

DOCUMENT



Arsenal-Wide

Conceptual Workplan
FOR THE BENICIA ARSENAL



Prepared for:
US Army Corps
of Engineers

Prepared by:
BROWN AND
CALDWELL

**CONCEPTUAL WORKPLAN
FOR
ENVIRONMENTAL INVESTIGATION AT
THE FORMERLY USED DEFENSE SITE (FUDS)
BENICIA ARSENAL
Benicia, California**

FUDS Site #: J09CA075600

PREPARED FOR
Department Of The Army
United States Army District, Sacramento
Corps Of Engineers
1325 J Street
Sacramento, California 95814-2922

Prepared By

BROWN AND CALDWELL

9616 Micron Avenue, Suite 600
Sacramento, California 95827

April 1998

Contract Number
DACW05-97-D-0035

TABLE OF CONTENTS

LIST OF TABLES	ii
LIST OF FIGURES	ii
FORWARD.....	F-1
SECTION 1. INTRODUCTION	1-1
The Benicia Arsenal	1-5
SECTION 2. ARSENAL AND PROJECT HISTORY.....	2-1
Arsenal History.....	2-1
Current Land Use And Ownership.....	2-4
Project History.....	2-5
SECTION 3. ARSENAL CHARACTERISTICS.....	3-1
Location and Topography.....	3-1
Subsurface Soil and Geology	3-1
Hydrology	3-2
SECTION 4. CONCEPTUAL TECHNICAL APPROACH.....	4-1
SECTION 5. CONCEPTUAL ADMINISTRATIVE APPROACH.....	5-1
APPENDIX A. DATA QUALITY OBJECTIVE WORKSHEET	
APPENDIX B. REFERENCES	

LIST OF TABLES

<u>No.</u>		<u>Page</u>
2-1	Benicia Arsenal Historic Responsibilities	2-3
2-2	Disposal of Benicia Arsenal Land	2-4
4-1	Chemicals of Potential Concern Identification	4-3

LIST OF FIGURES

<u>No.</u>		<u>Page</u>
1-1	Location of Benicia Arsenal	1-2
1-2	FUDS Decision Tree	1-3
1-3	Benicia Arsenal Map	1-6
5-1	Proposed Document Organization	5-3

FORWARD

The Defense Environmental Restoration Program for Formerly Used Defense Sites (DERP-FUDS) is committed to reduce, in a timely and cost effective manner, the risk to human health, safety, and the environment.

In the early 1980s, Congress passed the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). In 1986, Congress passed the Superfund Amendment and Reauthorization Act (SARA) which established the Defense Environmental Restoration Account (DERA) to fund a program of environmental restoration known as DERP. Responsibility for cleanup under FUDS was delegated to the United States Army Corps of Engineers (USACE).

There are three "goals" of the FUDS Program:

1. identification, investigation, research and development, and cleanup of contamination from hazardous substances, pollutants, and contaminants which are a result of the Department of Defense (DoD) use of the land;
2. correction of other environmental damage (such as detection and disposal of unexploded ordnances [UXO] which create an imminent and substantial endangerment to the public health, its welfare, or to the environment); and
3. demolition and removal of unsafe buildings and structures at properties formerly used by or under the jurisdiction of the Secretary of Defense.

This conceptual workplan addresses goal number 1. Goal number 2 will be addressed by USACE in separate documents. Goal number 3 does not apply at this site since the buildings were in good condition at the time of transfer. Lead-based paint and asbestos are beyond the scope of this investigation.

In addition to CERCLA, the DoD is required to comply with environmental statutes such as the Resource Conservation and Recovery Act (RCRA), Toxic Substances Control Act (TSCA), Clean Water Act (CWA), Safe Drinking Water Act (SDWA), and the Clean Air Act (CAA).

The waiver of sovereign immunity does not apply to FUDS. DoD components are not required to comply with the National Environmental Policy Act (NEPA) procedural requirements when undertaking a CERCLA or RCRA cleanup action; however, the DERP statute, 10 U.S.C. 2705, requires coordination with EPA, state, and local authorities. Statute requires a fully informed public, and policy encourages public comment and participation.

SECTION 1

INTRODUCTION

This conceptual workplan outlines the proposed scope and objectives of a United States Army Corps of Engineers (USACE) environmental restoration site investigation planned for the Benicia Arsenal (Arsenal). The Arsenal is a Formerly Used Defense Site (FUDS), located approximately one mile east of the City of Benicia and 25 miles northeast of San Francisco, California (Figure 1-1). The Arsenal's history is detailed in a record research report and summarized in Section 2 of this document.

The purpose of this conceptual workplan is to develop a consensus between USACE and the regulatory community regarding the approach of the environmental investigation prior to preparing an Arsenal-wide investigation workplan. This conceptual workplan is one of the first steps in the effort to achieve the intended goal of properly investigating this site and characterizing the nature and extent of any Department of Defense (DoD) related contamination at the Arsenal. Once this conceptual workplan has been approved, an Arsenal-wide investigation workplan will be prepared detailing area specific increments.

This conceptual workplan is organized as follows:

- Section 1 introduces the FUDS program and the Benicia Arsenal site;
- Section 2 describes the Arsenal and project history;
- Section 3 summarizes the Arsenal characteristics;
- Section 4 describes the conceptual technical approach; and
- Section 5 presents the conceptual administrative approach.

The FUDS program, a sub-program of the Defense Environmental Restoration Program, follows a step-wise approach (Figure 1-2) which is a standard EPA approach:

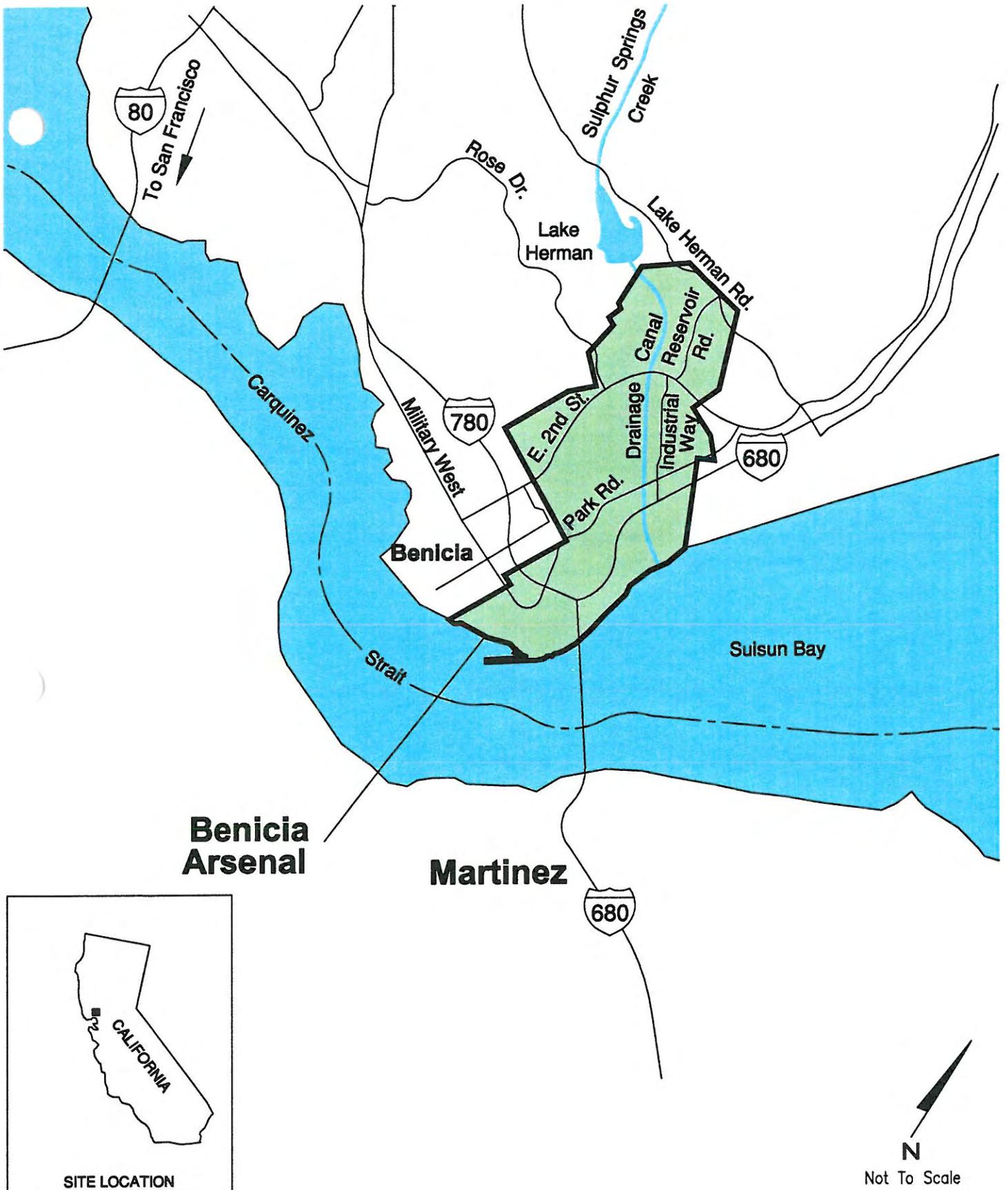
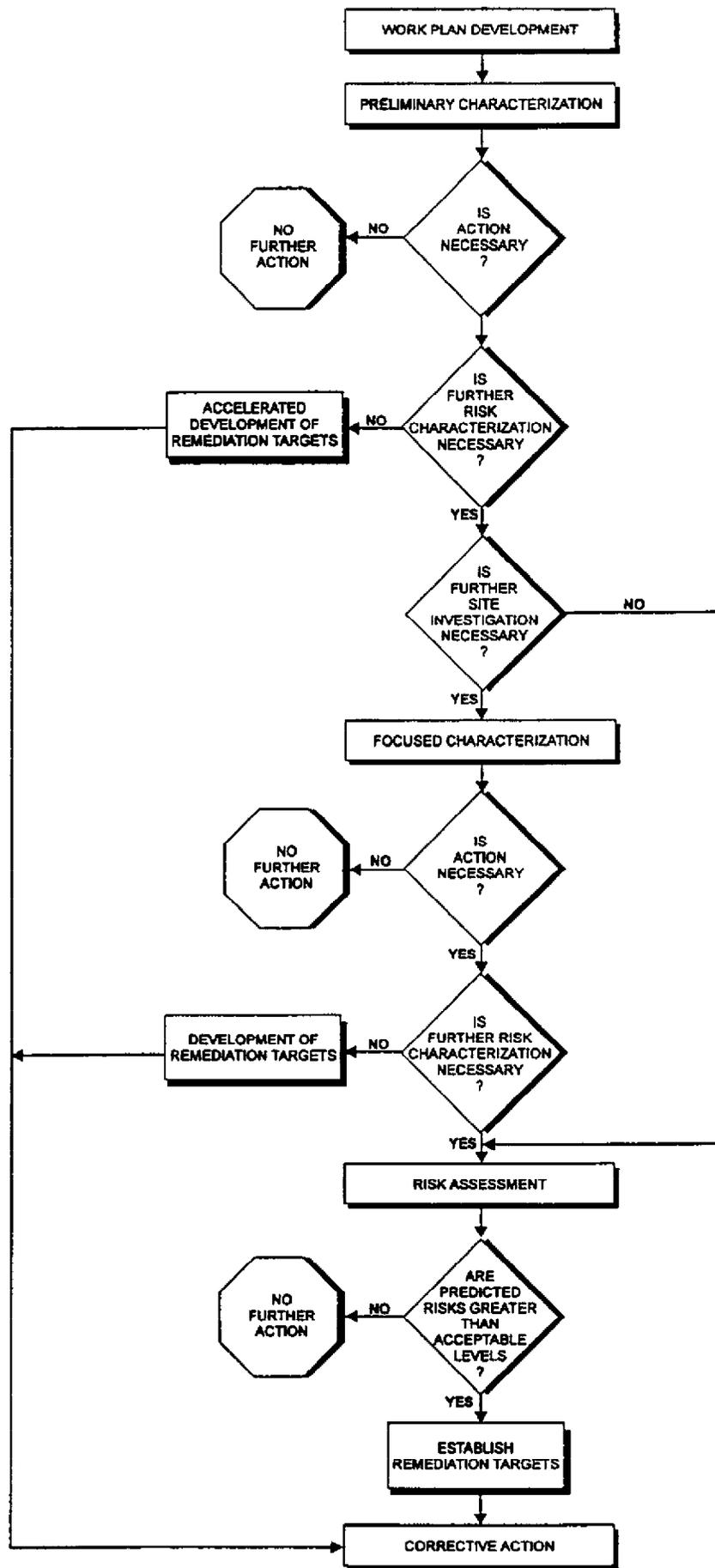


Figure 1-1.
Location of
Benicia Arsenal



FUDS Decision Tree

FIGURE 1-2

- records search
- preliminary site characterization
- focused characterization of any contamination found
- area-specific risk analysis (both to human health and the environment)
- corrective action
- site closure

This approach will be followed at the Benicia Arsenal. In addition, every effort will be made to streamline the investigation, minimize the impact to both the landowner and the tenant(s), and shorten the timeline. Where appropriate, field screening, rapid site characterization, and innovative technologies and evaluation techniques will be used.

The purpose of the records search is to determine DoD land use and identify "beneficial uses" by subsequent land owners. The DoD land use determines the potential sites of concern and the chemicals of potential concern (COPC). Under the FUDS program, land previously utilized by the DoD and with no "beneficial uses" from subsequent landowners or lessors will be characterized and remediated appropriately. Beneficial use of former DoD land is defined as use by subsequent landowners or lessors in a manner that would either mask contamination caused by DoD or continue contamination in the same way. For example, an underground storage tank (UST) installed and used by DoD and also used by a subsequent landowner or lessor, is considered to have had beneficial use. Once beneficial use has been established, no further investigation/characterization under the FUDS program will occur. The DoD use at each site determines the COPC.

In the preliminary characterization step, limited site-specific data are gathered to initially determine the presence of COPC. The data are then evaluated to determine whether additional investigation(s) is needed. If contamination exists, then subsequent focused investigation will define the horizontal and vertical extent, and the magnitude of DoD-related COPC. As discussed above, methods to accelerate this process will be utilized in the Arsenal investigation, as appropriate.

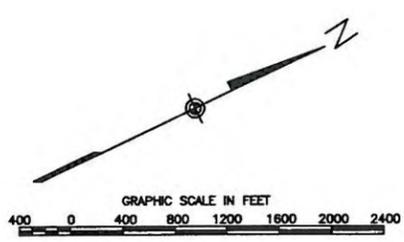
Following the data gathering step, the risks to human health and the environment are evaluated on a site-specific basis. Goals will be established for the recommendation of "no further action", or for the purpose of corrective action. A recommendation of "no further action" is made if there is no contamination, no DoD-related COPC are identified, the landowner refuses right of entry, the problem is resolved, or the risk evaluation determines that there is an acceptable risk to human health and the environment. If remediation is warranted, then an appropriate course of corrective action is established.

The Benicia Arsenal

As a result of the records search, the Arsenal was divided into five separate and distinct areas, WIRMS, which reflect the use of each area during the active life of the Arsenal (Figure 1-3). Area W is the warehouse expansion area of the 1940's and 50's. Area I is the industrial/manufacturing area. Area R is the revetment area or the explosives holding yard. Area M is the motor pool area and the former historical ordnance storage area, and Area S is the storage or igloo area.

Area W houses five large warehouse facilities and several smaller facilities used to store inert materials. Small warehouses were constructed in 1942, and four of the larger structures were constructed between 1952 and 1954. Other features include two underground small arms storage magazines, the guided missile shop, two septic tanks associated with the warehouse expansion facilities, a tank test track, and a fire-water reservoir. Following deactivation of the Arsenal several new industrial facilities have been constructed.

