

**APPENDIX A**  
**REMEDY INVENTORY SHEETS**

**Travis AFB DP039 Footprinting Analysis**  
**Green Remediation - Inventory of Energy, Material, Waste, and Other Remedy Aspects**  
**Remedy Conceptual Design and Assumptions:**  
**Alternative A1 - Bioreactor**

**Overview**

This remedy involves source area treatment of the DP039 site with a bioreactor. The remedy involves the construction of the bioreactor and installation of seven monitoring points. The remedy also involves operation, maintenance, and monitoring of the bioreactor for a 10-year period. The bioreactor is approximately 20 ft x 20 ft x 20 ft in size and is backfilled with a mixture of gravel, mulch, and iron pyrite. Vegetable oil and high fructose corn syrup were initially added to increase the total organic carbon content and foster anaerobic conditions for reductive dechlorination. Vegetable oil is added on an annual basis to maintain total organic carbon content. Water is extracted from the underlying aquifer with a solar powered pump and is infiltrated through the bioreactor. The seven new wells are sampled on a semi-annual basis.

Input for Bioreactor Construction

General Scope	Typical Scope Items	Useful Information
Installation of the bioreactor consists of excavating soil, filling the bioreactor pit, constructing the irrigation system, and installing the solar pump		- Plastic liner assumed to be 20 ft x 20 ft by 40 mil with specific gravity of 0.94 - 533 gallons of emulsified vegetable oil with assumed specific gravity of 0.97 - 110 gallons of high fructose corn syrup addition with assumed specific gravity of 1.38 - Density of sand and gravel assumed to be 1.5 tons per cubic yard - Photovoltaic system includes five 50 watt panels, control box, and Grundfos 11-SQF-2 pump (no inverter necessary)

Labor, Mobilizations, Mileage, and Fuel

Participant	Crew Size	Number of Days	Hours Worked Per Day	Total Hours Worked	Trips to Site	Roundtrip Miles to Site	Mode of Transport.	Fuel Type	Total Miles Traveled	Miles* Per Gallon	Total Fuel Used	Activity or Notes
work crew	4	1	8	32	1	33	Light-Duty Truck	Gasoline	33	15	2.2	establish soil stockpile area
work crew	4	1	8	32	1	33	Light-Duty Truck	Gasoline	33	15	2.2	remove and salvage wells EW563x39 and EW782x39
work crew	4	3	8	96	3	33	Light-Duty Truck	Gasoline	99	15	6.6	soil removal from bioreactor excavation
work crew	4	2	8	64	2	20	Light-Duty Truck	Gasoline	40	15	2.7	filling of bioreactor pit
work crew	3	1	8	24	2	33	Light-Duty Truck	Gasoline	66	15	4.4	irrigation system installation
work crew	1	1	8	8	1	33	Light-Duty Truck	Gasoline	33	15	2.2	solar pump installation

\*Passenger miles per gallon for airplanes, buses, and trains

Equipment Use, Mobilization, and Fuel Usage

Equipment Type	HP	Load Factor	Equip. Fuel Type	Gallons Fuel Used per Hour	Total Hours Operated	Gallons Fuel Used On-Site	Trips to Site	Roundtrip Miles to Site	Total Miles Transported	Transport Fuel Type	Miles per Gallon	Gallons Fuel Used for Transport.	Activity or Notes
Excavator (large)	396	0.57	Diesel	11.51172	4	46.04688	1	33	33	Diesel	7.2	4.6	John Deere 225C diesel used to remove wells EW563x39 and EW782x39
Excavator (large)	396	0.57	Diesel	11.51172	20	230.2344	0	20		Diesel	7.2		John Deere 225C diesel used to remove soil from bioreactor excavation
Excavator/hoe (small)	84	0.57	Diesel	2.44188	8	19.53504	1	20	20	Diesel	7.2	2.8	John Deere 310 diesel used to move soil in stockpile area
Dump truck		0.57	Diesel	0		0	12	0.2	2.4		7.2	0.3	20-yd3 dump truck used to move 240 yd3 of clean soil to fenced area on-site
Excavator (large)	396	0.57	Diesel	11.51172	8	92.09376	0	33		Diesel	7.2		John Deere 225C diesel used to fill bioreactor pit
Excavator/hoe (small)	84	0.57	Diesel	2.44188	16	39.07008	0	33		Diesel	7.2		John Deere 310 diesel used to mix mulch
Excavator/hoe (small)	84	0.57	Diesel	2.44188	8	19.53504	0	33		Diesel	7.2		John Deere 310 diesel used for irrigation system installation

Electricity Usage

Equipment Type	HP	% Full Load	Efficiency	Electrical Rating (kW)	Hours Used	Energy Used (kWh)	Notes
							Equipment with kW rating
							Equipment with kW rating
							Direct kWh information
<b>Totals</b>				0		0	

Natural Gas Usage

Equipment Type	Heat Load (btu/hr)	Power Rating (btu/hr)	Efficiency	Total Hours Used	Btus Required	Total Therms Used	Notes
<b>Totals</b>							















Input for Monitoring

General Scope	Typical Scope Items	Useful Information
Baseline monitoring plus 2 events per year thereafter for 10 years at 7 wells via low-flow sampling		- Polyethylene tubing weight of 0.08 pounds per foot

Labor, Mobilizations, Mileage, and Fuel

Participant	Crew Size	Number of Days	Hours Worked Per Day	Total Hours Worked	Trips to Site	Roundtrip Miles to Site	Mode of Transport.	Fuel Type	Total Miles Traveled	Miles Per Gallon	Total Fuel Used	Activity or Notes
well monitoring work crew	2	21	8	336	21	2	Light-Duty Truck	Gasoline	42	15	2.8	well monitoring crew (21 sampling events)
onsite water disposal					21	3.2	Light-Duty Truck	Gasoline	67.2	15	4.5	pickup truck for disposal of purged water to Central GW treatment plant labor for purge water disposal included in above items

Equipment Use, Mobilization, and Fuel Usage

Equipment Type	HP	Load Factor	Equip. Fuel Type	Gallons Fuel Used per Hour	Total Hours Operated	Gallons Fuel Used On-Site	Trips to Site	Roundtrip Miles to Site	Total Miles Transported	Transport Fuel Type	Miles per Gallon	Gallons Fuel Used for Transport.	Activity or Notes
Generator	2	0.51	Gasoline	0.05814	220.5	12.81987							generator operating at 1.5 hours per well per event

Electricity Usage

Equipment Type	HP	% Full Load	Efficiency	Electrical Rating (kW)	Hours Used	Energy Used (kWh)	Notes
							Equipment with kW rating
							Equipment with kW rating
							Direct kWh information
<b>Totals</b>				0		0	

Natural Gas Usage

Equipment Type	Heat Load (btu/hr)	Power Rating (btu/hr)	Efficiency	Total Hours Used	Btus Required	Total Therms Used	Notes
<b>Totals</b>							









Mode of Transport. For Personnel	Gasoline mpg	E85 mpg	Diesel mpg or pmpg	B20 mpg
Airplane	ERROR	ERROR	44.7	ERROR
Bus	ERROR	ERROR	95.6	ERROR
Car	20	14.6	22.3	20.6
Heavy-Duty Truck	10	7.3	11.2	10.3
Light-Duty Truck	15	10.95	16.7	15.4
Train	ERROR	ERROR	59.1	ERROR
Vehicle (other)	NO DATA	NO DATA	NO DATA	NO DATA

- Fuel usage for buses, airplanes, and trains are for passenger miles per gallon (pmpg)
- Airplane/jet fuel calculated as diesel for simplicity and due to similarities between kerosene and diesel
- Typical gasoline fuel efficiencies from [www.fueleconomy.gov](http://www.fueleconomy.gov)
- E85 efficiencies based on higher heating values (mmBtu per barrel) of 5.218 mmBtu (gasoline) and 3.539 for (ethanol), Climate Leaders Direct Emissions from Mobile Sources
- Diesel car and truck efficiencies based on higher heating values (mmBtu per barrel) of 5.218 mmBtu (gasoline) and 5.825 for (diesel), Climate Leaders Direct Emissions from Mobile Sources
- B20 car and truck efficiencies based on higher heating values of 5.825 mmBtu per barrel (diesel, Climate Leaders) and 127,960 btu per gallon (biodiesel, Alternative Fuels & Advanced Vehicles Data Center, [www.afdc.energy.gov](http://www.afdc.energy.gov))
- Diesel airplane, bus, and train efficiencies from converting average CO2 emissions Climate Leaders from Commuting, Business Travel and Product Transport to diesel usage assuming 22.5 lbs of CO2 per gallon of diesel.

