3.0 ALTERNATIVE IDENTIFICATION PROCESS

The EE/CA process is a non-time-critical decision process by which the most applicable (including NoFA), technically feasible, and socially acceptable alternatives for remediating a site are evaluated for their implementability, effectiveness, and cost.

Removal of all UXO is not considered practicable, given technical limitations and cost considerations. In addition, permanent exclusion of the public from areas that have the potential to contain UXO is not considered feasible, given possible future demands for use of the land and the potential for entry, inadvertent or intentional, to the Former Benicia Arsenal. As described in Section 1.1, the purpose of the EE/CA is to evaluate potential ordnance risk and develop alternative plans of action.

The chain of events that can result in a potential OE incident causing injury or death involves many steps and may be viewed as a process flow. The chain is:

UXO present	→	UXO in a sensitive state or configured to detonate	→	Public access (including excavation) (UXO exposure)	→	Individual interaction with UXO (potential OE incident)

Breaking or weakening this chain of events has been a focus for developing alternatives that limit public interaction with UXO. The steps in this process are:

- Document available information pertaining to the nature and extent of OE at the Former Benicia Arsenal
- Identify areas where further investigation is warranted
- Conduct a field investigation of the project site to statistically characterize the nature and extent of UXO at the project site
- Provide decision criteria for evaluating and recommending the most feasible alternatives
- Utilize proven technologies and management strategies (short- and long-term) to manage UXO in a manner that will break or weaken the chain of events identified above.

Using these steps, four risk management alternatives (including NoFA) were developed for the purpose of this EE/CA. Full descriptions of each of these alternatives are contained in Chapter 4.0, Identification of Risk Management Alternatives.

4.0 IDENTIFICATION OF RISK MANAGEMENT ALTERNATIVES

4.1 ALTERNATIVE IDENTIFICATION

Four risk management alternatives were selected for evaluation that, either alone or in combination, meet the objectives identified in Chapter 3.0. Implementation of the NoFA alternative would involve no site-specific work. Implementation of Institutional Controls alone would not involve clearance of UXO from an individual OE site; rather, these focus on separating the public from UXO and on educating the public to recognize the hazards of interacting with UXO. UXO clearance alternatives include implementation of technologies for efforts associated with surface and subsurface UXO clearances.

The four alternatives identified below and evaluated in this EE/CA were developed to break or weaken the chain of events described in Chapter 3.0 by limiting public interaction with UXO:

- Alternative 1: No Further Action (NoFA)
- Alternative 2: Institutional Controls (Access Controls and Behavior Modifications)
- Alternative 3: Surface Clearance of UXO
- Alternative 4: Detection and Clearance of UXO to Depth

In addition to the objectives identified in Chapter 3.0, these alternatives were selected because they generally provide discernible variability in their potential effectiveness, implementability, and cost; and because they are consistent with those considered at other OE sites throughout the United States.

4.1.1 Alternative 1 - No Further Action (NoFA)

Surface and subsurface OE clearance would not occur under this alternative. This alternative does not include any U.S. Army-initiated actions under current or anticipated future land use.

4.1.2 Alternative 2 - Institutional Controls

Institutional Controls include access controls and behavior modifications that are designed to reduce potential UXO exposures and/or potential OE incidents at the Former Benicia Arsenal by weakening the links in the chain of events (identified in Chapter 3.0) leading to UXO exposures. Generally speaking, Institutional Controls focus on the later events in the chain, in that these generally treat public access to and interaction with UXO. Institutional Controls do not involve removing UXO from the site.

Institutional Controls depend entirely on public and local agency support, involvement, and willingness of the institute to enforce the control. There are two

sets of tools institutes can use to enforce controls over a site. These tools include access controls and behavior modifications.

This entire array of enforcement procedures should not be considered applicable to each individual OE site. Chapter 6.0, Sector Evaluations, provides a detailed evaluation of these measures that can be used to determine the combination of controls and modifications appropriate to a given site at the Former Benicia Arsenal.

To better understand how institutional controls can be implemented at the Former Benicia Arsenal, an Institutional Analysis was performed. The analysis identified which, if any, of the described institutional controls could be implemented, and which agencies or entities would be responsible for maintaining or enforcing institutional controls. The report detailing the results of this study is contained in Appendix E of this document.

4.1.2.1 Access Controls.

Access controls may include the following:

- Direct intervention such as fencing and other barriers combined with trespass laws
- Land use restrictions (zoning laws and enforcement)
- Regulatory controls (permit applications, review, and approval of development plans)
- Construction support.

The effectiveness of access controls is dependent upon the willingness of the land owner and local agencies to enforce them. Tools to help enforce the controls include direct intervention measures such as fences, barricades, warning signs and security patrols combined with trespass laws. Direct intervention measures are considered effective as interim (short-term) measures and may be applicable over the long term. Generally speaking, they limit access to OE sites (thereby limiting potential exposures) and inform the public of the dangers of contacting UXO (limiting access to and interaction with UXO), thereby limiting both exposures and incidents.

4.1.2.1.1 Direct Intervention Measures

Fences and Barricades. Fences can physically restrict access to a site and can vary in effectiveness based upon the type and height of the fence installed. Generally speaking, the more substantial a fence, the more effective it is (i.e., a wall is more effective than barbed-wire fence). Taller fences are considered to be more effective at restricting access than shorter fences. Fences are considered for use in areas where UXO is present and where public access to UXO would likely result in potential exposures. At sites where the risk of UXO exposure is very low, fencing may not be necessary. Generally, fences would not

be appropriate as a permanent method of exposure prevention because they require continual maintenance and repair, and even the best of fences can be overcome by a determined individual.

For purposes of this analysis, a barbed-wire fence affixed with warning signs is considered an effective temporary measure to restrict access to OE sites. This type of fence would keep individuals from inadvertently accessing an OE site.

Barricades can be of value when closing roads or trails that access OE sites. Typically, barricades used at the Former Benicia Arsenal consist of locking gates that preclude public access. Other forms of barricades, including rock barriers or revegetation of unused roads or trails, can also be effective in blocking road/trail access. As with fences, barricades can be more effective when combined with warning signs.

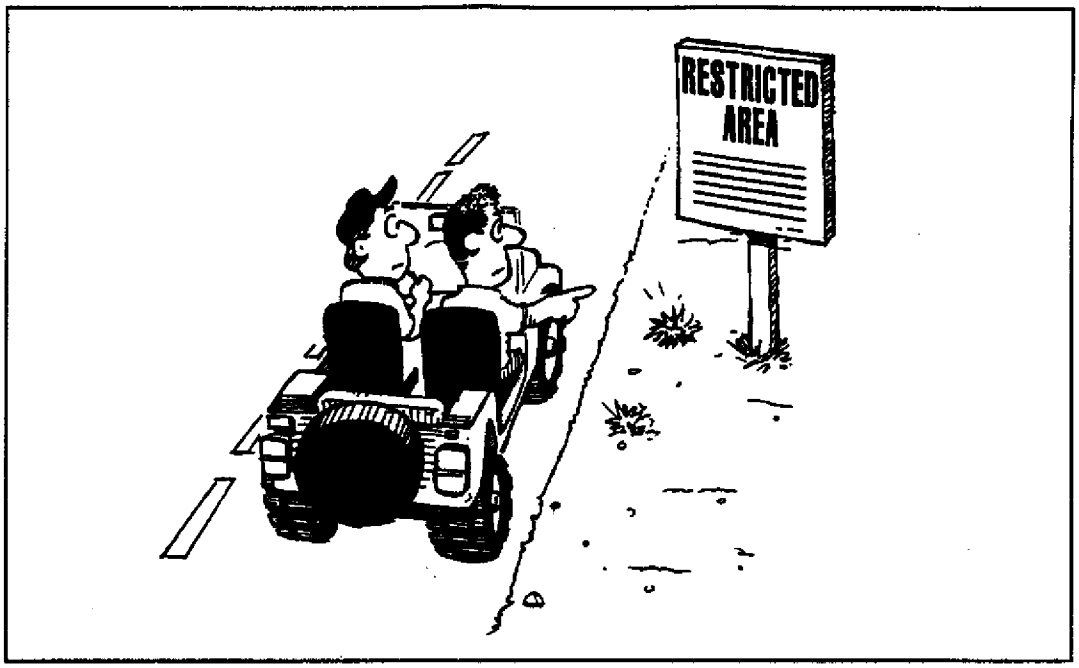
Security Patrols. Security patrols are characterized as access controls. Security patrols could be instituted by the entity having jurisdiction over an individual area and could involve law enforcement authorities (city of Benicia Police or Solano County Sheriff's Department) or private security firms (in the case of private lands). In order to be effective, regulations regarding site access would have to be implemented and then enforced by the entity having jurisdiction over that area. Private entities could restrict trespassing through a combination of police and private security firms.

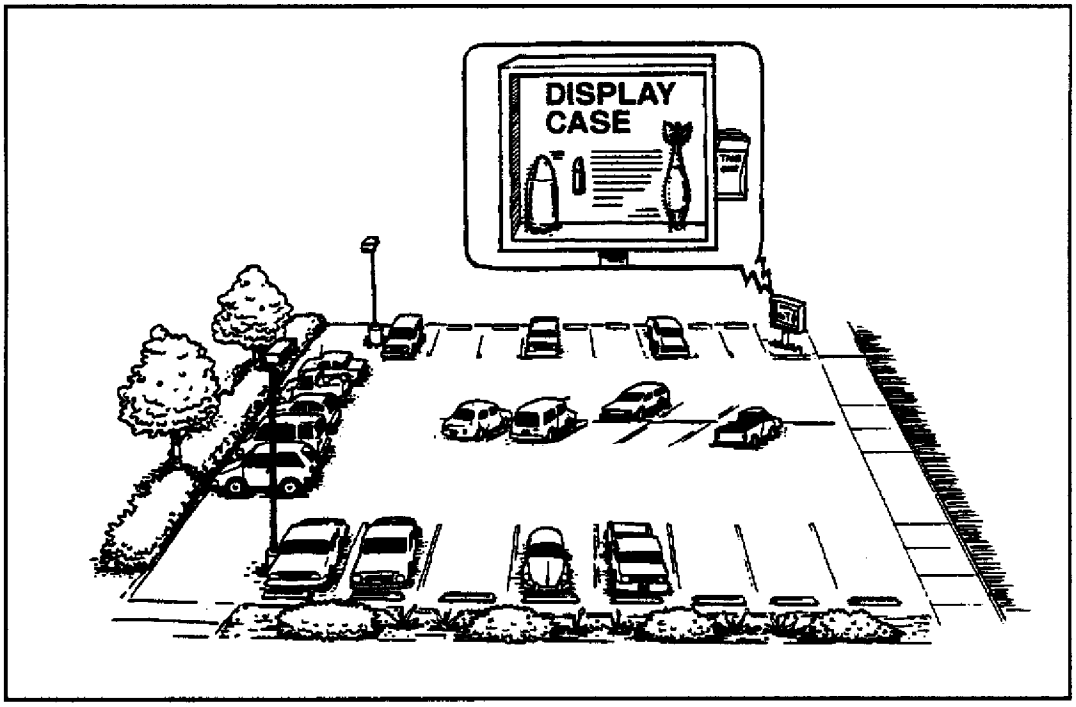
Warning Signs. Posted warning signs could include notices at the entrances to OE sites and/or along the perimeter fencing of an OE site or suspect area (Figure 4-1).

There has been considerable debate over whether signs are an effective means of communicating safety hazards at an OE site, or if they actually encourage scavenging of OE items. Given the potential for an otherwise unwary public to access an area containing UXO, and given the current trend in legal liability cases involving injury and death, warning signs communicating a hazard to the public are useful. The posted signs would inform the public of potential safety hazards and communicate:

- Why a safety hazard exists in the context of the history of the military installation or training area.
- How to avoid encountering a UXO item (i.e., by staying within picnic or campground areas or on specified roads and trails where UXO has been removed, and by avoiding access and/or excavation in areas of suspected UXO).
- What to do and whom to contact if an OE item is encountered.

Costs for various types of Institutional Controls (i.e., warning signs, display cases, safety training videos) that are available to landowners and local agencies are presented in Appendix F.





Benicia/019

Institutional Controls

Figure 4-1

4.1.2.1.2 Land Use Restrictions.

Land use restrictions are characterized in this EE/CA as nonphysical mechanisms (direct intervention measure) to control access to or use of OE sites, and can include, but are not limited to: zoning ordinances, regulatory control, and dedication of property to appropriate land uses or other land use regulations. These mechanisms can limit UXO exposures by limiting public access to a site, or by limiting the level of activity associated with excavations that may occur in OE sites.

Zoning Ordinances. Zoning ordinances could be developed and enforced by the city of Benicia to restrict development in areas identified as OE sites at the Former Benicia Arsenal. However, the city of Benicia's Draft General Plan, currently before the City Council for approval, defines future land for the Former Benicia Arsenal. All OE sites identified in the EE/CA report, with exception of Sector 3B, may be subject to future development (commercial, industrial or residential). Based on information presented in the Institutional Analysis Report (Appendix E), the city is unlikely to revise the proposed zoning in the Draft General Plan to restrict access and land use at any of the OE sites identified in this EE/CA document.

4.1.2.1.3 Regulatory Control

Permit Applications and Review of Development Plans. Other regulatory controls available to the city of Benicia include permit applications for construction and review of development plans. One potential avenue for access control could be to include an OE overlay that could be applied to any land use at the Former Benicia Arsenal. This would allow the city to regulate development in consideration of potential OE issues. For example, if an area identified as an OE site fell within a commercial land use, that area could be identified as "commercial" with an "OE overlay" designation. The city of Benicia Draft General Plan, when adopted, includes language that would require that all sites known or suspected to have UXO be tested and remediated before any development could occur. Therefore, if an OE overlay is developed for the Former Benicia Arsenal, the Draft General Plan has outlined a structure for enforcing any recommendations associated with development or construction within the OE overlay area. For an OE overlay to be effective, it should define the depth and areal extent to which OE clearances have occurred at the site. The city could then stipulate the conditions under which excavation or development could occur.

4.1.2.1.4 Construction Support.

One stipulation for excavation or development of a site may require the developer to obtain construction support from a qualified UXO removal contractor.

Construction support involves subsurface excavation of UXO to support small, focused grading activities associated with the installation of subsurface utilities, construction, or other ground-disturbing activities. The general protection standard for construction safety in OE sites identified in this EE/CA is to maintain a 2-foot buffer (which will have been subjected to OE excavation and clearance)

between the anticipated level of construction disturbance and any potential UXO that may lie below the disturbed site. For this reason, and because of the potential for excavation to occur in small, focused areas (as described in Chapter 2.0 and reiterated in the following paragraph), the construction support concept has been identified. Construction support would require anomaly detection and excavation to a depth of no fewer than 2 feet deeper than the anticipated depth of construction disturbance. Each site where construction support is contemplated should be scrutinized to determine whether there is a reasonable potential to expect UXO at depth.

In practice, construction support would be implemented as an "overlay" applied to those areas at the Former Benicia Arsenal where construction may occur. For example, a portion of the area may be designated for residential development or a parking lot requiring cut and fill. Here, an overall recommendation for a 3-foot OE excavation may be recommended (to address public access) throughout the site. In portions of the area where cut and fill would be required, deeper OE clearances could be specifically affected in the areas to be cut. The same concept could be applied to a deep utility corridor that may transect the area.

Typically, standard OE excavation operating procedures associated with construction support are similar to those described under Alternatives 3 and 4. Differences may exist, however, in that the configuration of sweep lanes may have to be adjusted to accommodate the irregular shape of trenches and excavations. Shoring of deep trenches also becomes a safety concern. Depending on the depth of excavation desired, one to three sweeps with a geophysical instrument over the same area would be needed as the anomaly investigation and the area of excavation becomes progressively deeper. Construction support would likely be implemented at the time of construction. It should be noted that construction support should be utilized if the following two conditions exist:

- The area identified for construction will be excavated deeper than that anticipated for the land use

- OE is suspected at these depths.

4.1.2.2 Behavior Modifications.

Behavior modifications may include the following:

- Notification of real estate defect
- Public Education Programs
- Permit Notices.

Behavior modifications rely on an institution (landowner or local agency) to inform the public of the hazards associated with an OE site. The effectiveness of behavior modifications is difficult to quantify because it relies solely on the public's willingness to abide by the warning of possible OE hazards that may be encountered on the site and whether certain steps are taken to minimize the risk associated with potential OE hazards. There are three main avenues available to

institutions to inform the public of potential OE hazards on a site: real estate defect notices when transferring property, public education programs for workers or visitors, and notices attached to building or construction permits.

4.1.2.2.1 Notification of Real Estate Defect

Real Estate Environmental Notices. California real estate law (Civil Code 1102.15) requires that the seller of residential real property give written notice to a buyer that the property lies within the neighborhood area of a "former federal or state ordnance location." "Neighborhood area" is defined as within a 1-mile radius of the ordnance site. A former federal or state ordnance location is an area identified by an agency or instrumentality of the federal or state government as once used for military training purposes and possibly containing potentially explosive munitions. Real estate notices are required by law, and regardless of the level of clean-up at the OE site(s), the area will have some residual risk associated with OE, therefore requiring a real state notice. Because of this requirement, real estate notices can be considered effective over the long term.

