Brown and Bryant
Operable Unit No. 2
Superfund Site

Arvin, California

Value Engineering Study

For
U.S. Environmental Protection Agency
Region 9

San Francisco, California

Study Date: January 12-13, 2010

Report: March 22, 2010

Facilitated by
Kenneth True

US Army
Corps of Engineers

US Environmental
Protection Agency

Appendices

A - Study Participants
B - Creative Ideas List
C - FAST Diagram
D - Project Function Model List
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EXECUTIVE SUMMARY

General
This report documents the results of a value engineering (VE) study on the project: Brown and Bryant Superfund Site, Operable Unit Number 02, Arvin, California. The VE study was conducted in the Environmental and Munitions Center of Expertise (EMCE) offices, downtown Omaha, NE via web cast on January 12-13, 2010. A site visit was not conducted. The value engineering team was two experts from the EMCE, engineers and scientists from the Albuquerque District Corps of Engineer, the Environmental Protection Agency Regional Project Manager (RPM) from California, an EPA Region 9 supervisor, and a contract CVS (Certified Value Specialist) Team Leader. There is a signed Record of Decision (ROD) for this project. The design by ECO and Associates, for the Arbor Well and Ground Water Monitoring Network is underway. The remedial action, construction, will probably be accomplished through an Invitation For Bids or use an in-place unit contract, Preplaced Remedial Action Contract, (PRAC). An exit review of the preliminary results of the study was conducted with the team at the conclusion of the second day.

The VE team was given the task of studying the project documents, applying VE methodology, and developing recommendations and comments to provide overall added value to the completed project.

The Project
The Brown and Bryant pesticide facility is located at 600 South Derby Road in Arvin, California, about 18 miles southeast of Bakersfield. Brown and Bryant operated as an herbicide and pesticide reformulator and custom applicator facility from 1960 to 1989. The site is currently on the National Priorities List. The Environmental Protection Agency Region 9 (EPA) signed the ROD for Operable Unit 2 (OU2) on September 28, 2007. Source reduction in the A-zone and Monitored Natural Attenuation were selected as remedies for this Site.

Estimate of Construction Cost
The summary of costs for the selected remedy is shown in table 12-1 in the ROD and summarized below:

Capital and Periodic Costs	$3,645,000
Annual Operating Costs	$1,700,000
Most Likely Total Costs	$15,585,000

Significant Aspects of This VE study
There are several aspects of this study that are noted. This VE study was compressed into a two day schedule. This required that the steps in the VE methodology be compressed. Also the VE study was conducted via web cast. This does somewhat limit the interaction of team members but does allow all of the participants to view data simultaneously as it was discussed and created. This method saves considerable costs, travel time, and professional time for the team members.

Summary of Recommendations

The Summary of Recommendations List represents a summary of the ideas that have been developed into recommendations for this project. Since cost is an important issue for comparison of VE Recommendations, the costs presented in this report are based upon original quantities with unit prices, using government estimates where possible. Where proposed alternate designs included items not in the original estimate, estimating databases or vender quotes were used.

Some recommendations were developed by the VE team but were withdrawn for the reasons stated in the justification paragraph of the recommendation. Those recommendations are included in the below summary as “Withdrawn”.

TABLE 1
SUMMARY OF VE RECOMMENDATIONS

VE Sequence Number	VE REC Number	Description	Potential Savings (Cost)
1	**1 & 2**	Install directional wells.	$5,597,000
2	**5**	Stimulate biodegradation in A-zone groundwater.	$6,924,500
3	**6**	Stimulate biodegradation in B-zone unsaturated soils.	($1,798,000)
4	**9**	Groundwater extraction in B-zone.	($278,150)
5	**11**	In-situ thermal remediation.	($700,000)
6	**22**	Co-metabolic biosparging in B-zone.	($2,600,000)
7	**40**	Belled-out caisson to reduce volume of excavated soil.	$297,000
8	**55**	Remove contaminated soil that is under the existing capped area.	$5,540,000

TABLE 2
Withdrawn Recommendations

Creative Idea ID #	DESCRIPTION
4	Constructed a slurry wall with extraction wells.
10	In-situ chemical oxidation of unsaturated B zone.
12	Remove contaminated soil from A zone.
16	Contaminant sequestration or stabilization A-zone.

TABLE 3
Value Engineering Study Team Members

NAME	FIRM / AGENCY (Please include e-mail address)	ROLE IN THIS STUDY	PHONE
Kenneth True	Contractor kentrue@maladon.con	VE Team Facilitator	402-339-1936 Cell 402-516-2635
Dave Becker	EMCX Dave.J.Becker@usace.army.mil	Geologist	402-697-2655
Chuck Coyle	EMCX Charles.G.Coyle@usace.army.mil	Process Engineer	402-697-2578
Carol Weis	Albuquerque District Carol.A.Wiess@usace.army.mil	CE Project Manager	505-342-3477
Cecilia Horner	Albuquerque District Cecilia.V.Horner@usace.army.mil	Environmental Engr	505-342-3474
Steve Wagner	Albuquerque District Steven.D.Wagner@usace.army.mil	Chemist	505-342-3331
Travis Cain	EPA Cain.Travis@epamail.epa.gov	Regional Project Manager	415-972-3161
Lynn Suer Part Time	EPA suer.lynn@epa.gov	Section Chief	415-972-3148

Acknowledgements
The CVS facilitator contractor, Mr. Kenneth True, thanks the EMCE staff for this opportunity to provide value engineering services and looks forward to working with them in the future.

Certification
This is to verify that the Value Engineering study was conducted in accordance with standard Value Engineering principles and practices.

Kenneth True, PE, CVS(R)
Value Engineering Study Team Leader

SECTION 1 – INTRODUCTION

This report documents the results of a value engineering (VE) study on the project: Brown and Bryant Superfund Site, Operable Unit Number 02, Arvin, California.

Job Plan

This study was performed conforming to the prescribed value engineering job plan as outlined by the Society of American Value Engineering. That plan requires six specific steps to execute a complete VE study. The Functional Analysis was recorded with the Functional Model. This report does not include any detailed explanations of the value engineering/value analysis processes used during the workshop in development of the results presented herein. A summary of the basic processes used in the study is included to give the reader an idea of the standard VE methodology, consisting of six phases:

Information Phase: The team studied the very preliminary design submittal drawing (diagram of eight foot diameter well) and pertinent site data.

Function Analysis Phase: The purpose of this phase is to clearly identify the function(s) of the project and to formulate a concept from which new directions can be taken. The Function Model is included in Appendix D.

Speculation Phase: The CVS led the team brainstorming sessions to generate ideas that could potentially be beneficial to the project execution. All team members contributed ideas, and critical analysis of the ideas was discouraged until the Analysis Phase. The result of this phase is the "Creative Ideas List" which is included in Appendix B. This list is just a speculation list and should be used only as such. Ideas on this list are put forth with no restrictions or analysis with the concept that one idea may build upon another. Analysis on sorting of the list follows, and caution should be extended in using the list beyond the scope of this VE study.

Analysis Phase: Evaluation, testing, and critical analysis of all ideas generated during speculation were performed to determine potential for savings or improvement to the project. Ideas that did not survive critical analysis were deleted. Those feasible ideas that survived the Analysis Phase were then developed into proposals. Those surviving ideas were assigned to members of the team for further development and validation of the merit of the proposal.

Development Phase: The VE study team members developed the surviving ideas into written recommendations. The recommendations' descriptions, along with technical support documentation, and cost estimates were prepared to support implementation of the ideas. Development generally takes the form of a written document clearly expressing the proposed idea, with a "Before" and "After" depiction. In addition, the VE study team identified items of interest as "Design Comments" that were not developed as proposals. These comments follow the study recommendations. Sometimes the attempt to substantiate the proposal results in the modification, elimination, or withdrawal of the idea. The withdrawn idea write up is included in the report to document why the idea was not recommended.

Presentation Phase: This portion of the study will be accomplished by distribution of the draft report for comments and submittal of the final report. The final report will be distributed to the project manager and user/customer for final determination of acceptance or rejection of recommendations. The reasons for rejecting any of the recommendations should be documented and recorded as part of the final report.

Value Engineering

The following is a note to those persons unfamiliar with value engineering. Because there is a value engineering study, and because recommendations for changes to the design have been made, one should not assume there is a problem with the existing design.

The value engineering team is called primarily to look for ways to add value to the project by suggesting alternatives the team believes will lead to improvement. It must be understood that a VE team works from a different perspective than does the design team. The value engineering team represents a second opinion with the benefit of hindsight and with the ability to challenge the owner's instructions to the designer.

In addition VE studies are done on designs in progress. Some recommendations will cover items that are still in a state of change, thus causing the recommendations, in certain cases, to be irrelevant. In other instances, the design team will already be intending to do the things the recommendations are suggesting.

The VE recommendations simply represent an attempt at a different way of looking at the problem to be solved and are presented as additional ideas for consideration by both the owner and the designer.

The final decision as to the acceptance of these recommendations and suggestions rests ultimately with the owner and the designer.

VE Recommendations

Part of the value methodology is to generate as many ideas as is practical, to then evaluate each idea, and to select as candidates for further development only those ideas that offer added value to the project. If an idea thus selected, turns out to work in the manner expected, then that idea is put forth as a formal value engineering recommendation. Recommendations represent only those ideas that are proven to the team's satisfaction.

Full documentation of all VE recommendations developed in this study can be found in Section 3 of this report. A full list of all VE ideas generated in this study can be found in Appendix B.

Some recommendations were developed by the VE team but were withdrawn for the reasons stated in the justification paragraph of the recommendation. Those recommendations are included in the below summary as “Withdrawn”.

Design Comments

Some ideas did not make the selection for development as recommendations but are judged worthy of further consideration. These ideas have been written up as “Design Comments”. Documentation of all Design Comments can be found in Section 5.

SECTION 2 – PROJECT DESCRIPTION

This project description is not in anyway intended to be complete about the history and/or present condition at the site. To fully understand the site, all documents should be reviewed including the remedial investigation report, the feasibility study, the ROD, and all other pertinent data in the record. A very brief description is included below to give the reader of this VE study an overview of the site, contaminates, and proposed remedial actions.

The Brown and Bryant pesticide facility is located at 600 South Derby Road in Arvin, California, about 18 miles southeast of Bakersfield. Brown and Bryant operated as an herbicide and pesticide reformulator and custom applicator facility from 1960 to 1989. The site is currently on the National Priorities List. The ROD for Operable Unit 2 (OU2) was signed by the EPA R9 on September 28, 2007. Source reduction in the A-zone and Monitored Natural Attenuation were selected as remedies for this Site.

The site covers approximately 5 acres and is bordered on the east and the north by irrigated agricultural fields, to the south by food packing and shipping facilities, and on the west by a residential area. Two schools (Gospel Tabernacle of Arvin and Stepping Stones Child Care Center) and a park (Bear Mountain Recreation and Park Center) are within 0.5 mile of the site. The Morning Star Preschool, at 416 North Hill Street, is within 1 mile of the site. The site is currently vacant and secured by a chain-link fence. An engineered bituminous pavement covers the entire site and acts as a Resource Conservation and Recovery Act (RCRA) cap on the Site's southern portion and as a non-RCRA cap in the Site's northern portion. The structures currently present within the fenced area are a warehouse, an open metal shed, and groundwater monitoring wells.

These remedies were chosen in accordance with the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) of 1980, as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA) (collectively referred to herein as CERCLA), and to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). The ROD decision was based on the Administrative Record file for the B&B Site OU-2.

The response action selected by the ROD was necessary to protect public health, or welfare, and the environment from actual or threatened releases of pollutants or contaminants from the B&B Site.

Types of Contamination and Affected Media

Facility operations at the B&B Site have resulted in the discharge of contaminants to the surface and subsurface soils, and certain contaminants have penetrated the groundwater in the A-zone and the unsaturated soils and the groundwater of the B-zone. Several VOCs, SVOCs, herbicides, and pesticides were detected in some of the soil samples. The principal COCs for the B&B Site identified during the OU-1 investigation are:

- Chloroform,

- 1,2-dibromo-3-clilioropropane (DBCP),
- 1,2-dichloropropane (1,2-DCP),
- 1,3-dichloropropane (1,3-DCP),
- 1,2,3-trichloropropane (1,2,3-TCP),
- Ethylene dibromide (EDB), and
- Dinoseb.

COCs identified for OU-2 are the same as those identified for OU-1.