Fuel Type for Equipment Transport	mpg
B20	7.09
Diesel	7.2

B20 efficiency based on higher heating value of 127,960 btu per gallon for biodiesel (Alternative Fuels & Advanced Vehicles Data Center, [www.afdc.energy.gov](http://www.afdc.energy.gov)).

Fuel Type for Equip. Use	Gals. per HP-hr
B20	0.052
Diesel	0.051
E85	0.078
Gasoline	0.057

Fuel consumption based on thermal efficiency of 36% for diesel and 38% for gasoline.

Mode of Transport. For Materials	rate (mpg or gptm)
Train (gptm)	0.0024
Truck A (< 5 tons)	8.5
Truck B (5-15 tons)	7.2
Truck C (15+ tons)	5.92
Truck Heavy Load (gptm)	0.011
Truck Light Load (gptm)	0.024

mpg = miles per gallon, gptm = gallons per ton-mile

Rail fuel usage from Climate Leaders, Direct Emissions from Mobile Sources  
 Truck usages from Climate Leaders, Direct Emissions from Mobil Sources and Effects of Payload on the Fuel Consumption of Trucks, Dept. for Transportation (Great Britain), December 2007. Truck heavy load based on Truck C carrying 15 tons. Truck light load based on Truck A carrying 5 tons.

### Lookup Table

Equipment Type	Default Load Factor	Typical HP
Asphalt paver	0.62	
Backhoe	0.57	
Concrete paving machine	0.53	
Dozer (large)	0.55	
Dozer (small)	0.55	
Drilling - direct push	0.75	
Drilling - large rig (e.g., CME-75)	0.75	
Drilling - medium rig (e.g., CME-55)	0.75	
Dump truck	0.57	
Excavator (large)	0.57	
Excavator (medium)	0.57	
Excavator/hoe (small)	0.57	
Generator	0.51	
Grader	0.61	
Grout pump	0.51	
Hydroseeder	0.62	
Integrated tool carrier	0.43	
Loader	0.55	
Loader (small)	0.55	
Mobile laboratory	0.5	
Mowers	0.6	
Other	0.5	
Riding trencher	0.75	
Roller	0.56	
Rotary-screw air compressor (250 cfm)	0.48	
Skid-steer (small)	0.55	
Telescopic handler	0.43	
Tractor mower	0.6	
Water truck	0.57	

Default equipment loads obtained from Road Construction Emissions Model Version 6.3.2, Sacramento Air Quality Management District. Generators and grout pumps considered "other general industrial equipment".

Lookup Table (continued)

Materials	Units	Conv. to tons	Default One-Way Distance from Source to Site (miles)	Site-Specific One-Way Distance (miles)
Asphalt	tons	1	30	
Bentonite	tons	1	1000	
Borrow	tons	1	30	
Cement	tons	1	30	
Cheese whey	lbs	0.0005	1000	
Concrete	tons	1	30	
Emulsified vegetable oil	lbs	0.0005	1000	
GAC: regenerated	lbs	0.0005	1000	
GAC: virgin coal-based	lbs	0.0005	1000	
GAC: virgin coconut-based	lbs	0.0005	1000	
Gravel/sand/clay	tons	1	30	
HDPE	lbs	0.0005	1,500	
Hydrochloric acid (30%, SG = 1.18)	lbs	0.0005	500	
Hydrogen peroxide (50%, SG=1.19)	lbs	0.0005	500	
Hydroseed	lbs	0.0005	500	
Lime	lbs	0.0005	500	
Molasses	lbs	0.0005	500	
Nitrogen fertilizer	lbs	0.0005	500	
Other 1 - PV system	W	0.000125	0	1000
Other 2 - Mulch	cy	0.54	0	30
Other 3			0	
Other 4			0	
Other 5			0	
Phosphorus fertilizer	lbs	0.0005	500	
Polymer	lbs	0.0005	1000	
Potable water	gals x 1000	4.17	30	
Potassium permanganate	lbs	0.0005	1400	
PVC	lbs	0.0005	500	
Sequestering agent	lbs	0.0005	1000	
Sodium hydroxide (20%, SG=1.22)	lbs	0.0005	500	
Stainless steel	lbs	0.0005	500	
Steel	lbs	0.0005	500	
Trees: root balls	each	NA	500	
Trees: whips	each	NA	1000	

Miles are one-way miles. In most cases a empty initial or return trip needs to be added.

Miles should be from manufacturer to supplier to site.

Waste Disposal Facility	Round-Trip Distance (Miles)	Name or Type of Facility
Non-hazardous - Local landfill	1	On-site stockpile
Hazardous	520	Clean Harbors Buttonwillow, California
Recyclable Oil		
Hauled to POTW		
For incineration		

Well Installation Worksheet

New Wells and New Well Depths

Aquifer	Number of New Wells	Depth of New Wells (ft)	Total Depth for New Wells (ft)
2-inch wells			
Zone A			0
Zone B			0
Zone C	0	0	0
Total	0		0
4-inch wells			
Zone A	0	0	0
Zone B	0	0	0
Zone C	0	0	0
Total	0		0
6-inch wells			
Zone A	0	0	0
Zone B	0	0	0
Zone C	0	0	0
Total	0		0

Above table assumes single-cased wells.