4.1.2.2.2 Public Education Programs

Public Education. Public education includes educational and community relations programs. Educational/community relations programs are important in weakening the chain leading to an OE incident in two key ways: They can inform the public of the danger of accessing OE sites, therefore preventing UXO exposures; and they can also educate those exposed to UXO not to interact with any UXO contacted, thereby limiting OE incidents. Educational programs can be considered effective over the short and long term.

Educational and community relations programs can focus either on a wide audience or on smaller groups or individuals. Wide audiences could include public meetings, information spots or advertisements in the local media (including radio, television, and newspapers), web sites on the internet, and mass mailings or other distribution of brochures, pamphlets, and fact sheets. Smaller, focused educational or local community relations programs may consist of short safety briefings prior to admission of groups or individuals to an OE site.

Public Meetings. The U.S. Army would continue its coordination with the community through a series of public meetings/public availability sessions. Public meetings are generally held when significant site remediation documents (e.g., Remedial Investigation/Feasibility Studies) that address OE issues are released to the public. Although not currently scheduled, a public meeting to provide information regarding: (1) OE at the Former Benicia Arsenal; (2) options available to remove ordnance and enhance public safety; (3) how this information was evaluated in the EE/CA; and (4) recommendations being made to address ordnance issues, will be held. However, once federal remediation actions are complete at the arsenal, the responsibility of conducting public meetings would transfer to local agencies.

Media Advertisements and Information Spots. Use of media advertisements and information spots can be an important tool in promoting public awareness regarding OE issues at the Former Benicia Arsenal. Use of media advertisements can include newspaper, radio, and television interviews. Although the media is generally limited in terms of the depth of information portrayed, it does have the advantage of reaching the widest possible audience.

Brochures, Pamphlets, and Fact Sheets. These informational materials can be developed and distributed to support safety briefings and/or speaking engagements and are also effective as stand-alone educational materials. Pamphlets warning the public of the dangers associated with UXO can be mailed to residents in the vicinity of an OE site, or they can be distributed from central locations such as libraries, or posted on educational display boards positioned at strategic locations throughout the site. However, one drawback of dispensing pamphlets from display boards is the potential for litter. Pamphlets/brochures can warn the public of the hazards of ordnance in the historical context of former military operations that occurred at an OE site. In that regard, an effective pamphlet/brochure may contain photographs and/or drawings of typical ordnance items that the public might encounter. OE site locations should be shown on all publicly distributed maps. A telephone number for the appropriate local authority should also be included in the pamphlet/brochure.

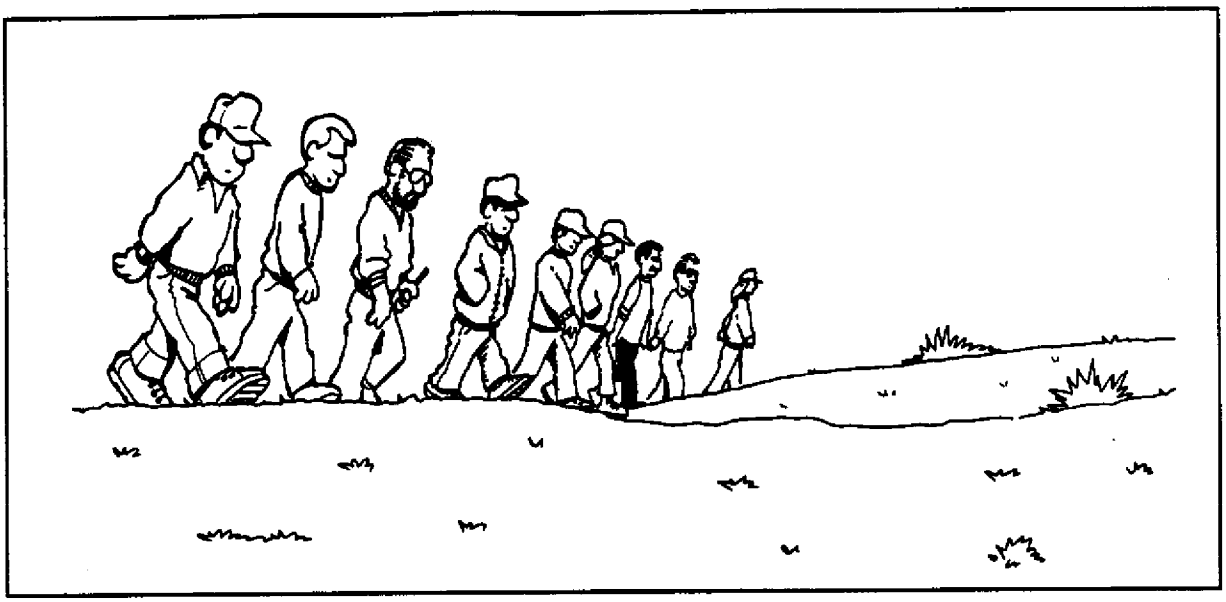
Internet. As the general public's use of the internet increases, a web site can become a valuable public information tool, allowing the reader greater proficiency in understanding OE issues. Web sites are accessible through public web browsers in local libraries and educational institutions, and via web browsers in the home or workplace. Use of a web site has several benefits: a large amount of information can be posted (e.g., public notices, news releases, fact sheets, maps); and the information can be updated on a regular basis.

4.1.2.2.3 Building and/or Construction Permit Notices.

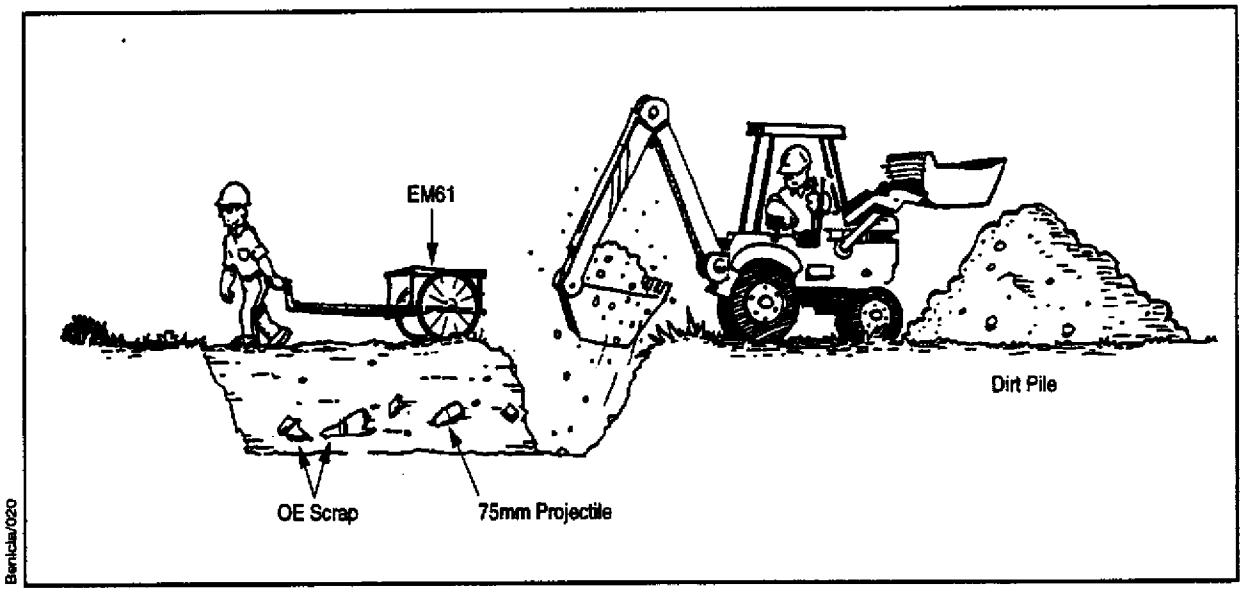
Community health and safety policies and programs outlined in the City of Benicia's Draft General Plan require that the general public be informed of potential industrial hazards including unexploded ordnance. One way of informing the public could be via notices attached to building or construction permits warning of the potential hazards associated with OE during construction activities in the area. As discussed previously in the subsection concerning access control tools, an OE overlay could be developed that would define the area in which the notices would be required. Notices should state the depth and type of OE that may be encountered as well as the precautions that should be taken while working in the area.

4.1.3 Alternative 3 - Surface Clearance of UXO

This alternative includes removal of ordnance from the ground surface (Figure 4-2). The purpose of the surface clearance is to locate and remove UXO. For surface clearance, teams of EOD-qualified personnel use visual identification, aided by hand-held metal detectors, to search for ordnance. The surface clearance would be conducted by establishing a system of grids within which



Alternative 3: Surface Clearance.



Alternative 4: Detection and Clearance of UXO to Depth.

Surface Clearance and Detection and Clearance of UXO to Depth

Figure 4-2

would be placed a series of sweep lanes. These lanes are typically 5 feet in width or narrower, depending on the geophysical instrumentation used.

Dense vegetation can be a hindrance to surface clearance. There are areas at the Former Benicia Arsenal that are characterized by dense brush that would hinder surface clearance activities. A vegetation clearance would have to be performed in areas containing dense brush prior to performance of a surface clearance.

As with subsurface ordnance excavation and clearances, UXO recovered during the surface clearance would be detonated in place if not safe to move to an on-site area specifically designated for destruction of recovered UXO items. Additionally, surface clearance and detonation of UXO items would occur within public safety exclusion zones, which vary in size, depending on the fragmentation distance of the OE item recovered. OE-related scrap would be taken off site and turned in to a local scrap metal recycler.

The costs associated with compliance with federal and state environmental laws have not been estimated for this alternative. These may include costs associated with species relocation, maintenance of on-site biological monitors, and revegetation of specified areas following surface clearance at specific sites, as appropriate (i.e., along major drainages).

4.1.4 Alternative 4 - Detection and Clearance of UXO to Depth

Alternative 4 includes the subsurface excavation and clearance of OE items to an appropriate depth using geophysical instrumentation, within a specified OE site (see Figure 4-2). Risk reduction benefits increase as the depth of clearance increases. Detection and clearance of OE to a depth of 1 foot provides effective risk reduction for surface and limited intrusive recreational activities. Detection and clearance of OE items to a depth of 2 feet provides effective risk reduction for areas subject to limited intrusive activities (i.e., fence post installation).

Factors taken into consideration in order to determine the depth of clearance for an OE site include the following:

- Previous DOD activities that may have occurred at the site
- Distribution of OE throughout the area
- Types of OE recovered during the EE/CA field investigation
- Depth of OE recovered during the EE/CA field investigation
- Future activities that may occur at the site (i.e., projected future land use)
- Detection capability of the clearance technology to remove OE from the site.

As discussed in Chapter 2.0, OE during the EE/CA field investigation was recovered at depths ranging from 0 to 48 inches below the surface. The maximum depth to which UXO was recovered was 32 inches. Based upon information presented in Table 2-3 (see Chapter 2.0), the history of the site, and future land use for each sector, an appropriate depth for the implementation of Alternative 4 (Detection and Clearance of UXO to Depth) has been determined for each sector at the Former Benicia Arsenal. The depths at which clearance actions would be performed in each individual sector are discussed and evaluated in Chapter 6.0, Sector Evaluations.

The geophysical method that would be used to detect OE for a clearance action is discussed in Section 4.2, Clearance Technologies. The methodology for performing the subsurface excavation of detected OE items would be very similar to that employed for the EE/CA field investigation. However, unlike an EE/CA, for which a small percentage of an area is investigated, for a clearance action, 100 percent of the area is inspected and evaluated for the presence of OE. Depending on the amount of UXO expected on the surface at a particular OE site, a surface clearance, as described for Alternative 3, may be necessary prior to geophysical mapping and subsequent removal of detectable OE items.

As with the UXO operations described under Alternative 3 - Surface Clearance of UXO (Section 4.1.3), subsurface excavation and clearance would require teams of EOD-qualified personnel. Geophysical methods would be used to map and identify anomalies in the proposed clearance areas. The detection technology would be determined during the design phase for the clearance action most likely by a geophysical prove-out test (see Section 4.2). The subsurface anomalies identified through processing of the geophysical data would be located (surveyed) and marked with pin flags. EOD personnel would conduct an intrusive investigation, during which time the anomalies identified by pin flags would be excavated. OE items found during the intrusive investigation would be relocated if safe and moved for disposal, or detonated in place after establishment of a public safety exclusion zone sized to provide a safe fragmentation distance from the OE item being detonated.

The costs associated with compliance with federal and state environmental laws have not been estimated for this alternative. These may include costs associated with species relocation, maintenance of on-site biological monitors, and revegetation of specified areas following OE clearance to specified depth as appropriate (e.g., along major drainages).

4.2 CLEARANCE TECHNOLOGIES

There are several clearance technologies available to detect and remove OE from a site. Before a clearance action is implemented in the field, an engineering design for the clearance action must be developed and reviewed. The clearance technology best suited to detect and remove OE from a site will be determined during the design phase for the clearance action. Much like the work plan for the EE/CA investigation, the engineering design will specify how the clearance action will proceed.

In order to determine which geophysical method will be used for a subsurface clearance action, a geophysical prove-out, similar to the one used to validate the geophysical methods for the EE/CA field investigation, would be conducted. First, a geophysical test plot would be constructed. This consists of burying various-sized items at different depths in a known configuration. The depths and sizes of the items used as targets are based on the types of OE expected to be encountered and the depth of removal anticipated for the clearance action. Once the test plot is constructed, several different types of geophysical instrumentation capable of mapping within the various physical constraints (mainly terrain and vegetation cover) of the OE site are used to collect data over the test plot. The data is then analyzed in order to identify the seeded targets. The results are then plotted on a map and compared against the known target locations. The geophysical method with the best overall performance, based on the results of the geophysical prove-out, is then used for the clearance action.

Other factors to consider during the geophysical prove-out include the reliability and cost effectiveness of the geophysical methods evaluated.

For the purpose of developing comparable cost estimates for the analysis of the alternatives, it has been assumed that a man-towed EM61 instrument would be used to collect the subsurface geophysical data. The instrument location would be tracked using the Global Positioning System (GPS). The data would then be processed, and target anomalies would be identified and reviewed by a geophysicist. Target anomalies would be excavated as described for Alternative 4 (Detection and Clearance of UXO to Depth). The manner in which anomalies would be identified and investigated would be similar to the method used during the EE/CA field investigation (as described in Chapter 2.0).

5.0 EVALUATION CRITERIA

This chapter describes the evaluation process utilized in determining recommendations for risk management options to be implemented at the Former Benicia Arsenal. The evaluation criteria used to assess the alternatives are presented in Section 5.1. The evaluation of each sector is provided in Chapter 6.0, Sector Evaluations. The results of this evaluation help to form the basis for the specific recommendations made for individual sectors, which are discussed in Chapter 7.0, Recommended Alternatives.

For each sector, alternatives are first evaluated in terms of their effectiveness, implementability, and cost. The purpose of this evaluation is to identify the best alternative to render each sector compatible with its intended disposition. For effectiveness, the ranking considers protection of public safety, compliance with ARARs, and long- and short-term effectiveness. For implementability, the alternatives are ranked by technical and administrative feasibility, agency and community acceptance, and availability of services and materials. Cost considerations are made using detailed costing assumptions and costing backup on a sector-by-sector basis (costs are presented in Appendix F). The exception is the NoFA alternative, for which there are no costs.

5.1 EFFECTIVENESS

Effectiveness is a measure of an alternative's ability to reduce the potential for exposure to or interaction with UXO. It is generally a measure of an alternative's ability to meet the criteria of protecting public safety and the identified ARARs. Effectiveness is also evaluated in terms of long-and short-term practicability. A concise interpretation of these criteria is as follows:

Protection of Human Safety/Health. This criterion is a measure of how well the alternative reduces the public's exposure to and interaction with UXO, the reduction in terms of possible injury or death to humans, and protection of the environment. As such, it considers the following:

- The net reduction in UXO
- The estimated quantity of residual UXO
- The expected depth of residual UXO
- The potential exposure pathway between humans (considering future land use) and UXO
- The potential for an individual to interact with any UXO once an exposure occurs.

Effectiveness rankings are based mainly upon exposure data provided through OE*Cert.* Exposure data are not available for Alternative 2 (Institutional Controls),

as the model does not account for the reduction of exposures expected as a result of display board placement or community relations, education, or land use restrictions. It has been assumed that the effectiveness of Alternative 2 in protecting public safety would be greater than NoFA (Alternative 1), but less than any surface or subsurface clearance action (Alternatives 3 and 4).

Compliance with ARARs. This criterion is a measure of how well the alternative meets the identified chemical-, action-, and location-specific ARARs (federal, state, and local). Currently, no chemical-specific ARARs exist for ordnance sites. Risk management actions at the Former Benicia Arsenal will be conducted in accordance with appropriate regulations.

Long-Term Effectiveness. This criterion is a measure of how well the alternative protects public safety once it has been implemented. The remaining potential for exposure or interaction with UXO at an area is characterized by the following factors:

- The magnitude of potential exposures and interaction following implementation of the selected alternative
- The permanence of the exposure and interaction reduction due to implementation of the selected alternative
- The reliability of the controls and maintenance measures in managing residual UXO following implementation of the selected alternative.