Description of the Selected Remedy

The remedial action for OU-2 at the B&B Site addresses contaminated groundwater. The overall cleanup strategy for the B&B Site is to reduce contamination in groundwater to protect human health and the environment. The contaminated groundwater in the B-zone above the cleanup levels is considered to be a threat to human health and the environment at the Site. The selected remedy reduces the threat of further groundwater contamination within the B-zone groundwater by extracting and treating the groundwater in the shallower A-zone, the source of contamination in the B-zone groundwater. To remove the potential threat to human health, the selected remedy will also use monitored natural attenuation (MNA) in the B-zone groundwater, a potential source of drinking water, placing institutional controls on the Site and nearby properties to prevent the use of B-zone groundwater until such time as drinking water criteria are attained and relocation of the Arvin City Well CW- 1 to remove the threat of cross contamination from the A-zone and the B-zone to the C-zone, as this well has potential to be a conduit. Extraction and treatment of A-zone groundwater was a component of the selected OU-1 remedy. However additional investigation was necessary for adequate design and implementation of A-zone groundwater remediation component. Therefore the A-zone groundwater extraction and treatment component of OU-1 selected remedy was not installed but was carried over to the OU-2.

The major components for the OU-2 include:

- Relocation of the Arvin City Well CW- 1: Properly abandon the existing Arvin CW- 1 and relocate a replacement well a suitable distance from the known B&B Site OU-2 plume.

- Installation of an extraction system in the shallow A-zone aquifer with above ground ultraviolet (UV)/oxidation water treatment and disposal of the treated water to the City of Arvin sewer system.

- Monitored Natural Attenuation: Conduct groundwater monitoring of the B-zone to evaluate: 1) the effectiveness of the remedy, 2) the location of the plume, and 3) that remediation goals have been met by natural attenuation in the B-zone. This component will include an MNA performance plan during implementation of the remedy, which will include details of the groundwater monitoring and natural attenuation progress evaluation for the B-zone groundwater. Actual performance of the natural attenuation remedy will be carefully monitored in accordance with the MNA Performance Plan. If monitoring data indicate that the COC levels do not continue to decline, as estimated in the fate and transport model, EPA and DTSC will reconsider the remedy decision.

- Place institutional controls on the Site and nearby properties to limit use of B-zone groundwater.

- See soil layering system diagram below:

Soil Layering Diagram

Figure 5-2, Brown and Bryant Superfund Site Soil Layering System
(Reproduced from the B&B Site RI/FS Report Figure I-6)

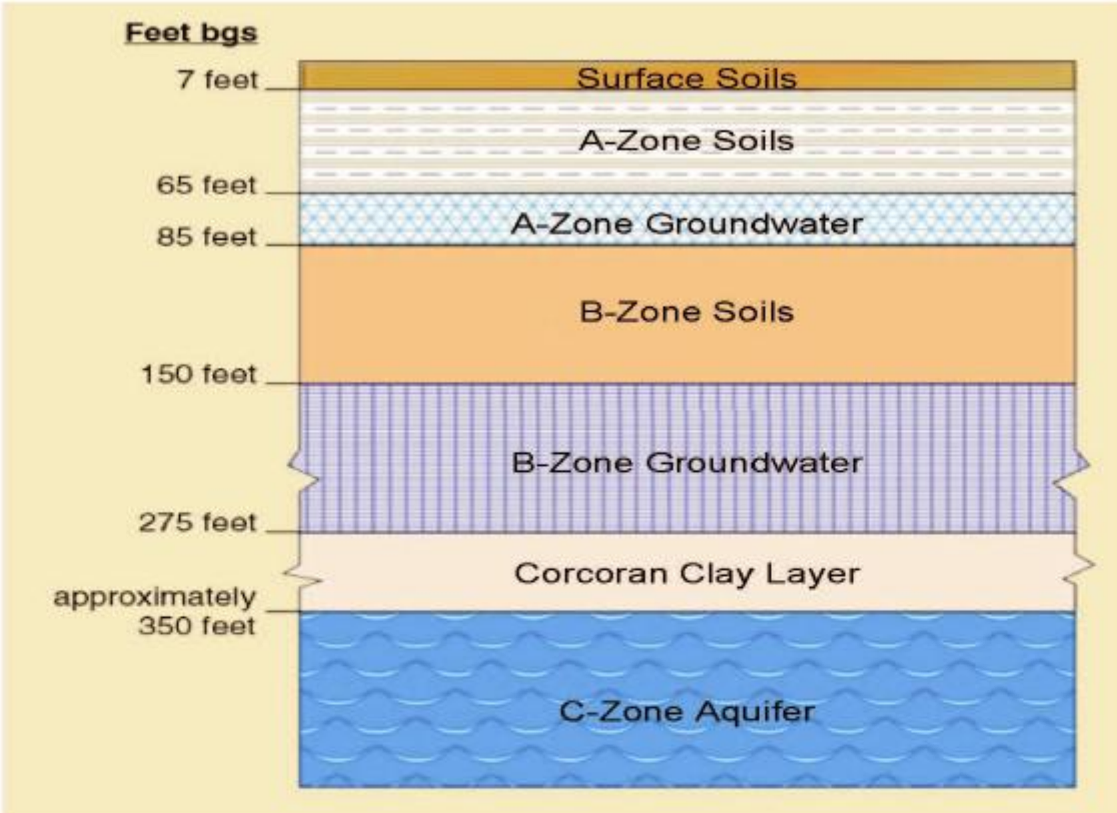

Figure 1-1, Location and Site Maps of Brown and Bryant Superfund Site

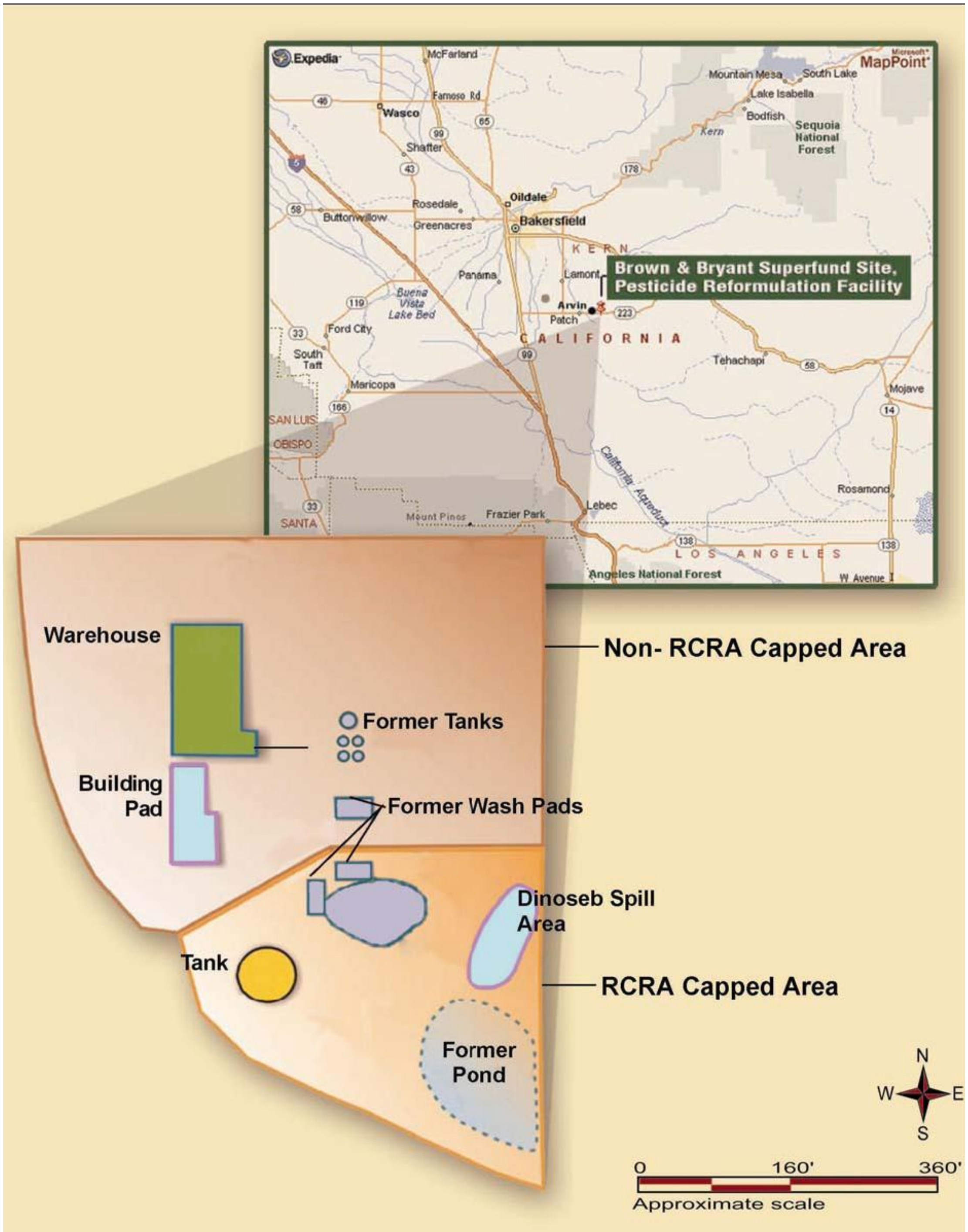

Figure 1. Location and Site Maps of Brown & Bryant Superfund Site

SECTION 3 – VE RECOMMENDATIONS

Organization of Proposals
This section contains the complete documentation of all recommendations resulting from this study. Each recommendation has been marked with a unique identification number. The parent idea, or ideas from which the proposal began, can be determined from the Creative Ideas List located in Appendix B of this report. For tracking purposes, the original idea numbers that make up a recommendation are shown within the recommendation.

Each recommendation is documented by a separate write-up including a description of both the original design and recommended change, a list of advantages and disadvantages, sketches where appropriate, calculations, cost estimate, and the economic impact of the recommendation on the first cost, and where applicable, the life cycle cost. The economic impact is shown in terms of savings or added cost.

VALUE ENGINEERING RECOMMENDATION # 1 & 2

PROJECT: Brown and Bryant Superfund Site
LOCATION: Arvin, California
STUDY DATE: January 12-13, 2010

DESCRIPTIVE TITLE OF RECOMMENDATION:

Creative Idea #: Install directional wells. Ideas 1 and 2 are considered together and Idea 2 is superseded by Idea 1 as directional drilling is deemed more feasible than a Ranney well given the depth to the A unit groundwater.

Creative Ideas #: 1 and 2 **Sequence #** 1

ORIGINAL DESIGN:

Intent is to dewater the saturated portion of the A unit. To do this, it was proposed to install 8-foot diameter vertical wells for recovery of contaminated water. A 6-inch-diameter casing and screen would be placed in the borehole. The bulk of the borehole would be filled with grout but gravel would fill the annulus around the 6-inch screen and extending 5 feet above the top of the screen. Time to effectively dewater the A unit was not available but is believed to be quite long due to the limited number of wells and the low hydraulic conductivity of the materials.

RECOMMENDED CHANGE:

Recommend that the large-diameter vertical wells be replaced with horizontal wells with submersible pumps (or wind-driven piston pumps – see Creative Idea 33). These horizontal wells would be installed using directional drilling technology (utility crossing rigs), with 8-inch boreholes initiated by drilling from areas south of the RCRA cap at a 45 degree angle from horizontal to locations in the paved areas north of the RCRA cap. The boreholes would extend perhaps 650-750 feet turning horizontal for at least 500 feet on northwest-southeast alignments. Spacing of the wells would be approximately 100 feet with a total of 2 wells. Based on analytical equations for the transient performance of drains, the expected flow rates are on the order of 5 gallons/min per horizontal well, decreasing to <0.2 gpm per well after about 3 years. A reasonable estimate is that the horizontal wells will dewater the A zone in approximately half the time of the vertical wells (5 years rather than 10 years).

SUMMARY OF COST ANALYSIS			
	First Cost	O & M Costs (Present Worth)	Total LC Cost (Present Worth)
ORIGINAL DESIGN	$1,282,000	$12,000,000	$13,282,000
RECOMMENDED DESIGN	$685,000	$7,000,000	$7,685,000
ESTIMATED SAVINGS OR (COST)	$597,000	$5,000,000	$5,597,000

VALUE ENGINEERING RECOMMENDATION # 1 and 2

ADVANTAGES:

- Less contaminated soil requiring disposal.
- Targets parts of the aquifer under the cap without disturbing cap.
- Wider capture area and quicker dewatering.
- More constructable/implementable.
- More competition for contract/more standard practice.

