Appendix A
ARARs Analysis for the West-Cap Area of the Tucson International Airport Superfund Site

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APPENDIX A

ARARs Analysis for the West-Cap Area of the Tucson International Airport Superfund Site

Section 121(d) of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) states that remedial actions on CERCLA sites must attain (or justify the waiver of) any federal or more stringent state environmental standards, criteria, or limitations that are determined to be legally applicable or relevant and appropriate requirements (ARAR). Applicable requirements are those cleanup standards, criteria, or limitations promulgated under federal or state law that specifically address the situation at a CERCLA site. A requirement is applicable if the jurisdictional prerequisites of the environmental standard show a direct correspondence when objectively compared with the conditions at the site.

If a requirement is not legally applicable, the requirement is evaluated to determine whether it is relevant and appropriate. Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that, while not applicable, address problems or situations sufficiently similar to the circumstances of the proposed response action and are well suited to the conditions of the site. The criteria for determining relevance and appropriateness are listed in Title 40, *Code of Federal Regulations* (CFR), Section 300.400(g)(2) (40 CFR 300.400[g][2]).

ARARs are concerned only with substantive, not administrative, requirements of a statute or regulation. The substantive portions of the regulation are those requirements that pertain directly to actions or conditions in the environment. Examples of substantive requirements include quantitative health- or risk-based restrictions upon exposure to types of hazardous substances. Administrative requirements are the mechanisms that facilitate implementation of the substantive requirements. Administrative requirements include issuance of permits, documentation, reporting, record keeping, and enforcement. Thus, in determining the extent to which onsite CERCLA response actions must comply with environmental laws, a distinction should be made between substantive requirements, which may be ARARs, and administrative requirements, which are not.

Furthermore, the ARARs provision in CERCLA applies to onsite actions. "Onsite" is defined as the areal extent of contamination and includes the groundwater plumes to be remediated. According to CERCLA § 121(e), a remedial response action that takes place entirely onsite may proceed without obtaining permits. This permit exemption applies to all administrative requirements, as well as to permits. Actions taken offsite will need to comply with the substantive, as well as the administrative requirements of all applicable regulations.

Pursuant to the U.S. Environmental Protection Agency (EPA) guidance, ARARs generally are classified into three categories: chemical-specific, location-specific, and action-specific requirements. This classification was developed to help identify ARARs, some of which do not fall precisely into one group or another.

Definitions for these categories of ARARs are listed below:

- **Chemical-Specific ARARs** include those laws and requirements that regulate the release to the environment of materials possessing certain chemical or physical characteristics or containing specified chemical compounds. These requirements generally set health- or risk-based concentration limits or discharge limitations for specific hazardous substances. If, in a specific situation, a chemical is subject to more than one discharge or exposure limit, the more stringent of the requirements should generally be applied.
- **Location-Specific ARARs** are those requirements that relate to the geographical or physical position of the site, rather than the nature of the contaminants or the proposed site remedial actions. These requirements may limit the placement of remedial action facilities, and may impose additional constraints on the cleanup action.
- **Action-Specific ARARs** are requirements that define acceptable handling, treatment, and disposal procedures for hazardous substances. These ARARs generally set performance, design, or other similar action-specific controls or restrictions on particular kinds of activities related to management of hazardous substances or pollutants. These requirements are triggered by the particular remedial activities that are selected to accomplish a remedy. Because site remediation usually involves several alternative actions, very different action-specific requirements can apply.

A requirement might not meet the definition of an ARAR as defined above, but could still be useful in determining whether to take action at a site and/or to what degree action is necessary. This can be particularly true when there are no ARARs for a site or a particular contaminant. Such requirements are called to-be-considered (TBC) requirements. TBC materials are non-promulgated advisories or guidance documents issued by federal or state government that are not legally binding, but that may provide useful information or recommended procedures for remedial action. Although TBCs do not have the status of ARARs, they may be considered together with ARARs as part of the site risk assessment to establish the required level of cleanup for protection of human health and the environment.

A.1 Description of Alternatives

The following list summarizes the alternatives retained from the initial screening of alternatives that are considered in this ARARs analysis:

- Alternative 1 Groundwater Extraction and Treatment
- Alternative 2 Enhanced Monitored Attenuation with In Situ Chemical Oxidation

A.2 Statutes Examined for the West-Cap Area of the Tucson International Airport Superfund Site for Groundwater Remedial Action

Federal and state statutes examined as potential ARARs for the West-Cap area of the Tucson International Airport (TIAA) Superfund Site (Site) feasibility study are listed in **Table A-1**. ARARs and TBCs are identified at various points throughout the Superfund process.

These criteria are identified on a site-specific basis and, therefore, as additional information is developed regarding the site, including special features of the site location, the specific chemicals at the site, and the actions being considered as remedies, more ARARs may progressively be identified, and the list of potential ARARs further refined.

TABLE A-1
Federal and State Statutes Included in the Identification of Potential ARARs
TIAA Superfund Site, West-Cap Project Area, Focused Feasibility Report, Tucson, Arizona

	Federal Requirements
1.	Clean Water Act (CWA)
2.	Safe Drinking Water Act (SDWA)
3.	Clean Air Act (CAA)
4.	Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)
5.	Resource Conservation and Recovery Act (RCRA)
6.	Superfund Amendments and Reauthorization Act (SARA)
7.	National Archaeological and Historic Preservation Act
8.	Endangered Species Act
9.	Fish and Wildlife Coordination Act
10.	Executive Order on the Protection of Wetlands
11.	Executive Order on the Protection of Flood Plains
12.	Federal Aviation Administration (FAA)
13.	National Historic Preservation Act (NHPA)
14.	Migratory Bird Treaty Act
	State and Local Requirements
1.	Pima County Code (Titles 7, 13, and 17)
2.	Arizona Revised Statutes (Title 49, The Environment)
3.	Arizona Administrative Code (Title 18, Environmental Quality)
4.	Arizona Human Health-Based Guidance Levels for Contaminants in Drinking Water (TBCs)

Note:

This table identifies sources from which potential ARARs can be derived for the groundwater remedial action alternatives presented in this focused feasibility study. Actual ARARs and TBCs for the selected remedial actions for contaminated groundwater at the Site will be identified in the Record of Decision.

The ARARS for the volatile organic compound (VOC)-contaminated groundwater remedies are presented in **Table A-2** (chemical-specific ARARs for groundwater), **Table A-3** (location-specific ARARs for groundwater), **Table A-4** (action-specific ARARS for groundwater). Each of these categories is summarized in the following sections.

TABLE A-2
Chemical-Specific ARARs for VOC-Contaminated Shallow Groundwater
TIAA Superfund Site, West-Cap Project Area, Focused Feasibility Report, Tucson, Arizona

Source	Standard, Requirement, Criteria, or Limitation	Applicable or Relevant and Appropriate	Description of Standard, Requirement, Criteria, or Limitation	Manner in Which ARAR Applies to Alternative
Federal Safe Drinking Water Act, 42 U.S.C. Sec. 300g-1, 40 CFR 141.161	40 CFR Part 141 (Subparts B, C, G), Federal Primary Drinking Water Standards-MCLs	Applicable	MCLs are health-based drinking water standards to protect public health from contamination that may be found in drinking water from public water systems. The NCP, 40 CFR §300.430(e)(2)(i)(B), provides that remedial actions generally must attain MCLs and non-zero MCLGs where groundwater is a source or potential source of drinking water.	The cleanup levels for the VOCs in the aquifer are set at federal MCLs. The selected remedy will comply with these requirements.
Clean Water Act 33 U.S.C 1311-1387		Relevant and Appropriate	Establishes Water Quality Criteria for discharges into Surface water. The CWA Water Quality Criteria are designed to protect aquatic life (both marine and freshwater). These standards are expressed on the basis of acute and chronic toxicity levels.	Any treated groundwater that is discharged into a surface water body will meet the CWA Water Quality Criteria.
Clean Water Act § 402; 40 CFR 125	SWPCB Order No. 92-08-DWQ, NPDES General Permit No. CAS000002 (Waste Discharge requirements for Discharges of Storm Water Associated with Construction Activity)	Relevant and Appropriate	The NPDES permit program regulates discharges into “waters of the United States” by establishing numeric limits for such discharge.	The discharge of treated water to “waters of the United States” will meet the substantive effluent limitations of the NPDES permit.
Arizona Clean Water Act	Arizona Aquifer Water Quality Standards, R18-11-405, R18-11-406	Applicable	Sets chemical-specific narrative and numeric groundwater standards.	Narrative standard prohibits discharges to groundwater (as would result from injection) that would cause a pollutant to be present above a numeric standard in an aquifer classified for drinking water. The numeric standards are ARARs with respect to any discharges, but are not in situ standards.
Arizona Soil Remediation Standards	A.A.C Title 18-7-205	Relevant and Appropriate	Provides residential and non-residential soil remediation standards for remedial actions.	Soil affected by the groundwater must meet the non-residential SRLs.

TABLE A-3
Location-Specific ARARs for VOC-Contaminated Shallow Groundwater
TIAA Superfund Site, West-Cap Project Area, Focused Feasibility Report, Tucson, Arizona

Source	Standard, Requirement, Criteria, or Limitation	Applicable or Relevant and Appropriate	Description of Standard, Requirement, Criteria, or Limitation	Manner in Which ARAR Applies to Alternative
Endangered Species Act, 6 U.S.C. § 1531	50 CFR 200 and 402	Applicable	Establishes procedures for determining presence of endangered and threatened species and their habitats, and for mitigating adverse impacts.	No endangered species have been identified at the site. If any native plants or species are identified as endangered or threatened, impacts of construction or other remedial activities will be mitigated to avoid affecting such species or its habitat.
Federal Aviation Administration Rules	AC 150/5300-13	Applicable	Restricts structure heights near airports.	Applies to using a drill rig onsite to drill and construct a monitor or an extraction well.
Federal Aviation Administration Rules	AC 150/5370-2C	Applicable	Restricts construction, operation, and emissions that may cause a navigational hazard near airports.	Applicable to emissions from excavation and construction or any operational emissions.
Federal Aviation Administration Rules	AC 70/7460-1K, 150/5345-43E	Applicable	Establishes marking and lighting requirements for construction equipment or permanent structures near airports.	Applies to construction of extraction wells on airport property
Federal Aviation Administration Rules	AC 150/5380-5B	Applicable	Sets procedures for debris containment and cleanup during construction and operation on airport property.	Applicable to construction and ongoing operations on airport property
Archaeological Discoveries, Historic Preservation	41 Arizona Revised Statutes (“A.R.S.”) §§ 841-847, 865	Applicable	Preserves archaeological artifacts and remains.	If any archaeological artifacts, human remains, or funerary objects are discovered during construction, excavation or other onsite activities, the activity must cease temporarily to allow for investigation and preservation of such artifacts, remains, or objects in accordance with these procedures.

TABLE A-4
Action-Specific ARARs for VOC-Contaminated Shallow Groundwater
TIAA Superfund Site, West-Cap Project Area, Focused Feasibility Report, Tucson, Arizona

Source	Standard, Requirement, Criteria, or Limitation	Applicable or Relevant and Appropriate	Description of Standard, Requirement, Criteria, or Limitation	Manner in Which ARAR Applies to Alternative
Arizona Remedial Action Requirements	ARS § 49-282.06 (A)(2)	Applicable	Treatment of groundwater must be conducted in a way to provide for the maximum beneficial use of the waters of the state.	Maximum beneficial use of the regional aquifer is for drinking water use.
Arizona Groundwater Management Act, ARS Title 45	ARS 45-454.01; 45-494, 45-495, 45-496, 45-600	Applicable	The regulation exempts new well construction, withdrawal, treatment and injection wells at CERCLA sites from obtaining ADWR approval to extract groundwater, subject to compliance with certain substantive provisions.	The substantive standards set forth in these sections will be compiled with in construction and logging of new wells.
Clean Water Act §402, 33 U.S.C. §1342; 40 CFR Part 122	SWPCB Order No. 92-08-DWQ, NPDES General Permit No. CAS000002 (Waste Discharge requirements for Discharges of Storm Water Associated with Construction Activity)	Applicable to construction activities affecting more than 5 acres; relevant and appropriate to such activities affecting fewer than 5 acres	Discharges of stormwater associated with construction activity from soil disturbance of more than five acres is regulated as industrial activity.	The substantive portions of the general permit are action-specific ARARs for activities associated with construction of the groundwater system.
Clean Air Act 42 U.S.C. §§ 7401-7671q	40 CFR Part 61, Subparts A and V	Applicable	Controls air emissions of VOCs and gaseous contaminants and requires leak detection and repair programs. Only applies if the equipment is in service of a liquid that contains at least 10% volatile hazardous air pollutant, such as TCE.	Requires reduction in, leak detection and repair programs for, VOC emissions from product accumulator vessels.
RCRA Subtitle C; ARS §49-921 *et seq.*	40 CFR Part 264, Subpart I and R18-8-264.170 et seq.	Relevant and Appropriate	Establishes requirements for containers holding RCRA hazardous waste for treatment, storage or disposal including condition, management, and inspection of containers, container compatibility with wastes and design and operation of container storage areas.	Containers storing treatment system waste (e.g. GAC carbons or other RCRA waste) must comply with substantive provisions.

TABLE A-4
Action-Specific ARARs for VOC-Contaminated Shallow Groundwater
TIAA Superfund Site, West-Cap Project Area, Focused Feasibility Report, Tucson, Arizona

Source	Standard, Requirement, Criteria, or Limitation	Applicable or Relevant and Appropriate	Description of Standard, Requirement, Criteria, or Limitation	Manner in Which ARAR Applies to Alternative
RCRA Subtitle C; ARS §49-921 *et seq.*	40 CFR Part 264, Subpart J and R18-8-264.190 et seq.	Relevant and Appropriate	Establishes requirements for tank systems used to store or treat hazardous waste, including design and installation, containment and detection of releases, operating requirements, inspections, responses to leaks or spills and closure and post-closure.	Tanks used for treatment or storage (e.g. VGAC vessels for off-gas treatment) must comply with substantive provisions.
RCRA Subtitle C; ARS §49-921 *et seq.*	40 CFR Part 268 and R18-8-268	Relevant and Appropriate	Storage of more than 1 year requires demonstration that such storage is solely for the purpose of accumulation to allow for proper recovery, treatment, and disposal.	Storage of land-banned waste must comply with these requirements.
40 CFR Section 262.11; AAC § R18-8-262	40 CFR Section 262.11 and AAC § R18-8-262	Applicable	Regulation of waste from construction & operation of remedial action requires waste generators to determine whether wastes are hazardous wastes and establishes procedures for such determinations.	These requirements are applicable to management of waste materials generated as a result of construction of the selected remedial action or operation of any groundwater treatment units.

TABLE A-4
Action-Specific ARARs for VOC-Contaminated Shallow Groundwater
TIAA Superfund Site, West-Cap Project Area, Focused Feasibility Report, Tucson, Arizona

Source	Standard, Requirement, Criteria, or Limitation	Applicable or Relevant and Appropriate	Description of Standard, Requirement, Criteria, or Limitation	Manner in Which ARAR Applies to Alternative
40 CFR § 270	40 CFR § 270	Relevant & Appropriate	Requires that environmental media containing RCRA listed hazardous waste must be managed as a RCRA hazardous waste.	Onsite treatment of the groundwater is subject to substantive requirements of RCRA permits. To the extent, if at all, that purge water associated with groundwater monitoring activities contains RCRA listed hazardous waste, then purge water must be managed as a RCRA hazardous waste. The groundwater itself must be managed as a RCRA hazardous waste because it contains a RCRA-listed waste. Onsite treatment of the groundwater is subject to substantive requirements of RCRA permits.
40 CFR § 262.34	40 CFR § 262.34	Relevant and Appropriate	Regulates temporary accumulation of hazardous waste onsite. Specifies procedure for accumulation of hazardous waste onsite for certain amounts of hazardous waste and for certain time periods under generator status.	These requirements are applicable to management of waste materials generated as a result of construction of the remedial action and operation of any of the groundwater treatment plants if the waste materials generated are hazardous wastes.

TABLE A-4
Action-Specific ARARs for VOC-Contaminated Shallow Groundwater
TIAA Superfund Site, West-Cap Project Area, Focused Feasibility Report, Tucson, Arizona

Source	Standard, Requirement, Criteria, or Limitation	Applicable or Relevant and Appropriate	Description of Standard, Requirement, Criteria, or Limitation	Manner in Which ARAR Applies to Alternative
A.R.S. § 49-221: AAC § R18-11-101 *et seq*.	A.R.S. § 49-221: AAC § R18-11-101 et seq.	Applicable	Regulates discharges to surface water	Discharge from treatment systems must comply with Arizona State Water Quality Standards for Surface Waters. This requirement is applicable at times when treated water is discharged to surface water (Arizona Canal System).
A.R.S. § 49-224	A.R.S. § 49-224	Relevant and Appropriate	All aquifers in the state identified under § 49-222(A) and any other aquifers subsequently discovered are classified for drinking water protected use.	
40 CFR Part 122 and Part 125	40 CFR Part 122 and Part 125	Applicable	Establishes treatment and monitoring requirements for discharges to surface water.	The substantive requirements of the NPDES program are applicable when treated groundwater is discharged to surface water.
40 CFR § 144.12 – 144.16	40 CFR § 144.12 - 144.16	Applicable	Criteria and standards for the Underground Injection Control (UIC) Program. These criteria include current and future use, yield and water quality characteristics and regulate the reinjection of groundwater.	These criteria are applicable for determining exempt aquifers. Injection wells will comply with these design, construction, operation and maintenance requirements.
AAC § R18-4-501-502	AAC § R18-4-502	Applicable	Identifies minimum siting and design criteria for treatment units associated with public water systems.	In the event that it is necessary to construct a replacement drinking water treatment plant, compliance with the criteria identified in these regulations is expected.

TABLE A-4
Action-Specific ARARs for VOC-Contaminated Shallow Groundwater
TIAA Superfund Site, West-Cap Project Area, Focused Feasibility Report, Tucson, Arizona

Source	Standard, Requirement, Criteria, or Limitation	Applicable or Relevant and Appropriate	Description of Standard, Requirement, Criteria, or Limitation	Manner in Which ARAR Applies to Alternative
AAC § R18-4-701 to R18-4-704 and R18-4-706, R 18-4-708-709, Apx. B		Relevant and Appropriate	Identifies requirements for annual consumer confidence reports for treatment facilities delivering drinking water.	Requires any treatment facility delivering drinking water to comply with these notification requirements.
Federal Clean Air Act, 42 U.S.C. §§7401 *et seq*.	Pima County Bureau of Air Pollution Control Rules and Regulations, Title 17 Pima County Air Quality Code, 17.16.430, Subparagraph F	Applicable	Limits pollution emissions from unclassified sources and requires reasonably available control equipment from a stationary source that emits VOCs.	If the final remedy resulted in emissions of air pollutants, these rules will apply.
AAC § R12-15-818		Relevant and Appropriate	Prohibits new well construction within 100 feet of any hazardous waste facility.	
Safe Drinking Water Act, 42 U.S.C. §300f *et seq*.	40 CFR 144.24(a), 146	Applicable	Establishes criteria for determining exempt aquifers, including current and future use, yield and water quality.	Applies to design, construction, operation and maintenance of Class V injection wells, if selected to return treated groundwater to the aquifer.
	EPA Office of Solid Waste, RCRA Groundwater Monitoring: Draft Technical Guidance, Nov., 1992 (EPA/530-R93--001)	Applicable	Sets forth requirements for the development and implementation of a groundwater monitoring program.	Applies to the development of a comprehensive groundwater monitoring program for the site.

Notes:

NPDES = National Pollutant Discharge Elimination System

A.3 Chemical-Specific ARARs

Chemical-specific ARARs for commonly detected organic compounds at the Site are summarized in **Table A-2**. Inorganic compounds are not considered contaminants of concern (COC) for the Site. The major statutes and regulations that contribute to the list of potential chemical-specific ARARs are the Clean Water Act (CWA), the Safe Drinking Water Act (SDWA), the Arizona Water Quality Standards (A.A.C Title 18, Chapter 11), and the Arizona Soil Remediation Levels (A.A.C, Title 18, Chapter 7). If an Arizona Water Quality Standard (AWQS) does not exist for a specific compound, the Arizona Department of Environmental Quality (ADEQ) Human Health-Based Guidance Levels for Contaminants in Drinking Water (HBGL) are TBCs. The chemical-specific ARARs that have been evaluated are those that 1) affect groundwater and vadose zone remedial goals, and 2) determine to what degree groundwater and the vadose zone should be treated prior to discharge.

A.3.1 Chemical-Specific ARARs Affecting Groundwater Remedial Goals

The SDWA maximum contaminant level (MCL) standards are formulated to protect water for human consumption for drinking, cooking, bathing, and other water contact activities. Economic issues and technical feasibility of treatment processes are considered in the establishment of these levels. MCLs are applicable to the quality of drinking water at the tap pursuant to the SDWA and are ARARs for treated groundwater when the end use is for purposes of human consumption. Pursuant to 40 CFR Section 300.430(e)(2)(i)(B), MCLs and non-zero maximum contaminant level goals (MCLG) are relevant and appropriate as in situ aquifer standards for groundwater that is or may be used for drinking water. The MCLs and non-zero MCLGs are presented in **Table A-5**. The State of Arizona has adopted the federal MCGLs and MCLs by reference as stated in §R18-4-108 and 109. The MCL for the most prevalent contaminant in the shallow groundwater zone, TCE, is 5 micrograms per liter (µg/L). The MCLs, if available, for other contaminants of concern in the shallow groundwater zone are set forth in **Table A-5**.

The Arizona Aquifer Water Quality Standards (AAC §R18-11-401 et seq.) are standards developed to protect groundwater by preventing discharges of pollutants above certain concentrations to aquifers that endanger human health, or that impair the uses of the aquifer. The AWQS applied to aquifers classified as sources of drinking water for the primary contaminants of concern are currently identical to the federal SDWA MCLs. In Arizona, all aquifers are identified as drinking water aquifers unless specifically exempt. As is the case with MCLs, the AWQSs are relevant and appropriate as in situ aquifer cleanup standards for groundwater that may be used for drinking water at the Site. Aquatic and wildlife standards are relevant and appropriate because discharge to a wash or for irrigation have been identified as end use options. These standards are expressed on the basis of acute and chronic toxicity levels. The concentration levels are presented in **Table A-5**.

TBCs that may be considered at the Site include the ADEQ HBGLs, which are health-based levels for drinking water. These levels, although set forth in Arizona regulations, are not "promulgated" in the sense of being legally enforceable and generally applicable. They might be useful TBCs for determining potential cleanup levels for groundwater at the Site primarily for compounds that do not have MCLs. Final cleanup standards will be presented in the ROD. The HBGLs for water are included in **Table A-5**.

A.3.2 Other Chemical-Specific ARARS

Groundwater from CERCLA actions may be treated as non-Resource Conservation and Recovery Act (RCRA) hazardous waste if the waste contains chemicals in concentrations below health-based levels (i.e., MCLs) selected by EPA Region IX as set forth in **Table A-5** or exhibits hazardous characteristics. Treatment-derived water may be subject to certain action-specific ARARs if the wastewater contains contaminants in concentrations above the levels set forth in **Table A-5** or exhibits hazardous characteristics.

TABLE A-5
Potential Chemical-Specific Groundwater ARARs and TBCs for the West-Cap Area of the Tucson International Airport Superfund Site (Concentrations in μg/L)
TIAA Superfund Site, West-Cap Project Area, Focused Feasibility Report, Tucson, Arizona

Parameter	Applicable or Relevant and Appropriate				To Be Considered
	Primary MCL[a]	MCLG[b]	A&Ww[c] Acute	A&Ww[c] Chronic	HBGL[d] for Water
Organics					
1,1-Dichloroethene	7	7	15,000	950	0.06
cis-1,2-Dichloroethene	70	70	-	-	
Tetrachloroethene (PCE)	5	-	6,500	680	0.7
Trichloroethene (TCE)	5	-	20,000	1,300	3.2

Notes:

The Arizona AWQS for 1,1-dichloroethene,cis-1,2-dichloroethene, PCE and TCE, are identical to the federal MCLs

[a]MCL = Maximum Contaminant Level.

[b] MCLG = Maximum Contaminant Level Goal

[c] A&Ww = Aquatic and Wildlife (warm water fishery).

[d] HBGL = Human Health-Based Guidance Levels are only applicable in the absence of an MCL or AWQS (March 1991 Update).

A.4 Location-Specific ARARs

Potential location-specific ARARs for the Site are listed in **Table A-3**. Location-specific ARARs differ from chemical-specific or action-specific ARARs in that they are not closely related to the characteristics of the wastes at the Site or to the specific remedial alternative under consideration. Location-specific ARARs are concerned with the area in which the Site is located. Actions may be required to preserve or protect aspects of the environment or cultural resources of the area that could be threatened by the existence of the Site or by the remedial actions to be undertaken at the Site. Final location-specific ARARs will be presented in the ROD.

A.4.1 Location-Specific ARARs Affecting Groundwater Remedial Goals

Construction or remediation activities performed on any lands owned or controlled by the State of Arizona, by any public agency or institution of the state, or by any county or municipal corporation within the state shall comply with State of Arizona ARARs (41 A.R.S. 841-847.865) establishing procedures for protecting artifacts.

A.5 Action-Specific ARARs

Potential action-specific ARARs considered for the Site are presented in **Table A-4**. The actions included in these tables are components of pump, treat, and end use remedial alternatives considered in the Site focused feasibility study.

For each action, a number of potential action-specific ARARs that may be applicable or relevant and appropriate to implementation of the remedial action has been identified. A description of the requirements associated with some of the significant potential ARARs and a discussion of the conditions under which the ARAR would be applicable or relevant and appropriate are included below.

A.5.1 Hazardous Waste Management ARARs Under RCRA

The RCRA is a federal statute passed in 1976 to meet three goals: the protection of human health and the environment; the reduction of waste and the conservation of energy and natural resources; and the elimination of the generation of hazardous waste as expeditiously as possible. The Hazardous and Solid Waste Amendments (HSWA) of 1984 significantly expanded the scope of RCRA by adding new corrective action requirements, land disposal restrictions, and technical requirements. Substantive RCRA requirements are applicable to response actions at CERCLA sites if contaminates are characterized as hazardous waste.

Untreated groundwater at the Site containing VOCs is not a listed waste. The groundwater is not a characteristic waste because the contaminants in the groundwater are below the levels established for the characteristic of toxicity. Consequently, the RCRA requirements triggered by the hazardous nature of waste are not applicable and not relevant and appropriate with respect to the groundwater.

Because the untreated groundwater is not a RCRA hazardous waste, and because of EPA's exception for contaminated media, the groundwater that has been treated to health-based

standard (i.e., MCLs) would not be a RCRA hazardous waste, and the RCRA requirements again would not be triggered.

Specific RCRA requirements may be considered relevant and appropriate and may be considered during remedial design. The RCRA requirements may be applicable to residues generated that result from groundwater treatment (e.g., contaminated carbon) and are classified as hazardous waste.

The RCRA program is a delegable program: a state may manage the program in lieu of the EPA if the state statutes and regulations are equivalent to or more stringent than the federal statutes and regulations. In some cases, the applicable or relevant and appropriate RCRA requirement will be cited as state law and in other cases as federal law. Some of the RCRA requirements that may be considered applicable or relevant and appropriate are discussed below.

Storage

The substantive storage requirements of RCRA's regulations found in 40 CFR 264, as incorporated into or modified by AAC R18-8-264, may be relevant and appropriate to the storage of hazardous wastes generated onsite, such as contaminated carbon. This includes requirements for container storage, secondary containment, and leak detection. Any offsite storage of hazardous wastes would be subject to administrative requirements as well.

Disposal

The substantive disposal requirements of RCRA's regulations found in 40 CFR 264, as incorporated into or modified by AAC R18-8-264, may be relevant and appropriate to the disposal of hazardous wastes generated onsite, such as contaminated carbon. This includes requirements for notification, disposal methods, and transport.

A.5.2 Groundwater Extraction and Injection ARARs

Federal regulations that govern underground injection programs are found in 40 CFR 144.12 and 144.13. According to these regulations, the injection of treated groundwater cannot allow movement of contaminants into underground sources of drinking water, which may result in violations of MCLs or adversely affect health. Reinjection of treated groundwater into the same formation it was withdrawn from is allowed as part of a CERCLA corrective action.

If treated groundwater is reinjected into an aquifer, substantive permit requirements will need to be met concerning recharge, poor quality groundwater withdrawal, and well installation. The substantive requirements of the Arizona Aquifer Protection (APP) Permits (ARS §49-241, et seq. and AAC §R18-9-101 et seq.) will be relevant and appropriate to alternatives requiring recharge or reinjection onsite. The APP program requires that any discharges to the aquifer must not cause or contribute to a violation of AWQS.

Arizona's state Superfund program, known as the Water Quality Assurance Revolving fund (WQARF), provides for cleanup of hazardous substances in groundwater. (ARS § 49-281 et seq.) Section 49-282.06 of WQARF, requires groundwater remedial actions to assure the protection of public health, welfare, and the environment; to manage and cleanup hazardous substances, to the extent practicable, so as to allow for the maximum beneficial

uses of the waters of the state; and to be reasonable, necessary, cost effective, and technically feasible. These criteria are very similar to criteria applicable to response actions under CERCLA and the NCP. Those authorities require that remediations be protective of human health and the environment, meet ARARs, and consider advancing numerous other factors, including: long-term permanence; the reduction of toxicity, mobility or volume; implementability; and cost effectiveness. In addition, the NCP requires that groundwater remedial actions generally attain federal MCLs and non-zero MGCLs where relevant and appropriate; the NCP also requires remedial alternatives to take into account the expectation that the remedial action will return groundwater to its beneficial uses wherever practicable within a reasonable timeframe for the site circumstances.

The WQARF provisions do not appear to be more stringent than those in the NCP and therefore are not ARARs. Nonetheless, any remedy EPA selects will meet the WQARF statutory criteria by meeting the NCP requirements.

A.5.3 Air Emissions Requirements

The federal CAA, 42 USC 7401, et seq., implemented through its regulations at 40 CFR Parts 50-99, establish National Ambient Air Quality Standards (NAAQS), New Source Performance Standards (NSPS), and Hazardous Air Pollutant Standards. The NSPS and Hazardous Air Pollutant Standards are not ARARs for the Site because none applies to the types of treatment being considered at the Site. The CAA's NAAQS are not ARARs because they are not enforceable as applied to individual sources. Rather, the NAAQS are implemented through State Implementation Plans (SIP). Although neither of the two treatment alternatives currently being considered will create air emissions, some emissions may be generated during construction of treatment facilities or in if other treatment alternatives such as air stripping or soil vapor extraction are considered in the future. Some requirements of the Pima County Implementation Plan may be potential ARARs.

- Pima County Code, Title 17. Air Quality Control potential ARARS are listed below:
  - Permits and Permit Revisions—Specifies general requirements for major sources of air emissions. Major sources are defined as those sources capable of emitting 100 tons per year or more of any regulated air pollutant. The proposed groundwater treatment sites are not expected to be a major source of VOC emissions; however, if this limitation is exceeded, emission of VOCs to the atmosphere must be reduced by specified methods including incineration, adsorption, or other processes not less effective than incineration or adsorption. Title 17 also includes efficiency requirements for the reduction process, and monitoring and testing requirements for VOC emissions.
  - Performance Tests—Establishes performance testing requirements for owners and operators of stationary sources to determine compliance with emission standards.
  - Open Fugitive Dust Emissions—This regulation may apply to construction of the treatment system. It imposes limits on the emission of particulate matter for any action, including construction activities that can cause open fugitive dust emissions. This regulation is applicable only for the treatment alternatives that require construction of conveyance pipelines associated with the end use options.

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Appendix B
Previous Evaluations of Monitored Natural Attenuation

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Using Monitored Natural Attenuation as a Potential Remedial Alternative for West Plume B

PREPARED FOR: Sean Hogan / US EPA

PREPARED BY: CH2M HILL

COPIES: Bill Ellett / ADEQ
Craig Kafura / ADEQ

DATE: March 8, 2000

Work Plan Task

Work to prepare this technical memorandum was performed under Subtask 10.02 (Remedial Alternatives Screening [RS.M1.WP]: West Plume B), of CH2M HILL's August 30, 1999 Work Plan Addendum for the West Cap RI / FS Work Assignment (WA #019).

Objective

The objective of this memorandum is to discuss whether using Monitored Natural Attenuation (MNA) is a viable alternative for remediation of the West Plume B portion of the former West Cap site (see **Figure 1**). The conclusions are preliminary and based on chlorinated solvent contamination levels, lithologic information, and screening parameters for the area north of Valencia Road. These parameters aid in determining if MNA will be a feasible remedy. The parameters include: Total Organic Carbon (TOC), Oxidation-Reduction Potential (ORP), dissolved oxygen, pH, Total Petroleum Hydrocarbons (TPH) contamination, methane in solution, sulfates, and nitrates. This assessment was conducted within the framework outlined by a paper entitled, "Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Ground Water."

Background

MNA can be used to monitor the reduction of contaminant levels to below risk-based corrective action criteria or regulatory standards without implementing additional remedial action alternatives. MNA has advantages over conventional engineered remediation alternatives. It is less expensive, requires no downtime or maintenance, and it is nonintrusive. Using MNA also enables monitoring of the potential biodegradation processes that can ultimately transform contaminants into innocuous by-products rather than transferring the contaminant to another phase.

In the case of chlorinated solvents, three biological attenuation mechanisms could be occurring. They are: reductive dechlorination, direct oxidation, and co-metabolism. A summary of each of these mechanisms and their applicability is presented in **Table 1**.

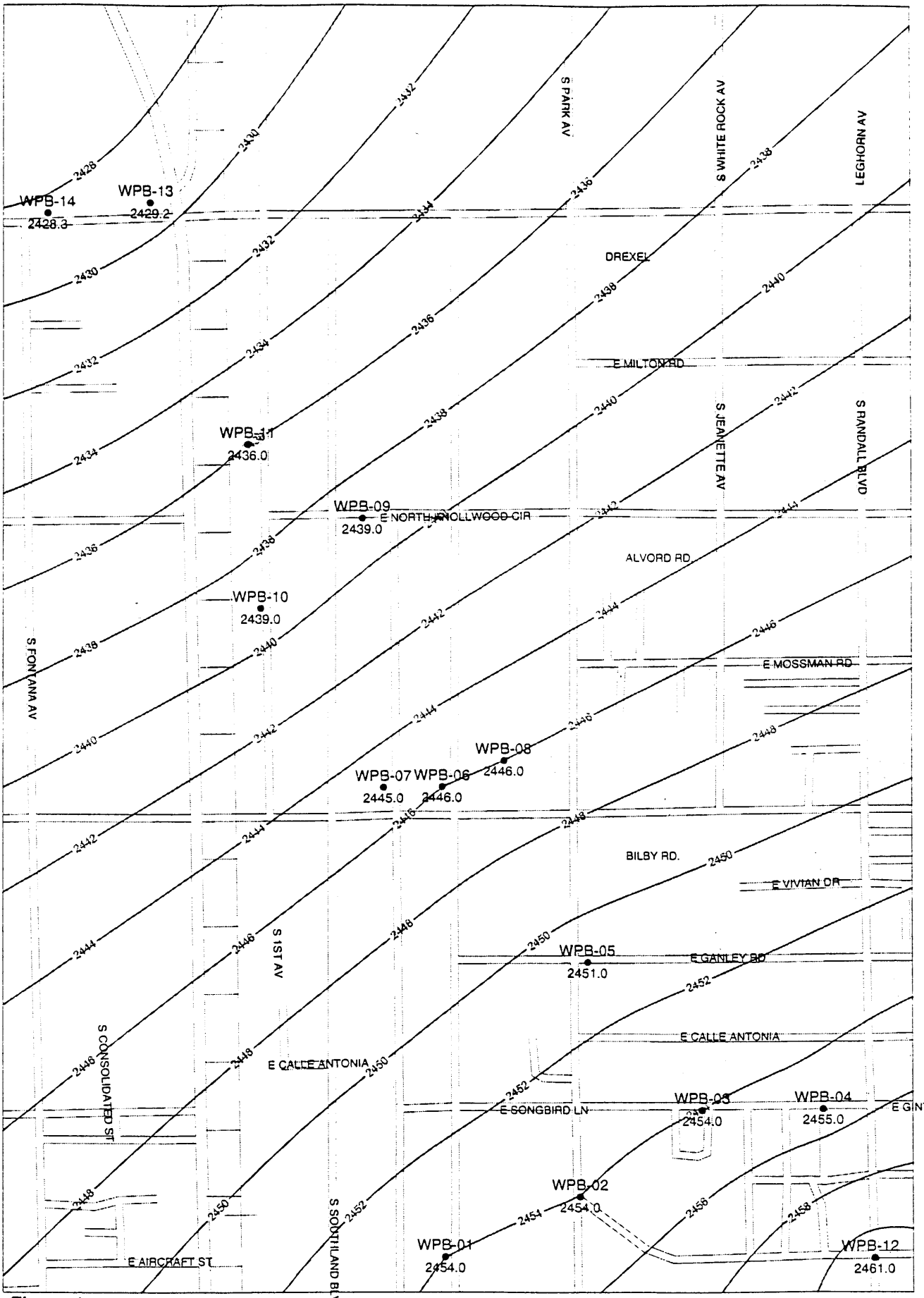


Figure 1

Former West Cap Area, Western Plume B.

WPB wells showing locations and static water levels.

Table 1.

Chlorinated Aliphatic Hydrocarbon Biodegradation Mechanisms

Mechanism	Description	Applicability	Comments
Reductive dechlorination (electron acceptor reactions)	• Chlorinated aliphatic hydrocarbons act as an electron acceptor (not as a source of carbon) • Chlorine atoms are removed and replaced with hydrogen atoms • Typically, sequential dechlorination occurs from perchloroethylene (PCE) to trichlorethylene (TCE) to dichloroethylene (DCE) to vinyl chloride (VCl) to ethylene	• The most oxidized chlorinated ethenes (e.g., PCE) are more susceptible to reductive dechlorination than less oxidized compounds (e.g., VCl) • The rate of reductive dechlorination appears to decrease as the degree of chlorination decreases	• Reductive dechlorination is the most important process for natural biodegradation of chlorinated aliphatic hydrocarbons • An appropriate carbon source (e.g., natural organic matter, fuel hydrocarbons, or other organic compounds) must be present for microbial growth to occur
Direct oxidation	• Microbes use chlorinated aliphatic hydrocarbons as an energy and organic carbon source (elector donor)	• Only the least oxidized chlorinated aliphatic hydrocarbons (e.g., VCl, DCA) can be degraded under this mechanism	• Direct oxidation is the dominant mechanism for biodegradation to fuel hydrocarbons—not chlorinated aliphatic hydrocarbons
Co-metabolism	• Microbial degradation is catalyzed by an enzyme or cofactor that is produced by the microorganisms	• Under aerobic conditions, most chlorinated ethylenes (except PCE) are susceptible to co-metabolic degradation • The co-metabolic rate appears to increase as the degree of dechlorination decreases	• The microbes involved in co-metabolism receive no known benefit from the degradation process; in fact in some cases, degradation may actually be harmful to the microbes

Source: Elsevier Science Inc.; adapted from T.H. Wiedemeier et al.

Other processes that may also contribute to natural attenuation are the physical and geochemical processes of adsorption, dispersion, diffusion, and mixing. Adsorption occurs when a dissolved contaminant is removed from a solution and attaches to the surface of a solid. Adsorption can contribute to lowering the effective concentration of the solute by determining the distribution coefficient. This coefficient is empirically determined by computing the ratio of contaminant adsorbed on the solid to the quantity in solution. Spatial and temporal trends of the contaminant can also be observed based on the historical data of the wells to determine if the contaminant concentrations are decreasing due to dispersion and mixing. These processes generally do not alter the chemistry of the contaminant but rather dilute the dissolved contaminant by spreading the lower concentration level of the contamination over a large volume of groundwater.

If there is not a significant amount of carbon source for biodegradation activities, these physical and geochemical processes can be the primary mechanisms for natural attenuation. These processes can also be sufficient to warrant natural attenuation as a remedial alternative if the contaminant concentrations are low, and temporal and spatial trends of the contaminant show stable levels downgradient of the source.

The mechanism most likely to cause biodegradation of chlorinated hydrocarbons is reductive dechlorination. During this process, the chlorinated hydrocarbon is used as an electron acceptor, not a source of carbon, as in the case with fuel hydrocarbons. A chlorine atom is removed and replaced with a hydrogen atom. **Figure 2** illustrates the transformation of the chlorinated hydrocarbons by reductive dechlorination. Of the compounds shown on Figure 2, PCE is the most susceptible to reductive dechlorination because it is the most oxidized. As a result, the rate of reductive dechlorination appears to decrease as the degree of chlorination decreases. Therefore, degradation of the least oxidized chlorinated hydrocarbons, such as vinyl chloride and 1,2-dichloroethane, most likely occurs if direct oxidation occurs.

At the West Plume B site, groundwater contamination is lower than 1 mg/L of TCE, degradation will most likely occur if reactive organic matter is present to produce the necessary reducing conditions.

Site Characteristics

Groundwater Chemistry

Before natural attenuation can be selected as the remedial action alternative at the site, it must be proven that natural mechanisms will reduce contaminant concentrations to below acceptable levels before potential exposure receptors are reached. Preliminary observations of the area north of Valencia Road show that TCE concentrations are highest at WPB-5 and WPB-8, then decrease as the plume moves downgradient (**Figure 3**). Figure 3 also shows that TCE concentrations are decreasing over time in the wells with concentrations higher than 2 ug/L. This gives some evidence that natural attenuation could be occurring. Overall, the concentration trends in Figure 3 show that soluble TCE is decreasing downgradient of the estimated source and with respect to time. This may suggest that decreasing concentrations of TCE are due to adsorption, mixing, and dispersion.

Another observation is the detection of *cis*-1,2-DCE in specific wells, and the detection of vinyl chloride (2.2 ug/L) in monitor well WPB-6 (see **Table 2**). Although *cis*-1,2-DCE is mostly nondetect throughout the plume, there have been detections in isolated areas. Vinyl chloride has also been nondetect for the entire West Plume B wells, except for a detection in well WPB-6 (at a level slightly above the maximum contaminant level) during the fourth quarter 1999 sampling event. These by-products are less oxidized chlorinated hydrocarbons and are produced during the dechlorination of TCE.

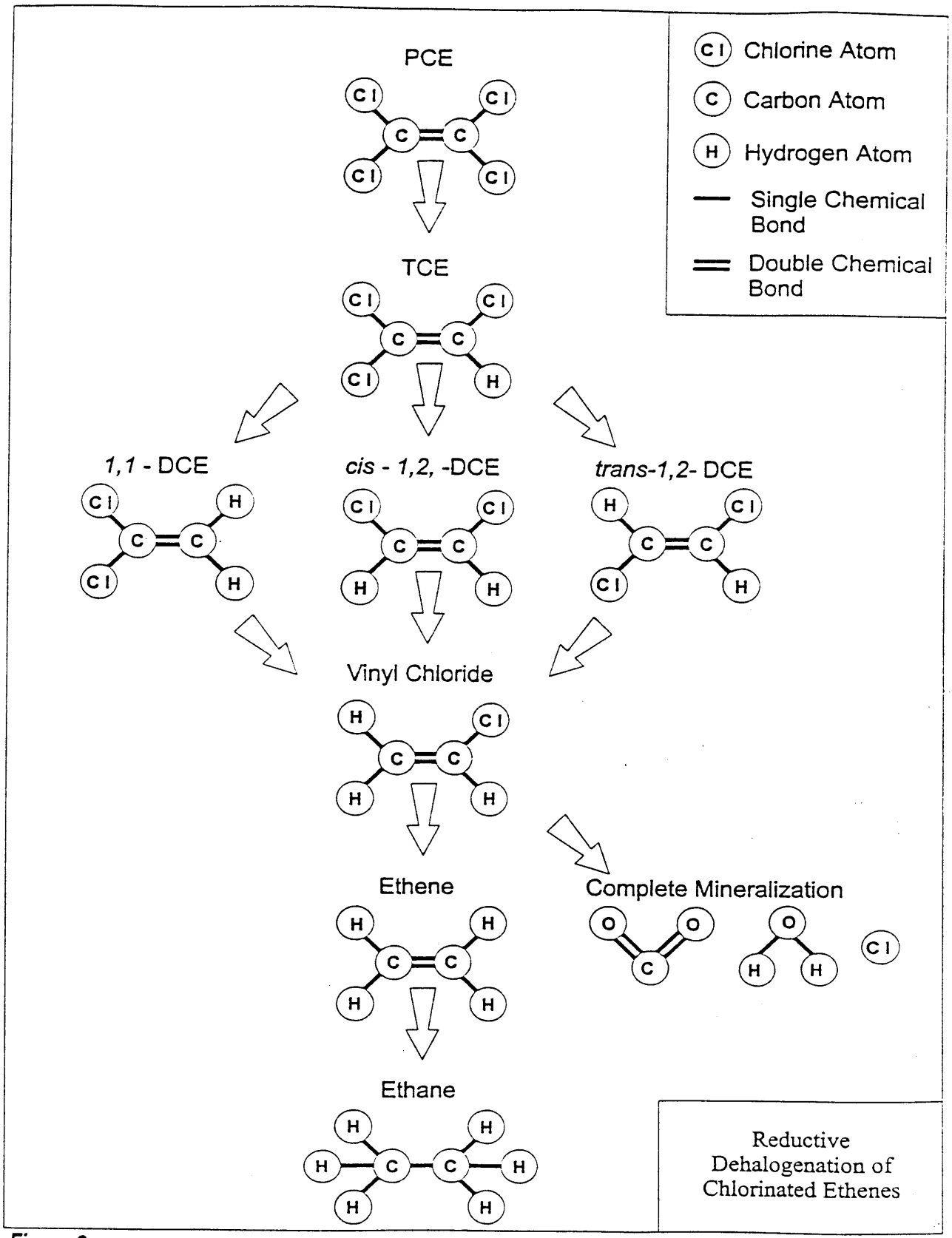


Figure 2
Reductive Dehalogenation of Chlorinated Ethenes

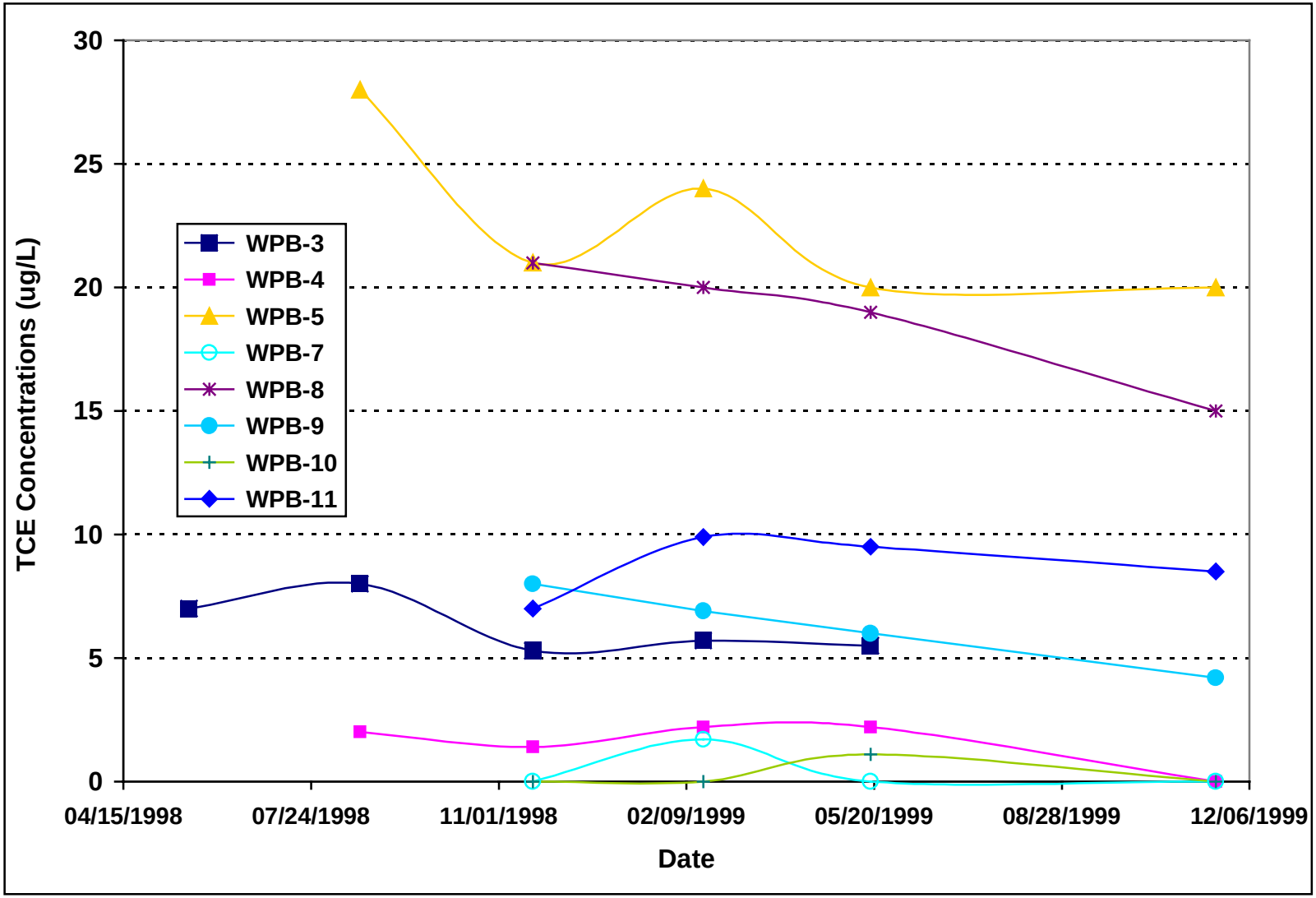


FIGURE 3. TCE CONCENTRATION TRENDS FOR WEST PLUME B WELLS.

TABLE 2.
Chlorinated Solvent Concentrations in West Plume B Monitor Wells.

Well ID	TCE concentrations (ug/l)							PCE concentrations (ug/l)							*cis*-1,2-DCE concentrations (ug/l)						
	5/98	8/98	11/98	2/99	5/99	8/99	11/99	5/98	8/98	11/98	2/99	5/99	8/99	11/99	5/98	8/98	11/98	2/99	5/99	8/99	11/99
WPB –1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
WPB-2	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
WPB-3	**7**	**8**	**5.3**	**5.7**	**5.5**	**3.6**	**-**	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
WPB-4	-	**2**	**1.4**	**2.2**	**2.2**	**1.7**	<1	-	<1	<1	<1	<1	<1	<1	-	<1	<1	<1	<1	<1	<1
WPB-5	-	**28**	**21**	**24**	**20**	**20**	**20**	-	<1	<1	<1	<1	<1	<1	-	**2**	<1	**1.1**	**1.2**		
WPB-6*	-	<1	<1	<1	<1	<1	<1	-	<1	<1	<1	<1	<1	<1	-	<1	<1	<1	<1	<1	<1
WPB-7	-	-	<1	**1.7**	<1	<1	<1	-	-	<1	<1	<1	<1	<1	-	-	<1	<1	<1	<1	<1
WPB-8	-	-	-	**20**	**19**	**19**	**15**	-	-	-	<1	<1	<1	<1	-	-	-	<1	**1.1**		
WPB-9	-	-	**8**	**6.9**	**6**	**3.4**	**4.2**	-	-	<1	<1	<1	<1	<1	-	-	<1	<1	<1	<1	<1
WPB-10	-	-	<1	<1	**1.1**	<1	<1	-	-	<1	<1	<1	<1	<1	-	-	<1	<1	<1	<1	<1
WPB-11	-	-	**7**	**9.9**	**9.5**	**8.3**	**8.5**	-	-	<1	<1	<1	<1	<1	-	-	<1	<1	<1	<1	<1

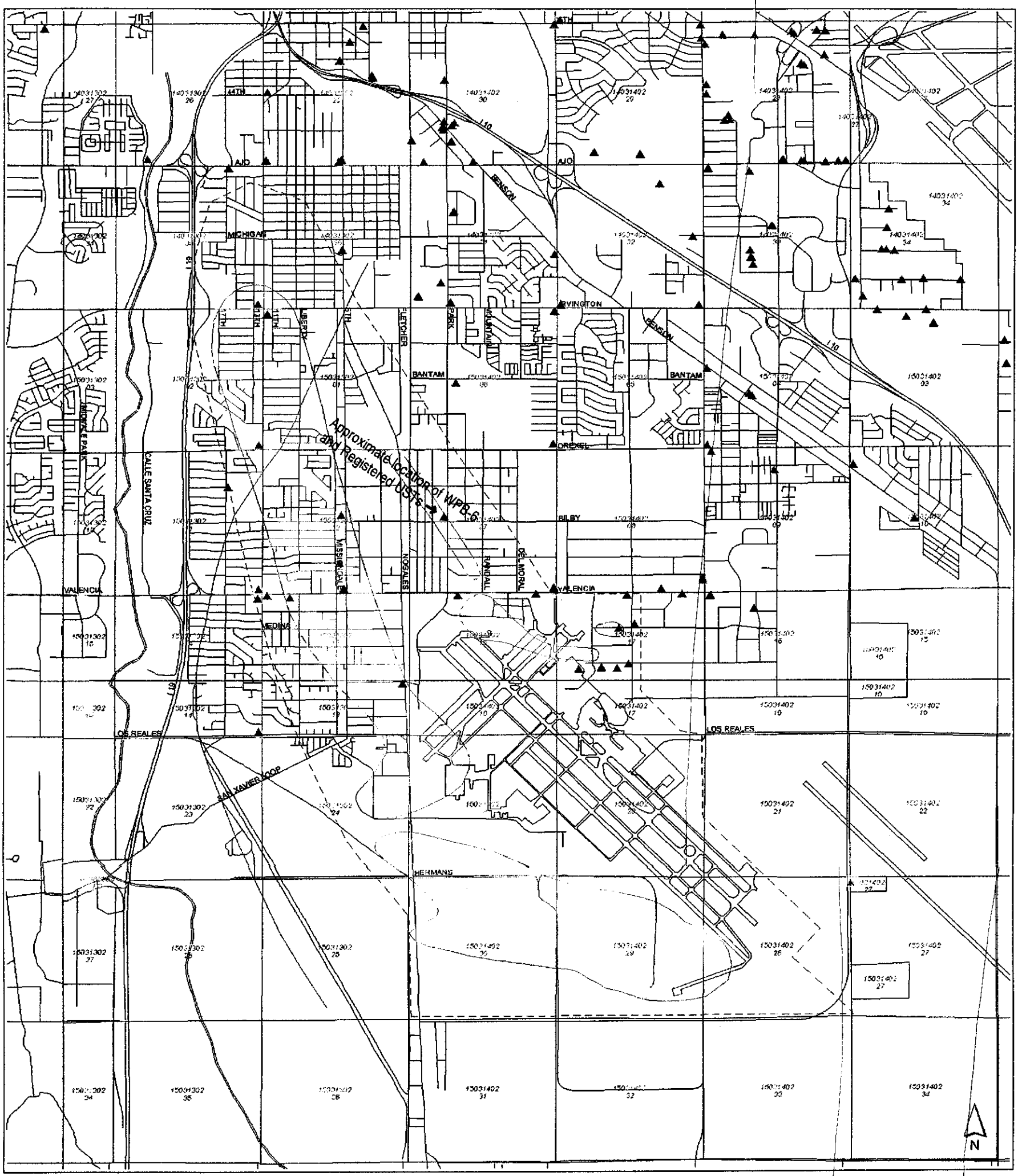
* Vinyl Chloride was detected at 2.2 ug/L during the 4th quarter sampling event 11/99.

A review of the ADEQ Underground Storage Tank (UST) Section files reveals that there are registered USTs in the immediate vicinity of well WPB-6 (**Figure 4**). It is likely that one or more of the USTs at this location is leaking (or has leaked in the past), and the resultant presence of fuel hydrocarbons in the groundwater creates the conditions needed for the anaerobic degradation of TCE to vinyl chloride. However, because vinyl chloride does not persist in groundwater over long distances when under aerobic conditions, it is likely that the vinyl chloride created from the localized anaerobic conditions of the fuel spill will quickly degrade as it moves downgradient away from the area affected by the fuel spill. This preliminary conclusion is supported by a review of the water quality results from downgradient monitor wells WPB-9 and WPB-10 which show that vinyl chloride is not detected at those locations.

The observations described above suggest that conditions needed for natural attenuation are likely present in isolated areas, resulting in limited degradation. However, this limited degradation may not be substantial enough to warrant natural attenuation as a remedial alternative.

Lithology

The soil logs taken during construction of the West Plume B wells show that the subsurface is primarily clay with intermittent layers of sand and/or gravel, then becomes somewhat homogenous below 100 feet, consisting of mostly clay and silt. The water table ranges from about 80 feet below ground surface (bgs) to 95 feet bgs downgradient. To further screen natural attenuation, CH2M HILL took soil samples for TPH analysis and TOC analysis during construction of monitor wells WPB-12, WPB-13, and WPB-14. The samples were taken just below the water table at 90 feet and also at about 120 feet bgs.



0.5 0 0.5 1 1.5 Miles

1:24,000

LEGEND:

Township, Range Section

▲ Underground Storage Tanks

EPA Site Boundary

TIAA Superfund Site
Underground Storage Tanks
January 25, 2000

Projection: UTM Zone 12
Datum: NAD27
Spheroid: Clarke 1866
Prepared By: Hans Huth
Revised By: Bill Ellett

Figure 4
Registered USTs Near TIAA

Collection of Natural Attenuation Data

To assess whether natural attenuation is occurring, additional screening parameters were measured from wells WPB-1 through WPB-14. Specific parameters, the objective of their analysis, and analytical methods used in this study are listed in **Table 3**. All data collected throughout the effort are provided in Appendix A.

TABLE 3.
Parameters and Analytical Methods used for Natural Attenuation Screening

Screening Parameters	Objective	Lab or Field	Method of Analysis
Chlorinated solvents	Contaminants of concern	Lab	8260B
Methane	By-product of biological degradation	Lab	GC/FID
Total Organic Carbon	Total Organic Loading	Lab	ASTM D4129-82M
TPH Diesel	Potential carbon source	Lab	8015B (MOD)
Alkalinity	Potential indication of bioactivity	Lab	EPA Method 310.1
Total Dissolved Solids (TDS)	General water quality parameters	Lab	EPA Method 160.1
Chloride	General water quality parameter (1)	Lab	EPA Method 300
Sulfates	Electron acceptor for anaerobic biodegradation	Lab	EPA Method 300
Nitrates	Electron acceptor	Lab	EPA Method 300
PH, EC, Temperature	General water quality parameter and redox state	Field	Field meters
Redox	Redox state (2)	Field	Field meter (YSI)
Dissolved Oxygen	Electron Acceptor in biodegradation	Field	Field meter (YSI)
Iron	Potential electron acceptor	Lab	6010B

(1) Indication that reductive dechlorination is occurring

(2) Indication of the relative tendency of a solute or species to accept or transfer electrons

The geochemical parameters used to evaluate the potential for natural attenuation are summarized in **Tables 4 and 5**. For a particular analyte, the values shown in Table 4 represent the highest concentrations ever detected in each well. The methane concentrations shown in Table 5 represent an average value of the samples taken only at monitor wells WPB-3, WPB-4, WPB-5, WPB-8, and WPB-11.

The TOC sample was taken at monitor well WPB-14 during construction of the well, and assuming that the subsurface is homogeneous, represents the TOC throughout the West Plume B site.

TABLE 4.
Natural Attenuation Screening Parameter Concentrations

Well Id	TCE (ug/L)	*cis*-1,2-DCE (ug/L)	Vinyl Chloride (ug/L)	Sulfates (mg/L)	Nitrates (mg/L)	Total Alkalinity (mg/L)	Iron (II) (mg/L)	Chloride (mg/L)	Dissolved Oxygen (mg/L)	Redox Potential (mV)	pH	TDS	Temperature (℃)	Conductivity (uhoms)
WPB-1	ND	ND	ND	170	14	230	1.9	93	1.53	138.5	11.5	-	25	1100
WPB-2	ND	ND	ND	210	10	180	0.15	62	8.2	291.0	7.99	0.616	25.5	860
WPB-3	8	ND	ND	240	18	180	0.71	60	7.06	285.7	7.47	0.638	25	905
WPB-4	2.2	ND	ND	180	15	150	0.67	73	8.75	303.9	7.57	0.605	25	853
WPB-5	28	2	ND	340	11	160	0.31	90	8.41	282.4	7.40	0.772	25	1082
WPB-6	ND	ND	2.2	240	13	190	0.11	62	8.44	304.0	7.37	0.709	25	994
WPB-7	1.7	ND	ND	240	17	190	0.08	58	9.54	312.7	7.47	0.656	25	929
WPB-8	20	1.1	ND	350	17	160	0.16	120	9.88	302.1	7.65	0.868	25	1176
WPB-9	8	ND	ND	240	17	140	12	100	9.50	298.1	7.89	0.660	24	929
WPB-10	1.1	ND	ND		19	170	1.0	88	7.27	290.0	7.51	0.733	24	1012
WPB-11	9.9	ND	ND	280		150	1.8	110	6.99	261.5	8.77	0.734	24	988

TABLE 5.
Natural Attenuation Screening Parameter Concentrations

Analyte	Concentration
TPH Diesel	14 mg/Kg
Total Organic Carbon	600 mg/Kg
Methane	<0.001 mg/l

To evaluate whether dechlorination of chlorinated hydrocarbons is occurring at the West Plume B site, a screening method developed by AFCEE was used. This method first determines if dechlorination of chlorinated hydrocarbons might be occurring.

As shown in Table 1, reductive dechlorination occurs under anaerobic conditions (DO < 1 mg/L), which is the desired mechanism for reducing chlorinated hydrocarbons into the innocuous by-products. The dissolved oxygen concentrations (see Table 4) measured at the West Plume B site are greater than 1 mg/L, which infers that reductive dechlorination is probably not occurring or is occurring too slowly to contribute to natural attenuation. Other parameters used to determine if anaerobic conditions exist are shown in **Table 6**. This table lists the screening parameter samples taken at the site, and the desired concentrations needed for anaerobic conditions to exist. The samples shown represent the values taken from the most contaminated zone.

Based on the evidence shown in Table 6, it is unlikely that significant anaerobic biodegradation is occurring.

TABLE 6.
Indicator Parameters for Anaerobic Biodegradation (Reductive Dechlorination) of Chlorinated Solvents

Analyte	Analyte Concentrations Required for Anaerobic Conditions	Concentration in Most Contaminated Zone at West Plume B
Dissolved Oxygen	< 1 mg/L	8.41 mg/L
Nitrate	< 1 mg/L	11 mg/L
Iron (II)	> 1 mg/L	0.31 mg/L
Sulfate	< 20 mg/L	340 mg/L
Methane	> 0.1 mg/L	< 0.001 mg/L
Oxidation-reduction potential (ORP)	< -100 mV	282.4 mV
Chloride	> 2 times background level	90 mg/L
TCE (released)	Any amount	28 µg/L
DCE	Any amount	2 µg/L
Vinyl Chloride	Any amount	2 µg/L

Conclusions and Recommendations

The MNA data suggest that the aquifer in the West Plume B area is generally aerobic and therefore not likely to support reductive dechlorination on a widespread basis. However, the data do provide some evidence that natural attenuation of TCE is occurring locally within the West Plume B area. This is apparent in monitor wells WPB-5, WPB-6, and WPB-8 where there are concentrations of the TCE breakdown products *cis*-1,2,-DCE and vinyl chloride. However, because the screening data suggest that reductive dechlorination most likely is not occurring on a widespread basis in the West Plume B area, breakdown of TCE into its byproducts is likely occurring only within these isolated areas.

The analytical data do show however that TCE concentrations appear to be decreasing over time throughout the area. Both temporal and spatial trends indicate that the contaminants are decreasing over time and downgradient of the estimated source. Because of this, further evaluation could be carried out to quantify the mobility of the contaminant, rather than monitoring the transformation of the contaminant into its breakdown products. This would include characterizing the aquifer hydraulics through modeling, and generating isocontours to see if dispersion, dilution, or adsorption play a key factor in the decrease of TCE in the groundwater at this site.

In summary, biological processes are not likely occurring to a great enough extent to degrade all the TCE via reductive dechlorination. However, the data suggest that physical and geochemical processes may be reducing groundwater concentrations with time and distance. Natural attenuation via physical and geochemical processes may eventually reduce groundwater concentrations to less than the maximum contaminant levels. Therefore, we recommend that MNA at West Plume B be retained as a potentially viable remedial alternative for further evaluation in the future Feasibility Study process.

ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY

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Janet Napolitano
Governor

Stephen A. Owens
Director

SROSPU06,001

E-4130.5.42

January 6, 2006

Mr. Matthew Jefferson
Remedial Project Manager
U.S. EPA Region IX
75 Hawthorne Street
San Francisco, CA 94105-3901

Re: Evaluation of Monitored Natural Attenuation at West Plume B, Tucson International Airport Area (TIAA) Superfund Site

Dear Matt,

The Arizona Department of Environmental Quality (ADEQ) has conducted an evaluation of monitored natural attenuation (MNA) at West Plume B (attached). Our review of existing data and information from 1999 to 2005 yielded the following observations: 1) The apparent absence of any known sources of TCE or other VOCs in the project area and active source control hydraulically upgradient; 2) A significant decline in the extent and degree of TCE contamination; 3) A relatively small total mass (perhaps less than 3 pounds) of TCE remaining; 4) The existence of several probable mechanisms for natural attenuation; and 5) No known current exposure to TCE contamination through private wells due to on-going risk management practices.

Based on these observations, ADEQ recommends that the remedy for WPB be monitored natural attenuation (MNA). The MNA remedy should include continued monitoring of existing monitor wells and private wells. It should also include the installation of an additional groundwater monitor well in the southern portion of the site and assurances from the Arizona Air National Guard that additional groundwater monitor wells will be installed west of their property to verify containment and capture of TCE south of Valencia Road. In addition, all owners and tenants of properties with private wells within 0.25-mile of the 5 ppb plume boundary should be periodically notified of the existence of the contamination and provided with other relevant risk management information. The MNA remedy should be reviewed every five years to verify its protectiveness. If it appears that residual TCE hotspots may persist longer than anticipated, these areas may be included in an in-situ oxidation pilot study.

If you have any questions regarding these recommendations, please call me at (520) 628-6714.

Sincerely,

W. J. Ellett

William J. Ellett, R.G.
Project Manager/Hydrogeologist
Superfund Programs Unit

cc: Matt Doolen/Reading file
Craig Kafura, Senior Hydrologist, SRO/SPU

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Printed on recycled paper

Monitored Natural Attenuation (MNA) Technical Memorandum
West Plume B - TIAA CERCLA Site
January 3, 2006

A. Executive Summary

A review of existing data and information for West Plume B (WPB) for the 1999-2005 time period yielded the following observations: 1) The absence of any known sources of TCE or other VOCs in the project area and active source control hydraulically upgradient of WPB; 2) A significant decline in the extent and degree of TCE over the time period; 3) A significant decrease in the estimated dissolved mass of TCE (42 percent) over the time period and a relatively small total mass (< 3 pounds) of TCE remaining in 2005; 4) The existence of several probable mechanisms for the natural attenuation of WPB; and 5) No known current exposure to WPB TCE contamination through private wells due to on-going risk management practices.

Based on these observations, ADEQ recommends that the remedy for WPB be monitored natural attenuation (MNA). The MNA remedy should include continued monitoring of existing monitor wells and private wells, and the installation of an additional groundwater monitor well in the southern portion of the site with assurances that additional groundwater monitor wells will be installed west of the AANG to verify containment and capture of TCE south of Valencia Road. In addition, all owners and tenants of properties with private wells within 0.25-mile of the 5 ppb plume boundary should be periodically notified of the existence of the contamination and provided with other relevant risk management information.

During remedy implementation, the collection of additional data should be considered to help understand the relative importance of the different WPB attenuation mechanisms. The WPB MNA remedy should be reviewed five years after implementation, concurrently with the other TIAA CERCLA Site project areas, to verify protectiveness. If it appears residual TCE hotspots may persist longer than anticipated, these areas may be included in a potassium permanganate (*in-situ* oxidation) pilot study as a means to accelerate remediation timeframes and reduce potential exposure risk.

B. Observations Supporting MNA Remedy for WPB Project Area

1. Sources of TCE Contamination

Figure 1 is a map showing the extent and degree of TCE contamination and the groundwater gradient in 2005 for Area B of the TIAA CERCLA Site, which includes the West-Cap, Texas Instruments, Arizona Air National Guard (AANG) and the WPB project areas. No sources of VOC contamination have been identified in the WPB Project Area. Known sources of TCE contamination have existed at the other project areas, all south of Valencia Road. TCE contamination currently in the WPB project area migrated into WPB from portions of Area B south of Valencia Road. The AANG maintains a groundwater pump, treat, and injection system to contain TCE contamination south of Valencia Road.

2. Extent and Degree of TCE Contamination

In WPB, TCE contamination is confined to an approximately 5-foot thick confined aquifer subunit, which is a portion of the Upper Zone of the Regional Aquifer, at the TIAA CERCLA Site. **Figure 2**, a map showing the extent and degree of TCE contamination for WPB in 2005, illustrates that the extent of TCE contamination at WPB exceeding the MCL of 5 ppb has been defined. There is some minor uncertainty regarding the degree of contamination in the southern portion of the project area between Valencia Road and WPB-05. In this southern area, historically the bulk of TCE contamination has probably been migrating south to north between monitor wells WPB-02 and WPB-03. As shown below, significant decreases in samples from wells WPB-05 and WPB-08 farther to the north indicate that TCE contamination in the southern area is probably overestimated by the 2005 plume map. An additional monitor well should be installed in the southern area to confirm this estimation.

Figure 3, a series of maps depicting the extent of contamination from 1999 through 2005 for several concentration ranges, clearly shows that the extent and degree of contamination is steadily decreasing due to attenuation. Figure 3a shows that the 5 ppb contour has not changed significantly during the time period; however, as indicated above, this is due largely to a data gap and a relatively conservative approach to constructing the contours that most likely overestimates the extent of contamination. Figure 3b shows that the extent of TCE contamination above 10 ppb has decreased steadily during the time period. Figure 3c shows that TCE contamination above 20 ppb, which was relatively extensive in 1999, no longer exists. As shown in these figures, decreases in concentrations in WPB are concomitant with decreases in concentrations at the AANG due to remediation activities south of Valencia Road.