Short-Term Effectiveness. This criterion is a measure of how well the alternative meets the exposure and interaction reduction objectives during its implementation. This includes:

- The ability of the alternative to reduce risk during implementation
- The potential for adverse effects on the environment during the alternative's implementation
- The time required to implement the alternative
- The potential for adverse effects on humans, including the community and personnel involved in implementation of the alternative.

5.2 IMPLEMENTABILITY

Implementability is a measure of whether an alternative can be physically and administratively implemented, such as the ability to construct, excavate, or demolish. It is also a measure of the availability of the services and materials needed to implement the alternative. Other considerations regarding implementability include local agency and community acceptance of a given

alternative. A concise interpretation of the criteria governing implementability is as follows:

Technical Feasibility. This criterion refers to:

- The reliability of the action with regard to implementation
- The actual ease of field implementation (e.g., construction, clearance action)
- The ease in undertaking future actions related to the initial undertaking
- The ability to monitor the effectiveness of the action.

Administrative Feasibility. This criterion is a measure of the ease with which an alternative can be implemented in terms of permits and rights-of-entry, coordination of services to support the action (e.g., legal services), or the arrangement of delivery or security services.

Availability of Services and Materials. This criterion is a measure of the availability of goods and services needed to support implementation of the alternative. Examples of this criterion include the availability of specialized personnel (e.g., UXO-qualified technicians) and equipment (e.g., geophysical instruments), availability of explosives for demolition purposes, availability of a suitable disposal facility for the OE-related scrap (i.e., proximity of local scrap metal recycling facility), and the condition of existing infrastructure to allow ingress and egress of personnel and material to the project site.

Local Agency Acceptance. This criterion deals with the acceptance of the alternative by applicable state, county, and city agencies, as expressed by representatives under the agency's authority. Rankings of alternatives under this criterion are marked under the "Agency Acceptance" column in the tables showing rankings of implementability (see Chapter 6.0). Local agency acceptance has been established based on interviews with local agencies and information collected during the EE/CA investigation.

Community Acceptance. This criterion relates to the degree of acceptance of the alternative by the community, including owners of property adjacent to the area. Public sentiment expressed during town hall meetings, public workshops, city council or county supervisor meetings, or institutional analysis is a means of determining community acceptance. Rankings of alternatives under this criterion have been established and are marked under the "Community Acceptance" column in the tables showing rankings of implementability (see Chapter 6.0).

5.3 COST

The cost of implementing each of the alternatives has been estimated for each Sector. The exception is NoFA, which involves no further action, and therefore

has no associated costs. A detailed summary of these costs and costing assumptions is presented in Appendix F.

For Alternative 2 (Institutional Controls), the costs include those associated with access controls (i.e., fences, barricades, warning signs) and behavior modifications (i.e., public meetings/education, brochures, fact sheets). For Alternatives 3 and 4 (surface and subsurface clearance actions), the costs are one-time capital costs and do not include monitoring for sensitive species or habitat restoration.

Examples of capital costs include those costs incurred by the UXO-qualified contractor for conducting the field activities (e.g., geophysical surveys) associated with implementing a subsurface clearance. Examples of operation and maintenance costs would include repairing and replacing perimeter signs and educational display boards over a specified length of time.

The benefit of the investment in reducing risk is also considered when ranking the alternatives. This involves identifying the overall reduction in risk to the public versus the cost of implementing the alternative. For example: If two alternatives provide an equal or comparable amount of protection, the less expensive alternative would provide the greatest benefit for the dollars spent and therefore would be ranked as the better alternative in terms of cost benefit.

5.4 ALTERNATIVE EVALUATION PROCESS

Table 5-1 provides an example of the alternative evaluation performed in Chapter 6.0. As shown below, each alternative has been ranked according to the criteria presented in Sections 5.1, 5.2, and 5.3. For effectiveness, Detection and Clearance of UXO to Depth (Alternative 4) has ranked 1 (best) because it provides the maximum protection against UXO (based upon exposure data from OE*Cert*) over the long term. For implementability, NoFA (Alternative 1) has ranked 1 (best) because it would be easier than implementing any of the other alternatives, from both an administrative and a technical feasibility perspective, as no effort, materials, or services would be required. For cost, Institutional Controls (Alternative 2) ranked 1 (best) because the cost to implement this alternative is lower than any clearance alternative, and the benefit of implementation could be similar to that of a surface clearance (at less than one-tenth of the price).

Once each alternative has been evaluated based upon the three criteria (effectiveness, implementability, and cost), an overall ranking of the four different alternatives can be performed. The score for each alternative is calculated based upon the ranking it received under each of the three criteria. The alternative with the lowest score (in this case, Institutional Controls) is ranked 1 (best), the alternative with the second lowest score is ranked 2 (second best), and the alternative with the highest score is ranked 4 (last). As shown in the example table below, Institutional Controls (Alternative 2) ranked 1 and is considered the best alternative based on its effectiveness, implementability, and cost.

Table 5-1. Alternative Evaluation Process

Alternative	Effectiveness Rank	Implementability Rank	Cost Rank	Overall Score	Overall Rank
1, NoFA	4	1	3	8	3
2, Institutional Controls	3	2	1	6	1
3, Surface Clearance	2	3	2	7	2
4, Detection and Clearance of UXO to Depth	1	4	4	9	4

Notes: Ranking from best to worst; best=1.
NoFA = No Further Action

6.0 SECTOR EVALUATIONS

This chapter describes the evaluation process for determining recommendations for risk management options to be implemented at the Former Benicia Arsenal. The evaluation criteria used to assess the alternatives are presented in Section 5.1. The results of this evaluation help to form the basis for the specific recommendations made for individual areas, which are discussed in Chapter 7.0, Recommended Alternatives.

This evaluation provides a detailed analysis for specified sectors at the Former Benicia Arsenal. The first of these is Sector 2 (Artillery Test Area), in which no UXO or OE items were encountered during a reconnaissance survey or subsurface sampling of a single grid. Exposure results and UXO density estimates for Sector 2 were calculated based upon the OE*Cert* analogy discussed in Section 2.6 and sampling results of Sectors 3A and 3B. Sector 3A (Tourtelot Property) was found to contain OE scattered primarily in the southern region. Sector 3B (Tourtelot Property) was found to contain OE scattered throughout the area, with two UXO items recovered in the central region. Sector 4 (Demolition Site on Exxon Property) was found to contain OE primarily scattered in the southern region. Sector 5 (Camel Barn Area) was found to contain OE scattered throughout the area, with 15 UXO items recovered in the north-central and eastern regions.

An evaluation of the four risk management alternatives was not performed for Sector 1 and Sector 3C. There were no UXO or OE items recovered in these two sectors during the EE/CA field investigation. As stated in Section 2.6, OE*Cert* is run only in sectors that are found to contain UXO or OE scrap. Therefore, exposure data and UXO density estimates have not been calculated for these two sectors. Subsequently, an evaluation of these two sectors was not required. Recommendations for Sector 1 and Sector 3C are presented in Chapter 7.0, Recommended Alternatives.

Definitive future land uses (as stated in Chapter 2.0) have been defined in the *City of Benicia Edited Draft General Plan* (November 1998) and are discussed in the Institutional Analysis (Appendix E). Future land use for each sector evaluated consists of the following:

- Sector 2: Limited Industrial/Open Space
- Sector 3A: Residential/Parks/Open Space
- Sector 3B: Open Space
- Sector 4: Limited Industrial
- Sector 5: Limited Industrial

The following evaluation analyzes the effectiveness, implementability, and cost for each alternative for Sectors 2, 3A, 3B, 4 and 5. Each alternative is applied to these sectors in order to identify the best alternative(s) to render the areas compatible with their intended disposition. The alternative with the lowest ranking score is considered the best in terms of these evaluation criteria.

6.1 SECTION 2 – ARTILLERY TEST AREA (LIMITED INDUSTRIAL/OPEN SPACE LAND USE)

6.1.1 Moderate Density Area

Future land use for Sector 2 is characterized as Limited Industrial/Open Space (see Section 2.1.4). There were no UXO or OE items recovered in Sector 2 during a reconnaissance survey or subsurface sampling of a single grid. Exposure results and UXO density estimates for Sector 2 were calculated based upon the OE*Cert* analogy discussed in Section 2.6 and sampling results of Sectors 3A and 3B. The OE*Cert* report indicated a minimum estimated UXO density of 2.09 and a maximum estimated UXO density of 5.55 UXO per acre within Sector 2.

6.1.1.1 Effectiveness of Alternative 1 - No Further Action.

Protection of Human Health. There were no UXO or OE items recovered in Sector 2 during the EE/CA field investigation. However, based upon the OE*Cert* risk analysis, there is a slight risk that UXO might exist in every sector (Appendix A). If the NoFA alternative were implemented, the potential UXO exposure risk would remain unchanged at 148 annual exposures. Because it did not result in reduced exposures, this alternative ranked 4, or last, for protectiveness.

Compliance with ARARs. Compliance with ARARs has been ranked equally (ranked 1) among Alternatives 1 and 2, as full compliance with the ARARs is expected with minimal impact to the environment.

Long-term and Short-term Effectiveness. Since this alternative would not further reduce the risk of potential UXO exposures to the public, it is considered the least effective of the alternatives over the long and short term.

6.1.1.2 Effectiveness of Alternative 2 - Institutional Controls.

Protection of Human Health. It is estimated that the maximum annual UXO exposures within Sector 2 would fall between 148 (expected with NoFA) and 78 (expected with the surface clearance alternative) under this land use. As a result, this alternative ranked 3 for protectiveness.

Institutional Controls can reduce the risk of public exposure to UXO through the implementation of access controls and behavior modifications (as discussed in Section 4.1.2). Currently, there are no access controls in place for Sector 2. Various types of access controls could be implemented by the existing landowner or the city of Benicia, such as warning signs and/or regulatory controls. The warning signs could be posted at the primary access road leading into Sector 2 and at intervals along the existing fenceline. The USACE would be responsible for providing warning signs for use on the property. A specified number of signs (as discussed in Appendix F) would be provided to the landowner in order to replace signs that may become damaged or stolen over a 5-year period.

In addition to various types of access controls, behavior modifications can also be implemented. Because there is no area designated for public gathering in this sector, certain types of behavior modifications (i.e., display cases, fact sheets, brochures) would not be very effective in terms of informing or educating the public concerning the dangers associated with OE that may be in the area.

The effectiveness of this alternative is based largely on the public's willingness to comply with access controls (i.e., fences, warning signs).

Compliance with ARARs. Compliance with ARARs has been ranked equally (ranked 1) among Alternatives 1 and 2, as full compliance with the ARARs is expected with minimal impact to the environment.

Long-term and Short-term Effectiveness. In general, the long-term effectiveness of access controls (i.e., warning signs) is dependent upon their maintenance. Land use restrictions can be effective in the long term, depending on the willingness of stakeholders to accept and/or enforce use restrictions. In terms of long-term effectiveness, this alternative ranked 3, second lowest of the acceptable alternatives.

This alternative ranked 1 (best) for short-term effectiveness, primarily because of the short time frame necessary to implement it to the point that it affords protection. The time involved includes meeting with responsible agencies to confirm the location of warning signs, construction of warning signs, and installation.

6.1.1.3 Effectiveness of Alternative 3 - Surface Clearance.

Protection of Human Health. The maximum expected UXO exposures to the public in Sector 2 under the Limited Industrial/Open Space land use were 148 under NoFA, and 78 if a surface clearance occurs. As a result, this alternative ranked 2 for protectiveness.

Compliance with ARARs. Compliance with ARARs is ranked 3 (tied with the subsurface clearance to depth), as full compliance with the ARARs will be more difficult due to the wetlands in this area.

Long-term and Short-term Effectiveness. The long-term effectiveness of a surface clearance is ranked 2, behind the subsurface clearance to depth (Alternative 4). The surface clearance is more effective over the long term than Institutional Controls (Alternative 2).

This alternative ranked 2, or second best, for short-term effectiveness, as it would take more time to implement than Institutional Controls (Alternative 2). This alternative would take less time to implement and would be more effective over the short-term than the subsurface clearance to depth (Alternative 4).

6.1.1.4 Effectiveness of Alternative 4 - UXO Detection and Clearance to Depth.

Protection of Human Health. The maximum expected UXO exposures to the public in Sector 2 under limited industrial/open space land use were 148 under NoFA, and 3 if a subsurface clearance to depth occurs. Because this alternative provides the maximum protection against UXO, it ranked 1 (best) for protectiveness.

Compliance with ARARs. Compliance with ARARs is ranked 3 (tied with the surface clearance), as full compliance with the ARARs will be more difficult due to the wetlands in this area.

Long-term and Short-term Effectiveness. The long-term effectiveness of a subsurface clearance to depth (Alternative 4) is ranked 1 for its effectiveness at reducing annual exposures. The subsurface clearance to depth is more effective over the long term than a surface clearance (Alternative 3), or Institutional Controls (Alternative 2).

This alternative ranked 3, or third best, for short-term effectiveness, as it would take more time to implement than Institutional Controls (Alternative 2) or Surface Clearance (Alternative 3).

6.1.1.5 Overall Effectiveness Ranking for Alternatives 1 through 4.

Table 6-1 provides the effectiveness criteria evaluation of the alternatives for the Sector 2 limited industrial/open space land use area. Institutional Controls (Alternative 2) and the subsurface clearance to depth (Alternative 4) both ranked equally as the best alternative in terms of effectiveness for Sector 2 under the limited industrial/open space land use, based upon their ability to reduce UXO exposures.

Table 6-1. Effectiveness Criteria Evaluation for Sector 2 Limited Industrial/Open Space Land Use

	Effectiveness					
Alternative	Protection of Human Health	Compliance with ARARs	Long-Term	Short-Term	Score	Rank
1, NoFA	4	1	4	4	13	4
2, Institutional Controls	3	1	3	1	8	1
3, Surface Clearance	2	3	2	2	9	3
4, Subsurface Clearance to Depth	1	3	1	3	8	1

Notes: Ranking from best to worst; best=1.
ARAR = applicable or relevant and appropriate requirement
NoFA = No Further Action

6.1.1.6 Implementability of Alternative 1 - No Further Action.

Technical and Administrative Feasibility. Implementing the NoFA alternative would be easier than implementing any of the other alternatives, from both an administrative and a technical feasibility perspective, as no effort, materials, or services would be required. This alternative ranked 1, or best, for technical and administrative feasibility.

Services and Materials. This alternative ranked 1 (best) for availability of services and materials, as no services or materials are required for this alternative.

Agency and Community Acceptance. Rankings for local agency and community acceptance of NoFA (Alternative 1) have been established based on interviews conducted with local agencies and interaction with the community. Based upon this input, it has been determined that local agencies and the community would not consider NoFA as an acceptable alternative in this area due to the nearby residential area and the anticipated future land use for this sector. Therefore, this alternative ranked 4 (last) in terms of local agency and community acceptance.

6.1.1.7 Implementability of Alternative 2 - Institutional Controls.

Technical and Administrative Feasibility. Institutional Controls (Alternative 2) can be implemented easily from both a technical and an administrative standpoint. The supplies and personnel needed to construct display cases and install warning signs, conduct educational programs, and implement and oversee use restrictions are readily available. This alternative ranked 2 from a technical and administrative feasibility standpoint.

Services and Materials. This alternative ranked 2 for availability of services and materials because the supplies and personnel needed to implement this alternative are readily available.

Agency and Community Acceptance. Rankings for local agency and community acceptance of Institutional Controls (Alternative 2) have been established based on interviews conducted with local agencies and interaction with the community. Based upon this input, it has been determined that local agencies and the community are not likely to consider Institutional Controls as an acceptable alternative in this area due to the proximity of a nearby residential area and the anticipated future land use for this sector. Therefore, this alternative ranked 3 (third best) in terms of local agency and community acceptance.

6.1.1.8 Implementability of Alternative 3 - Surface Clearance.

Technical and Administrative Feasibility. Implementation of a surface clearance would be quite feasible from a technical perspective. While relatively easier to implement than the subsurface clearance to depth (Alternative 4), the surface clearance would be more difficult to implement than Institutional Controls or NoFA. Therefore, this alternative ranked 3 for technical feasibility.

The administrative feasibility of this alternative is less than that of Institutional Controls. This alternative ranked 3 for administrative feasibility.

Services and Materials. Services and materials for this alternative would require specially trained and qualified personnel as well as the means of disposing of any encountered UXO. This alternative ranked 3 for availability of services and materials.

Agency and Community Acceptance. Rankings for local agency and community acceptance of Surface Clearance (Alternative 3) have been established based on interviews conducted with local agencies and interaction with the community. Based upon this input, it has been determined that local agencies and the community are likely to consider a surface clearance as an acceptable alternative in this area. Therefore, this alternative ranked 2 (second best) in terms of local agency and community acceptance.

