1.2 Institutional Controls.

Institutional controls include the technology types of access controls and monitoring. Typical access controls include physical measures (e.g., fencing, warning signs, security personnel to control access), land use controls (e.g., covenants to restrict use of property or covenants, local ordinances), and educational activities to increase community awareness of potential risks associated with Project Site conditions.

Monitoring would be conducted during implementation of any selected remedial action alternative to assess short-term impacts to workers and the public. Additionally, sampling and/or monitoring would be employed following completion of remedial actions to demonstrate attainment of soil remediation goals. Groundwater would be monitored through the sampling and analysis of existing and new well installations. Furthermore, surface water and sediment runoff would be monitored as needed.

Monitoring Technologies

The following discussion presents the monitoring process options considered.

Groundwater Monitoring. Groundwater quality would be evaluated through existing and/or new monitoring wells to detect and monitor COIs. Groundwater monitoring has been retained for evaluation.

Surface Water/Sediment Monitoring. Surface water and sediment monitoring may be used to assess the extent of constituent migration due to runoff, and the presence of dissolved constituents and chemically affected sediments in wetland areas of the Project Site. Accordingly, surface water/sediment monitoring has been retained for evaluation.

Access Control Technologies

Access controls would be implemented to regulate access to the Project Site and any affected media. The process options for access control technologies consider the potential implementation of active and passive controls. Active controls can consist of physical barriers such as fences, gates, and security forces. Passive controls include administrative controls that limit the potential for human exposure to affected media by limiting land use or resource use. Examples include easements, covenants, prohibitions or restrictions on drilling and other intrusive activities, zoning or other land use restrictions, and special building permit requirements. The following discussion presents the access control process options.

Physical Barriers. Physical barriers limit the potential for inadvertent public or worker exposure to on-property-affected media by restricting entry. Public access to the Project Site is currently controlled by security forces and fencing. In addition, access to affected areas is restricted by access gates, internal fences, and signs. Future plans for the Project Site include development as a residential area. Accordingly, this process option will be retained through the remedial process but will not meet the RAOs for the planned site use.

Administrative Controls. Administrative controls provide passive measures to limit the potential for public and worker exposure to affected media on property. This option controls potential exposure pathways by restricting public access and land use or by providing information relevant to potential exposures. Four categories of institutional administrative controls could be used for the Project Site: (1) governmental controls, (2) proprietary controls, (3) regulatory enforcement tools with access control components, and (4) informational devices. Administrative controls may be "layered" by adopting more than one type of control to provide overlapping assurances of protection.

Governmental Controls. Governmental controls are typically implemented and enforced by local government, and can include zoning restrictions, ordinances, statutes, building permits, or other provisions that restrict land or resource use at a site. Once implemented, local entities use traditional police powers to regulate and enforce the controls. Since this category of administrative controls is put in place under local jurisdiction, they may be changed or terminated by local government. This administrative control has been retained for evaluation.

Proprietary Controls. Proprietary controls, such as easements and covenants, involve legal instruments placed in the chain of title of the affected real property. These types of controls can impose restrictions on use of land, and can be made binding on subsequent purchasers of the property (successors in title). In some states, for a covenant to be enforceable against future owners, the use restriction must be for the benefit of an adjacent landowner. In California, the covenantee who holds the right to enforce the restriction against the original coventantor and subsequent owners need not be an owner of adjacent land if the use restrictions imposed by the covenant are reasonably necessary to protect present or future human health or safety or the environment as a result of the presence on the land of hazardous materials (California Civil Code Section 1471). This administrative control has been retained for evaluation.

Regulatory Enforcement Tools. Under Sections 104 and 106(a) of CERCLA, an agreement can be negotiated or an order issued to compel a landowner to limit certain site activities. A shortcoming of this tool is that most enforcement agreements are only binding on the signatories, and orders are only binding on the parties named in the order. Thus, the property restrictions are not transferred through a property transaction to successor owners. This administrative control has been retained for evaluation.

Informational Devices. Information tools provide information or notification that residual contaminants may remain on site. Informational tools can be used to warn of the dangers of encountering contaminants, and to instruct on appropriate steps to be followed in the event of an encounter. Examples include deed notices and public information programs. Because informational devices are not designed to prevent exposure, they are most likely to be used as a secondary "layer" to add to the reliability of other administrative controls. This administrative control has been retained for evaluation.

10.4.1.3 Containment.

Containment technologies consist of engineering controls to prevent contact with affected media and to limit their potential migration. Containment may be used in conjunction with other technologies, including removal options. Containment options do not reduce constituent toxicity or volume. These containment technologies include capping and run-on/runoff control.

Asphalt or Concrete-based Cap. A single-layered cap composed of asphalt or concrete can effectively control erosion and infiltration of runoff from precipitation. Periodic application of special surface treatment may be required to maintain integrity. This process option has not been retained for further evaluation since there would be permanent environmental impacts due to the required amount of "hardscaping" that is not compatible with the proposed residential development of the Project Site.

Earthen Cap. An earthen cap uses crushed bedrock or other unaffected soil components to form a layer over potentially affected soil of sufficient thickness to be below the depth of future excavations. This cap provides a barrier to prevent migration of COIs and potential exposure to COIs and OE that may be present in underlying soil. This option has been retained for evaluation.

The Department of Defense Explosive Safety Board (DDESB) has developed default criteria in terms of depth of removal (or depth of cover of clean soil) for various reuses of property in which OE or UXO may be present. For residential areas, DDESB has set a default criteria that OE/UXO must be removed to a depth of 10 feet. Conversely, this can be interpreted to state that at least 10 feet of clean material (free of OE) must be between the surface and any soils that may contain OE. However, in California, swimming pools are common and often are installed to a depth of approximately 10 feet. Therefore, in order to ensure that an earthen cap is effective ,it must be constructed with a thickness greater than 10 feet to remove the exposure pathway.

In order to ensure, based on the swimming pool scenario, that construction workers would not come in contact with OE, there must at least 4 feet of clean soil below the base of the pool (i.e., 10 feet bgs) and any soil that may contain OE.

Therefore, for an earthen cap to be completely effective, the total thickness must be at least 14 feet thick.

Run-on/Runoff Control Technologies

Run-on/runoff controls are used to divert surface runoff around affected areas, thus minimizing the potential for soil erosion. Graded contours, swales, and berms can effectively control surface water run-on/runoff and can limit constituent migration.

Also, sediment traps such as siltation fences, hay bales, or willow waddling may be used to intercept soil particles in runoff; however, their use requires active maintenance. Sedimentation basins or sediment traps could also be used in conjunction with surface diversions/controls for surface water control. The following discussion presents run-on/runoff control process options.

Diversion/Collection. Diversion and collection technologies include the use of dams, dikes, berms, channels, waterways, terraces/benches, chutes, seepage ditches/basins, levees, and flood walls as temporary or permanent measures for effective surface water control. Diversion/collection may be used to prevent flooding, control erosion, or direct surface runoff, and can effectively prevent contact of surface runoff with affected water or waste material. Diversion/collection has been retained for further evaluation for the surface water media of interest as a means to control potential surface water runoff.

Grading. By reshaping the land surface through grading, both surface water infiltration and runoff are managed while controlling erosion. Grading may be integrated with excavation and capping technologies. Spreading and compaction of soils are commonly used. This process option has been retained for evaluation.

Revegetation. Revegetation is a cost-effective method to stabilize the ground surface, especially when preceded by capping and grading. Revegetation decreases erosion by wind and water and contributes to the development of a naturally fertile and stable surface environment. This process option has been retained for further evaluation as a way to create or restore wetlands habitat, and stabilize the surface of regraded or capped land at the Project Site.

10.4.1.4 Removal.

Affected material may be removed in conjunction with ex situ treatment and/or disposal options. Point clearance of OE is required in order to remediate the Project Site for the planned land use. Removal measures can be applied to all affected media and the appropriate technology and process option depends on the physical properties of the medium.

Mechanical Removal Technology

The mechanical removal technology involves removing soil from the Project Site using mechanical means. Excavation was identified as a technology for removal of potentially affected soil.

Excavation. Mechanical excavation has been identified as the process option, for the excavation technology, applicable to affected soil. This process option for OE removal and affected soil removal includes removal of anomalies by hand (point clearance), followed by excavation in lifts with standard construction equipment such as bulldozers and front-end loaders. Excavations will be backfilled with clean soil as necessary to meet the removal plan design. This option may be combined with other technologies, including capping, grading, and revegetation. The types of equipment and removal techniques used will be developed during the final design phase. This option also includes pre-excavation investigations, sidewall and bottom confirmation sampling, and stockpile characterization sampling. This process option has been retained for evaluation.

10.4.1.5 OE Point Clearance Detection and Removal Technology.

There are two parameters that largely control the application of detection technologies for OE. These are the physical properties of the ordnance and the capabilities of the detection technology. Other important considerations in the application of detection technologies, such as geophysical surveys, are whether the particular technology is fast and reliable, and if it can identify ferrous and nonferrous objects. It is also essential that the technology be able to determine the location and approximate depth of the object.

A summary of the available ordnance detection technologies includes visual search, airborne photographic imaging, infrared imaging, ground-penetrating radar (GPR), magnetometers, metal locators, inductive electromagnetic (EM) sensors, excavation sampling, and side-scan sonar. Synthetic aperture radar (SAR) and light distance and ranging (LIDAR) laser technologies may add to currently deployable methods.

Ordnance detection technologies generally fall into two categories: (1) surface reconnaissance, and (2) subsurface detection and mapping. Detection technologies are briefly discussed below.

Surface Reconnaissance Technologies

Reconnaissance technologies used for OE detection consist of a variety of airborne imaging, visual searching, and excavation sampling.

Airborne Imaging. Types of airborne imaging include high-resolution airborne photography and infrared thermal imaging systems. These technologies are particularly effective in locating characteristic features that may not be recognizable from the ground. The quality of airborne imaging depends on the resolution of the recording medium (i.e., film) and the speed of the aircraft conducting the aerial flyover. Resolution is particularly important because it limits the maximum area that can be scanned per image frame and the dimensions of the targets to be detected.

Airborne instrument platforms include SAR, LIDAR laser, and more traditional magnetic and EM techniques. LIDAR methods could provide the best OE target resolution, but current technologies are limited to surface detection. SAR techniques could provide information pertaining to OE occurrence in the near surface (0-8 inches bgs), with target resolution of perhaps 6-8 inches. Both LIDAR and SAR methods require massive data reduction efforts. Airborne magnetic and EM techniques would not provide the detailed resolution of either LIDAR or SAR, but offer investigation to much greater depths, on the order of several feet versus a few inches. However, the OE found historically at the Project Site are too small for airborne magnetic and EM techniques.

Aerial photography and thermal imaging are useful in locating changes in vegetation that may indicate the presence of burn pits, trenches, or OE. Historic aerial photographs are often very useful in terms of locating ground scars that may not otherwise be recognizable. In some cases, thermal imaging may be useful in locating ordnance buried at shallow depths. Aerial photographs can be produced using high-resolution film, with the altitude of the aircraft and the focal length of the camera determining the scale of the photograph. These techniques are better suited for reconnaissance surveys and site characterization then for response action.

Infrared thermal imaging detectors function within the atmospheric infrared transmission window. The thermal image quality is determined by the resolution of the detector, which has pixel or scanning bandwidth limitations that limit resolution. Thermal imaging is helpful, however, in locating potential areas of ordnance or trenches. Thermal imaging discerns the differences in the thermal conductivity between soil and metallic objects or natural soil and backfill. Under ideal conditions, thermal imaging can discern natural soil from shallowly buried metallic objects, such as ordnance. However, this technology is of limited use for ordnance buried at depths greater than a few centimeters.

Most airborne imaging technologies are developed for gross screening of large areas for OE and do not provide sufficient resolution of individual anomalies for point clearance removal. Therefore these technologies have not been retained for evaluation

Visual Searching. Visual searching is an effective means of detecting ordnance that is exposed at the ground surface. Visual searching is often the preferable method of detecting small ordnance items at the ground surface. Lanes are usually set up for visual searching and, most often, UXO-qualified personnel conducting the visual search will carry a metal detector to assist in vegetated areas. Dense vegetation and irregular terrain, such as rocks and boulders, can obscure the visual detection of ordnance.

Excavation Sampling. Excavation sampling involves exploratory digging in areas of suspected OE and is usually based upon either observations from visual searching or the result of geophysical investigation methods. Hand-dug excavations typically range from ground surface to 2 feet bgs. Characterization of trenches or impact areas of large munitions may require much deeper excavations. Excavation sampling allows for cataloging of OE items found and their respective depths bgs.

Subsurface Detection and Mapping

There are four types of geophysical methods used for the detection of anomalies associated with suspected OE. These methods include mine/coin detectors, inductive EM instruments, magnetic field sensors, and GPR.

Mine/Coin Detectors. Mine/coin detectors (commonly used for searching for underground utilities, lost valuables, and coins) function on the principle of magnetic induction. Some metal detectors can distinguish between ferrous and nonferrous metallic objects. However, they have relatively shallow (less than 1 foot) detection depths. This technology has be retained for evaluation.

Inductive EM Instruments. Inductive EM instruments, such as the EM61, are used to map the apparent conductivity of the ground and near-surface material. Discrete anomalies or peaks represent possible OE sources and can be mapped by tracking the position of the EM instrument along the traverse. Inductive EM geophysical methods are practical for locating isolated targets, as well as buried trenches and pits containing OE. This technology has be retained for evaluation.

Magnetic Field Sensors. Instruments containing passive magnetic field sensors include cesium vapor, proton total-field, and fluxgate magnetometers. Such instruments operate by measuring very small distortions in the Earth's magnetic field. These distortions or anomalies are often caused by ferrous objects buried in the soil. Magnetometers are able to detect discrete ferromagnetic objects to depths of 3-5 meters, depending on the target size. However, like conventional metal detectors, magnetic field sensors are affected by ferrous soils, cultural clutter, and structures such as buildings, fences, and power lines. This technology has be retained for evaluation.

Ground-Penetrating Radar. The GPR method operates using high-frequency radio waves emitted by a transmitter. The radio waves produce a subsurface soil profile. GPR is most successful for locating munitions in areas where the soil conductivity is low. When the GPR signal is broadcast, it propagates radially into the subsurface. An antenna captures the reflected signals. If the soil's conductivity is not high, there is less dissipation of the EM energy into the soil, allowing radar reflection from buried objects. In this respect, GPR is commonly used to locate buried trenches, point sources, drums, and conduits. The GPR data can be displayed several ways upon post-processing of the data. Clayey wet soils typically exhibit high conductivity that dissipates the EM energy into soil, therefore limiting the ability of radar to discretely identify buried objects. As discussed in Chapter 2.0 soils at the Project Site are typically clayey and wet. Therefore this technology has not been retained for evaluation.

10.4.1.6 Treatment.

This response action contains both in-situ and ex-situ biological, physical/chemical, and physical/thermal treatment technologies.

In Situ Biological Treatment

Enhanced Biodegradation. Enhanced biodegradation is a process in which indigenous or inoculated micro-organisms (e.g., fungi, bacteria, other microbes) degrade (metabolize) organic constituents found in soil and/or ground water, converting them to innocuous end products. Nutrients, oxygen, or other amendments may be used to enhance bioremediation and constituent desorption from subsurface materials. This process option has been retained for soil and groundwater media of interest.

Natural Attenuation. Natural subsurface processes such as dilution, volatilization, biodegradation, adsorption, and chemical reactions with subsurface materials may reduce constituent concentrations to acceptable levels. Monitoring may be performed to confirm that degradation is proceeding at rates consistent with meeting cleanup objectives. This process option has been retained for evaluation.

Ex Situ Biological Treatment

Biopiles. Biopile treatment is a technology in which excavated soils are mixed with soil amendments and placed on a treatment area that includes leachate collection systems and some form of aeration. It is used to reduce concentrations of petroleum constituents in excavated soils through the use of biodegradation. Moisture, heat, nutrients, oxygen, and pH can be controlled to enhance biodegradation. This process option has been retained for the soil media of interest at the Project Site.

Composting. Composting is a controlled biological process by which organic constituents are converted by microorganisms (under aerobic and anaerobic conditions) to innocuous, stabilized byproducts. Typically, thermophilic conditions (54 to 65°C) must be maintained to properly compost soil affected with hazardous organic constituents. The increased temperatures result from heat produced by microorganisms during the degradation of the organic material in the waste. In most cases, this is achieved by the use of indigenous microorganisms. Soils are excavated and mixed with bulking agents and organic amendments, such as wood chips, animal, and vegetative wastes, to enhance the porosity of the mixture to be decomposed. Maximum degradation efficiency is achieved through maintaining oxygenation (e.g., daily windrow turning), irrigation as necessary, and closely monitoring moisture content, and temperature.

There are three process designs used in composting: aerated static pile composting (compost is formed into piles and aerated with blowers or vacuum pumps), mechanically agitated in-vessel composting (compost is placed in a reactor vessel where it is mixed and aerated), and windrow composting (compost is placed in long piles known as windrows and periodically mixed with mobile equipment). Windrow composting is usually considered to be the most cost-effective composting alternative. This process option has been effectively implemented at other sites with TNT-affected soil in the United States (U.S. Environmental Protection Agency, 1997) and is retained for the soil media of interest at the Project Site.

Fungal Biodegradation. The utilization of fungal biodegradation involves the controlled usage of specially cultivated white rot fungus.

White rot fungus has been reported to degrade a wide variety of organopollutants because of its lignin-degrading or wood-rotting enzymes. Two different treatment configurations have been tested for white rot fungus, in situ and bioreactor. An aerobic system using moisturized air on wood chips is used in a bioreactor for biodegradation. Temperature is not controlled in this type of system. The optimum temperature for biodegradation with lignin-degrading fungus ranges from 30 to 38°C (86 to 100°F). The heat of the biodegradation reaction will help to maintain the temperature of the process near the optimum.

Although white rot fungus degradation of TNT has been reported in laboratory-scale settings using pure cultures, several factors increase the difficulty of using this technology for full-scale remediation. These factors include competition from native bacterial populations, toxicity inhibition, chemical sorption, and the inability to meet risk-based cleanup levels. White rot works best in nitrogen-limited environments.

High TNT concentrations in soil also can inhibit growth of white rot fungus. A study suggested that one particular species of white rot fungus was incapable of growing in soils affected with 20 parts per million (ppm) or more of TNT. In addition, some reports indicate that TNT losses reported in white rot fungus studies can be attributed to adsorption onto the fungus and soil amendments, such as corn cobs and straw, rather than actual destruction of TNT (U.S. Environmental Protection Agency, Federal Remediation Technologies Roundtable, Remediation

Technologies Screening Matrix and Reference Guide Web Site). This process option has not been retained.

Landfarming. Landfarming is a full-scale bioremediation technology that usually involves excavation and placement of affected soils, sediments, or sludges into lined beds. The material is periodically turned over or tilled to aerate the waste. Soil conditions are often controlled to optimize the rate of constituent degradation. Conditions normally controlled include:

- Moisture content (usually by irrigation or spraying)
- Aeration (by tilling the soil with a predetermined frequency, the soil is mixed and aerated)
- pH (buffered near neutral pH by adding crushed limestone or agricultural lime)
- Other amendments (e.g., soil bulking agents, nutrients).

Affected media are usually treated in lifts that are up to 18 inches thick. When the desired level of treatment is achieved, the lift is removed and a new lift is constructed. It may be desirable to only remove the top of the remediated lift, then construct the new lift by adding more affected media to the remaining material and mixing. This serves to inoculate the freshly added material with an actively degrading microbial culture, and can reduce treatment times. Since this option does not offer substantial benefits over composting, it has not been retained for further evaluation.

Constructed Wetlands. This technology uses naturally occurring chemical, physical, and biological processes to remove substances from surface water. For example, dissolved metals may be removed through ion exchange, adsorption, absorption, and precipitation with geochemical and microbial oxidation and reduction. Ion exchange occurs as metals in the water contact humic or other organic substances in the wetland. Wetlands constructed for this purpose often have little or no soil. Instead, the bottom substrate may be composed of straw, manure or compost. Oxidation and reduction reactions catalyzed by bacteria that occur in the aerobic and anaerobic zones respectively, play a major role in precipitating metals as hydroxides and sulfides. Precipitated and adsorbed metals settle in quiescent ponds or are filtered out as water percolates through the medium or the plants.

Gravel may also be used as the bottom substrate of a constructed wetland. In this case, influent water with COIs could flow through and beneath the gravel, which is typically planted with aquatic vegetation. The wetland, using emergent plants, is a coupled anaerobic-aerobic system. The anaerobic cell uses plants in concert with natural microbes to degrade the constituent. The aerobic, also known as the reciprocating, cell further improves water quality through continued exposure to the plants and the movement of water between cell compartments. This process option has been retained for evaluation.

In Situ Physical Treatment

Homogenization. This technology involves the mechanical treatment of soil within the ground to modify soil properties and produce more uniform concentrations of TNT or other constituents. This process can be accomplished with wide-diameter vertical augers (single or multiple rigs), rotary tilling machines, tow-behind discs, and other conventional earthwork heavy equipment. The homogenization process displaces soils within the treatment zone, physically treating "pockets" or strata that contain relatively high concentrations of TNT, to reduce concentration gradients and lower the potential reactivity of soil. Various admixtures (e.g., Portland cement, fly ash, lime) may also be combined with the soil during the mechanical treatment process, if necessary, to increase the strength of weak soils, or reduce leachability of soil constituents. Homogenization can be performed as a wet or dry process. In the case of TNT, application of water would reduce the potential reactivity of soil constituents by controlling spark formation between steel components (e.g., auger or discs) and native rock fragments.

Ex Situ Physical/Chemical Treatment

Soil Washing. Soil washing is a water-based process for scrubbing soils ex-situ to remove constituents. The process removes constituents from soils in one of two ways:

- By dissolving or suspending them in the wash solution (which can be sustained by chemical manipulation of pH for a period of time)

- By concentrating them into a smaller volume of soil through particle size separation, gravity separation, and attrition scrubbing (similar to those techniques used in sand and gravel operations).

Soil washing systems incorporating most of the removal techniques offer the greatest promise for application to a variety of heavy metals, radionuclides, and organic constituents in soil. Commercialization of the process, however, is not yet extensive.

The concept of remediating constituents in soil through the use of particle size separation is based on the finding that most organic and inorganic constituents tend to bind, either chemically or physically, to clay, silt, and organic soil particles. The silt and clay, in turn, are attached to sand and gravel particles by physical processes, primarily compaction and adhesion. Washing processes that separate the fine (small) clay and silt particles from the coarser sand and gravel soil particles effectively separate and concentrate the constituents into a smaller volume of soil that can be further treated or disposed of. Gravity separation is effective for removing high or low specific gravity particles such as heavy metal-containing compounds (e.g., lead, radium oxide). Attrition scrubbing removes adherent constituent films from coarser particles. However, attrition washing can increase the fines in soils processed. The clean, larger fraction can be returned to the site for continued use.

Complex mixtures of constituents in the soil (e.g., a mixture of metals, nonvolatile organics, and SVOCs) and heterogeneous constituent compositions throughout the soil mixture make it difficult to formulate a single suitable washing solution that will consistently and reliably remove all of the different types of constituents. For these cases, sequential washing, using different wash formulations and/or different soil to wash fluid ratios may be required.

Soil washing is generally considered a media transfer technology. The wastewater generated from soil washing is usually treated with other technology(s) suitable for the constituents removed from the soil. Due to the difficulties associated with its use for this site, this process option has not been retained for use on this project.

Soil Sieving. Sieving and physical separation processes use different size sieves and screens to remove solids from water, as well as larger objects (e.g., gravels, rock, OE, debris) from soil. This option could potentially be used to separate OE from soil. The effectiveness of this option would depend on various factors, including the grain size distribution, moisture content, and cohesiveness of the matrix being treated and type of OE being removed. In addition to understanding the abuse factors, for OE, the safety and the probability of an accidental detonation of the OE being removed must be considered. This option has been retained for evaluation.

UV Oxidation. Ultra-violet (UV) oxidation is a destruction process that oxidizes organic and explosive constituents in wastewater by the addition of strong oxidizers and irradiation with UV light. Oxidation of target constituents is caused by direct reaction with the oxidizers, UV photolysis, and through the synergistic action of UV light, in combination with ozone and/or hydrogen peroxide. If complete mineralization is achieved, the final products of oxidation are carbon dioxide, water, and salts. The main advantage of UV oxidation is that it is a destruction process, as opposed to soil washing, for which constituents are extracted and concentrated in a separate phase. UV oxidation processes can be configured in batch or continuous flow modes, depending on the throughput under consideration.

The UV oxidation process is generally done with low pressure lamps operating at 65 watts of electricity for ozone systems and lamps operating at 15 kilowatts (kW) to 60 kW for hydrogen peroxide systems. This option has not been retained for evaluation.

Ex Situ Physical/Thermal Treatment

Hot Gas Decontamination. The process involves raising the temperature of the affected soil to 260°C (500°F) for a specified period. The gas effluent would be treated in an afterburner system to destroy all volatilized constituents. The method could significantly lower the concentration of non-OE constituents, allowing soil to be reused on site or disposed off site as a nonhazardous material.

Incineration. The process involves raising the temperature of the affected soil to 260°C (500°F) for a specified period. The gas effluent would be treated in an afterburner system to destroy all volatilized constituents. The method could significantly lower the concentration of non-OE compounds, allowing soil to be reused on site or disposed off site as a nonhazardous material.

Operating conditions are site-specific. Organic constituents may be completely destroyed. However, metals potentially present in non-OE soil would not be effectively treated by incineration. Considering the relatively high cost, limited availability of treatment units, and ineffectiveness for metals, these process options have not been retained for evaluation.

Physical/Thermal Treatment for OE

For physical/thermal treatment of OE, there are two categories of items: OE that is safe to move and OE that is not safe to move. For OE that is safe to move, there are three process options: (1) OB/OD on site, (2) OB/OD off site, and (3) on-site treatment within a self-contained blast chamber. For OE items that are not safe to move, there are two process options: (1) render safe and (2) blow in place (BIP).

OB and OD process options may be used to treat OE materials. In OB operations, energetics or OE are destroyed by self-sustained combustion, which is ignited by an external source, such as flame, heat, or a detonation wave. In this case, an auxiliary fuel may be added to initiate and sustain the combustion of materials. OB areas must be able to withstand accidental detonation of any or all energetics being destroyed, unless the operating OB technicians recognize that the characteristics of the materials involved are such that orderly burning without detonation can be ensured. Personnel with this type of knowledge must be consulted before any attempt is made at OB treatment, especially if primary explosives are present in any quantity. In OD operations, detonatable ordnance are destroyed by a detonation, which is generally initiated by the detonation of an energetic charge.

OB and OD can be initiated either by electric, burning, or energetic charge ignition systems. In general, electric systems are preferable because they provide better control over the timing of the initiation. In an electric system, electric current heats a bridge wire, which ignites a primary explosive or pyrotechnic, which, in turn, ignites or detonates the material slated to be burned or detonated. If necessary, safety fuses, which consists of propellants wrapped in plastic weather stripping, are used to initiate the burn or detonation. In some cases, scrap energetics or dried activated carbon from pink/red water treatment may be used as the initiation charge.

As discussed above, there are two sets of process options for OE, OE items that are safe to move and OE items that are not safe to move. The following susection provides detail on how the "safe to move" decision is made. Therefore, before considering which process options are available for the disposal of OE, determination of "safe/not safe to move" must be made.

Identification of Non-OE Metallic Items, OE Scrap, Potential OE, and OE

OE clearance crews will identify recovered anomalies as non-OE, OE scrap, potential OE, or OE. OE is ammunition, ammunition components, or explosives that have been abandoned, expelled from demolition pits or burn pads, lost, discarded, or buried.

Non-OE anomalies include inert metallic items such as metal cans, buckets, nails, bolts, steel reinforcing bars.

OE scrap includes those items that are fragments of OE that has functioned as designed, or been intentionally destroyed during demolition operations, and which contains no explosives or other items of a dangerous nature. OE scrap is inert and does not pose a safety risk. An item is determined to be OE scrap if it can be visually inspected for the presence of explosives from all sides and no explosive material is present. OE scrap containing residual explosives is considered OE.

An item will be identified as potential OE if it cannot be determined whether explosives are present. Potential OE items will be handled as OE by the clearance crew, and potential OE and OE items will be left in place and flagged during surface clearance for further inspection by the demolition team. Non-OE and OE scrap items will be collected and placed in the corner of each grid section that will be laid out on the Project Site.

After the clearance crew has collected the non-OE metallic items, OE scrap items and flagged potential OE and OE items, the demolition team will further inspect all flagged items to make a final determination if an item is OE or OE scrap. OE scrap items will be handled as previously described above. The demolition crew will also further inspect the non-OE and OE scrap items collected by the OE clearance crew to certify that these items are not OE. Once certified as not OE the non-OE and OE scrap items will be moved to a central on-site location for secure storage in a locked container. OE items will be further inspected as described below.

Determination of Safe to Move

The demolition team will inspect each OE item to determine if it is safe to move or not. The inspection will be directed by the Senior UXO Supervisor (SUXOS) in conjunction with the UXO Site Safety Officer (UXOSO). The SUXOS and UXOSO will be graduates of U.S. Naval School Explosive Ordnance Disposal Training Program, or equivalent, and have a minimum of 15 and 10 years experience, respectively. Their determination will be based on available Ordnance Technical Manual data, training, and professional knowledge, using the following criteria in conjunction with the OE process flow chart provided in the OE RDD.

Inspect the OE item to determine if it is armed or unarmed, and if it is unsafe due to damage. An item is considered armed if it has been fired or used for its intended purpose. The determination that it is armed or unarmed is in part based on the following criteria:

Projectiles. Check the rotating ban. If it has been scored by the rifling in the gun tube it has been fired, and if fuzed must be considered armed.

Mortars. Check the ignition cartridge and percussion primer. If the primer is impinged it must be considered fired, and if fuzed must be considered armed.

Hand Grenades. Check the safety pin and spoon. If the safety pin and/or spoon are missing it is armed.

An item, either armed or unarmed, may have been rendered unsafe due to damage. Types of damage that may render an item unsafe could include, but are not limited to, the following:

Dents - in the body or fuzing systems.

Holes - or rips in the body or fuzing systems.

Burned - visible scorching and/or soot present.

OE items that are armed or determined to be rendered unsafe due to damage, or whose status cannot be safely evaluated due to deterioration, positioning, etc., will not be considered safe to move. OE items that are unarmed and not rendered unsafe due to damage may be considered safe to move. In some cases, OE items that are damaged may be moved if OE Technical Manual data indicates that the item is safe to move.

Disposal of OE Items

Procedures for Safe to Move OE Items

Items that are determined to be safe to move will be relocated by the demolition team to a Bureau of Alcohol, Tobacco, and Firearms (ATF) Type II, explosive storage magazine that will be kept on the Project Site. Any applicable permits will be obtained for the storage of recovered OE items within the magazine. Placement and care of the magazine will follow ATF, state and local guidelines for the storage of high explosives. Recovered OE items will be temporarily stored in the magazine until they are disposed of. The duration OE items will be stored is dependent upon the accumulated explosive weight of the OE recovered, the explosive weight storage limit of the on site magazine as established by required permits, and Resource Conservation and Recovery Act (RCRA) storage requirements, which regulates the length of time OE items can be stored. To ensure the permitted magazine explosive weight limit is not exceeded, an inventory of all recovered OE items will be maintained on Magazine Data Cards, and a running total of accumulated explosive weights will be maintained. All OE items will be properly disposed of not later than the completion of clearance activities.

Process Options for Safe-to-Move OE Items

The treatment options for safe to move OE items will be screened according to the following criteria:

- Environmental impacts of disposal technology
- Ability to safely transport the item
- Availability of technology
- Willingness of off-site OB/OD facilities to accept the OE item
- Size of the OE item
- Ability to safely dispose of the item.

Off-Site OB/OD. Transporting OE off-site could present potential risks and would be very difficult to implement. Although an OE item may be safe to move on site during point clearance, it may not be safe to transport long distances. In addition, within California all permitted OB/OD facilities are government-owned and have very specific criteria on items they can accept.

Because of the prohibitive requirements for preparing OE items for off-site transportation and the difficulty in finding an OB/OD facility willing to accept OE items, this process option will not be retained.

On-Site OB/OD. An on-site OB/OD area may be established for the on-site treatment of safe to move OE items. The two main factors in determining if the on-site OB/OD process option is viable are: (1) the safety of treating the item at the proposed location, and (2) the impact on the environment. The size of the OE item being treated is a factor. However, in almost all cases, engineering controls such as sandbag enclosure can be designed to safely capture hazardous fragments from the largest OE items reasonably expected to be at the site. The capital cost is relatively low for the on-site OB/OD process option. This process option will be retained for evaluation.

On-Site Blast Chamber. There is sufficient area within the project site to house/set-up a self-contained blast chamber for the treatment of OE. There are four main factors in determining if the use of this process option is viable: (1) safety; (2) impact on the environment; (3) availability of the technology; and (4) size of the item being disposed of, due to the limited capacity of the chamber. If OE items exceed the capacity of the on-site blast chamber, then on-site OB/OD would be the only viable option. The capital cost is medium to high for the on-site blast chamber process option. This process option will be retained for evaluation.

Process Options For Not Safe-to-Move OE Items

There are two process options for treatment of OE items that are not safe to move: (1) Render Safe, and (2) BIP.

Render Safe. The render safe process option can only be performed by active EOD military personnel. Active EOD personnel are not available to perform this disposal option for non-government projects. Therefore, the render safe process option is not viable for treatment of OE at the Project Site. This process option will not be retained for further evaluation.

BIP. If it has been determined that an OE item cannot be moved, it will be BIP after authorization has been received to conduct the procedure from DTSC. BIP operations will be performed under the direction and supervision of the SUXOS. A Minimum Separation Area (MSA) will be in place during all OE clearance activities. An MPM and Minimum Separation Distance (MSD) have been recommended by USACE in their letter to the City of Benicia, dated December 11, 2000, from DTSC. These USACE recommendations were based on the Corps' review of the OE clearance work performed by Granite in 1996 and by USACE (Earth Tech, 2000d) along with other site specific information. Subsequently, the DTSC issued their recommendations regarding the MPM and MSD in a letter, dated February 9, 2001, from DTSC. DTSC concurred with the USACE regarding the site specific MPM and MSDs. In addition to the DTSC MSD recommendation, DTSC also recommended a voluntary separation distance (VSD). This concept is discussed as a mitigation measure in the Tourtelot Remediation EIR. The VSD is based on the maximum fragmentation distance for the MPM items (37mm [HE] and 60mm mortar). The MSA (based on the MSD) will be enforced for persons not related to project site OE clearance activities. The recommended VSD notifications and associated actions may be required as mitigation under the EIR. Prior to a BIP, all personnel, except those needed to safely and efficiently prepare the item(s) for destruction, will be evacuated from the MSA. The SUXOS will verify that all nonessential personnel are outside the MSA prior to a BIP.

All demolition operations will be conducted by safely detonating OE items using proven and USACE-approved engineering techniques to control/minimize hazards of blast and fragmentation. The UXOSO will monitor compliance with safety measures contained in the SSHP and will stop or suspend operations in the event of noncompliance. In all cases, disposal operations will be performed between the hours of 9:00 a.m. to 3:00 p.m., Monday through Friday, and will not be conducted during days of low cloud cover or temperature inversions, which could amplify noise associated with detonations and adversely affect local residences.

To identify if the item to be detonated is in direct contact with a secondary OE item that could add to the total explosive weight should it be sympathetically detonated during a BIP operation, the OE item will be investigated using a mine probe. Should the item be found to be in direct contact with another OE item, appropriate engineering controls will be employed to either eliminate the direct item-to-item contact which will eliminate the possibility of a sympathetic detonation, or to compensate for the potential detonation of the second item during the intentional demolition of the first item.

The BIP process option is the only viable option for OE that is not safe move. This process option will be retained for evaluation.

10.4.1.7 Disposal.

The following three process options are available for the disposal of soil within California: off-site disposal at Class I landfill, off-site disposal at a Class II landfill, and off-site disposal at a Class III landfill. Soil containing non-OE constituents could also be disposed at permitted facilities located outside of California. With regard to out-of-state disposal, soil containing non-OE constituents would be classified as RCRA or non-RCRA waste based on chemical characteristics.

Soil could be transported via trucks or rail to the selected landfill(s). In California, the specific waste acceptance criteria for each type of landfill are specified in facility-specific Waste Discharge Requirements (WDR) issued by the appropriate RWQCB. However, waste acceptance is generally based on the following criteria for the three classes of landfills in the state of California.

Class I Landfills. Class I landfills generally accept hazardous waste as defined in 22 CCR, Division 4.5, Chapter 11, which lists characteristics of ignitability, corrosivity, reactivity, and toxicity (Article 3) and that lists hazardous wastes from non-specific sources, specific sources, and discarded commercial chemical products. A waste is considered hazardous if it exhibits any of the above four characteristics. Depending on the specific characteristics of the waste, treatment may be required to meet regulatory requirements governing landfill disposal activities. It is expected that wastes generated during remediation activities at the Project Site will not exhibit hazardous characteristics for ignitability, corrosivity, or reactivity. Nor is it expected that these wastes will exhibit the criteria for wastes from specific sources or discarded commercial chemical products. However, due to the possibility that concentrations of TNT greater than 10 percent may be detected in certain soils from the TNT strips, pretreatment of those soils on-site may be required prior to off-site transportation.

Disposal of affected soil in an off-site Class I landfill is an effective means of achieving soil remediation goals for the Project Site.

The cost of the off-site Class I landfill process option depends on several factors such as (1) distance to the Class I landfill; (2) transportation method; and (3) the quantity of waste requiring disposal. The capital costs are moderate to high for Class I landfill disposal.

The Class I landfill process option will be retained for remedial alternative development and evaluation.

Class II Landfills. Class II landfills generally accept designated waste as defined in 23 CCR 2522. Acceptance criteria generally vary from landfill to landfill, depending on the provisions of their WDRs. Although numerical criteria for designated waste have not been promulgated, a typical Class II landfill in California has the following criteria:

- Waste is not a hazardous waste as described above
- Petroleum hydrocarbon concentrations that have no specific limits, but the waste must meet ignitability limits.

Disposal of affected soil at a Class II landfill is an effective way to achieve the Soil remediation goals for the Project Site. The cost of the off-site Class II landfill process option depends on several factors such as (1) distance between the Project Site and the landfill, and (2) the quantity of waste requiring disposal. The capital costs are moderate for Class II landfill disposal. For the purpose of this FS, the out-of-state disposal of soil that is not a RCRA waste would be considered Class II disposal.

Class III Landfills. Class III landfills generally accept soil and debris that are not classified as designated or hazardous wastes. The specific acceptance criteria vary from landfill to landfill, depending on WDR requirements. Depending on sampling results and characterization profiles, some soil excavated at the Project Site may be determined to be acceptable for off site disposal at a Class III landfill. The off-site disposal options at Class I, II, or III landfills will be retained for evaluation.

10.4.2 Evaluation of Technologies and Selection of Representative Technologies

The technologies and process options described in the preceding section have been further evaluated and screened to obtain a reasonable number of options that may be combined in alternatives (Chapter 11.0). Options not carried forward at this stage of the FS process may be reconsidered at a later time if assumptions made during this screening step change over time (e.g., treatment units become available, costs change significantly).

10.4.2.1 Criteria for Evaluating Technologies and Process Options.

The process options were evaluated based on effectiveness, implementability, and cost. These criteria are described below. The evaluation is only relative to similar process options and did not compare process options between technologies. Table 10-1 summarizes the results of the process option evaluations. A description of each evaluation criterion follows.

Effectiveness. The various process options identified under each technology type in Section 10.4.1 were evaluated for effectiveness based on the following:

- The potential effectiveness of the process option for meeting the purpose of the technology
- The potential impacts to human health and the environment during the construction and implementation phase
- The reliability of the process option as it relates to the chemicals of potential concern and conditions within the Project Site boundary.

Implementability. The implementability evaluation includes both technical and administrative feasibility of implementing a process option. Examples of administrative feasibility include the availability of skilled workers to implement the process option; the ability to obtain permits for off-site actions; and the availability and capacity of treatment or disposal facilities.

Cost. Each process option was evaluated as to whether costs were high, medium, or low relative to other process options of the same technology type.

10.4.2.2 Technology Screening

No-Action

The no-action GRA was retained for development into an alternative as required by CERCLA. Under the no-action GRA, no additional actions will be taken at the Project Site.

Effectiveness: This GRA is not effective. It provides no protection of human health and the environment and does nothing to reduce the toxicity, mobility, or volume of OE and non-OE constituents present.

Implementability: No technical or other issues exist that would affect implementation, but it would be difficult to gain public acceptance or regulatory acceptance for no action.

Cost: There are no costs associated with this alternative.

Screening decision: Retained, in accordance with the NCP and EPA RI/FS Guidance.

Institutional Controls

Technologies considered for the institutional control GRAs include monitoring and access control.

Monitoring Technology

Monitoring process options were considered for groundwater and surface water media at the Project Site. Process options evaluated for the monitoring technology include groundwater monitoring and surface water/sediment monitoring.

Groundwater Monitoring

Effectiveness: Monitoring wells are effective in evaluating groundwater quality over time, and the effectiveness of other remedial measures. The potential impact on human health and the environment during the construction and implementation phase of this option is negligible.

Implementability: Groundwater monitoring would be readily implementable at the Project Site, although there would be constraints to installing and accessing wells in developed areas.

Cost: Capital costs would include the potential installation of additional monitoring wells. Operations and maintenance (O&M) costs include well maintenance, sampling and analysis, data validation, database management, and preparation of periodic monitoring reports. Overall, costs would be low.

Screening decision: Retained.

Surface Water/Sediment Monitoring

Effectiveness: Surface water/sediment monitoring can be very effective for evaluating the quality of surface water and monitoring the performance of remedial actions.

Implementability: Surface water/sediment monitoring could be implemented at the Project Site.

Cost: Costs for this process option would be low. Laboratory analytical costs would constitute the largest part of the cost. Overall, costs would be low.

Screening decision: Retained.

Access Control Technology

Process options evaluated for access control technology include physical barriers and administrative controls.

Physical Barriers

Effectiveness: Fencing would effectively limit the access site.

Implementability: Physical barriers are already in place and could be maintained in the future.

Cost: The cost to install and maintain physical barriers is relatively low.

ADMINISTRATIVE CONTROLS

Governmental Controls

Effectiveness: Use restrictions in the form of land use or zoning restrictions or permit requirements imposed by the City of Benicia could be used to mitigate potential exposure pathways. For example, restrictions implemented through grading permit requirements could be used to impose appropriate requirements for construction support by OE technicians for excavation in areas where OE may remain. Zoning code provisions or General Plan land use designations could prohibit residential construction on land where OE may remain. The long-term effectiveness of governmental controls is dependent in part on the ownership of the parcels that would be subjected to the controls. Governmental controls for the Project Site would be implemented and enforced by the City of Benicia and the controls could be terminated or changed by unilateral action by the City. Some legal parcels for which Access Controls will potentially be needed at the Project Site are currently owned by the City and the City may accept ownership of additional parcels in the future. For such parcels, the use of Governmental Controls may not be effective since the restrictions could be changed by unilateral action of the City.

Implementability: Implementing Governmental Controls at the local level would require approval by Benicia City Council and would be subject to the uncertainties of the political process. Assuming that Governmental Controls win the support of a majority of the Council members, this option could be implemented. The City of Benicia would be responsible for enforcing the Governmental Controls, using traditional police powers and existing permitting and land use procedures.

Cost: The cost to implement Governmental Controls is relatively low. Enforcement would be under the control of the City of Benicia and would use existing mechanisms that apply to other land use restrictions and permit requirements. Enforcement costs would accordingly be relatively low.

Screening decision: Retained.

Proprietary Controls.

Effectiveness: Use restrictions in the form of covenants enforceable by DTSC or other appropriate governmental entities could effectively mitigate potential exposure pathways. Such covenants could impose requirements for appropriate construction support by OE technicians for excavation in areas where OE may remain and could prohibit residential construction on land where OE may remain. Enforcement of the covenants could be monitored through the post-remediation Operations and Maintenance Plan for the Project Site.

Implementability: Proprietary controls can be readily implemented. The restrictions would be set out in covenants executed by the owners of the legal parcels subject to the use restrictions. The covenants would set out the mechanism for enforcement. If recorded in the title chain for the affected parcels, the covenants would automatically be binding on any subsequent owners. The covenants would by their terms give the DTSC or other enforcement entity the legal authority to monitor and enforce the restrictions. Any modification of the covenants would require express approval of the enforcement entity.

Cost: The cost to implement proprietary controls is relatively low. Monitoring and enforcement costs would depend on the specific oversight program developed by DTSC.

Screening decision: Retained.

Regulatory Enforcement Tools

Effectiveness: DTSC could issue a post-remediation enforcement order or enter into an enforcement agreement with parties to the existing DTSC Order that could impose restrictions on land use to mitigate exposure pathways. The need to prevent exposure to any OE that could remain on the Project Site will require that the selected Administrative Control remain effective indefinitely. An enforcement order or agreement would not automatically be binding on future owners of the affected parcels, making this tool less effective than Proprietary Controls that are automatically enforceable and binding against future owners.

Implementability: An enforcement order could be issued by unilateral action of DTSC and an enforcement agreement could be implemented by agreement of DTSC and the project proponents. Because the City of Benicia owns some parcels at the Project Site that will be subject to the use restrictions, the City would need to be designated as a Potentially Responsible Party to make the restrictions binding on such parcels through an enforcement order or agreement. If ownership of the affected parcels were to change, DTSC would have to negotiate an agreement with the new owner or issue an order naming the new owner as a Potentially Responsible Party.