Figures 4a, 4b, 4c, and 4d, graphs of time-series TCE concentrations for each well, illustrate that TCE levels in samples from nearly all monitor wells have declined steadily between 1999 and 2005. TCE contamination in samples from wells WPB-1 through WPB-4 and WPB-12, which are located in the southern portion of the site, are all below the MCL of 5 ppb. TCE concentrations in samples from wells WPB-05 and WPB-08, which are located near the middle of the plume, have decreased significantly since monitoring began between 1997 and 1999. It is anticipated the concentrations in samples from well PW-002, located down-gradient from MW-08, will begin to decline as lower concentration groundwater continues to migrate north.

Overall, the data indicate the head of the plume is not advancing to the northwest and concentrations in the central and tail of the plume are decreasing. Wells in the northern extent of the plume have not declined as significantly because the effects of the AANG remediation system have not reached this area yet. In other words, when lower concentration TCE groundwater migrates into this northern area from the south, concentrations should begin to decline. Based on an extrapolation of current trends, the WPB project area should be below the MCL for TCE (5 ppb) in about 10 years provided the AANG maintains capture south of Valencia Road.

3. Mass Attenuation of TCE Contamination

Figures 5a and 5b, graphs of estimated TCE mass attenuation through time, illustrate that the mass of dissolved TCE in WPB has declined steadily from 1999 to 2005. Overall, estimated dissolved mass has decreased from 1.6 kg to about 0.9 kg or about 42 percent over this time period.

These estimates were calculated using a GIS model that calculated the total TCE mass within the 5 ppb contour for each year when input data were available. Model inputs included average TCE concentrations calculated from the GIS features depicting the 5, 10, and 20 ppb concentration contours, an average aquifer thickness of five feet, and an aquifer porosity of 30 percent (clean sand and gravel).

Total TCE currently in WPB may be somewhat more than about 0.9 kg depending on the quantity that is sorbed to organic carbon. Assuming a foc (fraction organic carbon) value of 0.001 (or 0.1% by mass), the total TCE mass would be about 30 percent greater for a total of about 1.20 kg (2.6 lbs). Thus, given the

above assumptions, it is likely that less than a total of 3 pounds of TCE remain in WPB in both dissolved and sorbed phases combined.

4. TCE Attenuation Mechanisms

Extensive data have not been collected to identify the relative importance of the different WPB attenuation mechanisms. However, it is clear that the plume is attenuating much faster than predicted by the groundwater flow and contaminant transport modeling conducted for the WPB Remedial Investigation. The model predicted that it could take 30 to 60 years for the TCE plume to attenuate under a no-action scenario depending on the hydraulic conductivity of the aquifer system. The model assumed source control south of Valencia Road, with transport by advection and dispersion, but no retardation or degradation of TCE

Working in conjunction with source control, attenuation mechanisms for WPB are likely a combination of a) dilution due to diffusion and dispersion, b) retardation due to sorption and diffusion into dead-end pore spaces, and c) anaerobic biodegradation. Considering the physically and chemically heterogeneous nature of the aquifer system, these mechanisms could be working in concert with each other. For example, TCE molecules may be dispersed into stagnant portions of the aquifer and may diffuse into dead-end pore spaces where sorption and/or anaerobic degradation may occur due to higher organic carbon and lower oxygen levels.

Specific evidence for anaerobic biodegradation includes the presence cis-1,2-dichloroethene (cis-1,2-DCE) in samples from two wells (WPB-08 and PW-002) with relatively high concentrations of TCE (**Figure 6**). The cis-1,2-DCE appears to be completely attenuated, probably due to either dispersion or complete degradation, since this chemical is not present above detection limits in down-gradient wells and there is an absence of other expected degradation products (i.e., vinyl chloride). The absence of cis-1,2-DCE in samples from other wells with lower concentrations of TCE does not indicate that anaerobic degradation is only occurring locally around WPB-08 and PW-002. Rather, it is likely that this degradation product is being produced at levels that are below detection limits in other locations where TCE levels are lower. Thus, it is possible that anaerobic degradation is occurring throughout the plume and that the by-products are completely attenuated through one or more mechanisms.

5. TCE Risk Management at WPB

Risk management at West Plume B, in addition to routine monitoring to track plume extent and migration, has consisted of coordination with ADWR on the installation of new private wells, tracking all known private wells in a GIS database, monitoring active private wells in cooperation with well owners, reporting the sampling and analysis results to cooperative well owners, and providing an alternate water supply through the municipal system, if necessary.

Until it is clear that WPB has naturally attenuated to below drinking water standards in all portions of the aquifer, these actions should be continued. In addition, the MNA remedy should include issuing periodic notices to all owners and tenants of properties with active and inactive private wells within 0.25 miles of WPB to manage unexpected exposure to TCE due to lack of public information about the problem.

If it appears residual TCE hotspots may persist longer than anticipated, these areas may be included in a pilot study to strategically address other select areas in Area B with potassium permanganate (*in-situ* oxidation) as a means to accelerate remediation timeframes and reduce potential exposure risk.

Figure 1 – Area B TCE Distribution in 2005

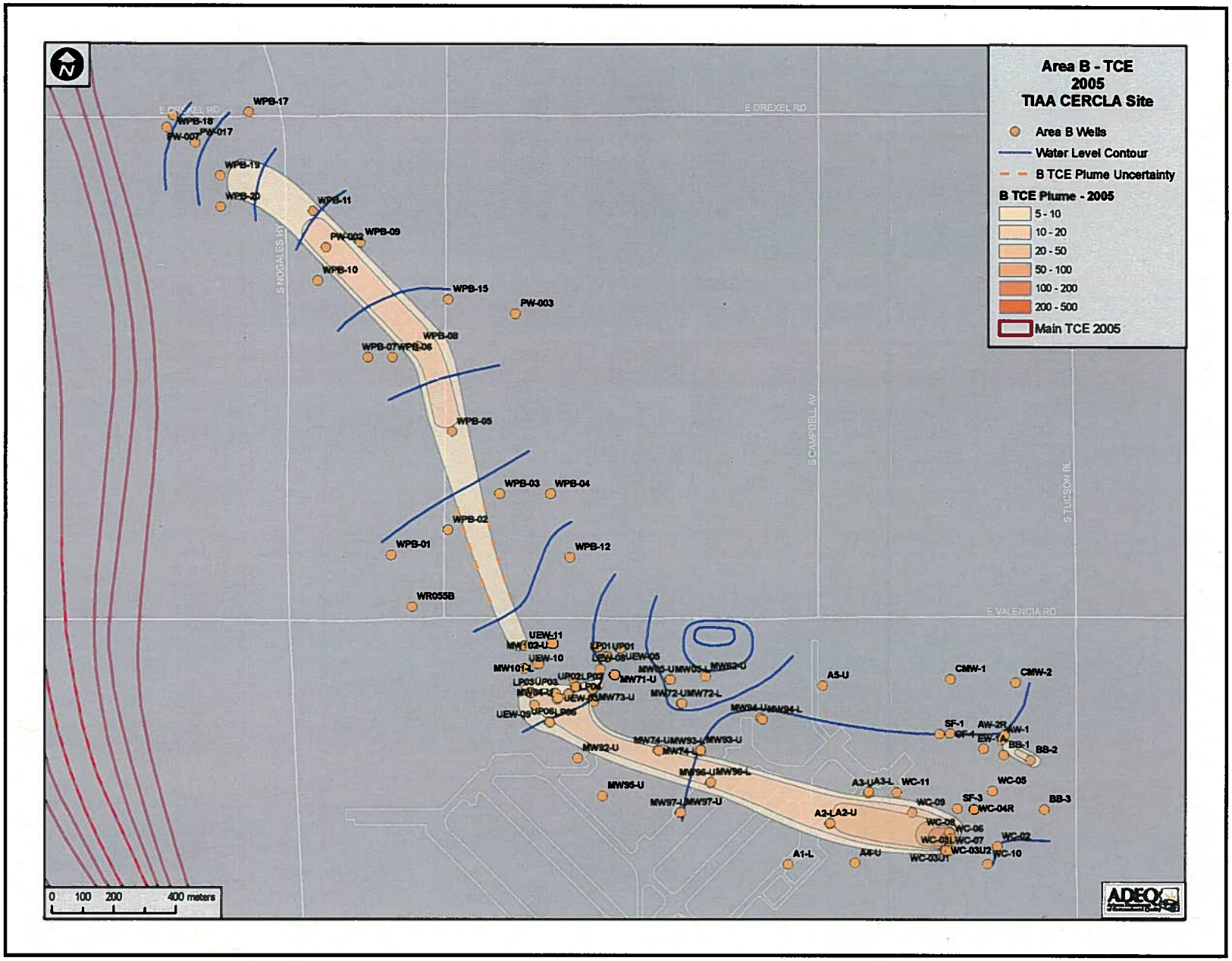


Figure 2 – WPB TCE Distribution in 2005

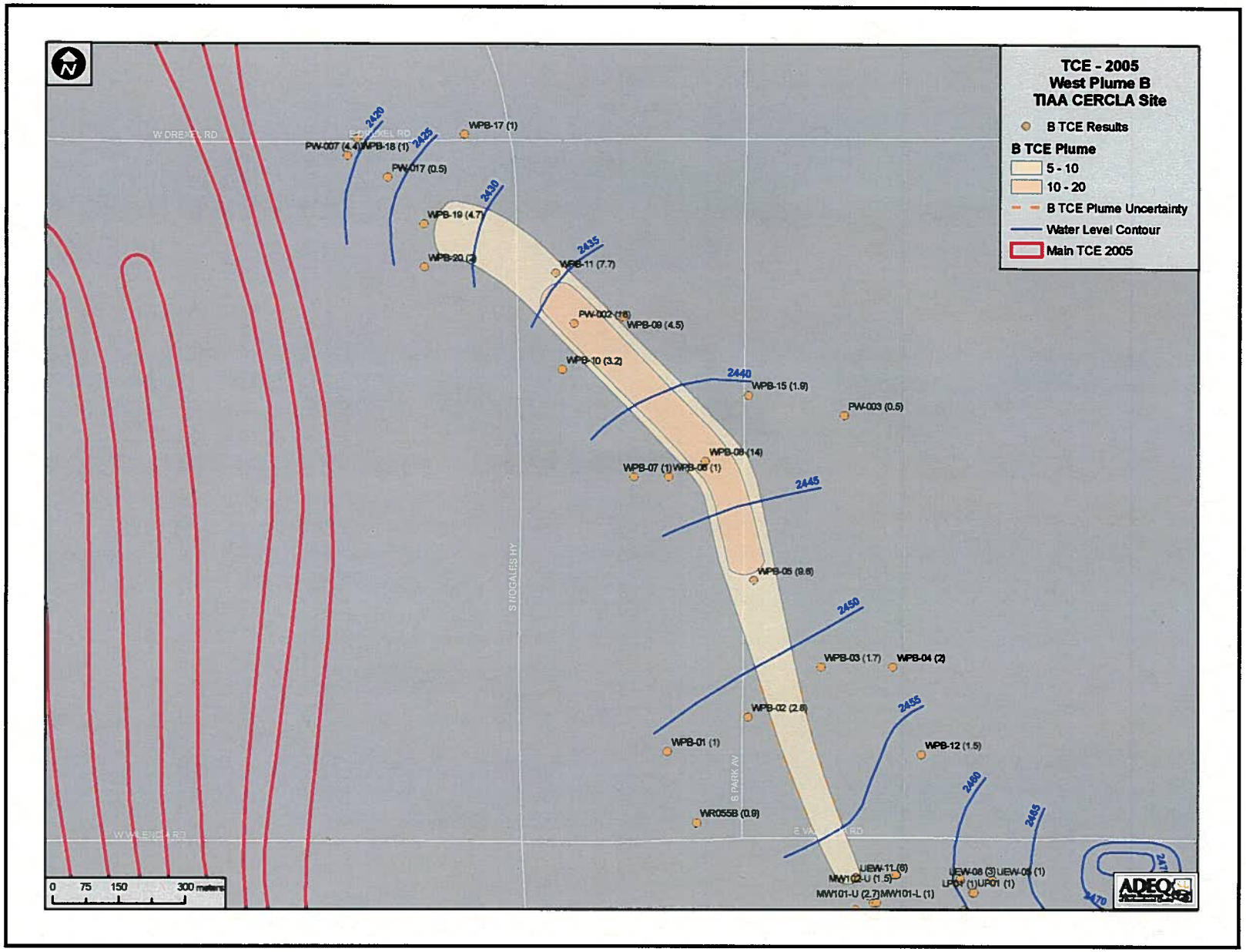


Figure 3 – Maps Showing the Extent of 5, 10, and 20 ppb TCE Contours for WPB During Various Years (1999-2005)

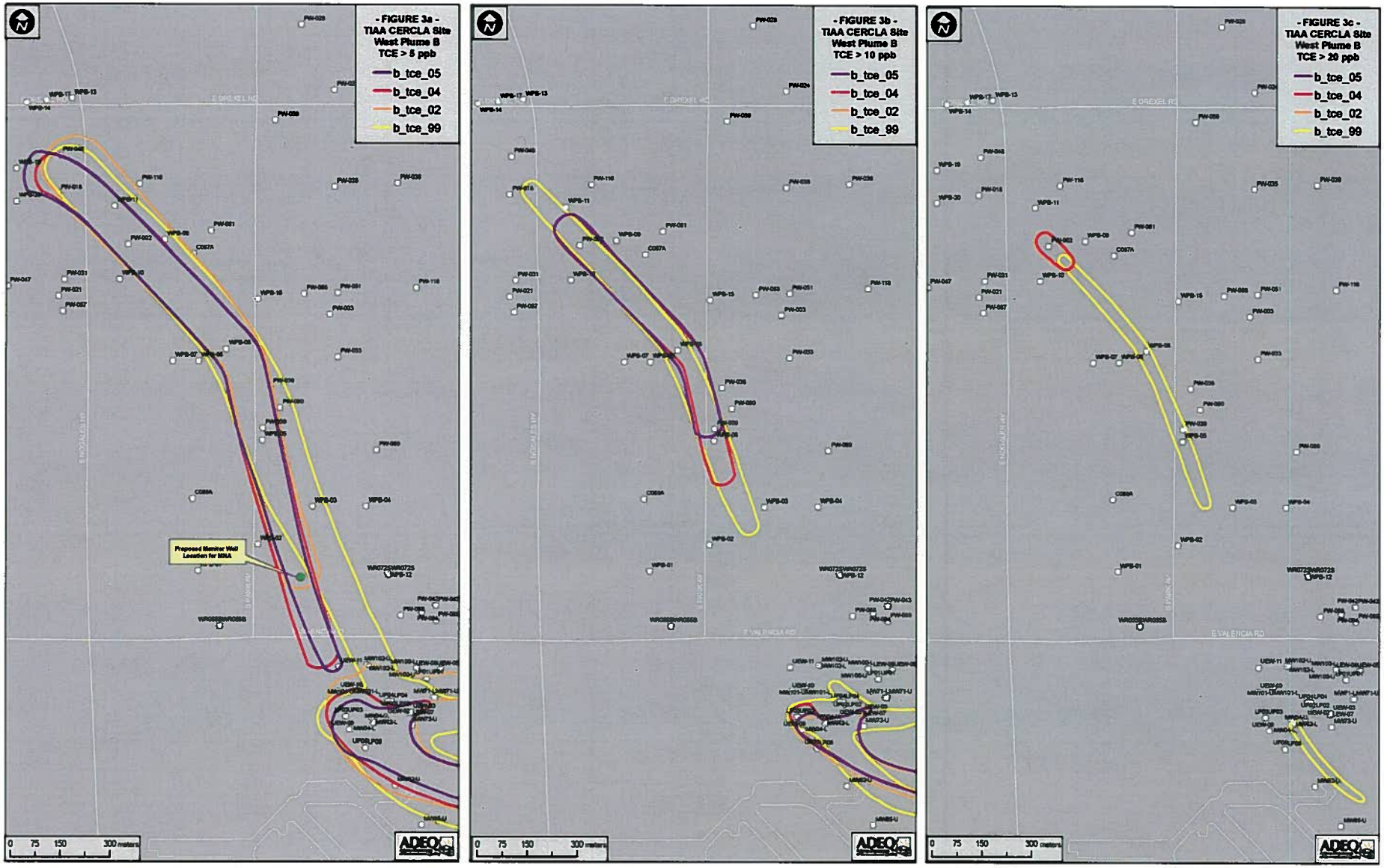


Figure 4a – TCE Concentrations vs. Time for WPB Wells – Southern Portion of WPB

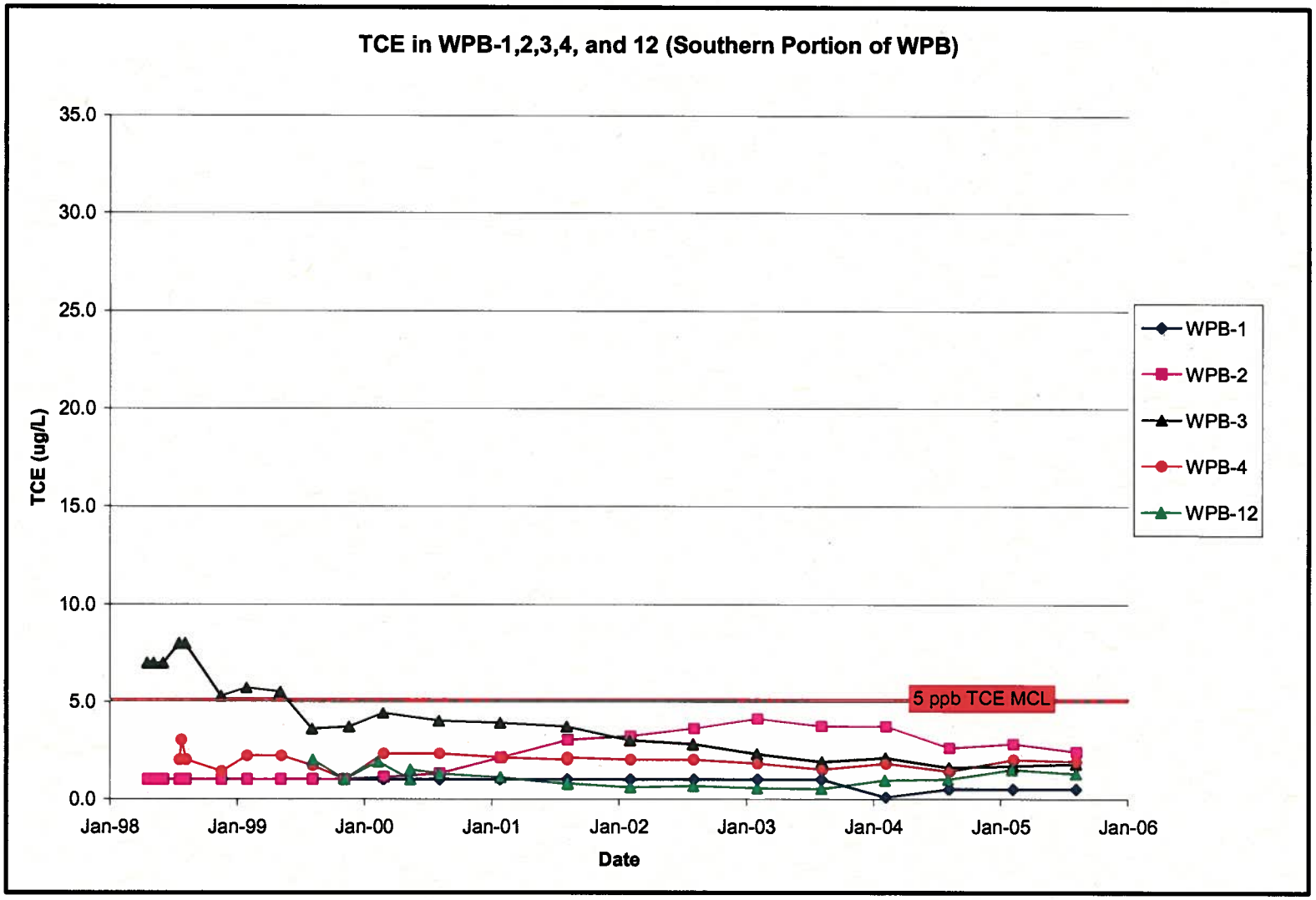


Figure 4b – TCE Concentrations vs. Time for WPB Wells – Central Portion of WPB

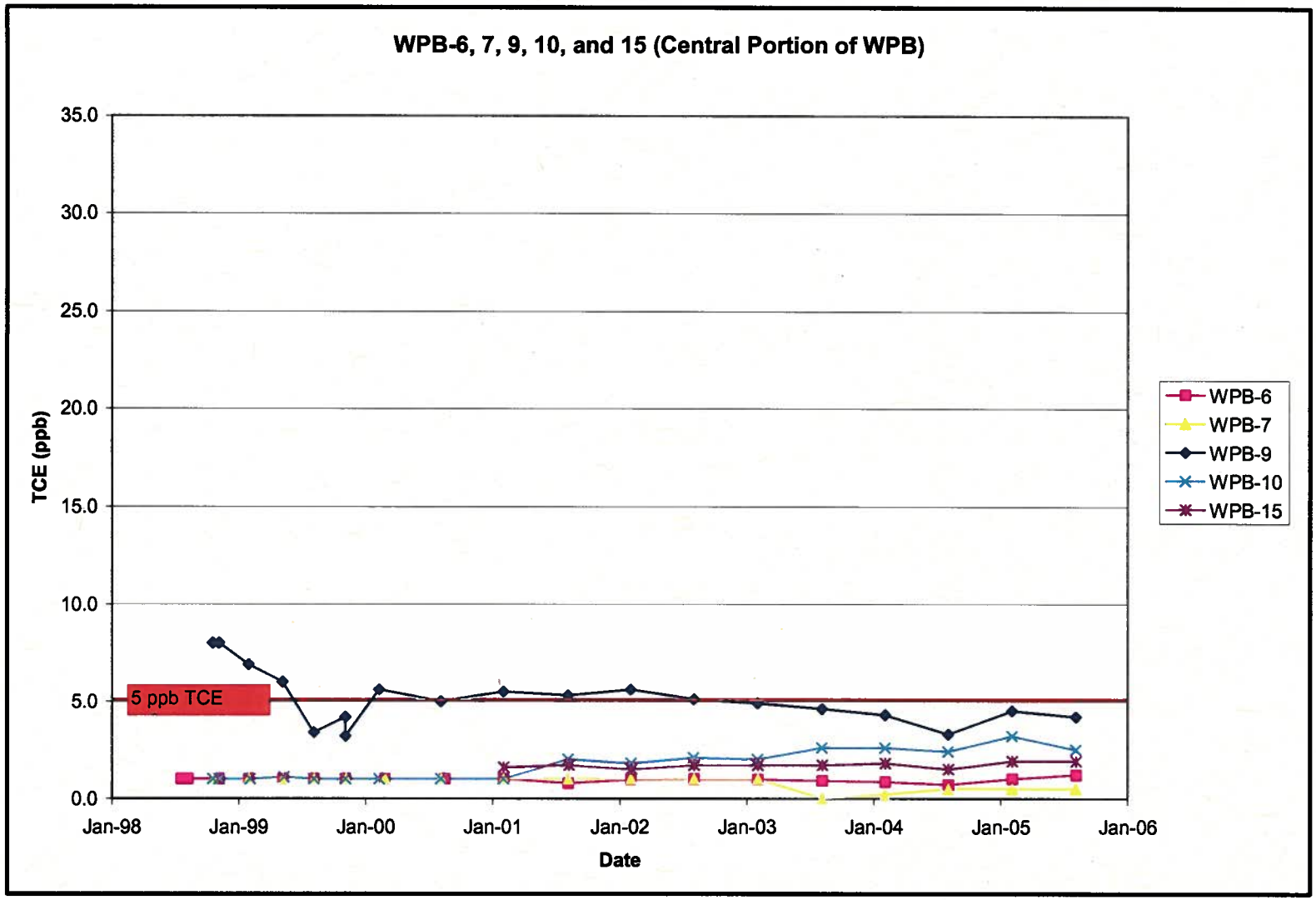


Figure 4c – TCE Concentrations vs. Time for WPB Wells – Central Portion of WPB

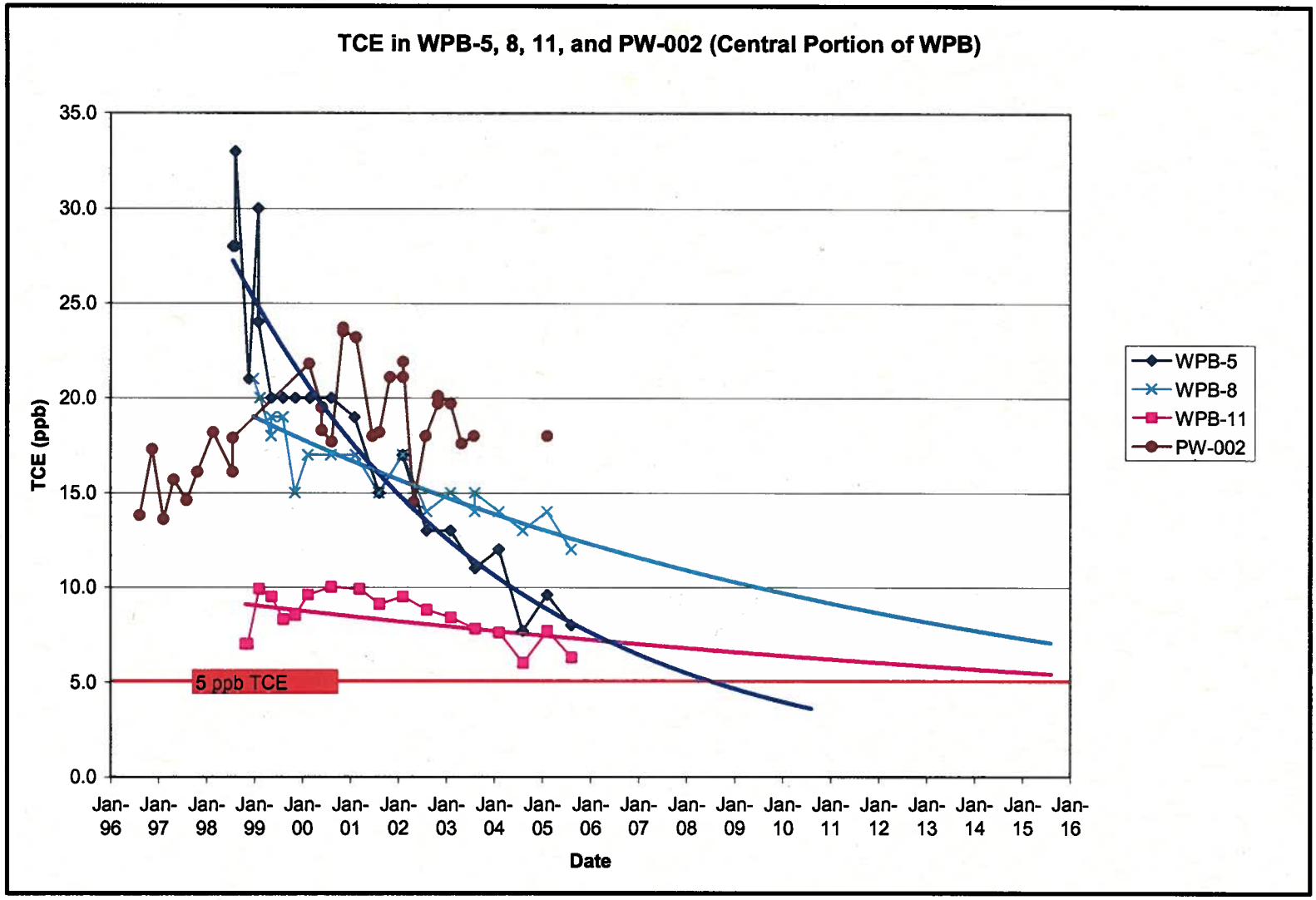


Figure 4d – TCE Concentrations vs. Time for WPB Wells – Northern Portion of WPB

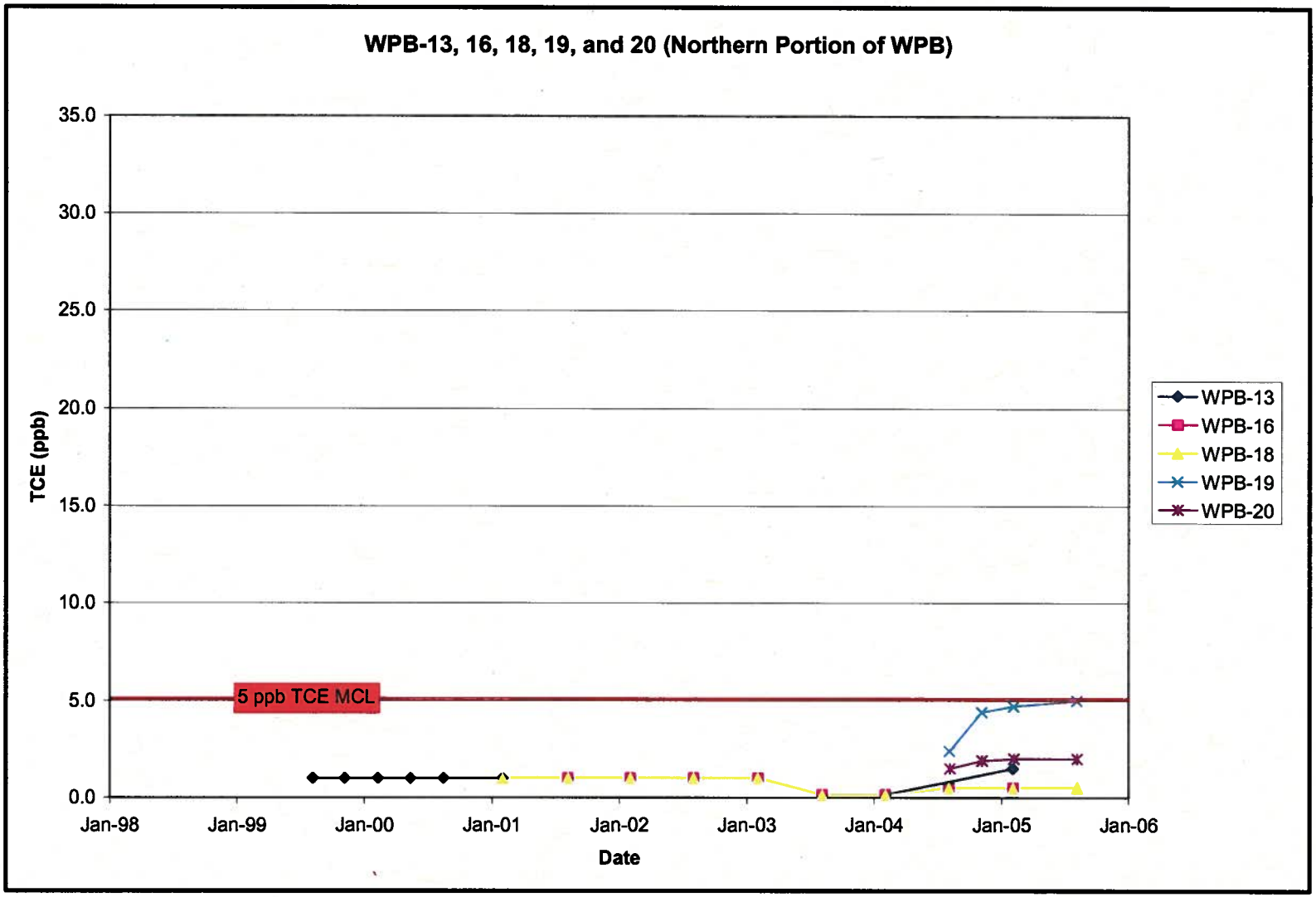


Figure 5a - Graph of Dissolved TCE Attenuation by Mass over Time (1999-2005)

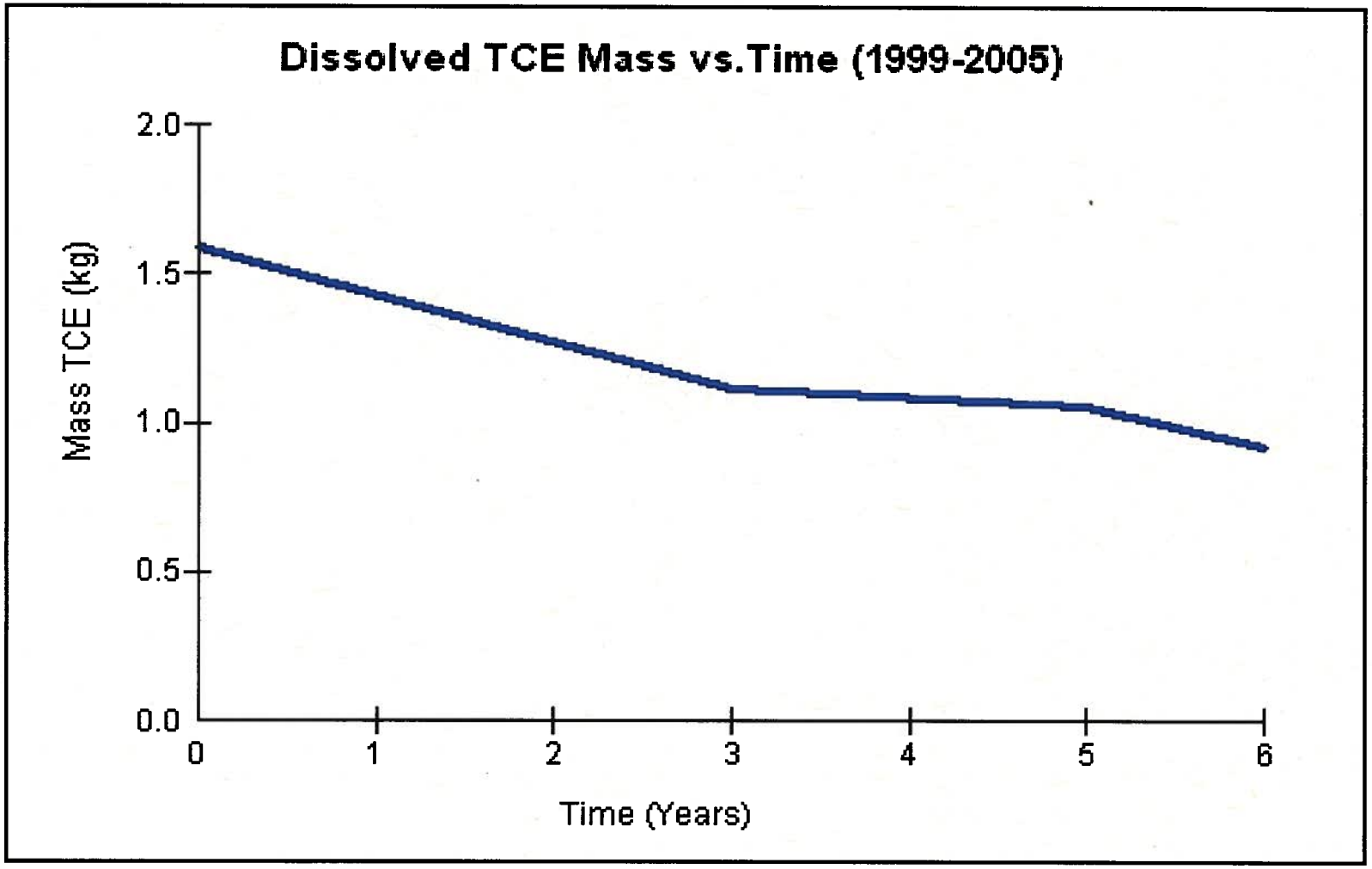


Figure 5b - Graph of Dissolved TCE Attenuation by Percent over Time (1999-2005)

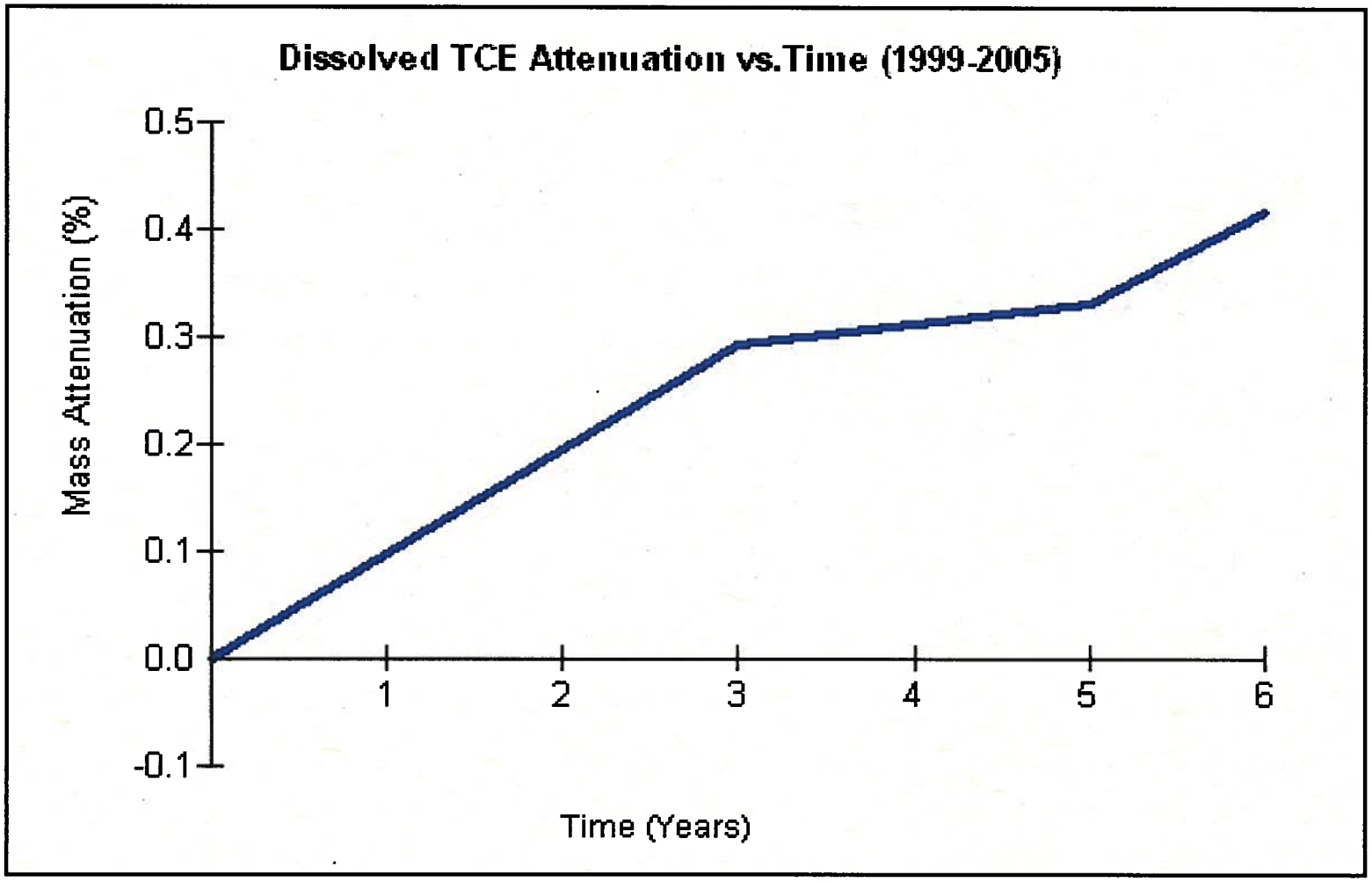
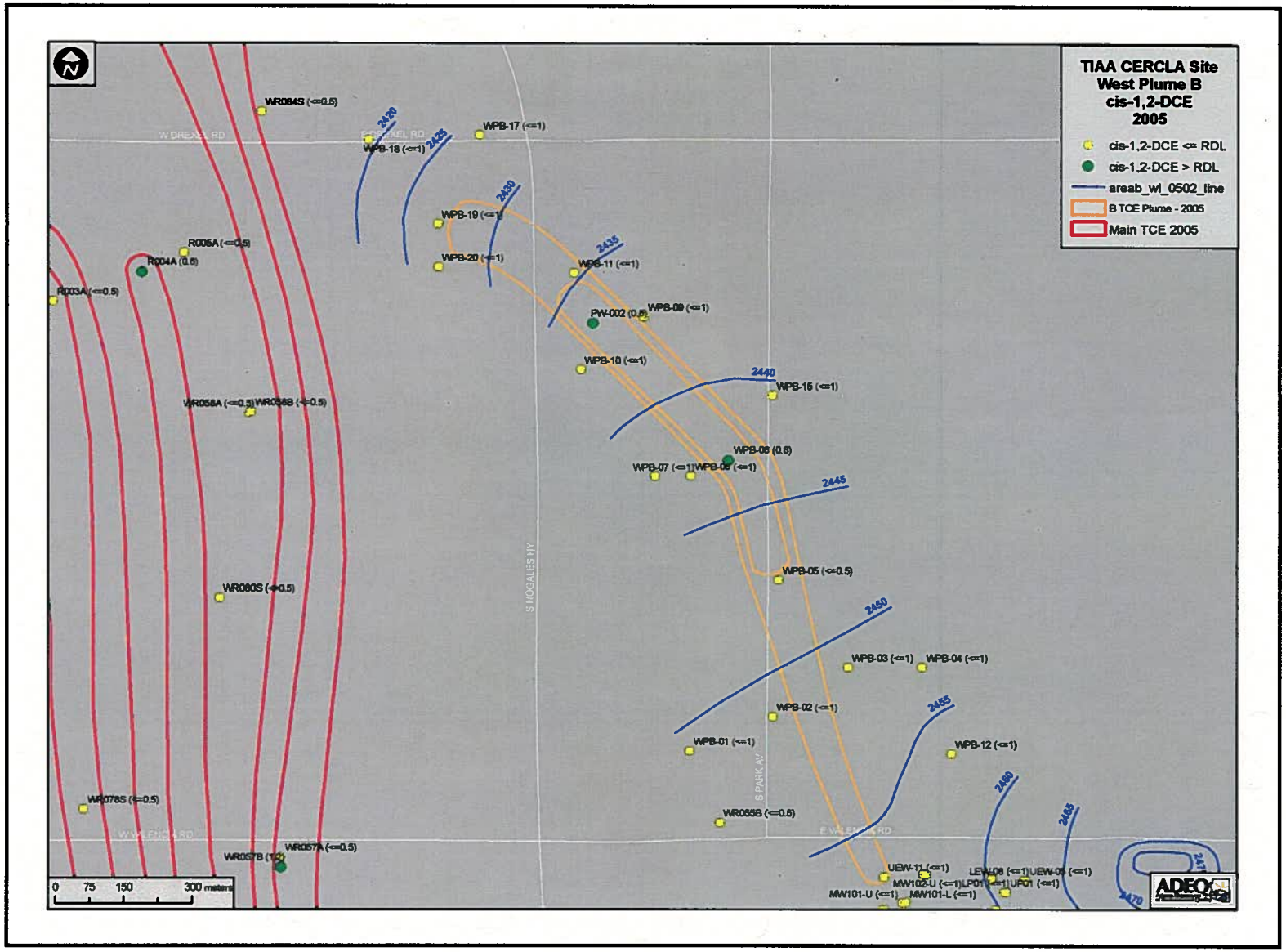


Figure 6 – Extent and Degree of WPB cis-1,2-DCE Contamination in 2005



Evaluation of Monitored Natural Attenuation within Area B of the Tucson International Airport Area Superfund Site

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PREPARED BY: CH2M HILL

DATE: September 14, 2011

1.0 Introduction

This memorandum evaluates whether using Monitored Natural Attenuation (MNA) is a viable alternative for remediation within Area B of the Tucson International Airport Area (TIAA) Superfund Site. Area B includes multiple plumes of trichloroethene (TCE) groundwater contamination; the plumes of contamination are managed as the West Plume B (WPB), Arizona Air National Guard (AANG), West Cap, and Texas Instruments project areas (Figure 1). The focus of this evaluation will be the WPB area because contaminant concentrations are relatively low and no active remediation has been implemented in this area. A more limited qualitative analysis of whether MNA could be a feasible alternative for AANG, West Cap and Texas Instruments project areas will also be discussed in the conclusions.

This MNA assessment was conducted within the framework outlined in the *Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Ground Water* (the Technical Protocol) (Unites States Environmental Protection Agency (USEPA), 1998). The basis for this analysis consists of the review of data presented in two previous MNA evaluations conducted in 2000 and 2006, as well as review of additional site data collected since the previous evaluations were conducted. This information was used to identify and quantify attenuation mechanisms taking place in the WPB area according to methods proposed in the Technical Protocol. If review of available data indicates insufficient information is available to quantify specific attenuation mechanisms, data gaps and methods of obtaining the missing information are identified.

This technical memorandum includes:

- 1.0 Introduction, which presents the purpose and organization of the memorandum.
- 2.0 Site Hydrogeology, which presents a brief description of hydrogeological conditions at the site.
- 3.0 Previous MNA Evaluations, which summarizes the findings presented in previous MNA evaluations conducted in 2000 and 2006.

- 4.0 New Site Data, which presents new data collected between 2006 and 2009 and compares the new TCE concentration trends and distribution to those presented in the 2006 MNA evaluation.
- 5.0 Attenuation Mechanisms, which identifies mechanisms responsible for the observed attenuation within WPB, and their relative significance compared to one another.
- 6.0 Quantification of Attenuation Mechanisms, which presents mathematical methods used to estimate the effect each attenuation mechanism has on the overall attenuation of the WPB contamination plume.
- 7.0 Enhanced Attenuation, which presents methods of enhanced attenuation (EA) which can be used in conjunction with MNA to achieve site remedial goals.
- 8.0 Conclusions, which summarizes the findings of this MNA evaluation.
- 9.0 References, which presents the cited references.

2.0 Site Hydrogeology

In the vicinity of the TIAA Site, the regional aquifer system is hydrogeologically complex due to lateral and vertical stratigraphic changes. This technical memorandum focuses on the Upper Unit of the aquifer, where VOC contamination has been observed. A complete description of the hydrogeology of the TIAA site is provided in the *Feasibility Study of Former West-Cap Property and West Plume B with Supplemental West-Cap Remedial Investigation Results* (CH2M HILL 2002).

Within Area B, the Upper Unit occurs between approximately 85 and 145 feet bgs, and contains one or two coarse-grained layers (subunits) in some areas of the Site, or consists entirely of fine-grained sediments. The coarse-grained subunits are termed the Upper Subunit (USU) and the Lower Subunit (LSU) based on their relative depths. The fine-grained sediments are termed Shallow Groundwater Zones (SGZs) when saturated. SGZs occur within the Upper Unit where unconfined saturated silt- and clay-rich sediments exist above or within the USU and/or the LSU. In these areas, continuously saturated conditions exist between the water table of the SGZ and the underlying subunit(s). SGZs consist predominately of saturated, fine-grained sediment, but may be locally interbedded with very thin (less than 1 foot), discontinuous, lenses of coarser-grained material.

The water table occurs about 110 feet below ground surface (bgs). Groundwater in Area B generally flows from southeast to northwest. The West Cap and Texas Instruments project areas appear to have distinct source zones, while the WPB and AANG project areas do not. These source areas are believed to be residual contaminants within fine-grained sediments at the base of the vadose zone, within the capillary fringe, and in the upper SGZ.

3.0 Previous MNA Evaluations

Previous MNA evaluations related to TCE groundwater contamination in the WPB project area of the TIAA Superfund Site were conducted by CH2M HILL in 2000 and by the

Arizona Department of Environmental Quality (ADEQ) in 2006. These evaluations are discussed below.

2000 MNA Evaluation

CH2M HILL conducted an evaluation of the potential use of MNA as a remedial treatment for the WPB area in 2000. The evaluation was based on data collected from fourteen monitoring wells in the WPB area (WPB-1 through WPB-14); the locations of these wells are presented in Figure 2. Historical groundwater sampling results from these monitoring wells were reviewed to evaluate temporal and spatial changes in TCE concentrations. MNA screening parameters including total petroleum hydrocarbons (TPH), oxidation-reduction potential (ORP), dissolved oxygen, pH, total organic carbon (TOC), methane, sulfate, and nitrate concentrations were measured to compare observed values in the WPB area to those values known to be conducive to biodegradation of TCE. The results of this evaluation are summarized below; the complete report is presented in *Using Monitored Natural Attenuation as a Potential Remedial Alternative for West Plume B* (CH2M HILL, 2000).

Three mechanisms for the biodegradation of chlorinated aliphatic hydrocarbons were presented, including reductive dechlorination, direct oxidation, and co-metabolism. Based on the chemical and physical properties of chlorinated hydrocarbons, reductive dechlorination was reported as the mechanism most likely to cause the biodegradation of TCE. However, reductive chlorination takes place in anaerobic conditions (e.g., dissolved oxygen concentration less than 1 milligram per liter (mg/L)), and the dissolved oxygen concentrations measured in monitoring wells studied in this evaluation ranged from 1.53 to 9.88 mg/L. Based on the observed dissolved oxygen concentrations, the WPB area was reported "not likely to support reductive chlorination on a widespread basis."

Despite the reportedly aerobic conditions observed in samples collected during this study, breakdown products of TCE, including primarily cis-1,2-dichloroethene (cis-1,2-DCE) and, to a lesser extent vinyl chloride, were detected in monitoring wells WPB-5, WPB-6, and WPB-8. The detections of these compounds provided evidence that the anaerobic biodegradation of TCE by reductive dechlorination was occurring in some areas. One hypothesis presented to explain a mechanism which could create the conditions necessary for the anaerobic degradation of TCE was the presence of underground storage tanks (USTs) in the WPB area which may have leaked petroleum hydrocarbons to the subsurface, resulting in the consumption of oxygen through the direct oxidation of petroleum hydrocarbons.

TCE concentrations in the WPB area were observed to be decreasing over time and down-gradient of the suspected source. Based on this information, CH2M HILL reported that further evaluation could be carried out to quantify the mobility of the contaminant to more accurately assess how dispersion, dilution, and adsorption affect MNA at the site.

The evaluation concluded that biological degradation was likely not occurring to a great enough extent to degrade all TCE by reductive dechlorination. It was concluded, however, that physical and geochemical processes may reduce TCE concentrations to less than the maximum contaminant levels (MCLs), and that MNA should be retained as a potentially viable remedial alternative for further evaluation in the future Feasibility Study process.

2006 MNA Evaluation

ADEQ conducted an evaluation of the potential use of MNA as a remedial treatment for the WPB area in 2006. The evaluation was based on review of (1) sources of TCE contamination, (2) extent and degree of TCE contamination, (3) mass attenuation of TCE contamination, (4) TCE attenuation mechanisms, and (5) TCE risk management in the West Plume B area. The results of this evaluation are summarized below; the complete report is presented in *Monitored Natural Attenuation (MNA) Technical Memorandum, West Plume B – TIAA CERCLA Site* (ADEQ, 2006).

Sources of TCE contamination were evaluated for Area B of the TIAA Superfund Site, including the WPB, AANG, West Cap, and Texas Instruments project areas. No sources of TCE were identified in the WPB area. Sources of TCE contamination were identified at project areas south of Valencia Road (hydraulically upgradient of WPB); however, ADEQ reported that the AANG operates a groundwater pump, treat, and injection system to contain TCE contamination south of Valencia Road.

TCE distribution plumes were presented for 1999, 2002, 2004, and 2005 for TCE concentration contours of 5, 10, and 20 parts per billion (ppb). Based on the change in distribution of the TCE concentration contours over time, the extent and degree of TCE contamination was reported to be "steadily decreasing due to attenuation." Concentration trend analysis was also performed for each monitoring well in the WPB project area; this concentration trend analysis showed that TCE concentrations in "nearly all monitor wells have declined steadily between 1999 and 2005." ADEQ reported that the head of the TCE plume is not advancing and concentrations in the central and tail of the plume are decreasing. ADEQ projected TCE concentrations in the WPB project area should be below the MCL for TCE (5 ppb) in approximately 10 years if capture of sources south of Valencia Road continues through the ongoing operation of the AANG treatment system.

ADEQ reported that the mass of dissolved-phase TCE decreased 42% from 1.6 kg in 1999 to 0.9 kg in 2005. Based on the assumption that the fraction of organic carbon (F_{oc}) in soil at the site is 0.001, the total mass of TCE (including sorbed-phase TCE) was estimated to be 1.2 kg in 2005.

The relative importance of TCE attenuation mechanisms (e.g., advection, dispersion, retardation, biodegradation) was not quantified in the evaluation. ADEQ reported that previous groundwater flow and contaminant transport modeling conducted for WPB, which assumed source control south of Valencia Road, no contaminant retardation or degradation, and transport by advection and dispersion, predicted TCE plume attenuation in 30 to 60 years. Based on the information presented above, ADEQ also reported that attenuation is occurring significantly faster than previously predicted through modeling. Attenuation mechanisms were reportedly a combination of (1) dilution due to diffusion and dispersion, (2) retardation due to sorption and diffusion into dead-end pore spaces, and (3) anaerobic biodegradation. Similar to the 2000 MNA evaluation, the detection of TCE breakdown products was presented as evidence of anaerobic biodegradation as cis-1,2-DCE was detected in monitoring wells WPB-8 and PW-002. WPB-8 was reported to exhibit detectable levels of cis-1,2-DCE in the previous MNA evaluation (CH2M HILL, 2000); however, the detection of TCE breakdown products in monitoring well PW-002 provided

new information not available in 2000 which indicated more widespread anaerobic biodegradation of TCE than previously observed.

ADEQ reported that risk management for the WPB project area includes coordination with the Arizona Department of Water Resources (ADWR) and private well owners on issues such as the installation of new wells, the monitoring of active private wells, reporting analytical groundwater sampling results to well owners, and providing municipal water supply to well owners whose wells have been impacted by contamination associated with WPB. These actions were recommended to continue until all portions of the aquifer in the vicinity of WPB exhibit chlorinated hydrocarbon concentrations below drinking water standards.

Based on the information summarized above, ADEQ recommended that MNA be the selected remedy for the WPB project area. ADEQ recommended continued monitoring of existing wells and the installation of one additional groundwater monitoring well in the southern portion of the site to confirm the plume between AANG and WPB was discontinuous. ADEQ also recommended that the AANG install additional groundwater monitoring wells west of the AANG property to confirm containment and capture of TCE south of Valencia Road. Continued risk management and communication with private well owners was recommended. ADEQ also recommended that if any localized hotspots of TCE contamination persist longer than expected, treatment of these areas with potassium permanganate *in-situ* oxidation may be performed in order to reduce exposure risk and remediation timeframes. Review of the MNA remedy was recommended to occur once every 5 years to verify protectiveness.

4.0 New Site Data

The MNA evaluations described in Section 3 included data from 1998 through 2005. On June 22, 2009, ADEQ provided CH2M HILL with groundwater sampling data for 173 monitoring wells within Area B, including the WPB, AANG, West Cap, and Texas Instruments project areas. The locations of each of the 173 monitoring wells included in the database are presented in Figure 2. The data included groundwater samples collected from February 1997 through March 2009. This database of analytical results was used to evaluate changes in the extent and degree of TCE contamination in the WPB project area which have occurred since the previous MNA evaluation was conducted, and also to review the behavior of TCE concentration trends among WPB monitoring wells over the entire period of record. The results of these evaluations are presented below.

As stated in the Technical Protocol, the definition of monitored natural attenuation includes:

> *"…a variety of physical, chemical, or biological processes that, under favorable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in soil and ground water."*
> (USEPA, 1998)

Pump and treat groundwater remediation systems have been operated at the AANG, West Cap, and Texas Instrument project areas for the majority of the period for which analytical data are available for these sites. This human influence on the reduction of mass, toxicity, mobility, volume, and concentration of contamination at these project areas makes

evaluation of the mechanisms and performance of MNA as a stand-alone remedy at these sites problematic. MNA is best evaluated under more steady-state conditions and over long periods of time. The conditions at AANG, West Cap, and Texas Instruments have been transient due to various active remediation efforts in operation. Therefore, the new site data has been used in this evaluation to assess possible mechanisms responsible for the observed attenuation at the WPB project area only, where no active remediation has taken place. Conclusions regarding the applicability of MNA at WPB will be evaluated to determine if the findings from WPB apply to other project areas within Area B. As stated in the Technical Protocol and the *Technical and Regulatory Guidance, Enhanced Attenuation: Chlorinated Organics* (Interstate Technology Regulatory Counsel (ITRC), 2008), when MNA is not an appropriate stand-alone remedy, successful application of MNA can be performed in conjunction with active remedies such as source control. The application of MNA in conjunction with active remedies is discussed further in Section 7.

Extent and Degree of TCE Contamination at WPB

The extent and degree of TCE contamination at WPB was evaluated graphically with TCE concentration contours of 5, 10, and 20 micrograms per liter (µg/L) for the years 1999, 2004, and 2009 to determine how the spatial distribution and magnitude of TCE concentrations has changed through time (Figures 3 through 5). Comparison of Figures 3 through 5 shows that the magnitude of TCE concentrations in WPB has decreased between 1999 and 2009. The overall findings from TCE concentration contour plots from 1999 through 2009 indicate that the TCE plume is not advancing, the size of the plume is reducing slowly, but more importantly the magnitude of TCE concentrations is decreasing towards the MCL of 5 µg/L. These findings are consistent with the TCE plume distributions presented in the 2006 MNA evaluation. The decreasing concentration trends graphically presented in Figures 3 through 5 are evaluated in more depth in the Concentration Trends in WPB Monitoring Wells section below.

Concentration Trends in WPB Monitoring Wells

The TCE concentration trends were evaluated for wells in the WPB project area. Duplicate samples were not considered in the concentration trend evaluation, and in instances of non-detect results, a value of one half the reporting limit was used.

Figures 6 and 7 present TCE concentrations for groundwater samples collected from wells in the southern and central portions of the WPB project area, respectively. All wells in these areas show decreasing or stable concentration trends below the MCL of 5 µg/L. The new data for the period between 2006 and 2009 indicate no change from conditions previously reported by ADEQ in 2006. Because all groundwater samples collected from these wells have exhibited TCE concentrations below 5 µg/L since at least February 2003, no further concentration trend analysis was performed for these locations.

Figure 8 presents TCE concentrations for groundwater samples collected from wells in the northern portion of the of WPB project area. Monitoring well WPB-19 exhibited an increasing concentration trend from June 2004 through November 2005 when the maximum concentration of 5.1µg/L was measured; since November 2005, WPB-19 has shown a decreasing concentration trend with all subsequent samples exhibiting TCE concentrations below the MCL of 5µg/L. All other wells presented in Figure 8 have exhibited stable

concentration trends below the MCL. The new data for the period between 2006 and 2009 did provide additional information on the concentration trend of WPB-19. At the time of the previous MNA evaluation, this monitoring well was exhibiting an increasing concentration trend with the most recent sample result equal to the MCL. Because this monitoring well is located in the northern portion of WPB, the concentration trend could be interpreted as the migration of WPB in the direction of groundwater flow to the northwest. However, seven consecutive samples collected subsequent to the 2006 MNA evaluation indicate that TCE concentrations in WPB-19 are both decreasing and have been below the MCL since at least February 2006. Because groundwater samples collected from these wells have consistently exhibited TCE concentrations below 5 µg/L, no further concentration trend analysis was performed for these locations.

Figure 9 presents TCE concentrations for groundwater samples collected from wells located in the zone of highest TCE concentrations in the WPB project area. Groundwater samples collected from these wells consistently exhibit TCE concentrations above 5 µg/L. Monitoring wells WPB-05, WPB-08 and WPB-11 have exhibited decreasing concentration trends since at least August 2000. Monitoring well PW-002 exhibited an increasing concentration trend from February 1997 to November 2000 after which time this well has exhibited a decreasing concentration trend. The new data for the period between 2006 and 2009 indicate the decreasing concentration trends (for all wells shown in Figure 9) previously reported by ADEQ in 2006 have persisted in the approximately three year period since the 2006 MNA evaluation. Projections regarding the attenuation rates in these wells which consistently exhibit TCE concentrations above the MCL will be discussed in Section 6.

The concentration trends of monitoring wells with fewer than three reported samples were not presented in Figures 6 through 10. This included monitoring well WPB-14 which was sampled once on August 2, 2006 and exhibited a TCE concentration of 4.7 µg/L, and monitoring well PW-021 which was sampled once on February 5, 2004 and exhibited a non-detect TCE result of less than 0.5 µg/L. In addition, monitoring wells MWAF-01 through MWAF-03 were each sampled on two occasions (August 2007 and February 2009). Both samples from monitoring well MWAF-01 contained less than or equal to 1.5 µg/L on both occasions. Samples collected from monitoring well MWAF-02 contained 6.3 µg/L TCE in August 2007 and 6.7 µg/L in February 2009. Samples collected from monitoring well MWAF-03 contained 7.6 µg/L TCE in August 2007 and 10 µg/L in February 2009.

The concentration trend analysis discussed above was made based on data collected over a time period when the water table elevation did not change significantly in WPB. Substantial increases in groundwater table elevation, while not anticipated, could lead to changes in concentration trends due to mobilization of contaminants historically located in the vadose zone.

Evidence of TCE Biodegradation

As presented in Section 3, both the 2000 and 2006 MNA evaluations reported detections of cis-1,2-DCE and/or vinyl chloride as evidence that anaerobic biodegradation of TCE was occurring within the WPB project area. Among the new data reviewed for WPB and Area B from 2006 to 2009, continued detections of cis-1,2-DCE continue to support the hypothesis that biodegradation of TCE is occurring despite the generally aerobic groundwater conditions present in the area. Among samples collected from February 2006 through March

2009, the TCE breakdown product cis-1,2-DCE was detected in 3 monitoring wells within the WPB project area (MWAF-03, PW-002, and WPB-08). The 2000 and 2006 MNA evaluations previously reported the detection of TCE breakdown products in monitoring wells PW-002 and WPB-08; however the detection of cis-1,2-DCE in monitoring well MWAF-03 provides evidence of a larger spatial distribution of locations where biodegradation of TCE is occurring than was previously reported.

Vinyl chloride was detected on one occasion between 1997 and 2009 in wells WPB-06, WPB-08 and WPB-10. The limited detections of vinyl chloride suggest that once this compound is formed, it is rapidly oxidized in the aerobic aquifer to form carbon dioxide, water and chloride ions.

5.0 Attenuation Mechanisms

As described in Section 1.3 of the Technical Protocol, several lines of evidence can be used to demonstrate attenuation of chlorinated aliphatic hydrocarbons, and include the following:

- Demonstrating clear and meaningful decreasing concentration trends over time at appropriate sampling locations; this trend shall not be the result of contaminant migration.
- Indirectly demonstrate the types of attenuation processes active in a study area, and determine the rate at which such processes will lower contamination levels to the remediation goals.

The distribution and concentration trend evaluations discussed in the first bullet above were provided in the 2006 MNA evaluation for the WPB project area; additional concentration trend information gathered from data collected between 2006 and 2009 was presented in Section 4. Section 5 of this MNA evaluation expands upon information previously reported in the 2000 and 2006 MNA evaluations to demonstrate what mechanisms are responsible for the attenuation observed in the WPB project area. This information will be used in the context of the second bullet above to support any estimates made regarding the rate at which attenuation processes at WPB will lower contamination levels to the remediation goals at the site.

Attenuation mechanisms of chlorinated aliphatic hydrocarbons include destructive and non-destructive processes which result in the decrease in concentration of a contaminant in groundwater. Destructive attenuation mechanisms include biodegradation and abiotic chemical reactions such as hydrolysis. Non-destructive mechanisms include hydrodynamic dispersion, sorption, volatilization, and dilution due to groundwater recharge. Each of these mechanisms is discussed in further detail below to determine what primary mechanisms are responsible for the attenuation observed in the WPB area. Following the initial discussion of each mechanism, methods used in the quantification of attenuation mechanisms are presented.

Hydrodynamic Dispersion

Hydrodynamic dispersion is the combination of molecular diffusion and mechanical dispersion. Molecular diffusion is the movement of molecules from areas of high

concentration to areas of low concentration, and is driven by concentration gradients. Mechanical dispersion is the result of phenomena associated with the advective flow of water through porous media. Variability in pore sizes, variability in the length and direction of groundwater flow paths at the pore scale, and variability of the speed of groundwater flow through a single pore (i.e., flow rate in center of pore versus flow rate at edge of pore) are all contributing factors to the mechanical dispersion which occurs when water flows through porous media. The consequence of hydrodynamic dispersion on a contamination plume is that over time the plume spreads out in space and concentrations within the plume decrease.

While molecular diffusion can be a significant driver for the movement of contaminants from relatively high permeability materials such as sands and gravels into lower permeability materials such as silts and clays, the relative contribution of molecular diffusion to hydrodynamic dispersion compared to the contribution from mechanical dispersion is often insignificant and frequently neglected (Fetter, 1999). One situation where molecular diffusion would play a significant role in hydrodynamic dispersion would be in the case where no groundwater flow is occurring. In such a scenario, no mechanical dispersion would take place and molecular diffusion would be the sole mechanism contributing to hydrodynamic dispersion. However, this is not the case at WPB or in Area B; therefore attenuation due to hydrodynamic dispersion within WPB and Area B is assumed to be dominated by mechanical dispersion rather that molecular diffusion.

The relative importance of mechanical dispersion can be further evaluated by analyzing mechanical dispersion in three dimensions. The effects of longitudinal mechanical dispersion (i.e., the degree of mechanical dispersion which takes place in the direction parallel to groundwater flow) is significantly greater than the effects of transverse mechanical dispersion (i.e., the degree of mechanical dispersion which takes place in directions perpendicular to groundwater flow). Transverse mechanical dispersion results only from the divergence of groundwater flow paths at the pore scale. Longitudinal mechanical dispersion, on the other hand, occurs as a result of additional mechanisms such as variations in pore size and variations in the velocity of groundwater flow through a pore (i.e., flow rate in center of pore versus flow rate at edge of pore) (USEPA, 1998).

Based on the information above, hydrodynamic dispersion is considered to be a significant mechanism in the attenuation observed at WPB. Mechanical dispersion is considered to play a much more important role than molecular diffusion in this process. Furthermore, the effects of longitudinal mechanical dispersion are expected to result in more significant attenuation than those of transverse mechanical dispersion. Methods used to approximate the magnitude of hydrodynamic dispersion are presented in Section 6.

Sorption

Sorption is a reversible process in which dissolved-phase chemicals partition from groundwater and adhere to the surfaces of aquifer matrix particles such as clay particles or organic carbon material. Sorption can play a significant role in attenuation for several reasons. When sorption takes place, the contaminant is no longer in the groundwater dissolved-phase thus temporarily reducing the concentration of the contaminant in groundwater. The ongoing cycle of sorption and desorption also results in the slowing down of the transport of a contaminant through porous media compared to the

groundwater flow rate through the same porous media, a phenomena known as retardation. Various intra-molecular forces and other mechanisms drive sorption; however, hydrophobic bonding is a critical driving force in the sorption of chlorinated compounds (Devinny *et al.*, 1990). The F_{oc} in the aquifer matrix has a significant influence on the amount of sorption that takes place. Previous soil samples collected from the WPB area have been analyzed for F_{oc}, and indicate that sorption is an attenuation mechanism which should be considered in the MNA evaluation for WPB and Area B. These results are discussed further in Section 6.

Volatilization

At the interface between a body of water and air, the concentration of a chemical in the water is proportional to the concentration of that chemical in the air above. This relationship is given by Henry's Law:

$$C_a = HC_w,$$

where,

C_a = The concentration of a given chemical in air

C_w = The concentration of a given chemical in water

H = Henry's Law Constant, specific to each chemical of interest

While volatilization of chlorinated aliphatic hydrocarbons does occur from groundwater contamination plumes, and this volatilization does result in the removal of contaminant mass from the plume, several factors combine to limit the amount of mass that is removed from the dissolved-phase plume and transferred into soil vapor. These factors include (1) the relatively small surface area over which chemical exchange can take place in the subsurface, (2) the limited movement of soil vapor in the subsurface, and (3) the fact that TCE and other chlorinated aliphatic hydrocarbons exhibit low Henry's Law constants due to their physical and chemical properties (USEPA, 1998). The Technical Protocol states that the effect of volatilization on contaminant mass reduction from a contamination plume can be neglected for most compounds. Based on this information, volatilization is not believed to be a primary attenuation mechanism in WPB or in Area B of the TIAA Superfund Site.

Dilution

Dilution of a contamination plume can occur through the recharge of groundwater from precipitation percolating through the vadose zone to the aquifer below, and from recharge by surface water bodies such as lakes or streams. There are no lakes or perennial streams in the vicinity of WPB or any other project area within Area B. The AANG operates a groundwater pump, treat, and injection system south (hydraulically up-gradient) of WPB. While upgradient re-injection of groundwater which is also extracted from an upgradient location does not fit the traditional definition of dilution (i.e., by rainfall or surface water bodies), it is possible that the AANG treatment system could have a net diluting effect on the southern portion of the WPB TCE plume. In addition, Tucson receives approximately 12 inches of precipitation annually. The majority of precipitation in the vicinity of Area B falls on paved asphalt and concrete surfaces as well as building roofs. Stormwater runoff flows to ephemeral washes which flow out of Area B. Unpaved surfaces in Area B contain

vegetation which intercepts some percentage of precipitation and releases it back into the atmosphere through evapotranspiration. While some small amount of contamination plume dilution due to aquifer recharge is expected to occur at WPB and in Area B, the amount of plume dilution due to groundwater recharge is inherently difficult to estimate. Methods used to quantify attenuation mechanisms are largely unable to separate out the effects of plume dilution from more significant mechanisms such as hydrodynamic dispersion; consequently, the net effect of mechanisms such as hydrodynamic dispersion and dilution are typically calculated together. Such methods are presented in Section 6.

Biodegradation

Biodegradation represents a significant mechanism involved in the attenuation of many forms of subsurface contamination. The process of biodegradation involves the consumption (or breakdown) of contaminants such as TCE during metabolic processes of microorganisms present in soil and groundwater. Specific metabolic processes depend on conditions such as the presence or absence of oxygen. As presented in Section 3, the process most likely to lead to the biodegradation of TCE in groundwater is reductive dechlorination, which takes place in anaerobic conditions. While groundwater in WPB and Area B exhibit levels of dissolved oxygen which largely indicate aerobic groundwater, evidence of reductive dechlorination is observed by the detection of TCE breakdown products such as cis-1,2-DCE in groundwater samples collected from these areas. Based on the detection of TCE breakdown products within WPB, biodegradation is considered to be a potentially significant attenuation mechanism for this area.

Abiotic Chemical Reaction

Abiotic destructive chemical reactions are not thought to contribute significantly to the attenuation of TCE in groundwater. The half life of TCE in the vadose and saturated zones has been reported to be approximately 274 years (ADEQ, 1996). As a result, while it is recognized that this attenuation mechanism does account for a small decrease in TCE concentrations within WPB, the magnitude of abiotic chemical reaction compared to others attenuation mechanisms discussed above is small. Therefore, this attenuation mechanism can be neglected and is not included in the attenuation mechanism calculations presented in Section 6.