6.1.1.9 Implementability of Alternative 4 - Detection and Clearance of UXO to Depth.

Technical and Administrative Feasibility. From technical and administrative perspectives, implementation of a subsurface clearance to depth is quite feasible. This alternative generally requires less logistical and management support than would a deeper clearance action but more than would be required for Institutional Controls or a surface clearance. Unlike a surface clearance, a subsurface clearance requires excavation equipment (in addition to specially trained and qualified personnel and a means of UXO disposal, which is required for all clearance actions). This alternative ranked 4 (last) in terms of technical and administrative feasibility, as it would take more time and effort to implement than the Surface Clearance (Alternative 3) or Institutional Controls (Alternative 2).

Services and Materials. A subsurface clearance requires excavation equipment (in addition to specially trained and qualified personnel) and a means of UXO disposal. The alternative ranked 4 for availability of services and materials.

Agency and Community Acceptance. Rankings for local agency and community acceptance of the subsurface clearance to depth (Alternative 4) have been established based on interviews conducted with local agencies and interaction with the community. Based upon this input, it has been determined that local agencies and the community would consider the subsurface clearance to depth as the most acceptable alternative in this area. Therefore, this alternative ranked as the best alternative in terms of local agency and community acceptance.

6.1.1.10 Overall Implementability Ranking for Alternatives 1 through 4.

Table 6-2 provides the implementability criteria evaluation of the alternatives for the Sector 2 limited industrial/open space land use area. NoFA (Alternative 1) ranked as the best alternative in terms of its ability to be implemented from both an administrative and technical feasibility standpoint, as no services or materials are required for this alternative.

Table 6-2. Implementability Criteria Evaluation for Sector 2 Limited Industrial/Open Space Land Use

	Implementability						
Alternative	Technical Feasibility	Administrative Feasibility	Services and Materials	Agency Acceptance	Community Acceptance	Score	Rank
1, NoFA	1	1	1	4	4	11	1
2, Institutional Controls	2	2	2	3	3	12	2
3, Surface Clearance	3	3	3	2	2	13	3
4, Subsurface Clearance to Depth	4	4	4	1	1	14	4

Notes: Ranking from best to worst; best=1.
NoFA = No Further Action

6.1.1.11 Cost of Alternatives 1 through 4.

The total estimated cost for implementing Alternatives 1 through 4 is shown in Table 6-3.

Table 6-3. Cost Criteria Evaluation for Sector 2 Limited Industrial/Open Space Land Use

Alternative	Cost	Investment	Benefit	Score	Rank
1, NoFA	$0	1	4	5	3
2, Institutional Controls	$2,868	2	2	4	1
3, Surface Clearance	$103,718	3	1	4	1
4, Subsurface Clearance to Depth	$232,283	4	3	7	4

Note: Ranking from best to worst; best=1
NoFA = No Further Action

Investment and Benefit. There is no cost associated with NoFA; therefore, NoFA ranked 1 (best) in terms of investment. The alternative that provides the greatest benefit, in terms of dollars spent to effect results, appears to be the Surface Clearance (Alternative 3), followed closely by Institutional Controls (Alternative 2). The cost of implementing Institutional Controls (Alternative 2) is lower than that of any clearance alternative, and the benefit of implementation could be similar to that of a surface clearance (at less than one-tenth of the price). The subsurface clearance to depth (Alternative 4) ranked last (ranked 4) for cost.

6.1.1.12 Overall Cost Ranking for Alternatives 1 through 4.

Institutional Controls (Alternative 2) and the Surface Clearance (Alternative 3) both ranked equally as the best alternative in terms of cost for Sector 2 under the limited industrial/open space land use (Table 6-3), based upon their ability to offer a substantial reduction in UXO exposures for dollars spent to effect results.

6.1.1.13 Overall Ranking of Alternatives for Sector 2.

The overall ranking of the different alternatives in terms of their effectiveness, implementability, and cost is presented in Table 6-4. The alternative with the

Table 6-4. Alternative Evaluation for Sector 2

Alternative	Effectiveness Rank	Implementability Rank	Cost Rank	Overall Score	Overall Rank
1, NoFA	4	1	3	8	3
2, Institutional Controls	1	2	1	4	1
3, Surface Clearance	3	3	1	7	2
4, Subsurface Clearance to Depth	1	4	4	9	4

Notes: Ranking from best to worst; best=1.
NoFA = No Further Action

lowest score is considered best for each criterion (effectiveness, implementability, and cost) evaluated.

Institutional Controls (Alternative 2) ranked 1 (best), followed by the Surface Clearance (Alternative 3) and NoFA (Alternative 1). The subsurface clearance to depth (Alternative 4) ranked 4 (last) based on cost and implementability issues. Specific recommendations for Sector 2 under limited industrial/open space land use are made in Chapter 7.0, Recommended Alternatives.

6.2 SECTOR 3A - TOURTELOT PROPERTY (RESIDENTIAL/PARKS/OPEN SPACE LAND USE)

6.2.1 Low-Density Area

Future land use for Sector 3A is characterized as Residential, Parks, and Open Space (see Section 2.1.4). There were no UXO items recovered in Sector 3A during subsurface sampling. The OE*Cert* report indicated a minimum estimated UXO density of 2.11 and a maximum estimated UXO density of 4.31 UXO per acre within Sector 3A.

6.2.1.1 Effectiveness of Alternative 1 - No Further Action.

Protection of Human Health. There were no UXO recovered in Sector 3A during the EE/CA field investigation. However, based upon the OE*Cert* risk analysis, there is a slight risk that UXO might exist in every sector (Appendix A). If the NoFA alternative were implemented, the potential UXO exposure risk would remain unchanged at 7,682 annual exposures. Because it did not result in reduced exposures, this alternative ranked 4, or last, for protectiveness.

Compliance with ARARs. Compliance with ARARs has been ranked equally among Alternatives 1 through 4, as full compliance with the ARARs is expected with minimal impact to the environment.

Long-term and Short-term Effectiveness. Since this alternative would not further reduce the risk of potential UXO exposures to the public, it is considered the least effective of the alternatives over the long and short term.

6.2.1.2 Effectiveness of Alternative 2 - Institutional Controls.

Protection of Human Health. It is estimated that the maximum annual UXO exposures within Sector 3A would fall between 7,682 (expected with NoFA) and 593 (expected with the surface clearance alternative) under this land use. As a result, this alternative ranked 3 for protectiveness.

Institutional Controls can reduce the risk of public exposure to UXO through the implementation of access controls and behavior modifications (as discussed in Section 4.1.2). Various types of access controls are currently in place by the existing landowner, such as a fence and security guards that monitor the area 24 hours a day. Warning signs could be posted at the primary access road leading into Sector 3A and at intervals along the existing fenceline. The USACE would be responsible for providing warning signs for use on the property. A specified number of signs (as discussed in Appendix F) would be provided to the landowner in order to replace signs that may become damaged or stolen over a 5-year period.

In addition to various types of access controls, behavior modifications can also be implemented in Sector 3A. These include educational materials and notices on permits or deeds to the property that would inform the public of the dangers of UXO.

The effectiveness of this alternative is based largely on the public's willingness to comply with access controls (i.e., fences, warning signs, security patrols) and respond (through public participation and compliance) to behavior modifications (i.e., avoid contact to OE and contact local authorities if OE is discovered).

Compliance with ARARs. Compliance with ARARs has been ranked equally among Alternatives 1 through 4, as full compliance with the ARARs is expected with minimal impact to the environment.

Long-term and Short-term Effectiveness. In general, the long-term effectiveness of access controls (i.e., fence, warning signs) is dependent upon their maintenance. Land use restrictions can be effective in the long term, depending on the willingness of stakeholders to accept and/or enforce use restrictions. The effectiveness of behavior modifications is difficult to judge because it relies solely on the public's willingness to abide by and follow the advise disseminated from warning signs, display cases, etc. In terms of long-term effectiveness, this alternative ranked 3, second lowest of the acceptable alternatives.

This alternative ranked 1 (best) for short-term effectiveness, primarily because of the short time frame necessary to implement it to the point that it affords protection. The time involved includes meeting with the appropriate agencies to confirm the location of warning signs, construction of warning signs, and installation.

6.2.1.3 Effectiveness of Alternative 3 - Surface Clearance.

Protection of Human Health. The maximum expected UXO exposures to the public in Sector 3A under the residential, parks, and open space land use were 7,682 under NoFA, and 593 if a surface clearance occurs. As a result, this alternative ranked 2 (second best) for protectiveness.

Compliance with ARARs. Compliance with ARARs has been ranked equally among Alternatives 1 through 4, as full compliance with the ARARs is expected with minimal impact to the environment.

Long-term and Short-term Effectiveness. The long-term effectiveness of a surface clearance is ranked 2, behind the subsurface clearance to depth (Alternative 4). The surface clearance is more effective over the long term than Institutional Controls (Alternative 2).

This alternative ranked 2, or second best, for short-term effectiveness, as it would take more time to implement than Institutional Controls (Alternative 2).

6.2.1.4 Effectiveness of Alternative 4 - UXO Detection and Clearance. to Depth.

Protection of Human Health. The maximum expected UXO exposures to the public in Sector 3A under residential, parks, and open space land use were 7,682 under NoFA, and 82 if a subsurface clearance to depth occurs. Because this alternative provides the maximum amount of protection against UXO, it ranked 1 (ranked best) for protectiveness.

Compliance with ARARs. Compliance with ARARs has been ranked equally among Alternatives 1 through 4, as full compliance with the ARARs is expected with minimal impact to the environment.

Long-term and Short-term Effectiveness. The long-term effectiveness of a subsurface clearance to depth (Alternative 4) is ranked 1 (best) for its effectiveness at reducing annual exposures. The subsurface clearance to depth is more effective over the long term than a Surface Clearance (Alternative 3), or Institutional Controls (Alternative 2).

This alternative ranked 3, or third best, for short-term effectiveness, as it would take more time to implement than a surface clearance or Institutional Controls.

6.2.1.5 Overall Effectiveness Ranking for Alternatives 1 through 4.

Table 6-5 provides the effectiveness criteria evaluation of the alternatives for the Sector 3A residential, parks, and open space land use areas. The subsurface clearance to depth (Alternative 4) ranked as the best alternative in terms of effectiveness for Sector 3A under the residential, parks, and open space land use, based upon its ability to provide maximum protection against UXO.

Table 6-5. Effectiveness Criteria Evaluation for Sector 3A Residential/Parks/Open Space

Alternative	Effectiveness: Protection of Human Health	Effectiveness: Compliance with ARARs	Effectiveness: Long-Term	Effectiveness: Short-Term	Score	Rank
1, NoFA	4	1	4	4	13	4
2, Institutional Controls	3	1	3	1	8	3
3, Surface Clearance	2	1	2	2	7	2
4, Subsurface Clearance to Depth	1	1	1	3	6	1

Notes: Ranking from best to worst; best=1.
ARAR = applicable or relevant and appropriate requirement
NoFA = No Further Action

6.2.1.6 Implementability of Alternative 1 - No Further Action.

Technical and Administrative Feasibility. Implementing the NoFA alternative would be easier than implementing any of the other alternatives, from both an administrative and a technical feasibility perspective, as no effort, materials, or services would be required. This alternative ranked 1, or best, for technical and administrative feasibility.

Services and Materials. This alternative ranked 1 (best) for availability of services and materials, as no services and materials are required for this alternative.

Agency and Community Acceptance. Rankings for local agency and community acceptance of NoFA (Alternative 1) have been established based on interviews conducted with local agencies and interaction with the community. Based upon this input, it has been determined that local agencies and the community would not consider NoFA as an acceptable alternative in this area, based on the number of UXO exposures expected under the anticipated future land use for this area. Therefore, this alternative ranked 4 (last) in terms of local agency and community acceptance.

6.2.1.7 Implementability of Alternative 2 - Institutional Controls.

Technical and Administrative Feasibility. Institutional Controls (Alternative 2) can be implemented easily from both a technical and an administrative standpoint. The supplies and personnel needed to install warning signs, conduct educational programs, and implement and oversee use restrictions are readily available. This alternative ranked 2 from a technical and administrative feasibility standpoint.

Services and Materials. This alternative ranked 2 for availability of services and materials because the supplies and personnel needed to implement this alternative are readily available.

Agency and Community Acceptance. Rankings for local agency and community acceptance of Institutional Controls (Alternative 2) have been established based on interviews conducted with local agencies and interaction

with the community. Based upon this input, it has been determined that local agencies and the community are not likely to consider Institutional Controls as an acceptable alternative in this area for the same reasons discussed for NoFA (Alternative 1). Therefore, this alternative ranked 3 (third best) in terms of local agency and community acceptance.

6.2.1.8 Implementability of Alternative 3 - Surface Clearance.

Technical and Administrative Feasibility. Implementation of a surface clearance would be quite feasible from a technical perspective. While relatively easier to implement than a subsurface clearance action, this alternative would be more difficult to implement than Institutional Controls or NoFA. Therefore, this alternative ranked 3 for technical feasibility.

The administrative feasibility of this alternative is less than that of Institutional Controls; however, planning and executing a program of this size is less difficult than managing a program for a subsurface clearance. This alternative ranked 3 for administrative feasibility.

Services and Materials. Services and materials for this alternative would require specially trained and qualified personnel as well as the means of disposing of any encountered UXO. This alternative ranked 3 for availability of services and materials.

Agency and Community Acceptance. Rankings for local agency and community acceptance of Surface Clearance (Alternative 3) have been established based on interviews conducted with local agencies and interaction with the community. Based upon this input, it has been determined that local agencies and the community are likely to consider a surface clearance as an acceptable alternative in this area. Therefore, this alternative ranked 2 (second best) in terms of local agency and community acceptance.

6.2.1.9 Implementability of Alternative 4 - Detection and Clearance of UXO to Depth.

Technical and Administrative Feasibility. From technical and administrative perspectives, implementation of a subsurface clearance to depth is quite feasible. This alternative generally requires less logistical and management support than would a deeper clearance action but more than would be required for Institutional Controls or a surface clearance. Unlike a surface clearance, a subsurface clearance requires excavation equipment (in addition to specially trained and qualified personnel and a means of UXO disposal, which is required for all clearance actions). This alternative ranked 4 (last) in terms of technical and administrative feasibility.

Services and Materials. This alternative would take longer to implement and would require more services and materials than any of the other alternatives. This alternative ranked 4 for availability of services and materials.

Agency and Community Acceptance. Rankings for local agency and community acceptance of the subsurface clearance to depth (Alternative 4) have been established based on interviews conducted with local agencies and interaction with the community. Based upon this input, it has been determined that local agencies and the community would consider the subsurface clearance to depth as the most acceptable alternative in this area because of its ability to provide maximum protection against UXO. Therefore, this alternative ranked as the best alternative in terms of local agency and community acceptance.

6.2.1.10 Overall Implementability Ranking for Alternatives 1 through 4.

Table 6-6 provides the implementability criteria evaluation of the alternatives for the Sector 3A residential, parks, and open space land use areas. NoFA (Alternative 1) ranked as the best alternative in terms of implementability for Sector 3A under the residential, parks, and open space land uses, based upon its ability to be implemented more quickly than any of the other alternatives.

Table 6-6. Implementability Criteria Evaluation for Sector 3A Residential/Parks/Open Space Land Use

	Implementability						
Alternative	Technical Feasibility	Administrative Feasibility	Services and Materials	Agency Acceptance	Community Acceptance	Score	Rank
1, NoFA	1	1	1	4	4	11	1
2, Institutional Controls	2	2	2	3	3	12	2
3, Surface Clearance	3	3	3	2	2	13	3
4, Subsurface Clearance to Depth	4	4	4	1	1	14	4

Notes: Ranking from best to worst; best=1.
NoFA = No Further Action

6.2.1.11 Cost of Alternatives 1 through 4.

The total estimated cost for implementing Alternatives 1 through 4 is shown in Table 6-7.

Table 6-7. Cost Criteria Evaluation for Sector 3A under Residential/Parks/Open Space

Alternative	Cost	Investment	Benefit	Score	Rank
1, NoFA	$0	1	4	5	3
2, Institutional Controls	$3,890	2	2	4	1
3, Surface Clearance	$210,581	3	1	4	1
4, Subsurface Clearance to Depth	$1,010,508	4	3	7	4

Note: Ranking from best to worst; best=1
NoFA = No Further Action

Investment and Benefit. There is no cost associated with NoFA; therefore, NoFA is ranked 1 (ranked first) in terms of investment. NoFA ranked 4 (last) in terms of benefit since there would be no net reduction in UXO exposures under this alternative. The Surface Clearance (Alternative 3) ranked 1 in terms of benefit, since the benefit would be greater than implementing Institutional Controls (Alternative 2). The alternatives that provide the greatest benefit in

terms of dollars spent to effect results would be Institutional Controls (Alternative 2) and Surface Clearance (Alternative 3).

6.2.1.12 Overall Cost Ranking for Alternatives 1 through 4.

Institutional Controls (Alternative 2) and the Surface Clearance (Alternative 3) both ranked equally as the best alternative in terms of cost for Sector 3A under residential, parks, and open space land use (Table 6-7), based upon their ability to provide a substantial reduction in UXO exposures for dollars spent to effect results.