DISADVANTAGES:

- Configuration possibly limits wind-powered pump, unless use a sump well.
- There is a slight potential for the drilling to penetrate the aquitard and create vertical pathway.
- There may be difficulty in assuring attaining a specific well screen elevation.
- Potential for degraded well performance due to drilling fluid.

JUSTIFICATION:

The increased effectiveness and more constructible nature and cost savings justify consideration of this alternative. The work is consistent with ROD language.

	Duration	Annual Cost per FS	Present Worth
ROD	10 yrs	1,700,000	($11,940,088.62)
Alt Horiz Wells	5 yrs	1,700,000	($6,970,335.64)
Discount Rate	7%		

The estimate in the table below does not consider the savings from the difference in disposal costs. These have been estimated separately.

<u>To assess impact on disposal costs:</u>
Assume lower 50 feet of vertical wells are contaminated. (4 ft radius)^2 * 50 feet * pi = 2500 cu ft * 1.2 bulking factor = 3000 cu ft/well requiring disposal, plus 35/50X that for the less contaminated soil = 2100 cu ft. Total 5100 cu ft per well (190 cu yd)
For horizontal wells, 750 feet * (radius 0.25 ft)2 * pi * 2 to account for bulking and drilling fluid = 300 cu ft (assume all contaminated) = 11 cu yd. Reduce volume requiring disposal by 90%.
Transient flow to horizontal wells – Q(t) = SQRT(8 C k H_o^3 S_y t / 3) where

Q(t) = flow as function of time

C = factor between 0.5 to 0.75 depending on seepage face (use 0.75 to be conservative)

k = hydraulic conductivity (use 3.9E-4 – RI values had no units, back-calculated from the reported velocity, porosity, and gradient)

H_o = depth of well below static water level (assume 15 feet initially)

Sy = Specific yield (estimated to be 0.1)

t = time

VALUE ENGINEERING RECOMMENDATION # 1 and 2

COST ESTIMATE – First Cost

Cost Item	Units	$/Unit	Original Design		Recommended Design	
			Num of Units	Total $	Num of Units	Total $
ORIGINAL DESIGN				$1,282,000		
Install Well	ft	390.00			1,500	$585,000
Pumps, piping	ls	5,000.00			2	$10,000
Construction Cost				$1,282,000		$595,000
Engr. Costing 15%						$90,000
Total Cost				$1,282,000		$685,000

Linear foot cost for horizontal drilling includes Overhead, Profit, per Means, 2010, p 619.

Horizontal well flow vs. time

C		0.75					
k		0.00077	ft/min				
Ho		10	ft				
Sy		0.1					
t				Cumulative Q		Ave Q	
1	day	1440	min	14.89161	cu ft/ft	5.170697	
10	day	14400	min	47.0914		1.816798	
100	day	144000	min	148.9161		0.574522	
1000	day	1440000	min	470.914		0.18168	
10000	day	14400000	min	1489.161		0.057452	

VALUE ENGINEERING RECOMMENDATION # 5

PROJECT: Brown and Bryant Superfund Site
LOCATION: Arvin, California
STUDY DATE: January 12-13, 2010

DESCRIPTIVE TITLE OF RECOMMENDATION:
Stimulate biodegradation in A-zone groundwater.

Creative Idea #: 5 **Sequence #** 2

ORIGINAL DESIGN:

Groundwater extraction via several large-diameter vertical wells with associated off-site shipment and treatment.

RECOMMENDED CHANGE:

To stimulate biodegradation, electron donor would be injected into the A-zone groundwater. Laboratory microcosm studies would be performed to determine the effectiveness of anaerobic biodegradation and bioaugmentation for the site-specific mixture of contaminants. A bioaugmentation culture, capable of complete dechlorination of 1, 2, 3-TCP, would be used (Yan, J., et al., 2009). A pilot-scale study would be performed to demonstrate the effectiveness of this approach, and to determine spacing of injection points. After completion of the pilot study, a grid of injection points would be installed. After anaerobic conditions have been established, thru electron donor injection, a bioaugmentation culture would be injected. Continued monitoring would be required to track biogeochemical conditions and contaminant levels. Depending on the monitoring results, additional injection of electron donor and/or bioaugmentation culture may be necessary.

Monitoring of the B-zone would also be performed to determine if any arsenic mobilization is occurring. This recommendation could be combined with either recommendation 6 or recommendation 10 for added protection against the potential for electron donor and/or arsenic to migrate from the A- to the B-zone. Recommendations 6 and 10 both involve injection of vapor-phase amendments for treatment of the unsaturated portion of the B-zone. Recommendation 6 involves injection of a mixture of air and cometabolite, while recommendation 10 involves injection of ozone. A less complicated way to mitigate the risk of mobilizing arsenic would be to simply inject air into the unsaturated portion of the B-zone.

VALUE ENGINEERING RECOMMENDATION # 5

SUMMARY OF COST ANALYSIS			
	First Cost	O & M Costs (Present Worth)	Total LC Cost (Present Worth)
ORIGINAL DESIGN	$1,282,000	$12,000,000	13,300,000
RECOMMENDED DESIGN			6,375,500
ESTIMATED SAVINGS OR (COST)			6,924,500

VALUE ENGINEERING RECOMMENDATION # 5

ADVANTAGES:

- May accelerate attenuation, avoids stranding contaminant sorbed on dewatered soils.
- Permanent, in-situ contaminant mass destruction.
- Does not require extraction and above-ground treatment or disposal of groundwater.
- Can address all site COCs (including dinoseb) by creating anaerobic conditions, and using bioaugmentation with new strain of Dehalococcoides capable of degradation of 1,2,3-TCP.

DISADVANTAGES:

- Creating anaerobic conditions makes for potential risk of mobilization of arsenic (though arsenic may not migrate far from A-zone).
- May be difficult to distribute amendments and create uniformly anaerobic conditions.
- Specialized culture for 1,2,3-TCP degradation may not yet be commercially available, but it may be possible to coordinate with researchers to obtain the culture and permission to use it.
- May be difficult to explain the technology to the public.

JUSTIFICATION:

The ROD does not address the potential for in-situ treatment such as this.

The following tool was used to estimate for this recommendation: COST ESTIMATING TOOL FOR ENHANCED ANAEROBIC BIOREMEDIATION OF CHLORINATED SOLVENTS, Version 1.3, April 2005. It was assumed that the area to be treated is 400 feet by 370 feet (3.4 acres) with a saturated thickness of 10 feet. Within the cost estimating tool, default assumptions were used except for the following fields: aquifer description (site specific values for depth to groundwater, hydraulic conductivity, seepage velocity, and treatment cell dimensions were entered); design life for monitoring period (10 yrs); number of slow-release injection points (1974); number of monitoring wells (30); number of injection events (2); monitoring frequency (every 6 months). For added conservatism, injection spacing was assumed to be one injection point every 75 square feet, rather than the default (one injection point every 100 square feet).

Costs for laboratory and pilot-scale study were also included in the estimate. It is expected that the combined cost for these two items would be about $150,000.

References:
Yan J., Rash B.A., Rainey F.A., and Moe W.M., Isolation of novel bacteria within the Chloroflexi capable of reductive dechlorination of 1,2,3-trichloropropane; Environmental microbiology 11(4):833-43, 2009 Apr.

VALUE ENGINEERING RECOMMENDATION # 5

Bio cost estimate screen shot

A	B	C	D	E	F	G	H

Cost Estimate for Enhanced Anaerobic Bioremediation of Chlorinated Solvents

Model Summary Report

Project Name	**Brown & Bryant**
Project Location	**Anywhere, USA**
Proposed Remedial Configuration	**Source Area Or Grid**
Design Life (years)	**10**

The Model reflects April 2005 Costs

Main Back Next Help

Task	Category (Subtask)	Cost Type	Percent	No. Events	Amount
D	Delivery System	ODCs		1	$0
				Subtotal:	**$0**
3A	**Operations and Maintenance Soluble Substrate Systems**				
A	Mobilization/Maintenance/Monitoring/Injection	labor		Varies	$0
B	Analytical Cost	subcontractor		Varies	$0
C	Materials and Equipment (excludes substrate)	ODCs		Varies	$0
				Subtotal:	**$0**
SLOW RELEASE SUBSTRATES					
2B	**Capital Construction Slow-Release Substrate Systems**				
A	Permitting and Construction Management	labor		1	$300,600
B	System Installation and Injection	labor		1	$457,650
C	Injection and Monitoring Well Construction	subcontractor		1	$1,125,000
D	Delivery System	ODCs		1	$3,000
				Subtotal:	**$1,886,250**
3B	**Operations and Maintenance Slow-Release Substrate Systems**				
A	Materials and Equipment	ODCs		Varies	$197,400
B	Subcontractor	subcontractor		Varies	$1,975,000
C	Labor	labor		Varies	$888,300
				Subtotal:	**$3,060,700**
4	**Substrate Cost**				
A	Life-Cycle Substrate Cost	ODCs		Lump Sum	$0
				Subtotal:	**$0**
5	**Process Monitoring**				
A	Analytical Cost	subcontractor		21	$277,200
B	Materials and Equipment	ODCs		21	$207,900
C	Mobilization, Sampling, Data Management	labor		21	$378,000
				Subtotal:	**$863,100**
6	**Reporting**		10.0%		
A	System Evaluation	labor	9.5%	1	$551,955
B	Report Production	ODCs	0.5%	1	$29,050
				Subtotal:	**$581,005**
7	**Project Management/Markups/Fees/Contingency**				
A	Project Management		10.0%	lump sum	$697,206
B	Subcontractors and ODCs Markup		5.0%	lump sum	$192,180
C	Labor Profit (Fixed Fee)		5.0%	lump sum	$156,423
D	Contingency (percent of total costs less markups and fees)		0.0%	lump sum	$0
				Subtotal:	**$1,045,809**
				Total Project Cost:	**$8,017,869**
				Present Net Worth:	**$6,225,493**
				Discount Rate (1-10%):	7.0%

VALUE ENGINEERING RECOMMENDATION # 6

PROJECT: Brown and Bryant Superfund Site
LOCATION: Arvin, California
STUDY DATE: January 12-13, 2010

DESCRIPTIVE TITLE OF RECOMMENDATION:
Stimulate biodegradation in B-zone unsaturated soils.

Creative Idea #: 6 **Sequence #** 3

ORIGINAL DESIGN:

Groundwater extraction via several large-diameter vertical wells in A-zone with associated off-site shipment and treatment. Current ROD only calls for monitored natural attenuation (MNA) for B-zone groundwater (i.e., no active treatment in B-zone).

RECOMMENDED CHANGE:

Transport of contaminants from the A-zone to the B-zone would be intercepted via in-situ bioremediation. Air and a cometabolite (propane or methane) would be injected into the unsaturated B-zone. Propane or methane levels would be kept significantly below the lower explosive limit. Vapor injection wells would be installed on a 100 foot spacing with well screens extending from just below the basal A-zone clay layer to approximately 5 feet above the highest B-zone water levels. These wells would be connected to an air compressor and either a natural gas source or a propane storage system. Injection would be controlled by a logic controller set to pulse air and cometabolite into each well on a rotating schedule. Vapor monitoring points would be installed into the unsaturated B-zone to assess the adequacy of oxygen and cometabolite distribution. Although it may be difficult to uniformly distribute the oxygen and cometabolite throughout the unsaturated B-zone, there should be stratigraphic zones where adequate treatment is expected to greatly reduce loading on the B-zone aquifer. Both bench-scale and pilot-scale testing would be required to support the design.

There is no risk of arsenic mobilization associated with implementing this recommendation as a stand- alone action. If recommendation 6 were to be combined with recommendation 5, it would provide added protection against the potential for electron donor and/or arsenic to migrate from the A- to the B-zone. The air would stimulate biodegradation of electron donor that seeps down from the A-zone, which should prevent arsenic from being mobilized in the B-zone. The air would also be expected to transform reduced arsenic species that could potentially seep down from the A-zone into a less mobile, oxidized form.