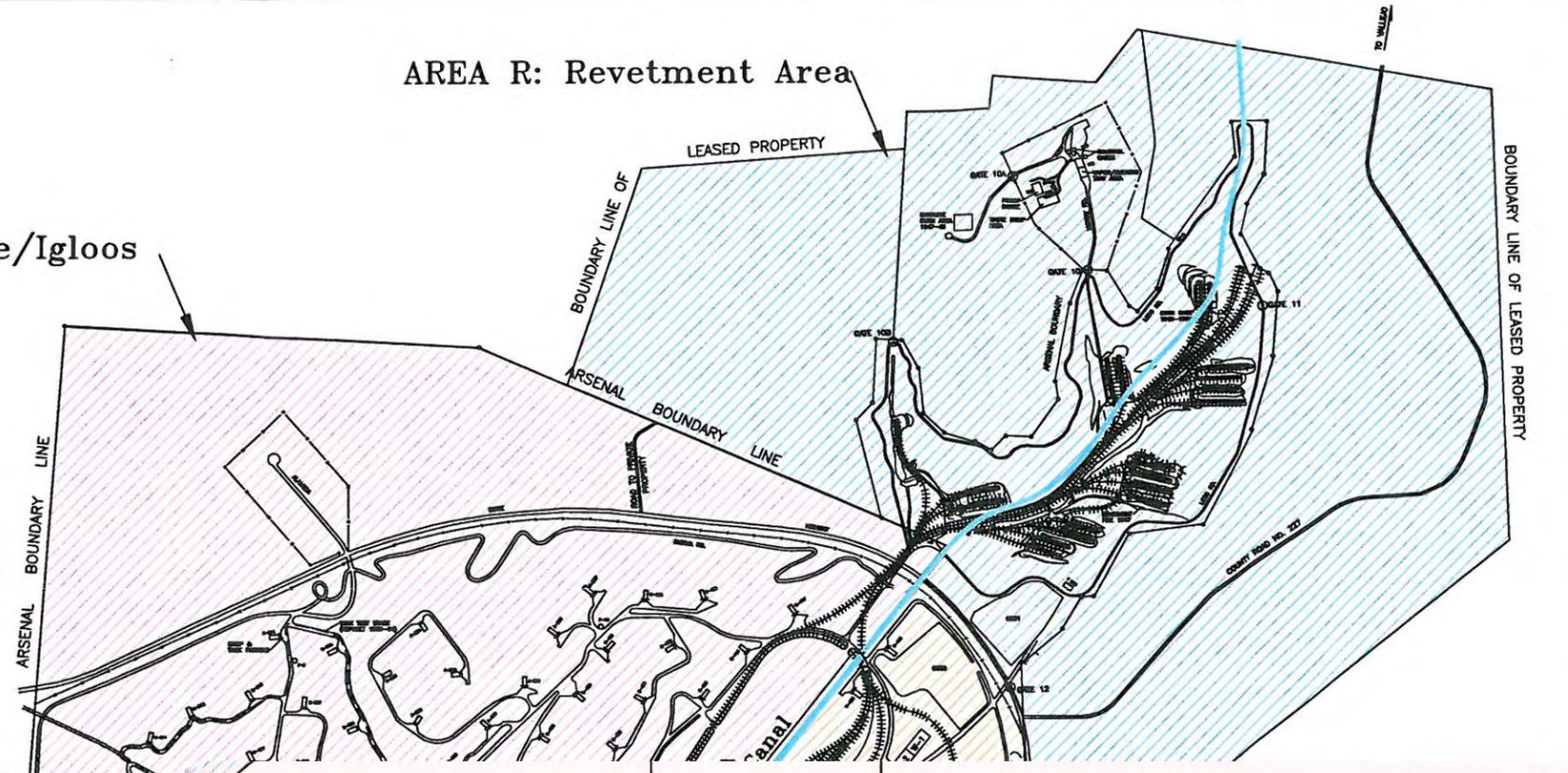
Area I contains heavy industrial type structures dating to the 1850s. Other features include two sandstone quarries, two landfills, the Storehouse or "Clock Tower", and military housing. Several service stations were later constructed. Small arms and artillery manufacturing and servicing, repairing and preserving were performed in this area from circa 1861 until deactivation in 1964.



SOURCES: BASIC INFORMATION MAPS, MARCH 1958
 LAND UTILIZATION MAP, MAY 1956
 PRELIMINARY BENICIA ARSENAL REHABILITATION OF
 MAINTENANCE BLDGS. PLOT PLAN, AUGUST 1950

AREA R: Revetment Area

AREA S: Storage/Igloos



AREA M: Motor Pool

AREA I: Industrial/
 Manufacturing

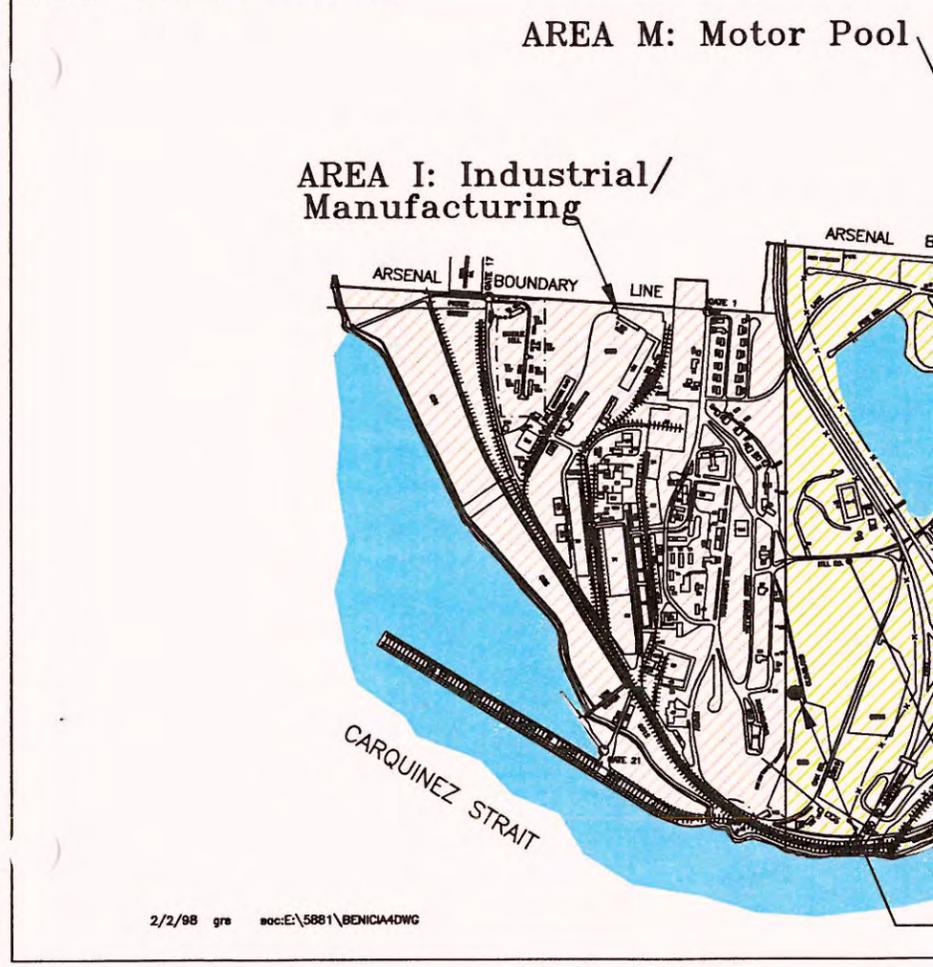
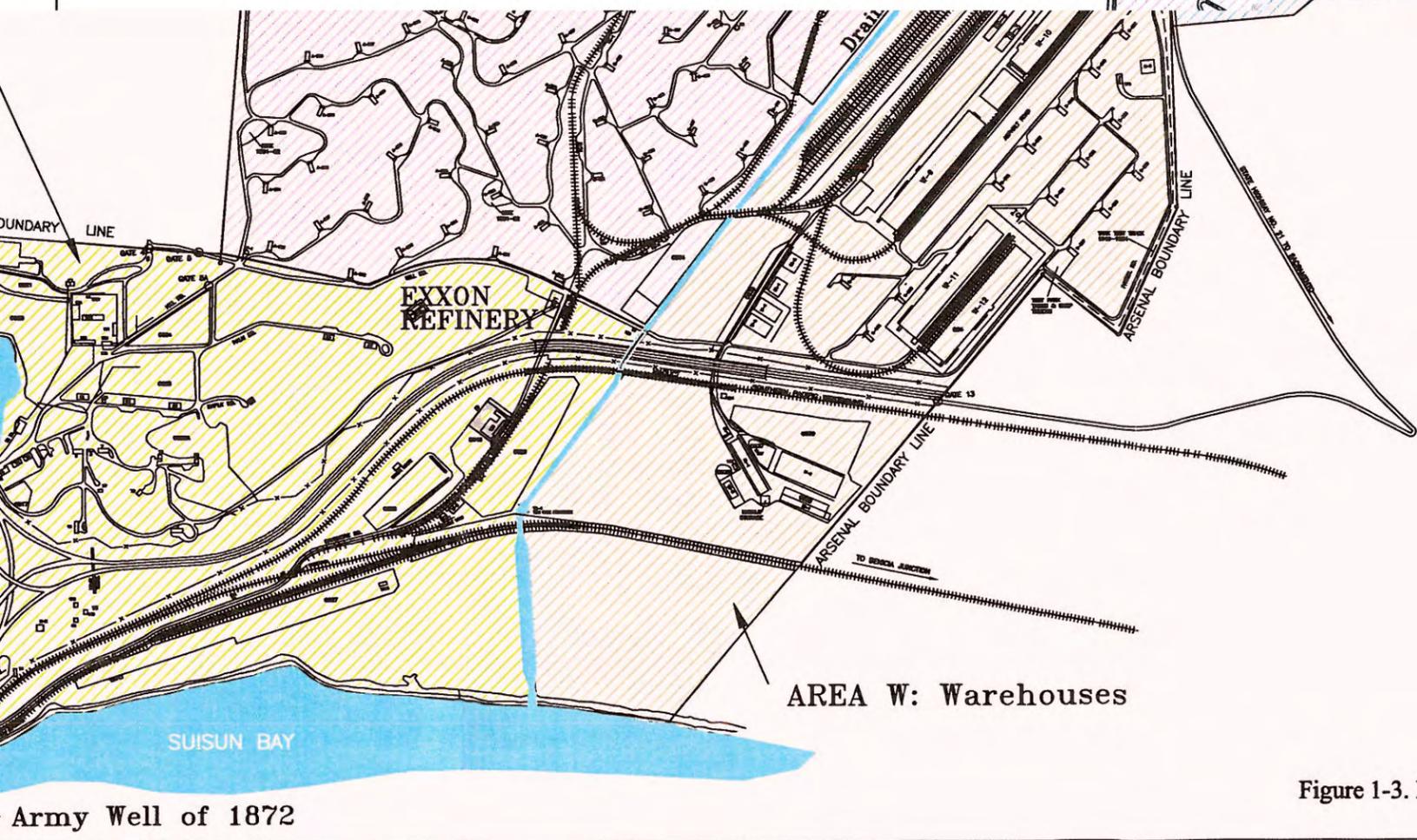