6.0 Quantification of Attenuation Mechanisms

Several methods were used to quantify the attenuation observed at WPB. These methods included the application of a curve-fitting model to data collected from monitoring wells which exhibit TCE concentrations above the MCL, and the use of mathematical methods for estimating the magnitude of select attenuation mechanisms described previously in Section 5 of this memorandum. The basis for these methods and calculations used in this Technical Memorandum were Appendices B and C of the Technical Protocol which provide guidance on applicable models and techniques which can be used in attenuation-related calculations. These analyses are presented below.

Overall Attenuation Rate

Figure 10 presents the projected attenuation of TCE in monitoring wells which consistently exhibit TCE at concentrations above the MCL. The attenuation projections are based on an exponential decay model of the form:

$$C = C_o e^{-kt},$$

where,

C = TCE concentration at time t

C_o = Initial TCE concentration

e = an irrational numerical constant approximately equal to 2.71828

k = overall attenuation rate

t = time

Based on the projected attenuations for each well shown in Figure 10, TCE concentrations in monitoring wells WPB-11 and WPB-08 are predicted to be less than 5µg/L between 2014 and 2016. The projected attenuation of TCE to concentrations below 5µg/L in monitoring well WPB-05 is predicted to have occurred in the past (in 2008). In fact, the first sample collected from WPB-05 which exhibited a TCE concentration less than 5µg/L was collected in February 2008. Since that time, two samples collected in July 2008 and February 2009 have exhibited TCE concentrations of 5.2 and 5.5µg/L, respectively; however, TCE concentrations in this well are expected to continue to decrease and stabilize at concentrations below 5µg/L in the near future. The projected attenuation of TCE to concentrations below 5µg/L in monitoring well PW-002 is predicted to occur in approximately 2032.

These projected attenuation periods are similar to those forecast by ADEQ in the 2006 MNA evaluation which appear to have been estimated using the same exponential decay function described above. TCE concentrations below 5µg/L were predicted by ADEQ to occur in monitoring well WPB-05 in 2008. Attenuation timeframes for WPB-11 and WPB-08 were predicted by ADEQ to occur several years after the 2014 – 2016 timeframe described above; the reduction in the predicted attenuation timeframe for WPB-11 and WPB-08 can be attributed to the relatively lower concentrations of TCE observed in these wells in samples collected between 2006 and 2009. No attenuation timeframe was proposed by ADEQ in 2006 for PW-002, so no comparison can be made for that well.

The attenuation projections described above are based on the measured TCE concentrations in groundwater samples collected from WPB. Decreases in TCE concentrations in these groundwater samples can be attributed to all applicable attenuation mechanisms described in Section 5. In other words, the curves shown in Figure 10 represent the combined effect of hydrodynamic dispersion, biodegradation, sorption, dilution from groundwater recharge, and all other acting attenuation mechanisms. In some cases, it is very difficult or impossible to accurately separate these mechanisms from one another and quantitatively predict their individual effect on a contamination plume. In other cases, it is possible to isolate the contribution of one mechanism over another. These methods are summarized below.

Biodegradation vs. Other Attenuation Mechanisms

As presented in Appendix C of the Technical Protocol, attenuation due to biodegradation can be separated out from attenuation due to other mechanisms if data for a suitable tracer compound are available. Tracer compounds suitable for this purpose include compounds with measurable concentrations which are resistant to biodegradation. The best tracer compounds will have physical properties such as a Henry's Law constant and a soil sorption coefficient which are the same as the contaminant of interest. In addition, when possible, it is recommended to use multiple tracers to compare results for consistency (USEPA, 1998). The Technical Protocol recommends selection of suitable tracer compounds for this purpose on a site by site basis with choices based on site-specific conditions. A suitable tracer has not been identified for the West Plume B.

Sorption

Several mathematical relationships describing the behavior of organic chemicals with regard to sorption are given in Appendix B of the Technical Protocol. The distribution coefficient, K_d, represents the distribution of an organic compound between the phase sorbed to the aquifer matrix and the phase dissolved in groundwater:

$$K_d = \frac{C_a}{C_l}$$

where,

K_d = Distribution coefficient (milliliters per gram (mL/g))

C_a = Sorbed concentration (mass contaminant in micrograms per mass of soil in grams)

C_l = Dissolved concentration (mass of contaminant in micrograms per volume of solution in milliliters)

The distribution coefficient can also be related to organic content of soil, as:

$$K_{oc} = \frac{K_d}{F_{oc}}$$

where,

K_{oc} = Soil Sorption coefficient

K_d = Distribution coefficient

F_{oc} = Fraction total organic carbon

The soil sorption coefficient (K_{oc}) is chemical specific, and the soil sorption coefficient for TCE is reported in literature between 87 and 150 mL/g (Knox *et al.*, 1993; Jeng *et al.*, 1992; Howard, 1990; USEPA, 1998). The fraction total organic carbon in soil at WPB was previously reported in the 2000 MNA evaluation as 0.0006. Assuming a K_{oc} value of the average of 87 and 150 mL/g (118.5 mL/g), the distribution coefficient can be calculated:

$$K_d = K_{oc} \times F_{oc} = 118.5 \times 0.0006 = 0.0711 mL/g$$

Using the original equation for the distribution coefficient from above:

$$K_d = \frac{C_a}{C_l} = \frac{0.0711}{1} = 0.0711$$

This is to say that based on the measured fraction of organic carbon in soil at WPB, and based on the values of K_{oc} reported in literature, out of every 1.0711 micrograms TCE in the WPB groundwater contamination plume, approximately 1 microgram will be dissolved in groundwater and approximately 0.0711 micrograms will be sorbed to the aquifer matrix. In other words, 6.6% of TCE in the WPB groundwater contamination plume is in a non-aqueous phase due to sorption; this results in the lower observed groundwater concentrations than would be present if sorption were not active.

Sorption also affects the speed with which a compound can flow through the aquifer matrix, with sorption resulting in the net reduction in transport velocity, also referred to as retardation. The retarded contaminant transport velocity can be calculated based on the distribution coefficient; this velocity is always lower than the advective velocity of groundwater through the aquifer matrix.

7.0 Enhanced Attenuation

EA is a plume remediation strategy to achieve groundwater remediation goals by providing a "bridge" between MNA and aggressive source zone or dissolved-phase treatment (ITRC, 2008). Treatment of project areas within Area B which exhibit ongoing sources of TCE to groundwater may require a more aggressive remedial treatment, rather than using MNA as a stand-alone remedy. At the same time, aggressive treatment methods such as pump and treat systems may not necessarily be appropriate in some of these areas. EA strategies such as MNA with source zone control are being studied to determine if EA may be the preferred remedial alternative at the other project areas within Area B.

The primary method of enhancing attenuation that has been evaluated at Area B is using in-situ chemical oxidation (ISCO) to control source areas or reduce VOC concentrations in dissolved plume areas. As reported in *In-Situ Chemical Oxidation Pilot Test, Former West-Cap Property, Tucson International Airport Area Superfund Site* (CH2M HILL, 2009), a pilot test was conducted between March 6, 2009 and May 4, 2009 at the West Cap project area using potassium permanganate (KP) injection as a method of source control for TCE contamination at that site. The ISCO process involves the delivery of KP to the zone of contamination where it oxidizes residual TCE, producing inert compounds. Similar ISCO pilot tests using KP injection are being planned, performed, or have been recently performed at other project areas within Area B, including the Texas Instruments and AANG project areas. Ongoing groundwater monitoring results will be used to evaluate the effect of KP injection on TCE concentration in groundwater. If ISCO is demonstrated to be an effective treatment of TCE source zones within Area B, continued ISCO treatment may be selected as an EA method for source zone control to be used in conjunction with MNA to reach remedial goals of Area B of the TIAA Superfund Site.

Enhancement Implementation

As discussed in the technical and regulatory guidance for EA (ITRC, 2008), remediation of a contaminated site is an iterative process whereby the methods of remediation may change over time due to changes in site conditions. In order to evaluate these changes in remedial strategy over time, a decision sequence can be performed to evaluate when MNA is a suitable stand-alone remedy, when EA should be considered, and what conditions would justify the transition from one treatment method to another. This decision sequence is presented in the Expanded MNA/EA Decision Flowchart (Figure 2-1, ITRC, 2008). In this decision sequence, site data are used to evaluate risk, system performance, remediation timeframe, and cost-benefit relationships to determine whether MNA alone is an appropriate remedial alternative. If the answer is no, then enhancements can be evaluated by stating the project goals, identifying technologies available to (1) increase attenuation or (2) reduce loading, and consider options available to meet the project goals. After implementing an enhancement, plume stability is evaluated through time and decision sequences are repeated (i.e., annually) to evaluate changes that justify transition from one remedial strategy to another.

The first step in implementing EA is to provide source area treatment. The current and planned ISCO pilot tests are intended to decrease the VOC loading from the source zone, although ISCO will likely be scaled up to a full-scale remedy before it can be considered a remedial enhancement. Once the enhancements have been implemented, data obtained through routine monitoring can be used to answer questions in the Decision Flowchart, and continue the iterative process. Questions in the Decision Flowchart include:

- Are the risks acceptable?
- Is the plume stable or shrinking?
- Are conditions sustainable?
- Is the remediation time frame acceptable?
- Are the cost-benefits acceptable? (ITRC, 2008)

Evaluation of these questions can help determine whether additional enhancement is required.

8.0 Conclusions

CH2M HILL conducted an evaluation to determine whether MNA is an appropriate remedial alternative for the treatment of TCE groundwater contamination found within Area B of the TIAA Superfund Site. The WPB project area was the primary focus of this evaluation based on the fact that active remediation techniques (such as pump and treat) have not taken place at the WPB project area. This allowed a clear evaluation of the effectiveness of MNA as a stand-alone remedy, and the specific mechanisms responsible for the attenuation observed in this area could also be identified. Conclusions drawn regarding the use of MNA at WPB were then considered in the context of other Area B project areas, including the AANG, Texas Instruments, and West Cap project areas, particularly in conjunction with attenuation enhancements such as ISCO.

Mechanisms identified that play an important role in the attenuation of TCE contamination within the WPB project area include hydrodynamic dispersion, sorption, and biodegradation. Of the mechanisms which contribute to hydrodynamic dispersion, longitudinal mechanical dispersion is the most influential mechanism, with transverse mechanical dispersion and molecular diffusion playing much less significant roles. Additional attenuation mechanisms which are thought to contribute on a very limited basis to the attenuation of WPB include dilution due to groundwater recharge, volatilization, and abiotic chemical reactions.

Based on the cumulative effect each of the attenuation mechanisms listed above have on TCE concentrations in groundwater, projections were made to predict the timeframe needed for MNA to achieve the remediation goal of lowering TCE concentrations below the MCL of 5 µg/L throughout the entire WPB project area. The data indicate that all but one monitoring well in the WPB area are expected to exhibit TCE concentrations below 5 µg/L by 2016, with one monitoring well (PW-002) expected to take until 2032. An alternate well head treatment method may be an alternative for this well if it remains in active use.

The time frames to reach the cleanup appear reasonable with respect to changes in current and foreseeable end use of the groundwater. Although the final remedial goal is to restore the aquifer to drinking water quality there appears to be no current or short-term end use that is limited by implementing an MNA strategy. However, it is always recommended that a regular review of changes in user needs along with the monitoring of remedial progress be established.

Overall, MNA appears to be an appropriate remedial alternative for the WPB project area because:

- The VOC plume in groundwater is shrinking over time, and is not migrating downgradient;
- There is no continuing source of VOCs to the WPB plume;
- Attenuation mechanisms have been identified; and
- The site is expected to meet remediation goals within a reasonable time frame.

Likewise, EA appears to be an appropriate remedial alternative for the lower concentration portion of the plumes in the West Cap, AANG and Texas Instruments project areas provided that certain criteria are met. For example, based on analogy with WPB, MNA is likely feasible for portions of the other TCE plumes that are below approximately 30 ug/L (the initial concentrations observed at WPB), while the higher concentration zones would remain under an active remedy until they reached the necessary threshold. It is recommended that if this strategy is pursued, a more quantitative evaluation be focused on each area to identify potential local conditions that may inhibit attenuation.

9.0 References

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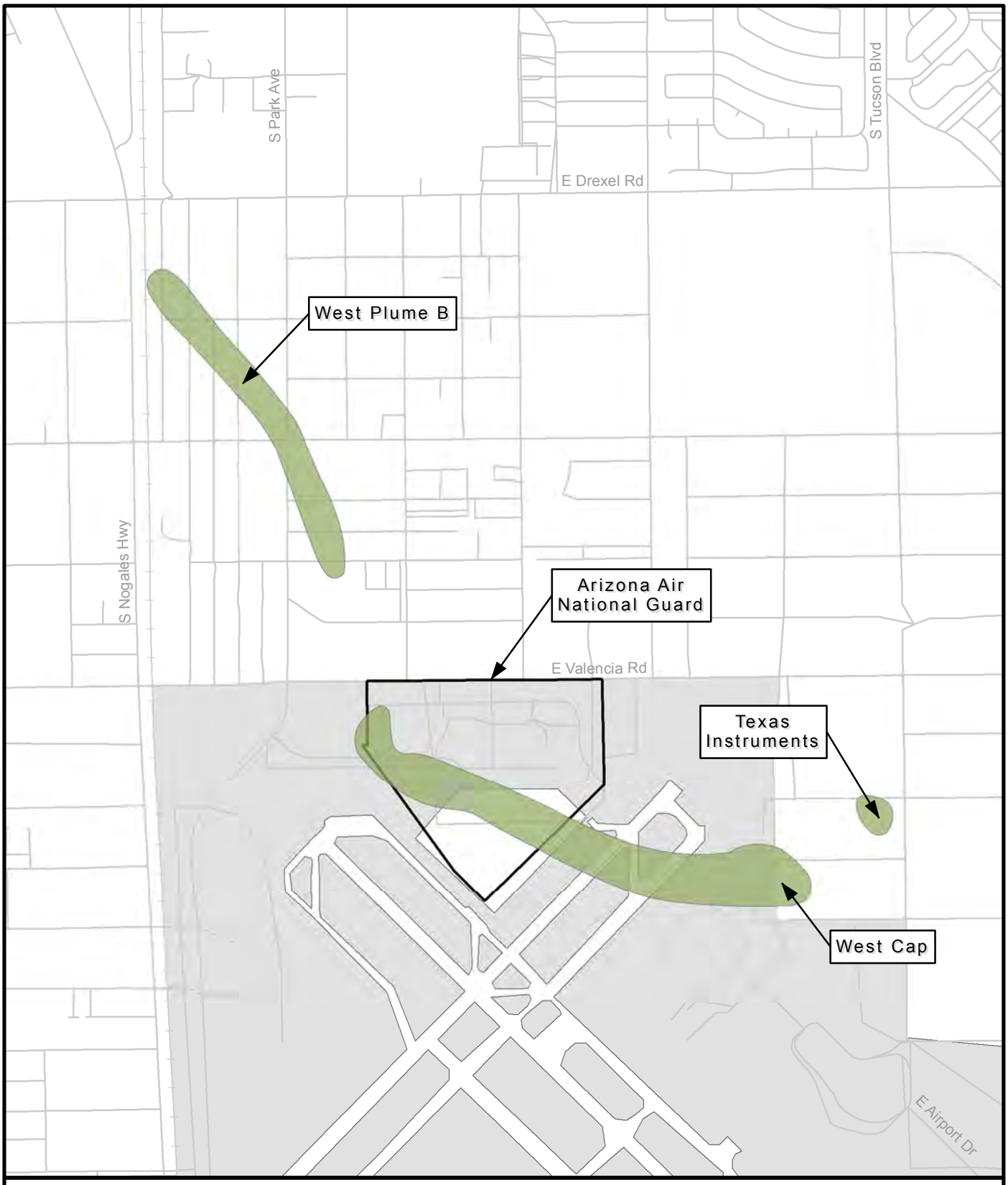
Figures



Legend

- Road
- Union Pacific Railroad
- TCE Plume Concentration ≥ 5 micrograms per liter
- Tucson International Airport

N

0 375 750 1,500 Feet

Note: Plume contours based on groundwater sampling results from February 2009.

FIGURE 1
Site Location Map and Project Areas

Area B
TIAA Superfund Site
Tucson, Arizona

\\MADISON\GROUPS\EMS\GIS_LIBRARY\TUC_OFFICE\TIAA\MAPFILES\CERCLA SITE\FIG1_SITELOCATION.MXD TWONG2 7/14/2009 11:40:33

Legend

- Groundwater Monitoring Well
- Road
- Union Pacific Railroad
- TCE Plume Concentration ≥ 5 micrograms per liter
- Tucson International Airport

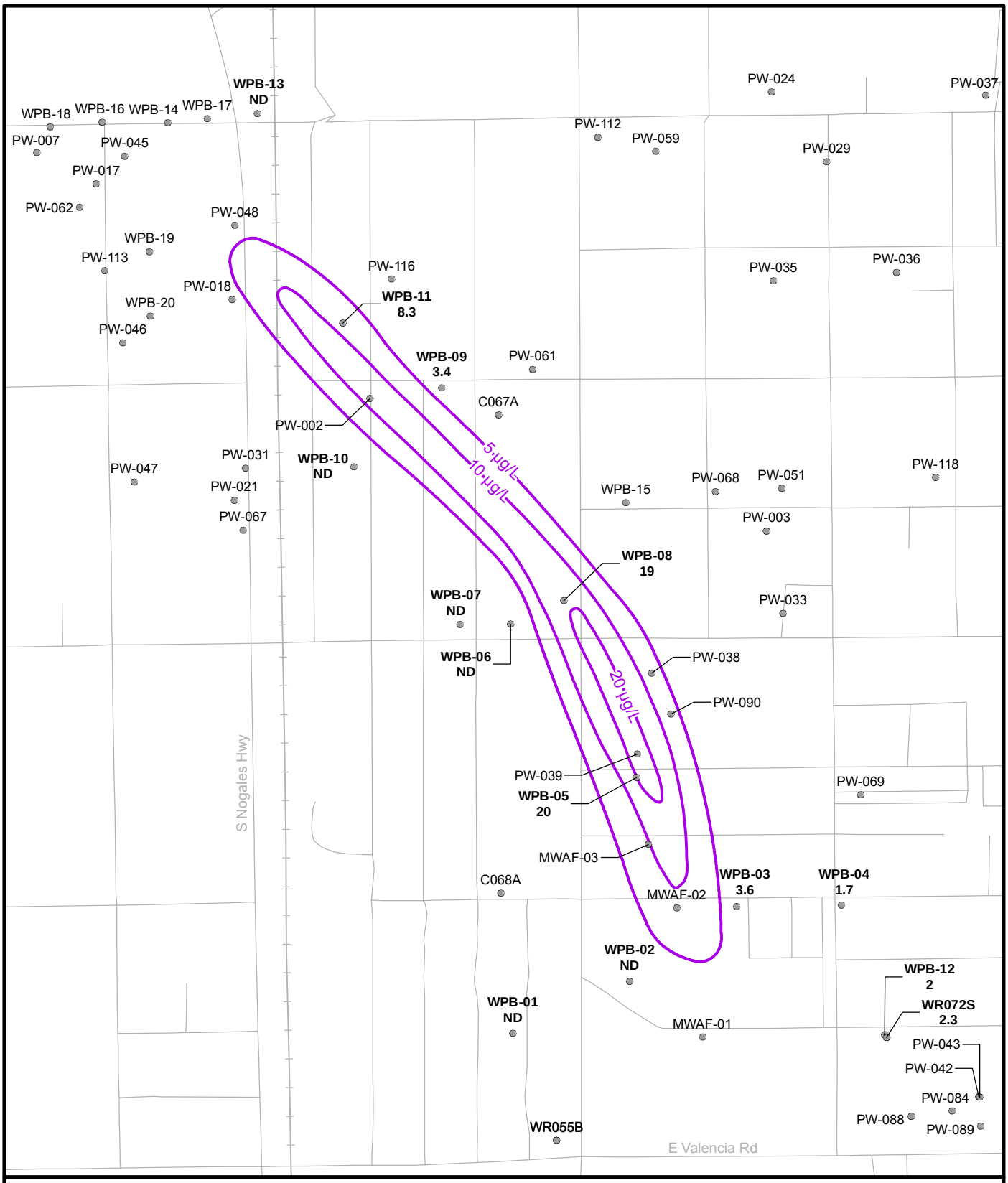
N

0 0.25 0.5 Miles

FIGURE 2
Groundwater Monitoring Well Locations

Area B
TIAA Superfund Site
Tucson, Arizona

\\MADISON\GROUPS\EMS\GIS_LIBRARY\TUC_OFFICE\TIAA\MAPFILES\CERCLA SITE\FIG2_GWMONITORINGWELLS.MXD TWONG2 7/15/2009 15:11:29



Legend

- Area B Well
- Road
- Union Pacific Railroad
- Trichloroethene Plume

WPB-03 — Monitoring Well ID
3.6 — Trichloroethene Concentration

N

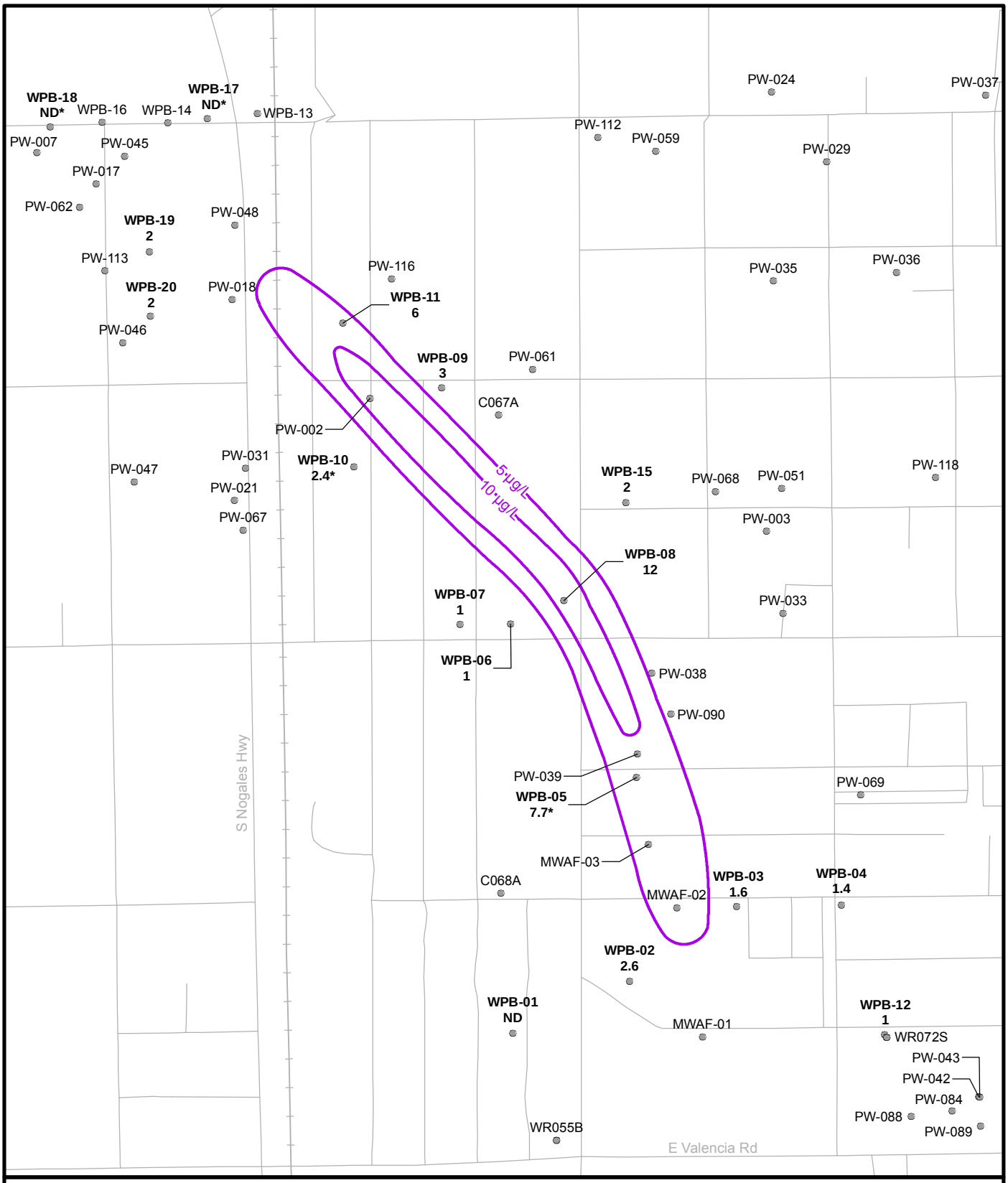
0 350 700 Feet

Notes: All concentrations in micrograms per liter (µg/L).
ND = Not Detected

FIGURE 3
West Plume B, August 1999 Trichloroethene Plume

Area B
TIAA Superfund Site
Tucson, Arizona

\\MADISON\GROUPS\EMS\GIS_LIBRARY\TUC_OFFICE\TIAA\MAPFILES\CERCLA SITE\FIG3_WESTPLUMEB_AUG99.MXD TWONG2 7/14/2009 11:42:14



Legend

- Area B Well
- Road
- Union Pacific Railroad
- Trichloroethene Plume

WPB-03 — Monitoring Well ID
1.6 — Trichloroethene Concentration

N

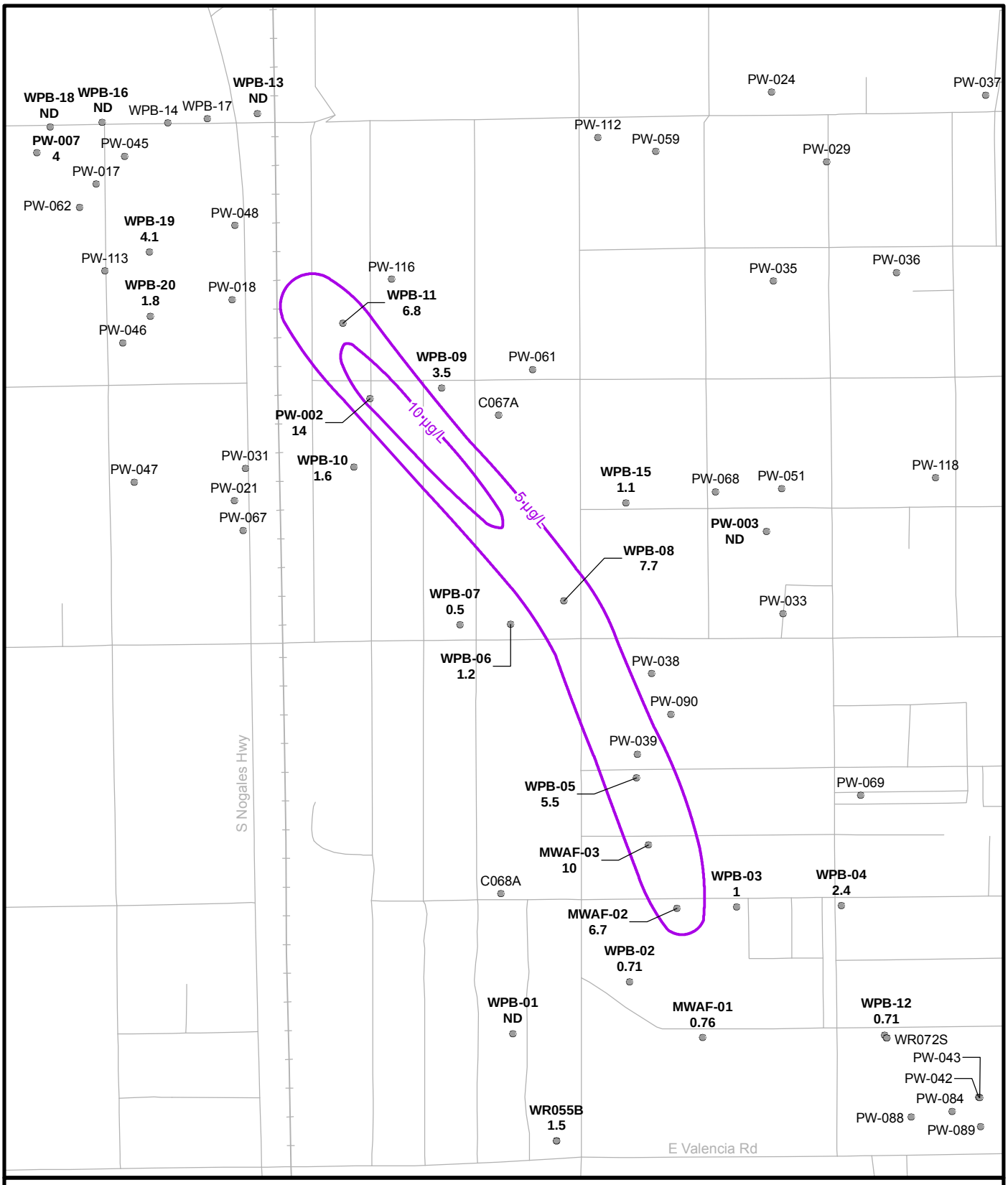
0 350 700 Feet

Notes: All concentrations in micrograms per liter (µg/L).
* Results from sample collected in September 2004.
ND = Not Detected

FIGURE 4
West Plume B, August 2004 Trichloroethene Plume

Area B
TIAA Superfund Site
Tucson, Arizona

\\MADISON\GROUPS\EMS\GIS_LIBRARY\TUC_OFFICE\TIAA\MAPFILES\CERCLA SITE\FIG4_WESTPLUMEB_AUG2004.MXD TWONG2 7/14/2009 16:18:36



Legend

- Area B Well
- Road
- Union Pacific Railroad
- Trichloroethene Plume

WPB-03 — Monitoring Well ID
1 — Trichloroethene Concentration

N

0 350 700 Feet

Notes: All concentrations in micrograms per liter (µg/L).
ND = Not Detected

FIGURE 5
West Plume B, February 2009
Trichloroethene Plume

Area B
TIAA Superfund Site
Tucson, Arizona

\\MADISON\GROUPS\EMS\GIS_LIBRARY\TUC_OFFICE\TIAA\MAPFILES\CERCLA SITE\FIG5_WESTPLUMEB_FEB2009.MXD TWONG2 7/14/2009 18:27:10

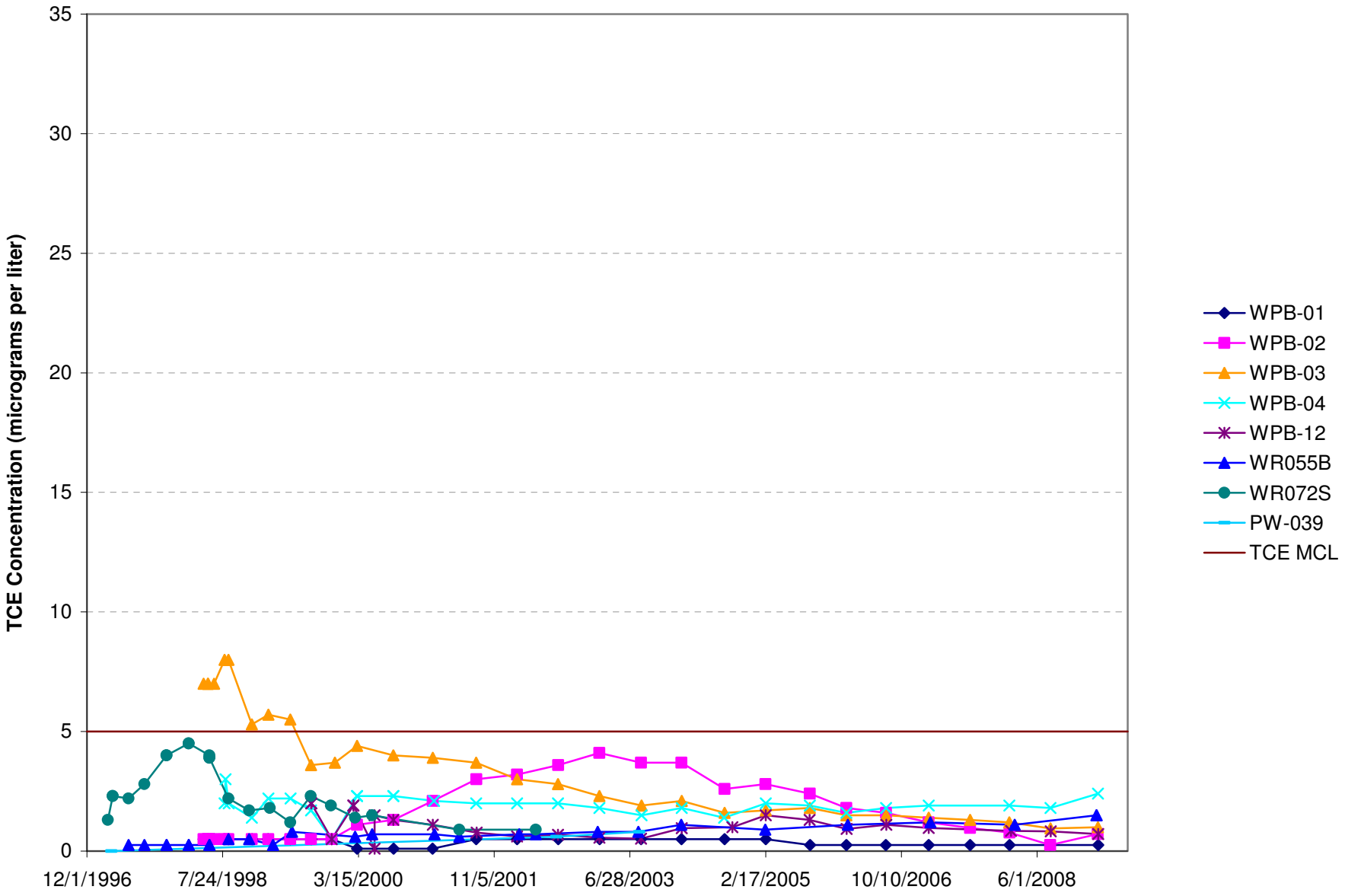


FIGURE 6
TCE CONCENTRATION VS TIME
SOUTHERN PORTION OF WEST PLUME B
West Plume B
TIAA Superfund Site, Tucson, Arizona

CH2MHILL

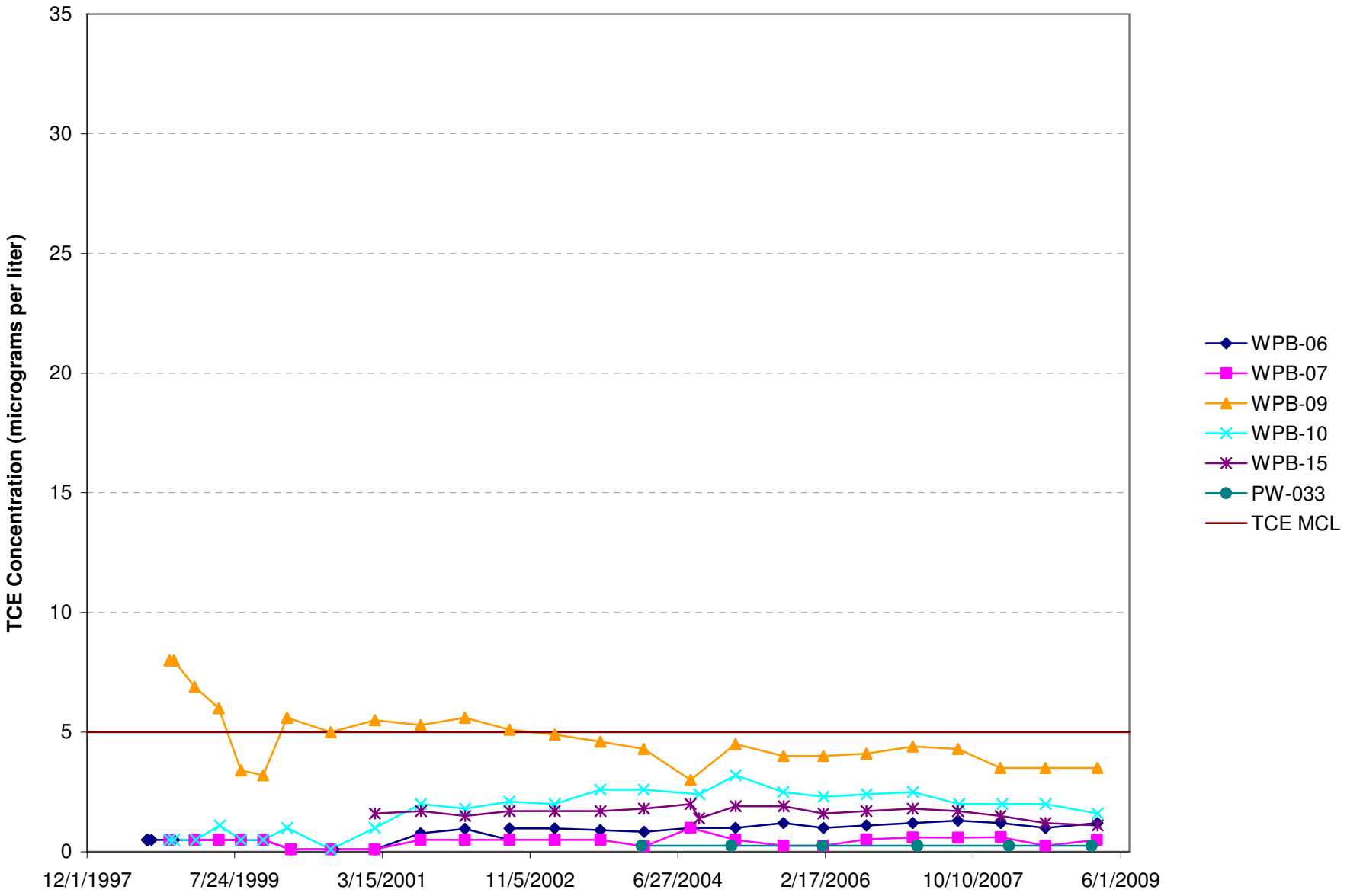


FIGURE 7
TCE CONCENTRATION VS TIME
CENTRAL PORTION OF WEST PLUME B
West Plume B
TIAA Superfund Site, Tucson, Arizona

CH2MHILL

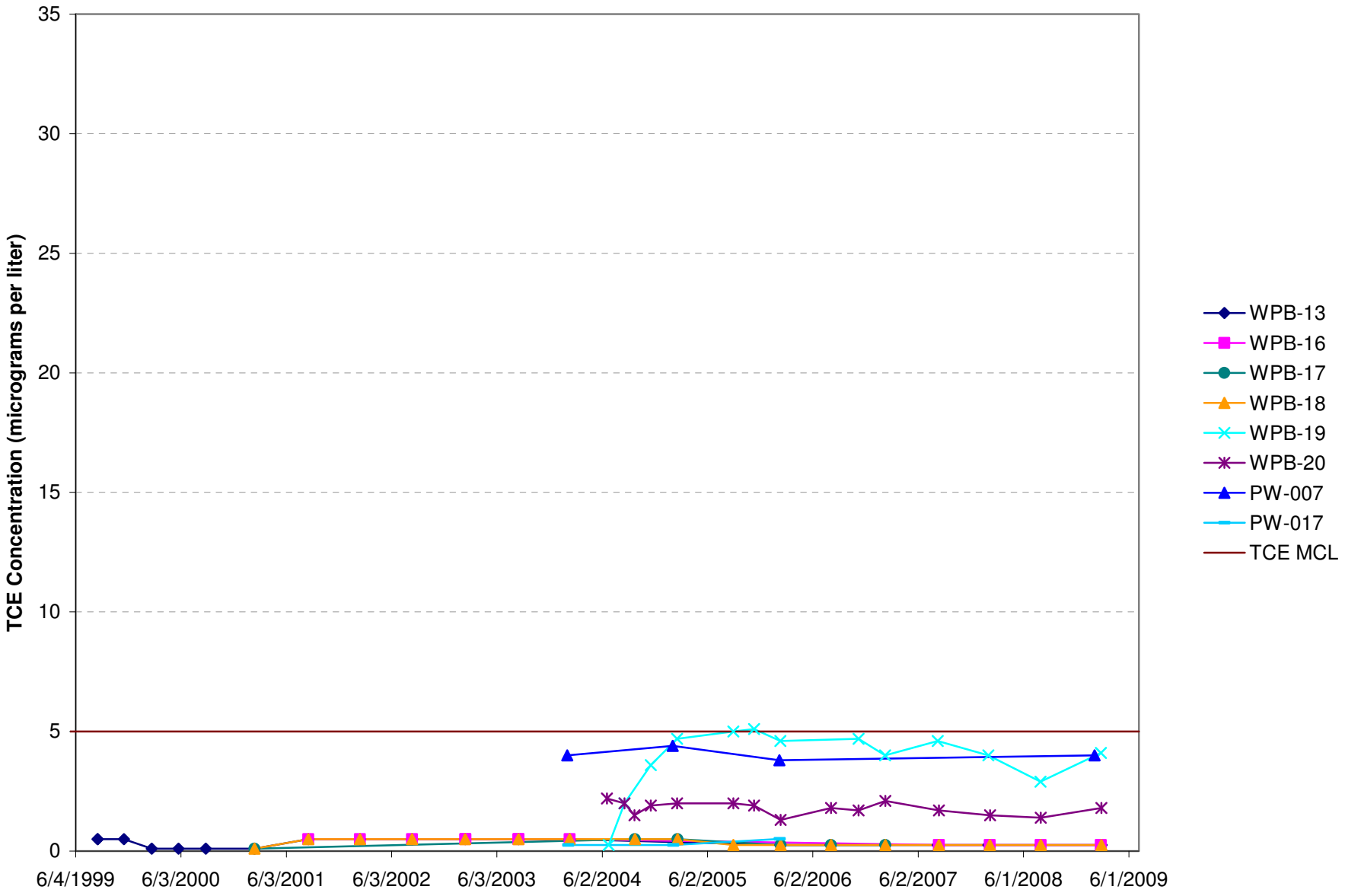


FIGURE 8
TCE CONCENTRATION VS TIME
NORTHERN PORTION OF WEST PLUME B
West Plume B
TIAA Superfund Site, Tucson, Arizona

CH2MHILL

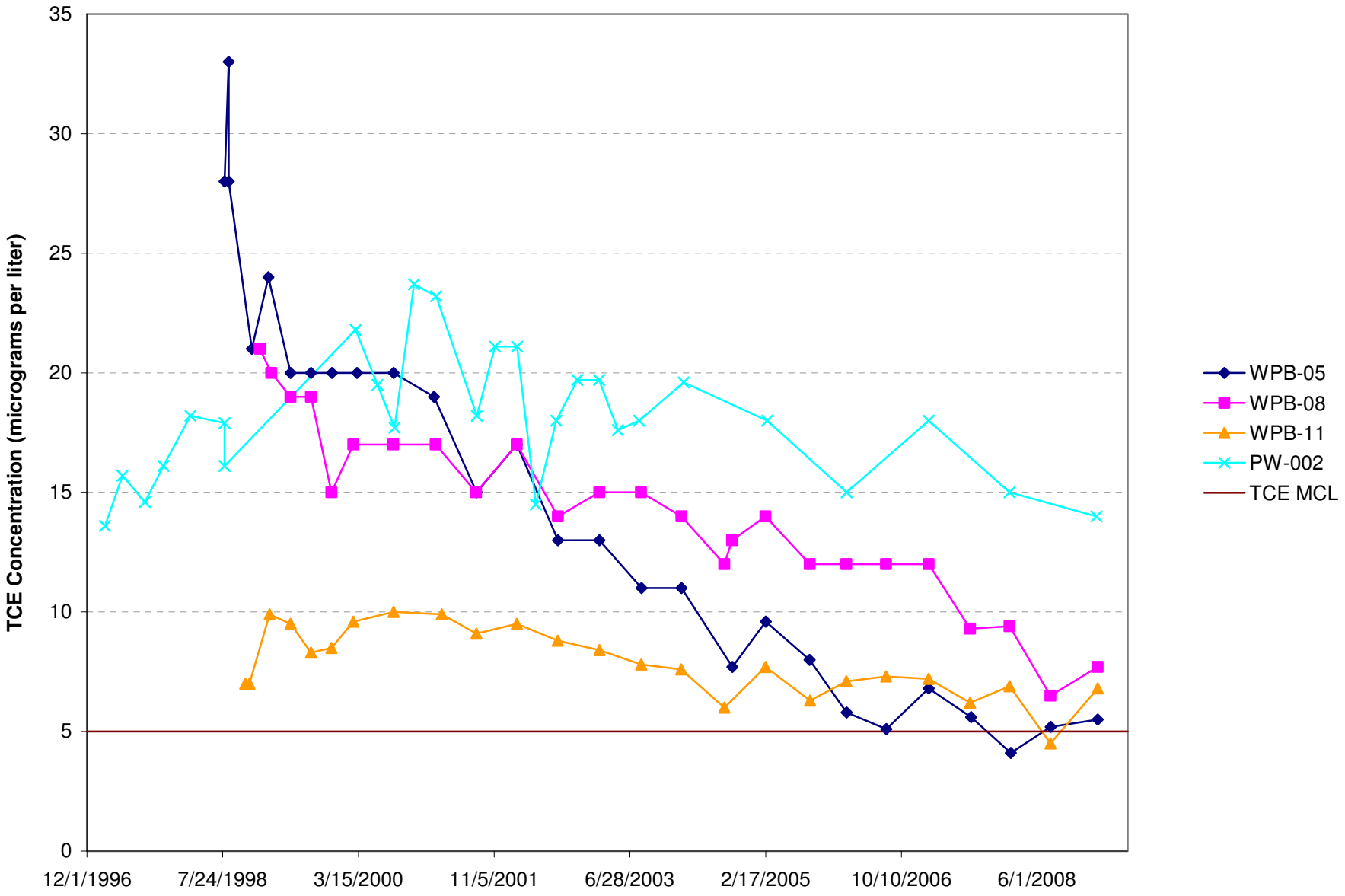


FIGURE 9
TCE CONCENTRATION VS TIME
IN-PLUME PORTION OF WEST PLUME B
West Plume B
TIAA Superfund Site, Tucson, Arizona

CH2MHILL

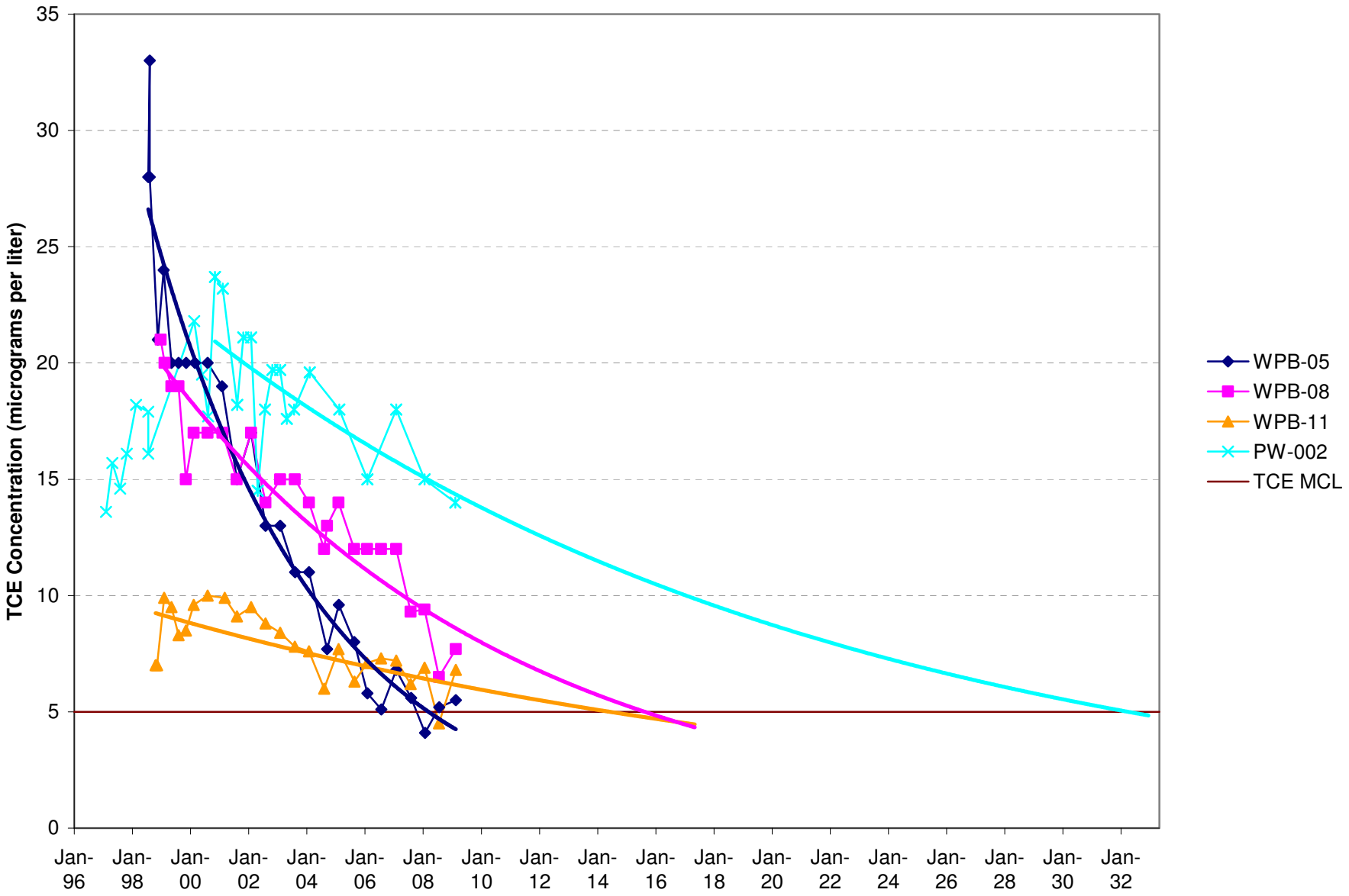


FIGURE 10
TCE ATTENUATION FORECAST
West Plume B
TIAA Superfund Site, Tucson, Arizona

CH2MHILL

Appendix C
Environmental Footprint Analysis

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ENVIRONMENTAL FOOTPRINT ANALYSIS IN ASSOCIATION WITH A FOCUSED FEASIBILITY STUDY

TUCSON INTERNATIONAL AIRPORT WEST-CAP PROJECT AREA
TUCSON, ARIZONA

Revised Report
July 20, 2011

NOTICE

Work described herein was performed by Tetra Tech GEO (formerly GeoTrans, Inc.) for the U.S. Environmental Protection Agency (U.S. E.P.A). Work conducted Tetra Tech GEO, including preparation of this report, was performed under Work Assignments #58 and #73 of EPA contract EP-W-07-078 with Tetra Tech EM, Inc., Chicago, Illinois. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

PREFACE

This report was prepared as a collaborative pilot effort between U.S. EPA Region 9 and the U.S. EPA Office of Superfund Remediation and Technology Innovation (OSRTI). This report is available for download from www.cluin.org/greenremediation. Contact information for the project team is presented below.

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LIST OF ACRONYMS

CO2e – Carbon dioxide equivalents of global warming potential

EPA – U.S. Environmental Protection Agency

GHGs – Greenhouse gases

HAP – Hazardous air pollutant as defined by the Clean Air Act

HDPE – High density polyethylene

ISO – International Standards Organization

LTM – Long-term monitoring

Mbtu – One thousand btus

NOx – Nitrogen oxides (e.g., nitrogen dioxide)

O&M – Operations and maintenance

PM – Particulate matter (particles 10 microns or less in diameter)

POTW – Publicly owned treatment works

PVC – Polyvinyl chloride

SOx – Sulfur oxides (e.g., sulfur dioxide)

VOCs – Volatile organic compounds

1.0 INTRODUCTION

1.1 ENVIRONMENTAL FOOTPRINT ANALYSIS

U.S. EPA defines green remediation as the practice of considering all environmental effects of remedy implementation and incorporating options to minimize the environmental footprints of a cleanup. To this end, green remediation involves quantifying the environmental effects of a remedy and then taking steps to reduce negative environmental effects and enhance positive environmental effects, while meeting the regulatory requirements governing the remedy.

Two concepts are central to quantifying the environmental effects of a remedy. The first is to establish those parameters that are to be quantified, and the second is to establish a straightforward methodology for quantifying those parameters. The term "footprint", which is commonly applied to quantifying the emissions of carbon dioxide (i.e., "carbon footprint"), refers to the quantification or measure of a specific parameter that has been assigned some meaning. For example, the carbon footprint is the quantification or measure of carbon dioxide (and other greenhouse gases) emitted by a particular activity, facility, individual, or remedy. The carbon footprint is of interest because emissions of carbon dioxide (and other green house gases) have been linked to environmental effects such global warming and related climate change. The term "footprint" can be expanded to other environmental parameters such as energy use, water use, land use, and air pollutant emissions. In addition, an environmental footprint can be local, regional, or global. For example, the combustion of diesel fuel at a site will result in nitrogen oxide emissions (among other compounds) in the immediate vicinity of the site. The most significant environmental effects from this nitrogen oxide may be greatest near the site where it is most concentrated (i.e., a local effect). Contrastingly, diesel combustion at a site and diesel production at a refinery located far from the site will both emit carbon dioxide into the atmosphere. The environmental effects of carbon dioxide are of global not local concern, and a pound of carbon dioxide emitted at the site or far from the site will have equal environmental effect (i.e., a global effect).

1.2 STUDY OBJECTIVES

This study involves the detailed footprint analysis of green remediation parameters for two remedial alternatives evaluated in a Draft Focused Feasibility Study (Draft FFS) for the Tucson International Airport Area Superfund Site (TIAA Site) - West Cap Project Area (West-Cap site). The study considers contributions to the parameter footprints from construction, operations and maintenance, and long-term monitoring of the two remedial options. Both on-site and off-site activities associated with each remedy component are included in the study.

This study is not a formal life-cycle assessment following ISO Standards 14040 and 14044. Rather, it is a footprint analysis that borrows from life-cycle assessment principles. Like a life-cycle assessment, this study uses data from life-cycle inventory databases to convert energy usage, materials usage, and various services associated with a particular activity (e.g., site remediation) into the environmental footprints of that activity. Like life-cycle assessment, the environmental footprints from resource extraction through use and "end-of-life" treatment are considered. Unlike a formal life-cycle assessment, this study

estimates environmental footprints but does not convert them into actual human or ecological impacts or effects through a formal impact assessment.

The primary objectives of this study are as follows:

- Estimate the footprints of several green remediation parameters for two remedial alternatives and compare the footprints of these parameters for the two remedial alternatives

- For each environmental parameter, estimate the contribution to the footprint from on-site activities (e.g., on-site fuel combustion), electricity generation, transportation (e.g., personnel transportation, freight), and off-site activities (e.g., waste disposal, material manufacturing)

- Conduct a sensitivity analysis for key components of remedies

- Identify components of the two remedial options that have a significant effect on the environmental footprint and those components that have a negligible effect on the environmental footprint

- Provide recommendations for reducing the footprints of the two remedy options

A footprint analysis conducted at the remedy selection stage provides useful background information for site managers, but is not expected to play a role in remedy selection. In this case, the footprint analysis is conducted based on the information in the Draft FFS to provide additional information regarding the remedy footprints that can be incorporated into the Final FFS. The footprint information alone would not result in changing the results of the comparative analysis of the remedial alternatives between the Draft and Final FFS. The results of the footprint analysis are also intended to be used during remedy design to identify areas where the environmental footprint of the remedy may be reduced.

The findings from this analysis are specific to the West-Cap site and to the remedies evaluated.

1.3 GREEN REMEDIATION PARAMETERS

U.S. EPA has identified five core elements of green remediation. This study has identified the following 15 green remediation parameters organized by core element.

<u>Core Element – Energy</u>

- Total Energy Used – This parameter includes all energy associated with electricity generation, transmission, and on-site use, plus energy embodied in various fuels that are used, plus energy associated with manufacturing or providing off-site services (e.g., laboratory analysis). This parameter is measured in thousands of btus (Mbtu).

- % of Energy from Renewable Resources – This is a percentage of the above energy that comes from renewable resources (e.g., solar thermal, photovoltaic, wind, biomass, biofuels, etc.). It is assumed that energy used in association manufacturing or off-site services are not from renewable resources unless it is specifically documented.

<u>Core Element – Air Quality</u>

- Global Warming Potential – This parameter is the global warming potential associated with greenhouse gases (e.g., carbon dioxide, methane, nitrous oxide) emitted as part of the remedy.

- Criteria Pollutant Emissions – This parameter is limited to nitrogen oxides, sulfur oxides, and particulate matter emitted as part of the remedy.

- Hazardous Air Pollutant Emissions - This parameter refers to emissions of hazardous air pollutants (HAPs) as defined by EPA.

For all air quality parameters, emissions associated with the following are included: on-site emissions from process equipment, electricity generation, fuel combustion for equipment use and transportation, manufacturing of materials used by the remedy, and off-site services used by the remedy.

Core Element – Water

- Potable Water Used – This parameter refers to local potable water use from a public or private supply system. The potable water use is counted regardless of the fate of the water after use.

- Other Water Used with a Reduction in Quality – This parameter refers to all other local water use associated with the remedy (e.g., groundwater, surface water, reclaimed water) if the water has a lower quality after use. Extracting and reinjecting water into the same aquifer is not counted. However, water that is extracted and discharged to the sanitary sewer is counted as is water used in a manufacturing process.

Core Element – Materials & Waste

- Quantity of Refined Materials Used – This parameter is intended to account for materials that require a manufacturing process such as treatment chemicals, steel, cement, plastic, and the cement portion of concrete.

- % of Refined Materials from Recycling/Reuse – This parameter refers to the recycled or reused content of the above refined materials. Regenerated GAC would be an example of a product that has recycled content, typically assumed to be approximately 90% recycled.

- Quantity of Unrefined Materials Used – This parameter refers to materials such as sand/gravel, fill, the aggregate portion of concrete, or other unrefined materials that is a used resource but does not have the same intensive manufacturing process as more refined materials.

- % of Unrefined Materials from Recycled or Reused Materials – This parameter refers to recycled or reused content of the above unrefined materials. Reused crushed concrete or cement made with coal combustion by-products are examples of products with recycled or reused content.

- Quantity of Non-Hazardous Waste – This parameter is the quantity of non-hazardous waste generated in association with a remedy. Waste generated in association with off-site materials manufacturing and from on-site activities are included in the analysis.

- Quantity of Hazardous Waste – This parameter is the quantity of hazardous waste generated in association with a remedy. Waste generated in association with off-site materials manufacturing and from on-site activities are included in the analysis.

- % of Total Potential Waste Generated On-Site that is Recycled or Reused – This parameter is intended to help encourage diversion of waste to reuse or recycling rather than landfill disposal.

Core Element – Land and Ecosystems

- Destruction of Existing Ecosystem Services – This parameter refers to local/on-site ecosystem services such as soil erosion control, nutrient uptake, food production, recreation, and natural habitat that may be destroyed (temporarily or permanently) as part of remedial activities.

1.4 Brief Site Background

In September 1983, the TIAA Site was officially included on the National Priorities List. For the purpose of investigating and remediating groundwater contamination, EPA divided the TIAA Site into the following three geographic areas. As a result of remedy undertaken by other parties and additional investigation, EPA further subdivided the remedy. The West-Cap Project Area is a specific area that has been identified and confirmed as a source of volatile organic compound (VOC) groundwater contamination.

In early 1998, EPA initiated a time critical removal action for the remediation of groundwater below the West-Cap project area. Contaminated groundwater was extracted and pumped to an existing treatment plant at a neighboring remedy. Increasing the extract rate to control the plume would result in exceeding the capacity of the existing treatment plant and groundwater extraction was discontinued in 2006.

During 2009, a treatability study was performed for the former West-Cap facility. The purpose of the treatability study was to evaluate the applicability of ISCO, monitored natural attenuation (MNA) and enhanced attenuation within Area B. Results from the pilot test indicated that permanganate can be successfully delivered into the source area and that it could persist in the source area for 2 years or more, providing medium- to long-term treatment. The treatability study also indicated that natural attenuation could be effective for managing VOCs outside the source area. The September 2010 Draft Focused Feasibility Study evaluates the following two remedial alternatives for the West-Cap site:

- Extraction and Treatment – This alternative involves the extraction, treatment, and injection of groundwater at the West-Cap site to remove VOCs from groundwater. Under this alternative, existing infrastructure is augmented with three injection wells and a groundwater treatment facility. The alternative also includes monitoring and MNA. For a period of 4 years, the extraction rate is 80 gpm, and then the extraction rate is reduced to 40 gpm for the following 26 years. Monitoring for VOCs is conducted at 26 wells semi-annually for 30 years, and MNA parameters are monitored annually from 5 wells for the last 26 years.

- In-situ Treatment – This alternative involves injection of potassium permanganate solution, monitoring, and MNA. A total of 11,902 pounds of potassium permanganate is injected and recirculated with extracted groundwater for a period of 22 days. Monitoring for VOCs is conducted at 16 wells semi-annually for 3 years. Monitoring for VOCs at 16 wells and MNA parameters at 5 wells is conducted annually for 10 additional years.

1.5 Remedy Alternatives to be Analyzed

This study evaluates the two remedial alternatives as described in the Draft Focused Feasibility Study and noted in the above section. For the purpose of this study the Extraction and Treatment alternative is referred to as Alternative 1 or the Pump and Treat (P&T) Alternative and the In-Situ alternative is referred to as Alternative 2 or the In-situ Chemical Oxidation (ISCO) Alternative.

The two remedial alternatives address contamination in different ways and with different time scales. These differences are addressed as part of the comparative analysis in the Draft FFS and are not discussed further in this evaluation.

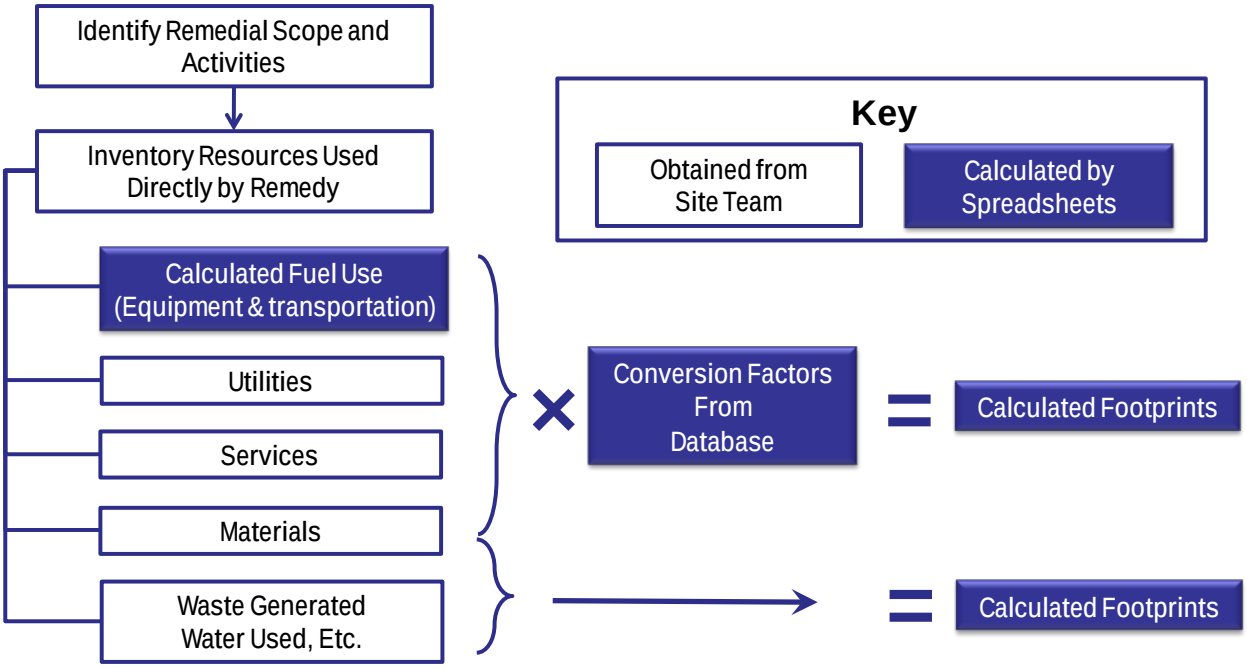
Sufficient information for each remedial alternative is necessary to quantify or inventory the use of energy, materials, and off-site services for implementing the alternative. For this study, the preliminary remedy design information is obtained from the Draft FFS. In some cases, the level of detail in the Draft Focused Feasibility Study is sufficient for the purpose of footprint analysis. For example, the Draft FFS provides an estimate of the total amount of granular activated carbon (GAC) that is needed for the P&T Alternative. In other cases, estimates or assumptions need to be made. For example, the Draft FFS mentions a canopy for the P&T system, but does not provide adequate information to note the type and quantity of materials required for the canopy. In these cases, estimates have been made.

Appendix A provides for each remedial option a printout of a set of spreadsheet modules that is used to document the remedy information and inventory the level of effort, fuel, electricity, water, and materials usage. The printouts include a more detailed description of the remedies. The inventory files provided in Appendix A include the assumptions and information used to convert remedy activities into services, materials, or energy use.

1.6 METHODOLOGY

The process of footprint analysis involves gathering relevant site information and converting that information into measured values for the green remediation parameters. In some cases, the site information is simply organized and tallied (e.g., quantity of specialty materials used), and other cases, remedy conversion factors are used to convert remedy parameters into green remediation parameters (e.g., drill rig operation into diesel use and diesel use into nitrogen oxide emissions. The calculations are generally facilitated by spreadsheets specifically designed for this purpose. The general process is illustrated in Figure 1.

Figure 1. Footprint Process



For this project, a series of spreadsheets are used to help inventory the materials and activities and use conversion factors to calculate the footprints. The input spreadsheets are in Appendix A, the conversion factors are in Appendix B, and the spreadsheet calculations and output are in Appendix C.

Where possible, publicly-available databases are used to obtain the footprint conversion factors used in this study so that the information is readily available for confirmation and use by others. The following publicly-available databases are the primary sources of information for this study:

- The U.S. Dept. of Energy, National Renewable Energy Laboratory (NREL), Life-Cycle Inventory Database (NREL LCI) available at www.nrel.gov/lci and maintained by the Alliance for Sustainable Energy

- European Reference Life Cycle Database (EUROPA ECLD), version II compiled under contract on behalf of the European Commission - DG Joint Research Centre - Institute for Environment and Sustainability with technical and scientific support by JRC-IES from early 2008 to early 2009 available at http://lca.jrc.ec.europa.eu/lcainfohub/datasetArea.vm

It is recognized that the life-cycle data developed for Europe may not translate directly to materials manufactured in the United States, but it is assumed that the manufacturing practices are similar and that the life-cycle inventory values reasonably represent those associated with activities in the United States, especially given that the life-cycle databases are based on average values from multiple manufacturing facilities. The information from these databases typically includes environmental footprints from resource extraction through the production of material. The information, however, is not specific to the form of the material. For example, the databases include the footprints for manufacturing of steel and PVC resin beginning at resource extraction, but do not include the specific footprints for manufacturing steel fencing, steel pipe, PVC pipe, or PVC liner.

Conversion factors for some items and services were not available from the life-cycle data resources used, such as potassium permanganate, sodium thiosulfate, granular activated carbon, and laboratory analyses. The study team used professional judgment to estimate these conversion factors. Refer to Appendix B for additional information.

2.0 RESULTS AND ANALYSIS

2.1 FOOTPRINT RESULTS AND ANALYSIS

The following table provides the total or global footprint results (e.g., on-site plus off-site) based on the spreadsheet input in Appendix A and the output in Appendix C.

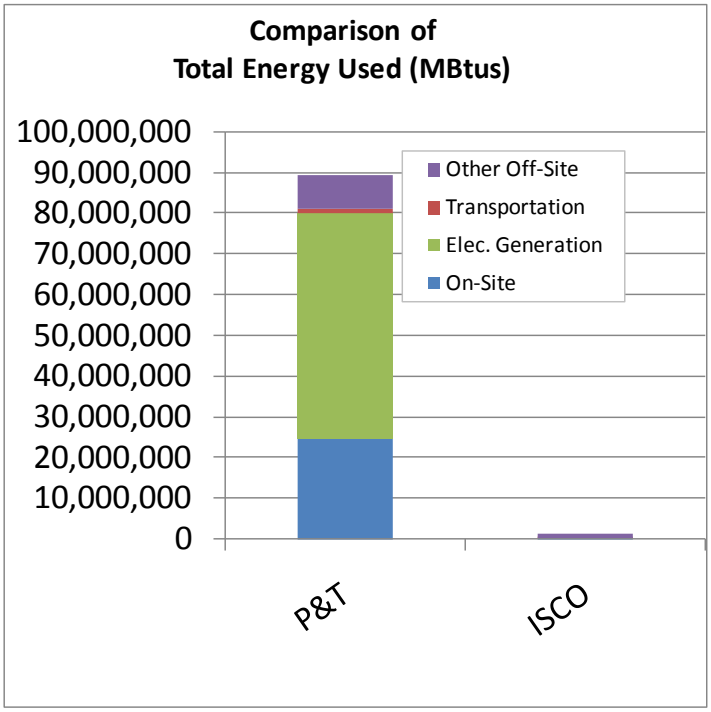
	Unit	P&T	ISCO
GSR Parameter			
Energy			
Total Energy Used	Mbtu	89,086,011	1,109,998
% of Energy from Renewable Resources	%	0%	0%
Air Quality			
Global Warming Potential	lbs CO2e	19,267,326	181,425
Criteria Pollutant Emissions	Lbs	185,994	1,375
Hazardous Air Pollutant Emissions	Lbs	5,271	14
Water (see Table 2)			
Potable Water Used	1000 x gal	0	0
Other Water Used with Reduction in Quality	1000 x gal	45	16.5
Materials & Waste			
Quantity of Refined Materials Used	Lbs	117,000	13,471
% Refined Materials from Recycling/Reuse	%	25%	<1%
Quantity of Unrefined Materials Used	Tons	180	1.4
% Unrefined Materials from Recycling/Reuse	%	0%	0%
Quantity of Non-Hazardous Waste	Tons	73	16.5
Quantity of Hazardous Waste	Tons	Negligible	negligible
% of Total Potential Waste Recycled or Reused	%	0%	0%
Land & Ecosystems			
Destruction of Existing Ecosystem Services	Varies	None	None

The results for each of the parameters are discussed in the following sections.

