# CTS Printex ROD Amendment Appendices

# APPENDIX A – TCE AND 1,2-DCE GROUNDWATER MONITORING DATA

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**CTS Printex Superfund Site**
Mountain View, California

**FIGURE A-2**
TCE and c/t-1,2-DCE in
B-Zone Monitoring Wells

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**CTS Printex Superfund Site**
Mountain View, California

**FIGURE A-1**
TCE and c/t-1,2-DCE in
A-Zone Monitoring Wells

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# APPENDIX B – VOC CONCENTRATIONS IN SHALLOW GROUNDWATER FROM THE SUPPLEMENTAL REMEDIAL INVESTIGATION

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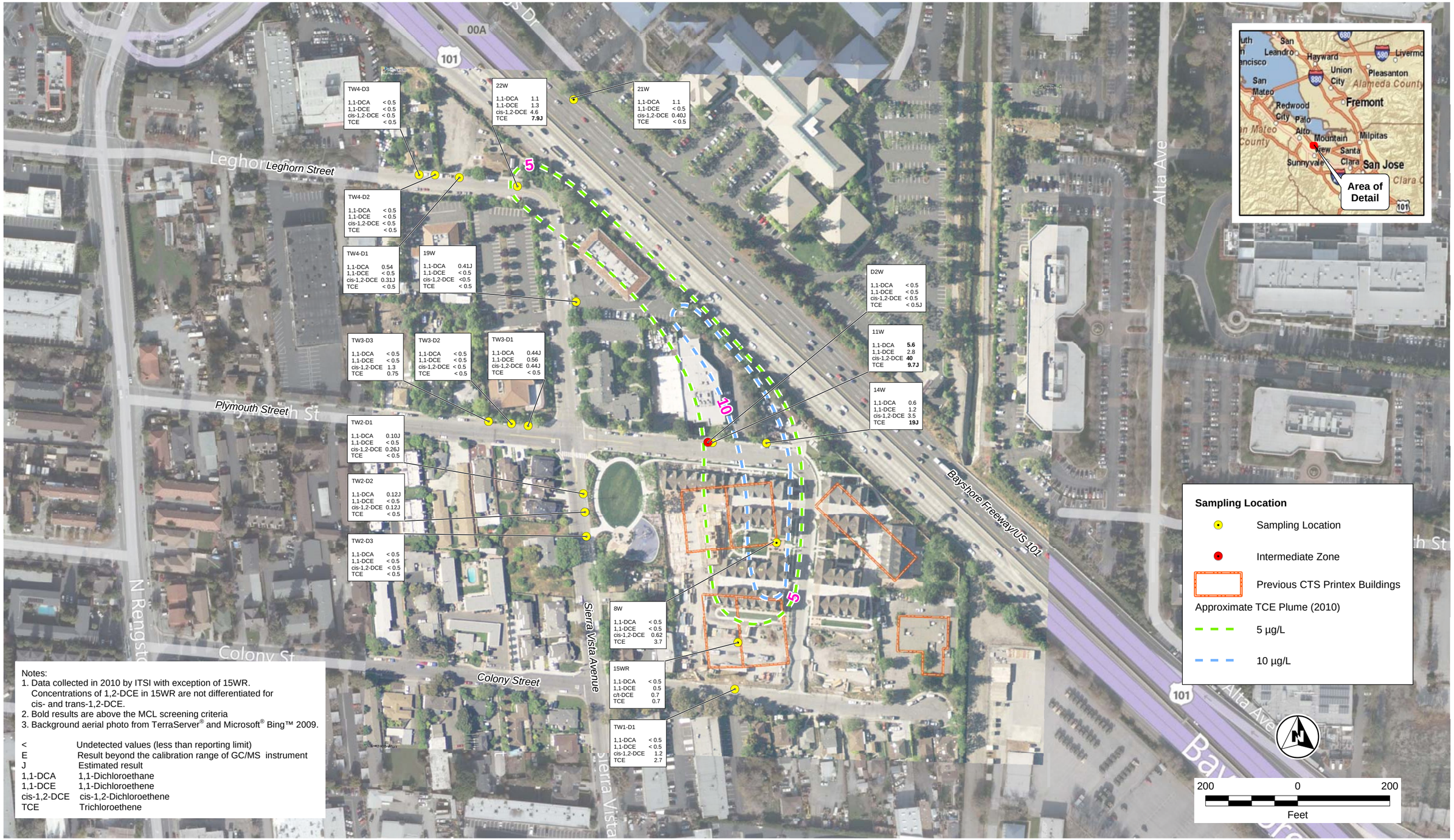