Figure 1-3. BENICIA ARSENAL

Army Well of 1872

2/2/98 gra noc:E:\5881\BENICIA4DWG

Area R was improved in the mid-to late-1940's for managing and storing explosives. Other features include eighteen earthen revetments constructed around railroad spurs, several ordnance disposal areas, howitzer test tunnels, a firing butt, a concrete powder loading room, and a weapons testing facility which was built in the 1950s. Explosives were routinely burned on the Arsenal grounds. A demolition site is noted on base maps, located on the northwest edge of the Arsenal in Area R (USACE, 1997).

Area M was originally (1852 to 1945) used for storage of explosives and fabricated ordnance. Detonation of ordnance was probably conducted on the Suisun Bay tidal flats adjoining Area M. A gasoline refueling station was added in 1955. During this period, in 1945, the motor pool was temporarily moved from Area I into Area M. In 1953 the motor pool was permanently located in Area M. Area M contains some of the oldest remaining structures of the Arsenal, including the Camel Barn Museum and the original Arsenal hospital. Other features include a tire retreading facility, 2 sandstone quarries, 4 fire/domestic water reservoirs, and an Italian POW barracks (later used for California Youth Authority housing).

Area S houses over 100 former underground storage igloos, both medium and large in size. One of these igloos reportedly contained radioactive source material (probably used for calibration of equipment). Other features include two open storage areas, a firing range, a demolition area, several railroad loading platforms, and two former NIKE missile launch sites. Scattered throughout the hills of the Arsenal were NIKE launching racks, which held the missiles in readiness (Cowell, 1963).

Under the FUDS program, work cannot proceed in an area until the area is cleared of unexploded ordnances (UXO). Area I has been chosen as the starting point for work at the Arsenal because it has the lowest potential for buried UXO. Eventually, the entire Arsenal will be investigated. The Arsenal-wide investigation workplan will be written to allow for this incremental approach.

SECTION 2

ARSENAL AND PROJECT HISTORY

This section describes the Benicia Arsenal (Arsenal) history, current land use and ownership, and the project history.

Arsenal History

The Benicia Arsenal (Arsenal) was created in 1849 with a land transfer of 345 acres from the founders of the City of Benicia (Cannon, 1993). Originally referred to as "the Post at Point near Benicia, California," the post was later designated Benicia Barracks (Cowell, 1963). In 1862, then President Lincoln ordered that a plot of land at Benicia be segregated from the public lands for the purpose of a military reservation. Between 1849 and 1958, the United States acquired 1,790.48 fee acres, 351.12 public domain acres, 6.40 license acres, and 580.04 easement acres, for a total of 2,728.04 acres. Of the 2,728.04 acres acquired for the Arsenal, 190 acres were located in Carquinez Strait to the south, and the Suisun Bay to the northeast (War Department Boundary Map, 1935).

The Arsenal served as the principal depot for ordnance and ordnance stores, issuance (supplies, ammunition, small arms parts and accessories), the manufacture and testing of small arms, mobile and seacoast artillery targets, and vehicle maintenance for the Division of the Pacific. Table 2-1 presents a breakdown of the historic responsibilities of the Arsenal during its 115-year history.

Improvements to the site (prior to 1940) included four brick officers quarters, eleven enlisted men's barracks and quarters, eight shop buildings, 19 magazines, and 39 storage buildings. Utilities included a sewer and drainage collection systems, electric power generation and light distribution systems, water pumping and distribution systems, and telephone and fire alarm systems (United States Army Corps of Engineers [USACE], 1997).

A massive expansion took place at the Arsenal during World War II. Physical expansion included the addition of 1,847 acres and over 200 structures. The Arsenal served as the principal supply point for the campaign areas in the Pacific (Cannon, 1993).

Another full-scale expansion took place just prior to and following the Korean Conflict, with the addition of approximately 40 to 50 structures. Many of these additions were warehouses for inert materials, and transitory shelters. During this time, the Arsenal also reached its peak activity with nearly 7,000 civilian employees on its payroll.

Over the years, the Arsenal had a recurring problem establishing a reliable water source. A 20-year exploratory drilling program began in 1862, following 10 years of planning and funding requests, to locate a satisfactory drinking water source. This effort failed, and only non-potable water was found to an explored depth of 1,400 ft (Cowell, 1963). To counter the problem, at least 14 cisterns were installed to catch rainwater during the wet months. The Arsenal maintained five reservoirs that served both as a fresh water drinking source, and as a water reserve for fire fighting during the summer. Water was frequently pumped directly from the Carquinez Strait to replenish the reservoirs.

The Arsenal was continuously occupied by the military from its establishment in 1849 to its closure in 1964. Benicia Arsenal was declared excess by DoD and was reported to the General Services Administration (GSA) on 11 January 1963. Deactivation and closure of the Arsenal was completed on 31 March 1964 (Cowell, 1963). The total property acres acquired for the Arsenal were disposed of as presented in Table 2-2. The dates presented in this conceptual workplan are not necessarily consistent with dates cited in other published reports. However, they are based on documents found during the most recent records research.