Cost: The cost to implement an enforcement order or agreement with the proponents would be low. Additional costs would be incurred to impose the restrictions on current or future landowners that are not currently subject to jurisdiction of the DTSC. Enforcement costs would be equivalent to those for Proprietary Controls.

Screening decision: Not retained.

Informational Devices

Effectiveness: Informational Devices could provide information or notification that residual OE may remain on portions of the Project Site. Such tools would not reduce the exposure pathways, but would warn of the dangers of activities that could expose OE and help inform those who could become exposed to the appropriate manner of dealing with any OE that may be encountered. Informational Devices would be effective primarily as a secondary layer to help ensure the overall reliability of other Administrative Controls.

Implementability: Informational Devices could be readily implemented. USACE has already indicated that it plans to implement Informational Devices that will apply to all areas within the Former Benicia Arsenal (including Sectors 1 through 5, which includes the Project Site) (Earth Tech, 2000d).

Cost: The cost to implement Informational Devices is relatively low since it can be done as part of the program that USACE has already committed to undertaking.

Screening: Retained as secondary layer to be used on conjunction with other Administrative Controls

Containment

The following technologies were considered for the containment GRA: capping and run-on/runoff control.

Capping

Construction of an earthen cap of crushed bedrock was determined to be a viable remedial technology for use at the Project Site.

Effectiveness: Soil-based caps would be effective in eliminating future exposure to OE that are not detected by geophysical scanning at the Project Site. Construction of an earthen cap would be effective but could require maintenance and repair over time.

Implementability: A single-layered bedrock based cap could be constructed with standard construction equipment and methods. There is sufficient crushed bedrock available on site for use as an earthen cap.

Cost: Construction of a crushed bedrock cap would have a relatively high cost, due to the labor and equipment costs to excavate, crush, and place the bedrock material over potentially affected soils.

Screening decision: Retained.

Run-Off/Run-On Control Technology

Run-on/runoff control technology was determined to be a remedial technology applicable for soil and surface water media at the Project Site. Process options evaluated for run-on/runoff control include diversion/collection, grading, and revegetation.

Diversion/Collection

Diversion/collection was evaluated as a process option for the surface water/ wetlands media of interest at the Project Site.

Effectiveness: This surface water control method is used to prevent flooding, control erosion, and direct surface runoff. When used in conjunction with other remedial action technologies, this technology can be effective. Diversion of storm water runoff will reduce the potential for migration or erosion processes.

Implementability: This method can be readily implemented using standard equipment and materials and local contractors. Most excavation and grading equipment is readily available.

Cost: Generally, cost of diversion and collection techniques usually is not high with the installation cost dependent on the site topography and geology. Low maintenance costs are common to almost all diversion and collection methods. Overall, costs are considered moderate.

Screening decision: Retained.

Grading

Effectiveness: Grading is a highly effective method of promoting and controlling site drainage and preventing erosion. Grading can be used with in-situ remediation alternatives as well as removal, treatment, and disposal alternatives. Some form of site grading will be used with any remediation alternative. Short-term fugitive dust emissions would need to be controlled in accordance with a SSHP.

Implementability: Grading can be implemented at the site using standard construction equipment. The techniques used in grading operations are well established and widely used. Personnel and equipment to perform grading can usually be obtained locally.

Cost: Capital costs would be moderate. Required equipment can be either purchased or leased. Grading has been carried forward to the development of alternatives for the soil media of interest.

Screening decision: Retained.

Revegetation

Revegetation was evaluated as a process option for the soil and surface water/ wetlands media of interest.

Effectiveness: Revegetation effectively establishes a vegetative cover that stabilizes the surface or replaces vegetation removed during remedial activities. This technique decreases erosion by wind and precipitation.

Implementability: This process option is considered readily implementable due to the minimal equipment requirement.
Planning involves the selection of suitable plant species, seedbed preparation, seeding/planting, mulching, fertilization, and maintenance.

Cost: Relative to other technologies, revegetation is an inexpensive stabilization process. Periodic maintenance such as lining, fertilizing, mowing, replanting, and grading eroded slopes are O&M costs associated with this remedial technique. Overall, costs would be low.

Screening decision: Retained.

Removal

The following technologies have been further evaluated for the removal GRA: point clearance detection and removal, and mechanical removal.

Mechanical Removal Technology

The process options being evaluated for the mechanical removal technology includes excavation.

Excavation

The use of conventional earthmoving equipment (i.e., scraper, backhoe, wheeled or tracked front-end loader, and dozer) was evaluated under the mechanical removal technology for soil at the Project Site. This process includes in-situ homogenization of soil in the TNT Strip area prior to excavation. Homogenization will produce more uniform TNT concentrations that are consistently less than the reactivity criterion, allowing TNT-affected soils to be safely excavated and transported off site.

Effectiveness: This process option is very effective in removing soil and debris for treatment and removal options. Standard procedures would need to be implemented to control fugitive dust emissions.

Implementability: Scrapers, backhoes, front-end loaders, dozers, and water trucks are widely used for earth-moving activities and can be readily obtained. This process option is implementable.

Cost: Capital costs would be low and would only include equipment cost. Overall, costs would be moderate.

Screening decision: Retained.

OE Point Clearance Detection and Removal Technology

The process options being evaluated for point clearance detection include visual searching, excavation sampling, mine/coin detectors, inductive EM instruments, and magnetic field sensors.

Visual Searching

Effectiveness: Visual searching is an effective method to detect OE that is present at the ground surface, particularly in areas with sparse vegetation. Use of a metal detector in conjunction with visual searching increases the effectiveness of this option.

Implementability: Visual searching is readily implementable in open areas. Qualified persons trained in OE detection are needed to perform this activity. Visual searching is less implementable in areas with dense vegetation or rugged topography (i.e., steep terrain and boulders).

Cost: This process option has a relatively low cost compared with other detection technologies.

Screening decision: Retained.

Excavation Sampling

Effectiveness: Excavation sampling is an effective method to locate buried ordnance, when used in conjunction with geophysical methods.

Implementability: Excavation sampling is implementable using hand excavation equipment. Qualified personnel trained in OE detection procedures are required to perform excavation sampling.

Cost: The cost to implement this technology is moderate to high, depending on the excavation depth, soil hardness, and density of anomalies being identified.

Screening decision: Retained.

Mine/Coin Detectors Evaluation

Effectiveness: Mine/coin detectors are effective in detecting shallow ferrous metal items. As with other detection technologies, the rate of detection is a function of the size and depth of burial of the OE item being acquired. The smaller and deeper the item is buried the less effective the technology is in locating the item. However, in general mine/coin detectors are effective in finding OE items which may be buried less then 1 foot. Generally mine/coin detectors are used in conjunction with other detection methods to help refine the target location.

Implementability: Mine/coin detection equipment is readily available from a number of purveyors. Most mine/coin detection equipment does not require post processing to discern anomalies and can be used "real time" to locate OE items. Mine/coin detector equipment has been implemented at a number of sites across the country.

Cost: The initial capital cost for deploying mine/coin detector equipment is relatively low. However, depending on soil type, this technology can have a high false alarm rate and thus increase excavation costs.

Screening decision: Retained.

Inductive Electromagnetic Instruments

Effectiveness: Time-domain EM (THEM) systems have been proven by independent government evaluation and field implementation to be one of the most effective means for the detection of OE. However, not all OE is detected by TDEM technology. The rate of detection is a function of the size and depth of burial of the OE item being acquired. The smaller or deeper the item is, the less effective the TDEM technology is in locating the item. The actual performance of the equipment will vary depending on site conditions. In order to determine the actual effectiveness of TDEM equipment deployed at the site, an equipment test should be performed over a test bed with seeded OE items that duplicate the size and depth of items expected to be present at the site. However, in general TDEM equipment detects 70 to 90 percent of the subsurface OE at a site in a single pass.

Implementability: TDEM equipment is readily available from a number of purveyors. TDEM equipment is most efficient when data are collected digitally and post processed in order to discern anomalies for excavation. Once anomalies are identified in the data, the anomalies must be reacquired in the field, usually with the assistance of a hand-held EM device. TDEM have been implemented at a number of sites across the country.

Cost: The initial capital cost for deploying a TDEM system with post processing the data and reacquiring anomalies can be high. The post processing provides an opportunity to more readily screen those anomalies associated with geologic and/or topographic conditions thus reducing the false alarm rate and reducing excavation costs over other detection systems.

Screening decision: Retained

Magnetic Field Sensors

Effectiveness: Magnetic field sensors systems have been proven by both independent government evaluation and field implementation to be an effective means for the detection of OE. However, not all OE is detected by Magnetic field sensor technology. The rate of detection is a function of the size and depth of burial of the OE item being acquired. The smaller or deeper the item is, the less effective the technology is in locating the item. The actual performance of the equipment will vary depending on site conditions. In order to determine the actual effectiveness of Magnetic field sensor equipment deployed at the site, an equipment test should be performed over a test bed with seeded OE items that simulate the size and depth of items expected to be present at the site. Magnetic field sensor equipment are affected by ferrous soils, cultural clutter, and structures such as buildings, fences, and power lines. Magnetic field sensors tend to be less effective then inductive EM instruments for shallowly buried targets due to cultural interference and the complexity of the magnetic response.

Implementability: Magnetic field sensor equipment is readily available from a number of purveyors. Magnetic field sensor equipment is most efficient when data are collected digitally and post processed in order to discern anomalies for excavation. Once anomalies are identified in the data, the anomalies must be reacquired in the field, usually with the assistance of a hand-held detection device. Magnetic field sensors have been implemented at a number of sites across the country.

Cost: The initial capital cost for deploying a magnetic field sensor system with post processing the data and reacquiring anomalies can be high. The post processing provides an opportunity to more readily screen those anomalies associated with geologic and/or topographic conditions thus reducing the false alarm rate. However, magnetic field sensor equipment does have a higher false alarm rate then inductive EM instruments, and, therefore, a higher overall cost.

Screening decision: Retained.

Treatment

The following treatment technologies have been evaluated: in-situ biological treatment, ex-situ biological treatment, ex-situ physical/chemical treatment, and ex-situ physical/thermal treatment.

In-situ Biological Treatment

The process options being evaluated for the in-situ biological treatment technology include: enhanced biodegradation, and monitored natural attenuation.

Enhanced Bioremediation

Effectiveness: Bioremediation techniques have been successfully used at other sites to remediate soils, sludges, and groundwater containing petroleum hydrocarbons, solvents, pesticides, wood preservatives, and other organic chemicals. Bench- and pilot-scale studies have demonstrated the effectiveness of anaerobic microbial degradation of nitrotoluenes in soils. Bioremediation is especially effective for remediating low-level residuals in conjunction with source removal.

Implementability: Bioremediation is readily implementable at the Project Site. Limitations include the length of time required for remediation.

Cost: The costs for enhanced bioremediation would be moderate, and would depend on the nature and depth of the constituents, and the need to add amendments to stimulate effective biodegradation of constituents.

Screening decision: Retained as a backup option to composting.

Natural Attenuation

Natural attenuation was evaluated for non-OE constituents, particularly for petroleum hydrocarbons in soil at the Project Site.

Effectiveness: Petroleum hydrocarbons are commonly remediated by natural attenuation. Additionally, natural attenuation may be appropriate for some metals, when natural attenuation processes result in a change in the valence state of the metal that results in immobilization (e.g., chromium). Overall, the effectiveness is good, depending on the chemicals present.

Implementability: Natural attenuation does not require specialized equipment and could be readily implemented at the Project Site.

Cost: The most significant costs associated with natural attenuation are often due to monitoring requirements, which include two major parts: site characterization and performance monitoring. Site characterization determines the extent of the affected soil. Performance monitoring may provide information on constituent migration and degradation and cleanup status. Overall, natural attenuation costs are considered low.

Screening decision: Rretained for petroleum hydrocarbons in soil.

Ex Situ Biological Treatment

The process options being evaluated for the ex situ biological treatment technology include composting and constructed wetlands.

Composting

Effectiveness: The composting process may be applied to soils affected with biodegradable organic compounds. Pilot and full-scale projects have demonstrated that aerobic, thermophilic composting is effective in reducing the concentration of explosives (TNT, RDX, and HMX), ammonium picrate (or yellow-D), and associated toxicity to acceptable levels. Aerobic, thermophilic composting is also applicable to PAH-affected soil. Windrow composting has been demonstrated as an effective process alternative for treatment of explosives-affected soil. During a field demonstration conducted by USACE and the Umatilla Depot Activity (UMDA), TNT reductions were as high as 99.7 percent in 40 days of operation, with the majority of removal occurring in the first 20 days of operation. Maximum removal efficiencies for RDX and HMX were 99.8 percent and 96.8 percent, respectively.

Implementability: All materials and equipment used for composting are commercially available. The space requirements to implement the technology are available at the Project Site. This technology is readily implementable at the Project Site.

Cost: Costs will vary with the amount of soil to be treated, the soil fraction in the compost, availability of amendments, constituent type, and the type of process design employed. Cost is considered high, relative to other treatment options.

Screening decision: Retained.

Constructed Wetlands (Wetlands Restoration)

The constructed wetlands process option was evaluated for surface water/wetlands at the Project Site.

Effectiveness: Restoration includes the construction of a wetland on top of the wetland area removed during remedial activities. Reintroduction of plants and wildlife can be difficult. This is a moderately effective option for replacing damaged or destroyed wetlands habitat.

Implementability: The materials and equipment used for wetlands construction are commercially available. This technology may be implementable at the Project Site, but would require significant regulatory review and approval.

Cost: Costs will vary with the amount of area to be treated and size of wetlands to be constructed. The cost for this option is considered moderate relative to other treatment options.

Screening decision: Retained.

In Situ Physical Treatment

Homogenization

Homogenization was evaluated for TNT Strip soils as a preliminary treatment process that would precede excavation, above-ground handling (including composting treatment), and off-site disposal activities.

Effectiveness: The purpose of homogenization of soils in this area is to modify soil characteristics, primarily the elimination of localized zones of soil with TNT concentrations exceeding 10 percent by weight. The Department of the Army considers soil containing 10 percent or more TNT as potentially reactive. The homogenization treatment process will effectively produce more uniform TNT concentrations, lowering the potential reactivity of the soil to a level that would allow it to be classified as non-OE affected soil and safely excavated. The effectiveness of homogenization will be confirmed by collecting and analyzing soil samples for TNT after treatment.

Implementability: This physical treatment process is implementable using conventional earthwork equipment. However, equipment may be armored, as a precautionary measure. Soil could be homogenized using a tractor-driven rotary till discs, and other earthwork equipment. Water would be applied to reduce the potential for sparking between steel and native rock in the treatment zone, and to control dust.

Cost: The cost to homogenize soils is relatively low.

Screening Decision: Retained.

Ex Situ Physical/Chemical Treatment

The process options being evaluated for the ex-situ physical/chemical treatment technology include soil sieving.

Soil Sieving

Soil sieving was evaluated for OE removal within demolition site soils.

Effectiveness: Gravity separation and sieving processing are widely used to remove coarse solids from water and wastewater. For application with soils, the matrix must be relatively dry and be composed primarily of coarse granular material (e.g., sands, gravels). Most soils at the Project Site consist of fine-grained alluvial and colluvial sediments, characterized as silty or sandy clays. Soils with relatively high clay and moisture content have a very high potential to clog sieve screens. For this reason, and because of potential health and safety issues, sieving is not recommended to separate OE from soil. Therefore, this technology would have a very low effectiveness for use at the Project Site.

Implementability: All materials and equipment used for sieving are commercially available. However, this technology would be difficult to implement, as described above.

Cost: Costs would vary with the amount of soil to be treated and the soil properties including clay and moisture content. Overall, costs for soil sieving would be high. The soil sieving process option will not be considered further due to the significant limitations in effectiveness, and the availability of more effective process options to detect and remove OE from demolition and Flare Site soils.

Screening decision: Not retained.

Ex Situ Physical/Thermal Treatment

The process options being evaluated for the ex-situ physical/thermal treatment technology include OB/OD for OE, on-site blast chamber, and BIP at the Project Site.

Open Burn/Open Detonation

All materials and equipment used for an OB/OD are commercially available. With engineering controls in place, minimum distance requirements can generally be reduce to less then 200 feet. Specially trained personnel are required to perform this operation. This option is implementable at the project site.

Effectiveness: OB/OD can be used to destroy ordnance and related energetic materials. It is an effective option for OE at the Project Site.

Implementability: All materials and equipment used for OB/OD are commercially available. Minimum distance requirements for safety purposes mean substantial space is required for open processes. This option is implementable at the Project Site.

Cost: Overall, costs for OB/OD are moderate.

Screening decision: Retained.

On-Site Blast Chamber

Effectiveness: An on-site blast chamber is a very effective method to treat OE and other energetic materials. The blast chamber contains all fragments within the chamber and can be equipped to contain or reduce environmental emissions. However, the on-site blast chamber has limited capacity in terms of size of OE item it can treat (e.g., no greater than an 81mm round).

Implementability: There are a limited number of permitted on-site blast chambers available on the market for use at the Project Site. Specially trained personnel also must operate the blast chamber further limiting its availability. However, the unit is easily transported from site to site and given sufficient time to plan coordinate its use can be readily implementable.

Cost: Overall cost for an on-site blast chamber can be moderate to high. Cost is dependent on its available and the number times the chamber must be mobilized to the site.

Screening decision: Retained.

Blow-in-Place

Effectiveness: If an OE item is determined not safe to move the only effective method to destroy the item is to BIP. BIP procedures are very similar to OB/OD operation and when implemented properly are a very effective means of destroying OE.

Implementability: All materials and equipment used for a BIP are commercial available. With engineering controls in place, minimum distance requirements can generally be reduce to less then 200 feet. As with the on-site blast chamber, specially trained personnel are required to perform the operation. This option is Implementability at the Project Site.

Cost: Overall cost for a BIP are low.

Screening decision: Retained.

Disposal

The following disposal technologies have been evaluated: off-site disposal.

Off-Site Disposal

The following off-property disposal technologies have been evaluated: transport of non-OE soil to off-site Class I Facility, transport of non-OE soil to off-site Class II Facility, transport of non-OE soil to off-site Class III Facility, and transport of OE to approved treatment/disposal Facility.

Transport of Non-OE Soil to Class I Facility

Effectiveness: Disposal is an effective technology.

Implementability: This option is implementable at the Project Site.

Cost: Overall, Class I disposal costs are moderate to high.

Screening decision: Retained.

Transport of Non-OE Soil to Class II Facility

Effectiveness: Disposal is an effective technology.

Implementability: This option is implementable at the Project Site.

Cost: Overall, Class II disposal costs are moderate to high.

Screening decision: Retained.

Transport of Non-OE Soil to Class III Facility

Effectiveness: Disposal is an effective technology.

Implementability: This option may be implementable, depending on the characteristics of non-OE soil containing low or non-detectable concentrations of constituents.

Cost: Overall, Class III disposal costs are low to moderate.

Screening decision: Retained.

Transport of OE to Off-Site Treatment/Disposal Facility

Effectiveness: Disposal is an effective technology.

Implementability: This option is not implementable because of prohibitive requirements for preparing OE items for off-site transportation and the difficulty of finding an OB/OD facility willing to accept OE items.

Cost: Overall, off-site disposal costs at a permitted OB/OD facility are very high.

Screening decision: Not retained.

11.0 DEVELOPMENT AND SCREENING OF ALTERNATIVES

This section presents the development and screening of remedial alternatives assembled from combinations of technologies and associated process options evaluated in Chapter 10.0. Section 11.1 presents the development and description of a range of alternatives based on the GRAs and technologies discussed in Chapter 10.0. Section 11.2 presents the initial screening of alternatives evaluated against the three broad criteria of effectiveness, implementability, and cost. This screening step incorporates the CEQA screening process for preparation of a draft Environmental Impact Report, as described in Section 11.2.1.

The purpose of the FS and the overall remedy selection process is to implement remedial actions that eliminate, reduce, or control risks to human health and the environment (40 CFR Part 300). The national program goal for the FS process, as defined in the NCP, is to select remedies that are protective of human health and the environment, that maintain protection over time, and that minimize untreated waste. The criteria for identifying potentially applicable technologies to achieve these goals are provided in EPA guidance (U.S. Environmental Protection Agency 1988) and in the NCP (U.S. Environmental Protection Agency, 1990). A strong statutory preference for remedies that will result in a permanent and significant decrease in toxicity, mobility, or volume and provide long-term protection is identified in Section 121 of CERCLA, as amended. The primary requirements for the final remedy are that it be both protective of human health and the environment and comply with ARARs; hence, alternative screening focuses on these criteria.

In addition to the above objectives, the NCP defines certain guidelines in developing and screening remedial action alternatives.

1. The expectation to use treatment to address the principal threats posed by a site, wherever practical.

2. The expectation to use engineering controls, such as containment, for waste that poses a relatively low long-term threat and for which treatment is impractical.

3. The expectation to use a combination of methods, as appropriate, to achieve protection of human health and the environment. In appropriate site situations, treatment of principal threats will be combined with engineering controls (e.g., containment) and institutional actions for treatment residuals and untreated waste.

4. The expectation to use institutional actions, such as covenants to restrict use of property, to supplement engineering controls for short- and long-term management to prevent or limit exposures.

5. The expectation to consider using innovative technology when such technology offers the potential for comparable or superior treatment performance or implementability, less impacts than other available approaches, or lower costs for similar levels of performance than demonstrated technologies.

6. The expectation to return environmental media such as groundwater to their beneficial uses, wherever practical, within a time frame that is reasonable given the particular circumstances of the site.

7. When restoration of groundwater to beneficial uses is not practical, EPA expects to prevent further migration of the plume, prevent exposures to such groundwater, and evaluate further risk reduction.

These expectations have been applied in the development and screening of alternatives which follow.

11.1 DEVELOPMENT OF ALTERNATIVES

Eight alternatives have been preliminarily considered for the Project Site, as described in Table 11-1 and summarized below. These alternatives range from No-Action (in accordance with the NCP, EPA's RI/FS Guidance, and CEQA) to comprehensive actions that incorporate various treatment, disposal, and containment technologies.

Alternative 1: No-Action.

Alternative 2: Institutional controls over entire Project Site and monitoring.

Alternative 3: OE point clearance and institutional controls over entire Project Site, and monitoring.

Alternative 4: OE point clearance; excavation, treatment and disposal of non-OE-affected soil; institutional controls over entire Project Site, and monitoring.

Alternative 5: Includes Alternative 4 components and the areawide clearance of OE in portions of the North Valley, South Valley, and Ridge, in accordance with the OE RDD, installation of an OE-free crushed bedrock layer in future residential areas over areawide clearance soil, and institutional controls in South Valley and McAllister Drive Land Bridge.

Alternative 6: Includes same components as Alternative 5, with the additional excavation of all South Valley OE kick-out zone soil, except the wetlands, placement of kick-out zone soils in the North Valley and in the South Valley adjacent to the wetlands; with additional geophysical scanning of OE kick-out zone soil in lifts during placement in North Valley.

TABLE 11-1: ALTERNATIVE SCREENING ANALYSIS

ALTERNATIVE NUMBER AND DESCRIPTION	APPLICABLE PROCESS OPTIONS	Initial Screening of Alternatives in Accordance with NCP and CEQA			
		EFFECTIVENESS • Ability to achieve RAOs • Technical feasibility • Protection of health and environment	**IMPLEMENTABILITY** • Ability to reduce or avoid significant impacts • Feasibility, based on legal, social and economic considerations	**COST** • Relative cost to implement alternative	Screening Decision
Alternatives 7A and 7B: Include Alternative 5 Components. In Addition, South Valley Wetlands Soil Would be Excavated and wetlands would be reconstructed. **Subalternative A:** includes homogenization of TNT strip soils. **Subalternative B:** includes homogenization and composting of soil containing elevated TNT concentrations.	• OE Point Clearance and area-wide clearance • Excavation of Non-OE-affected soils • Dispose of affected non-OE soils at approved landfill • Administrative controls on McAllister Drive Land Bridge • Excavation of South Valley Kickout Zone soils • Geophysical scanning of Kickout Zone soils in 1-ft lifts, during replacement in South Valley • Removal and reconstruction of South Valley Wetlands • Grading and placement of OE-free layer of crushed bedrock over future residential areas • Groundwater/surface water monitoring **Subalternative B:** • Composting of TNT strip soils	**Alternative 7A:** Meets RAOs. Effective in reducing the toxicity, mobility, or volume of OE and affected Non-OE soil. ------------------------------ **Alternative 7B:** Similar to 7A	**Alternative 7A:** Difficult to Implement; Removal of existing wetlands would create significant environmental impacts. Regulatory approvals would be difficult. Short-term increase in traffic from hauling non-OE soil offsite and potential short-term impacts to parties within minimum separation distance if OE treated ------------------------------ **Alternative 7B:** Implementability is generally similar to Alternative 7A.	**Alternative 7A:** High ------------------------------ **Alternative 7B:** High	**Alternative 7A:** Not Retained -------------------- **Alternative 7B:** Not Retained
Alternatives 8A and 8B: Include Alternative 5 Components. In Addition, Kickout zone soil would be excavated and replaced in South Valley. **Subalternative A:** includes homogenization of TNT strip soils. **Subalternative B:** includes homogenization and composting of soil containing elevated TNT concentrations.	• OE Point Clearance and area-wide clearance • Excavation of Non-OE-affected soils • Dispose of affected non-OE soils at approved landfill • Administrative controls on McAllister Drive Land Bridge and wetland • Excavation of South Valley Kickout Zone soils • Geophysical scanning of Kickout Zone soils in 1-ft lifts, during replacement in South Valley • Grading and placement of OE-free layer of crushed bedrock over future residential areas • Groundwater/surface water monitoring **Subalternative B:** • Composting of TNT strip soils	**Alternative 8A:** Meets RAOs. Effective in reducing the toxicity, mobility, or volume of OE and affected Non-OE soil. ------------------------------ **Alternative 8B:** Similar to 8A	**Alternative 8A:** Implementable; short-term increase in traffic from hauling non-OE soil offsite and potential short-term impacts to parties within minimum separation distance if OE treated ------------------------------ **Alternative 8B:** Implementability is generally similar to Alternative 8A.	**Alternative 8A:** High ------------------------------ **Alternative 8B:** High	**Alternative 8A:** Retained -------------------- **Alternative 8B:** Retained

Alternative 7: Includes the same components of Alternative 6, as well as the removal and reconstruction of the South Valley wetland.

Alternative 8: Includes the same components as Alternative 5. In addition, kick-out zone soils would be excavated, geophysically scanned for OE, and replaced in the South Valley.

Alternatives 4 through 8 each include two sub-alternatives ("A" and "B") related to the remediation of soil containing TNT. Subalternatives 4A through 8A involve the in-situ homogenization of shallow soil in the vicinity of the TNT Strips prior to excavation. Homogenization will produce more uniform TNT concentrations that are consistently less than the reactivity criterion, allowing TNT-affected soil to be safely excavated and transported off site. Subalternatives 4B through 8B also include the homogenization step. Additionally, Subalternatives 4B through 8B include composting of soil as necessary to lower TNT concentrations to levels acceptable for disposal as a nonhazardous waste.

11.2 SCREENING OF ALTERNATIVES

11.2.1 Introduction

The alternatives listed above were qualitatively evaluated against three criteria: effectiveness, implementability, and cost. These criteria are specified in EPA guidance (U.S. Environmental Protection Agency 1988) and in the NCP (40 CFR Part 300) (U.S. Environmental Protection Agency, 1990). This screening process also has been used to select a range of reasonable alternatives for the project EIR in accordance with CEQA guidelines (14 CCR 15126.6(c). The NCP criteria generally address the CEQA threshold screening criteria as described below.

Effectiveness Evaluation. The key aspect of the screening evaluation is the assessment of the alternatives' ability to meet the soil remediation goals. In terms of CEQA, the effectiveness evaluation considers the extent to which the alternative meets the project objectives. Other measures of effectiveness include (1) technical feasibility (i.e., reduction of constituent toxicity, mobility, or volume); (2) long-term protection of health and the environment; (3) short-term protection of human health and the environment during the remedial action (i.e., potential environmental effects of the alternative).

Implementability Evaluation. This criterion considers the alternative's feasibility based primarily on legal, social and economic factors, and the ability to reduce or avoid significant impacts. This criterion provides a way to evaluate the reasonableness of an alternative, considering site-specific factors (e.g., the availability of services and materials, regulatory approvals, and public input).

Cost Evaluation. This step in the FS process is based on qualitative estimates of the capital and long-term costs, considering the relative costs of each alternative.

11.2.2 Alternative 1: No-Action

11.2.2.1 Description.

Under the No-Action Alternative, no cleanup activities would be conducted, and the Project Site would not be redeveloped for residential or other uses. This alternative represents the "No Project" alternative with respect to CEQA. This alternative would not include maintenance of current security measures or any other access restrictions. The Project Site would remain in its current state with respect to the presence of OE and non-OE constituents in soil.

11.2.2.2 Evaluation.

Under this alternative, the Project Site conditions would remain unchanged. OE that is potentially present and affected non-OE soil would not be removed, treated or further contained. Therefore, the soil remediation goals and related project objectives would not be achieved. This alternative would not satisfy ARARs. This alternative would not be effective.

The criterion of technical feasibility would not apply to this alternative, since no actions would be implemented.

No capital or long-term maintenance costs would be required for this alternative. In summary, the No-Action Alternative would not meet soil remediation goals and would not be protective of health or the environment. Because no remedial action would be taken, potential OE and affected non-OE soil would remain in place.

Notwithstanding these considerations, the No-Action alternative has been carried forward as a comparative base alternative, in accordance with the NCP and CEQA Guidelines.

11.2. Alternative 2: Institutional Controls over Entire Project Site and Monitoring

11.2.3.1 Description.

Under this alternative, no cleanup activities would be conducted, and the Project Site would not be developed for residential use. The Project Site would remain in its current state with respect to the presence of OE and non-OE constituents in soil. Institutional controls would be implemented, including continued maintenance of existing fencing, security measures, and access restrictions for the entire Project site. Additionally, covenants to restrict use of property would be recorded to prohibit any development on the Project Site unless and until appropriate cleanup activities were completed.

In addition, USACE has stated that "Institutional controls will be implemented for all areas within the Former Benicia Arsenal (including Sectors 1 through 5) and include: (1) educational programs (i.e., display cases), (2) distribution of pamphlets and brochures, (3) OE safety awareness training video, and (4) notices to be placed with underground service alert systems...." (Earth Tech, 2000d).

Periodic monitoring would be performed to evaluate groundwater and surface water quality over time. The USACE would assume the responsibility for performing periodic monitoring. Since no cleanup is proposed under this alternative, periodic monitoring would likely continue indefinitely for both natural and manmade hazards.

11.2.3.2 Evaluation.

Under this alternative, OE that is potentially present and affected non-OE soil would not be removed, treated or further contained. While institutional controls would reduce potential exposures at the Project Site, the remediation objectives would not be achieved, and this alternative would not satisfy ARARs. This alternative is not considered to be effective.

The maintenance of institutional controls would be technically feasible. Besides the maintenance of existing access controls, no equipment, personnel, or construction activities would be required to implement this alternative, and no permits or licenses would be required.

No capital costs would be required for this alternative. Continuation of access controls and monitoring would be the only O&M costs.

Alternative 2 will be retained for detailed analysis and evaluation as an additional "No Project" alternative, since it reduces potential exposures beyond Alternative 1.

11.2.4 Alternative 3: OE Point Clearance and Institutional Controls over Entire Project Site, and Monitoring

11.2.4.1 Description.

The major components of this alternative are as follows:

Point Clearance of OE and OE Scrap over Entire Site: Mobilization, surface preparation, surface clearance, geophysical investigation, and mapping activities. Wetland areas will be dewatered, as necessary, to expose the ground surface for surface and geophysical inspection and removal activities.

Removal and disposal of all detected OE in surface and subsurface soils. Implementation of MSA during OE clearance activities.

A 100-percent QC check (re-mapping with geophysical equipment and subsequent removal of additional anomalies, if any, that are identified) over the entire Project Site.

Backfilling all anomaly excavation locations except in wetlands to pre-existing conditions.

Institutional Controls and Monitoring: Institutional controls would include covenants to restrict use of the entire Project Site, including limitations on excavation or other activities that would penetrate the ground. Any planned excavation on the Project Site would require that notice be provided to the City of Benicia, DTSC, and USACE, and that the activities would only be conducted using OE support. Additionally, the Flare Site and the TNT Strip area would be fenced and access restricted. In addition, institutional controls in the form of covenants to restrict use of property would be imposed to prohibit residential development on the Project Site unless and until further cleanup activities were completed to make the property safe for residential use.

In addition, USACE has stated that "Institutional controls will be implemented for all areas within the Former Benicia Arsenal (including Sectors 1 through 5) and include: (1) educational programs (i.e., display cases), (2) distribution of pamphlets and brochures, (3) OE safety awareness training video, and (4) notices to be placed with underground service alert systems...." (Earth Tech, 2000d).

Periodic monitoring would be performed to evaluate groundwater and surface water quality over time. The proposed monitoring program for the recommended alternative, including the frequency and location of monitoring activities, will be described in the RAP and remedial design documents for the Project Site. Under Alternative 3, USACE would assume the responsibility for performing periodic monitoring. Since this alternative does not include the cleanup of chemical-affected soil, periodic monitoring would likely continue indefinitely for chemicals of interest, and to verify maintenance of the required institutional controls for the Project Site.

11.2.4.2 Evaluation.

Alternative 3 would be only partially effective in meeting soil remediation goals with respect to OE because available in-situ OE detection technologies may not detect OE that may be present below the reliable depth of the geophysical instrument. The existing wetland in the South Valley would be cleared of OE, OE scrap, and metallic debris as thoroughly as feasible. Impacts to wetlands would be minor, considering the short time that surface water would be diverted from each section being cleared. As detailed in Appendix H-1, various ARARs exist for remedial activities in wetland areas, including provisions of the Clean Water Act (CWA), the Fish and Wildlife Coordination Act, and other requirements. Any impacts to the wetland resulting from point clearance activities would be mitigated as necessary, using methods developed in consultation with the USACE, USFWS, RWQCB, and CDFG.

Soil containing non-OE constituents above soil remediation goals would not be remediated under this alternative. Therefore, environmental conditions in those portions of the Project Site containing TNT, metals, and other substances would remain unchanged. Considering that non-OE-affected soils, and possibly OE, would remain at the Project Site, this alternative is not considered effective.

Alternative 3 would be implementable, using available equipment and services. However, OE point clearance activities would require specially trained personnel and equipment. Additionally, there would be short-term impacts to the community when implementing the MSA. The relative cost for Alternative 3 would be moderate.

Considering the fact that Alternative 3 would not adequately meet soil remediation goals, this alternative has not be retained for detailed analysis.

11.2.5 Alternative 4: OE Point Clearance; Excavation, Treatment and Disposal of Non-OE-affected Soil for the Entire Project Site, Including Homogenization of TNT Strip Soils; Institutional Controls; and Monitoring

11.2.5.1 Description.

Alternative 4 includes all of the components described above for Alternative 3. Additional components of Alternative 4 include:

Remediation of Non-OE-Affected Soil: Soil from all areas of the Project Site that exceed remediation goals would be excavated and disposed of off site, including soil from the TNT Strips, the Flare Site, Demolition Site #1 and #3, and stockpile areas. Soil in Demolition Sites #1 and #3 would be scanned in 1-foot lifts and excavated to bedrock. Flare Site soil would also be scanned in 1-foot lifts. The excavated soil would be tested for chemicals of interest. Additional lifts will be scanned and excavated until all chemically-impacted soil and anomalies are removed.

Sub-alternative 4A involves the in-situ homogenization of shallow soil in the TNT Strips Area to produce more uniform TNT concentrations, thereby reducing the potential reactivity of this soil prior to excavation and disposal. Sub-alternative 4B includes homogenization and composting. Composting is an additional treatment step for the TNT Strips soil to reduce TNT concentrations to nonhazardous concentrations. Once TNT concentrations reach levels acceptable for off-site transport and disposal, the material may be removed from the site, or if treated soil meets all remediation goals, it may be left on site.

Run-on/Run-off Control: Grading and revegetation of the areas that have been excavated.

Institutional Controls: Institutional controls would be the same as described above for Alternative 3, except that the Flare Site and TNT Strip area would not be fenced off, since these portions of the Project Site would be remediated.

11.2.5.2 Evaluation.

Alternative 4 would be more effective than the preceding alternatives because non-OE-affected soil would be treated as necessary (in addition to OE) and disposed of in an approved off-site landfill if it exceeds the soil remediation goals. These measures would meet the cleanup objectives for non-OE constituents and effectively reduce potential risks associated with the Project Site. However, OE point clearance activities alone would not completely eliminate the potential future exposure to OE in residentially developed portions of the Project Site. Therefore, this alternative would not effectively achieve soil remediation goals and project objectives.

Alternative 4 is implementable, but would require more time and resources to implement, compared to the preceding alternatives. Implementing the MSA would create short-term impacts to the community.

The relative cost for Alternative 4 is moderate. The cost would depend on the amount of soil that must be treated and/or transported to an off-site landfill. Alternative 4 has not been retained for detailed analysis, because it is would not provide sufficient protection under the anticipated development scenario.

11.2.6 Alternative 5: Includes Alternative 4 Components and Areawide OE Clearance in Portions of the North Valley, South Valley, and Ridge, in Accordance with the OE RDD, Installation of a Crushed Bedrock Cap in Residential Areas, and Institutional Controls

11.2.6.1 Description.

Alternative 5 includes all of the components described above for Alternative 4, and the additional components described below.

Additional OE Clearance Activities: Alternative 5 includes excavation of soil suspected of having a potential to contain OE below the geophysical scan and QA/QC scan in future residential areas. This soil removal activity is proposed in response to Section 5.2.1 of DTSC's Order I/SE 98/99-011, which specifies the RI/FS objective to provide a minimum of 10 feet of OE-free soil in areas where OE is potentially present. So il would be scanned using geophysical techniques to identify metallic anomalies. Excavations would be made to remove all detected anomaly sources including non-OE debris, OE, and OE scrap. The OE scanning protocols are described in detail in the OE RDD and are summarized below.

In future residential areas, each lift will be removed and the next surface will be scanned for potential anomalies. Each lift will have a QA/QC activity consisting of re-scanning of soils in the North Valley after placement in lifts or an in-situ QA/QC scan. The process of scanning, QA/QC, and excavation in lifts will be continued until no OE or OE scrap are found in two consecutive lifts, or bedrock is encountered.

Remediation of Non-OE Affected Soil: Sub-alternative 5A involves the in-situ homogenization of soil in the TNT Strips Area to produce more uniform TNT concentrations, thereby reducing the potential reactivity of this soil prior to excavation and disposal. Sub-alternative 5B includes composting, as an additional treatment step for the TNT Strips soil. Once TNT concentrations reach levels acceptable for off-site transport and disposal, the material may be removed from the site, or if treated soil meets all soil remediation goals, it may be left on site.

OE-Free Layer: This alternative includes the construction of a layer of crushed bedrock over areawide cleared soil in future residential areas. This layer would provide additional protection against potential exposure to residual chemicals and OE, if any, that may be present in the underlying soil and bedrock. Future residential areas where overburden soil has been removed (i.e., areas where bedrock is less than 14 feet below finished grade) would be covered with a minimum of 4 feet of clean crushed bedrock. This requirement is designed to prevent the potential home-grown vegetable exposure pathway in the TNT strip area.

Run-on/Run-off Control: The Ridge and North Valley areas that have been excavated, filled, or mass-graded will be re-vegetated, as necessary for erosion control purposes.

Institutional Controls: Alternative 5 is designed to remove all OE and OE scrap from future residential areas in the Project Site. As an additional safety measure all soils moved to the North Valley during point clearance and areawide clearance would be covered with a minimum of fourteen feet of crushed bedrock, certified to be free of OE and OE scrap. These measures are designed to ensure that future residents could not encounter residual OE and OE scrap in future residential areas and eliminating the need for Access Controls in future residential areas.
For Alternative 5, the areas potentially of concern and requiring Access Controls include (i) subsurface areas on legal parcels within the Project Site boundaries that are designated as open space parcels in the City of Benicia's General Plan and zoned as Open Space in Benicia's Zoning Ordinance ("Open Space Parcels") and (ii) subsurface areas below currently paved areas of Unit D-1 and the McAllister Land Bridge ("Paved Areas"). While point clearance and 100% QA/QC re-scanning and clearance would be performed in the Open Space Parcels, such

areas would not undergo areawide clearance. Accordingly, it is potentially possible that OE or OE scrap that is deeper the reliable scan depth of the geophysical instruments used or that is not otherwise detected through scanning will remain below the ground surface in the Open Space Parcels. Since neither point clearance nor areawide clearance will occur beneath the currently paved areas of Unit D-1 or the McAllister Land Bridge, and it is potentially possible that OE or OE Scrap will remain below the pavement in such areas.

Institutional controls would include recording Covenants to Restrict Use of Property with Solano County on portions of the Project Site. The affected portions of the Project Site would include the roads in Unit D-1 and open space parcels in the South and North Valleys, including a portion of the McAllister Drive Land Bridge. The restrictions would permanently apply to the affected areas and would restrict any excavation or other activities that would penetrate the ground. Any planned excavation in these areas would require that notice be provided to the City of Benicia, DTSC, and USACE, and that the activities would only be conducted using OE support. The restrictions would also prevent any change in the land use designation or zoning for the South and North Valley open space parcels. "A form of "Covenants to Restrict Use of Property" that is acceptable to DTSC, Granite and the City of Benicia will be prepared, executed and recorded in the Recorders Office for the County of Solano to become part of the chain of title of the affected parcels. The City will be a party to the Covenants since it will have future responsibility for maintenance of streets, sidewalks, curbs and gutters in Unit D-1 and on the McAllister Land Bridge. Additionally, the City currently owns some of the Open Space parcels to be restricted by the Covenants and is expected to own additional Open Space parcels in the future. The Covenants will authorize the DTSC to enforce the restrictions and will prohibit any future change in the restrictions without DTSC's express approval. The form of the Covenants will be included as an appendix to the OE RDD.

In addition, USACE has stated that "Institutional controls will be implemented for all areas within the Former Benicia Arsenal (including Sectors 1 through 5) and include: (1) educational programs (i.e., display cases), (2) distribution of pamphlets and brochures, (3) OE safety awareness training video, and (4) notices to be placed with underground service alert systems...." (Earth Tech, 2000d).

Groundwater and Surface Water Monitoring

In order to verify the effectiveness of the above remedial actions, long-term monitoring at the Project Site boundaries will be implemented for groundwater, subdrain water, surface water, and seeps. Paired groundwater monitoring wells will be installed in three locations to sample groundwater in alluvium (shallow sediments) and in the bedrock (deeper sediments). Groundwater will be monitored at both ends of the North Valley (southeast and northwest) at the property boundaries and southeast of the McAllister Drive Land Bridge at the outlet of the small tributary swale that enters the South Valley from the north. Subdrain water will be sampled at both ends of the North Valley (southeast and northwest) at the property boundaries. Surface water will be monitored at a station located northwest of the McAllister drive Land Bridge. The two existing seeps will be monitored in the South Valley. All chemicals exceeding upgradient groundwater concentrations previously detected in samples taken from the groundwater or seeps during the RI will be monitored. The surface water will continue to be tested for the suite of constituents specified in the RI. Monitoring would be conducted quarterly for one year and semi-annually for the next 4 years. The need for continued monitoring or other actions would be assessed following review of the data and discussions between DTSC and USACE.

11.2.6.2 Evaluation.

Alternative 5 would be effective because OE that may be present at the Project Site would be detected and removed using both point-clearance and areawide clearance procedures. These measures would meet soil remediation goals and effectively reduce potential risks associated with the Project Site. Placement of soil that potentially contains OE in lifts, and monitoring each lift for OE would provide the opportunity for an additional level of inspection. Alternative 5 provides a high degree of assurance that all OE have been removed prior to use of the soil as deep fill at the Project Site. Placement of a layer of crushed bedrock over areawide cleared soils would further limit potential future exposure risks, if any, associated with this soil. Non-OE-affected soil would be treated as necessary and disposed of in an approved off-site landfill.

Alternative 5 is implementable, but would require more time and resources to complete geophysical scanning, excavation and filling activities, compared to the preceding alternatives. The relative cost for Alternative 5 is high. The cost would depend on the amount of soil that must be treated and/or transported to an off-site landfill and the extent of areawide clearance that must be undertaken.

Subalternatives 5A and 5B will be retained for detailed analysis, because they meet the soil remediation goals, and are technically feasible, implementable, and would provide a high degree of protection.

11.2.7 Alternative 6: Includes Same Components as Alternative 5, with Additional Excavation of the South Valley Kick-out Zone Soils, Areawide OE Clearance, and Placement of Most of this Soil in the North Valley

11.2.7.1 Description.

Alternative 6 would include all of the components described above for Alternative 5. In addition, after completing point clearance and non-OE remediation activities, areawide clearance of OE will be conducted within the limits of the OE kick-out zone (determined by the OE Site Conceptual Model that will be developed after the completion of point clearance activities) surrounding the demolition sites (exclusive of wetland areas). This mass-excavation work will involve removing all soil above bedrock, to the maximum practical depth, and placing most of the soil as engineered fill in the bottom of the North Valley. Additionally, the OE kick-out zone soil would be scanned using geophysical methods while being placed in lifts in the North Valley. A portion of the OE-cleared soil will be scanned using geophysical methods and reused as fill along the edge of the South Valley Wetlands, to maintain the stability and hydrologic characteristics of the wetlands. Excavation in the South Valley wetlands would be limited to point clearance, as described for Alternative 3. Institutional controls would be applied in the South Valley wetlands and the McAllister Drive Land Bridge.