6.2.1.13 Overall Ranking of Alternatives for Sector 3A.

The overall ranking of the different alternatives in terms of their effectiveness, implementability, and cost is presented in Table 6-8. The alternative with the lowest score is considered best for each criterion (effectiveness, implementability, and cost) evaluated.

Table 6-8. Alternative Evaluation for Sector 3A

Alternative	Effectiveness Rank	Implementability Rank	Cost Rank	Overall Score	Overall Rank
1, NoFA	4	1	3	8	3
2, Institutional Controls	3	2	1	6	1
3, Surface Clearance	2	3	1	6	1
4, Subsurface Clearance to Depth	1	4	4	9	4

Notes: Ranking from best to worst; best=1.
NoFA = No Further Action

Institutional Controls (Alternative 2) ranked 1 (tied as best) with the Surface Clearance (Alternative 3). The subsurface clearance to depth (Alternative 4) ranked 4 (last) based on cost and implementability issues. Specific recommendations for Sector 3A under the residential/parks/open space land use are made in Chapter 7.0, Recommended Alternatives.

6.3 SECTOR 3B - CITY PROPERTY ADJACENT TO TOURTELOT PROPERTY (OPEN SPACE LAND USE)

6.3.1 Moderate Density Area

Future land use for Sector 3B is characterized as Open Space (see Section 2.1.4). There were two UXO items recovered in Sector 3B during subsurface sampling. The OE*Cert* report indicated a minimum estimated UXO density of 2.09 and a maximum estimated UXO density of 5.55 UXO per acre within Sector 3B.

6.3.1.1 Effectiveness of Alternative 1 - No Further Action.

Protection of Human Health. There were two UXO items recovered in Sector 3B during the EE/CA field investigation. However, based upon the OE*Cert* risk analysis, there is a high risk from the remaining UXO that may exist throughout this area (Appendix A). If the NoFA alternative were implemented, the potential UXO exposure risk would remain unchanged at 6,069 annual exposures. Because it did not result in reduced exposures, this alternative ranked 4, or last, for protectiveness.

Compliance with ARARs. Compliance with ARARs has been ranked equally (ranked 1) among Alternatives 1 and 2, as full compliance with the ARARs is expected with minimal impact to the environment.

Long-term and Short-term Effectiveness. Since this alternative would not further reduce the risk of potential UXO exposures to the public, it is considered the least effective of the alternatives over the long and short term.

6.3.1.2 Effectiveness of Alternative 2 - Institutional Controls.

Protection of Human Health. It is estimated that the maximum annual UXO exposures within Sector 3B would fall between 6,069 (expected with NoFA) and 301 (expected with the surface clearance alternative) under this land use. As a result, this alternative ranked 3 for protectiveness.

Institutional Controls can reduce the risk of public exposure to UXO through the implementation of access controls and behavior modifications (as discussed in Section 4.1.2). Various types of access controls are currently in place by the existing landowner, such as a fence and security guards that monitor the area 24 hours a day. Warning signs could be posted at the primary access road leading into Sector 3B and at intervals along the existing fenceline. The USACE would be responsible for providing warning signs for use on the property. A specified number of signs (as discussed in Appendix F) would be provided to the landowner in order to replace signs that may become damaged or stolen over a 5-year period.

In addition to various types of access controls, behavior modifications, as discussed for Sector 3A, could be implemented.

The effectiveness of this alternative is based largely on the public's willingness to comply with access controls (i.e., fences, warning signs, security patrols) and respond (through public participation and compliance) to behavior modifications.

Compliance with ARARs. Compliance with ARARs has been ranked equally (ranked 1) for Alternatives 1 and 2, as full compliance with the ARARs is expected with minimal impact to the environment.

Long-term and Short-term Effectiveness. In general, the long-term effectiveness of access controls (i.e., warning signs) is dependent upon their maintenance. Land use restrictions can be effective in the long term, depending

on the willingness of stakeholders to accept and/or enforce use restrictions. The effectiveness of behavior modifications (as discussed for Sector 3A) is difficult to judge over the long term and short term. In terms of long-term effectiveness, this alternative ranked 3, second lowest of the acceptable alternatives.

This alternative ranked 1 (best) for short-term effectiveness, primarily because of the short time frame necessary to implement it to the point that it affords protection. The time involved includes meeting with responsible agencies to confirm the location of warning signs, construction of warning signs, and installation.

6.3.1.3 Effectiveness of Alternative 3 - Surface Clearance.

Protection of Human Health. The maximum expected UXO exposures to the public in Sector 3B under the open space land use were 6,069 under NoFA, and 301 if a surface clearance occurs. As a result, this alternative ranked 2 for protectiveness.

Compliance with ARARs. Compliance with ARARs is ranked 3 (tied with the subsurface clearance to depth), as full compliance with the ARARs will be more difficult due to the wetlands in this area.

Long-term and Short-term Effectiveness. The long-term effectiveness of a surface clearance is ranked 2, behind the subsurface clearance to depth (Alternative 4). The surface clearance is more effective over the long term than Institutional Controls (Alternative 2).

This alternative ranked 2, or second best, for short-term effectiveness, as it would take more time to implement than Institutional Controls (Alternative 2). This alternative would take less time to implement and be more effective over the short term than the subsurface clearance to depth (Alternative 4).

6.3.1.4 Effectiveness of Alternative 4 - UXO Detection and Clearance to Depth.

Protection of Human Health. The maximum expected UXO exposures to the public in Sector 3B under Open Space land use were 6,069 under NoFA, and 65 if a subsurface clearance to depth occurs. Because this alternative provides the maximum protection against UXO, it ranked 1 (best) for protectiveness.

Compliance with ARARs. Compliance with ARARs is ranked 3 (tied with the surface clearance), as full compliance with the ARARs will be more difficult due to the wetlands located in this area.

Long-term and Short-term Effectiveness. The long-term effectiveness of a subsurface clearance to depth (Alternative 4) is ranked 1 for its effectiveness at reducing annual exposures. The subsurface clearance to depth is more effective over the long term than a surface clearance (Alternative 3), or Institutional Controls (Alternative 2).

This alternative ranked 3, or third best, for short-term effectiveness, as it would take more time to implement than Institutional Controls (Alternative 2) or NoFA (Alternative 1).

6.3.1.5 Overall Effectiveness Ranking for Alternatives 1 through 4.

Table 6-9 provides the effectiveness criteria evaluation of the alternatives for the Sector 3B open space land use area. Institutional Controls (Alternative 2) and the subsurface clearance to depth (Alternative 4) both ranked equally as the best alternative in terms of effectiveness for Sector 3B under the open space land use, based upon their ability to reduce UXO exposures.

Table 6-9. Effectiveness Criteria Evaluation for Sector 3B Open Space Land Use

	Effectiveness					
Alternative	Protection of Human Health	Compliance with ARARs	Long-Term	Short-Term	Score	Rank
1, NoFA	4	1	4	4	13	4
2, Institutional Controls	3	1	3	1	8	1
3, Surface Clearance	2	3	2	2	9	3
4, Subsurface Clearance to Depth	1	3	1	3	8	1

Notes: Ranking from best to worst; best=1.
ARAR = applicable or relevant and appropriate requirement
NoFA = No Further Action

6.3.1.6 Implementability of Alternative 1 - No Further Action.

Technical and Administrative Feasibility. Implementing the NoFA alternative would be easier than implementing any of the other alternatives, from both an administrative and a technical feasibility perspective, as no effort, materials, or services would be required. This alternative ranked 1, or best, for technical and administrative feasibility.

Services and Materials. This alternative ranked 1 (best) for availability of services and materials, as no services or materials are required for this alternative.

Agency and Community Acceptance. Rankings for local agency and community acceptance of NoFA (Alternative 1) have been established based on interviews conducted with local agencies and interaction with the community. Based upon this input, it has been determined that local agencies and the community would not consider NoFA as an acceptable alternative in this area because of the two UXO items that were recovered in this sector during the EE/CA field investigation. Therefore, this alternative ranked 4 (last) in terms of local agency and community acceptance.

6.3.1.7 Implementability of Alternative 2 - Institutional Controls.

Technical and Administrative Feasibility. Institutional Controls (Alternative 2) can be implemented easily from both a technical and an administrative standpoint. The supplies and personnel needed to construct display cases and install warning signs, conduct educational programs, and implement and oversee use restrictions are readily available. This alternative ranked 2 from a technical and administrative feasibility standpoint.

Services and Materials. This alternative ranked 2 for availability of services and materials because the supplies and personnel needed to implement this alternative are readily available.

Agency and Community Acceptance. Rankings for local agency and community acceptance of Institutional Controls (Alternative 2) have been established based on interviews conducted with local agencies and interaction with the community. Based upon this input, it has been determined that local agencies and the community are not likely to consider Institutional Controls as an acceptable alternative in this area because of the two UXO items that were recovered in this sector during subsurface sampling. Therefore, this alternative ranked 3 (third best) in terms of local agency and community acceptance.

6.3.1.8 Implementability of Alternative 3 - Surface Clearance.

Technical and Administrative Feasibility. Implementation of a surface clearance would be quite feasible from a technical perspective. While relatively easier to implement than the subsurface clearance to depth (Alternative 4), the surface clearance would be more difficult to implement than Institutional Controls or NoFA. Therefore, this alternative ranked 3 for technical feasibility.

The administrative feasibility of this alternative is less than that of Institutional Controls. This alternative ranked 3 for administrative feasibility.

Services and Materials. Services and materials for this alternative would require specially trained and qualified personnel as well as the means of disposing of any encountered UXO. This alternative ranked 3 for availability of services and materials.

Agency and Community Acceptance. Rankings for local agency and community acceptance of Surface Clearance (Alternative 3) have been established based on interviews conducted with local agencies and interaction with the community. Based upon this input, it has been determined that local agencies and the community are likely to consider a surface clearance as an acceptable alternative in this area. Therefore, this alternative ranked 2 (second best) in terms of local agency and community acceptance.

6.3.1.9 Implementability of Alternative 4 - Detection and Clearance of UXO to Depth.

Technical and Administrative Feasibility. From technical and administrative perspectives, implementation of a subsurface clearance to depth is quite feasible. This alternative generally requires less logistical and management support than would a deeper clearance action but more than would be required for institutional controls or a surface clearance. Unlike a surface clearance, a subsurface clearance requires excavation equipment (in addition to specially trained and qualified personnel and a means of UXO disposal, which is required for all clearance actions). This alternative ranked 4 (last) in terms of technical and administrative feasibility, as it would be take more time and effort to implement than the Surface Clearance (Alternative 3) or Institutional Controls (Alternative 2).

Services and Materials. The alternative ranked 4 for availability of services and materials as it requires more logistical and management support than a Surface Clearance (Alternative 3).

Agency and Community Acceptance. Rankings for local agency and community acceptance of the subsurface clearance to depth (Alternative 4) have been established based on interviews conducted with local agencies and interaction with the community. Based upon this input, it has been determined that local agencies and the community would consider the subsurface clearance to depth as the most acceptable alternative in this area. Therefore, this alternative ranked as the best alternative in terms of local agency and community acceptance.

6.3.1.10 Overall Implementability Ranking for Alternatives 1 through 4.

Table 6-10 provides the implementability criteria evaluation of the alternatives for the Sector 3B open space land use area. NoFA (Alternative 1) ranked as the best alternative in terms of its ability to be implemented from both an administrative and technical feasibility standpoint, as no services or materials are required for this alternative.

Table 6-10. Implementability Criteria Evaluation for Sector 3B Open Space Land Use

	Implementability						
Alternative	Technical Feasibility	Administrative Feasibility	Services and Materials	Agency Acceptance	Community Acceptance	Score	Rank
1, NoFA	1	1	1	4	4	11	1
2, Institutional Controls	2	2	2	3	3	12	2
3, Surface Clearance	3	3	3	2	2	13	3
4, Subsurface Clearance to Depth	4	4	4	1	1	14	4

Notes: Ranking from best to worst; best=1.
NoFA = No Further Action

6.3.1.11 Cost of Alternatives 1 through 4.

The total estimated cost for implementing Alternatives 1 through 4 is shown in Table 6-11.

Table 6-11. Cost Criteria Evaluation for Sector 3B Open Space Land Use

Alternative	Cost	Investment	Benefit	Score	Rank
1, NoFA	$0	1	4	5	3
2, Institutional Controls	$2,938	2	2	4	1
3, Surface Clearance	$131,059	3	1	4	1
4, Subsurface Clearance to Depth	$436,540	4	3	7	4

Note: Ranking from best to worst; best=1
NoFA = No Further Action

Investment and Benefit. There is no cost associated with NoFA; therefore, NoFA ranked 1 (best) in terms of investment. The alternative that provides the greatest benefit, in terms of dollars spent to effect results, appears to be the Surface Clearance (Alternative 3), followed closely by Institutional Controls (Alternative 2). The cost of implementing Institutional Controls (Alternative 2) is lower than that of any clearance alternative, and the benefit of implementation could be similar to that of a surface clearance (at less than one-tenth of the price). The subsurface clearance to depth (Alternative 4) ranked 4 (last) for cost.

6.3.1.12 Overall Cost Ranking for Alternatives 1 through 4.

Institutional Controls (Alternative 2) and the Surface Clearance (Alternative 3) both ranked equally as the best alternative in terms of cost for Sector 3B under the open space land use (Table 6-11), based upon their ability to offer a substantial reduction in UXO exposures for dollars spent to effect results.

6.3.1.13 Overall Ranking of Alternatives for Sector 3B.

The overall ranking of the different alternatives in terms of their effectiveness, implementability, and cost is presented in Table 6-12. The alternative with the lowest score is considered best for each criterion (effectiveness, implementability, and cost) evaluated.

Table 6-12. Alternative Evaluation for Sector 3B

Alternative	Effectiveness Rank	Implementability Rank	Cost Rank	Overall Score	Overall Rank
1, NoFA	4	1	3	8	3
2, Institutional Controls	1	2	1	4	1
3, Surface Clearance	3	3	1	7	2
4, Subsurface Clearance to Depth	1	4	4	9	4

Notes: Ranking from best to worst; best=1.
NoFA = No Further Action

Institutional Controls (Alternative 2) ranked 1 (best), followed by the Surface Clearance (Alternative 3) and NoFA (Alternative 1). The subsurface clearance to depth (Alternative 4) ranked 4 (last) based on cost and implementability issues. Specific recommendations for Sector 3B under open space land use are made in Chapter 7.0, Recommended Alternatives.

6.4 SECTION 4 - DEMOLITION SITE ON EXXON PROPERTY (LIMITED INDUSTRIAL LAND USE)

6.4.1 Low-Density Area

Future land use for Sector 4 is characterized as Limited Industrial (see Section 2.1.4). There were no UXO items recovered in Sector 4 during OE sampling. The OE*Cert* report indicated a minimum estimated UXO density of 0 and a maximum estimated UXO density of 0.53 UXO per acre within Sector 4.

6.4.1.1 Effectiveness of Alternative 1 - No Further Action.

Protection of Human Health. There were no UXO items found in Sector 4 during the EE/CA field investigation. However, based upon the OE*Cert* risk analysis, there is a slight risk that UXO might exist in every sector (Appendix A). If the NoFA alternative were implemented, the potential UXO exposure risk would remain unchanged at 17 annual exposures. Because it did not result in reduced exposures, this alternative ranked 4, or last, for protectiveness.

Compliance with ARARs. Compliance with ARARs has been ranked equally among Alternatives 1 through 4, as full compliance with the ARARs is expected with minimal impact to the environment.

Long-term and Short-term Effectiveness. Since this alternative would not further reduce the risk of potential UXO exposures to the public, it is considered the least effective of the alternatives over the long and short term.

6.4.1.2 Effectiveness of Alternative 2 - Institutional Controls.

Protection of Human Health. It is estimated that the maximum annual residual UXO exposures within Sector 4 would fall between 17 (expected with NoFA) and 1 (expected with the surface clearance alternative) under this land use. As a result, this alternative ranked 3 for protectiveness.

Institutional Controls can reduce the risk of public exposure to UXO through the implementation of access controls and behavior modifications (as discussed in Section 4.1.2). Various types of access controls (i.e., fence, security patrols) are already in place in this sector and are enforced by the existing landowner. In addition to these existing controls, warning signs could be posted at the primary access road leading into Sector 4 and at intervals along the existing fenceline. The USACE would be responsible for providing warning signs for use on the property. A specified number of signs (as discussed in Appendix F) would be provided to the landowner in order to replace signs that may become damaged or stolen over a 5-year period. The effectiveness of this alternative is based largely on the public's willingness to comply with access controls (i.e., fences, warning signs, security patrols) directing them to stay out of specific areas (i.e., leave undisturbed).

In addition to various types of access controls, behavior modifications could also be implemented in Sector 4. These would include educational programs and

materials (i.e., UXO Safety Training/Awareness Video, pamphlets, brochures, fact sheets) for workers and visitors to the area.

The effectiveness of this alternative is based largely on the public's willingness to comply with access controls (i.e., fences, warning signs, security patrols) and respond (through public participation and compliance) to behavior modifications.

Compliance with ARARs. Compliance with ARARs has been ranked equally among Alternatives 1 through 4, as full compliance with the ARARs is expected with minimal impact to the environment.