Notes:
1. Data collected in 2010 by ITSI with exception of 15WR. Concentrations of 1,2-DCE in 15WR are not differentiated for cis- and trans-1,2-DCE.
2. Bold results are above the MCL screening criteria
3. Background aerial photo from TerraServer® and Microsoft® Bing™ 2009.

| | |
|---|---|
| < | Undetected values (less than reporting limit) |
| E | Result beyond the calibration range of GC/MS instrument |
| J | Estimated result |
| 1,1-DCA | 1,1-Dichloroethane |
| 1,1-DCE | 1,1-Dichloroethene |
| cis-1,2-DCE | cis-1,2-Dichloroethene |
| TCE | Trichloroethene |

**CTS Printex Superfund Site**
Mountain View, California

**FIGURE B-2**
VOC Concentrations in B-Zone

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Notes:
1. Data collected in 2010 by ITSI with exception of 16WR. Concentrations of 1,2-DCE in 16WR are not differentiated for cis- and trans-1,2-DCE.
2. Bold results are above the MCL screening criteria
3. Background aerial photo from TerraServer® and Microsoft® Bing™ 2009.

| | |
|---|---|
| < | Undetected values (less than reporting limit) |
| E | Result beyond the calibration range of GC/MS instrument |
| J | Estimated result |
| 1,1-DCA | 1,1-Dichloroethane |
| 1,1-DCE | 1,1-Dichloroethene |
| cis-1,2-DCE | cis-1,2-Dichloroethene |
| TCE | Trichloroethene |

**CTS Printex Superfund Site**
Mountain View, California

**FIGURE B-1**
VOC Concentrations in A-Zone

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# APPENDIX C – NATURAL ATTENUATION MODELING FOR THE SELECTED GROUNDWATER REMEDY

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# APPENDIX C

# BIOCHLOR ANALYSIS

## 1. Introduction

Trichloroethene (TCE) migration was modeled in groundwater at the CTS Printex Superfund Site (Site) located in Mountain View, California, using groundwater quality data obtained from the January 2010 groundwater sampling event. This evaluation has been conducted to estimate the potential time required for TCE to reach its Maximum Contaminant Level (MCL) of 5 µg/L (0.005 mg/L) due to natural attenuation alone for the areas of the Site without application of enhanced anaerobic bioremediation.

The BIOCHLOR version 2.2 spreadsheet model was utilized for this assessment (USEPA, 2000, 2002). BIOCHLOR is a screening model that predicts the natural attenuation of chlorinated solvents through sequential decay. This model was used to calculate the concentration of TCE in groundwater throughout the Site. The model allows for three-dimensional dispersion, one-dimensional advection, linear adsorption, and biotransformation by means of reductive dechlorination.

The BIOCHLOR model allows calculation of concentrations along the centerline of the plume and in a three-dimensional array. The output of the model is regenerated each time any element of the input data is changed, which allows the user to see almost immediately the effects of changes in the input data. The BIOCHLOR model is intended for use with chlorinated solvents that may react with organic carbon in soil and/or may be subject to biotransformation that can be described by a sequential first-order decay process. BIOCHLOR is used to evaluate natural attenuation via reductive dechlorination.

The shallow groundwater at the Site is divided into two zones: A Zone - depths between 10 and 20 feet below ground surface (bgs) and B Zone – depths between 30 and 40 feet bgs.

The sources of the model input parameters are as follows:

- Source Concentration (mg/L): The concentration of TCE detected in the plume in January 2010, excluding monitoring well 17W where the selected groundwater remedy will be applied. A Zone - Highest TCE concentration of 0.016 mg/L was detected in monitoring well 12W. B Zone - Highest TCE concentration of 0.019 mg/L was detected in monitoring well 14W.