11.2.7.2 Evaluation.

Alternative 6 would be effective at remediating OE, considering the iterative procedures that would be utilized to clear OE from the entire Project Site. Alternative 6 provides a higher degree of assurance that all OE have been removed from the South Valley compared to the preceding alternative. Covering the areawide clearance soil including the kick-out zone soil with crushed bedrock would further limit potential future exposure risks, if any, associated with soil excavated from the vicinity of the South Valley kick-out zone. Following point clearance activities, due to the protected nature of wetlands and limited access due to site conditions, the probability would be low that there would be any future contact with any OE remaining in this wetland.

Alternative 6 would be more difficult to implement than the preceding alternatives, and would require additional time and resources. It would also be more difficult to obtain regulatory approval of this alternative, based on the RWQCB position that "the proposal to excavate to bedrock adjacent to wetlands in the South Valley Section is unacceptable because it would permanently alter the hydrologic conditions of these wetlands" (letter dated June 6, 2000 from Stephen Berger to Stewart Black). Based on public comments received to date, community members have also expressed concerns about the possible adverse impacts of removing soil from the hillsides in the South Valley.

The relative capital cost for Alternative 6 would be high because of the increased labor cost associated with excavation of OE kick-out zone soils and their placement in the North Valley.

Considering the additional benefit of areawide OE clearance in the South Valley, Alternative 6 will be retained for further analysis.

11.2.8 Alternative 7: Includes Same Components as Alternative 6, as well as Removal and Reconstruction of the South Valley Wetland

11.2.8.1 Description.

Alternative 7 includes the same activities as the preceding alternative. In addition, the wetlands area in the South Valley would be partially removed and filled in with clean soil, and a new wetlands area would be reconstructed in the same general location, at a similar elevation.

11.2.8.2 Evaluation.

The effectiveness of Alternative 7 would be generally similar to Alternative 6 with respect to OE clearance and remediation of non-OE-affected soil. The placement of crushed bedrock over the wetland would further reduce the potential risks associated with previous OE demolition activities in the South Valley. No institutional controls would be applied to the newly constructed wetland. The cost for Alternative 7 would be high.

There would be significant environmental impacts as a result of wetland destruction. The successful re-establishment and long-term health of the new wetland would depend on several factors, including future surface water drainage patterns, sediment deposition rates, and depth to groundwater. Obtaining regulatory approval for this alternative probably would be difficult, given the requirement that the project must represent "the least damaging practicable alternative that will satisfy the basic project purpose" (Clean Water Act Section 404(b)(1). Regulatory approvals would be needed from a number of agencies, including the DTSC, RWQCB, CDFG, USACE and the U.S. EPA.

Based on the potentially significant environmental impacts, potential difficulties in re-establishing a sustainable wetlands, the level of effort anticipated to obtain regulatory approval, and the lack of probable future exposure pathways without removing and replacing the wetlands, Alternative 7 has been screened from further consideration.

11.2.9 Alternative 8: Includes the Same Components of Alternative 5, Plus Excavation of South Valley Kick-out Zone Soil and Replacement in the South Valley; with Additional Geophysical Scanning of OE Kick-out Zone Soil during Placement in the South Valley

11.2.9.1 Description.

Alternative 8 includes the components described above for Alternative 5. In addition, this alternative includes the excavation of South Valley OE kick-out zone soils (exclusive of wetland areas). Soil that is excavated from the kick-out zones would be scanned again for OE and reused as backfill in the South Valley. This soil would be deposited in lifts. Upon placement of each lift, OE specialists will search the newly deposited soil for anomalies using geophysical instruments. If an anomaly is encountered, it will be removed and disposed using the same procedures as have been conducted with point clearance activities. The plan to excavate and replace OE kick-out zone soil in the South Valley would be carefully engineered to maintain slope stability including surface and subsurface drainage controls.

11.2.9.2 Evaluation

Alternative 8 would provide a high degree of assurance that all OE have been removed, considering the iterative procedures that would be utilized to clear OE from the entire Project Site. Placement of soil in lifts, and scanning each lift for OE would provide an additional level of inspection beyond that achieved by point clearance alone.

Alternative 8 would be implementable, but would require substantial time and resources, given the technical and regulatory requirements of excavating and filling the South Valley kick-out zones. The cost to implement Alternative 8 would be very high. Alternative 8 will be retained for detailed analysis in Chapter 12.0, because it would effectively remediate soil containing OE and non-OE constituents, and would reduce the institutional controls required for the Project Site.

12.0 DETAILED ANALYSIS OF ALTERNATIVES

Each of the remedial alternatives that has been retained through the preliminary screening process described in Chapter 11.0 is further evaluated in this chapter. The purpose of this analysis is to provide sufficient information for comparing the alternatives and selecting the remedy for the Project Site. The evaluation criteria for all alternatives are based on statutory requirements of CERCLA as amended by SARA, Section 121; the NCP; and the U.S. EPA guidance (U.S. Environmental Protection Agency, 1988). The nine criteria used for evaluating alternatives are discussed below.

Overall Protection of Human Health and the Environment. This criterion describes how each alternative, as a whole, protects human health and the environment and indicates how each hazardous substance source is to be eliminated, reduced, or controlled.

Compliance with ARARs. This criterion evaluates each alternative's compliance with ARARs, or, if an ARAR waiver is required, how the waiver is justified. ARARs consider location-specific, chemical-specific, and cleanup action-specific interests.

Long-term effectiveness and permanence. This criterion evaluates the effectiveness of each alternative in protecting human health and the environment after the remedial action is complete. Factors considered include magnitude of residual risks and adequacy and reliability of release controls.

Reduction of toxicity, mobility, or volume through treatment. This criterion evaluates the anticipated performance of each alternative's specific treatment technologies to reduce the toxicity, mobility, or volume of hazardous substances. As stated in CERCLA Section 121(b)(1), "remedial actions in which treatment permanently and significantly reduces the volume, toxicity or mobility of the hazardous substances, pollutants, and contaminants as a principal element, are to be preferred over remedial actions not involving such treatment."

Short-term effectiveness. This criterion examines the effectiveness of each alternative in protecting human health and the environment during the construction and implementation period. Four factors are considered when assessing the short-term effectiveness of an alternative: protection of the community during remedial actions, protection of workers during remedial actions, environmental impacts of remedial actions, and time required to complete remedial action.

Implementability. This criterion evaluates the technical and administrative feasibility of each alternative and the availability of required resources.

Cost: This criterion evaluates the capital and O&M cost of each alternative. Cost estimates for the alternatives were prepared from cost information included in (1) the 1999 Means Construction Cost Data Guide: "Environmental Cost Handling Options and Solutions," (2) estimates for similar projects, and (3) estimates provided by equipment manufacturers.

Community acceptance: This criterion evaluates the issues and concerns the public may have regarding each of the alternatives.

State acceptance: This criterion evaluates the technical and administrative issues and concerns the state may have regarding each of the alternatives.

The first two evaluation criteria listed above are threshold criteria that must be satisfied in order for a remedy to be eligible for selection. The next five criteria are balancing criteria used to evaluate the advantages and disadvantages of the remedies; and the final two criteria (community and state acceptance) are modifying criteria generally taken into account after public comment is received on the recommended alternative.

In the sections below, each remedial alternative is individually analyzed against the nine evaluation criteria, and subsequently compared to assess the relative performance of each alternative with respect to these criteria.

12.1 INDIVIDUAL ANALYSIS OF ALTERNATIVES

The following five alternatives have been retained for detailed analysis, based on their effectiveness, implementability and cost, as discussed in the preceding section.

Alternative 1: No action.

Alternative 2: Institutional controls over Project Site and monitoring.

Alternative 5: OE point clearance over entire site; areawide clearance of OE in portions of the North Valley, South Valley and Ridge, in accordance with OE RDD protocols; excavation, treatment, and disposal of non-OE-affected soil; installation of an OE-free layer of crushed bedrock in future residential areas; and institutional controls.

Alternative 6: Includes Alternative 5 components plus the excavation of OE kick-out zone soil, except the wetlands, placement of kick-out zone soils in the North Valley and in the South Valley adjacent to the wetlands; with geophysical scanning of OE kick-out zone soil in lifts during placement.

Alternative 8: Includes Alternative 5 components plus the excavation of OE kick-out zone soil and replacement in the South Valley; with additional geophysical scanning of kick-out zone soil during placement in South Valley

Alternatives 5, 6, and 8 include two subalternatives for the remediation of TNT-affected soil. Subalternative A involves the in-situ homogenization of soils in the TNT Strips area to produce more uniform TNT concentrations, thereby reducing the potential reactivity of this soil prior to excavation and disposal. Subalternative B also includes homogenization and composting, as an additional treatment process. Once TNT concentrations reach levels acceptable for off-site transport and disposal, the material may be removed from the site, or if treated soil meets all soil remediation goals, it may be left on site.

12.1.1 Alternative 1: No-Action

Overall Protection of Human Health and the Environment: This alternative would not be protective of human health and the environment. Conditions at the Project Site related to OE and non-OE constituents would remain unchanged. Since this alternative does not include continuation of current security controls and access restrictions, the potential would exist for trespassers to enter the site and encounter OE and non-OE-affected soil.

Compliance with ARARs: Alternative 1 would not satisfy ARARs since no administrative controls or other remedial measures would be undertaken.

Long-term Effectiveness and Permanence: Since no remedial measures would be completed, Alternative 1 would not achieve this criterion.

Reduction of Toxicity, Mobility, or Volume Through Treatment: Alternative 1 does not include any treatment components and, therefore, would not affect the toxicity, mobility, or volume of OE and non-OE-affected soil.

Short-term Effectiveness: This alternative would not create any short-term impacts beyond the current conditions at the Project Site.

Implementability: Alternative 1 would be implementable. However, if the Project Site is not remediated, then it could not be used for residential purposes.

Cost: No remediation costs are associated with implementing the No- Action alternative.

Community Acceptance: The acceptability of this alternative to the community is not known at this time. This criterion will be further assessed following the public notice and comment period on the Draft RAP.

State Acceptance

Implementation of no action would not be acceptable to the state of California, considering that DTSC has stated that conditions at the Project Site present an imminent and substantial endangerment.

12.1.2 Alternative 2: Institutional Controls over Project Site and Monitoring

Overall Protection of Human Health and the Environment: Alternative 2 would provide greater protection of human health and the environment than the No-Action. Implementation of institutional controls would reduce the potential for any health impacts. A deed restriction would be recorded for the Project Site, limiting future use and development of the property. Existing security measures would be maintained, including stationing of a security guard at the Project Site entrance 24-hours a day. Existing signs and fencing would be maintained. The condition of signs and fencing would be inspected on a regular basis and would be repaired or replaced as necessary. These measures would limit unauthorized access to the Project Site, and reduce the potential for contact with OE and non-OE-affected soil.

Compliance with ARARs: This alternative would not comply with ARARs for the Project Site.

Long-term Effectiveness and Permanence: This alternative would not achieve the soil remediation goals for the Project Site. Since Alternative 2 does not include any remedial action components besides institutional controls and monitoring, existing conditions related to OE and non-OE constituents in soil would not change substantially over time. Since elevated concentrations of TNT and metals would remain in soils, there is a possibility that these substances could be transported to other media over time. Periodic monitoring would be performed to evaluate groundwater and surface water quality over time. Since no cleanup is proposed under this alternative, periodic monitoring would likely continue indefinitely for both natural and manmade hazards. However, potential risks related to the Project Site would remain essentially constant, so long as institutional controls are appropriately maintained.

Reduction of Toxicity, Mobility, or Volume through Treatment: This alternative does not include any treatment component, and would not achieve any reduction in the toxicity, mobility, or volume of OE and non-OE-affected soil.

Short-term Effectiveness: Current institutional controls and monitoring options would be effective at limiting access to the property and assessing potential changes in site conditions. However, Alternative 2 would not achieve the soil remediation goals, and therefore, is not considered to satisfy this criterion.

Implementability: Alternative 2 is considered to be implementable. However, with the implementation of institutional controls and no other remediation, the Project Site could not be developed residentially.

Cost: This alternative would have a relatively low implementation cost compared to alternatives that include treatment and disposal of OE and non-OE-affected soils. The estimated cost for Alternative 2 is $870,000, based on a 30-year present worth, as indicated in Table H-1.

Community Acceptance: Based on comments received on the draft RI/FS report, this alternative does not appear to be acceptable to the community. However, this criterion will be further assessed following the public notice and comment period on the draft RAP.

State Acceptance: Implementation of institutional controls and monitoring may not provide sufficient remedial measures over the long term, considering that DTSC has an imminent and substantial endangerment order for the Project Site.

12.1.3 Alternative 5: OE Point Clearance over Entire Site; Excavation, Treatment, and Disposal of Non-OE-affected Soil over Entire Site; Areawide OE Clearance in Portions of North Valley, South Valley, and Ridge, in Accordance with OE RDD; Installation of a Crushed Bedrock Cap in Future Residential Areas; Institutional Controls; and Monitoring

Overall Protection of Human Health and the Environment: Alternative 5 includes several process options that would effectively remediate OE and non-OE constituents, thereby achieving soil remediation goals, allowing portions of the Project Site to be residentially developed and providing public access to open space areas. Comprehensive point clearance activities, including 100-percent QA scanning would be performed to identify and remove anomalies over the entire Project Site. Soil that is considered to potentially contain OE beneath future residential areas would be excavated and scanned for ordinance using geophysical techniques. This soil would be placed as fill in the North Valley, and would be overlain by at least 14 feet of OE-free crushed bedrock, as an additional measure to eliminate potential pathways from the public to come in contact with areawide clearance soils. Figures 12-1 and 12-2 show the proposed excavation and fill areas associated with this alternative. The OE RDD will include a decision tree that shows the process by which live OE items, if found, will be managed.

Land use and access restrictions would be implemented for the South Valley open space, including the wetlands, the paved portion of the McAllister Drive Land Bridge, North Valley open space, and the paved areas of Unit D-1.

Soil containing non-OE constituents would be remediated using a combination of process options to satisfy the soil remediation goals. Future residential areas would be founded on bedrock, overlain by 14 feet of crushed bedrock, or underlain by a combination of crushed bedrock and underlain by bedrock. The minimum thickness of crushed bedrock in the TNT Hillside Area is 4 feet.

Compliance with ARARs: Alternative 5 would be designed and implemented to comply with the regulatory requirements specified in Appendix H-1of the RI/FS (Proposed ARARs) and the EIR. The applicability of and compliance with these requirements are addressed in detail in the EIR, and summarized below. ARARs are classified as location-specific requirements (i.e., protection of wetlands), action-specific requirements (i.e., management of storm water), and chemical-specific (i.e., compliance with air emission standards for particular type of air pollutant).

Compliance with location-specific ARARs would likely include the following activities:

- **Federal Clean Water Act, Section 404.** Under Section 404 of the Clean Water Act (CWA), any activities that may result in the discharge of dredged or fill material into the "Waters of the United States" are required to be authorized by USACE. Granite will coordinate with USACE and the RWQCB regarding methods to limit the disturbance of wetland areas during OE clearance activities. Granite will file a pre-construction notification for proposed fill placement within the jurisdictional seep wetlands of the northern slope, within the South Valley, and within the jurisdictional North Valley wetland. In accordance with CWA Section 401, the RWQCB would need to prepare a Water Quality Certification, ensuring that the proposed activity will not violate state or federal water quality standards.

- **California Fish and Game Code Section 1603.** This statute requires parties to notify the CDFG before beginning any construction project that will divert, obstruct, or change the natural flow or the bed, channel, or bank of any stream that is subject to Section 1603. The water body in the South Valley does not appear to meet the CDFG definition of a stream, because it does not exhibit a well-defined stream bed and bank, and supports characteristics of a wetland rather than a stream. However, this water body supports other stream characteristics, such as riparian vegetation and aquatic life. Therefore, this project may require a Section 1603 Streambed Alteration Agreement. Prior to beginning any work in this portion of the Project Site, Granite will initiate the Streambed Alteration Notification process by submitting a notification form and questionnaire to the CDFG.

- **Endangered Species Act.** Section 9 of the Endangered Species Act (ESA) prohibits the "taking" of federally listed wildlife species without first obtaining the necessary authorization from the USFWS. "Take" may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or shelter. In accordance with Section 7 of the ESA, if a proposed project activity requires a federal permit (e.g., a section 404 permit from USACE), the federal lead agency (USACE) must determine if there is a potential for any adverse impacts (including a potential "taking") to federally protected species from the proposed activity, as part of the permit review process. The potential occurrence of federally protected species at the Project Site is evaluated in the Project EIR. The EIR will be the basis for any further consultations that may be required by the USFWS or other applicable regulatory authorities subsequent to their review of the EIR and assessment of potential impacts.

- **California Endangered Species Act.** The California ESA protects state-listed species and their habitats. Disturbance to riparian, wetland habitat, or vegetation would require mitigation measures, such as grading and revegetating disturbed areas with native plant species. The potential biological impacts and proposed mitigation measures are further discussed in the EIR.

Action-specific ARARs are anticipated to include:

- **Underground Storage Tank Requirements.** California Code of Regulations (CCR) Title 23 establishes permanent closure requirements for USTs and associated piping, including the removal of residual materials, sampling, and reporting to the appropriate local agency. These requirements would apply if any USTs are found during point-clearance activities at the Project Site. Figure 12-3 presents a process decision tree that illustrates how this ARAR would be implemented at the Project Site.

- **California Health and Safety Code and Hazardous Waste Regulations.** The California Health and Safety Code (HSC), Division 20, Chapters 6.5 and 6.8, and their associated regulations in CCR Title 22, establish requirements for management of hazardous waste. These requirements specify the minimum standards that must be met by parties that generate, store, treat, transport, or dispose of hazardous waste. Waste that is generated during site remediation activities will be tested and characterized with respect to hazardous waste criteria. Specific requirements (e.g., use of EPA generator ID number, uniform hazardous waste manifests, adherence to storage time limits) will be followed, as appropriate, in conjunction with site remediation activities.

Chemical-specific ARARs include:

- **Hazardous Waste Identification Regulations**. CCR Title 22, Sections 66261 and 66268.1 establish the criteria for identifying hazardous waste, as well as the land disposal requirements (LDRs) for hazardous waste. OE waste and soil may be characterized as hazardous if they exhibit hazardous waste characteristics or contain a listed waste.

Long-term Effectiveness and Permanence: Alternative 5 would permanently remediate OE and non-OE-affected soil at the Project Site. Therefore, this alternative satisfies the criterion of long-term effectiveness. After remediation, groundwater, subdrain water, seeps, and surface water would be monitored to evaluate the effectiveness of the remedial actions.

Reduction of Toxicity, Mobility, or Volume through Treatment: OE that may be present in the Project Site would be remediated using point clearance and areawide clearance activities. These measures involve treatment of all detected OE.

Under subalternative A, soil from the TNT Strips Area would be physically treated by homogenization, to produce more uniform TNT concentrations, prior to excavation and off-site disposal. U nder subalternative B, soil containing the highest TNT concentrations (e.g., 5 percent or more) would be composted prior to disposal. The treatment of OE and non-OE-affected soils would enable residential development of the Project Site. While subalternatives 5A and 5B would both achieve soil remediation goals, subalternative 5B involves more treatment of TNT-affected soil than subalternative 5A.

Short-term Effectiveness

OE Clearance Activities. Alternative 5 would achieve short-term effectiveness. Strict safety protocols will be followed at all times during the excavation of anomalies, movement of OE, and treatment activities, including the enforcement of an MSD and a Project Site Access Control Plan and VSD. These measures would effectively control potential short-term risks to workers and the community. Engineering controls may be used during treatment of OE, to reduce the MSD and the VSD as necessary.

Specially designed point clearance procedures would be used to avoid significant impact to the South Valley wetlands. These procedures include dividing the wetlands into separate reaches that may be temporarily dewatered, if necessary, to scan for and remove anomalies. Temporary wooden structures may be placed across the wetlands areas to allow access and reduce potential impacts to wetland habitat. A limited amount of soil might need to be removed from the wetlands to excavate anomalies. However, excavated soil would not intentionally be placed back in the wetlands, because of regulations that limit the filling of wetlands.

Alternative 5 includes the excavation of the soils in several swale areas on the northern slope of South Valley. A series of benches would be cut into the hillside, and a fill composed of crushed bedrock or imported soil would be placed and compacted. Subdrains would be installed in the benches to control drainage and further stabilize the fill (see Figure 12-1).

The areawide OE clearance requires excavation and mass grading of the Ridge and a portion of the North Valley soils in the vicinity of TNT Strips 4 and 5. Areawide clearance soil would be excavated, hauled, and placed in the floor of the North Valley in lifts. The areawide cleared soil would be scanned for OE during placement. Afterwards, this soil would be covered with a minimum of 14 feet of crushed bedrock. Excavation and grading would be accomplished using standard construction methods and equipment, including bulldozers, scrapers, water trucks, and other support equipment. OE safety specialists will monitor all construction activities involving potential contact with OE. Potential short-term impacts associated with this construction work would be abated, as necessary, using standard engineering controls, including application of water to reduce fugitive dust emissions. The approximate duration of areawide OE clearance and mass grading activities is 90 days.

Remediation of Non-OE-Affected Soil: This alternative includes the remediation of soil containing non-OE constituents above soil remediation goals. Non-OE-affected soil would be excavated and removed from the TNT Strips, the Flare Site, Stockpiles #1, #2, and #3, Demolition Site 3, and any other areas identified by additional investigative work that will be performed after the completion of point clearance activities (see Table 8-1). Soil would be removed with a backhoe, excavator, or loader after point clearance activities are completed, including a 100-percent QC check of cleared areas. The excavated soil would be temporarily stockpiled or directly loaded into trucks and transported from the Project Site. For the purposes of this FS, it has been assumed that soil from the Flare Site would be disposed at a Class I landfill in California. Soil from the other affected areas will likely go to Class II or III landfills depending on the results of soil profiling and acceptance by an appropriate permitted landfill. The non-OE RDD will include decision diagrams for the remediation of non-OE-affected soil at the Project Site. Figure 12-3 provides the decision tree to evaluate non-OE-affected soil and groundwater associated with underground storage tanks and piping that are potentially present at the site.

Soil containing TNT concentrations greater than the soil remediation goal would be removed off site. Alternative 5A includes physical treatment of TNT Strip Area soils by in-situ homogenization, to produce more uniform soil concentrations that are less than the reactivity criterion, prior to excavation and off-site disposal. Subalternative 5B includes in-situ homogenization and composting to treat soil containing the highest concentrations of TNT (approximately 5 percent or more). The soil would be excavated and temporarily stockpiled near the composting area, to be located in the bottom of the North Valley or on the Ridge in the area of TNT Strip #1. A treatment pad would be constructed to contain the soil and collect leachate, if any, produced during composting operations. The pad would include a synthetic liner and leachate collection system. A layer of slightly TNT-affected soil would be placed on the liner and over the drainage piping to protect the pad. The stockpiled soil would be mixed with various organic substances to provide a carbon source and nutrients, and to promote microbiological degradation of the TNT. Typical additives include wood chips, sawdust, manure, and food-processing waste products. The TNT-affected soil is mixed with the above materials at a typical ratio of 1 part soil to 3 parts soil amendments. After mixing, the soil is placed in windrows and periodically turned over to promote mixing and aeration. Water is regularly added to the windrows to maintain optimum soil moisture and control dust generation. Leachate that is produced and collected in the drainage system would be re-applied to the windrows as necessary. The composting time is typically approximately 30 to 90 days. Following composting, the treated soil would be disposed at an approved off-site landfill or may be left on site if it satisfies soil remediation goals.

Implementability: Non-OE-affected soil could be remediated using standard construction procedures and equipment, including scrapers, excavators, and other earthmoving equipment. Fugitive dust emissions would be controlled using water trucks or other dust suppressants. The proposed point clearance and areawide clearance of OE requires highly trained specialists and sensitive geophysical monitoring equipment that have limited availability maintenance of the MSD and VSD during the excavation and treatment of anomalies could be difficult to implement for anomalies that are located near the property boundaries. Based on preliminary discussions with the BAAQMD, no permits from the BAAQMD are anticipated to be necessary for the treatment of OE and non-OE-affected soils, or for the proposed grading activities.

Cost: The estimated cost for Alternative 5A is $17.5 million dollars. The estimated cost for Alternative 5B is $18.2 million dollars. Details of these costs are shown in Tables H-2 and H-3, respectively.

Community Acceptance: Based on comments that community members have provided to DTSC to date, Alternative 5 appears to be generally favored by the community. This criterion will be further assessed following the public notice and comment period on the Draft RAP.

State Acceptance: Alternatives 5A and 5B would meet soil remediation goals, be protective of health and the environment, and would not be expected to have significant short- or long-term impacts. There would be short-term impacts associated with implementation of the MSD and VSD during OE point clearance and possibly areawide clearance activities. State acceptance of this alternative is anticipated.

12.1.4 Alternative 6: Includes All Components of Alternative 5, Plus Excavation of All OE Kick-out Zone Soil, Except the Wetlands, Placement of OE Kick-out Zone Soils in North Valley and South Valley Adjacent to the Wetlands, and Geophysical Scanning of OE Kick-out Zone Soil during Placement.

Overall Protection of Human Health and the Environment: Alternative 6 would meet the soil remediation goals and allow residential development of the Project Site. The primary difference between this alternative and Alternative 5 is the quantity and location of soil that would be removed from the South Valley area. Alternative 6 includes areawide OE clearance over the entire demolition site OE kick-out zones (exclusive of wetlands), as shown in Figure 12-4. This alternative would remove all OE kick-out zone soils from the upland portions of the South Valley, except in the wetlands. The excavation and removal of OE kick-out zone soil from the upland areas could influence the hydrologic characteristics of the South Valley, potentially affecting the wetlands habitat.

Compliance with ARARs: Alternative 6 would be designed and implemented to comply with most ARARs. The RWQCB has indicated that excavation to bedrock adjacent to wetlands in the South Valley could permanently alter the hydrologic conditions of the wetlands. The RWQCB has asked for development of a contingency plan and financial assurance to provide measures to assure the long term viability of the wetlands if this alternative is implemented. The contingency plan would include mitigation measures to address potential adverse impacts on wetlands, if this alternative is implemented.

Long-term Effectiveness and Permanence: Alternative 6 would permanently remediate OE and non-OE-affected soil at the Project Site. Areawide clearance of OE in the South Valley would provide greater long-term effectiveness than the point clearance activities specified for Alternative 5.

Reduction of Toxicity, Mobility, or Volume Through Treatment: Alternative 6 would effectively reduce the toxicity, mobility, or volume of OE and non-OE-affected soil, as described for Alternative 5.

Short-term Effectiveness: The short-term effectiveness of Alternative 6 would be generally similar to Alternative 5. However, this alternative requires the removal of an estimated 170,000 cy of soil from the OE kick-out zone. This work would increase the project duration and the extent of construction-related activities. However, all construction-related impacts could be effectively controlled using standard construction practices, as described for Alternative 5. Additionally, there would be short-term impacts associated with implementing the MSD and VSD.

Implementability: The OE clearance activities for Alternative 6 require highly trained specialists and sophisticated geophysical monitoring equipment, as described for Alternative 5. The excavation of OE kick-out zone soil along the southern slope of the South Valley is implementable, but would need to address several features within the Project Site, including the removal of soil behind five lots on Casey Court, along the sewer bench, and adjacent to the wetlands. Excavation of soil behind Casey Court would involve making a vertical cut in the bedrock, and creating a sloped buttressing fill along the vertical cut to support the soils along the lot lines. An 8-inch gravity sewer line is also present on the south slope of the South Valley. This line crosses the south portion of the OE kick-out zone, and appears to be supported by soil in five discrete locations. Excavating soil at these locations would undermine the sewer line. Therefore, this alternative would include rerouting portions of the sewer line, as necessary to maintain support.

Soil in the floor of the South Valley adjacent to the wetlands would be excavated in a manner to avoid impacts to the wetlands. At locations with shallow soil (i.e., less than 4 to 5 feet), that is stable, soil would be excavated using a vertical cut to bedrock. The excavation would be backfilled with soil from the area that has been cleared of OE, soon after excavation to provide support for the wetlands. In deeper soil (i.e., greater than 5 feet) or unstable soil, the soil would be cut with a slope of 1:1 or flatter to maintain stability of the wetlands. The removal of OE kick-out zone soils and non-OE-affected soils could be completed using standard construction equipment, services, and materials, as described for Alternative 5.

Cost: The cost for Alternative 6A is estimated to be approximately $20.5 million dollars. The cost for Alternative 6B is estimated to be approximately $21.0 million dollars. Details of these costs are shown in Tables H-4 and H-5, respectively.

Community Acceptance: Community members have provided comments to DTSC expressing concerns about the environmental impacts of this alternative. These concerns include potential impacts on the South Valley wetlands and habitat loss on the South Valley slopes resulting from removal of OE kick-out zone soils. This criterion will be further assessed following the public notice and comment period on the drat RAP.

State Acceptance: Alternatives 6A and 6B would meet soil remediation goals and be protective of health and the environment. However, the RWQCB has indicated that removal of soil to bedrock in the South Valley is unacceptable, because of potential changes to the hydrology of the South Valley wetlands. The acceptability of this alternative would depend on the acceptability of the Contingency Plan and Financial Assurance documents requested by the RWQCB. State acceptance will be further evaluated based on comments received on the Draft RAP.

12.1.5 Alternative 8: Includes Alternative 5 Components, Plus Excavation of OE Kick-out Zone Soil and Replacement in South Valley; with Additional Geophysical Scanning of OE Kick-out Zone Soil during Placement in South Valley

Overall Protection of Human Health and the Environment: Alternative 8 would be protective of human health and the environment. With this alternative, all OE kick-out zone soil would be excavated and scanned to a similar degree as included under Alternative 6, except OE kick-out zone soil below the layer of crushed bedrock.

Compliance with ARARs: Alternative 8 would be designed and implemented to comply with ARARs for the Project Site. It is unlikely that removal and replacement of OE kick-out zone soil in the South Valley would satisfy the RWQCB's requirement to restore the preexisting soil and hydrologic conditions wherever possible. Therefore, the requirements for a contingency plan and financial assurance would also apply to Alternative 8.

Long-term Effectiveness and Permanence: Alternative 8 would be designed and implemented to permanently remediate the Project Site. The long-term effectiveness of this alternative would depend on the ability to reestablish stable slopes and hydrologic conditions that are similar to pre-existing conditions.

Reduction of Toxicity, Mobility, or Volume Through Treatment: Alternative 8 would effectively reduce the toxicity, mobility, and volume of OE and non-OE-affected soil, as described for Alternatives 5 and 6.

Short-term Effectiveness: The short-term effectiveness of this alternative would be similar to that described for Alternative 6. Construction activities would need to be carefully monitored and controlled during excavation and re-construction of the South Valley slopes to avoid compacting or filling the wetlands, to maintain stable slopes, and to control the potential erosion of sediment from fill areas.

Implementability: The OE clearance activities for Alternative 8 require highly trained specialists and sophisticated geophysical monitoring equipment, as described for Alternative 6. The remediation of non-OE-affected soils could be completed using standard construction equipment, services, and materials, as described for Alternative 6. However, restoration of the South Valley slopes would require substantial effort.

Cost: The cost for Alternative 8A is estimated to be approximately $21.3 million dollars. The cost for Alternative 8B is estimated to be approximately $22.1 million dollars. Details of these costs are shown in Tables H-6 and H-7, respectively. This alternative is the most costly alternative considered for the Project Site. This alternative costs more than Alternative 6 because of the construction methods that must be used to replace soil in the South Valley. These methods include benching the bedrock, installing subdrainage systems, and placing engineered fill to maintain stability.

Community Acceptance: Based on comments received on the draft RI/FS report, this alternative does not appear to be favored by the community. However, this criterion will be further assessed following the public notice and comment period on the draft RAP.

State Acceptance: Alternatives 8A and 8B would meet soil remediation goals and be protective of health and the environment. Placement of subdrain systems may affect South Valley hydrology. The acceptability of this alternative will be further evaluated following receipt of DTSC and RWQCB comments on the Draft RAP.

12.2 COMPARATIVE ANALYSIS OF ALTERNATIVES

Table 12-1 summarizes the detailed analysis of alternatives that have been retained for the Project Site. These alternatives range from No Action (Alternative 1, as required by the NCP) to options that involve substantial construction activities to permanently remediate OE and non-OE-affected soil for the entire Project Site. Alternative 2 does not include any active remedial action components, but achieves protection of human health with the maintenance of institutional controls. Under Alternative 2, conditions at the Project Site would remain relatively constant over time. This alternative would not allow residential development of the site, and represents the "No Project" alternative under CEQA.

Alternatives 5, 6, and 8 include active remedial measures to effectively reduce or eliminate potential risks related to current conditions at the Project Site. All of these alternatives include the remediation of non-OE-affected soil and point clearance of OE over the entire Project Site, areawide clearance of OE in future residential areas that are considered to have a potential to contain OE after the sitewide scan and QA/QC scan, and covering areawide cleared soils in future residential areas with 14 feet of crushed bedrock. Point clearance activities would require implementing an MSD and notification of the VSD that would result in short-term impacts to the community. These alternatives differ with respect to the areawide clearance of OE kick-out zone soil in the South Valley. Each alternative includes 2 subalternatives based on the method for remediating TNT Strip soils.

Alternative 5 includes limited areawide clearance for OE of overburden soils on a portion of the southern slope of the South Valley. Several swale areas on the northern slope of the South Valley will be graded through benching, subdrainage and filling. This alternative would have minimal potential impacts on the South Valley wetlands, and would involve less mass grading than Alternatives 6 and 8. Although Alternative 5 includes point clearance of the South Valley soils, this alternative does not include areawide clearance of kick-out zone soils. Point

Table 12-1. Detailed Analysis of Alternatives

ALTERNATIVE NUMBER AND DESCRIPTION	Overall Protection	Compliance with ARARs	Long-term Effectiveness and Permanence	Reduction of Toxicity, Mobility, or Volume	Short-term Effectiveness	Implementability	Cost	Community Acceptance	State Acceptance
Alternative 1: No Action	Would not be protective	Would not satisfy ARARs	Not effective over long-term	No reduction in toxicity, mobility, or volume	No short-term impacts beyond current conditions	Would be implementable	None	Not likely to be accepted, based on comments received to date. Will be further assessed following public comment period on Draft RAP	Not likely to be acceptable based on comments received to date.
Alternative 2: Institutional controls over entire Project Site and Monitoring	Criterion met through access restrictions	Would not satisfy ARARs	Long-term effectiveness depends on maintaining of access restrictions	No reduction in toxicity, mobility, or volume	No short-term impacts beyond current conditions	Would be implementable	Low	Not likely to be accepted, based on comments received to date. Will be further assessed following public comment period on Draft RAP	Not likely to be acceptable, based on comments received to date.
Alternatives 5A and 5B: Includes OE point clearance for entire Site and area-wide clearance in North Valley, Ridge, and D-1 areas; excavation and disposal of non-OE affected soil above remediation goals for entire Site; installation of OE-free crushed bedrock layer in future residential areas over area-wide clearance soil; Institutional Controls on South Valley wetlands, Kick-out zone, and McAllister Drive Land Bridge; and surface water/groundwater monitoring. **Subalternative A:** includes homogenization of TNT strip soils. **Subalternative B:** includes homogenization and composting of soil containing elevated TNT concentrations.	Would be protective of human health and environment	Would satisfy ARARs	Would provide long-term effectiveness	Would reduce toxicity, mobility, and volume. Subalternative B would treat more soil than Subalternative A	Potential short-term impacts related to excavation, offhauling soil and clearing OE	Would be implementable, but establishment of minimum separation distance would require substantial planning and coordination activities.	High Subalternative B would cost more than Subalternative A	Preferred alternative, based on comments received to date. Will be further assessed following public comment period on draft RAP.	State acceptance is anticipated based on comments received to date.
Alternative 6A and 6B: Includes Alternative 5 components except most South Valley Kickout Zone soils will be excavated and placed in North Valley; additional geophysical scanning of OE Kickout Zone soil in 1-foot lifts in the North Valley. **Subalternative A:** includes homogenization of TNT strip soils. **Subalternative B:** includes homogenization and composting of soil containing elevated TNT concentrations.	Would be protective of human health and environment, although removal of kickout zone soil might affect hydrology of South Valley	Would satisfy ARARs, with possible exception that a waiver of Clean Water Act, Section 404(b)(1) may be required	Would provide long-term effectiveness	Would reduce toxicity, mobility, and volume. Subalternative B would treat more soil than Subalternative A	Potential short-term impacts related to excavation, offhauling soil and clearing OE	Would be implementable, but potential expansion of minimum separation distance would decrease implementability.	High Subalternative B would cost more than Subalternative A	Not likely to be accepted, based on comments received to date. Will be further assessed following public comment period on Draft RAP	May not be acceptable, based on comments received to date.
Alternatives 8A and 8B: Includes Alternative 5 Components. In addition, Kickout Zone Soil Would be Excavated and Replaced in South Valley. **Subalternative A:** includes homogenization of TNT strip soils. **Subalternative B:** includes homogenization and composting of soil containing elevated TNT concentrations.	Would be protective of human health and environment; might affect the hydrology of South Valley	Would satisfy ARARs	Would provide long-term effectiveness	Would reduce toxicity, mobility, and volume. Subalternative B would treat more soil than Subalternative A	Potential short-term impacts related to excavation, offhauling soil and clearing OE	Would be implementable, but potential expansion of minimum separation distance would decrease implementability.	High Subalternative B would cost more than Subalternative A	Does not appear to be favored, based on comments received to date. Will be further assessed following public comment period on Draft RAP	May not be preferred because of potential environmental and community impacts, based on comments received to date.

clearance methods alone cannot be assured of detecting and removing all OE, particularly at locations where OE may be covered by recent ground disturbing activities (e.g., landslides or deposition from erosion). Deeply buried OE on the South Valley slopes could pose a long-term future hazard since it could be exposed at the ground surface by future landslide events or other erosional processes.

Alternative 6 includes the excavation of OE kick-out zone soils around the former demolition sites (except the wetlands). Most of this soil would be hauled to the North Valley, where it would be scanned for OE, and covered with 14 feet of crushed bedrock. A portion of the OE-cleared soil would be scanned for OE and used as backfill along the edge of the wetland area. This alternative would virtually eliminate any risks related to OE in the South Valley. However, this alternative would have the greatest potential impact on the wetlands due to hydrologic changes in the South Valley. Removal of overburden soils in the South Valley would also require re-routing a sewer line on the southern slope, stabilizing five residential lots on Casey Court at the top of this slope, and excavating adjacent to the wetlands. As with Alternative 6, Alternative 8 would also involve the areawide clearance of OE kick-out zone soil. However, after this soil is excavated and scanned for OE, it would be replaced in the South Valley. In order to reconstruct the valley slopes, it would be necessary to cut benches in the bedrock, and place fills on each bench. A subdrainage system would also be required to properly drain the hillsides. Alternative 8 would involve the most earthwork and require the greatest cost.

12.3 RECOMMENDED ACTION ALTERNATIVE

It is recommended that Alternative 5A be implemented for the Project Site. This alternative would satisfy the soil remediation goals and permanently remediate OE and non-OE-affected soil over the entire Project Site. This option would limit potential impacts on the South Valley wetlands to a greater degree than Alternatives 6 or 8. Soil containing non-OE compounds above soil remediation goals would be treated as necessary, excavated and transported to an appropriate off-site landfill.

Based on comments received on the draft RI/FS Report, Alternative 5A appears to be favored by both and the agencies the community. This alternative would be implementable. Potential impacts during construction would be managed using various engineering and institutional controls. Following completion of the remedial activities, groundwater, subdrain water, surface water and seeps would continue to be monitored to verify that conditions do not present any significant health or environmental risks. Covenants to restrict the use of property or provide similar control measures would be implemented in portions of the South Valley, McAllister Drive Land Bridge, and Unit D-1 area to limit future use of these areas and establish procedures for workers needing to perform ground-intrusive activities in areas where there is a potential to encounter OE.

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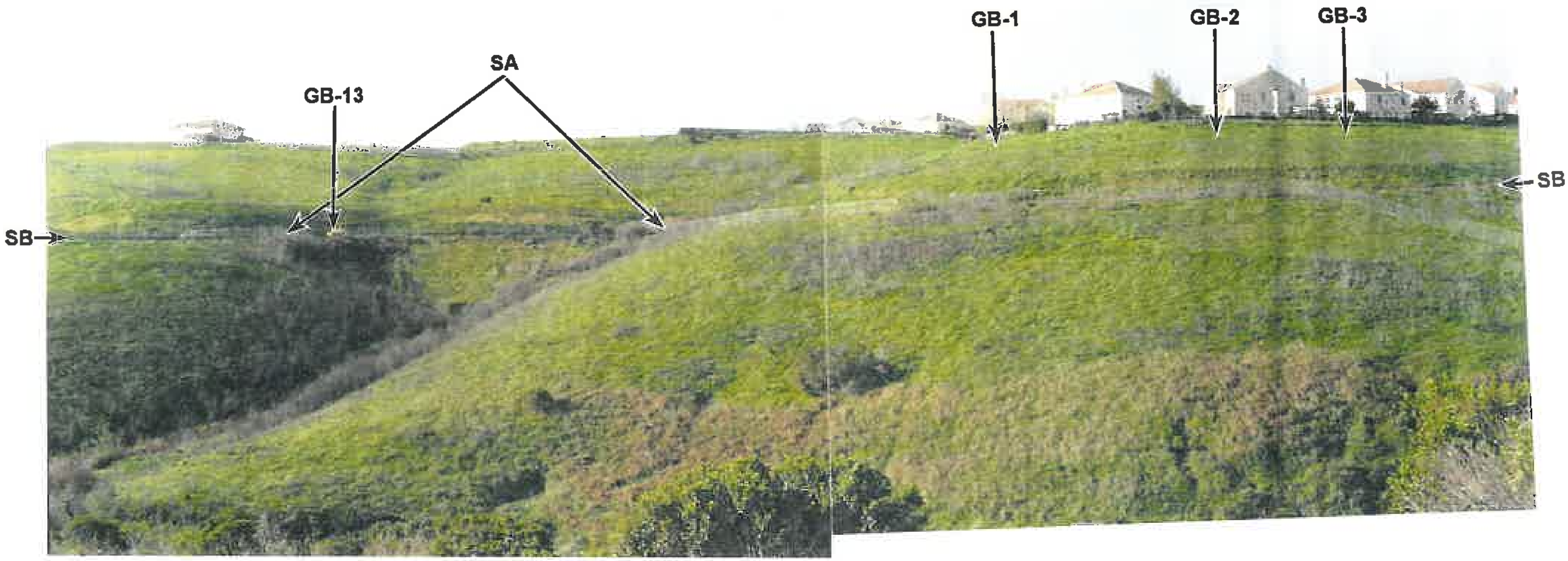

Photo 1. Panoramic view looking south at portion of potential ordnance "kick-out" area on south side of South Valley. Slide area (SA) shown by arrows at left. Horizontal fence line at upper part of photo is sewer bench (SB). Houses at top right are on Casey Court. Geotechnical boreholes (GB-1, GB-2 and GB-3) indicated shallow bedrock at 4.5, 2.5, and 2 feet below ground surface (bgs), respectively. Drill rig at left on bench is set up on borehole GB-13 which encountered bedrock at 11.5 feet bgs.

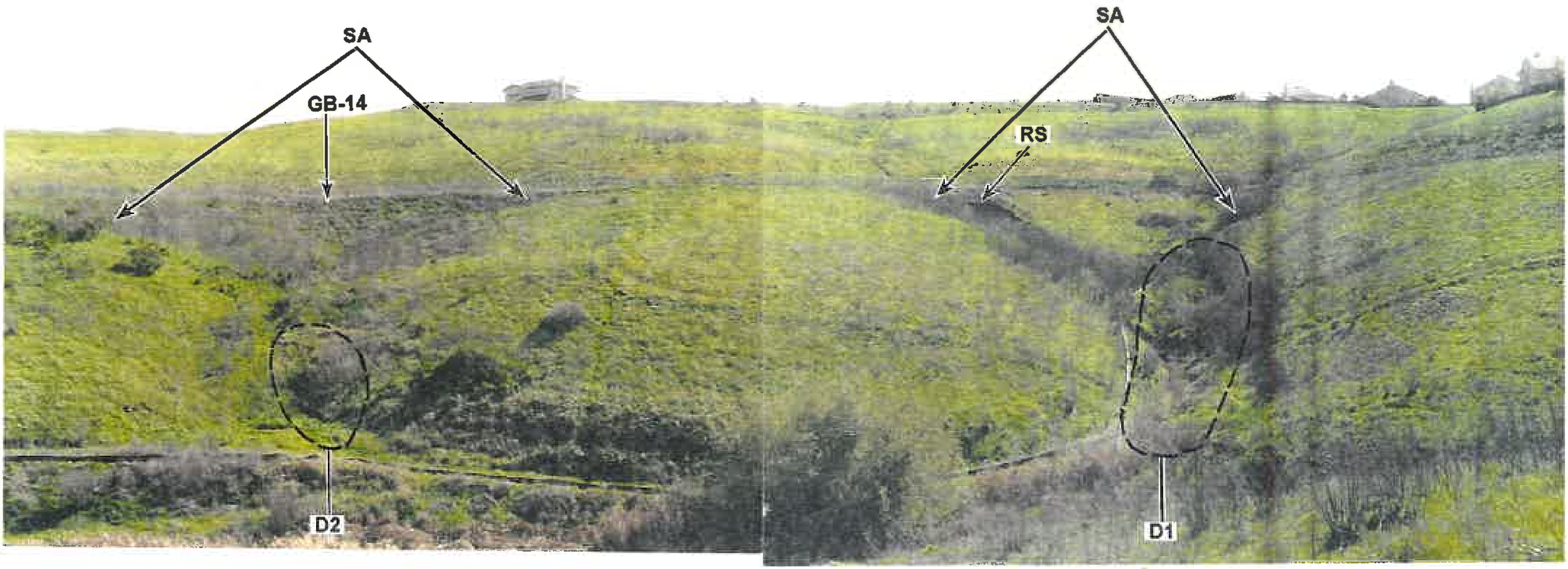

Photo 2. Panoramic view looking south at portion of potential ordnance "kick-out" area on south side of South Valley. Dash outlined areas are Demolition Site #1 (D1) and Demolition Site #2 (D2). Slide areas (SA) shown by arrows. Slide area above bench at right indicated by hummocky topography and leaning posts. Horizontal fence line at upper part of photo is sewer bench. Recent slide shown by arrow at right (RS). GB-14 at left encountered bedrock at a depth of 23.5 feet bgs.