	2-inch	4-inch	6-inch
Existing wells	0	0	

Well Installation Worksheet

Well Construction Information			Units	Quantity by Well Size			
Well diameter			inches	2	4	6	Total
Number of wells to install			#	7	0	0	7
Borehole diameter			inches	6	8	10	
Total depth of all new boreholes			feet	45	135	0	180
Total length of well casing PVC			feet	276	0	0	276
Total length of gravel/sand pack			feet	10	60	0	70
Total length of bentonite seal			feet	2	12	0	14
Total length of cement grout from bentonite to surface			feet	33	63	0	96
Volume of drill cuttings			cy	0.3	1.7	0	2
Volume of gravel/sand for sand pack			cy	0.1	0.6	0	0.7
Volume of bentonite for seal			cy	0	0.1	0	0.1
Volume of cement grout			cy	0.2	0.6	0	0.8
Number of flush mount covers			#	1	3	0	4
Number of bollards at wells (4 per well)			#	0	0	0	0
Number of concrete vaults 4'x4' with H2O steel doors			#	0	0	0	0
Number of steel DOT rated 55-gallon drums for disposal			#	0	0	0	0
<b>Materials</b>				<b>Materials by Well Size</b>			
Total mass of 2-inch PVC	0.68	lbs/ft	lbs	187.68			187.68
Total mass of 4-inch PVC	2.0	lbs/ft	lbs		0		0
Total mass of 6-inch PVC	3.5	lbs/ft	lbs			0	0
Total mass of PVC			lbs				187.68
Total weight of gravel/sand	1.5	tons/cy	tons	0.15	0.9	0	1.05
Total dry weight of bentonite	0.92	tons/cy	tons	0	0.1	0	0.1
Total dry weight of cement grout	0.99	tons/cy	tons	0.2	0.6	0	0.8
Total potable water for grout	0.06	gal/lb	gals	26	77	0	103
Weight of steel for flush mount covers	18	lbs/unit	lbs	18	54	0	72
Weight of steel for bollards	50	lbs/unit	lbs	0	0	0	0
Weight of steel vault doors	291	lbs/unit	lbs	0	0	0	0
Total weight of steel for surface finish			lbs	18	54	0	72
Weight of concrete for flush mount covers	0.15	tons/unit	tons	0	0	0.0	0.58
Weight of concrete for bollards	0.019	tons/unit	tons	0	0	0	0
Weight of concrete for vaults	4.7	tons/unit	tons	0	0	0	0
Total weight of concrete for surface finish			tons	0	0	0	0.58
Total steel for drums for disposal	63	lbs/drum	lbs	0	0	0	0
Total stain. steel for for extraction pump	13	lbs/pump	lbs	0	0	0	0
<b>Waste</b>				<b>Waste by Well Size</b>			
Development water	30	gal/well	gallons	210	0	0	210
Development water returned to aquifer	0	gal/well	gallons	0	0	0	0
Water to POTW	0	gal/well	gallons	0	0	0	0
Total weight drill cuttings & other waste	1.5	tons/cy	tons	0.5	2.6	0	3.1
Weight of hazardous waste	0	% of total	tons	0	0	0	0
Weight of non-hazardous waste	0	% of total	tons	0	0	0	0
Waste characterization (at \$700 per sample)			\$	0	0	0	0

Notes:

Three shallow wells (32 ft) co-located in 8-inch boring with a deep well (45 ft) plus one additional deep well.

**Travis AFB DP039 Footprinting Analysis**  
**Green Remediation - Inventory of Energy, Material, Waste, and Other Remedy Aspects**  
**Remedy Conceptual Design and Assumptions:**  
**Alternative A2 - Dual-Phase Extraction (DPE)**

**Overview**

This remedy involves dual-phase extraction to capture and remediate the source area of the DP039 site. The groundwater is extracted at a rate of approximately 3 gpm and pumped to the central groundwater treatment plant (CGWTP) for treatment. Soil vapor is extracted by a centrally-located blower and treated by a centrally located treatment facility. The base case for treatment is UV/OX for groundwater treatment and thermal oxidation for soil vapors. An alternate case involves GAC treatment for groundwater treatment and GAC for extracted soil vapors. No additional process water sampling is required because sampling is already conducted for the CGWTP. Additional soil vapors are collected quarterly at several locations for the SVE system. Site-wide groundwater monitoring is analyzed separately as part of this footprint analysis. No additional groundwater monitoring beyond the site-wide sampling program is required for this remedy. Groundwater extraction is anticipated to operate for 20 years, soil vapor extraction for 10 years. The remedy infrastructure is already in place and does not require the installation of wells or equipment; therefore, the installation of these items is not included in this analysis.

Input for O&M - UV/OX & ThOx

General Scope	Typical Scope Items	Useful Information
Operate existing dual-phase extraction system for 20-years - P&T operates for 20 years and SVE operates for 10 years - extract water at average of 3 gpm total from three existing extraction wells - groundwater treatment assumed to be provided by Central Groundwater Treatment Plant (CGWTP) using UV/OX. - vapor treatment assumed to be provided by existing thermal oxidizer - limited or no GAC expected for treatment given these other treatment options	- groundwater pumps assumed to be three 1/3 HP pumps operating at 30% of full load to extract and convey water - vapor extraction assumed to be from a centrally, located blower to provide vapor extraction at other locations. Assume 1 HP for extracting 40cfm at 80inches of water for vacuum and 20 inches of water for pressure associated with conveyance and treatment - thermal oxidizer assumed to be in centrally located area to treat other vapors. Based on actual data, gas usage is approximately 0.00104 therms per scf treated and electricity of 0.00348 kWh/scf - hydrogen peroxide assumed to be added at 50 mg/L to 3 gpm of process water	

Labor, Mobilizations, Mileage, and Fuel

Participant	Crew Size	Number of Days	Hours Worked Per Day	Total Hours Worked	Trips to Site	Roundtrip Miles to Site	Mode of Transport.	Fuel Type	Total Miles Traveled	Miles* Per Gallon	Total Fuel Used	Activity or Notes
O&M technician	1	1040	4	4160	1040	33	Light-Duty Truck	Gasoline	34320	15	2288	routine weekly O&M checks

\*Passenger miles per gallon for airplanes, buses, and trains

Equipment Use, Mobilization, and Fuel Usage

Equipment Type	HP	Load Factor	Equip. Fuel Type	Gallons Fuel Used per Hour	Total Hours Operated	Gallons Fuel Used On-Site	Trips to Site	Roundtrip Miles to Site	Total Miles Transported	Transport Fuel Type	Miles per Gallon	Gallons Fuel Used for Transport.	Activity or Notes

Electricity Usage

Equipment Type	HP	% Full Load	Efficiency	Electrical Rating (kW)	Hours Used	Energy Used (kWh)	Notes
Pumps	1	30%	60%	0.5	175200	87600	pumps for extraction and conveyance
SVE blower	1	100%	70%	1.42857143	87600	125142.86	represents fraction of large blower used for vapor extraction
CGWTP						119200	actual electricity scaled by flow rate
Thermal oxidizer						731635.2	actual electricity scaled by flow rate
<b>Totals</b>				1.92857143		1063578.1	

Natural Gas Usage

Equipment Type	Heat Load (btu/hr)	Power Rating (btu/hr)	Efficiency	Total Hours Used	Btus Required	Total Therms Used	Notes
Thermal oxidizer						218649.6	for SVE component only for 10 years based on actual current usage
<b>Totals</b>						218649.6	







Input for O&M - GAC & Solar

General Scope	Typical Scope Items	Useful Information
Operate existing dual-phase extraction system for 20-years - P&T operates for 20 years. SVE operates for 10 years - extract water at average of 3 gpm total from three existing extraction wells - groundwater treatment assumed to be provided by Central Groundwater Treatment Plant (CGWTP) using GAC instead of UV/OX - vapor treatment assumed to be provided by GAC instead of thermal oxidizer All electricity provided by PV system, assuming 1400 kWhs per year per installed kW (PVWATTS)	- groundwater pumps assumed to be three 1/3 HP pumps operating at 40% of full load to extract water, convey water, and pump through GAC - vapor extraction assumed to be from a centrally, located blower to provide vapor extraction at other locations. Assume 1 HP for extracting 40cfm at 80inches of water for vacuum and 20 inches of water for pressure associated with conveyance and treatment - GAC usage for extracted groundwater assumed to be approximately 84 lbs of GAC per pound of TCE treated and 1000 lbs of GAC per pound of DCE treated - Liquid GAC usages based on average influent of 250 ug/L for TCE and 50 ug/L for DCE and isotherms from USACE DG 1110-1-2, 2001 - Vapor GAC usage for SVE off-gas assumed to be approximately 10 lbs of GAC per pound of TCE and 50 pounds of GAC per pound of DCE treated - Vapor GAC usage based on average TCE concentration of 1 ppmv and average DCE concentration of 0.5 ppmv.	