VALUE ENGINEERING RECOMMENDATION # 6

SUMMARY OF COST ANALYSIS			
	First Cost	O & M Costs (Present Worth)	Total LC Cost (Present Worth)
ORIGINAL DESIGN			0
RECOMMENDED DESIGN	1,208,000	590,000	1,798,000
ESTIMATED SAVINGS OR (COST)			(1,798,000)

VALUE ENGINEERING RECOMMENDATION # 6

ADVANTAGES:

- May accelerate attenuation.
- Permanent contaminant mass destruction.
- Does not require extraction and above-ground treatment or disposal of groundwater.
- Can address most site COCs, except dinoseb, using aerobic degradation with cometabolite.
- Will address 1, 2, 3-TCP.
- If combined with recommendation 5, will reduce the risk of arsenic mobilization.

DISADVANTAGES:

- May be difficult to distribute amendments (though easier task than in the A-zone.
- May be difficult to explain the technology to the public.
- Treatment zone is large and deep.
- Does not address dinoseb.

JUSTIFICATION:

ROD does not preclude later in-situ enhancements to monitored natural attenuation.
Based on the conceptual design described above, an estimated cost was determined for the alternative using the RACER cost-estimating tool. The costs provided here are thought to be within the typically accepted range of +50/-30% and include design, capital costs, operations and maintenance, monitoring, oversight. and contingencies. The duration of the operation of the systems is assumed to be 5 years. Five years of operation would be followed by several years of subsequent monitoring, but these costs are not included. The costs for the remediation of unsaturated B-zone soils are estimated to be $1.798M ($0.98M capital costs, $0.59M O&M, $78,000 design, and $150,000 for bench-scale and pilot-scale studies). These totals include markups but not contingencies. Given the nature of the RACER estimates, a contingency of at least 20% is recommended. Future costs are not discounted to present worth, so the costs are conservative in that regard.

Assumptions for Cost Estimate:

Assume that the area to be treated is 400 feet by 370 feet (3.4 acres) with an unsaturated thickness of 65 feet.
Cometabolic Injection System: Require 13 injection wells, 150 feet deep, Assume PVC casing, but adjust price up, assume 50 feet screen
Require blower – assume 25 cfm/well, but cycle, total flow 150 cfm
Require piping, 2-inch vapor to 6-inch header
Require cometabolic amendment storage and controls (propane tank and piping)
Require 13 vapor monitoring points 150 feet deep, two ports each, steel casing, 2-foot screens.
Require electrical service to pad (for both multi-phase and cometabolic injection systems)
Assume housed on same pad as multi-phase extraction system

VALUE ENGINEERING RECOMMENDATION # 9

PROJECT: Brown and Bryant Superfund Site
LOCATION: Arvin, CA
STUDY DATE: January 12-13, 2010

DESCRIPTIVE TITLE OF RECOMMENDATION:
Groundwater extraction in B-zone.

Creative Idea #: 9 **Sequence #** 4

ORIGINAL DESIGN:

No ground water extraction is included in the original design.

RECOMMENDED CHANGE:

The proposed change would include ground water extraction as a means to control a contaminant plume in the B-zone aquifer in the event natural attenuation is not adequate to limit the contaminant migration. Assuming:

- hydraulic conductivity of 8E-3 cm/sec for the saturated B-zone (per RI report, p. 7),
- a saturated thickness of 50 feet (from the B-zone water table to top of intermediate continuous clay layer per RI, p 7, and ROD p 2-9),
- a hydraulic gradient of 0.0004 (per the RI, p 7),
- and a plume width of 800 feet,

a total pumpage of approximately 2 gpm would be required. This seems low, so a value of 20 gpm was used. Assume 3 wells pumping approximately 7 gpm (a sustainable yield per the RI) located along Franklin and Derby Streets. Each well would be 150 feet deep, 6 inches in diameter, with stainless steel screen and schedule 80 PVC casing. Each well would be fitted with a 4-inch submersible pump with variable-frequency drive motors capable of pumping up to 12 gpm to allow easy flow modification and capacity for higher pumpage if necessary. The wells would pump via HDPE piping installed in City right-of-way to a modular treatment plant located on site.

Treatment would consist of liquid-phase granular activated carbon (GAC). Before this decision was reached, an evaluation of advanced oxidation processes (AOP) was performed. The AOP evaluation is shown below. Influent levels of contaminants in the extracted groundwater were based on a summary from the Independent Evaluation Report. It was assumed that the extracted groundwater would have to be treated to meet the groundwater cleanup levels shown in the ROD. The Independent Evaluation Report summarized contaminant levels in the A-zone & B-zone groundwater as follows: "The upper portion of the underlying B-zone aquifer is also contaminated with these compounds, but at lower concentrations. Maximum concentrations in May 2003 included 72 µg/L 1, 2 DCP, 240 µg/L 1, 2, 3 TCP, 36 µg/L DBCP, 6.7 µg/L chloroform, and 39 µg/L dinoseb. No EDB was observed in the B-zone." The cleanup criteria shown in the ROD are as follows: 5 µg/L 1,2 DCP, 0.5 µg/L 1,2,3 TCP, 0.2 µg/L DBCP, 80 µg/L total trihalomethanes (includes chloroform), and 7 µg/L dinoseb.

Effective treatment of TCP and DBCP has been demonstrated at the laboratory scale via a process that requires both ozone and hydrogen peroxide (Dombeck, G., and C. Borg. 2005). The study employed a continuous in-line, pressurized, advanced oxidation processes (AOP) referred to as HiPOx. However, the starting concentrations of TCP and DBCP used in the study were about 2.5 orders of magnitude lower than the maximum levels of that have been detected in B-zone groundwater. The study also indicated that testing was not performed to determine whether reaction byproducts were generated during treatment.

Chloroform is generally not amenable to AOP treatment. However chloroform levels appear to already be low enough such that treatment of this contaminant may not be necessary. The maximum of chloroform detected in the B-zone in May 2003 was 6.7 µg/L. The Federal MCL for total trihalomethanes is 80 µg/L. Trihalomethanes include: chloroform, bromodichloromethane, dibromochloromethane, and bromoform.

According to Dombeck and Borg, the cost to treat TCP and DBCP (at the concentrations used for the study) using a HiPOx system were $230 per acre-foot ($0.71 per 1000 gallon). At 20 gpm, this translates to an annual cost of $7420. However this figure only includes costs for: electricity, ozone, and hydrogen peroxide. Operational costs may be higher because of unknowns regarding the composition of the extracted water, and because contaminant levels in water extracted from the B&B site are expected be higher than the contaminant levels used in the study. The presence of suspended solids, organic carbon, and high levels of dissolved solids could impact costs. To account for these unknowns, it was assumed that annual operational costs would be in the area of $30,000, excluding labor. Labor costs would be comparable to that of liquid-phase GAC (in the area of $85,000 per year).

According to a 2005 Technology Information Summary sheet, capital costs for a small HiPOx reactor would be between $90,000 and $300,000 (for a flow-rate range from 1-250 gpm). It was assumed that the capital costs for a 20 gpm reactor would be in the area of $200,000. GAC vessels would probably also be required as a polishing step, following the HiPOx reactor. GAC would probably be necessary because there is potential for generation of reaction byproducts. Capital costs for a GAC polishing system were not estimated. Based on the above estimated costs, the AOP alternative was deemed to be cost prohibitive.

Granular activated carbon (GAC) is recommended as the sole treatment process to treat the extracted groundwater. As indicated above, B-zone contaminants include: 1, 2, 3-TCP, 1, 2-DCP, DBCP, dinoseb, and chloroform. With the exception of chloroform, all of the contaminants that are expected to be present in the B-zone groundwater are amenable to GAC adsorption.

VALUE ENGINEERING RECOMMENDATION # 9

A liquid-phase GAC treatment system would be simpler to operate and maintain than an advanced oxidation reactor. To assure effective treatment, a GAC system would be installed with 2 vessels in series, and with monitoring between vessels. The capital cost for the GAC system was estimated to be $28,800. Based on discussions with a Calgon technical representative, the system would include two CR2000 vessels. The carbon capacity of each vessel is 2000 lbs. Costs for the 2-vessel system and piping are approximately $25,000, plus 15% for transportation and installation. Carbon consumption was estimated in consultation with Calgon. Assuming $1.50 per pound, annual carbon consumption costs were estimated to be about $2,700. Labor costs for operation of the GAC system were estimated to be $83,200 per year. It was assumed that the system could operate unattended for the majority of the time, but an operator would be required for 16 hours per week. A fully burdened labor rate of $100 per hour was assumed.

References:

Dombeck, G., and C. Borg. 2005. “Multicontaminant Treatment for 1, 2, 3 Trichloropropane Destruction Using the HiPOx Reactor.” Reprinted from the Proceedings of the 2005 NGWA Conference on MTBE and Perchlorate: Assessment, Remediation, and Public Policy with permission of the National Ground Water Association Press. Copyright 2005. ISBN #1-56034-120-3.

Response Technology Ready Reference, Technology Information Summary, USEPA ORD NHSRC, Oct 2005.

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SUMMARY OF COST ANALYSIS			
	First Cost	O & M Costs (Present Worth)	Total LC Cost (Present Worth)
ORIGINAL DESIGN	N/A	N/A	N/A
RECOMMENDED DESIGN			
Wells, $125/foot * 150 feet * 3 wells	$56,250	$39,200	$95,450
Piping 2400 feet * $12/foot installed	$28,000	$39,200	$68,000
Package Treatment Plant	$28,800	$85,900	$114, 700
ESTIMATED SAVINGS OR (COST)	($103,800)	($164,300)	($278,150)

VALUE ENGINEERING RECOMMENDATION # 9

ADVANTAGES:

- Provides a positive control of migration of mobile dissolved contaminants (containment).
- Removes contaminant mass from the environment.
- Is implementable in B-zone due to higher hydraulic conductivities.
- May slightly reduce the time for management of the B zone plume.
- May be attractive to the community.
- If combined with recommendation 5, may mitigate the risk of arsenic mobilization.

DISADVANTAGES:

- Requires above-ground treatment facilities with attendant long-term operations costs and commitment.
- Difficult to determine when to cease pump and treat operations (question on acceptable exit strategy).
- State acceptance is unlikely.

JUSTIFICATION:

ROD does not anticipate active remediation of B-zone, but might be considered a contingent remedy component.

Cost estimate based on Means, 2010 costs for piping. Piping costs include trenching ($1.89/ft), materials ($4/ft), backfill ($3.45/ft), and roughly $2.70/ft for patching pavement/cover. Operations costs for wells and piping include $2,000/year for well and piping rehabilitation for 30 years using a 3% discount rate.

VALUE ENGINEERING RECOMMENDATION # 11

PROJECT: Brown and Bryant Superfund Site
LOCATION: Arvin, CA
STUDY DATE: January 12-13, 2010

DESCRIPTIVE TITLE OF RECOMMENDATION:
In-situ thermal remediation.

Creative Idea #: 11 **Sequence #** 5

ORIGINAL DESIGN:

Groundwater extraction via several large-diameter vertical wells with associated off-site shipment and treatment.

RECOMMENDED CHANGE:

Install in-situ thermal treatment (electrical resistivity heating) system with associated above-ground treatment of vapors and condensate. The thermal treatment will evaporate water from the perched A-zone and volatilize much of the contaminants, with the likely exceptions of the dinoseb and dibromochloropropane (DBCP). Assume that the area to be treated is 400 feet by 370 feet (3.4 acres) with a treated thickness of 15 feet for a total of 2,220,000 cu ft or 83,000 cu yd. Electrical resistivity heating (ERH) has a cost of $80-200 cu yd (USACE EM 1110-1-4015). Given the size of this project, there will be economies of scale, but these are offset to some degree by the depth to the treatment zone, the extended heating times to remove the water, and the lower volatility contaminants. Assume $170/cu yd.

SUMMARY OF COST ANALYSIS			
	First Cost	O & M Costs (Present Worth)	Total LC Cost (Present Worth)
ORIGINAL DESIGN	$1,282,000	$12,000,000	13,300,000
RECOMMENDED DESIGN	$14,000,000	Included	$14,000,000
ESTIMATED SAVINGS OR (COST)			($700,000)

VALUE ENGINEERING RECOMMENDATION # 11

ADVANTAGES:

- Substantial removal of contaminant mass.
- Remove water from perched A-zone.
- May eliminate need for long-term management of the A-zone groundwater.
- Likely to be favorably received by the State and public than other alternatives.
- Works well in heterogeneous and low-permeability soils.

DISADVANTAGES:

- Relatively high capital cost.
- Requires extraction and treatment of contaminant vapors and condensate.
- Dinoseb and DBCP will either require long treatment times or higher temperatures or both. Assume that these compounds are immobilized by removing perched water.