- Seepage Velocity (feet/year): 25 feet/year in A Zone and 30 feet/year in B Zone which are values within the range of site-specific conditions.
- Longitudinal Dispersivity (alpha x): 40 feet for the A Zone and 104 feet for the B Zone, which are values derived using the BIOCHLOR calibration tool.
- Transverse Dispersivity (alpha y) / Longitudinal Dispersivity (alpha x): 0.1 for the A and B Zones, which is the value recommended by USEPA.
- Vertical Dispersivity (alpha z) / Longitudinal Dispersivity (alpha x): $1 \times 10^{-99}$, the value recommended by USEPA for a conservative estimate of vertical dispersion.
- Soil Bulk Density (kilogram/Liter): 1.55 kilogram/Liter for both the A and B Zones based on site-specific data.
- Fraction of Organic Carbon (foc) (unitless): 0.0002 for both the A and B Zones, which is a value in the recommended range by USEPA for the site-specific soil type.
- Partition Coefficient (Koc) (Liter/kilogram): 130 Liter/kilogram for TCE which is a USEPA default value.
- First Order Decay Coefficient (1/year): See Table C-1 for values which are derived using the BIOCHLOR calibration tool from site-specific data. 0.047 per year used for groundwater in the A and B Zones.
- Source Width (feet): 425 feet for the A Zone and 280 feet for the B Zone, estimated source width perpendicular to groundwater flow direction based upon site-specific data.
- Source Thickness: 10 feet, the estimated thickness of the source in both zones based upon site-specific data.

## 2. Limitations

BIOCHLOR is a Domenico-based model which approximates the analytical solutions of the advective-dispersive solute transport equation. Therefore, an error could be generated for a set of input parameters when compared to the exact values. The error is largely sensitive to high values of longitudinal dispersivity. When the longitudinal dispersivity value is low, this error is insignificant. Since longitudinal dispersivity is a calibration parameter and not a site-specific value, BIOCHLOR is appropriate for use as a screening tool.

A major limitation of any analytical groundwater transport model is that steady, uniform groundwater flow is assumed. BIOCHLOR is primarily intended for use in unconsolidated (soil) aquifers with reasonably uniform physical and hydrogeologic

properties, whereas the Site's soil in the saturated zone associated with the A and B Zones has some degree of heterogeneities. These heterogeneities may create preferential constituent migration pathways, which could not be predicted by the model.

## 3. Results

The results of the BIOCHLOR model runs are shown in Table C-2. According to the model, the time for natural attenuation to reduce TCE concentrations at the Site below its MCL of 0.005 mg/L will vary from 7 to 29 years, with an average time frame for the A Zone and B Zone being estimated at 15 years.

## 4. Calibration

In order to calibrate the BIOCHLOR model, groundwater analytical results were plotted against model results using the BIOCHLOR calibration tool. Monitoring wells 12W and 14W were considered to be the source of contamination in the A and B Zones, respectively. Monitoring wells 23W and 33W are located approximately 800 feet, and 880 feet, respectively, downgradient of 12W in the A Zone. Monitoring well 22W is located approximately 1,040 feet downgradient of 14W in the B Zone. TCE concentrations at the various monitoring wells from groundwater analytical results were plotted for each zone and then values for dispersivity were adjusted until the model results were comparable to the plotted analytical results.

## 5. References

United States Environmental Protection Agency (USEPA). 2000. BIOCHLOR Natural Attenuation Decision Support System. User's Manual. Version 1.0. EPA/600/R-00/008. January.

United States Environmental Protection Agency (USEPA). 2002. BIOCHLOR Natural Attenuation Decision Support System. User's Manual Addendum. Version 2.2. March.

**Table C-1**

**Former CTS Printex Superfund Site**
**Mountain View, California**

**First Order Source Decay Constant (ks)**

| A Zone Groundwater | |
|---|---|
| **Well** | **ks (1/years)** |
| 12W | 0.103 |
| 17W | 0.0064 |
| 20W | 0.0094 |
| 23W | 0.0023 |
| 33W | 0.0004 |
| combined data | 0.0313 |

| B Zone Groundwater | |
|---|---|
| **Well** | **ks (1/years)** |
| 8W | 0.2334 |
| 14W | 0.0187 |
| 11W | 0.0036 |
| 22W | 0.0009 |
| combined data | 0.0647 |

| A and B Zones Groundwater | |
|---|---|
| **Well** | **ks (1/years)** |
| combined data | 0.047 |

BIOCHLOR requires that ks be < 0.055 $years^{-1}$ which is less than the ks calculated for some wells.

**Table C-2**

**Former CTS Printex Superfund Site**
**Mountain View, California**

**Time Required for TCE in Groundwater to Reach the MCL**

| A Zone Groundwater | | |
|---|---|---|
| **Well** | **TCE Concentration (mg/L)** | **Time to Reach MCL (years)** |
| 12W | 0.016 | 25 |
| 17W | 0 | 0 |
| 20W | 0.007 | 7 |
| 23W | 0.007 | 7 |
| 33W | 0.008 | 10 |

| B Zone Groundwater | | |
|---|---|---|
| **Well** | **TCE Concentration (mg/L)** | **Time to Reach MCL (years)** |
| 8W | 0.0037 | 0 |
| 14W | 0.019 | 29 |
| 11W | 0.01 | 15 |
| 22W | 0.008 | 10 |

Note:
TCE MCL = 0.005 mg/L
Based on ks = 0.047 / yr for A and B Zones.