Table 2-1. Benicia Arsenal Historic Responsibilities

Years	Military Period	Primary Responsibilities
1849-1859	Native American hostilities	Benicia Barracks, home to two Army divisions, was taken over by the Arsenal installation, first Ordnance Supply Depot in the west.
1860-1899	Civil War Spanish-American War	Proving ground for testing of various types of gunpowder manufactured on the Pacific Coast, cleaning and repairing of arms, guns and carriages; manufacturing holsters, ammo boxes and chests; packing ammunition; principal repository and distribution point of ordnance, and ordnance stores of the Pacific Coast.
1900-1939	World War I	Storage, issuance and repair of Army ordnance; principal distribution and maintenance depot for military arms and equipment on the West Coast; manufacture of targets and target materials for firing practice by seacoast artillery, mobile or field artillery and small arms; assembling powder charges and fixed ammunition; modification of armor-piercing projectiles; parts fabrication for repair or replacement of seacoast artillery material; repository for returned supplies from war efforts.
1939-1950	World War II	Major expansion of the Arsenal involved the construction of a concrete wharf capable of docking four ocean-going vessels simultaneously; 109 ammunition storage bunkers; several warehouses; shop building for rebuilding of combat and artillery vehicles; numerous shop building additions. Arsenal responsible for supplying the Pacific Ports of Embarkation with small arms, automatic weapons, light field artillery, field artillery, mobile anti-aircraft artillery, heavy field artillery, fire control instruments, tank and gun motor carriages, parts supplies, tools and equipment for weapons, tanks, and fast-moving items of fire control instruments. Rebuild, reclaim, and modify all forms of artillery and weaponry. Transshipment depot for storage and holding of all classes of ammunition and explosives for the Port of San Francisco (including 500-pound bombs). Physical Arsenal expansion from 345 acres to 2,192 acres.
1950-1953	Korean Conflict	Field Ordnance Supply operations for the West Coast following release of Stockton Ordnance Depot as Sub-Depot to Benicia; transshipment facility; maintenance of general supplies, field artillery, armored and half-track cars and combat vehicles; rapid expansion in rebuilding operations; proving ground for 155mm howitzer tubes manufactured under contract by Yuba Manufacturing Company. Peak civilian employment of nearly 7,000.
1954-1959	Far East hostilities	Shop established for the reconditioning, maintenance and repair of NIKE guided missile propellant systems and internal guidance systems; became a point of anti-aircraft defense of the San Francisco Bay area with NIKE missiles secretly placed atop the Arsenal's hills. Tire Rebuild Branch in operation rebuilding and recapping tires; extensive rebuild of artillery, as well as transport, general purpose, and combat vehicles, and general supplies requiring maintenance-in-storage; storage and issuance of missiles (less their explosive components and fuels); manufacture of "O" rings for guided missiles in Rubber Production Shop; extensive property disposal.
1960-1964	Far East hostilities and closure	Ordnance Supply Depot, involving the storage, stock control, maintenance and distribution of general ordnance supplies and equipment for Army, Air Force, National Guard, Navy and Marine Corps; made urgent shipments to South Vietnam; functional testing of artillery material and calibration of ordnance test equipment and calibration standards; W-1 and W-2 moved to new location for vehicles previously stored in open; inactivation manual established for shutdown scheduled for 30 March 1964; 30 September 1962 guided missile rebuild operations complete; Arsenal operation with skeletal force. Arsenal closed 30 March 1964.

Source: History of Benicia Arsenal
Benicia, California
Josephine W. Cowell, 1963.

Table 2-2. Disposal of Benicia Arsenal Land

Land Area	Method of Disposal	Disposal Date
360.78 acres	Public domain/License/Lease acres reported excess	11 January 1962
575.45 acres	Lease terminated from City of Benicia	11 January 1963
5.03 fee acres	GSA quitclaim deeded to the City of Benicia	12 March 1964
1,785.45 fee acres	GSA quitclaim deeded to the City of Benicia	20 February 1965
1.33 acres	Reassigned to Benicia Arsenal Cemetery	26 February 1965
2,728.04 Total acres		

Source: Revised Site Survey Summary Sheet
Benicia Arsenal
Sacramento District, Corps of Engineer, January 1997.

Current Land Use and Ownership

The area formerly occupied by the Arsenal is currently a combination of residential, light to heavy industrial/commercial activities, warehousing, and a port. Prior to, and after the Arsenal closed, Arsenal land was transferred to the City of Benicia. To fast-track economic recovery, much of the land and buildings were leased to Benicia Industries, Inc. (BII). Over the years, BII has purchased much of the land in fee, and hold a lease through the year 2031 on most of the waterfront property (Plant, 1997). They now operate the port and are developing the Industrial Park. A portion of Area R is currently being developed for residences by Granite Construction, Inc. Toyota Motor Sales operates a facility in Area M. This area also contains the US Interstate 680 and 780 freeways, and 2nd Street corridors. Exxon owns land which encompasses much of Areas S and M. They operate a refinery on that land.

Several of the buildings within the Arsenal property are currently used for industrial endeavors. Further investigation will identify the present occupants, operations, and landowners of the buildings.

Project History

To date, four reports have been prepared for the Arsenal by the USACE. This conceptual workplan is the fifth project report to date for the Arsenal. The following project reports have been prepared and finalized:

- Inventory Project Report (INPER);
- Ordnance and Explosive Waste Chemical Warfare Materials (OEW/CWM) Archives Search Report Findings;
- Ordnance and Explosive Waste Chemical Warfare Materials Archives Search Report Conclusions and Recommendations; and
- Supplemental Report to the March 1994 OEW/CWM Archives Search Report.

As part of the FUDS funding screening process, an INPER was prepared by the USACE, Sacramento District in December 1990. The INPER identified a need for hazardous and toxic waste/remedial investigation (HTW/RI) and ordnance removal (OE) activities.

The USACE, Huntsville District, produced the OEW/CWM Archives Search Report Findings, and Conclusions and Recommendations reports in March, 1994. The OEW/CWM Archives Search Report Conclusions and Recommendations recommended two courses of action for the site: (1) advise all owners of undeveloped arsenal property of the potential for buried ordnance and to contact the USACE prior to any excavation activities; and (2) survey all undeveloped portions of the Arsenal property for buried ordnance contamination (USACE, 1994b).

The USACE, St. Louis District, prepared the Supplemental Report to the March 1994 OEW/CWM Archives Search Report. The primary focus of the supplemental report is to confirm storage areas and potential disposal sites for chemical warfare materials (CWM). The conclusion of this report is that CWM are not expected. The report notes that if any suspect items are found, work should stop and local law enforcement contacted (USACE, 1997).

SECTION 3

PHYSICAL CHARACTERISTICS OF BENICIA ARSENAL

This section describes the general topography, geology, and hydrology of the Arsenal.

Location and Topography

The Benicia Arsenal is located in the City of Benicia, Solano County, California (Figure 1-1), bordering the Carquinez Strait and Suisun Bay. The southern property line of the Arsenal extends into the waters of Carquinez Strait. Adjacent to Carquinez Strait and Suisun Bay the topography is relatively flat. Moving northward, away from Carquinez Strait and Suisun Bay, the topography consists of gently rolling hills, with elevations increasing to a maximum of approximately 420 feet above sea level. The maximum elevation is reached at the westernmost portion of the Arsenal.

Subsurface Soil and Geology

The following description of soils and lithology of the Arsenal are based largely on work by Dibblee (1980) and Sims (1973). Most of the Arsenal (with the exception of the flat portions adjacent to Carquinez Strait/Suisun Bay and the alluvial valley of the drainage canal) is composed of a thin layer of soil, underlain by bedrock. Where fully developed, soil beneath the Arsenal consists of three major horizons; surface soil, organic clay, and weathered sandstone/siltstone. The surface soil is typically silty organic clay, or pale brown to dark grayish-brown clay. Underneath the surface soil is light olive-brown, silty organic clay. Underlying this clay is yellowish-brown, weathered sandstone or siltstone. The thickness of soil varies from a few inches to several tens of feet within the Arsenal. Not necessarily all soil horizons exist throughout the Arsenal.