Photo 3. Panoramic view looking south at portion of potential ordnance "kick-out" area on south side of South Valley. Dash outlined areas are Demolition Site #2 (D2) and Flare Site (FS). Slide areas (SA) shown by arrows. Horizontal fence line at upper part of photo is sewer bench (SB). Drill rig on bench at left is set up on borehole GB-15 which encountered bedrock at 8.5 feet bgs.

Photo 4. Looking southwest at recent slide below sewer bench between manholes #12 and #13. See Photo 2 for location of slide on sewer bench.

Photo 5. Closer view of slide scarp shown on Photo 4. Sewer bench is on other side of chain link fence. Material exposed on scarp is loose, mixed siltstone and sandstone fragments in a matrix of sandy clay.

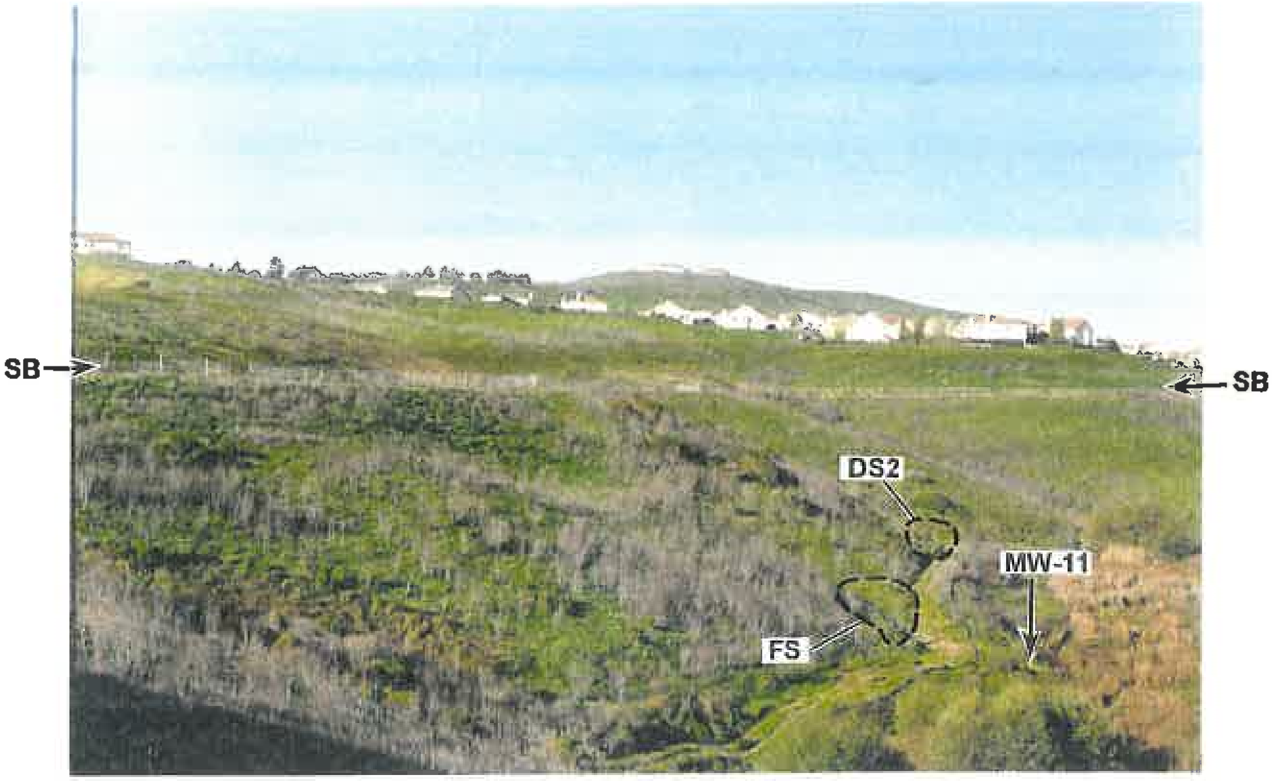

Photo 6. Looking west at south slopes of South Valley. Creek is at lower right. Horizontal fence line across upper part of photo is sewer bench (SB). Dash outlined areas are Flare Site (FS) and Demolition Site #2 (D2). Monitoring well MW-11 is at lower left near wetlands.

Photo 7. Looking west at valley bottom of South Valley. Brown reeds marks approximate limits of wetlands. Monitoring well MW-10 location at foreground.

Photo 8. Looking west at South Valley from McAllister Drive Land Bridge. Demolition Site # 3 at center (arrow, D3).

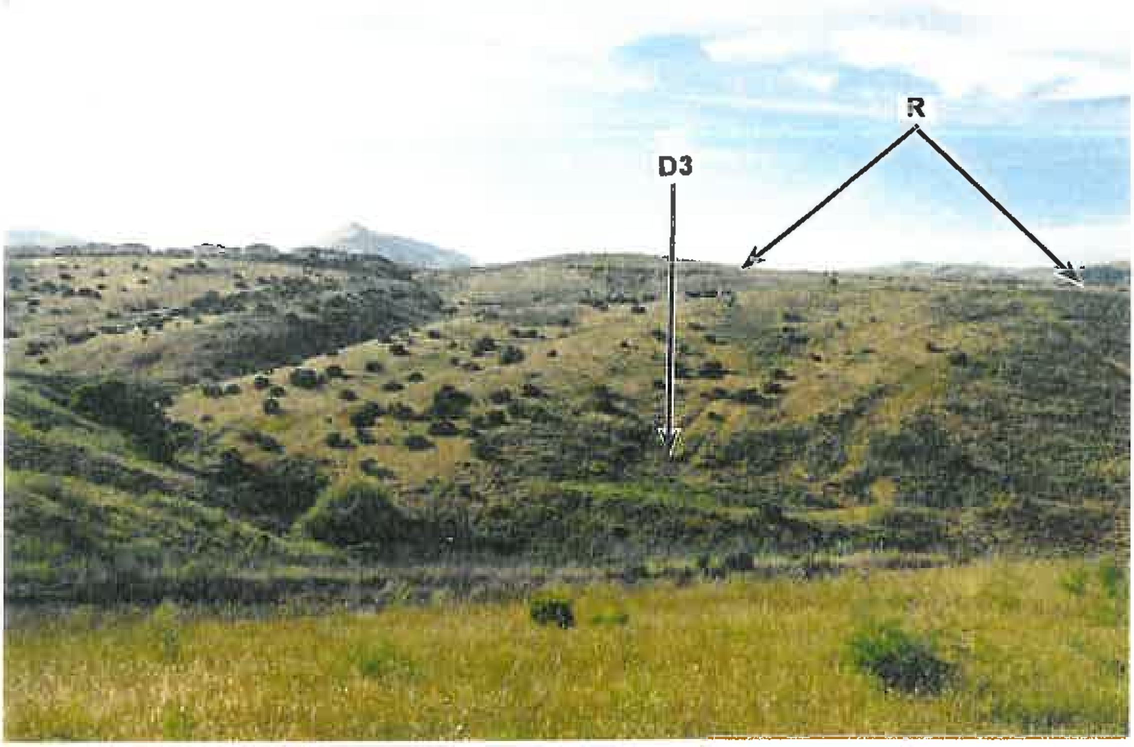

Photo 9. Looking north at Demolition Site # 3 (arrow, D3). Note bowl-shaped graded area which is site of filled-in demolition crater. Ridge cut area at right (arrows, R)

Photo 10. Panoramic view looking southwest at Howitzer Test Tunnel location (H), Stockpiles # 1 and #2 (arrows, SP1 and SP2).
Taken from same general area as shown on historical photograph Figure 2-9.

Photo 11. View looking northwest at Howitzer Test Facility (left) showing approximate location of tunnel (dashed lines). Stockpiles #1, #2 and #3 at right (arrows, SP1, SP2 and SP3). Part of North Valley Military Landfill at far right (white plastic cover, LF).

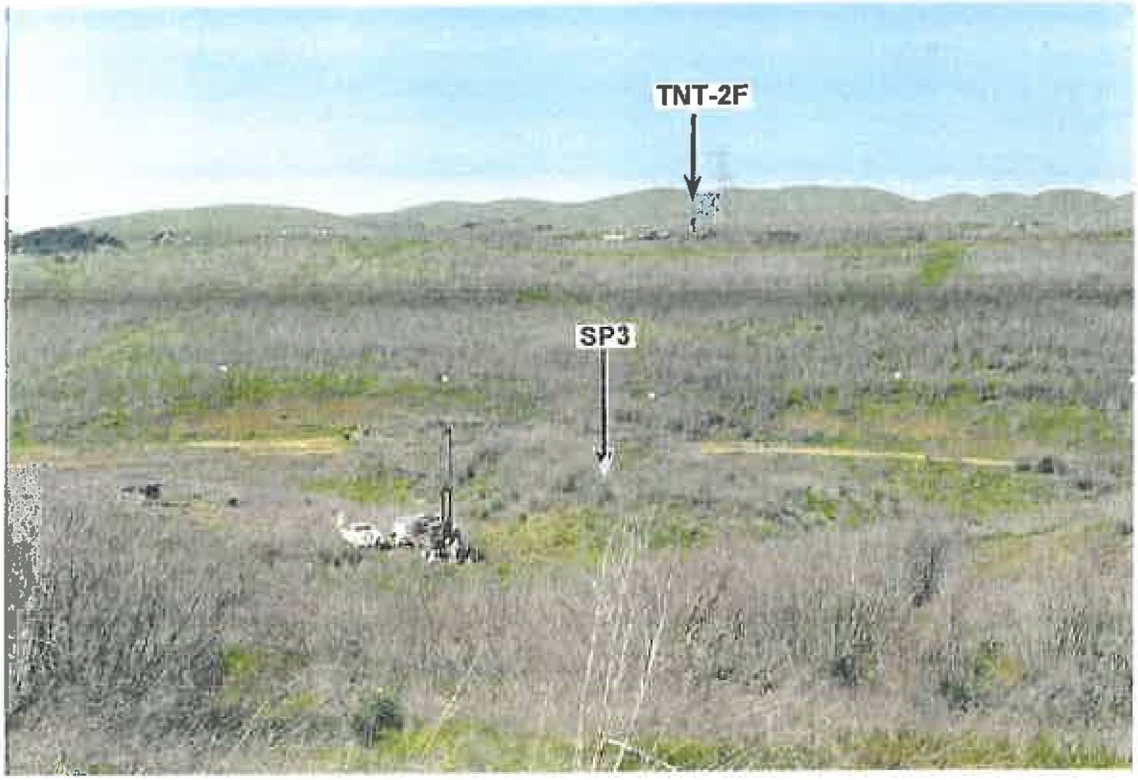

Photo 12. Looking northeast across North Valley and TNT Strips area. Drill rig at foregound is set up on borehole HF-9. Mound to right of drill rig is Stockpile # 3 (SP3). Drill rig at background is set up on borehole TNT-2F on TNT Strips.

Photo 13. Looking northwest along upper portion of North Valley towards Lake Herman (LH). Dash outlined area is former Ammunition Renovation/Primer Destruction Site (AR).

Photo 14. View looking south at Howitzer Test Tunnel location (arrows, H), Stockpile # 3 (arrow, SP-3), and North Valley Military Landfill (white plastic-covered area).

Photo 15. View looking southwest at North Valley Military Landfill. Plastic covered areas are test pits excavated to explore extent of landfill.

Photo 16. Dumped stockpile in Ridge cut area. Material consists mostly of mixed rock and soil.

Photo 17. Looking southeast at stockpiles of soil, rock, and concrete debris in Ridge cut area.

Photo 18. All-terrain drill rig set up on borehole TNT-2F on TNT Strip #2. TNT Strip #3 at foreground.

Photo 19. Drilling borehole TNT-2F using continuous dry coring. Cores from earlier runs are stored in box at right, foreground. The upper 3 feet of soil was hand augered and temporarily cased with a 10-inch PVC casing (white pipe).

TNT-1P 11.5-29'

TNT-1P 29-47'

Photo 20. Rock core samples from borehole TNT-1P, depth interval 11.5 to 47 feet. Material is severely to moderately weathered shale and siltstone. Note steeply dipping fractures at 19 feet which represent bedding planes. Physical (broken) condition of bedrock material induced during transfer of core from core barrel to core boxes.

Photo 21. Rock core samples from borehole TNT-1Q, depth interval 11 to 48 feet. Material is severely to moderately weathered shale and siltstone. Note heavy iron oxide staining along fractures as deep as 43-48 feet. Physical (broken) condition of bedrock material induced during transfer of core from core barrel to core boxes. See Photos 23 and 24 for condition of bedrock core from 15 to 25 feet in core barrel.

Photo 22. Rock core samples from borehole TNT-2F, depth interval 10.5 to 47.5 feet. Material is severely to moderately weathered shale and siltstone. Physical (broken) condition of bedrock material induced during transfer of core from core barrel to core boxes. Compare stored broken core from 20 to 25 feet with condition of same bedrock core in core barrel in Photo 24.

Photo 23. Dry core in steel core barrel from the 15 to 20 feet core run in borehole TNT-1Q. Material is severely weathered, interbedded shale and siltstone that is soft in hardness and easily crumbles. Color banding is parallel to bedding and is about 50° dip from the horizontal.

Photo 24. Dry core in split core barrel from the 20 to 25 feet core run in borehole TNT-1Q. Solid core is moderately weathered shale and siltstone. The bedrock is soft in hardness and easily crumbles when placed in core boxes. In the split core barrel, the bedrock, although weathered appears tight and compact. Fractures are weathered and infilled with clay.

MW 3A 36-53.5

Photo 25. Rock core samples from borehole MW-3A in North Valley, depth interval 36 to 53.5 feet. Bedrock material is slightly weathered to fresh shale, siltstone, and sandstone.

Photo 26. Rock core samples from borehole MW-4A in North Valley, depth interval 35 to 50.6 feet. Bedrock material is slightly weathered to fresh shale, siltstone, and sandstone. Physical (broken) condition of bedrock material induced during transfer of core from core barrel to core boxes.

MW4A 35-50.6

AR-7 : 26'-44'

Photo 27. Rock core samples from borehole AR-7 in North Valley, depth interval 26 to 44 feet. Bedrock material is moderately weathered to fresh shale, siltstone, and sandstone. Bedrock is intensely fractured to crushed and sheared. Physical (broken) condition of bedrock material induced during transfer of core from core barrel to core boxes.

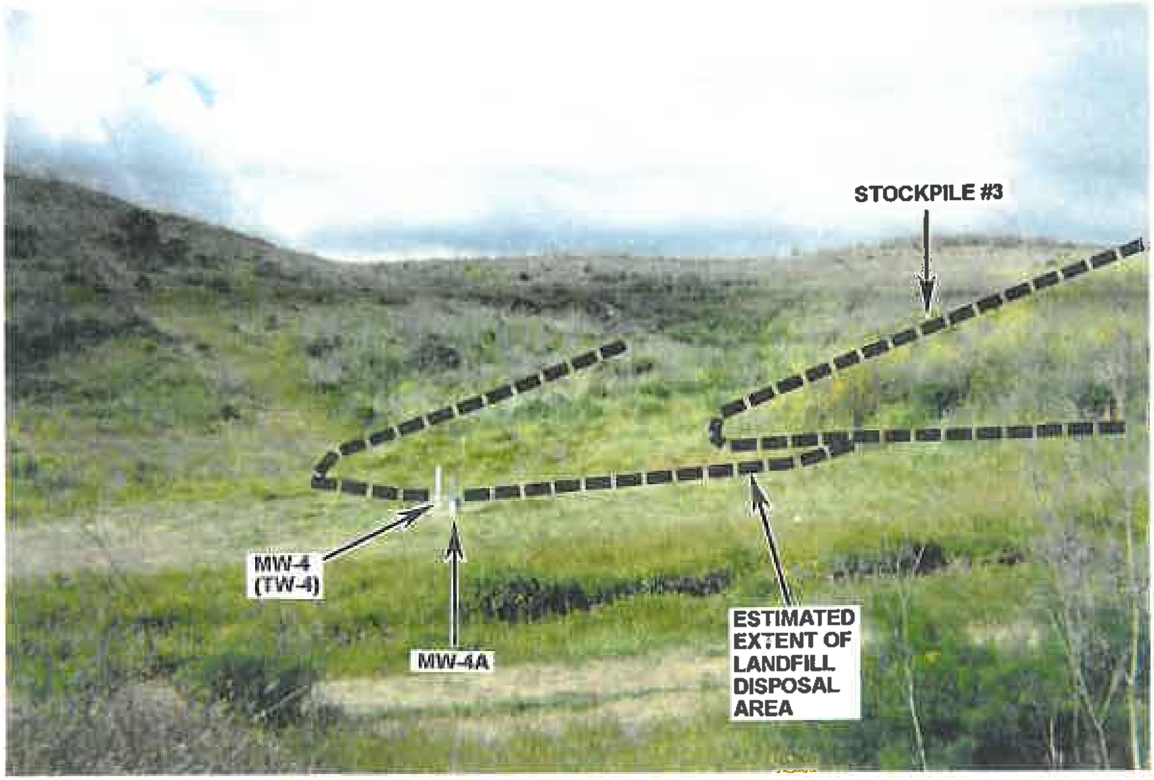

Photo 28. North Valley Military Landfill Area before removal action investigation. MW-4(TW-4) and MW-4A in center of photo.

Photo 29. North Valley Military Landfill Area cleared of weeds and grass.

Photo 30. Small orange "Clay Pigeons" mark anomalies located during geophysical investigation.

Photo 31. A Schonstedt magnetic locator used during 1-foot depth excavations of geophysical anomalies.

Photo 32. Miniature Open-Front Barricade (MOFB) used during excavation of geophysical anomalies to reduce the minimum separation distance in three directions.

Photo 33. Metal debris encountered during geophysical anomaly investigation.

Photo 34. Metal debris encountered during geophysical anomaly investigation.

Photo 35. Example of wood debris

Photo 36. Case 9020 excavator used to dig test pits.

Photo 37. Steam cleaning before entering and after leaving the site.

Photo 38. Test Pit LFP-17 (note debris layer of weed and sand)

Photo 39. Test Pit LFP-1 (note pocket of white, non-native sand associated with wood and metal debris)

Photo 40. Excavated landfill material stockpiled onto and covered with Visqueen.™

Photo 41. Metal debris excavated from Test Pit LFP-3.

Photo 42. Test Pit LFP-27, landfill material pinches out half way across trench.

Photo 43. Test Pit LFP-28, no landfill material was encountered, only undisturbed alluvium.

Photo 44. Groundwater encountered at Test Pit LFP-24.

Photo 45. BATF Type 2 storage magazines placed on the Project Site to store OE, if necessary, during the removal action investigation. It should be noted that no OE was located during the removal action investigation.

Photo 46. Test pits and stockpiles covered at the end of each shift.

Photo 47. Overview of North Valley Military Landfill removal action investigation (looking south).

Table 2-1. Summary of DOD-Related Activities, Potential Release Sites, and Years of Operation
Page 1 of 2

Areas of Interest (Potential Release Sites)	Structural Features	Type of Activity	Year Started	Years of Operation	Year Abandoned	Abandonment Method	Evidence
NORTH VALLEY							
TNT Strips	--	Burning of TNT.	1947(?)	(?)	(?)	Not removed.	Aerial photographs. Lack of vegetation.
Howitzer Test Facility (& Stockpile #3)	Test Firing Tunnels (Building 181)	Testing howitzer barrels and propellants.	1945	1945-1955	September 1996	Demolished during initial site preparation activities.	Aerial and ground level photographs. RRR.
	Test Firing Butts (Building 182)		1945	1945-1955	September 1996	Demolished during initial site preparation activities.	Aerial and ground level photographs. RRR.
	Powder Loading Room (Building 183)		1945	1945-1955	September 1996	Demolished during initial site preparation activities.	Aerial and ground level photographs. RRR.
	Cement Block Test Cell (Buildings 540 and 542)	Exact use unknown. Reported uses include: - Calibration Facility - Soil Test Laboratory - Cement Block Test Cell.	1957 (Building 540) 1958 (Building 542)	(?)	Post 4/26/96 Pre 7/28/97	Demolished during initial site preparation activities (late 1996).	Aerial photographs. RRR.
North Valley Military Landfill	--	Suspected disposal of gravel, shell casings and shrapnel removed from howitzer test tunnels.	1945	1945-1955	1955(?)	During initial site preparation activities (late 1996), wood crates, pallets, and packing material were removed from area northeast of suspected disposal area.	Aerial photographs. RRR.
Primer Destruction Facility	"Squirrel Cages"	Destroying primers by burning.	1945(?)	1945(?)-1947(?)	(?)	(?)	RRR

Table 2-1. Summary of DOD-Related Activities, Potential Release Sites, and Years of Operation

Areas of Interest (Potential Release Sites)	Structural Features	Type of Activity	Year Started	Years of Operation	Year Abandoned	Abandonment Method	Evidence
NORTH VALLEY (continued)							
Ammunition Renovation Site (& Stockpiles #1 and #2)	Two wooden buildings	Inspecting and refurbishing ordnance, including breakdown operations, cleaning and processing of ammunition casings, and painting.	1950	1950-1955 (?)	September 1996	Demolished during initial site preparation activities.	Aerial and ground level photographs. RRR.
	Two temporary canvas structures		1950	1950-1955 (?)	(?)	Removed by Army (?).	Aerial and ground level photographs. RRR.
RIDGE							
Dynamite Burn Site	--	Burning of aged dynamite.	1947	Three months between 1947-1948	1990	Removed during grading activities for construction of McAllister Drive Land Bridge.	Aerial photographs. RRR.
SOUTH VALLEY							
Flare Site	--	Burning of flares.	1945(?)	(?)	(?)	Not removed.	Aerial photographs. RRR.
Demolition Site #1	--	Destruction of defective and out-dated ammunition.	1945	(?)	(?)	Not removed.	Aerial photographs. RRR.
Demolition Site #2	--		1945(?)	(?)	(?)	Not removed.	Aerial photographs. RRR.
Demolition Site #3	--		1945(?)	(?)	(?)	Half-track armored personnel vehicle removed in mid-1990s and crater backfilled with fill.	Aerial photographs. RRR.

Notes: See Appendix A for copies of aerial photographs.
RRR = *Benicia Arsenal, Records Research Report, Final*, prepared by Jacobs Engineering, dated 1999.

Table 3-1. SECOR Analytical Results for Soil
TNT Strips
(Unvalidated Screening-Level Data)

(1 of 6)

TNT Strips	Field Sample ID		SS-1		SS-2		SS-3		SS-4	
	Sample Date		09/09/98		09/09/98		09/09/98		09/09/98	
Parameter		**Units**	**Result**	**MDL**	**Result**	**MDL**	**Result**	**MDL**	**Result**	**MDL**
Metals										
Antimony		mg/kg	ND	5.0	ND	5.0	ND	5.0	ND	5.0
Manganese		mg/kg	1,200	5.0	1,500	5.0	690	5.0	890	5.0
Potassium		mg/kg	1,500	10	1,400	10	1,500	10	1,300	10
Arsenic		mg/kg	ND	5.0	ND	5.0	ND	5.0	ND	5.0
Barium		mg/kg	220	0.5	250	0.5	180	0.5	160	0.5
Beryllium		mg/kg	0.89	0.5	1.0	0.5	0.84	0.5	0.85	0.5
Cadmium		mg/kg	ND	0.5	ND	0.5	ND	0.5	ND	0.5
Chromium		mg/kg	41	0.5	44	0.5	34	0.5	37	0.5
Cobalt		mg/kg	12	0.5	15	0.5	11	0.5	7.2	0.5
Copper		mg/kg	54	0.5	54	0.5	37	0.5	35	0.5
Lead		mg/kg	9.1	1.0	9.2	1.0	ND	1.0	ND	1.0
Molybdenum		mg/kg	ND	0.5	ND	0.5	ND	0.5	ND	0.5
Nickel		mg/kg	50	1.0	50	1.0	25	1.0	28	1.0
Selenium		mg/kg	ND	5.0	ND	5.0	ND	5.0	ND	5.0
Silver		mg/kg	ND	0.5	ND	0.5	ND	0.5	ND	0.5
Thallium		mg/kg	ND	5.0	ND	5.0	ND	5.0	ND	5.0
Vanadium		mg/kg	53	0.5	63	0.5	84	0.5	88	0.5
Zinc		mg/kg	79	1.0	65	1.0	62	1.0	60	1.0
Nitrate as Nitrogen		mg/kg	-	-	-	-	-	-	-	-
Nitrate/Nitrite as Nitrogen		mg/kg	-	-	-	-	-	-	-	-
Mercury		mg/kg	0.044	0.010	0.041	0.010	0.030	0.010	0.039	0.010
Explosive Compounds										
PETN		mg/kg	-	-	-	-	-	-	-	-
HMX		mg/kg	ND	3,000	ND	300	ND	300	ND	3000
Cyclonite (RDX)		mg/kg	ND	3,000	ND	300	ND	300	ND	3000
1,3,5-Trinitrobenzene		mg/kg	ND	3,000	ND	300	ND	300	ND	3000
1,3-Dinitrobenzene		mg/kg	ND	3,000	ND	300	ND	300	ND	3000
Tetryl		mg/kg	ND	3,000	ND	300	ND	300	ND	3000
Nitrobenzene		mg/kg	ND	3,000	ND	300	ND	300	ND	3000
2,4,6-Trinitrotoluene (TNT)		mg/kg	72,400	3,000	12,200	300	4,990	300	49,000	3000
4-Amino-2,6-Dinitrotoluene		mg/kg	ND	3,000	ND	300	ND	300	ND	3000
2-Amino-4,6-Dinitrotoluene		mg/kg	ND	3,000	ND	300	ND	300	ND	3000
2,4-Dinitrotoluene		mg/kg	ND	3,000	ND	300	ND	300	ND	3000
2,6-Dinitrotoluene		mg/kg	ND	3,000	ND	300	ND	300	ND	3000
4-Nitrotoluene		mg/kg	ND	3,000	ND	300	ND	300	ND	3000
3-Nitrotoluene		mg/kg	ND	3,000	ND	300	ND	300	ND	3000
2-Nitrotoluene		mg/kg	ND	3,000	ND	300	ND	300	ND	3000
Phosphate		mg/kg	-	-	-	-	-	-	-	-

Notes:

Data collected by SECOR International, Inc. Analytical data on this table was provided to Earth Tech by SECOR, as shown, with no modification. Analytical data have not been verified or validated by Earth Tech.

- = not analyzed

mg/kg = milligrams per kilogram

MDL = Method Detection Limit

ND = not detected above the Method Detection Limit

Notes regarding SS samples:

SS = soil sample

Samples collected from depths ranging from 2 to 5 inches below the ground surface

Metals were analyzed for using EPA Method SW6000 series.

Explosive compounds were analyzed for using EPA Method SW8330.

Notes regarding FSS samples:

FSS = field screening soil sample

Soil samples not air dried

FSS analyzed using EnSys Soil Test System, Rapid Field Screen for TNT and RDX.

* Analysis of FSS-10 and FSS-40 using EPA Method SW8330.

** = sample concentration was out of the range of the test method (1 to 30 mg/kg), therefore the sample was re-extracted, diluted and the concentration was re-reported.

Source: SECOR International, Inc.

Table 3-1. SECOR Analytical Results for Soil
TNT Strips
(Unvalidated Screening-Level Data)
(2 of 6)

TNT Strips	Field Sample ID		SS-5		SS-6		SS-37		SS-38	
	Sample Date		09/09/98		09/09/98		11/20/98		11/20/98	
Parameter		**Units**	**Result**	**MDL**	**Result**	**MDL**	**Result**	**MDL**	**Result**	**MDL**
Metals										
Antimony		mg/kg	ND	5.0	ND	5.0	ND	6.00	ND	6.00
Manganese		mg/kg	2100	5.0	1700	5.0	1,090	1.00	1,130	1.00
Potassium		mg/kg	1,800	10	2,400	10	1,780	500	2,110	500
Arsenic		mg/kg	ND	5.0	ND	5.0	13.6	10.00	15.7	10.00
Barium		mg/kg	300	0.5	180	0.5	219	0.400	227	0.400
Beryllium		mg/kg	1.3	0.5	0.90	0.5	0.786	0.100	0.898	0.100
Cadmium		mg/kg	ND	0.5	0.95	0.5	ND	1.00	ND	1.00
Chromium		mg/kg	71	0.5	47	0.5	36.9	1.00	44.1	1.00
Cobalt		mg/kg	27	0.5	15	0.5	15.2	0.700	16.2	0.700
Copper		mg/kg	71	0.5	61	0.5	48.6	1.00	55.3	1.00
Lead		mg/kg	ND	1.0	30	1.0	20.4	7.50	24.8	7.50
Molybdenum		mg/kg	ND	0.5	ND	0.5	ND	2.00	ND	2.00
Nickel		mg/kg	64	1.0	52	1.0	46.2	3.00	51.9	3.00
Selenium		mg/kg	ND	5.0	ND	5.0	ND	10.0	ND	10.0
Silver		mg/kg	ND	0.5	ND	0.5	ND	0.700	ND	0.700
Thallium		mg/kg	ND	5.0	ND	5.0	ND	10.0	ND	10.0
Vanadium		mg/kg	90	0.5	66	0.5	59.2	1.00	68.2	1.00
Zinc		mg/kg	79	1.0	91	1.0	61.3	2.00	69.7	2.00
Nitrate as Nitrogen		mg/kg	-	-	-	-	1.98	1.00	2.66	1.00
Nitrate/Nitrite as Nitrogen		mg/kg	-	-	-	-	1.98	2.00	2.66	2.00
Mercury		mg/kg	0.024	0.010	0.14	0.010	0.0615	0.0500	0.0630	0.0500
Explosive Compounds										
PETN		mg/kg	-	-	-	-	ND	0.30	ND	0.30
HMX		mg/kg	ND	30	ND	30	ND	0.30	ND	0.30
Cyclonite (RDX)		mg/kg	ND	30	ND	30	ND	0.30	ND	0.30
1,3,5-Trinitrobenzene		mg/kg	ND	30	ND	30	ND	0.30	ND	0.30
1,3-Dinitrobenzene		mg/kg	ND	30	ND	30	ND	0.30	ND	0.30
Tetryl		mg/kg	ND	30	ND	30	ND	0.30	ND	0.30
Nitrobenzene		mg/kg	ND	30	ND	30	ND	0.30	ND	0.30
2,4,6-Trinitrotoluene (TNT)		mg/kg	738	30	200	30	ND	0.30	ND	0.30
4-Amino-2,6-Dinitrotoluene		mg/kg	ND	30	ND	30	ND	0.30	ND	0.30
2-Amino-4,6-Dinitrotoluene		mg/kg	ND	30	ND	30	ND	0.30	ND	0.30
2,4-Dinitrotoluene		mg/kg	ND	30	ND	30	ND	0.30	ND	0.30
2,6-Dinitrotoluene		mg/kg	ND	30	ND	30	ND	0.30	ND	0.30
4-Nitrotoluene		mg/kg	ND	30	ND	30	ND	0.30	ND	0.30
3-Nitrotoluene		mg/kg	ND	30	ND	30	ND	0.30	ND	0.30
2-Nitrotoluene		mg/kg	ND	30	ND	30	ND	0.30	ND	0.30
Phosphate		mg/kg	-	-	-	-	181	2.50	258	2.50

Notes:

Data collected by SECOR International, Inc. Analytical data on this table was provided to Earth Tech by SECOR, as shown, with no modification. Analytical data have not been verified or validated by Earth Tech.

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Notes regarding SS samples:

SS = soil sample

Samples collected from depths ranging from 2 to 5 inches below the ground surface

Metals were analyzed for using EPA Method SW6000 series.

Explosive compounds were analyzed for using EPA Method SW8330.

Notes regarding FSS samples:

FSS = field screening soil sample

Soil samples not air dried

FSS analyzed using EnSys Soil Test System, Rapid Field Screen for TNT and RDX.

* Analysis of FSS-10 and FSS-40 using EPA Method SW8330.

** = sample concentration was out of the range of the test method (1 to 30 mg/kg), therefore the sample was re-extracted, diluted and the concentration was re-reported.

Source: SECOR International, Inc.

Table 3-1. SECOR Analytical Results for Soil
TNT Strips
(Unvalidated Screening-Level Data)

TNT Strips	Field Sample ID	FSS-9		FSS-10*		FSS-10		FSS-31	
	Sample Date	12/01/98		12/01/98		12/02/98**/12/08/98		12/02/98	
Parameter	Units	Result	MDL	Result	MDL	Result	MDL	Result	MDL
Metals									
Antimony	mg/kg	-	-	-	-	-	-	-	-
Manganese	mg/kg	-	-	-	-	-	-	-	-
Potassium	mg/kg	-	-	-	-	-	-	-	-
Arsenic	mg/kg	-	-	-	-	-	-	-	-
Barium	mg/kg	-	-	-	-	-	-	-	-
Beryllium	mg/kg	-	-	-	-	-	-	-	-
Cadmium	mg/kg	-	-	-	-	-	-	-	-
Chromium	mg/kg	-	-	-	-	-	-	-	-
Cobalt	mg/kg	-	-	-	-	-	-	-	-
Copper	mg/kg	-	-	-	-	-	-	-	-
Lead	mg/kg	-	-	-	-	-	-	-	-
Molybdenum	mg/kg	-	-	-	-	-	-	-	-
Nickel	mg/kg	-	-	-	-	-	-	-	-
Selenium	mg/kg	-	-	-	-	-	-	-	-
Silver	mg/kg	-	-	-	-	-	-	-	-
Thallium	mg/kg	-	-	-	-	-	-	-	-
Vanadium	mg/kg	-	-	-	-	-	-	-	-
Zinc	mg/kg	-	-	-	-	-	-	-	-
Nitrate as Nitrogen	mg/kg	-	-	-	-	-	-	-	-
Nitrate/Nitrite as Nitrogen	mg/kg	-	-	-	-	-	-	-	-
Mercury	mg/kg	-	-	-	-	-	-	-	-
Explosive Compounds									
PETN	mg/kg	-	-	ND	250	-	-	-	-
HMX	mg/kg	-	-	ND	250	-	-	-	-
Cyclonite (RDX)	mg/kg	-	-	ND	250	3.1	1.0	-	-
1,3,5-Trinitrobenzene	mg/kg	-	-	ND	250	-	-	-	-
1,3-Dinitrobenzene	mg/kg	-	-	ND	250	-	-	-	-
Tetryl	mg/kg	-	-	ND	250	-	-	-	-
Nitrobenzene	mg/kg	-	-	ND	250	-	-	-	-
2,4,6-Trinitrotoluene (TNT)	mg/kg	ND	1.0	5400	250	81.55**/2074.35	1.0	ND	1.0
4-Amino-2,6-Dinitrotoluene	mg/kg	-	-	ND	250		-	-	-
2-Amino-4,6-Dinitrotoluene	mg/kg	-	-	ND	250	-	-	-	-
2,4-Dinitrotoluene	mg/kg	-	-	ND	250	-	-	-	-
2,6-Dinitrotoluene	mg/kg	-	-	ND	250	-	-	-	-
4-Nitrotoluene	mg/kg	-	-	ND	250	-	-	-	-
3-Nitrotoluene	mg/kg	-	-	ND	250	-	-	-	-
2-Nitrotoluene	mg/kg	-	-	ND	250	-	-	-	-
Phosphate	mg/kg	-	-	-	-	-	-	-	-

Notes:

Data collected by SECOR International, Inc. Analytical data on this table was provided to Earth Tech by SECOR, as shown, with no modification. Analytical data have not been verified or validated by Earth Tech.

- = not analyzed

mg/kg = milligrams per kilogram

MDL = Method Detection Limit

ND = not detected above the Method Detection Limit

Notes regarding SS samples:

SS = soil sample

Samples collected from depths ranging from 2 to 5 inches below the ground surface

Metals were analyzed for using EPA Method SW6000 series.

Explosive compounds were analyzed for using EPA Method SW8330.

Notes regarding FSS samples:

FSS = field screening soil sample

Soil samples not air dried

FSS analyzed using EnSys Soil Test System, Rapid Field Screen for TNT and RDX.

* Analysis of FSS-10 and FSS-40 using EPA Method SW8330.

** = sample concentration was out of the range of the test method (1 to 30 mg/kg), therefore the sample was re-extracted, diluted and the concentration was re-reported.

Source: SECOR International, Inc.

Table 3-1. SECOR Analytical Results for Soil
TNT Strips
(Unvalidated Screening-Level Data)

TNT Strips	Field Sample ID	FSS-33		FSS-34		FSS-35		FSS-36	
	Sample Date	12/02/98		12/02/98		12/02/98		12/02/98	
Parameter	**Units**	**Result**	**MDL**	**Result**	**MDL**	**Result**	**MDL**	**Result**	**MDL**
Metals									
Antimony	mg/kg	-	-	-	-	-	-	-	-
Manganese	mg/kg	-	-	-	-	-	-	-	-
Potassium	mg/kg	-	-	-	-	-	-	-	-
Arsenic	mg/kg	-	-	-	-	-	-	-	-
Barium	mg/kg	-	-	-	-	-	-	-	-
Beryllium	mg/kg	-	-	-	-	-	-	-	-
Cadmium	mg/kg	-	-	-	-	-	-	-	-
Chromium	mg/kg	-	-	-	-	-	-	-	-
Cobalt	mg/kg	-	-	-	-	-	-	-	-
Copper	mg/kg	-	-	-	-	-	-	-	-
Lead	mg/kg	-	-	-	-	-	-	-	-
Molybdenum	mg/kg	-	-	-	-	-	-	-	-
Nickel	mg/kg	-	-	-	-	-	-	-	-
Selenium	mg/kg	-	-	-	-	-	-	-	-
Silver	mg/kg	-	-	-	-	-	-	-	-
Thallium	mg/kg	-	-	-	-	-	-	-	-
Vanadium	mg/kg	-	-	-	-	-	-	-	-
Zinc	mg/kg	-	-	-	-	-	-	-	-
Nitrate as Nitrogen	mg/kg	-	-	-	-	-	-	-	-
Nitrate/Nitrite as Nitrogen	mg/kg	-	-	-	-	-	-	-	-
Mercury	mg/kg	-	-	-	-	-	-	-	-
Explosive Compounds									
PETN	mg/kg	-	-	-	-	-	-	-	-
HMX	mg/kg	-	-	-	-	-	-	-	-
Cyclonite (RDX)	mg/kg	ND	1.0	ND	1.0	ND	1.0	ND	1.0
1,3,5-Trinitrobenzene	mg/kg	-	-	-	-	-	-	-	-
1,3-Dinitrobenzene	mg/kg	-	-	-	-	-	-	-	-
Tetryl	mg/kg	-	-	-	-	-	-	-	-
Nitrobenzene	mg/kg	-	-	-	-	-	-	-	-
2,4,6-Trinitrotoluene (TNT)	mg/kg	ND	1.0	ND	1.0	ND	1.0	ND	1.0
4-Amino-2,6-Dinitrotoluene	mg/kg	-	-	-	-	-	-	-	-
2-Amino-4,6-Dinitrotoluene	mg/kg	-	-	-	-	-	-	-	-
2,4-Dinitrotoluene	mg/kg	-	-	-	-	-	-	-	-
2,6-Dinitrotoluene	mg/kg	-	-	-	-	-	-	-	-
4-Nitrotoluene	mg/kg	-	-	-	-	-	-	-	-
3-Nitrotoluene	mg/kg	-	-	-	-	-	-	-	-
2-Nitrotoluene	mg/kg	-	-	-	-	-	-	-	-
Phosphate	mg/kg	-	-	-	-	-	-	-	-

Notes:

Data collected by SECOR International, Inc. Analytical data on this table was provided to Earth Tech by SECOR, as shown, with no modification. Analytical data have not been verified or validated by Earth Tech.

- = not analyzed

mg/kg = milligrams per kilogram

MDL = Method Detection Limit

ND = not detected above the Method Detection Limit

Notes regarding SS samples:

SS = soil sample

Samples collected from depths ranging from 2 to 5 inches below the ground surface

Metals were analyzed for using EPA Method SW6000 series.

Explosive compounds were analyzed for using EPA Method SW8330.

Notes regarding FSS samples:

FSS = field screening soil sample

Soil samples not air dried

FSS analyzed using EnSys Soil Test System, Rapid Field Screen for TNT and RDX.

* Analysis of FSS-10 and FSS-40 using EPA Method SW8330.

** = sample concentration was out of the range of the test method (1 to 30 mg/kg), therefore the sample was re-extracted, diluted and the concentration was re-reported.

Source: SECOR International, Inc.

Table 3-1. SECOR Analytical Results for Soil
TNT Strips
(Unvalidated Screening-Level Data)
(5 of 6)

TNT Strips	Field Sample ID	FSS-37		FSS-38		FSS-39		FSS-40*	
	Sample Date	12/02/98		12/02/98		12/02/98		12/01/98	
Parameter	**Units**	**Result**	**MDL**	**Result**	**MDL**	**Result**	**MDL**	**Result**	**MDL**
Metals									
Antimony	mg/kg	-	-	-	-	-	-	-	-
Manganese	mg/kg	-	-	-	-	-	-	-	-
Potassium	mg/kg	-	-	-	-	-	-	-	-
Arsenic	mg/kg	-	-	-	-	-	-	-	-
Barium	mg/kg	-	-	-	-	-	-	-	-
Beryllium	mg/kg	-	-	-	-	-	-	-	-
Cadmium	mg/kg	-	-	-	-	-	-	-	-
Chromium	mg/kg	-	-	-	-	-	-	-	-
Cobalt	mg/kg	-	-	-	-	-	-	-	-
Copper	mg/kg	-	-	-	-	-	-	-	-
Lead	mg/kg	-	-	-	-	-	-	-	-
Molybdenum	mg/kg	-	-	-	-	-	-	-	-
Nickel	mg/kg	-	-	-	-	-	-	-	-
Selenium	mg/kg	-	-	-	-	-	-	-	-
Silver	mg/kg	-	-	-	-	-	-	-	-
Thallium	mg/kg	-	-	-	-	-	-	-	-
Vanadium	mg/kg	-	-	-	-	-	-	-	-
Zinc	mg/kg	-	-	-	-	-	-	-	-
Nitrate as Nitrogen	mg/kg	-	-	-	-	-	-	-	-
Nitrate/Nitrite as Nitrogen	mg/kg	-	-	-	-	-	-	-	-
Mercury	mg/kg	-	-	-	-	-	-	-	-
Explosive Compounds									
PETN	mg/kg	-	-	-	-	-	-	ND	0.25
HMX	mg/kg	-	-	-	-	-	-	ND	0.25
Cyclonite (RDX)	mg/kg	-	-	-	-	-	-	ND	0.25
1,3,5-Trinitrobenzene	mg/kg	-	-	-	-	-	-	ND	0.25
1,3-Dinitrobenzene	mg/kg	-	-	-	-	-	-	ND	0.25
Tetryl	mg/kg	-	-	-	-	-	-	ND	0.25
Nitrobenzene	mg/kg	-	-	-	-	-	-	ND	0.25
2,4,6-Trinitrotoluene (TNT)	mg/kg	ND	1.0	ND	1.0	ND	1.0	ND	0.25
4-Amino-2,6-Dinitrotoluene	mg/kg	-	-	-	-	-	-	ND	0.25
2-Amino-4,6-Dinitrotoluene	mg/kg	-	-	-	-	-	-	ND	0.25
2,4-Dinitrotoluene	mg/kg	-	-	-	-	-	-	ND	0.25
2,6-Dinitrotoluene	mg/kg	-	-	-	-	-	-	ND	0.25
4-Nitrotoluene	mg/kg	-	-	-	-	-	-	ND	0.25
3-Nitrotoluene	mg/kg	-	-	-	-	-	-	ND	0.25
2-Nitrotoluene	mg/kg	-	-	-	-	-	-	ND	0.25
Phosphate	mg/kg	-	-	-	-	-	-	-	-

Notes:

Data collected by SECOR International, Inc. Analytical data on this table was provided to Earth Tech by SECOR, as shown, with no modification. Analytical data have not been verified or validated by Earth Tech.

- = not analyzed

mg/kg = milligrams per kilogram

MDL = Method Detection Limit

ND = not detected above the Method Detection Limit

Notes regarding SS samples:

SS = soil sample

Samples collected from depths ranging from 2 to 5 inches below the ground surface

Metals were analyzed for using EPA Method SW6000 series.

Explosive compounds were analyzed for using EPA Method SW8330.

Notes regarding FSS samples:

FSS = field screening soil sample

Soil samples not air dried

FSS analyzed using EnSys Soil Test System, Rapid Field Screen for TNT and RDX.

* Analysis of FSS-10 and FSS-40 using EPA Method SW8330.

