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Southwest Division
Naval Facilities Engineering Command
Contracts Department
1220 Pacific Highway, Room 135
San Diego, California 92132-5187

Contract No. N68711-92-D-4670

COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY

CLEAN II

TECHNICAL MEMORANDUM
PREDESIGN EVALUATION OF SOIL VAPOR EXTRACTION EQUIPMENT FACILITY OPTIONS
MARINE CORPS AIR STATION EL TORO
SITE 24 (VOC SOURCE AREA)

CTO-0142/0018

July 1997

Prepared by:

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BECHTEL NATIONAL INC.

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Southwest Division
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DATE: July 10, 1997
CTO #: 142
LOCATION: MCAS El Toro

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D. J. Tedaldi, Ph.D., P.E., Project Manager

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ACRONYMS/ABBREVIATIONS

AFB	Air Force Base
bgs	below ground surface
BNI	Bechtel National, Inc.
CLEAN	Comprehensive Long-Term Environmental Action Navy
CTO	Contract Task Order
DON	Department of the Navy
MCAS	Marine Corps Air Station
O&M	operation and maintenance
OHM	OHM Remediation Services Corporation
PCE	tetrachloroethene
RI	Remedial Investigation
SCAQMD	South Coast Air Quality Management District
scfm	standard cubic feet per minute
SVE	soil vapor extraction
SWDIV	Southwest Division Naval Facilities Engineering Command
VOC	volatile organic compound

Section 1
INTRODUCTION

This memorandum presents a comparison of soil vapor extraction (SVE) system equipment facility options for the volatile organic compound (VOC) source area (Site 24) at Marine Corps Air Station (MCAS) El Toro in Orange County, California. This technical memorandum has been prepared by Bechtel National, Inc. (BNI), on behalf of the United States Department of the Navy (DON), Southwest Division Naval Facility Engineering Command (SWDIV) in accordance with Contract Task Order (CTO)-0142. This CTO was issued under the Comprehensive Long-Term Environmental Action Navy (CLEAN) II Program, contract No. N68711-92-D-4670. The design and cost information presented in this evaluation were developed for use in comparing the equipment facility options and are not intended to represent detailed SVE system design and costs. Detailed design and cost estimates will be performed in the future.

SVE has been selected as the preferred remedial alternative to address VOC-contaminated soil in the vadose zone at Site 24 (BNI 1997). As part of the SVE system design activities, several equipment facility options are being considered. These options include 1) design and construction of a central treatment facility capable of simultaneously extracting and treating vapors from all of the site SVE wells, 2) design and construction of three fixed treatment facilities each capable of simultaneously extracting and treating vapors from approximately one third of the site's SVE wells, and 3) design and construction of mobile SVE unit(s) capable of extracting and treating vapors from small groups of wells.

In the following sections, conceptual designs for each of these options are described and evaluated.

Section 2
DEVELOPMENT OF EQUIPMENT FACILITY OPTIONS

This section includes a description of the SVE equipment facility options. For the purpose of this evaluation, the SVE equipment facility is assumed to be the major equipment such as conveyance piping, vacuum blower, air/water separator, filters, equipment silencers, and activated carbon adsorption beds. Components common to all three options, such as the SVE well field, are not considered to be part of the equipment facility. However, to develop equipment performance specifications for cost-estimating purposes, it was necessary to develop a conceptual design of the SVE well field. This conceptual design is also provided below.

2.1 NORTON AFB SVE SYSTEM

In developing the MCAS El Toro SVE equipment facility options, the SVE system currently operating at Norton Air Force Base (AFB) was used as a model (Earth Tech 1995). The MCAS El Toro SVE system is expected to be similar to the Norton AFB system and, in addition, components of the Norton AFB system may be available for use at MCAS El Toro. Costs and availability of these components are currently unknown. The major components of the Norton AFB SVE system are listed in Table 2-1.

Table 2-1
Norton AFB SVE System Equipment List

Equipment	
Vacuum Blower Specifications	two 4,250 scfm, positive-displacement blowers with 150-horsepower motors
Vapor-Phase Activated Carbon	two 20,000-pound adsorbers
Other Equipment	one moisture separator (Wright-Austin Type TS gas-liquid separator)
	one condensate transfer pump with a capacity of 10 gallons per minute
	one condensate storage tank, cylindrical polyethylene, 7.5 feet in diameter and 6.5 feet high
	one water-cooled heat exchanger, model C/TV-400
	one evaporative cooling tower, model T-40
	one cooling centrifugal pump, model EP 150 3030

2.2 CONCEPTUAL DESIGN OF SVE WELL FIELD

The conceptual SVE well field design developed for this evaluation is based on the results of the subsurface soil gas investigation performed as part of the Phase II Remedial Investigation (RI) for Site 24 (BNI 1996), preliminary evaluation of SVE pilot test results (OHM 1997) and a facility map indicating potential source areas (i.e., degreaser sumps and sewer lines). The results of the subsurface soil gas investigation indicates that the

primary VOC source area is in the vicinity of Buildings 296 and 297. A secondary VOC source area was also identified approximately 500 feet to the west of Building 297 (i.e., tetrachloroethene [PCE] source area). In general, the areal extent of the source areas increases with depth (BNI 1996). For the purpose of the conceptual design, the vadose zone was divided into three vertical zones: a shallow zone (0 to 40 feet below ground surface [bgs]), an intermediate zone (41 to 70 feet bgs), and a deep zone (71 to 110 feet bgs). The well field developed for each zone was designed to address the areal extent of the source areas within that zone with wells having screened intervals specific to the zone. An average radius of influence of 100 feet was used in the well field development. The radius of influence of 100 feet was selected based on a preliminary evaluation of the SVE pilot test data (OHM 1997) using methods developed by P.C. Johnson et. al (Johnson et al. 1990a,b).