The bedrock consists of layers of sedimentary rocks, principally siltstone, sandstone, and shale. Individual layers vary in thickness from less than a foot to tens of feet. These layers

are stacked on top of each other and generally tilt toward the west-southwest. This tilting was caused by the uplift of the Coast Range mountains. The siltstone and sandstone are typically tan or yellowish-brown in color. The shale is commonly red to reddish-brown. The bedrock beneath the Arsenal is part of the Panoche, Chico, and Martinez Formations (formation is a term used by geologists to group a body of rocks with similar characteristics), and is approximately 150-250 million years old.

The flat portions of the Arsenal bordering Carquinez Strait and Suisun Bay consist of unconsolidated sediments, such as mud and silt. The alluvial valley in which the drainage canal lies, consists of sediments which range in thickness from approximately 15 feet at the north end of the Arsenal to more than 80 feet near Suisun Bay.

Hydrology

The location, quantity, and quality of groundwater beneath the Arsenal is not well known. Throughout most of its history the Arsenal lacked a satisfactory fresh water supply. In 1872, the Army attempted to obtain a water source by drilling a well in the southern portion of the Arsenal. During drilling, groundwater was first encountered at a depth of 960 feet. Drilling continued until the well was 1,407 feet deep. However, this water was determined to be unfit for human consumption and the well was blocked off to a depth of 960 feet using cement, sand, and grain sacks. Water at the 960-foot depth contained organic matter and was considered "unfit for food" (Cowell, 1963), so this well was only used to produce water for boilers and irrigation. Although the well installed in 1872 did not identify groundwater until a depth of 960 feet, there have been several monitoring wells installed at the Arsenal by private parties, for the purpose of environmental investigation. These wells identified water at much shallower depths. At this time, data from these wells have not been evaluated by USACE, but it is anticipated that information regarding the locations and depths of existing monitoring wells installed by private parties will be reviewed and summarized in the Arsenal-Wide Investigation Workplan. An important part of the environmental investigation at the Arsenal will be to evaluate this information, and to determine where groundwater exists, its quality, and where and how it moves.

In the flat portions of the Arsenal bordering Carquinez Strait and Suisun Bay, it is likely that groundwater is directly connected to these water bodies. As such, it is relatively shallow and most likely under tidal influence. Specific water quality data for this groundwater has not been reviewed, however, water quality is assumed to be brackish as it most likely represents inflow and underflow of bay waters.

Adjacent to the Arsenal, in the Bay itself, are tidal flats and marshlands where a maze of natural drainage channels have created islands (USACE, 1994a). Several marshlands, identified as swamps on historical site maps, have since been filled in and developed. The Arsenal contains one main surface drainage, a drainage canal, which is located in an alluvial valley approximately 80 feet deep running northwest-southeast. The drainage canal extends from Lake Herman to Suisun Bay (Figure 1-1). Sulfur Springs Creek, located north-northwest of the Arsenal, feeds Lake Herman.

SECTION 4

CONCEPTUAL TECHNICAL APPROACH

This section describes the proposed conceptual technical approach to the environmental investigation at the Benicia Arsenal (Arsenal). The goal of the technical approach is to provide a clear framework for collecting data and making decisions in a defensible and cost-effective manner. The technical approach should be viewed in conjunction with the conceptual administrative approach discussed in Section 5.

The technical approach began with breaking the Arsenal into areas of similar use, the five WIRMS areas (Figure 1-3). Within each area, DoD conducted activities at specific facilities. (The facility can be a building, a pipe, or a landfill.) The DoD activities within each facility are well documented in the records search report and from these activities will evolve the list of chemicals of potential concern (COPC). The Arsenal-wide Investigation Workplan will detail the chemicals of potential concern and the investigative approach for each COPC by facility.

For the purposes of this concept document, we have grouped the DoD activities into the following six categories: 1) manufacturing/industrial; 2) refueling; 3) transformer; 4) ordnance storage; 5) sump/sewer; and 6) landfill.

Each of these categories are expected to be associated with a definable suite of chemicals related to the DoD activity. The chemicals which will be investigated are called Chemicals of Potential Concern (COPC).

COPC at the Arsenal can generally be categorized as follows:

- metals;
- pesticides;
- halogenated and fuel-related volatile organic compounds (VOCs) including solvents;
- chemical warfare material (CWM);

- acids and bases;
- polychlorinated biphenols (PCBs);
- petroleum oil lubricants (POL);
- semi-volatile organic compounds; and
- explosive residuals.

Table 4-1 is a matrix which shows how specific COPC relate to the six categories of former DoD activities. The purpose of this table is to illustrate the process which will be used to focus the investigation on COPC for individual sites. Once the COPC for a specific site is determined, the appropriate analytical methods will be applied to verify the extent, if any, of each COPC related to DoD use. Although radioactive source materials (probably used in calibration of equipment) may have been stored in small quantities in one of the igloos in Area S, there is no evidence that these materials were spilled, inappropriately handled, or misused in any way. Therefore, they are not included in the list of COPC at this time. However, as additional information becomes available, they may be added to the list of COPC in the future.

The COPC provided above are conceptual, actual analytical schedules (to be provided in site-specific field sampling plans discussed in Section 5) will be based on records review and chemical-specific evidence found during preliminary on-site observations. Specifically, analyses for nonvolatile COPC (e.g., pesticides, metals, etc.) will be based on evidences of point source contamination associated with DoD operations and land usage (e.g., potential for metals found in small arms alloys, etc.). Likewise, sampling matrices will be on a site-specific basis, and may include surface soils, surface water, and near-grade soil gas, as warranted by preliminary evidence. Field investigation will not proceed until a site has been cleared of UXO by qualified ordnance disposal personnel.

Table 4-1. COPC Identification

Area	Primary Functional Activities	COPC
Area W	<ul style="list-style-type: none"> • Manufacturing/Industrial • Sump/Sewer 	Solvents, VOCs, POL, acids, bases, CWM, reducing agents, explosives and metals
Area I	<ul style="list-style-type: none"> • Manufacturing/Industrial • Refueling • Ordnance Storage • Sump/Sewer • Landfills 	Solvents, VOCs, POL, acids, bases, reducing agents, explosives and metals
Area R	<ul style="list-style-type: none"> • Ordnance Storage 	Explosives and metals
Area M	<ul style="list-style-type: none"> • Refueling • Ordnance Storage • Sump/Sewer • Landfills 	Solvents, VOCs, POL, acids, bases, reducing agents, explosives and metals
Area S	<ul style="list-style-type: none"> • Ordnance Storage 	Explosives and metals

SECTION 5

CONCEPTUAL ADMINISTRATIVE APPROACH

This section describes the conceptual administrative approach to the environmental investigation at the Benicia Arsenal (Arsenal). Proposed documents to be prepared for the environmental investigation at the Arsenal are summarized below. Figure 5-1 presents a graphic representation of these documents.

- Community Relations Plan
- Conceptual Workplan (this report)
- Arsenal-Wide Health and Safety Plan (HSP)
- Arsenal-Wide Quality Assurance Project Plan (QAPP)
 - Standard Operating Procedures (SOP)
- Arsenal-Wide Investigation Workplan
 - Investigation-derived waste management plan
 - Field Site Investigation Plans (FSIP) [provided as appendices to the Arsenal-wide investigation workplan]
 - Site-Specific Safety and Health Plans (SSHP) [provided as appendices to the Arsenal-wide investigation workplan]

The Arsenal-wide investigative workplan will be separated into five subsections corresponding to the five major areas of the Arsenal: Warehouses, Industrial/Manufacturing, Revetment, Motor Pool and Storage/Igloos (WIRMS). A conceptual model will be prepared for each area. Information that is common to the area and a detailed historical use of each of the facilities within an area will be included in the main body of the plan under the appropriate subsection. The actual investigation will proceed by facility. The first set of FSIP will be included as attachments in their appropriate subsection(s) at the time of submittal of the main body of the plan. At the front of each WIRMS subsection will be an index that will list the included FSIP.