** = sample concentration was out of the range of the test method (1 to 30 mg/kg), therefore the sample was re-extracted, diluted and the concentration was re-reported.

Source: SECOR International, Inc.

Table 3-1. SECOR Analytical Results for Soil
TNT Strips
(Unvalidated Screening-Level Data)

TNT Strips	Field Sample ID	FSS-40		FSS-41	
	Sample Date	12/03/98		12/03/1998**/12/08/98	
Parameter	**Units**	**Result**	**MDL**	**Result**	**MDL**
Metals					
Antimony	mg/kg	-	-	-	-
Manganese	mg/kg	-	-	-	-
Potassium	mg/kg	-	-	-	-
Arsenic	mg/kg	-	-	-	-
Barium	mg/kg	-	-	-	-
Beryllium	mg/kg	-	-	-	-
Cadmium	mg/kg	-	-	-	-
Chromium	mg/kg	-	-	-	-
Cobalt	mg/kg	-	-	-	-
Copper	mg/kg	-	-	-	-
Lead	mg/kg	-	-	-	-
Molybdenum	mg/kg	-	-	-	-
Nickel	mg/kg	-	-	-	-
Selenium	mg/kg	-	-	-	-
Silver	mg/kg	-	-	-	-
Thallium	mg/kg	-	-	-	-
Vanadium	mg/kg	-	-	-	-
Zinc	mg/kg	-	-	-	-
Nitrate as Nitrogen	mg/kg	-	-	-	-
Nitrate/Nitrite as Nitrogen	mg/kg	-	-	-	-
Mercury	mg/kg	-	-	-	-
Explosive Compounds					
PETN	mg/kg	-	-	-	-
HMX	mg/kg	-	-	-	-
Cyclonite (RDX)	mg/kg	-	-	3.4	1.0
1,3,5-Trinitrobenzene	mg/kg	-	-	-	-
1,3-Dinitrobenzene	mg/kg	-	-	-	-
Tetryl	mg/kg	-	-	-	-
Nitrobenzene	mg/kg	-	-	-	-
2,4,6-Trinitrotoluene (TNT)	mg/kg	ND	1.0	79.566**/789.5	1.0
4-Amino-2,6-Dinitrotoluene	mg/kg	-	-	-	-
2-Amino-4,6-Dinitrotoluene	mg/kg	-	-	-	-
2,4-Dinitrotoluene	mg/kg	-	-	-	-
2,6-Dinitrotoluene	mg/kg	-	-	-	-
4-Nitrotoluene	mg/kg	-	-	-	-
3-Nitrotoluene	mg/kg	-	-	-	-
2-Nitrotoluene	mg/kg	-	-	-	-
Phosphate	mg/kg	-	-	-	-

Notes:

Data collected by SECOR International, Inc. Analytical data on this table was provided to Earth Tech by SECOR, as shown, with no modification. Analytical data have not been verified or validated by Earth Tech.

- = not analyzed

mg/kg = milligrams per kilogram

MDL = Method Detection Limit

ND = not detected above the Method Detection Limit

Notes regarding SS samples:

SS = soil sample

Samples collected from depths ranging from 2 to 5 inches below the ground surface

Metals were analyzed for using EPA Method SW6000 series.

Explosive compounds were analyzed for using EPA Method SW8330.

Notes regarding FSS samples:

FSS = field screening soil sample

Soil samples not air dried

FSS analyzed using EnSys Soil Test System, Rapid Field Screen for TNT and RDX.

* Analysis of FSS-10 and FSS-40 using EPA Method SW8330.

** = sample concentration was out of the range of the test method (1 to 30 mg/kg), therefore the sample was re-extracted, diluted and the concentration was re-reported.

Source: SECOR International, Inc.

Table 3-2. SECOR Analytical Results for Soil
Howitzer Test Facility
(Unvalidated Screening-Level Data)

Howitzer Test Facility	Field Sample ID		SS-19
	Sample Date		11/20/98
Parameter	**Units**	**Result**	**MDL**
Metals			
Antimony	mg/kg	ND	6.00
Manganese	mg/kg	917	0.500
Potassium	mg/kg	2,040	500
Arsenic	mg/kg	17.0	10.0
Barium	mg/kg	238	0.400
Beryllium	mg/kg	0.804	0.100
Cadmium	mg/kg	ND	1.00
Chromium	mg/kg	43.1	1.00
Cobalt	mg/kg	16.4	0.700
Copper	mg/kg	48.5	1.00
Lead	mg/kg	16.0	7.50
Molybdenum	mg/kg	ND	2.00
Nickel	mg/kg	48.0	3.00
Selenium	mg/kg	ND	10.0
Silver	mg/kg	ND	0.700
Thallium	mg/kg	ND	10.0
Vanadium	mg/kg	71.6	1.00
Zinc	mg/kg	75.3	2.00
Nitrate as Nitrogen	mg/kg	1.24	1.00
Nitrate/Nitrite as Nitrogen	mg/kg	1.24	1.00
Mercury	mg/kg	ND	0.040
Explosive Compounds			
PETN	mg/kg	ND	0.30
HMX	mg/kg	ND	0.30
Cyclonite (RDX)	mg/kg	ND	0.30
1,3,5-Trinitrobenzene	mg/kg	ND	0.30
1,3-Dinitrobenzene	mg/kg	ND	0.30
Tetryl	mg/kg	ND	0.30
Nitrobenzene	mg/kg	ND	0.30
2,4,6-Trinitrotoluene (TNT)	mg/kg	ND	0.30
4-Amino-2,6-Dinitrotoluene	mg/kg	ND	0.30
2-Amino-4,6-Dinitrotoluene	mg/kg	ND	0.30
2,4-Dinitrotoluene	mg/kg	ND	0.30
2,6-Dinitrotoluene	mg/kg	ND	0.30
4-Nitrotoluene	mg/kg	ND	0.30
3-Nitrotoluene	mg/kg	ND	0.30
2-Nitrotoluene	mg/kg	ND	0.30
Phosphate	mg/kg	10.5	0.500

Notes:

Data collected by SECOR International, Inc. Analytical data on this table was provided to Earth Tech by SECOR, as shown, with no modification. Analytical data have not been verified or validated by Earth Tech.

- = not analyzed

mg/kg = milligrams per kilogram

MDL = Method Detection Limit

ND = not detected above the Method Detection Limit

Notes regarding SS samples:

SS = soil sample

Samples collected from depths ranging from 2 to 5 inches below the ground surface.

Metals were analyzed for using EPA Method SW6000 series.

Explosive compounds were analyzed for using EPA Method SW8330.

**Sample analyzed using EnSys Soil Test System, Rapid Field Screen for TNT and RDX.

Source: SECOR International, Inc.

Table 3-3. SECOR Analytical Results for Soil
Ammunition Renovation/Primer Destruction Site
(Unvalidated Screening-Level Data)

Ammunition Renovation/ Primer Destruction Site	**Field Sample ID** / **Sample Date**	FSS-32 / 12/02/98	
Parameter	**Units**	**Result**	**MDL**
Metals			
Antimony	mg/kg	-	-
Manganese	mg/kg	-	-
Potassium	mg/kg	-	-
Arsenic	mg/kg	-	-
Barium	mg/kg	-	-
Beryllium	mg/kg	-	-
Cadmium	mg/kg	-	-
Chromium	mg/kg	-	-
Cobalt	mg/kg	-	-
Copper	mg/kg	-	-
Lead	mg/kg	-	-
Molybdenum	mg/kg	-	-
Nickel	mg/kg	-	-
Selenium	mg/kg	-	-
Silver	mg/kg	-	-
Thallium	mg/kg	-	-
Vanadium	mg/kg	-	-
Zinc	mg/kg	-	-
Nitrate as Nitrogen	mg/kg	-	-
Nitrate/Nitrite as Nitrogen	mg/kg	-	-
Mercury	mg/kg	-	-
Explosive Compounds			
PETN	mg/kg	-	-
HMX	mg/kg	-	-
Cyclonite (RDX)	mg/kg	-	-
1,3,5-Trinitrobenzene	mg/kg	-	-
1,3-Dinitrobenzene	mg/kg	-	-
Tetryl	mg/kg	-	-
Nitrobenzene	mg/kg	-	-
2,4,6-Trinitrotoluene (TNT)	mg/kg	ND	1.0
4-Amino-2,6-Dinitrotoluene	mg/kg	-	-
2-Amino-4,6-Dinitrotoluene	mg/kg	-	-
2,4-Dinitrotoluene	mg/kg	-	-
2,6-Dinitrotoluene	mg/kg	-	-
4-Nitrotoluene	mg/kg	-	-
3-Nitrotoluene	mg/kg	-	-
2-Nitrotoluene	mg/kg	-	-
Phosphate	mg/kg	-	-

Notes:

Data collected by SECOR International, Inc. Analytical data on this table was provided to Earth Tech by SECOR, as shown, with no modification. Analytical data have not been verified or validated by Earth Tech.

- = not analyzed

mg/kg = milligrams per kilogram

MDL = Method Detection Limit

ND = not detected above the Method Detection Limit

Notes regarding FSS samples:

FSS = field screening soil sample

Soil samples not air dried

FSS analyzed using EnSys Soil Test System, Rapid Field Screen for TNT and RDX.

Source: SECOR International, Inc.

Table 3-4. SECOR Analytical Results for Soil
Flare Site
(Unvalidated Screening-Level Data)
(1 of 2)

Flare Site	Field Sample ID		SS-22		SS-22*		SS-22***	
	Sample Date		11/20/98		11/20/98		12/01/98	
Parameter		Units	Result	MDL	Result	MDL	Result	MDL
Metals								
Antimony		mg/kg	1,470	600	666	48	-	-
Manganese		mg/kg	395	50.0	236	12.0	-	-
Potassium		mg/kg	ND	50,000	-	-	-	-
Arsenic		mg/kg	ND	1,000	9.9**	1.0**	-	-
Barium		mg/kg	74,100	40.0	76,600	160.0	-	-
Beryllium		mg/kg	ND	10.0	ND	4.0	-	-
Cadmium		mg/kg	ND	100	ND	4	-	-
Chromium		mg/kg	185	100	87.5	8	-	-
Cobalt		mg/kg	80.2	70.0	-	-	-	-
Copper		mg/kg	24,200	100	21,200	20	-	-
Lead		mg/kg	46,600	750	42,200/32,000**	40/5,000**	-	-
Molybdenum		mg/kg	ND	200	-	-	-	-
Nickel		mg/kg	ND	300	50.3	32	-	-
Selenium		mg/kg	ND	1,000	ND**	2.5**	-	-
Silver		mg/kg	ND	70.0	ND	8.0	-	-
Thallium		mg/kg	ND	1,000	ND**	2.5**	-	-
Vanadium		mg/kg	ND	100	-	-	-	-
Zinc		mg/kg	4,560	200	3,870	16	-	-
Nitrate as Nitrogen		mg/kg	3.21	1.0	ND	0.25	-	-
Nitrate/Nitrite as Nitrogen		mg/kg	4.56	1.0	1.3	0.25	-	-
Mercury		mg/kg	0.092	0.050	ND**	0.10**	-	-
Explosive Compounds								
PETN		mg/kg	ND	0.30	ND	0.50	-	-
HMX		mg/kg	ND	0.30	ND	0.25	-	-
Cyclonite (RDX)		mg/kg	ND	0.30	ND	0.25	-	-
1,3,5-Trinitrobenzene		mg/kg	ND	0.30	ND	0.25	-	-
1,3-Dinitrobenzene		mg/kg	ND	0.30	ND	0.25	-	-
Tetryl		mg/kg	ND	0.30	ND	0.25	-	-
Nitrobenzene		mg/kg	ND	0.30	ND	0.25	-	-
2,4,6-Trinitrotoluene (TNT)		mg/kg	ND	0.30	ND	0.25	ND	1.0
4-Amino-2,6-Dinitrotoluene		mg/kg	ND	0.30	ND	0.25	-	-
2-Amino-4,6-Dinitrotoluene		mg/kg	ND	0.30	ND	0.25	-	-
2,4-Dinitrotoluene		mg/kg	ND	0.30	ND	0.25	-	-
2,6-Dinitrotoluene		mg/kg	ND	0.30	ND	0.25	-	-
4-Nitrotoluene		mg/kg	ND	0.30	ND	0.25	-	-
3-Nitrotoluene		mg/kg	ND	0.30	ND	0.25	-	-
2-Nitrotoluene		mg/kg	ND	0.30	ND	0.25	-	-
Phosphate		mg/kg	17.1	0.500	18.1	10.0	-	-

Notes:

Data collected by SECOR International, Inc. Analytical data on this table was provided to Earth Tech by SECOR, as shown, with no modification. Analytical data have not been verified or validated by Earth Tech.

- = not analyzed

mg/kg = milligrams per kilogram

MDL = Method Detection Limit

ND = not detected above the Method Detection Limit

Notes regarding SS samples:

SS = soil sample

Samples collected from depths ranging from 2 to 5 inches below the ground surface.

Metals were analyzed for using EPA Method SW6000 series.

Explosive compounds were analyzed for using EPA Method SW8330.

*Second analysis of Sample SS-22.

** Samples analyzed using EPA Method SW7000 series.

***Sample analyzed using EnSys Soil Test System, Rapid Field Screen for TNT and RDX.

Notes regarding FSS samples:

FSS = field screening soil sample

Soil samples not air dried

FSS analyzed using EnSys Soil Test System, Rapid Field Screen for TNT and RDX.

Source: SECOR International, Inc.

Table 3-4. SECOR Analytical Results for Soil
Flare Site
(Unvalidated Screening-Level Data)
(2 of 2)

Flare Site	Field Sample ID		FSS-21		FSS-29	
	Sample Date		12/02/98		12/02/98	
Parameter		Units	Result	MDL	Result	MDL
Metals						
Antimony		mg/kg	-	-	-	-
Manganese		mg/kg	-	-	-	-
Potassium		mg/kg	-	-	-	-
Arsenic		mg/kg	-	-	-	-
Barium		mg/kg	-	-	-	-
Beryllium		mg/kg	-	-	-	-
Cadmium		mg/kg	-	-	-	-
Chromium		mg/kg	-	-	-	-
Cobalt		mg/kg	-	-	-	-
Copper		mg/kg	-	-	-	-
Lead		mg/kg	-	-	-	-
Molybdenum		mg/kg	-	-	-	-
Nickel		mg/kg	-	-	-	-
Selenium		mg/kg	-	-	-	-
Silver		mg/kg	-	-	-	-
Thallium		mg/kg	-	-	-	-
Vanadium		mg/kg	-	-	-	-
Zinc		mg/kg	-	-	-	-
Nitrate as Nitrogen		mg/kg	-	-	-	-
Nitrate/Nitrite as Nitrogen		mg/kg	-	-	-	-
Mercury		mg/kg	-	-	-	-
Explosive Compounds						
PETN		mg/kg	-	-	-	-
HMX		mg/kg	-	-	-	-
Cyclonite (RDX)		mg/kg	-	-	2.6	1.0
1,3,5-Trinitrobenzene		mg/kg	-	-	-	-
1,3-Dinitrobenzene		mg/kg	-	-	-	-
Tetryl		mg/kg	-	-	-	-
Nitrobenzene		mg/kg	-	-	-	-
2,4,6-Trinitrotoluene (TNT)		mg/kg	ND	1.0	ND	1.0
4-Amino-2,6-Dinitrotoluene		mg/kg	-	-	-	-
2-Amino-4,6-Dinitrotoluene		mg/kg	-	-	-	-
2,4-Dinitrotoluene		mg/kg	-	-	-	-
2,6-Dinitrotoluene		mg/kg	-	-	-	-
4-Nitrotoluene		mg/kg	-	-	-	-
3-Nitrotoluene		mg/kg	-	-	-	-
2-Nitrotoluene		mg/kg	-	-	-	-
Phosphate		mg/kg	-	-	-	-

Notes:

Data collected by SECOR International, Inc. Analytical data on this table was provided to Earth Tech by SECOR, as shown, with no modification. Analytical data have not been verified or validated by Earth Tech.

- = not analyzed

mg/kg = milligrams per kilogram

MDL = Method Detection Limit

ND = not detected above the Method Detection Limit

Notes regarding SS samples:

SS = soil sample

Samples collected from depths ranging from 2 to 5 inches below the ground surface.

Metals were analyzed for using EPA Method SW6000 series.

Explosive compounds were analyzed for using EPA Method SW8330.

*Second analysis of Sample SS-22.

** Samples analyzed using EPA Method SW7000 series.

***Sample analyzed using EnSys Soil Test System, Rapid Field Screen for TNT and RDX.

Notes regarding FSS samples:

FSS = field screening soil sample

Soil samples not air dried

FSS analyzed using EnSys Soil Test System, Rapid Field Screen for TNT and RDX.

Source: SECOR International, Inc.

Table 3-5. SECOR Analytical Results for Soil
Demolition Site #1
(Unvalidated Screening-Level Data)
(1 of 2)

Demolition Site #1	Field Sample ID		SS-24		FSS-24	
	Sample Date		11/20/98		12/02/98	
Parameter		**Units**	**Result**	**MDL**	**Result**	**MDL**
Metals						
Antimony		mg/kg	ND	6.00	-	-
Manganese		mg/kg	759	0.500	-	-
Potassium		mg/kg	1,770	500	-	-
Arsenic		mg/kg	14.7	10.0	-	-
Barium		mg/kg	173	0.400	-	-
Beryllium		mg/kg	0.778	0.100	-	-
Cadmium		mg/kg	ND	1.00	-	-
Chromium		mg/kg	46.4	1.00	-	-
Cobalt		mg/kg	14.6	0.700	-	-
Copper		mg/kg	48.9	1.00	-	-
Lead		mg/kg	12.7	7.50	-	-
Molybdenum		mg/kg	ND	2.00	-	-
Nickel		mg/kg	48.6	3.00	-	-
Selenium		mg/kg	ND	10.0	-	-
Silver		mg/kg	ND	0.700	-	-
Thallium		mg/kg	ND	10.0	-	-
Vanadium		mg/kg	63.0	1.00	-	-
Zinc		mg/kg	97.9	2.00	-	-
Nitrate as Nitrogen		mg/kg	9.16	1.00	-	-
Nitrate/Nitrite as Nitrogen		mg/kg	9.16	1.00	-	-
Mercury		mg/kg	0.12	0.500	-	-
Explosive Compounds						
PETN		mg/kg	ND	0.30	-	-
HMX		mg/kg	ND	0.30	-	-
Cyclonite (RDX)		mg/kg	ND	0.30	-	-
1,3,5-Trinitrobenzene		mg/kg	ND	0.30	-	-
1,3-Dinitrobenzene		mg/kg	ND	0.30	-	-
Tetryl		mg/kg	ND	0.30	-	-
Nitrobenzene		mg/kg	ND	0.30	-	-
2,4,6-Trinitrotoluene (TNT)		mg/kg	ND	0.30	ND	1.0
4-Amino-2,6-Dinitrotoluene		mg/kg	ND	0.30	-	-
2-Amino-4,6-Dinitrotoluene		mg/kg	ND	0.30	-	-
2,4-Dinitrotoluene		mg/kg	ND	0.30	-	-
2,6-Dinitrotoluene		mg/kg	ND	0.30	-	-
4-Nitrotoluene		mg/kg	ND	0.30	-	-
3-Nitrotoluene		mg/kg	ND	0.30	-	-
2-Nitrotoluene		mg/kg	ND	0.30	-	-
Phosphate		mg/kg	360	5.00	-	-

Notes:

Data collected by SECOR International, Inc. Analytical data on this table was provided to Earth Tech by SECOR, as shown, with no modification. Analytical data have not been verified or validated by Earth Tech.

- = not analyzed

mg/kg = milligrams per kilogram

MDL = Method Detection Limit

ND = not detected above the Method Detection Limit

Notes regarding SS samples:

SS = soil sample

Samples collected from depths ranging from 2 to 5 inches below the ground surface.

Metals were analyzed for using EPA Method SW6000 series.

Explosive compounds were analyzed for using EPA Method SW8330.

Notes regarding FSS samples:

FSS = field screening soil sample

Soil samples not air dried

FSS analyzed using EnSys Soil Test System, Rapid Field Screen for TNT and RDX.

Source: SECOR International, Inc.

Table 3-5. SECOR Analytical Results for Soil
Demolition Site #1
(Unvalidated Screening-Level Data)
(2 of 2)

Demolition Site #1	Field Sample ID		FSS-25		FSS-26		FSS-27	
	Sample Date		12/02/98		12/02/98		12/02/98	
Parameter		**Units**	**Result**	**MDL**	**Result**	**MDL**	**Result**	**MDL**
Metals								
Antimony		mg/kg	-	-	-	-	-	-
Manganese		mg/kg	-	-	-	-	-	-
Potassium		mg/kg	-	-	-	-	-	-
Arsenic		mg/kg	-	-	-	-	-	-
Barium		mg/kg	-	-	-	-	-	-
Beryllium		mg/kg	-	-	-	-	-	-
Cadmium		mg/kg	-	-	-	-	-	-
Chromium		mg/kg	-	-	-	-	-	-
Cobalt		mg/kg	-	-	-	-	-	-
Copper		mg/kg	-	-	-	-	-	-
Lead		mg/kg	-	-	-	-	-	-
Molybdenum		mg/kg	-	-	-	-	-	-
Nickel		mg/kg	-	-	-	-	-	-
Selenium		mg/kg	-	-	-	-	-	-
Silver		mg/kg	-	-	-	-	-	-
Thallium		mg/kg	-	-	-	-	-	-
Vanadium		mg/kg	-	-	-	-	-	-
Zinc		mg/kg	-	-	-	-	-	-
Nitrate as Nitrogen		mg/kg	-	-	-	-	-	-
Nitrate/Nitrite as Nitrogen		mg/kg	-	-	-	-	-	-
Mercury		mg/kg	-	-	-	-	-	-
Explosive Compounds								
PETN		mg/kg	-	-	-	-	-	-
HMX		mg/kg	-	-	-	-	-	-
Cyclonite (RDX)		mg/kg	-	-	1.4	1.0	-	-
1,3,5-Trinitrobenzene		mg/kg	-	-	-	-	-	-
1,3-Dinitrobenzene		mg/kg	-	-	-	-	-	-
Tetryl		mg/kg	-	-	-	-	-	-
Nitrobenzene		mg/kg	-	-	-	-	-	-
2,4,6-Trinitrotoluene (TNT)		mg/kg	ND	1.0	ND	1.0	ND	1.0
4-Amino-2,6-Dinitrotoluene		mg/kg	-	-	-	-	-	-
2-Amino-4,6-Dinitrotoluene		mg/kg	-	-	-	-	-	-
2,4-Dinitrotoluene		mg/kg	-	-	-	-	-	-
2,6-Dinitrotoluene		mg/kg	-	-	-	-	-	-
4-Nitrotoluene		mg/kg	-	-	-	-	-	-
3-Nitrotoluene		mg/kg	-	-	-	-	-	-
2-Nitrotoluene		mg/kg	-	-	-	-	-	-
Phosphate		mg/kg	-	-	-	-	-	-

Notes:

Data collected by SECOR International, Inc. Analytical data on this table was provided to Earth Tech by SECOR, as shown, with no modification. Analytical data have not been verified or validated by Earth Tech.

- = not analyzed

mg/kg = milligrams per kilogram

MDL = Method Detection Limit

ND = not detected above the Method Detection Limit

Notes regarding SS samples:

SS = soil sample

Samples collected from depths ranging from 2 to 5 inches below the ground surface.

Metals were analyzed for using EPA Method SW6000 series.

Explosive compounds were analyzed for using EPA Method SW8330.

Notes regarding FSS samples:

FSS = field screening soil sample

Soil samples not air dried

FSS analyzed using EnSys Soil Test System, Rapid Field Screen for TNT and RDX.

Source: SECOR International, Inc.

Table 3-6. SECOR Analytical Results for Soil
Demolition Site #2
(Unvalidated Screening-Level Data)

Demolition Site #2	Field Sample ID / Sample Date	SS-23 11/20/98		FSS-22 12/02/98		FSS-23 12/02/98		FSS-28 12/02/98	
Parameter	**Units**	**Result**	**MDL**	**Result**	**MDL**	**Result**	**MDL**	**Result**	**MDL**
Metals									
Antimony	mg/kg	ND	6.00	-	-	-	-	-	-
Manganese	mg/kg	928	0.500	-	-	-	-	-	-
Potassium	mg/kg	2,260	500	-	-	-	-	-	-
Arsenic	mg/kg	16.8	10.0	-	-	-	-	-	-
Barium	mg/kg	206	0.400	-	-	-	-	-	-
Beryllium	mg/kg	0.821	0.100	-	-	-	-	-	-
Cadmium	mg/kg	ND	1.00	-	-	-	-	-	-
Chromium	mg/kg	50.4	1.00	-	-	-	-	-	-
Cobalt	mg/kg	20.6	0.700	-	-	-	-	-	-
Copper	mg/kg	55.1	1.00	-	-	-	-	-	-
Lead	mg/kg	25.8	7.50	-	-	-	-	-	-
Molybdenum	mg/kg	ND	2.00	-	-	-	-	-	-
Nickel	mg/kg	52.4	3.00	-	-	-	-	-	-
Selenium	mg/kg	ND	10.0	-	-	-	-	-	-
Silver	mg/kg	ND	0.700	-	-	-	-	-	-
Thallium	mg/kg	ND	10.0	-	-	-	-	-	-
Vanadium	mg/kg	71.1	1.00	-	-	-	-	-	-
Zinc	mg/kg	86.3	2.00	-	-	-	-	-	-
Nitrate as Nitrogen	mg/kg	11.6	1.00	-	-	-	-	-	-
Nitrate/Nitrite as Nitrogen	mg/kg	11.6	1.00	-	-	-	-	-	-
Mercury	mg/kg	0.21	0.050	-	-	-	-	-	-
Explosive Compounds									
PETN	mg/kg	ND	0.30	-	-	-	-	-	-
HMX	mg/kg	ND	0.30	-	-	-	-	-	-
Cyclonite (RDX)	mg/kg	ND	0.30	-	-	-	-	-	-
1,3,5-Trinitrobenzene	mg/kg	ND	0.30	-	-	-	-	-	-
1,3-Dinitrobenzene	mg/kg	ND	0.30	-	-	-	-	-	-
Tetryl	mg/kg	ND	0.30	-	-	-	-	-	-
Nitrobenzene	mg/kg	ND	0.30	-	-	-	-	-	-
2,4,6-Trinitrotoluene (TNT)	mg/kg	ND	0.30	ND	1.0	ND	1.0	ND	1.0
4-Amino-2,6-Dinitrotoluene	mg/kg	ND	0.30	-	-	-	-	-	-
2-Amino-4,6-Dinitrotoluene	mg/kg	ND	0.30	-	-	-	-	-	-
2,4-Dinitrotoluene	mg/kg	ND	0.30	-	-	-	-	-	-
2,6-Dinitrotoluene	mg/kg	ND	0.30	-	-	-	-	-	-
4-Nitrotoluene	mg/kg	ND	0.30	-	-	-	-	-	-
3-Nitrotoluene	mg/kg	ND	0.30	-	-	-	-	-	-
2-Nitrotoluene	mg/kg	ND	0.30	-	-	-	-	-	-
Phosphate	mg/kg	307	2.50	-	-	-	-	-	-

Notes:

Data collected by SECOR International, Inc. Analytical data on this table was provided to Earth Tech by SECOR, as shown, with no modification. Analytical data have not been verified or validated by Earth Tech.

- = not analyzed

mg/kg = milligrams per kilogram

MDL = Method Detection Limit

ND = not detected above the Method Detection Limit

Notes regarding SS samples:

SS = soil sample

Samples collected from depths ranging from 2 to 5 inches below the ground surface

Metals were analyzed for using EPA Method SW6000 series.

Explosive compounds were analyzed for using EPA Method SW8330

Notes regarding FSS samples:

FSS = field screening soil sample

Soil samples not air dried

FSS analyzed using EnSys Soil Test System, Rapid Field Screen for TNT and RDX.

Source: SECOR International, Inc.

Table 3-7. SECOR Analytical Results of Soil
Demolition Site #3
(Unvalidated Screening-Level Data)
(1 of 4)

Demolition Site #3	Field Sample ID		SS-25		SS-25*		SS-26	
	Sample Date		11/20/98		11/20/98		11/20/98	
Parameter		**Units**	**Result**	**MDL**	**Result**	**MDL**	**Result**	**MDL**
Metals								
Antimony		mg/kg	ND	6.00	-	-	ND	6.00
Manganese		mg/kg	589	0.500	-	-	735	0.500
Potassium		mg/kg	1,040	500	-	-	1,250	500
Arsenic		mg/kg	13.4	10.0	-	-	19.1	10.0
Barium		mg/kg	158	0.400	-	-	183	0.400
Beryllium		mg/kg	0.547	0.100	-	-	0.637	0.100
Cadmium		mg/kg	ND	1.00	-	-	ND	1.00
Chromium		mg/kg	26.4	1.00	-	-	38.1	1.00
Cobalt		mg/kg	13.7	0.700	-	-	13.8	0.700
Copper		mg/kg	44.8	1.00	-	-	49.9	1.00
Lead		mg/kg	24.9	7.50	-	-	12.9	7.50
Molybdenum		mg/kg	ND	2.00	-	-	ND	2.00
Nickel		mg/kg	24.6	3.00	-	-	34.0	3.00
Selenium		mg/kg	ND	10.0	-	-	ND	10.0
Silver		mg/kg	ND	0.700	-	-	ND	0.700
Thallium		mg/kg	ND	10.0	-	-	ND	10.0
Vanadium		mg/kg	67.6	1.00	-	-	76.2	1.00
Zinc		mg/kg	90.0	2.00	-	-	72.7	2.00
Nitrate as Nitrogen		mg/kg	3.00	1.00	-	-	ND	1.00
Nitrate/Nitrite as Nitrogen		mg/kg	3.75	1.00	-	-	ND	1.00
Mercury		mg/kg	0.90	0.050	-	-	0.39	0.043
Explosive Compounds								
PETN		mg/kg	ND	0.30	-	-	ND	0.30
HMX		mg/kg	ND	0.30	ND	0.25	ND	0.30
Cyclonite (RDX)		mg/kg	ND	0.30	ND	0.25	ND	0.30
1,3,5-Trinitrobenzene		mg/kg	ND	0.30	ND	0.25	ND	0.30
1,3-Dinitrobenzene		mg/kg	ND	0.30	ND	0.25	ND	0.30
Tetryl		mg/kg	ND	0.30	ND	0.25	ND	0.30
Nitrobenzene		mg/kg	ND	0.30	ND	0.25	ND	0.30
2,4,6-Trinitrotoluene (TNT)		mg/kg	ND	0.30	ND	0.25	ND	0.30
4-Amino-2,6-Dinitrotoluene		mg/kg	ND	0.30	ND	0.25	ND	0.30
2-Amino-4,6-Dinitrotoluene		mg/kg	ND	0.30	ND	0.25	ND	0.30
2,4-Dinitrotoluene		mg/kg	ND	0.30	ND	0.25	ND	0.30
2,6-Dinitrotoluene		mg/kg	ND	0.30	ND	0.25	ND	0.30
4-Nitrotoluene		mg/kg	ND	0.30	ND	0.25	ND	0.30
3-Nitrotoluene		mg/kg	ND	0.30	ND	0.25	ND	0.30
2-Nitrotoluene		mg/kg	ND	0.30	ND	0.25	ND	0.30
Phosphate		mg/kg	255	5.00	-	-	214	2.50

Notes:

Data collected by SECOR International, Inc. Analytical data on this table was provided to Earth Tech by SECOR, as shown, with no modification. Analytical data have not been verified or validated by Earth Tech.

- = not analyzed

mg/kg = milligrams per kilogram

MDL = Method Detection Limit

ND = not detected above the Method Detection Limit

Notes regarding SS samples:

SS = soil sample

Samples collected from depths ranging from 2 to 5 inches below the ground surface.

Metals were analyzed for using EPA Method SW6000 series.

Explosive compounds were analyzed for using EPA Method SW8330.

*Second analysis of Samples SS-25 and SS-28.

**Sample analyzed using EnSys Soil Test System, Rapid Field Screen for TNT and RDX.

FSS = field screening soil sample

Soil samples not air dried

FSS analyzed using EnSys Soil Test System, Rapid Field Screen for TNT and RDX.

Source: SECOR International, Inc.

Table 3-7. SECOR Analytical Results of Soil
Demolition Site #3
(Unvalidated Screening-Level Data)
(2 of 4)

Demolition Site #3	Field Sample ID / Sample Date	SS-26** 12/01/98		SS-27 11/20/98		SS-27** 12/01/98		SS-28 11/20/98	
Parameter	Units	Result	MDL	Result	MDL	Result	MDL	Result	MDL
Metals									
Antimony	mg/kg	-	-	ND	6.00	-	-	ND	6.00
Manganese	mg/kg	-	-	614	0.500	-	-	448	0.500
Potassium	mg/kg	-	-	1,420	500	-	-	881	500
Arsenic	mg/kg	-	-	16.3	10.0	-	-	16.7	10.0
Barium	mg/kg	-	-	197	0.400	-	-	182	0.400
Beryllium	mg/kg	-	-	0.650	0.100	-	-	0.599	0.100
Cadmium	mg/kg	-	-	ND	1.00	-	-	ND	1.00
Chromium	mg/kg	-	-	28.4	1.00	-	-	27.8	1.00
Cobalt	mg/kg	-	-	23.1	0.700	-	-	13.5	0.700
Copper	mg/kg	-	-	59.1	1.00	-	-	44.6	1.00
Lead	mg/kg	-	-	27.4	7.50	-	-	12.7	7.50
Molybdenum	mg/kg	-	-	ND	2.00	-	-	ND	2.00
Nickel	mg/kg	-	-	31.8	3.00	-	-	27.0	3.00
Selenium	mg/kg	-	-	ND	10.0	-	-	ND	10.0
Silver	mg/kg	-	-	ND	0.700	-	-	ND	0.700
Thallium	mg/kg	-	-	ND	10.0	-	-	ND	10.0
Vanadium	mg/kg	-	-	78.6	1.00	-	-	77.2	1.00
Zinc	mg/kg	-	-	74.8	2.00	-	-	64.5	2.00
Nitrate as Nitrogen	mg/kg	-	-	4.13	1.00	-	-	ND	1.00
Nitrate/Nitrite as Nitrogen	mg/kg	-	-	4.13	1.00	-	-	ND	1.00
Mercury	mg/kg	-	-	0.861	0.200	-	-	0.455	0.050
Explosive Compounds									
PETN	mg/kg	-	-	ND	0.30	-	-	ND	0.30
HMX	mg/kg	-	-	ND	0.30	-	-	ND	0.30
Cyclonite (RDX)	mg/kg	-	-	ND	0.30	-	-	ND	0.30
1,3,5-Trinitrobenzene	mg/kg	-	-	ND	0.30	-	-	ND	0.30
1,3-Dinitrobenzene	mg/kg	-	-	ND	0.30	-	-	ND	0.30
Tetryl	mg/kg	-	-	ND	0.30	-	-	ND	0.30
Nitrobenzene	mg/kg	-	-	ND	0.30	-	-	ND	0.30
2,4,6-Trinitrotoluene (TNT)	mg/kg	ND	1.0	ND	0.30	ND	1.0	ND	0.30
4-Amino-2,6-Dinitrotoluene	mg/kg	-	-	ND	0.30	-	-	ND	0.30
2-Amino-4,6-Dinitrotoluene	mg/kg	-	-	ND	0.30	-	-	ND	0.30
2,4-Dinitrotoluene	mg/kg	-	-	ND	0.30	-	-	ND	0.30
2,6-Dinitrotoluene	mg/kg	-	-	ND	0.30	-	-	ND	0.30
4-Nitrotoluene	mg/kg	-	-	ND	0.30	-	-	ND	0.30
3-Nitrotoluene	mg/kg	-	-	ND	0.30	-	-	ND	0.30
2-Nitrotoluene	mg/kg	-	-	ND	0.30	-	-	ND	0.30
Phosphate	mg/kg	-	-	44.1	0.500	-	-	149	2.50

Notes:

Data collected by SECOR International, Inc. Analytical data on this table was provided to Earth Tech by SECOR, as shown, with no modification. Analytical data have not been verified or validated by Earth Tech.

- = not analyzed

mg/kg = milligrams per kilogram

MDL = Method Detection Limit

ND = not detected above the Method Detection Limit

Notes regarding SS samples:

SS = soil sample

Samples collected from depths ranging from 2 to 5 inches below the ground surface.

Metals were analyzed for using EPA Method SW6000 series.

Explosive compounds were analyzed for using EPA Method SW8330.

*Second analysis of Samples SS-25 and SS-28.

**Sample analyzed using EnSys Soil Test System, Rapid Field Screen for TNT and RDX.

FSS = field screening soil sample

Soil samples not air dried

FSS analyzed using EnSys Soil Test System, Rapid Field Screen for TNT and RDX.

Source: SECOR International, Inc.

Table 3-7. SECOR Analytical Results of Soil
Demolition Site #3
(Unvalidated Screening-Level Data)

Demolition Site #3	Field Sample ID	SS-28*		SS-28**		SS-29		SS-29**	
	Sample Date	11/20/98		12/01/98		11/20/99		12/01/98	
Parameter	**Units**	**Result**	**MDL**	**Result**	**MDL**	**Result**	**MDL**	**Result**	**MDL**
Metals									
Antimony	mg/kg	-	-	-	-	ND	6.00	-	-
Manganese	mg/kg	-	-	-	-	662	0.500	-	-
Potassium	mg/kg	-	-	-	-	1,560	500	-	-
Arsenic	mg/kg	-	-	-	-	17.2	10.0	-	-
Barium	mg/kg	-	-	-	-	190	0.400	-	-
Beryllium	mg/kg	-	-	-	-	0.650	0.100	-	-
Cadmium	mg/kg	-	-	-	-	ND	1.00	-	-
Chromium	mg/kg	-	-	-	-	32.1	1.00	-	-
Cobalt	mg/kg	-	-	-	-	14.7	0.700	-	-
Copper	mg/kg	-	-	-	-	53.3	1.00	-	-
Lead	mg/kg	-	-	-	-	28.6	7.50	-	-
Molybdenum	mg/kg	-	-	-	-	ND	2.00	-	-
Nickel	mg/kg	-	-	-	-	30.5	3.00	-	-
Selenium	mg/kg	-	-	-	-	ND	10.0	-	-
Silver	mg/kg	-	-	-	-	ND	0.700	-	-
Thallium	mg/kg	-	-	-	-	ND	10.0	-	-
Vanadium	mg/kg	-	-	-	-	73.1	1.00	-	-
Zinc	mg/kg	-	-	-	-	80.1	2.00	-	-
Nitrate as Nitrogen	mg/kg	-	-	-	-	4.50	1.00	-	-
Nitrate/Nitrite as Nitrogen	mg/kg	-	-	-	-	4.50	1.00	-	-
Mercury	mg/kg	-	-	-	-	2.17	0.200	-	-
Explosive Compounds									
PETN	mg/kg	-	-	-	-	ND	0.30	-	-
HMX	mg/kg	ND	0.25	-	-	ND	0.30	-	-
Cyclonite (RDX)	mg/kg	ND	0.25	-	-	ND	0.30	-	-
1,3,5-Trinitrobenzene	mg/kg	ND	0.25	-	-	ND	0.30	-	-
1,3-Dinitrobenzene	mg/kg	ND	0.25	-	-	ND	0.30	-	-
Tetryl	mg/kg	ND	0.25	-	-	ND	0.30	-	-
Nitrobenzene	mg/kg	ND	0.25	-	-	ND	0.30	-	-
2,4,6-Trinitrotoluene (TNT)	mg/kg	ND	0.25	ND	1.0	ND	0.30	ND	1.0
4-Amino-2,6-Dinitrotoluene	mg/kg	ND	0.25	-	-	ND	0.30	-	-
2-Amino-4,6-Dinitrotoluene	mg/kg	ND	0.25	-	-	ND	0.30	-	-
2,4-Dinitrotoluene	mg/kg	ND	0.25	-	-	ND	0.30	-	-
2,6-Dinitrotoluene	mg/kg	ND	0.25	-	-	ND	0.30	-	-
4-Nitrotoluene	mg/kg	ND	0.25	-	-	ND	0.30	-	-
3-Nitrotoluene	mg/kg	ND	0.25	-	-	ND	0.30	-	-
2-Nitrotoluene	mg/kg	ND	0.25	-	-	ND	0.30	-	-
Phosphate	mg/kg	-	-	-	-	233	2.50	-	-

Notes:

Data collected by SECOR International, Inc. Analytical data on this table was provided to Earth Tech by SECOR, as shown, with no modification. Analytical data have not been verified or validated by Earth Tech.

- = not analyzed

mg/kg = milligrams per kilogram

MDL = Method Detection Limit

ND = not detected above the Method Detection Limit

Notes regarding SS samples:

SS = soil sample

Samples collected from depths ranging from 2 to 5 inches below the ground surface.

Metals were analyzed for using EPA Method SW6000 series.

Explosive compounds were analyzed for using EPA Method SW8330.

*Second analysis of Samples SS-25 and SS-28.

**Sample analyzed using EnSys Soil Test System, Rapid Field Screen for TNT and RDX.

FSS = field screening soil sample

Soil samples not air dried

FSS analyzed using EnSys Soil Test System, Rapid Field Screen for TNT and RDX.

Source: SECOR International, Inc.

Table 3-7. SECOR Analytical Results of Soil
Demolition Site #3
(Unvalidated Screening-Level Data)

Demolition Site #3	Field Sample ID	FSS-3		FSS-11	
	Sample Date	12/02/98		12/02/98	
Parameter	**Units**	**Result**	**MDL**	**Result**	**MDL**
Metals					
Antimony	mg/kg	-	-	-	-
Manganese	mg/kg	-	-	-	-
Potassium	mg/kg	-	-	-	-
Arsenic	mg/kg	-	-	-	-
Barium	mg/kg	-	-	-	-
Beryllium	mg/kg	-	-	-	-
Cadmium	mg/kg	-	-	-	-
Chromium	mg/kg	-	-	-	-
Cobalt	mg/kg	-	-	-	-
Copper	mg/kg	-	-	-	-
Lead	mg/kg	-	-	-	-
Molybdenum	mg/kg	-	-	-	-
Nickel	mg/kg	-	-	-	-
Selenium	mg/kg	-	-	-	-
Silver	mg/kg	-	-	-	-
Thallium	mg/kg	-	-	-	-
Vanadium	mg/kg	-	-	-	-
Zinc	mg/kg	-	-	-	-
Nitrate as Nitrogen	mg/kg	-	-	-	-
Nitrate/Nitrite as Nitrogen	mg/kg	-	-	-	-
Mercury	mg/kg	-	-	-	-
Explosive Compounds					
PETN	mg/kg	-	-	-	-
HMX	mg/kg	-	-	-	-
Cyclonite (RDX)	mg/kg	-	-	-	-
1,3,5-Trinitrobenzene	mg/kg	-	-	-	-
1,3-Dinitrobenzene	mg/kg	-	-	-	-
Tetryl	mg/kg	-	-	-	-
Nitrobenzene	mg/kg	-	-	-	-
2,4,6-Trinitrotoluene (TNT)	mg/kg	ND	1.0	ND	1.0
4-Amino-2,6-Dinitrotoluene	mg/kg	-	-	-	-
2-Amino-4,6-Dinitrotoluene	mg/kg	-	-	-	-
2,4-Dinitrotoluene	mg/kg	-	-	-	-
2,6-Dinitrotoluene	mg/kg	-	-	-	-
4-Nitrotoluene	mg/kg	-	-	-	-
3-Nitrotoluene	mg/kg	-	-	-	-
2-Nitrotoluene	mg/kg	-	-	-	-
Phosphate	mg/kg	-	-	-	-

Notes:

Data collected by SECOR International, Inc. Analytical data on this table was provided to Earth Tech by SECOR, as shown, with no modification. Analytical data have not been verified or validated by Earth Tech.

- = not analyzed

mg/kg = milligrams per kilogram

MDL = Method Detection Limit

ND = not detected above the Method Detection Limit

Notes regarding SS samples:

SS = soil sample

Samples collected from depths ranging from 2 to 5 inches below the ground surface.

Metals were analyzed for using EPA Method SW6000 series.

Explosive compounds were analyzed for using EPA Method SW8330.

*Second analysis of Samples SS-25 and SS-28.

**Sample analyzed using EnSys Soil Test System, Rapid Field Screen for TNT and RDX.

FSS = field screening soil sample

Soil samples not air dried

FSS analyzed using EnSys Soil Test System, Rapid Field Screen for TNT and RDX.

Source: SECOR International, Inc.