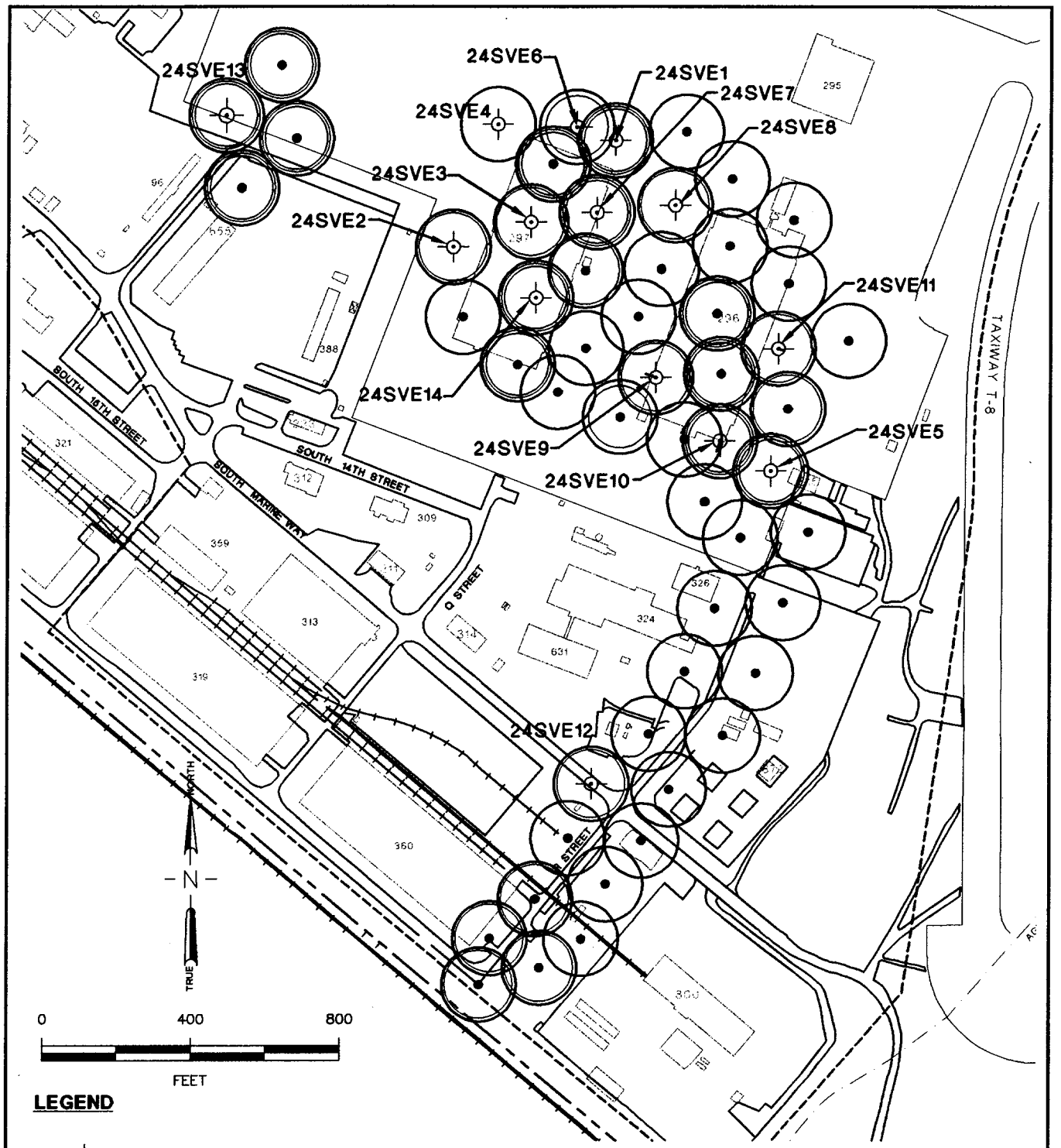
The conceptual SVE well field includes a total of 94 wells (including existing wells): 15 screened within the shallow zone, 25 screened within the intermediate zone and 54 screened within the deep zone (Figure 2-1). This well field is used for all three SVE equipment facility options. The ring surrounding each well in Figure 2-1 indicates the assumed radius of influence. Multiple, different-colored rings indicate multiple wells, with different screened intervals, at a single location.

For the purpose of developing equipment performance specifications for each equipment facility option, it was assumed that each SVE well would produce a flow of 100 standard cubic feet per minute (scfm) at a vacuum 100 inches (approximately 7 inches of mercury) of water column. It was also assumed that vacuum losses through the conveyance system and treatment equipment components would range between 5 and 8 inches of mercury.

2.3 SVE EQUIPMENT FACILITY OPTION 1 – CENTRAL TREATMENT FACILITY

This option includes a fixed central treatment facility located near the south end of Building 296 (Figure 2-2). The SVE equipment includes four 250-horsepower, positive-displacement blowers (10,000 scfm) at 15 inches of mercury vacuum; two 20,000-pound, vapor-phase granular activated carbon adsorbers; an air/water separator, condensate storage tank; equipment silencers; water transfer pump; and miscellaneous controls and electrical equipment. The skid-mounted system will be installed within a fenced area. It is assumed that the treatment facility will have dimensions similar to those of the Norton AFB system, approximately 90 by 90 feet, and will include a 43- by 17-foot concrete containment area for the air/water separator and condensate storage tank. The remaining skid-mounted equipment will be placed directly on the existing concrete surface.

For the purpose of this evaluation, it is assumed that conveyance plumbing in the vicinity of Buildings 296 and 297 will be installed in subgrade trenches resurfaced to match the existing pavement. However, depending on access requirements and planned activity around Buildings 296 and 297, some pipe lengths may be installed aboveground. The conveyance plumbing along R Street (Figure 2-2) will be installed aboveground to South



LEGEND

24SVE1 PHASE II SOIL VAPOR EXTRACTION WELL

PROPOSED SOIL VAPOR EXTRACTION WELLS

SCREENING IN THE DEEP ZONE

SCREENING IN THE INTERMEDIATE ZONE

SCREENING IN THE SHALLOW ZONE

NOTE: ALL RADII OF INFLUENCE ASSUMED TO BE 100 FEET

Technical Memorandum

Figure 2-1

Conceptual SVE Well Field Design

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Bechtel National, Inc.