# APPENDIX D – COST ESTIMATE SUMMARY FOR GROUNDWATER SELECTED REMEDY

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# Appendix D

## Cost Estimate Summary for Groundwater Selected Remedy
## Enhanced Anaerobic Bioremediation with Monitored Natural Attenuation

| ***Capital Costs*** | | | | |
|---|---|---|---|---|
| **Description** | **Quantity** | **Unit** | **Unit Cost ($)** | **Cost ($)** |
| **Construction** | | | | |
| 1. Easements and Permits | 1 | LS | 144,000 | 144,000 |
| 2. Mobilization/Demobilization | 1 | LS | 3,000 | 3,000 |
| 3. Site Preparation | | | | |
| Temporary Fencing | 420 | LF | 9.28 | 3,896 |
| Supplies and Rental Equipment | 1 | LS | 887 | 887 |
| 4. Install Wells | | | | |
| Extraction & Injection Wells | 260 | LF | 141.25 | 36,725 |
| Pumps and Control Components | 2 | EA | 2,402 | 4,805 |
| 5. Install Trenching | | | | |
| Remove Pavement & Curbing | 308 | LF | 3.54 | 1,090 |
| Excavate Trench | 308 | LF | 2.64 | 813 |
| Piping | 616 | LF | 72.05 | 44,383 |
| Backfill and Pavement Patch | 308 | LF | 12.52 | 3,855 |
| 6. Electrical Service | | | | |
| Cable | 500 | LF | 19.72 | 9,858 |
| Starters and other Components | 2 | EA | 7,686 | 15,372 |
| 7. EAB Augmentation | | | | |
| Chemicals and Microbial Augments | 1,910 | KG | 5.28 | 10,085 |
| Direct Injection | 5 | Days | 5,568 | 27,840 |
| 8. Site Restoration | | | | |
| Tree Removal and Replacement | 1 | LS | 17,340 | 17,340 |
| Debris Disposal | 1 | LS | 1,128 | 1,128 |
| 9. Construction Oversight | 20 | Days | 7,332 | 146,640 |
| Subtotal | | | | $472,000 |
| Contingency (20%) | | | | 95,000 |
| Construction Capital w/ Contingency | | | | 567,000 |
| | | | | |
| Treatability Study | 1 | LS | 150,000 | 150,000 |
| Remedial Design | 1 | LS | 85,000 | 85,000 |
| Project Management (10%) | | | | 56,700 |
| | | | | |
| ***Total Capital Costs*** | | | | **$859,000** |

Abbreviations: LS - Lump Sum, LF - linear feet, EA - each, and KG - kilogram.

| *Annual Operation and Maintenance Costs* | | | | | |
|---|---|---|---|---|---|
| | **Description** | **Quantity** | **Unit** | **Unit Cost ($)** | **Cost ($)** |
| **Year 1** | | | | | |
| 1. | Groundwater Monitoring | 2 | EA | 10,400 | 20,800 |
| | Purge Water Disposal | 2 | EA | 300 | 600 |
| | MNA Parameters | 2 | EA | 1,450 | 2,900 |
| | Microbial Population | 2 | EA | 1,200 | 2,400 |
| 2. | EAB System | | | | |
| | Operation Oversight | 24 | EA | 460 | 11,040 |
| | 17W Sampling and Analysis | 4 | EA | 120 | 480 |
| | Well Maintenance | 2 | EA | 350 | 700 |
| | Electrical Power | 3,504 | KW-HR | 0.15 | 526 |
| | Analysis for Organic Content | 4 | EA | 60 | 240 |
| | Microbial Analysis | 4 | EA | 600 | 2,400 |
| 3. | Reporting | | | | |
| | Quarterly EAB Report | 2 | EA | 8,000 | 16,000 |
| | Groundwater Monitoring | 2 | EA | 15,000 | 30,000 |
| **Subtotal** | | | | | **$88,086** |
| | Contingency (20%) | | | | 17,617 |
| **O&M Subtotal** | | | | | **105,703** |
| | Project Management and Technical Support (30%) | | | | 31,711 |
| **Year 1 Total Annual O&M Cost** | | | | | **$138,000** |
| **Year 2** | | | | | |
| 1. | Groundwater Monitoring | 2 | EA | 10,400 | 20,800 |
| | Purge Water Disposal | 2 | EA | 300 | 600 |
| | MNA Parameters | 2 | EA | 1,450 | 2,900 |
| | Microbial Population | 2 | EA | 1,200 | 2,400 |
| 2. | EAB System | | | | |
| | Operation Oversight | 12 | EA | 460 | 5,520 |
| | 17W Sampling and Analysis | 4 | EA | 120 | 480 |
| | Well Maintenance | 2 | EA | 350 | 700 |
| | Electrical Power | 3,504 | KW-HR | 0.15 | 526 |
| | Analysis for Organic Content | 4 | EA | 60 | 240 |
| | Microbial Analysis | 4 | EA | 600 | 2,400 |
| 3. | Reporting | | | | |
| | Quarterly EAB Report | 2 | EA | 8,000 | 16,000 |
| | Groundwater Monitoring | 2 | EA | 15,000 | 30,000 |
| **Subtotal** | | | | | **$82,566** |
| | Contingency (20%) | | | | 16,513 |
| **O&M Subtotal** | | | | | **99,079** |
| | Project Management and Technical Support (30%) | | | | 29,724 |