JUSTIFICATION:

If success is determined to be defined by the removal of the saturated A-zone and the removal and immobilization of the contaminants currently in the saturated A-zone soils, ERH has a significantly higher probability of success compared to the current design using ground water extraction.

VALUE ENGINEERING RECOMMENDATION # 22

PROJECT: Brown and Bryant Superfund
LOCATION: Arvin, CA
STUDY DATE: January 12-13, 2010

DESCRIPTIVE TITLE OF RECOMMENDATION:
Co-metabolic biosparging in B-zone.

Creative Idea # 22 **Sequence #** 6

ORIGINAL DESIGN:

Current ROD only calls for monitored natural attenuation (MNA) for B-zone groundwater (i.e., no active treatment in B-zone).

RECOMMENDED CHANGE:

In the event that treatment of the saturated B-zone is required, cometabologic biosparging may address most of the likely contaminants to impact this deeper aquifer. Note that dinoseb would not be significantly treated. This recommendation would be simply and cost-effectively combined with recommendation 6 that addresses the unsaturated B-zone. Air and a cometabolite (propane or methane) would be injected into the saturated B-zone via vertical wells (assuming additional wells beyond those assumed for recommendation 6) or a horizontal well oriented perpendicular to the ground water flow. The objective of this configuration would be to establish a barrier to off-site migration of contaminants in the B-zone aquifer. Once the mass loading from the A-zone is controlled, the overall concentrations in the B-zone will decline as ground water passes by the sparging barrier. As noted in recommendation 6, propane or methane levels would be kept significantly below the lower explosive limit. A horizontal well would be connected to an air compressor and either a natural gas source or a propane storage system. Slightly larger compressors with larger energy demand would be required for the biosparging than would be required for cometabolic bioventing in recommendation 6. Injection would be controlled by a logic controller set to pulse air and cometabolite into the well on a schedule meant to minimize electrical cost and to provide maximum dissolution of oxygen and carbon source in the aquifer. If combined with recommendation 6, the injection would occur for longer intervals to assure deliver of air and cometabolite to the unsaturated B-zone Monitoring wells would be installed into the saturated B-zone to supplement existing monitoring wells for assessing the adequacy of oxygen and cometabolite distribution. Additional investigation of the vertical contaminant distribution and aquifer stratigraphic characterization would be needed. Both bench-scale and pilot-scale testing would be required to support the design.
If recommendation 22 (and/or 6) were to be combined with recommendation 5, it would provide added protection against the potential for electron donor and/or arsenic to migrate from the A- to the B-zone.

VALUE ENGINEERING RECOMMENDATION # 22

SUMMARY OF COST ANALYSIS			
	First Cost	O & M Costs (Present Worth)	Total LC Cost (Present Worth)
ORIGINAL DESIGN*	N/A	N/A	N/A
RECOMMENDED DESIGN	$1,800,000	$800,000	$2,600,000
ESTIMATED SAVINGS OR (COST)			($2,600,000)

*The original ROD did not include any active remediation for the B-zone groundwater.

VALUE ENGINEERING RECOMMENDATION # 22

ADVANTAGES:

- May accelerate attenuation.
- Permanent contaminant mass destruction.
- Does not require extraction and above-ground treatment or disposal of groundwater.
- Can address most site COCs, except dinoseb, using aerobic degradation with cometabolite.
- Will address 1,2,3-TCP.

DISADVANTAGES:

- May be difficult to distribute air and co-metabolite (though easier task than in the A-zone).
- May be difficult to explain the technology to the public.
- Treatment zone is large and deep.
- Does not address dinoseb.

JUSTIFICATION:

ROD does not preclude later in-situ enhancements to monitored natural attenuation. May be implemented if MNA is not working.

Using the RACER cost estimate prepared for recommendation 6 as a baseline, the costs would increase by perhaps $540,000 for either 20 additional vertical wells (at a 30-foot spacing over 600 feet, to a depth of 180 feet at $150/ft), or one horizontal well 600 feet long. Additional equipment costs (for the larger compressor and piping) would be perhaps $50,000. The costs provided here are thought to be within the typically accepted range of +50/-30% and include design, capital costs, operations and maintenance, monitoring, oversight, and contingencies. As with recommendation 6, the duration of the operation of the systems is assumed to be 5 years. Five years of operation would be followed by several years of subsequent monitoring, but these costs are not included. The costs for the remediation of unsaturated B-zone soils are estimated to be approximately $2.6M ($1.6M capital costs, $0.8M O&M, $78,000 design, and $150,000 for bench- & pilot-scale studies). These totals include markups, but not contingencies. Given the nature of the RACER estimates, a contingency of at least 20% is recommended. Future costs are not discounted to present worth, so the costs are conservative in that regard.

VALUE ENGINEERING RECOMMENDATION # 40

PROJECT: Brown and Bryant Superfund Site
LOCATION: Arvin, California
STUDY DATE: January 12-13, 2010

DESCRIPTIVE TITLE OF RECOMMENDATION:
Belled-out caisson to reduce volume of excavated soil.

Creative Idea #: 40 **Sequence #** 7

ORIGINAL DESIGN:

The proposed design is to provide eight foot diameter wells approximately 85 feet below ground surface. The bottom 20 feet have a pea gravel filter pack. The wells will have a 2 inch PVC discharge pipe and an approximate 10 gallon per minute submersible discharge pump. See attached drawing "Groundwater Extraction Well Construction detail by Eco & Associates, Inc., Figure 1.

RECOMMENDED CHANGE:

Use a much small diameter well with a belled bottom similar to a belled bottom structural caisson. The belled portion could be eight foot in diameter and be gravel packed similar to the proposed design.

SUMMARY OF COST ANALYSIS			
	First Cost	O & M Costs (Present Worth)	Total LC Cost (Present Worth)
ORIGINAL DESIGN	$361,000		$361,000
RECOMMENDED DESIGN	$64,000		$64,000
ESTIMATED SAVINGS OR (COST)	$297,000	$0	$297,000

VALUE ENGINEERING RECOMMENDATION # 40

ADVANTAGES:

- Significantly reduces amount of excavated materials.
- Significantly increases constructability relative to current design.
- Uses known construction methods, established technology.

DISADVANTAGES:

- Potential bell hole collapse during construction.

JUSTIFICATION:

This recommended change is consistent with the current ROD.
It is assumed that the reason for the large proposed diameter is to obtain the circumference area for the filter pack area. Using a smaller diameter bore but belling the bottom produces the same results. The stability of the soil during the belling process could be an issue but due to the minimum water content of the soils, this problem is not anticipated with this design solution. This recommendation provides all of the benefits of the larger well with a significant cost savings and considerably less soil disposal problems. See attached sketch.

The limited research done into caisson construction found that up to 84 inch (7 feet) diameter caisson could be drilled and belled out up to 14 feet. The soil condition and depth would be critical factors. 24 inch caissons can be belled out up to 4 feet in diameter. 36 inch caisson can be belled out up to 8 feet in diameter. For structural caissons, the bell depth would not typically be as deep as the proposed depth for a groundwater extraction well. Not withstanding the soil conditions stability, there should not be any constructability limitations on the bell depths.

Recommend that a 36 inch caisson be used belled to an eight foot diameter. The bell depth could be 20 to 22 feet deep as proposed, packed with gravel, etc.

The need to case the entire length during construction and/or permanently would be the same for either a 36 inch diameter or an eight foot diameter. In fact, a 36 inch may hold during construction and packing the entire height better than an eight foot diameter. The proposed plan does not indicate casing for the entire length. Cost for casing would be less for a 36 inch than for eight foot well.

For cost estimating purposes, an 84 inch caisson belled to eight foot was used as the original design. The actual construction method planned for the eight foot diameter well was unknown, but could be assumed to be considerably higher than the 84 inch belled caisson. Therefore the cost estimate for the “original” designed well could be much higher than estimated.

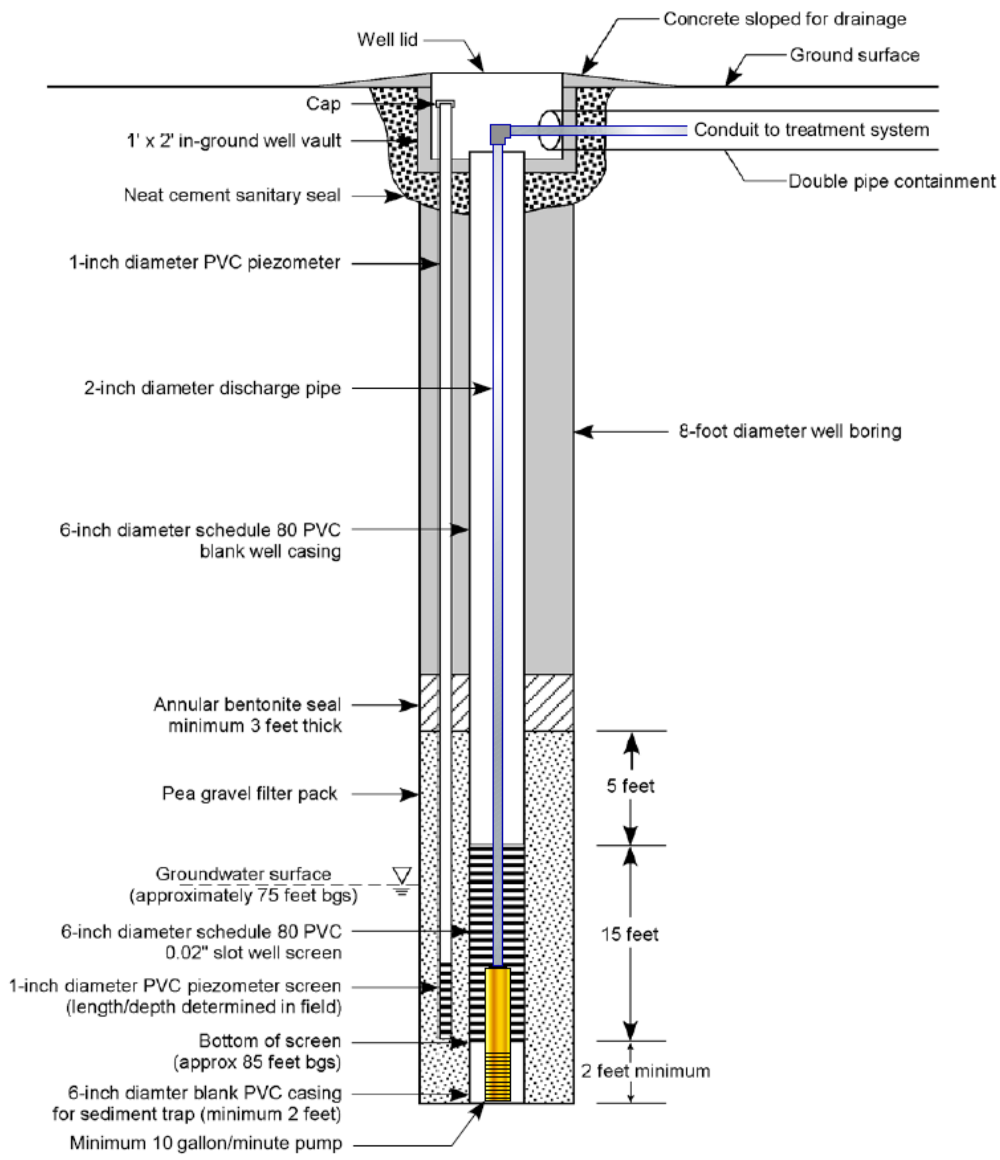
The potential savings for this recommendation could be far greater than estimated.