Long-term and Short-term Effectiveness. In general, the long-term effectiveness of access controls (i.e., fence, warning signs, security patrols) is dependent upon their maintenance. Land use restrictions can be effective in the long term, depending on the willingness of stakeholders to accept and/or enforce use restrictions. The effectiveness of behavior modification is difficult to judge because it relies solely on public willingness to participate. In terms of long-term effectiveness, this alternative ranked 3, second lowest of the acceptable alternatives.

This alternative ranked 1 (best) for short-term effectiveness, primarily because of the short time frame necessary to implement it to the point that it affords protection. The time involved includes determining the location of warning signs, construction of warning signs, and installation.

6.4.1.3 Effectiveness of Alternative 3 - Surface Clearance.

Protection of Human Health. The maximum expected UXO exposures to the public in Sector 4 under the limited industrial land use were 17 under NoFA, and 1 if a surface clearance occurs. Because this alternative reduced exposures as well as the subsurface clearance to depth (Alternative 4), it ties as best (ranked 1) for protectiveness.

Compliance with ARARs. Compliance with ARARs has been ranked equally among Alternatives 1 through 4, as full compliance with the ARARs is expected with minimal impact to the environment.

Long-term and Short-term Effectiveness. The long-term effectiveness of a surface clearance is ranked 1, tied with the subsurface clearance to depth (Alternative 4). Both alternatives offer the same reduction of exposures and are considered equally effective over the long term. The surface clearance and subsurface clearance to depth are more effective over the long term than Institutional Controls (Alternative 2) or NoFA (Alternative 1).

The surface clearance alternative ranked 2, or second best, for short-term effectiveness, as it would take more time to implement than Institutional Controls (Alternative 2), but less time than the subsurface clearance to depth (Alternative 4).

6.4.1.4 Effectiveness of Alternative 4 - UXO Detection and Clearance to Depth.

Protection of Human Health. The maximum expected UXO exposures to the public in Sector 4 under the Limited Industrial land use were 17 under NoFA, and 1 if a subsurface clearance to depth occurs (the same number of exposures as a surface clearance). This alternative ties as best (ranked 1) for protectiveness.

Compliance with ARARs. Compliance with ARARs has been ranked equally among Alternatives 1 through 4, as full compliance with the ARARs is expected with minimal impact to the environment.

Long-term and Short-term Effectiveness. The long-term effectiveness of a subsurface clearance to depth is ranked 1, tied with the surface clearance (Alternative 3). Both alternatives offer the same reduction of exposures and are considered equally effective over the long term. The subsurface clearance to depth is no more effective over the long term than the surface clearance. However, both alternatives are more effective at reducing annual UXO exposures over the long term than Institutional Controls (Alternative 2) or NoFA (Alternative 1).

This alternative ranked 3, or third best, for short-term effectiveness, as it would take more time to implement than a surface clearance or Institutional Controls.

6.4.1.5 Overall Effectiveness Ranking for Alternatives 1 through 4.

Table 6-13 provides the effectiveness criteria evaluation of the alternatives for the Sector 4 limited industrial land use area. The Surface Clearance (Alternative 3) ranked as the best alternative in terms of effectiveness for Sector 4 under the limited industrial land use, based upon its ability to provide maximum protection against UXO.

Table 6-13. Effectiveness Criteria Evaluation for Sector 4 Limited Industrial Land Use

	Effectiveness					
Alternative	Protection of Human Health	Compliance with ARARs	Long-Term	Short-Term	Score	Rank
1, NoFA	4	1	4	4	13	4
2, Institutional Controls	3	1	3	1	8	3
3, Surface Clearance	1	1	1	2	5	1
4, Subsurface Clearance to Depth	1	1	1	3	6	2

Notes: Ranking from best to worst; best=1.
ARAR = applicable or relevant and appropriate requirement
NoFA = No Further Action

6.4.1.6 Implementability of Alternative 1 - No Further Action.

Technical and Administrative Feasibility. Implementing the NoFA alternative would be easier than implementing any of the other alternatives, from both an administrative and a technical feasibility perspective, as no effort, materials, or services would be required. This alternative ranked 1, or best, for technical and administrative feasibility.

Services and Materials. This alternative ranked 1, or best, for services and materials, as no effort, materials, or services would be required.

Agency and Community Acceptance. Rankings for local agency and community acceptance of NoFA (Alternative 1) have been established based on interviews conducted with local agencies and interaction with the community. Based upon this input, local agency acceptance of NoFA has ranked 3 (third best) behind Institutional Controls (Alternative 2) and Surface Clearance (Alternative 3). This is due to the number of exposures expected under the anticipated future land use for this area. For the same reasoning, community acceptance of this alternative has ranked 4 (last).

6.4.1.7 Implementability of Alternative 2 - Institutional Controls.

Technical and Administrative Feasibility. Institutional Controls (Alternative 2) can be implemented easily from both a technical and an administrative standpoint. The supplies and personnel needed to construct and install warning signs, conduct educational programs, and implement and oversee use restrictions are readily available. This alternative ranked 2 from a technical and administrative feasibility standpoint.

Services and Materials. The supplies and personnel needed to construct and install warning signs, conduct educational programs, and implement and oversee use restrictions are readily available. This alternative ranked 2 for availability of services and materials.

Agency and Community Acceptance. Rankings for local agency and community acceptance of Institutional Controls (Alternative 2) have been established based on interviews conducted with local agencies and interaction with the community. Based upon this input, it has been determined that local agencies would consider Institutional Controls as the most acceptable alternative in this area primarily because the property owner has already implemented access controls (i.e., fences and security patrols) and is enforcing them. Community acceptance of this alternative has ranked 3 (third best) behind the Surface Clearance (Alternative 1) and the subsurface clearance to depth (Alternative 4) due to the proximity of a residential community.

6.4.1.8 Implementability of Alternative 3 - Surface Clearance.

Technical and Administrative Feasibility. Implementation of a surface clearance would be quite feasible from a technical perspective. While relatively easier to implement than a subsurface clearance action, this alternative would be

more difficult to implement than Institutional Controls or NoFA. Therefore, this alternative ranked 3 for technical feasibility.

The administrative feasibility of this alternative is less than that of Institutional Controls; however, planning and executing a program of this size is less difficult than managing a program for a subsurface clearance. This alternative ranked 3 for administrative feasibility.

Services and Materials. Services and materials for this alternative would require specially trained and qualified personnel as well as the means of disposing of any encountered UXO. This alternative ranked 3 for availability of services and materials.

Agency and Community Acceptance. Rankings for local agency and community acceptance of a Surface Clearance (Alternative 3) have been established based on interviews conducted with local agencies and interaction with the community. Based upon this input, it has been determined that local agencies would consider the surface clearance as a more acceptable alternative in this area than NoFA (Alternative 1) or the subsurface clearance to depth (Alternative 4). In terms of community acceptance of this alternative, the surface clearance ranked 1 (best) as the most acceptable alternative for Sector 4.

6.4.1.9 Implementability of Alternative 4 - Detection and Clearance of UXO to Depth.

Technical and Administrative Feasibility. From technical and administrative perspectives, implementation of a subsurface clearance to depth is quite feasible. This alternative generally requires less logistical and management support than would a deeper clearance action but more than would be required for Institutional Controls or a surface clearance. Unlike a surface clearance, a subsurface clearance requires excavation equipment (in addition to specially trained and qualified personnel and a means of UXO disposal, which is required for all clearance actions). This alternative ranked 4 in terms of technical and administrative feasibility.

Services and Materials. Unlike a surface clearance, implementation of a subsurface clearance to depth requires excavation equipment (in addition to specially trained and qualified personnel and a means of UXO disposal). Therefore, this alternative ranked 4 for availability of services and materials.

Agency and Community Acceptance. Rankings for local agency and community acceptance of the subsurface clearance to depth (Alternative 4) have been established based on interviews conducted with local agencies and interaction with the community. Based upon this input, it has been determined that local agencies would not consider the subsurface clearance to depth (Alternative 4) an acceptable alternative in this area because access controls (i.e., fence and security patrols) are already in place and are currently being enforced by the landowner. Community acceptance of this alternative ranked 2 (second best) because it would take longer to implement than the Surface Clearance (Alternative 3).

6.4.1.10 Overall Implementability Ranking for Alternatives 1 through 4.

Table 6-14 provides the implementability criteria evaluation of the alternatives for the Sector 4 limited industrial land use area. NoFA (Alternative 1) and Institutional Controls (Alternative 2) both ranked equally as the best alternative in terms of implementability for Sector 4 under the limited industrial land use, based upon their ability to be implemented more quickly than any of the other alternatives.

Table 6-14. Implementability Criteria Evaluation for Sector 4 Limited Industrial Land Use

	Implementability						
Alternative	Technical Feasibility	Administrative Feasibility	Services and Materials	Agency Acceptance	Community Acceptance	Score	Rank
1, NoFA	1	1	1	3	4	10	1
2, Institutional Controls	2	2	2	1	3	10	1
3, Surface Clearance	3	3	3	2	1	12	3
4, Subsurface Clearance to Depth	4	4	4	4	2	18	4

Notes: Ranking from best to worst; best=1.
NoFA = No Further Action

6.4.1.11 Cost of Alternatives 1 through 4.

The total estimated cost for implementing Alternatives 1 through 4 is shown in Table 6-15.

Table 6-15. Cost Criteria Evaluation for Sector 4 Limited Industrial Land Use

Alternative	Cost	Investment	Benefit	Score	Rank
1, NoFA	$0	1	2	3	1
2, Institutional Controls	$4,372	2	1	3	1
3, Surface Clearance	$139,050	3	3	6	3
4, Subsurface Clearance to Depth	$377,538	4	4	8	4

Note: Ranking from best to worst; best=1
NoFA = No Further Action

Investment and Benefit. There is no cost associated with NoFA; therefore, NoFA ranked 1 in terms of investment. Only minimal exposures are anticipated in Sector 4 under this land use. Therefore, only minimal benefits will be gained from dollars spent performing clearance actions. Any clearance action greater in depth than the surface clearance provides no greater reductions in expected exposures, and therefore, the more money spent for deeper clearances, the less benefit derived for each additional dollar spent. Because exposure numbers (and reductions in exposures) are negligible, the alternatives that provide the greatest benefit, in terms of dollars spent to effect results, appear to be Institutional Controls (Alternative 2) and NoFA (Alternative 1). The cost of implementing Institutional Controls is lower than that of any clearance alternative, and the benefit of implementation could be similar to that of a surface clearance (at less

than one-tenth of the price). Alternative 4, the subsurface clearance to depth, was ranked last (ranked 4) for cost.

6.4.1.12 Overall Cost Ranking for Alternatives 1 through 4.

NoFA (Alternative 1) and Institutional Controls (Alternative 2) both ranked equally as the best alternative in terms of cost for Sector 4 under the limited industrial land use (Table 6-15), based upon the minimal UXO exposures anticipated in this sector.

6.4.1.13 Overall Ranking of Alternatives for Sector 4.

The overall ranking of the different alternatives in terms of their effectiveness, implementability, and cost is presented in Table 6-16. The alternative with the lowest score is considered best for each criterion (effectiveness, implementability, and cost) evaluated.

Table 6-16. Alternative Evaluation for Sector 4

Alternative	Effectiveness Rank	Implementability Rank	Cost Rank	Overall Score	Overall Rank
1, NoFA	4	1	1	6	2
2, Institutional Controls	3	1	1	5	1
3, Surface Clearance	1	3	3	7	3
4, Subsurface Clearance to Depth	2	4	4	10	4

Notes: Ranking from best to worst; best=1.
NoFA = No Further Action

Institutional Controls (Alternative 2) ranked 1 (best), followed by NoFA (Alternative 1) and the Surface Clearance (Alternative 3). UXO Detection and Clearance to Depth (Alternative 4) ranked 4 (last) based on cost and implementability issues. Specific recommendations for Sector 4 under limited industrial land use are made in Chapter 7.0, Recommended Alternatives.

6.5 SECTOR 5 - CAMEL BARN AREA (LIMITED INDUSTRIAL LAND USE)

6.5.1 High-Density Area

Future land use for Sector 5 is characterized as Limited Industrial (see Section 2.1.4). A total of 15 UXO items were recovered in Sector 5 during subsurface sampling. The OE*Cert* report indicated a minimum estimated UXO density of 3.69 and a maximum estimated UXO density of 6.89 UXO per acre within Sector 5.

6.5.1.1 Effectiveness of Alternative 1 - No Further Action.

Protection of Human Health. A total of 15 UXO items were recovered in Sector 5 during the EE/CA field investigation, and, based upon the OE*Cert* risk analysis, there is a high risk from the remaining UXO that exists throughout this area (Appendix A). If the NoFA alternative were implemented under this land

use, the potential UXO exposure risk would remain unchanged at 6,752 annual exposures. Therefore, the NoFA alternative does not meet the effectiveness criteria in terms of limiting public exposure to UXO at this site. From an effectiveness standpoint, this alternative for the anticipated land use (Limited Industrial) is unacceptable and will not be considered further in terms of implementability and cost.

6.5.1.2 Effectiveness of Alternative 2 - Institutional Controls.

Protection of Human Health. It is estimated that the maximum annual residual UXO exposures within Sector 5 would fall between 6,752 (expected with NoFA) and 287 (expected with the surface clearance alternative) under this alternative and land use. As a result, this alternative ranked 3 for protectiveness.

Institutional Controls can reduce the risk of public exposure to UXO through the implementation of access controls and behavior modifications (as discussed in Section 4.1.2). Access controls are currently in place for Sector 5 and include a fence that surrounds a large area adjacent to the Camel Barn Museum. Other types of access controls that could be implemented by the existing landowner include barricades and security patrols.

In addition to various types of access controls, behavior modifications can also be implemented in Sector 5. A display case illustrating the types of ordnance could be set up in an area designated for public gathering (i.e., parking lot adjacent to Camel Barn Museum). Warning sings could be posted at the primary access road leading into the Camel Barn Museum parking lot area and at intervals along the existing fenceline. The USACE would be responsible for providing warning signs for use on the property. A specified number of signs (as discussed in Appendix F) would be provided to the landowner in order to replace signs that may become damaged or stolen over a 5-year period. Behavior modifications have the potential to be very successful and very well adopted by the public in this area. The Camel Barn Museum is a public point of interest and a prime location for the public to become educated and informed concerning the danger associated with UXO in the area. The Camel Barn Museum currently has displays illustrating types of ordnance previously used at the site. The museum offers a venue for public education on the dangers associated with UXO. Other types of tools to implement behavior modifications in this area could include the distribution of fact sheets and brochures, and the use of a UXO safety awareness video.

The effectiveness of this alternative is based largely on the public's willingness to comply with access controls (i.e., fences, warning signs, security patrols) and respond (through public participation and compliance) to behavior modifications (i.e., display case, brochures, fact sheets).

Compliance with ARARs. Compliance with ARARs has been ranked equally among Alternatives 2 through 4, as full compliance with the ARARs is expected with minimal impact to the environment.

Long-term and Short-term Effectiveness. In general, the long-term effectiveness of access controls (i.e., fences, warning signs) is dependent upon

their maintenance. Land use restrictions can be effective in the long term, depending on the willingness of stakeholders to accept and/or enforce use restrictions. The long-term effectiveness of behavior modifications are dependent upon public interaction and involvement. Therefore, this alternative ranked 3 for long-term effectiveness, lowest of the acceptable alternatives.

This alternative ranked 1 (best) for short-term effectiveness, primarily because of the short time frame necessary to implement it to the point that it affords protection. The time involved includes determining the location of warning signs/display cases, construction of warning signs/display cases, creating interpretive exhibits for the display cases, and installation.

6.5.1.3 Effectiveness of Alternative 3 - Surface Clearance.

Protection of Human Health. The maximum expected UXO exposures to the public in Sector 5 under the Limited Industrial land use were 6,752 under NoFA, and 287 if a surface clearance occurs. As a result, this alternative ranked 2 for protectiveness.

Compliance with ARARs. Compliance with ARARs has been ranked equally among Alternatives 2 through 4, as full compliance with the ARARs is expected with minimal impact to the environment.

Long-term and Short-term Effectiveness. The long-term effectiveness of a surface clearance is ranked 2 (second best), behind the subsurface clearance to depth (Alternative 4). The surface clearance is more effective over the long term than Institutional Controls (Alternative 2).

This alternative ranked 2, or second best, for short-term effectiveness, as it would take more time to implement than Institutional Controls (Alternative 2), but less time than the subsurface clearance action.

6.5.1.4 Effectiveness of Alternative 4 - Detection and Clearance of UXO to Depth.

Protection of Human Health. The maximum expected UXO exposures to the public in Sector 5 under limited industrial land use were 6,752 under NoFA, and 73 if a subsurface clearance to depth occurs. Because this alternative reduced annual UXO exposures, it ranked 1, or best, for protectiveness.

Compliance with ARARs. Compliance with ARARs has been ranked equally among Alternatives 2 through 4, as full compliance with the ARARs is expected with minimal impact to the environment.