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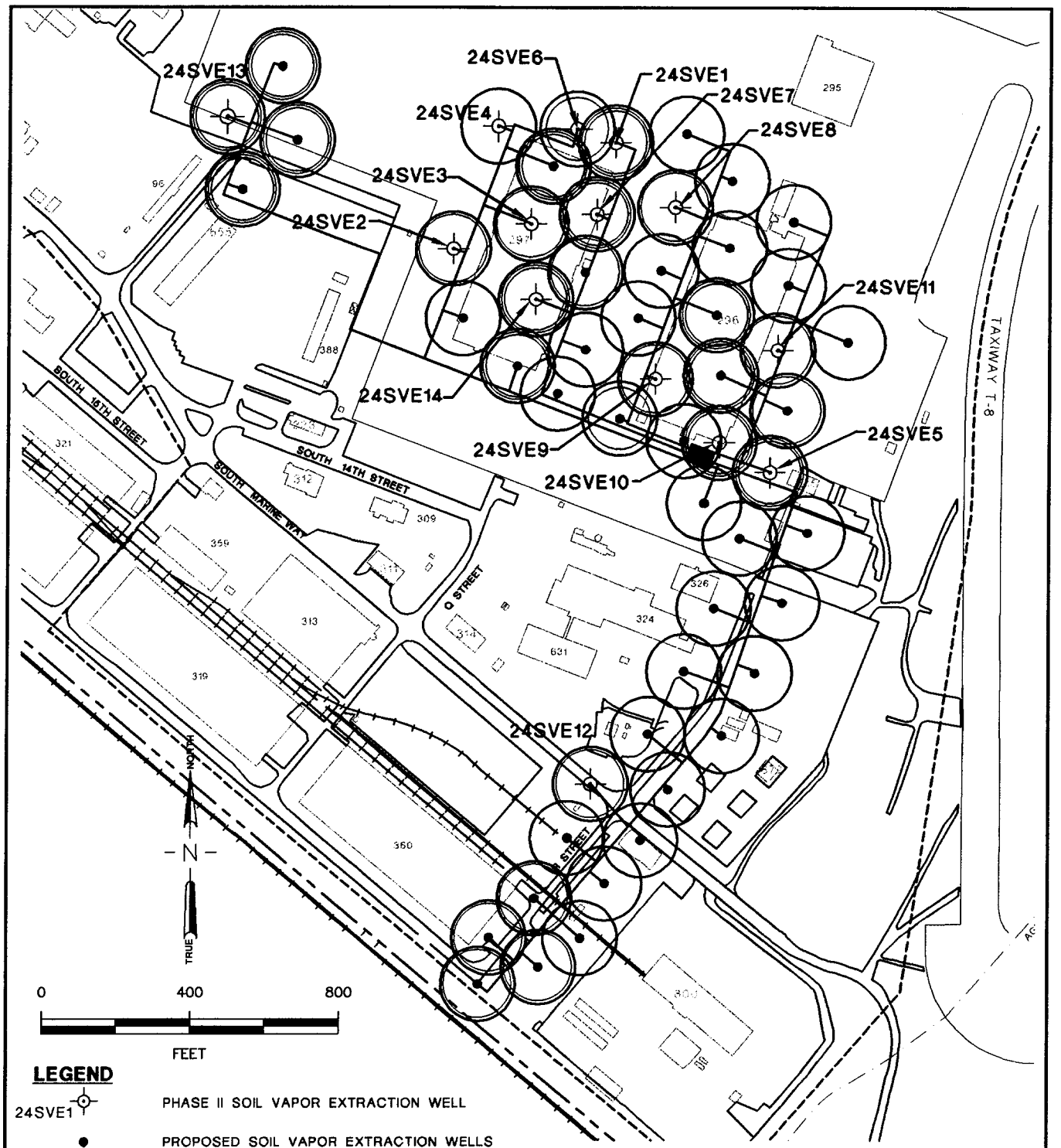

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24SVE1 — PHASE II SOIL VAPOR EXTRACTION WELL

● PROPOSED SOIL VAPOR EXTRACTION WELLS

■ PROPOSED EQUIPMENT FACILITY

PVC PIPE

SCREENING IN THE DEEP ZONE

SCREENING IN THE INTERMEDIATE ZONE

SCREENING IN THE SHALLOW ZONE

NOTE: ALL RADII OF INFLUENCE ASSUMED TO BE 100 FEET

Technical Memorandum

Figure 2-2

Conceptual Pipe Layout

Option 1 - Central Treatment Facility

MCAS, El Toro, California

Bechtel National, Inc.

CLEAN II Program

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Marine Way. At South Marine Way, the plumbing will pass under the roadway and remain underground in the unpaved parking lot southeast of Building 360 and along South Marine Way. It is assumed that power to the treatment facility will be provided by the existing service at Building 296.

2.4 SVE EQUIPMENT FACILITY OPTION 2 – MULTIPLE FIXED TREATMENT FACILITIES

This option includes design and construction of three fixed treatment facilities at the following focus areas (Figure 2-3):

- at the southwestern corner of Building 297 (Facility A),
- at the south end of Building 296 (Facility B),
- in the unpaved parking lot south of the intersection of South Marine Way and R Street (Facility C).