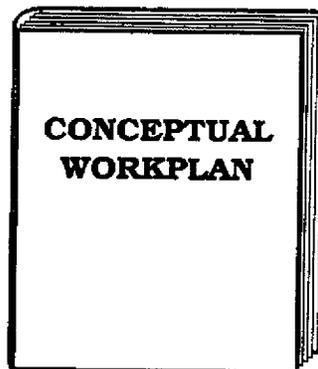
As the study moves to additional facilities, only the FSIP will be submitted for review and approval. After approval, an updated index will be provided for the subsection along with the final approved FSIP for inclusion in the original document. This approach is intended to shorten the workplan writing/submittal/review/approval process without compromising quality.

As a minimum, each FSIP will include the following:

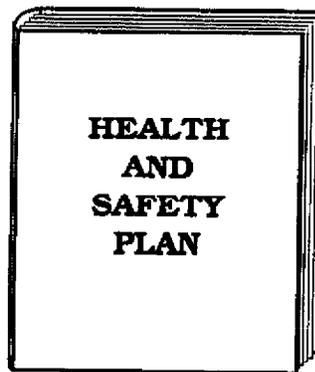
- Section 1.1 will describe, very briefly, the history of the site, including past DoD use, current land use, and previous investigations (if any).
- Section 1.2 will describe the data quality objectives for the proposed field investigations, using a table format. The data quality objectives will be determined using the United States Army Corps of Engineers (USACE) Data Quality Objective guidance worksheet, which is included as Appendix A to this conceptual workplan.
- Section 1.3 will outline the proposed sampling locations, chemicals of potential concern (COPC), analytical matrices, field specifications, and the rationale and objectives for the number of samples, sampling locations, step outs, etc. This section will include a figure showing the sample locations, and tables to describe the sampling and analysis matrix, and the sampling and field specifications.
- Section 1.4 will describe the site-specific safety and health plan for each site. This section will reference Brown and Caldwell's Corporate Health and Safety Plan, and will provide specific details on the site safety requirements for the site and for the COPC.



Overall plan for
community relations
at the Arsenal



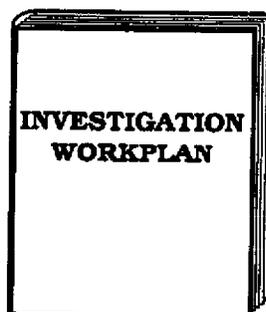
This plan introduces
general approach to
Arsenal investigation



Overall health and
safety plan for Arsenal-wide
field work



Overall plan for
Arsenal-wide field work,
including standard
operating procedures



Detailed work plan for
Arsenal-wide environmental
investigation, including
investigation - derived waste
management plan



Detailed plans for field
investigation of each site



Specific to work at
each site

Figure 5-1. Proposed Document Organization

The data quality objectives to be included in Section 1.2 will follow the United States Army Corps of Engineers (USACE) Data Quality Objectives (DQO) guidance process (provided in Appendix A), which includes the following 7 steps:

1. State the Problem
2. Identify the Decision (specify the questions that must be answered by the investigative effort)
3. Identify inputs (specify the data required to answer the questions)
4. Define Study Boundaries (time, funding, spatial)
5. Develop a Decision Rule (define action levels)
6. Specify Tolerable Limits on Decision Errors
7. Optimize Design for Study

EXAMPLE

**INDEX TO FIELD SITE INVESTIGATION PLANS
AREA I**

The following table will be prepared for each Arsenal area, and will correlate FSIPs to specific sites. It will facilitate review of individual FSIPs and will be updated as sites are added.

Site Name	General Location	Page Number
Building X	Area I, former armory	1
Landfill	Area I, former landfill	2

EXAMPLE

Field Site Investigation Plan for Building X

This Field Site Investigation Plan (FSIP) follows the approach outlined in the Arsenal-Wide Investigation Workplan for the Benicia Arsenal dated _____.

Section 1.1 Area History

This section will describe, very briefly, the history of site, including the DoD use, current land use, and previous investigations (if any).

Section 1.2 Data Quality Objectives

The data quality objectives for this field investigation are shown in Table 1-1. The United States Army Corps of Engineers (USACE) Data Quality Objective guidance worksheet was used to generate Table 1-1.

Section 1.3 Sampling Plan

Proposed sampling locations are shown in Figure 1-1. Chemicals of Potential Concern (COPC) and the sampling and analytical matrix are shown in Table 1-2. Field specifications for sampling locations are included in Table 1-3. Rationale and specific objectives for sampling locations are outlined below. *The rationale and objectives for number of samples, sampling locations, step outs, etc. will be described in detailed text in this portion of the FSIP.*

Section 1.4 Site-Specific Safety and Health Plan

The site-specific safety and health plan (SSHP) for each individual site will be included here. This section will reference the Brown and Caldwell Health and Safety Plan, and will provide specific details on the safety requirements for the site and for the COPC.

EXAMPLE

Table 1-1. Data Quality Objectives

State the Problem:

Hazardous materials were used for operations in *Building X* and may have spilled or leaked into the subsurface.

Identify the Decision:

- Determine if operations in *Building X* have contaminated the surface and/or subsurface.
- Determine the location priority.

Identify Inputs:

VOCs in soil gas; SVOCs and inorganics in soil.

Define Study Boundaries:

Soil gas samples from approximately 20 to 40 feet bgs will be collected around the perimeter of *Building X*. Soil samples collected from 0.25 to 5 feet bgs from five separate boreholes.

Develop a Decision Rule:

- If VOCs are reported in soil gas, and if concentrations decrease with distance from the location horizontally, then VOC contamination most likely originates at the location.
- If inorganics are reported above background concentrations in surface soil samples, then spills or leaks may have contaminated the location and the decision process for inorganics should be applied.

Specify Tolerable Limits on Decision Errors:

Analytical data must meet project specifications for precision and accuracy.

Optimize Design for Study:

Six soil gas borings will be drilled around perimeter of *Building X* at approximately 100-foot intervals from each other and existing borings. Soil samples will be collected from five of these six boreholes.

Figure 1-1. Sample location map to be inserted here

EXAMPLE

Table 1-2. Sampling and Analysis Matrix

Location:	<i>Building X</i>		
Potential Chemicals of Concern:	<i>List of Target Chemicals</i>		
Sampling Location:	<i>Sample Name</i>	<i>Sample Name</i>	<i>Sample Name</i>
Sample Depth and Analytical Method:	<i>(depth in feet)</i> <i>SW846 method</i>		

EXAMPLE

Table 1-3. Sampling and Field Specifications

Boring/Location Name	Reference Point	Distance	Maximum Depth Interval (ft bgs)
<u>Surface Sample</u> <i>Sample Names</i>	<i>Building X, etc.</i>	<i>Feet and Direction</i>	<i>Depth</i>
<u>Hand Augers</u> <i>Sample Names</i>			
<u>Borings</u> <i>Sample Names</i>			

APPENDIX A

**UNITED STATES ARMY CORPS OF ENGINEERS
DATA QUALITY OBJECTIVES WORKSHEET**



ENVIRONMENTAL DESIGN SECTION
DATA QUALITY OBJECTIVES
WORKSHEET

____ Reviewer's Initials

Site Name: GUIDANCE SHEET

Location:

Project Scope:

Project Objectives: 1.
2.
3.
4.

Data User: (client and use)

Project Personnel (names, discipline, organization and phone #)

Project Leader: (technical team leader)

Lead Regulator:

TM:

Other principle team members:

list project chemist, geologist, toxicologist, industrial hygienist etc.

Site History Previous Uses:

Present Use:

Chemicals of Potential Concern:

State the Problem:

- State a concise description of the environmental problem for the site.
- Use prior studies and existing site information to help define the problem, i.e. prior analytical data, reports, site history.
- Typical examples of environmental problems include conditions that may pose a threat to human health or the environment and/or circumstances of potential regulatory non-compliance.

Identify the Decision: (what questions must be answered by this effort?)

List the expected decisions that will be based on the data collected and the actions that could result from that decision. Identify and prioritize potential uses of the the data. Typical examples of the types of questions that could be addressed for EDS activities are:

- Is there a potential that chemicals of concern have been released in areas at the site not previously investigated or not investigated adequately?
- Is the list of chemicals of concern complete?