VALUE ENGINEERING RECOMMENDATION # 40

COST ESTIMATE – First Cost

Cost Item	Units	$/Unit	Original Design		Recommended Design	
			Num of Units	Total $	Num of Units	Total $
84 inch well, belled to eight foot	l ft	850.00	340	$289,000		
36 inch caisson belled to 8 foot	l ft	150.00			340	$51,000
Assume 4 wells, 85 foot deep						
Construction Cost				$289,000		$51,000
CWE 125%				$361,250		$63,750

Figure 1 Well Drawing



Environmental Excellence

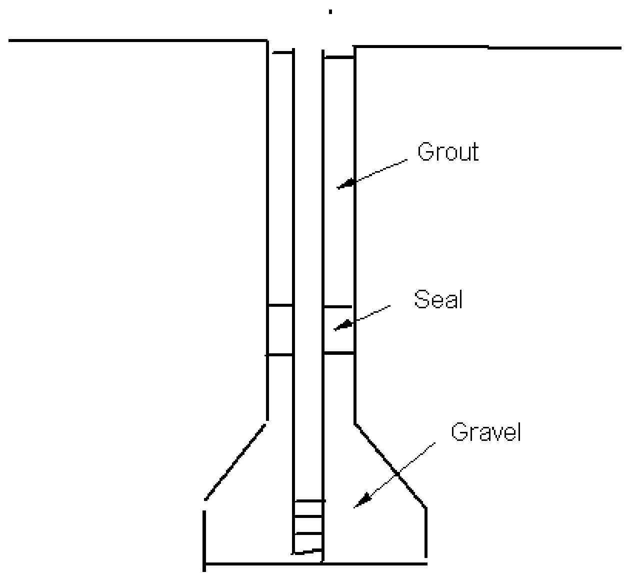
Eco & Associates, Inc.
1855 W Katella Avenue, Suite 340
Orange, California 92867
Phone: 714.289.0995 FAX: 714.289.0965

GROUNDWATER EXTRACTION WELL CONSTRUCTION DETAIL
Brown & Bryant, Arvin, California

Project No.: Eco-09-350 Jan 2010

FIGURE: 1

Figure 2



VALUE ENGINEERING RECOMMENDATION # 55

PROJECT: Brown & Bryant Superfund Site
LOCATION: Arvin, CA
STUDY DATE: January 12-13, 2010

DESCRIPTIVE TITLE OF RECOMMENDATION:

Creative Idea #: 55 Remove contaminated soil that is under the existing capped area.

Creative Idea #: 55 **Sequence #** 8

ORIGINAL DESIGN:

The original design for the Second Operable Unit (OU2) does not address soils. A soil impoundment or RCRA cell was designed and constructed on the project site in support of the First Operable Unit (OU1) Record of Decision (ROD). The soils in this impoundment cell are highly contaminated with the COCs identified for this project. The cell also contains other debris associated with site demolition such as wasted asphalt. The OU1 ROD requires that the cap for the RCRA cell be maintained.

RECOMMENDED CHANGE:

Recommended that the soil impoundment under the existing cap be removed. Although the RCRA cap remains at the site, it is probable that the soils present in the cell are continuing to release contaminants to the A-zone groundwater aquifer. Groundwater monitoring events continue to show the presence of COCs at very high levels in the A-zone groundwater immediately adjacent and laterally from the RCRA cell. This would eliminate the source of continuing contamination in the A-zone soils. The A-zone groundwater below and adjacent to the site would be able to attenuate faster without continued exposure the highly contaminated subsurface soils. Given the present level of contamination in the A-zone groundwater, initial natural attenuation calculations have projected a 100-yr required timeframe for groundwater to reach OU2 maximum contaminant levels. Since the A-zone groundwater could attenuate more readily, this recommendation would also reduce the continuing contamination of the B-zone groundwater.

SUMMARY OF COST ANALYSIS			
	First Cost	O & M Costs (Present Worth)	Total LC Cost (Present Worth)
ORIGINAL DESIGN	0	$9,846,000	$9,846,000
RECOMMENDED DESIGN	($4,306,000)	0	($4,306,000)
ESTIMATED SAVINGS OR (COST)	($4,306,000)	$9,846,000	$5,540,000

VALUE ENGINEERING RECOMMENDATION # 55

ADVANTAGES:

- Permanent remedy
- Eliminates operations and maintenance costs for long-term management of RCRA-cap
- Reduce time for natural attenuation of COCs in the A-zone
- Remove source of contaminants that may impact B zone
- Reduce time for natural attenuation of COCs in the B-zone
- Railroad available for transport immediately adjacent to site
- Stimulate local employment/economy
- Would be favorably received by the State and the community
- Site could be reused without significant restrictions

DISADVANTAGES:

- Disruptive to neighborhood: noise, traffic
- Requires dust control
- Question of availability and cost of clean backfill, if excavated soil not treated on site.

JUSTIFICATION:

Not a component of the remedy presented in the ROD. Question if the contaminated soil can be treated on-site. Although the anticipated cost to implement this recommendation are considerable, the advantages associated with this recommendation could be significant including saved costs for continuing cap maintenance and reduced groundwater well monitoring and maintenance. This recommendation would also highly support EPA policy for the re-use of properties.

Recommendation Costs:
Removal volume at assumed depth = 1.2 acres x 10 feet deep = 19,360 cubic yards

Remove 19,360cy and haul to landfill at $150/cy = $2,904,000
Place 19,360cy with clean fill at $25/cy = $484,000
Assumed Shoring = $200,000
Subtotal = $3,588,000
Markup and Contingency at 20% = $717,600
Total = $4,305,600

Saved Costs:
Annual gw monitoring (OU2 ROD) = $384,200
Assume cutting ½ of groundwater monitoring attenuation time = 50 year reduction
Annual RCRA cap maintenance (OU2 ROD) = $65,000
Eliminates all 100-years of assumed site life

PV at 4% = $384,200(21.482) + $65,000(24.505) = $8,253,384 + $1,592,825 = $9,846,209

SECTION 4 – WITHDRAWN RECOMMENDATIONS

WITHDRAWN RECOMMENDATION # 4

PROJECT: Brown and Bryant Superfund Site
LOCATION: Arvin, California
STUDY DATE: January 12-13, 2010

DESCRIPTIVE TITLE OF RECOMMENDATION:
Construct a slurry wall with extraction wells.

Creative Idea #: 4
This creative idea is withdrawn from further consideration.

ORIGINAL DESIGN:

The original design to address site contamination in the A-zone groundwater was a traditional pump and treat system. After further studies of the A-zone perched aquifer, it was determined that traditional pump and treat for the A-zone aquifer was unacceptable due to the low yield of water. The A-zone aquifer is relatively homogeneous in the horizontal but vertically anisotropic as a result of stratification. The aquitard for the A-zone is leaking. The hydraulic conductivity values are in the range of silt and mixtures of sands, which creates a poor aquifer. The actual sustainable pumping rates were less than 0.5 gallons per minute. The sustainable period was about 4 hours and days for recovery. The traditional pump and treat remedy for the A-zone aquifer was abandoned and transferred to OU-2 to be studied. After the OU-2 study, the conclusion to drain the A-zone aquifer and treat the water was still considered a good idea. The method changed from a traditional pump and treat system to using large arbor wells (six to eight feet in diameter) in a pump and treat system to assist in the lower water yield of the A-zone aquifer.

RECOMMENDED CHANGE:

Construct a bentonite slurry wall and extraction wells inside the slurry zone. The bentonite slurry wall would impede horizontal groundwater fluid in the A-zone. Groundwater extraction from wells inside the slurry wall would induce a neutral or inward hydraulic gradient across the wall. The slurry wall construction would start with excavation of a two foot width trench to a depth of approximately seventy-five feet (to the top of the A-zone aquitard). The slurry wall would require a linear space of approximately 4000 feet.

SUMMARY OF COST ANALYSIS			
	First Cost	O & M Costs (Present Worth)	Total LC Cost (Present Worth)
ORIGINAL DESIGN	$3,645,000	1,700,000	15,585,000
RECOMMENDED DESIGN	$21,402,344	$2,270,000	$23,672,344
ESTIMATED SAVINGS OR (COST)	($1,504,756)	($570,000)	($8,087,344)

This creative idea is withdrawn from further consideration.

WITHDRAWN RECOMMENDATION # 4

ADVANTAGES:

- Inhibit lateral migration of contaminants from A-zone source area.
- Would more efficiently dewater A-zone.
- Extraction of water within wall will reduce vertical gradient driving water through underlying aquitard.

DISADVANTAGES:

- Does not directly address potential for vertical seepage through aquitard below A-zone.
- Difficult to key slurry wall into relatively thin aquitard.
- Standard vertical extraction wells, if used, will have limited productivity and may potentially require penetrate the RCRA cap.
- Does not address contamination that has already migrated to the B-zone.
- Operation and maintenance (O & M) cost will be high.

JUSTIFICATION:

Groundwater extraction from wells inside the slurry wall would induce a neutral or inward hydraulic gradient across the wall**.** The slurry wall could enhance the extraction of water from the A-zone. Some disadvantages are shared with current design.

Approximate Cost

Excavation: (assume 4000ft x 75ft x 2ft) 22,224 CY or 30,000 tons
22,224 CY soil removal from trench @ 6$/CY = $133,344
30,000 tons soil transport and treatment @ $100 tons = $3,000,000

Construction: (assume 4000 ft x 75 ft x 2ft) 300,000 SF or 33,330 SY
33,330 SY @300/SY = $9,999,000

Extraction Wells: (assume ten wells to 75 feet)
40 extraction wells capital cost = $7,285,000
O & M annual cost = $2,270,000
City Well Cost: Relocate Arvin City Well CW-1 = $985,000

This creative idea is withdrawn from further consideration.

WITHDRAWN RECOMMENDATION # 10

PROJECT: Brown and Bryant Superfund Site
LOCATION: Arvin, CA
STUDY DATE: January 12-13, 2010

DESCRIPTIVE TITLE OF RECOMMENDATION:
In-situ chemical oxidation of unsaturated B-zone.

Creative Idea #: 10

This creative idea is withdrawn from further consideration.

ORIGINAL DESIGN:

No treatment of the unsaturated B-zone is included in the original design.

RECOMMENDED CHANGE:

The contaminant mass migrating from the A-zone aquifer through the unsaturated B-zone to the B-zone aquifer would be destroyed by ozone injection via either horizontal wells or a number of vertical wells. Ozone in air would be injected under pressure into all but the lowest 5 feet of the unsaturated B-zone. If vertical wells are used, the wells could be constructed so as to allow their use for ozone sparging of the saturated portion of the B-zone aquifer. This could be done through use of a blank casing extending from several feet above the highest likely B-zone water table to a depth of 20 feet below the normal B-zone water table with screened intervals above and below this blank casing. If ozone or air sparging is desired for control or remediation of the upper portion of the B-zone aquifer, a separate small-diameter pipe could be inserted through a packer set in the blank casing. Ozone injection into the aquifer could be conducted separately or concurrently with ozone injection into the unsaturated B-zone. Costs for recommendation 10 are comparable to the costs for recommendation 22.

Assuming a spacing of 40 feet between injection wells (each well treating ~1200 sq feet) and treatment of an area of 500 by 150 feet (75,000 sq ft), a total of approximately 65 vertical wells. Each well would be approximately 180 feet deep for a total of about 12,000 feet. Assuming $100/foot for the wells, a total cost for the wells would be $1,200,000.

If recommendation 10 were to be combined with recommendation 5, it would provide added protection against the potential for electron donor and/or arsenic to migrate from the A- to the B-zone. The ozone would oxidize electron donor that seeps down from the A-zone, which should prevent arsenic from being mobilized in the B-zone. The ozone would also be expected to transform reduced arsenic species that could potentially seep down from the A-zone into a less mobile, oxidized form.

Effective treatment of TCP and DBCP has been demonstrated at the laboratory scale via a process that requires both ozone and hydrogen peroxide (Dombeck, G., and C. Borg. 2005).

WITHDRAWN RECOMMENDATION # 10

However evidence of effective treatment with ozone as the sole oxidant could not be located in the literature. The half-lives of some organic contaminants in the presence of ozonated water were looked up and used to assess the effectiveness of ozone for treatment of site contaminants. The half-lives for TCE, dinoseb, and chloroform are: 34 min, 0.23 sec, and >>100 hr, respectively (Gunten, 2003). No data was shown for TCP or DCP. This data indicates that dinoseb may be amenable to ozone injection. However, contact between ozone and dinoseb will probably be hindered by the strong tendency of dinoseb to partition into organic carbon present in soil. Chemical oxidants are generally not very effective for chlorinated ethanes, or chlorinated methanes. In the most recent ITRC guidance on chemical oxidation, dichloroethane (DCA) is listed as a “Reluctant” contaminant for ozone treatment (ITRC, 2005). The three categories shown in the ITRC document are: Amenable, Reluctant, & Recalcitrant. Thus, there is considerable uncertainty regarding the effectiveness of ozone against other chloroethanes such as TCP and DCP. Because chloroform is listed as a “Recalcitrant” contaminant for ozone treatment (ITRC, 2005), ozone injection probably would not be effective against chloroform.