2.1.1 TOTAL ENERGY USED

The total energy used for the P&T alternative is more than 90 times higher than that of the ISCO alternative. Chart 1 illustrates that a large portion of the energy usage for the P&T alternative is associated with electricity generation and on-site energy use. Electricity generation refers to the energy lost as waste heat in the electricity generation process at the power plant, and in this case, much of the on-site energy represents the on-site use of electricity. Other more minor sources of on-site energy use would be diesel fuel combustion associated with on-site drilling. The large majority of energy used in association with the P&T alternative is therefore for electricity use. Further analysis also reveals that much of the transportation energy usage is the "transportation" of electricity through utility transmission lines, which further increases the electricity component of the total energy footprint. More information is available in Appendix C for the breakdown of energy usage. Because GAC is used for treating the water (rather than air stripping), most of the electricity is simply for extracting the water, pumping it through the GAC units, and discharging the water. For reference, the GAC production, regeneration, and transportation contribute less than 1% of the total energy footprint for the P&T alternative.

Chart 1



"Total" refers to on-site plus off-site footprint for the life-time of the remedies.

2.1.2 % OF ENERGY FROM RENEWABLE RESOURCES

None of the energy used in either of the remedy alternatives is from renewable resources. No biofuels are used and the references for the electricity generation mix (see Appendix B) indicate that the electricity from Tucson Electric Power is predominantly from coal and natural gas combustion.

2.1.3 GLOBAL WARMING POTENTIAL

The results for global warming potential closely mimic the results for total energy used, which is expected given the use of coal and natural gas to produce electricity and the close relationship between fossil fuel production and greenhouse gas emissions. See the Supplemental Charts section or Appendix C for more information.

2.1.4 Criteria Pollutant Emissions

The results for criteria pollutant emissions closely mimic the results for total energy used, which is expected given the use of coal and natural gas to produce electricity and the close relationship between fossil fuel production and criteria pollutant emissions. See the Supplemental Charts section or Appendix C for more information.

2.1.5 Hazardous Air Pollutant Emissions

The results for hazardous air pollutant emissions closely mimic the results for total energy used. This is due to the release of hazardous air pollutants during coal combustion, which provides over 90% of the fuel source for electricity production by the site's electricity provider. See the Supplemental Charts section or Appendix C for more information.

2.1.6 Potable Water Used

Neither remedy uses an appreciable amount of potable water.

2.1.7 Other Water Resources Used On-Site with a Reduction in Quality

In both cases, other water used is primarily the result of extracted groundwater that is discharge to the sanitary sewer for treatment by the publicly-owned treatment works (POTW). For the both alternatives, groundwater extraction during remedy operation is reinjected, which returns the water to its original location. However, during well installation in the P&T alternative, over 60,000 gallons is extracted and hauled to the POTW for treatment. The extracted water, which could theoretically be treated and used for beneficial purposes, is blended with sewage. Even after treatment by the POTW, the water would not be expected to be used for a beneficial purpose. For the ISCO alternative, substantially less water is extracted during well development. Most of the extracted water that is not reinjected is purge water from groundwater sampling that is similarly treated off-site. As a note, the P&T alternative includes an option for on-site treatment and reinjection of the purge water.

2.1.8 Quantity of Refined Material Used and % from Recycling/Reuse

For the P&T alternative, these materials include GAC for water treatment plus steel, PVC, and HDPE associated with the treatment plant construction. More materials are likely used but are difficult to track and are not considered. The following table items the various refined materials used.

Refined Material	**Mass (lbs)**	
	Virgin Material	**Recycled Material**
Cement grout	22,000	0
Cement portion of concrete	48,000	0
GAC (virgin and regenerated)	4,400	21,700
HDPE	1,500	0
PVC	5,700	0
Steel	4,100	7,600
Totals	**87,700**	**29,300**
Percentage from Recycled Materials	**25%**	

Assumptions:

- *GAC includes 4,000 lbs of virgin GAC in delivered GAC vessels, plus 24,100 lbs of "regenerated" GAC during system operation. The 24,100 lbs of regenerated GAC includes 10% virgin material (2,400 lbs) as make up material for GAC lost in the regeneration process (based on typical vendor descriptions)*
- *Excluding mass associated with water, concrete is assumed to be approximately 17% cement and 83% aggregate (based on approximate values provided by a Portland Cement Association fact sheet).*
- *Steel is assumed to consist of approximately 65% recycled content based on an approximate average of recycle content of steel from electric arc furnaces and basic oxygen furnaces provided by the American Iron and Steel Institute)*

For the ISCO alternative, the materials include potassium permanganate and sodium thiosulfate plus steel, PVC, and HDPE associated with the well installation and injection system.

Refined Material	**Mass (lbs)**	
	Virgin Material	**Recycled Material**
Cement grout	18,800	0
HDPE	1,000	0
Steel	38	70
PVC	930	0
Potassium permanganate	11,902	0
Sodium thiosulfate	550	0
Totals	**13,401**	**70**
Percentage from Recycled Materials	**<1%**	

Assumptions:

- *Steel is assumed to consist of approximately 65% recycled content based on an approximate average of recycle content of steel from electric arc furnaces and basic oxygen furnaces provided by the American Iron and Steel Institute)*

2.1.9 Quantity of Unrefined Materials Used and % from Recycling/Reuse

Sand and gravel used for the well sand packs and for concrete aggregate account for all of the unrefined materials used in both remedial alternatives, and it is assumed that none of it is from recycled or reused material.

2.1.10 Quantity of Non-Hazardous Waste

All tracked non-liquid waste associated with the project is drill cuttings from well installation. The extraction wells and injection wells associated with the P&T alternative are substantially larger in diameter than the monitoring wells and injection wells for the ISCO alternative resulting in higher waste generation for the P&T alternative.

2.1.11 Quantity of Hazardous Waste

The project team assumes that the all drilling derived waste is non-hazardous. A relatively small amount of hazardous waste (less than 50 pounds) was generated off-site as part of the manufacturing of materials used by the remedy.

2.1.12 % of Total Potential Waste that is Recycled or Reused

The primary waste source is drilling derived waste, and at this stage of the remedy process, the site team assumes the waste will be disposed of at a landfill and not productively reused elsewhere.

2.1.13 Destruction of Ecosystem Services

The remedy is occurring in a former industrial park adjacent to the Tucson International Airport. Therefore, ecosystems and ecosystem services (such as erosion control, nutrient uptake, etc.) are not present and are not affected by the remedy.

2.2 Footprint Contributors

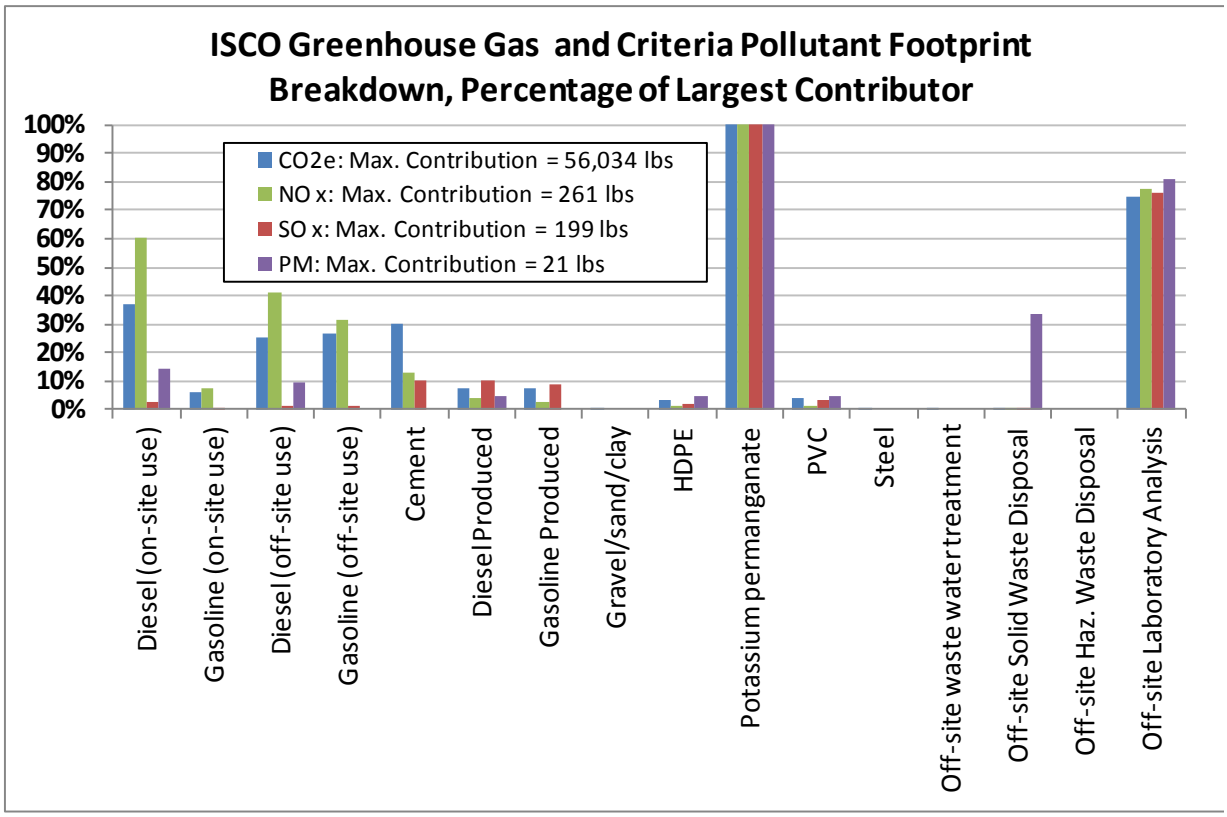
2.2.1 P&T Footprint Contributors

The primary contributors to the various green remediation parameters have been discussed for the P&T alternative in the previous section because electricity generation, transmission, and use are the dominant contributors for that remedy alternative.

2.2.2 ISCO Footprint Contributors

Chart 2 illustrates the various contributors to the air quality parameters, and the distribution of contributions closely matches the distribution of energy usage. Chart 2 shows that the potassium permanganate manufacturing is the largest contributor to these parameters but that laboratory analysis, on-site diesel use (for equipment operation), and off-site diesel use (for equipment/material transportation) are also large contributors. Off-site gasoline usage for personnel transport and cement grout manufacturing for well sealing are also significant contributors. Solid waste disposal (i.e., the activities at the landfill and not the transportation to the landfill) is a significant source of particulate matter.

Chart 2



Potassium permanganate includes 550 pounds of potassium permanganate that serve as a surrogate material for 550 pounds of sodium thiosulfate.

2.3 Sensitivity Analysis

2.3.1 Sensitivity to Individual Items

The remedy alternatives are most sensitive to changes in the largest contributors. For the P&T alternative, this includes electricity usage with respect to energy and air quality parameters. It also includes well development water and how it is handled for water resource parameters. For the ISCO alternative, the analysis is sensitive to many factors as discussed below.

- Energy and air quality parameters are sensitive to the following remedy components in order of importance:
  - Potassium permanganate use
  - Laboratory analysis
  - Off-site diesel use (for transportation) and corresponding diesel production
  - On-site diesel use (for equipment operation) and corresponding diesel production
  - Off-site gasoline use (for personnel transportation) and corresponding gasoline production
  - Cement for grout to seal the wells

- Water use parameters are most sensitive to the quantity and handling of sampling purge water
- Materials parameters are most sensitive to chemicals usage

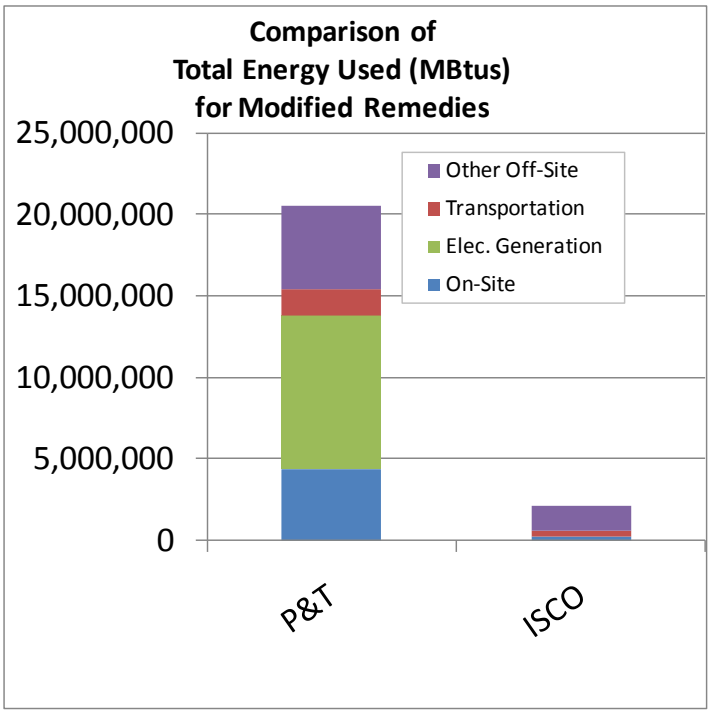
2.3.2 Sensitivity to Modified Remedy Assumptions

Another method of evaluating sensitivity of the analysis is to conduct footprint analyses of reasonably modified remedies and evaluate if the original conclusions change. To conduct this type of analysis, the following reasonable modifications are considered.

- P&T – The Draft FFS appears to conservatively overestimate the electricity usage for P&T operation. Extraction of 80 gpm from a depth of approximately 100 feet, pumping through GAC units, and reinjection is estimated to require approximately 45 HP of pumps and motors. These pumping requirements and control board cooling could likely be accomplished with approximately 17% of this estimated power requirement, especially given that the motors are controlled with variable frequency drives. Similarly, the Draft FFS estimates that at an extraction rate of 40 gpm, approximately 35 HP of pumps and motors are required. Again, it is estimated that these pumping requirements and control board cooling could be achieved for approximately 17% of this estimated power requirement. For sensitivity analysis purposes, assume that the remedial parameters are the same but that 17% of the electrical usage estimated in the Draft FFS is used..

- ISCO – The Draft FFS estimates that a single injection event followed by recirculation is adequate to allow MNA to occur for the source area. For sensitivity analysis purposes, assume that three injection events are required.

Chart 3



"Total" refers to on-site plus off-site footprint for the life-time of the remedies.

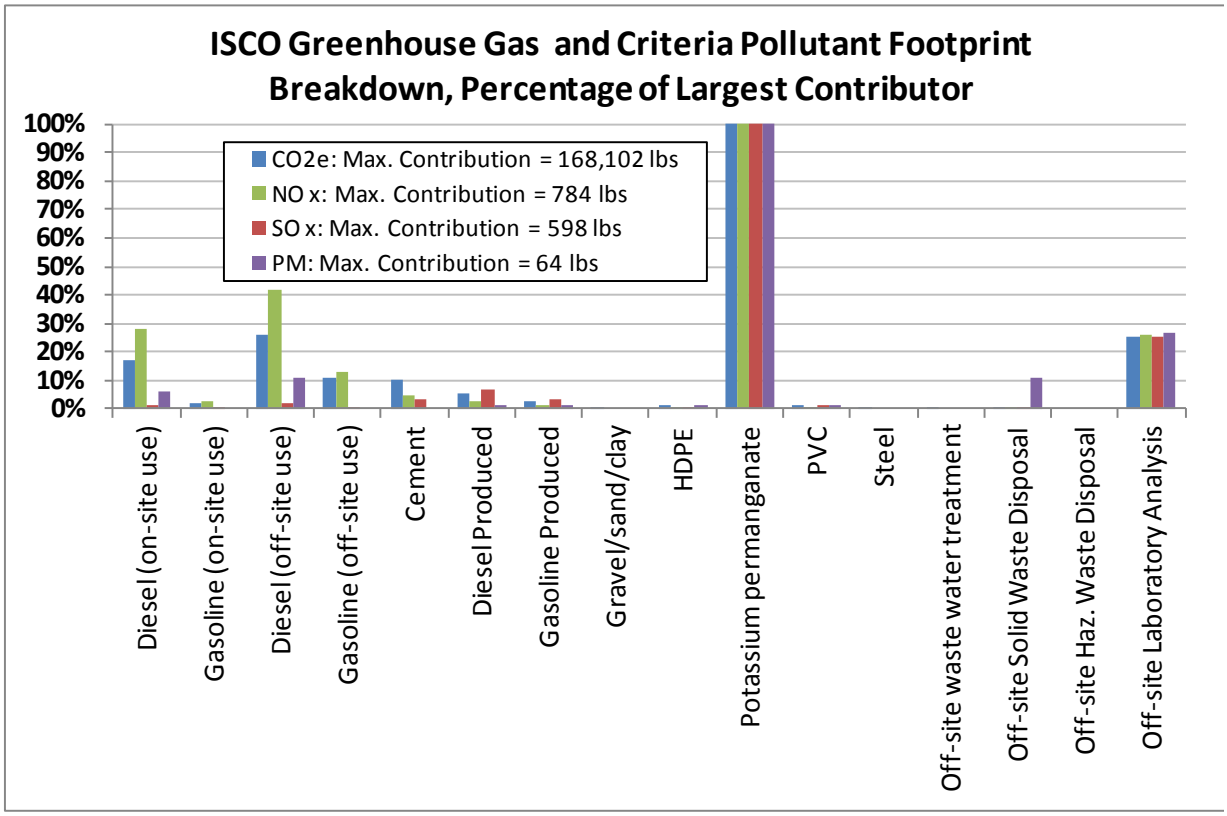
Chart 3 illustrates the breakdown of energy footprints for the two modified remedies. Even under these conditions of decreasing the electricity usage of the P&T remedy and tripling the number of injection events for the ISCO remedy, the energy footprint for the P&T alternative still exceeds the energy footprint of the ISCO alternative by approximately a factor of 10. The air quality parameters would have similar results, and the water resource parameters and waste parameters

would remain unchanged from the original analysis. The results would change for the refined materials usage because all materials would remain the same except the amounts of potassium permanganate and sodium thiosulfate would triple.

Based on the above analysis, it is reasonable to conclude that the ISCO alternative has a substantially lower footprint than the P&T alternative by a relatively wide margin.

Chart 4 illustrates the contributors to the air quality parameters for the increased-scope ISCO alternative. Comparing Chart 4 with Chart 3, it is apparent with more chemical injections that the contributions from well installation and laboratory analysis are smaller relative to the potassium permanganate contributions.

Chart 4



Potassium permanganate includes 1,650 pounds of potassium permanganate that serve as a surrogate material for 1,650 pounds of sodium thiosulfate.

3.0 CONCLUSIONS AND RECOMMENDATIONS

The conclusions and recommendations discussed here are specific to the West-Cap site and the two discussed remedy alternatives.

3.1 CONCLUSIONS REGARDING THE P&T ALTERNATIVE

- The water table at the West-Cap site is relatively deep (approximately 100 feet below ground surface) and the energy requirements to lift that water are substantial.

- The energy and emissions footprints associated with treatment plant construction are negligible compared to the footprint associated with operating the treatment plant. The water footprint and materials footprints, however, are comparable between the construction and O&M phases. Although various fittings, piping, valves, wiring, and controls were not included in the materials for this footprint analysis, including them would not have changed the outcome of the energy and emissions footprints but could have changed the materials footprint.

- Due to the substantial use of electricity for the P&T remedy, renewable energy could be used to offset the air quality parameters associated with this remedy. This renewable energy could be in the form of an on-site renewable energy system or purchased renewable energy (e.g., renewable energy certificates). If renewable energy was applied to the site, the global warming potential footprint of the P&T alternative could be reduced to as little as 1,200,000 lbs of CO2e (still more than a factor of three higher than an ISCO remedy that involves three injection events). Although the renewable energy would offset the air emissions and increase the percentage of remedy energy that is from renewable resources, the total energy usage for the remedy would still be very high.

- A substantial amount of water is generated during development of the injection and extraction wells. Given this large volume it may be practical to provide on-site treatment followed by reinjection or nearby beneficial use.

- Use of regenerated GAC substantially reduces the raw materials required for refined materials use and increases the % of refined materials from recycling/reuse. Because of this recycling only 10,700 pounds of virgin GAC are used for the remedy (4,000 pounds associated with the procurement of the GAC units and 6,700 pounds as make-up GAC after regeneration).

- Use of native fill for trench bedding, if appropriate, would substantially reduce the use of unrefined materials at the site and the truck transportation associated with hauling the sand/gravel.

- If the drill cuttings are not hazardous (as is assumed in the Draft FFS), land application of the drill cuttings at the site would substantially reduce the amount of waste from the remedy that would otherwise be landfilled.

3.2 CONCLUSIONS REGARDING THE ISCO ALTERNATIVE

- The use of an in-situ remedy at this site results in substantial energy savings and air emission reductions relative to a P&T system because it avoids the energy/electricity usage associated with extracting large volumes of water. Even multiple injection events would result in footprint reductions relative to the historic and presumptive P&T remedy.

- Although there are significant footprint contributions from installing permanent injection wells, the use of permanent injection wells allows for additional injection events without the added footprint of remobilizing of drilling or direct-push equipment.

- Potassium permanganate manufacturing is the largest contributor to the energy, air quality, and refined materials footprints. Reductions in the remedy footprint would result if the potassium permanganate usage can be lowered without sacrificing effectives. However, reducing the potassium permanganate usage could potentially result in extending the duration of the remedy and monitoring period, which could increase the overall footprint.

- Laboratory analysis is a significant contributor to the remedy footprint. Efforts to minimize the monitoring period could result in significant footprint reduction. In addition, the remedy team could consider requesting the laboratory that analyzes the samples use renewable energy.

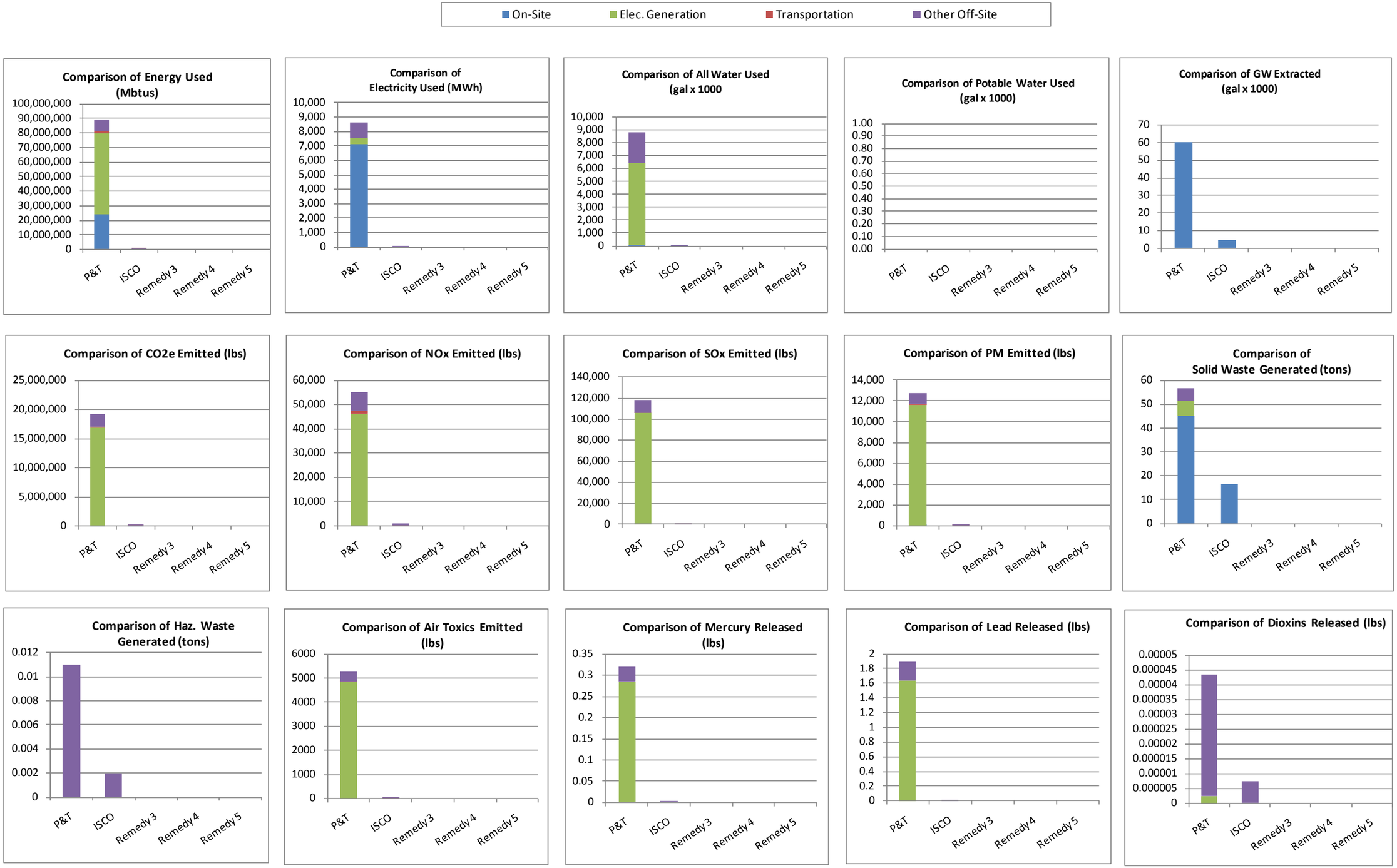
- In the absence of a treatment system, the purge water from sampling requires off-site disposal. The site team could consider an approach of adding potassium permanganate to the purge water and reinjecting the resulting potassium permanganate solution into the injection wells to eliminate the need for containerization and off-site disposal.

- A 25 kW generator may be oversized for the pumping and mixing requirements associated with the injection event. Fuel efficiency of generators at low load is generally lower. Optimally sizing the generator could result in some fuel savings.

SUPPLEMENTAL CHARTS

(Note: "All Water" in the Supplemental Charts includes water used in the generation of electricity and manufacturing of material. Mercury, lead, and dioxin emissions in the Supplemental Charts refers to releases of these contaminants to air or water from off-site activities. These parameters are calculated by the spreadsheets used for this analysis, but are not discussed in the report.)

TIAA West-Cap, Tucson – Parameter Footprints by Remedy Phase



APPENDIX A

REMEDY INVENTORY SHEETS

REMEDY INVENTORY SHEETS

The remedy information for each remedy alternative is entered into a set of spreadsheet modules that documents these remedy parameters and calculates the level of effort, fuel, electricity, water, and materials usage to implement the remedy. The set of spreadsheet modules is sufficiently flexible to use for other remedial alternatives or for other sites. Modules can be added for various remedy components, and more modules can be added to the spreadsheet file as long as the summary tables at the end of the spreadsheet are linked to the new modules.

TIAA West Cap Project Area Footprint Analysis
Green Remediation - Inventory of Energy, Material, Waste, and Other Remedy Aspects
Remedy Conceptual Design and Assumptions:
Alternative A - P&T

Overview

Construct and operate a pump and treat (P&T) system. Utilize exisiting extraction wells to extract up to approximately 80 gpm. The treatment system will consist of a concrete pad, canopy, fencing, two 2000-lb GAC vessels, transfer pump, discharge pumps, three tanks used for equalizing flow of influent and treated water, and system controls. Three injection wells and associated piping will be installed for reinjecting the treated water to the subsurface. Pumps are controlled with variable frequency drives. There are two phases of system operation. The first phase is assumed to operate for 4 years with an extraction rate of 80 gpm. The second phase is assumed to operate for 26 additional y ears with an extraction rate of 40 gpm. Process water sampling and groundwater sampling are considered.

	White cells are for manual data input
	Yellow cells are for manual data input from a drop-down list of selections and are protected
	Blue cells are calculated cells that are protected

Instructions

1. Enter site or project name on row three of this tab.
2. Enter remedy name on row six of this tab.
3. Enter site and remedy description on row nine of this tab.
4. Copy the template tab and rename as a specific activity (e.g., O&M) on tab label and on row six of the tab.
5. Enter activity-specific information into the white and yellow cells on the copied/renamed tab.
6. Repeat steps 4 through 5 as needed for up to a total of 15 activities/tabs.
7. In cells E6 to S6 of the Summary tab, enter the names of the activity tabs from steps 4 through 6 (one name per cell).
8. In cells E4 to S4 of the Summary tab, enter the number (1 to 6) corresponding to the Level of the activity named in the corresponding cell in Row 6. For example, if the analysis defines Level 1 as construction, and the activities named in E6, F6, and G6 are all related to construction, then enter the number 1 in E4, F4, and G4.

Information from the activity tabs is compiled and summarized in the Summary tab. Some of the blue (calculated) cells of the activity tabs refer to the Lookup tab for conversion factors and default values. Each section of the activity tabs include white cells only if user override values are preferred instead of the default values from the Lookup tab.

All of the activities for a particular remedy to be included n the footprint analysis should be included in a single inventory spreadsheet. The spreadsheets are organized so that each remedy or remedy alternative has its own inventory spreadsheet.

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This workbook is designed to assist EPA Region 9 with conducting footprint analyses and to help EPA Region 9 better understand the process of footprint quantification for environmental remedies. The workbook does not represent EPA guidance, requirements, or suggestions with respect to footprint quantification. The workbook is in draft status as of March 2011, and is intended for use only EPA Region 5 and EPA Region 9 for testing purposes. For more information about this draft template and footprint analyses at clean-up sites, contact:

Karen Scheuermann (EPA Region 9) at scheuermann.karen@epa.gov or Carlos Pachon (EPA OSRTI) at pachon.carlos@epa.gov.

Input for *Construction*

General Scope	***Typical Scope Items***	***Useful Information***
- Install three 12-inch SCH 80 injection wells (18-inch boreholes), 150 feet deep, 50 feet of screen - non-haz drill cuttings - Install a total of 850 feet of 2-inch schedule 40 PVC conveyance piping - Install LGAC units, building, and fence - Commission system	- Distances for personnel, material, and equipment transportation are reasonble estimates and are not based on specific locations. - two skid-mounted 2,000-lb LGAC units with 4,000 lbs of virgin GAC - 3 HP transfer pump, two 5 HP discharge pumps (one is an alternate), 0.75 HP sump pump - 4 stainless steel dual housing filter bags each rated for 200 gpm - three 2,500 gallon polyethylene tanks - concrete pad and chain-linked fence	- SCH 80 2-inch pipe, 0.94 lbs per foot - SCH 80 12-inch pipe, 16.5 lbs per foot - 1inch 2stainless steel well screen, 14.5 lbs per foot - cement 94 lbs per cubic foot, slurry = 15 lbs per gal (94 lbs cement, 6 gal water) - sand/gravel = 1.5 tons per cubic yard - concrete, 145 lbs per cubic 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
Driller	3	9	8	216								Vehicle transport under equipment section, 3 days of work per well
Construction contractors	4	30	8	960	240	40	Light-Duty Truck	Gasoline	9600	15	640	Crew travels to site daily in two pickup trucks. Local contractor
Oversight	1	54	8	432	54	20	Light-Duty Truck	Gasoline	1080	15	72	
Well development	1	15	8	120	15	20	Light-Duty Truck	Gasoline	300	15	20	One crew member, one week per well. Local travel from a hotel or local facility
Commissioning	1	10	8	80	10	30	Light-Duty Truck	Gasoline	300	15	20	Two weeks of daily trips from a hotel or lcoal office.
Long-distance travel					17	200	Light-Duty Truck	Gasoline	3400	15	226.7	Long-distance travel for oversight and commissiong consultant. Above travel is from

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
Drilling - large rig (e.g., CME-75)	200	0.75	Diesel	7.65	54	413.1	1	200	200	Diesel	7.2	27.8	drill rig for installation of six wells, 6 hours per well
Excavator (medium)	100	0.57	Diesel	2.907	48	139.536	1	40	40	Diesel	7.2	5.6	excavator for piping installation
Integrated tool carrier	50	0.43	Diesel	1.0965	24	26.316	1	40	40	Diesel	7.2	5.6	installation of treatment plant equipment
Telescopic handler	50	0.43	Diesel	1.0965	24	26.316	1	40	40	Diesel	7.2	5.6	installation of treatment plant equipment

Electricity Usage

Equipment Type	HP	% Full Load	Efficiency	Electrical Rating (kW)	Hours Used	Energy Used (kWh)	Notes
Equip. with kW rating							
Equip. with kW rating							
Direct kWh info.							
			Totals	0		0	

Cells shaded in dark gray are not relevant to the equipment types noted

"Direct kWh info" refers to total electricity usage calculated or provided elsewhere (e.g., an electric meter).

Natural Gas Usage

Equipment Type	Power Rating (btu/hr)	Efficiency	Total Hours Used	Btus Required	Total Therms Used	Notes
		Totals		0	0	

If heat load is known instead of unit power rating, then enter power rating as 125% of heat load and choose 80% for efficiency.

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Input for *Construction*

Materials Usage

Material Type	Unit	Quantity	Site-Spec. One-Way Distance (miles)*	Number of Trips	Total One-Way Miles	Mode of Transport.	Fuel Type	Fuel Use Rate (mpg or gptm)	Total Fuel Use	Notes
Steel	lbs	900		1	500	Truck Light Load (gptm)	Diesel	0.024	5.4	engineering estimate
Steel	lbs	500		1	500	Truck Heavy Load (gptm)	Diesel	0.011	1.4	building canopy (estimated)
Steel	lbs	5700		1	500	Truck Heavy Load (gptm)	Diesel	0.011	15.7	rebar for concrete (#4 rebar, 6" x 6")
Steel	lbs	3600		1	500	Truck Light Load (gptm)	Diesel	0.024	21.6	GAC vessels, estimated
Steel	lbs	1000		1	500	Truck Light Load (gptm)	Diesel	0.024	6	Vault doors for wells, estimated
Concrete	tons	140		7	210	Truck C (15+ tons)	Diesel	5.92	35.5	12-in pad (50 x 35 feet) and 2-ft berm
PVC	lbs	5700		1	1000	Truck Light Load (gptm)	Diesel	0.024	68.4	Well casing and pipe
Gravel/sand/clay	tons	64		4	120	Truck C (15+ tons)	Diesel	5.92	20.3	Sand pack for 3 wells 100-150 ft interval
Cement	tons	11		1	500	Truck B (5-15 tons)	Diesel	7.2	69.4	Grout for three wells 0-100 ft interval
Stainless steel	lbs	2200		1	500	Truck Light Load (gptm)	Diesel	0.024	13.2	well screen (150 feet total)
HDPE	lbs	1500		1	1000	Truck Light Load (gptm)	Diesel	0.024	18	estimate
GAC: virgin coal-based	lbs	4000		1	1000	Truck B (5-15 tons)	Diesel	7.2	138.9	initial GAC
										Materials for pumps, bag filters, and
										other process components not included
			Empty Return Trips	12	1330	**Truck A (< 5 tons)**	Diesel	8.5	156.5	assumed for concrete, sand, & GAC only

** Leave site-specific one-way miles blank if value is not known and a default will be used for*

Fuel Use Rate reported in miles per gallon (mpg) and gallons per ton-mile (gptm)

Laboratory Analysis

Parameter and Notes	Unit Cost	Number of Samples	Total Cost
VOCs			0
SVOCs			0
PCBs/Pesticides			0
Metals			0
Other			0
Other			0
Other			0
Other			0
Other			0
Other			0
	Totals	**0**	**0**

Waste Generation

Waste Type	Unit	Quantity	Site-Spec. One-Way Distance (miles)	Number of Trips	Total One-Way Miles	Mode of Transport.	Fuel Type	Fuel Use Rate	Total Fuel Use	Notes
Non-hazardous landfill	tons	45		3	75	Truck C (15+ tons)	Diesel	5.92	12.7	drill cutting waste in roll-off bins
Hauled to POTW	tons	250.2		10	500	Truck C (15+ tons)	Diesel	5.92	84.5	60,000 gallons of well development water
	tons									
	tons									
	tons									
			Empty Return Trips			**Truck A (< 5 tons)**				

** Leave site-specific one-way miles blank if value is not known and a default will be used for calculating total-one way miles*

gptm = gallons per ton-mile

On-Site Water Usage (1000 x gallons)

Resource Type	Quantity	Use of Resource
Extracted GW #1	60	well development water
Water table drawdown (ft)		

Fate of On-Site Water Usage (1000 x gallons)

Discharge Location	Notes
Discharge to POTW	

If potable water is trucked to site, use "potable water" in materials section to calculate fuel use. Only the potable water use from the On-Site Water Use Section will be input into the Summary tab. It is assumed that the quantity of potable water in the Materials section is accounted for in in the On-Site Water Use Section.

Miscellaneous Emissions and Reductions

Item	Quantity	Activity or Notes
Other HAP emissions		
Other GHG emissions		
Other GHG reductions		
Other NOx reductions		
Other SOx reductions		
Other PM reductions		

On-Site Renewable Energy Generation

Item	Quantity	Activity or Notes
Photovoltaic (kWh)		
Renewable Energy #1 (kWh)		
Renewable Energy #2 (kWh)		

Purchased Renewable Energy (including Renewable Energy Certificates "RECs")

Item	Quantity	Activity or Notes
Purchased from Utility (kWh)		
RECs (kWh)		

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Input for *O&M*

General Scope	***Typical Scope Items***	***Useful Information***
- Phase 1 - 2 extraction wells at a total of 80 gpm for 4 years - Phase 2 - 1 extraction well at 40 gpm for 26 more years - Regenerate 2,500 lbs of GAC every 5 months for Phase 1 - Regenerate 2,500 lbs of GAC every 18 months for Phase 2 - Semi-monthly sampling of influent, mid-GAC, effluent, and three QA/QC samples (144 samples per year)	Distances for personnel, material, and equipment transportation are reasonble estimates and are not based on specific locations.	- 3 HP transfer pump and 5 HP discharge pump operating at 80% load and 75% efficiency - 0.75 HP sump pump

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
Operator	1	1560	8	12480	1560	30	Light-Duty Truck	Gasoline	46800	15	3120	Weekly maintence for system over 30 years

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
							Usage from FFS document
							294,073 kWh per year for 4 years
							228,724 kWh per year for 26 years
Equip. with kW rating							
Equip. with kW rating							
Direct kWh info.						7123116	
			Totals	0		7123116	

Cells shaded in dark gray are not relevant to the equipment types noted

"Direct kWh info" refers to total electricity usage calculated or provided elsewhere (e.g., an electric meter).

Natural Gas Usage

Equipment Type	Power Rating (btu/hr)	Efficiency	Total Hours Used	Btus Required	Total Therms Used	Notes
		Totals		0	0	

If heat load is known instead of unit power rating, then enter power rating as 125% of heat load and choose 80% for efficiency.

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Input for *O&M*

Materials Usage

Material Type	Unit	Quantity	Site-Spec. One-Way Distance (miles)*	Number of Trips	Total One-Way Miles	Mode of Transport.	Fuel Type	Fuel Use Rate (mpg or gptm)	Total Fuel Use	Notes
GAC: regenerated	lbs	5112		2	2000	Truck A (< 5 tons)	Diesel	8.5	235.3	GAC replacement for Phase 1
GAC: regenerated	lbs	18980		8	8000	Truck A (< 5 tons)	Diesel	8.5	941.2	GAC replacement for Phase 2
			Empty Return Trips	10	10000	**Truck A (< 5 tons)**	Diesel	8.5	1176.5	

** Leave site-specific one-way miles blank if value is not known and a default will be used for* *Fuel Use Rate reported in miles per gallon (mpg) and gallons per ton-mile (gptm)*

Laboratory Analysis

Parameter and Notes	Unit Cost	Number of Samples	Total Cost
VOCs	$90.00	4320	388800
SVOCs			0
PCBs/Pesticides			0
Metals			0
Other			0
Other			0
Other			0
Other			0
Other			0
Other			0
	Totals	**4320**	**388800**

Waste Generation

Waste Type	Unit	Quantity	Site-Spec. One-Way Distance (miles)	Number of Trips	Total One-Way Miles	Mode of Transport.	Fuel Type	Fuel Use Rate	Total Fuel Use	Notes
	tons									
	tons									
	tons									
	tons									
	tons									
			Empty Return Trips			**Truck A (< 5 tons)**				

** Leave site-specific one-way miles blank if value is not known and a default will be used for calculating total-one way miles* *gptm = gallons per ton-mile*

On-Site Water Usage (1000 x gallons) / ***Fate of On-Site Water Usage (1000 x gallons)***

Resource Type	Quantity	Use of Resource	Discharge Location	Notes
Extracted GW #1	0	extracted water reinjected to same aquifer	Reinjected to aquifer	
Water table drawdown (ft)				

If potable water is trucked to site, use "potable water" in materials section to calculate fuel use. Only the potable water use from the On-Site Water Use Section will be input into the Summary tab. It is assumed that the quantity of potable water in the Materials section is accounted for in in the On-Site Water Use Section.

Miscellaneous Emissions and Reductions

Item	Quantity	Activity or Notes
Other HAP emissions		
Other GHG emissions		
Other GHG reductions		
Other NOx reductions		
Other SOx reductions		
Other PM reductions		

On-Site Renewable Energy Generation

Item	Quantity	Activity or Notes
Photovoltaic (kWh)		
Renewable Energy #1 (kWh)		
Renewable Energy #2 (kWh)		

Purchased Renewable Energy (including Renewable Energy Certificates "RECs")

Item	Quantity	Activity or Notes
Purchased from Utility (kWh)		
RECs (kWh)		

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Input for *LTM*

General Scope	***Typical Scope Items***	***Useful Information***
- Phase 1 - semi-annual sampling of 26 wells for VOCs (4 years) - Phase 2 - semi-annual sampling of 26 wells for VOCs plus 5 wells annually for MNA parameters (26 years)	Distances for personnel, material, and equipment transportation are reasonble estimates and are not based on specific locations.	

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
Sampling crew	2	450	8	7200	450	20	Light-Duty Truck	Gasoline	9000	15	600	2-person sampling crew carpools, 2 events per year for 30 years. Travel from hotels.
Long-distance travel					90	200	Light-Duty Truck	Gasoline	18000	15	1200	Long-distance travel for sampling crew (once per week). Above travel is from hotel.

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
Other	3	0.5	Gasoline	0.0855	7200	615.6							gas powered generators or compressors carried to site in truck

Electricity Usage

Equipment Type	HP	% Full Load	Efficiency	Electrical Rating (kW)	Hours Used	Energy Used (kWh)	Notes
Equip. with kW rating							
Equip. with kW rating							
Direct kWh info.							
			Totals	0		0	

Cells shaded in dark gray are not relevant to the equipment types noted

"Direct kWh info" refers to total electricity usage calculated or provided elsewhere (e.g., an electric meter).

Natural Gas Usage

Equipment Type	Power Rating (btu/hr)	Efficiency	Total Hours Used	Btus Required	Total Therms Used	Notes
		Totals		0	0	

If heat load is known instead of unit power rating, then enter power rating as 125% of heat load and choose 80% for efficiency.

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Input for *LTM*

Materials Usage

Material Type	Unit	Quantity	Site-Spec. One-Way Distance (miles)*	Number of Trips	Total One-Way Miles	Mode of Transport.	Fuel Type	Fuel Use Rate (mpg or gptm)	Total Fuel Use	Notes
										Assume materials are negligible
										dedicated tubing and pumps
										gloves and protective equipment is limited
			Empty Return Trips			**Truck A (< 5 tons)**				

** Leave site-specific one-way miles blank if value is not known and a default will be used for*

Fuel Use Rate reported in miles per gallon (mpg) and gallons per ton-mile (gptm)

Laboratory Analysis

Parameter and Notes	Unit Cost	Number of Samples	Total Cost
VOCs	$90	1560	140400
SVOCs			0
PCBs/Pesticides			0
Metals			0
MNA Parameters	$150	130	19500
QA/QC 20% of total	$31,980	1	31980
Other			0
Other			0
Other			0
Other			0
	Totals	**1691**	**191880**

Waste Generation

Waste Type	Unit	Quantity	Site-Spec. One-Way Distance (miles)	Number of Trips	Total One-Way Miles	Mode of Transport.	Fuel Type	Fuel Use Rate	Total Fuel Use	Notes
	tons									
	tons									
	tons									
	tons									
	tons									assume purge water is discharged to
			Empty Return Trips			**Truck A (< 5 tons)**				P&T system

** Leave site-specific one-way miles blank if value is not known and a default will be used for calculating total-one way miles*

gptm = gallons per ton-mile

On-Site Water Usage (1000 x gallons) / ***Fate of On-Site Water Usage (1000 x gallons)***

Resource Type	Quantity	Use of Resource	Discharge Location	Notes
Extracted GW #1	0	purge water reinjected to same aquifer	Reinjected to aquifer	
Water table drawdown (ft)				

If potable water is trucked to site, use "potable water" in materials section to calculate fuel use. Only the potable water use from the On-Site Water Use Section will be input into the Summary tab. It is assumed that the quantity of potable water in the Materials section is accounted for in in the On-Site Water Use Section.

Miscellaneous Emissions and Reductions

Item	Quantity	Activity or Notes
Other HAP emissions		
Other GHG emissions		
Other GHG reductions		
Other NOx reductions		
Other SOx reductions		
Other PM reductions		

On-Site Renewable Energy Generation

Item	Quantity	Activity or Notes
Photovoltaic (kWh)		
Renewable Energy #1 (kWh)		
Renewable Energy #2 (kWh)		

Purchased Renewable Energy (including Renewable Energy Certificates "RECs")

Item	Quantity	Activity or Notes
Purchased from Utility (kWh)		
RECs (kWh)		

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Summary

Level		1	2	0	3	0	0	0	0	0	0	0	0	0	0	0	
Item		**Construction**	**O&M**	**O&M Alternate**	**LTM**												**Total**
Labor and Travel																	
Hours worked	(hrs)	1808	12480	8320	7200												**21488**
Heavy equip. operating hours	(hrs)	150	0	0	7200												**7350**
Passenger trips to site	(trips)	336	1560	1040	540												**2436**
Passenger vehicle miles	(miles)	14680	46800	31200	27000												**88480**
Heavy equip. trips to site	(trips)	4	0	0	0												**4**
Heavy equip. transport miles	(miles)	320	0	0	0												**320**
Materials transport trips	(trips)	33	20	54	0												**53**
Materials transport miles	(miles)	8160	20000	54000	0												**28160**
Waste transport trips	(trips)	13	0	0	0												**13**
Waste transport miles	(miles)	575	0	0	0												**575**
Energy																	
On-site																	
Gasoline	(gallons)	0	0	0	615.6												**615.6**
E85	(gallons)	0	0	0	0												**0**
Diesel	(gallons)	605.268	0	0	0												**605.268**
B20	(gallons)	0	0	0	0												**0**
Photovoltaic	(MWh)	0	0	0	0												**0**
Other Renewable Energy #1		0	0	0	0												**0**
Other Renewable Energy #2		0	0	0	0												**0**
Off-site																	
Gasoline	(gallons)	978.7	3120	2080	1800												**5898.7**
E85	(gallons)	0	0	0	0												**0**
Diesel	(gallons)	712.1	2353	6353	0												**3065.1**
B20	(gallons)	0	0	0	0												**0**
Total Fuel																	
Gasoline	(gallons)	978.7	3120	2080	2415.6												**6514.3**
E85	(gallons)	0	0	0	0												**0**
Diesel	(gallons)	1317.368	2353	6353	0												**3670.368**
B20	(gallons)	0	0	0	0												**0**
Electricity Demand	(kW)	0	0	8.969771429	0												**0**
Electricity Usage	(MWh)	0	7123.116	1218.58583	0												**7123.116**
Purchased Renewable Electricity	(MWh)	0															**0**
Natural gas usage	(therms)	0	0	0	0												**0**

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Summary

Level		1	2	0	3	0	0	0	0	0	0	0	0	0	0	0	
Item		**Construction**	**O&M**	**O&M Alternate**	**LTM**												**Total**
Materials																	
Asphalt	(tons)	0	0	0	0												**0**
Bentonite	(tons)	0	0	0	0												**0**
Borrow	(tons)	0	0	0	0												**0**
Cement	(tons)	11	0	0	0												**11**
Cheese whey	(lbs)	0	0	0	0												**0**
Concrete	(tons)	140	0	0	0												**140**
Emulsified vegetable oil	(lbs)	0	0	0	0												**0**
GAC: regenerated	(lbs)	0	24092	24092	0												**24092**
GAC: virgin coal-based	(lbs)	4000	0	0	0												**4000**
GAC: virgin coconut-based	(lbs)	0	0	0	0												**0**
Gravel/sand/clay	(tons)	64	0	0	0												**64**
HDPE	(lbs)	1500	0	0	0												**1500**
Hydrochloric acid (30%, SG = 1.18)	(lbs)	0	0	0	0												**0**
Hydrogen peroxide (50%, SG=1.19)	(lbs)	0	0	0	0												**0**
Hydroseed	(lbs)	0	0	0	0												**0**
Lime	(lbs)	0	0	0	0												**0**
Molasses	(lbs)	0	0	0	0												**0**
Nitrogen fertilizer	(lbs)	0	0	0	0												**0**
Other 1 - PV system	(W)	0	0	0	0												**0**
Other 2 - Mulch	(cy)	0	0	0	0												**0**
Other 3	()	0	0	0	0												**0**
Other 4	()	0	0	0	0												**0**
Other 5	()	0	0	0	0												**0**
Phosphorus fertilizer	(lbs)	0	0	0	0												**0**
Polymer	(lbs)	0	0	0	0												**0**
Potable water	(gals)	0	0	0	0												**0**
Potassium permanganate	(lbs)	0	0	0	0												**0**
PVC	(lbs)	5700	0	0	0												**5700**
Sequestering agent	(lbs)	0	0	0	0												**0**
Sodium hydroxide (20%, SG=1.22)	(lbs)	0	0	0	0												**0**
Stainless steel	(lbs)	2200	0	0	0												**2200**
Steel	(lbs)	11700	0	0	0												**11700**
Trees: root balls	(each)	0	0	0	0												**0**
Trees: whips	(each)	0	0	0	0												**0**
Waste																	
Non-hazardous landfill	(tons)	45	0	0	0												**45**
Hazardous landfill	(tons)	0	0	0	0												**0**
Recycling facility	(tons)	0	0	0	0												**0**
Hauled to POTW	(gals x 1000)	250.2	0	0	0												**250.2**
Incineration	(tons)	0	0	0	0												**0**
Location for reuse	(tons)	0															
Water Use																	
Potable water	(gals x 1000)	0	0	0	0												**0**
Extracted GW #1	(gals x 1000)	60	0	0	0												**60**
Extracted GW #2	(gals x 1000)	0	0	0	0												**0**
Surface water	(gals x 1000)	0	0	0	0												**0**
Reclaimed water	(gals x 1000)	0	0	0	0												**0**
Stormwater	(gals x 1000)	0	0	0	0												**0**

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Summary

Level		1	2	0	3	0	0	0	0	0	0	0	0	0	0	0	
Item		**Construction**	**O&M**	**O&M Alternate**	**LTM**												**Total**
Water Discharge																	
Discharge to surface water	(gals x 1000)	0	0	0	0												**0**
Reinjected to aquifer	(gals x 1000)	0	0	0	0												**0**
Discharge to POTW	(gals x 1000)	60	0	0	0												**60**
Discharge to atmosphere	(gals x 1000)	0	0	0	0												**0**
Public Use	(gals x 1000)	0	0	0	0												**0**
Irrigation	(gals x 1000)	0	0	0	0												**0**
Industrial process water	(gals x 1000)	0	0	0	0												**0**
Other beneficial use	(gals x 1000)	0	0	0	0												**0**
Laboratory Analysis																	
Total samples	(samples)	0	4320	2880	1691												**6011**
Total cost	($)	0	388800	259200	191880												**580680**
Other																	
Other HAP emissions	(lbs)	0	0	0	0												**0**
Other GHG emissions	(lbs)	0	0	0	0												**0**
Other GHG reductions	(lbs)	0	0	0	0												**0**
Other NOx reductions	(lbs)	0	0	0	0												**0**
Other SOx reductions	(lbs)	0	0	0	0												**0**
Other PM reductions	(lbs)	0	0	0	0												**0**

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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
- E85 efficiences 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 efficiences 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 efficiences 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)
- Diesel airplane, bus, and train efficiences 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.

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 considerd "other general industrial equipment".

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Lookup Table (continued)

Materials	Units	Conv. to tons	Default One-Way Distance from Source to Site (miles)
Asphalt	tons	1	30
Bentonite	tons	1	1000
Borrow	tons	1	30
Cement	tons	1	500
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	1,000
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
Other 2 - Mulch	cy	0.54	0
Other 3			0
Other 4			0
Other 5			0
Phosphorus fertilizer	lbs	0.0005	500
Polymer	lbs	0.0005	1000
Potable water	gals	0.00417	25
Potassium permanganate	lbs	0.0005	1000
PVC	lbs	0.0005	1000
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	Default One-Way Distance (Miles)	Notes
Hauled to POTW	50	
Hazardous landfill	500	
Incineration facility	50	
Location for reuse	50	
Non-hazardous landfill	25	
Recycling facility	100	

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TIAA West Cap Project Area Footprint Analysis
Green Remediation - Inventory of Energy, Material, Waste, and Other Remedy Aspects
Remedy Conceptual Design and Assumptions:
Alternative B - ISCO

Overview

The source area will be treated with in-situ chemical oxidation (ISCO) followed by natural attenuation. Four existing wells would be used to create a hydraulic gradient for recirculation and distribution of permanganate. The extracted groundwater would be dosed with permanganate and reinjected through the injection wells during one month-long event. The remedy would involve four new injection wells, 500 feet of abovegrade PVC conveyance piping, various tanks for blending and mixing permanganate, secondary containment pads, submersible well pumps, above-ground transfer pumps, permanganate powder, and valves and instrumentation.

	White cells are for manual data input
	Yellow cells are for manual data input from a drop-down list of selections and are protected
	Blue cells are calculated cells that are protected

Instructions

1. Enter site or project name on row three of this tab.
2. Enter remedy name on row six of this tab.
3. Enter site and remedy description on row nine of this tab.
4. Copy the template tab and rename as a specific activity (e.g., O&M) on tab label and on row six of the tab.
5. Enter activity-specific information into the white and yellow cells on the copied/renamed tab.
6. Repeat steps 4 through 5 as needed for up to a total of 15 activities/tabs.
7. In cells E6 to S6 of the Summary tab, enter the names of the activity tabs from steps 4 through 6 (one name per cell).
8. In cells E4 to S4 of the Summary tab, enter the number (1 to 6) corresponding to the Level of the activity named in the corresponding cell in Row 6. For example, if the analysis defines Level 1 as construction, and the activities named in E6, F6, and G6 are all related to construction, then enter the number 1 in E4, F4, and G4.

Information from the activity tabs is compiled and summarized in the Summary tab. Some of the blue (calculated) cells of the activity tabs refer to the Lookup tab for conversion factors and default values. Each section of the activity tabs include white cells only if user override values are preferred instead of the default values from the Lookup tab.

All of the activities for a particular remedy to be included n the footprint analysis should be included in a single inventory spreadsheet. The spreadsheets are organized so that each remedy or remedy alternative has its own inventory spreadsheet.

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This workbook is designed to assist EPA Region 9 with conducting footprint analyses and to help EPA Region 9 better understand the process of footprint quantification for environmental remedies. The workbook does not represent EPA guidance, requirements, or suggestions with respect to footprint quantification. The workbook is in draft status as of March 2011, and is intended for use only EPA Region 5 and EPA Region 9 for testing purposes. For more information about this draft template and footprint analyses at clean-up sites, contact:

Karen Scheuermann (EPA Region 9) at scheuermann.karen@epa.gov or Carlos Pachon (EPA OSRTI) at pachon.carlos@epa.gov.

Input for Construction

General Scope	***Typical Scope Items***	***Useful Information***
- Install four 2-inch PVC injection wells (9-inch boreholes), 102 feet deep, non-haz drill cuttings - Install two nested 2-inch PVC monitoring wells (9-inch boreholes), 132 feet deep, non-haz drill cuttings - assume 10-foot screen intervals - inject 11,902 pounds of potassium permanganate with 400,000 gallons of extracted water - power provided by 25 kW generator to injection/recirculation pumps.	Distances for personnel, material, and equipment transportation are reasonble estimates and are not based on specific locations.	- SCH 80 2-inch pipe, 0.94 lbs per foot - SCH 40 2-inch pipe, 0.68 lbs per foot - cement 94 lbs per cubic foot, slurry = 15 lbs per gal (94 lbs cement, 6 gal water) - sand/gravel = 1.5 tons per cubic yard - concrete, 145 lbs per cubic 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
Driller	3	12	8	288								Vehicle transport under equipment section, 2 days of work per well
Construction contractors	4	5	8	160	40	20	Light-Duty Truck	Gasoline	800	15	53.3	Crew travels to site daily in two pickup trucks
Oversight	1	20	8	160	20	20	Light-Duty Truck	Gasoline	400	15	26.7	Local travel from hotel.
Well development	2	3	8	48	6	20	Light-Duty Truck	Gasoline	120	15	8	One crew member, one week per well.
Injection crew	2	22	10	440	22	20	Light-Duty Truck	Gasoline	440	15	29.3	Permanganate injection. Local travel from hotel.
Long-distance travel					9	200	Light-Duty Truck	Gasoline	1800	15	120	Initial long-distance travel for oversight and injection crew.

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
Drilling - large rig (e.g., CME-75)	200	0.75	Diesel	7.65	96	734.4	1	100	100	Diesel	7.2	13.9	drill rig for installation of six wells.
Integrated tool carrier	50	0.43	Diesel	1.0965	8	8.772	1	40	40	Diesel	7.2	5.6	installation of tanks
Other	36	0.5	Diesel	0.918	200	183.6							25 kW generator to power pumps, towed behind truck

Electricity Usage

Equipment Type	HP	% Full Load	Efficiency	Electrical Rating (kW)	Hours Used	Energy Used (kWh)	Notes
Equip. with kW rating							
Equip. with kW rating							
Direct kWh info.							
			Totals	0		0	

Cells shaded in dark gray are not relevant to the equipment types noted

"Direct kWh info" refers to total electricity usage calculated or provided elsewhere (e.g., an electric meter).

Natural Gas Usage

Equipment Type	Power Rating (btu/hr)	Efficiency	Total Hours Used	Btus Required	Total Therms Used	Notes
		Totals		0	0	

If heat load is known instead of unit power rating, then enter power rating as 125% of heat load and choose 80% for efficiency.

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Input for Construction

Materials Usage

Material Type	Unit	Quantity	Site-Spec. One-Way Distance (miles)*	Number of Trips	Total One-Way Miles	Mode of Transport.	Fuel Type	Fuel Use Rate (mpg or gptm)	Total Fuel Use	Notes
PVC	lbs	930		1	1000	Truck Light Load (gptm)	Diesel	0.024	11.2	well casing and 500 feet of piping
Cement	tons	9.4		1	30	Truck Heavy Load (gptm)	Diesel	0.011	3.1	grout for wells
Steel	lbs	108		1	500	Truck Light Load (gptm)	Diesel	0.024	0.6	steel for surface finish of wells
Gravel/sand/clay	tons	1.4		1	30	Truck A (< 5 tons)	Diesel	8.5	3.5	sand pack for wells
Potassium permanganate	lbs	11902		1	1000	Truck B (5-15 tons)	Diesel	7.2	138.9	
HDPE	lbs	1,000		1	1000	Truck Heavy Load (gptm)	Diesel	0.011	5.5	HPDE process tanks
Potassium permanganate	lbs	550		1	1000	Truck A (< 5 tons)	Diesel	8.5	117.6	sodium thiosulfate (quantity in gallons)
										use permanganate as surrogate material
										Materials for pumps, bag filters, and
										other process components not considered
			Empty Return Trips	2	2000	**Truck A (< 5 tons)**	Diesel	8.5	235.3	for permanganate and thiosulfate only

** Leave site-specific one-way miles blank if value is not known and a default will be used for*

Fuel Use Rate reported in miles per gallon (mpg) and gallons per ton-mile (gptm)

Laboratory Analysis

Parameter and Notes	Unit Cost	Number of Samples	Total Cost
VOCs			0
SVOCs			0
PCBs/Pesticides			0
Metals			0
Other			0
Other			0
Other			0
Other			0
Other			0
Other			0
	Totals	**0**	**0**

Waste Generation

Waste Type	Unit	Quantity	Site-Spec. One-Way Distance (miles)	Number of Trips	Total One-Way Miles	Mode of Transport.	Fuel Type	Fuel Use Rate	Total Fuel Use	Notes
Non-hazardous landfill	tons	16.5		1	25	Truck B (5-15 tons)	Diesel	7.2	3.5	drill cutting waste in roll-off bins
	tons									
	tons									
Hauled to POTW	tons	2.502		1	50	Truck A (< 5 tons)	Diesel	8.5	5.9	well development water
	tons									
			Empty Return Trips	2	75	**Truck A (< 5 tons)**	Diesel	8.5	8.8	

** Leave site-specific one-way miles blank if value is not known and a default will be used for calculating total-one way miles*

gptm = gallons per ton-mile

On-Site Water Usage (1000 x gallons)

Resource Type	Quantity	Use of Resource
Extracted GW #1	0.6	well development water
Extracted GW #2	0	extracted water for chemical blending reinjected into same aquifer
Water table drawdown (ft)		

Fate of On-Site Water Usage (1000 x gallons)

Discharge Location	Notes
Discharge to POTW	
Reinjected to aquifer	

If potable water is trucked to site, use "potable water" in materials section to calculate fuel use. Only the potable water use from the On-Site Water Use Section will be input into the Summary tab. It is assumed that the quantity of potable water in the Materials section is accounted for in in the On-Site Water Use Section.

Miscellaneous Emissions and Reductions

Item	Quantity	Activity or Notes
Other HAP emissions		
Other GHG emissions		
Other GHG reductions		
Other NOx reductions		
Other SOx reductions		
Other PM reductions		

On-Site Renewable Energy Generation

Item	Quantity	Activity or Notes
Photovoltaic (kWh)		
Renewable Energy #1 (kWh)		
Renewable Energy #2 (kWh)		

Purchased Renewable Energy (including Renewable Energy Certificates "RECs")

Item	Quantity	Activity or Notes
Purchased from Utility (kWh)		
RECs (kWh)		

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Input for *LTM*

General Scope	***Typical Scope Items***	***Useful Information***
- semi-annual sampling of 16 wells for VOCs (3 years) - annual sampling of 16 wells for VOCs (10 years) - annual sampling of 5 wells for VOCs and MNA (10 years)	Distances for personnel, material, and equipment transportation are reasonble estimates and are not based on specific locations.	

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
Sampling crew (3 years)	2	48	8	768	48	20	Light-Duty Truck	Gasoline	960	15	64	2-person sampling crew carpools, 2 events per year for 3 years, from local hotel
Sampling crew (10 years)	2	80	8	1280	80	20	Light-Duty Truck	Gasoline	1600	15	106.7	2-person sampling crew carpools, 1 event per year for 10 years. From local hotel
Long-distance travel					26	200	Light-Duty Truck	Gasoline	5200	15	346.7	long-distance travel from sampling crew office to site

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
Other	3	0.5	Gasoline	0.0855	2048	175.104							gas powered generators or compressors carried to site in truck

Electricity Usage

Equipment Type	HP	% Full Load	Efficiency	Electrical Rating (kW)	Hours Used	Energy Used (kWh)	Notes
Equip. with kW rating							
Equip. with kW rating							
Direct kWh info.							
			Totals	0		0	

Cells shaded in dark gray are not relevant to the equipment types noted

"Direct kWh info" refers to total electricity usage calculated or provided elsewhere (e.g., an electric meter).

Natural Gas Usage

Equipment Type	Power Rating (btu/hr)	Efficiency	Total Hours Used	Btus Required	Total Therms Used	Notes
		Totals		0	0	

If heat load is known instead of unit power rating, then enter power rating as 125% of heat load and choose 80% for efficiency.

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Input for *LTM*

Materials Usage

Material Type	Unit	Quantity	Site-Spec. One-Way Distance (miles)*	Number of Trips	Total One-Way Miles	Mode of Transport.	Fuel Type	Fuel Use Rate (mpg or gptm)	Total Fuel Use	Notes
										Assume materials are negligible
										dedicated tubing and pumps
										gloves and protective equipment is limited
		Empty Return Trips				Truck A (< 5 tons)				

** Leave site-specific one-way miles blank if value is not known and a default will be used for*

Fuel Use Rate reported in miles per gallon (mpg) and gallons per ton-mile (gptm)

Laboratory Analysis

Parameter and Notes	Unit Cost	Number of Samples	Total Cost
VOCs	$90	306	27540
SVOCs			0
PCBs/Pesticides			0
Metals			0
MNA Parameters	$150	50	7500
QA/QC samples 20% of total	$7,008	1	7008
Other			0
Other			0
Other			0
Other			0
	Totals	357	42048

Waste Generation

Waste Type	Unit	Quantity	Site-Spec. One-Way Distance (miles)	Number of Trips	Total One-Way Miles	Mode of Transport.	Fuel Type	Fuel Use Rate	Total Fuel Use	Notes
Hauled to POTW	tons	15		13	650	Truck A (< 5 tons)	Diesel	8.5	76.5	purge water to POTW once per year
	tons									
	tons									
	tons									
	tons									
		Empty Return Trips				Truck A (< 5 tons)				

** Leave site-specific one-way miles blank if value is not known and a default will be used for calculating total-one way miles*

gptm = gallons per ton-mile

On-Site Water Usage (1000 x gallons) / ***Fate of On-Site Water Usage (1000 x gallons)***

Resource Type	Quantity	Use of Resource	Discharge Location	Notes
Extracted GW #1	4	purge water	Discharge to POTW	
Water table drawdown (ft)				

If potable water is trucked to site, use "potable water" in materials section to calculate fuel use. Only the potable water use from the On-Site Water Use Section will be input into the Summary tab. It is assumed that the quantity of potable water in the Materials section is accounted for in in the On-Site Water Use Section.

Miscellaneous Emissions and Reductions

Item	Quantity	Activity or Notes
Other HAP emissions		
Other GHG emissions		
Other GHG reductions		
Other NOx reductions		
Other SOx reductions		
Other PM reductions		

On-Site Renewable Energy Generation

Item	Quantity	Activity or Notes
Photovoltaic (kWh)		
Renewable Energy #1 (kWh)		
Renewable Energy #2 (kWh)		

Purchased Renewable Energy (including Renewable Energy Certificates "RECs")

Item	Quantity	Activity or Notes
Purchased from Utility (kWh)		
RECs (kWh)		

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Summary

Level		1	0	3	0	0	0	0	0	0	0	0	0	0	0	0	
Item		**Construction**	**Construction Alternate**	**LTM**													**Total**
Labor and Travel																	
Hours worked	(hrs)	1096	1976	2048													**3144**
Heavy equip. operating hours	(hrs)	304	704	2048													**2352**
Passenger trips to site	(trips)	97	149	154													**251**
Passenger vehicle miles	(miles)	3560	6040	7760													**11320**
Heavy equip. trips to site	(trips)	2	2	0													**2**
Heavy equip. transport miles	(miles)	140	140	0													**140**
Materials transport trips	(trips)	9	9	0													**9**
Materials transport miles	(miles)	6560	14820	0													**6560**
Waste transport trips	(trips)	4	3	13													**17**
Waste transport miles	(miles)	150	100	650													**800**
Energy																	
On-site																	
Gasoline	(gallons)	0	0	175.104													**175.104**
E85	(gallons)	0	0	0													**0**
Diesel	(gallons)	926.772	1293.972	0													**926.772**
B20	(gallons)	0	0	0													**0**
Photovoltaic	(MWh)	0	0	0													**0**
Other Renewable Energy #1		0	0	0													**0**
Other Renewable Energy #2		0	0	0													**0**
Off-site																	
Gasoline	(gallons)	237.3	402.7	517.4													**754.7**
E85	(gallons)	0	0	0													**0**
Diesel	(gallons)	553.4	1840.1	76.5													**629.9**
B20	(gallons)	0	0	0													**0**
Total Fuel																	
Gasoline	(gallons)	237.3	402.7	692.504													**929.804**
E85	(gallons)	0	0	0													**0**
Diesel	(gallons)	1480.172	3134.072	76.5													**1556.672**
B20	(gallons)	0	0	0													**0**
Electricity Demand	(kW)	0	0	0													**0**
Electricity Usage	(MWh)	0	0	0													**0**
Purchased Renewable Electricity	(MWh)	0															**0**
Natural gas usage	(therms)	0	0	0													**0**

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Summary

Level		1	0	3	0	0	0	0	0	0	0	0	0	0	0	0	
Item		**Construction**	**Construction Alternate**	**LTM**													**Total**
Materials																	
Asphalt	(tons)	0	0	0													**0**
Bentonite	(tons)	0	0	0													**0**
Borrow	(tons)	0	0	0													**0**
Cement	(tons)	9.4	9.4	0													**9.4**
Cheese whey	(lbs)	0	0	0													**0**
Concrete	(tons)	0	0	0													**0**
Emulsified vegetable oil	(lbs)	0	0	0													**0**
GAC: regenerated	(lbs)	0	0	0													**0**
GAC: virgin coal-based	(lbs)	0	0	0													**0**
GAC: virgin coconut-based	(lbs)	0	0	0													**0**
Gravel/sand/clay	(tons)	1.4	1.4	0													**1.4**
HDPE	(lbs)	1000	1000	0													**1000**
Hydrochloric acid (30%, SG = 1.18)	(lbs)	0	0	0													**0**
Hydrogen peroxide (50%, SG=1.19)	(lbs)	0	0	0													**0**
Hydroseed	(lbs)	0	0	0													**0**
Lime	(lbs)	0	0	0													**0**
Molasses	(lbs)	0	0	0													**0**
Nitrogen fertilizer	(lbs)	0	0	0													**0**
Other 1 - PV system	(W)	0	0	0													**0**
Other 2 - Mulch	(cy)	0	0	0													**0**
Other 3	()	0	0	0													**0**
Other 4	()	0	0	0													**0**
Other 5	()	0	0	0													**0**
Phosphorus fertilizer	(lbs)	0	0	0													**0**
Polymer	(lbs)	0	0	0													**0**
Potable water	(gals)	0	0	0													**0**
Potassium permanganate	(lbs)	12452	37356	0													**12452**
PVC	(lbs)	930	930	0													**930**
Sequestering agent	(lbs)	0	0	0													**0**
Sodium hydroxide (20%, SG=1.22)	(lbs)	0	0	0													**0**
Stainless steel	(lbs)	0	0	0													**0**
Steel	(lbs)	108	108	0													**108**
Trees: root balls	(each)	0	0	0													**0**
Trees: whips	(each)	0	0	0													**0**
Waste																	
Non-hazardous landfill	(tons)	16.5	16.5	0													**16.5**
Hazardous landfill	(tons)	0	0	0													**0**
Recycling facility	(tons)	0	0	0													**0**
Hauled to POTW	(gals x 1000)	2.502	2.502	15													**17.502**
Incineration	(tons)	0	0	0													**0**
Location for reuse	(tons)	0															
Water Use																	
Potable water	(gals x 1000)	0	0	0													**0**
Extracted GW #1	(gals x 1000)	0.6	0.6	4													**4.6**
Extracted GW #2	(gals x 1000)	0	0	0													**0**
Surface water	(gals x 1000)	0	0	0													**0**
Reclaimed water	(gals x 1000)	0	0	0													**0**
Stormwater	(gals x 1000)	0	0	0													**0**

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Summary

Level		1	0	3	0	0	0	0	0	0	0	0	0	0	0	0	
Item		**Construction**	**Construction Alternate**	**LTM**													**Total**
Water Discharge																	
Discharge to surface water	(gals x 1000)	0	0	0													**0**
Reinjected to aquifer	(gals x 1000)	0	0	0													**0**
Discharge to POTW	(gals x 1000)	0.6	0.6	4													**4.6**
Discharge to atmosphere	(gals x 1000)	0	0	0													**0**
Public Use	(gals x 1000)	0	0	0													**0**
Irrigation	(gals x 1000)	0	0	0													**0**
Industrial process water	(gals x 1000)	0	0	0													**0**
Other beneficial use	(gals x 1000)	0	0	0													**0**
Laboratory Analysis																	
Total samples	(samples)	0	0	357													**357**
Total cost	($)	0	0	42048													**42048**
Other																	
Other HAP emissions	(lbs)	0	0	0													**0**
Other GHG emissions	(lbs)	0	0	0													**0**
Other GHG reductions	(lbs)	0	0	0													**0**
Other NOx reductions	(lbs)	0	0	0													**0**
Other SOx reductions	(lbs)	0	0	0													**0**
Other PM reductions	(lbs)	0	0	0													**0**

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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
- E85 efficiences 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 efficiences 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 efficiences 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)
- Diesel airplane, bus, and train efficiences 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.