| *Annual Operation and Maintenance Costs* | | | | |
|---|---|---|---|---|
| **Description** | **Quantity** | **Unit** | **Unit Cost ($)** | **Cost ($)** |
| **Year 2 Total Annual O&M Cost** | | | | **$129,000** |
| **Years 3 through 5** | | | | |
| 1. Groundwater Monitoring | 2 | EA | 10,400 | 20,800 |
| Purge Water Disposal | 2 | EA | 300 | 600 |
| 2. MNA Parameters | 2 | EA | 1,450 | 2,900 |
| 3. Semi-Annual Reporting | 2 | EA | 15,000 | 30,000 |
| **Subtotal** | | | | **$54,300** |
| Contingency (20%) | | | | 10,860 |
| **O&M Subtotal** | | | | **65,160** |
| Project Management and Technical Support (25%) | | | | 16,290 |
| **Years 3 through 5 Total Annual O&M Cost** | | | | **$82,000** |
| **Years 6 through 10** | | | | |
| 1. Groundwater Monitoring | 2 | EA | 10,400 | 20,800 |
| Purge Water Disposal | 2 | EA | 300 | 600 |
| 2. MNA Parameters | 2 | EA | 1,450 | 2,900 |
| 3. Semi-Annual Reporting | 2 | EA | 15,000 | 30,000 |
| **Subtotal** | | | | **$54,300** |
| Contingency (20%) | | | | 10,860 |
| **O&M Subtotal** | | | | **65,160** |
| Project Management and Technical Support (25%) | | | | 16,290 |
| **Years 6 through 10 Total Annual O&M Cost** | | | | **$82,000** |
| **Years 11 through 15** | | | | |
| 1. Groundwater Monitoring | 1 | EA | 6,240 | 6,240 |
| Purge Water Disposal | 1 | EA | 300 | 300 |
| 2. MNA Parameters | 1 | EA | 700 | 700 |
| 3. Annual Reporting | 1 | EA | 15,000 | 15,000 |
| **Subtotal** | | | | **$22,240** |
| Contingency (20%) | | | | 4,448 |
| **O&M Subtotal** | | | | **26,688** |
| Project Management and Technical Support (25%) | | | | 6,672 |
| **Years 11 through 15 Total Annual O&M Cost** | | | | **$34,000** |

| *Periodic Costs* | | | | |
|---|---|---|---|---|
| **Description** | **Quantity** | **Unit** | **Unit Cost ($)** | **Cost ($)** |

| | | | | | |
|---|---|---|---|---|---|
| 1. | Well and EAB System Decommissioning | | | | |
| | EAB System-Abandon Year 6 | | | | |
| | Injection/Extraction Wells | 260 | LF | 55 | 14,300 |
| | Other Components | 1 | LS | 5,000 | 5,000 |
| 2. | Well Abandonment-Year 6 | | | | |
| | Year 11 | 220 | LF | 55.00 | 12,100 |
| | Year 16 | 160 | LF | 55.00 | 8,800 |
| 3. | Reporting | | | | |
| | 5-year Review Reports | 2 | EA | 25,000 | 50,000 |
| | Final report | 1 | EA | 50,000 | 50,000 |

