Final Letter Workplan
Piezometer Installation and Sampling for the Site Hydrogeologic Model

FOR THE BENICIA ARSENAL

December 2001

Prepared for:
US Army Corps of Engineers
Sacramento District

Prepared by:
FORSGREN ASSOCIATES/
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A Joint Venture

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5 December 2001

Mr. Bruce Handel
U.S. Army Corps of Engineers
Sacramento District
1325 J Street
Sacramento, California 95814-2922

Subject: Final Letter Workplan – Piezometer Installation and Sampling for the Site Hydrogeologic Model at the Former Benicia Arsenal, Benicia, California

Dear Mr. Handel:

This Final Letter Workplan presents the methods and procedures to be used during installation and sampling of 20 piezometers at the former Benicia Arsenal (Arsenal) located in Benicia, California (Plate 1). The work described herein is part of the Benicia Arsenal Environmental Restoration Program, conducted by the United States Army Corps of Engineers (USACE) under the Formerly Used Defense Sites (FUDS) program. The purpose of this investigation is to fill data gaps that were identified in the draft Site Hydrogeologic Model (SHM) (Forsgren Associates/Brown and Caldwell [FA/BC], 2001a) and provide a baseline of information on water level and water chemistry for the former Arsenal.

The scope and objectives of the investigation are summarized below:

- Prepare a Letter Workplan and associated standard Site Safety and Health Plan (SSHP) which fully address the potential physical and chemical hazards associated with piezometer installation and sampling. Information for the Letter Workplan and SSHP shall be based on the SHM and a site visit.
- Obtain all utility clearances, well installation permits and encroachment permits (if necessary) from Solano County and/or the City of Benicia before proceeding with any drilling at any site.
- Coordinate with USACE to obtain all rights-of-entry for piezometer installation and monitoring.
- Use either local utility-locating service or non-intrusive geophysical techniques to identify underground utilities prior to drilling.
- Drill and install 20 piezometers (Plate 1).
- Survey the ground and top-of-casing elevations of each piezometer by a California-licensed surveyor.

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- Collect 11 monthly measurements of groundwater elevation from each piezometer.
- Sample the piezometers approximately one month after installation.
- Prepare a technical memorandum documenting results of the investigation.

The data collected from the piezometer installation will assess general hydrogeologic conditions in areas throughout the formal Arsenal and increase available information on the presence of groundwater, depth to groundwater, groundwater gradients, hydrostratigraphy, and groundwater chemistry. These data will be used to plan and focus future site investigations conducted at the formal Arsenal.

This Letter Workplan is organized into five sections. Section 1.0 presents background information and the purpose for this investigation. Procedures to implement this Letter Workplan are included in Section 2.0. The planned soil sampling and borehole drilling are described in Section 3.0, including details on installation, development, and survey of the piezometers. Section 4.0 describes piezometer gauging and sampling procedures. Details regarding the type, storage, and disposal of Investigation Derived Waste (IDW) are included in Section 5.0. Section 6.0 outlines the project schedule. References are presented in Section 7.0.

This Letter Workplan is to be used together with the following documents: Arsenal-Wide Investigation Workplan (FA/BC, 1999a), Arsenal-Wide Quality Assurance Project Plan (QAPP) (FA/BC, 2001b), Benicia Arsenal General Site Safety and Health Plan (FA/BC 1999b), and Health and Safety Program Manual (Brown and Caldwell [BC], 1998). The site-specific Safety and Health Plan is included as Appendix A to this Letter Workplan.

1.0 BACKGROUND AND PURPOSE

The following subsections summarize the information used to develop this Letter Workplan and select locations for piezometer installation. Background information has been compiled from the Records Research Report (RRR) (Jacobs Engineering, 1999), site investigations completed to date under the FUDS program, and data from numerous local and regional agencies and resources. These data were used to develop the rationale for various proposed piezometer locations and depths. Following the background section, a subsection is included that describes the purpose of this investigation.

1.1 Background and Rationale

Data from over 100 borings and wells, along with more than 50 previous site investigations, were used to assess the general hydrogeology of the former Arsenal area and to develop the rationale for locating 20 new piezometers. Numerous data resources were identified and reviewed (e.g., City of Benicia Public Works, Solano County Department of Public Health, Valero

Energy Corporation [Valero], USACE, California Department of Water Resources [DWR], and California Regional Water Quality Control Board, San Francisco Bay Region [RWQCB]). These data are summarized briefly below in terms of surface and bedrock topography, presence and depth to groundwater, surface water and groundwater flow, hydrostratigraphy, and water quality.

1.1.1 Surface and Bedrock Topography. In general, the topography of the former Arsenal is characterized by rolling hills underlain by Tertiary and Cretaceous siltstone and sandstone, and lowlands underlain by Quaternary alluvium, bay mud, and artificial fill. Previous investigations and data suggest that the depth to bedrock and the nature and thickness of overlying alluvium and fill are important factors governing the hydrogeology of the former Arsenal area. Several of the proposed borings will help determine the stratigraphy and hydrostratigraphy in selected lowland areas. There is also a scarcity of data in the highland areas, which may indicate a lack of water. Piezometers placed in the highland areas will provide stratigraphic and possibly hydrostratigraphic information that will supplement data already gathered.

1.1.2 Depth to Water. Depth to groundwater beneath the former Arsenal ranges from less than 5 feet below grade in low-lying areas, to greater than 40 feet below ground surface (bgs) in highland areas. Some areas of the Arsenal, especially where bedrock is near the surface, contain groundwater only during the rainy season. This generalization is based on data from focused investigations in selected areas (e.g., a spill at a warehouse, a former underground storage tank) and does not necessarily represent the hydrology of the former Arsenal on a macro scale. There are many areas within the boundaries of the former Arsenal where no information regarding stratigraphy, depth to groundwater, or groundwater direction is available. Piezometers placed in these areas will provide the detailed data needed to refine other available information.

1.1.3 Flow Direction. Surface water flow and the presence of shallow groundwater in the Benicia area appear to be controlled by topography. Groundwater flow direction is expected to be similar to that of surface water, which flows from areas of higher elevation to areas of lower elevation. Based on some previous data, the depth and topography of the bedrock surface may also influence groundwater flow.

In general, groundwater and surface water flow within the former Arsenal are directed into two main alluvial drainage channels: the Sulphur Springs Creek drainage, and the drainage south of the Clocktower that occupies most of Area I. The Sulphur Springs Creek drainage is located on the eastern and northern portions of the former Arsenal. The drainage south of the Clocktower flows toward Carquinez Strait. Piezometers placed within these main drainage areas will determine groundwater flow direction in relation to known surface water flow.

1.1.4 Tidal Fluctuations. Tidal influence on shallow groundwater at the former Arsenal has not been determined. Transducers will be installed on selected SHM piezometers near the Carquinez Strait to monitor groundwater interaction with the daily tides. Chemical analysis of groundwater samples from these piezometers may also assist in evaluating the potential influence of saline water.

1.1.5 Hydrostratigraphy. The subsurface beneath the former Arsenal has been divided into hydrostratigraphic units that are either relatively permeable or relatively non-permeable. The three relatively permeable units at the former Arsenal are believed to be:

1. Alluvium or colluvium
2. Weathered bedrock
3. Artificial fill

In addition, there are four relatively non-permeable units:

1. Cemented or compacted alluvium or colluvium
2. Competent bedrock
3. Imported fill consisting of clay, silt, or mud
4. Bay mud

Groundwater at the former Arsenal is likely to flow most easily in the permeable units. Groundwater may also be present within the non-permeable units, although it may flow less readily. The hydrologic interaction between these hydrostratigraphic units is unknown. The proposed piezometer borings will be continuously cored to provide detailed data on the nature of the subsurface. Several piezometers will also be installed in clusters to begin to assess groundwater movement between hydrostratigraphic units.

1.1.6 Groundwater Quality. Groundwater quality is also an integral part of the SHM model, in addition to groundwater elevations, gradients and stratigraphy. Data compiled to date includes sparse or infrequent water quality information (concentrations of general water quality parameters, as well as concentrations of potential contaminants). Most of the available groundwater chemistry data is related to past investigations of the presence or absence of contamination at specific locations. The groundwater quality data collected during implementation of this Letter Workplan will supplement the limited available data and will be focused on suspected groundwater basins within the former Arsenal.

1.1.7 Previous Investigations. The Valero petroleum refinery represents a large portion (350 acres) of the former Arsenal. Over 150 wells have been installed by Valero to date and the locations of these wells have influenced the proposed locations of piezometers presented in this Letter Workplan. Some data from Valero was used in the preliminary draft SHM because it covers a large area of the former Arsenal. In addition to Valero's data, other information is available from wells installed at the Tourtelot property. Because sufficient data are available from these areas, no piezometers are proposed on the Tourtelot property or in the area of the Valero Refinery. Existing data from selected Valero and Tourtelot wells will be used to further develop the SHM.