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 considerd "other general industrial equipment".

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Lookup Table (continued)

Materials	Units	Conv. to tons	Default One-Way Distance from Source to Site (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	1,000
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
Other 2 - Mulch	cy	0.54	0
Other 3			0
Other 4			0
Other 5			0
Phosphorus fertilizer	lbs	0.0005	500
Polymer	lbs	0.0005	1000
Potable water	gals	0.00417	25
Potassium permanganate	lbs	0.0005	1000
PVC	lbs	0.0005	1000
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	Default One-Way Distance (Miles)	Notes
Hauled to POTW	50	
Hazardous landfill	500	
Incineration facility	50	
Location for reuse	50	
Non-hazardous landfill	25	
Recycling facility	100	

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APPENDIX B

FOOTPRINT CONVERSION FACTORS

Footprint Analysis
Green Remediation - Inventory of Energy, Material, Waste, and Other Remedy Aspects
Footprint Conversion Factors

Default conversion factors are provided in the "Default Conversion Factors" tab for use in calculating footprints. The references for these conversion factors are provided in the "Default Reference Summary" Tab. The default values will be used for footprint calculation unless a value is specified in the "Actual Conversion Factors" tab for a specific conversion factor. If an actual value is specified in the "Actual Conversion Factors" tab, then an "X" will occur next to the associated default conversion factor in the "Default Conversion Factors" tab. If an actual conversion factor is provided, docoumentation should be entered in the "Actual Reference Summary" tab.

The conversion factors for electricity production are the average conversion factors for electricity generation for the United States. Conversion factors specific to the local electricity provider should be used. These can be calculated by entering the "generation mix" or "fuel blend" into the "local electricity" tab.

The footprint conversion factors are input into the "Footprint Conversions" worksheets to convert information from the inventory sheets into footprint parameters.

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This workbook is designed to assist EPA Region 9 with conducting footprint analyses and to help EPA Region 9 better understand the process of footprint quantification for environmental remedies. The workbook does not represent EPA guidance, requirements, or suggestions with respect to footprint quantification. The workbook is in draft status as of March 2011, and is intended for use only EPA Region 5 and EPA Region 9 for testing purposes. For more information about this draft template and footprint analyses at clean-up sites, contact:

Karen Scheuermann (EPA Region 9) at scheuermann.karen@epa.gov or Carlos Pachon (EPA OSRTI) at pachon.carlos@epa.gov.

Default Conversion and Emission Factors

		Default Conversion Factors														
		Parameters Used, Extracted, Emitted, or Generated														
		Energy	Grid Electricity	All Water	Potable Water	Groundwater	CO2e	NO x	SO x	PM	Solid Waste	Haz. Waste	Air Toxics	Mercury	Lead	Dioxins
		Used	**Used**	**Used**	**Used**	**Extracted**	**Emitted**	**Emitted**	**Emitted**	**Emitted**	**Generated**	**Generated**	**Emitted**	**Released**	**Released**	**Released**
		Mbtu	MWh	gal x 1000	gal x 1000	gal x 1000	lbs	lbs	lbs	lbs	tons	tons	lbs	lbs	lbs	lbs
ON-SITE																
Energy																
Diesel (on-site use)	gal	139					22.5	0.17	0.0054	0.0034			0.0000052	0	0	0
Gasoline (on-site use)	gal	124					19.6	0.11	0.0045	0.00054			0.000039	0	0	0
Natural gas (on-site use)	ccf	103					12.2	0.01	0.0000063	0.00076			0.0000084	0.000000026	0.00000005	0
Electricity (on-site use)	MWh	3413	1													
Photovoltaic (on-site system)	MWh	37922.22222	1													
Other Energy 2	TBD															
Other Energy 3	TBD															
Water																
Groundwater Extracted On-site	gal x 1000			1		1										
Potable Water Used On-site	gal x 1000			1	1											
Other On-Site Water 1	gal x 1000			1												
Other On-Site Water 2	gal x 1000			1												
Other On-Site Water 3	gal x 1000			1												
Waste Generation																
On-Site Solid Waste Generation	ton										1					
On-Site Solid Waste Disposal	ton															
On-Site Hazardous Waste Generation	ton											1				
On-Site Hazardous Waste Disposal	ton															
Other																
On-site process emissions (HAPs)	lbs												1			
On-site process emissions (GHGs)	lbs CO2e						1									
On-site GHG storage	lbs CO2e						-1									
On-site NOx reduction	lbs							-1								
On-site SOx reduction	lbs								-1							
On-site PM reduction	lbs									-1						
Other 1	TBD															
Other 2	TBD															
ELECTRICITY GENERATION																
Electricity production	MWh	7800	0.06	2	X		1540	X 3.9	X 10	X 0.94	X 0.0009	0	0.4	X 0.000023	X 0.00017	X 2.40E-10 X
Purchased Renewa ble Electricity	MWh	0	0	-2			1540	3.9	10	0.94	0.0009	0	0.4	0.000023	0.00017	2.40E-10
TRANSPORTATION																
Diesel (off-site use)	gal	139					22.5	0.17	0.0054	0.0034			0.0000052	0	0	0
Gasoline (off-site use)	gal	124					19.6	0.11	0.0045	0.00054			0.000039	0	0	0
Natural gas (off-site use)	ccf	103					12.2	0.01	0.0000063	0.00076			0.0000084	0.000000026	0.00000005	0
Other Transportation 1	TBD															
Other Transportation 2	TBD															
Other Transportation 3	TBD															
Other Transportation 4	TBD															
Other Transportation 5	TBD															
OFF-SITE OTHER																
Materials																
Asphalt	tons															
Bentonite	tons	55	0.0027	0.13			6.7	0.033	0.03	0.004	0	0	0.00000041	6.4E-11	1.2E-09	1.5E-16
Borrow (clean soil)	tons	15.75	0.000059	0.000077			2.52	0.01764	0.00184	0.000374	0.000000036	0	0.00001252	4.8E-09	0.00000015	3E-15
Cement	dry-ton	4100	0.13	0.41			1800	3.6	2.1	0.0063	0	0	0.058	0.000057	0.00013	8.50E-11
Cheese Whey	lbs	1.87	0	0			1.1	0.0083	0.0099	0.000166	0	0	0	0	0	0
Concrete	tons	3019	0.096	0.34			1322	2.6	1.5	0.0054	0.000000012	0	0.043	0.000042	0.000095	6.2E-11
Diesel Produced	gal	18.5	0.00059	0.00077			2.7	0.0064	0.013	0.00034	0.000000036	0	0.00012	0.000000048	0.0000015	3E-14
Emulsified vegetable oil	lbs	3.6	0.000055	0.000024			3.51	0.0265	0.031	0.0017	0	0	0	0	0	0
GAC: regenerated	lbs	9.6	0.00044	0.0064			2	0.025	0.015	0	0	0	0	0	0	0
GAC: virgin coal-based	lbs	10.8	0.000045				4.5	0.12	0.074							
GAC: virgin coconut-based	lbs															
Gasoline Produced	gal	21	0.00059	0.00079			4.4	0.008	0.019	0.00052	0.00000042	0	0.00016	0.000000085	0.0000022	3.1E-14
Gravel/sand/clay	ton	55	0.0027	0.13			6.7	0.033	0.03	0.004	0	0	0.00000041	6.4E-11	1.2E-09	1.5E-16
HDPE	lb	31	0.00025	0.0023			1.9	0.0032	0.0041	0.00064	0.00000043	0.000001	0.0000034	2.6E-09	2.4E-09	9.8E-10

Default Conversion and Emission Factors

		Default Conversion Factors														
		Parameters Used, Extracted, Emitted, or Generated														
		Energy	Grid Electricity	All Water	Potable Water	Groundwater	CO2e	NO x	SO x	PM	Solid Waste	Haz. Waste	Air Toxics	Mercury	Lead	Dioxins
		Used	**Used**	**Used**	**Used**	**Extracted**	**Emitted**	**Emitted**	**Emitted**	**Emitted**	**Generated**	**Generated**	**Emitted**	**Released**	**Released**	**Released**
		Mbtu	MWh	gal x 1000	gal x 1000	gal x 1000	lbs	lbs	lbs	lbs	tons	tons	lbs	lbs	lbs	lbs
Hydrochloric acid (30%, SG = 1.18)	lbs															
Hydrogen peroxide (50%, SG=1.19)	lbs	4.95	0.000597	0.019			1.35	0.0087	0.0066	0.0025	0.000013	0.00000048	0.00023			
Hydroseed	lbs	0.049	1.46044E-07	0.00012			0.0046	0.0000027	0.000053	0.00000028	0	0	0.00000081	2E-11	1.29E-10	0
Lime	lbs															
Molasses	lbs	1.31	0.000005	0.000091			0.4	0.003	0.0026	0.00006	0	0	0	0	0	0
Natural Gas Produced	ccf	5.2	0.00025	0.000077			2.2	0.0037	0.0046	0.000072	0	0	0.0000061	2.1E-08	0.0000009	5.1E-14
Nitrogen fertilizer	lbs	16.2	0.000023				1.5	0.00078	0.0174	0.000067			0.00026	6.1E-09	0.000000038	
Other Material #1 - PV System	W	33.6	0.000262994				4.47	0.015	0.032	0.00063		0.0000029	0.0000029		0.0000029	
Other Material #2 - Mulch	cy															
Other Material #3 - acetic acid	lb	5.2	0.00002				0.67	0.00064	0.02	0.000058			0.00029	1.7E-09	0.00000001	3E-15
Other Material #4 - guar gum	lb	0.91	0.000047	0.0001			1	0.073	0.0068	0.00012			0.000014	1.1E-09	0.00000011	6.00E-14
Other Material #5	TBD															
Phosphorus fertilizer	lbs	3.39	0.000073				0.35	0.0017	0.017	0.00011			0.000052	2.1E-09	0.000000048	
Polymer	lbs															
Potable Water	gal x 1000	9.2	0.00044	0.021			5	0.0097	0.0059	0.016	8.34E-07	0	0.000015	8.2E-09	0.000000067	1E-13
Potassium permanganate	lbs	29.22	0.0016	0.003			4.5	0.021	0.016	0.0017	0.0000013		0.0006	0.000000038	0.000000038	3.5E-13
PVC	lbs	22	0.00056	0.0069			2.6	0.0048	0.0076	0.0012	0.0000022	0.0000016	0.00047	0.00000034	0.00000013	6.9E-09
Sequestering agent	lbs															
Sodium hydroxide (dry bulk)	lbs	6.6	0.00032	0.00115			1.37	0.003	0.0048	0.00054	0.000019	4.70E-07	0.000062	2.20E-07	2.50E-08	2.40E-14
Stainless Steel	lb	11.6	0.00056	0.0023			3.4	0.0075	0.012	0.0044	0.00062	0	0.000144	0	0.00000052	2.2E-12
Steel	lb	4.4	0.00021	0.00064			1.1	0.0014	0.0017	0.00056	0.00025	0	0.000067	0.0000001	0.0000025	6.5E-12
Tree: root ball	trees	3.7	0.0000019	0.004			0.6	0.003	0.00061	0.000029	0.00000001		0.000006	2.2E-09	0.00000006	
Tree: whip	trees			0												
Off-Site Services																
Off-site waste water treatment	gal x 1000	15	0.00073	0.00292			4.4	0.016	0.015	0.0017	0.0024	0	0.00058	3.70E-08	3.70E-07	3.45E-13
Off-site Solid Waste Disposal	ton	160	0.0077	0.15			25	0.14	0.075	0.4	0.000008	0	0.0014	9.70E-07	0.0000076	1.20E-11
Off-site Haz. Waste Disposal	ton	176	0.0085	0.165			27.5	0.154	0.0825	0.44	0.0000088	0	0.00154	0.000001067	0.00000836	1.32E-11
Off-site Laboratory Analysis	$	6.49	0.00035	0.00066			1	0.0048	0.0036	0.0004	0	0	0.00013	8.4E-09	0.000000085	7.9E-14
Other 1	TBD															
Other 2	TBD															
Other 3	TBD															
Other 4	TBD															
Other 5	TBD															
Other																
Potable Water Transported	gal x 1000	7.4	0.000645995	0.00129199			0.994832041	0.00251938	0.006459948	0.000607235	5.81395E-07	0	0.000258398	1.48579E-08	1.09819E-07	1.55039E-13
Electricity transmission	MWh	410	0.12	0.24			184.8	0.468	1.2	0.1128	0.000108	0	0.048	0.00000276	0.0000204	2.88E-11
Other 1	TBD															
Other 2	TBD															
Other 3	TBD															

Notes: An "X" n Notes: An "X" next to a conversion rate indicates that a "actual" value has been assigned and is overriding the "default" value.

Actual Conversion and Emission Factors

		Actual Conversion Factors														
		Parameters Used, Extracted, Emitted, or Generated														
		Energy	Grid Electricity	All Water	Potable Water	Groundwater	CO2e	NO x	SO x	PM	Solid Waste	Haz. Waste	Air Toxics	Mercury	Lead	Dioxins
		Used	**Used**	**Used**	**Used**	**Extracted**	**Emitted**	**Emitted**	**Emitted**	**Emitted**	**Generated**	**Generated**	**Emitted**	**Released**	**Released**	**Released**
		Mbtu	MWh	gal x 1000	gal x 1000	gal x 1000	lbs	lbs	lbs	lbs	tons	tons	lbs	lbs	lbs	lbs
ON-SITE																
Energy																
Diesel (on-site use)	gal															
Gasoline (on-site use)	gal															
Natural gas (on-site use)	ccf															
Electricity (on-site use)	MWh															
Other Energy 1	TBD															
Other Energy 2	TBD															
Other Energy 3	TBD															
Water																
Groundwater Extracted On-site	gal x 1000															
Potable Water Used On-site	gal x 1000															
Other On-Site Water 1	gal x 1000															
Other On-Site Water 2	gal x 1000															
Other On-Site Water 3	gal x 1000															
Waste Generation																
On-Site Solid Waste Generation	ton															
On-Site Solid Waste Disposal	ton															
On-Site Hazardous Waste Generation	ton															
On-Site Hazardous Waste Disposal	ton															
Other																
On-site process emissions (HAPs)	lbs															
On-site process emissions (GHGs)	lbs CO2e															
On-site GHG storage	lbs CO2e															
On-site NOx reduction	TBD															
On-site SOx reduction	TBD															
On-site PM reduction	TBD															
Other 1	TBD															
Other 2	TBD															
ELECTRICITY GENERATION																
Electricity production	MWh			0.9			2360	6.48	14.9	1.636			0.6797	0.00004	0.00023	3.40E-10
Purchased Renewable Electricity	MWh															
TRANSPORTATION																
Diesel (off-site use)	gal															
Gasoline (off-site use)	gal															
Natural gas (off-site use)	ccf															
Other Transportation 1	TBD															
Other Transportation 2	TBD															
Other Transportation 3	TBD															
Other Transportation 4	TBD															
Other Transportation 5	TBD															

Actual Conversion and Emission Factors

		Actual Conversion Factors														
		Parameters Used, Extracted, Emitted, or Generated														
		Energy	Grid Electricity	All Water	Potable Water	Groundwater	CO2e	NO x	SO x	PM	Solid Waste	Haz. Waste	Air Toxics	Mercury	Lead	Dioxins
		Used	**Used**	**Used**	**Used**	**Extracted**	**Emitted**	**Emitted**	**Emitted**	**Emitted**	**Generated**	**Generated**	**Emitted**	**Released**	**Released**	**Released**
		Mbtu	MWh	gal x 1000	gal x 1000	gal x 1000	lbs	lbs	lbs	lbs	tons	tons	lbs	lbs	lbs	lbs
OFF-SITE OTHER																
Materials																
Asphalt	tons															
Bentonite	tons															
Borrow (clean soil)	tons															
Cement	dry-ton															
Cheese Whey	lbs															
Concrete	tons															
Diesel Produced	gal															
Emulsified vegetable oil	lbs															
GAC: regenerated	lbs															
GAC: virgin coal-based	lbs															
GAC: virgin coconut-based	lbs															
Gasoline Produced	gal															
Gravel/sand/clay	ton															
HDPE	lb															
Hydrochloric acid (30%, SG = 1.18)	lbs															
Hydrogen peroxide (50%, SG=1.19)	lbs															
Hydroseed	lbs															
Lime	lbs															
Molasses	lbs															
Natural Gas Produced	ccf															
Nitrogen fertilizer	lbs															
Other Material #1 - PV System	gal															
Other Material #2 - Mulch	TBD															
Other Material #3 - acetic acid	TBD															
Other Material #4 - guar gum	TBD															
Other Material #5	TBD															
Phosphorus fertilizer	lbs															
Polymer	lbs															
Potable water	lbs															
Potassium permanganate	lbs															
PVC	lbs															
Sequestering agent	lbs															
Sodium hydroxide (dry bulk)	lbs															
Stainless Steel	lb															
Steel	lb															
Tree: root ball	trees															
Tree: whip	trees															
Off-Site Services																
Off-site waste water treatment	gal x 1000															
Off-site Solid Waste Disposal	ton															
Off-site Haz. Waste Disposal	ton															
Off-site Laboratory Analysis	$															
Other 1	TBD															
Other 2	TBD															
Other 3	TBD															
Other 4	TBD															
Other 5	TBD															
Other																
Potable Water Transported	gal x 1000															
Electricity transmission	MWh															
Other 1	TBD															
Other 2	TBD															
Other 3	TBD															

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
Diesel (on-site use)	Energy Used	139	Mbtu/gal	The reference provides the higher heating value of diesel as 5.825 MMBTU per barrel and defines a barrel as 42 gallons. This converts to approximately 139 Mbtu/gallon.	Climate Leader GHG Inventory EPA-430--K-08-004, May 2008
	Grid Electricity Used		MWh/gal		
	All Water Used		gal x 1000/gal		
	Potable Water Used		gal x 1000/gal		
	Groundwater Extracted		gal x 1000/gal		
	CO2e Emitted	22.5	lbs/gal	The reference provides CO2e emitted as 10.15 kg of CO2 per gallon. This converts to 22.3 pounds per gallon. Additionally, N2O and CH4 emissions are provided as g/gal. Values are converted to lbs/gal using a global warming potential (GWP) of 1 for carbon dioxide, 21 for methane, and 310 for nitrous oxide.	Climate Leader GHG Inventory EPA-430--K-08-004, May 2008
	NO x Emitted	0.17	lbs/gal	NREL LCI reported the amount of diesel in liters required to transport one ton-kilometer (tkm) and provided outputs to nature in kg. The output (nitrogen oxides) generated from transporting 1 tkm was divided by the amount of diesel required to transport 1 tkm, and the units of the result were converted from kg/L to lbs/gallon.	NREL LCI File: SS_Transport, single unit truck, diesel powered.xls
	SO x Emitted	0.0054	lbs/gal	NREL LCI reported the amount of diesel in liters required to transport one ton-kilometer (tkm) and provided outputs to nature in kg. The output (sulfur oxides) generated from transporting 1 tkm was divided by the amount of diesel required to transport 1 tkm, and the units of the result were converted from kg/L to lbs/gallon.	NREL LCI File: SS_Transport, single unit truck, diesel powered.xls
	PM Emitted	0.0034	lbs/gal	NREL LCI reported the amount of diesel in liters required to transport one ton-kilometer (tkm) and provided outputs to nature in kg. The output (Particulates, > 2.5 um, and < 10um) generated from transporting 1 tkm was divided by the amount of diesel required to transport 1 tkm, and the units of the result were converted from kg/L to lbs/gallon.	NREL LCI File: SS_Transport, single unit truck, diesel powered.xls
	Solid Waste Generated		tons/gal	not applicable -- no waste generated when diesel is combusted on-site or in transportation (solid waste and waste oil from maintenance would be tracked separately)	
	Haz. Waste Generated		tons/gal	not applicable -- no waste generated when diesel is combusted on-site or in transportation (solid waste and waste oil from maintenance would be tracked separately)	
	Air Toxics Emitted	0.0000052	lbs/gal	Not available in NREL LCI transport files. Summed hazardous air pollutants emitted from combusting diesel in industrial equipment. NREL LCI provides results in kg per L combusted. Converted this to pounds per gallon by multiplying by 3.785 and multiplying by .2.2	NREL LCI File: SS_diesel combusted in industrial equipment.xls
	Mercury Released	0	lbs/gal	EUROPA ELCD - Reference does not indicate a release of mercury.	EUROPA file location: Lorry transport; Euro 0, 1, 2, 3, 4 mix; 22 t total weight, 17,3 t max payload (excluding fuel supply): http://lca.jrc.ec.europa.eu/lcainfohub/datasets/elcd/processes/b444f4d2-3393-11dd-bd11-0800200c9a66_02.00.000.xml
	Lead Released	0	lbs/gal	EUROPA ELCD - Reference does not indicate a release of lead	
	Dioxins Released	0	lbs/gal	EUROPA ELCD - Reference does not indicate a release of dioxins.	

"NREL LCI" refers to the U.S. Dept. of Energy, National Renewable Energy Laboratory (NREL), Life-Cycle Inventory Database (www.nrel.gov/lci) maintained by the Alliance for Sustainable Energy, LLC.
EUROPA ECLD refers to the European Reference Life Cycle Database (ELCD core database), version II compiled under contract on behalf of the European Commission - DG Joint Research Centre - Institute for Environment and Sustainability with technical and scientific support by JRC-IES from early 2008 to early 2009.
(http://lca.jrc.ec.europa.eu/lcainfohub/datasetArea.vm)

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
Gasoline (on-site use)	Energy Used	124	Mbtu/gal	The reference provides the higher heating value of gasoline as 5.218 MMBTU per barrel and defines a barrel as 42 gallons. This converts to approximately 124 Mbtu/gallon.	Climate Leader GHG Inventory EPA-430--K-08-004, May 2008
	Grid Electricity Used		MWh/gal	not applicable -- no electricity used when gasoline is combusted on-site or in transportation	
	All Water Used		gal x 1000/gal	not applicable -- no water used when gasoline is combusted on-site or in transportation	
	Potable Water Used		gal x 1000/gal	not applicable -- no water used when gasoline is combusted on-site or in transportation	
	Groundwater Extracted		gal x 1000/gal	not applicable -- no water used when gasoline is combusted on-site or in transportation	
	CO2e Emitted	19.6	lbs/gal	The reference provides CO2e emitted as 8.81 kg of CO2 per gallon. This converts to 19.4 pounds per gallon. Additionally, N2O and CH4 emissions are provided as g/gal. Values are converted to lbs/gal using a global warming potential (GWP) of 1 for carbon dioxide, 21 for methane, and 310 for nitrous oxide.	Climate Leader GHG Inventory EPA-430--K-08-004, May 2008
	NO x Emitted	0.11	lbs/gal	NREL LCI reported the amount of gasoline in liters required to transport one ton-kilometer (tkm) and provided outputs to nature in kg. The output (nitrogen oxides) generated from transporting 1 tkm was divided by the amount of gasoline required to transport 1 tkm, and the units of the result were converted from kg/L to lbs/gallon.	NREL LCI File: SS_Transport, single unit truck, gasoline powered.xls
	SO x Emitted	0.0045	lbs/gal	NREL LCI reported the amount of gasoline in liters required to transport one ton-kilometer (tkm) and provided outputs to nature in kg. The output (sulfur oxides) generated from transporting 1 tkm was divided by the amount of gasoline required to transport 1 tkm, and the units of the result were converted from kg/L to lbs/gallon.	NREL LCI File: SS_Transport, single unit truck, gasoline powered.xls
	PM Emitted	0.00054	lbs/gal	NREL LCI reported the amount of gasoline in liters required to transport one ton-kilometer (tkm) and provided outputs to nature in kg. The output (Particulates, > 2.5 um, and < 10um) generated from transporting 1 tkm was divided by the amount of gasoline required to transport 1 tkm, and the units of the result were converted from kg/L to lbs/gallon.	NREL LCI File: SS_Transport, single unit truck, gasoline powered.xls
	Solid Waste Generated		tons/gal	not applicable -- no waste generated when gasoline is combusted on-site or in transportation (solid waste and waste oil from maintenance would be tracked separately)	
	Haz. Waste Generated		tons/gal	not applicable -- no waste generated when gasoline is combusted on-site or in transportation (solid waste and waste oil from maintenance would be tracked separately)	
	Air Toxics Emitted	0.000039	lbs/gal	Not available in NREL LCI transport files. Summed hazardous air pollutants emitted from combusting gasoline in industrial equipment. NREL LCI provides results in kg per L combusted. Converted this to pounds per gallon by multiplying by 3.785 and multiplying by .2.2	NREL LCI File: SS_gasoline combusted in industrial equipment.xls
	Mercury Released	0	lbs/gal	EUROPA ELCD - Reference does not indicate a release of mercury.	EUROPA file location: Lorry transport; Euro 0, 1, 2, 3, 4 mix; 22 t total weight, 17,3 t max payload (excluding fuel supply): http://lca.jrc.ec.europa.eu/lcainfohub/datasets/elcd/processes/b444f4d2-3393-11dd-bd11-0800200c9a66_02.00.000.xml
	Lead Released	0	lbs/gal	EUROPA ELCD - Reference does not indicate a release of lead	
	Dioxins Released	0	lbs/gal	EUROPA ELCD - Reference does not indicate a release of dioxins.	

"NREL LCI" refers to the U.S. Dept. of Energy, National Renewable Energy Laboratory (NREL), Life-Cycle Inventory Database (www.nrel.gov/lci) maintained by the Alliance for Sustainable Energy, LLC.

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
Natural gas (on-site use)	Energy Used	103	Mbtu/ccf	The reference provides the higher heating value of natural gas as 1,027 BTU per scf. This converts to approximately 103 Mbtu/ccf.	Climate Leader GHG Inventory EPA-430--K-08-004, May 2008
	Grid Electricity Used		MWh/ccf	not applicable -- no electricity used when nat gas is combusted on-site or in transportation	
	All Water Used		gal x 1000/ccf	not applicable -- no water used when nat gas is combusted on-site or in transportation	
	Potable Water Used		gal x 1000/ccf	not applicable -- no water used when nat gas is combusted on-site or in transportation	
	Groundwater Extracted		gal x 1000/ccf	not applicable -- no water used when nat gas is combusted on-site or in transportation	
	CO2e Emitted	12.2	lbs/ccf	NREL LCI reported output in kg and input in m3. The units were converted from kg/m3 to lbs per 100 cubic feet (ccf) and rounded to two significant digits. Outputs for carbon dioxide and fossil methane were used to calculated CO2e. Nitrous oxide was not included as an output. Methane was assigned a global warming potential equal to 21 times that of CO2.	NREL LCI File: SS_Natural gas, combusted in industrial boiler.xls
	NO x Emitted	0.01	lbs/ccf	NREL LCI reported output in kg and input in m3. The units were converted from kg/m3 to lbs per 100 cubic feet (ccf) and rounded to two significant digits.	NREL LCI File: SS_Natural gas, combusted in industrial boiler.xls
	SO x Emitted	0.0000063	lbs/ccf	NREL LCI reported output in kg and input in m3. The units were converted from kg/m3 to lbs per 100 cubic feet (ccf) and rounded to two significant digits.	NREL LCI File: SS_Natural gas, combusted in industrial boiler.xls
	PM Emitted	0.00076	lbs/ccf	NREL LCI reported output in kg and input in m3. The units were converted from kg/m3 to lbs per 100 cubic feet (ccf) and rounded to two significant digits.	NREL LCI File: SS_Natural gas, combusted in industrial boiler.xls
	Solid Waste Generated		tons/ccf	not applicable -- no solid waste generated when natural gas is combusted on-site or in transportation	
	Haz. Waste Generated		tons/ccf	not applicable -- no haz waste generated when natural gas is combusted on-site or in transportation	
	Air Toxics Emitted	0.0000084	lbs/ccf	NREL - Sum of all hazardous air pollutants and groups of contaminants as defined by EPA (HAPs) emitted to atmosphere converted from kg/m3 to lb/ccf. Note that the value for combustion in equipment is significantly lower than the value reported here for use in an industrial boiler.	NREL LCI File: SS_Natural gas, combusted in industrial boiler.xls
	Mercury Released	0.000000026	lbs/ccf	NREL - Mercury released converted from kg/m3 to lb/ccf. Note that according to NREL there is no mercury released for natural gas combusted in industrial equipment.	NREL LCI File: SS_Natural gas, combusted in industrial boiler.xls
	Lead Released	0.00000005	lbs/ccf	NREL - Lead released converted from kg/m3 to lb/ccf. Note that according to NREL there is no lead released for natural gas combusted in industrial equipment.	NREL LCI File: SS_Natural gas, combusted in industrial boiler.xls
	Dioxins Released	0	lbs/ccf	NREL does not indicate the formation of dioxins during natural gas combustion	NREL LCI File: SS_Natural gas, combusted in industrial boiler.xls

"NREL LCI" refers to the U.S. Dept. of Energy, National Renewable Energy Laboratory (NREL), Life-Cycle Inventory Database (www.nrel.gov/lci) maintained by the Alliance for Sustainable Energy, LLC.

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
Electricity (on-site use)	Energy Used	3413	Mbtu/MWh	Actual conversion factor	
	Grid Electricity Used	1	MWh/MWh	One to one conversion.	
	All Water Used		gal x 1000/MWh		
	Potable Water Used		gal x 1000/MWh		
	Groundwater Extracted		gal x 1000/MWh		
	CO2e Emitted		lbs/MWh		
	NO x Emitted		lbs/MWh		
	SO x Emitted		lbs/MWh		
	PM Emitted		lbs/MWh		
	Solid Waste Generated		tons/MWh		
	Haz. Waste Generated		tons/MWh		
	Air Toxics Emitted		lbs/MWh		
	Mercury Released		lbs/MWh		
	Lead Released		lbs/MWh		
	Dioxins Released		lbs/MWh		

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
Photovoltaic (on-site system)	Energy Used	37922.22222	Mbtu/MWh	Incoming radiation required to produce 1 MWh of electricity. Based on solar radiation and generated electricity from PVWATTS plus average of 12 watts per square foot of typical multicrystaline solar modules. Assumes AC electricity is generated.	
	Grid Electricity Used	1	MWh/MWh	One to one conversion.	
	All Water Used		gal x 1000/MWh		
	Potable Water Used		gal x 1000/MWh		
	Groundwater Extracted		gal x 1000/MWh		
	CO2e Emitted		lbs/MWh		
	NO x Emitted		lbs/MWh		
	SO x Emitted		lbs/MWh		
	PM Emitted		lbs/MWh		
	Solid Waste Generated		tons/MWh		
	Haz. Waste Generated		tons/MWh		
	Air Toxics Emitted		lbs/MWh		
	Mercury Released		lbs/MWh		
	Lead Released		lbs/MWh		
	Dioxins Released		lbs/MWh		

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
Other Energy 2	Energy Used		Mbtu/TBD		
	Grid Electricity Used		MWh/TBD		
	All Water Used		gal x 1000/TBD		
	Potable Water Used		gal x 1000/TBD		
	Groundwater Extracted		gal x 1000/TBD		
	CO2e Emitted		lbs/TBD		
	NO x Emitted		lbs/TBD		
	SO x Emitted		lbs/TBD		
	PM Emitted		lbs/TBD		
	Solid Waste Generated		tons/TBD		
	Haz. Waste Generated		tons/TBD		
	Air Toxics Emitted		lbs/TBD		
	Mercury Released		lbs/TBD		
	Lead Released		lbs/TBD		
	Dioxins Released		lbs/TBD		

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
Other Energy 3	Energy Used		Mbtu/TBD		
	Grid Electricity Used		MWh/TBD		
	All Water Used		gal x 1000/TBD		
	Potable Water Used		gal x 1000/TBD		
	Groundwater Extracted		gal x 1000/TBD		
	CO2e Emitted		lbs/TBD		
	NO x Emitted		lbs/TBD		
	SO x Emitted		lbs/TBD		
	PM Emitted		lbs/TBD		
	Solid Waste Generated		tons/TBD		
	Haz. Waste Generated		tons/TBD		
	Air Toxics Emitted		lbs/TBD		
	Mercury Released		lbs/TBD		
	Lead Released		lbs/TBD		
	Dioxins Released		lbs/TBD		

EUROPA ECLD refers to the European Reference Life Cycle Database (ELCD core database), version II compiled under contract on behalf of the European Commission - DG Joint Research Centre - Institute for Environment and Sustainability with technical and scientific support by JRC-IES from early 2008 to early 2009. (http://lca.jrc.ec.europa.eu/lcainfohub/datasetArea.vm)

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
Groundwater Extracted On-site	Energy Used		Mbtu/gal x 1000		
	Grid Electricity Used		MWh/gal x 1000		
	All Water Used	1	gal x 1000/gal x 1000	One to one conversion.	
	Potable Water Used		gal x 1000/gal x 1000		
	Groundwater Extracted	1	gal x 1000/gal x 1000	One to one conversion.	
	CO2e Emitted		lbs/gal x 1000		
	NO x Emitted		lbs/gal x 1000		
	SO x Emitted		lbs/gal x 1000		
	PM Emitted		lbs/gal x 1000		
	Solid Waste Generated		tons/gal x 1000		
	Haz. Waste Generated		tons/gal x 1000		
	Air Toxics Emitted		lbs/gal x 1000		
	Mercury Released		lbs/gal x 1000		
	Lead Released		lbs/gal x 1000		
	Dioxins Released		lbs/gal x 1000		

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
Potable Water Used On-site	Energy Used		Mbtu/gal x 1000		
	Grid Electricity Used		MWh/gal x 1000		
	All Water Used	1	gal x 1000/gal x 1000	One to one conversion.	
	Potable Water Used	1	gal x 1000/gal x 1000	One to one conversion.	
	Groundwater Extracted		gal x 1000/gal x 1000	Not applicable -- no local or on-site ground water extracted.	
	CO2e Emitted		lbs/gal x 1000		
	NO x Emitted		lbs/gal x 1000		
	SO x Emitted		lbs/gal x 1000		
	PM Emitted		lbs/gal x 1000		
	Solid Waste Generated		tons/gal x 1000		
	Haz. Waste Generated		tons/gal x 1000		
	Air Toxics Emitted		lbs/gal x 1000		
	Mercury Released		lbs/gal x 1000		
	Lead Released		lbs/gal x 1000		
	Dioxins Released		lbs/gal x 1000		

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
Other On-Site Water 1	Energy Used		Mbtu/gal x 1000		
	Grid Electricity Used		MWh/gal x 1000		
	All Water Used	1	gal x 1000/gal x 1000	One to one conversion.	
	Potable Water Used		gal x 1000/gal x 1000		
	Groundwater Extracted		gal x 1000/gal x 1000		
	CO2e Emitted		lbs/gal x 1000		
	NO x Emitted		lbs/gal x 1000		
	SO x Emitted		lbs/gal x 1000		
	PM Emitted		lbs/gal x 1000		
	Solid Waste Generated		tons/gal x 1000		
	Haz. Waste Generated		tons/gal x 1000		
	Air Toxics Emitted		lbs/gal x 1000		
	Mercury Released		lbs/gal x 1000		
	Lead Released		lbs/gal x 1000		
	Dioxins Released		lbs/gal x 1000		

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
Other On-Site Water 2	Energy Used		Mbtu/gal x 1000		
	Grid Electricity Used		MWh/gal x 1000		
	All Water Used	1	gal x 1000/gal x 1000	One to one conversion.	
	Potable Water Used		gal x 1000/gal x 1000		
	Groundwater Extracted		gal x 1000/gal x 1000		
	CO2e Emitted		lbs/gal x 1000		
	NO x Emitted		lbs/gal x 1000		
	SO x Emitted		lbs/gal x 1000		
	PM Emitted		lbs/gal x 1000		
	Solid Waste Generated		tons/gal x 1000		
	Haz. Waste Generated		tons/gal x 1000		
	Air Toxics Emitted		lbs/gal x 1000		
	Mercury Released		lbs/gal x 1000		
	Lead Released		lbs/gal x 1000		
	Dioxins Released		lbs/gal x 1000		

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
Other On-Site Water 3	Energy Used		Mbtu/gal x 1000		
	Grid Electricity Used		MWh/gal x 1000		
	All Water Used	1	gal x 1000/gal x 1000	One to one conversion.	
	Potable Water Used		gal x 1000/gal x 1000		
	Groundwater Extracted		gal x 1000/gal x 1000		
	CO2e Emitted		lbs/gal x 1000		
	NO x Emitted		lbs/gal x 1000		
	SO x Emitted		lbs/gal x 1000		
	PM Emitted		lbs/gal x 1000		
	Solid Waste Generated		tons/gal x 1000		
	Haz. Waste Generated		tons/gal x 1000		
	Air Toxics Emitted		lbs/gal x 1000		
	Mercury Released		lbs/gal x 1000		
	Lead Released		lbs/gal x 1000		
	Dioxins Released		lbs/gal x 1000		

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
On-Site Solid Waste Generation	Energy Used		Mbtu/ton		
	Grid Electricity Used		MWh/ton		
	All Water Used		gal x 1000/ton		
	Potable Water Used		gal x 1000/ton		
	Groundwater Extracted		gal x 1000/ton		
	CO2e Emitted		lbs/ton		
	NO x Emitted		lbs/ton		
	SO x Emitted		lbs/ton		
	PM Emitted		lbs/ton		
	Solid Waste Generated	1	tons/ton	One to one conversion.	
	Haz. Waste Generated		tons/ton		
	Air Toxics Emitted		lbs/ton		
	Mercury Released		lbs/ton		
	Lead Released		lbs/ton		
	Dioxins Released		lbs/ton		

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
On-Site Solid Waste Disposal	Energy Used		Mbtu/ton		
	Grid Electricity Used		MWh/ton		
	All Water Used		gal x 1000/ton		
	Potable Water Used		gal x 1000/ton		
	Groundwater Extracted		gal x 1000/ton		
	CO2e Emitted		lbs/ton		
	NO x Emitted		lbs/ton		
	SO x Emitted		lbs/ton		
	PM Emitted		lbs/ton		
	Solid Waste Generated		tons/ton		
	Haz. Waste Generated		tons/ton		
	Air Toxics Emitted		lbs/ton		
	Mercury Released		lbs/ton		
	Lead Released		lbs/ton		
	Dioxins Released		lbs/ton		

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
On-Site Hazardous Waste Generation	Energy Used		Mbtu/ton		
	Grid Electricity Used		MWh/ton		
	All Water Used		gal x 1000/ton		
	Potable Water Used		gal x 1000/ton		
	Groundwater Extracted		gal x 1000/ton		
	CO2e Emitted		lbs/ton		
	NO x Emitted		lbs/ton		
	SO x Emitted		lbs/ton		
	PM Emitted		lbs/ton		
	Solid Waste Generated		tons/ton		
	Haz. Waste Generated	1	tons/ton	One to one conversion.	
	Air Toxics Emitted		lbs/ton		
	Mercury Released		lbs/ton		
	Lead Released		lbs/ton		
	Dioxins Released		lbs/ton		

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
On-Site Hazardous Waste Disposal	Energy Used		Mbtu/ton		
	Grid Electricity Used		MWh/ton		
	All Water Used		gal x 1000/ton		
	Potable Water Used		gal x 1000/ton		
	Groundwater Extracted		gal x 1000/ton		
	CO2e Emitted		lbs/ton		
	NO x Emitted		lbs/ton		
	SO x Emitted		lbs/ton		
	PM Emitted		lbs/ton		
	Solid Waste Generated		tons/ton		
	Haz. Waste Generated		tons/ton		
	Air Toxics Emitted		lbs/ton		
	Mercury Released		lbs/ton		
	Lead Released		lbs/ton		
	Dioxins Released		lbs/ton		

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
On-site process emissions (HAPs)	Energy Used		Mbtu/lbs		
	Grid Electricity Used		MWh/lbs		
	All Water Used		gal x 1000/lbs		
	Potable Water Used		gal x 1000/lbs		
	Groundwater Extracted		gal x 1000/lbs		
	CO2e Emitted		lbs/lbs		
	NO x Emitted		lbs/lbs		
	SO x Emitted		lbs/lbs		
	PM Emitted		lbs/lbs		
	Solid Waste Generated		tons/lbs		
	Haz. Waste Generated		tons/lbs		
	Air Toxics Emitted	1	lbs/lbs	One to one conversion.	
	Mercury Released		lbs/lbs		
	Lead Released		lbs/lbs		
	Dioxins Released		lbs/lbs		

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
On-site process emissions (GHGs)	Energy Used		Mbtu/lbs CO2e		
	Grid Electricity Used		MWh/lbs CO2e		
	All Water Used		gal x 1000/lbs CO2e		
	Potable Water Used		gal x 1000/lbs CO2e		
	Groundwater Extracted		gal x 1000/lbs CO2e		
	CO2e Emitted	1	lbs/lbs CO2e	One to one conversion.	
	NO x Emitted		lbs/lbs CO2e		
	SO x Emitted		lbs/lbs CO2e		
	PM Emitted		lbs/lbs CO2e		
	Solid Waste Generated		tons/lbs CO2e		
	Haz. Waste Generated		tons/lbs CO2e		
	Air Toxics Emitted		lbs/lbs CO2e		
	Mercury Released		lbs/lbs CO2e		
	Lead Released		lbs/lbs CO2e		
	Dioxins Released		lbs/lbs CO2e		

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
On-site GHG storage	Energy Used		Mbtu/lbs CO2e		
	Grid Electricity Used		MWh/lbs CO2e		
	All Water Used		gal x 1000/lbs CO2e		
	Potable Water Used		gal x 1000/lbs CO2e		
	Groundwater Extracted		gal x 1000/lbs CO2e		
	CO2e Emitted	-1	lbs/lbs CO2e	One to one conversion.	
	NO x Emitted		lbs/lbs CO2e		
	SO x Emitted		lbs/lbs CO2e		
	PM Emitted		lbs/lbs CO2e		
	Solid Waste Generated		tons/lbs CO2e		
	Haz. Waste Generated		tons/lbs CO2e		
	Air Toxics Emitted		lbs/lbs CO2e		
	Mercury Released		lbs/lbs CO2e		
	Lead Released		lbs/lbs CO2e		
	Dioxins Released		lbs/lbs CO2e		

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
On-site NOx reduction	Energy Used		Mbtu/lbs		
	Grid Electricity Used		MWh/lbs		
	All Water Used		gal x 1000/lbs		
	Potable Water Used		gal x 1000/lbs		
	Groundwater Extracted		gal x 1000/lbs		
	CO2e Emitted		lbs/lbs		
	NO x Emitted	-1	lbs/lbs	One to one conversion.	
	SO x Emitted		lbs/lbs		
	PM Emitted		lbs/lbs		
	Solid Waste Generated		tons/lbs		
	Haz. Waste Generated		tons/lbs		
	Air Toxics Emitted		lbs/lbs		
	Mercury Released		lbs/lbs		
	Lead Released		lbs/lbs		
	Dioxins Released		lbs/lbs		

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
On-site SOx reduction	Energy Used		Mbtu/lbs		
	Grid Electricity Used		MWh/lbs		
	All Water Used		gal x 1000/lbs		
	Potable Water Used		gal x 1000/lbs		
	Groundwater Extracted		gal x 1000/lbs		
	CO2e Emitted		lbs/lbs		
	NO x Emitted		lbs/lbs		
	SO x Emitted	-1	lbs/lbs	One to one conversion.	
	PM Emitted		lbs/lbs		
	Solid Waste Generated		tons/lbs		
	Haz. Waste Generated		tons/lbs		
	Air Toxics Emitted		lbs/lbs		
	Mercury Released		lbs/lbs		
	Lead Released		lbs/lbs		
	Dioxins Released		lbs/lbs		

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
On-site PM reduction	Energy Used		Mbtu/lbs		
	Grid Electricity Used		MWh/lbs		
	All Water Used		gal x 1000/lbs		
	Potable Water Used		gal x 1000/lbs		
	Groundwater Extracted		gal x 1000/lbs		
	CO2e Emitted		lbs/lbs		
	NO x Emitted		lbs/lbs		
	SO x Emitted		lbs/lbs		
	PM Emitted	-1	lbs/lbs	One to one conversion.	
	Solid Waste Generated		tons/lbs		
	Haz. Waste Generated		tons/lbs		
	Air Toxics Emitted		lbs/lbs		
	Mercury Released		lbs/lbs		
	Lead Released		lbs/lbs		
	Dioxins Released		lbs/lbs		

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
Other 1	Energy Used		Mbtu/TBD		
	Grid Electricity Used		MWh/TBD		
	All Water Used		gal x 1000/TBD		
	Potable Water Used		gal x 1000/TBD		
	Groundwater Extracted		gal x 1000/TBD		
	CO2e Emitted		lbs/TBD		
	NO x Emitted		lbs/TBD		
	SO x Emitted		lbs/TBD		
	PM Emitted		lbs/TBD		
	Solid Waste Generated		tons/TBD		
	Haz. Waste Generated		tons/TBD		
	Air Toxics Emitted		lbs/TBD		
	Mercury Released		lbs/TBD		
	Lead Released		lbs/TBD		
	Dioxins Released		lbs/TBD		

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
Other 2	Energy Used		Mbtu/TBD		
	Grid Electricity Used		MWh/TBD		
	All Water Used		gal x 1000/TBD		
	Potable Water Used		gal x 1000/TBD		
	Groundwater Extracted		gal x 1000/TBD		
	CO2e Emitted		lbs/TBD		
	NO x Emitted		lbs/TBD		
	SO x Emitted		lbs/TBD		
	PM Emitted		lbs/TBD		
	Solid Waste Generated		tons/TBD		
	Haz. Waste Generated		tons/TBD		
	Air Toxics Emitted		lbs/TBD		
	Mercury Released		lbs/TBD		
	Lead Released		lbs/TBD		
	Dioxins Released		lbs/TBD		

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
Electricity production	Energy Used	7800	Mbtu/MWh	Calculated using information from the cited reference. See attached support file titled "Electricity and Energy Used for the Production, Transmission, and On-Site Use of Electricity" for calculations.	U.S. Dept. of Energy GridWorks: Overview of the Electric Grid http://sites.energetics.com/gridworks/grid.html Consumptive Water Use for U.S. Power Production December 2003 • NREL/TP-550-33905
	Grid Electricity Used	0.06	MWh/MWh	Calculated using information from the cited reference. See attached support file titled "Electricity and Energy Used for the Production, Transmission, and On-Site Use of Electricity" for calculations.	
	All Water Used	2	gal x 1000/MWh	Default water usage is for U.S. average directly from Consumptive Water Use for U.S. Power Production. Actual water usage based on the specific fuel blend (see attached support file titled "Power Sources and Global Emissions Factors for Electricity Provided by PG&E" for calculations). Actual water usage includes estimate from Gleick for obtaining and processing fuel resources and consumptive use for thermoelectric and hydroelectric in California from Consumptive Water Use for U.S. Power Production. Default water usage does not include water use for obtaining and processing fuel for electricity generation.	Gleick PH. Water and energy. Annu. Rev. Energy Environ. Vol 19, 1994. p 267-99. Consumptive Water Use for U.S. Power Production December 2003 • NREL/TP-550-33905
	Potable Water Used		gal x 1000/MWh	potable water not delineated separately from "all water use"	
	Groundwater Extracted		gal x 1000/MWh	groundwater not delineated separately from "all water use"	
	CO2e Emitted	1540	lbs/MWh	Default for CO2e, NOx, and SOx obtained from EGRID 2007 v1.1 for average United States values. All results for actual values are multiplied by 1.12 to account for additional electricity generated to offset transmission losses (1.12 = 1 MWh + 0.12 MWh for transmission losses, see above). Default values DO NOT include resource extraction and transportation.	EGRID 2007 v1.1 U.S. EPA
	NO x Emitted	3.9	lbs/MWh		
	SO x Emitted	10	lbs/MWh		
	PM Emitted	0.94	lbs/MWh		
	Solid Waste Generated	0.0009	tons/MWh	EUROPA ELCD - Sum of all listed wastes (demolition debris) except for radioactive wastes, slag, and mining wastes, which would likely not be disposed of in a landfill.	EUROPA file location: Process data set: Electricity Mix; AC; consumption mix, at consumer; < 1kV (en) http://lca.jrc.ec.europa.eu/lcainfohub/datasets/html/processes/001b3cb7-b868-4061-8a91-3e6d7bcc90c6_02.00.000.html
	Haz. Waste Generated	0	tons/MWh	EUROPA ELCD - "Chemical waste, toxic" converted into tons per pound of product. No hazardous waste is listed in EUROPA for diesel production, suggesting that little or no hazardous waste is produced as a result of these activities.	
	Air Toxics Emitted	0.4	lbs/MWh	For all parameters, used output values from NREL for electricity production from natural gas, bituminous coal, and nuclear. For natural gas and bituminous coal, accounted only for direct combustion for energy production and did not account for resource extraction as it is anticipated to be negligible. For nuclear, accounted for major components of processing uranium (electricity, coal in industrial boiler, natural gas in industrial boiler, and diesel in industrial boiler). For electricity in uranium processing, assumed a 50/50 blend of bituminous coal and natural gas (excluded resource extraction). For default values, applied output to an electricity generation blend of 54% bitum. coal, 17% natural gas, 21% nuclear, and 8% hydro, which approximates the NREL blend for US electricity generation. NREL output is for electricity at the power plant. All results are multiplied by 1.12 to account for additional electricity generated to offset transmission losses (1.12 = 1 MWh + 0.12 MWh for transmission losses, see above).	Primary NREL LCI Files: - SS_Electricity, natural gas, at power plant.xls - SS_Electricity, nuclear, at power plant.xls - SS_Electricity, bituminous coal, at power plant.xls Secondary NREL LCI files: - SS_Fuel grade uranium, at regional storage.xls - SS_Bituminous coal, combusted in industrial boiler.xls - SS_Natural gas, combusted in industrial boiler.xls - SS_Diesel, combusted in industrial boiler.xls
	Mercury Released	0.000023	lbs/MWh		
	Lead Released	0.00017	lbs/MWh		
	Dioxins Released	2.4E-10	lbs/MWh		

EUROPA ECLD refers to the European Reference Life Cycle Database (ELCD core database), version II compiled under contract on behalf of the European Commission - DG Joint Research Centre - Institute for Environment and Sustainability with technical and scientific support by JRC-IES from early 2008 to early 2009. (http://lca.jrc.ec.europa.eu/lcainfohub/datasetArea.vm)

"NREL LCI" refers to the U.S. Dept. of Energy, National Renewable Energy Laboratory (NREL), Life-Cycle Inventory Database (www.nrel.gov/lci) maintained by the Alliance for Sustainable Energy, LLC.

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
Purchased Renewa ble Electricity	Energy Used	0	Mbtu/MWh	No value, a REC does not offset the energy used to produce electricity.	
	Grid Electricity Used	0	MWh/MWh	No value, a REC does not offset electricity use.	
	All Water Used	-2	gal x 1000/MWh	Negative value of same parameter for electricity production. Assumes RECs are generated in same region.	
	Potable Water Used		gal x 1000/MWh	Negative value of same parameter for electricity production. Assumes RECs are generated in same region.	
	Groundwater Extracted		gal x 1000/MWh	Negative value of same parameter for electricity production. Assumes RECs are generated in same region.	
	CO2e Emitted	1540	lbs/MWh	Negative value of same parameter for electricity production. Assumes RECs are generated in same region.	
	NO x Emitted	3.9	lbs/MWh	Negative value of same parameter for electricity production. Assumes RECs are generated in same region.	
	SO x Emitted	10	lbs/MWh	Negative value of same parameter for electricity production. Assumes RECs are generated in same region.	
	PM Emitted	0.94	lbs/MWh	Negative value of same parameter for electricity production. Assumes RECs are generated in same region.	
	Solid Waste Generated	0.0009	tons/MWh	Negative value of same parameter for electricity production. Assumes RECs are generated in same region.	
	Haz. Waste Generated	0	tons/MWh	Negative value of same parameter for electricity production. Assumes RECs are generated in same region.	
	Air Toxics Emitted	0.4	lbs/MWh	Negative value of same parameter for electricity production. Assumes RECs are generated in same region.	
	Mercury Released	0.000023	lbs/MWh	Negative value of same parameter for electricity production. Assumes RECs are generated in same region.	
	Lead Released	0.00017	lbs/MWh	Negative value of same parameter for electricity production. Assumes RECs are generated in same region.	
	Dioxins Released	2.4E-10	lbs/MWh	Negative value of same parameter for electricity production. Assumes RECs are generated in same region.	

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
Diesel (off-site use)	Energy Used	139	Mbtu/gal	The reference provides the higher heating value of diesel as 5.825 MMBTU per barrel and defines a barrel as 42 gallons. This converts to approximately 139 Mbtu/gallon.	Climate Leader GHG Inventory EPA-430--K-08-004, May 2008
	Grid Electricity Used		MWh/gal		
	All Water Used		gal x 1000/gal		
	Potable Water Used		gal x 1000/gal		
	Groundwater Extracted		gal x 1000/gal		
	CO2e Emitted	22.5	lbs/gal	The reference provides CO2e emitted as 10.15 kg of CO2 per gallon. This converts to 22.3 pounds per gallon. Additionally, N2O and CH4 emissions are provided as g/gal. Values are converted to lbs/gal using a global warming potential (GWP) of 1 for carbon dioxide, 21 for methane, and 310 for nitrous oxide.	Climate Leader GHG Inventory EPA-430--K-08-004, May 2008
	NO x Emitted	0.17	lbs/gal	NREL LCI reported the amount of diesel in liters required to transport one ton-kilometer (tkm) and provided outputs to nature in kg. The output (nitrogen oxides) generated from transporting 1 tkm was divided by the amount of diesel required to transport 1 tkm, and the units of the result were converted from kg/L to lbs/gallon.	NREL LCI File: SS_Transport, single unit truck, diesel powered.xls
	SO x Emitted	0.0054	lbs/gal	NREL LCI reported the amount of diesel in liters required to transport one ton-kilometer (tkm) and provided outputs to nature in kg. The output (sulfur oxides) generated from transporting 1 tkm was divided by the amount of diesel required to transport 1 tkm, and the units of the result were converted from kg/L to lbs/gallon.	NREL LCI File: SS_Transport, single unit truck, diesel powered.xls
	PM Emitted	0.0034	lbs/gal	NREL LCI reported the amount of diesel in liters required to transport one ton-kilometer (tkm) and provided outputs to nature in kg. The output (Particulates, > 2.5 um, and < 10um) generated from transporting 1 tkm was divided by the amount of diesel required to transport 1 tkm, and the units of the result were converted from kg/L to lbs/gallon.	NREL LCI File: SS_Transport, single unit truck, diesel powered.xls
	Solid Waste Generated		tons/gal	not applicable -- no waste generated when diesel is combusted on-site or in transportation (solid waste and waste oil from maintenance would be tracked separately)	
	Haz. Waste Generated		tons/gal	not applicable -- no waste generated when diesel is combusted on-site or in transportation (solid waste and waste oil from maintenance would be tracked separately)	
	Air Toxics Emitted	0.0000052	lbs/gal	Not available in NREL LCI transport files. Summed hazardous air pollutants emitted from combusting diesel in industrial equipment. NREL LCI provides results in kg per L combusted. Converted this to pounds per gallon by multiplying by 3.785 and multiplying by .2.2	NREL LCI File: SS_diesel combusted in industrial equipment.xls
	Mercury Released	0	lbs/gal	EUROPA ELCD - Reference does not indicate a release of mercury.	EUROPA file location: Lorry transport; Euro 0, 1, 2, 3, 4 mix; 22 t total weight, 17,3 t max payload (excluding fuel supply): http://lca.jrc.ec.europa.eu/lcainfohub/datasets/elcd/processes/b444f4d2-3393-11dd-bd11-0800200c9a66_02.00.000.xml
	Lead Released	0	lbs/gal	EUROPA ELCD - Reference does not indicate a release of lead	
	Dioxins Released	0	lbs/gal	EUROPA ELCD - Reference does not indicate a release of dioxins.	

EUROPA ECLD refers to the European Reference Life Cycle Database (ELCD core database), version II compiled under contract on behalf of the European Commission - DG Joint Research Centre - Institute for Environment and Sustainability with technical and scientific support by JRC-IES from early 2008 to early 2009. (http://lca.jrc.ec.europa.eu/lcainfohub/datasetArea.vm)

"NREL LCI" refers to the U.S. Dept. of Energy, National Renewable Energy Laboratory (NREL), Life-Cycle Inventory Database (www.nrel.gov/lci) maintained by the Alliance for Sustainable Energy, LLC.

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
Gasoline (off-site use)	Energy Used	124	Mbtu/gal	The reference provides the higher heating value of gasoline as 5.218 MMBTU per barrel and defines a barrel as 42 gallons. This converts to approximately 124 Mbtu/gallon.	Climate Leader GHG Inventory EPA-430--K-08-004, May 2008
	Grid Electricity Used		MWh/gal	not applicable -- no electricity used when gasoline is combusted on-site or in transportation	
	All Water Used		gal x 1000/gal	not applicable -- no water used when gasoline is combusted on-site or in transportation	
	Potable Water Used		gal x 1000/gal	not applicable -- no water used when gasoline is combusted on-site or in transportation	
	Groundwater Extracted		gal x 1000/gal	not applicable -- no water used when gasoline is combusted on-site or in transportation	
	CO2e Emitted	19.6	lbs/gal	The reference provides CO2e emitted as 8.81 kg of CO2 per gallon. This converts to 19.4 pounds per gallon. Additionally, N2O and CH4 emissions are provided as g/gal. Values are converted to lbs/gal using a global warming potential (GWP) of 1 for carbon dioxide, 21 for methane, and 310 for nitrous oxide.	Climate Leader GHG Inventory EPA-430--K-08-004, May 2008
	NO x Emitted	0.11	lbs/gal	NREL LCI reported the amount of gasoline in liters required to transport one ton-kilometer (tkm) and provided outputs to nature in kg. The output (nitrogen oxides) generated from transporting 1 tkm was divided by the amount of gasoline required to transport 1 tkm, and the units of the result were converted from kg/L to lbs/gallon.	NREL LCI File: SS_Transport, single unit truck, gasoline powered.xls
	SO x Emitted	0.0045	lbs/gal	NREL LCI reported the amount of gasoline in liters required to transport one ton-kilometer (tkm) and provided outputs to nature in kg. The output (sulfur oxides) generated from transporting 1 tkm was divided by the amount of gasoline required to transport 1 tkm, and the units of the result were converted from kg/L to lbs/gallon.	NREL LCI File: SS_Transport, single unit truck, gasoline powered.xls
	PM Emitted	0.00054	lbs/gal	NREL LCI reported the amount of gasoline in liters required to transport one ton-kilometer (tkm) and provided outputs to nature in kg. The output (Particulates, > 2.5 um, and < 10um) generated from transporting 1 tkm was divided by the amount of gasoline required to transport 1 tkm, and the units of the result were converted from kg/L to lbs/gallon.	NREL LCI File: SS_Transport, single unit truck, gasoline powered.xls
	Solid Waste Generated		tons/gal	not applicable -- no waste generated when gasoline is combusted on-site or in transportation (solid waste and waste oil from maintenance would be tracked separately)	
	Haz. Waste Generated		tons/gal	not applicable -- no waste generated when gasoline is combusted on-site or in transportation (solid waste and waste oil from maintenance would be tracked separately)	
	Air Toxics Emitted	0.000039	lbs/gal	Not available in NREL LCI transport files. Summed hazardous air pollutants emitted from combusting gasoline in industrial equipment. NREL LCI provides results in kg per L combusted. Converted this to pounds per gallon by multiplying by 3.785 and multiplying by .2.2	NREL LCI File: SS_gasoline combusted in industrial equipment.xls
	Mercury Released	0	lbs/gal	EUROPA ELCD - Reference does not indicate a release of mercury.	EUROPA file location: Lorry transport; Euro 0, 1, 2, 3, 4 mix; 22 t total weight, 17,3 t max payload (excluding fuel supply): http://lca.jrc.ec.europa.eu/lcainfohub/datasets/elcd/processes/b444f4d2-3393-11dd-bd11-0800200c9a66_02.00.000.xml
	Lead Released	0	lbs/gal	EUROPA ELCD - Reference does not indicate a release of lead	
	Dioxins Released	0	lbs/gal	EUROPA ELCD - Reference does not indicate a release of dioxins.	

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Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
Natural gas (off-site use)	Energy Used	103	Mbtu/ccf	The reference provides the higher heating value of natural gas as 1,027 BTU per scf. This converts to approximately 103 Mbtu/ccf.	Climate Leader GHG Inventory EPA-430--K-08-004, May 2008
	Grid Electricity Used		MWh/ccf	not applicable -- no electricity used when nat gas is combusted on-site or in transportation	
	All Water Used		gal x 1000/ccf	not applicable -- no water used when nat gas is combusted on-site or in transportation	
	Potable Water Used		gal x 1000/ccf	not applicable -- no water used when nat gas is combusted on-site or in transportation	
	Groundwater Extracted		gal x 1000/ccf	not applicable -- no water used when nat gas is combusted on-site or in transportation	
	CO2e Emitted	12.2	lbs/ccf	NREL LCI reported output in kg and input in m3. The units were converted from kg/m3 to lbs per 100 cubic feet (ccf) and rounded to two significant digits. Outputs for carbon dioxide and fossil methane were used to calculated CO2e. Nitrous oxide was not included as an output. Methane was assigned a global warming potential equal to 21 times that of CO2.	NREL LCI File: SS_Natural gas, combusted in industrial boiler.xls
	NO x Emitted	0.01	lbs/ccf	NREL LCI reported output in kg and input in m3. The units were converted from kg/m3 to lbs per 100 cubic feet (ccf) and rounded to two significant digits.	NREL LCI File: SS_Natural gas, combusted in industrial boiler.xls
	SO x Emitted	0.0000063	lbs/ccf	NREL LCI reported output in kg and input in m3. The units were converted from kg/m3 to lbs per 100 cubic feet (ccf) and rounded to two significant digits.	NREL LCI File: SS_Natural gas, combusted in industrial boiler.xls
	PM Emitted	0.00076	lbs/ccf	NREL LCI reported output in kg and input in m3. The units were converted from kg/m3 to lbs per 100 cubic feet (ccf) and rounded to two significant digits.	NREL LCI File: SS_Natural gas, combusted in industrial boiler.xls
	Solid Waste Generated		tons/ccf	not applicable -- no solid waste generated when natural gas is combusted on-site or in transportation	
	Haz. Waste Generated		tons/ccf	not applicable -- no haz waste generated when natural gas is combusted on-site or in transportation	
	Air Toxics Emitted	0.0000084	lbs/ccf	NREL - Sum of all hazardous air pollutants and groups of contaminants as defined by EPA (HAPs) emitted to atmosphere converted from kg/m3 to lb/ccf. Note that the value for combustion in equipment is significantly lower than the value reported here for use in an industrial boiler.	NREL LCI File: SS_Natural gas, combusted in industrial boiler.xls
	Mercury Released	0.000000026	lbs/ccf	NREL - Mercury released converted from kg/m3 to lb/ccf. Note that according to NREL there is no mercury released for natural gas combusted in industrial equipment.	NREL LCI File: SS_Natural gas, combusted in industrial boiler.xls
	Lead Released	0.00000005	lbs/ccf	NREL - Lead released converted from kg/m3 to lb/ccf. Note that according to NREL there is no lead released for natural gas combusted in industrial equipment.	NREL LCI File: SS_Natural gas, combusted in industrial boiler.xls
	Dioxins Released	0	lbs/ccf	NREL does not indicate the formation of dioxins during natural gas combustion	NREL LCI File: SS_Natural gas, combusted in industrial boiler.xls

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Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
Other Transportation 1	Energy Used		Mbtu/TBD		
	Grid Electricity Used		MWh/TBD		
	All Water Used		gal x 1000/TBD		
	Potable Water Used		gal x 1000/TBD		
	Groundwater Extracted		gal x 1000/TBD		
	CO2e Emitted		lbs/TBD		
	NO x Emitted		lbs/TBD		
	SO x Emitted		lbs/TBD		
	PM Emitted		lbs/TBD		
	Solid Waste Generated		tons/TBD		
	Haz. Waste Generated		tons/TBD		
	Air Toxics Emitted		lbs/TBD		
	Mercury Released		lbs/TBD		
	Lead Released		lbs/TBD		
	Dioxins Released		lbs/TBD		

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
Other Transportation 2	Energy Used		Mbtu/TBD		
	Grid Electricity Used		MWh/TBD		
	All Water Used		gal x 1000/TBD		
	Potable Water Used		gal x 1000/TBD		
	Groundwater Extracted		gal x 1000/TBD		
	CO2e Emitted		lbs/TBD		
	NO x Emitted		lbs/TBD		
	SO x Emitted		lbs/TBD		
	PM Emitted		lbs/TBD		
	Solid Waste Generated		tons/TBD		
	Haz. Waste Generated		tons/TBD		
	Air Toxics Emitted		lbs/TBD		
	Mercury Released		lbs/TBD		
	Lead Released		lbs/TBD		
	Dioxins Released		lbs/TBD		

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
Other Transportation 3	Energy Used		Mbtu/TBD		
	Grid Electricity Used		MWh/TBD		
	All Water Used		gal x 1000/TBD		
	Potable Water Used		gal x 1000/TBD		
	Groundwater Extracted		gal x 1000/TBD		
	CO2e Emitted		lbs/TBD		
	NO x Emitted		lbs/TBD		
	SO x Emitted		lbs/TBD		
	PM Emitted		lbs/TBD		
	Solid Waste Generated		tons/TBD		
	Haz. Waste Generated		tons/TBD		
	Air Toxics Emitted		lbs/TBD		
	Mercury Released		lbs/TBD		
	Lead Released		lbs/TBD		
	Dioxins Released		lbs/TBD		

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
Other Transportation 4	Energy Used		Mbtu/TBD		
	Grid Electricity Used		MWh/TBD		
	All Water Used		gal x 1000/TBD		
	Potable Water Used		gal x 1000/TBD		
	Groundwater Extracted		gal x 1000/TBD		
	CO2e Emitted		lbs/TBD		
	NO x Emitted		lbs/TBD		
	SO x Emitted		lbs/TBD		
	PM Emitted		lbs/TBD		
	Solid Waste Generated		tons/TBD		
	Haz. Waste Generated		tons/TBD		
	Air Toxics Emitted		lbs/TBD		
	Mercury Released		lbs/TBD		
	Lead Released		lbs/TBD		
	Dioxins Released		lbs/TBD		

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
Other Transportation 5	Energy Used		Mbtu/TBD		
	Grid Electricity Used		MWh/TBD		
	All Water Used		gal x 1000/TBD		
	Potable Water Used		gal x 1000/TBD		
	Groundwater Extracted		gal x 1000/TBD		
	CO2e Emitted		lbs/TBD		
	NO x Emitted		lbs/TBD		
	SO x Emitted		lbs/TBD		
	PM Emitted		lbs/TBD		
	Solid Waste Generated		tons/TBD		
	Haz. Waste Generated		tons/TBD		
	Air Toxics Emitted		lbs/TBD		
	Mercury Released		lbs/TBD		
	Lead Released		lbs/TBD		
	Dioxins Released		lbs/TBD		

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
Asphalt	Energy Used		Mbtu/tons		
	Grid Electricity Used		MWh/tons		
	All Water Used		gal x 1000/tons		
	Potable Water Used		gal x 1000/tons		
	Groundwater Extracted		gal x 1000/tons		
	CO2e Emitted		lbs/tons		
	NO x Emitted		lbs/tons		
	SO x Emitted		lbs/tons		
	PM Emitted		lbs/tons		
	Solid Waste Generated		tons/tons		
	Haz. Waste Generated		tons/tons		
	Air Toxics Emitted		lbs/tons		
	Mercury Released		lbs/tons		
	Lead Released		lbs/tons		
	Dioxins Released		lbs/tons		

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
Bentonite	Energy Used	55	Mbtu/tons	Absent other information, gravel and sand used as a surrogate material. See notes for "gravel and sand".	
	Grid Electricity Used	0.0027	MWh/tons	Absent other information, gravel and sand used as a surrogate material. See notes for "gravel and sand".	
	All Water Used	0.13	gal x 1000/tons	Absent other information, gravel and sand used as a surrogate material. See notes for "gravel and sand".	
	Potable Water Used		gal x 1000/tons	Absent other information, gravel and sand used as a surrogate material. See notes for "gravel and sand".	
	Groundwater Extracted		gal x 1000/tons	Absent other information, gravel and sand used as a surrogate material. See notes for "gravel and sand".	
	CO2e Emitted	6.7	lbs/tons	Absent other information, gravel and sand used as a surrogate material. See notes for "gravel and sand".	
	NO x Emitted	0.033	lbs/tons	Absent other information, gravel and sand used as a surrogate material. See notes for "gravel and sand".	
	SO x Emitted	0.03	lbs/tons	Absent other information, gravel and sand used as a surrogate material. See notes for "gravel and sand".	
	PM Emitted	0.004	lbs/tons	Absent other information, gravel and sand used as a surrogate material. See notes for "gravel and sand".	
	Solid Waste Generated	0	tons/tons	Absent other information, gravel and sand used as a surrogate material. See notes for "gravel and sand".	
	Haz. Waste Generated	0	tons/tons	Absent other information, gravel and sand used as a surrogate material. See notes for "gravel and sand".	
	Air Toxics Emitted	0.00000041	lbs/tons	Absent other information, gravel and sand used as a surrogate material. See notes for "gravel and sand".	
	Mercury Released	6.4E-11	lbs/tons	Absent other information, gravel and sand used as a surrogate material. See notes for "gravel and sand".	
	Lead Released	1.2E-09	lbs/tons	Absent other information, gravel and sand used as a surrogate material. See notes for "gravel and sand".	
	Dioxins Released	1.5E-16	lbs/tons	Absent other information, gravel and sand used as a surrogate material. See notes for "gravel and sand".	