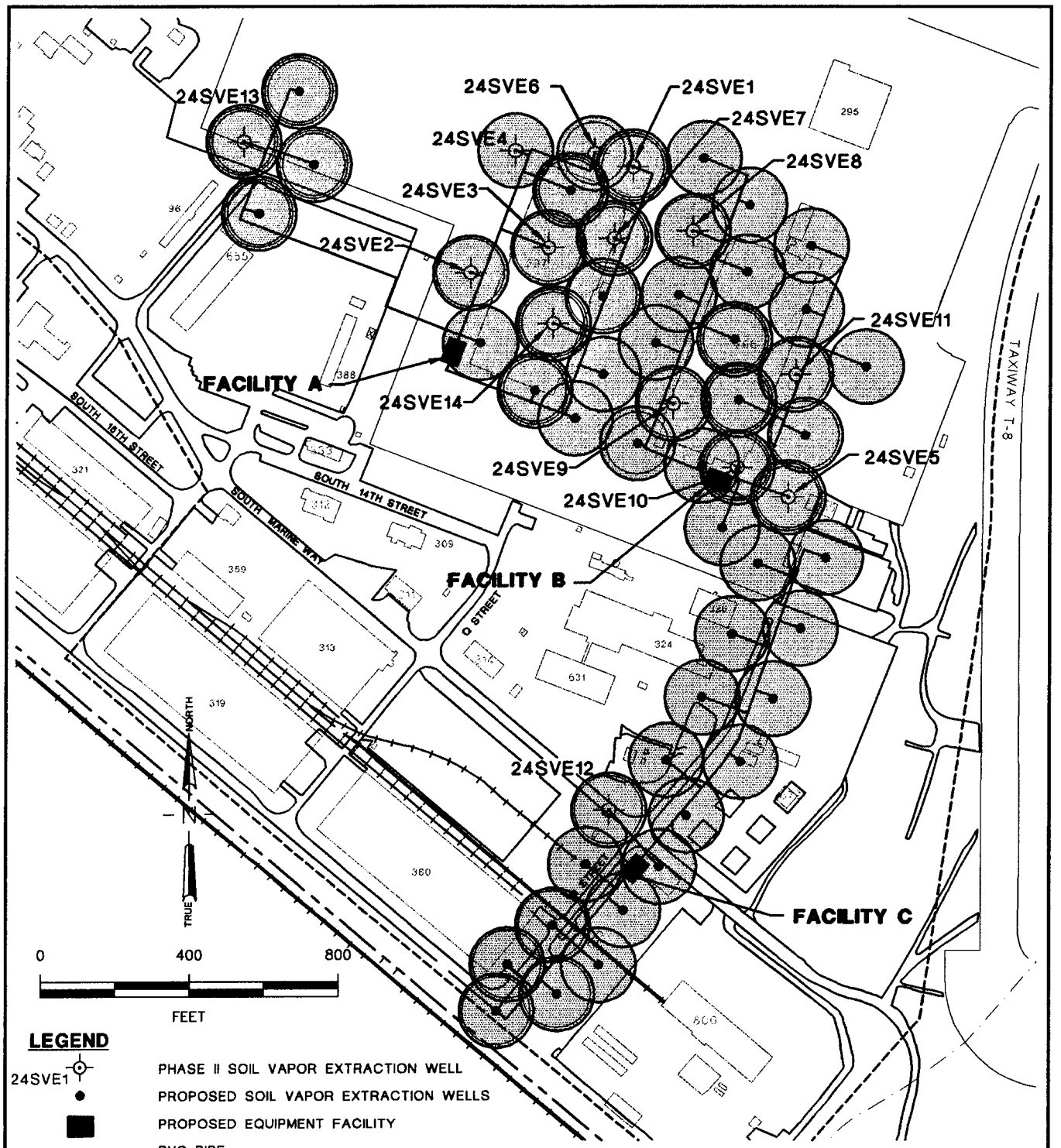
It is assumed that each location will have independently operating SVE systems with a process design similar to the fixed central treatment facility.

Facility A will address the SVE wells in the PCE source area and a portion of the wells around Building 297 (Figure 2-3). This facility will include two 150-horsepower, positive-displacement blowers capable of 4,000 scfm at 12 inches of mercury; two 5,000-pound, vapor-phase activated carbon adsorbers; an air/water separator; a condensate storage tank; equipment silencers; a water transfer pump; and miscellaneous controls and electrical equipment.

Facility B will address SVE wells around Building 296. This facility will include two 125-horsepower, positive-displacement blowers capable of 3,000 scfm at 12 inches of mercury; two 3,000-pound, vapor-phase activated carbon adsorbers; an air/water separator; a condensate storage tank; equipment silencers; a water transfer pump; and miscellaneous controls and electrical equipment.

Facility C will address the SVE wells along R Street and in the vicinity of Building 360. This facility will include two 100-horsepower, positive-displacement blowers capable of 2,500 scfm at 12 inches of mercury; two 3,000-pound, vapor-phase activated carbon adsorbers; an air/water separator; a condensate storage tank; equipment silencers; a water transfer pump; and miscellaneous controls and electrical equipment.

As with Option 1, a concrete containment area for the air/water separator and condensate storage tank will be constructed at Facilities A and B. The size of the containment area is assumed to be approximately one-half the size of the containment area for the Norton AFB system. The remaining equipment will be skid-mounted and placed directly on the existing pavement.



LEGEND

- 24SVE1 — PHASE II SOIL VAPOR EXTRACTION WELL
- PROPOSED SOIL VAPOR EXTRACTION WELLS
- PROPOSED EQUIPMENT FACILITY
- PVC PIPE
- SCREENING IN THE DEEP ZONE
- SCREENING IN THE INTERMEDIATE ZONE
- SCREENING IN THE SHALLOW ZONE
- SVE WELLS ADDRESSED BY THE TREATMENT FACILITY A
- SVE WELLS ADDRESSED BY THE TREATMENT FACILITY B
- SVE WELLS ADDRESSED BY THE TREATMENT FACILITY C

NOTE: ALL RADII OF INFLUENCE ASSUMED TO BE 100 FEET

Technical Memorandum

Figure 2-3

Conceptual Pipe Layout
Option 2 - Multiple Treatment Facilities

MCAS, El Toro, California

Bechtel National, Inc.
CLEAN II Program

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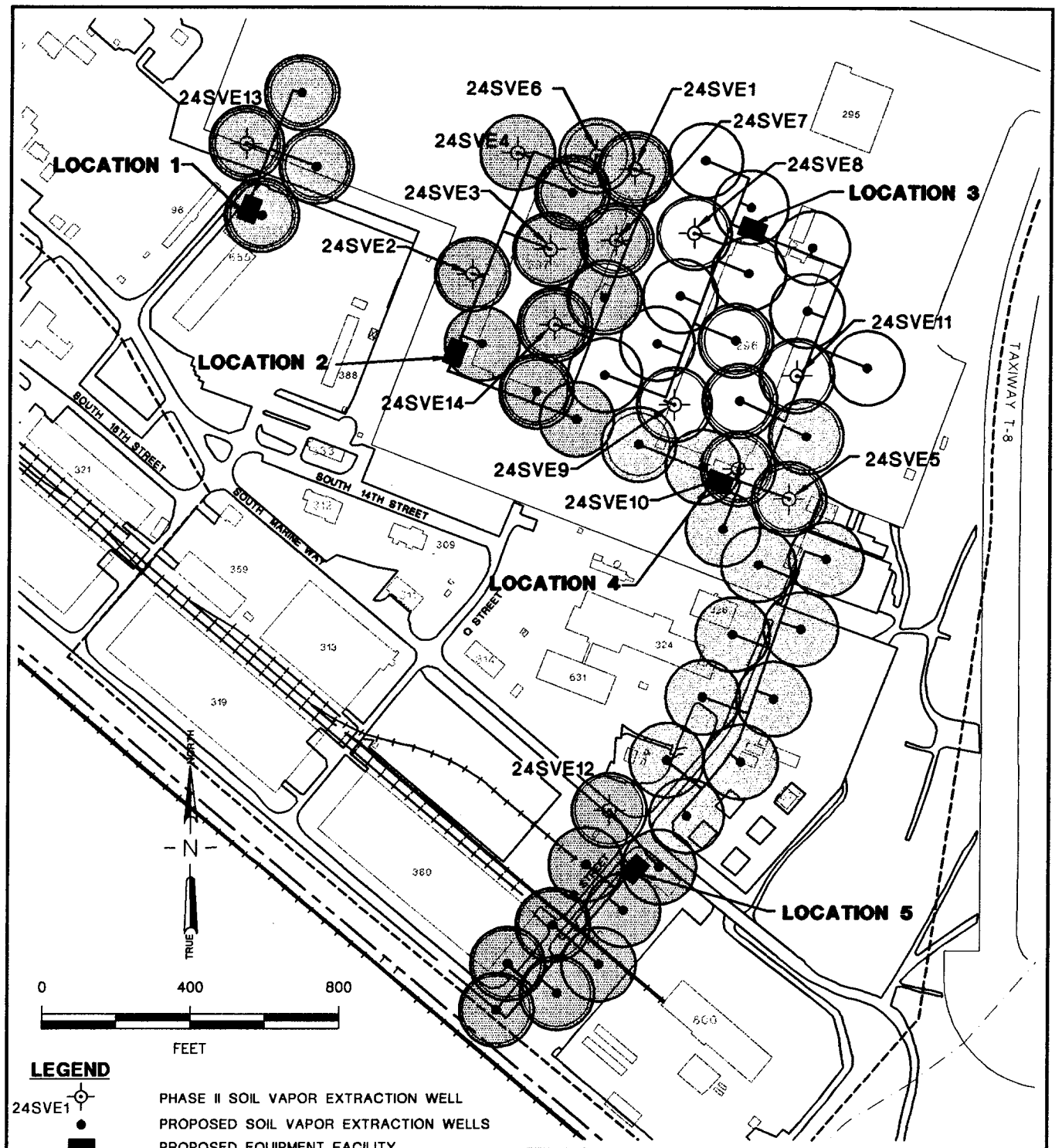
At Facility C it is assumed that a 40- by 40-foot concrete pad approximately 8 inches thick will be constructed in the unpaved parking lot. The pad will also include a containment area similar to those of Facilities A and B.