Labor, Mobilizations, Mileage, and Fuel

Participant	Crew Size	Number of Days	Hours Worked Per Day	Total Hours Worked	Trips to Site	Roundtrip Miles to Site	Mode of Transport.	Fuel Type	Total Miles Traveled	Miles* Per Gallon	Total Fuel Used	Activity or Notes
O&M technician	1	1040	4	4160	1040	33	Light-Duty Truck	Gasoline	34320	15	2288	routine weekly O&M checks

\*Passenger miles per gallon for airplanes, buses, and trains

Equipment Use, Mobilization, and Fuel Usage

Equipment Type	HP	Load Factor	Equip. Fuel Type	Gallons Fuel Used per Hour	Total Hours Operated	Gallons Fuel Used On-Site	Trips to Site	Roundtrip Miles to Site	Total Miles Transported	Transport Fuel Type	Miles per Gallon	Gallons Fuel Used for Transport.	Activity or Notes

Electricity Usage

Equipment Type	HP	% Full Load	Efficiency	Electrical Rating (kW)	Hours Used	Energy Used (kWh)	Notes
							All approximate 242,000 kWh provided by a 10kW PV system operation over a 20-year period see materials section for materials see renewable section for on-site energy use
<b>Totals</b>				0		0	

Natural Gas Usage

Equipment Type	Heat Load (btu/hr)	Power Rating (btu/hr)	Efficiency	Total Hours Used	Btus Required	Total Therms Used	Notes
<b>Totals</b>							









Mode of Transport. For Personnel	Gasoline mpg	E85 mpg	Diesel mpg or pmpg	B20 mpg
Airplane	ERROR	ERROR	44.7	ERROR
Bus	ERROR	ERROR	95.6	ERROR
Car	20	14.6	22.3	20.6
Heavy-Duty Truck	10	7.3	11.2	10.3
Light-Duty Truck	15	10.95	16.7	15.4
Train	ERROR	ERROR	59.1	ERROR
Vehicle (other)	NO DATA	NO DATA	NO DATA	NO DATA

- Fuel usage for buses, airplanes, and trains are for passenger miles per gallon (pmpg)
- Airplane/jet fuel calculated as diesel for simplicity and due to similarities between kerosene and diesel
- Typical gasoline fuel efficiencies from from [www.fueleconomy.gov](http://www.fueleconomy.gov)
- E85 efficiencies based on higher heating values (mmBtu per barrel) of 5.218 mmBtu (gasoline) and 3.539 for (ethanol), Climate Leaders Direct Emissions from Mobile Sources
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- B20 car and truck efficiencies based on higher heating values of 5.825 mmBtu per barrel (diesel, Climate Leaders) and 127,960 btu per gallon (biodiesel, Alternative Fuels & Advanced Vehicles Data Center, [www.afdc.energy.gov](http://www.afdc.energy.gov))
- Diesel airplane, bus, and train efficiencies from converting average CO2 emissions Climate Leaders from Commuting, Business Travel and Product Transport to diesel usage assuming 22.5 lbs of CO2 per gallon of diesel.

Fuel Type for Equipment Transport	mpg
B20	7.09
Diesel	7.2

B20 efficiency based on higher heating value of 127,960 btu per gallon for biodiesel (Alternative Fuels & Advanced Vehicles Data Center, [www.afdc.energy.gov](http://www.afdc.energy.gov)).

Fuel Type for Equip. Use	Gals. per HP-hr
B20	0.052
Diesel	0.051
E85	0.078
Gasoline	0.057

Fuel consumption based on thermal efficiency of 36% for diesel and 38% for gasoline.

Mode of Transport. For Materials	rate (mpg or gptm)
Train (gptm)	0.0024
Truck A (< 5 tons)	8.5
Truck B (5-15 tons)	7.2
Truck C (15+ tons)	5.92
Truck Heavy Load (gptm)	0.011
Truck Light Load (gptm)	0.024

mpg = miles per gallon, gptm = gallons per ton-mile

Rail fuel usage from Climate Leaders, Direct Emissions from Mobile Sources  
Truck usages from Climate Leaders, Direct Emissions from Mobil Sources and Effects of Payload on the Fuel Consumption of Trucks, Dept. for Transportation (Great Britain), December 2007. Truck heavy load based on Truck C carrying 15 tons. Truck light load based on Truck A carrying 5 tons.

### Lookup Table

Equipment Type	Default Load	Typical HP
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Dozer (small)	0.55	
Drilling - direct push	0.75	
Drilling - large rig (e.g., CME-75)	0.75	
Drilling - medium rig (e.g., CME-55)	0.75	
Dump truck	0.57	
Excavator (large)	0.57	
Excavator (medium)	0.57	
Excavator/hoe (small)	0.57	
Generator	0.51	
Grader	0.61	
Grout pump	0.51	
Hydroseeder	0.62	
Integrated tool carrier	0.43	
Loader	0.55	
Loader (small)	0.55	
Mobile laboratory	0.5	
Mowers	0.6	
Other	0.5	
Riding trencher	0.75	
Roller	0.56	
Rotary-screw air compressor (250 cfm)	0.48	
Skid-steer (small)	0.55	
Telescopic handler	0.43	
Tractor mower	0.6	
Water truck	0.57	

Default equipment loads obtained from Road Construction Emissions Model Version 6.3.2, Sacramento Air Quality Management District. Generators and grout pumps considered "other general industrial equipment".

Lookup Table (continued)

Materials	Units	Conv. to tons	Default One-Way Distance from Source to Site (miles)	Site-Specific One-Way Distance (miles)
Asphalt	tons	1	30	
Bentonite	tons	1	1000	
Borrow	tons	1	30	
Cement	tons	1	30	
Cheese whey	lbs	0.0005	1000	
Concrete	tons	1	30	
Emulsified vegetable oil	lbs	0.0005	1000	
GAC: regenerated	lbs	0.0005	1000	
GAC: virgin coal-based	lbs	0.0005	1000	
GAC: virgin coconut-based	lbs	0.0005	1000	
Gravel/sand/clay	tons	1	30	
HDPE	lbs	0.0005	1,500	
Hydrochloric acid (30%, SG = 1.18)	lbs	0.0005	500	
Hydrogen peroxide (50%, SG=1.19)	lbs	0.0005	500	
Hydroseed	lbs	0.0005	500	
Lime	lbs	0.0005	500	
Molasses	lbs	0.0005	500	
Nitrogen fertilizer	lbs	0.0005	500	
Other 1 - PV system	W	0.000125	0	1000
Other 2 - Mulch	cy	0.54	0	30
Other 3			0	
Other 4			0	
Other 5			0	
Phosphorus fertilizer	lbs	0.0005	500	
Polymer	lbs	0.0005	1000	
Potable water	gals x 1000	4.17	30	
Potassium permanganate	lbs	0.0005	1400	
PVC	lbs	0.0005	500	
Sequestering agent	lbs	0.0005	1000	
Sodium hydroxide (20%, SG=1.22)	lbs	0.0005	500	
Stainless steel	lbs	0.0005	500	
Steel	lbs	0.0005	500	
Trees: root balls	each	NA	500	
Trees: whips	each	NA	1000	

Miles are one-way miles. In most cases a empty initial or return trip needs to be added.

Miles should be from manufacturer to supplier to site.