1.2 Purpose

This Letter Workplan describes site-specific activities necessary to drill and install 20 piezometers at the former Arsenal. The purpose of these activities is to supplement

hydrogeologic data collected to date and provide baseline information on water level and groundwater chemistry for the former Arsenal. Data from each piezometer will be used to answer some or all of the following questions:

- What is the stratigraphy?
- Does groundwater exist at the proposed location at the proposed depth?
- What is the depth to groundwater?
- What is the groundwater gradient in the water table unit?
- Are there seasonal fluctuations of the water table unit?
- What is the influence of tides on groundwater levels?
- What is the general quality of groundwater?

In addition to the above questions related to groundwater hydrology and soil stratigraphy, soil samples will be collected at each borehole location and submitted for metals analysis. The purpose of collecting this data is to supplement currently available information on ambient metals concentrations in soil.

2.0 PROCEDURES

The following items are addressed in this Letter Workplan:

- Summary of procedures for drilling 20 boreholes.
- Summary of procedures for collecting soil samples during drilling.
- Summary of procedures for installation and development of 20 piezometers, including methods for determining piezometer construction details.
- Summary of procedures for surveying piezometer elevations.
- Summary of procedures for piezometer gauging and sampling.

FA/BC will mobilize all personnel and equipment as required upon receiving written notice to proceed from USACE. The goal of mobilization is to ensure that the field team and subcontracted personnel are prepared and have the resources to perform all tasks described in this Letter Workplan.

3.0 PIEZOMETER INSTALLATION

Detailed information regarding the location, purpose, construction, and total planned depth of each boring is listed in Table 1. There are 3 types of piezometers to be constructed for this project – water table piezometers to monitor groundwater in the alluvium/fill, piezometers to

monitor a deeper water-bearing zone in the alluvium/fill, and piezometers to monitor groundwater in bedrock. The planned locations of each boring are shown on Plate 1. The piezometers were located to achieve the objectives of this Letter Workplan while minimizing impacts to current landowners.

3.1 Borehole Drilling and Soil Sample Collection

Boreholes will be drilled at the locations shown on Plate 1 by a licensed drilling subcontractor. A truck-mounted drilling rig equipped with nominal 8-inch-diameter hollow-stem augers will be used. Because of the planned use of the hollow-stem auger technique, penetration into competent bedrock may be limited. All equipment will be steam-cleaned prior to drilling.

Proposed piezometer locations will be on paved material wherever possible for ease of access during all seasons. Piezometers will not be installed in active roads or streets that may require special permits or access. If the proposed location for a piezometer is inaccessible due to property right-of-entry issues, the piezometer location will be moved.

Several precautions will be taken to ensure that the locations of underground utilities are determined prior to drilling the boreholes. Underground Services Alert (1-800-642-2444) will be contacted at least two working days prior to drilling. A contractor, specializing in underground utility clearance, will locate all buried utilities within 10 feet of the borehole. Landowners will be asked to supply FA/BC with available information regarding the locations of underground utilities within their properties. Finally, the first 5 feet of each boring will be hand augered prior to the use of drilling equipment to verify the absence of buried utilities. Drilling will be performed in accordance with Standard Operating Procedure (SOP) No. 27 (FA/BC, 2001b).

During drilling, soil samples will be collected continuously for purposes of lithologic identification. The samples will be examined in the field and classified according to the Unified Soil Classification System. Two discrete-depth soil samples will be collected from each boring. One sample will be collected by hand at the surface (in the first 6 inches below any paving materials). The second sample will target a different lighology of significance (greater than 2 feet thick) between the surface and 10 feet bgs or between the surface and saturated soil, whichever is encountered first. If the lithology does not change significantly or saturated materials are not encountered above 10 feet bgs, then the second sample will be collected at 8 feet bgs. The two discrete-depth soil samples will be analyzed for metals in accordance with the QAPP (the list of metals is included in the footnotes of Table 2).

3.2 Piezometer Installation

Each borehole will be completed as a piezometer with 2-inch diameter, schedule 40 PVC screen and casing. Typical construction details will include 10 feet of screen with approximately 7 feet of screen penetrating the saturated zone. The estimated depth to water at each proposed borehole location is listed in Table 1. Depth to water is unknown at some of the piezometer locations. As a result, the location of the screen will be based solely on field evidence. For

other locations, data gathered from the draft SHM indicates the approximate location of water. Therefore, most of the screen depth and total depth of these borings can be estimated (Table 2). Piezometer construction will be performed in accordance with SOP No. 21 (FA/BC, 2001b).

Piezometer design may be modified in the field depending on conditions encountered during drilling. For example, if a shallow boring penetrates a clay unit greater than five feet thick in the saturated zone, then drilling will be stopped and the screen will be set above the clay unit. If the clay zone or bedrock are encountered at a shallow depth (about 15 feet bgs or shallower) that would prohibit proper construction of the piezometer with 10 feet of screen, then the screen length will be shortened. Each piezometer will be constructed to adequately meet project objectives for its location and to comply with local and state requirements for well construction.

If groundwater is not encountered during drilling, then the piezometer will be installed as a monitoring point to measure water that may enter the well seasonally. The screen will be installed above an impermeable unit (>5 feet thick) or at the top of the bedrock surface, whichever is encountered first. If the borehole meets refusal at a depth shallower than approximately 15 feet, then the screen length will be shortened to provide a piezometer that monitors seasonal water and complies with local and state requirements for well construction.

Most of the piezometers will be located on paved surfaces. Therefore, the surface completion of each monitoring point will include flush-mounted traffic rated boxes set in concrete. Piezometers completed in other areas will be constructed with above ground monuments.

3.3 Piezometer Development

Each piezometer will be developed by surging, bailing, or pumping until clean, relatively sediment-free water is produced. The time required for development is unpredictable and will depend upon field conditions. Development of each piezometer will be performed in accordance with SOP No. 15 (FA/BC, 2001b). Field readings during development will be collected for pH, temperature and electrical conductivity, in accordance to SOP Nos. 22, 23, and 24, respectively. Dry piezometers will be considered for development only when sufficient water enters the borehole (5 feet of water).

3.4 Piezometer Survey

The top of casing (TOC) and ground surface elevations will be surveyed for vertical and horizontal locations by a licensed surveyor, and all depths to water will be measured in relation to the surveyed mark on the TOC. Horizontal positions will be measured to the nearest 0.10 foot. Vertical positions will be measured to the nearest 0.01 foot. Survey data will be located on the Benicia Arsenal Base Map and then transferred into the Benicia Arsenal GIS system for incorporation into the project database.

4.0 DEPTH TO GROUNDWATER MEASUREMENT AND SAMPLING

This section describes measurement of depth to groundwater and sampling of the piezometers.

4.1 Depth to Water Measurements

Each piezometer will be gauged every month for a period of 11 months. Field measurements of water levels and decontamination of equipment will be in accordance with SOP Nos. 25 and 11 (FA/BC, 2001), respectively. In addition, a transducer will be placed in three piezometers (PZ4, PZ11 and PZ12) to collect water level data for a period of 48 hours. Transducer data will be used to assess water level fluctuations due to tidal effects.

4.2 Groundwater Sampling

Once installed, each piezometer will be purged and sampled within one month of development (one sampling event only at the time the first water level measurement is made). Each piezometer will be sampled for the constituents listed in Table 2. Groundwater sampling will be performed in accordance with SOP Nos. 17, 22, 23, and 24 (FA/BC, 2001b).

5.0 INVESTIGATION DERIVED WASTE

IDW generated during implementation of this Letter Workplan will include soil from drilling, purge water, decontamination rinsate from drilling equipment, disposable personal protective equipment (PPE) and ground covers. Soil and groundwater may be containerized into roll-off bins (20 cubic yards capacity) and a 6,500-gallon poly tank, respectively. The soil and groundwater containers will be placed at a temporary staging area (location not yet selected pending USACE negotiations with property owners). This area will be a secure site. Heavy equipment will be decontaminated at each borehole location or at the staging area, whichever is most convenient to the subcontractor and the landowner. Decontamination will be in accordance with procedures described in the QAPP (FA/BC, 2001). Decontamination of sampling equipment used during groundwater purging will be staged at the FA/BC Benicia Arsenal Field Office at 942 Tyler Street.

Excess disposable wastes derived from sampling, such as PPE, gloves and bailers, will be managed by BFI, the garbage disposal service provider for the area.

Soil and groundwater samples will be collected from each container for the purpose of IDW characterization and identification of potential disposal facilities. Additional analytical work may be required based on specific requirements of the selected disposal facility. If visual and instrument readings with a organic vapor analyzer indicate contamination, then the IDW from drilling and sampling activities will be segregated, if possible. For example, wastes with

potential solvent impacts will be segregated from potential fuel-only impacts. However, it should be noted that the piezometer locations are planned in areas of no known soil or groundwater contamination.

6.0 PROJECT SCHEDULE

Field activities described in this Letter Workplan will begin approximately three weeks after this document is approved by USACE. Once field work begins, the investigation will be conducted sequentially so that project personnel can refine the scope of work as new data are collected. Non-invasive activities will be conducted before invasive activities.