Based on the above literature review, it appears that a cometabolic, aerobic bioventing process will probably be more effective than ozone for the contaminants that are expected to be present at the highest concentrations (such as TCP and DCP). For this reason, and because of the high level of uncertainty in the effectiveness of ozone for TCP, DCP, and DBCP, the recommendation will be withdrawn.

References:

Dombeck, G., and C. Borg. 2005. “Multicontaminant Treatment for 1, 2, 3 Trichloropropane Destruction Using the HiPOx Reactor.” Reprinted from the Proceedings of the 2005 NGWA Conference on MTBE and Perchlorate: Assessment, Remediation, and Public Policy with permission of the National Ground Water Association Press. Copyright 2005. ISBN #1-56034-120-3.

Technical and Regulatory Guidance for In Situ Chemical Oxidation of Contaminated Soil and Groundwater, Second Edition, 2005.

Ozonation of Drinking Water: Part I. Oxidation Kinetics and Product Formation, Urs von Gunten, Water Research 37 (2003) 1443–1467

This creative idea is withdrawn from further consideration.

WITHDRAWN RECOMMENDATION # 12

PROJECT: Brown and Bryant Superfund Site
LOCATION: Arvin, CA
STUDY DATE: January 12-13, 2010

DESCRIPTIVE TITLE OF RECOMMENDATION:
Remove contaminated soil from A-zone.

Creative Idea #: 12
This creative idea is withdrawn from further consideration.

ORIGINAL DESIGN:

Groundwater extraction via several large-diameter vertical wells with associated off-site shipment and treatment.

RECOMMENDED CHANGE:

Remove the contaminated soil by excavating all of the soils, hauling the contaminated soils to an approved landfill, and replacing with suitable soil.

SUMMARY OF COST ANALYSIS			
	First Cost	O & M Costs (Present Worth)	Total LC Cost (Present Worth)
ORIGINAL DESIGN	$1,282,000	$12,000,000	13,300,000
RECOMMENDED DESIGN	99,768,500	0	99,768,500
ESTIMATED SAVINGS OR (COST)	($98,486,000)		($98,486,000)

This creative idea is withdrawn from further consideration.

WITHDRAWN RECOMMENDATION # 12

ADVANTAGES:

- Substantially removes all of the contaminant mass from A-zone.
- May eliminate need for long-term management of the A-zone groundwater.
- Likely to be favorably received by the State and public than other alternatives.

DISADVANTAGES:

- High cost.
- During removal, has a high negative impact on community; trucks, noise, large hole, etc.

JUSTIFICATION:

If success is determined to be defined by the removal of the contaminants in A-zone, then this is the “removal" method. The costs are very high.

This creative idea is withdrawn from further consideration.

WITHDRAWN RECOMMENDATION # 12

Cost Analysis

B&B VE Rec 12: Remove contaminated soil from A-zone January 27, 2010

Very Optimistic Cost Estimate

Preliminary look at costs: Very Rough Order of Magnitude Cost Estimate

5 acres 75 feet deep = 605,000 cy

Assume 20% hauled to land fill and replaced, 121,000 cy.

Assume no shoring. (Very unlikely)
Assume staged work, cut and fill on site. (Very optimistic)

Therefore move 484,000 cy up to 75 feet deep		$50/yd=	$24,200,000
Remove 121,000 cy avg 70 feet deep, haul to landfill		$150/yd=	$18,150,000
Replace 121,000 cy		$25/yd	$3,025,000
	Sub-Total		$45,375,000
	Markup and Counting	25%	$11,343,750
	Minimum Total		$56,718,750

High End Cost Estimate

Move 484,000 cy up to 75 feet deep Rough	$75/yd=		$ 36,300,000
Remove 150,000 cy avg 70 feet deep, haul to landfill		$200/yd=	$ 30,000,000
Replace 121,000 cy		$45/yd	$ 5,445,000
Shoring	LS		$5,000,000
	Sub-Total		$ 76,745,000
	Markup and Counting	30%	$ 23,023,500
	Total		$ 99,768,500

WITHDRAWN RECOMMENDATION # 16

PROJECT: Brown & Bryant Superfund Site OU-2
LOCATION: Arvin, California
STUDY DATE: January 12-13, 2010

DESCRIPTIVE TITLE OF RECOMMENDATION:
Contaminant Sequestration or Stabilization A-zone.

Creative Idea #: 16
This creative idea is withdrawn from further consideration.

ORIGINAL DESIGN:

The concept was for a layer of vegetable oil or cement grout to be injected across the entire depth interval of A-zone groundwater. Sufficient volume would need to be injected to fill the pore volume of at least part of the A-zone aquifer. The intent was to sequester the contaminants of concern to prevent future migration into the groundwater.

RECOMMENDED CHANGE:

Upon further evaluation, it was determined that the use of vegetable oil for sequestration was not a viable suggestion. The gradual dissolution of oil into the groundwater would be a long term source of electron donor and could result in the risk of mobilizing arsenic, which is naturally occurring in the region.

The second alternative was to inject grout as a stabilizer or sequester. It is suspected that the formation is not porous enough to effectively apply the layer of grout. The formation is too tight to inject grout to establish a horizontal grout layer.

The costs for these applications were therefore not estimated.

SUMMARY OF COST ANALYSIS			
	First Cost	O & M Costs (Present Worth)	Total LC Cost (Present Worth)
ORIGINAL DESIGN			
RECOMMENDED DESIGN			
ESTIMATED SAVINGS OR (COST)			

This creative idea is withdrawn from further consideration.

WITHDRAWN RECOMMENDATION # 16

ADVANTAGES:

- Pseudo-permanently reduces mobility/leachability of contaminants.
- May promote anaerobic degradation of some site contaminants, if use oil.
- May be able to generate conditions (e.g., high pH) that may cause destruction of some contaminants (possibly dinoseb), using cement, lime, etc.
- Reduces operations and maintenance costs relative to current remedy.

DISADVANTAGES:

- Some questions of implementability/constructability of chemical fixation compounds.
- Difficult to assure distribution of amendments in heterogeneous and low permeability soil.
- Does not necessarily destroy or remove the contaminants.
- May not adequately address contaminants above the saturated A-zone.
- Potential for vegetable oil to mobilize arsenic.
- The formation is not porous enough to allow for injection and distribution of cement grout as a stabilizer.

JUSTIFICATION:

Not a component of the remedy as presented in the ROD. Injection of reagents (e.g., Portland cement) or oil. Neither of the suggested reagents was determined to be a viable option upon further evaluation.

This creative idea is withdrawn from further consideration.

SECTION 5 – DESIGN COMMENTS

Design Comment 29. Portable treatment units for extracted water and **Design Comment 53.** Air stripping

The ROD indicated that groundwater extracted from the proposed A-zone arbor wells would be treated on-site using an advanced oxidation process. However the project team indicated that they had changed course on this aspect of the remedy, and that the extracted groundwater would probably be pumped into a holding tank. The contents of the tank would then be periodically removed and transported to an off-site treatment facility.
The comment suggests that extracted groundwater could be treated via an on-site treatment system. This change would only be applicable to current proposed remedy, or if recommendations 1-2 are adopted. An analysis of treatment technologies for site contaminants was provided within recommendation 9. Based on this analysis, the recommended means of treatment would be liquid-phase granular activated carbon (GAC). The system would probably consist of filtration unit followed by two GAC vessels in series. Carbon consumption for this system will be different from that described in recommendation 9 because the concentrations of contaminants in the A-zone are not the same as the B-zone, because EDB is present in the A-zone, and because the groundwater extraction rate is expected to be lower than the rate that was estimated for the B-zone. It is expected that sustainable groundwater extraction rates from the A-zone would be no more than about 10 gpm.
Neither costs for transportation and off-site groundwater treatment nor for on site treatment system has been calculated. This comment just suggests that on site treatment may be feasible and economical.

Design Comment 32. Solar-powered extraction system and **Design Comment 33.** Wind-powered extraction system (mechanical)

These design comments are aimed at reducing the carbon footprint for the remediation at the Brown & Bryant site. Assuming some pumping will be installed as part of the remediation, an alternate power source for the pumps could be considered. These issues were discussed with EPA's R9 Green Remediation team. They recommend using EPA's existing contract for green remediation services to develop ideas/cost estimates. EPA's green remediation initiative deserves an in-depth analysis. The power usage profile of the selected pump/s needs to be known before any cost estimates could be developed.

Design Comment 54. Cleanup levels

There were some discussions about the required cleanup levels for the site. The following comments were generated and are included in the VE For Information Only.

1,2,3-Trichloropropane (1,2,3-TCP) was used historically as a paint and varnish remover, cleaning and degreasing agent, a cleaning and maintenance solvent, and more currently as a chemical intermediate. Its use as a pesticide was in formulations with dichloropropenes in the manufacture of D-D, a soil fumigant. TCP is an emerging contaminant of interest to the government, private sector, and other parties, is recognized by the State of California to cause cancer and is a known toxin. Currently there is no federal drinking water standard (maximum contaminant level [MCL]) for 1, 2, 3-TCP. In 1999 the California Department of Public Health (CDPH) established the state notification level of 0.005 ug/L, which is used primarily to support drinking water purveyors and water systems that must meet the California state specified limit. In 2001 the Department developed protocols for detecting 1, 2, 3 -TCP at 0.005 ug/L. Given the number of sources with 1, 2, 3-TCP detections, the CDPH considers this chemical to be a good candidate for future regulation (i.e., establishment of an MCL). The State of Hawaii has established a state maximum contaminant level (MCL) of 0.6 ug/L. In July 2004 CDPH requested a public health goal (PHG) from the Office of Environmental Health Hazard Assessment (OEHHA) to begin the early steps of the regulatory process. In September 2007, OEHHA released a draft PHG, and in January 2009, a revised draft PHG. In August 2009, OEHHA established a PHG equal to 0.0007ug/L. In the absense of an MCL for 1, 2, 3-TCP, CDPH will continue to use the 0.005 µg/L notification level to provide information to local governing agencies and consumers.

The Brown & Bryant ROD specifies a cleanup level of 0.5 µg/L . This value is the detection limit for 1, 2, 3-TCP reported in the 2006 Record of Decision for the Frontier Fertilizer Superfund Site. For sake of consistency, this value was also adopted for B & B, even though methods exist for achieving much lower detection limits. The B & B ROD incorrectly states that 0.5 ug/L is the 1999 Response Level for CDHS (as stated above, the state notification level is 0.005 µg/L). The B & B cleanup level applies to restoration of the B-zone groundwater and is not equivalent to a treatment discharge standard for groundwater extracted from the A-zone. The ROD specifies that treated groundwater will be discharged to the sanitary sewer but does not specify what those discharge standards may be. Arvin's utilities district should be consulted to determine what the discharge standard would be prior to designing the groundwater treatment system. If it is determined that water could be re-used (e.g., for irrigation or groundwater recharge), then the treatment standard would likely be more stringent to conform to the State's substantive requirements for a Waste Discharge Permit, possibly requiring changes in the treatment process.

The existing ROD standard for 1, 2, 3-TCP is feasible to implement; from the standpoint of treating and monitoring the extracted groundwater (treatment technologies and analytical methods are available). It may, however, be more costly or take longer than estimated in the Feasibility Study, and lower detection limits will be needed to fully delineate the 1, 2, 3-TCP groundwater plume. If California's future MCL is in the range of Hawaii's existing MCL (0.6 ug/L), then the current B&B cleanup level represents a practical alternative to the State's existing public health goal. Alternatively, if California's future MCL is significantly more stringent than Hawaii's, then we may need to amend the ROD to reflect a more stringent cleanup goal.