Waste Disposal Facility	Round-Trip Distance (Miles)	Name or Type of Facility
Non-hazardous - Local landfill	1	On-site stockpile
Hazardous	520	Clean Harbors Buttonwillow, California
Recyclable Oil		
Hauled to POTW		
For incineration		

**Travis AFB DP039 Footprinting Analysis**  
**Green Remediation - Inventory of Energy, Material, Waste, and Other Remedy Aspects**  
**Remedy Conceptual Design and Assumptions:**  
**Alternative B1 - Biobarrier**

**Overview**

This remedy involves use of a biobarrier to prevent migration of the plume beyond the 500 ug/L VOC contour. The biobarrier is established by injecting emulsified vegetable oil into a line of 13 injection wells oriented perpendicular to groundwater flow. The injection wells are 65 feet deep with a 40-foot screened interval. The monitoring network includes six new monitoring well pairs and three injection wells monitored for VOCs and natural attenuation parameters. The six shallow monitoring wells are 30 feet deep and the six deep wells are 60 feet deep. Sampling will occur at the wells semi-annually for the first two years and annually thereafter. Approximately 25,000 pounds of emulsified vegetable oil was injected in the initial injection at a 10% by volume solution at a rate of 4 gpm per well. Approximately 33,000 gallons of water from a local hydrant will be used for blending, injection, and post injection flushing. The site team anticipates that the emulsified vegetable oil will provide adequate treatment for 3 to 5 years, but this length of effectiveness prior to maintenance injections is uncertain. For the purpose of this study, it is assumed that migration control with the biobarrier is required for 10 years with one repeat injection after 5 years.























Mode of Transport. For Personnel	Gasoline mpg	E85 mpg	Diesel mpg or pmpg	B20 mpg
Airplane	ERROR	ERROR	44.7	ERROR
Bus	ERROR	ERROR	95.6	ERROR
Car	20	14.6	22.3	20.6
Heavy-Duty Truck	10	7.3	11.2	10.3
Light-Duty Truck	15	10.95	16.7	15.4
Train	ERROR	ERROR	59.1	ERROR
Vehicle (other)	NO DATA	NO DATA	NO DATA	NO DATA

- Fuel usage for buses, airplanes, and trains are for passenger miles per gallon (pmpg)
- Airplane/jet fuel calculated as diesel for simplicity and due to similarities between kerosene and diesel
- Typical gasoline fuel efficiencies from from [www.fueleconomy.gov](http://www.fueleconomy.gov)
- E85 efficiencies based on higher heating values (mmBtu per barrel) of 5.218 mmBtu (gasoline) and 3.539 for (ethanol), Climate Leaders Direct Emissions from Mobile Sources
- Diesel car and truck efficiencies based on higher heating values (mmBtu per barrel) of 5.218 mmBtu (gasoline) and 5.825 for (diesel), Climate Leaders Direct Emissions from Mobile Sources
- B20 car and truck efficiencies based on higher heating values of 5.825 mmBtu per barrel (diesel, Climate Leaders) and 127,960 btu per gallon (biodiesel, Alternative Fuels & Advanced Vehicles Data Center, [www.afdc.energy.gov](http://www.afdc.energy.gov))
- Diesel airplane, bus, and train efficiencies from converting average CO2 emissions Climate Leaders from Commuting, Business Travel and Product Transport to diesel usage assuming 22.5 lbs of CO2 per gallon of diesel.

Fuel Type for Equipment Transport	mpg
B20	7.09
Diesel	7.2

B20 efficiency based on higher heating value of 127,960 btu per gallon for biodiesel (Alternative Fuels & Advanced Vehicles Data Center, [www.afdc.energy.gov](http://www.afdc.energy.gov)).

Fuel Type for Equip. Use	Gals. per HP-hr
B20	0.052
Diesel	0.051
E85	0.078
Gasoline	0.057

Fuel consumption based on thermal efficiency of 36% for diesel and 38% for gasoline.

Mode of Transport. For Materials	rate (mpg or gptm)
Train (gptm)	0.0024
Truck A (< 5 tons)	8.5
Truck B (5-15 tons)	7.2
Truck C (15+ tons)	5.92
Truck Heavy Load (gptm)	0.011
Truck Light Load (gptm)	0.024

mpg = miles per gallon, gptm = gallons per ton-mile

Rail fuel usage from Climate Leaders, Direct Emissions from Mobile Sources  
 Truck usages from Climate Leaders, Direct Emissions from Mobil Sources and Effects of Payload on the Fuel Consumption of Trucks, Dept. for Transportation (Great Britain), December 2007. Truck heavy load based on Truck C carrying 15 tons. Truck light load based on Truck A carrying 5 tons.

### Lookup Table

Equipment Type	Default Load	Typical HP
Asphalt paver	0.62	
Backhoe	0.57	
Concrete paving machine	0.53	
Dozer (large)	0.55	
Dozer (small)	0.55	
Drilling - direct push	0.75	
Drilling - large rig (e.g., CME-75)	0.75	
Drilling - medium rig (e.g., CME-55)	0.75	
Dump truck	0.57	
Excavator (large)	0.57	
Excavator (medium)	0.57	
Excavator/hoe (small)	0.57	
Generator	0.51	
Grader	0.61	
Grout pump	0.51	
Hydroseeder	0.62	
Integrated tool carrier	0.43	
Loader	0.55	
Loader (small)	0.55	
Mobile laboratory	0.5	
Mowers	0.6	
Other	0.5	
Riding trencher	0.75	
Roller	0.56	
Rotary-screw air compressor (250 cfm)	0.48	
Skid-steer (small)	0.55	
Telescopic handler	0.43	
Tractor mower	0.6	
Water truck	0.57	

Default equipment loads obtained from Road Construction Emissions Model Version 6.3.2, Sacramento Air Quality Management District. Generators and grout pumps considered "other general industrial equipment".

Lookup Table (continued)

Materials	Units	Conv. to tons	Default One-Way Distance from Source to Site (miles)	One-Way Site-Specific Distance (miles)
Asphalt	tons	1	30	
Bentonite	tons	1	1000	
Borrow	tons	1	30	
Cement	tons	1	30	
Cheese whey	lbs	0.0005	1000	
Concrete	tons	1	30	
Emulsified vegetable oil	lbs	0.0005	1000	
GAC: regenerated	lbs	0.0005	1000	
GAC: virgin coal-based	lbs	0.0005	1000	
GAC: virgin coconut-based	lbs	0.0005	1000	
Gravel/sand/clay	tons	1	30	
HDPE	lbs	0.0005	1,500	
Hydrochloric acid (30%, SG = 1.18)	lbs	0.0005	500	
Hydrogen peroxide (50%, SG=1.19)	lbs	0.0005	500	
Hydroseed	lbs	0.0005	500	
Lime	lbs	0.0005	500	
Molasses	lbs	0.0005	500	
Nitrogen fertilizer	lbs	0.0005	500	
Other 1 - PV system	W	0.000125	0	1000
Other 2 - Mulch	cy	0.54	0	30
Other 3			0	
Other 4			0	
Other 5			0	
Phosphorus fertilizer	lbs	0.0005	500	
Polymer	lbs	0.0005	1000	
Potable water	gals x 1000	4.17	30	
Potassium permanganate	lbs	0.0005	1400	
PVC	lbs	0.0005	500	
Sequestering agent	lbs	0.0005	1000	
Sodium hydroxide (20%, SG=1.22)	lbs	0.0005	500	
Stainless steel	lbs	0.0005	500	
Steel	lbs	0.0005	500	
Trees: root balls	each	NA	500	
Trees: whips	each	NA	1000	

Miles are one-way miles. In most cases a empty initial or return trip needs to be added.

Miles should be from manufacturer to supplier to site.