The investigation will begin with acquisition of the right-of-entry for each property. Following property owner approval, each piezometer location will be cleared for subsurface utilities or obstructions. Invasive activities will consist of drilling and installing the piezometers. The sequence of piezometer drilling may be based on landowner restrictions (time and date). Otherwise, the sequence of piezometer drilling and installation will proceed in an orderly fashion from one end of the former Arsenal to the other. After completion, the piezometers will be developed and surveyed. Within one month of development, the piezometers will be gauged and sampled one time for analysis of chemical parameters. Depth to water in the piezometers will then be measured every month for the succeeding 11 months.

7.0 REFERENCES

FA/BC. 2001a. Arsenal-Wide Quality Assurance Project Plan. Prepared for the USACE. Revision 2, Draft.

FA/BC. 2001b. Draft Site Hydrogeologic Model. Prepared for the USACE. July 11.

FA/BC. 1999a. Arsenal-Wide Investigation Workplan. Prepared for the USACE. February.

FA/BC. 1999b. Benicia Arsenal General Site Safety and Health Plan. Prepared for the USACE. January.

FA/BC. 1998. Corporate Health and Safety Program Manual. Prepared for the USACE. August.

If you have any questions, please contact me at (916) 444-0123.

Sincerely,

FORSGREN ASSOCIATES/BROWN AND CALDWELL

David Zuber, R.G. #5933
Task Manager

DZ:jw

cc: Chris Parent, DTSC
Gary Riley, RWQCB
Mike Rees, Solano County

Table 1
Rationale for SHM Piezometer Locations

Well ID	General Location	Purpose							Estimated Boring Depth (feet bgs)	Estimated Screen Interval* (feet bgs)	Estimated Depth to Bedrock (feet)	Estimated Depth to Water (feet)
		Depth to Water	Horizontal Gradient	Vertical Gradient (Alluvium/fill)	Vertical Gradient (Bedrock)	Tidal Influence	General Water Quality	Background Soil Metals Concentrations				
PZ-1 (water table)	Area I, west	✓	✓				✓	✓	15	Across water table	25	5 to 10
PZ-2 (water table)	Area I, west	✓	✓				✓	✓	15	Across water table	25	5 to 10
PZ-3 (bedrock)	Area I, west	✓			✓		✓	✓	<40	Base of bedrock	25	5 to 10
PZ-4 (water table)	Area I, central	✓	✓			✓	✓	✓	<20	Across water table	25	5 to 10
PZ-5 (water table)	Area I, central	✓	✓				✓	✓	<20	Across water table	25	5 to 10
PZ-6 (deep)	Area I, central	✓		✓			✓	✓	<20	Middle or base of alluvium/fill	25	?
PZ-7 (water table)	Area W, northern	✓	✓				✓	✓	<30	Across water table	50 to 70	0 to 20
PZ-8 (water table)	Area W, northern	✓	✓				✓	✓	<30	Across water table	50 to 70	0 to 20
PZ-9 (water table)	Area W, central	✓	✓				✓	✓	<30	Across water table	50 to 70	0 to 20
PZ-10 (deep)	Area W, central	✓		✓			✓	✓	<30	Middle or base of alluvium/fill	50 to 70	0 to 20
PZ-11 (water table)	Area W, western side of Sulphur Springs Creek	✓	✓			✓	✓	✓	<20	Across water table	70 to 90	0 to 10
PZ-12 (water table)	Area W, eastern side of Sulphur Springs Creek	✓	✓			✓	✓	✓	<60	Across water table	50 to 70	0 to 10
PZ-13 (water table)	Area R, central	✓	✓				✓	✓	<30	Across water table	<30	10 to 20

Table 1
Rationale for SHM Piezometer Locations

Well ID	General Location	Purpose							Estimated Boring Depth (feet bgs)	Estimated Screen Interval* (feet bgs)	Estimated Depth to Bedrock (feet)	Estimated Depth to Water (feet)
		Depth to Water	Horizontal Gradient	Vertical Gradient (Alluvium/fill)	Vertical Gradient (Bedrock)	Tidal Influence	General Water Quality	Background Soil Metals Concentrations				
PZ-14 (water table)	Area R, southern	✓	✓				✓	✓	<20	Across water table	<30	10 to 20
PZ-15 (deep)	Area R, southern	✓		✓			✓	✓	<20	Middle or base of alluvium/fill	<30	10 to 20
PZ-16 (bedrock)	Area R, southern	✓			✓		✓	✓	<20	Base of bedrock	<30	10 to 20
PZ-17 (water table)	Area S, west of Valero	✓	✓				✓	✓	40 to 50	Across water table	?	?
PZ-18 (water table)	Area R, north-central	✓	✓				✓	✓	<30	Across water table	<30	10 to 20
PZ-19 (water table)	Area M, Camel Barn Area	✓	✓				✓	✓	<30	Across water table	10 to 30	20 to 30
PZ-20 (water table)	Area M, 500 feet northeast of Pine Lake	✓	✓				✓	✓	<60	Across water table	?	>30

* Piezometer screens are 10 foot long and when screened across the water table should be about 3 feet above the water table and about 7 feet below the surface of the water table.

Table 2
Summary of Groundwater Analytical and QA/QC Specifications

	Matrix	Soil***	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW
	Container	Stainless steel sleeve	VOA	VOA	1 liter amber	1 liter poly	1 liter poly	Field Measurements				
	Preservative	NP	HCL	HCL	NP	HNO_3/F	NP/F	NP	NP	NP	NP	NP
	Lab	EMAX	EMAX	EMAX	EMAX	EMAX	EMAX	NA	NA	NA	NA	NA
Sample location	Sample type	PML*	VOCs (8260B)	TPH volatile (8015B)	TPH extractable (8015B)	PML*/ cations**	Anions (300.0) TDS (160.3)	Dissolved oxygen	Temp.	Conductivity	Redox	pH
PZ-1	R	2	3	3	2	1	1	✓	✓	✓	✓	✓
PZ-2	R	2	3	3	2	1	1	✓	✓	✓	✓	✓
PZ-3	R	2	3	3	2	1	1	✓	✓	✓	✓	✓
PZ-4	R	2	3	3	2	1	1	✓	✓	✓	✓	✓
PZ-5	R	2	3	3	2	1	1	✓	✓	✓	✓	✓
PZ-6	R	2	3	3	2	1	1	✓	✓	✓	✓	✓
PZ-7	R	2	3	3	2	1	1	✓	✓	✓	✓	✓
PZ-8	R	2	3	3	2	1	1	✓	✓	✓	✓	✓
PZ-9	R	2	3	3	2	1	1	✓	✓	✓	✓	✓
PZ-10	R	2	3	3	2	1	1	✓	✓	✓	✓	✓
PZ-11	R	2	3	3	2	1	1	✓	✓	✓	✓	✓
PZ-12	R	2	3	3	2	1	1	✓	✓	✓	✓	✓
PZ-13	R	2	3	3	2	1	1	✓	✓	✓	✓	✓
PZ-14	R	2	3	3	2	1	1	✓	✓	✓	✓	✓
PZ-15	R	2	3	3	2	1	1	✓	✓	✓	✓	✓
PZ-16	R	2	3	3	2	1	1	✓	✓	✓	✓	✓
PZ-17	R	2	3	3	2	1	1	✓	✓	✓	✓	✓
PZ-18	R	2	3	3	2	1	1	✓	✓	✓	✓	✓
PZ-19	R	2	3	3	2	1	1	✓	✓	✓	✓	✓
PZ-20	R	2	3	3	2	1	1	✓	✓	✓	✓	✓
Total Containers		**40**	**60**	**60**	**40**	**20**	**20**					
Total equipment rinsate blank samples	EB	2	0	0	0	0	0					
Total filter blank samples	FB	0	0	0	0	1	0					
Total ambient blank samples	AB	0	0	0	0	0	0					
Total trip blank samples	TB	0	4	4	0	0	0					
Total regular samples	R	40	20	20	20	20	20					

Table 2
Summary of Groundwater Analytical and QA/QC Specifications (continued)

	Matrix	Soil***	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW
	Container	Stainless steel sleeve	VOA	VOA	1 liter amber	1 liter poly	1 liter poly	Field Measurements				
	Preservative	NP	HCL	HCL	NP	HNO_3/F	NP/F	NP	NP	NP	NP	NP
	Lab	EMAX	EMAX	EMAX	EMAX	EMAX	EMAX	NA	NA	NA	NA	NA
Sample location	Sample type	PML*	VOCs (8260B)	TPH volatile (8260B)	TPH extractable (8015B)	PML*/ cations**	Anions (300.0) TDS (160.3)	Dissolved oxygen	Temp.	Conductivity	Redox	pH
Total field QC duplicate samples	D	2	1	1	1	1	1					
Total lab QC sample pairs	MS/MSD	4	2	2	2	2	2					
Total split lab QA samples	S	0	0	0	0	0	0					
Total analyses		**48**	**27**	**27**	**23**	**23**	**23**					

Matrix: GW = groundwater
Preservative: NP = not preserved; HCL = hydrochloric acid; HNO_3 = nitric acid; F = filtered (0.45 micron)

Analyses: TDS = total dissolved solids; TPH = total petroleum hydrocarbons; VOCs = volatile organic compounds

Sample Type: D = field duplicate; EB = equipment rinsate blank; AB = ambient blank; FB = filter blank sample; MS/MSD =matrix spike/ matrix spike duplicate; R = regular sample; S = split sample; TB = trip blank sample; QA = quality assurance; QC = quality control

Notes:

- Field QC samples, including soil homogenization equipment rinsate blanks, and field duplicates, will be taken at the minimum frequency of 5 percent as per the March 14, 2001 Scope of Work.
- No equipment rinsate blanks are planned for water samples based on the assumption that samples will be collected with disposable bailers.
- Procedures to be used for proper collection, characterization, storage, containerization, transport and disposal of the Arsenal's IDW will be in accordance with the IDW Plan in the Arsenal-Wide Investigation Workplan.
- Sampling points, locations, and depths to be determined in the field.
- The location of QC samples will be determined based on field conditions.