Long-term and Short-term Effectiveness. The long-term effectiveness of a subsurface clearance to depth (Alternative 4) is ranked 1 for its effectiveness at reducing annual exposures. The subsurface clearance to depth is more effective over the long term than a surface clearance (Alternative 3), or Institutional Controls (Alternative 2).

This alternative ranked 3, or third best, for short-term effectiveness, as it would take more time to implement than a surface clearance or Institutional Controls.

6.5.1.5 Overall Effectiveness Ranking for Alternatives 1 through 4.

Table 6-17 provides the effectiveness criteria evaluation of the alternatives for the Sector 5 limited industrial land use area. The subsurface clearance to depth (Alternative 4) ranked as the best alternative in terms of effectiveness for Sector 5 under the limited industrial land use, based upon its ability to provide maximum protection against UXO.

Table 6-17. Effectiveness Criteria Evaluation for Sector 5 Limited Industrial Land Use

	Effectiveness					
Alternative	Protection of Human Health	Compliance with ARARs	Long-Term	Short-Term	Score	Rank
1, NoFA	NA	NC	NC	NC	NC	NC
2, Institutional Controls	3	1	3	1	8	3
3, Surface Clearance	2	1	2	2	7	2
4, Subsurface Clearance to Depth	1	1	1	3	6	1

Notes: Ranking from best to worst; best=1.
ARAR = applicable or relevant and appropriate requirement
NA = not acceptable
NC = not considered
NoFA = No Further Action

6.5.1.6 Implementability of Alternative 2 - Institutional Controls.

Technical and Administrative Feasibility. Institutional Controls (Alternative 2) can be implemented easily from both a technical and an administrative standpoint. The supplies and personnel needed to construct display cases and install warning signs, conduct educational programs and implement and oversee use restrictions are readily available. However, the public does not always conform to access controls (i.e. fences, barricades) or respond to behavior modifications (i.e., display cases, fact sheets). Based on the high number of exposures expected under this alternative, Institutional Controls ranked 3 (last) from a technical feasibility perspective. This alternative can be easily implemented from an administrative standpoint, and ranked 1 for administrative feasibility.

Services and Materials. The services and materials required for this alternative can be more easily obtained and implemented than any of the other alternatives. Therefore, this alternative ranked 1 for services and materials.

Agency and Community Acceptance. Rankings for local agency and community acceptance of Institutional Controls (Alternative 2) have been established based on interviews conducted with local agencies and interaction with the community. Based upon this input, it has been determined that local agencies and the community would not consider Institutional Controls (Alternative 2) as an acceptable alternative in this area. Reasons for the

disapproval of this alternative by local agencies and the community include the following: first, there were 15 UXO items recovered in Sector 5 during subsurface OE sampling (one of which was recovered on the ground surface); second, the area is a public point of interest (i.e., Camel Barn Museum) and therefore easily accessible to the public. Therefore, this alternative ranked 3 (ranked last) in terms of local agency and community acceptance.

6.5.1.7 Implementability of Alternative 3 - Surface Clearance.

Technical and Administrative Feasibility. Implementation of a surface clearance would be quite feasible from a technical perspective. While relatively easier to implement than a subsurface clearance action, this alternative would be more difficult to implement than Institutional Controls or NoFA. However, because this alternative has the ability to reduce exposures more than Institutional Controls (Alternative 2), it ranked 1 for technical feasibility.

The administrative feasibility of this alternative is less than that of Institutional Controls; however, planning and executing a program of this size is less difficult than managing a program for a subsurface clearance. This alternative ranked 2 for administrative feasibility.

Services and Materials. Services and materials for this alternative would require specially trained and qualified personnel as well as the means of disposing of any encountered UXO. This alternative ranked 2 for availability of services and materials.

Agency and Community Acceptance. Rankings for local agency and community acceptance of a Surface Clearance (Alternative 3) have been established based on interviews conducted with local agencies and interaction with the community. Based upon this input, it has been determined that local agencies and the community would consider the Surface Clearance (Alternative 3) as a more acceptable alternative in this area than Institutional Controls (Alternative 2), based upon its ability to remove UXO from the area and reduce the annual number of UXO exposures. Therefore, this alternative ranked 2 (second best) in terms of local agency and community acceptance.

6.5.1.8 Implementability of Alternative 4 - Detection and Clearance of UXO to Depth.

Technical and Administrative Feasibility. From technical and administrative perspectives, implementation of a subsurface clearance to depth is quite feasible. This alternative generally requires less logistical and management support than would a deeper clearance action but more than would be required for Institutional Controls or a Surface Clearance. Unlike a Surface Clearance, a subsurface clearance requires excavation equipment (in addition to specially trained and qualified personnel and a means of UXO disposal, which is required for all clearance actions). This alternative ranked 2 in terms of technical feasibility because it could offer a more significant reduction in exposures than Institutional Controls (Alternative 2). This alternative ranked 3 for administrative feasibility as

it would require more logistical and management support than a Surface Clearance (Alternative 3) or Institutional Controls (Alternative 2).

Services and Materials. Unlike a surface clearance, implementation of a subsurface clearance to depth requires excavation equipment (in addition to specially trained and qualified personnel and a means of UXO disposal). Therefore, this alternative ranked 3 for availability of services and materials.

Agency and Community Acceptance. Rankings for local agency and community acceptance of the subsurface clearance to depth (Alternative 4) have been established based on interviews conducted with local agencies and interaction with the community. Based upon this input, it has been determined that local agencies and the community would consider the subsurface clearance to depth the most acceptable alternative in this area, due to the high number of UXO exposures anticipated in Sector 5 under the limited industrial land use. Therefore, this alternative ranked 1 (best) in terms of local agency and community acceptance.

6.5.1.9 Overall Implementability Ranking for Alternatives 2 through 4.

Table 6-18 provides the implementability criteria evaluation of the alternatives for the Sector 5 limited industrial land use area. The surface clearance (Alternative 3) ranked as the best alternative in terms of implementability for Sector 5 under the limited industrial land use, based on its ability to reduce the expected number of UXO exposures anticipated under this land use and for the ease to which it can be implemented.

Table 6-18. Implementability Criteria Evaluation for Sector 5 Limited Industrial Land Use

	Implementability						
Alternative	Technical Feasibility	Administrative Feasibility	Services and Materials	Agency Acceptance	Community Acceptance	Score	Rank
2, Institutional Controls	3	1	1	3	3	11	3
3, Surface Clearance	1	2	2	2	2	9	1
4, Subsurface Clearance to Depth	2	3	3	1	1	10	2

Notes: Ranking from best to worst; best=1.
NoFA = No Further Action

6.5.1.10 Cost of Alternatives 2 through 4.

The total estimated cost for implementing Alternatives 2 through 4 is presented in Table 6-19.

Table 6-19. Cost Criteria Evaluation for Sector 5 Limited Industrial Land Use

Alternative	Cost	Investment	Benefit	Score	Rank
2, Institutional Controls	$10,194	1	3	4	2
3, Surface Clearance	$115,317	2	1	3	1
4, Subsurface Clearance to Depth	$445,289	3	2	5	3

Note: Ranking from best to worst; best=1
NoFA = No Further Action

Investment and Benefit. There is minimal cost associated with implementing Institutional Controls; therefore, Institutional Controls is ranked first in terms of investment. Institutional Controls ranks third (last) in terms of benefit, since little benefit is believed to be gained from implementing this alternative; essentially, the risk reduction would be negligible. The Surface Clearance (Alternative 3) ranked second in terms of investment, followed by the subsurface clearance to depth (Alternative 4). The surface clearance ranked first for benefit, followed by the subsurface clearance to depth (Alternative 4). Both of these alternatives offer substantial reductions in exposures for dollars spent to effect results. The alternative that provides the greatest benefit in terms of dollars spent to effect results is the Surface Clearance (Alternative 3).

6.5.1.11 Overall Cost Ranking for Alternatives 2 through 4.

The surface clearance (Alternative 3) ranked as the best alternative in terms of cost for Sector 5 under the limited industrial land use (Table 6-19), based on its ability to offer a substantial reduction in UXO exposures for dollars spent to effect results.

6.5.1.12 Overall Ranking of Alternatives for Sector 5.

The overall ranking of the different alternatives in terms of their effectiveness, implementability, and cost is presented in Table 6-20. The alternative with the lowest score is considered best for each criterion (effectiveness, implementability, and cost) evaluated.

Table 6-20. Alternative Evaluation for Sector 5

Alternative	Effectiveness Rank	Implementability Rank	Cost Rank	Overall Score	Overall Rank
2, Institutional Controls	3	3	2	8	3
3, Surface Clearance	2	1	1	4	1
4, Subsurface Clearance to Depth	1	2	3	6	2

Notes: Ranking from best to worst; best=1.
NoFA = No Further Action

The surface clearance (Alternative 3) ranked as the best alternative for Sector 5 because it would provide the most significant reduction in annual UXO exposures. The subsurface clearance to depth (Alternative 4) ranked 2 (second best) based on cost and implementability issues. Both alternatives are effective in reducing UXO exposures over the long and short-term. Institutional Controls (Alternative 2) ranked last primarily for its ineffectiveness at reducing annual UXO exposures. Specific recommendations for Sector 5 under the limited industrial land use are made in Chapter 7.0, Recommended Alternatives.

7.0 RECOMMENDED ALTERNATIVES

This chapter presents the recommendations for reducing the potential risk of UXO exposures to the public at the Former Benicia Arsenal.

Recommendations are based upon the field investigation, the OE*Cert* Report (analysis of risk), review of the hazards associated with the types of OE found at the site, and the results of the evaluation documented in Chapter 6.0. For areas where Institutional Controls and/or clearance actions are warranted, reduction of potential exposures to UXO is recommended.

The underlying goal of these recommendations is to provide a plan for managing risk associated with exposures to and interaction with UXO for the Former Benicia Arsenal.

7.1 GENERAL RECOMMENDATIONS

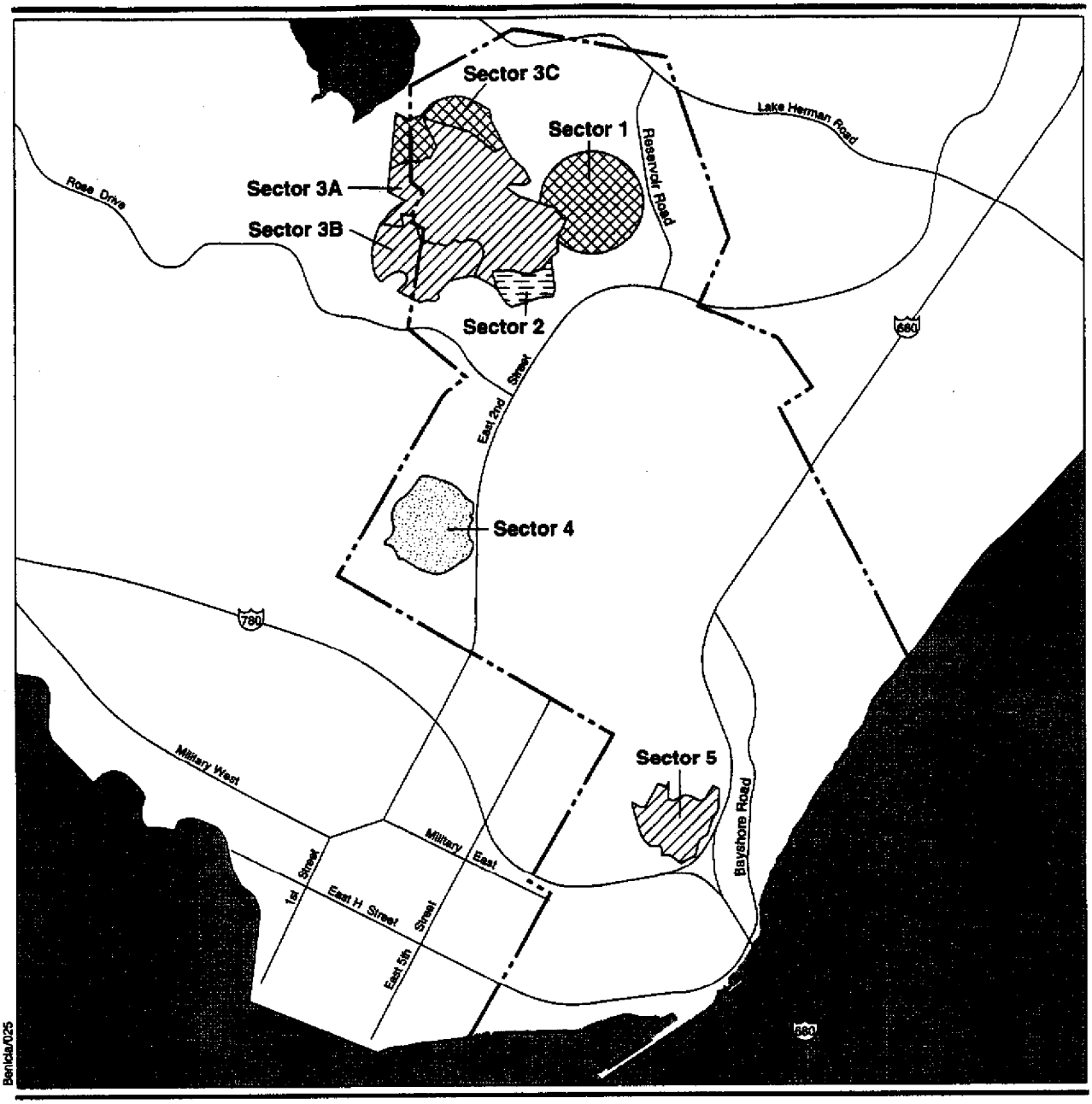
There are five areas at the Former Benicia Arsenal for which clearance actions and/or Institutional Controls are recommended (Figure 7-1). They include Sector 2 (Artillery Test Area), Sectors 3A and 3B (Tourtelot Property), and Sector 5 (Camel Barn Area). Institutional Controls are recommended for Sector 4 (Demolition Site on Exxon Property). Specific recommendations for these areas are discussed in detail in Section 7.2, Recommendations for Individual OE Sites.

For all other areas within the Former Benicia Arsenal, based on the results of the EE/CA investigation, analysis of risk, and review of the hazards associated with the types of OE found at the site, No Further Action is recommended. NoFA does not include any U.S. Army-initiated actions under current or anticipated future land use. A surface or subsurface OE clearance would not occur. However, if significant new information is presented for an OE site, the project may be reopened. For specific sites where NoFA is recommended, further details are presented below.

7.2 RECOMMENDATIONS FOR INDIVIDUAL OE SITES

7.2.1 Sector 1 - Revetment Area (Limited Industrial)

No Further Action is recommended for Sector 1 based on the following: (1) The sampling in this sector was exploratory to assess if any munitions had been distributed over the area from explosions that may have occurred from munitions destroyed in a 1946/1947 fire that occurred in Spur D of the Revetment Area; (2) No OE items of any kind were recovered during sampling; (3) The Final Records Research Report was able to clarify that .50 caliber rounds were stored in the railcars that may have burned in the 1946/1947 fire.



EXPLANATION

Sector 1 Revetment Area (68 acres)
Sector 2 Artillery Test Area (15 acres)
Sector 3A Tourtelot Property (131 acres)
Sector 3B Tourtelot Property (47 acres)
Sector 3C City Property Adjacent to Tourtelot Property (34 acres)
Sector 4 Demolition Site on Exxon Property (54 acres)
Sector 5 Camel Barn Area (35 acres)
Grid OT01 Overturned Truck Area (0.23 acre)

0 .125 .25 .5 Mile

680 Interstate Highway
Former Benicia Arsenal Boundary (estimated)
Subsurface Clearance to Depth
Surface and Subsurface Clearance
No Further Action
Institutional Controls

Recommended Clearance Areas

Figure 7-1

For these purposes, .50 caliber rounds are not considered UXO, and do not contain any explosives. Additionally, no .50-caliber rounds were recovered during OE sampling of the area.

7.2.2 Sector 2 – Artillery Test Area (Limited Industrial/Open Space)

A surface clearance on the steep valley walls and a subsurface clearance to a depth of 4 feet on the valley floor is recommended for Sector 2. Additionally, once the clearance has occurred, a map showing the area cleared of ordnance should be developed and filed with the city of Benicia, and the existing fence along with the gates at either end of the sewer bunch trail, should be affixed with warning signs.

This recommendation is based on the following: (1) Right of entry was not able to be obtained for this area until after sampling crews had demobilized from the site. Therefore, it was necessary to make assumptions regarding the type, depth and distribution of OE across the sector. Based on historical information, site inspections, and OE distribution in adjacent areas (Sector 3), it was determined that the western portion of the sector nearest the McAllister land bridge would have a similar OE distribution; (2) the ASR report and the Records Research Report both indicated that this sector may have been used as an artillery testing area. However, the Records Research Report indicated that only the firing mechanisms were tested in the area; (3) although portions of the sector are zoned as limited industrial, it will most likely be used as open space; (4) surface clearance along the valley walls and a subsurface clearance of the valley floor, coupled with educational programs (behavior modifications), provide a significant level of protection to the public from UXO regardless of the amount or type of UXO that may be present; (5) sufficient information was available for the OE*Cert* program to generate hypothetical UXO exposure numbers. Based on these numbers, the OE*Cert* program predicted that UXO exposures could be significantly reduced with a surface and/or subsurface clearance; (6) with current detection technology, there is minimal cost difference between clearing an area to 1, 2, or 4 feet in depth. Therefore, a clearance depth of 4 feet was chosen because it would provide the maximum amount of protection from UXO risk.