As with Option 1, conveyance plumbing in the vicinity of Buildings 296 and 297 (Facilities A and B) will be installed in subgrade trenches resurfaced to match the existing pavement. Conveyance plumbing along R Street will be above grade to the intersection of South Marine Way, where it will be installed below the intersection and remain in subgrade trenches resurfaced to match the existing paved and unpaved surfaces. It is assumed that power to each of the equipment facilities will be provided from existing services at nearby buildings (e.g., Buildings 296, 297 and 360).

2.5 SVE EQUIPMENT FACILITY OPTION 3 – TRAILER-MOUNTED MOBILE SVE UNITS

This option includes design and construction of two trailer-mounted SVE systems with a flow capacity of 2,500 scfm each at a maximum vacuum of 12 inches of mercury. At this capacity, it is expected that the mobile units will be moved to five different locations and operated for a period of 24 months at each location. Proposed locations for the mobile SVE units are shown on Figure 2-4. The equipment for each trailer includes two 100-horsepower, positive-displacement blowers; two 3,000-pound, vapor-phase activated carbon adsorbers; an air/water separator; a condensate storage tank; equipment silencers; a water transfer pump; and miscellaneous controls and electrical equipment. It is assumed that power to the mobile SVE units will be supplied by existing electrical services at nearby buildings. It is also assumed that the SVE units will be moved from location to location and all conveyance plumbing will be temporary and aboveground.



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24SVE1	PHASE II SOIL VAPOR EXTRACTION WELL
●	PROPOSED SOIL VAPOR EXTRACTION WELLS
■	PROPOSED EQUIPMENT FACILITY
—	PVC PIPE
○	SCREENING IN THE DEEP ZONE
○	SCREENING IN THE INTERMEDIATE ZONE
○	SCREENING IN THE SHALLOW ZONE

NOTES: ALL RADII OF INFLUENCE ASSUMED TO BE 100 FEET

COLOR SHADED AREAS INDICATE SVE WELLS THAT WILL BE ADDRESSED AT EACH MOBILE UNIT LOCATION.

Technical Memorandum

Figure 2-4

Conceptual Pipe Layout
Option 3 - Mobile Treatment Facility

MCAS, El Toro, California

Bechtel National, Inc.
CLEAN II Program

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Section 3
EVALUATION OF SVE EQUIPMENT FACILITY OPTIONS

In this section, each equipment facility option is evaluated with respect to operational and functional advantages and disadvantages and with respect to costs.

3.1 ADVANTAGES AND DISADVANTAGES OF EQUIPMENT FACILITY OPTIONS

Table 3-1 includes a qualitative evaluation of advantages and disadvantages of each equipment facility option. Option 1 is used as the basis of comparison for Options 2 and 3.

3.2 COST COMPARISON OF EQUIPMENT FACILITY OPTIONS

This section includes a cost comparison of each equipment facility option. In an effort to streamline the cost-estimating activities, comprehensive cost estimates for each alternative were not developed. Only those elements that were expected to change significantly between options were selected for cost estimating. Cost estimates were not developed for elements common to all three options, such as installation of new SVE wells, wellhead reconstruction, SVE well-monitoring costs, and activated carbon usage. Therefore, cost totals present in the technical memorandum may be lower than actual construction costs. The elements selected for evaluation are as follows:

- design cost;
- equipment costs;
- equipment facility construction costs (e.g., fencing, foundation);
- power costs;
- operation and maintenance (O&M) costs;
- mobilization/demobilization costs; and
- conveyance systems installation costs.

Several methods were used to develop cost estimates for each element. The following paragraphs include a discussion of the methods and assumptions used for each element.

3.2.1 Design

Design of the equipment facility will include preparation of plans and specifications for:

- conveyance plumbing layout and sizing;
- utilities;
- equipment facility, including fencing and foundations;
- equipment selection and sizing;
- design of equipment trailer (Option 3 only).

Design costs are estimated to be 10 percent of equipment costs, facility construction costs, and conveyance system installation costs.