* Project metals list (PML) consists of antimony (soil), barium, beryllium, total chromium, cobalt, copper, manganese, molybdenum, nickel, silver, tin, vanadium and zinc by 6010B, cadmium and lead by 6010B ICP trace, antimony by 7041 (water), arsenic by 7060A, selenium by 7740, thallium by 7841 and mercury by 7471A (soil)/7470 (water).
** Cations include calcium, magnesium, sodium and potassium.
*** One sample will be collected by hand at the surface (0-0.5 feet below paving materials), and the second discrete-depth sample will be collected at depth between 5 feet bgs and 10 feet bgs.

AVAILABLE FOR VIEWING
IN THE CITY ATTORNEY'S OFFICE.

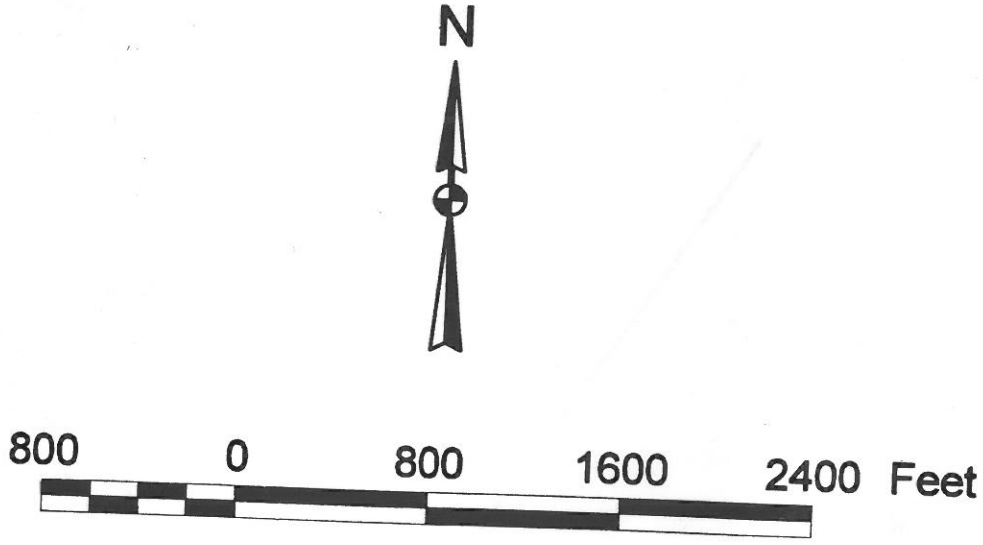


Plate 1
Proposed Locations of SHM Piezometers

APPENDIX A

SITE SAFETY AND HEALTH PLAN

SITE SAFETY AND HEALTH PLAN
SITE HYDROGEOLOGIC MODEL
BENICIA ARSENAL

Prepared by: _____ Date: 11/21/01
Ms. Wendy Linck
Site Safety Officer

Reviewed/Approved by: Anne Baptiste Date: November 21, 2001
Ms. Anne Baptiste, CIH
Health and Safety Director

Reviewed/Approved by: _____ Date: 11/21/01
Ms. Wendy Linck
Site Safety Officer

Effective Dates: 11/21/01 to 11/21/02

FORSGREN ASSOCIATES/BROWN AND CALDWELL

SITE SAFETY AND HEALTH PLAN

PREFACE

This SSHP has been prepared for the installation and sampling of piezometers at the former Benicia Arsenal. This SSHP is supplemented by the FA/BC Health and Safety Program Manual and the Benicia Arsenal General SSHP (General SSHP) for the Arsenal FUDS, which will be referenced throughout this site specific SSHP. The FA/BC Health and Safety Program Manual will be referenced by using the appropriate 100 series number followed by the page number. For example, (203.5; p.2-13) represents the 200 series, Section 203.5, page 2-13.

This SSHP presents detailed procedures and limits to address potential chemical, physical and biological hazards in the areas of investigation.

This investigation of potential contamination and potential waste characterization at each investigation location will be conducted according to procedures and requirements of this site specific SSHP.

PROJECT SUMMARY

The purpose of this investigation is to install 20 piezometers at the former Benicia Arsenal. In addition to the drilling and construction of these piezometers, the wells will be gauged for water levels and sampled for water quality parameters. The information from the installation and sampling of these piezometers will be used to evaluate the hydrogeology of the former Arsenal.

A detailed description of field activities is presented in the Workplan for the Site Hydrogeologic Model (SHM).

KEY PERSONNEL

The key personnel for this site specific SSHP are:

- Program Manager: Mr. Jay Lucas
- Health and Safety Director: Ms. Anne Baptiste, Certified Industrial Hygienist
- Project Manager: Ms. Patti De La O
- Task Order Manager: Mr. Dave Zuber
- Site Safety Officers and Field Personnel: Ms. Wendy Linck and Mr. Brad Ziegler

Descriptions of responsibilities for each key personnel and subcontractor are included in the General SSHP.

Project Contacts

A reference list of project contacts is located in the General SSHP.

HAZARD ANALYSIS

The site specific potential hazards have been identified as chemical hazards, physical hazards, and biological hazards. Each potential hazard, the potential for exposure, and recommended control for all the sites are presented in Table A-1.

Chemical Hazards

Soil sampling will be conducted at each location.

Drilling and well installation are the invasive techniques proposed for this project. Locations of wells will be in areas where no documented sources of chemical related hazards are expected.

The potential of unexploded ordnance/ordnance and explosives (UXO/OE) has been identified at the former Arsenal. Piezometer locations will NOT be in areas where there is ANY potential of UXO/OE.

Based on the industrial nature of the former Arsenal, typical chemical-related health hazards would likely be petroleum, oils, and lubricants (specifically benzene and total petroleum hydrocarbon [TPH]), polyaromatic hydrocarbons (PAHs), metal dusts, and solvents (specifically trichloroethane [TCE]) that may be found in soil or groundwater.

The primary routes for exposure for benzene, TCE, and solvents would be inhalation and skin contact. Worker exposures to metal dusts are commonly a result of inhalation. The primary route of work exposure to PAHs is skin contact. A more detailed discussion of each of the chemical compounds or groups is presented below. Potential chemical hazards, exposure limits and chemical characteristics for key chemicals that may be present at the site are listed in Table A-2.

Benzene. Benzene is regulated by OSHA as an occupational carcinogen and has been associated with leukemia. Acute health effects include irritation to the eyes, nose and respiratory system, headache, giddiness, nausea and anorexia. Benzene exposure can also lead to disturbances in gait, dermatitis and bone marrow depression.

The other BTEX compounds (toluene, ethylbenzene and xylenes) may cause irritation to the eyes, nose and respiratory system, and dermatitis. Acute exposure can lead to central nervous system effects including headache, dizziness, confusion and irritability. Exposure to toluene may also result in pupil dilatation, nervousness, reproductive toxicity and insomnia. Elevated concentrations of xylene isomers may lead to corneal damage, and gastrointestinal symptoms including abdominal pain, nausea and vomiting.

Total Petroleum Hydrocarbons. TPH refers to heavy hydrocarbons that may present a fire hazard in extreme circumstances, such as the presence of flame, excessive heat or strong oxidizers. An exposure limit for TPH has not been established due to its varied chemical composition. Presently, there are no known chronic health hazards associated with TPH.

Oils. Oils are not considered flammable, only combustible. Because of their low vapor pressure, they do not typically constitute an inhalation hazard unless working conditions include extremely hot temperatures or create excessive airborne oil-contaminated dust. These conditions are not anticipated.

Oxygenated Solvents. Oxygenated solvents are flammable liquids such as acetone and methyl ethyl ketone. In high concentrations, inhalation of these materials can cause anesthesia with dizziness being the usual symptom. They do not display serious chronic effects (acetone is found in the human body). These materials are very flammable. They cannot be readily detected by a photoionization detector (PID), but are easily detected by flame ionization detectors (FID). These materials have considerable odor and can be readily recognized by smell at levels well below those requiring protection.

PAHs. PAHs are common components of diesel fuel, fuel oil, and other oils and lubricants. Routes of entry include inhalation, ingestion, and skin contact. PAHs are not typically very volatile but many are carcinogens. Therefore, unless they are known to be in significant concentrations, such as when strong odors are evident or dust clouds are present, the primary method of protection is by avoiding skin contact and thorough decontamination.