Table 3-8. SECOR Analytical Results for Soil
Outside Areas of Interest
(Unvalidated Screening-Level Data)

Outside Areas of Interest	Field Sample ID	SS-7		SS-8		SS-9		SS-10	
	Sample Date	11/20/98		11/20/98		11/20/98		11/20/98	
Parameter	**Units**	**Result**	**MDL**	**Result**	**MDL**	**Result**	**MDL**	**Result**	**MDL**
Metals									
Antimony	mg/kg	ND	6.00	ND	6.00	ND	6.00	ND	6.00
Manganese	mg/kg	651	0.500	907	0.500	1,240	1.00	1,050	1.00
Potassium	mg/kg	1,110	500	1,930	500	2,370	500	1,760	500
Arsenic	mg/kg	17.7	10.0	19.7	10.0	18.6	10.0	20.5	10.0
Barium	mg/kg	253	0.400	250	0.400	307	0.400	319	0.400
Beryllium	mg/kg	0.791	0.100	0.756	0.100	0.888	0.100	0.838	0.100
Cadmium	mg/kg	ND	1.00	ND	1.00	ND	1.00	ND	1.00
Chromium	mg/kg	39.7	1.00	38.6	1.00	49.2	1.00	38.3	1.00
Cobalt	mg/kg	13.1	0.700	14.9	0.700	17.4	0.700	16.2	0.700
Copper	mg/kg	37.7	1.00	49.1	1.00	57.7	1.00	42.9	1.00
Lead	mg/kg	8.84	7.50	31.8	7.50	23.6	7.50	34.0	7.50
Molybdenum	mg/kg	ND	2.00	ND	2.00	ND	2.00	ND	2.00
Nickel	mg/kg	30.8	3.00	41.0	3.00	53.4	3.00	36.0	3.00
Selenium	mg/kg	ND	10.0	ND	10.0	ND	10.0	ND	10.0
Silver	mg/kg	ND	0.700	ND	0.700	ND	0.700	ND	0.700
Thallium	mg/kg	ND	10.0	ND	10.0	ND	10.0	ND	10.0
Vanadium	mg/kg	96.7	1.00	70.2	1.00	74.7	1.00	83.9	1.00
Zinc	mg/kg	57.8	2.00	71.0	2.00	79.0	2.00	63.0	2.00
Nitrate as Nitrogen	mg/kg	1.53	1.00	ND	1.00	1.53	1.00	1.70	1.00
Nitrate/Nitrite as Nitrogen	mg/kg	1.53	1.00	ND	1.00	1.53	1.00	1.70	1.00
Mercury	mg/kg	ND	0.050	0.12	0.050	0.096	0.050	0.11	0.050
Explosive Compounds									
PETN	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
HMX	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
Cyclonite (RDX)	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
1,3,5-Trinitrobenzene	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
1,3-Dinitrobenzene	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
Tetryl	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
Nitrobenzene	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
2,4,6-Trinitrotoluene (TNT)	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
4-Amino-2,6-Dinitrotoluene	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
2-Amino-4,6-Dinitrotoluene	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
2,4-Dinitrotoluene	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
2,6-Dinitrotoluene	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
4-Nitrotoluene	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
3-Nitrotoluene	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
2-Nitrotoluene	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
Phosphate	mg/kg	11.3	0.500	241	2.50	283	2.50	174	2.50

Notes:

Data collected by SECOR International, Inc. Analytical data on this table was provided to Earth Tech by SECOR, as shown, with no modification. Analytical data have not been verified or validated by Earth Tech.

- = not analyzed

mg/kg = milligrams per kilogram

MDL = Method Detection Limit

ND = not detected above the Method Detection Limit

Notes regarding SS samples:

SS = soil sample

Samples collected from depths ranging from 2 to 5 inches below the ground surface.

Metals were analyzed for using EPA Method SW6000 series.

Explosive compounds were analyzed for using EPA Method SW8330.

*Second analysis of Samples SS-30 and SS-33.

**Sample analyzed using EnSys Soil Test System, Rapid Field Screen for TNT and RDX.

Notes regarding FSS samples:

FSS = field screening soil sample

Soil samples not air dried

FSS analyzed using EnSys Soil Test System, Rapid Field Screen for TNT and RDX.

Source: SECOR International, Inc.

Table 3-8. SECOR Analytical Results for Soil
Outside Areas of Interest
(Unvalidated Screening-Level Data)
(2 of 12)

Outside Areas of Interest	Field Sample ID	SS-11		SS-12		SS-13		SS-14	
	Sample Date	11/20/98		11/20/98		11/20/98		11/20/98	
Parameter	**Units**	**Result**	**MDL**	**Result**	**MDL**	**Result**	**MDL**	**Result**	**MDL**
Metals									
Antimony	mg/kg	ND	6.00	ND	6.00	ND	6.00	ND	6.00
Manganese	mg/kg	834	0.500	1,070	1.00	558	0.500	1,180	1.00
Potassium	mg/kg	2,330	500	2,210	500	987	500	2,170	500
Arsenic	mg/kg	13.0	10.0	21.9	10.0	13.5	10.0	18.7	10.0
Barium	mg/kg	599	0.400	305	0.400	338	0.400	262	0.400
Beryllium	mg/kg	0.769	0.100	0.765	0.100	0.601	0.100	0.953	0.100
Cadmium	mg/kg	ND	1.00	ND	1.00	ND	1.00	ND	1.00
Chromium	mg/kg	41.3	1.00	39.5	1.00	31.1	1.00	50.1	1.00
Cobalt	mg/kg	13.8	0.700	21.6	0.700	13.7	0.700	16.3	0.700
Copper	mg/kg	46.8	1.00	57.6	1.00	44.9	1.00	53.7	1.00
Lead	mg/kg	10.8	7.50	17.7	7.50	ND	7.50	26.5	7.50
Molybdenum	mg/kg	ND	2.00	ND	2.00	ND	2.00	ND	2.00
Nickel	mg/kg	46.7	3.00	47.4	3.00	34.7	3.00	48.4	3.00
Selenium	mg/kg	ND	10.0	ND	10.0	ND	10.0	ND	10.0
Silver	mg/kg	ND	0.700	ND	0.700	ND	0.700	ND	0.700
Thallium	mg/kg	ND	10.0	ND	10.0	ND	10.0	ND	10.0
Vanadium	mg/kg	57.1	1.00	67.6	1.00	64.1	1.00	74.9	1.00
Zinc	mg/kg	67.4	2.00	83.4	2.00	65.5	2.00	71.4	2.00
Nitrate as Nitrogen	mg/kg	6.20	1.00	ND	1.00	ND	1.00	3.14	1.00
Nitrate/Nitrite as Nitrogen	mg/kg	6.20	1.00	ND	1.00	ND	1.00	3.14	1.00
Mercury	mg/kg	ND	0.050	0.064	0.050	ND	0.050	0.075	0.050
Explosive Compounds									
PETN	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
HMX	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
Cyclonite (RDX)	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
1,3,5-Trinitrobenzene	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
1,3-Dinitrobenzene	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
Tetryl	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
Nitrobenzene	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
2,4,6-Trinitrotoluene (TNT)	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
4-Amino-2,6-Dinitrotoluene	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
2-Amino-4,6-Dinitrotoluene	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
2,4-Dinitrotoluene	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
2,6-Dinitrotoluene	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
4-Nitrotoluene	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
3-Nitrotoluene	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
2-Nitrotoluene	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
Phosphate	mg/kg	394	5.00	21.0	0.500	56.1	0.500	223	2.50

Notes:

Data collected by SECOR International, Inc. Analytical data on this table was provided to Earth Tech by SECOR, as shown, with no modification. Analytical data have not been verified or validated by Earth Tech.

- = not analyzed

mg/kg = milligrams per kilogram

MDL = Method Detection Limit

ND = not detected above the Method Detection Limit

Notes regarding SS samples:

SS = soil sample

Samples collected from depths ranging from 2 to 5 inches below the ground surface.

Metals were analyzed for using EPA Method SW6000 series.

Explosive compounds were analyzed for using EPA Method SW8330.

*Second analysis of Samples SS-30 and SS-33.

**Sample analyzed using EnSys Soil Test System, Rapid Field Screen for TNT and RDX.

Notes regarding FSS samples:

FSS = field screening soil sample

Soil samples not air dried

FSS analyzed using EnSys Soil Test System, Rapid Field Screen for TNT and RDX.

Source: SECOR International, Inc.

Table 3-8. SECOR Analytical Results for Soil
Outside Areas of Interest
(Unvalidated Screening-Level Data)

Outside Areas of Interest	Field Sample ID	SS-15		SS-16		SS-17		SS-18	
	Sample Date	11/20/98		11/20/98		11/20/98		11/20/98	
Parameter	**Units**	**Result**	**MDL**	**Result**	**MDL**	**Result**	**MDL**	**Result**	**MDL**
Metals									
Antimony	mg/kg	ND	6.00	ND	6.00	ND	6.00	ND	6.00
Manganese	mg/kg	840	0.500	820	0.500	513	0.500	832	0.500
Potassium	mg/kg	1,500	500	2,590	500	1,330	500	2,500	500
Arsenic	mg/kg	18.4	10.0	48.1	10.0	14.0	10.0	13.1	10.0
Barium	mg/kg	182	0.400	163	0.400	176	0.400	286	0.400
Beryllium	mg/kg	0.712	0.100	0.723	0.100	0.696	0.100	0.905	0.100
Cadmium	mg/kg	ND	1.00	1.67	1.00	ND	1.00	ND	1.00
Chromium	mg/kg	34.8	1.00	38.2	1.00	27.6	1.00	47.1	1.00
Cobalt	mg/kg	15.1	0.700	14.0	0.700	11.6	0.700	13.5	0.700
Copper	mg/kg	40.7	1.00	48.2	1.00	38.3	1.00	48.6	1.00
Lead	mg/kg	25.6	7.50	76.3	7.50	28.6	7.50	16.1	7.50
Molybdenum	mg/kg	ND	2.00	ND	2.00	ND	2.00	ND	2.00
Nickel	mg/kg	32.0	3.00	43.0	3.00	27.0	3.00	41.8	3.00
Selenium	mg/kg	ND	10.0	ND	10.0	ND	10.0	ND	10.0
Silver	mg/kg	ND	0.700	ND	0.700	ND	0.700	ND	0.700
Thallium	mg/kg	ND	10.0	ND	10.0	ND	10.0	ND	10.0
Vanadium	mg/kg	77.6	1.00	59.9	1.00	61.9	1.00	72.0	1.00
Zinc	mg/kg	64.0	2.00	83.9	2.00	56.7	2.00	63.3	2.00
Nitrate as Nitrogen	mg/kg	2.19	1.00	9.84	1.00	4.15	1.00	2.00	1.00
Nitrate/Nitrite as Nitrogen	mg/kg	2.73	1.00	10.4	1.00	4.15	1.00	2.00	1.00
Mercury	mg/kg	0.093	0.050	1.9	0.043	0.11	0.042	0.092	0.050
Explosive Compounds									
PETN	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
HMX	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
Cyclonite (RDX)	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
1,3,5-Trinitrobenzene	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
1,3-Dinitrobenzene	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
Tetryl	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
Nitrobenzene	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
2,4,6-Trinitrotoluene (TNT)	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
4-Amino-2,6-Dinitrotoluene	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
2-Amino-4,6-Dinitrotoluene	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
2,4-Dinitrotoluene	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
2,6-Dinitrotoluene	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
4-Nitrotoluene	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
3-Nitrotoluene	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
2-Nitrotoluene	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
Phosphate	mg/kg	94.5	0.500	375	2.50	13.2	0.500	108	1.00

Notes:

Data collected by SECOR International, Inc. Analytical data on this table was provided to Earth Tech by SECOR, as shown, with no modification. Analytical data have not been verified or validated by Earth Tech.

- = not analyzed

mg/kg = milligrams per kilogram

MDL = Method Detection Limit

ND = not detected above the Method Detection Limit

Notes regarding SS samples:

SS = soil sample

Samples collected from depths ranging from 2 to 5 inches below the ground surface.

Metals were analyzed for using EPA Method SW6000 series.

Explosive compounds were analyzed for using EPA Method SW8330.

*Second analysis of Samples SS-30 and SS-33.

**Sample analyzed using EnSys Soil Test System, Rapid Field Screen for TNT and RDX.

Notes regarding FSS samples:

FSS = field screening soil sample

Soil samples not air dried

FSS analyzed using EnSys Soil Test System, Rapid Field Screen for TNT and RDX.

Source: SECOR International, Inc.

Table 3-8. SECOR Analytical Results for Soil
Outside Areas of Interest
(Unvalidated Screening-Level Data)

Outside Areas of Interest	Field Sample ID	SS-20		SS-21		SS-30		SS-30*	
	Sample Date	11/20/98		11/20/98		11/20/98		12/01/98	
Parameter	**Units**	**Result**	**MDL**	**Result**	**MDL**	**Result**	**MDL**	**Result**	**MDL**
Metals									
Antimony	mg/kg	ND	6.00	ND	6.00	ND	6.00	-	-
Manganese	mg/kg	545	0.500	922	0.500	886	0.500	-	-
Potassium	mg/kg	2,240	500	2,150	500	1,660	500	-	-
Arsenic	mg/kg	13.7	10.0	16.5	10.0	16.8	10.0	-	-
Barium	mg/kg	331	0.400	212	0.400	258	0.400	-	-
Beryllium	mg/kg	0.805	0.100	0.793	0.100	0.699	0.100	-	-
Cadmium	mg/kg	ND	1.00	ND	1.00	ND	1.00	-	-
Chromium	mg/kg	41.2	1.00	39.5	1.00	31.5	1.00	-	-
Cobalt	mg/kg	12.3	0.700	15.2	0.700	15.1	0.700	-	-
Copper	mg/kg	47.1	1.00	45.4	1.00	39.3	1.00	-	-
Lead	mg/kg	21.4	7.50	20.0	7.50	34.4	7.50	-	-
Molybdenum	mg/kg	ND	2.00	ND	2.00	ND	2.00	-	-
Nickel	mg/kg	36.5	3.00	41.5	3.00	30.8	3.00	-	-
Selenium	mg/kg	ND	10.0	ND	10.0	ND	10.0	-	-
Silver	mg/kg	ND	0.700	ND	0.700	ND	0.700	-	-
Thallium	mg/kg	ND	10.0	ND	10.0	ND	10.0	-	-
Vanadium	mg/kg	70.5	1.00	68.3	1.00	75.9	1.00	-	-
Zinc	mg/kg	65.9	2.00	70.4	2.00	59.6	2.00	-	-
Nitrate as Nitrogen	mg/kg	1.82	1.00	2.76	1.00	4.63	1.00	-	-
Nitrate/Nitrite as Nitrogen	mg/kg	1.82	1.00	2.76	1.00	4.63	1.00	-	-
Mercury	mg/kg	0.11	0.043	0.11	0.050	0.121	0.0500	-	-
Explosive Compounds									
PETN	mg/kg	ND	0.30	ND	0.30	ND	0.30	-	-
HMX	mg/kg	ND	0.30	ND	0.30	ND	0.30	-	-
Cyclonite (RDX)	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	1.0
1,3,5-Trinitrobenzene	mg/kg	ND	0.30	ND	0.30	ND	0.30	-	-
1,3-Dinitrobenzene	mg/kg	ND	0.30	ND	0.30	ND	0.30	-	-
Tetryl	mg/kg	ND	0.30	ND	0.30	ND	0.30	-	-
Nitrobenzene	mg/kg	ND	0.30	ND	0.30	ND	0.30	-	-
2,4,6-Trinitrotoluene (TNT)	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	1.0
4-Amino-2,6-Dinitrotoluene	mg/kg	ND	0.30	ND	0.30	ND	0.30	-	-
2-Amino-4,6-Dinitrotoluene	mg/kg	ND	0.30	ND	0.30	ND	0.30	-	-
2,4-Dinitrotoluene	mg/kg	ND	0.30	ND	0.30	ND	0.30	-	-
2,6-Dinitrotoluene	mg/kg	ND	0.30	ND	0.30	ND	0.30	-	-
4-Nitrotoluene	mg/kg	ND	0.30	ND	0.30	ND	0.30	-	-
3-Nitrotoluene	mg/kg	ND	0.30	ND	0.30	ND	0.30	-	-
2-Nitrotoluene	mg/kg	ND	0.30	ND	0.30	ND	0.30	-	-
Phosphate	mg/kg	296	2.50	311	2.50	4.39	0.500	-	-

Notes:

Data collected by SECOR International, Inc. Analytical data on this table was provided to Earth Tech by SECOR, as shown, with no modification. Analytical data have not been verified or validated by Earth Tech.

- = not analyzed

mg/kg = milligrams per kilogram

MDL = Method Detection Limit

ND = not detected above the Method Detection Limit

Notes regarding SS samples:

SS = soil sample

Samples collected from depths ranging from 2 to 5 inches below the ground surface.

Metals were analyzed for using EPA Method SW6000 series.

Explosive compounds were analyzed for using EPA Method SW8330.

*Second analysis of Samples SS-30 and SS-33.

**Sample analyzed using EnSys Soil Test System, Rapid Field Screen for TNT and RDX.

Notes regarding FSS samples:

FSS = field screening soil sample

Soil samples not air dried

FSS analyzed using EnSys Soil Test System, Rapid Field Screen for TNT and RDX.

Source: SECOR International, Inc.

Table 3-8. SECOR Analytical Results for Soil
Outside Areas of Interest
(Unvalidated Screening-Level Data)

Outside Areas of Interest	Field Sample ID	SS-31		SS-32		SS-33		SS-33*	
	Sample Date	11/20/98		11/20/98		11/20/98		12/01/98	
Parameter	Units	Result	MDL	Result	MDL	Result	MDL	Result	MDL
Metals									
Antimony	mg/kg	ND	6.00	ND	6.00	ND	6.00	-	-
Manganese	mg/kg	791	0.500	712	0.500	805	0.500	-	-
Potassium	mg/kg	1,660	500	1,670	500	1,630	500	-	-
Arsenic	mg/kg	15.9	10.0	16.6	10.0	21.1	10.0	-	-
Barium	mg/kg	237	0.400	221	0.400	331	0.400	-	-
Beryllium	mg/kg	0.673	0.100	0.621	0.100	0.933	0.100	-	-
Cadmium	mg/kg	1.18	1.00	1.23	1.00	ND	1.00	-	-
Chromium	mg/kg	30.5	1.00	27.7	1.00	45.8	1.00	-	-
Cobalt	mg/kg	16.0	0.700	15.5	0.700	17.0	0.700	-	-
Copper	mg/kg	46.6	1.00	40.8	1.00	57.1	1.00	-	-
Lead	mg/kg	89.0	7.50	49.2	7.50	12.8	7.50	-	-
Molybdenum	mg/kg	ND	2.00	ND	2.00	ND	2.00	-	-
Nickel	mg/kg	32.3	3.00	28.1	3.00	45.2	3.00	-	-
Selenium	mg/kg	ND	10.0	ND	10.0	ND	10.0	-	-
Silver	mg/kg	ND	0.700	ND	0.700	ND	0.700	-	-
Thallium	mg/kg	ND	10.0	ND	10.0	ND	10.0	-	-
Vanadium	mg/kg	66.3	1.00	69.1	1.00	91.1	1.00	-	-
Zinc	mg/kg	70.1	2.00	71.9	2.00	74.0	2.00	-	-
Nitrate as Nitrogen	mg/kg	1.70	1.00	5.34	1.00	1.44	1.00	-	-
Nitrate/Nitrite as Nitrogen	mg/kg	1.70	1.00	5.34	1.00	1.44	1.00	-	-
Mercury	mg/kg	0.679	0.0500	0.570	0.0500	0.330	0.0500	-	-
Explosive Compounds									
PETN	mg/kg	ND	0.30	ND	0.30	ND	0.30	-	-
HMX	mg/kg	ND	0.30	ND	0.30	ND	0.30	-	-
Cyclonite (RDX)	mg/kg	ND	0.30	ND	0.30	ND	0.30	-	-
1,3,5-Trinitrobenzene	mg/kg	ND	0.30	ND	0.30	ND	0.30	-	-
1,3-Dinitrobenzene	mg/kg	ND	0.30	ND	0.30	ND	0.30	-	-
Tetryl	mg/kg	ND	0.30	ND	0.30	ND	0.30	-	-
Nitrobenzene	mg/kg	ND	0.30	ND	0.30	ND	0.30	-	-
2,4,6-Trinitrotoluene (TNT)	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	1.0
4-Amino-2,6-Dinitrotoluene	mg/kg	ND	0.30	ND	0.30	ND	0.30	-	-
2-Amino-4,6-Dinitrotoluene	mg/kg	ND	0.30	ND	0.30	ND	0.30	-	-
2,4-Dinitrotoluene	mg/kg	ND	0.30	ND	0.30	ND	0.30	-	-
2,6-Dinitrotoluene	mg/kg	ND	0.30	ND	0.30	ND	0.30	-	-
4-Nitrotoluene	mg/kg	ND	0.30	ND	0.30	ND	0.30	-	-
3-Nitrotoluene	mg/kg	ND	0.30	ND	0.30	ND	0.30	-	-
2-Nitrotoluene	mg/kg	ND	0.30	ND	0.30	ND	0.30	-	-
Phosphate	mg/kg	191	2.50	287	2.50	18.6	0.500	-	-

Notes:

Data collected by SECOR International, Inc. Analytical data on this table was provided to Earth Tech by SECOR, as shown, with no modification. Analytical data have not been verified or validated by Earth Tech.

- = not analyzed

mg/kg = milligrams per kilogram

MDL = Method Detection Limit

ND = not detected above the Method Detection Limit

Notes regarding SS samples:

SS = soil sample

Samples collected from depths ranging from 2 to 5 inches below the ground surface.

Metals were analyzed for using EPA Method SW6000 series.

Explosive compounds were analyzed for using EPA Method SW8330.

*Second analysis of Samples SS-30 and SS-33.

**Sample analyzed using EnSys Soil Test System, Rapid Field Screen for TNT and RDX.

Notes regarding FSS samples:

FSS = field screening soil sample

Soil samples not air dried

FSS analyzed using EnSys Soil Test System, Rapid Field Screen for TNT and RDX.

Source: SECOR International, Inc.

Table 3-8. SECOR Analytical Results for Soil Outside Areas of Interest (Unvalidated Screening-Level Data)

Outside Areas of Interest	Field Sample ID	SS-35		SS-36		SS-39		SS-40	
	Sample Date	11/20/98		11/20/98		11/20/98		11/20/98	
Parameter	**Units**	**Result**	**MDL**	**Result**	**MDL**	**Result**	**MDL**	**Result**	**MDL**
Metals									
Antimony	mg/kg	ND	6.00	ND	6.00	ND	6.00	ND	6.00
Manganese	mg/kg	517	0.500	629	0.500	1,320	1.00	599	0.500
Potassium	mg/kg	1,130	500	1,740	500	2,700	500	1,910	500
Arsenic	mg/kg	16.6	10.0	18.1	10.0	20.0	10.0	19.7	10.0
Barium	mg/kg	152	0.400	176	0.400	183	0.400	223	0.400
Beryllium	mg/kg	0.676	0.100	0.759	0.100	0.778	0.100	0.599	0.100
Cadmium	mg/kg	ND	1.00	ND	1.00	ND	1.00	ND	1.00
Chromium	mg/kg	33.8	1.00	35.9	1.00	39.6	1.00	26.3	1.00
Cobalt	mg/kg	11.2	0.700	14.3	0.700	16.7	0.700	12.3	0.700
Copper	mg/kg	42.7	1.00	49.5	1.00	52.6	1.00	38.1	1.00
Lead	mg/kg	58.7	7.50	37.3	7.50	51.1	7.50	56.3	7.50
Molybdenum	mg/kg	ND	2.00	ND	2.00	ND	2.00	ND	2.00
Nickel	mg/kg	34.8	3.00	40.5	3.00	44.9	3.00	26.5	3.00
Selenium	mg/kg	ND	10.0	ND	10.0	ND	10.0	ND	10.0
Silver	mg/kg	ND	0.700	ND	0.700	ND	0.700	ND	0.700
Thallium	mg/kg	ND	10.0	ND	10.0	ND	10.0	ND	10.0
Vanadium	mg/kg	70.4	1.00	58.7	1.00	59.2	1.00	65.3	1.00
Zinc	mg/kg	58.3	2.00	76.8	2.00	85.4	2.00	71.5	2.00
Nitrate as Nitrogen	mg/kg	1.91	1.00	7.92	1.00	5.22	1.00	3.65	1.00
Nitrate/Nitrite as Nitrogen	mg/kg	1.91	1.00	8.62	1.00	5.22	1.00	3.65	1.00
Mercury	mg/kg	0.0537	0.0500	0.102	0.0500	0.127	0.0500	0.216	0.0500
Explosive Compounds									
PETN	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
HMX	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
Cyclonite (RDX)	mg/kg	ND	0.30	ND	0.30	1.73	0.30	ND	0.30
1,3,5-Trinitrobenzene	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
1,3-Dinitrobenzene	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
Tetryl	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
Nitrobenzene	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
2,4,6-Trinitrotoluene (TNT)	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
4-Amino-2,6-Dinitrotoluene	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
2-Amino-4,6-Dinitrotoluene	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
2,4-Dinitrotoluene	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
2,6-Dinitrotoluene	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
4-Nitrotoluene	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
3-Nitrotoluene	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
2-Nitrotoluene	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
Phosphate	mg/kg	1.70	0.500	26.2	0.500	283	2.50	7.82	0.500

Notes:

Data collected by SECOR International, Inc. Analytical data on this table was provided to Earth Tech by SECOR, as shown, with no modification. Analytical data have not been verified or validated by Earth Tech.

- = not analyzed

mg/kg = milligrams per kilogram

MDL = Method Detection Limit

ND = not detected above the Method Detection Limit

Notes regarding SS samples:

SS = soil sample

Samples collected from depths ranging from 2 to 5 inches below the ground surface.

Metals were analyzed for using EPA Method SW6000 series.

Explosive compounds were analyzed for using EPA Method SW8330.

*Second analysis of Samples SS-30 and SS-33.

**Sample analyzed using EnSys Soil Test System, Rapid Field Screen for TNT and RDX.

Notes regarding FSS samples:

FSS = field screening soil sample

Soil samples not air dried

FSS analyzed using EnSys Soil Test System, Rapid Field Screen for TNT and RDX.

Source: SECOR International, Inc.

Table 3-8. SECOR Analytical Results for Soil
Outside Areas of Interest
(Unvalidated Screening-Level Data)

Outside Areas of Interest	Field Sample ID	SS-41		SS-42		SS-43		SS-44	
	Sample Date	11/20/98		11/20/98		11/20/98		11/20/98	
Parameter	**Units**	**Result**	**MDL**	**Result**	**MDL**	**Result**	**MDL**	**Result**	**MDL**
Metals									
Antimony	mg/kg	ND	6.00	ND	6.00	ND	6.00	ND	6.00
Manganese	mg/kg	904	0.500	943	0.500	1,070	1.00	1,160	1.00
Potassium	mg/kg	1,440	500	1,190	500	1,830	500	1,400	500
Arsenic	mg/kg	11.4	10.0	17.5	10.0	18.3	10.0	13.2	10.0
Barium	mg/kg	307	0.400	372	0.400	245	0.400	183	0.400
Beryllium	mg/kg	0.510	0.100	0.669	0.100	0.766	0.100	0.549	0.100
Cadmium	mg/kg	ND	1.00	ND	1.00	1.21	1.00	1.07	1.00
Chromium	mg/kg	23.7	1.00	28.1	1.00	35.3	1.00	25.1	1.00
Cobalt	mg/kg	13.0	0.700	14.8	0.700	20.4	0.700	19.5	0.700
Copper	mg/kg	29.7	1.00	37.4	1.00	49.1	1.00	31.2	1.00
Lead	mg/kg	26.6	7.50	27.6	7.50	40.1	7.50	37.1	7.50
Molybdenum	mg/kg	ND	2.00	ND	2.00	ND	2.00	ND	2.00
Nickel	mg/kg	23.1	3.00	25.3	3.00	39.0	3.00	22.8	3.00
Selenium	mg/kg	ND	10.0	ND	10.0	ND	10.0	ND	10.0
Silver	mg/kg	ND	0.700	ND	0.700	ND	0.700	ND	0.700
Thallium	mg/kg	ND	10.0	ND	10.0	ND	10.0	ND	10.0
Vanadium	mg/kg	57.6	1.00	87.1	1.00	66.4	1.00	56.1	1.00
Zinc	mg/kg	49.5	2.00	63.6	2.00	68.2	2.00	52.9	2.00
Nitrate as Nitrogen	mg/kg	5.63	1.00	3.40	1.00	1.01	1.00	18.4	1.00
Nitrate/Nitrite as Nitrogen	mg/kg	5.63	1.00	3.40	1.00	1.01	1.00	18.4	1.00
Mercury	mg/kg	0.0831	0.0500	0.0982	0.0500	0.238	0.0500	0.151	0.0500
Explosive Compounds									
PETN	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
HMX	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
Cyclonite (RDX)	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
1,3,5-Trinitrobenzene	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
1,3-Dinitrobenzene	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
Tetryl	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
Nitrobenzene	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
2,4,6-Trinitrotoluene (TNT)	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
4-Amino-2,6-Dinitrotoluene	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
2-Amino-4,6-Dinitrotoluene	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
2,4-Dinitrotoluene	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
2,6-Dinitrotoluene	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
4-Nitrotoluene	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
3-Nitrotoluene	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
2-Nitrotoluene	mg/kg	ND	0.30	ND	0.30	ND	0.30	ND	0.30
Phosphate	mg/kg	15.7	0.500	ND	0.500	204	2.50	11.0	0.500

Notes:

Data collected by SECOR International, Inc. Analytical data on this table was provided to Earth Tech by SECOR, as shown, with no modification. Analytical data have not been verified or validated by Earth Tech.

- - = not analyzed

mg/kg = milligrams per kilogram

MDL = Method Detection Limit

ND = not detected above the Method Detection Limit

Notes regarding SS samples:

SS = soil sample

Samples collected from depths ranging from 2 to 5 inches below the ground surface.

Metals were analyzed for using EPA Method SW6000 series.

Explosive compounds were analyzed for using EPA Method SW8330.

*Second analysis of Samples SS-30 and SS-33.

**Sample analyzed using EnSys Soil Test System, Rapid Field Screen for TNT and RDX.

Notes regarding FSS samples:

FSS = field screening soil sample

Soil samples not air dried

FSS analyzed using EnSys Soil Test System, Rapid Field Screen for TNT and RDX

Source: SECOR International, Inc.

Table 3-8. SECOR Analytical Results for Soil
Outside Areas of Interest
(Unvalidated Screening-Level Data)

Outside Areas of Interest	Field Sample ID	FSS-1		FSS-2		FSS-4		FSS-5	
	Sample Date	12/02/98		12/02/98		12/02/98		12/02/98	
Parameter	**Units**	**Result**	**MDL**	**Result**	**MDL**	**Result**	**MDL**	**Result**	**MDL**
Metals									
Antimony	mg/kg	-	-	-	-	-	-	-	-
Manganese	mg/kg	-	-	-	-	-	-	-	-
Potassium	mg/kg	-	-	-	-	-	-	-	-
Arsenic	mg/kg	-	-	-	-	-	-	-	-
Barium	mg/kg	-	-	-	-	-	-	-	-
Beryllium	mg/kg	-	-	-	-	-	-	-	-
Cadmium	mg/kg	-	-	-	-	-	-	-	-
Chromium	mg/kg	-	-	-	-	-	-	-	-
Cobalt	mg/kg	-	-	-	-	-	-	-	-
Copper	mg/kg	-	-	-	-	-	-	-	-
Lead	mg/kg	-	-	-	-	-	-	-	-
Molybdenum	mg/kg	-	-	-	-	-	-	-	-
Nickel	mg/kg	-	-	-	-	-	-	-	-
Selenium	mg/kg	-	-	-	-	-	-	-	-
Silver	mg/kg	-	-	-	-	-	-	-	-
Thallium	mg/kg	-	-	-	-	-	-	-	-
Vanadium	mg/kg	-	-	-	-	-	-	-	-
Zinc	mg/kg	-	-	-	-	-	-	-	-
Nitrate as Nitrogen	mg/kg	-	-	-	-	-	-	-	-
Nitrate/Nitrite as Nitrogen	mg/kg	-	-	-	-	-	-	-	-
Mercury	mg/kg	-	-	-	-	-	-	-	-
Explosive Compounds									
PETN	mg/kg	-	-	-	-	-	-	-	-
HMX	mg/kg	-	-	-	-	-	-	-	-
Cyclonite (RDX)	mg/kg	-	-	-	-	-	-	-	-
1,3,5-Trinitrobenzene	mg/kg	-	-	-	-	-	-	-	-
1,3-Dinitrobenzene	mg/kg	-	-	-	-	-	-	-	-
Tetryl	mg/kg	-	-	-	-	-	-	-	-
Nitrobenzene	mg/kg	-	-	-	-	-	-	-	-
2,4,6-Trinitrotoluene (TNT)	mg/kg	ND	1.0	ND	1.0	ND	1.0	ND	1.0
4-Amino-2,6-Dinitrotoluene	mg/kg	-	-	-	-	-	-	-	-
2-Amino-4,6-Dinitrotoluene	mg/kg	-	-	-	-	-	-	-	-
2,4-Dinitrotoluene	mg/kg	-	-	-	-	-	-	-	-
2,6-Dinitrotoluene	mg/kg	-	-	-	-	-	-	-	-
4-Nitrotoluene	mg/kg	-	-	-	-	-	-	-	-
3-Nitrotoluene	mg/kg	-	-	-	-	-	-	-	-
2-Nitrotoluene	mg/kg	-	-	-	-	-	-	-	-
Phosphate	mg/kg	-	-	-	-	-	-	-	-

Notes:

Data collected by SECOR International, Inc. Analytical data on this table was provided to Earth Tech by SECOR, as shown, with no modification. Analytical data have not been verified or validated by Earth Tech.

- = not analyzed

mg/kg = milligrams per kilogram

MDL = Method Detection Limit

ND = not detected above the Method Detection Limit

Notes regarding SS samples:

SS = soil sample

Samples collected from depths ranging from 2 to 5 inches below the ground surface.

Metals were analyzed for using EPA Method SW6000 series.

Explosive compounds were analyzed for using EPA Method SW8330.

*Second analysis of Samples SS-30 and SS-33.

**Sample analyzed using EnSys Soil Test System, Rapid Field Screen for TNT and RDX.

Notes regarding FSS samples:

FSS = field screening soil sample

Soil samples not air dried

FSS analyzed using EnSys Soil Test System, Rapid Field Screen for TNT and RDX.

Source: SECOR International, Inc.

Outside Areas of Interest	Field Sample ID / Sample Date	FSS-6 12/02/98		FSS-7 12/02/98		FSS-8 12/02/98		FSS-12 12/02/98	
Parameter	**Units**	**Result**	**MDL**	**Result**	**MDL**	**Result**	**MDL**	**Result**	**MDL**
Metals									
Antimony	mg/kg	-	-	-	-	-	-	-	-
Manganese	mg/kg	-	-	-	-	-	-	-	-
Potassium	mg/kg	-	-	-	-	-	-	-	-
Arsenic	mg/kg	-	-	-	-	-	-	-	-
Barium	mg/kg	-	-	-	-	-	-	-	-
Beryllium	mg/kg	-	-	-	-	-	-	-	-
Cadmium	mg/kg	-	-	-	-	-	-	-	-
Chromium	mg/kg	-	-	-	-	-	-	-	-
Cobalt	mg/kg	-	-	-	-	-	-	-	-
Copper	mg/kg	-	-	-	-	-	-	-	-
Lead	mg/kg	-	-	-	-	-	-	-	-
Molybdenum	mg/kg	-	-	-	-	-	-	-	-
Nickel	mg/kg	-	-	-	-	-	-	-	-
Selenium	mg/kg	-	-	-	-	-	-	-	-
Silver	mg/kg	-	-	-	-	-	-	-	-
Thallium	mg/kg	-	-	-	-	-	-	-	-
Vanadium	mg/kg	-	-	-	-	-	-	-	-
Zinc	mg/kg	-	-	-	-	-	-	-	-
Nitrate as Nitrogen	mg/kg	-	-	-	-	-	-	-	-
Nitrate/Nitrite as Nitrogen	mg/kg	-	-	-	-	-	-	-	-
Mercury	mg/kg	-	-	-	-	-	-	-	-
Explosive Compounds									
PETN	mg/kg	-	-	-	-	-	-	-	-
HMX	mg/kg	-	-	-	-	-	-	-	-
Cyclonite (RDX)	mg/kg	-	-	-	-	ND	1.0	-	-
1,3,5-Trinitrobenzene	mg/kg	-	-	-	-	-	-	-	-
1,3-Dinitrobenzene	mg/kg	-	-	-	-	-	-	-	-
Tetryl	mg/kg	-	-	-	-	-	-	-	-
Nitrobenzene	mg/kg	-	-	-	-	-	-	-	-
2,4,6-Trinitrotoluene (TNT)	mg/kg	ND	1.0	ND	1.0	ND	1.0	ND	1.0
4-Amino-2,6-Dinitrotoluene	mg/kg	-	-	-	-	-	-	-	-
2-Amino-4,6-Dinitrotoluene	mg/kg	-	-	-	-	-	-	-	-
2,4-Dinitrotoluene	mg/kg	-	-	-	-	-	-	-	-
2,6-Dinitrotoluene	mg/kg	-	-	-	-	-	-	-	-
4-Nitrotoluene	mg/kg	-	-	-	-	-	-	-	-
3-Nitrotoluene	mg/kg	-	-	-	-	-	-	-	-
2-Nitrotoluene	mg/kg	-	-	-	-	-	-	-	-
Phosphate	mg/kg	-	-	-	-	-	-	-	-

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- = not analyzed

mg/kg = milligrams per kilogram

MDL = Method Detection Limit

ND = not detected above the Method Detection Limit

Notes regarding SS samples:

SS = soil sample

Samples collected from depths ranging from 2 to 5 inches below the ground surface.

Metals were analyzed for using EPA Method SW6000 series.

Explosive compounds were analyzed for using EPA Method SW8330.

*Second analysis of Samples SS-30 and SS-33.

**Sample analyzed using EnSys Soil Test System, Rapid Field Screen for TNT and RDX.

Notes regarding FSS samples:

FSS = field screening soil sample

Soil samples not air dried

FSS analyzed using EnSys Soil Test System, Rapid Field Screen for TNT and RDX.

Source: SECOR International, Inc.

Table 3-8. SECOR Analytical Results for Soil
Outside Areas of Interest
(Unvalidated Screening-Level Data)

Outside Areas of Interest	Field Sample ID	FSS-13		FSS-14		FSS-15		FSS-16	
	Sample Date	12/02/98		12/02/98		12/02/98		12/02/98	
Parameter	Units	Result	MDL	Result	MDL	Result	MDL	Result	MDL
Metals									
Antimony	mg/kg	-	-	-	-	-	-	-	-
Manganese	mg/kg	-	-	-	-	-	-	-	-
Potassium	mg/kg	-	-	-	-	-	-	-	-
Arsenic	mg/kg	-	-	-	-	-	-	-	-
Barium	mg/kg	-	-	-	-	-	-	-	-
Beryllium	mg/kg	-	-	-	-	-	-	-	-
Cadmium	mg/kg	-	-	-	-	-	-	-	-
Chromium	mg/kg	-	-	-	-	-	-	-	-
Cobalt	mg/kg	-	-	-	-	-	-	-	-
Copper	mg/kg	-	-	-	-	-	-	-	-
Lead	mg/kg	-	-	-	-	-	-	-	-
Molybdenum	mg/kg	-	-	-	-	-	-	-	-
Nickel	mg/kg	-	-	-	-	-	-	-	-
Selenium	mg/kg	-	-	-	-	-	-	-	-
Silver	mg/kg	-	-	-	-	-	-	-	-
Thallium	mg/kg	-	-	-	-	-	-	-	-
Vanadium	mg/kg	-	-	-	-	-	-	-	-
Zinc	mg/kg	-	-	-	-	-	-	-	-
Nitrate as Nitrogen	mg/kg	-	-	-	-	-	-	-	-
Nitrate/Nitrite as Nitrogen	mg/kg	-	-	-	-	-	-	-	-
Mercury	mg/kg	-	-	-	-	-	-	-	-
Explosive Compounds									
PETN	mg/kg	-	-	-	-	-	-	-	-
HMX	mg/kg	-	-	-	-	-	-	-	-
Cyclonite (RDX)	mg/kg	-	-	-	-	-	-	-	-
1,3,5-Trinitrobenzene	mg/kg	-	-	-	-	-	-	-	-
1,3-Dinitrobenzene	mg/kg	-	-	-	-	-	-	-	-
Tetryl	mg/kg	-	-	-	-	-	-	-	-
Nitrobenzene	mg/kg	-	-	-	-	-	-	-	-
2,4,6-Trinitrotoluene (TNT)	mg/kg	ND	1.0	ND	1.0	ND	1.0	ND	1.0
4-Amino-2,6-Dinitrotoluene	mg/kg	-	-	-	-	-	-	-	-
2-Amino-4,6-Dinitrotoluene	mg/kg	-	-	-	-	-	-	-	-
2,4-Dinitrotoluene	mg/kg	-	-	-	-	-	-	-	-
2,6-Dinitrotoluene	mg/kg	-	-	-	-	-	-	-	-
4-Nitrotoluene	mg/kg	-	-	-	-	-	-	-	-
3-Nitrotoluene	mg/kg	-	-	-	-	-	-	-	-
2-Nitrotoluene	mg/kg	-	-	-	-	-	-	-	-
Phosphate	mg/kg	-	-	-	-	-	-	-	-

Notes:

Data collected by SECOR International, Inc. Analytical data on this table was provided to Earth Tech by SECOR, as shown, with no modification. Analytical data have not been verified or validated by Earth Tech.

- = not analyzed

mg/kg = milligrams per kilogram

MDL = Method Detection Limit

ND = not detected above the Method Detection Limit

Notes regarding SS samples:

SS = soil sample

Samples collected from depths ranging from 2 to 5 inches below the ground surface.

Metals were analyzed for using EPA Method SW6000 series.

Explosive compounds were analyzed for using EPA Method SW8330.

*Second analysis of Samples SS-30 and SS-33.

**Sample analyzed using EnSys Soil Test System. Rapid Field Screen for TNT and RDX.

Notes regarding FSS samples:

FSS = field screening soil sample

Soil samples not air dried

FSS analyzed using EnSys Soil Test System. Rapid Field Screen for TNT and RDX.

Source: SECOR International, Inc.

Table 3-8. SECOR Analytical Results for Soil Outside Areas of Interest (Unvalidated Screening-Level Data)

Outside Areas of Interest	Field Sample ID / Sample Date	FSS-17 12/02/98		FSS-18 12/02/98		FSS-19 12/02/98		FSS-20 12/02/98	
Parameter	Units	Result	MDL	Result	MDL	Result	MDL	Result	MDL
Metals									
Antimony	mg/kg	-	-	-	-	-	-	-	-
Manganese	mg/kg	-	-	-	-	-	-	-	-
Potassium	mg/kg	-	-	-	-	-	-	-	-
Arsenic	mg/kg	-	-	-	-	-	-	-	-
Barium	mg/kg	-	-	-	-	-	-	-	-
Beryllium	mg/kg	-	-	-	-	-	-	-	-
Cadmium	mg/kg	-	-	-	-	-	-	-	-
Chromium	mg/kg	-	-	-	-	-	-	-	-
Cobalt	mg/kg	-	-	-	-	-	-	-	-
Copper	mg/kg	-	-	-	-	-	-	-	-
Lead	mg/kg	-	-	-	-	-	-	-	-
Molybdenum	mg/kg	-	-	-	-	-	-	-	-
Nickel	mg/kg	-	-	-	-	-	-	-	-
Selenium	mg/kg	-	-	-	-	-	-	-	-
Silver	mg/kg	-	-	-	-	-	-	-	-
Thallium	mg/kg	-	-	-	-	-	-	-	-
Vanadium	mg/kg	-	-	-	-	-	-	-	-
Zinc	mg/kg	-	-	-	-	-	-	-	-
Nitrate as Nitrogen	mg/kg	-	-	-	-	-	-	-	-
Nitrate/Nitrite as Nitrogen	mg/kg	-	-	-	-	-	-	-	-
Mercury	mg/kg	-	-	-	-	-	-	-	-
Explosive Compounds									
PETN	mg/kg	-	-	-	-	-	-	-	-
HMX	mg/kg	-	-	-	-	-	-	-	-
Cyclonite (RDX)	mg/kg	-	-	-	-	-	-	-	-
1,3,5-Trinitrobenzene	mg/kg	-	-	-	-	-	-	-	-
1,3-Dinitrobenzene	mg/kg	-	-	-	-	-	-	-	-
Tetryl	mg/kg	-	-	-	-	-	-	-	-
Nitrobenzene	mg/kg	-	-	-	-	-	-	-	-
2,4,6-Trinitrotoluene (TNT)	mg/kg	ND	1.0	ND	1.0	ND	1.0	ND	1.0
4-Amino-2,6-Dinitrotoluene	mg/kg	-	-	-	-	-	-	-	-
2-Amino-4,6-Dinitrotoluene	mg/kg	-	-	-	-	-	-	-	-
2,4-Dinitrotoluene	mg/kg	-	-	-	-	-	-	-	-
2,6-Dinitrotoluene	mg/kg	-	-	-	-	-	-	-	-
4-Nitrotoluene	mg/kg	-	-	-	-	-	-	-	-
3-Nitrotoluene	mg/kg	-	-	-	-	-	-	-	-
2-Nitrotoluene	mg/kg	-	-	-	-	-	-	-	-
Phosphate	mg/kg	-	-	-	-	-	-	-	-

Notes:

Data collected by SECOR International, Inc. Analytical data on this table was provided to Earth Tech by SECOR, as shown, with no modification. Analytical data have not been verified or validated by Earth Tech.

- = not analyzed

mg/kg = milligrams per kilogram

MDL = Method Detection Limit

ND = not detected above the Method Detection Limit

Notes regarding SS samples:

SS = soil sample

Samples collected from depths ranging from 2 to 5 inches below the ground surface.

Metals were analyzed for using EPA Method SW6000 series.

Explosive compounds were analyzed for using EPA Method SW8330.

*Second analysis of Samples SS-30 and SS-33.

**Sample analyzed using EnSys Soil Test System, Rapid Field Screen for TNT and RDX.

Notes regarding FSS samples:

FSS = field screening soil sample

Soil samples not air dried

FSS analyzed using EnSys Soil Test System, Rapid Field Screen for TNT and RDX.