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
Borrow (clean soil)	Energy Used	15.75	Mbtu/tons	All parameters based on the use of 0.1 gallons of diesel per ton of soil provided, which is represenative of excavating bulk soil with a hydraulic excavator and hauling bulk soil a short distance in a dump truck.	
	Grid Electricity Used	0.000059	MWh/tons		
	All Water Used	0.000077	gal x 1000/tons		
	Potable Water Used		gal x 1000/tons		
	Groundwater Extracted		gal x 1000/tons		
	CO2e Emitted	2.52	lbs/tons		
	NO x Emitted	0.01764	lbs/tons		
	SO x Emitted	0.00184	lbs/tons		
	PM Emitted	0.000374	lbs/tons		
	Solid Waste Generated	0.000000036	tons/tons		
	Haz. Waste Generated	0	tons/tons		
	Air Toxics Emitted	0.00001252	lbs/tons		
	Mercury Released	4.8E-09	lbs/tons		
	Lead Released	0.00000015	lbs/tons		
	Dioxins Released	3E-15	lbs/tons		

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
Cement	Energy Used	4100	Mbtu/dry-ton	EUROPA ELCD - All forms of energy summed and converted to Mbtus per short ton of product.	Primary NREL LCI Files: -SS_portland cement, at plant.xls EUROPA file location: Portland Cement: http://lca.jrc.ec.europa.eu/lcainfohub/datasets/html/processes/600573dd-dfa5-44e5-b458-8727e793ffd7_02.00.000.html
	Grid Electricity Used	0.13	MWh/dry-ton	Not provided by EUROPA ELCD. NREL LCI includes electricity usage for portland cement. Electricity from portland cement, at plant (but none of the subcomponent files as they are assumed to be negligible) is included in this estimate.	
	All Water Used	0.41	gal x 1000/dry-ton	EUROPA ELCD - Sum of "water", "surface water", "groundwater", and "river water". Negative values (indicating return of water to the hydrosphere) were not included. Sea water was also not included. Result converted to thousands of gallons per short ton of product.	
	Potable Water Used		gal x 1000/dry-ton	Not applicable -- no local potable water used.	
	Groundwater Extracted		gal x 1000/dry-ton	Not applicable -- no local or on-site ground water extracted.	
	CO2e Emitted	1800	lbs/dry-ton	EUROPA ELCD - Sum of total global warming potential for carbon dioxide, methane, and nitrous oxide released to atmosphere. A global warming potential of 21 is used for methane and a global warming potential of 310 is used for nitrous oxide. Results converted to pounds of carbon dioxide equivalents per short ton of product.	
	NO x Emitted	3.6	lbs/dry-ton	EUROPA ELCD - Sum of nitrogen oxides emitted to atmosphere. Results converted to pounds of NO x per short ton of product.	
	SO x Emitted	2.1	lbs/dry-ton	EUROPA ELCD - Sum of sulfur oxides emitted to atmosphere. Results converted to pounds of SO x per short ton of product.	
	PM Emitted	0.0063	lbs/dry-ton	EUROPA ELCD - Sum of particulate matter (PM 10 and smaller) emitted to atmosphere. Results converted to pounds of PM per short ton of product.	
	Solid Waste Generated	0	tons/dry-ton	EUROPA ELCD - There is no indication of generated solid waste that would be disposed ofat a landfill. Typical wastes indicated include radioactive wastes, mining wastes, and slag (expected to be used in some form elsewhere in industry).	
	Haz. Waste Generated	0	tons/dry-ton	EUROPA ELCD - "Chemical waste, toxic" converted into tons per pound of product. No hazardous waste is listed in EUROPA for gravel/sand, suggesting that little or no hazardous waste is produced as a result of these activities.	
	Air Toxics Emitted	0.058	lbs/dry-ton	EUROPA ELCD - Sum of all hazardous air pollutants and groups of contaminants as defined by EPA (HAPs) emitted to atmosphere. Reported in pounds per short ton of product.	
	Mercury Released	0.000057	lbs/dry-ton	EUROPA ELCD - Sum of all mercury and mercury compounds released to air or water. Reported in pounds per short ton of product.	
	Lead Released	0.00013	lbs/dry-ton	EUROPA ELCD - Sum of all lead and lead compounds released to air or water. Reported in pounds per short ton of product.	
	Dioxins Released	8.5E-11	lbs/dry-ton	EUROPA ELCD - Sum of all dioxins released to air or water. Reported in pounds per short ton of product.	

EUROPA ECLD refers to the European Reference Life Cycle Database (ELCD core database), version II compiled under contract on behalf of the European Commission - DG Joint Research Centre - Institute for Environment and Sustainability with technical and scientific support by JRC-IES from early 2008 to early 2009. (http://lca.jrc.ec.europa.eu/lcainfohub/datasetArea.vm)

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
Cheese Whey	Energy Used	1.87	Mbtu/lbs	See attached support file titled "Derivation of Cheese Whey Values from LCA Food"	- Nielsen PH, Nielsen AM, Weidema BP, Dalgaard R and Halberg N (2003). LCA food data base. www.lcafood.dk Andersen M and Jensen JD (2003). Marginale producenter af udvalgte basislevnedsmidler (in Danish) Udkast d. 5. februar 2003
	Grid Electricity Used	0	MWh/lbs	None indicated.	
	All Water Used	0	gal x 1000/lbs	None indicated.	
	Potable Water Used		gal x 1000/lbs	Not applicable -- no local potable water used.	
	Groundwater Extracted		gal x 1000/lbs	Not applicable -- no local or on-site ground water extracted.	
	CO2e Emitted	1.1	lbs/lbs	See attached support file titled "Derivation of Cheese Whey Values from LCA Food"	
	NO x Emitted	0.0083	lbs/lbs	See attached support file titled "Derivation of Cheese Whey Values from LCA Food"	
	SO x Emitted	0.0099	lbs/lbs	See attached support file titled "Derivation of Cheese Whey Values from LCA Food"	
	PM Emitted	0.000166	lbs/lbs	See attached support file titled "Derivation of Cheese Whey Values from LCA Food"	
	Solid Waste Generated	0	tons/lbs	Not available	
	Haz. Waste Generated	0	tons/lbs	Not available	
	Air Toxics Emitted	0	lbs/lbs	Not available	
	Mercury Released	0	lbs/lbs	Not available	
	Lead Released	0	lbs/lbs	Not available	
	Dioxins Released	0	lbs/lbs	Not available	

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
Concrete	Energy Used	3019	Mbtu/tons	Energy and all parameters calculated using values for potable water, sand/gravel, and cement grout assuming a 0.45:1:4 ratio by weight (typical). A quantity of 0.02 gals x 1000 is also added to "all water" to account for the 8.25% of the concrete mass that is water.	
	Grid Electricity Used	0.096	MWh/tons		
	All Water Used	0.34	gal x 1000/tons		
	Potable Water Used		gal x 1000/tons		
	Groundwater Extracted		gal x 1000/tons		
	CO2e Emitted	1322	lbs/tons		
	NO x Emitted	2.6	lbs/tons		
	SO x Emitted	1.5	lbs/tons		
	PM Emitted	0.0054	lbs/tons		
	Solid Waste Generated	0.000000012	tons/tons		
	Haz. Waste Generated	0	tons/tons		
	Air Toxics Emitted	0.043	lbs/tons		
	Mercury Released	0.000042	lbs/tons		
	Lead Released	0.000095	lbs/tons		
	Dioxins Released	6.2E-11	lbs/tons		

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
Diesel Produced	Energy Used	18.5	Mbtu/gal	EUROPA ELCD - All forms of energy summed and converted to Mbtus per gallon of product.	Primary NREL LCI File: -SS_crude oil, in refinery.xls Secondary NREL LCI File: -SS_crude oil, at production.xls EUROPA file location: Diesel at refinery: http://lca.jrc.ec.europa.eu/lcainfohub/datasets/html/processes/244524ed-7b85-4548-b345-f58dc5cf9dac_02.00.000.html
	Grid Electricity Used	0.00059	MWh/gal	Not provided by EUROPA ELCD. NREL LCI includes electricity usage for crude oil, in refinery with an allocation to diesel. Electricity from crude oil, in refinery (allocated to diesel) and crude oil, at production are included.	
	All Water Used	0.00077	gal x 1000/gal	EUROPA ELCD - Sum of "water", "surface water", "groundwater", and "river water". Negative values (indicating return of water to the hydrosphere) were not included. Sea water was also not included. Result converted to thousands of gallons per gallon of product	
	Potable Water Used		gal x 1000/gal	Not applicable -- no local potable water used during diesel production.	
	Groundwater Extracted		gal x 1000/gal	Not applicable -- no local or on-site ground water extracted during diesel production.	
	CO2e Emitted	2.7	lbs/gal	EUROPA ELCD - Sum of total global warming potential for carbon dioxide, methane, and nitrous oxide released to atmosphere. A global warming potential of 21 is used for methane and a global warming potential of 310 is used for nitrous oxide. Results converted to pounds of carbon dioxide equivalents per gallon of product.	
	NO x Emitted	0.0064	lbs/gal	EUROPA ELCD - Sum of nitrogen oxides emitted to atmosphere. Results converted to pounds of NO x per gallon of product.	
	SO x Emitted	0.013	lbs/gal	EUROPA ELCD - Sum of sulfur oxides emitted to atmosphere. Results converted to pounds of SO x per gallon of product.	
	PM Emitted	0.00034	lbs/gal	EUROPA ELCD - Sum of particulate matter (PM 10 and smaller) emitted to atmosphere. Results converted to pounds of PM per gallon of product.	
	Solid Waste Generated	0.00000036	tons/gal	EUROPA ELCD - Sum of all listed wastes (demolition debris) except for radioactive wastes, slag, and mining wastes, which would likely not be disposed of in a landfill.	
	Haz. Waste Generated	0	tons/gal	EUROPA ELCD - "Chemical waste, toxic" converted into tons per pound of product. No hazardous waste is listed in EUROPA for diesel production, suggesting that little or no hazardous waste is produced as a result of these activities.	
	Air Toxics Emitted	0.00012	lbs/gal	EUROPA ELCD - Sum of all hazardous air pollutants and groups of contaminants as defined by EPA (HAPs) emitted to atmosphere. Reported as pounds per gallon of product.	
	Mercury Released	0.000000048	lbs/gal	EUROPA ELCD - Sum of all mercury and mercury compounds released to air or water. Reported as pounds per gallon of product.	
	Lead Released	0.0000015	lbs/gal	EUROPA ELCD - Sum of all lead and lead compounds released to air or water. Reported as pounds per gallon of product.	
	Dioxins Released	3E-14	lbs/gal	EUROPA ELCD - Sum of all dioxins released to air or water. Reported as pounds per gallon of product.	

EUROPA ECLD refers to the European Reference Life Cycle Database (ELCD core database), version II compiled under contract on behalf of the European Commission - DG Joint Research Centre - Institute for Environment and Sustainability with technical and scientific support by JRC-IES from early 2008 to early 2009. (http://lca.jrc.ec.europa.eu/lcainfohub/datasetArea.vm)

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
Emulsified vegetable oil	Energy Used	3.6	Mbtu/lbs	See attached support file titled "Derivation of Vegetable Oil Values from LCA Food"	Nielsen PH, Nielsen AM, Weidema BP, Dalgaard R and Halberg N (2003). LCA food data base. www.lcafood.dk Landbrugets rådgivningscenter (2000). Tal fra Fodermiddeltabellen, Raport nr. 91. In Danish. Weidema BP (1999). System expansions to handle co-products of renewable materials. Presentation Summaries of the 7th LCA Case Studies Symposium SETAC-Europe, 1999. Pp. 45-48. pdf. Weidema B (2003). Market information in life cycle assessments. Technical report, Danish Environmental Protection Agency (Environmental Project no. 863).
	Grid Electricity Used	0.000055	MWh/lbs	See attached support file titled "Derivation of Vegetable Oil Values from LCA Food"	
	All Water Used	0.000024	gal x 1000/lbs	See attached support file titled "Derivation of Vegetable Oil Values from LCA Food"	
	Potable Water Used		gal x 1000/lbs	Not used. -- no local potable water used during soybean oil production.	
	Groundwater Extracted		gal x 1000/lbs	Not used. -- no local or on-site ground water extracted during soybean oil production.	
	CO2e Emitted	3.51	lbs/lbs	See attached support file titled "Derivation of Vegetable Oil Values from LCA Food"	
	NO x Emitted	0.0265	lbs/lbs		
	SO x Emitted	0.031	lbs/lbs		
	PM Emitted	0.0017	lbs/lbs		
	Solid Waste Generated	0	tons/lbs	Not available	
	Haz. Waste Generated	0	tons/lbs	Not available	
	Air Toxics Emitted	0	lbs/lbs	Not available	
	Mercury Released	0	lbs/lbs	Not available	
	Lead Released	0	lbs/lbs	Not available	
	Dioxins Released	0	lbs/lbs	Not available	

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
GAC: regenerated	Energy Used	9.6	Mbtu/lbs	Calculated using information from the cited reference. See support file for calculations.	Use of Adsorbents for the Removal of Pollutants from Wastewaters, by Gordon McKay, published by CRC Press, 1995, ISBN 0849369207
	Grid Electricity Used	0.00044	MWh/lbs	Calculated using information from the cited reference. See support file for calculations.	
	All Water Used	0.0064	gal x 1000/lbs	Calculated using information from the cited reference. See support file for calculations.	
	Potable Water Used		gal x 1000/lbs	Not applicable -- no local potable water used.	
	Groundwater Extracted		gal x 1000/lbs	Not applicable -- no local or on-site ground water extracted.	
	CO2e Emitted	2	lbs/lbs	Calculated using information from the cited reference. See support file for calculations.	
	NO x Emitted	0.025	lbs/lbs		
	SO x Emitted	0.015	lbs/lbs		
	PM Emitted	0	lbs/lbs	Not calculated	
	Solid Waste Generated	0	tons/lbs	Information not available. To be added when additional information becomes available.	
	Haz. Waste Generated	0	tons/lbs	Information not available. To be added when additional information becomes available.	
	Air Toxics Emitted	0	lbs/lbs	Information not available. To be added when additional information becomes available.	
	Mercury Released	0	lbs/lbs	Information not available. To be added when additional information becomes available.	
	Lead Released	0	lbs/lbs	Information not available. To be added when additional information becomes available.	
	Dioxins Released	0	lbs/lbs	Information not available. To be added when additional information becomes available.	

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
GAC: virgin coal-based	Energy Used	10.8	Mbtu/lbs	Calculated using information from the cited reference. See support file for calculations.	Use of Adsorbents for the Removal of Pollutants from Wastewaters, by Gordon McKay, published by CRC Press, 1995, ISBN 0849369207
	Grid Electricity Used	0.000045	MWh/lbs	Calculated using information from the cited reference. See support file for calculations.	
	All Water Used		gal x 1000/lbs	Calculated using information from the cited reference. See support file for calculations.	
	Potable Water Used		gal x 1000/lbs	Not applicable -- no local potable water used.	
	Groundwater Extracted		gal x 1000/lbs	Not applicable -- no local or on-site ground water extracted.	
	CO2e Emitted	4.5	lbs/lbs	Calculated using information from the cited reference. See support file for calculations.	
	NO x Emitted	0.12	lbs/lbs		
	SO x Emitted	0.074	lbs/lbs		
	PM Emitted		lbs/lbs	Not calculated	
	Solid Waste Generated		tons/lbs	Information not available. To be added when additional information becomes available.	
	Haz. Waste Generated		tons/lbs	Information not available. To be added when additional information becomes available.	
	Air Toxics Emitted		lbs/lbs	Information not available. To be added when additional information becomes available.	
	Mercury Released		lbs/lbs	Information not available. To be added when additional information becomes available.	
	Lead Released		lbs/lbs	Information not available. To be added when additional information becomes available.	
	Dioxins Released		lbs/lbs	Information not available. To be added when additional information becomes available.	

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
GAC: virgin coconut-based	Energy Used		Mbtu/lbs	Calculated using information from the cited reference. See support file for calculations.	Use of Adsorbents for the Removal of Pollutants from Wastewaters, by Gordon McKay, published by CRC Press, 1995, ISBN 0849369207
	Grid Electricity Used		MWh/lbs	Calculated using information from the cited reference. See support file for calculations.	
	All Water Used		gal x 1000/lbs	Calculated using information from the cited reference. See support file for calculations.	
	Potable Water Used		gal x 1000/lbs	Not applicable -- no local potable water used.	
	Groundwater Extracted		gal x 1000/lbs	Not applicable -- no local or on-site ground water extracted.	
	CO2e Emitted		lbs/lbs	Calculated using information from the cited reference. See support file for calculations.	
	NO x Emitted		lbs/lbs		
	SO x Emitted		lbs/lbs		
	PM Emitted		lbs/lbs	Not calculated	
	Solid Waste Generated		tons/lbs	Information not available. To be added when additional information becomes available.	
	Haz. Waste Generated		tons/lbs	Information not available. To be added when additional information becomes available.	
	Air Toxics Emitted		lbs/lbs	Information not available. To be added when additional information becomes available.	
	Mercury Released		lbs/lbs	Information not available. To be added when additional information becomes available.	
	Lead Released		lbs/lbs	Information not available. To be added when additional information becomes available.	
	Dioxins Released		lbs/lbs	Information not available. To be added when additional information becomes available.	

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
Gasoline Produced	Energy Used	21	Mbtu/gal	EUROPA ELCD - All forms of energy summed and converted to Mbtus per gallon of product.	Primary NREL LCI File: -SS_crude oil, in refinery.xls Secondary NREL LCI File: -SS_crude oil, at production.xls EUROPA file location: Gasoline at refinery: http://lca.jrc.ec.europa.eu/lcainfohub/datasets/html/processes/5f62ed77-85d0-4c99-8d2c-be56951d8fb3_02.00.000.html
	Grid Electricity Used	0.00059	MWh/gal	Not provided by EUROPA ELCD. NREL LCI includes electricity usage for crude oil, in refinery with an allocation to diesel. Electricity from crude oil, in refinery (allocated to diesel) and crude oil, at production are included.	
	All Water Used	0.00079	gal x 1000/gal	EUROPA ELCD - Sum of "water", "surface water", "groundwater", and "river water". Negative values (indicating return of water to the hydrosphere) were not included. Sea water was also not included. Result converted to thousands of gallons per gallon of product	
	Potable Water Used		gal x 1000/gal	Not applicable -- no local potable water used during gasoline production.	
	Groundwater Extracted		gal x 1000/gal	Not applicable -- no local or on-site ground water extracted during gasoline production.	
	CO2e Emitted	4.4	lbs/gal	EUROPA ELCD - Sum of total global warming potential for carbon dioxide, methane, and nitrous oxide released to atmosphere. A global warming potential of 21 is used for methane and a global warming potential of 310 is used for nitrous oxide. Results converted to pounds of carbon dioxide equivalents per gallon of product.	
	NO x Emitted	0.008	lbs/gal	EUROPA ELCD - Sum of nitrogen oxides emitted to atmosphere. Results converted to pounds of NO x per gallon of product.	
	SO x Emitted	0.019	lbs/gal	EUROPA ELCD - Sum of sulfur oxides emitted to atmosphere. Results converted to pounds of SO x per gallon of product.	
	PM Emitted	0.00052	lbs/gal	EUROPA ELCD - Sum of particulate matter (PM 10 and smaller) emitted to atmosphere. Results converted to pounds of PM per gallon of product.	
	Solid Waste Generated	0.00000042	tons/gal	EUROPA ELCD - Sum of all listed wastes (demolition debris) except for radioactive wastes, slag, and mining wastes, which would likely not be disposed of in a landfill.	
	Haz. Waste Generated	0	tons/gal	EUROPA ELCD - "Chemical waste, toxic" converted into tons per pound of product. No hazardous waste is listed in EUROPA for diesel production, suggesting that little or no hazardous waste is produced as a result of these activities.	
	Air Toxics Emitted	0.00016	lbs/gal	EUROPA ELCD - Sum of all hazardous air pollutants and groups of contaminants as defined by EPA (HAPs) emitted to atmosphere. Reported as pounds per gallon of product.	
	Mercury Released	0.000000085	lbs/gal	EUROPA ELCD - Sum of all mercury and mercury compounds released to air or water. Reported as pounds per gallon of product.	
	Lead Released	0.0000022	lbs/gal	EUROPA ELCD - Sum of all lead and lead compounds released to air or water. Reported as pounds per gallon of product.	
	Dioxins Released	3.1E-14	lbs/gal	EUROPA ELCD - Sum of all dioxins released to air or water. Reported as pounds per gallon of product.	

EUROPA ECLD refers to the European Reference Life Cycle Database (ELCD core database), version II compiled under contract on behalf of the European Commission - DG Joint Research Centre - Institute for Environment and Sustainability with technical and scientific support by JRC-IES from early 2008 to early 2009. (http://lca.jrc.ec.europa.eu/lcainfohub/datasetArea.vm)

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
Gravel/sand/clay	Energy Used	55	Mbtu/ton	EUROPA ELCD - All forms of energy summed and converted to Mbtus per short ton of product.	EUROPA file Location: Gravel 2/32: http://lca.jrc.ec.europa.eu/lcainfohub/datasets/html/processes/898618b2-3306-11dd-bd11-0800200c9a66_02.00.000.html
	Grid Electricity Used	0.0027	MWh/ton	Not provided by EUROPA ELCD. Arbritrarily taken as 50% of all energy consumed assuming a 33% thermal efficiency. (i.e., MWh 50% of Mbtus of energy multiplied by 33%)	
	All Water Used	0.13	gal x 1000/ton	EUROPA ELCD - Sum of "water", "surface water", "groundwater", and "river water". Negative values (indicating return of water to the hydrosphere) were not included. Sea water was also not included. Result converted to thousands of gallons per short ton of product.	
	Potable Water Used		gal x 1000/ton	Not applicable -- no local potable water used.	
	Groundwater Extracted		gal x 1000/ton	Not applicable -- no local or on-site ground water extracted.	
	CO2e Emitted	6.7	lbs/ton	EUROPA ELCD - Sum of total global warming potential for carbon dioxide, methane, and nitrous oxide released to atmosphere. A global warming potential of 21 is used for methane and a global warming potential of 310 is used for nitrous oxide. Results converted to pounds of carbon dioxide equivalents per short ton of product.	
	NO x Emitted	0.033	lbs/ton	EUROPA ELCD - Sum of nitrogen oxides emitted to atmosphere. Results converted to pounds of NO x per short ton of product.	
	SO x Emitted	0.03	lbs/ton	EUROPA ELCD - Sum of sulfur oxides emitted to atmosphere. Results converted to pounds of SO x per short ton of product.	
	PM Emitted	0.004	lbs/ton	EUROPA ELCD - Sum of particulate matter (PM 10 and smaller) emitted to atmosphere. Results converted to pounds of PM per short ton of product.	
	Solid Waste Generated	0	tons/ton	EUROPA ELCD - There is no indication of generated solid waste that would be disposed ofat a landfill. Typical wastes indicated include radioactive wastes, mining wastes, and slag (expected to be used in some form elsewhere in industry).	
	Haz. Waste Generated	0	tons/ton	EUROPA ELCD - "Chemical waste, toxic" converted into tons per pound of product. No hazardous waste is listed in EUROPA for gravel/sand, suggesting that little or no hazardous waste is produced as a result of these activities.	
	Air Toxics Emitted	0.00000041	lbs/ton	EUROPA ELCD - Sum of all hazardous air pollutants and groups of contaminants as defined by EPA (HAPs) emitted to atmosphere. Reported in pounds per short ton of product.	
	Mercury Released	6.4E-11	lbs/ton	EUROPA ELCD - Sum of all mercury and mercury compounds released to air or water. Reported in pounds per short ton of product.	
	Lead Released	1.2E-09	lbs/ton	EUROPA ELCD - Sum of all lead and lead compounds released to air or water. Reported in pounds per short ton of product.	
	Dioxins Released	1.5E-16	lbs/ton	EUROPA ELCD - Sum of all dioxins released to air or water. Reported in pounds per short ton of product.	

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Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
HDPE	Energy Used	31	Mbtu/lb	EUROPA ELCD - All forms of energy summed and converted to Mbtus per pound of product.	EUROPA file location: Polyethylene high density granulate (PE-HD) ; production mix, at plant: http://lca.jrc.ec.europa.eu/lcainfohub/datasets/html/processes/0704c700-2fb0-43c5-8803-bed8a6f1b968_02.00.000.html
	Grid Electricity Used	0.00025	MWh/lb	Not provided by EUROPA ELCD. NREL LCI includes electricity usage for HDPE manufacturing. Electricity from polyvinyl chloride resin, at plant file and the following major subcomponent files is included in this estimate: Ethylene dichloride-vinyl chloride monomer, at plant; Ethylene, at plant; Chlorine, PVC producer average, at plant; Oxygen, liquid, at plant.	
	All Water Used	0.0023	gal x 1000/lb	EUROPA ELCD - Sum of "water", "surface water", "groundwater", and "river water". Negative values (indicating return of water to the hydrosphere) were not included. Sea water was also not included. Result converted to thousands of gallons per pound.	
	Potable Water Used		gal x 1000/lb	Not applicable -- no local potable water used.	
	Groundwater Extracted		gal x 1000/lb	Not applicable -- no local or on-site ground water extracted.	
	CO2e Emitted	1.9	lbs/lb	EUROPA ELCD - Sum of total global warming potential for carbon dioxide, methane, and nitrous oxide released to atmosphere. A global warming potential of 21 is used for methane and a global warming potential of 310 is used for nitrous oxide. Results converted to pounds of carbon dioxide equivalents per pound of product.	
	NO x Emitted	0.0032	lbs/lb	EUROPA ELCD - Sum of nitrogen oxides emitted to atmosphere. Results converted to pounds of NO x per pound of product.	
	SO x Emitted	0.0041	lbs/lb	EUROPA ELCD - Sum of sulfur oxides emitted to atmosphere. Results converted to pounds of SO x per pound of product.	
	PM Emitted	0.00064	lbs/lb	EUROPA ELCD - Sum of particulate matter (PM 10 and smaller) emitted to atmosphere. Results converted to pounds of PM per pound of product.	
	Solid Waste Generated	0.00000043	tons/lb	EUROPA ELCD - Sum of all wastes except for mine wastes and toxic chemical wastes.	
	Haz. Waste Generated	0.000001	tons/lb	EUROPA ELCD - "Chemical waste, toxic" converted into tons per pound of product.	
	Air Toxics Emitted	0.0000034	lbs/lb	EUROPA ELCD - Sum of all hazardous air pollutants and groups of contaminants as defined by EPA (HAPs) emitted to atmosphere.	
	Mercury Released	2.6E-09	lbs/lb	EUROPA ELCD - Sum of all mercury and mercury compounds released to air or water.	
	Lead Released	2.4E-09	lbs/lb	EUROPA ELCD - Sum of all lead and lead compounds released to air or water.	
	Dioxins Released	9.8E-10	lbs/lb	EUROPA ELCD - Sum of all dioxins released to air or water.	

EUROPA ECLD refers to the European Reference Life Cycle Database (ELCD core database), version II compiled under contract on behalf of the European Commission - DG Joint Research Centre - Institute for Environment and Sustainability with technical and scientific support by JRC-IES from early 2008 to early 2009. (http://lca.jrc.ec.europa.eu/lcainfohub/datasetArea.vm)

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
Hydrochloric acid (30%, SG = 1.18)	Energy Used		Mbtu/lbs		
	Grid Electricity Used		MWh/lbs		
	All Water Used		gal x 1000/lbs		
	Potable Water Used		gal x 1000/lbs		
	Groundwater Extracted		gal x 1000/lbs		
	CO2e Emitted		lbs/lbs		
	NO x Emitted		lbs/lbs		
	SO x Emitted		lbs/lbs		
	PM Emitted		lbs/lbs		
	Solid Waste Generated		tons/lbs		
	Haz. Waste Generated		tons/lbs		
	Air Toxics Emitted		lbs/lbs		
	Mercury Released		lbs/lbs		
	Lead Released		lbs/lbs		
	Dioxins Released		lbs/lbs		

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
Hydrogen peroxide (50%, SG=1.19)	Energy Used	4.95	Mbtu/lbs	The value for energy is obtained from the provided reference, converted from MJ to Mbtus and multiplied by 50% to convert from a pure product to the 50% product indicated here.	Ecoprofile of Hydrogen Peroxide CEFIC Peroxygens Sector Group European Chemical Industry Council http://www.cefic.be/sector/peroxy/ecohydro/tc.htm
	Grid Electricity Used	0.000597	MWh/lbs	The value for energy is obtained from the provided reference, converted from MJ to MWh and multiplied by 50% to convert from a pure product to the 50% product indicated here.	
	All Water Used	0.019	gal x 1000/lbs	The value for all water is obtained from the provided reference, converted from mg/kg to 1000 gallons per lb multiplied by 50% plus an additional lb of water per lb of product to account for the 50% solution used here. Process water and cooling water are used. Sea water is not used.	
	Potable Water Used		gal x 1000/lbs		
	Groundwater Extracted		gal x 1000/lbs		
	CO2e Emitted	1.35	lbs/lbs	The value for CO2e emissions is obtained from the provided reference, converted from mg/kg to lbs/lb and multiplied by 50% to convert from a pure product to the 50% product indicated here. CO2 is given a global warming potential of 1 CO2e, methane is given a global warming potential of 21 CO2e, and nitrous oxide is given a global warming potential of 310 CO2e.	
	NO x Emitted	0.0087	lbs/lbs	The value for NOx emissions is obtained from the provided reference, converted from mg/kg to lbs/lb and multiplied by 50% to convert from a pure product to the 50% product indicated here.	
	SO x Emitted	0.0066	lbs/lbs	The value for SOx emissions is obtained from the provided reference, converted from mg/kg to lbs/lb and multiplied by 50% to convert from a pure product to the 50% product indicated here.	
	PM Emitted	0.0025	lbs/lbs	The value for PM emissions is obtained from the "dust" category in the provided reference, converted from mg/kg to lbs/lb and multiplied by 50% to convert from a pure product to the 50% product indicated here.	
	Solid Waste Generated	0.000013	tons/lbs	Solid waste values are obtained from the provided reference, convereted from mg/kg to tons/lb and multiplied by 50% to convert from the pure product in the ecoprofile to the 50% solution used here. Mixed industrial, slags/ash, inert chemical, metals, and plastics are considered. Mineral (i.e., mining wastes), regulated waste, and incinerated waste are not considered.	
	Haz. Waste Generated	0.00000048	tons/lbs	Hazardous waste values are obtained from the provided reference, convereted from mg/kg to tons/lb and multiplied by 50% to convert from the pure product in the ecoprofile to the 50% solution used here. Only regulated chemical waste is included.	
	Air Toxics Emitted	0.00023	lbs/lbs	The value for air toxics emissions is obtained from the provided reference, converted from mg/kg to lbs/lb and multiplied by 50% to convert from a pure product to the 50% product indicated here. All metals, H2S, HCl, chlorine, HF, metals, fluorine, organo-Cl, and aromatic HCs are considered air toxics.	
	Mercury Released		lbs/lbs	Not available	
	Lead Released		lbs/lbs	Not available	
	Dioxins Released		lbs/lbs	Not available	

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
Hydroseed	Energy Used	0.049	Mbtu/lbs	Assume content by weight as follows: - 90% water - 10% mulch - 0.3% nitrogen fertilizer - 0.5% seed Assume mulch is readily available wood waste product that is being recycled and has a negligible footprint. Assume water is obtained by pumping against a head of 50 psi with a 75% efficient pump and 75% efficient motor Assume seeds have a negligible footprint.	
	Grid Electricity Used	1.46044E-07	MWh/lbs		
	All Water Used	0.00012	gal x 1000/lbs		
	Potable Water Used		gal x 1000/lbs		
	Groundwater Extracted		gal x 1000/lbs		
	CO2e Emitted	0.0046	lbs/lbs		
	NO x Emitted	0.0000027	lbs/lbs		
	SO x Emitted	0.000053	lbs/lbs		
	PM Emitted	0.00000028	lbs/lbs		
	Solid Waste Generated	0	tons/lbs		
	Haz. Waste Generated	0	tons/lbs		
	Air Toxics Emitted	0.00000081	lbs/lbs		
	Mercury Released	2E-11	lbs/lbs		
	Lead Released	1.29E-10	lbs/lbs		
	Dioxins Released	0	lbs/lbs		

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
Lime	Energy Used		Mbtu/lbs		
	Grid Electricity Used		MWh/lbs		
	All Water Used		gal x 1000/lbs		
	Potable Water Used		gal x 1000/lbs		
	Groundwater Extracted		gal x 1000/lbs		
	CO2e Emitted		lbs/lbs		
	NO x Emitted		lbs/lbs		
	SO x Emitted		lbs/lbs		
	PM Emitted		lbs/lbs		
	Solid Waste Generated		tons/lbs		
	Haz. Waste Generated		tons/lbs		
	Air Toxics Emitted		lbs/lbs		
	Mercury Released		lbs/lbs		
	Lead Released		lbs/lbs		
	Dioxins Released		lbs/lbs		

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
Molasses	Energy Used	1.31	Mbtu/lbs	See attached support file titled "Derivation of Molasses Values from LCA Food"	Nielsen PH, Nielsen AM, Weidema BP, Dalgaard R and Halberg N (2003). LCA food data base. www.lcafood.dk Sugar Production based on Danisco Sugar Author: Per H. Nielsen July 2003
	Grid Electricity Used	0.000005	MWh/lbs	See attached support file titled "Derivation of Molasses Values from LCA Food"	
	All Water Used	0.000091	gal x 1000/lbs	See attached support file titled "Derivation of Molasses Values from LCA Food"	
	Potable Water Used		gal x 1000/lbs	Not applicable -- no local potable water used.	
	Groundwater Extracted		gal x 1000/lbs	Not applicable -- no local or on-site ground water extracted.	
	CO2e Emitted	0.4	lbs/lbs	See attached support file titled "Derivation of Molasses Values from LCA Food"	
	NO x Emitted	0.003	lbs/lbs		
	SO x Emitted	0.0026	lbs/lbs		
	PM Emitted	0.00006	lbs/lbs		
	Solid Waste Generated	0	tons/lbs	Not available	
	Haz. Waste Generated	0	tons/lbs	Not available	
	Air Toxics Emitted	0	lbs/lbs	Not available	
	Mercury Released	0	lbs/lbs	Not available	
	Lead Released	0	lbs/lbs	Not available	
	Dioxins Released	0	lbs/lbs	Not available	

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
Natural Gas Produced	Energy Used	5.2	Mbtu/ccf	EUROPA ELCD - All forms of energy summed and converted to Mbtus per hundred cubic feet (ccf) of product, assuming 0.05 pounds per cubic foot (approximately 20 liters per mole of methane).	EUROPA file location: Natural Gas at consumer: http://lca.jrc.ec.europa.eu/lcainfohub/datasets/html/processes/3d602e55-aaa2-44e3-adb9-40f49eb1a915_02.00.000.html
	Grid Electricity Used	0.00025	MWh/ccf	Not provided by EUROPA ELCD. Arbitrarily taken as 50% of all energy consumed assuming a 33% thermal efficiency. (i.e., MWh 50% of Mbtus of energy multiplied by 33%)	
	All Water Used	0.000077	gal x 1000/ccf	EUROPA ELCD - Sum of "water", "surface water", "groundwater", and "river water". Negative values (indicating return of water to the hydrosphere) were not included. Sea water was also not included. Result converted to thousands of gallons per hundred cubic feet (ccf) of product, assuming 0.05 pounds per cubic foot.	
	Potable Water Used		gal x 1000/ccf	Not applicable -- no local potable water used during natural gas production.	
	Groundwater Extracted		gal x 1000/ccf	Not applicable -- no local or on-site ground water extracted during natural gas production.	
	CO2e Emitted	2.2	lbs/ccf	EUROPA ELCD - Sum of total global warming potential for carbon dioxide, methane, and nitrous oxide released to atmosphere. A global warming potential of 21 is used for methane and a global warming potential of 310 is used for nitrous oxide. Results converted to pounds of carbon dioxide equivalents per hundred cubic feet (ccf) of product, assuming 0.05 pounds per cubic foot.	
	NO x Emitted	0.0037	lbs/ccf	EUROPA ELCD - Sum of nitrogen oxides emitted to atmosphere. Results converted to pounds of NO x per hundred cubic feet (ccf) of product, assuming 0.05 pounds per cubic foot.	
	SO x Emitted	0.0046	lbs/ccf	EUROPA ELCD - Sum of sulfur oxides emitted to atmosphere. Results converted to pounds of SO x per hundred cubic feet (ccf) of product, assuming 0.05 pounds per cubic foot.	
	PM Emitted	0.000072	lbs/ccf	EUROPA ELCD - Sum of particulate matter (PM 10 and smaller) emitted to atmosphere. Results converted to pounds of PM per hundred cubic feet (ccf) of product, assuming 0.05 pounds per cubic foot.	
	Solid Waste Generated	0	tons/ccf	EUROPA ELCD - There is no indication of generated solid waste that would be disposed ofat a landfill. Typical wastes indicated include radioactive wastes, mining wastes, and slag (expected to be used in some form elsewhere in industry).	
	Haz. Waste Generated	0	tons/ccf	EUROPA ELCD - No hazardous waste is listed in EUROPA for natural gas production, suggesting that little or no hazardous waste is produced as a result of these activities.	
	Air Toxics Emitted	0.0000061	lbs/ccf	EUROPA ELCD - Sum of all hazardous air pollutants and groups of contaminants as defined by EPA (HAPs) emitted to atmosphere. Reported as pounds per hundred cubic feet (ccf) of product, assuming 0.05 pounds per cubic foot.	
	Mercury Released	0.000000021	lbs/ccf	EUROPA ELCD - Sum of all mercury and mercury compounds released to air or water. Reported as pounds per hundred cubic feet (ccf) of product, assuming 0.05 pounds per cubic foot.	
	Lead Released	0.0000009	lbs/ccf	EUROPA ELCD - Sum of all lead and lead compounds released to air or water. Reported as pounds per hundred cubic feet (ccf) of product, assuming 0.05 pounds per cubic foot.	
	Dioxins Released	5.1E-14	lbs/ccf	EUROPA ELCD - Sum of all dioxins released to air or water. Reported as pounds per hundred cubic feet (ccf) of product, assuming 0.05 pounds per cubic foot.	

EUROPA ECLD refers to the European Reference Life Cycle Database (ELCD core database), version II compiled under contract on behalf of the European Commission - DG Joint Research Centre - Institute for Environment and Sustainability with technical and scientific support by JRC-IES from early 2008 to early 2009. (http://lca.jrc.ec.europa.eu/lcainfohub/datasetArea.vm)

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
Nitrogen fertilizer	Energy Used	16.6	Mbtu/lbs	NREL - Consistent with www.eia.gov calculators, coal assumed to have an energy content of 10,000 btu per pound, and natural gas is assumed to have an energy content of 1,000 btus. Electricity at the grid is assumed to be generated with 33% thermal efficiency and 10% loss from transmission.	Primary NREL LCI File: -SS_Nitrogen fertilizer, production mix, at plant.xls All supporting files
	Grid Electricity Used	0.000023	MWh/lbs		
	All Water Used		gal x 1000/lbs		
	Potable Water Used		gal x 1000/lbs		
	Groundwater Extracted		gal x 1000/lbs		
	CO2e Emitted	1.5	lbs/lbs	NREL - Sum of total global warming potential for carbon dioxide, methane, and nitrous oxide released to atmosphere. A global warming potential of 21 is used for methane and a global warming potential of 310 is used for nitrous oxide.	
	NO x Emitted	0.00078	lbs/lbs	NREL - Sum of nitrogen oxides emitted to atmosphere. Results converted to pounds of NO x per pound of product.	
	SO x Emitted	0.0174	lbs/lbs	NREL - Sum of sulfur oxides emitted to atmosphere. Results converted to pounds of SO x per pound of product.	
	PM Emitted	0.000067	lbs/lbs	NREL - Sum of particulate matter (PM 10 and smaller) emitted to atmosphere. Results converted to pounds of PM per pound of product.	
	Solid Waste Generated		tons/lbs		
	Haz. Waste Generated		tons/lbs		
	Air Toxics Emitted	0.00026	lbs/lbs	NREL - Sum of all hazardous air pollutants and groups of contaminants as defined by EPA (HAPs) emitted to atmosphere.	
	Mercury Released	6.1E-09	lbs/lbs	NREL - Sum of all mercury and mercury compounds released to air or water.	
	Lead Released	0.000000038	lbs/lbs	NREL - Sum of all lead and lead compounds released to air or water.	
	Dioxins Released		lbs/lbs		

"NREL LCI" refers to the U.S. Dept. of Energy, National Renewable Energy Laboratory (NREL), Life-Cycle Inventory Database (www.nrel.gov/lci) maintained by the Alliance for Sustainable Energy, LLC.

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
Other Material #1 - PV System	Energy Used	33.6	Mbtu/W	Energy per rated W of multi-crystalline modules on page 50 (34 MJ/W = 32 Mbtu/W) plus the percentage of the energy for balance of system components, installation, and inverter associated with the multi-crystalline modules. Transporation is excluded because it is accounted for separately in this remediation footprint analysis. 10,560W / (10,560 W+ 17,952W +4650W) = 32% from page 21 for percentage associated with the multi-cyrstalline modules and 48,000 MJ for balance of system components, installation, and inverter from page 49 of reference. Electricity used is based on 85% of the total energy for module manufacturing due to electricity use (i.e., 85% of 32 Mbtu/W), page 12. Assume 33% thermal efficiency and 10% transmission loss for electricity.	Life-Cycle Assessment of the 33 kW Photovoltaic System on the Dana Building at the University of Michigan Thin Film Laminates, Multi-Crystalline Modules, and Balance of System Components Sergio Pacca, Deepak Sivaraman and Gregory A. Keoleian Center for Sustainable Systems, University of MIchigan Report No. CSS05-09, June 1, 2006
	Grid Electricity Used	0.000262994	MWh/W		
	All Water Used		gal x 1000/W	Not calculated	
	Potable Water Used		gal x 1000/W	Not calculated	
	Groundwater Extracted		gal x 1000/W	Not calculated	
	CO2e Emitted	4.47	lbs/W	Emissions of CO2e, NOx, SOx, PM, and hazardous pollutants per rated kW of module for the multi-crystalline modules on page 51 of reference plus the percentage of pollutant emissions for balance of system components, installation, and inverter associated with the multi-crystalline modules. Transporation is excluded because it is accounted for separately in this remediation footprint analysis. 10,560W / (10,560 + 17,952 +4650) = 32% from page 21 of reference document for percentage of system associated with multi-crystalline modules and the emissions on page 51 of reference for balance of system components (excluding transporation). Using NOx as an example on page 51: - Multi-crystalline panels (KC120) = 67.60 kg x 2.2 lbs/kg /10,560 W = 0.014 lbs/W - BOS = 2.38 kg x 2.2 lbs/kg x 32% associated with multicrystalline modules / 10,560 W = 0.00016 lbs/W - Installation = 2.33 kg x 2.2 lbs/kg x 32% associated with multicrystalline modules / 10,560W = 0.0016 lbs/W - Inverter = 3.45 kg x 2.2 lbs/kg x 32% associated with multicrystalline modules / 10,560W = 0.00023 lbs/W Total = 0.015 lbs/W NOTE: Based on the text of the reference document and a comparison of the energy and emission values, it appears that the "installation" and "transport" categories in the table on page 51 are reversed. The values used here take this into account.	
	NO x Emitted	0.015	lbs/W		
	SO x Emitted	0.032	lbs/W		
	PM Emitted	0.00063	lbs/W		
	Solid Waste Generated		tons/W	Not calculated	
	Haz. Waste Generated	0.0000029	tons/W	Not calculated	
	Air Toxics Emitted	0.0000029	lbs/W	Air toxic emissions are limited to lead emissions because no additional information is available from this study. Other hazardous air pollutants are likely emitted, including some of the emitted hydrocarbons that are quantified in the study.	
	Mercury Released		lbs/W	Not calculated	
	Lead Released	0.0000029	lbs/W	Not calculated	
	Dioxins Released		lbs/W	Not calculated	

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
Other Material #2 - Mulch	Energy Used		Mbtu/cy		
	Grid Electricity Used		MWh/cy		
	All Water Used		gal x 1000/cy		
	Potable Water Used		gal x 1000/cy		
	Groundwater Extracted		gal x 1000/cy		
	CO2e Emitted		lbs/cy		
	NO x Emitted		lbs/cy		
	SO x Emitted		lbs/cy		
	PM Emitted		lbs/cy		
	Solid Waste Generated		tons/cy		
	Haz. Waste Generated		tons/cy		
	Air Toxics Emitted		lbs/cy		
	Mercury Released		lbs/cy		
	Lead Released		lbs/cy		
	Dioxins Released		lbs/cy		

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
Other Material #3 - acetic acid	Energy Used	5.2	Mbtu/lb	NREL - Consistent with www.eia.gov calculators, coal assumed to have an energy content of 10,000 btu per pound, and natural gas is assumed to have an energy content of 1,000 btus. Electricity at the grid is assumed to be generated with 33% thermal efficiency and 10% loss from transmission.	Primary NREL LCI File: -SS_acetic acid, at plant.xls All supporting files
	Grid Electricity Used	0.00002	MWh/lb		
	All Water Used		gal x 1000/lb		
	Potable Water Used		gal x 1000/lb		
	Groundwater Extracted		gal x 1000/lb		
	CO2e Emitted	0.67	lbs/lb	NREL - Sum of total global warming potential for carbon dioxide, methane, and nitrous oxide released to atmosphere. A global warming potential of 21 is used for methane and a global warming potential of 310 is used for nitrous oxide.	
	NO x Emitted	0.00064	lbs/lb	NREL - Sum of nitrogen oxides emitted to atmosphere. Results converted to pounds of NO x per pound of product.	
	SO x Emitted	0.02	lbs/lb	NREL - Sum of sulfur oxides emitted to atmosphere. Results converted to pounds of SO x per pound of product.	
	PM Emitted	0.000058	lbs/lb	NREL - Sum of particulate matter (PM 10 and smaller) emitted to atmosphere. Results converted to pounds of PM per pound of product.	
	Solid Waste Generated		tons/lb		
	Haz. Waste Generated		tons/lb		
	Air Toxics Emitted	0.00029	lbs/lb	NREL - Sum of all hazardous air pollutants and groups of contaminants as defined by EPA (HAPs) emitted to atmosphere.	
	Mercury Released	1.7E-09	lbs/lb	NREL - Sum of all mercury and mercury compounds released to air or water.	
	Lead Released	0.00000001	lbs/lb	NREL - Sum of all lead and lead compounds released to air or water.	
	Dioxins Released	3E-15	lbs/lb		

"NREL LCI" refers to the U.S. Dept. of Energy, National Renewable Energy Laboratory (NREL), Life-Cycle Inventory Database (www.nrel.gov/lci) maintained by the Alliance for Sustainable Energy, LLC.

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
Other Material #4 - guar gum	Energy Used	0.91	Mbtu/lb	Guar gum is produced by milling and sifting of plant matter. Publicly avaliable life-cycle inventory data for guar gum could not be identified. Life-cycle inventory data was identified for wheat flour, which is also produced by milling plant matter, in the provided reference and is used here. Values were extracted directly from the provided database using the Demo Version of Simapro 7.1.	wheat flour www.lcafood.dk Landbrugets radgivningscenter (2000) Tal fra Fodermiddeltabellen, Raport nr. 91. In Danish
	Grid Electricity Used	0.000047	MWh/lb	Guar gum is produced by milling and sifting of plant matter. Publicly avaliable life-cycle inventory data for guar gum could not be identified. Life-cycle inventory data was identified for wheat flour, which is also produced by milling plant matter, in the provided reference and is used here. Values were extracted directly from the provided database using the Demo Version of Simapro 7.1.	
	All Water Used	0.0001	gal x 1000/lb	Guar gum is produced by milling and sifting of plant matter. Publicly avaliable life-cycle inventory data for guar gum could not be identified. Life-cycle inventory data was identified for wheat flour, which is also produced by milling plant matter, in the provided reference and is used here. Values were extracted directly from the provided database using the Demo Version of Simapro 7.1.	
	Potable Water Used		gal x 1000/lb		
	Groundwater Extracted		gal x 1000/lb		
	CO2e Emitted	1	lbs/lb	Guar gum is produced by milling and sifting of plant matter. Publicly avaliable life-cycle inventory data for guar gum could not be identified. Life-cycle inventory data was identified for wheat flour, which is also produced by milling plant matter, in the provided reference and is used here. Values were extracted directly from the provided database using the Demo Version of Simapro 7.1.	
	NO x Emitted	0.073	lbs/lb	Guar gum is produced by milling and sifting of plant matter. Publicly avaliable life-cycle inventory data for guar gum could not be identified. Life-cycle inventory data was identified for wheat flour, which is also produced by milling plant matter, in the provided reference and is used here. Values were extracted directly from the provided database using the Demo Version of Simapro 7.1.	
	SO x Emitted	0.0068	lbs/lb	Guar gum is produced by milling and sifting of plant matter. Publicly avaliable life-cycle inventory data for guar gum could not be identified. Life-cycle inventory data was identified for wheat flour, which is also produced by milling plant matter, in the provided reference and is used here. Values were extracted directly from the provided database using the Demo Version of Simapro 7.1.	
	PM Emitted	0.00012	lbs/lb	Guar gum is produced by milling and sifting of plant matter. Publicly avaliable life-cycle inventory data for guar gum could not be identified. Life-cycle inventory data was identified for wheat flour, which is also produced by milling plant matter, in the provided reference and is used here. Values were extracted directly from the provided database using the Demo Version of Simapro 7.1.	
	Solid Waste Generated		tons/lb	Guar gum is produced by milling and sifting of plant matter. Publicly avaliable life-cycle inventory data for guar gum could not be identified. Life-cycle inventory data was identified for wheat flour, which is also produced by milling plant matter, in the provided reference and is used here. Values were extracted directly from the provided database using the Demo Version of Simapro 7.1.	
	Haz. Waste Generated		tons/lb	Guar gum is produced by milling and sifting of plant matter. Publicly avaliable life-cycle inventory data for guar gum could not be identified. Life-cycle inventory data was identified for wheat flour, which is also produced by milling plant matter, in the provided reference and is used here. Values were extracted directly from the provided database using the Demo Version of Simapro 7.1.	
	Air Toxics Emitted	0.000014	lbs/lb	Guar gum is produced by milling and sifting of plant matter. Publicly avaliable life-cycle inventory data for guar gum could not be identified. Life-cycle inventory data was identified for wheat flour, which is also produced by milling plant matter, in the provided reference and is used here. Values were extracted directly from the provided database using the Demo Version of Simapro 7.1.	
	Mercury Released	1.1E-09	lbs/lb	Guar gum is produced by milling and sifting of plant matter. Publicly avaliable life-cycle inventory data for guar gum could not be identified. Life-cycle inventory data was identified for wheat flour, which is also produced by milling plant matter, in the provided reference and is used here. Values were extracted directly from the provided database using the Demo Version of Simapro 7.1.	
	Lead Released	0.00000011	lbs/lb	Guar gum is produced by milling and sifting of plant matter. Publicly avaliable life-cycle inventory data for guar gum could not be identified. Life-cycle inventory data was identified for wheat flour, which is also produced by milling plant matter, in the provided reference and is used here. Values were extracted directly from the provided database using the Demo Version of Simapro 7.1.	
	Dioxins Released	6E-14	lbs/lb	Guar gum is produced by milling and sifting of plant matter. Publicly avaliable life-cycle inventory data for guar gum could not be identified. Life-cycle inventory data was identified for wheat flour, which is also produced by milling plant matter, in the provided reference and is used here. Values were extracted directly from the provided database using the Demo Version of Simapro 7.1.	

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
Other Material #5	Energy Used		Mbtu/TBD		
	Grid Electricity Used		MWh/TBD		
	All Water Used		gal x 1000/TBD		
	Potable Water Used		gal x 1000/TBD		
	Groundwater Extracted		gal x 1000/TBD		
	CO2e Emitted		lbs/TBD		
	NO x Emitted		lbs/TBD		
	SO x Emitted		lbs/TBD		
	PM Emitted		lbs/TBD		
	Solid Waste Generated		tons/TBD		
	Haz. Waste Generated		tons/TBD		
	Air Toxics Emitted		lbs/TBD		
	Mercury Released		lbs/TBD		
	Lead Released		lbs/TBD		
	Dioxins Released		lbs/TBD		

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
Phosphorus fertilizer	Energy Used	3.39	Mbtu/lbs	NREL - Consistent with www.eia.gov calculators natural gas is assumed to have an energy content of 1,000 btus. Electricity at the grid is assumed to be generated with 33% thermal efficiency and 10% loss from transmission.	Primary NREL LCI File: -SS_Phosphorous fertilizer, production mix, at plant.xls All supporting files
	Grid Electricity Used	0.000073	MWh/lbs		
	All Water Used		gal x 1000/lbs		
	Potable Water Used		gal x 1000/lbs		
	Groundwater Extracted		gal x 1000/lbs		
	CO2e Emitted	0.35	lbs/lbs	NREL - Sum of total global warming potential for carbon dioxide, methane, and nitrous oxide released to atmosphere. A global warming potential of 21 is used for methane and a global warming potential of 310 is used for nitrous oxide.	
	NO x Emitted	0.0017	lbs/lbs	NREL - Sum of nitrogen oxides emitted to atmosphere. Results converted to pounds of NO x per pound of product.	
	SO x Emitted	0.017	lbs/lbs	NREL - Sum of sulfur oxides emitted to atmosphere. Results converted to pounds of SO x per pound of product.	
	PM Emitted	0.00011	lbs/lbs	NREL - Sum of particulate matter (PM 10 and smaller) emitted to atmosphere. Results converted to pounds of PM per pound of product.	
	Solid Waste Generated		tons/lbs		
	Haz. Waste Generated		tons/lbs		
	Air Toxics Emitted	0.000052	lbs/lbs	NREL - Sum of all hazardous air pollutants and groups of contaminants as defined by EPA (HAPs) emitted to atmosphere.	
	Mercury Released	2.1E-09	lbs/lbs	NREL - Sum of all mercury and mercury compounds released to air or water.	
	Lead Released	0.000000048	lbs/lbs	NREL - Sum of all lead and lead compounds released to air or water.	
	Dioxins Released		lbs/lbs		

"NREL LCI" refers to the U.S. Dept. of Energy, National Renewable Energy Laboratory (NREL), Life-Cycle Inventory Database (www.nrel.gov/lci) maintained by the Alliance for Sustainable Energy, LLC.

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
Polymer	Energy Used		Mbtu/lbs		
	Grid Electricity Used		MWh/lbs		
	All Water Used		gal x 1000/lbs		
	Potable Water Used		gal x 1000/lbs		
	Groundwater Extracted		gal x 1000/lbs		
	CO2e Emitted		lbs/lbs		
	NO x Emitted		lbs/lbs		
	SO x Emitted		lbs/lbs		
	PM Emitted		lbs/lbs		
	Solid Waste Generated		tons/lbs		
	Haz. Waste Generated		tons/lbs		
	Air Toxics Emitted		lbs/lbs		
	Mercury Released		lbs/lbs		
	Lead Released		lbs/lbs		
	Dioxins Released		lbs/lbs		

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
Potable Water	Energy Used	9.2	Mbtu/gal x 1000	EUROPA ELCD - Average of values from drinking water derived from surface water and drinking water derived from groundwater. All forms of energy summed and converted to Mbtus per thousand gallons of product.	EUROPA file location: Drinking water from surface water and drinking water from groundwater: http://lca.jrc.ec.europa.eu/lcainfohub/datasets/html/processes/db009014-338f-11dd-bd11-0800200c9a66_02.00.000.html http://lca.jrc.ec.europa.eu/lcainfohub/datasets/html/processes/db009013-338f-11dd-bd11-0800200c9a66_02.00.000.html
	Grid Electricity Used	0.00044	MWh/gal x 1000	Not provided by EUROPA ELCD. Arbritrarily taken as 50% of all energy consumed assuming a 33% thermal efficiency. (i.e., MWh 50% of Mbtus of energy multiplied by 33% and divided by 3,413 Mbtu/MWh to convert to MWh).	
	All Water Used	0.021	gal x 1000/gal x 1000	EUROPA ELCD - Average of values from drinking water derived from surface water and drinking water derived from groundwater. Sum of "water", "surface water", "groundwater", and "river water". Negative values (indicating return of water to the hydrosphere) were not included. Sea water was also not included. Result converted to thousands of gallons per thousand gallons of product. The EUROPA file provides all of the water required to produce on gallon of water leaving the treatment plant. This conversion factor does not include the water that is used by the consumer. That water is considered in Potable Water Used On-Site.	
	Potable Water Used		gal x 1000/gal x 1000	One to one conversion.	
	Groundwater Extracted		gal x 1000/gal x 1000	Not applicable -- no local or on-site ground water extracted.	
	CO2e Emitted	5	lbs/gal x 1000	EUROPA ELCD - Average of values from drinking water derived from surface water and drinking water derived from groundwater. Sum of total global warming potential for carbon dioxide, methane, and nitrous oxide released to atmosphere. A global warming potential of 21 is used for methane and a global warming potential of 310 is used for nitrous oxide. Results converted to pounds of carbon dioxide equivalents per thousand gallons of product.	
	NO x Emitted	0.0097	lbs/gal x 1000	EUROPA ELCD - Average of values from drinking water derived from surface water and drinking water derived from groundwater. Sum of nitrogen oxides emitted to atmosphere. Results converted to pounds of NO x per thousand gallons of product.	
	SO x Emitted	0.0059	lbs/gal x 1000	EUROPA ELCD - Sum of sulfur oxides emitted to atmosphere. Results converted to pounds of SO x per gallon of product.	
	PM Emitted	0.016	lbs/gal x 1000	EUROPA ELCD - Average of values from drinking water derived from surface water and drinking water derived from groundwater. Sum of particulate matter (PM 10 and smaller) emitted to atmosphere. Results converted to pounds of PM per thousand gallons of product.	
	Solid Waste Generated	0.000000834	tons/gal x 1000	EUROPA ELCD - Sum of all listed wastes (demolition debris) except for radioactive wastes, slag, and mining wastes, which would likely not be disposed of in a landfill.	
	Haz. Waste Generated	0	tons/gal x 1000	EUROPA ELCD - No hazardous waste is listed in EUROPA for water production, suggesting that little or no hazardous waste is produced as a result of these activities.	
	Air Toxics Emitted	0.000015	lbs/gal x 1000	EUROPA ELCD - Average of values from drinking water derived from surface water and drinking water derived from groundwater. Sum of all hazardous air pollutants and groups of contaminants as defined by EPA (HAPs) emitted to atmosphere. Reported as pounds per thousand gallons of product.	
	Mercury Released	8.2E-09	lbs/gal x 1000	EUROPA ELCD - Average of values from drinking water derived from surface water and drinking water derived from groundwater. Sum of all mercury and mercury compounds released to air or water. Reported as pounds per thousand gallons of product.	
	Lead Released	0.000000067	lbs/gal x 1000	EUROPA ELCD -Average of values from drinking water derived from surface water and from groundwater. Sum of all lead and lead compounds released to air or water. Reported as pounds per thousand gallons of product.	
	Dioxins Released	1E-13	lbs/gal x 1000	EUROPA ELCD - Average of values from drinking water derived from surface water and drinking water derived from groundwater. Sum of all dioxins released to air or water. Reported as pounds per thousand gallons of product.	

EUROPA ECLD refers to the European Reference Life Cycle Database (ELCD core database), version II compiled under contract on behalf of the European Commission - DG Joint Research Centre - Institute for Environment and Sustainability with technical and scientific support by JRC-IES from early 2008 to early 2009. (http://lca.jrc.ec.europa.eu/lcainfohub/datasetArea.vm)

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
Potassium permanganate	Energy Used	29.22	Mbtu/lbs	Based on the cited reference, approximatley 1.36 lb of CO2 is emitted per dollar of output in the manufacturing sector. In the absence of other information, it is assumed that the permanganate manufacturer also has an emission profile of approximately 1.36 lb of CO2 emitted per dollar of output. Conversion factor estimates assume that 50% of each pound CO2 results from electricity use (U.S. average fuel blend) and 50% results from diesel use. Using an approximate, typical cost of $3 per pound of product, a pound of product can then be converted into electricity and diesel usage. The conversion factors for the other parameters result from this electricity and diesel usage. The resulting carbon footprint is consistent the values presented by the permanganate manufacturer CARUS in marketing presentations.	U.S. CARBON DIOXIDE EMISSIONS AND INTENSITIES OVER TIME: A DETAILED ACCOUNTING OF INDUSTRIES, GOVERNMENT AND HOUSEHOLDS, APRIL 2010
	Grid Electricity Used	0.0016	MWh/lbs		
	All Water Used	0.003	gal x 1000/lbs		
	Potable Water Used		gal x 1000/lbs		
	Groundwater Extracted		gal x 1000/lbs		
	CO2e Emitted	4.5	lbs/lbs		
	NO x Emitted	0.021	lbs/lbs		
	SO x Emitted	0.016	lbs/lbs		
	PM Emitted	0.0017	lbs/lbs		
	Solid Waste Generated	0.0000013	tons/lbs		
	Haz. Waste Generated		tons/lbs		
	Air Toxics Emitted	0.0006	lbs/lbs		
	Mercury Released	0.000000038	lbs/lbs		
	Lead Released	0.00000038	lbs/lbs		
	Dioxins Released	3.5E-13	lbs/lbs		

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
PVC	Energy Used	22	Mbtu/lbs	EUROPA ELCD - All forms of energy summed and converted to Mbtus per pound of product.	Primary NREL file for electricity: polyvinyl chloride resin, at plant file Secondary NREL files for electricity: Ethylene dichloride-vinyl chloride monomer, at plant; Ethylene, at plant; Chlorine, PVC producer average, at plant; Oxygen, liquid, at plant. EUROPA file location: Suspension Polymerisation PVC: http://lca.jrc.ec.europa.eu/lcainfohub/datasets/html/processes/129b8f8d-7667-41bc-91f4-421bfcdfc8c3_02.00.000.html
	Grid Electricity Used	0.00056	MWh/lbs	Not provided by EUROPA ELCD. NREL LCI includes electricity usage for PVC manufacturing. Electricity from polyvinyl chloride resin, at plant file and the following major subcomponent files is included in this estimate: Ethylene dichloride-vinyl chloride monomer, at plant; Ethylene, at plant; Chlorine, PVC producer average, at plant; Oxygen, liquid, at plant.	
	All Water Used	0.0069	gal x 1000/lbs	EUROPA ELCD - Sum of "water", "surface water", "groundwater", and "river water". Negative values (indicating return of water to the hydrosphere) were not included. Sea water was also not included. Result converted to gallons per pound.	
	Potable Water Used		gal x 1000/lbs	Not applicable -- no local potable water used.	
	Groundwater Extracted		gal x 1000/lbs	Not applicable -- no local or on-site ground water extracted.	
	CO2e Emitted	2.6	lbs/lbs	EUROPA ELCD - Sum of total global warming potential for carbon dioxide, methane, and nitrous oxide released to atmosphere. A global warming potential of 21 is used for methane and a global warming potential of 310 is used for nitrous oxide. Results converted to pounds of carbon dioxide equivalents per pound of product.	
	NO x Emitted	0.0048	lbs/lbs	EUROPA ELCD - Sum of nitrogen oxides emitted to atmosphere. Results converted to pounds of NO x per pound of product.	
	SO x Emitted	0.0076	lbs/lbs	EUROPA ELCD - Sum of sulfur oxides emitted to atmosphere. Results converted to pounds of SO x per pound of product.	
	PM Emitted	0.0012	lbs/lbs	EUROPA ELCD - Sum of particulate matter (PM 10 and smaller) emitted to atmosphere. Results converted to pounds of PM per pound of product.	
	Solid Waste Generated	0.0000022	tons/lbs	EUROPA ELCD - Sum of all wastes except for mine wastes and toxic chemical wastes.	
	Haz. Waste Generated	0.0000016	tons/lbs	EUROPA ELCD - "Chemical waste, toxic" converted into tons per pound of product.	
	Air Toxics Emitted	0.00047	lbs/lbs	EUROPA ELCD - Sum of all hazardous air pollutants and groups of contaminants as defined by EPA (HAPs) emitted to atmosphere.	
	Mercury Released	0.00000034	lbs/lbs	EUROPA ELCD - Sum of all mercury and mercury compounds released to air or water.	
	Lead Released	0.00000013	lbs/lbs	EUROPA ELCD - Sum of all lead and lead compounds released to air or water.	
	Dioxins Released	6.9E-09	lbs/lbs	EUROPA ELCD - Sum of all dioxins released to air or water.	

EUROPA ECLD refers to the European Reference Life Cycle Database (ELCD core database), version II compiled under contract on behalf of the European Commission - DG Joint Research Centre - Institute for Environment and Sustainability with technical and scientific support by JRC-IES from early 2008 to early 2009. (http://lca.jrc.ec.europa.eu/lcainfohub/datasetArea.vm)

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
Sequestering agent	Energy Used		Mbtu/lbs		
	Grid Electricity Used		MWh/lbs		
	All Water Used		gal x 1000/lbs		
	Potable Water Used		gal x 1000/lbs		
	Groundwater Extracted		gal x 1000/lbs		
	CO2e Emitted		lbs/lbs		
	NO x Emitted		lbs/lbs		
	SO x Emitted		lbs/lbs		
	PM Emitted		lbs/lbs		
	Solid Waste Generated		tons/lbs		
	Haz. Waste Generated		tons/lbs		
	Air Toxics Emitted		lbs/lbs		
	Mercury Released		lbs/lbs		
	Lead Released		lbs/lbs		
	Dioxins Released		lbs/lbs		

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
Sodium hydroxide (dry bulk)	Energy Used	6.6	Mbtu/lbs	EUROPA ELCD - All forms of energy summed and converted to Mbtus per pound of product.	EUROPA file location: Sodium Hydroxide, at plant 100%
	Grid Electricity Used	0.00032	MWh/lbs	Not provided by EUROPA ELCD. Arbritrarily taken as 50% of all energy consumed assuming a 33% thermal efficiency. (i.e., MWh 50% of Mbtus of energy multiplied by 33%)	
	All Water Used	0.00115	gal x 1000/lbs	EUROPA ELCD - Sum of "water", "surface water", "groundwater", and "river water". Negative values (indicating return of water to the hydrosphere) were not included. Sea water was also not included. Result converted to thousands of gallons per pound.	
	Potable Water Used		gal x 1000/lbs	Not applicable -- no local potable water used.	
	Groundwater Extracted		gal x 1000/lbs	Not applicable -- no local or on-site ground water extracted.	
	CO2e Emitted	1.37	lbs/lbs	EUROPA ELCD - Sum of total global warming potential for carbon dioxide, methane, and nitrous oxide released to atmosphere. A global warming potential of 21 is used for methane and a global warming potential of 310 is used for nitrous oxide. Results converted to pounds of carbon dioxide equivalents per pound of product.	
	NO x Emitted	0.003	lbs/lbs	EUROPA ELCD - Sum of nitrogen oxides emitted to atmosphere. Results converted to pounds of NO x per pound of product.	
	SO x Emitted	0.0048	lbs/lbs	EUROPA ELCD - Sum of sulfur oxides emitted to atmosphere. Results converted to pounds of SO x per pound of product.	
	PM Emitted	0.00054	lbs/lbs	EUROPA ELCD - Sum of particulate matter (PM 10 and smaller) emitted to atmosphere. Results converted to pounds of PM per pound of product.	
	Solid Waste Generated	0.000019	tons/lbs	EUROPA ELCD - All waste for steel production is listed as "unspecified". Until additional information is available, all "unspecified" waste has been included in the "solid waste generated" category, and no value is provided for hazardous waste.	
	Haz. Waste Generated	0.00000047	tons/lbs	EUROPA ELCD - All waste for steel production is listed as "unspecified". Until additional information is available, all "unspecified" waste has been included in the "solid waste generated" category, and no value is provided for hazardous waste.	
	Air Toxics Emitted	0.000062	lbs/lbs	EUROPA ELCD - Sum of all hazardous air pollutants and groups of contaminants as defined by EPA (HAPs) emitted to atmosphere.	
	Mercury Released	0.00000022	lbs/lbs	EUROPA ELCD - Sum of all mercury and mercury compounds released to air or water.	
	Lead Released	0.000000025	lbs/lbs	EUROPA ELCD - Sum of all lead and lead compounds released to air or water.	
	Dioxins Released	2.4E-14	lbs/lbs	EUROPA ELCD - Sum of all dioxins released to air or water.	

EUROPA ECLD refers to the European Reference Life Cycle Database (ELCD core database), version II compiled under contract on behalf of the European Commission - DG Joint Research Centre - Institute for Environment and Sustainability with technical and scientific support by JRC-IES from early 2008 to early 2009. (http://lca.jrc.ec.europa.eu/lcainfohub/datasetArea.vm)

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
Stainless Steel	Energy Used	11.6	Mbtu/lb	EUROPA ELCD - All forms of energy summed and converted to Mbtus per pound of product.	EUROPA file location: Stainless Steel: http://lca.jrc.ec.europa.eu/lcainfohub/datasets/html/processes/119e8cc1-0859-45ca-8f63-93a8a518ffd2_02.00.000.html
	Grid Electricity Used	0.00056	MWh/lb	Not provided by EUROPA ELCD. Arbritrarily taken as 50% of all energy consumed assuming a 33% thermal efficiency. (i.e., MWh 50% of Mbtus of energy multiplied by 33%)	
	All Water Used	0.0023	gal x 1000/lb	EUROPA ELCD - Sum of "water", "surface water", "groundwater", and "river water". Negative values (indicating return of water to the hydrosphere) were not included. Sea water was also not included. Result converted to thousands of gallons per pound.	
	Potable Water Used		gal x 1000/lb	Not applicable -- no local potable water used.	
	Groundwater Extracted		gal x 1000/lb	Not applicable -- no local or on-site ground water extracted.	
	CO2e Emitted	3.4	lbs/lb	EUROPA ELCD - Sum of total global warming potential for carbon dioxide, methane, and nitrous oxide released to atmosphere. A global warming potential of 21 is used for methane and a global warming potential of 310 is used for nitrous oxide. Results converted to pounds of carbon dioxide equivalents per pound of product.	
	NO x Emitted	0.0075	lbs/lb	EUROPA ELCD - Sum of nitrogen oxides emitted to atmosphere. Results converted to pounds of NO x per pound of product.	
	SO x Emitted	0.012	lbs/lb	EUROPA ELCD - Sum of sulfur oxides emitted to atmosphere. Results converted to pounds of SO x per pound of product.	
	PM Emitted	0.0044	lbs/lb	EUROPA ELCD - Sum of particulate matter (PM 10 and smaller) emitted to atmosphere. Results converted to pounds of PM per pound of product.	
	Solid Waste Generated	0.00062	tons/lb	EUROPA ELCD - All waste for steel production is listed as "unspecified". Until additional information is available, all "unspecified" waste has been included in the "solid waste generated" category, and no value is provided for hazardous waste.	
	Haz. Waste Generated	0	tons/lb	EUROPA ELCD - All waste for steel production is listed as "unspecified". Until additional information is available, all "unspecified" waste has been included in the "solid waste generated" category, and no value is provided for hazardous waste.	
	Air Toxics Emitted	0.000144	lbs/lb	EUROPA ELCD - Sum of all hazardous air pollutants and groups of contaminants as defined by EPA (HAPs) emitted to atmosphere.	
	Mercury Released	0	lbs/lb	EUROPA ELCD - Sum of all mercury and mercury compounds released to air or water.	
	Lead Released	0.00000052	lbs/lb	EUROPA ELCD - Sum of all lead and lead compounds released to air or water.	
	Dioxins Released	2.2E-12	lbs/lb	EUROPA ELCD - Sum of all dioxins released to air or water.	