Halocarbon Solvents. Halocarbon solvents are non-flammable liquids such as methylene chloride, TCE, tetrachloride, and chloroform. In high concentration, inhalation of these materials can cause acute liver and kidney damage. In lesser concentrations, they may cause acute effects such as dizziness or sleepiness related to their anaesthetic ability. The main chronic effect of these materials is their potential to cause liver disease. They are potential carcinogens as demonstrated by animal studies. Because of the potential of these materials to cause liver disease and cancer, exposure should be minimized. These materials are volatile and will evaporate if left in the open air. They can be detected by PIDs and/or FIDs.

Arsenic. Arsenic has toxic health effects, which include dermatitis, gastrointestinal upset, peripheral neuritis, irritation to the respiratory system, and discoloration of the skin. Arsenic is associated with skin cancer and lung cancer due to chronic exposure. Arsenic is an occupational carcinogen, and is regulated by OSHA through a comprehensive occupational health standard. The current PEL for arsenic is 0.01 milligrams per cubic meter (mg/m^3) as an 8-hour time weighted average (TWA) airborne dust concentration. The regulatory action level is 0.005 mg/m^3 TWA dust concentration. No employee may be exposed to any skin or eye contact with arsenic trichloride or to skin or eye contact likely to cause skin or eye irritation. Significant arsenic contamination is not anticipated on this site.

Chromium. Chromium has toxic health effects that can range from allergic skin reactions to mild, and eventually severe, respiratory system irritation. Chromium may exist in one of three valence states (+2, +3, or +6). Toxic health effects are primarily associated with Cr+6 (hexavalent chromium) exposure. CR+6 is a suspect carcinogen. Symptoms of acute exposure include coughing, wheezing, painful deep inhalation, and fever. Pulmonary edema may persist after other symptoms subside. Other effects include dermatitis, ulceration of the skin, conjunctivitis and asthma. Chronic exposure may be associated with lung cancer. The current exposure limit for chromium as Cr+6 is 0.05 mg/m^3 as an 8-hour TWA airborne dust concentration.

Inorganic Lead. To present a health hazard, lead must be in such a form as to gain entrance into the body or tissue in measurable quantities. The primary mode of entry of concern is inhalation of lead dust. Ingestion is a secondary concern if poor personal hygiene is practiced. Lead is a cumulative poison. It is stored in the body and acts as a cellular poison to all organ systems before symptoms and disability are evident. Lead poisoning creates a red cell anemia and damages organs and tissues of the body such as kidneys, liver, blood vessels, nervous system and reproductive organs. Chemical and physical properties may vary depending upon the specific lead compound.

Lead is considered a carcinogen and reproductive toxin and has an airborne PEL of 0.05 mg/m^3. The blood lead action level for adults is equal to or less than 30 milligrams per deciliters (mg/dl) of blood. There is no safe level of lead exposure for children. Therefore, decontamination of adults and their clothing is a primary concern.

Particulates Not Otherwise Regulated. PNOC is a term given to a variety of dusts that may not cause fibrosis or systemic effects. At high concentrations, otherwise nontoxic particulates have been associated with the occasionally fatal condition know as alveolar proteinosis. High concentration of finely divided dusts and powders can also be explosive. At lower concentrations, the dust can inhibit the clearance of dust from the lung by decreasing the mobility of the alveolar macrophages. The airborne PEL is 10 mg/m^3 for PNOC total dust and

5.0 mg/m^3 for dust small enough to enter the lower respiratory tract.

Fire Safety. Fire is a potential hazard due to equipment malfunction or combustible gas levels. Before beginning any work activities, locate fire extinguishers and other emergency equipment. When work is conducted in the field, a fire extinguisher will be carried with the sampling vehicle. Do not block the path to this emergency equipment with work materials. Be familiar with the type of extinguishers and what kind of fire they are designated to put out. All job locations must have applicable fire extinguishers.

- Type A extinguishers put out ordinary combustibles such as paper, wood and some plastics.
- Type B extinguishers put out flammable liquids like oil and gasoline.
- Type C extinguishers put out electrical fires.
- Type ABC extinguishers put out all three types of fires.

In addition to potential fire hazard due to equipment malfunction, fire hazard during field operations is a potential for operating vehicles and equipment in and around dry grass, weeds, or other plant material. To reduce potential for vegetative fires, weeds, grass and dry brush will be cleared from work-areas prior to operating equipment. Vehicles will be operated on paved and dirt roads wherever possible. When off-road travel is necessary, areas with tall weeds or grasses will be avoided.

TRAINING REQUIREMENTS

There are no special training requirements anticipated for this site. General training requirements for all FA/BC staff working on site are described in the General SSHP.

PERSONAL PROTECTIVE EQUIPMENT

The minimum required level of personal protection for all the sites at all times is modified Level D. Level D includes safety boots/shoes, safety glasses, hard hat, and gloves for handling soil and debris. These items are also listed on Table A-3, Field Equipment. Based on the environmental monitoring plan, upgrade to Level C will be conducted to protect personnel if conditions warrant. Descriptions of other levels of PPE are described in the FA/BC Health and Safety Program Manual (301 and 302; p. 1-24) and the General SSHP.

ENVIRONMENTAL MONITORING PLAN

The following is the anticipated environmental monitoring plan for SHM field activities. Equipment anticipated for environmental monitoring is listed on Table A-3. Environmental monitoring will be in accordance with the Organic Vapor Response criteria outlined in Table A-4. Generally, only invasive activities will include monitoring of air quality in and around the work area and heat or cold stress. If conditions warrant the use of respirators in accordance with Table A-4 the appropriate Cartridge End of Service Life calculations for TCE and TPH (in the form of octane) is provided as Attachment F to this Appendix.

MEDICAL SURVEILLANCE REQUIREMENTS

There are no special medical surveillance requirements anticipated for SHM field activities. The General SSHP describes the general medical surveillance requirements.

SITE CONTROL MEASURES

A typical work zone is shown on Figure A-1. The actual zone locations are subject to change based on work activities, site

access, and wind direction. Equipment necessary for site control measures is listed on Table A-3. Further details regarding site control measures can be found in the FA/BC Health and Safety Program Manual (406; p.25-28).

DECONTAMINATION

Decontamination will take place within the work zones. A sample decontamination set-up can be found in the FA/BC Health and Safety Program Manual (405; p.23). There are no special emergency decontamination procedures anticipated for this project. General decontamination equipment necessary for this project is listed on Table A-3.

EMERGENCY PROCEDURES

The nearest medical assistance center is **Kaiser Permanente Hospital** located at **975 Sereno Dr., Vallejo, CA.**, telephone number: **(707) 651-1000**. Directions from all sites to the nearest hospital are presented below.

*Directions from **I-780** to **Kaiser Permanente Hospital:***

- Travel on **I-780 West** for approximately 5.4 miles.
- Take **I-80 East** towards Sacramento for ≈ 2 miles (heading north).
- Take **Redwood Street** exit.
- Travel west on **Redwood Street** for ≈ 1 mile.
- Right onto **Broadway** heading north for ≈ 0.4 miles.
- Right onto **Sereno Drive** heading east for ≈ 0.2 miles.
- **Hospital** is located on the right at **975 Sereno Drive.**

Total travel time from the project area to Kaiser Permanente hospital is approximately 20 minutes, and the total distance is approximately 10 miles. The nearest telephone is located in the work zone. If a cell phone is to be used for emergency purposes, it must be checked upon arrival to the site to verify that reception to the area is available. The emergency telephone numbers to be used to call for assistance are listed in the section on Key Personnel and Responsibilities in the FA/BC Health and Safety Program Manual (Forward; p. F-5). **In the event of a medical emergency cell phones must dial (707) 745-3411 or 3412 for the Benicia Police Department. FA/BC will post the number on or near each cell phone.**

DOCUMENTATION

Proper completion of standard Attachments A through E is required health and safety documentation for this site. Attachments A through E are located at the end of this SSHP. The procedures and frequency in which each Attachment must be completed is described in Table A-5.

REFERENCES

Brown and Caldwell. 1999. Benicia Arsenal General SSHP. Prepared for U.S. Army Corps of Engineers, Sacramento, California. January.

Forsgren Associates/Brown and Caldwell. 1998. Health and Safety Program Manual. Prepared for U.S. Army Corps of Engineers, Sacramento, California. August.

U.S. Army Corps of Engineers. 1996. Interim Guidance (ETL 385-1-2). Generic Scope of Work for Ordnance Avoidance Operations. Draft. August.