Source: SECOR International, Inc.

Table 3-8. SECOR Analytical Results for Soil
Outside Areas of Interest
(Unvalidated Screening-Level Data)

Outside Areas of Interest	**Field Sample ID**		FSS-30	
	Sample Date		12/02/98	
Parameter		**Units**	**Result**	**MDL**
Metals				
Antimony		mg/kg	-	-
Manganese		mg/kg	-	-
Potassium		mg/kg	-	-
Arsenic		mg/kg	-	-
Barium		mg/kg	-	-
Beryllium		mg/kg	-	-
Cadmium		mg/kg	-	-
Chromium		mg/kg	-	-
Cobalt		mg/kg	-	-
Copper		mg/kg	-	-
Lead		mg/kg	-	-
Molybdenum		mg/kg	-	-
Nickel		mg/kg	-	-
Selenium		mg/kg	-	-
Silver		mg/kg	-	-
Thallium		mg/kg	-	-
Vanadium		mg/kg	-	-
Zinc		mg/kg	-	-
Nitrate as Nitrogen		mg/kg	-	-
Nitrate/Nitrite as Nitrogen		mg/kg	-	-
Mercury		mg/kg	-	-
Explosive Compounds				
PETN		mg/kg	-	-
HMX		mg/kg	-	-
Cyclonite (RDX)		mg/kg	-	-
1,3,5-Trinitrobenzene		mg/kg	-	-
1,3-Dinitrobenzene		mg/kg	-	-
Tetryl		mg/kg	-	-
Nitrobenzene		mg/kg	-	-
2,4,6-Trinitrotoluene (TNT)		mg/kg	ND	1.0
4-Amino-2,6-Dinitrotoluene		mg/kg	-	-
2-Amino-4,6-Dinitrotoluene		mg/kg	-	-
2,4-Dinitrotoluene		mg/kg	-	-
2,6-Dinitrotoluene		mg/kg	-	-
4-Nitrotoluene		mg/kg	-	-
3-Nitrotoluene		mg/kg	-	-
2-Nitrotoluene		mg/kg	-	-
Phosphate		mg/kg	-	-

Notes:

Data collected by SECOR International, Inc. Analytical data on this table was provided to Earth Tech by SECOR, as shown, with no modification. Analytical data have not been verified or validated by Earth Tech.

- = not analyzed

mg/kg = milligrams per kilogram

MDL = Method Detection Limit

ND = not detected above the Method Detection Limit

Notes regarding SS samples:

SS = soil sample

Samples collected from depths ranging from 2 to 5 inches below the ground surface.

Metals were analyzed for using EPA Method SW6000 series.

Explosive compounds were analyzed for using EPA Method SW8330.

*Second analysis of Samples SS-30 and SS-33.

**Sample analyzed using EnSys Soil Test System, Rapid Field Screen for TNT and RDX.

Notes regarding FSS samples:

FSS = field screening soil sample

Soil samples not air dried

FSS analyzed using EnSys Soil Test System, Rapid Field Screen for TNT and RDX.

Source: SECOR International, Inc.

Table 3-9. SECOR Analytical Results for Surface Water
South Valley Wetlands
(Unvalidated Screening-Level Data)

South Valley Wetlands (Water Samples)	Field Sample ID / Sample Date		WS-1 12/04/98	WS-1 12/10/98	WS-2 12/04/98	WS-2 12/10/98
Parameter	**Units**	**MDL**				
Metals						
Antimony	mg/L	60.0	ND	ND	ND	ND
Manganese	mg/L	5.00	377	25.9	22.6	ND
Potassium	mg/L	5000	ND	ND	ND	ND
Arsenic	mg/L	100	ND	ND	ND	ND
Barium	mg/L	4.00	82.3	56.1	12.3	9.24
Beryllium	mg/L	1.00	ND	ND	ND	ND
Cadmium	mg/L	10.0	ND	ND	ND	ND
Chromium	mg/L	10.0	ND	ND	ND	ND
Cobalt	mg/L	7.00	ND	ND	ND	ND
Copper	mg/L	10.0	17.8	ND	11.8	ND
Lead	mg/L	75.0	ND	ND	ND	ND
Molybdenum	mg/L	20.0	ND	ND	ND	ND
Nickel	mg/L	30.0	ND	ND	ND	ND
Selenium	mg/L	100	ND	ND	ND	ND
Silver	mg/L	7.00	ND	ND	ND	ND
Thallium	mg/L	100	ND	ND	ND	ND
Vanadium	mg/L	10.0	11.1	ND	ND	ND
Zinc	mg/L	20.0	33.6	28.9	61.5	26.0
Nitrate as Nitrogen	mg/L	100	ND	-	338	-
Nitrate/Nitrite as Nitrogen	mg/L	100	ND	-	338	-
Mercury	mg/L	0.20	ND	ND	ND	ND
Explosive Compounds						
PETN	mg/L	1.50	ND	-	ND	-
HMX	mg/L	1.50	ND	-	ND	-
Cyclonite (RDX)	mg/L	1.50	ND	-	ND	-
1,3,5-Trinitrobenzene	mg/L	1.50	ND	-	ND	-
1,3-Dinitrobenzene	mg/L	1.50	ND	-	ND	-
Tetryl	mg/L	1.50	ND	-	ND	-
Nitrobenzene	mg/L	1.50	ND	-	ND	-
2,4,6-Trinitrotoluene (TNT)	mg/L	1.50	ND	-	ND	-
4-Amino-2,6-Dinitrotoluene	mg/L	1.50	ND	-	ND	-
2-Amino-4,6-Dinitrotoluene	mg/L	1.50	ND	-	ND	-
2,4-Dinitrotoluene	mg/L	1.50	ND	-	ND	-
2,6-Dinitrotoluene	mg/L	1.50	ND	-	ND	-
4-Nitrotoluene	mg/L	1.50	ND	-	ND	-
3-Nitrotoluene	mg/L	1.50	ND	-	ND	-
2-Nitrotoluene	mg/L	1.50	ND	-	ND	-
Phosphate	mg/L	50.0	85.3	-	95.4	-

Notes:

Data collected by SECOR International, Inc. Analytical data on this table was provided to Earth Tech by SECOR, as shown, with no modification. Analytical data have not been verified or validated by Earth Tech.

- = not analyzed

mg/L = micrograms per liter

MDL = Method Detection Limit

ND = not detected above the Method Detection Limit

Metals were analyzed for using EPA Method SW6000/7000 Series.

Nitrate/Nitrite were analyzed for using EPA Method 353.2.

Total Phosphate was analyzed for using EPA Method 365.2.

Explosive compounds were analyzed for using EPA Method SW8330.

Source: SECOR International, Inc.

Table 4-1. Compounds of Interest and Association to Project Site

Compounds of Interest	Association to Project Site Activities	Applicable Area of Interest
Explosives (incl. nitroaromatics and nitroamines, RDX, HMX, nitroglycerin, and PETN); specific compounds analyzed by EPA Method SW8330 and listed in Tables 5-1 through 5-23	Known: burning of TNT; burning of dynamite; burning of primers; burning of flares; use of propellants; demolition activities.	TNT Strips Howitzer Test Facility North Valley Military Landfill Ammunition Renovation/Primer Destruction Site Dynamite Burn Site Flare Site Stockpile #1 Stockpile #2 Stockpile #3 Demolition Site #1 Demolition Site #2 Demolition Site #3
Metals from the CAM list plus major metals (24 total): Al, Sb, As, Ba, Be, Cd, Ca, Cr (total), Co, Cu, Fe, P, Pb, Mg, Mn, Hg, Mo, Ni, K, Se, Sr, Ag, Na, Tl, V, Zn	Known: residue from flares and explosives; scrap from casings. Suspected: residue from detonators; machine shop and various industrial/manufacturing-type activities. Possible: see Table 4-2. NOTE: metals are naturally occurring in the environment.	TNT Strips Howitzer Test Facility North Valley Military Landfill Ammunition Renovation/Primer Destruction Site Flare Site Stockpile #1 Stockpile #2 Stockpile #3 Demolition Site #1 Demolition Site #2 Demolition Site #3
PAHs; specific compounds analyzed by EPA Method SW8310 or SW8270C and listed in Tables 5-1 through 5-23	Suspected: by-product of incomplete combustion of organic chemical or organic matter; component of heavy fuel hydrocarbons and asphalt.	TNT Strips Howitzer Test Facility North Valley Military Landfill Ammunition Renovation/Primer Destruction Site Dynamite Burn Site Flare Site Stockpile #1 Stockpile #2 Stockpile #3 Demolition Site #1 Demolition Site #2 Demolition Site #3
Dioxins and Furans; specific compounds analyzed by EPA Method SW8290 and listed in Tables 5-1 through 5-23	Possible: by-product of incineration, particularly wood products permeated with preservative pentachlorophenol. NOTE: dioxins are ubiquitous in the environment due to airborne deposition from industrial activities.	TNT Strips Howitzer Test Facility North Valley Military Landfill Ammunition Renovation/Primer Destruction Site Dynamite Burn Site Flare Site Stockpile #1 Stockpile #2 Stockpile #3

Table 4-1. Compounds of Interest and Association to Project Site

Compounds of Interest	Association to Project Site Activities	Applicable Area of Interest
Petroleum Hydrocarbons; measured against diesel, motor oil, and kerosene standards	Known: use of kerosene as a fuel for burning of OE. Suspected: underground diesel or heating oil storage tanks; motor oil from vehicles. Possible: dust control	TNT Strips Howitzer Test Facility Ammunition Renovation/Primer Destruction Site Stockpile #1 Stockpile #2 Stockpile #3
VOCs; specific compounds analyzed by EPA Method SW8260B and listed in Tables 5-1 through 5-23	Suspected: cleaning and general maintenance activity.	Destruction Site Howitzer Test Facility North Valley Military Landfill Ammunition Renovation/Primer Destruction Site
Nitrate/Nitrite	Known: gunpowder/propellant use. Suspected: residue of explosives breakdown; septic tank. Possible: fertilizers.	Howitzer Test Facility Ammunition Renovation/Primer Destruction Site Dynamite Burn Site
Pentachlorophenol	Possible: Wood preservatives associated with wood wastes.	North Valley Military Landfill
Perchlorates	Possible: rocket/missile fuel.	Building 540 in Howitzer Test Facility
Hydrazine	Possible: rocket/missile fuel; breakdown of certain explosives (e.g., RDX).	Building 540 in Howitzer Test Facility
Chloropicrin	Possible: powerful chemical irritant used with some WWI-era weapons; indicator of chemical warfare agents.	Howitzer Test Facility
PCBs; specific compounds analyzed by EPA Method SW8082 and listed in Tables 5-1 through 5-23	Possible: mixture with petroleum hydrocarbons for dust control.	Howitzer Test Facility North Valley Military Landfill Ammunition Renovation/Primer Destruction Site
Organochlorine Pesticides; specific compounds analyzed by EPA Method SW8081 and listed in Tables 5-1 through 5-23	Possible: soils testing.	Soil Test Laboratory (Building 540) in Howitzer Test Facility North Valley Military Landfill
Phosphorus	Suspected: residue from flares.	Flare Site

RDX = hexahydro-1,3,5-trinitro-1,3,5-triazine
HMX = octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine
PETN = pentaerythritol tetranitrate
CAM = California Assessment Manual
PAH = polynuclear aromatic hydrocarbon
PCB = polychlorinated biphenyl
OE = ordnance and explosives
VOCs = volatile organic compound

Table 4-2. Potential Association of Metals to Ordnance and Explosives

Metal	Potential Association to OE
Aluminum (Al)	Metal (powder): mixed with TNT to form high explosives
Antimony (Sb)	Metal: small arms and tracer bullets; alloy for hardening of lead bullets; machine tools Sulfide: pyrotechnics and fire-proofing agent
Arsenic (As)	Pyrotechnics, and improving the sphericity of shot
Barium (Ba)	Nitrate: pyrotechnics and signal flares Chromate: pyrotechnics Oxalate: pyrotechnics Peroxide: pyrotechnics Perchlorate: explosives and rocket propellant Tartrate: pyrotechnics Stearate: ammunition binder Sulfide: fireproofing agent Thiosulfate: explosives manufacturing Compounds of nitrate and chlorate used for coloring agent for pyrotechnics
Beryllium (Be)	No identified specific association; can be alloyed with copper or other metals; machine parts
Cadmium (Cd)	No identified specific association; bearings and batteries
Calcium (Ca)	Nitrate: explosives Oxalate: pyrotechnics Resinate: ammunition binder Stearate: ammunition binder
Cobalt (Co)	No identified specific association; machine tools , magnets, and alloyed with other metals
Chromium (Cr)	Chromate: pyrotechnics Associated with steel and used to make armor plate
Copper (Cu)	Metal: component of brass shell casings; jacket for bullets
Iron (Fe)	Metal: component of steel shell casings; bullets
Lead (Pb)	Metal: ammunition Nitrate: pyrotechnics Azide: detonator of various types of detonating fuses Styphnate: primer and detonator mixtures Thiocyanite: ammunition manufacturing
Magnesium (Mg)	Metal (powder): pyrotechnics, flares, and incendiary bombs Carbonate: ammunition
Mercury (Hg)	Fulminate: detonator widely used in explosives
Molybdenum (Mo)	No identified specific association; common lubricant
Nickel (Ni)	Metal (powder): chemical catalyst Metal: component of stainless steel; used to make armor plate; magnets and batteries

Table 4-2. Potential Association of Metals to Ordnance and Explosives
Page 2 of 2

Metal	Potential Association to OE
Phosphorus (P)	Elemental: pyrotechnics, incendiary shells, smoke bombs, tracer bullets
Potassium (K)	Nitrate: gunpowder Chlorate: pyrotechnics Perchlorate: pyrotechnics, rocket fuel
Selenium (Se)	Blasting caps; chemical catalyst
Silver (Ag)	Fulminate: powerful explosive
Sodium (Na)	Nitrate: pyrotechnics, component of dynamite Oxalate: pyrotechnics
Thallium (Tl)	No identified specific association
Vanadium (V)	No identified specific association
Zinc (Zn)	Metal: component of brass Chloride: fireproofing agent for wood

OE = ordnance and explosives
TNT = 2,4,6-trinitrotoluene

Table 4-3. Compounds of Interest Analyzed by Investigative Program

(Page 1 of 2)

Compounds of Interest	TNT Strips				Howitzer				Stockpile#3				NVML				AR/PD				Stockpile#1				Stockpile#2				NV GW				Dynamite			
	Interim	Remedial	Data Gaps	Removal	Interim	Remedial	Data Gaps	Removal	Interim	Remedial	Data Gaps	Removal	Interim	Remedial	Data Gaps	Removal	Interim	Remedial	Data Gaps	Removal	Interim	Remedial	Data Gaps	Removal	Interim	Remedial	Data Gaps	Removal	Interim	Remedial	Data Gaps	Removal	Interim	Remedial	Data Gaps	Removal
Explosives, incl. TNT[1]	X	X	X			X	X		X							X		X			X	X			X	X				X	X					
Nitroglycerin and PETN[2]	X	X	X			X										X		X				X				X				X	X			X	X	
PAHs[3]	X	X				X			X							X		X			X	X			X	X				X						
Metals[4]	X	X				X	X		X							X		X			X	X			X	X				X	X					
TEPH-D/MO/K[5]			X			X										X		X	X											X	X					
VOCs[6]						X	X									X		X	X											X	X					
Nitrate/Nitrite (as N)						X	X									X		X				X				X				X				X	X	
Dioxins/Furans			X			X										X			X																	
Perchlorate																X														X						
Organochlorine Pesticides							X									X															X					
Chloropicrin							X									X															X					
PCBs							X									X			X												X					
Phosphorus																																				
Pentachlorophenol																X																				
Hydrazine																															X					
Other Parameters																																				
Total Organic Carbon																		X												X						
Grain Size																		X												X						
Sulfate																														X	X					
Chloride																														X	X					
Field pH, conductivity																														X	X					
TDS																															X					
TSS																															X					

Table 4-3. Compounds of Interest Analyzed by Investigative Program

(Page 2 of 2)

Compounds of Interest	Flare Site				Demo #1				Demo #2				Demo #3				SV Sed/SW				SV GW				RSP 1 - 9				McAllister LB				Background			
	Interim	Remedial	Data Gaps	Removal	Interim	Remedial	Data Gaps	Removal	Interim	Remedial	Data Gaps	Removal	Interim	Remedial	Data Gaps	Removal	Interim	Remedial	Data Gaps	Removal	Interim	Remedial	Data Gaps	Removal	Interim	Remedial	Data Gaps	Removal	Interim	Remedial	Data Gaps	Removal	Interim	Remedial	Data Gaps	Removal
Explosives, incl. TNT[1]	X	X			X	X			X				X	X			X	X	X			X	X			X										
Nitroglycerin and PETN[2]						X								X				X	X			X	X							X						
PAHs[3]	X	X			X	X			X				X	X			X	X				X	X													
Metals[4]	X	X			X	X			X				X	X			X	X				X	X			X								X		
TEPH-D/MO/K[5]																						X	X			X										
VOCs[6]																						X														
Nitrate/Nitrite (as N)						X								X				X												X						
Dioxins/Furans		X																	X																	
Perchlorate																						X	X													
Organochlorine Pesticides																																				
Chloropicrin																																				
PCBs																																				
Phosphorous		X																																		
Pentachlorophenol																																				
Hydrazine																																				
Other Parameters																																				
Total Organic Carbon																																				
Grain Size																																				
Sulfate																		X																		
Chloride																		X																		
Field pH, conductivity																		X				X														
TDS																		X				X	X													
TSS																		X				X	X													

Notes:

(1) Explosives (EPA Method SW8330 list) including 2,4,6-Trinitrotoluene (TNT

(2) Nitroglycerin and Pentaerythritol Tetranitrate (PETN) by EPA Method SW833(

(3) Polynuclear Aromatic Hydrocarbons (PAHs) (EPA Method SW8310 list
EPA Method SW8270C used if interference with SW8310)

(4) Al, Sb, As, Ba, Be, Cd, Ca, Cr, Co, Cu, Fe, K, Pb, Mg, Mn, Hg, Mo, Ni, P, Se, Ag, Na, Tl, V, and Zn
(SW6010B/SW7470A/SW7471A)

(5) Total Extractable Petroleum Hydrocarbons (TEPH-D/MO/K)
as measured against diesel, motor oil, and kerosene standards

(6) Volatile Organic Compounds (VOCs) (EPA Method SW8260B list)

(7) Polychlorinated Biphenyls (PCBs) (EPA Method SW8082 list

(8) Total Dissolved Solids (TDS) (EPA Method 160.1)

(9) Total Suspended Solids (TSS) (EPA Method 160.2)

NVML	North Valley Military Landfil
AR/PD	Ammunition Renovation/Primer Destruction Site
NVGW	North Valley Groundwatei
Dynamite	Dynamite Burn Site
Demo #1	Demolition Site #1
Demo #2	Demolition Site #2
Demo #3	Demolition Site #3
SV Sed/SW	South Valley Sediment/Surface Watei
SVGW	South Valley Groundwatei
RSP	Ridge Stockpiles
McAllister LB	McAllister Drive Land Bridge
Howitzer	Howitzer Test Facility

Table 4-4. Summary of Interim Investigation Program - May to July 1999

AREAS OF INTEREST	NORTH VALLEY		
	TNT Strips	**Howitzer Test Facility**	**Stockpile #3**
Scope of Investigation	Soil samples collected from the following borehole locations: TNT Strip #1 3 boreholes on axis of strip (TNT-1A, TNT-1B, TNT-1C). TNT Strip #2 3 boreholes on axis of strip (TNT-2A, TNT-2B, TNT-2C). 2 step-out boreholes (TNT-2D, TNT-2E). TNT Strip #3 3 boreholes on axis of strip (TNT-3A, TNT-3B, TNT-3C). TNT Strip #4 3 boreholes on axis of strip (TNT-4A, TNT-4B, TNT-4C). TNT Strip #5 3 boreholes on axis of strip (TNT-5A, TNT-5B, TNT-5C). 2 boreholes on possible southern extension near the western end of the strip (TNT-5D, TNT-5E).	Site not included in interim investigation.	Soil samples collected from 4 discrete locations (SP3-1, SP3-2, SP3-3, SP3-4).
Media Sampled & Analyses Performed	Soil samples analyzed for the following: - Explosives, including nitroglycerin and PETN - PAHs - Metals One soil sample collected at 1-foot bgs from TNT Strip #2 and from TNT Strip #5 analyzed for dioxins/furans.	No boreholes advanced or soil samples collected.	Soil samples analyzed for the following: - Explosives - PAHs - Metals Samples requiring dilution during PAH analysis, due to matrix interference, were reanalyzed using EPA Method SW8270C (SVOCs).
Comments	Maximum depth of boreholes range from 2.5 to 4.5 feet bgs. Surface soil screening level SECOR data on or very near axis of TNT Strip #2 (SS-1), TNT Strip #4 (SS-2, SS-3), TNT Strip #5 (SS-4, SS-5). Surface soil field screening level SECOR data on or very near axis of TNT Strip #4 (FSS-10, FSS-36, FSS-41). Other surface soil field screening level SECOR data in general vicinity of TNT Strips area i.e., north slope of North Valley (SS-6, SS-37, SS-38, FSS-9, FSS-31, FSS-33, FSS-34, FSS-35, FSS-37, FSS-38, FSS-39, FSS-40).	Surface soil screening level SECOR data within Howitzer Test Facility (SS-19).	Samples collected approximately 2 feet below stockpile surface.

Table 4-4. Summary of Interim Investigation Program - May to July 1999
Page 2 of 4

AREAS OF INTEREST	NORTH VALLEY		
	Ammunition Renovation/Primer Destruction Site	**Stockpile #1 & Stockpile #2**	**North Valley Groundwater**
Scope of Investigation	Site not included in interim investigation.	Soil samples collected from 2 discrete locations at Stockpile #1 (SP1-A, SP1-B). Soil samples collected from 2 discrete locations at Stockpile #2 (SP2-A, SP2-B).	Groundwater not included in interim investigation.
Media Sampled & Analyses Performed	No boreholes advanced or soil samples collected.	Soil samples analyzed for the following: - Explosives - PAHs - Metals Samples requiring dilution during PAH analysis, due to matrix interference, were reanalyzed using EPA Method SW8270C (SVOCs).	No monitoring wells installed or groundwater samples collected.
Comments	Surface soil field screening level SECOR data within Ammunition Renovation/Primer Destruction Site (FSS-32).	Samples collected approximately 2 feet below stockpile surface.	

	NORTH VALLEY	RIDGE	SOUTH VALLEY
	North Valley Military Landfill	**Dynamite Burn Site**	**Flare Site**
Scope of Investigation	Site not included in interim investigation.	Site not included in interim investigation.	Soil samples collected from 3 borehole locations (FA-1, FA-2, FA-3).
Media Sampled & Analyses Performed	No boreholes advanced or soil samples collected.	No boreholes advanced or soil samples collected.	Soil samples analyzed for the following: - Explosives - PAHs - Metals One soil sample collected at 0.5-foot bgs from Flare Site analyzed for dioxins/furans.
Comments			Maximum depth of boreholes 2.5 feet bgs. Surface soil screening level SECOR data at Flare Site (SS-22). Surface soil field screening level SECOR data at Flare Site (FSS-29). Other surface soil field screening level SECOR data in general vicinity of Flare Site (FSS-21).

Table 4-4. Summary of Interim Investigation Program - May to July 1999

AREAS OF INTEREST	SOUTH VALLEY		
	Demolition Site #1	**Demolition Site #2**	**Demolition Site #3**
Scope of Investigation	Soil samples collected from 2 borehole locations (DA1-1, DA1-2).	Soil samples collected from 2 borehole locations (DA2-1, DA2-2).	Soil samples collected from 2 borehole locations (DA3-1, DA3-2).
Media Sampled & Analyses Performed	Soil samples analyzed for the following: - Explosives - PAHs - Metals	Soil samples analyzed for the following: - Explosives - PAHs - Metals	Soil samples analyzed for the following: - Explosives - PAHs - Metals
Comments	Maximum depth of boreholes 4.5 feet bgs. Surface soil screening level SECOR data at Demolition Site #1 (SS-24). Other surface soil field screening level SECOR data in general vicinity of Demolition Site #1 (FSS-24, FSS-25, FSS-26, FSS-27).	Maximum depth of boreholes 4.5 feet bgs. Surface soil screening level SECOR data at Demolition Site #2 (SS-23). Other surface soil field screening level SECOR data in general vicinity of Demolition Site #2 (FSS-22, FSS-23, FSS-28).	Maximum depth of boreholes 4.5 feet bgs. Surface soil screening level SECOR data at Demolition Site #3 (SS-26, SS-27, SS-28). Other surface soil screening level SECOR data in general vicinity of Demolition Site #2 (SS-25, SS-29). Surface soil field screening level SECOR data at Demolition Site #3 (FSS-3). Other surface soil field screening level SECOR data in general vicinity of Demolition Site #3 (FSS-11).

	SOUTH VALLEY		OTHER ACTIVITIES OUTSIDE "AREAS OF INTEREST"
	Wetlands Sediment & Surface Water	**South Valley Groundwater**	**Ridge Stockpile #1 through #9**
Scope of Investigation	Sediment sample collected from 1 location (WET-1B). No surface water samples collected.	Groundwater not included in interim investigation.	No soil samples collected.
Media Sampled & Analyses Performed	Sediment sample analyzed for the following: - Explosives - PAHs - Metals	No monitoring wells installed or groundwater samples collected.	Not applicable.
Comments	Sample collected from upper 6 inches of sediment. Screening level SECOR data include surface water samples (WS-1, WS-2).		Site not included in interim investigation.

Table 4-4. Summary of Interim Investigation Program - May to July 1999
Page 4 of 4

AREAS OF INTEREST	OTHER ACTIVITIES OUTSIDE "AREAS OF INTEREST"		
	McAllister Drive Land Bridge	Ambient	Geotechnical/Seismic
Scope of Investigation	Site not included in interim investigation.	Not included in interim investigation.	A seismic survey was conducted in South Valley to estimate thickness and overburden and highly weathered bedrock overlying unweathered bedrock.
Media Sampled & Analyses Performed	No boreholes advanced or soil samples collected.	No boreholes advanced or soil samples collected for analysis outside areas of interest.	Not applicable.
Comments		Other surface soil and field screening level SECOR data: -Northeast of the McAllister Drive Land Bridge (SS-7, SS-8, SS-9, SS-10, SS-11, SS-14, SS-15, SS-16, SS-17, SS-18) - South Slope of South Valley (SS-13, SS-21, FSS-19, FSS-20, FSS-30) -North Slope of South Valley (SS-12, SS-30, SS-31, SS-32, SS-33, SS-41, SS-42, SS-43, SS-44, FSS-1, FSS-2, FSS-4, FSS-5, FSS-6, FSS-7, FSS-8, FSS-12, FSS-13, FSS-14, FSS-15, FSS-16, FSS-17, FSS-18) -South Slope of North Valley (SS-20, SS-35, SS-40) - Floor of North Valley (SS-36, SS-39)	22 boreholes, 4 trenches and 10 ten test pits advanced by ENGEO within and in the general vicinity of Project, provide site-specific geologic information.

Samples analyzed by the following EPA Test Methods:
- Explosives, including nitroglycerin and pentaerythritol tetranitrate (PETN), by EPA Method SW8330
- Polynuclear aromatic hydrocarbons (PAHs) by EPA Method SW8310
- Semi-volatile organic compounds (SVOCs) by EPA Method SW8270C
- California Assessment Manual (CAM) 17 metals by EPA Methods SW6010B, SW7470A, and SW7471A
- Dioxins/furans by EPA Method SW8290

ENGEO data collected in two phases of investigation November/December 1988 and January/February 1990.
SECOR data collected in late 1998. SS-series soil samples were analyzed for the metals antimony, manganese, potassium, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, molybdenum, nickel, selenium, silver, thallium, vanadium, zinc, and mercury by EPA Method SW6010A/7000 series, explosives by EPA Method SW8330, phosphate by EPA Method 365.3, and nitrate as nitrogen and nitrate/nitrite as nitrogen by EPA Method 353.2. The FSS-series soil samples were analyzed for 2,4,6-trinitrotoluene (TNT) and the high melting explosive RDX (hexahydro-1,3,5-trinitro-1,3,5,7-tetrazocine [Cyclonite]) using the Ensys® Soil Test System, a field testing method.

bgs = below ground surface

Table 4-5. Summary of Remedial Investigation Program - December 1999

AREAS OF INTEREST	NORTH VALLEY		
	TNT Strips	Howitzer Test Facility	Stockpile #3
Scope of Investigation	Soil samples collected from the following borehole locations: <u>TNT Strip #1</u> 9 TNT-1C series step-out boreholes (TNT-1C2, -1C3, -1C4, -1C5,-1C6, -1C7, -1C8, -1C9, -1C10) 9 TNT-1F series step-out boreholes (TNT-1F, -1F2, -1F3, -1F4, -1F5, -1F6, -1F7, -1F8, -1F9) 7 boreholes along possible southeastern extension of TNT Strip #1 (TNT-1D, -1E, -1G, -1H, -1J, -1K, -1L) 3 surface samples collected over the ridgeline to the northeast of TNT Strip #1 (TNT-1I, -1M, -1N) <u>TNT Strip #4</u> 13 TNT-4C series step-out boreholes (TNT-4C1, -4C2, -4C3, -4C4, -4C5, -4C6, -4C7, -4C8, -4C9, -4C11, -4C12, -4C13, -4C14) <u>TNT Strip #5</u> 9 TNT-5A series step-out boreholes (TNT-5A1, -5A2, -5A3, -5A4, -5A5, -5A6, -5A8, -5A9, -5A10) 3 boreholes along possible southern extension at western end of TNT Strip #5 (TNT-5G, -5H, -5I) 3 boreholes along possible southern extension near western end of TNT Strip #5 (TNT-5F, -5J, -5L)	Soil samples collected from 4 borehole locations (HF-1, HF-2, HF-4, HF-4). Soil samples collected from 3 additional boreholes (TW-4, TW-5, TW-6), advanced as part of the North Valley hydrogeologic investigation (see North Valley Groundwater).	Site not included in remedial investigation.
Media Sampled & Analyses Performed	All soil samples analyzed for the following: - Explosives (on-site mobile analytical laboratory) Selected soil samples from TNT-1C series also analyzed for the following: - PAHs (on-site mobile analytical laboratory) - Metals (off-site analytical laboratory) Minimum10 percent confirmation soil samples analyzed for explosives, including nitroglycerin and PETN (off-site analytical laboratory)	Soil samples analyzed for the following: - Explosives, including nitroglycerin and PETN - PAHs - TEPH-D/MO/K - VOCs - Metals - Nitrate/nitrite as nitrogen Two soil samples collected at 5.5 feet and 10.5 feet bgs from TW-5 analyzed for dioxins/furans.	No stockpile soil samples collected.
Comments	Maximum depth of boreholes on axis of TNT Strips range from 3 to 4 feet bgs Maximum depth of boreholes off the TNT Strips range from 2 to 11.5 feet bgs Two additional boreholes TNT-1CY (primary) and TNT-1CAY (replicate/split) advanced; soil samples collected from cuttings.	Maximum depth of boreholes at the Howitzer Test Facility range from 6 to 25 feet bgs. Groundwater encountered at TW-4 at 22 feet bgs, groundwater monitoring well installed (see North Valley Groundwater).	

Table 4-5. Summary of Remedial Investigation Program - December 1999

AREAS OF INTEREST	NORTH VALLEY		
	Ammunition Renovation/Primer Destruction Site	**Stockpile #1 & Stockpile #2**	**North Valley Groundwater**
Scope of Investigation	Soil samples collected from 4 borehole locations (AR-1, AR-2, AR-3, AR-4). Soil samples collected from 2 additional boreholes (TW-1, TW-7), advanced as part of the North Valley hydrogeologic investigation (see North Valley Groundwater).	Soil sample collected from 1 discrete location at Stockpile #1 (SP1-C) Soil sample collected from 1 discrete location at Stockpile #2 (SP2-C)	Nine boreholes (TW-1, TW-2, TW-3, TW-4, TW-5, TW-6, TW-7, TW-8, TW-9) advanced to evaluate depth and quality of groundwater in North Valley. Groundwater encountered at 2 locations, single-cased temporary groundwater monitoring wells (TW-3, TW-4) installed.
Media Sampled & Analyses Performed	Soil samples analyzed for the following: - Explosives, including nitroglycerin and PETN - PAHs - TEPH-D/MO/K - VOCs - Metals - Nitrate/nitrite as nitrogen Two bulk soil samples collected from TW-1 analyzed for total organic carbon, and grain size.	Soil samples analyzed for the following: - Explosives, including nitroglycerin and PETN - PAHs - TEPH-D/MO/K - Metals - Nitrate/nitrite as nitrogen	See Howitzer Test Facility for soil sample analysis for TW-4, TW-5, TW-6. See Ammunition Renovation/Primer Destruction Site for soil sample analysis for TW-1, TW-7. One soil sample collected from bottom of boreholes TW-8 and TW-9 analyzed for the following: - Explosives, including nitroglycerin and PETN - PAHs - TEPH-D/MO/K - VOCs A soil sample collected from bottom of borehole TW-8 analyzed for metals, sulfate, chloride, and nitrate/nitrite. A soil sample collected from bottom of borehole TW-9 analyzed for perchlorate. Bulk soil samples from TW-1 and TW-2 analyzed for grain size. Bulk soil samples collected from TW-2 and TW-8 analyzed for total organic carbon. No soil samples collected from TW-2 and TW-3 were analyzed for compounds of interest. Groundwater samples from temporary wells TW-3 and TW-4 analyzed for the following: - Explosives, including nitroglycerin and PETN - PAHs - TEPH-D/MO/K - VOCs - Dissolved Metals - Perchlorate - General water chemistry - Field Parameters
Comments	Maximum depth of boreholes at the Ammunition Renovation/ Primer Destruction Site range from 10 to 31 feet bgs.	Samples collected approximately 2 feet below stockpile surface	Maximum depth of boreholes advanced as part of North Valley hydrogeologic investigation ranges from 9.5 to 31.5 feet bgs.

Table 4-5. Summary of Remedial Investigation Program - December 1999

AREAS OF INTEREST	NORTH VALLEY	RIDGE	SOUTH VALLEY
	North Valley Military Landfill	**Dynamite Burn Site**	**Flare Site**
Scope of Investigation	Site not included in remedial investigation.	Surface bedrock samples collected from 4 locations (R1-A, R1-B, R1-C, R1-D).	Soil samples collected from 3 boreholes locations (FA-4, FA-5, FA-6).
Media Sampled & Analyses Performed	No boreholes advanced or soil samples collected.	Samples analyzed for the following: - Nitroglycerin and PETN - Nitrate/nitrite as nitrogen	Soil samples analyzed for the following: - Metals One soil sample collected at 1 foot bgs from center of the Flare Site analyzed for explosives, PAHs, dioxins/furans, and nitrate/nitrite as nitrogen.
Comments		When the Dynamite Burn Site was operational the Ridge was approximately 20 to 40 feet higher than its current elevation.	Maximum depths of boreholes range from 3.5 to 6.5 feet bgs.

	SOUTH VALLEY		
	Demolition Site #1	**Demolition Site #2**	**Demolition Site #3**
Scope of Investigation	Soil samples collected from sidewalls from incised channel running through Demolition Site #1 (DA1-3W1, DA1-3W2).	Site not included in remedial investigation.	Soil samples collected from 4 borehole locations (DA3-3, DA3-4, DA3-5, DA3-6).
Media Sampled & Analyses Performed	Soil samples analyzed for the following: - Explosives, including nitroglycerin and PETN - PAHs - Metals - Nitrate/nitrite as nitrogen	No boreholes advanced or soil samples collected.	Soil samples analyzed for the following: - Explosives - PAHs - Metals Two soil samples collected from 8 feet and 10 feet bgs at Demolition Site #3 analyzed for nitroglycerin and PETN. One sample collected from 10.5 feet bgs also analyzed for nitrate/nitrite as nitrogen.
Comments		Since no physical evidence or ordnance-related activities have been found at Demolition Site #2, the site was eliminated from further investigation.	Maximum depth of boreholes from 8.5 to17 feet bgs.

AREAS OF INTEREST	SOUTH VALLEY		OTHER ACTIVITIES OUTSIDE "AREAS OF INTEREST"
	Wetlands Sediment & Surface Water	South Valley Groundwater	Ridge Stockpile #1 through #9
Scope of Investigation	Sediment sample collected from 2 locations (WET-1, WET-2) Surface water samples collected from 2 locations (SW-1, SW-2)	Two boreholes (TW-11, TW-12) advanced to evaluate depth and quality of groundwater in South Valley. Groundwater encountered at 1 location, single-cased permanent groundwater monitoring well (TW-12) installed.	Four samples collected from each stockpile (RSP-1, RSP-2, RSP-3, RSP-4, RSP-5, RSP-6, RSP-7, RSP-8, RSP-9). Each set of four samples composited into a single sample for analysis.
Media Sampled & Analyses Performed	Sediment sample analyzed for the following: - Explosives, including nitroglycerin and PETN - PAHs - Metals - Nitrate/nitrite as nitrogen Surface water analyzed for the following: - Explosives, including nitroglycerin and PETN - PAHs - Total and Dissolved Metals - General water chemistry	Soil samples collected between 15 and 16.5 feet bgs from bottom of borehole TW-11 analyzed for the following: - Explosives, including nitroglycerin and PETN - PAHs - TEPH-D/MO/K - VOCs - Metals Groundwater sample from TW-12 analyzed for the following: - Explosives, including nitroglycerin and PETN - PAHs - VOCs - Dissolved Metals - General water chemistry - Field Parameters	Soil samples analyzed for the following: - Explosives - TEPH-D/MO - Metals
Comments	Sample collected from upper 6 inches of sediment Surface water and sediment samples collected in close proximity to one another.	One additional borehole TW-10 was proposed in the final Work Plan (Earth Tech, 2000b), but was not advanced during remedial investigation (see Data Gaps Investigation Program).	Samples collected approximately 2 feet below stockpile surface.

AREAS OF INTEREST	OTHER ACTIVITIES OUTSIDE "AREAS OF INTEREST"		
	McAllister Drive Land Bridge	Ambient	Geotechnical/Seismic
Scope of Investigation	Soil samples collected from three borehole locations (LB-1, LB-2, LB-3) at the upgradient toe of the Land Bridge. Soil samples collected from three borehole locations (LB-4, LB-5, LB-6)at the downgradient toe of the Land Bridge.	Surface soil samples collected from 20 locations (19, 27, 38, 44, 50, 68, 89, 99, 100, 118, 129, 132, 146, 170, 173, 179, 184, 210, 238, 241) based on a systemic random sampling design outside areas of interest.	Site not included in remedial investigation.
Media Sampled & Analyses Performed	Soil samples collected at 4.5 feet bgs from all boreholes (except LB-2) analyzed for the following: - Nitroglycerin and PETN - Nitrate/nitrite as nitrogen Soil sample collected from borehole LB-2 at 14.5 feet bgs analyzed for nitroglycerin/PETN and nitrate/nitrite as nitrogen. One sample collected from borehole LB-3 at 4.5 feet bgs analyzed for metals.	Soil samples analyzed for the following: - Metals	Not applicable
Comments		Surface samples collected from the following three areas: - Ridge area northeast of the McAllister Drive Land Bridge - Areas northwest and southwest of the TNT Strips - Western end of the South Valley	

Samples analyzed by the following EPA Test Methods:
- Explosives, including nitroglycerin and pentaerythritol tetranitrate (PETN), by EPA Method SW8330
- Polynuclear aromatic hydrocarbons (PAHs) by EPA Method SW8310
- Total extractable petroleum hydrocarbons quantified against a diesel, motor oil, and kerosene standard (TEPH-D/MO/K), respectively, by California LUFT Modified EPA Method SW8015B
- Volatile organic compounds (VOCs) by EPA Method SW8260B
- Semi-volatile organic compounds (SVOCs) by EPA Method SW8270C
- California Assessment Manual (CAM) 17 metals, plus aluminum, calcium, iron, manganese, magnesium, potassium, phosphorus (total), and sodium by EPA Methods SW6010B, SW7470A, and SW7471A
- Organochlorine pesticides by EPA Method SW8081A
- Polychlorinated biphenyls (PCBs) by EPA Method SW8082
- Dioxins/furans by EPA Method SW8290
- Chloropicrin and pentachlorophenyl by EPA Method SW8270C
- Perchlorate by California Department of Health Services (CADOHS) 300.0 Modified
- Hydrazine by Modified EPA Method SW8315
- Nitrate/nitrite as nitrogen by EPA Method 300.0
- General water chemistry (chloride, nitrate/nitrite, sulphate by EPA Method 300.0, total organic carbon by EPA Method 415.1, TDS by EPA Method 160.1, and TSS by EPA Method 160.2)
- Field parameters (temperature by EPA Method 170.1, pH by EPA Method 150.1, electrical conductivity by EPA Method 120.1, and turbidity by EPA Method 180.1)

bgs = below ground surface

Table 4-6. Summary of Data Gaps Investigation Program - February to August 2000

AREAS OF INTEREST	NORTH VALLEY		
	TNT Strips	**Howitzer Test Facility**	**Stockpile #3**
Scope of Investigation	Soil samples collected from the following borehole locations: <u>TNT Strip #1</u> 2 boreholes on axis of strip (TNT-1P, TNT-1Q) <u>TNT Strip #2</u> 1 borehole on axis of strip (TNT-2F) Surface soil samples collected from 5 locations (TNT-R1, -R2, -R3, -R4, -5R) along the ridgeline from TNT Strip #1 to the north/northeast.	Soil samples collected from 5 borehole locations (HF-5, HF-6, HF-7, HF-8, HF-9). Soil samples collected from 2 additional boreholes (MW-5, MW-6), advanced as part of the North Valley hydrogeologic investigation (see North Valley Groundwater).	See Comments.
Media Sampled & Analyses Performed	All soil samples from TNT Strips analyzed for the following: - Explosives - TEPH-D/MO/K All surface soil samples from over ridgeline analyzed for explosives. Two soil samples collected at 1 foot bgs from TNT Strip#1 and TNT Strip #2, respectively, and one sample collected at 4 feet bgs from TNT Strip #1 analyzed for dioxins/furans.	Soil samples from borehole HF-8 analyzed for the following: - Pesticides - Chloropicrin Soil samples from boreholes HF-5 through HF-9 analyzed for the following: - Explosives - VOCs One soil samples collected at 10.5 feet bgs from MW-5 analyzed for dioxins/furans. Soil samples from MW-6 analyzed for the following: - Explosives - Metals - Nitrate/nitrite as nitrogen	See Comments.

Table 4-6. Summary of Data Gaps Investigation Program - February to August 2000

AREAS OF INTEREST	NORTH VALLEY		
	TNT Strips	Howitzer Test Facility	Stockpile #3
Comments	Maximum depth of boreholes on axis of TNT Strips 47 to 50 feet bgs. 3 cores from 3 boreholes (TNT-1P, TNT-1Q, TNT-2F) up to 44 to 46.5 feet within bedrock to evaluate hardness, strength, degree of weathering, degree of fracturing, amount of discoloration or staining, stratification. Based on preliminary data obtained while data gaps investigation on-going, surface sample from TNT-1P also analyzed for PCBs to evaluate possible correlation between petroleum hydrocarbons and PCBs. Based on preliminary data obtained from the ridgeline surface soil samples, near-surface soil samples from 10 on-site locations (TNT-R6 through TNT-R15) and 9 off-site locations (TNT-R21 through TNT-R29) and analyzed for explosives including nitroglycerin and PETN to further define lateral extent of explosive-impacted soil. Based on preliminary data obtained from the toe of the south-facing slope, 5 additional boreholes (TNT-R16 through TNT-R20) advanced along slope to further define lateral and vertical extent of explosive-impacted soil.	Maximum depth of boreholes at the Howitzer Test Facility range from 10.5 to 26.5 feet bgs. Based on the results of the remedial investigation data validation and verification an additional borehole (HF-3R) was advanced and soil samples analyzed for TEPH-D/MO/K. Based on preliminary data obtained while data gaps investigation on-going, near-surface sample from HR-3R also analyzed for PCBs. Based on preliminary data obtained while data gaps investigation on-going, an additional near-surface sample (HF-2R) collected and analyzed for TEPHs and PCBs to evaluate possible correlation between petroleum hydrocarbons and PCBs. Groundwater encountered at HF-5 and HF-8 at 18 and 13 feet bgs, respectively. Groundwater encountered at MW-6 at 14 feet bgs, groundwater monitoring well installed. No groundwater was encountered during advancement of MW-5; however, a groundwater monitoring well was installed (see North Valley Groundwater).	Based on the results of the remedial investigation data validation and verification an additional stockpile sampling was performed. Four samples collected from each quarter of the stockpile (SP3-R1[A, B, C, D], SP3-R2[A, B, C, D], SP3-R3[A, B, C, D], SP3-R4[A, B, C, D]). Each set of four samples composited into a single sample for analysis. Samples collected approximately 2 feet below stockpile surface. Samples analyzed for the TEPH-D/MO/K and PAHs. PAHs analyzed by EPA Method SW8270C (SVOCs) due to possible petroleum hydrocarbon matrix interference.
	NORTH VALLEY		
	Ammunition Renovation/Primer Destruction Site	**Stockpile #1 & Stockpile #2**	**North Valley Groundwater**
Scope of Investigation	Soil samples collected from 8 borehole locations (AR-5, AR-6, AR-7, AR-8, AR-9, AR-10, AR-11, AR-12). Soil samples collected from 2 additional boreholes (MW-1, MW-7), advanced as part of the North Valley hydrogeologic investigation (see North Valley Groundwater).	See comments.	Ten single-cased groundwater monitoring wells (MW-1, MW-2, MW-5, MW-6, MW-7, MW-8, MW-9, MW-13, MW-14, MW-15) to evaluate depth and quality of shallow groundwater in North Valley. Two double-cased monitoring wells (MW-3B and MW-4A) to evaluate depth and quality of bedrock groundwater in North Valley. Existing temporary groundwater monitoring wells TW-3 and TW-4 converted into permanent groundwater monitoring wells and renamed MW-3(TW-3) and MW-4(TW-4).