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Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
Steel	Energy Used	4.4	Mbtu/lb	EUROPA ELCD - All forms of energy summed and converted to Mbtus per pound of product.	Conversion numbers were based upon an avearage of the following three files, EUROPA file locations: Steel hot rolled section:http://lca.jrc.ec.europa.eu/lcainfohub/datasets/html/processes/f9d4581e-14de-417e-8f9f-6c74e6f14051_02.00.000.html Steel hot rolled coil: http://lca.jrc.ec.europa.eu/lcainfohub/datasets/html/processes/119e8cc1-0859-45ca-8f63-93a8a518ffd2_02.00.000.html Steel rebar: http://lca.jrc.ec.europa.eu/lcainfohub/datasets/html/processes/268a11fb-baf2-4b9e-8867-38bea0e76ef6_02.00.000.html
	Grid Electricity Used	0.00021	MWh/lb	Not provided by EUROPA ELCD or NREL. Arbritrarily taken as 50% of all energy consumed assuming a 33% thermal efficiency. (i.e., MWh 50% of Mbtus of energy multiplied by 33%)	
	All Water Used	0.00064	gal x 1000/lb	EUROPA ELCD - Sum of "water", "surface water", "groundwater", and "river water". Negative values (indicating return of water to the hydrosphere) were not included. Sea water was also not included. Result converted to thousands of gallons per pound.	
	Potable Water Used		gal x 1000/lb	Not applicable -- no local potable water used.	
	Groundwater Extracted		gal x 1000/lb	Not applicable -- no local or on-site ground water extracted.	
	CO2e Emitted	1.1	lbs/lb	EUROPA ELCD - Sum of total global warming potential for carbon dioxide, methane, and nitrous oxide released to atmosphere. A global warming potential of 21 is used for methane and a global warming potential of 310 is used for nitrous oxide. Results converted to pounds of carbon dioxide equivalents per pound of product.	
	NO x Emitted	0.0014	lbs/lb	EUROPA ELCD - Sum of nitrogen oxides emitted to atmosphere. Results converted to pounds of NO x per pound of product.	
	SO x Emitted	0.0017	lbs/lb	EUROPA ELCD - Sum of sulfur oxides emitted to atmosphere. Results converted to pounds of SO x per pound of product.	
	PM Emitted	0.00056	lbs/lb	EUROPA ELCD - Sum of particulate matter (PM 10 and smaller) emitted to atmosphere. Results converted to pounds of PM per pound of product.	
	Solid Waste Generated	0.00025	tons/lb	EUROPA ELCD - All waste for steel production is listed as "unspecified". Until additional information is available, all "unspecified" waste has been included in the "solid waste generated" category, and no value is provided for hazardous waste.	
	Haz. Waste Generated	0	tons/lb	EUROPA ELCD - EUROPA indicates all waste for steel production as "unspecified". Until additional information is available, all "unspecified" waste has been included in the "solid waste generated" category, and no value is provided for hazardous waste.	
	Air Toxics Emitted	0.000067	lbs/lb	EUROPA ELCD - Sum of all hazardous air pollutants and groups of contaminants as defined by EPA (HAPs) emitted to atmosphere.	
	Mercury Released	0.0000001	lbs/lb	EUROPA ELCD - Sum of all mercury and mercury compounds released to air or water.	
	Lead Released	0.0000025	lbs/lb	EUROPA ELCD - Sum of all lead and lead compounds released to air or water.	
	Dioxins Released	6.5E-12	lbs/lb	EUROPA ELCD - Sum of all dioxins released to air or water.	

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Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
Tree: root ball	Energy Used	3.7	Mbtu/trees	Energy based on electricity required to pump water to water trees and gasoline for commute. For electricity assume 4 gallons of water (Keeling Nursery) at a total head of 50 psi,, 75% pump efficiency, 0.746 kW per horsepower, energy for electricity and electricity production. For gasoline, assume 0.025 gallons of gasoline based on a tree requiring 0.2 man hours over lifetime at nursery (Keeling Nursery), a 8-hour day, and a gallon of gasoline to commute to and from the nursery.	
	Grid Electricity Used	0.0000019	MWh/trees		
	All Water Used	0.004	gal x 1000/trees	4 gallons of water over life-time in nursery based on verbal discussions with Keeling Nursery	
	Potable Water Used		gal x 1000/trees		
	Groundwater Extracted		gal x 1000/trees		
	CO2e Emitted	0.6	lbs/trees	All paramete values based on the energy consumption outlined above.	
	NO x Emitted	0.003	lbs/trees		
	SO x Emitted	0.00061	lbs/trees		
	PM Emitted	0.000029	lbs/trees		
	Solid Waste Generated	0.00000001	tons/trees		
	Haz. Waste Generated		tons/trees		
	Air Toxics Emitted	0.000006	lbs/trees	All paramete values based on the energy consumption outlined above.	
	Mercury Released	2.2E-09	lbs/trees		
	Lead Released	0.00000006	lbs/trees		
	Dioxins Released		lbs/trees		

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
Tree: whip	Energy Used		Mbtu/trees		
	Grid Electricity Used		MWh/trees		
	All Water Used	0	gal x 1000/trees		
	Potable Water Used		gal x 1000/trees		
	Groundwater Extracted		gal x 1000/trees		
	CO2e Emitted		lbs/trees		
	NO x Emitted		lbs/trees		
	SO x Emitted		lbs/trees		
	PM Emitted		lbs/trees		
	Solid Waste Generated		tons/trees		
	Haz. Waste Generated		tons/trees		
	Air Toxics Emitted		lbs/trees		
	Mercury Released		lbs/trees		
	Lead Released		lbs/trees		
	Dioxins Released		lbs/trees		

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
Off-site waste water treatment	Energy Used	15	Mbtu/gal x 1000	Consistent with life-cycle total energy requirements for the Ann Abor waste water treatment plant and the average of all three waste water treatment plants in the study. See Table 5-2 of the referenced report.	Life-Cycle Energy and Emissions for Municipal Water and Wastewater Services: Case-Studies of Treatment Plants in US Malavika Tripathi, Center for Sustainable Systems, University of Michigan Report No. CSS07-06, April 17, 2007
	Grid Electricity Used	0.00073	MWh/gal x 1000	Consistent with total energy for electricity for the Ann Abor waste water treatment plant and the average of all three waste water treatment plants in the study. See Figure 5-3 of the referenced report. Total energy converted to electricity usage assuming a 33% thermal efficiency.	
	All Water Used	0.00292	gal x 1000/gal x 1000	Assume that 50% of the CO2e results from electricity use (U.S. average fuel blend) and 50% is due to diesel use. The conversion factor results from this electricity and diesel usage.	
	Potable Water Used		gal x 1000/gal x 1000		
	Groundwater Extracted		gal x 1000/gal x 1000		
	CO2e Emitted	4.4	lbs/gal x 1000	Consistent with life-cycle total energy requirements for the Ann Abor waste water treatment plant and the average of all three waste water treatment plants in the study. See Table 5-2 of the referenced report.	
	NO x Emitted	0.016	lbs/gal x 1000	Calculated from acidification potential from NOx (Table 3-5 of the reference document) by dividing by an impact factor of 40.04 (Table 1-2 of the referenced document).	
	SO x Emitted	0.015	lbs/gal x 1000	Calculated from acidification potential from SOx (Table 3-5 of the reference document) by dividing by an impact factor of 50.79 (Table 1-2 of the referenced document).	
	PM Emitted	0.0017	lbs/gal x 1000	Assume that 50% of the CO2e results from electricity use (U.S. average fuel blend) and 50% is due to diesel use. The conversion factor results from this electricity and diesel usage.	
	Solid Waste Generated	0.0024	tons/gal x 1000	Calcualted from approximate average of 15,000 metric tons of sludge taken to landfill (see Table 3-1 of referenced report), converted to short tons, and assuming sludge generation from 19 million gallons of wastewater per day (see page 53 of referenced report).	
	Haz. Waste Generated	0	tons/gal x 1000		
	Air Toxics Emitted	0.00058	lbs/gal x 1000	Assume that 50% of the CO2e results from electricity use (U.S. average fuel blend) and 50% is due to diesel use. The conversion factor results from this electricity and diesel usage.	
	Mercury Released	0.000000037	lbs/gal x 1000	Assume that 50% of the CO2e results from electricity use (U.S. average fuel blend) and 50% is due to diesel use. The conversion factor results from this electricity and diesel usage.	
	Lead Released	0.00000037	lbs/gal x 1000	Assume that 50% of the CO2e results from electricity use (U.S. average fuel blend) and 50% is due to diesel use. The conversion factor results from this electricity and diesel usage.	
	Dioxins Released	3.45E-13	lbs/gal x 1000	Assume that 50% of the CO2e results from electricity use (U.S. average fuel blend) and 50% is due to diesel use. The conversion factor results from this electricity and diesel usage.	

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
Off-site Solid Waste Disposal	Energy Used	160	Mbtu/ton	EUROPA ELCD - All forms of energy summed and converted to Mbtus per short ton disposed of.	EUPOA ECLD file location: Inert waste disposal: http://lca.jrc.ec.europa.eu/lcainfohub/datasets/html/processes/64197304-3307-11dd-bd11-0800200c9a66_02.00.000.html Inert waste used so that methane and carbon dioxide from decomposing waste is not included.
	Grid Electricity Used	0.0077	MWh/ton	Not provided by EUROPA ELCD. Arbritrarily taken as 50% of all energy consumed assuming a 33% thermal efficiency. (i.e., MWh 50% of Mbtus of energy multiplied by 33%)	
	All Water Used	0.15	gal x 1000/ton	EUROPA ELCD - Sum of "water", "surface water", "groundwater", and "river water". Negative values (indicating return of water to the hydrosphere) were not included. Sea water was also not included. Result converted to thousands of gallons per short ton disposed of.	
	Potable Water Used		gal x 1000/ton	Not applicable -- no local potable water used during waste disposal.	
	Groundwater Extracted		gal x 1000/ton	Not applicable -- no local or on-site ground water extracted during waste disposal.	
	CO2e Emitted	25	lbs/ton	EUROPA ELCD - Sum of total global warming potential for carbon dioxide, methane, and nitrous oxide released to atmosphere. A global warming potential of 21 is used for methane and a global warming potential of 310 is used for nitrous oxide. Results converted to pounds of carbon dioxide equivalents per short ton disposed of.	
	NO x Emitted	0.14	lbs/ton	EUROPA ELCD - Sum of nitrogen oxides emitted to atmosphere. Results converted to pounds of NO x per short ton disposed of.	
	SO x Emitted	0.075	lbs/ton	EUROPA ELCD - Sum of sulfur oxides emitted to atmosphere. Results converted to pounds of SO x per short ton disposed of.	
	PM Emitted	0.4	lbs/ton	EUROPA ELCD - Sum of particulate matter (PM 10 and smaller) emitted to atmosphere. Results converted to pounds of PM per short ton disposed of.	
	Solid Waste Generated	0.000008	tons/ton	EUROPA ELCD - Sum of all listed wastes (demolition debris) except for radioactive wastes, slag, and mining wastes, which would likely not be disposed of in a landfill.	
	Haz. Waste Generated	0	tons/ton	EUROPA ELCD - No hazardous waste is listed in EUROPA for water production, suggesting that little or no hazardous waste is produced as a result of these activities.	
	Air Toxics Emitted	0.0014	lbs/ton	EUROPA ELCD - Sum of all hazardous air pollutants and groups of contaminants as defined by EPA (HAPs) emitted to atmosphere. Reported as pounds per short ton disposed of.	
	Mercury Released	0.00000097	lbs/ton	EUROPA ELCD - Sum of all mercury and mercury compounds released to air or water. Reported as pounds per short ton disposed of.	
	Lead Released	0.0000076	lbs/ton	EUROPA ELCD - Sum of all lead and lead compounds released to air or water. Reported as pounds per short ton disposed of.	
	Dioxins Released	1.2E-11	lbs/ton	EUROPA ELCD - Sum of all dioxins released to air or water. Reported as pounds per short ton disposed of.	

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Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
Off-site Haz. Waste Disposal	Energy Used	176	Mbtu/ton	For energy and all other parameters, values are calculated by assuming a 10% premium on values for solid waste disposal.	
	Grid Electricity Used	0.0085	MWh/ton		
	All Water Used	0.165	gal x 1000/ton		
	Potable Water Used		gal x 1000/ton		
	Groundwater Extracted		gal x 1000/ton		
	CO2e Emitted	27.5	lbs/ton		
	NO x Emitted	0.154	lbs/ton		
	SO x Emitted	0.0825	lbs/ton		
	PM Emitted	0.44	lbs/ton		
	Solid Waste Generated	0.0000088	tons/ton		
	Haz. Waste Generated	0	tons/ton		
	Air Toxics Emitted	0.00154	lbs/ton		
	Mercury Released	0.000001067	lbs/ton		
	Lead Released	0.00000836	lbs/ton		
	Dioxins Released	1.32E-11	lbs/ton		

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
Off-site Laboratory Analysis	Energy Used	6.49	Mbtu/$	Based on the cited reference, approximatley 1 lb of CO2 is emitted per dollar of GDP. In the absence of other information, it is assumed that the laboratory also has an emission profile of approximately 1 lb of CO2 emitted per dollar of sample cost. Conversion factor estimates assume that 50% of this 1 lb of CO2 per dollar of sample cost results from electricity use (U.S. average fuel blend) and 50% is due to diesel use. A dollar of sample cost can then be converted into electricity and diesel usage. The conversion factors result from this electricity and diesel usage. Additionally, one gallon of potable water is added per $100 of analytical cost to account for water usage associated with lab activities.	U.S. CARBON DIOXIDE EMISSIONS AND INTENSITIES OVER TIME: A DETAILED ACCOUNTING OF INDUSTRIES, GOVERNMENT AND HOUSEHOLDS, APRIL 2010
	Grid Electricity Used	0.00035	MWh/$		
	All Water Used	0.00066	gal x 1000/$		
	Potable Water Used		gal x 1000/$		
	Groundwater Extracted		gal x 1000/$		
	CO2e Emitted	1	lbs/$		
	NO x Emitted	0.0048	lbs/$		
	SO x Emitted	0.0036	lbs/$		
	PM Emitted	0.0004	lbs/$		
	Solid Waste Generated	0	tons/$		
	Haz. Waste Generated	0	tons/$		
	Air Toxics Emitted	0.00013	lbs/$		
	Mercury Released	8.4E-09	lbs/$		
	Lead Released	0.000000085	lbs/$		
	Dioxins Released	7.9E-14	lbs/$		

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
Other 1	Energy Used		Mbtu/TBD		
	Grid Electricity Used		MWh/TBD		
	All Water Used		gal x 1000/TBD		
	Potable Water Used		gal x 1000/TBD		
	Groundwater Extracted		gal x 1000/TBD		
	CO2e Emitted		lbs/TBD		
	NO x Emitted		lbs/TBD		
	SO x Emitted		lbs/TBD		
	PM Emitted		lbs/TBD		
	Solid Waste Generated		tons/TBD		
	Haz. Waste Generated		tons/TBD		
	Air Toxics Emitted		lbs/TBD		
	Mercury Released		lbs/TBD		
	Lead Released		lbs/TBD		
	Dioxins Released		lbs/TBD		

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
Other 2	Energy Used		Mbtu/TBD		
	Grid Electricity Used		MWh/TBD		
	All Water Used		gal x 1000/TBD		
	Potable Water Used		gal x 1000/TBD		
	Groundwater Extracted		gal x 1000/TBD		
	CO2e Emitted		lbs/TBD		
	NO x Emitted		lbs/TBD		
	SO x Emitted		lbs/TBD		
	PM Emitted		lbs/TBD		
	Solid Waste Generated		tons/TBD		
	Haz. Waste Generated		tons/TBD		
	Air Toxics Emitted		lbs/TBD		
	Mercury Released		lbs/TBD		
	Lead Released		lbs/TBD		
	Dioxins Released		lbs/TBD		

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
Other 3	Energy Used		Mbtu/TBD		
	Grid Electricity Used		MWh/TBD		
	All Water Used		gal x 1000/TBD		
	Potable Water Used		gal x 1000/TBD		
	Groundwater Extracted		gal x 1000/TBD		
	CO2e Emitted		lbs/TBD		
	NO x Emitted		lbs/TBD		
	SO x Emitted		lbs/TBD		
	PM Emitted		lbs/TBD		
	Solid Waste Generated		tons/TBD		
	Haz. Waste Generated		tons/TBD		
	Air Toxics Emitted		lbs/TBD		
	Mercury Released		lbs/TBD		
	Lead Released		lbs/TBD		
	Dioxins Released		lbs/TBD		

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
Other 4	Energy Used		Mbtu/TBD		
	Grid Electricity Used		MWh/TBD		
	All Water Used		gal x 1000/TBD		
	Potable Water Used		gal x 1000/TBD		
	Groundwater Extracted		gal x 1000/TBD		
	CO2e Emitted		lbs/TBD		
	NO x Emitted		lbs/TBD		
	SO x Emitted		lbs/TBD		
	PM Emitted		lbs/TBD		
	Solid Waste Generated		tons/TBD		
	Haz. Waste Generated		tons/TBD		
	Air Toxics Emitted		lbs/TBD		
	Mercury Released		lbs/TBD		
	Lead Released		lbs/TBD		
	Dioxins Released		lbs/TBD		

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
Other 5	Energy Used		Mbtu/TBD		
	Grid Electricity Used		MWh/TBD		
	All Water Used		gal x 1000/TBD		
	Potable Water Used		gal x 1000/TBD		
	Groundwater Extracted		gal x 1000/TBD		
	CO2e Emitted		lbs/TBD		
	NO x Emitted		lbs/TBD		
	SO x Emitted		lbs/TBD		
	PM Emitted		lbs/TBD		
	Solid Waste Generated		tons/TBD		
	Haz. Waste Generated		tons/TBD		
	Air Toxics Emitted		lbs/TBD		
	Mercury Released		lbs/TBD		
	Lead Released		lbs/TBD		
	Dioxins Released		lbs/TBD		

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
Potable Water Transported	Energy Used	7.4	Mbtu/gal x 1000	Calculated based on electricity used. Accounts for 10% energy loss through electricity transmission losses and a thermal efficiency of 33%.	
	Grid Electricity Used	0.000645995	MWh/gal x 1000	Electricity usage calculated assuming water is distributed from the source at 50 psi by a 75% efficient pump with a 75% efficient motor. Some head loss will be realized during pipe flow such that the site will receive water at a lower pressure, but the 50 psi represents the energy that is needed at the treatment plant to distribute the water through the distribution network. All other environmental parameters are calculated from this calculated	
	All Water Used	0.00129199	gal x 1000/gal x 1000	Calculated based on calculated "electricity used". Default value uses default electricity parameters and actual value uses actual electricity parameters.	
	Potable Water Used		gal x 1000/gal x 1000	not applicable -- no potable water used when potable water is being transported (assumes no leakage water distribution system).	
	Groundwater Extracted		gal x 1000/gal x 1000	not applicable -- no on-site ground water used when potable water is being transported.	
	CO2e Emitted	0.994832041	lbs/gal x 1000	Calculated based on calculated "electricity used". Default value uses default electricity parameters and actual value uses actual electricity parameters.	
	NO x Emitted	0.00251938	lbs/gal x 1000	Calculated based on calculated "electricity used". Default value uses default electricity parameters and actual value uses actual electricity parameters.	
	SO x Emitted	0.006459948	lbs/gal x 1000	Calculated based on calculated "electricity used". Default value uses default electricity parameters and actual value uses actual electricity parameters.	
	PM Emitted	0.000607235	lbs/gal x 1000	Calculated based on calculated "electricity used". Default value uses default electricity parameters and actual value uses actual electricity parameters.	
	Solid Waste Generated	5.81395E-07	tons/gal x 1000	Calculated based on calculated "electricity used". Default value uses default electricity parameters and actual value uses actual electricity parameters.	
	Haz. Waste Generated	0	tons/gal x 1000	Calculated based on calculated "electricity used". Default value uses default electricity parameters and actual value uses actual electricity parameters.	
	Air Toxics Emitted	0.000258398	lbs/gal x 1000	Calculated based on calculated "electricity used". Default value uses default electricity parameters and actual value uses actual electricity parameters.	
	Mercury Released	1.48579E-08	lbs/gal x 1000	Calculated based on calculated "electricity used". Default value uses default electricity parameters and actual value uses actual electricity parameters.	
	Lead Released	1.09819E-07	lbs/gal x 1000	Calculated based on calculated "electricity used". Default value uses default electricity parameters and actual value uses actual electricity parameters.	
	Dioxins Released	1.55039E-13	lbs/gal x 1000	Calculated based on calculated "electricity used". Default value uses default electricity parameters and actual value uses actual electricity parameters.	

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
Electricity transmission	Energy Used	410	Mbtu/MWh	Footprint associated with electricity that is generated but lost to transmission, using U.S. average fuel blend for electricity production	U.S. Dept. of Energy GridWorks: Overview of the Electric Grid http://sites.energetics.com/gridworks/grid.html Consumptive Water Use for U.S. Power Production December 2003 • NREL/TP-550-33905 Note relevant to all the entries for "electricity transmitted": "electricity transmitted" refers to the flow of electricity through the lines, which would have 0 emissions and resource use. Another aspect of electrical transmissions would be installation and maintenance of electrical transmission lines. This would result in emissions and resource use, but they would be very small when allocated per kWh transmitted. It would also be similar in concept to installation and maintenance of roadways for truck transportation, which we also do not account for in this analysis.
	Grid Electricity Used	0.12	MWh/MWh	Footprint associated with electricity that is generated but lost to transmission, using U.S. average fuel blend for electricity production	
	All Water Used	0.24	gal x 1000/MWh	Footprint associated with electricity that is generated but lost to transmission, using U.S. average fuel blend for electricity production	
	Potable Water Used		gal x 1000/MWh	Footprint associated with electricity that is generated but lost to transmission, using U.S. average fuel blend for electricity production	
	Groundwater Extracted		gal x 1000/MWh	Footprint associated with electricity that is generated but lost to transmission, using U.S. average fuel blend for electricity production	
	CO2e Emitted	184.8	lbs/MWh	Footprint associated with electricity that is generated but lost to transmission, using U.S. average fuel blend for electricity production	
	NO x Emitted	0.468	lbs/MWh	Footprint associated with electricity that is generated but lost to transmission, using U.S. average fuel blend for electricity production	
	SO x Emitted	1.2	lbs/MWh	Footprint associated with electricity that is generated but lost to transmission, using U.S. average fuel blend for electricity production	
	PM Emitted	0.1128	lbs/MWh	Footprint associated with electricity that is generated but lost to transmission, using U.S. average fuel blend for electricity production	
	Solid Waste Generated	0.000108	tons/MWh	Footprint associated with electricity that is generated but lost to transmission, using U.S. average fuel blend for electricity production	
	Haz. Waste Generated	0	tons/MWh	Footprint associated with electricity that is generated but lost to transmission, using U.S. average fuel blend for electricity production	
	Air Toxics Emitted	0.048	lbs/MWh	Footprint associated with electricity that is generated but lost to transmission, using U.S. average fuel blend for electricity production	
	Mercury Released	0.00000276	lbs/MWh	Footprint associated with electricity that is generated but lost to transmission, using U.S. average fuel blend for electricity production	
	Lead Released	0.0000204	lbs/MWh	Calculated using information from the cited reference. See attached support file titled "Electricity and Energy Used for the Production, Transmission, and On-Site Use of Electricity" for calculations.	
	Dioxins Released	2.88E-11	lbs/MWh	Calculated using information from the cited reference. See attached support file titled "Electricity and Energy Used for the Production, Transmission, and On-Site Use of Electricity" for calculations.	

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
Other 1	Energy Used		Mbtu/TBD		
	Grid Electricity Used		MWh/TBD		
	All Water Used		gal x 1000/TBD		
	Potable Water Used		gal x 1000/TBD		
	Groundwater Extracted		gal x 1000/TBD		
	CO2e Emitted		lbs/TBD		
	NO x Emitted		lbs/TBD		
	SO x Emitted		lbs/TBD		
	PM Emitted		lbs/TBD		
	Solid Waste Generated		tons/TBD		
	Haz. Waste Generated		tons/TBD		
	Air Toxics Emitted		lbs/TBD		
	Mercury Released		lbs/TBD		
	Lead Released		lbs/TBD		
	Dioxins Released		lbs/TBD		

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
Other 2	Energy Used		Mbtu/TBD		
	Grid Electricity Used		MWh/TBD		
	All Water Used		gal x 1000/TBD		
	Potable Water Used		gal x 1000/TBD		
	Groundwater Extracted		gal x 1000/TBD		
	CO2e Emitted		lbs/TBD		
	NO x Emitted		lbs/TBD		
	SO x Emitted		lbs/TBD		
	PM Emitted		lbs/TBD		
	Solid Waste Generated		tons/TBD		
	Haz. Waste Generated		tons/TBD		
	Air Toxics Emitted		lbs/TBD		
	Mercury Released		lbs/TBD		
	Lead Released		lbs/TBD		
	Dioxins Released		lbs/TBD		

Default Environmental Footprint Conversion Factor References

Material/Fuel/Service	Green Indicator	Value	Units	Assumptions	Information Source
Other 3	Energy Used		Mbtu/TBD		
	Grid Electricity Used		MWh/TBD		
	All Water Used		gal x 1000/TBD		
	Potable Water Used		gal x 1000/TBD		
	Groundwater Extracted		gal x 1000/TBD		
	CO2e Emitted		lbs/TBD		
	NO x Emitted		lbs/TBD		
	SO x Emitted		lbs/TBD		
	PM Emitted		lbs/TBD		
	Solid Waste Generated		tons/TBD		
	Haz. Waste Generated		tons/TBD		
	Air Toxics Emitted		lbs/TBD		
	Mercury Released		lbs/TBD		
	Lead Released		lbs/TBD		
	Dioxins Released		lbs/TBD		

Power Sources and Global Emissions Factors for Electricity Provided by
Tucson Electric Power from EGRID 2005 Data

Type	% Used*	Water (gal/kWh)		CO2e (lbs/kWh)		NOx (lbs/kWh)		SOx (lbs/kWh)		PM (lbs/kWh)		HAPs (lbs/kWh)		Lead (lbs/kWh)		Mercury (lbs/kWh)		Dioxins (lbs/kWh)	
		Full Load	Adjusted	Full Load	Adjusted	Full Load	Adjusted	Full Load	Adjusted	Full Load	Adjusted	Full Load	Adjusted	Full Load	Adjusted	Full Load	Adjusted	Full Load	Adjusted
Biomass	0%	168	0	0	0	0.0015	0	0.00060	0	0.000084	0	0	0	0	0	0	0	0	0
Coal	96%	0.94	0.9024	2.4	2.304	0.0067	0.006432	0.015	0.0144	0.0017	0.001632	0.0007	0.000672	0.00000024	2.304E-07	0.000000042	4.032E-08	3.8E-13	3.4291E-13
Geothermal	0%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydro	0%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Natural Gas	4%	0.79	0.0316	1.4	0.056	0.0012	0.000048	0.012	0.00048	0.000088	0.00000352	0.000193	0.00000772	1.31E-08	5.24E-10	2.9E-09	1.16E-10	0	0
Nuclear	0%	0.72	0	0.024	0	0.000056	0.0000000	0.000131	0	0.0000126	0	0.0000053	0	5.2E-09	0	4.6E-10	0	2.9E-15	0
Oil	0%	3.52	0	1.9	0	0.0036	0.0000000	0.0041	0	0.00029	0	0.0000902	0	0.00000129	0	1.01E-08	0	1.04E-12	0
Solar	0%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wind	0%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	0%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total based on kWh at plant	**100%**		**0.9**		**2.36**		**0.00648**		**0.0149**		**0.001636**		**0.0006797**		**0.00000023**		**0.00000004**		**3.4E-13**
Total based on kWh at point of use (0.12 kWh/kWh lost in transmission)			**1**		**2.64**		**0.00726**		**0.0167**		**0.001832**		**0.000761**		**0.00000026**		**4.5E-08**		**3.8E-13**

** Based on the following:*
Obtain "generation mix" or "fuel blend" from the local utility provider and enter the percentages of each type of electrcity generation method into the "% Used" column of the above table. Percentages should add to 100%.*
The above table provides the conversion factors to convert each kWh of electricity from each generation type into each of the environmental parameters.
"Adjusted" refers to adjusting the footprint value by the percentage of electricity from that particular generation type (e.g., the adjusted value for CO2e emitted by nuclear is 10% of the full-load value if the % of electricity generated by nuclear is 10%).

Notes:
*- Water consumption for thermoelectric power plants in U.S. - 0.47 gallons per kWh**
- Water consumption for hydroelectric power assumed to be 0 gallons per kWh (i.e., considers evaporation from reservoir as non-additive)
*- Water consumption for coal resource extraction and fuel processing - 0.16 cubic meters per GJ of extracted energy, and 33% thermal energy conversion to electricity***
*- Water consumption for uranium resource extraction and fuel processing - 0.086 cubic meters per GJ of extracted energy and 33% thermal energy conversion to electricity***
*- Water consumption for natural gas resource extraction and fuel processing - 0.11 cubic meters per GJ of extracted energy and 33% thermal energy conversion to electricity***
*- Water consumption for oil resource extraction and fuel processing - 1.06 cubic meters per GJ of extracted energy and 33% thermal energy conversion to electricity***
*- Water consumption for biomass based on 55 cubic meters per GJ of extracted energy and 33% thermal energy conversion to electricity****
*- CO2e, Nox, SOx, and PM emissions from NREL LCI for each fuel type *****

** Consumptive Water Use for U.S. Power Production, December 2003 • NREL/TP-550-33905*
*** Gleick PH. Water and energy. Annu. Rev. Energy Environ. Vol 19, 1994. p 267-99.*
**** The Water Footprint of Energy Consumption : an Assessment of Water Requirements of Primary Energy Carriers, Winnie Gerbens-Leenes, Arjen Hoekstra, Theo an der Meer, ISESCO Science and Technology Vision, Volume 4 - Number 5, May 2008*
***** "NREL LCI" refers to the U.S. Dept. of Energy, National Renewable Energy Laboratory (NREL), Life-Cycle Inventory Database (www.nrel.gov/lci) maintained by the Alliance for Sustainable Energy, LLC.*

Electricity and Energy Used for the Production, Transmission, and On-Site Use of Electricity

For the purpose of this study, the sum of the "energy used" for "electricity production", "electricity transmission", and "on-site electricity use" equals the total amount of energy used to generate the 1 MWh used by the consumer. According to the U.S. Dept. of Energy (GridWorks: Overview of the Electric Grid http://sites.energetics.com/gridworks/grid.html) approximately power plants have a thermal efficiency of approximately 33% and the transmission of electricity results in a loss of approximately 10% of the electricity produced. In addition, the National Renewable Energy Laboratory (Consumptive Water Use for U.S. Power Production December 2003 • NREL/TP-550-33905) states that thermoelectric plants use approximately 5% of the gross electricity produced for on-site demand (i.e., parasitic loads).

This study assumes that the 33% thermal efficiency includes the 5% parasitic load and that this efficiency applies to all major electricity generation technologies. It is noted that actual efficiencies may differ by method of generation and by power plant.

For use of 1 MWh of electricity on-site, the following calculations illustrate the electricity and energy used.

$$G = P + T + U$$
$$G = 5\%G + 10\%G + 1$$
$$G(1 - 15\%) = 1$$
$$G = 1.18$$

where

$G = \textit{electricity generated}\ (MWh)$

$P = \textit{parasitic load}\ (MWh)\text{:}5\%\ \textit{of}\ G$

$T = \textit{transmission loss}\ (MWh)\text{:}10\%\ \textit{of}\ G$

$U = \textit{energy used onsite}\ (MWh)$

$$P = 5\% \times 1.18 = 0.06\ MWh$$
$$T = 10\% \times 1.18 = 0.12\ MWh$$

$$E_I = E_P + E_T + E_U$$
$$E_U + E_T = \eta \times E_I$$

$$E_U = 1\ MWh \times \frac{3{,}413 btu}{MWh} = 3{,}413 btu$$
$$E_T = 0.12\ MWh \times \frac{3{,}413 btu}{MWh} = 410 btu$$

$$E_I = \frac{(3{,}413 + 410)}{33\%} = 11{,}584 btu$$

$$E_P = 11{,}584 - 3{,}413 - 410 = 7{,}761 btu$$

where

$E_I = \textit{energy input}\ (btu)$

$E_P = \textit{energy lost electricity production}$
$(\textit{thermal loss and parasitic load})\ (btu)$

$E_T = \textit{energy lost electricity transmission}\ (btu)$

$E_U = \textit{energy used onsite in the form of}$
$\textit{electricity}\ (btu)$

$\eta = \textit{thermal efficiency}\ (33\%)$

Virgin and Regenerated GAC Footprints

Information from Literature

Use of Adsorbents for the Removal of Pollutants from Wastewaters, by Gordon McKay, published by CRC Press, 1995, ISBN 0849369207

Table 8.1

Granular Carbon Regeneration Process Energy Requirements (15,000 kg/day Regeneration Rate)			
System	**Fuel, kJ/kg**	**Electricity, kWh/kg**	**Steam, kg/kg**
Electric infrared furnace	0	0.36	0
Multiple-hearth furnace	18,600	0.10	1.0
Rotary Kiln	23,300	0.07	1.0
Fluid bed furnace	11,700	0.11	0.8

1.2		Specific gravity of coal (www.engineeringtoolbox.com)
0.5		Specific gravity of GAC (Westates/Siemens)
0.7		Fraction of coal that is carbon (http://www.eia.doe.gov/cneaf/coal/quarterly/co2_article/co2.html)
0.015		Fraction of coal that is sulfur (http://www.eia.doe.gov/cneaf/coal/quarterly/co2_article/co2.html)
0.015		Fraction of coal that is nitrogen (assumed to be similar to that of sulfur)
0.27	lb CO2e/lb	Carbon footprint of extracting and delivering 1 lb of coal to a plant (EUROPA ELCD - Hard Coal)
0.0007	lb SO2/lb	Sulfur dioxide (SOx) footprint of extracting and delivering 1 lb of coal (EUROPA ELCD - Hard Coal)
0.001	lb NO2/lb	Nitrogen dioxide (NOx) footprint of extracting and delivering 1 lb of coal (EUROPA ELCD - Hard Coal)
600	btu/lb	Energy requirement of extracting and delivering 1 lb of coal to plant (EUROPA ELCD)
0.38	gal/lb	Water requirement of extracting and delivering 1 lb of coal to plant (EUROPA ELCD)
14	lb CO2e	Carbon footprint of natural gas, including natural gas production (per therm) (NREL, industrial boiler)
0.0046	lb SO2	SOx footprint of natural gas combustion per therm (NREL), including natural gas production (EUROPA ELCD)
0.0138	lb NO2	NOx footprint of natural gas combustion per therm (NREL), including natural gas production (EUROPA ELCD)
1.34	lb CO2e	Carbon footprint of electricity (per kWh) (EGRID, US Average)
0.0053	lb SO2	SOx footprint of electricity (per kWh) (EGRID, US Average)
0.00088	lb NO2	NOx footprint of electricity (per kWh) (EGRID, US Average)

Assumptions:

- Use fuel and electricity requirements for multiple hearth furnace to estimate energy required for regeneration
- Assume energy and water requirements for regeneration is the same as they are for initial activation

Calculations for Virgin Coal:

Carbon Footprint

2.4		Pounds of coal required to produce one pound of GAC
1.68		Pounds of that coal that is carbon
1		Pounds of carbon in one pound of GAC
0.68		Pounds of carbon from coal emitted to atmosphere
2.5	lb CO2e	Pounds of carbon dioxide emitted for burning off coal (measured as pounds of CO2)
0.65	lb CO2e	Pounds of CO2e emitted during coal extraction
8,920	btus	Fuel required to activate one pound of GAC (2.2 pounds per kg and 1.055 kJ/btu)
1.2	lb CO2e	Pounds of CO2e emitted for combustion of natural gas during activation (100,000 btus per therm)
0.045	kWh	Electricity required to activate one pound of GAC
0.061	lb CO2e	Pounds of CO2e emitted for electricity generation
4.5	lb CO2e	Total CO2e emitted for carbon activation

Energy Footprint

2.4		Pounds of coal required to produce one pound of GAC
1440	btus	Energy required during coal extraction
8,920	btus	Fuel required to activate one pound of GAC (2.2 pounds per kg and 1.055 kJ/btu)
0.045	kWh	Electricity required to activate one pound of GAC
470	btus	Energy required to generate that electricity (3,413 btus/kWh and 33% thermal efficiency)
10,800	btus	Total energy required for virgin carbon activation

SOx Footprint

2.4		Pounds of coal required to produce one pound of GAC
0.036		Pounds of that coal that is sulfur
0		Pounds of sulfur in one pound of GAC
0.036		Pounds of sulfur from coal emitted to atmosphere
0.072	lb SO2	Pounds of sulfur dioxide emitted for burning off coal (measured as pounds of SO2)
0.00168	lb SO2	Pounds of SO2 emitted during coal extraction
8,920	btus	Fuel required to activate one pound of GAC (2.2 pounds per kg and 1.055 kJ/btu)
0.00041	lb SO2	Pounds of SO2 emitted for combustion of natural gas during activation (100,000 btus per therm)
0.045	kWh	Electricity required to activate one pound of GAC
0.00024	lb SO2	Pounds of SO2 emitted for electricity generation
0.074	lb SO2	Total SO2 emitted for carbon activation

NOx Footprint

2.4		Pounds of coal required to produce one pound of GAC
0.036		Pounds of that coal that is nitrogen
0		Pounds of nitrogen in one pound of GAC
0.036		Pounds of nitrogen from coal emitted to atmosphere
0.12	lb NO2	Pounds of nitrogen dioxide emitted for burning off coal (measured as pounds of NO2)
0.0024	lb NO2	Pounds of NO2 emitted during coal extraction
8,920	btus	Fuel required to activate one pound of GAC (2.2 pounds per kg and 1.055 kJ/btu)
0.00123	lb NO2	Pounds of NO2 emitted for combustion of natural gas during activation (100,000 btus per therm)
0.045	kWh	Electricity required to activate one pound of GAC
0.00004	lb NO2	Pounds of NO2 emitted for electricity generation
0.12	lb NO2	Total NO2 emitted for carbon activation

Calculations for Regenerated Coal

Footprint per Regeneration Cycle (including 10% virgin GAC to make-up for loss)

Energy	CO2e	NOx	SOx
9500	1.6	0.014	0.008

Footprints over 10 Regeneration Cycles

Cycle	Energy	CO2e	NOx	SOx
1	10,800	4.50	0.12	0.074
2	10,200	3.1	0.069	0.041
3	9,900	2.6	0.051	0.03
4	9,800	2.3	0.041	0.025
5	9,800	2.2	0.036	0.021
6	9,700	2.1	0.032	0.019
7	9,700	2	0.03	0.017
8	9,700	2	0.028	0.016
9	9,600	1.9	0.026	0.015
10	9,600	1.9	0.025	0.015

Calculations for Water Footprint

Use Siemens Water Technologies (formerly Westates Carbon) in Parker, AZ as a basis

4,000 tons/yr hazardous spent carbon treated at Siemens

Each year, Siemens receives about 4,000 tons of spent carbon from 30 - 35 states across the United States. About half of this is considered hazardous waste by EPA.

source: http://www.epa.gov/region09/waste/siemens/

EPA Web Page on Siemens Carbon Regeneration Facility (last updated Dec 2007), see third paragraph on first page

conversion: 2,000 lb/ton

8,000,000 lbs/yr spent carbon treated

138,000 gallons/day wastewater discharged by Siemens to POTW

source: Fact Sheet for NPDES Permit for Colorado River Sewage System Joint Venture (EPA June 2001) -- hard copy in EPA files

page 1, General Information: Westates Carbon discharges about 138,000 gallons per day of process waste water used in the air pollution control unit, equipment/facility washdown, and slurry spent carbon.

conversion: 365 days/yr

50,370,000 gal/yr wastewater discharged

as an estimate, assume this is equal to the amount of fresh water withdrawn for processing spent carbon

this assumption will lead to an underestimate of the water withdrawn because water is "lost" as steam in the stack gases (note also that some of the steam exiting in the stack gases is due to products of combustion, rather than volatilization of water introduced into the system as liquid)

50,370,000 gal/yr fresh water withdrawn

6.3 gallons H2O / lb carbon regenerated

Water Footprint for Coal Extraction

2.4		Pounds of coal required to produce one pound of GAC
0.91	gallons	Gallons of water consumed during extraction of the coal

7.2 Total gallons of water for generating one pound of virgin GAC

6.3 Gallons of water per pound of regenerated GAC (includes makeup GAC if the original GAC is produced at the same plant)

Footprints over 10 Regeneration Cycles

Cycle	Water
1	7.2
2	6.8
3	6.6
4	6.5
5	6.5
6	6.5
7	6.4
8	6.4
9	6.4
10	6.4

APPENDIX C

FOOTPRINT ANALYSIS SPREADSHEET OUTPUT

SPREADSHEET OUTPUT FILES

Figures C-1and C-2 illustrate the organization of the footprint analysis spreadsheets. Each remedy has a footprint analysis spreadsheet that receives the information from the remedy inventory sheets. The information and calculations from all of the footprint analysis spreadsheets are then compiled in a general or main spreadsheet. Each remedy footprint analysis spreadsheet refers to its own footprint conversion spreadsheet so that the footprint conversion factors can be changed by alternative if preferred. For each alternative, a total footprint is calculated and subtotals for on-site, electricity generation, transportation, and "other off-site" footprints are calculated.

This appendix provides all of the spreadsheet output for the BP analysis. The output from the main sheet is provided first, followed by the detailed spreadsheet output for each of the remedy alternatives. The charts illustrating the output are provided in the "Supplemental Charts" section of the report and are not reproduced here.

For this analysis the following assignments apply:

- Alternative A – P&T
- Alternative B – ISCO

- Level 1 – Construction
- Level 2 – O&M
- Level 3 – Long-term Monitoring

Figure C-1. Organization of Files for Analysis

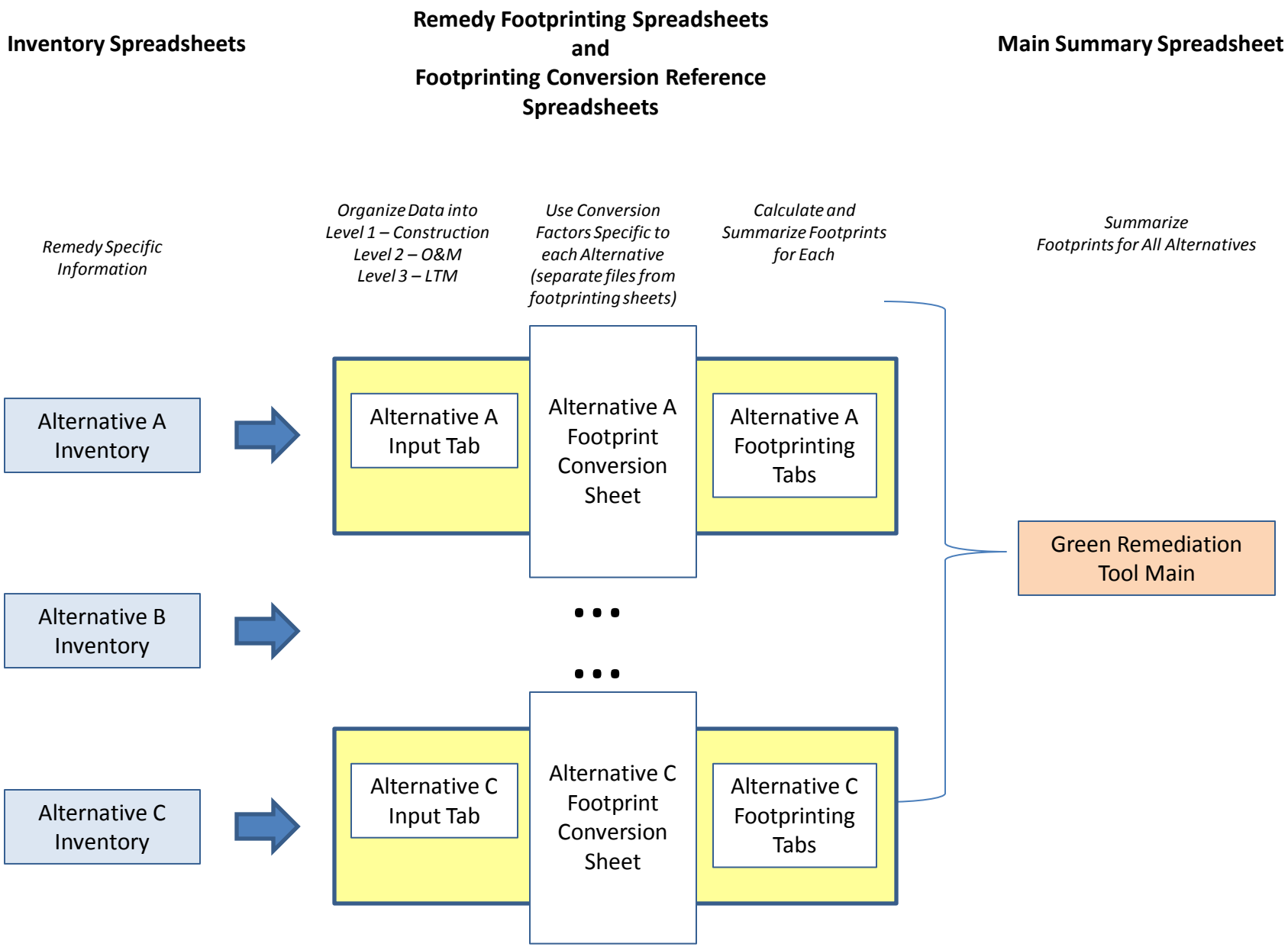
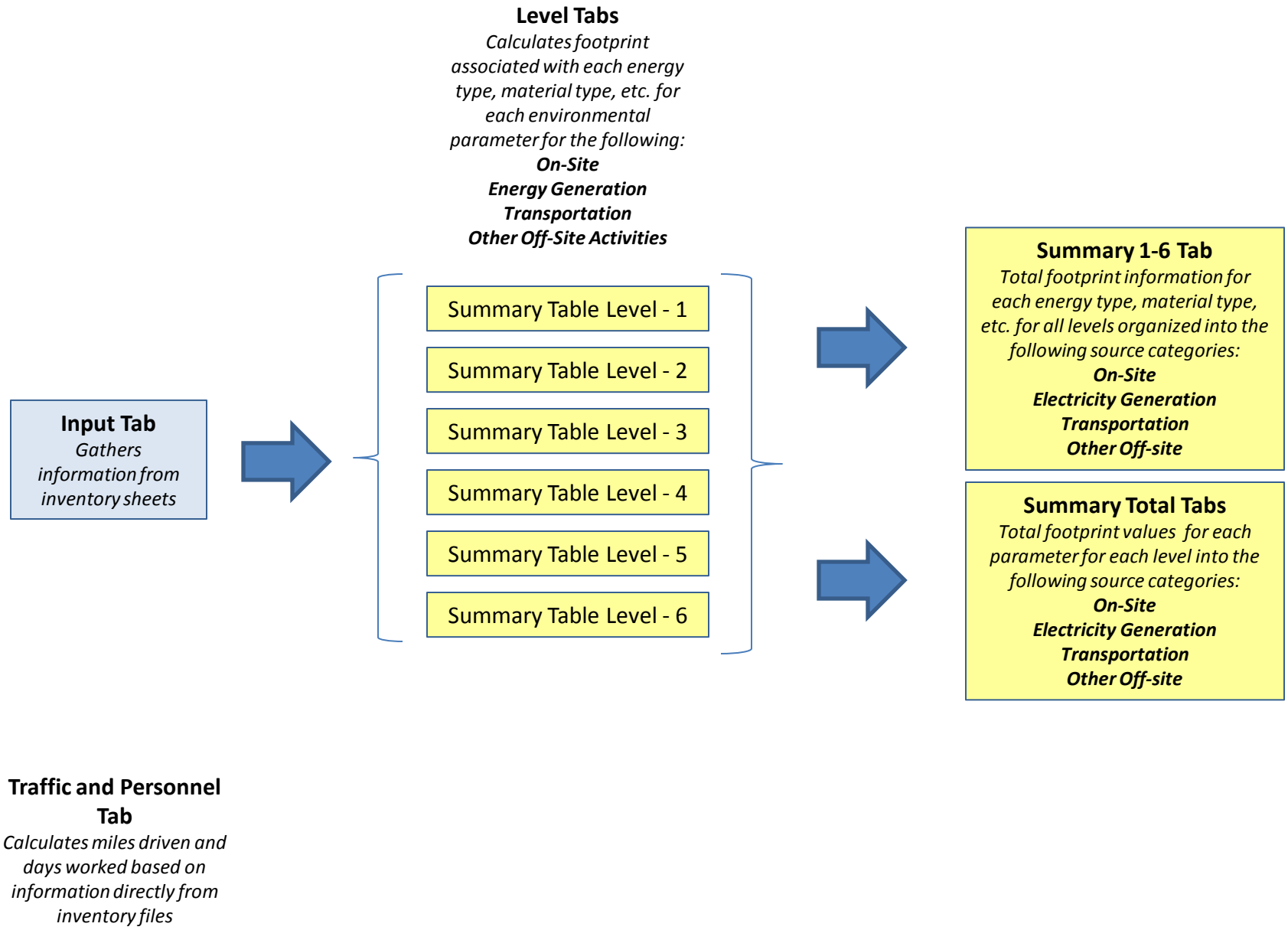


Figure C-2. Organization of Footprint Analysis Spreadsheets



	Comparison for Parameters Used, Extracted, Emitted, or Generated On-Site														
	Energy Used	Grid Electricity Used	All Water Used	Potable Water Used	Groundwater Extracted	CO2e Emitted	NO x Emitted	SO x Emitted	PM Emitted	Solid Waste Generated	Haz. Waste Generated	Air Toxics Emitted	Mercury Released	Lead Released	Dioxins Released
	Mbtu	MWh	gal x 1000	gal x 1000	gal x 1000	lbs	lbs	lbs	lbs	tons	tons	lbs	lbs	lbs	lbs
Level 1 - Construction															
P&T	84,132.	0	60.	0	60.	13,619.	103.	3.	2.	45.	0	0.0031	0	0	0
ISCO	128,821.	0	1.	0	1.	20,852.	158.	5.	3.	16.5	0	0.0048	0	0	0
Remedy 3															
Remedy 4															
Remedy 5															
Level 2 - O&M															
P&T	24,311,195.	7,123.	0	0	0	0	0	0	0	0	0	0	0	0	0
ISCO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Remedy 3															
Remedy 4															
Remedy 5															
Level 3 - Monitoring															
P&T	76,334.	0	0	0	0	12,066.	68.	3.	0	0	0	0.024	0	0	0
ISCO	21,713.	0	4.	0	4.	3,432.	19.	1.	0	0	0	0.0068	0	0	0
Remedy 3															
Remedy 4															
Remedy 5															
Level 4 - Not Used															
P&T	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ISCO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Remedy 3															
Remedy 4															
Remedy 5															
Level 5 - Not Used															
P&T	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ISCO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Remedy 3															
Remedy 4															
Remedy 5															
Level 6 - Not Used															
P&T	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ISCO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Remedy 3															
Remedy 4															
Remedy 5															
Total (All Levels)															
P&T	24,471,661.	7,123.	60.	0	60.	25,685.	171.	6.	2.	45.	0	0.0271	0	0	0
ISCO	150,534.	0	5.	0	5.	24,284.	177.	6.	3.	16.5	0	0.0116	0	0	0
Remedy 3															
Remedy 4															
Remedy 5															

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	Comparison for Parameters Used, Extracted, Emitted, or Generated from Electricity Generation														
	Energy Used Mbtu	Grid Electricity Used MWh	All Water Used gal x 1000	Potable Water Used gal x 1000	Groundwater Extracted gal x 1000	CO2e Emitted lbs	NO x Emitted lbs	SO x Emitted lbs	PM Emitted lbs	Solid Waste Generated tons	Haz. Waste Generated tons	Air Toxics Emitted lbs	Mercury Released lbs	Lead Released lbs	Dioxins Released lbs
Level 1 - Construction															
P&T	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ISCO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Remedy 3															
Remedy 4															
Remedy 5															
Level 2 - O&M															
P&T	55,560,305.	427.	6,411.	0	0	16,810,554.	46,158.	106,134.	11,653.	6.4	0	4,841.5819	0.28492464	1.63831668	0.000002421859
ISCO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Remedy 3															
Remedy 4															
Remedy 5															
Level 3 - Monitoring															
P&T	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ISCO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Remedy 3															
Remedy 4															
Remedy 5															
Level 4 - Not Used															
P&T	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ISCO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Remedy 3															
Remedy 4															
Remedy 5															
Level 5 - Not Used															
P&T	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ISCO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Remedy 3															
Remedy 4															
Remedy 5															
Level 6 - Not Used															
P&T	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ISCO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Remedy 3															
Remedy 4															
Remedy 5															
Total (All Levels)															
P&T	55,560,305.	427.	6,411.	0	0	16,810,554.	46,158.	106,134.	11,653.	6.4	0	4,841.5819	0.28492464	1.63831668	0.000002421859
ISCO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Remedy 3															
Remedy 4															
Remedy 5															

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	Comparison for Total Parameters Used, Extracted, Emitted, or Generated from Transportation														
	Energy Used Mbtu	Grid Electricity Used MWh	All Water Used gal x 1000	Potable Water Used gal x 1000	Groundwater Extracted gal x 1000	CO2e Emitted lbs	NO x Emitted lbs	SO x Emitted lbs	PM Emitted lbs	Solid Waste Generated tons	Haz. Waste Generated tons	Air Toxics Emitted lbs	Mercury Released lbs	Lead Released lbs	Dioxins Released lbs
Level 1 - Construction															
P&T	220,341.	0	0	0	0	35,205.	229.	8.	3.	0	0	0.0419	0	0	0
ISCO	106,348.	0	0	0	0	17,103.	120.	4.	2.	0	0	0.0122	0	0	0
Remedy 3															
Remedy 4															
Remedy 5															
Level 2 - O&M															
P&T	713,947.	0	0	0	0	114,095.	743.	27.	10.	0	0	0.1339	0	0	0
ISCO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Remedy 3															
Remedy 4															
Remedy 5															
Level 3 - Monitoring															
P&T	223,200.	0	0	0	0	35,280.	198.	8.	1.	0	0	0.0702	0	0	0
ISCO	74,792.	0	0	0	0	11,862.	70.	2.	0	0	0	0.0206	0	0	0
Remedy 3															
Remedy 4															
Remedy 5															
Level 4 - Not Used															
P&T	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ISCO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Remedy 3															
Remedy 4															
Remedy 5															
Level 5 - Not Used															
P&T	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ISCO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Remedy 3															
Remedy 4															
Remedy 5															
Level 6 - Not Used															
P&T	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ISCO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Remedy 3															
Remedy 4															
Remedy 5															
Total (All Levels)															
P&T	1,157,488.	0	0	0	0	184,580.	1,170.	43.	14.	0	0	0.246	0	0	0
ISCO	181,140.	0	0	0	0	28,965.	190.	6.	2.	0	0	0.0328	0	0	0
Remedy 3															
Remedy 4															
Remedy 5															

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	Comparison for Parameters Used, Extracted, Emitted, or Generated from Other Off-Site Activities														
	Energy Used	Grid Electricity Used	All Water Used	Potable Water Used	Groundwater Extracted	CO2e Emitted	NO x Emitted	SO x Emitted	PM Emitted	Solid Waste Generated	Haz. Waste Generated	Air Toxics Emitted	Mercury Released	Lead Released	Dioxins Released
	Mbtu	MWh	gal x 1000	gal x 1000	gal x 1000	lbs	lbs	lbs	lbs	tons	tons	lbs	lbs	lbs	lbs
Level 1 - Construction															
P&T	816,404.	22.	124.	0	0	270,581.	974.	666.	45.	4.4	0.011	10.8553	0.009811198	0.050362069	0.000040891136
ISCO	489,414.	23.	52.	0	0	82,856.	315.	255.	31.	0	0.002	8.7031	0.001445822	0.009215002	0.000007403108
Remedy 3															
Remedy 4															
Remedy 5															
Level 2 - O&M															
P&T	5,784,124.	1,005.	2,125.	0	0	1,773,417.	5,842.	10,399.	962.	0.8	0	393.2352	0.023303864	0.188753066	0.000000236029
ISCO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Remedy 3															
Remedy 4															
Remedy 5															
Level 3 - Monitoring															
P&T	1,296,029.	68.	129.	0	0	202,509.	940.	737.	78.	0	0	25.3309	0.001817118	0.02162412	0.000000015234
ISCO	288,910.	15.	29.	0	0	45,320.	208.	165.	17.	0	0	5.5885	0.000415886	0.005213819	0.000000003346
Remedy 3															
Remedy 4															
Remedy 5															
Level 4 - Not Used															
P&T	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ISCO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Remedy 3															
Remedy 4															
Remedy 5															
Level 5 - Not Used															
P&T	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ISCO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Remedy 3															
Remedy 4															
Remedy 5															
Level 6 - Not Used															
P&T	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ISCO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Remedy 3															
Remedy 4															
Remedy 5															
Total (All Levels)															
P&T	7,896,557.	1,095.	2,378.	0	0	2,246,507.	7,756.	11,802.	1,085.	5.2	0.011	429.4214	0.03493218	0.260739255	0.000041142399
ISCO	778,324.	38.	81.	0	0	128,176.	523.	420.	48.	0	0.002	14.2916	0.001861708	0.014428821	0.000007406454
Remedy 3															
Remedy 4															
Remedy 5															

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	Comparison for TOTAL Parameters Used, Extracted, Emitted, or Generated														
	Energy Used Mbtu	Grid Electricity Used MWh	All Water Used gal x 1000	Potable Water Used gal x 1000	Groundwater Extracted gal x 1000	CO2e Emitted lbs	NO x Emitted lbs	SO x Emitted lbs	PM Emitted lbs	Solid Waste Generated tons	Haz. Waste Generated tons	Air Toxics Emitted lbs	Mercury Released lbs	Lead Released lbs	Dioxins Released lbs
Level 1 - Construction															
P&T	1,120,877.	22.	184.	0	60.	319,405.	1,306.	677.	50.	49.4	0.011	10.9003	0.009811198	0.050362069	0.000040891136
ISCO	724,583.	23.	53.	0	1.	120,811.	593.	264.	36.	16.5	0.002	8.7201	0.001445822	0.009215002	0.000007403108
Remedy 3															
Remedy 4															
Remedy 5															
Level 2 - O&M															
P&T	86,369,571.	8,555.	8,536.	0	0	18,698,066.	52,743.	116,560.	12,625.	7.2	0	5,234.951	0.308228504	1.827069746	0.000002657888
ISCO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Remedy 3															
Remedy 4															
Remedy 5															
Level 3 - Monitoring															
P&T	1,595,563.	68.	129.	0	0	249,855.	1,206.	748.	79.	0	0	25.4251	0.001817118	0.02162412	0.000000015234
ISCO	385,415.	15.	33.	0	4.	60,614.	297.	168.	17.	0	0	5.6159	0.000415886	0.005213819	0.000000003346
Remedy 3															
Remedy 4															
Remedy 5															
Level 4 - Not Used															
P&T	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ISCO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Remedy 3															
Remedy 4															
Remedy 5															
Level 5 - Not Used															
P&T	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ISCO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Remedy 3															
Remedy 4															
Remedy 5															
Level 6 - Not Used															
P&T	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ISCO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Remedy 3															
Remedy 4															
Remedy 5															
Total (All Levels)															
P&T	89,086,011.	8,645.	8,849.	0	60.	19,267,326.	55,255.	117,985.	12,754.	56.6	0.011	5,271.2764	0.31985682	1.899055935	0.000043564258
ISCO	1,109,998.	38.	86.	0	5.	181,425.	890.	432.	53.	16.5	0.002	14.336	0.001861708	0.014428821	0.000007406454
Remedy 3															
Remedy 4															
Remedy 5															

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	Totals For Parameters Used, Extracted, Emitted, or Generated - Alternate A														
	Energy Used	Grid Electricity Used	All Water Used	Potable Water Used	Groundwater Extracted	CO2e Emitted	NO x Emitted	SO x Emitted	PM Emitted	Solid Waste Generated	Haz. Waste Generated	Air Toxics Emitted	Mercury Released	Lead Released	Dioxins Released
	Mbtu	MWh	gal x 1000	gal x 1000	gal x 1000	lbs	lbs	lbs	lbs	tons	tons	lbs	lbs	lbs	lbs
Level 1 - Construction															
On-Site	84,132.	0	60.	0	60.	13,619.	103.	3.	2.	45.	0	0.0031	0	0	0
Electricity Generation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transportation	220,341.	0	0	0	0	35,205.	229.	8.	3.	0	0	0.0419	0	0	0
Other Off-Site	816,404.	22.	124.	0	0	270,581.	974.	666.	45.	4.4	0.011	10.8553	0.009811198	0.050362069	0.000040891136
Construction Total	***1,120,877.***	***22.***	***184.***	***0***	***60.***	***319,405.***	***1,306.***	***677.***	***50.***	***49.4***	***0.011***	***10.9003***	***0.009811198***	***0.050362069***	***0.000040891136***
Level 2 - O&M															
On-Site	24,311,195.	7,123.	0	0	0	0	0	0	0	0	0	0	0	0	0
Electricity Generation	55,560,305.	427.	6,411.	0	0	16,810,554.	46,158.	106,134.	11,653.	6.4	0	4,841.5819	0.28492464	1.63831668	0.000002421859
Transportation	713,947.	0	0	0	0	114,095.	743.	27.	10.	0	0	0.1339	0	0	0
Other Off-Site	5,784,124.	1,005.	2,125.	0	0	1,773,417.	5,842.	10,399.	962.	0.8	0	393.2352	0.023303864	0.188753066	0.000000236029
O&M Total	***86,369,571.***	***8,555.***	***8,536.***	***0***	***0***	***18,698,066.***	***52,743.***	***116,560.***	***12,625.***	***7.2***	***0***	***5,234.951***	***0.308228504***	***1.827069746***	***0.000002657888***
Level 3 - Monitoring															
On-Site	76,334.	0	0	0	0	12,066.	68.	3.	0	0	0	0.024	0	0	0
Electricity Generation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transportation	223,200.	0	0	0	0	35,280.	198.	8.	1.	0	0	0.0702	0	0	0
Other Off-Site	1,296,029.	68.	129.	0	0	202,509.	940.	737.	78.	0	0	25.3309	0.001817118	0.02162412	0.000000015234
Monitoring Total	***1,595,563.***	***68.***	***129.***	***0***	***0***	***249,855.***	***1,206.***	***748.***	***79.***	***0***	***0***	***25.4251***	***0.001817118***	***0.02162412***	***0.000000015234***
Level 4 - Not Used															
On-Site	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Electricity Generation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transportation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Off-Site	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Not Used Total	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***
Level 5 - Not Used															
On-Site	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Electricity Generation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transportation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Off-Site	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Not Used Total	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***
Level 6 - Not Used															
On-Site	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Electricity Generation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transportation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Off-Site	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Not Used Total	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***
Total	***89,086,011.***	***8,645.***	***8,849.***	***0***	***60.***	***19,267,326.***	***55,255.***	***117,985.***	***12,754.***	***56.6***	***0.011***	***5,271.2764***	***0.31985682***	***1.899055935***	***0.000043564258***

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All Levels - Parameters Used, Extracted, Emitted, or Generated - Alternate A

		Quantity Used	Energy		Grid Electricity		All Water		Potable Water		Groundwater		CO2e		NO x		SO x		PM		Solid Waste		Haz. Waste		Air Toxics		Mercury		Lead		Dioxins	
			Conv. Factor	Used	Conv. Factor	Used	Conv. Factor	Used	Conv. Factor	Used	Conv. Factor	Extracted	Conv. Factor	Emitted	Conv. Factor	Emitted	Conv. Factor	Emitted	Conv. Factor	Emitted	Conv. Factor	Generated	Conv. Factor	Generated	Conv. Factor	Emitted	Conv. Factor	Released	Conv. Factor	Released	Conv. Factor	Released
				Mbtu		MWh		gal x 1000		gal x 1000		gal x 1000		lbs		lbs		lbs		lbs		tons		tons		lbs		lbs		lbs		lbs
Totals				***89,086,010.***		***8,645.***		***8,848.***		***0***		***60.***		***19,267,326.***		***55,255.***		***117,985.***		***12,751.***		***56.***		***0.011***		***5,271.2762***		***0.31985682***		***1.899055935***		***0.000043564257***
ON-SITE																																
Energy																																
Diesel (on-site use)	gal	605.268	139	84,132.	0	0	0	0	0	0	0	0	22.5	13,619.	0.17	103.	0.0054	3.	0.0034	2.	0	0	0	0	5E-06	0.0031	0	0	0	0	0	0
Gasoline (on-site use)	gal	615.6	124	76,334.	0	0	0	0	0	0	0	0	19.6	12,066.	0.11	68.	0.0045	3.	0.0005	0	0	0	0	0	4E-05	0.024	0	0	0	0	0	0
Natural gas (on-site use)	ccf	0	103	0	0	0	0	0	0	0	0	0	12.2	0	0.01	0	6E-06	0	0.0008	0	0	0	0	0	8E-06	0	3E-08	0	5E-08	0	0	0
Electricity (on-site use)	MWh	7123.116	3413	24,311,195.	1	7,123.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Photovoltaic (on-site system)	MWh	0	37922	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Energy 2	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Energy 3	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Water																																
Groundwater Extracted On-site	gal x 1000	60	0	0	0	0	1	60.	0	0	1	60.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Potable Water Used On-site	gal x 1000	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other On-Site Water 1	gal x 1000	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other On-Site Water 2	gal x 1000	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other On-Site Water 3	gal x 1000	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Waste Generation																																
On-Site Solid Waste Generation	ton	45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	45.	0	0	0	0	0	0	0	0	0	0
On-Site Solid Waste Disposal		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
On-Site Hazardous Waste Generation	ton	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
On-Site Hazardous Waste Disposal		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other																																
On-site process emissions (HAPs)	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
On-site process emissions (GHGs)	lbs CO2e	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
On-site GHG storage	lbs CO2e	0	0	0	0	0	0	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
On-site NOx reduction	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
On-site SOx reduction	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
On-site PM reduction	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0
Other 1	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other 2	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ON-SITE TOTAL			0	**24,471,661.**	0	**7,123.**	0	**60.**	0	**0**	0	**60.**	0	**25,685.**	0	**171.**	0	**6.**	0	**2.**	0	**45.**	0	**0**	0	**0.0271**	0	**0**	0	**0**	0	**0**
ELECTRICITY GENERATION																																
Electricity production	MWh	7123.116	7800	55,560,305.	0.06	427.	0.9	6,411.	0	0	0	0	2360	16,810,554.	6.48	46,158.	14.9	106,134.	1.636	11,653.	0.0009	6.	0	0	0.6797	4,841.5819	4E-05	0.28492464	0.0002	1.63831668	3E-10	0.000002421859
Purchased Renewa ble Electricity	MWh	0	0	0	0	0	-2	0	0	0	0	0	1540	0	3.9	0	10	0	0.94	0	0.0009	0	0	0	0.4	0	2E-05	0	0.0002	0	2E-10	0
TRANSPORTATION																																
Diesel (off-site use)	gal	3065.1	139	426,049.	0	0	0	0	0	0	0	0	22.5	68,965.	0.17	521.	0.0054	17.	0.0034	10.	0	0	0	0	5E-06	0.0159	0	0	0	0	0	0
Gasoline (off-site use)	gal	5898.7	124	731,439.	0	0	0	0	0	0	0	0	19.6	115,615.	0.11	649.	0.0045	27.	0.0005	3.	0	0	0	0	4E-05	0.23	0	0	0	0	0	0
Natural gas (off-site use)	ccf	0	103	0	0	0	0	0	0	0	0	0	12.2	0	0.01	0	6E-06	0	0.0008	0	0	0	0	0	8E-06	0	3E-08	0	5E-08	0	0	0
Other Transportation 1	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Transportation 2	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Transportation 3	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Transportation 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Transportation 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TRANSPORTATION TOTAL			0	**1,157,488.**	0	**0**	0	**0**	0	**0**	0	**0**	0	**184,580.**	0	**1,170.**	0	**44.**	0	**13.**	0	**0**	0	**0**	0	**0.2459**	0	**0**	0	**0**	0	**0**