Table A-1
Potential Hazards and Recommended Controls for SHM Investigation Activities

Potential hazards	Recommended controls
Chemical exposure	No chemical exposure is expected for this investigation. However, based on the heavy industrial activity of the former Arsenal, chemical exposure can not be ruled out. The minimum level of proper PPE during activities is Level D. This level is considered adequate to protect individuals from exposure to petroleum hydrocarbon constituents. Air monitoring will be performed with an OVM to monitor the air quality in and around the work zone during invasive activities.
Back injury	No sampling, using heavy equipment, or hand digging is anticipated for this project that would require excessive lifting. In general, high manual labor causes high stress forces on the back. Use proper lifting techniques, proper tools, vacuum bailers, two person rotations and adequate back support during all field tasks. Proper lifting techniques may also vary with task. Therefore, these techniques will also be addressed in the daily site safety briefings. Refer to the Ergonomics Program of the FA/BC Health and Safety Program Manual (103; p. 7-9).
Noise	Heavy equipment is anticipated for this project (i.e., drilling rig), such that hearing protection may be necessary. Refer to the Noise/Hearing Conservation section in the FA/BC Health and Safety Program Manual (210; p. 44-45). In general, use hearing protection whenever the noise levels are such that conversation is impaired without raising the voice level.
Drum handling	Drum handling is not anticipated for this project. In general, drums may be used to store soil or water as a result of drilling or excavation operations. Utilize appropriate drum handling equipment (dollies, lift gates, etc.) and avoid manual lifting of filled or partially filled drums.
Migration of contamination	A work zone will be delineated before start of invasive work activities. An area within the work zone will be established for decontamination prior to exiting the site. The decontamination area must be away from the actual working area. Figure A-1 is provided in this SSHP to show the typical area of the work zone for each site.
Exposure to potentially contaminated soil/water	Level D PPE is the minimum level required for this project. All personnel will don the appropriate level of PPE upon entering the work area and then use proper decontamination procedures before exiting the work zone. Workers will exit the work zone before eating.
Slips, trips and falls	The proper footwear for this project will include steel-toed boots upon entering the work zone. Wear proper footwear and anticipate footing hazards (i.e., steep slopes, potholes, and uneven surfaces).
Utilities/electrical	Have all utilities (underground and overhead) located and documented prior to the initiation drilling or excavation activities. Maintain a minimum distance of 20 feet clearance between any energized line of 37 kv or less, and any part of a drill rig, boom, or other piece of equipment at all times. If voltage is between 37 kv and 55 kv, then maintain a minimum distance of 27 feet. If voltage is between 55 kv and 100 kv, then maintain a minimum distance of 42 feet (8 CCR Division 1, Chapter 4, Subchapter 5, Group 2, Article 37, Section 2946.

Table A-1 (continued)
Potential Hazards and Recommended Controls for SHM Investigation Activities

Potential Hazards	Recommended Controls
Heavy equipment and backhoes	Drilling and excavating equipment may be necessary for this project. Personnel communication and wearing proper PPE during work activities is essential for the protection of workers at the site. See the Trenching, Drilling and Heavy Equipment SOPs for specifics. The competent person for trenching will be the on-site SSO.
Unexploded ordnance (UXO/OE)	There are no UXO/OE hazards anticipated for this project.
Biological hazards	The project is in an area where animals, insects, or animal droppings may be present. Level D PPE will be donned for this project, unless conditions indicate an infestation of insects, mold, or animal droppings. Significant amounts of which would cause work stoppage. Be aware of spiders inside well boxes or insect swarms on buildings or in trees. The area around all the sites is open and these types of biological hazards are not anticipated.
Radiological hazards	There are no radiological hazards anticipated for this project.

Table A-2

Chemical Exposure Limits and Characteristics Controls for Typical Industrial Chemicals

Constituent	IP[a]	OVA[b] relative response percent	TLV[c] 8-hour TWA	PEL[d] 8-hour TWA	IDLH[e] level	Flammable range percent	Odor threshold, ppm	Notes[f]	Potential symptoms of exposure[g]
CHEMICALS									
Benzene	9.24	185	0.5 ppm	1 ppm	500 ppm	1.3-7.9	4.68	Ca, 65	irritation to eyes, nose, respiratory system, giddiness, headache, nausea, staggered gait, fatigue, anorexia, lassitude, dermatitis, bone marrow, depression
Ethylbenzene	8.76	111	100 ppm	100 ppm	800 ppm	1.0-6.7	0.25-200		irritation to eyes, muscle membranes, headache, dermatitis, narcosis, coma
PAHs	NA	NA	50 mg/m^3	0.2 mg/m^3 (coal tar pitch)	500 ppm	0.9%-5.9%	NA		Irritation to eyes, skin, respiratory system. Carcinogen: lung, skin
Stoddard solvent	NA	approx 40	100 ppm	500 ppm	20,000 mg/m^3	unknown			irritation to eyes, nose, throat, dizziness, dermatitis
Toluene	8.82	126	50 ppm	200 ppm	500 ppm	1.2-7.1	0.17-40	65	fatigue, weakness, confusion, euphoria, dizziness, headache, dilated pupils, lassitude, nervousness, muscle fatigue, insomnia, paresthesia, dermatitis
Trichloroethene	9.5	54	50 ppm	25 ppm	1,000 ppm	8-10.5		Ca, 65	headache, vertigo, visual disturbance, tremors, somnolence, nausea, vomiting, irritation to eyes, dermatitis, cardiac arrhythmias, paresthesia
Xylene	8.56	111	100 ppm	100 ppm	900 ppm	1.0-7.0	0.05-200		dizziness, drowsiness, excitement, incoherence, staggered gait, irritation to eyes, nose, throat, corneal vacuolization, anorexia, nausea, vomiting, abdominal pain, dermatitis

Table A-2 (continued)

Chemical Exposure Limits and Characteristics Controls for Typical Industrial Chemicals

Constituent	IP[a]	OVA[b] relative response percent	TLV[c] 8-hour TWA	PEL[d] 8-hour TWA	IDLH[e] level	Flammable range percent	Odor threshold, ppm	Notes[f]	Potential symptoms of exposure[g]
METALS									
Antimony	NA	NA	0.5 mg/m^3	0.5 mg/m^3	50 mg/m^3	NC			irritation to nose, throat, mouth, coughing, dizziness, headache, nausea, vomiting, diarrhea, stomach cramps, insomnia, anorexia, irritation to skin, unable to smell properly, cardiac abnormalities in antimony trichloride exposures
Arsenic	NA	NA	0.01 mg/m^3	0.01 mg/m^3	5 mg/m^3	NC		Ca, 65	ulceration of the nasal septum, dermatitis, gastrointestinal disturbance, peripheral neuropathy, respiratory irritation, hyper-pigmentation of the skin
Chromium III	(h)	NA	0.5 mg/m^3	0.5 mg/m^3	25 mg/m^3	NC		65	histologic fibrosis of the lungs, lung cancer, nexochrome, ulceration and perforation of the nasal septum
Copper	NA	NA	1 mg/m^3	1 mg/m^3	100 mg/m^3	NC			irritation to nasal and mucous membrane, pharynx, nasal perforation, irritation to eye, metallic taste, dermatitis
Lead	NA	NA	0.05 mg/m^3	0.05 mg/m^3	100 mg/m3	NC		65	weakness, lassitude, insomnia, facial pallor, pal eye, anorexia, low weight, malnutrition, constipation, abdominal pain, colic, anemia, gingival lead line, tremor, paralysis of the wrists and ankles, encephalopathy, nephropathy, irritation to eyes, hypotension

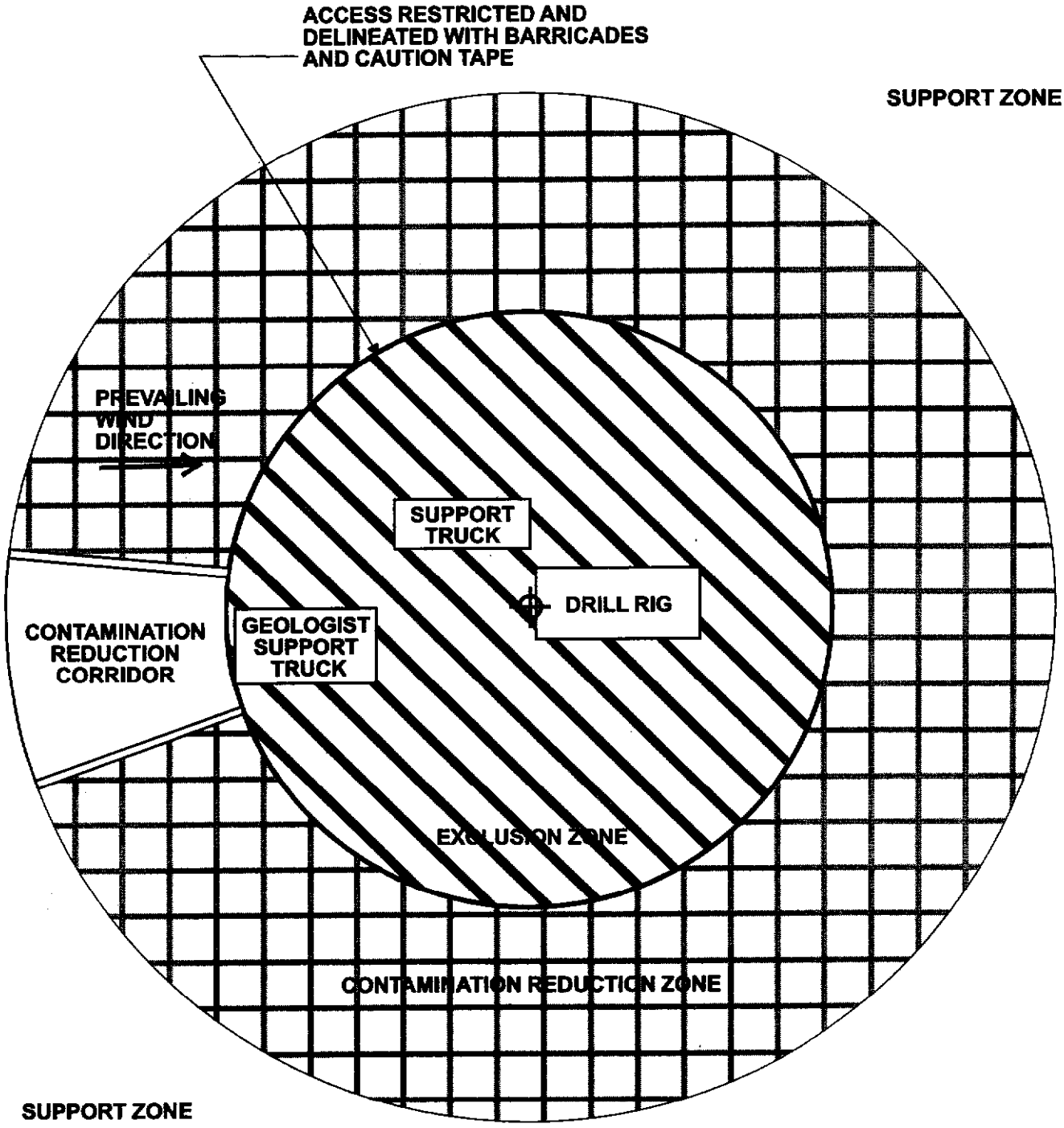
Table A-2 (continued)