Table 4-6. Summary of Data Gaps Investigation Program - February to August 2000

AREAS OF INTEREST	NORTH VALLEY		
	Ammunition Renovation/Primer Destruction Site	**Stockpile #1 & Stockpile #2**	**North Valley Groundwater**
Media Sampled & Analyses Performed	All soil samples from AR boreholes analyzed for the following: - VOCs (excluding surface sample) - TEPH-D/MO/K One sample collected at 1 foot bgs from borehole AR-7 analyzed for dioxins/furans. All soil samples collected from MW boreholes analyzed for the following: - TEPH-D/MO/K Surface soil sample collected from MW-7 analyzed for PCBs. Soil samples from MW-1 collected between 17.5 and 24 feet bgs also analyzed for VOCs and dioxins/furans (two of three samples only).	See comments.	See Howitzer Test Facility for soil sample analysis for MW-1, MW-7. See Ammunition Renovation/Primer Destruction Site for soil sample analysis for MW-5, MW-6. Soil samples collected from MW-2, MW-3A, MW-8, MW-9, MW-13, MW-14, MW-15 analyzed for the following: - Explosives - TEPH-D/MO/K - VOCs <u>April 2000 Monitoring Event</u> Groundwater samples from MW-3(TW-3) and MW-4(TW-4) analyzed for the following: - Explosives, including nitroglycerin and PETN - TEPH-D/MO/K - Organochlorine Pesticides - Hydrazine - Chloropicrin - General water chemistry Groundwater samples from all remaining wells in North Valley and three seeps analyzed for the following: - Explosives, including nitroglycerin and PETN - PAHs - TEPH-D/MO/K - VOCs - Dissolved Metals - Organochlorine Pesticides - Hydrazine - Perchlorate - General water chemistry - Field Parameters

Table 4-6. Summary of Data Gaps Investigation Program - February to August 2000

AREAS OF INTEREST	NORTH VALLEY		
	Ammunition Renovation/Primer Destruction Site	Stockpile #1 & Stockpile #2	North Valley Groundwater
Comments	Maximum depth of boreholes at the Ammunition Renovation/Primer Destruction Site ranges from 11 to 44 feet bgs. 1 core from 1 borehole (AR-7) up to 30 feet within unweathered bedrock to evaluate hardness, strength, degree of weathering, degree of fracturing, amount of discoloration or staining, stratification. No groundwater was encountered during advancement of MW-1 and MW-7; however, groundwater monitoring wells were installed (see North Valley Groundwater). Based on preliminary data obtained while data gaps investigation on-going, additional near-surface samples (MW-1 and AR-1R, -2R, -4R, -7R, -8R, 9R, -10R) were collected and analyzed for TEPHs and PCBs to evaluate possible correlation between petroleum hydrocarbons and PCBs.	Based on the results of the remedial investigation data validation and verification an additional stockpile sampling was performed. Four samples collected from each half of the stockpile (SP1-R1[A, B, C, D], SP1-R2[A, B, C, D] and SP2-R1[A, B, C, D], SP2-R2[A, B, C, D]). Each set of four samples composited into a single sample for analysis. Samples collected approximately 2 feet below stockpile surface. Samples analyzed for the TEPH-D/MO/K and PAHs. PAHs analyzed by EPA Method SW8270C (SVOCs) due to possible petroleum hydrocarbon matrix interference.	Maximum depth of boreholes advanced as part of North Valley hydrogeologic investigation range from 9.5 to 55 feet bgs. 3 cores from 3 boreholes (MW-3A, MW-3B, MW-4A) between 24.6 and 35 feet into bedrock to evaluate hardness, strength, degree of weathering, degree of fracturing, amount of discoloration or staining, stratification. No groundwater was encountered during advancement of boreholes for North Valley wells; however, groundwater was encountered after well installation. Grout intrusion during setting of the conductor casing of MW-3A. Monitoring well MW-3B was installed as a replacement well. Given that only grab groundwater samples were collected from wells MW-3(TW-3) and MW-4(TW-4) (i.e., the wells had not been fully developed) during the remedial investigation it was decided to collect additional groundwater samples (after proper well development) for analysis of PAHs, VOCs, dissolved metals, and perchlorate to avoid potential future data gaps. Based on preliminary data obtained while data gaps investigation on-going, additional near-surface samples (MW-14 and MW-15) were collected and analyzed for TEPHs and PCBs to evaluate possible correlation between petroleum hydrocarbons and PCBs. Groundwater samples from wells MW-3(TW-3), MW-4(TW-4) and MW-7 were also analyzed for PCBs. August 2000 Monitoring Event Supplemental groundwater samples collected from wells with sufficient water analyzed for explosives (excluding nitroglycerin and PETN), PAHs, TEPH-D/MO/K, VOCs, total and dissolved metals (including strontium), organochlorine pesticides, and field parameters. Wells MW-5, MW-13, and MW-15 were dry during August 2000 event, as were all North Valley seeps. Field Permeability Testing Falling head permeability test conducted on wells MW-2, MW-3B, MW-4A, and MW-6.

Table 4-6. Summary of Data Gaps Investigation Program - February to August 2000

AREAS OF INTEREST	NORTH VALLEY	RIDGE	SOUTH VALLEY
	North Valley Military Landfill	**Dynamite Burn Site**	**Flare Site**
Scope of Investigation	Site not included in data gaps investigation.		Site not included in data gaps investigation.
Media Sampled & Analyses Performed	No boreholes advanced or soil samples collected.		No boreholes advanced or soil samples collected.
Comments		Based on updated aerial photograph review. Surface bedrock samples collected from 3 additional locations (R1-E, R1-F, R1-G). Samples analyzed for the following: - Nitroglycerin and PETN - Nitrate/nitrite as nitrogen	
	SOUTH VALLEY		
	Demolition Site #1	**Demolition Site #2**	**Demolition Site #3**
Scope of Investigation	Site not included in data gaps investigation. No boreholes advanced or soil samples collected.	Site not included in data gaps investigation. No boreholes advanced or soil samples collected.	Site not included in data gaps investigation. No boreholes advanced or soil samples collected.
Comments			
	SOUTH VALLEY		**OTHER ACTIVITIES OUTSIDE "AREAS OF INTEREST"**
	Wetlands Sediment & Surface Water	**South Valley Groundwater**	**Ridge Stockpiles #1 through #9**
Scope of Investigation	Sediment sample collected from 1 location (WET-2R) Surface water samples collected from 2 locations (SW-1R, SW-2R)	Two single-cased groundwater monitoring wells (MW-10, MW-11) to evaluate depth and quality of shallow groundwater in South Valley. Existing groundwater monitoring well TW-12 renamed MW-12(TW-12).	Site not included in data gaps investigation.

Table 4-6. Summary of Data Gaps Investigation Program - February to August 2000

AREAS OF INTEREST	SOUTH VALLEY		OTHER ACTIVITIES OUTSIDE "AREAS OF INTEREST"
	Wetlands Sediment & Surface Water	**South Valley Groundwater**	**Ridge Stockpiles #1 through #9**
Media Sampled & Analyses Performed	Sediment sample analyzed for dioxins/furans. Surface water analyzed for explosives, including nitroglycerin and PETN.	No soil samples collected for analysis. April 2000 Monitoring Event Groundwater samples from new wells in South Valley and one seep analyzed for the following: - Explosives, including nitroglycerin and PETN - PAHs - VOCs - Dissolved Metals - Perchlorate - Hydrazine - General water chemistry - Field Parameters Groundwater sample from MW-12(TW-12) analyzed for the following: - Explosives, including nitroglycerin and PETN - Hydrazine - General water chemistry - Field Parameters	No stockpile samples collected.
Comments	Sample collected from upper 6 inches of sediment Surface water and sediment samples collected in close proximity to samples collected during remedial investigation. Supplemental sediment samples collected from 5 additional locations (WET-3, WET-4, WET-5, WET-6, WET-7). Sediment samples analyzed for the following: - Mercury (total) - Methyl mercury	Maximum depth of boreholes ranges from 15.5 to 23 feet bgs. Groundwater encountered at 3.5 feet (MW-10) and 14 feet (MW-11) bgs. August 2000 Monitoring Event Supplemental groundwater samples collected from all wells analyzed for explosives (excluding nitroglycerin and PETN), PAHs, TEPH-D/MO/K, VOCs, total and dissolved metals (including strontium), organochlorine pesticides, and field parameters. South Valley seeps were all dry. Field Permeability Testing Falling head permeability test conducted on wells MW-10, MW-11.	

Table 4-6. Summary of Data Gaps Investigation Program - February to August 2000

	OTHER ACTIVITIES OUTSIDE "AREAS OF INTEREST"		
	McAllister Drive Land Bridge	**Ambient**	**Geotechnical/Seismic**
Scope of Investigation	Site not included in data gaps investigation.	Not included in data gaps investigation.	Thirty boreholes advanced throughout the Project Site: - Upper south slope of South Valley, by Casey Court (GB-1, GB-2, GB-3, GB-9) - Sewer bench (GB-4, GB-5, GB-6, GB-7, GB-8, GB-12, GB-13, GB-14, GB-15, GB-16) - South Valley wetlands (GB-10, GB-11, GB-17) - Northeast of McAllister Drive Land Bridge (GB-18, GB-19, GB-20, GB-21) - South slope of Ridge (GB-27, GB-28, GB-29, GB-30) - North slope of Ridge (GB-22, GB-23, GB-24, GB-25) - North slope of North Valley (GB-26)
Media Sampled & Analyses Performed	No boreholes advanced or soil sample collected.	No boreholes advanced or soil samples collected for analysis outside areas of interest.	Not sampled.
Comments			Maximum depth of boreholes ranged from 3 to 26.5 feet bgs. Provide site-specific geologic information, specifically depth to bedrock, and whether sewer line was installed in bedrock or overburden

Samples analyzed by the following EPA Test Methods:
- Explosives, including nitroglycerin and pentaerythritol tetranitrate (PETN), by EPA Method SW8330
- Polynuclear aromatic hydrocarbons (PAHs) by EPA Method SW8310
- Total extractable petroleum hydrocarbons quantified against a diesel, motor oil, and kerosene standard (TEPH-D/MO/K), respectively, by California LUFT Modified EPA Method SW8015B
- Volatile organic compounds (VOCs) by EPA Method SW8260B
- Semi-volatile organic compounds (SVOCs) by EPA Method SW8270C
- California Assessment Manual (CAM) 17 metals, plus aluminum, calcium, iron, manganese, magnesium, potassium, phosphorus (total), and sodium by EPA Methods SW6010B, SW7470A, and SW7471A
- Methyl mercury by Frontier GeoScience proprietary Method FGS-070.1
- Organochlorine pesticides by EPA Method SW8081A
- Polychlorinated biphenyls (PCBs) by EPA Method SW8082
- Dioxins/furans by EPA Method SW8290
- Chloropicrin and pentachlorophenol by EPA Method SW8270C
- Perchlorate by California Department of Health Services (CADOHS) 300.0 Modified
- Hydrazine by Modified EPA Method SW8315
- Nitrate/nitrite as nitrogen by EPA Method 300.0
- General water chemistry (chloride, nitrate/nitrite, sulphate by EPA Method 300.0, total organic carbon by EPA Method 415.1, TDS by EPA Method 160.1, and TSS by EPA Method 160.2)
- Field parameters (temperature by EPA Method 170.1, pH by EPA Method 150.1, electrical conductivity by EPA Method 120.1, and turbidity by EPA Method 180.1)

bgs = below ground surface

Table 4-7. Summary of Removal Action Investigation - May/June 2000

	North Valley Military Landfill
Scope of Investigation	Thirty pits excavated thoughout the landfill (LFP-1 through LFP-30) Soil samples collected from 15 pits plus four additional soil samples collected from landfill soil stockpiles (LFM-1 through LFM-4) Grab water samples collected from two pits (LFP-9 and LFP-24)
Media Sampled & Analyses Performed	All soil samples* were analyzed for the following: - Explosives, including nitroglycerin and PETN - PAHs - TEPHs - VOCs - SVOCs (chloropicrin and pentachlorophenol) - Metals (soil)/Dissolved Metals (water) - Organochlorine pesticides - PCBs - Nitrate/Nitrite - Perchlorate *Because of limited sample volume, LFM-1 was not analyzed for nitrate/nitrite or SVOCs (chloropicrin and pentachlorophenol). Soil samples from LFM-1, LFM-2, LFM-3, LFM-4, LFP-1, LFP-7, LFP-10, LFP-12, LFP-22, LFP-24 were also analyzed for dioxins/furans. Both grab water samples were analyzed for the following: - Explosives, including nitroglycerin and PETN - PAHs - TEPHs - VOCs - SVOCs (chloropicrin and pentachlorophenol) - Metals (soil)/Dissolved Metals (water) - Organochlorine pesticides - PCBs - Nitrate/Nitrite - Dioxins/Furans
Comments	Shallow groundwater was encountered at 4 feet bgs in test pit LFP-9 and 4 feet bgs in test pit LFP-24. Maximum depth of test pits ranged from 2 feet (LFP-2) to 10 feet (LFP-24)

Samples analyzed by the following EPA Test Methods:
- Explosives, including nitroglycerin and pentaerythritol tetranitrate (PETN), by EPA Method SW8330
- Polynuclear aromatic hydrocarbons (PAHs) by EPA Method SW8310
- Total extractable petroleum hydrocarbons quantified against a diesel, motor oil, and kerosene standard (TEPH-D/MO/K), respectively, by California LUFT Modified EPA Method SW8015BB
- Volatile organic compounds (VOCs) by EPA Method SW8260B
- Semi-volatile organioc compounds (SVOCs) by EPA Method SW8270C
- California Assessment Manual (CAM) 17 metals, plus aluminum, calcium, iron, manganese, potassium, phosphorus (total), and sodium by EPA Methods SW6010B, SW7470A, and SW7471A
- Organochlorine pesticides by EPA Method SW8081A
- Polychlorinated biphenyls (PCBs) by EPA Method SW8082
- Dioxins/furans by EPA Method SW8290
- Perchlorate by California Department of Health Services (CADOHS) 300.0 Modified
- Nitrate/nitrite as nitrogen by EPA Method 300.0

bgs = below ground surface

Table 4-8. Log K_{oc} and Vapor Pressure for Selected Compounds of Interest

Compounds of Interest	log K_{oc}	Source*	Vapor Pressure**	Source*
Explosives				
2,4,6-Trinitrotoluene (TNT)	2.7	EPA, 2000	2.00E-04	Montgomery, 1996
2,4-Dinitrotoluene	1.8	Montgomery, 1996	1.10E-04	Montgomery, 1996
2,6-Dinitrotoluene	1.8	Montgomery, 1996	3.50E-04	Montgomery, 1996
Nitrobenzene	1.49 - 2.36	Montgomery, 1996	0.15	Montgomery, 1996
Tetryl	2.37	Montgomery, 1996	<1.0	Montgomery, 1996
Polycyclic Aromatics				
Benzo(g,h,i)perylene	6.20	ASTM, 1995	1.00E-10	Montgomery, 1996
Benzo(a)anthracene	6.14	ASTM, 1995	5.00E-09	Montgomery, 1996
Benzo(a)pyrene	5.59	ASTM, 1995	5.25E-09	Mackay et al., 1992b
Pyrene	4.58	ASTM, 1995	4.50E-06	Mackay et al., 1992b
Benzo(k)fluoranthrene	5.74	ASTM, 1995	3.90E-10	Mackay et al., 1992b
Chrysene	5.30	ASTM, 1995	4.28E-09	Mackay et al., 1992b
Indeno(1,2,3-c,d)pyrene	7.49	Montgomery, 1996	1.01E-10	Montgomery, 1996
Fluoranthene	4.58	ASTM, 1995	9.23E-06	Mackay et al., 1992b
Naphthalene	3.11	ASTM, 1995	7.80E-02	Mackay et al., 1992b
Phenanthrene	4.15	ASTM, 1995	1.50E-04	Mackay et al., 1992b
Acenapthylene	3.68	Montgomery, 1996	6.68E-03	Montgomery, 1996
Volatile Organics				
sec-butylbenzene	2.95	Montgomery, 1996	1.8	Montgomery, 1996
2-butanone	1.47	Montgomery, 1996	91	Montgomery, 1996
dibromochloromethane	1.92	Montgomery, 1996	76	Montgomery, 1996
benzene	1.58	ASTM, 1995	95	Mackay et al., 1992a
methylene chloride	0.94	Montgomery, 1996	362 - 455	Montgomery 1996
ethylbenzene	1.98	ASTM, 1995	9.5	Mackay et al., 1992a
bromodichloromethane	1.79	Montgomery, 1996	50	Mackay et al., 1993c
chloroform	1.46 - 1.94	Montgomery, 1996	197	Mackay et al., 1993c
xylene (all isomers)	1.92 - 3.2	Montgomery, 1996	6.6 - 8.8	Montgomery, 1996
acetone	nominal	Montgomery, 1996	180 - 235	Montgomery, 1996
1,2,3-trichlorobenzene	3.24 - 3.97	Montgomery, 1996	2.1	Montgomery, 1996
1,2,4-trichlorobenzene	2.94 - 5.11	Montgomery, 1996	0.29 - 0.4	Montgomery, 1996
Dioxins/Furans				
2,3,7,8-TCDD	6.6	Montgomery, 1996	1.50E-09	Mackay et al., 1992b
2,3,7,8-TCDF	5.2 - 7.5	Mackay et al., 1992b	1.40E-08	Mackay et al., 1992b
Pesticides				
p,p'-DDD	5.38 - 6.60	Montgomery, 1996	4.68E-06 to 1.22E-05	Montgomery, 1996
p,p'-DDT	5.14 - 6.70	Montgomery, 1996	1.00E-07 to 6.23E-06	Montgomery, 1996
Lindane	2.38 - 3.52	Montgomery, 1996	1.43E-05 to 8.03E-04	Montgomery, 1996
PCBs				
PCB-1016	4.41 - 5.51	Montgomery, 1996	9.0E-04	Montgomery, 1996
PCB-1260	6.42	Montgomery, 1996	1.50E-06 to 9.00E-05	Mackay et al., 1992a
Other Compounds				
Pentachlorophenol	2.48 - 4.16	Montgomery, 1996	1.7E-05 to 1.7E-04	Montgomery, 1996
Chloropicrin	0.82	Montgomery, 1996	23.80	Montgomery, 1996
Hydrazine	unknown	n/a	14.40	NAS, 1993

Notes:

* see References section of this document for full citation

** mm Hg @ 20 or 25 degrees Celsius (°C)

NAS = National Academy of Sciences

PCBs = Polychlorinated Biphenyls

n/a = Not Applicable

TCDD = Tetrachlorodibenzo-p-dioxin

TCDF = Tetrachlorodibenzo furan

DDD = 4,4'-dichlorodiphenyldi-chloroethane

DDT = 4-4'-dichlorodiphenyltrichloro-ethane

Table 4-9. Summary of Well Construction Details

Well ID	Date Installed	Driller	Total Depth Borehole (ft.bgs)	Borehole Diameter (inches)	Well Size and Material	Screen Interval (ft.bgs)	Screen Slot Size	Filter Pack Material	Filter Pack Interval (ft.bgs)	Bentonite Seal (ft.bgs)	Grout Sanitary Seal Interval (ft.bgs)
MW-1	2/23/00	Clear Heart	20	6	2-inch Sch 40 PVC	15 - 20	0.01-inch	#2/12 Lonestar Sand	13 - 20	11-13	0 - 11
MW-2	2/22/00	Clear Heart	21	6	2-inch Sch 40 PVC	15 - 20	0.01-inch	#2/12 Lonestar Sand	13 - 20	11-13	0 - 11
MW-3 (TW-3)	12/10/99	Clear Heart	31.5	6	1-inch Sch 40 PVC	20 - 30	0.01-inch	#2/12 Lonestar Sand (Native Fill 30 - 31.5 ft.bgs)	18 - 30	16 - 18	0 - 16
MW-3A *	4/13/00	All Terrain	53.5	8 (Reamed to 14 inches 0 - 35 ft.bgs; 10-inch conductor casing set 0 - 36 ft.bgs)	2-inch Sch 40 PVC	43 - 53	0.01-inch	#2/12 Lonestar Sand (Shale cuttings 40 - 53 ft.bgs) (Native Fill 53 - 53.5 ft.bgs)	39 - 53	37 - 39	0 - 37
MW-3B	4/20/00	All Terrain	55	8 (Reamed to 14 inches 0 - 35 ft.bgs; 10-inch conductor casing set 0 - 36 ft.bgs)	2-inch Sch 40 PVC	45 - 55	0.01-inch	#2/12 Lonestar Sand	42 - 55	32 - 42	0 - 32
MW-4 (TW-4)	12/13/99	Clear Heart	27	6	1-inch Sch 40 PVC	17 - 27	0.01-inch	#2/12 Lonestar Sand	15 - 27	13 - 15	0 - 13
MW-4A	4/11/00	All Terrain	50.6	8 (Reamed to 15 inches 0 - 35 ft.bgs; 10-inch conductor casing set 0 - 36 ft.bgs)	2-inch Sch 40 PVC	37 - 47	0.01-inch	#2/12 Lonestar Sand (Native Fill 47 - 50.6 ft.bgs)	35 - 47	33.5 - 35	0 - 33.5

Table 4-9. Summary of Well Construction Details

Well ID	Date Installed	Driller	Total Depth Borehole (ft.bgs)	Borehole Diameter (inches)	Well Size and Material	Screen Interval (ft.bgs)	Screen Slot Size	Filter Pack Material	Filter Pack Interval (ft.bgs)	Bentonite Seal (ft.bgs)	Grout Sanitary Seal Interval (ft.bgs)
MW-5	2/24/00	Clear Heart	11.5	6	2-inch Sch 40 PVC	6 - 11	0.01-inch	#2/12 Lonestar Sand (Native Fill 11 - 11.5 ft.bgs)	4 - 11	2 -4	0 -2
MW-6	4/5/00	All Terrain	20	8	2-inch Sch 40 PVC	15 - 20	0.01-inch	#2/12 Lonestar Sand	13.5 - 20	11.5 - 13.5	0 - 11.5
MW-7	2/25/00	Clear Heart	9.5	6	2-inch Sch 40 PVC	4 - 9	0.01-inch	#2/12 Lonestar Sand (Native Fill 9 - 9.5 ft.bgs)	2.5 - 9	1.5 - 2.5	0 - 1.5
MW-8	2/24/00	Clear Heart	15.5	6	2-inch Sch 40 PVC	10.5 - 15.5	0.01-inch	#2/12 Lonestar Sand	8.5 - 15.5	6.5 - 8.5	0 - 6.5
MW-8	2/25/00	Clear Heart	15.5	6	2-inch Sch 40 PVC	7-15	0.01-inch	#2/12 Lonestar Sand (Native Fill 15-15.5 ft.bgs)	5 - 15	3 - 5	0 - 3
MW-10	3/28/00	Clear Heart	15	6	2-inch Sch 40 PVC	10 - 15	0.01-inch	#2/12 Lonestar Sand	8 - 15	6 - 8	0 - 6
MW-11	3/29/00	Clear Heart	23	6	2-inch Sch 40 PVC	13 - 23	0.01-inch	#2/12 Lonestar Sand	10.5 - 23	8.5 - 10.5	0 - 8.5
MW-12 (TW-12)	12/18/99	Clear Heart	28	6	1-inch Sch 40 PVC	18 - 28	0.01-inch	#2/12 Lonestar Sand	14.5 - 28	12.5 - 14.5	0 - 12.5
MW-13	3/29/00	Clear Heart	19	6	2-inch Sch 40 PVC	9 - 19	0.01-inch	#2/12 Lonestar Sand	7 - 19	5 - 7	0 - 5
MW-14	3/29/00	Clear Heart	13	6	2-inch Sch 40 PVC	8 - 13	0.01-inch	#2/12 Lonestar Sand	6 - 13	4 - 6	0 - 4
MW-15	3/30/00	Clear Heart	22	6	2-inch Sch 40 PVC	17 - 22	0.01-inch	#2/12 Lonestar Sand	15 - 22	13 - 15	0 - 13

Notes: *Well is grout-impacted
ft. bgs = feet below ground surface
PVC = Polyvinyl chloride

Table 4-9A.
Groundwater Monitoring Well Construction Information
Tourtelot RI/FS

Well ID	Northing	Easting	TOC Elevation (MSL)	GS Elevation (MSL)	Screen Length (Feet)	TOS Elevation (MSL)	BOS Elevation (MSL)
MW-1	1794208.54	6519132.03	157.65	155.00	5	141.0	136.0
MW-2	1793835.68	6519918.72	115.40	113.30	5	98.3	93.3
MW-3	1794017.99	6519680.65	128.95	126.10	10	106.1	96.1
MW-3A	1794012.71	6519681.02	127.22	126.90	10	83.9	73.9
MW-3B	1794020.71	6519666.75	129.42	127.10	10	82.1	72.1
MW-4	1794044.67	6519484.20	140.17	137.50	10	120.5	110.5
MW-4A	1794050.24	6519486.22	131.56	137.50	10	100.5	90.5
MW-5	1794038.81	6519226.92	156.48	154.40	5	148.4	143.4
MW-6	1793812.30	6519286.40	156.44	154.30	5	139.3	134.3
MW-7	1794366.19	6518839.11	162.38	159.40	5	155.4	150.4
MW-8			162.15	160.00	5	149.5	144.5
MW-9	1794755.29	6518614.21	148.32	145.70	8	138.7	130.7
MW-10	1792547.04	6518169.16	116.16	113.30	5	103.3	98.3
MW-11	1792243.17	6519010.34	81.54	78.70	10	65.7	55.7
MW-12			67.30	65.00	10	47.0	37.0
MW-13	1794154.67	6519513.30	148.46	146.00	10	137.0	127.0
MW-14	1793756.50	6520008.82	109.97	107.20	5	99.2	94.2
MW-15	1794082.20	6519622.27	140.05	137.40	5	120.4	115.4

TOC Top of Casing Elevation
GS Ground Surface Elevation
BOS Bottom of Screen Elevation
TOS Top of Screen Elevation

Table 4-10. Depth to Groundwater in Soil Boreholes

Borehole #	Depth to Water (ft. bgs)	Approximate Ground Elevation (ft. msl)	Approximate Water Elevation (ft. msl)
North Valley			
TW-1	10	153	143
MW-3 (TW-3)	22	126	104
MW-3A	15	127	112
MW-3B	15	127	112
MW-4 (TW-4)	22	138	116
MW-4A	12	138	126
MW-6	14	154	140
MW-8	14	160	146
MW-14	10	107	97
B-18	21	167	146
HF-5	18	151	133
HF-8	13	153	140
LB-2	17	85	68
South Valley			
MW-10	3	113	110
MW-11	14	79	65
MW-12 (TW-12)	23	65	42
B-9	8	160	152
GB-14	7	171	164
GB-17	11	92	81

ft. bgs = feet below ground surface
ft. msl = feet above mean sea level

Table 4-11. Summary of Groundwater Elevation Data

Well I.D.	Top of Well Casing (ft. msl)	Depth to Groundwater 5/30/00 (ft.)	Groundwater Elevation 5/30/00 (ft. msl)	Depth to Groundwater 8/02/00 (ft.)	Groundwater Elevation 8/02/00 (ft. msl)	Change in Water Level May to August (ft.)
Alluvial and Interface Wells						
MW-1	157.67	10.43	147.24	17.38	140.29	6.95
MW-2	115.39	5.82	109.57	7.54	107.85	1.72
MW-4 (TW-4)	140.16/139.91*	9.16	131.00	16.06	123.85	7.15
MW-5	156.45	10.96	145.49	dry	<142.45	>3.04
MW-7	162.30	10.05	152.25	dry	<150.30	>2.19
MW-8	162.15	9.66	152.49	13.53	148.62	3.87
MW-9	148.29	11.80	136.49	15.42	132.87	3.62
MW-10	116.18	8.54	107.64	9.30	106.88	0.76
MW-11	81.50	9.62	71.88	10.85	70.65	1.23
MW-12 (TW-12)	67.30	17.33	49.97	18.50	48.80	1.17
MW-14	109.95	7.08	102.87	8.77	101.18	1.69
MW-15	140.12	17.60	122.52	23.59	116.53	5.99
Bedrock Wells						
MW-3 (TW-3)	128.97	8.10	120.87	13.81	115.16	5.71
MW-3B	129.46	5.97	123.49	12.03	117.43	6.06
MW-4A	140.02	9.55	130.47	16.56	123.46	7.01
MW-6	156.43	2.71	153.72	10.83	145.60	8.12
MW-13	148.43	18.44	129.99	21.20	127.23	2.76

ft. msl = feet above mean sea level
* well repaired and resurveyed on 7/21/00

Table 4-12. Hydraulic Conductivities Determined by Slug Testing - August 2000

	Well ID	Hydraulic Conductivity (feet/day) Hvorslev Method	Bouwer and Rice Method
Alluvial/Interface Wells	MW-2	0.47	0.45
	MW-10	0.18	0.16
	MW-11	2.0	1.6
Bedrock Wells	MW-3B	0.60	0.59
	MW-4A	0.040	0.036
	MW-6	1.00	0.82

Table 5-1. Analytical Results for TNT Strip #1 - Soil
(Page 1 of 55)

	Location ID		TNT-1A/1	TNT-1A/2	TNT-1B/0.5	TNT-1B/1	TNT-1B/2
	Sample Depth		1-1.5	2-2.5	0.5-1	1-1.5	2-2.5
	Sample Date		7/19/99	7/19/99	7/19/99	7/19/99	7/19/99
	Lab		CalTest	CalTest	CalTest	CalTest	CalTest
	Sample Type		N	N	N	FR	N
	Event		INTERIM	INTERIM	INTERIM	INTERIM	INTERIM
Analyte	**Method**	**Units**					
aluminum	SW6010B	MG/KG	21000	15000	22000	21000	17000
antimony	SW6010B	MG/KG	0.502 U	0.502 U	0.502 U	0.502 U	0.502 U
arsenic	SW6010B	MG/KG	17	13	15	14	12
barium	SW6010B	MG/KG	330	170	220	220	200
beryllium	SW6010B	MG/KG	0.66	0.43	0.74	0.62	0.49
cadmium	SW6010B	MG/KG	0.4	0.2 J	0.12 J	0.24 J	0.24
calcium	SW6010B	MG/KG	5100	26000	5900	6200	30000
chromium, total	SW6010B	MG/KG	61	44	54	52	45
cobalt	SW6010B	MG/KG	21	13	20	21	22
copper	SW6010B	MG/KG	74	58	71	71	72
iron	SW6010B	MG/KG	50000	38000	43000	49000	41000
lead	SW6010B	MG/KG	20	9.5	12	11	10
magnesium	SW6010B	MG/KG	6600	7600	7200	7000	7900
manganese	SW6010B	MG/KG	1200	700	1200	1700	1800
molybdenum	SW6010B	MG/KG	0.69 J	0.42 J	0.74 J	0.59 J	0.77 J
nickel	SW6010B	MG/KG	66	54	65	64	66
phosphorus, total (as P)	SW6010B	MG/KG					
potassium	SW6010B	MG/KG	1800	760	1700	1500	1100
selenium	SW6010B	MG/KG	0.9 J	0.69 J	0.98 J	0.75 J	0.464 U
silver	SW6010B	MG/KG	0.099 U	0.099 U	0.12 J	0.099 U	0.099 U
sodium	SW6010B	MG/KG	79 J	54 J	86 J	62 J	49 J
thallium	SW6010B	MG/KG	0.741 U	0.741 U	0.741 U	0.741 U	0.741 U
vanadium	SW6010B	MG/KG	88	55	80	77	63
zinc	SW6010B	MG/KG	94	80	88	92	95
mercury	SW7471A	MG/KG	0.04	0.054	0.025	0.037	0.049

Table 5-1. Analytical Results for TNT Strip #1 - Soil
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	Location ID		**TNT-1C/1**	**TNT-1C/2**	**TNT-1C/4**	**TNT-1C3/3.5**	**TNT-1C3A/0**
	Sample Depth		**1-1.5**	**2-2.5**	**4-4.5**	**3.5-4**	**0-0.5**
	Sample Date		**7/19/99**	**7/19/99**	**7/19/99**	**12/04/99**	**12/04/99**
	Lab		**CalTest**	**CalTest**	**CalTest**	**Quanterra**	**Quanterra**
	Sample Type		**N**	**N**	**N**	**N**	**N**
	Event		**INTERIM**	**INTERIM**	**INTERIM**	**REMEDIAL**	**REMEDIAL**
Analyte	**Method**	**Units**					
aluminum	SW6010B	MG/KG	11000	19000	16000	29200	20800
antimony	SW6010B	MG/KG	0.502 U	0.502 U	0.502 U	0.93 J	1.7 J
arsenic	SW6010B	MG/KG	7.9	14	14	8.9 J-	13.3 J
barium	SW6010B	MG/KG	130	220	190	131	232
beryllium	SW6010B	MG/KG	0.29	0.55	0.34	0.76	0.81
cadmium	SW6010B	MG/KG	0.057 U	0.15 J	0.34	0.49 U	0.83 J
calcium	SW6010B	MG/KG	3100	5900	16000	9910 J	4220
chromium, total	SW6010B	MG/KG	31	59	48	85.4 J+	56.5
cobalt	SW6010B	MG/KG	11	20	27	25.2	18.8
copper	SW6010B	MG/KG	36	68	73	82.4	59.6 J-
iron	SW6010B	MG/KG	25000	45000	45000	40300	37500
lead	SW6010B	MG/KG	9.8	12	13	10.6 J	41.9 J
magnesium	SW6010B	MG/KG	3600	7100	8000	11800	8070
manganese	SW6010B	MG/KG	660	1100	3800	608	1250
molybdenum	SW6010B	MG/KG	0.26 J	0.61 J	0.51 J	0.57 U	0.68 J
nickel	SW6010B	MG/KG	38	68	110	70.8	59.4
phosphorus, total (as P)	SW6010B	MG/KG				309	451
potassium	SW6010B	MG/KG	1000	1600	800	1950	3550
selenium	SW6010B	MG/KG	0.74 J	0.464 U	0.464 U	0.51 J	0.35 UJ
silver	SW6010B	MG/KG	0.099 U	0.099 U	0.099 U	0.22 U	0.31 J
sodium	SW6010B	MG/KG	23.96 U	68 J	57 J	151 J	131 J
thallium	SW6010B	MG/KG	0.741 U	0.741 U	0.741 U	0.43 U	0.46 UJ
vanadium	SW6010B	MG/KG	41	72	58	78.9	65.8
zinc	SW6010B	MG/KG	49	87	94	109	97.3 J
mercury	SW7471A	MG/KG	0.058	0.068	0.08	0.058	0.062

Table 5-1. Analytical Results for TNT Strip #1 - Soil
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	Location ID		TNT-1C3A/1	TNT-1C3A/2	TNT-1C4/3.5	TNT-1C4A/0	TNT-1C4A/1
	Sample Depth		1-1.5	2-2.5	3.5-4	0-0.5	1-1.5
	Sample Date		12/04/99	12/04/99	12/04/99	12/04/99	12/04/99
	Lab		Quanterra	Quanterra	Quanterra	Quanterra	Quanterra
	Sample Type		N	N	N	N	N
	Event		REMEDIAL	REMEDIAL	REMEDIAL	REMEDIAL	REMEDIAL
Analyte	**Method**	**Units**					
aluminum	SW6010B	MG/KG	23300	23400	20700	25700	24000
antimony	SW6010B	MG/KG	1 J	0.84 J	0.73 J	2.2 J	2 J
arsenic	SW6010B	MG/KG	10.5 J	10.4 J	11.6 J	25.3 J-	23.1 J-
barium	SW6010B	MG/KG	240	235	99.7	247	251
beryllium	SW6010B	MG/KG	0.94	0.84	0.7	0.84	0.78
cadmium	SW6010B	MG/KG	0.51 U	0.49 U	0.48 U	0.55 U	0.5 U
calcium	SW6010B	MG/KG	6090	18500	8980	3610	11500
chromium, total	SW6010B	MG/KG	59.1	58.8	66.8	63.1	57.1
cobalt	SW6010B	MG/KG	26.3	20.5	28.1	22.2	18.9
copper	SW6010B	MG/KG	66 J-	67.5 J-	73.3 J-	67.9 J-	64 J-
iron	SW6010B	MG/KG	42500	41500	37000	42000	38800
lead	SW6010B	MG/KG	9.6 J	9.1 J	8.2 J	48.9 J	51.6 J
magnesium	SW6010B	MG/KG	7610	8440	10300	10900	13700
manganese	SW6010B	MG/KG	1330	1470	574	1340	1320
molybdenum	SW6010B	MG/KG	0.59 U	0.57 U	0.56 U	0.64 U	0.57 U
nickel	SW6010B	MG/KG	67.2	65.7	58.7	66.9	64
phosphorus, total (as P)	SW6010B	MG/KG	323	367	290	356	292
potassium	SW6010B	MG/KG	1750	1740	1440	2460	1820
selenium	SW6010B	MG/KG	0.33 UJ	0.33 UJ	0.32 UJ	0.72 U	0.65 U
silver	SW6010B	MG/KG	0.23 U	0.27 J	0.22 U	0.25 U	0.23 U
sodium	SW6010B	MG/KG	112 J	116 J	135 J	101 J	107 J
thallium	SW6010B	MG/KG	0.45 UJ	0.44 UJ	0.43 UJ	0.97 U	0.88 U
vanadium	SW6010B	MG/KG	71.3	67.2	62.4	75.2	68.3
zinc	SW6010B	MG/KG	82.1 J	87.2 J	95.4 J	91.4 J	86.2 J
mercury	SW7471A	MG/KG	0.039 J	0.084	0.073	0.082	0.089

Table 5-1. Analytical Results for TNT Strip #1 - Soil
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	Location ID		TNT-1C5A/0	TNT-1C6/4.5	TNT-1C6A/0	TNT-1C6A/0.5	TNT-1C6A/1
	Sample Depth		0-0.5	4.5-5	0-0.5	0.5-1	1-1.5
	Sample Date		12/04/99	12/04/99	12/04/99	12/04/99	12/04/99
	Lab		Quanterra	Quanterra	Quanterra	Quanterra	Quanterra
	Sample Type		N	N	N	FR	N
	Event		REMEDIAL	REMEDIAL	REMEDIAL	REMEDIAL	REMEDIAL
Analyte	**Method**	**Units**					
aluminum	SW6010B	MG/KG	26100	22200	25700	25200	24700
antimony	SW6010B	MG/KG	1.2 J	0.73 J	1.2 J	1.3 J	0.94 J
arsenic	SW6010B	MG/KG	12.5 J	9.1 J	14.9 J-	13.3 J-	10.7 J-
barium	SW6010B	MG/KG	281	146	257	251	271
beryllium	SW6010B	MG/KG	1	0.75	0.9	0.89	0.88
cadmium	SW6010B	MG/KG	0.52 U	0.5 U	0.55 U	0.49 U	0.49 U
calcium	SW6010B	MG/KG	2970	5570	4140	4430	5040
chromium, total	SW6010B	MG/KG	66.2	59.1	62.3	60.7	61.5
cobalt	SW6010B	MG/KG	23.4	18.6	22.2	20.5	19.9
copper	SW6010B	MG/KG	71.1 J-	71.8 J-	70.5 J-	68.3 J-	66.6 J-
iron	SW6010B	MG/KG	48300	39500	42900	43100	41400
lead	SW6010B	MG/KG	11.7 J	7.9 J	25.5 J	24.4 J	12.8 J
magnesium	SW6010B	MG/KG	11600	9960	9220	8710	8870
manganese	SW6010B	MG/KG	1750	506	1400	1180	991
molybdenum	SW6010B	MG/KG	0.6 U	0.58 U	0.75 J	0.57 U	0.57 U
nickel	SW6010B	MG/KG	74.8	64.6	68.4	65.3	64.7
phosphorus, total (as P)	SW6010B	MG/KG	485	185	298	266	224
potassium	SW6010B	MG/KG	1970	1150	2960	1970	1760
selenium	SW6010B	MG/KG	0.68 UJ	0.33 UJ	0.36 U	0.65 U	0.65 U
silver	SW6010B	MG/KG	0.23 U	0.28 J	0.25 U	0.22 U	0.22 U
sodium	SW6010B	MG/KG	98.1 J	126 J	125 J	128 J	139 J
thallium	SW6010B	MG/KG	0.92 UJ	0.44 UJ	0.49 U	0.87 U	0.88 U
vanadium	SW6010B	MG/KG	79.8	58.7	76.5	73.3	68.8
zinc	SW6010B	MG/KG	90.1 J	91.4 J	91.4 J	92.6 J	89.1 J
mercury	SW7471A	MG/KG	0.038 J	0.075	0.085	0.085	0.066

Table 5-1. Analytical Results for TNT Strip #1 - Soil
(Page 5 of 55)

	Location ID		TNT-1C6A/2	TNT-1C7A/0	TNT-1C7A/1	TNT-1C7A/1.5	TNT-1C10A/0	TNT-1C10A/2
	Sample Depth		2-2.5	0-0.5	1-1.5	1.5-2	0-0.5	2-2.5
	Sample Date		12/04/99	12/04/99	12/04/99	12/04/99	12/18/99	12/18/99
	Lab		Quanterra	Quanterra	Quanterra	Quanterra	Quanterra	Quanterra
	Sample Type		N	N	N	FR	N	N
	Event		REMEDIAL	REMEDIAL	REMEDIAL	REMEDIAL	REMEDIAL	REMEDIAL
Analyte	**Method**	**Units**						
aluminum	SW6010B	MG/KG	23700	25900	28600	24500	26700	19900
antimony	SW6010B	MG/KG	0.91 J	2.5 J	0.96 J	0.74 J	0.78 J	0.62 J
arsenic	SW6010B	MG/KG	8.5 J-	24.4 J-	14.9 J-	11.6 J-	11.8	8.7
barium	SW6010B	MG/KG	160	243	271	220	273	151
beryllium	SW6010B	MG/KG	0.78	0.88	0.95	0.83	0.72	0.39 J
cadmium	SW6010B	MG/KG	0.49 U	0.54 U	0.5 U	0.5 U	0.48 U	0.48 U
calcium	SW6010B	MG/KG	5030	5350	6490	5500	2290	33400
chromium, total	SW6010B	MG/KG	61.6	61	67.5	60.7	63.8 J+	54 J+
cobalt	SW6010B	MG/KG	18.5	19.6	22.7	19.3	21.9	15.6
copper	SW6010B	MG/KG	67 J-	70.6 J-	78 J-	68.5 J-	67.8	59.5
iron	SW6010B	MG/KG	43600	41700	47800	45100	43500	32300
lead	SW6010B	MG/KG	10.2 J	34.5 J	19.5 J	11.5 J	10.2 UJ	8.1 UJ
magnesium	SW6010B	MG/KG	9980	8440	8510	8920	13100	9270
manganese	SW6010B	MG/KG	431	1180	1380	910	1620	2120
molybdenum	SW6010B	MG/KG	0.57 U	0.63 U	0.58 U	0.58 U	0.56 U	0.55 U
nickel	SW6010B	MG/KG	67.9	65.7	73.4	63.8	72.1	59.3
phosphorus, total (as P)	SW6010B	MG/KG	217	321	298	259	231	269
potassium	SW6010B	MG/KG	1490	2150	2190	1700	2090	1430
selenium	SW6010B	MG/KG	0.64 U	0.71	0.66 U	0.66 U	1.5 J	0.84 J
silver	SW6010B	MG/KG	0.22 U	0.25 U	0.23 U	0.23 U	0.22 U	0.22 U
sodium	SW6010B	MG/KG	140 J	161 J	127 J	115 J	105 UJ	133 UJ
thallium	SW6010B	MG/KG	0.87 U	0.96 U	0.89 U	0.88 U	0.85 U	0.42 U
vanadium	SW6010B	MG/KG	62.7	74.1	82.7	67	76.2 J+	56.5 J+
zinc	SW6010B	MG/KG	99.1 J	92.5 J	99.6 J	91.8 J	90.4	84.4
mercury	SW7471A	MG/KG	0.043 J	0.079	0.059	0.071	0.059 UJ	0.077 UJ

Table 5-1. Analytical Results for TNT Strip #1 - Soil
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	Location ID		**TNT-1P/0**
	Sample Depth		**0-0.5**
	Sample Date		**3/27/00**
	Lab		**Quanterra**
	Sample Type		**N**
	Event		**GAPS2**
Analyte	**Method**	**Units**	
PCB-1016 (Arochlor 1016)	SW8082	MG/KG	0.038 UR
PCB-1221 (Arochlor 1221)	SW8082	MG/KG	0.078 UR
PCB-1232 (Arochlor 1232)	SW8082	MG/KG	0.038 UR
PCB-1242 (Arochlor 1242)	SW8082	MG/KG	0.038 UR
PCB-1248 (Arochlor 1248)	SW8082	MG/KG	0.038 UR
PCB-1254 (Arochlor 1254)	SW8082	MG/KG	0.038 UR
PCB-1260 (Arochlor 1260)	SW8082	MG/KG	0.038 UR