Table 3-1
Advantages and Disadvantages of Equipment Facilities Options

Equipment Facility Option 1 – Central Treatment Facility	
Advantages	**Disadvantages**
• Preplumbing and prevalving of entire well field will allow operational flexibility. Wells at great distances from one another can be operated simultaneously. • Centralized monitoring and operations and maintenance • Single, central equipment facility can be placed in a convenient, accessible location. • Simultaneous operation of all SVE[a] wells.	• Large capital expenditure required for equipment purchase. • High level of design required for conveyance system. • High cost of conveyance-system materials and installation. • Ability to turn down system limited by minimum blower capacity (i.e., 2,500 scfm[b]).
Equipment Facility Option 2 – Multiple Fixed Treatment Facilities	
Advantages	**Disadvantages**
• Capital equipment costs are lower than in Option 1. • More flexibility to adjust flow and vacuum rates to suit local conditions than in Option 1. • Lower capital costs for conveyance system than Option 1 due to elimination of large connecting trunk lines between focus areas.	• Higher monthly operations and maintenance costs than Option 1 due to multiple systems. • Greater level of effort for air emission permitting due to multiple facilities (SCAQMD 1997).
Equipment Facility Option 3 – Trailer-Mounted Mobile SVE Units	
Advantages	**Disadvantages**
• Lower capital equipment costs in comparison to Options 1 and 2. • Level of design for conveyance system is lower than in Options 1 and 2 due to aboveground temporary installations. • Conveyance system installation costs are lower than Options 1 and 2 due to aboveground installation. • Lower level of design required for equipment trailers than for permanent equipment facilities included in Options 1 and 2.	• Limited capacity of the smaller, trailer-mounted system(s) may increase overall operational times and operation and maintenance costs. • Ability to increase existing system capacity will be limited. • Equipment trailer will have to be located near power source or new temporary services will have to be provided.

(table continues)

Table 3-1 (continued)

Advantages	Disadvantages
• Mobility of the remediation equipment will allow for a high level of flexibility in addressing individual hot spots or groups of wells. • Applied vacuums can be modified to suit the local conditions.	

Notes:
[a] SVE – soil vapor extraction
[b] scfm – standard cubic feet per minute

3.2.2 Equipment Cost

Equipment capital cost estimates for each option were developed based on vendor quotes. Vendor quotes, based on the performance specifications outlined in Table 3-2 and depicted in Figure 3-1, were requested for the primary SVE equipment involved in each option.

Two equipment vendors specializing in assembly of SVE systems, Seneca Environmental Services and King, Buck Technology, responded to the request for quotes. A comparison of the price quotes for each option is provided in Table 3-3. The quote from King, Buck Technology was used for the cost evaluation because it was the lowest and the vendor is located in San Diego.

3.2.3 Equipment Facility Construction

The equipment facility for Option 1 (Central Treatment Facility) will consist of a 90- by 90-foot fence-enclosed area with one 43- by 17-foot concrete containment area for containment of the air/water separator and condensate storage tank. These dimensions are based on the dimension of the Norton AFB equipment facility. The remaining equipment (blowers, carbon filters, and other miscellaneous equipment) will be skid mounted and placed directly on the existing concrete surface outside Building 296.

A similar but smaller (40- by 40-foot) equipment facility will be constructed at Facilities A and B for Option 2 (Multiple Fixed Treatment Facility). In addition, it is assumed that an 8-inch-thick, 40- by 40-foot concrete pad with a containment area approximately one-half the size of the Norton AFB containment area will be constructed at Facility C.

Since Option 3 involves temporary installation of mobile equipment, the equipment facility will consist of only temporary fencing (40- by 40-foot) at each location.

Table 3-2
Summary of Performance Specifications for Mobile SVE[a] Units

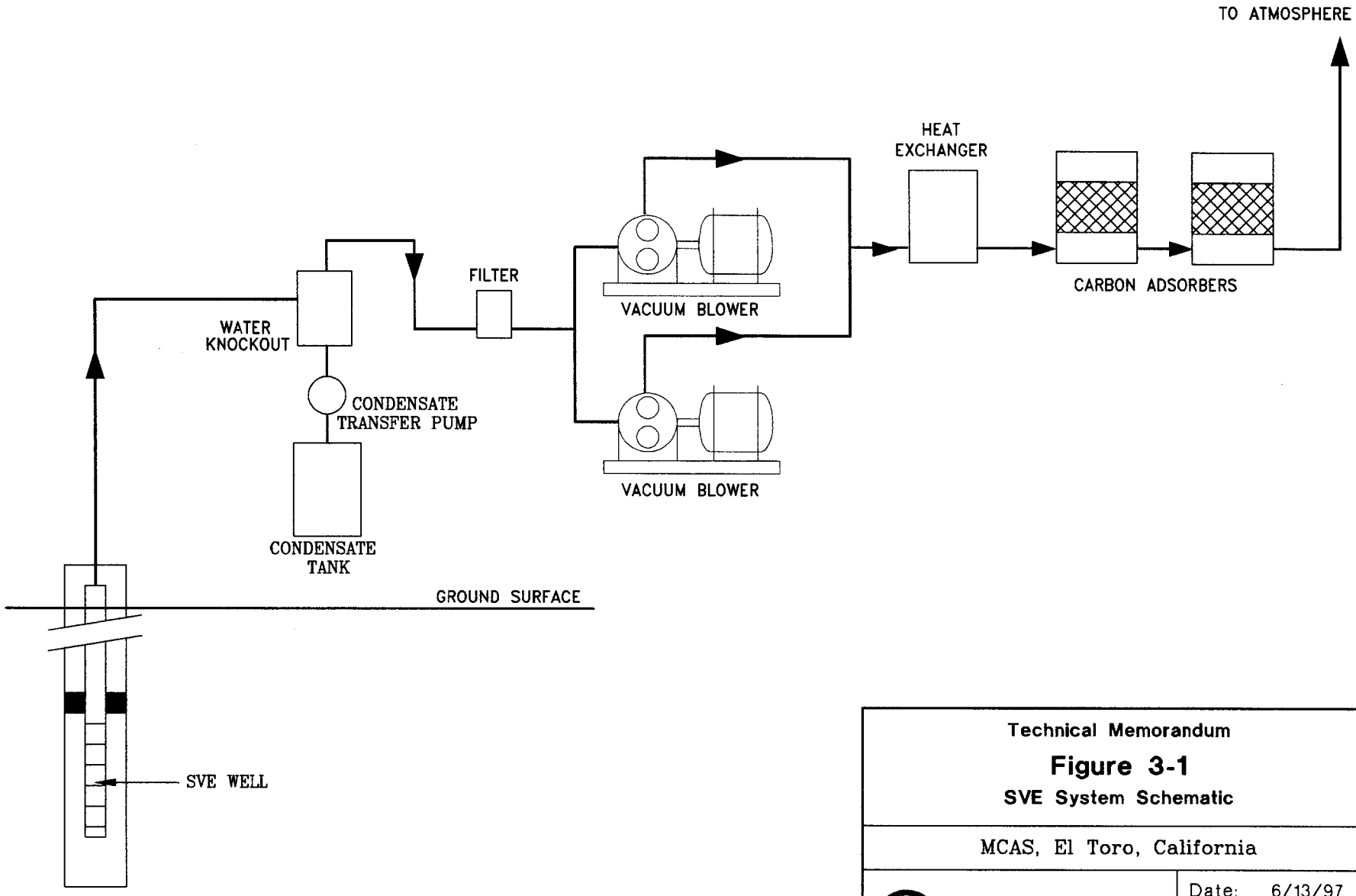
Equipment Facility Option 1 – Central Treatment Facility	
Equipment Configuration	skid mounted (see Figure 3-1 for general layout)
Vacuum Blower Specifications	four 2,500-scfm[b], positive-displacement blowers with 250-horsepower, totally enclosed, fan-cooled motors
Vapor-Phase Activated Carbon	two 20,000-pound adsorbers (10,000 scfm each) plumbed for serial operation
Other Equipment (capacity to match blower capacity)	one common air/water separator with three-level switches and condensate transfer pump
	heat exchanger (cooler) for process air following blowers
	air flow monitoring device
	pressure/vacuum gauges (before and after, air/water separator, carbon, in-line filter, and blowers)
	in-line filters
	blower silencers
	electric control panels (Nema 4)
	auto dialer
	separate motor starters for each blower
Equipment Facility Option 2 – Multiple Fixed Treatment Facilities	
Equipment Configuration	three systems each skid mounted (see Figure 3-1 for general layout)
Vacuum Blower Specifications (each system):	
Facility A (Building 297)	two 2,000-scfm, positive-displacement blowers with 150-horsepower, totally enclosed, fan-cooled motors
Facility B (Building 296)	two 1,500-scfm, positive-displacement blowers with 125-horsepower, totally enclosed, fan-cooled motors
Facility C (South Marine Way and R Street)	two 1,250-scfm, positive-displacement blowers with 100-horsepower, totally enclosed, fan-cooled motors
Vapor-Phase Activated Carbon:	
Facility A (Building 297)	two 5,000-pound adsorbers (4,000 scfm each) plumbed for serial operation
Facility B (Building 296)	two 3,000-pound adsorbers (3,000 scfm each) plumbed for serial operation
Facility C (South Marine Way and R Street)	two 3,000-pound adsorbers (2,500 scfm each) plumbed for serial operation