Chemical Exposure Limits and Characteristics Controls for Typical Industrial Chemicals

Constituent	IP[a]	OVA[b] relative response percent	TLV[c] 8-hour TWA	PEL[d] 8-hour TWA	IDLH[e] level	Flammable range percent	Odor threshold, ppm	Notes[f]	Potential symptoms of exposure[g]
Nickel	NA	NA	1 mg/m^3	1 mg/m^3	10 mg/m^3	unknown combustible solid			headache, vertigo, nausea, vomiting, epigastric pain, substernal pain, coughing, hyperpnea, cyanosis, weakness, leukocytosis, pneumonitis, delirium, convulsions
Zinc Chloride	NA	NA		1 mg/m^3	50 mg/m^3	unknown			(as zinc chloride fumes) conjunctivitis, irritation to nose, throat, coughing, copious sputum, dyspnea, chest pain, pulmonary edema, bronchopneumonia, pulmonary fibrosis, corpulmonale, fever, cyanosis, tachypnea, burns to skin, irritation to eyes, skin

[a] Ionization potential in electron-volts.
[b] Century Organic Vapor Analyzer relative response to the compound in percent with methane calibration.
[c] Threshold Limit Value as the airborne 8-hour TWA established by the American Conference of Governmental Industrial Hygienist (ACGIH), 1999.
[d] Permissible Exposure as the airborne 8-hour TWA established by the OSHA.
[e] Immediately Dangerous to Life and Health level as published in the National Institute for Occupational Safety and Health (NIOSH), Pocket Guide to Chemical Hazards, 1994 edition.
[f] Hazard category; Ca-Carcinogen; C-Ceiling; S-Skin absorption; 65 – Proposition 65 chemicals known to the State of California to cause cancer or reproductive harm.
[g] Sources: NIOSH Pocket Guide to Chemical Hazards, June, 1994; Amdur, Mar O; Doull, John; Klaassen, Curtis, D., Toxicology, The Basic Science of Poisons, fourth Edition, 1993; and Merk & Co. Inc. The Merk Index, 1996.
[h] IP varies with chromium compound.

Notes:
NA = not applicable or not available
NC = noncombustible
NE = not established
NF = non-flammable
PAHs = polyaromatic hydrocarbons



DEFINITION OF THESE ZONES IS INCLUDED IN THE FA/BC SITE SAFETY AND HEALTH PROGRAM MANUAL, SECTION 406.

Figure A-1
Typical Work Zone Map
Site Hydrogeologic Model SSHP
Benicia Arsenal

Table A-3
Anticipated Field Equipment for SHM Investigation Activities

Equipment	Purpose and description
Personal Protective Equipment	
Nitrile disposable gloves	Prevents exposure to potentially contaminated soil or groundwater.
Tyvek© coveralls or equivalent	Prevents exposure to potentially contaminated soil or groundwater.
Respirators and cartridges	If necessary, half face or full face respirator will be used if the level of PPE is upgraded during work. Respiratory equipment must be in working condition and fit-tested for that person. A combination organic vapor/acid gas P100 particulate cartridge should be adequate protection for the contaminants expected at this site. The end of service for cartridge will be 12 hours based on toluene/trichloroethane and the respiratory manufacturers recommendations. If upgrade to Level C for unexpected chemicals is required, the HSD will be contacted to determine End of Service Life change out schedule for cartridges based on exposure conditions. All personnel wearing respiratory protection will be in compliance with fit-testing requirements as specified in the FA/BC Health and Safety Program Manual Section 302.
Steel-toed boots or shoes and a hard hat	Required PPE for Level D.
Gloves – leather or nitrile depending on conditions	Required PPE for Level D.
Environmental Monitoring Equipment	
Organic vapor monitor or equivalent	An OVM or equivalent is required to monitor air quality in and around the work zone. The OVM must be calibrated before and after each workday. A calibration data sheet will be maintained. A periodic response check will be performed during the workday to determine that it is responding to contaminants.
Benzene detector tubes (0.5-10 ppm)	Detector tubes, benzene specific, is required to monitor air quality in the work zone.
Site Control Measures	
Traffic Cones, barricades and safety tape	All work areas will be delineated with traffic cones and/or safety tape to prevent people from entering the work zone. Barricades may also be used in higher traffic areas.
Decontamination Equipment	
Wash buckets and soap, plastic drop cloth, disposable towels, disposal containers.	Necessary for proper decontamination of small equipment and non-disposable PPE (i.e., work boots).

Table A-3 (continued)
Anticipated Field Equipment for SHM Investigation Activities

Equipment	Purpose and Description
Other Equipment	
Water level probe	There is a possibility during drilling that groundwater may be encountered. All equipment will be checked prior to use to determine if it is working properly.
Interface probe	There is a possibility during drilling that free-phase petroleum hydrocarbons in groundwater may be encountered. All equipment will be checked prior to use to determine if it is working properly.
pH/electrical conductance (EC) meter	If groundwater is encountered, physical properties (such as pH, EC, color, odor, and relative clarity) will be noted in the field logbook. This equipment will be calibrated before use and calibration notes will be logged in the field logbook.
Sampling containers (soil and water)	If necessary, appropriate containers for soil and groundwater samples will be required.
Sample labels, COC forms, zip-lock bags, cooler, ice (if necessary), custody seals	Necessary for any soil or groundwater sampling. Proper COC forms, labels, and custody seals will be completed for proper QC. Samples will be stored in a clean cooler (with ice, if necessary for specified analysis) for delivery to an analytical laboratory. If ice is used, all samples will be sealed around the end caps, lids, or caps to prevent water from invading the sample. Then the samples will be double-bagged and sealed for an additional protective barrier from melt water.
Hand auger or post hole digger	Prior to using power drilling equipment, a hand auger or hand operated post hole digger will be used to explore the upper 3 to 5 feet for underground utilities and other obstructions. In addition, the hand auger may be used for the collection of shallow subsurface soil samples.
Thermometer	Monitor air temperature when ambient temperature is above 70 degrees F. Thermometer should be placed in a shady area.
Illumination	All work activities will be conducted in daylight hours to provide adequate lighting for outside activities. Work activities will not be conducted indoors.
Potable water and sanitation	Drinking water and toilets are located at the site for use by all workers.

Table A-4
Organic Vapor Response Criteria for Petroleum Hydrocarbons that may Include Gasoline, Diesel and Fuel Oil

Organic vapor concentrations in breathing zone[a]	Sampling frequency	Action taken
0 less than 1 ppm	At a minimum of every 15 minutes, whenever active excavation or drilling is being conducted, upon initial approach to surface water and sediment sampling sites where contamination is anticipated.	Continue work with required minimum PPE for the field activity
1 ppm to 10 ppm for more than 2 minutes	Every 15 minutes until organic vapor concentration levels decrease less than 1 ppm.	Collect benzene detector tubes (DTs) at borehole: • If DTs reveal no detectable concentrations then, continue work with required minimum PPE for the field activity • If DTs reveal detectable concentrations greater than 1 ppm upgrade to Level C PPE • If DTs for benzene reveal detectable concentrations greater than 10 ppm, then stop work
10 to 100 ppm for more than 2 minutes	Every 15 minutes	Level C PPE required
100 ppm for more than 2 minutes with ½-face respirator (500 ppm with full-face respirator)	Every 10 minutes	• Stop work • Work crews position themselves upwind of site • Re-evaluate in 15 minutes • Contact HSD and PjM • Evacuate

[a] OVA calibrated to methane (concentrations will be less if calibrated to isobutylene).