Waste Disposal Facility	Round-Trip Distance (Miles)	Name or Type of Facility
Non-hazardous - Local landfill	1	On-site stockpile
Hazardous	520	Clean Harbors Buttonwillow, California
Recyclable Oil		
Hauled to POTW		
For incineration		

Well Installation Worksheet

New Wells and New Well Depths

Aquifer	Number of New Wells	Depth of New Wells (ft)	Total Depth for New Wells (ft)
2-inch wells			
Zone A	6	30	180
Zone B	6	60	360
Zone C	0	0	0
Total	12		540
4-inch wells			
Zone A	0	0	0
Zone B	13	65	845
Zone C	0	0	0
Total	13		845
6-inch wells			
Zone A	0	0	0
Zone B	0	0	0
Zone C	0	0	0
Total	0		0

Above table assumes single-cased wells.

	2-inch	4-inch	6-inch
Existing wells	0	0	0

Well Installation Worksheet

Well Construction Information			Units	Quantity by Well Size			
				2	4	6	Total
Well diameter			inches	2	4	6	Total
Number of wells to install			#	12	13	0	25
Borehole diameter			inches	6	8	10	
Total depth of all new boreholes			feet	540	845	0	1385
Total length of PVC			feet	540	845	0	1385
Total length of gravel/sand pack			feet	120	520	0	640
Total length of bentonite seal			feet	24	26	0	50
Total length of cement grout from bentonite to surface			feet	396	299	0	695
Volume of drill cuttings			cy	3.9	10.9	0	14.8
Volume of gravel/sand for sand pack			cy	0.8	5	0	5.8
Volume of bentonite for seal			cy	0.2	0.3	0	0.5
Volume of cement grout			cy	2.6	2.9	0	5.5
Number of flush mount covers			#	12	13	0	25
Number of bollards at wells (4 per well)			#	0	0	0	0
Number of concrete vaults 4'x4' with H2O steel doors			#	0	0	0	0
Number of steel DOT rated 55-gallon drums for disposal			#	0	0	0	0
<u>Materials</u>				<b>Materials by Well Size</b>			
Total mass of 2-inch PVC	0.68	lbs/ft	lbs	367.2			367.2
Total mass of 4-inch PVC	2.0	lbs/ft	lbs		1690		1690
Total mass of 6-inch PVC	3.5	lbs/ft	lbs			0	0
Total mass of PVC			lbs				2057.2
Total weight of gravel/sand	1.5	tons/cy	tons	1.2	7.5	0	8.7
Total dry weight of bentonite	0.92	tons/cy	tons	0.2	0.3	0	0.5
Total dry weight of cement grout	0.99	tons/cy	tons	2.6	2.9	0	5.5
Total potable water for grout	0.06	gal/lb	gals	332	370	0	702
Weight of steel for flush mount covers	18	lbs/unit	lbs	216	234	0	450
Weight of steel for bollards	50	lbs/unit	lbs	0	0	0	0
Weight of steel vault doors	291	lbs/unit	lbs	0	0	0	0
Total weight of steel for surface finish			lbs	216	234	0	450
Weight of concrete for flush mount covers	0.15	tons/unit	tons	2	2	0.0	3.625
Weight of concrete for bollards	0.019	tons/unit	tons	0	0	0	0
Weight of concrete for vaults	4.7	tons/unit	tons	0	0	0	0
Total weight of concrete for surface finish			tons	2	2	0	3.625
Total steel for drums for disposal	63	lbs/drum	lbs	0	0	0	0
Total stain. steel for for extraction pump	13	lbs/pump	lbs	156	169	0	325
<u>Waste</u>				<b>Waste by Well Size</b>			
Development water	30	gal/well	gallons	360	390	0	750
Development water returned to aquifer	0	gal/well	gallons	0	0	0	0
Water to POTW	0	gal/well	gallons	0	0	0	0
Total weight drill cuttings & other waste	1.5	tons/cy	tons	5.9	16.4	0	22.3
Weight of hazardous waste	0	% of total	tons	0	0	0	0
Weight of non-hazardous waste	0	% of total	tons	0	0	0	0
Waste characterization (at \$700 per sample)			\$	0	0	0	0

Notes:

**Travis AFB DP039 Footprinting Analysis**  
**Green Remediation - Inventory of Energy, Material, Waste, and Other Remedy Aspects**  
**Remedy Conceptual Design and Assumptions:**  
**Alternative B2 - Permeable Reactive Barrier (PRB)**

**Overview**

This remedy involves use of a permeable reactive barrier (PRB) to prevent migration of the plume beyond the 500 ug/L VOC contour. The PRB is established by high pressuring jetting of zero valent iron, guar gum, acetic acid, and water into formation to 60 feet deep in 50 locations. The size is based on extrapolating from the pilot permeable reactive barrier to a size comparable to the installed biobarrier. Materials use and construction is based on scaling the pilot values from 24 to 50 columns for the appropriate size and 50 feet to 60 feet for the appropriate depth. Based on this scaling factor a total of 758 tons of zero valent iron is used. Injection is conducted at a lift rate of 1 foot per minute (60 minutes for the full well depth), and two passes are made at each hole. The first pass includes water, guar gum, acetic acid, and air, the second pass includes water, guar gum, acetic acid, and zero valent iron. Injections are conducted at 120 gpm. Guar gum is used at a rate of 40 pounds per 1,000 gallons of water, and acetic acid is used at a rate of 24 pounds per 1,000 gallons of water.

It is assumed that the wall will last for 10 years and that this coincides with the duration that migration control is required. A sensitivity analysis can be conducted for reinstalling the wall a single time by multiplying all results by 2. Because this technology and the biobarrier technology are both based on passive treatment through a reactive zone, the monitoring program for the PRB is assumed to be the same as that for the biobarrier.



















Mode of Transport. For Personnel	Gasoline mpg	E85 mpg	Diesel mpg or pmpg	B20 mpg
Airplane	ERROR	ERROR	44.7	ERROR
Bus	ERROR	ERROR	95.6	ERROR
Car	20	14.6	22.3	20.6
Heavy-Duty Truck	10	7.3	11.2	10.3
Light-Duty Truck	15	10.95	16.7	15.4
Train	ERROR	ERROR	59.1	ERROR
Vehicle (other)	NO DATA	NO DATA	NO DATA	NO DATA

- Fuel usage for buses, airplanes, and trains are for passenger miles per gallon (pmpg)
- Airplane/jet fuel calculated as diesel for simplicity and due to similarities between kerosene and diesel
- Typical gasoline fuel efficiencies from [www.fueleconomy.gov](http://www.fueleconomy.gov)
- E85 efficiencies based on higher heating values (mmBtu per barrel) of 5.218 mmBtu (gasoline) and 3.539 for (ethanol), Climate Leaders Direct Emissions from Mobile Sources
- Diesel car and truck efficiencies based on higher heating values (mmBtu per barrel) of 5.218 mmBtu (gasoline) and 5.825 for (diesel), Climate Leaders Direct Emissions from Mobile Sources
- B20 car and truck efficiencies based on higher heating values of 5.825 mmBtu per barrel (diesel, Climate Leaders) and 127,960 btu per gallon (biodiesel, Alternative Fuels & Advanced Vehicles Data Center, [www.afdc.energy.gov](http://www.afdc.energy.gov))
- Diesel airplane, bus, and train efficiencies from converting average CO2 emissions Climate Leaders from Commuting, Business Travel and Product Transport to diesel usage assuming 22.5 lbs of CO2 per gallon of diesel.

Fuel Type for Equipment Transport	mpg
B20	7.09
Diesel	7.2

B20 efficiency based on higher heating value of 127,960 btu per gallon for biodiesel (Alternative Fuels & Advanced Vehicles Data Center, [www.afdc.energy.gov](http://www.afdc.energy.gov)).

Fuel Type for Equip. Use	Gals. per HP-hr
B20	0.052
Diesel	0.051
E85	0.078
Gasoline	0.057

Fuel consumption based on thermal efficiency of 36% for diesel and 38% for gasoline.