(table continues)

Table 3-2 (continued)

Other Equipment (capacity to match blower capacity)	one common air/water separator with three-level switches and condensate transfer pump heat exchanger (cooler) for process air following blowers air flow monitoring device pressure/vacuum gauges (before and after, air/water separator, carbon, in-line filter, and blowers) in-line filters blower silencers electric control panels (Nema 4) auto dialer separate motor starters for each blower
Equipment Facility Option 3 – Trailer-Mounted Mobile SVE Units	
Equipment Configuration	two trailer-mounted units (see Figure 3-1 for general layout)
Vacuum Blower Specifications	two 1,250-scfm, positive-displacement blowers with 100-horsepower, totally enclosed, fan-cooled motors
Vapor-Phase Activated Carbon	two 3,000-pound adsorbers (2,500 scfm each) plumbed for serial operation
Other Equipment (capacity to match blower capacity)	one common air/water separator with three-level switches and condensate transfer pump heat exchanger (cooler) for process air following blowers air flow monitoring device pressure/vacuum gauges (before and after, air/water separator, carbon, in-line filter, and blowers) in-line filters blower silencers electric control panels (Nema 4) auto dialer with remote base station separate motor starters for each blower

Notes:
[a] SVE – soil vapor extraction
[b] scfm – standard cubic feet per minute



Technical Memorandum

Figure 3-1

SVE System Schematic

MCAS, El Toro, California

Bechtel National, Inc.
CLEAN II Program

Date: 6/13/97
File No: 142M2483
Job No: 22214-142
Rev No: A

Table 3-3
Vendor Quotes Summary

Vendor Name	Option 1 Single Fixed Facility	Option 2 Multiple Fixed Facility	Option 3 Mobile Treatment Facilities
Seneca Environmental Services	$702,000	$814,000	$520,000
King, Buck Technology	$543,200	$452,400	$222,400

3.2.4 Monthly Operation and Maintenance

The monthly O&M activities are expected to include routine equipment maintenance and repairs, performance monitoring, data collection for permit compliance, oversight during activated carbon change-outs, and condensate sampling and disposal. Activated carbon replacement and regeneration cost are not considered here because the total carbon usage is based on the mass of contaminant in the subsurface. This will not change with each equipment design option. Estimates for the monthly O&M costs were developed as follows.

- The central treatment facility (Option 1) is expected to require two full-time (160 hours per month) technicians at an hourly rate of $55. Expenses, including laboratory analysis and equipment rental, are expected to be approximately $2,500 per month.
- The three fixed treatment facilities (Option 2) are expected to require three full-time (160 hours per month) technicians at an hourly rate of $55. Expenses are estimated to be $2,500 per month for each facility (total estimated expenses of $7,500 per month).
- The mobile treatment units (Option 3) are expected to require two full-time (160 hours per month) technicians at an hourly rate of $55. Expenses are estimated to be $2,500 per month for each unit (total estimated expenses of $5,000 per month).

3.2.5 Mobilization/Demobilization

Options 1 and 2 will involve a single mobilization of equipment to the equipment facilities. Although some equipment and materials costs will be incurred, it is expected that the primary costs associated with these activities will be labor related. These activities will consist of moving the SVE equipment onto the site, making the appropriate power connection, and connecting the previously installed conveyance plumbing to the SVE equipment. This will be a one-time event for both Options 1 and 2. It is expected to take two technicians, at an hourly rate of $55, 3 days (8 hours per day) for mobilization of treatment equipment for Option 1 and two technicians for 6 days (8 hours per day) for mobilization of the three treatment units in Option 2.

Option 3 will involve multiple mobilization and demobilization events. Each mobilization will involve moving the trailer-mounted equipment to the appropriate location, completion of the power connections, installation of the conveyance piping, and connection of the conveyance piping to the SVE equipment. Demobilization will include disconnection of the power service, disconnection and mobilization of the conveyance piping, and securing the equipment for transport. It is expected to take three technicians, at an hourly rate of $55, 1 week (40 hours per week) to mobilize and demobilize one equipment unit.