Table A-5

Attachments A – E for SHM Investigation Activities

Attachment	Procedures	Frequency
Attachment A – Site Safety & Health Plan Acknowledgement Form	Attachment A will be completed and signed by all contractors and subcontractors involved with the field effort. An emergency contact for each contractor and subcontractor will also be required on Attachment A.	Once, prior to the start of the field project
Attachment B – Site Safety & Health Plan Site Activity and Safety Briefing	A safety briefing will be held every day prior to start of work. Attachment B will be included with all other daily sheets (i.e., field notes, boring logs) submitted by the contractor at the end of the day.	Daily
Attachment C – Site Safety & Health Plan Safety Plan Implementation Checklist	Attachment C will be completed prior to the start of each field project and all items listed and their respective status will be reviewed every day of the field effort.	Once, prior to the start of the field project
Attachment D – Unsafe Conditions	Attachment D will be completed, if necessary, for every occurrence of an unsafe condition. If an Attachment D is completed for an unsafe condition, the PjM and the HSD will be notified immediately and all work at the job site will stop until the unsafe condition is corrected.	When necessary
Attachment E – Site Safety & Health Plan Safety Plan Environmental Monitoring Documentation	Attachment E is a sheet to record daily air monitoring data. This attachment will be included with all other daily sheets (i.e., field notes, boring logs) submitted by the contractor at the end of the day.	Daily during invasive activities

FA/BC

Attachment A—Site Safety and Health Plan Employee Acknowledgment

Employee Name		
Project Name	Project Location	Project Number

Employee Statement of Acknowledgment

I hereby certify that I have read and that I understand the safety and health guidelines contained in FA/BC's Site Safety and Health Plan for the above-named project.

Employee Signature _____ Date _____

In the Case of an Emergency, contact:

	Name	Relationship	Phone Number
1.			
2.			

Name of Site Safety Officer Receiving This Form	
Signature of Site Safety Officer	Date

NOTE: Send completed form to Health and Safety Director.

FA/BC

Attachment B—Site Safety and Health Plan Site Activity and Safety Briefing

Name of Site Safety Officer	Signature of Site Safety Officer	
Project Name	Project Location	Project Number

Who attended the briefing?

Names of FA/BC Employees	**Names of Subcontractor(s) Employees**

What items were discussed?

- ☐ Site Safety and Health Plan
- ☐ Specific Accident/Incident
- ☐ Protective Equipment to be Used
- ☐ Emergency Hospital Route
- ☐ Other _____
- ☐ Hazardous Site Conditions/Activities
- ☐ Changes/Solutions to Specific Accident(s)
- ☐ Location of Emergency Telephone Number
- ☐ Work Schedule

Do any items require assistance from FA/BC Health and Safety staff? (If yes, describe the item and type of assistance required and contact the Health and Safety staff directly.)

☐ YES ☐ NO

_____

_____

_____

_____

NOTE: Place a copy of the completed form in the project file.

FA/BC

Attachment C—Site Safety and Health Plan Safety Plan Implementation Checklist

Project Name	Project Location (city and state)	Date
Name of Site Safety Coordinator	Weather Conditions	Project Number

FA/BC Staff Present

Name	Office

Indicate the status of each of the following:

1.	Is a copy of the Site Safety and Health Plan (SSHP) on site?	☐ YES	☐ NO ☐ N/A
2.	Is the personal protective equipment required by the SSHP available and being used correctly?	☐ YES	☐ NO ☐ N/A
3.	Have the work zones been delineated?	☐ YES	☐ NO ☐ N/A
4.	Has a decontamination station been set up as required by the SSHP?	☐ YES	☐ NO ☐ N/A
5.	Are the decontamination procedures being followed?	☐ YES	☐ NO ☐ N/A
6.	Is access to the exclusion zone being controlled?	☐ YES	☐ NO ☐ N/A
7.	Has the site activities briefing and tailgate safety meeting been provided?	☐ YES	☐ NO ☐ N/A
8.	Is the list of emergency telephone numbers posted at the support zone?	☐ YES	☐ NO ☐ N/A
9.	Are directions to nearest emergency medical assistance posted at support zone?	☐ YES	☐ NO ☐ N/A
10.	Is emergency equipment available and functional, as required by the SSHP?	☐ YES	☐ NO ☐ N/A
11.	Has the nearest toilet facility been identified or a portable facility been set up?	☐ YES	☐ NO ☐ N/A
12.	Has an adequate supply of drinking water been provided?	☐ YES	☐ NO ☐ N/A
13.	Has water for decontamination been provided?	☐ YES	☐ NO ☐ N/A
14.	Have the instruments for environmental and exposure monitoring been calibrated and set up as required by the SSHP?	☐ YES	☐ NO ☐ N/A
15.	Are the instruments being used properly and periodically checked during the shift for battery charge status?	☐ YES	☐ NO ☐ N/A
16.	Have the trenches and excavations been clearly marked?	☐ YES	☐ NO ☐ N/A
17.	Have trenches and excavations been shored or sloped as required by soil type and work activities?	☐ YES	☐ NO ☐ N/A
18.	Are dust suppression measures being used?	☐ YES	☐ NO ☐ N/A
19.	Is food and tobacco consumption being restricted to the support zone?	☐ YES	☐ NO ☐ N/A
20.	Has a confined space been identified as part of this project?	☐ YES	☐ NO ☐ N/A
21.	Are the confined space entry procedures being correctly implemented?	☐ YES	☐ NO ☐ N/A
22.	Has the work/rest cycle for the shift been established?	☐ YES	☐ NO ☐ N/A
	TIME ON (minutes): _____ TIME OFF (minutes): _____		
23.	Has a shaded rest area been set up in the support zone?	☐ YES	☐ NO ☐ N/A

NOTE: Place completed form in project file.

FA/BC

Attachment D
Notice of Unsafe Conditions

Contractor	Date
Project Name	Project Number

THIS NOTICE . . .

This notice is to advise you, the Prime Contractor on the above-named Contract, that this Representative of the Owner of the above-mentioned Project has observed (on the date shown above) an unsafe condition on the Project.

These conditions are listed as follows:

ITEM	CONDITION

By this Notice, the Owner or its Representatives shall not assume any responsibility under the GENERAL CONDITIONS or assume any liability for the existence or correction thereof, for the unsafe conditions, or any others that may have been unnoticed.

These conditions shall be remedied as soon as possible within a safe working period. If these corrections are not made, the Owner will be forced to remove all field staff from the job. No payment shall be made for any work installed after this date without first examination of work in accordance with the GENERAL CONDITIONS.

Signature of Owner's Representative	Title	Date
Received by (Signature of Contractor's Representative)	Title	Date

NOTE: Place a copy of completed form in project file.

FA/BC Attachment E—Site Safety and Health Plan Environmental Monitoring Documentation

Project Name	Project Number

Employee Name	Project Location

Equipment Used (check as appropriate)

	Calibrated	Date	Used	Dates(s)
OVA (Organic Vapor Analyzer)/FID	☐	_____	☐	_____
OVM (Organic Vapor Monitor)/PID	☐	_____	☐	_____
HNU	☐	_____	☐	_____
PTLV Sniffer	☐	_____	☐	_____
Photovac TIP	☐	_____	☐	_____
Combustible Gas Meter/Explosimeter	☐	_____	☐	_____
Other _____	☐	_____	☐	_____

Instrument	Date	Time	Readout Value	Area Monitored	Changes in PPE			User's Initials
					YES	NO	Type of PPE	

NOTE: Place completed form in project file.

ATTACHMENT F

TCE
Cartridge Life Calculator

MSA Cartridge Life Expectancy Calculator

MSA Cartridge Life Expectancy Results

Final Breakthrough Time Calculation

When using a Advantage200 Facepiece with a Adv. 200 GMC Cartridge under the following conditions:

Chemical Name:	Trichloroethylene
Chemical PEL (ppm):	100 OSHA PEL
Temperature:	50 C
Relative Humidity:	50 %
Pressure:	760 Torr
Breathing Rate:	30 LPM
Use Concentration:	100 ppm
Breakthrough Concentration:	10 % OSHA PEL
The estimated Breakthrough Time at which cartridges need to be replaced is:	1278 **minutes**

Final Draft Letter Workplan – Piezometer Installation and Sampling
Benicia Arsenal, Benicia, CA
November 2001

1.		If any groundwater contamination is discovered as a result of the analysis of the piezometer water samples, additional investigation will be required to delineate the full nature and extent.	Concur
2.		RWQCB staff expect to be provided a detailed field schedule with opportunity for site visits during the piezometer installation process. In addition, if any of the proposed piezometer locations must be changed in the field, a notification process to the agencies should be initiated.	Concur
3.		Selected piezometer locations are largely based on site data gaps identified in the draft Site Hydrogeologic Model. It should be noted that this document has not been provided to the RWQCB for review. However, based on the recent working group meeting where findings of the SHM were presented, the proposed piezometer locations appear to be appropriate. Any significant changes to these locations should be communicated to the agencies per Comment #2.	Concur
[illegible]			
1.		DTSC concurs with Gary Riley's (RWQCB) comments regarding the Piezometer Work Plan for Benicia Arsenal, Benicia, CA.	Concur
[illegible]			
1.		No comment other than to remind you to permit the installation and eventual destruction of the piezometers.	Concur