Mode of Transport. For Materials	rate (mpg or gptm)
Train (gptm)	0.0024
Truck A (< 5 tons)	8.5
Truck B (5-15 tons)	7.2
Truck C (15+ tons)	5.92
Truck Heavy Load (gptm)	0.011
Truck Light Load (gptm)	0.024

mpg = miles per gallon, gptm = gallons per ton-mile

Rail fuel usage from Climate Leaders, Direct Emissions from Mobile Sources  
 Truck usages from Climate Leaders, Direct Emissions from Mobil Sources and Effects of Payload on the Fuel Consumption of Trucks, Dept. for Transportation (Great Britain), December 2007. Truck heavy load based on Truck C carrying 15 tons. Truck light load based on Truck A carrying 5 tons.

### Lookup Table

Equipment Type	Default Load	Typical HP
Asphalt paver	0.62	
Backhoe	0.57	
Concrete paving machine	0.53	
Dozer (large)	0.55	
Dozer (small)	0.55	
Drilling - direct push	0.75	
Drilling - large rig (e.g., CME-75)	0.75	
Drilling - medium rig (e.g., CME-55)	0.75	
Dump truck	0.57	
Excavator (large)	0.57	
Excavator (medium)	0.57	
Excavator/hoe (small)	0.57	
Generator	0.51	
Grader	0.61	
Grout pump	0.51	
Hydroseeder	0.62	
Integrated tool carrier	0.43	
Loader	0.55	
Loader (small)	0.55	
Mobile laboratory	0.5	
Mowers	0.6	
Other	0.5	
Riding trencher	0.75	
Roller	0.56	
Rotary-screw air compressor (250 cfm)	0.48	
Skid-steer (small)	0.55	
Telescopic handler	0.43	
Tractor mower	0.6	
Water truck	0.57	

Default equipment loads obtained from Road Construction Emissions Model Version 6.3.2, Sacramento Air Quality Management District. Generators and grout pumps considered "other general industrial equipment".

Lookup Table (continued)

Materials	Units	Conv. to tons	Default One-Way Distance from Source to Site (miles)	One-Way Site-Specific Distance (miles)
Asphalt	tons	1	30	
Bentonite	tons	1	1000	
Borrow	tons	1	30	
Cement	tons	1	30	
Cheese whey	lbs	0.0005	1000	
Concrete	tons	1	30	
Emulsified vegetable oil	lbs	0.0005	1000	
GAC: regenerated	lbs	0.0005	1000	
GAC: virgin coal-based	lbs	0.0005	1000	
GAC: virgin coconut-based	lbs	0.0005	1000	
Gravel/sand/clay	tons	1	30	
HDPE	lbs	0.0005	1,500	
Hydrochloric acid (30%, SG = 1.18)	lbs	0.0005	500	
Hydrogen peroxide (50%, SG=1.19)	lbs	0.0005	500	
Hydroseed	lbs	0.0005	500	
Lime	lbs	0.0005	500	
Molasses	lbs	0.0005	500	
Nitrogen fertilizer	lbs	0.0005	500	
Other 1 - PV system	W	0.000125	0	1000
Other 2 - Mulch	cy	0.54	0	30
Other 3 - acetic acid	lbs	0.0005	0	500
Other 4 - guar gum	lbs	0.0005	0	500
Other 5			0	
Phosphorus fertilizer	lbs	0.0005	500	
Polymer	lbs	0.0005	1000	
Potable water	gals x 1000	4.17	30	
Potassium permanganate	lbs	0.0005	1400	
PVC	lbs	0.0005	500	
Sequestering agent	lbs	0.0005	1000	
Sodium hydroxide (20%, SG=1.22)	lbs	0.0005	500	
Stainless steel	lbs	0.0005	500	
Steel	lbs	0.0005	500	
Trees: root balls	each	NA	500	
Trees: whips	each	NA	1000	

Miles are one-way miles. In most cases a empty initial or return trip needs to be added.

Miles should be from manufacturer to supplier to site.

Waste Disposal Facility	Round-Trip Distance (Miles)	Name or Type of Facility
Non-hazardous - Local landfill	1	On-site stockpile
Hazardous	520	Clean Harbors Buttonwillow, California
Recyclable Oil		
Hauled to POTW		
For incineration		

Well Installation Worksheet

New Wells and New Well Depths

Aquifer	Number of New Wells	Depth of New Wells (ft)	Total Depth for New Wells (ft)
2-inch wells			
Zone A	6	30	180
Zone B	6	60	360
Zone C	0	0	0
Total	12		540
4-inch wells			
Zone A	0	0	0
Zone B	0	0	0
Zone C	0	0	0
Total	0		0
6-inch wells			
Zone A	0	0	0
Zone B	0	0	0
Zone C	0	0	0
Total	0		0

Above table assumes single-cased wells.

	2-inch	4-inch	6-inch
Existing wells	0	0	0

Well Installation Worksheet

Well Construction Information			Units	Quantity by Well Size			
Well diameter			inches	2	4	6	Total
Number of wells to install			#	12	0	0	12
Borehole diameter			inches	6	8	10	
Total depth of all new boreholes			feet	540	0	0	540
Total length of PVC			feet	540	0	0	540
Total length of gravel/sand pack			feet	120	0	0	120
Total length of bentonite seal			feet	24	0	0	24
Total length of cement grout from bentonite to surface			feet	396	0	0	396
Volume of drill cuttings			cy	3.9	0	0	3.9
Volume of gravel/sand for sand pack			cy	0.8	0	0	0.8
Volume of bentonite for seal			cy	0.2	0	0	0.2
Volume of cement grout			cy	2.6	0	0	2.6
Number of flush mount covers			#	12	0	0	12
Number of bollards at wells (4 per well)			#	0	0	0	0
Number of concrete vaults 4'x4' with H2O steel doors			#	0	0	0	0
Number of steel DOT rated 55-gallon drums for disposal			#	0	0	0	0
<u>Materials</u>				<b>Materials by Well Size</b>			
Total mass of 2-inch PVC	0.68	lbs/ft	lbs	367.2			367.2
Total mass of 4-inch PVC	2.0	lbs/ft	lbs		0		0
Total mass of 6-inch PVC	3.5	lbs/ft	lbs			0	0
Total mass of PVC			lbs				367.2
Total weight of gravel/sand	1.5	tons/cy	tons	1.2	0	0	1.2
Total dry weight of bentonite	0.92	tons/cy	tons	0.2	0	0	0.2
Total dry weight of cement grout	0.99	tons/cy	tons	2.6	0	0	2.6
Total potable water for grout	0.06	gal/lb	gals	332	0	0	332
Weight of steel for flush mount covers	18	lbs/unit	lbs	216	0	0	216
Weight of steel for bollards	50	lbs/unit	lbs	0	0	0	0
Weight of steel vault doors	291	lbs/unit	lbs	0	0	0	0
Total weight of steel for surface finish			lbs	216	0	0	216
Weight of concrete for flush mount covers	0.15	tons/unit	tons	2	0	0.0	1.74
Weight of concrete for bollards	0.019	tons/unit	tons	0	0	0	0
Weight of concrete for vaults	4.7	tons/unit	tons	0	0	0	0
Total weight of concrete for surface finish			tons	2	0	0	1.74
Total steel for drums for disposal	63	lbs/drum	lbs	0	0	0	0
Total stain. steel for for extraction pump	0	lbs/pump	lbs	0	0	0	0
<u>Waste</u>				<b>Waste by Well Size</b>			
Development water	30	gal/well	gallons	360	0	0	360
Development water returned to aquifer	0	gal/well	gallons	0	0	0	0
Water to POTW	0	gal/well	gallons	0	0	0	0
Total weight drill cuttings & other waste	1.5	tons/cy	tons	5.9	0	0	5.9
Weight of hazardous waste	0	% of total	tons	0	0	0	0
Weight of non-hazardous waste	0	% of total	tons	0	0	0	0
Waste characterization (at \$700 per sample)			\$	0	0	0	0

Notes:

**Travis AFB DP039 Footprinting Analysis**  
**Green Remediation - Inventory of Energy, Material, Waste, and Other Remedy Aspects**  
**Remedy Conceptual Design and Assumptions:**  
**Alternative M - Long-term Monitoring**

**Overview**

This monitoring program represents the component of the site-wide groundwater monitoring that is conducted at the DP039 location, and is the same for all remedy options. Additional performance monitoring may be conducted as part of the individual remedial options.