3.2.6 Conveyance System

Cost estimates for the Option 1 and 2 conveyance systems include equipment, labor, and materials associated with installation of aboveground and belowground conveyance plumbing from the SVE wellheads to the SVE equipment facility(s). The estimates were performed using Heavy Construction Cost Data published by R.S. Means (R.S. Means 1997). The quantity takeoffs for Options 1 and 2 were based on the conceptual pipe layouts shown on Figures 2-2 and 2-3. The cost estimate for the Option 3 conveyance system includes only the materials associated with temporary aboveground conveyance plumbing from the SVE wellheads to the mobile SVE unit. Labor costs associated with connection of the conveyance piping are included in Mobilization/Demobilization.

The following assumptions were made in developing the materials list and cost estimates for the conveyance system(s).

- The design flow for each SVE location is 100 scfm per depth interval.
- The thickness of the existing reinforced concrete apron surrounding Buildings 296 and 297 is 12 inches.
- All conveyance plumbing in the vicinity of Buildings 296 and 297 will be installed in trenches with a minimum depth of 4 feet.
- Conveyance plumbing trenches will be backfilled and covered with 12-inch-thick reinforced concrete and 6-inch-thick asphalt to match the existing pavement.
- The conveyance plumbing along R Street (Figure 2-1) will be installed aboveground to South Marine Way. At South Marine Way, the plumbing will pass under the roadway and remain underground in the unpaved parking lot southeast of Building 360 and along South Marine Way.
- Existing joints in the concrete apron around Buildings 296 and 297 will be used for one side of conveyance plumbing trenches. This will reduce the concrete cutting costs by 50 percent.

3.3 COST COMPARISON SUMMARY

Table 3-4 presents capital and O&M costs for each option. An operational period of 24 months is assumed for Options 1 and 2. This is consistent with the operational period developed for the SVE system in the feasibility study (BNI 1997b). A total operational period of 72 months is assumed for Option 3 (i.e., two units operating simultaneously for a period of 48 months and one unit operating alone for an additional 24 months). Based on the total life-cycle cost in Table 3-4 it appears that Options 1, 2 and 3 will have approximately equivalent costs for the assumed operational periods.

Table 3-4
Cost Evaluation Summary[a]

A Capital Cost Element	Option 1 Single Fixed Facility	Option 2 Multiple Fixed Facility	Option 3 Mobile Treatment Facility
Design Costs	$ 119,000	$ 100,000	$ 31,000
Equipment Costs	543,000	452,000	223,000
Equipment Facility Construction Costs	18,000	40,000	10,000
Mobilization/Demobilization (per location)	4,000	5,000	33,000
Conveyance System Installation Costs	631,000	503,000	73,000
Total Capital Cost	**$1,315,000**	**$1,100,000**	**$370,000**
B Monthly O&M[b] Cost			
Monthly Power Costs	47,000	36,000	19,000[c]
Monthly O&M Costs	20,000	34,000	23,000[c]
Total Monthly O&M Cost	**$67,000**	**$70,000**	**$42,000**
C Total O&M Cost			
Power Costs	1,128,000	864,000	1,140,000[d]
O&M Costs	480,000	816,000	1,380,000[d]
Total O&M Cost	**$1,608,000**	**$1,680,000**	**$2,520,000**
Total Life-Cycle Cost (A + C)	**$2,923,000**	**$2,780,000**	**$2,890,000**

Notes:
[a] Cost Evaluation Summary reflects only part of the soil vapor extraction (SVE) system, not the entire system
[b] O&M – operation and maintenance
[c] indicates monthly cost for two mobile SVE units operating simultaneously
[d] includes operation of two mobile SVE units for 48 months and one unit for an additional 24 months

Section 4
DISCUSSION AND CONCLUSION

This section presents discussion and conclusions for the SVE equipment facility at the VOC source area, Site 24, MCAS El Toro.

4.1 DISCUSSION

The total cost differential between options is not significant in comparison to the overall project costs and with respect to the accuracy of the cost estimates. The cost to implement Option 2 would be approximately 5 percent less than Option 1 and Option 3. Several assumptions made in developing the cost estimates have a significant impact on the cost outcomes. The following is an evaluation of these assumptions and an assessment of their impact on the cost.

- An operational period of 24 months at each location was used to calculate the total monthly power and O&M costs for Option 3 (Table 3-4). It is assumed that two mobile SVE units will be operating simultaneously for a period of 48 months and one mobile unit will be operating for a period of 24 months. Proposed locations for the mobile SVE units are shown on Figure 2-4. If additional locations are necessary, the operational period may extend beyond 72 months, increasing the cost of Option 3 by $21,000 per month, or more mobile units will be required, adding additional capital and monthly costs.
- Equipment vendor estimates for capital costs varied by 30 percent for Option 1, 80 percent for Option 2, and 130 percent for Option 3. The lowest vendor quote was used in Table 3-4 (King, Buck Technology, Table 3-3). However, the variability in the vendor estimates indicates that the actual costs may be greater. In addition, because the variability for Option 3 was the greatest, it is likely that the value used in Table 3-4 will have the greatest degree of error (i.e., capital costs for Option 3 are likely to be greater than estimated).
- The Option 1 and 2 calculations for conveyance system installation assumed that all conveyance plumbing in the vicinity of Buildings 296 and 297 would be installed below ground. It is possible that 25 to 50 percent of this plumbing may be installed above ground, depending on site utilization and access requirements. Aboveground installation of the conveyance plumbing would likely decrease conveyance system installation costs by as much as 50 percent ($250,000), making Options 1 and 2 more cost effective.

4.2 CONCLUSION

After consideration of the qualitative advantages and disadvantages and the differential costs between Options 1, 2, and 3, Option 2 appears to be the more attractive equipment design option for the Site 24 SVE system for the following reasons:

- Option 2 offers the greatest level of operational flexibility and a minimal operational period. The individual systems can be designed and independently operated to suit local conditions. However, unlike Option 3, all three systems can be operated simultaneously, minimizing overall operational time.

- The differential cost between Option 2 and Options 1 and 3 is insignificant in comparison with the overall project costs with respect to the accuracy of the cost estimates developed in this evaluation. Additional cost saving may be realized in the implementation of Option 2 through reduction of belowground conveyance plumbing and optimization of equipment design to suit local conditions.

Section 5
REFERENCES

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