| ***Summary of Present Worth*** | | | | | | |
|---|---|---|---|---|---|---|
| **Year** | **Cost Type** | **Total Cost** | **Escalation (2%)** | **Escalated Cost ($)** | **Discount Factor (7%)** | **Present Worth ($)** |
| 0 | Capital | $859,000 | 1.0000 | 859,000 | 1.0000 | 859,000 |
| 1 | Annual O&M | $138,000 | 1.0200 | 140,760 | 0.9346 | 131,551 |
| 2 | Annual O&M | $129,000 | 1.0404 | 134,212 | 0.8734 | 117,226 |
| 3 | Annual O&M | $82,000 | 1.0612 | 87,019 | 0.8163 | 71,033 |
| 4 | Annual O&M | $82,000 | 1.0824 | 88,759 | 0.7629 | 67,714 |
| 5 | Annual O&M | $82,000 | 1.1041 | 90,535 | 0.7130 | 64,550 |
| 6 | Annual O&M | $82,000 | 1.1262 | 92,345 | 0.6663 | 61,534 |
| 7 | Annual O&M | $82,000 | 1.1487 | 94,192 | 0.6227 | 58,658 |
| 8 | Annual O&M | $82,000 | 1.1717 | 96,076 | 0.5820 | 55,917 |
| 9 | Annual O&M | $82,000 | 1.1951 | 97,998 | 0.5439 | 53,304 |
| 10 | Annual O&M | $82,000 | 1.2190 | 99,958 | 0.5083 | 50,813 |
| 11 | Annual O&M | $34,000 | 1.2434 | 42,275 | 0.4751 | 20,084 |
| 12 | Annual O&M | $34,000 | 1.2682 | 43,120 | 0.4440 | 19,146 |
| 13 | Annual O&M | $34,000 | 1.2936 | 43,983 | 0.4150 | 18,251 |
| 14 | Annual O&M | $34,000 | 1.3195 | 44,862 | 0.3878 | 17,398 |
| 15 | Annual O&M | $34,000 | 1.3459 | 45,760 | 0.3624 | 16,585 |
| Total O&M Costs | | $1,093,000 | | | | |
| | | | | | | |
| ***Average Annual O&M Cost*** | | **$72,900** | | | | |
| 6 | Periodic Cost | $19,300 | 1.1262 | 21,735 | 0.6663 | 14,483 |
| 6 | Periodic Cost | $25,000 | 1.1262 | 28,154 | 0.6663 | 18,760 |
| 11 | Periodic Cost | $12,100 | 1.2434 | 15,045 | 0.4751 | 7,148 |
| 11 | Periodic Cost | $25,000 | 1.2434 | 31,084 | 0.4751 | 14,768 |
| 16 | Periodic Cost | $8,800 | 1.3728 | 12,081 | 0.3387 | 4,092 |
| 16 | Periodic Cost | $50,000 | 1.3728 | 68,639 | 0.3387 | 23,251 |
| | | | | | | |
| ***Total Present Worth*** | | | | | | **$1,766,000** |

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# APPENDIX E – COST ESTIMATE SUMMARY FOR VAPOR INTRUSION SELECTED REMEDY

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**Appendix E**
**Cost Estimate Summary for Vapor Intrusion Selected Remedy**
**Vapor Barrier with Sub-Slab Ventilation**

***Capital Costs*** *(see Notes 1 and 2)*

| | Description | Quantity | Unit | Unit Cost ($) | Cost ($) |
|---|---|---|---|---|---|
| 1. | Mobilization/Demobilization | 1 | LS | 2,000 | 2,000 |
| 2. | Prepare Site for Vapor Barrier | 1 | LS | 5,100 | 5,100 |
| 3. | Install Vapor Barrier | 7,000 | SF | 8.50 | 59,500 |
| 4. | Install Sub-slab Ventilation System | 7,000 | SF | 2.00 | 14,000 |
| Subtotal | | | | | $80,600 |
| | Contingency (20%) | | | | 16,120 |
| | Project Management and Field Support (10%) | | | | 8,060 |
| ***Total Capital Costs*** | | | | | **$105,000** |

Notes:

1. Building assumed to be 7,000 square ft. commercial building, similar in size to existing commercial buildings at the site.
2. Cost estimate only includes incremental costs for vapor intrusion system.
3. Abbreviations:
   LS - Lump Sum
   SF - Square Feet
   EA - Each

| *Annual Operation and Maintenance Costs* | | | | | |
|---|---|---|---|---|---|
| | **Description** | **Quantity** | **Unit** | **Unit Cost ($)** | **Cost ($)** |
| **Year 1** | | | | | |
| 1. | Indoor Air Sampling | 1 | EA | 480.00 | 480 |
| 2. | Air Sample Analysis | 6 | EA | 300.00 | 1,800 |
| 3. | Vapor Barrier and Ventilation Inspection | 1 | EA | 460.00 | 460 |
| 4. | Reporting of Indoor Air Sampling | 1 | EA | 4,000.00 | 4,000 |
| 5. | Annual Report on Vapor Barrier System | 1 | EA | 1,000.00 | 1,000 |
| Subtotal | | | | | $7,740 |
| | Contingency (15%) | | | | 1,161 |
| | Project Management and Field Support (10%) | | | | 774 |
| **Year 1 Total Annual O&M Cost** | | | | | **$10,000** |
| **Years 2 through 15** | | | | | |
| 1. | Indoor Air Sampling | 0 | EA | 480.00 | 0 |
| 2. | Vapor Barrier and Ventilation Inspection | 1 | EA | 460.00 | 460 |
| 3. | Annual Report on Vapor Barrier System | 1 | EA | 1,000.00 | 1,000 |
| Subtotal | | | | | $1,460 |
| | Contingency (15%) | | | | 219 |
| | Project Management and Field Support (10%) | | | | 146 |
| **Years 2 through 15 Total Annual O&M Cost** | | | | | **$2,000** |

| ***Summary of Present Worth*** | | | | | | |
|---|---|---|---|---|---|---|
| **Year** | **Cost Type** | **Total Cost** | **Escalation (2%)** | **Escalated Cost ($)** | **Discount Factor (7%)** | **Present Worth ($)** |
| 0 | Capital | $105,000 | 1.0000 | 105,000 | 1.0000 | 105,000 |
| 1 | Annual O&M | $10,000 | 1.0200 | 10,200 | 0.9346 | 9,533 |
| 2 | Annual O&M | $2,000 | 1.0404 | 2,081 | 0.8734 | 1,817 |
| 3 | Annual O&M | $2,000 | 1.0612 | 2,122 | 0.8163 | 1,733 |
| 4 | Annual O&M | $2,000 | 1.0824 | 2,165 | 0.7629 | 1,652 |
| 5 | Annual O&M | $2,000 | 1.1041 | 2,208 | 0.7130 | 1,574 |
| 6 | Annual O&M | $2,000 | 1.1262 | 2,252 | 0.6663 | 1,501 |
| 7 | Annual O&M | $2,000 | 1.1487 | 2,297 | 0.6227 | 1,431 |
| 8 | Annual O&M | $2,000 | 1.1717 | 2,343 | 0.5820 | 1,364 |
| 9 | Annual O&M | $2,000 | 1.1951 | 2,390 | 0.5439 | 1,300 |
| 10 | Annual O&M | $2,000 | 1.2190 | 2,438 | 0.5083 | 1,239 |
| 11 | Annual O&M | $2,000 | 1.2434 | 2,487 | 0.4751 | 1,181 |
| 12 | Annual O&M | $2,000 | 1.2682 | 2,536 | 0.4440 | 1,126 |
| 13 | Annual O&M | $2,000 | 1.2936 | 2,587 | 0.4150 | 1,074 |
| 14 | Annual O&M | $2,000 | 1.3195 | 2,639 | 0.3878 | 1,023 |
| 15 | Annual O&M | $2,000 | 1.3459 | 2,692 | 0.3624 | 976 |
| | | $38,000 | | | | |
| ***Average Annual O&M Cost*** | | **$2,600** | | | | |
| ***Total Present Worth*** | | | | | | **$134,000** |

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# APPENDIX F – CONTINGENCY REMEDY

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# Appendix F

## Basis of Capital Cost Estimate for Groundwater Contingency Remedy

Assumptions and the scope of work associated with constructing the Groundwater Recirculating System for Enhanced Anaerobic Bioremediation as a contingency for the shallow groundwater around monitoring well 20W are described below.

*Treatability Study*

- No costs included for the contingency. Assumes use of the treatability study results and therefore costs for treatability study covered by the selected remedy.