APPENDIX A
STUDY PARTICIPANTS

VE Team for Brown and Bryant Superfund Site, Operable Unit Number 02

January 12-13, 2010

NAME	FIRM / AGENCY (Please include e-mail address)	ROLE IN THIS STUDY	PHONE
Kenneth True	Contractor kentrue@maladon.con	VE Team Facilitator	402-339-1936 Cell 402-516-2635
Dave Becker	EMCX Dave.J.Becker@usace.army.mil	Geologist	402-697-2655
Chuck Coyle	EMCX Charles.G.Coyle@usace.army.mil	Process Engineer	402-697-2578
Carol Weis	Albuquerque District Carol.A.Wiess@usace.army.mil	CE Project Manager	505-342-3477
Cecilia Horner	Albuquerque District Cecilia.V.Horner@usace.army.mil	Environmental Engr	505-342-3474
Steve Wagner	Albuquerque District Steven.D.Wagner@usace.army.mil	Chemist	505-342-3331
Travis Cain	EPA Cain.Travis@epamail.epa.gov	Regional Project Manager	415-972-3161
Lynn Suer Part Time	EPA suer.lynn@epa.gov	Section Chief	415-972-3148

APPENDIX B
CREATIVE IDEAS LIST

List of CREATIVE IDEAS		
ID #	**Name of Idea / Description**	**Value Potential**
1	Install horizontal wells	R
2	Install Ranney wells	R combine with 1
3	Install slurry wall	E
4	Install slurry wall with extraction wells	W
5	Stimulate biodegradation in A-zone groundwater	R
6	Stimulate biodegradation in B-zone unsaturated soils	R
7	Traditional groundwater extraction in A-zone	E
8	In-situ chemical oxidation in A-zone	E
9	Groundwater extraction in B-zone (Contingent component?)	R
10	In-situ chemical oxidation in B-zone unsaturated soils	W
11	In-situ thermal remediation of A-zone	R
12	Remove contaminated soil from A-zone	W
13	Flushing water through A-zone	E
14	In-situ cosolvent or surfactant flushing of A-zone	E
15	Multi-phase extraction of A-zone	E
16	In-situ stabilization or sequestration of A-zone	W
17	Vertical Permeable Reactive Barrier (PRB) of A-zone	E
18	Vertical PRB of B-zone	E
19	Horizontal PRB below A-zone	E
20	Vapor extraction in B-zone soils	E
21	Sheet pile wall to base of A-zone	E
22	Biosparging or air sparging in B-zone	R
23	Biosparging or air sparging in A-zone	E
24	Standard extraction wells in A-zone	E (Dupl)
25	Grouting around A-zone	E
26	In-situ desiccation around/below A-zone	E
27	Excavation and soil washing	E

List of CREATIVE IDEAS		
ID #	**Name of Idea / Description**	**Value Potential**
28	Phytoremediation/ex-situ bioremediation or alkaline hydrolysis of excavated soils from selected portions of site	E
29	Portable treatment units for extracted water	DC
30	Recirculate treated water into A-zone	E
31	Beneficial re-use of treated water	E
32	Solar-powered extraction system	DC With 33
33	Wind-powered extraction system (mechanical)	DC With 32
34	Dilute extracted water with CW-1 water	E
35	Biodigester-generated methane as energy source for extraction and treatment	E
36	Biodigester-generated methane as in-situ cometabolite	E
37	Use agricultural waste products for ex-situ biotreatment of extracted water	E
38	Use agricultural waste products for ex-situ biotreatment of excavated soil	E
39	Vegetable oil injection as a sequestrant	Combine with 16
40	Belled-out caisson to reduce volume of excavated soil	R
41	E-Barrier (FE Warren AFB, Pueblo Army Depot ESTCP demonstration)	E
42	Electrokinetic moisture and contaminant mobilization	E
43	Ground freezing	E
44	Surface recharge for A-zone flushing	E
45	Constructed wetlands for extracted water treatment	E
46	Bioaugmentation with new strain of dehalococcoides that degrades 1,2,3-TCP (both A- and B-zones)	R (with 5,6)
47	Hollow-fiber membrane reactor for ex-situ treatment of 1,2,3-TCP in groundwater (Dr. Bruce Rittman, NW Univ)	E
48	Horizontal wells as amendment injection, flushing, or sparging component	Combine with others
49	Passive SVE to control mass flux of volatile site COCs	E
50	Recirculation wells B-zone	E
51	Base-catalyzed decomposition process	E

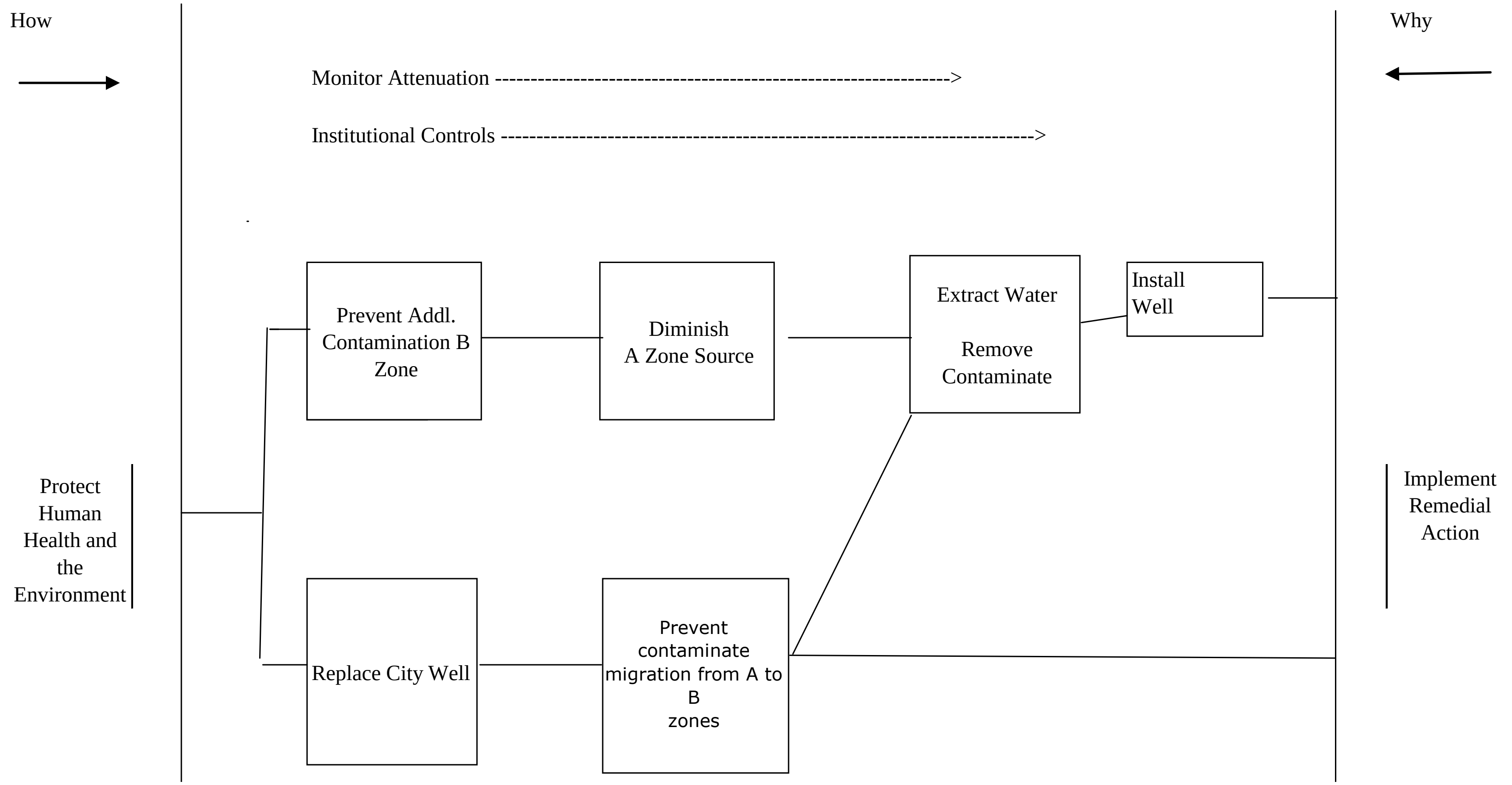
List of CREATIVE IDEAS		
ID #	**Name of Idea / Description**	**Value Potential**
52	Hydraulic fracture with zero-valent iron	E
53	Air stripping	Combine with 29
54	Cleanup levels	DC
55	Remove contaminated soil that is under the existing capped area	R

Legend

R = Recommendation
DC = Design Comment
E = Eliminate from further consideration
W =Withdrawn, Was developed as recommendation but turned out to be not feasible

APPENDIX C
FAST DIAGRAM

Brown and Bryant, January 12-13, FAST Diagram



APPENDIX D
PROJECT FUNCTION MODEL LIST

Function Model List

Item	Function
8 foot diameter well	Collect water
New City Well	Provide clean water
Groundwater Monitoring system	Monitor attenuation
Groundwater screen	Allow passage of water
Pump	Move water
Lid	Secure well
Cap	Secure well
Treat/disposal	Remove contaminant
Casing	Line well/prevent collapse
Depth	Reaches water
Contaminated soil	COC
Contaminated water, A-zone	COC
Water B-zone	Prevent COC
Gravel	Extend influence
Storage tank	Holds contaminated water
Piping	Transmits contaminated water

APPENDIX E
ACRONYMS

List of Acronyms

1, 2-DCP	1, 2-Dichloropropane
1, 2, 3-TCP	1, 2, 3-Trichloropropane
1, 3-DCP	1, 3-Dichloropropane
4, 4-DDE	dichloroethylene
ACSD	Arvin Community Services District
ARARs	Applicable or Relevant and Appropriate Requirements
ASTM	American Society for Testing and Materials
B&B	Brown & Bryant
bgs	below ground surface
BHHRA	Baseline Human Health Risk Assessment
BRA	Baseline Risk Assessment
Cal/EPA	California Environmental Protection Agency
CBA	Committee for a Better Arvin
CCR	California Code of Regulation
CDFG	California Department of Fish and Games
CDHS	California Department of Health Services
CDPR.	California Department of Pesticides Regulation Endangered Species Project Species degrees
oC	Celsius degrees
CEM	Conceptual Exposure Model
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CERES	California Environmental Resource Evaluation System
CHHSLs	California Human Health Screening Levels
cm/sec	centimeters per second
cm2/sec	square centimeters per second
CMP	Corrugated Metal Pipe
CNDDB	California Natural Diversity Data Base
COCs	Contaminants of Concern
COPCs	Constituents of Potential Concern
CPF	California Cancer Potency Factors
CRPE	Center on Race, Poverty and the Environment
CSFs	Cancer Slope Factors
CSM	Conceptual Site Model
CVRWQB	Central Valley Regional Water Quality Control Board
CW-1	Arvin City Well-1
DBCP	1, 2-Dibromo-3-chloropropane
DDT	Dichlorodiphenyltrichloroethane
DMS	Data Management System
DNAPL	Dense Non Aqueous Phase Liquid
DQOs	Data Quality Objectives
DTSC	California Department of Toxic Substances Control
EDB	Ethylene dibromide, also called l, 2-Dibromoethane
EPA	Environmental Protection Agency

List of Acronyms

EPCs	Exposure Point Concentrations
oF	Fahrenheit degrees
FS	Feasibility Study
Facility	Brown and Bryant Arvin Pesticide Reformulation Facility
ft/ft	foot per foot
gpm	gallon per minute
HEAST	Health Effects Assessment Summary Tables
HHRA	Human Health Risk Assessment
HI	Hazard Index
HQ	Hazard Quotient
ILCR	Incremental Lifetime Cancer Risk
in/yr	inches per year
IRIS	Integrated Risk Information System
"J"	Estimated value (laboratory qualifier)
Kd	Distribution coefficient
MCL	Maximum Contaminant Level
MCPP	2-(2-Methyl-4-chlorophenoxy) propionic acid
mg/Kg	milligrams per kilogram
MNA	Monitored Natural Attenuation
MULTIMED	Multimedia exposure assessment model
NAPL	Non-Aqueous Phase Liquids
NCP	National Contingency Plan
NPL	National Priority List
OEHHA	Office of Environmental Health Hazard Assessment
OU	Operable Unit
Panacea	Panacea, Inc.
QA/QC	Quality Assurance/Quality Control
RCRA	Resource Conservation and Recovery Act
RfD	Reference Dose Level
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
RME	Reasonable Maximum Exposure
ROD	Record of Decision
SDWA	Safe Drinking Water Act
Shell	the Shell Chemical Company
SVE	Soil-Vapor Extraction
SVOCs	Semi-Volatile Organic Compounds
T2VOC	modeling code developed by Lawrence Berkeley National Laboratory
TBC	To-be-considered
TAT	Technical Assistance Team
UCL	Upper Confidence Limit
µg/L	microgram per liter
USACE	United States Army Corps of Engineers

List of Acronyms

USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UST	Underground Storage Tank
UV	Ultraviolet
VLEACH	one-dimensional finite-difference vadose zone leaching model
VOCs	Volatile Organic Compounds