The cost to implement this recommendation is approximately $169,000. This estimate does not include costs associated with compliance with federal and state environmental laws, such as costs associated with species relocation and revegetation of specified areas following surface clearance at specific sites.

7.2.3 Sector 3A (Residential/Parks/Open Space) and 3B (Open Space) - Tourtelot Property

Detection and clearance of UXO to a depth of 4 feet (Alternative 4) is recommended for this sector. This recommendation is based on the following: (1) over 90 percent of the anomalies recovered during field sampling were in the top 2 feet of soil; (2) the area was used as a demolition area and not a firing range, meaning that ordnance items were not fired into the ground. Therefore, any OE that may remain on the site is most likely the result of being "kicked-out" from the demolition pit and having fallen to the ground under the force of gravity

and would be shallowly buried; (3) the borrow site portion of the sector (see Figure 7-1) has been excluded from the clearance action because nearly 15 feet of soils and bedrock have been removed, and it is highly unlikely any OE would remain in this area; (4) current geophysical methods can detect anomalies with a high degree of success down to approximately 4 feet, and there is minimal cost difference between clearing an area to 2 feet versus 4 feet; (5) the evaluation in Chapter 6.0 clearly shows that a subsurface clearance to depth, Alternative 4, is the best alternative in terms of its effectiveness at reducing UXO risk.

The cost to implement this recommendation is approximately $1,500,000. This estimate does not include costs associated with compliance with federal and state environmental laws such as costs associated with species relocation and revegetation of specified areas following subsurface clearance.

7.2.4 Sector 3C - City Property Adjacent to Tourtelot Property (Open Space)

NoFA is recommended for Sector 3C. This recommendation is based on the following: (1) the sampling in this sector was exploratory to assess if any DOD activities occurred that may have caused the scarring of the landscape in this area; (2) no OE items of any kind were recovered during sampling, nor were any other items recovered that may have been associated with military activities; and (3) Granite Management Corporation geophysically mapped and collected several soil samples from the scarred areas. The geophysical data clearly indicated that the scarring was not associated with the burial of munitions. Results of the preliminary soil samples collected did have trace amounts of trinitrotoluene (TNT). Based on the screening samples collected, the amount of TNT in the soil is not sufficient to be considered "explosive soils" as defined by USACE, and therefore, does not present an explosive hazard and warrant clean-up under the UXO program. However, the scarred areas will be further investigated under the arsenal-wide HTRW CERCLA investigation.

7.2.5 Sector 4 - Demolition Site on Exxon Property (Limited Industrial)

Institutional controls are recommend for this sector. The property owner should maintain the existing fence around the parcel to limit access to the site. Additionally, warning signs should be affixed to the existing fence. The warning signs should clearly state that the area may contain UXO, that ordnance, if encountered, is not to be disturbed, and whom to contact should an OE item be discovered. Educational materials should be made available to any Exxon employees or city maintenance personnel that may work in the area. It is unknown if a real estate environmental notice is attached to the deed of the property. However, California Civil Code would require that if the property were to be sold, written notification to the buyer must be given indicating that the site is considered a federal ordnance site.

This recommendation is based on the following: (1) OE scrap was found in nearly one-half the grids sampled for OE in this sector, indicating that some type of demolition activity may have occurred in this area; (2) although no UXO were encountered during sampling, there is some potential for the public to be exposed to UXO; (3) Institutional controls would provide a level of protection in terms of reduction in exposures, similar to what a surface clearance may provide, at less than one-tenth of the price; (4) although the area is zoned limited industrial, no future development is planned for the area; and (5) the evaluation of alternatives in Chapter 6.0 determined that institutional controls described previously would be the best overall alternative in terms of effectiveness, implementability, and cost.

Minimal cost would be associated with the implementation of this alternative. The installation of warning signs would cost approximately $4,400. Exxon currently maintains the existing fence and has security patrols for the area. Therefore, no additional costs would be incurred to maintain the fence in accordance with this recommendation. There would be no environmental impacts associated with the implementation of this recommendation.

7.2.6 Sector 5 - Camel Barn Area (Limited Industrial)

A clearance to a depth of 4 feet is recommended for this sector. Additionally, once a clearance has occurred, a map indicating the depth and area cleared of ordnance should be developed and filed with the city. The map would constitute an OE overlay, as described in Chapter 4.0. The city could then stipulate the conditions under which excavation or development could occur. Specifically, the city should recommend to the developer to obtain construction support for any construction or excavations that would exceed 4 feet in depth.

This recommendation is based on the following: (1) 15 UXO items were recovered from this sector during the EE/CA field investigation. One UXO item was found on the surface, three UXO items were found at a depth of 4 inches, and 11 UXO items were recovered at depths ranging from 16 to 32 inches below the surface; (2) currently, Sector 5 is zoned as limited industrial use and may be subject to future development. Should the area be developed, a significant amount of ground disturbance may occur over most of the sector, thereby potentially exposing workers to UXO; (3) a clearance to a depth of 4 feet would provide the greatest reduction in UXO exposures and provide the maximum amount of risk reduction; (4) the evaluation of alternatives in Chapter 6.0 determined that subsurface clearance to a depth of 4 feet would be the best alternative in terms of effectiveness in protecting human health.

The cost to implement this recommendation is approximately $445,000. This estimate does not include costs associated with compliance with federal and state environmental laws, such as costs associated with species relocation and revegetation of specified areas following subsurface clearance.

7.3 CITY OF BENICIA TOURTELOT CLEAN-UP PROGRAM

The city of Benicia and the property owner for the Tourtelot Property (majority of Sector 3) have developed a clean-up strategy to remediate the Tourtelot Property.

This clean-up strategy will involve a subsurface clearance to depth as described for Alternative 4 over the entire property followed by a 100-percent QC check (remapping with geophysical equipment with subsequent removal of additional anomalies identified) of the clearance area. Once the area has been cleared, traditional cut-and-fill grading methods would be used to further reduce the risk of UXO to the public by selectively moving soils across the site. The clearance action would follow USACE safety procedures and standards for detection and removal of anomalies. Through concurrence with USACE procedures, this action would achieve the USACE goal for managing risk associated with exposures to and interaction with UXO.

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9.0 GLOSSARY OF TERMS AND ACRONYMS/ABBREVIATIONS

Anomaly. An indication of a buried item that might be a UXO.

Archive Search Report. A report prepared by the U.S. Army Corps of Engineers to give historic findings, data, and information pertaining to ordnance and explosives and chemical warfare materials.

Bunker. A fortified structure for the protection of personnel, defended gun position, or a defensive position.

California State Plane (CSP) Coordinates. A mapping system that measures the position, or coordinates of objects in distance north and east of a known position in the state of California.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Federal law (PL 96-510 and codified as 42 U.S. Code [USC] 9601 et. seq.; and 26 USC 4611,4612, 4661, 4662, 4671, and 4672) passed on 11 December 1980 which provides a series of programs to address clean-up of hazardous waste disposal and spill sites. CERCLA has been modified several times, most significantly in 1986 by the Superfund Amendments and Reauthorization Act (SARA).

Confidence level. In statistical sampling, we are often trying to determine a "best" estimate of some population value (e.g., UXO density/acre) from a sample of observations from that population. Short of 100-percent sampling, we can never be absolutely certain of the accuracy of our estimate. Consequently, it is common practice to avoid stating, "We are 100 percent confident that there are 0.3 OE/acre in this sector," but rather to state, "We are 90 percent confident that the OE density in this sector falls between 0.2 and 0.4 OE/acre." Ninety percent is the "confidence level," and the range 0.2 to 0.4 is the "confidence interval."

Cultural Resources. Prehistoric and historic districts, sites, buildings, objects, or any other physical evidence of human activity considered important to a culture, subculture, or a community for scientific, traditional, religious, or any other reason.

Demilitarized. The mutilation, cutting, crushing, scrapping, melting, burning or other alteration of military equipment or material, designed to prevent it from being used for its originally intended military purpose.

Demolition. Destruction of structures, facilities, or material by use of fire, water, explosives, mechanical, or other means.

Detonation. A chemical reaction that propagates with such rapidity that the rate of advance of the reaction zone into the unreacted material exceeds the velocity of sound and explosions.

Dig Team. A team consisting of UXO specialists that search for and excavate anomalies below the ground surface.

Electromagnetic (EM). A geophysical survey instrument that utilizes the rate at which electromagnetic signals in the ground decrease to detect and map metal objects that are buried near ground level (less than 10 feet below ground surface).

Exclusion Zone. A safety area surrounding an OE excavation site from which all but UXO qualified personnel are excluded while excavation activities are being performed. Excavation operations halt once unauthorized personnel enter an exclusion zone and resume once those individuals exit the area. Exclusion zones may vary in size based on the suspected OE under investigation.

Explosive Ordnance Disposal (EOD). The detection, identification, field evaluation, rendering safe, recovery, evacuation, and disposal of explosive ordnance that has been fired, dropped, launched, projected, or placed in such a manner as to constitute a hazard to operations, installations, personnel, or material.

Exposure. An "exposure" to UXO is defined as occurring when the person traversing or working on the site is in "close proximity" to ordnance, whether or not the person knows the ordnance is present (it could be buried). An accident or injury is not necessarily assumed to occur when an exposure takes place. The definition of "close proximity" varies depending on the specific activity.

Frost Heave. The uneven lifting or upward movement and general distortion of surface soils, rocks, vegetation, and structures, such as pavement, due to subsurface freezing of water and growth of ice masses.

Fuze. A device with explosive components designed to initiate a train of fire or detonation in an item of ammunition by an action such as hydrostatic pressure, electrical energy, chemical action, impact, mechanical time, or a combination of these.

Grid. A geographic parcel of land 50' x 50' in size which was investigated to determine the presence or absence of OE. The number of grids within a sector is dependent upon the size of the sector and the size of the grids.

High explosive (HE). An explosive that normally detonates rather than burns; that is, the rate of detonation exceeds the velocity of sound.

Homogeneous. In UXO sampling context, "homogeneous" refers to the assumption that UXO are distributed randomly throughout a sector and not concentrated in specific areas of the sector. If this assumption is valid, exposures to UXO through hiking, construction, child play, etc., may be assumed equally likely throughout the sector.

Hypergeometric statistical distribution. One of many defined statistical distributions that characterize various types of data. If a set of data follows a hypergeometric distribution, observations are being collected (e.g., UXO) from a finite population (e.g., anomalies in a grid) about which some information is known or assumed, and the sampled UXO are not being returned to the sector (i.e., they are being counted and then removed).

Inert. Ordnance, or components thereof, that contains no explosives, pyrotechnic, or chemical agents.

Live. A slang term indicating ordnance containing explosives or active chemicals.

Memorandum of Agreement (MOA). A record between government agencies agreeing upon a specific action item.

Military munitions. The term "military munitions" is defined to include all types of both conventional and chemical ammunition products and their components, produced by or for the military for national defense and security.

NCP (National Contingency Plan). The National Contingency Plan is the U.S. EPA's blueprint for implementing a Superfund law that addresses the legal requirements for responding to a potential hazard at a CERCLA site. The plan defines responsibilities and activities of affected parties within the site (which could include a Superfund site). The NCP is also the process used to address non-Superfund contaminated sites.

Non-OE Scrap. Items that are non-ordnance-related including, but not limited to: wooden boxes, wire, banding material, trash, auto parts, and nails.

OE Scrap. OE scrap includes those items which are fragments of functioned ordnance, as designed or intentionally destroyed, and which contain no explosive or other items of a dangerous nature. OE scrap is inert and does not pose a safety risk.

OE Sites. Areas of potential ordnance and explosives.

Ordnance and Explosives (OE). OE includes bombs and warheads, artillery and mortar; rocket ammunition, mines, and propellants; and all similar and related items or components, explosive in nature or otherwise designed to cause damage to personnel or material. Soils with explosive constituents are considered OE if the concentration is sufficient to be reactive and presents an imminent safety hazard. UXO is a subset of OE.

Ordnance and Explosives Cost-Effectiveness Risk Tool (OE*Cert*). OE*Cert*, a computer model, measures risk by quantifying how often people are exposed to UXO when participating in commonly performed activities at a site (e.g., hiking, jogging).

Probabilistic UXO Density. The density of UXO computed in the 90-percent confidence level by using a probabilistic estimator. The probabilistic estimator is calculated by using the field data during the sampling investigation.

Remediation. The process of removing or detoxifying environmental contamination.

Risk. Exposures to the chance of injury or loss (Random House), or a function of the probability that an accident (or adverse situation) will occur within a certain time, as well as the accident's consequences to people, property or the environment.

Sector. A designated geographic parcel of land designated to be investigated during an EE/CA.

Sequential Probability Ratio Test (SPRT). A statistical sampling scheme used in SiteStats/GridStats in which more and more data are collected until an estimator with a prespecified accuracy is achieved.

Small arms rounds. Small arms ammunition consists of cartridges and shells used in rifles, pistols, machine guns, and shotguns.

Subsurface OE sampling. Consists of excavating to a prescribed depth to identify potential subsurface UXO.

Surface Clearance. The process in which ordnance and explosives are visually searched for and removed from the ground surface, without conducting any intrusive activities, and properly disposed of.

Time-Critical Removal Action (TCRA). Response taken when a removal action is appropriate and must be initiated within 6 months.

Total Magnetic Field. The strength or intensity of the magnetic field of the earth as measured at any given point.

Tracer round. A device that fits into or is attached to ordnance. It normally contains a starting mixture and illuminant and leaves a trail of flame or smoke to show the trajectory of the ordnance.

Tri-Service Spacital Data Standard (TSSDS). File naming and data organization convention defined by the Tri-Services (U.S. Army/Navy/Air Force).

Unexploded Ordnance (UXO). Military munitions that have been primed, fuzed, armed, or otherwise prepared for action, and have been fired, dropped, launched, projected, or placed in such a manner as to constitute a hazard to operations, installation personnel, or material and remain unexploded either by malfunction, design, or any other cause. UXO is a subset of OE.

UXO Clearance. The surface or subsurface removal of identified unexploded ordnance from a defined area.

Vertical Magnetic Gradient. The numerical difference in the total magnetic field of the earth measured at two different heights above the same point on the earth.

LIST OF ACRONYMS AND ABBREVIATIONS

A-E	Architect-Engineer
ARAR	applicable or relevant and appropriate requirement
ARPA	Archaeological Resources Protection Act
ASCII	American Standard Code for Information Interchange
ASR	Archives Search Report
bgs	below ground surface
Blackhawk	Blackhawk Geometrics
C	Centrigrade
CAA	Clean Air Act
CAD	Computer-Aided Drafting
CEHNC	U.S. Army Engineering and Support Center, Huntsville
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CESPK	U.S. Army Corps of Engineers, Sacramento District
CFR	Code of Federal Regulations
cm	centimeter
CWA	Clean Water Act
CWM	chemical warfare materials
DDESB	Department of Defense Explosives Safety Board
°	Degree
DQO	Data Quality Objectives
DOD	Department of Defense
DTSC	Department of Toxic Substances Control
EE/CA	engineering evaluation/cost analysis
EM	electromagnetic
EOD	explosive ordnance demolition
EPA	Environmental Protection Agency
EPP	Environmental Protection Plan
F	Fahrenheit
FDE	Findings and Determination of Eligibility
FUDS	Formerly Used Defense Site
GIS	Geographic Information System
GPR	ground-penetrating radar
GPS	Global Positioning System
GSA	General Services Administration
HE	high explosive
HTRW	Hazardous, Toxic, and Radioactive Waste
I	International Highway
MBTA	Migratory Bird Treaty Act
mm	millimeter
MOA	Memorandum of Agreement
mph	miles per hour
msl	mean sea level
mV	milliVolts
NAGPRA	Native American Graves Protection and Repatriation Act
NCP	National Contingency Plan
NE	not established
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

NoFA	No Further Action
NORCAL	Norcal Geophysical Consultants, Inc.
OE	ordnance and explosives
OE*Cert*	Ordnance and Explosives Cost-Effectiveness Risk Tool
OEW	Ordnance and Explosives Waste
OS	Open Storage
PC	Personal Computer
QA	quality assurance
QC	quality control
Quantitech	Quantitech, Inc.
RCRA	Resource Conservation and Recovery Act
SARA	Superfund Amendments and Reauthorization Act
SC	Species of Concern
SDWA	Safe Drinking Water Act
SOW	Scope of Work
TBC	To Be Considered
TEM	Transient Electronic Metal
TM	Technical Manual
TMF	total magnetic field
TNT	Trinitrotoluene
TO	Task Order
TSSDS	Tri-Service Spatial Data Standard
USACE	U.S. Army Corps of Engineers
USAE	USA Environmental, Inc.
USATHAMA	U.S. Army Toxic and Hazardous Materials Agency
USFWS	U.S. Fish and Wildlife Service
UXO	unexploded ordnance

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