*Injection of Organic Substrate and Amendments (time frame 1 week)*

- Prepare work plan for injection activities. Assumes modification of work plan for the selected remedy.
- Inject organic substrate using direct push technology to distribute substrates through 2 injection points at depths between 10 and 20 feet bgs. Organic substrate consisting of 60% sodium lactate at estimated mass of 180 kg would be used to enhance and/or promote anaerobic conditions in the treatment area around well 20W. In addition to organic substrate, amendments consisting of Dehalococcoides microbial cultures and nutrients will also be distributed within the treatment zone.

*Re-circulating Well System (construction time frame estimated at 2 weeks)*

- Develop work plan for well installation. Assumes modification of work plan for the selected remedy.
- Perform utility survey to clear utility interferences from drilling locations.
- Drill and install 1 extraction wells (A-zone) and 2 re-injection wells.
- Develop all wells.
- Dispose of drilling and well development wastes. Assumes disposal of approximately 1.5 cubic yards of soil cuttings and 200 gallons of purged water.

*Installation of Pumps (construction time frame estimated at 1 week)*

- Install 1 submersible pumps (0.5 HP) and associated piping.
- Install a well vault for extraction wells, electrical power supply with service box, process control (water level and timer) to control pump operation, associated valves (shut-off, check, etc.), and inline flow meter and totalizer.

*Electrical (construction time frame estimated at 1 week)*

- Electrical service drop to well vault from PG&E's nearest available power source at the extraction well location.
- Complete electrical service connection in each well vault.

*Trench (construction time frame estimated at 1 week)*

- Conduct utility clearance for proposed trench lines from the extraction wells location to the re-injection wells. Approximately 60 linear feet will be trenched across the 20W well paved parking lot.
- Saw cut asphalts and/or concrete pavement.
- Excavate trenches to 3.5 feet deep, place piping bedding of sand, and install PVC piping connecting the extraction wells to the re-injection wells.

- Backfill and compact soil in trenches at 6-inch incremental layers. Assumes use of excavated soil for backfill.
- Dispose of asphalt and concrete debris.

*Site Restoration (construction time frame estimated at one week)*

- Restore asphalt within the trenched lines in the well 20W's parking lot.

Fees and contingency estimated as a percent of the direct Capital Cost subtotal at the following rates:

- G&A at 20%
- Contingency at 20%

**Capital Cost Estimate for Groundwater Contingency**
**Enhanced Anaerobic Bioremediation at 20W**

***Capital Costs***

| Description | Quantity | Unit | Unit Cost ($) | Cost ($) |
|---|---|---|---|---|
| **Construction** | | | | |
| 1. Easements and Permits | 1 | LS | 25,000 | 25,000 |
| 2. Mobilization/Demobilization | 1 | LS | 3,000 | 3,000 |
| 3. Site Preparation | | | | |
| Temporary Fencing | 200 | LF | 9.28 | 1,855 |
| Supplies and Rental Equipment | 1 | LS | 887 | 887 |
| 4. Install Wells | | | | |
| Extraction & Injection Wells | 60 | LF | 141.25 | 8,475 |
| Pumps and Control Components | 1 | EA | 2,402 | 2,402 |
| 5. Install Trenching | | | | |
| Remove Pavement & Curbing | 60 | LF | 3.54 | 212 |
| Excavate Trench | 60 | LF | 2.64 | 158 |
| Piping | 120 | LF | 72.05 | 8,646 |
| Backfill and Pavement Patch | 60 | LF | 12.52 | 751 |
| 6. Electrical Service | | | | |
| Cable | 100 | LF | 19.72 | 1,972 |
| Starters and other Components | 1 | EA | 7,686 | 7,686 |
| 7. EAB Augmentation | | | | |
| Chemicals and Microbial Augments | 180 | KG | 5.28 | 950 |
| Direct Injection | 1 | Days | 5,568 | 5,568 |
| 8. Site Restoration | | | | |
| Tree Removal and Replacement | 0 | LS | 17,340 | 0 |
| Debris Disposal | 1 | LS | 500 | 500 |
| 9. Construction Oversight | 5 | Days | 1,650 | 8,250 |
| Subtotal | | | | $77,000 |
| Contingency (20%) | | | | 16,000 |
| Construction Capital w/ Contingency | | | | 93,000 |
| | | | | |
| Treatability Study | 0 | LS | 150,000 | 0 |
| Remedial Design | 1 | LS | 15,000 | 15,000 |
| Project Management (10%) | | | | 9,300 |
| | | | | |
| ***Total Capital Costs*** | | | | **$118,000** |

Abbreviations: LS - Lump Sum, LF - linear feet, EA - each, and KG - kilogram.