ENVIRONMENTAL DESIGN SECTION DATA QUALITY OBJECTIVES WORKSHEET

____ Reviewer's Initials

- Has the horizontal and vertical extent of the chemicals of concern in affected media (e.g., soil, water,) been assessed adequately?
- Are there concentrations of chemicals of concern present at the site that exceed project-specific decision levels?
- Are concentrations of chemicals of concern present at the site increasing, decreasing, or remaining stable?
- Are there remedial alternatives suitable for treating the affected media? Have the remedial alternatives been evaluated adequately to support selection of an appropriate remedy for this site, i.e. are pilot studies needed?
- Is remedial action necessary or is natural attenuation an option?
- Is the site being characterized to support no further action statements or transfer of title on the property?

Identify inputs: (what data is required to answer the questions?)

Identify the information needed to support the decisions and specify the inputs requiring environmental measurements. For example the following activities may answer the questions identified in the step above:

- Prepare a list or table that specifies the action levels or standards upon which decisions will be made.
- Specify the form of the data (mean, maximum, range, etc.) when compared to the action levels or standard.
- Define the number and location of samples for the collection of laboratory data. This data can be used to assess the nature and extent of potential contamination, verify field analysis results, monitor progress and completion of remedial design studies, assess effectiveness of various remedial design studies, and/or provide information on where to locate future sampling or monitoring points.
- Define the number and location of samples for the collection of field analysis. This data can be collected using soil vapor probes, immunoassay, or XRF techniques to provide data on extent of contamination, estimate limits of excavation, monitor progress of remediation studies, and provide information on where to locate future sampling or monitoring points.
- All data to be collected will be consistent with procedures and requirements to be specified in the site-specific SAP.

Define Study Boundaries (time, funding, spatial)

The purpose of this step is to define the population for which the decision will be made including area and time. The study will involve sampling from this population to make inferences about the population as a whole.

- Definition of site boundaries including source areas within a site (including depth of sampling).
- Sampling constraints, including physical and logistical constraints should be addressed.
- Temporal constraints that may apply (due to weather, transfer or sale of property, loss of funding at end of year etc.).
- Fiscal constraints.

Develop a Decision Rule: (define action levels)

Define the conditions that would cause decision makers to choose between available options. These should be "if...then" statements that incorporate the study result, the action levels or standards for the project, and the action(s) that will be taken based on those action levels or standards. Confirm that you will need all the data that will be collected. If not, then define a more narrowly focused set of input variables.

Specify Tolerable Limits on Decision Errors:

Decisions for obtaining sample numbers can be based on one or more of the following options:

- Statistically derived based sampling as prescribed in the USACE guidance EM-200-1-2, Final, 1995.
- A modified statistical approach based sampling.
- No statistical based sampling (use of previous data and/or professional judgement).

For routine analytical procedures, precision, accuracy and sensitivity requirements will be specified in the site specific QAPP will



ENVIRONMENTAL DESIGN SECTION
DATA QUALITY OBJECTIVES
WORKSHEET

____ Reviewer's Initials

be followed. Laboratory data will be evaluated against the precision, accuracy, representativeness, completeness and comparability (PRACC) requirements as outlined in the project's QAPP and which have been developed and used by the Sacramento District. Possible decision errors will be considered tolerable when data meet the stated PRACC goals.

Optimal Design for Study:

Consider the data user. Are DQO parameters optimized and have decisions been made to ensure that the most effective sampling and analysis design been developed to generate data that can support project decisions including any uncertainties and their consequences?

APPENDIX B

REFERENCES

REFERENCES

The references listed are both those cited in the text and those used to provide additional information necessary to create this conceptual work plan.

Benicia Arsenal (BA). 1883. Arsenal Diary, Record Group 156, Box 113, National Archives-San Bruno, CA., 14 September.

Benicia Arsenal (BA). 1912a. Supplemental List B of Ordnance property destroyed in the fire at Benicia Arsenal, Record Group 156, Box 128, National Archives-San Bruno, CA., 18 October.

Benicia Arsenal (BA). 1912b. Letter from The Commanding Officer to The Chief of Ordnance, U.S.A. regarding Destruction by fire of main arsenal building, Record Group 156, Box 52, National-Archives-San Bruno, CA., 19 October.

Benicia Arsenal (BA). 1912c. Letter from The Commanding Officer to The Chief of Ordnance, U.S.A. regarding Stores at Benicia Arsenal requiring immediate replacement. Record Group 156, Box 113, National Archives-San Bruno, CA., 11 November.

Benicia Arsenal (BA). 1913. Personal communication from De La R. Kiff, Clerk Property Division, Colonel Joyes regarding List C and the articles recovered from the fire, Record Group 156, Box 121, National Archives-San Bruno, CA., 19 November.

Benicia Arsenal (BA). 1961. Facility Data Report. Analyses of Existing Buildings and Structures. May.

Breugmann, Robert (Breugmann). 1980. Benicia: Portrait of an Early California Town. San Francisco: 101 Productions.

California State Parks (CSP). 1991. Benicia State Recreation Area General Plan. June.

Cannon Design Group (Cannon). 1993. Benicia California Arsenal Historic Conservation Plan, November.

Couch, Thom. 1997. Personal communication regarding quarries with Thom Couch, Curator, Camel Barn Museum, dated 23 July.

Cowell, Josephine W. (Cowell). 1963. History of Benicia Arsenal, Benicia, CA. Berkeley: Howell-North Press.

- Dibblee, T.W. Jr., 1980. Preliminary Geologic Maps of Benicia Quadrangle, Contra Costa, and Solano Counties. U.S. Geological Survey Open File Report 80-400.
- The Earth Technology Corporation, 1990. Defense Environmental Restoration Program Formerly Used Defense Sites, Inventory Project, Benicia Arsenal, Solano County, CA., August.
- Headquarters Department of California, Office of the Inspector General. 1908. Inspection of Benicia Arsenal, Record Group 156, Box 121, National Archives-San Bruno, CA., 3 April.
- Plant, Phil. 1997. Personal correspondence from Phil Plant, President, Benicia Industries, Inc. September.
- Pollock, Mark. 1994. Personal correspondence from Mark S. Pollock, Attorney for Gordon Potter, to Nikki Holmes USACE, RE: Property of Gordon Potter. Attachments. 14 September.
- Sims, J.D., Fox K.F. Jr., Bartow, J.A., and Helley, E.J., 1973. Preliminary Geologic Map of Solano County and Parts of Napa, Contra Costa, Marin, and Yolo Counties, California. U.S. Geological Survey. Miscellaneous Field Studies Map MF-484. Reprinted 1980, 1985.
- U.S. Army of Corps of Engineers (CORPS). Revised 1997. Sacramento District, Corps of Engineers. Defense Environmental Restoration Program Formerly Used Defense Sites, Inventory Project Report (Supplemental), Benicia Arsenal, Solano County, CA., January.
- U.S. Army Corps of Engineers (CORPS). 1994a. St. Louis District, US Army Corps of Engineers. DERP for FUDS, Ordnance and Explosive Waste, Chemical Warfare Materials Archives Search Report Findings, Benicia Arsenal, Benicia Arsenal, Solano County, CA., March.
- U.S. Army Corps of Engineers (CORPS). 1994b. St. Louis District, US Army Corps of Engineers. DERP for FUDS, Ordnance and Explosive Waste, Chemical Warfare Materials Archives Search Report Conclusions and Recommendations, Benicia Arsenal, Benicia Arsenal, Solano County, CA., March.
- U. S. Engineer Office. 1944. Topography between Benicia Arsenal and Lake Herman Reservoir, Solano County, California. 19 January.
- U.S. Engineer Office. 1944. Explosives Holding Yard General Plan, Benicia Arsenal, California. 7 November.
- U.S. Engineer Office. 1944. Topography for Firing Range, Benicia Arsenal, California. 5 December.

War Department. 1935. Benicia Arsenal, California Boundary Map. October.

Wittles, Mike. 1997. Personal communication regarding the former shop buildings (55, 56, and 57) with Mike Wittles, resident of the present facility, dated 22 September.