THIS IS NOT A MONITORED NATURAL ATTENUATION ALTERNATIVE. RATHER, IT IS THE LONG-TERM MONITORING THAT OCCURS AT THE SITE IN ASSOCIATION WITH THE VARIOUS ONGOING ACTIVE REMEDIES.











Mode of Transport. For Personnel	Gasoline mpg	E85 mpg	Diesel mpg or pmpg	B20 mpg
Airplane	ERROR	ERROR	44.7	ERROR
Bus	ERROR	ERROR	95.6	ERROR
Car	20	14.6	22.3	20.6
Heavy-Duty Truck	10	7.3	11.2	10.3
Light-Duty Truck	15	10.95	16.7	15.4
Train	ERROR	ERROR	59.1	ERROR
Vehicle (other)	NO DATA	NO DATA	NO DATA	NO DATA

- Fuel usage for buses, airplanes, and trains are for passenger miles per gallon (pmpg)
- Airplane/jet fuel calculated as diesel for simplicity and due to similarities between kerosene and diesel
- Typical gasoline fuel efficiencies from from [www.fueleconomy.gov](http://www.fueleconomy.gov)
- E85 efficiencies based on higher heating values (mmBtu per barrel) of 5.218 mmBtu (gasoline) and 3.539 for (ethanol), Climate Leaders Direct Emissions from Mobile Sources
- Diesel car and truck efficiencies based on higher heating values (mmBtu per barrel) of 5.218 mmBtu (gasoline) and 5.825 for (diesel), Climate Leaders Direct Emissions from Mobile Sources
- B20 car and truck efficiencies based on higher heating values of 5.825 mmBtu per barrel (diesel, Climate Leaders) and 127,960 btu per gallon (biodiesel, Alternative Fuels & Advanced Vehicles Data Center, [www.afdc.energy.gov](http://www.afdc.energy.gov))
- Diesel airplane, bus, and train efficiencies from converting average CO2 emissions Climate Leaders from Commuting, Business Travel and Product Transport to diesel usage assuming 22.5 lbs of CO2 per gallon of diesel.

Fuel Type for Equipment Transport	mpg
B20	7.09
Diesel	7.2

B20 efficiency based on higher heating value of 127,960 btu per gallon for biodiesel (Alternative Fuels & Advanced Vehicles Data Center, [www.afdc.energy.gov](http://www.afdc.energy.gov)).

Fuel Type for Equip. Use	Gals. per HP-hr
B20	0.052
Diesel	0.051
E85	0.078
Gasoline	0.057

Fuel consumption based on thermal efficiency of 36% for diesel and 38% for gasoline.

Mode of Transport. For Materials	rate (mpg or gptm)
Train (gptm)	0.0024
Truck A (< 5 tons)	8.5
Truck B (5-15 tons)	7.2
Truck C (15+ tons)	5.92
Truck Heavy Load (gptm)	0.011
Truck Light Load (gptm)	0.024

mpg = miles per gallon, gptm = gallons per ton-mile

Rail fuel usage from Climate Leaders, Direct Emissions from Mobile Sources  
Truck usages from Climate Leaders, Direct Emissions from Mobil Sources and Effects of Payload on the Fuel Consumption of Trucks, Dept. for Transportation (Great Britain), December 2007. Truck heavy load based on Truck C carrying 15 tons. Truck light load based on Truck A carrying 5 tons.

### Lookup Table

Equipment Type	Default Load	Typical HP
Asphalt paver	0.62	
Backhoe	0.57	
Concrete paving machine	0.53	
Dozer (large)	0.55	
Dozer (small)	0.55	
Drilling - direct push	0.75	
Drilling - large rig (e.g., CME-75)	0.75	
Drilling - medium rig (e.g., CME-55)	0.75	
Dump truck	0.57	
Excavator (large)	0.57	
Excavator (medium)	0.57	
Excavator/hoe (small)	0.57	
Generator	0.51	
Grader	0.61	
Grout pump	0.51	
Hydroseeder	0.62	
Integrated tool carrier	0.43	
Loader	0.55	
Loader (small)	0.55	
Mobile laboratory	0.5	
Mowers	0.6	
Other	0.5	
Riding trencher	0.75	
Roller	0.56	
Rotary-screw air compressor (250 cfm)	0.48	
Skid-steer (small)	0.55	
Telescopic handler	0.43	
Tractor mower	0.6	
Water truck	0.57	

Default equipment loads obtained from Road Construction Emissions Model Version 6.3.2, Sacramento Air Quality Management District. Generators and grout pumps considered "other general industrial equipment".

Lookup Table (continued)

Materials	Units	Conv. to tons	Default One-Way Distance from Source to Site (miles)	One-Way Site-Specific Distance (miles)
Asphalt	tons	1	30	
Bentonite	tons	1	1000	
Borrow	tons	1	30	
Cement	tons	1	30	
Cheese whey	lbs	0.0005	1000	
Concrete	tons	1	30	
Emulsified vegetable oil	lbs	0.0005	1000	
GAC: regenerated	lbs	0.0005	1000	
GAC: virgin coal-based	lbs	0.0005	1000	
GAC: virgin coconut-based	lbs	0.0005	1000	
Gravel/sand/clay	tons	1	30	
HDPE	lbs	0.0005	1,500	
Hydrochloric acid (30%, SG = 1.18)	lbs	0.0005	500	
Hydrogen peroxide (50%, SG=1.19)	lbs	0.0005	500	
Hydroseed	lbs	0.0005	500	
Lime	lbs	0.0005	500	
Molasses	lbs	0.0005	500	
Nitrogen fertilizer	lbs	0.0005	500	
Other 1 - PV system	W	0.000125	0	1000
Other 2 - Mulch	cy	0.54	0	30
Other 3			0	
Other 4			0	
Other 5			0	
Phosphorus fertilizer	lbs	0.0005	500	
Polymer	lbs	0.0005	1000	
Potable water	gals x 1000	4.17	30	
Potassium permanganate	lbs	0.0005	1400	
PVC	lbs	0.0005	500	
Sequestering agent	lbs	0.0005	1000	
Sodium hydroxide (20%, SG=1.22)	lbs	0.0005	500	
Stainless steel	lbs	0.0005	500	
Steel	lbs	0.0005	500	
Trees: root balls	each	NA	500	
Trees: whips	each	NA	1000	

Miles are one-way miles. In most cases a empty initial or return trip needs to be added.

Miles should be from manufacturer to supplier to site.

Waste Disposal Facility	Round-Trip Distance (Miles)	Name or Type of Facility
Non-hazardous - Local landfill	1	On-site stockpile
Hazardous	520	Clean Harbors Buttonwillow, California
Recyclable Oil		
Hauled to POTW		
For incineration		