			All Levels - Parameters Used, Extracted, Emitted, or Generated - Alternate A																											
			Energy		Grid Electricity		All Water		Potable Water		Groundwater		CO2e		NO x		SO x		PM		Solid Waste		Haz. Waste		Air Toxics		Mercury		Lead		Dioxins	
		Quantity Used	Conv. Factor	Used	Conv. Factor	Used	Conv. Factor	Used	Conv. Factor	Used	Conv. Factor	Extracted	Conv. Factor	Emitted	Conv. Factor	Emitted	Conv. Factor	Emitted	Conv. Factor	Emitted	Conv. Factor	Generated	Conv. Factor	Generated	Conv. Factor	Emitted	Conv. Factor	Released	Conv. Factor	Released	Conv. Factor	Released
				Mbtu		MWh		gal x 1000		gal x 1000		gal x 1000		lbs		lbs		lbs		lbs		tons		tons		lbs		lbs		lbs		lbs
OFF-SITE OTHER																																
Materials																																
Asphalt	tons	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bentonite	tons	0	55	0	0.0027	0	0.13	0	0	0	0	0	6.7	0	0.033	0	0.03	0	0.004	0	0	0	0	0	4E-07	0	6E-11	0	1E-09	0	2E-16	0
Borrow (clean soil)	tons	0	15.75	0	6E-05	0	8E-05	0	0	0	0	0	2.52	0	0.0176	0	0.0018	0	0.0004	0	4E-08	0	0	0	1E-05	0	5E-09	0	2E-07	0	3E-15	0
Cement	dry-ton	11	4100	45,100.	0.13	1.	0.41	5.	0	0	0	0	1800	19,800.	3.6	40.	2.1	23.	0.0063	0	0	0	0	0	0.058	0.638	6E-05	0.000627	0.0001	0.00143	9E-11	0.000000000935
Cheese Whey	lbs	0	1.87	0	0	0	0	0	0	0	0	0	1.1	0	0.0083	0	0.0099	0	0.0002	0	0	0	0	0	0	0	0	0	0	0	0	0
Concrete	tons	140	3019	422,660.	0.096	13.	0.34	48.	0	0	0	0	1322	185,080.	2.6	364.	1.5	210.	0.0054	1.	1E-08	0	0	0	0.043	6.02	4E-05	0.00588	1E-04	0.0133	6E-11	0.00000000868
Diesel Produced	gal	3670.368	18.5	67,902.	0.0006	2.	0.0008	3.	0	0	0	0	2.7	9,910.	0.0064	23.	0.013	48.	0.0003	1.	4E-07	0	0	0	0.0001	0.4404	5E-08	0.000176178	2E-06	0.005505552	3E-14	0.000000000011
Emulsified vegetable oil	lbs	0	3.6	0	6E-05	0	2E-05	0	0	0	0	0	3.51	0	0.0265	0	0.031	0	0.0017	0	0	0	0	0	0	0	0	0	0	0	0	0
GAC: regenerated	lbs	24092	9.6	231,283.	0.0004	11.	0.0064	154.	0	0	0	0	2	48,184.	0.025	602.	0.015	361.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GAC: virgin coal-based	lbs	4000	10.8	43,200.	5E-05	0	0	0	0	0	0	0	4.5	18,000.	0.12	480.	0.074	296.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GAC: virgin coconut-based	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gasoline Produced	gal	6514.3	21	136,800.	0.0006	4.	0.0008	5.	0	0	0	0	4.4	28,663.	0.008	52.	0.019	124.	0.0005	3.	4E-07	0	0	0	0.0002	1.0423	9E-08	0.000553716	2E-06	0.01433146	3E-14	0.000000000202
Gravel/sand/clay	ton	64	55	3,520.	0.0027	0	0.13	8.	0	0	0	0	6.7	429.	0.033	2.	0.03	2.	0.004	0	0	0	0	0	4E-07	0	6E-11	0.000000004	1E-09	0.000000077	2E-16	0
HDPE	lb	1500	31	46,500.	0.0003	0	0.0023	3.	0	0	0	0	1.9	2,850.	0.0032	5.	0.0041	6.	0.0006	1.	4E-07	0	1E-06	0.002	3E-06	0.0051	3E-09	0.0000039	2E-09	0.0000036	1E-09	0.00000147
Hydrochloric acid (30%, SG = 1.18)	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydrogen peroxide (50%, SG=1.19)	lbs	0	4.95	0	0.0006	0	0.019	0	0	0	0	0	1.35	0	0.0087	0	0.0066	0	0.0025	0	1E-05	0	5E-07	0	0.0002	0	0	0	0	0	0	0
Hydroseed	lbs	0	0.049	0	1E-07	0	0.0001	0	0	0	0	0	0.0046	0	3E-06	0	5E-05	0	3E-07	0	0	0	0	0	8E-07	0	2E-11	0	1E-10	0	0	0
Lime	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Molasses	lbs	0	1.31	0	5E-06	0	9E-05	0	0	0	0	0	0.4	0	0.003	0	0.0026	0	6E-05	0	0	0	0	0	0	0	0	0	0	0	0	0
Natural Gas Produced	ccf	0	5.2	0	0.0003	0	8E-05	0	0	0	0	0	2.2	0	0.0037	0	0.0046	0	7E-05	0	0	0	0	0	6E-06	0	2E-08	0	9E-07	0	5E-14	0
Nitrogen fertilizer	lbs	0	16.2	0	2E-05	0	0	0	0	0	0	0	1.5	0	0.0008	0	0.0174	0	7E-05	0	0	0	0	0	0.0003	0	6E-09	0	4E-08	0	0	0
Other Material #1 - PV System	W	0	33.6	0	0.0003	0	0	0	0	0	0	0	4.47	0	0.015	0	0.032	0	0.0006	0	0	0	3E-06	0	3E-06	0	0	0	3E-06	0	0	0
Other Material #2 - Mulch	cy	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Material #3 - acetic acid	lb	0	5.2	0	2E-05	0	0	0	0	0	0	0	0.67	0	0.0006	0	0.02	0	6E-05	0	0	0	0	0	0.0003	0	2E-09	0	1E-08	0	3E-15	0
Other Material #4 - guar gum	lb	0	0.91	0	5E-05	0	0.0001	0	0	0	0	0	1	0	0.073	0	0.0068	0	0.0001	0	0	0	0	0	1E-05	0	1E-09	0	1E-07	0	6E-14	0
Other Material #5	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phosphorus fertilizer	lbs	0	3.39	0	7E-05	0	0	0	0	0	0	0	0.35	0	0.0017	0	0.017	0	0.0001	0	0	0	0	0	5E-05	0	2E-09	0	5E-08	0	0	0
Polymer	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Potable Water	gal x 1000	0	9.2	0	0.0004	0	0.021	0	0	0	0	0	5	0	0.0097	0	0.0059	0	0.016	0	8E-07	0	0	0	2E-05	0	8E-09	0	7E-08	0	1E-13	0
Potassium permanganate	lbs	0	29.22	0	0.0016	0	0.003	0	0	0	0	0	4.5	0	0.021	0	0.016	0	0.0017	0	1E-06	0	0	0	0.0006	0	4E-08	0	4E-07	0	4E-13	0
PVC	lbs	5700	22	125,400.	0.0006	3.	0.0069	39.	0	0	0	0	2.6	14,820.	0.0048	27.	0.0076	43.	0.0012	7.	2E-06	0	2E-06	0.009	0.0005	2.679	3E-07	0.001938	1E-07	0.000741	7E-09	0.00003933
Sequestering agent	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sodium hydroxide (dry bulk)	lbs	0	6.6	0	0.0003	0	0.0012	0	0	0	0	0	1.37	0	0.003	0	0.0048	0	0.0005	0	2E-05	0	5E-07	0	6E-05	0	2E-07	0	3E-08	0	2E-14	0
Stainless Steel	lb	2200	11.6	25,520.	0.0006	1.	0.0023	5.	0	0	0	0	3.4	7,480.	0.0075	17.	0.012	26.	0.0044	10.	0.0006	1.	0	0	0.0001	0.3168	0	0	5E-07	0.001144	2E-12	0.00000000484
Steel	lb	11700	4.4	51,480.	0.0002	2.	0.0006	7.	0	0	0	0	1.1	12,870.	0.0014	16.	0.0017	20.	0.0006	7.	0.0003	3.	0	0	7E-05	0.7839	1E-07	0.00117	3E-06	0.02925	7E-12	0.00000007605
Tree: root ball	trees	0	3.7	0	2E-06	0	0.004	0	0	0	0	0	0.6	0	0.003	0	0.0006	0	3E-05	0	1E-08	0	0	0	6E-06	0	2E-09	0	6E-08	0	0	0
Tree: whip	trees	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Off-Site Services																																
Off-site waste water treatment	gal x 1000	60	15	900.	0.0007	0	0.0029	0	0	0	0	0	4.4	264.	0.016	1.	0.015	1.	0.0017	0	0.0024	0	0	0	0.0006	0.0348	4E-08	0.00000222	4E-07	0.0000222	3E-13	0.000000000021
Off-site Solid Waste Disposal	ton	45	160	7,200.	0.0077	0	0.15	7.	0	0	0	0	25	1,125.	0.14	6.	0.075	3.	0.4	18.	8E-06	0	0	0	0.0014	0.063	1E-06	0.00004365	8E-06	0.000342	1E-11	0.00000000054
Off-site Haz. Waste Disposal	ton	0	176	0	0.0085	0	0.165	0	0	0	0	0	27.5	0	0.154	0	0.0825	0	0.44	0	9E-06	0	0	0	0.0015	0	1E-06	0	8E-06	0	1E-11	0
Off-site Laboratory Analysis	$	580680	6.49	3,768,613.	0.0004	203.	0.0007	383.	0	0	0	0	1	580,680.	0.0048	2,787.	0.0036	2,090.	0.0004	232.	0	0	0	0	0.0001	75.4884	8E-09	0.004877712	9E-08	0.0493578	8E-14	0.000000045874
Other 1	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other 2	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other 3	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other 4	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other 5	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other																																
Potable Water Transported	gal x 1000	0	7.4	0	0.0006	0	0.0013	0	0	0	0	0	0.9948	0	0.0025	0	0.0065	0	0.0006	0	6E-07	0	0	0	0.0003	0	1E-08	0	1E-07	0	2E-13	0
Electricity transmission	MWh	7123.116	410	2,920,478.	0.12	855.	0.24	1,710.	0	0	0	0	184.8	1,316,352.	0.468	3,334.	1.2	8,548.	0.1128	803.	0.0001	1.	0	0	0.048	341.9096	3E-06	0.0196598	2E-05	0.145311566	3E-11	0.000000205146
Other 1	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other 2	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other 3	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OFF-SITE OTHER TOTAL			0	7,896,556.	0	1,095.	0	2,377.	0	0	0	0	0	2,246,507.	0	7,756.	0	11,801.	0	1,083.	0	5.	0	0.011	0	429.4213	0	0.03493218	0	0.260739255	0	0.000041142398

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Level 1 (Construction) Parameters Used, Extracted, Emitted, or Generated - Alternate A

		Quantity Used	Energy		Grid Electricity		All Water		Potable Water		Groundwater		CO2e		NO x		SO x		PM		Solid Waste		Haz. Waste		Air Toxics		Mercury		Lead		Dioxins	
			Conv. Factor	Used	Conv. Factor	Used	Conv. Factor	Used	Conv. Factor	Used	Conv. Factor	Extracted	Conv. Factor	Emitted	Conv. Factor	Emitted	Conv. Factor	Emitted	Conv. Factor	Emitted	Conv. Factor	Generated	Conv. Factor	Generated	Conv. Factor	Emitted	Conv. Factor	Released	Conv. Factor	Released	Conv. Factor	Released
				Mbtu		MWh		gal x 1000		gal x 1000		gal x 1000		lbs		lbs		lbs		lbs		tons		tons		lbs		lbs		lbs		lbs
Totals				***1,120,877.***		***22.***		***184.***		***0***		***60.***		***319,405.***		***1,306.***		***677.***		***50.***		***49.4***		***0.011***		***10.9003***		***0.009811198***		***0.050362069***		***0.000040891136***
ON-SITE																																
Energy																																
Diesel (on-site use)	gal	605.268	139	84,132.	0	0	0	0	0	0	0	0	22.5	13,619.	0.17	103.	0.0054	3.	0.0034	2.	0	0	0	0	5E-06	0.0031	0	0	0	0	0	0
Gasoline (on-site use)	gal	0	124	0	0	0	0	0	0	0	0	0	19.6	0	0.11	0	0.0045	0	0.0005	0	0	0	0	0	4E-05	0	0	0	0	0	0	0
Natural gas (on-site use)	ccf	0	103	0	0	0	0	0	0	0	0	0	12.2	0	0.01	0	6E-06	0	0.0008	0	0	0	0	0	8E-06	0	3E-08	0	5E-08	0	0	0
Electricity (on-site use)	MWh	0	3413	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Photovoltaic (on-site system)	MWh	0	37922	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Energy 2	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Energy 3	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Water																																
Groundwater Extracted On-site	gal x 1000	60	0	0	0	0	1	60.	0	0	1	60.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Potable Water Used On-site	gal x 1000	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other On-Site Water 1	gal x 1000	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other On-Site Water 2	gal x 1000	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other On-Site Water 3	gal x 1000	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Waste Generation																																
On-Site Solid Waste Generation	ton	45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	45.	0	0	0	0	0	0	0	0	0	0
On-Site Solid Waste Disposal		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
On-Site Hazardous Waste Generation	ton	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
On-Site Hazardous Waste Disposal		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other																																
On-site process emissions (HAPs)	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
On-site process emissions (GHGs)	lbs CO2e	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
On-site GHG storage	lbs CO2e	0	0	0	0	0	0	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
On-site NOx reduction	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
On-site SOx reduction	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
On-site PM reduction	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0
Other 1	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other 2	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ON-SITE TOTAL			0	**84,132.**	0	**0**	0	**60.**	0	**0**	0	**60.**	0	**13,619.**	0	**103.**	0	**3.**	0	**2.**	0	**45.**	0	**0**	0	**0.0031**	0	**0**	0	**0**	0	**0**
ELECTRICITY GENERATION																																
Electricity production	MWh	0	7800	0	0.06	0	0.9	0	0	0	0	0	2360	0	6.48	0	14.9	0	1.636	0	0.0009	0	0	0	0.6797	0	4E-05	0	0.0002	0	3E-10	0
Purchased Renewa ble Electricity	MWh	0	0	0	0	0	-2	0	0	0	0	0	1540	0	3.9	0	10	0	0.94	0	0.0009	0	0	0	0.4	0	2E-05	0	0.0002	0	2E-10	0
TRANSPORTATION																																
Diesel (off-site use)	gal	712.1	139	98,982.	0	0	0	0	0	0	0	0	22.5	16,022.	0.17	121.	0.0054	4.	0.0034	2.	0	0	0	0	5E-06	0.0037	0	0	0	0	0	0
Gasoline (off-site use)	gal	978.7	124	121,359.	0	0	0	0	0	0	0	0	19.6	19,183.	0.11	108.	0.0045	4.	0.0005	1.	0	0	0	0	4E-05	0.0382	0	0	0	0	0	0
Natural gas (off-site use)	ccf	0	103	0	0	0	0	0	0	0	0	0	12.2	0	0.01	0	6E-06	0	0.0008	0	0	0	0	0	8E-06	0	3E-08	0	5E-08	0	0	0
Other Transportation 1	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Transportation 2	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Transportation 3	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Transportation 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Transportation 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TRANSPORTATION TOTAL			0	**220,341.**	0	**0**	0	**0**	0	**0**	0	**0**	0	**35,205.**	0	**229.**	0	**8.**	0	**3.**	0	**0**	0	**0**	0	**0.0419**	0	**0**	0	**0**	0	**0**

			Level 1 (Construction) Parameters Used, Extracted, Emitted, or Generated - Alternate A																											
			Energy		Grid Electricity		All Water		Potable Water		Groundwater		CO2e		NO x		SO x		PM		Solid Waste		Haz. Waste		Air Toxics		Mercury		Lead		Dioxins	
		Quantity Used	Conv. Factor	Used	Conv. Factor	Used	Conv. Factor	Used	Conv. Factor	Used	Conv. Factor	Extracted	Conv. Factor	Emitted	Conv. Factor	Emitted	Conv. Factor	Emitted	Conv. Factor	Emitted	Conv. Factor	Generated	Conv. Factor	Generated	Conv. Factor	Emitted	Conv. Factor	Released	Conv. Factor	Released	Conv. Factor	Released
				Mbtu		MWh		gal x 1000		gal x 1000		gal x 1000		lbs		lbs		lbs		lbs		tons		tons		lbs		lbs		lbs		lbs
OFF-SITE OTHER																																
Materials																																
Asphalt	tons	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bentonite	tons	0	55	0	0.0027	0	0.13	0	0	0	0	0	6.7	0	0.033	0	0.03	0	0.004	0	0	0	0	0	4E-07	0	6E-11	0	1E-09	0	2E-16	0
Borrow (clean soil)	tons	0	15.75	0	6E-05	0	8E-05	0	0	0	0	0	2.52	0	0.0176	0	0.0018	0	0.0004	0	4E-08	0	0	0	1E-05	0	5E-09	0	2E-07	0	3E-15	0
Cement	dry-ton	11	4100	45,100.	0.13	1.	0.41	5.	0	0	0	0	1800	19,800.	3.6	40.	2.1	23.	0.0063	0	0	0	0	0	0.058	0.638	6E-05	0.000627	0.0001	0.00143	9E-11	0.000000000935
Cheese Whey	lbs	0	1.87	0	0	0	0	0	0	0	0	0	1.1	0	0.0083	0	0.0099	0	0.0002	0	0	0	0	0	0	0	0	0	0	0	0	0
Concrete	tons	140	3019	422,660.	0.096	13.	0.34	48.	0	0	0	0	1322	185,080.	2.6	364.	1.5	210.	0.0054	1.	1E-08	0	0	0	0.043	6.02	4E-05	0.00588	1E-04	0.0133	6E-11	0.00000000868
Diesel Produced	gal	1317.368	18.5	24,371.	0.0006	1.	0.0008	1.	0	0	0	0	2.7	3,557.	0.0064	8.	0.013	17.	0.0003	0	4E-07	0	0	0	0.0001	0.1581	5E-08	0.000063234	2E-06	0.001976052	3E-14	0.00000000004
Emulsified vegetable oil	lbs	0	3.6	0	6E-05	0	2E-05	0	0	0	0	0	3.51	0	0.0265	0	0.031	0	0.0017	0	0	0	0	0	0	0	0	0	0	0	0	0
GAC: regenerated	lbs	0	9.6	0	0.0004	0	0.0064	0	0	0	0	0	2	0	0.025	0	0.015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GAC: virgin coal-based	lbs	4000	10.8	43,200.	5E-05	0	0	0	0	0	0	0	4.5	18,000.	0.12	480.	0.074	296.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GAC: virgin coconut-based	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gasoline Produced	gal	978.7	21	20,553.	0.0006	1.	0.0008	1.	0	0	0	0	4.4	4,306.	0.008	8.	0.019	19.	0.0005	1.	4E-07	0	0	0	0.0002	0.1566	9E-08	0.00008319	2E-06	0.00215314	3E-14	0.00000000003
Gravel/sand/clay	ton	64	55	3,520.	0.0027	0	0.13	8.	0	0	0	0	6.7	429.	0.033	2.	0.03	2.	0.004	0	0	0	0	0	4E-07	0	6E-11	0.000000004	1E-09	0.000000077	2E-16	0
HDPE	lb	1500	31	46,500.	0.0003	0	0.0023	3.	0	0	0	0	1.9	2,850.	0.0032	5.	0.0041	6.	0.0006	1.	4E-07	0	1E-06	0.002	3E-06	0.0051	3E-09	0.0000039	2E-09	0.0000036	1E-09	0.00000147
Hydrochloric acid (30%, SG = 1.18)	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydrogen peroxide (50%, SG=1.19)	lbs	0	4.95	0	0.0006	0	0.019	0	0	0	0	0	1.35	0	0.0087	0	0.0066	0	0.0025	0	1E-05	0	5E-07	0	0.0002	0	0	0	0	0	0	0
Hydroseed	lbs	0	0.049	0	1E-07	0	0.0001	0	0	0	0	0	0.0046	0	3E-06	0	5E-05	0	3E-07	0	0	0	0	0	8E-07	0	2E-11	0	1E-10	0	0	0
Lime	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Molasses	lbs	0	1.31	0	5E-06	0	9E-05	0	0	0	0	0	0.4	0	0.003	0	0.0026	0	6E-05	0	0	0	0	0	0	0	0	0	0	0	0	0
Natural Gas Produced	ccf	0	5.2	0	0.0003	0	8E-05	0	0	0	0	0	2.2	0	0.0037	0	0.0046	0	7E-05	0	0	0	0	0	6E-06	0	2E-08	0	9E-07	0	5E-14	0
Nitrogen fertilizer	lbs	0	16.2	0	2E-05	0	0	0	0	0	0	0	1.5	0	0.0008	0	0.0174	0	7E-05	0	0	0	0	0	0.0003	0	6E-09	0	4E-08	0	0	0
Other Material #1 - PV System	W	0	33.6	0	0.0003	0	0	0	0	0	0	0	4.47	0	0.015	0	0.032	0	0.0006	0	0	0	3E-06	0	3E-06	0	0	0	3E-06	0	0	0
Other Material #2 - Mulch	cy	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Material #3 - acetic acid	lb	0	5.2	0	2E-05	0	0	0	0	0	0	0	0.67	0	0.0006	0	0.02	0	6E-05	0	0	0	0	0	0.0003	0	2E-09	0	1E-08	0	3E-15	0
Other Material #4 - guar gum	lb	0	0.91	0	5E-05	0	0.0001	0	0	0	0	0	1	0	0.073	0	0.0068	0	0.0001	0	0	0	0	0	1E-05	0	1E-09	0	1E-07	0	6E-14	0
Other Material #5	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phosphorus fertilizer	lbs	0	3.39	0	7E-05	0	0	0	0	0	0	0	0.35	0	0.0017	0	0.017	0	0.0001	0	0	0	0	0	5E-05	0	2E-09	0	5E-08	0	0	0
Polymer	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Potable Water	gal x 1000	0	9.2	0	0.0004	0	0.021	0	0	0	0	0	5	0	0.0097	0	0.0059	0	0.016	0	8E-07	0	0	0	2E-05	0	8E-09	0	7E-08	0	1E-13	0
Potassium permanganate	lbs	0	29.22	0	0.0016	0	0.003	0	0	0	0	0	4.5	0	0.021	0	0.016	0	0.0017	0	1E-06	0	0	0	0.0006	0	4E-08	0	4E-07	0	4E-13	0
PVC	lbs	5700	22	125,400.	0.0006	3.	0.0069	39.	0	0	0	0	2.6	14,820.	0.0048	27.	0.0076	43.	0.0012	7.	2E-06	0	2E-06	0.009	0.0005	2.679	3E-07	0.001938	1E-07	0.000741	7E-09	0.00003933
Sequestering agent	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sodium hydroxide (dry bulk)	lbs	0	6.6	0	0.0003	0	0.0012	0	0	0	0	0	1.37	0	0.003	0	0.0048	0	0.0005	0	2E-05	0	5E-07	0	6E-05	0	2E-07	0	3E-08	0	2E-14	0
Stainless Steel	lb	2200	11.6	25,520.	0.0006	1.	0.0023	5.	0	0	0	0	3.4	7,480.	0.0075	17.	0.012	26.	0.0044	10.	0.0006	1.4	0	0	0.0001	0.3168	0	0	5E-07	0.001144	2E-12	0.00000000484
Steel	lb	11700	4.4	51,480.	0.0002	2.	0.0006	7.	0	0	0	0	1.1	12,870.	0.0014	16.	0.0017	20.	0.0006	7.	0.0003	2.9	0	0	7E-05	0.7839	1E-07	0.00117	3E-06	0.02925	7E-12	0.00000007605
Tree: root ball	trees	0	3.7	0	2E-06	0	0.004	0	0	0	0	0	0.6	0	0.003	0	0.0006	0	3E-05	0	1E-08	0	0	0	6E-06	0	2E-09	0	6E-08	0	0	0
Tree: whip	trees	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Off-Site Services																																
Off-site waste water treatment	gal x 1000	60	15	900.	0.0007	0	0.0029	0	0	0	0	0	4.4	264.	0.016	1.	0.015	1.	0.0017	0	0.0024	0.1	0	0	0.0006	0.0348	4E-08	0.00000222	4E-07	0.0000222	3E-13	0.000000000021
Off-site Solid Waste Disposal	ton	45	160	7,200.	0.0077	0	0.15	7.	0	0	0	0	25	1,125.	0.14	6.	0.075	3.	0.4	18.	8E-06	0	0	0	0.0014	0.063	1E-06	0.00004365	8E-06	0.000342	1E-11	0.00000000054
Off-site Haz. Waste Disposal	ton	0	176	0	0.0085	0	0.165	0	0	0	0	0	27.5	0	0.154	0	0.0825	0	0.44	0	9E-06	0	0	0	0.0015	0	1E-06	0	8E-06	0	1E-11	0
Off-site Laboratory Analysis	$	0	6.49	0	0.0004	0	0.0007	0	0	0	0	0	1	0	0.0048	0	0.0036	0	0.0004	0	0	0	0	0	0.0001	0	8E-09	0	9E-08	0	8E-14	0
Other 1	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other 2	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other 3	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other 4	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other 5	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other																																
Potable Water Transported	gal x 1000	0	7.4	0	0.0006	0	0.0013	0	0	0	0	0	0.9948	0	0.0025	0	0.0065	0	0.0006	0	6E-07	0	0	0	0.0003	0	1E-08	0	1E-07	0	2E-13	0
Electricity transmission	MWh	0	410	0	0.12	0	0.24	0	0	0	0	0	184.8	0	0.468	0	1.2	0	0.1128	0	0.0001	0	0	0	0.048	0	3E-06	0	2E-05	0	3E-11	0
Other 1	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other 2	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other 3	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OFF-SITE OTHER TOTAL			0	816,404.	0	22.	0	124.	0	0	0	0	0	270,581.	0	974.	0	666.	0	45.	0	4.4	0	0.011	0	10.8553	0	0.009811198	0	0.050362069	0	0.000040891136

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Level 2 (O&M) Parameters Used, Extracted, Emitted, or Generated - Alternate A

		Quantity Used	Energy		Grid Electricity		All Water		Potable Water		Groundwater		CO2e		NO x		SO x		PM		Solid Waste		Haz. Waste		Air Toxics		Mercury		Lead		Dioxins	
			Conv. Factor	Used	Conv. Factor	Used	Conv. Factor	Used	Conv. Factor	Used	Conv. Factor	Extracted	Conv. Factor	Emitted	Conv. Factor	Emitted	Conv. Factor	Emitted	Conv. Factor	Emitted	Conv. Factor	Generated	Conv. Factor	Generated	Conv. Factor	Emitted	Conv. Factor	Released	Conv. Factor	Released	Conv. Factor	Released
				Mbtu		MWh		gal x 1000		gal x 1000		gal x 1000		lbs		lbs		lbs		lbs		tons		tons		lbs		lbs		lbs		lbs
Totals				***86,369,571.***		***8,555.***		***8,536.***		***0***		***0***		***18,698,066.***		***52,743.***		***116,560.***		***12,625.***		***7.2***		***0***		***5,234.951***		***0.308228504***		***1.827069746***		***0.000002657888***
ON-SITE																																
Energy																																
Diesel (on-site use)	gal	0	139	0	0	0	0	0	0	0	0	0	22.5	0	0.17	0	0.0054	0	0.0034	0	0	0	0	0	5E-06	0	0	0	0	0	0	0
Gasoline (on-site use)	gal	0	124	0	0	0	0	0	0	0	0	0	19.6	0	0.11	0	0.0045	0	0.0005	0	0	0	0	0	4E-05	0	0	0	0	0	0	0
Natural gas (on-site use)	ccf	0	103	0	0	0	0	0	0	0	0	0	12.2	0	0.01	0	6E-06	0	0.0008	0	0	0	0	0	8E-06	0	3E-08	0	5E-08	0	0	0
Electricity (on-site use)	MWh	7123.116	3413	24,311,195.	1	7,123.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Photovoltaic (on-site system)	MWh	0	37922	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Energy 2	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Energy 3	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Water																																
Groundwater Extracted On-site	gal x 1000	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Potable Water Used On-site	gal x 1000	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other On-Site Water 1	gal x 1000	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other On-Site Water 2	gal x 1000	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other On-Site Water 3	gal x 1000	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Waste Generation																																
On-Site Solid Waste Generation	ton	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
On-Site Solid Waste Disposal		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
On-Site Hazardous Waste Generation	ton	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
On-Site Hazardous Waste Disposal		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other																																
On-site process emissions (HAPs)	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
On-site process emissions (GHGs)	lbs CO2e	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
On-site GHG storage	lbs CO2e	0	0	0	0	0	0	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
On-site NOx reduction	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
On-site SOx reduction	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
On-site PM reduction	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0
Other 1	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other 2	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ON-SITE TOTAL			0	**24,311,195.**	0	**7,123.**	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**
ELECTRICITY GENERATION																																
Electricity production	MWh	7123.116	7800	55,560,305.	0.06	427.	0.9	6,411.	0	0	0	0	2360	16,810,554.	6.48	46,158.	14.9	106,134.	1.636	11,653.	0.0009	6.4	0	0	0.6797	4,841.5819	4E-05	0.28492464	0.0002	1.63831668	3E-10	0.000002421859
Purchased Renewa ble Electricity	MWh	0	0	0	0	0	-2	0	0	0	0	0	1540	0	3.9	0	10	0	0.94	0	0.0009	0	0	0	0.4	0	2E-05	0	0.0002	0	2E-10	0
TRANSPORTATION																																
Diesel (off-site use)	gal	2353	139	327,067.	0	0	0	0	0	0	0	0	22.5	52,943.	0.17	400.	0.0054	13.	0.0034	8.	0	0	0	0	5E-06	0.0122	0	0	0	0	0	0
Gasoline (off-site use)	gal	3120	124	386,880.	0	0	0	0	0	0	0	0	19.6	61,152.	0.11	343.	0.0045	14.	0.0005	2.	0	0	0	0	4E-05	0.1217	0	0	0	0	0	0
Natural gas (off-site use)	ccf	0	103	0	0	0	0	0	0	0	0	0	12.2	0	0.01	0	6E-06	0	0.0008	0	0	0	0	0	8E-06	0	3E-08	0	5E-08	0	0	0
Other Transportation 1	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Transportation 2	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Transportation 3	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Transportation 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Transportation 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TRANSPORTATION TOTAL			0	**713,947.**	0	**0**	0	**0**	0	**0**	0	**0**	0	**114,095.**	0	**743.**	0	**27.**	0	**10.**	0	**0**	0	**0**	0	**0.1339**	0	**0**	0	**0**	0	**0**

			Level 2 (O&M) Parameters Used, Extracted, Emitted, or Generated - Alternate A																											
			Energy		Grid Electricity		All Water		Potable Water		Groundwater		CO2e		NO x		SO x		PM		Solid Waste		Haz. Waste		Air Toxics		Mercury		Lead		Dioxins	
		Quantity Used	Conv. Factor	Used	Conv. Factor	Used	Conv. Factor	Used	Conv. Factor	Used	Conv. Factor	Extracted	Conv. Factor	Emitted	Conv. Factor	Emitted	Conv. Factor	Emitted	Conv. Factor	Emitted	Conv. Factor	Generated	Conv. Factor	Generated	Conv. Factor	Emitted	Conv. Factor	Released	Conv. Factor	Released	Conv. Factor	Released
				Mbtu		MWh		gal x 1000		gal x 1000		gal x 1000		lbs		lbs		lbs		lbs		tons		tons		lbs		lbs		lbs		lbs
OFF-SITE OTHER																																
Materials																																
Asphalt	tons	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bentonite	tons	0	55	0	0.0027	0	0.13	0	0	0	0	0	6.7	0	0.033	0	0.03	0	0.004	0	0	0	0	0	4E-07	0	6E-11	0	1E-09	0	2E-16	0
Borrow (clean soil)	tons	0	15.75	0	6E-05	0	8E-05	0	0	0	0	0	2.52	0	0.0176	0	0.0018	0	0.0004	0	4E-08	0	0	0	1E-05	0	5E-09	0	2E-07	0	3E-15	0
Cement	dry-ton	0	4100	0	0.13	0	0.41	0	0	0	0	0	1800	0	3.6	0	2.1	0	0.0063	0	0	0	0	0	0.058	0	6E-05	0	0.0001	0	9E-11	0
Cheese Whey	lbs	0	1.87	0	0	0	0	0	0	0	0	0	1.1	0	0.0083	0	0.0099	0	0.0002	0	0	0	0	0	0	0	0	0	0	0	0	0
Concrete	tons	0	3019	0	0.096	0	0.34	0	0	0	0	0	1322	0	2.6	0	1.5	0	0.0054	0	1E-08	0	0	0	0.043	0	4E-05	0	1E-04	0	6E-11	0
Diesel Produced	gal	2353	18.5	43,531.	0.0006	1.	0.0008	2.	0	0	0	0	2.7	6,353.	0.0064	15.	0.013	31.	0.0003	1.	4E-07	0	0	0	0.0001	0.2824	5E-08	0.000112944	2E-06	0.0035295	3E-14	0.000000000071
Emulsified vegetable oil	lbs	0	3.6	0	6E-05	0	2E-05	0	0	0	0	0	3.51	0	0.0265	0	0.031	0	0.0017	0	0	0	0	0	0	0	0	0	0	0	0	0
GAC: regenerated	lbs	24092	9.6	231,283.	0.0004	11.	0.0064	154.	0	0	0	0	2	48,184.	0.025	602.	0.015	361.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GAC: virgin coal-based	lbs	0	10.8	0	5E-05	0	0	0	0	0	0	0	4.5	0	0.12	0	0.074	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GAC: virgin coconut-based	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gasoline Produced	gal	3120	21	65,520.	0.0006	2.	0.0008	2.	0	0	0	0	4.4	13,728.	0.008	25.	0.019	59.	0.0005	2.	4E-07	0	0	0	0.0002	0.4992	9E-08	0.0002652	2E-06	0.006864	3E-14	0.000000000097
Gravel/sand/clay	ton	0	55	0	0.0027	0	0.13	0	0	0	0	0	6.7	0	0.033	0	0.03	0	0.004	0	0	0	0	0	4E-07	0	6E-11	0	1E-09	0	2E-16	0
HDPE	lb	0	31	0	0.0003	0	0.0023	0	0	0	0	0	1.9	0	0.0032	0	0.0041	0	0.0006	0	4E-07	0	1E-06	0	3E-06	0	3E-09	0	2E-09	0	1E-09	0
Hydrochloric acid (30%, SG = 1.18)	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydrogen peroxide (50%, SG=1.19)	lbs	0	4.95	0	0.0006	0	0.019	0	0	0	0	0	1.35	0	0.0087	0	0.0066	0	0.0025	0	1E-05	0	5E-07	0	0.0002	0	0	0	0	0	0	0
Hydroseed	lbs	0	0.049	0	1E-07	0	0.0001	0	0	0	0	0	0.0046	0	3E-06	0	5E-05	0	3E-07	0	0	0	0	0	8E-07	0	2E-11	0	1E-10	0	0	0
Lime	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Molasses	lbs	0	1.31	0	5E-06	0	9E-05	0	0	0	0	0	0.4	0	0.003	0	0.0026	0	6E-05	0	0	0	0	0	0	0	0	0	0	0	0	0
Natural Gas Produced	ccf	0	5.2	0	0.0003	0	8E-05	0	0	0	0	0	2.2	0	0.0037	0	0.0046	0	7E-05	0	0	0	0	0	6E-06	0	2E-08	0	9E-07	0	5E-14	0
Nitrogen fertilizer	lbs	0	16.2	0	2E-05	0	0	0	0	0	0	0	1.5	0	0.0008	0	0.0174	0	7E-05	0	0	0	0	0	0.0003	0	6E-09	0	4E-08	0	0	0
Other Material #1 - PV System	W	0	33.6	0	0.0003	0	0	0	0	0	0	0	4.47	0	0.015	0	0.032	0	0.0006	0	0	0	3E-06	0	3E-06	0	0	0	3E-06	0	0	0
Other Material #2 - Mulch	cy	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Material #3 - acetic acid	lb	0	5.2	0	2E-05	0	0	0	0	0	0	0	0.67	0	0.0006	0	0.02	0	6E-05	0	0	0	0	0	0.0003	0	2E-09	0	1E-08	0	3E-15	0
Other Material #4 - guar gum	lb	0	0.91	0	5E-05	0	0.0001	0	0	0	0	0	1	0	0.073	0	0.0068	0	0.0001	0	0	0	0	0	1E-05	0	1E-09	0	1E-07	0	6E-14	0
Other Material #5	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phosphorus fertilizer	lbs	0	3.39	0	7E-05	0	0	0	0	0	0	0	0.35	0	0.0017	0	0.017	0	0.0001	0	0	0	0	0	5E-05	0	2E-09	0	5E-08	0	0	0
Polymer	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Potable Water	gal x 1000	0	9.2	0	0.0004	0	0.021	0	0	0	0	0	5	0	0.0097	0	0.0059	0	0.016	0	8E-07	0	0	0	2E-05	0	8E-09	0	7E-08	0	1E-13	0
Potassium permanganate	lbs	0	29.22	0	0.0016	0	0.003	0	0	0	0	0	4.5	0	0.021	0	0.016	0	0.0017	0	1E-06	0	0	0	0.0006	0	4E-08	0	4E-07	0	4E-13	0
PVC	lbs	0	22	0	0.0006	0	0.0069	0	0	0	0	0	2.6	0	0.0048	0	0.0076	0	0.0012	0	2E-06	0	2E-06	0	0.0005	0	3E-07	0	1E-07	0	7E-09	0
Sequestering agent	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sodium hydroxide (dry bulk)	lbs	0	6.6	0	0.0003	0	0.0012	0	0	0	0	0	1.37	0	0.003	0	0.0048	0	0.0005	0	2E-05	0	5E-07	0	6E-05	0	2E-07	0	3E-08	0	2E-14	0
Stainless Steel	lb	0	11.6	0	0.0006	0	0.0023	0	0	0	0	0	3.4	0	0.0075	0	0.012	0	0.0044	0	0.0006	0	0	0	0.0001	0	0	0	5E-07	0	2E-12	0
Steel	lb	0	4.4	0	0.0002	0	0.0006	0	0	0	0	0	1.1	0	0.0014	0	0.0017	0	0.0006	0	0.0003	0	0	0	7E-05	0	1E-07	0	3E-06	0	7E-12	0
Tree: root ball	trees	0	3.7	0	2E-06	0	0.004	0	0	0	0	0	0.6	0	0.003	0	0.0006	0	3E-05	0	1E-08	0	0	0	6E-06	0	2E-09	0	6E-08	0	0	0
Tree: whip	trees	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Off-Site Services																																
Off-site waste water treatment	gal x 1000	0	15	0	0.0007	0	0.0029	0	0	0	0	0	4.4	0	0.016	0	0.015	0	0.0017	0	0.0024	0	0	0	0.0006	0	4E-08	0	4E-07	0	3E-13	0
Off-site Solid Waste Disposal	ton	0	160	0	0.0077	0	0.15	0	0	0	0	0	25	0	0.14	0	0.075	0	0.4	0	8E-06	0	0	0	0.0014	0	1E-06	0	8E-06	0	1E-11	0
Off-site Haz. Waste Disposal	ton	0	176	0	0.0085	0	0.165	0	0	0	0	0	27.5	0	0.154	0	0.0825	0	0.44	0	9E-06	0	0	0	0.0015	0	1E-06	0	8E-06	0	1E-11	0
Off-site Laboratory Analysis	$	388800	6.49	2,523,312.	0.0004	136.	0.0007	257.	0	0	0	0	1	388,800.	0.0048	1,866.	0.0036	1,400.	0.0004	156.	0	0	0	0	0.0001	50.544	8E-09	0.00326592	9E-08	0.033048	8E-14	0.000000030715
Other 1	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other 2	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other 3	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other 4	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other 5	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other																																
Potable Water Transported	gal x 1000	0	7.4	0	0.0006	0	0.0013	0	0	0	0	0	0.9948	0	0.0025	0	0.0065	0	0.0006	0	6E-07	0	0	0	0.0003	0	1E-08	0	1E-07	0	2E-13	0
Electricity transmission	MWh	7123.116	410	2,920,478.	0.12	855.	0.24	1,710.	0	0	0	0	184.8	1,316,352.	0.468	3,334.	1.2	8,548.	0.1128	803.	0.0001	0.8	0	0	0.048	341.9096	3E-06	0.0196598	2E-05	0.145311566	3E-11	0.000000205146
Other 1	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other 2	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other 3	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OFF-SITE OTHER TOTAL			0	5,784,124.	0	1,005.	0	2,125.	0	0	0	0	0	1,773,417.	0	5,842.	0	10,399.	0	962.	0	0.8	0	0	0	393.2352	0	0.023303864	0	0.188753066	0	0.000000236029

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			Level 3 (Monitoring) Parameters Used, Extracted, Emitted, or Generated - Alternate A																											
			Energy		Grid Electricity		All Water		Potable Water		Groundwater		CO2e		NO x		SO x		PM		Solid Waste		Haz. Waste		Air Toxics		Mercury		Lead		Dioxins	
		Quantity Used	Conv. Factor	Used	Conv. Factor	Used	Conv. Factor	Used	Conv. Factor	Used	Conv. Factor	Extracted	Conv. Factor	Emitted	Conv. Factor	Emitted	Conv. Factor	Emitted	Conv. Factor	Emitted	Conv. Factor	Generated	Conv. Factor	Generated	Conv. Factor	Emitted	Conv. Factor	Released	Conv. Factor	Released	Conv. Factor	Released
				Mbtu		MWh		gal x 1000		gal x 1000		gal x 1000		lbs		lbs		lbs		lbs		tons		tons		lbs		lbs		lbs		lbs
Totals				***1,595,563.***		***68.***		***129.***		***0***		***0***		***249,855.***		***1,206.***		***748.***		***79.***		***0***		***0***		***25.4251***		***0.001817118***		***0.02162412***		***0.000000015234***
ON-SITE																																
Energy																																
Diesel (on-site use)	gal	0	139	0	0	0	0	0	0	0	0	0	22.5	0	0.17	0	0.0054	0	0.0034	0	0	0	0	0	5E-06	0	0	0	0	0	0	0
Gasoline (on-site use)	gal	615.6	124	76,334.	0	0	0	0	0	0	0	0	19.6	12,066.	0.11	68.	0.0045	3.	0.0005	0	0	0	0	0	4E-05	0.024	0	0	0	0	0	0
Natural gas (on-site use)	ccf	0	103	0	0	0	0	0	0	0	0	0	12.2	0	0.01	0	6E-06	0	0.0008	0	0	0	0	0	8E-06	0	3E-08	0	5E-08	0	0	0
Electricity (on-site use)	MWh	0	3413	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Photovoltaic (on-site system)	MWh	0	37922	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Energy 2	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Energy 3	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Water																																
Groundwater Extracted On-site	gal x 1000	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Potable Water Used On-site	gal x 1000	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other On-Site Water 1	gal x 1000	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other On-Site Water 2	gal x 1000	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other On-Site Water 3	gal x 1000	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Waste Generation																																
On-Site Solid Waste Generation	ton	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
On-Site Solid Waste Disposal		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
On-Site Hazardous Waste Generation	ton	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
On-Site Hazardous Waste Disposal		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other																																
On-site process emissions (HAPs)	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
On-site process emissions (GHGs)	lbs CO2e	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
On-site GHG storage	lbs CO2e	0	0	0	0	0	0	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
On-site NOx reduction	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
On-site SOx reduction	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
On-site PM reduction	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0
Other 1	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other 2	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ON-SITE TOTAL			0	**76,334.**	0	**0**	0	**0**	0	**0**	0	**0**	0	**12,066.**	0	**68.**	0	**3.**	0	**0**	0	**0**	0	**0**	0	**0.024**	0	**0**	0	**0**	0	**0**
ELECTRICITY GENERATION																																
Electricity production	MWh	0	7800	0	0.06	0	0.9	0	0	0	0	0	2360	0	6.48	0	14.9	0	1.636	0	0.0009	0	0	0	0.6797	0	4E-05	0	0.0002	0	3E-10	0
Purchased Renewa ble Electricity	MWh	0	0	0	0	0	-2	0	0	0	0	0	1540	0	3.9	0	10	0	0.94	0	0.0009	0	0	0	0.4	0	2E-05	0	0.0002	0	2E-10	0
TRANSPORTATION																																
Diesel (off-site use)	gal	0	139	0	0	0	0	0	0	0	0	0	22.5	0	0.17	0	0.0054	0	0.0034	0	0	0	0	0	5E-06	0	0	0	0	0	0	0
Gasoline (off-site use)	gal	1800	124	223,200.	0	0	0	0	0	0	0	0	19.6	35,280.	0.11	198.	0.0045	8.	0.0005	1.	0	0	0	0	4E-05	0.0702	0	0	0	0	0	0
Natural gas (off-site use)	ccf	0	103	0	0	0	0	0	0	0	0	0	12.2	0	0.01	0	6E-06	0	0.0008	0	0	0	0	0	8E-06	0	3E-08	0	5E-08	0	0	0
Other Transportation 1	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Transportation 2	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Transportation 3	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Transportation 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Transportation 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TRANSPORTATION TOTAL			0	**223,200.**	0	**0**	0	**0**	0	**0**	0	**0**	0	**35,280.**	0	**198.**	0	**8.**	0	**1.**	0	**0**	0	**0**	0	**0.0702**	0	**0**	0	**0**	0	**0**

			Level 3 (Monitoring) Parameters Used, Extracted, Emitted, or Generated - Alternate A																											
			Energy		Grid Electricity		All Water		Potable Water		Groundwater		CO2e		NO x		SO x		PM		Solid Waste		Haz. Waste		Air Toxics		Mercury		Lead		Dioxins	
		Quantity Used	Conv. Factor	Used	Conv. Factor	Used	Conv. Factor	Used	Conv. Factor	Used	Conv. Factor	Extracted	Conv. Factor	Emitted	Conv. Factor	Emitted	Conv. Factor	Emitted	Conv. Factor	Emitted	Conv. Factor	Generated	Conv. Factor	Generated	Conv. Factor	Emitted	Conv. Factor	Released	Conv. Factor	Released	Conv. Factor	Released
				Mbtu		MWh		gal x 1000		gal x 1000		gal x 1000		lbs		lbs		lbs		lbs		tons		tons		lbs		lbs		lbs		lbs
OFF-SITE OTHER																																
Materials																																
Asphalt	tons	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bentonite	tons	0	55	0	0.0027	0	0.13	0	0	0	0	0	6.7	0	0.033	0	0.03	0	0.004	0	0	0	0	0	4E-07	0	6E-11	0	1E-09	0	2E-16	0
Borrow (clean soil)	tons	0	15.75	0	6E-05	0	8E-05	0	0	0	0	0	2.52	0	0.0176	0	0.0018	0	0.0004	0	4E-08	0	0	0	1E-05	0	5E-09	0	2E-07	0	3E-15	0
Cement	dry-ton	0	4100	0	0.13	0	0.41	0	0	0	0	0	1800	0	3.6	0	2.1	0	0.0063	0	0	0	0	0	0.058	0	6E-05	0	0.0001	0	9E-11	0
Cheese Whey	lbs	0	1.87	0	0	0	0	0	0	0	0	0	1.1	0	0.0083	0	0.0099	0	0.0002	0	0	0	0	0	0	0	0	0	0	0	0	0
Concrete	tons	0	3019	0	0.096	0	0.34	0	0	0	0	0	1322	0	2.6	0	1.5	0	0.0054	0	1E-08	0	0	0	0.043	0	4E-05	0	1E-04	0	6E-11	0
Diesel Produced	gal	0	18.5	0	0.0006	0	0.0008	0	0	0	0	0	2.7	0	0.0064	0	0.013	0	0.0003	0	4E-07	0	0	0	0.0001	0	5E-08	0	2E-06	0	3E-14	0
Emulsified vegetable oil	lbs	0	3.6	0	6E-05	0	2E-05	0	0	0	0	0	3.51	0	0.0265	0	0.031	0	0.0017	0	0	0	0	0	0	0	0	0	0	0	0	0
GAC: regenerated	lbs	0	9.6	0	0.0004	0	0.0064	0	0	0	0	0	2	0	0.025	0	0.015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GAC: virgin coal-based	lbs	0	10.8	0	5E-05	0	0	0	0	0	0	0	4.5	0	0.12	0	0.074	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GAC: virgin coconut-based	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gasoline Produced	gal	2415.6	21	50,728.	0.0006	1.	0.0008	2.	0	0	0	0	4.4	10,629.	0.008	19.	0.019	46.	0.0005	1.	4E-07	0	0	0	0.0002	0.3865	9E-08	0.000205326	2E-06	0.00531432	3E-14	0.000000000075
Gravel/sand/clay	ton	0	55	0	0.0027	0	0.13	0	0	0	0	0	6.7	0	0.033	0	0.03	0	0.004	0	0	0	0	0	4E-07	0	6E-11	0	1E-09	0	2E-16	0
HDPE	lb	0	31	0	0.0003	0	0.0023	0	0	0	0	0	1.9	0	0.0032	0	0.0041	0	0.0006	0	4E-07	0	1E-06	0	3E-06	0	3E-09	0	2E-09	0	1E-09	0
Hydrochloric acid (30%, SG = 1.18)	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydrogen peroxide (50%, SG=1.19)	lbs	0	4.95	0	0.0006	0	0.019	0	0	0	0	0	1.35	0	0.0087	0	0.0066	0	0.0025	0	1E-05	0	5E-07	0	0.0002	0	0	0	0	0	0	0
Hydroseed	lbs	0	0.049	0	1E-07	0	0.0001	0	0	0	0	0	0.0046	0	3E-06	0	5E-05	0	3E-07	0	0	0	0	0	8E-07	0	2E-11	0	1E-10	0	0	0
Lime	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Molasses	lbs	0	1.31	0	5E-06	0	9E-05	0	0	0	0	0	0.4	0	0.003	0	0.0026	0	6E-05	0	0	0	0	0	0	0	0	0	0	0	0	0
Natural Gas Produced	ccf	0	5.2	0	0.0003	0	8E-05	0	0	0	0	0	2.2	0	0.0037	0	0.0046	0	7E-05	0	0	0	0	0	6E-06	0	2E-08	0	9E-07	0	5E-14	0
Nitrogen fertilizer	lbs	0	16.2	0	2E-05	0	0	0	0	0	0	0	1.5	0	0.0008	0	0.0174	0	7E-05	0	0	0	0	0	0.0003	0	6E-09	0	4E-08	0	0	0
Other Material #1 - PV System	W	0	33.6	0	0.0003	0	0	0	0	0	0	0	4.47	0	0.015	0	0.032	0	0.0006	0	0	0	3E-06	0	3E-06	0	0	0	3E-06	0	0	0
Other Material #2 - Mulch	cy	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Material #3 - acetic acid	lb	0	5.2	0	2E-05	0	0	0	0	0	0	0	0.67	0	0.0006	0	0.02	0	6E-05	0	0	0	0	0	0.0003	0	2E-09	0	1E-08	0	3E-15	0
Other Material #4 - guar gum	lb	0	0.91	0	5E-05	0	0.0001	0	0	0	0	0	1	0	0.073	0	0.0068	0	0.0001	0	0	0	0	0	1E-05	0	1E-09	0	1E-07	0	6E-14	0
Other Material #5	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phosphorus fertilizer	lbs	0	3.39	0	7E-05	0	0	0	0	0	0	0	0.35	0	0.0017	0	0.017	0	0.0001	0	0	0	0	0	5E-05	0	2E-09	0	5E-08	0	0	0
Polymer	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Potable Water	gal x 1000	0	9.2	0	0.0004	0	0.021	0	0	0	0	0	5	0	0.0097	0	0.0059	0	0.016	0	8E-07	0	0	0	2E-05	0	8E-09	0	7E-08	0	1E-13	0
Potassium permanganate	lbs	0	29.22	0	0.0016	0	0.003	0	0	0	0	0	4.5	0	0.021	0	0.016	0	0.0017	0	1E-06	0	0	0	0.0006	0	4E-08	0	4E-07	0	4E-13	0
PVC	lbs	0	22	0	0.0006	0	0.0069	0	0	0	0	0	2.6	0	0.0048	0	0.0076	0	0.0012	0	2E-06	0	2E-06	0	0.0005	0	3E-07	0	1E-07	0	7E-09	0
Sequestering agent	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sodium hydroxide (dry bulk)	lbs	0	6.6	0	0.0003	0	0.0012	0	0	0	0	0	1.37	0	0.003	0	0.0048	0	0.0005	0	2E-05	0	5E-07	0	6E-05	0	2E-07	0	3E-08	0	2E-14	0
Stainless Steel	lb	0	11.6	0	0.0006	0	0.0023	0	0	0	0	0	3.4	0	0.0075	0	0.012	0	0.0044	0	0.0006	0	0	0	0.0001	0	0	0	5E-07	0	2E-12	0
Steel	lb	0	4.4	0	0.0002	0	0.0006	0	0	0	0	0	1.1	0	0.0014	0	0.0017	0	0.0006	0	0.0003	0	0	0	7E-05	0	1E-07	0	3E-06	0	7E-12	0
Tree: root ball	trees	0	3.7	0	2E-06	0	0.004	0	0	0	0	0	0.6	0	0.003	0	0.0006	0	3E-05	0	1E-08	0	0	0	6E-06	0	2E-09	0	6E-08	0	0	0
Tree: whip	trees	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Off-Site Services																																
Off-site waste water treatment	gal x 1000	0	15	0	0.0007	0	0.0029	0	0	0	0	0	4.4	0	0.016	0	0.015	0	0.0017	0	0.0024	0	0	0	0.0006	0	4E-08	0	4E-07	0	3E-13	0
Off-site Solid Waste Disposal	ton	0	160	0	0.0077	0	0.15	0	0	0	0	0	25	0	0.14	0	0.075	0	0.4	0	8E-06	0	0	0	0.0014	0	1E-06	0	8E-06	0	1E-11	0
Off-site Haz. Waste Disposal	ton	0	176	0	0.0085	0	0.165	0	0	0	0	0	27.5	0	0.154	0	0.0825	0	0.44	0	9E-06	0	0	0	0.0015	0	1E-06	0	8E-06	0	1E-11	0
Off-site Laboratory Analysis	$	191880	6.49	1,245,301.	0.0004	67.	0.0007	127.	0	0	0	0	1	191,880.	0.0048	921.	0.0036	691.	0.0004	77.	0	0	0	0	0.0001	24.9444	8E-09	0.001611792	9E-08	0.0163098	8E-14	0.000000015159
Other 1	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other 2	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other 3	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other 4	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other 5	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other																																
Potable Water Transported	gal x 1000	0	7.4	0	0.0006	0	0.0013	0	0	0	0	0	0.9948	0	0.0025	0	0.0065	0	0.0006	0	6E-07	0	0	0	0.0003	0	1E-08	0	1E-07	0	2E-13	0
Electricity transmission	MWh	0	410	0	0.12	0	0.24	0	0	0	0	0	184.8	0	0.468	0	1.2	0	0.1128	0	0.0001	0	0	0	0.048	0	3E-06	0	2E-05	0	3E-11	0
Other 1	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other 2	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other 3	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OFF-SITE OTHER TOTAL			0	1,296,029.	0	68.	0	129.	0	0	0	0	0	202,509.	0	940.	0	737.	0	78.	0	0	0	0	0	25.3309	0	0.001817118	0	0.02162412	0	0.000000015234

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	Totals For Parameters Used, Extracted, Emitted, or Generated - Alternative B														
	Energy Used	Grid Electricity Used	All Water Used	Potable Water Used	Groundwater Extracted	CO2e Emitted	NO x Emitted	SO x Emitted	PM Emitted	Solid Waste Generated	Haz. Waste Generated	Air Toxics Emitted	Mercury Released	Lead Released	Dioxins Released
	Mbtu	MWh	gal x 1000	gal x 1000	gal x 1000	lbs	lbs	lbs	lbs	tons	tons	lbs	lbs	lbs	lbs
Level 1 - Construction															
On-Site	128,821.	0	1.	0	1.	20,852.	158.	5.	3.	16.5	0	0.0048	0	0	0
Electricity Generation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transportation	106,348.	0	0	0	0	17,103.	120.	4.	2.	0	0	0.0122	0	0	0
Other Off-Site	489,414.	23.	52.	0	0	82,856.	315.	255.	31.	0	0.002	8.7031	0.001445822	0.009215002	0.000007403108
Construction Total	***724,583.***	***23.***	***53.***	***0***	***1.***	***120,811.***	***593.***	***264.***	***36.***	***16.5***	***0.002***	***8.7201***	***0.001445822***	***0.009215002***	***0.000007403108***
Level 2 - O&M															
On-Site	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Electricity Generation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transportation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Off-Site	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
O&M Total	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***
Level 3 - Monitoring															
On-Site	21,713.	0	4.	0	4.	3,432.	19.	1.	0	0	0	0.0068	0	0	0
Electricity Generation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transportation	74,792.	0	0	0	0	11,862.	70.	2.	0	0	0	0.0206	0	0	0
Other Off-Site	288,910.	15.	29.	0	0	45,320.	208.	165.	17.	0	0	5.5885	0.000415886	0.005213819	0.000000003346
Monitoring Total	***385,415.***	***15.***	***33.***	***0***	***4.***	***60,614.***	***297.***	***168.***	***17.***	***0***	***0***	***5.6159***	***0.000415886***	***0.005213819***	***0.000000003346***
Level 4 - Not Used															
On-Site	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Electricity Generation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transportation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Off-Site	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Not Used Total	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***
Level 5 - Not Used															
On-Site	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Electricity Generation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transportation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Off-Site	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Not Used Total	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***
Level 6 - Not Used															
On-Site	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Electricity Generation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transportation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Off-Site	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Not Used Total	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***
Total	***1,109,998.***	***38.***	***86.***	***0***	***5.***	***181,425.***	***890.***	***432.***	***53.***	***16.5***	***0.002***	***14.336***	***0.001861708***	***0.014428821***	***0.000007406454***

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			All Levels - Parameters Used, Extracted, Emitted, or Generated - Alternative B																											
			Energy		Grid Electricity		All Water		Potable Water		Groundwater		CO2e		NO x		SO x		PM		Solid Waste		Haz. Waste		Air Toxics		Mercury		Lead		Dioxins	
		Quantity Used	Conv. Factor	Used	Conv. Factor	Used	Conv. Factor	Used	Conv. Factor	Used	Conv. Factor	Extracted	Conv. Factor	Emitted	Conv. Factor	Emitted	Conv. Factor	Emitted	Conv. Factor	Emitted	Conv. Factor	Generated	Conv. Factor	Generated	Conv. Factor	Emitted	Conv. Factor	Released	Conv. Factor	Released	Conv. Factor	Released
				Mbtu		MWh		gal x 1000		gal x 1000		gal x 1000		lbs		lbs		lbs		lbs		tons		tons		lbs		lbs		lbs		lbs
Totals				***1,109,997.***		***39.***		***86.***		***0***		***5.***		***181,424.***		***890.***		***432.***		***53.***		***17.***		***0.002***		***14.336***		***0.001861707***		***0.014428821***		***0.000007406457***
ON-SITE																																
Energy																																
Diesel (on-site use)	gal	926.772	139	128,821.	0	0	0	0	0	0	0	0	22.5	20,852.	0.17	158.	0.0054	5.	0.0034	3.	0	0	0	0	5E-06	0.0048	0	0	0	0	0	0
Gasoline (on-site use)	gal	175.104	124	21,713.	0	0	0	0	0	0	0	0	19.6	3,432.	0.11	19.	0.0045	1.	0.0005	0	0	0	0	0	4E-05	0.0068	0	0	0	0	0	0
Natural gas (on-site use)	ccf	0	103	0	0	0	0	0	0	0	0	0	12.2	0	0.01	0	6E-06	0	0.0008	0	0	0	0	0	8E-06	0	3E-08	0	5E-08	0	0	0
Electricity (on-site use)	MWh	0	3413	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Photovoltaic (on-site system)	MWh	0	37922	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Energy 2	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Energy 3	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Water																																
Groundwater Extracted On-site	gal x 1000	4.6	0	0	0	0	1	5.	0	0	1	5.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Potable Water Used On-site	gal x 1000	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other On-Site Water 1	gal x 1000	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other On-Site Water 2	gal x 1000	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other On-Site Water 3	gal x 1000	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Waste Generation																																
On-Site Solid Waste Generation	ton	16.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	17.	0	0	0	0	0	0	0	0	0	0
On-Site Solid Waste Disposal		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
On-Site Hazardous Waste Generation	ton	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
On-Site Hazardous Waste Disposal		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other																																
On-site process emissions (HAPs)	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
On-site process emissions (GHGs)	lbs CO2e	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
On-site GHG storage	lbs CO2e	0	0	0	0	0	0	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
On-site NOx reduction	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
On-site SOx reduction	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
On-site PM reduction	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0
Other 1	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other 2	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ON-SITE TOTAL			0	**150,534.**	0	**0**	0	**5.**	0	**0**	0	**5.**	0	**24,284.**	0	**177.**	0	**6.**	0	**3.**	0	**17.**	0	**0**	0	**0.0116**	0	**0**	0	**0**	0	**0**
ELECTRICITY GENERATION																																
Electricity production	MWh	0	7800	0	0.06	0	0.9	0	0	0	0	0	2360	0	6.48	0	14.9	0	1.636	0	0.0009	0	0	0	0.6797	0	4E-05	0	0.0002	0	3E-10	0
Purchased Renewa ble Electricity	MWh	0	0	0	0	0	-2	0	0	0	0	0	1540	0	3.9	0	10	0	0.94	0	0.0009	0	0	0	0.4	0	2E-05	0	0.0002	0	2E-10	0
TRANSPORTATION																																
Diesel (off-site use)	gal	629.9	139	87,556.	0	0	0	0	0	0	0	0	22.5	14,173.	0.17	107.	0.0054	3.	0.0034	2.	0	0	0	0	5E-06	0.0033	0	0	0	0	0	0
Gasoline (off-site use)	gal	754.7	124	93,583.	0	0	0	0	0	0	0	0	19.6	14,792.	0.11	83.	0.0045	3.	0.0005	0	0	0	0	0	4E-05	0.0294	0	0	0	0	0	0
Natural gas (off-site use)	ccf	0	103	0	0	0	0	0	0	0	0	0	12.2	0	0.01	0	6E-06	0	0.0008	0	0	0	0	0	8E-06	0	3E-08	0	5E-08	0	0	0
Other Transportation 1	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Transportation 2	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Transportation 3	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Transportation 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Transportation 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TRANSPORTATION TOTAL			0	**181,139.**	0	**0**	0	**0**	0	**0**	0	**0**	0	**28,965.**	0	**190.**	0	**6.**	0	**2.**	0	**0**	0	**0**	0	**0.0327**	0	**0**	0	**0**	0	**0**

			All Levels - Parameters Used, Extracted, Emitted, or Generated - Alternative B																											
			Energy		Grid Electricity		All Water		Potable Water		Groundwater		CO2e		NO x		SO x		PM		Solid Waste		Haz. Waste		Air Toxics		Mercury		Lead		Dioxins	
		Quantity Used	Conv. Factor	Used	Conv. Factor	Used	Conv. Factor	Used	Conv. Factor	Used	Conv. Factor	Extracted	Conv. Factor	Emitted	Conv. Factor	Emitted	Conv. Factor	Emitted	Conv. Factor	Emitted	Conv. Factor	Generated	Conv. Factor	Generated	Conv. Factor	Emitted	Conv. Factor	Released	Conv. Factor	Released	Conv. Factor	Released
				Mbtu		MWh		gal x 1000		gal x 1000		gal x 1000		lbs		lbs		lbs		lbs		tons		tons		lbs		lbs		lbs		lbs
OFF-SITE OTHER																																
Materials																																
Asphalt	tons	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bentonite	tons	0	55	0	0.0027	0	0.13	0	0	0	0	0	6.7	0	0.033	0	0.03	0	0.004	0	0	0	0	0	4E-07	0	6E-11	0	1E-09	0	2E-16	0
Borrow (clean soil)	tons	0	15.75	0	6E-05	0	8E-05	0	0	0	0	0	2.52	0	0.0176	0	0.0018	0	0.0004	0	4E-08	0	0	0	1E-05	0	5E-09	0	2E-07	0	3E-15	0
Cement	dry-ton	9.4	4100	38,540.	0.13	1.	0.41	4.	0	0	0	0	1800	16,920.	3.6	34.	2.1	20.	0.0063	0	0	0	0	0	0.058	0.5452	6E-05	0.0005358	0.0001	0.001222	9E-11	0.000000000799
Cheese Whey	lbs	0	1.87	0	0	0	0	0	0	0	0	0	1.1	0	0.0083	0	0.0099	0	0.0002	0	0	0	0	0	0	0	0	0	0	0	0	0
Concrete	tons	0	3019	0	0.096	0	0.34	0	0	0	0	0	1322	0	2.6	0	1.5	0	0.0054	0	1E-08	0	0	0	0.043	0	4E-05	0	1E-04	0	6E-11	0
Diesel Produced	gal	1556.672	18.5	28,798.	0.0006	1.	0.0008	1.	0	0	0	0	2.7	4,203.	0.0064	10.	0.013	20.	0.0003	1.	4E-07	0	0	0	0.0001	0.1868	5E-08	0.00007472	2E-06	0.002335008	3E-14	0.000000000047
Emulsified vegetable oil	lbs	0	3.6	0	6E-05	0	2E-05	0	0	0	0	0	3.51	0	0.0265	0	0.031	0	0.0017	0	0	0	0	0	0	0	0	0	0	0	0	0
GAC: regenerated	lbs	0	9.6	0	0.0004	0	0.0064	0	0	0	0	0	2	0	0.025	0	0.015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GAC: virgin coal-based	lbs	0	10.8	0	5E-05	0	0	0	0	0	0	0	4.5	0	0.12	0	0.074	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GAC: virgin coconut-based	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gasoline Produced	gal	929.804	21	19,526.	0.0006	1.	0.0008	1.	0	0	0	0	4.4	4,091.	0.008	7.	0.019	18.	0.0005	0	4E-07	0	0	0	0.0002	0.1488	9E-08	0.000079033	2E-06	0.002045569	3E-14	0.000000000029
Gravel/sand/clay	ton	1.4	55	77.	0.0027	0	0.13	0	0	0	0	0	6.7	9.	0.033	0	0.03	0	0.004	0	0	0	0	0	4E-07	0	6E-11	0	1E-09	0.000000002	2E-16	0
HDPE	lb	1000	31	31,000.	0.0003	0	0.0023	2.	0	0	0	0	1.9	1,900.	0.0032	3.	0.0041	4.	0.0006	1.	4E-07	0	1E-06	0.001	3E-06	0.0034	3E-09	0.0000026	2E-09	0.0000024	1E-09	0.00000098
Hydrochloric acid (30%, SG = 1.18)	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydrogen peroxide (50%, SG=1.19)	lbs	0	4.95	0	0.0006	0	0.019	0	0	0	0	0	1.35	0	0.0087	0	0.0066	0	0.0025	0	1E-05	0	5E-07	0	0.0002	0	0	0	0	0	0	0
Hydroseed	lbs	0	0.049	0	1E-07	0	0.0001	0	0	0	0	0	0.0046	0	3E-06	0	5E-05	0	3E-07	0	0	0	0	0	8E-07	0	2E-11	0	1E-10	0	0	0
Lime	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Molasses	lbs	0	1.31	0	5E-06	0	9E-05	0	0	0	0	0	0.4	0	0.003	0	0.0026	0	6E-05	0	0	0	0	0	0	0	0	0	0	0	0	0
Natural Gas Produced	ccf	0	5.2	0	0.0003	0	8E-05	0	0	0	0	0	2.2	0	0.0037	0	0.0046	0	7E-05	0	0	0	0	0	6E-06	0	2E-08	0	9E-07	0	5E-14	0
Nitrogen fertilizer	lbs	0	16.2	0	2E-05	0	0	0	0	0	0	0	1.5	0	0.0008	0	0.0174	0	7E-05	0	0	0	0	0	0.0003	0	6E-09	0	4E-08	0	0	0
Other Material #1 - PV System	W	0	33.6	0	0.0003	0	0	0	0	0	0	0	4.47	0	0.015	0	0.032	0	0.0006	0	0	0	3E-06	0	3E-06	0	0	0	3E-06	0	0	0
Other Material #2 - Mulch	cy	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Material #3 - acetic acid	lb	0	5.2	0	2E-05	0	0	0	0	0	0	0	0.67	0	0.0006	0	0.02	0	6E-05	0	0	0	0	0	0.0003	0	2E-09	0	1E-08	0	3E-15	0
Other Material #4 - guar gum	lb	0	0.91	0	5E-05	0	0.0001	0	0	0	0	0	1	0	0.073	0	0.0068	0	0.0001	0	0	0	0	0	1E-05	0	1E-09	0	1E-07	0	6E-14	0
Other Material #5	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phosphorus fertilizer	lbs	0	3.39	0	7E-05	0	0	0	0	0	0	0	0.35	0	0.0017	0	0.017	0	0.0001	0	0	0	0	0	5E-05	0	2E-09	0	5E-08	0	0	0
Polymer	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Potable Water	gal x 1000	0	9.2	0	0.0004	0	0.021	0	0	0	0	0	5	0	0.0097	0	0.0059	0	0.016	0	8E-07	0	0	0	2E-05	0	8E-09	0	7E-08	0	1E-13	0
Potassium permanganate	lbs	12452	29.22	363,847.	0.0016	20.	0.003	37.	0	0	0	0	4.5	56,034.	0.021	261.	0.016	199.	0.0017	21.	1E-06	0	0	0	0.0006	7.4712	4E-08	0.000473176	4E-07	0.00473176	4E-13	0.000000004358
PVC	lbs	930	22	20,460.	0.0006	1.	0.0069	6.	0	0	0	0	2.6	2,418.	0.0048	4.	0.0076	7.	0.0012	1.	2E-06	0	2E-06	0.001	0.0005	0.4371	3E-07	0.0003162	1E-07	0.0001209	7E-09	0.0000006417
Sequestering agent	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sodium hydroxide (dry bulk)	lbs	0	6.6	0	0.0003	0	0.0012	0	0	0	0	0	1.37	0	0.003	0	0.0048	0	0.0005	0	2E-05	0	5E-07	0	6E-05	0	2E-07	0	3E-08	0	2E-14	0
Stainless Steel	lb	0	11.6	0	0.0006	0	0.0023	0	0	0	0	0	3.4	0	0.0075	0	0.012	0	0.0044	0	0.0006	0	0	0	0.0001	0	0	0	5E-07	0	2E-12	0
Steel	lb	108	4.4	475.	0.0002	0	0.0006	0	0	0	0	0	1.1	119.	0.0014	0	0.0017	0	0.0006	0	0.0003	0	0	0	7E-05	0.0072	1E-07	0.0000108	3E-06	0.00027	7E-12	0.000000000702
Tree: root ball	trees	0	3.7	0	2E-06	0	0.004	0	0	0	0	0	0.6	0	0.003	0	0.0006	0	3E-05	0	1E-08	0	0	0	6E-06	0	2E-09	0	6E-08	0	0	0
Tree: whip	trees	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Off-Site Services																																
Off-site waste water treatment	gal x 1000	4.6	15	69.	0.0007	0	0.0029	0	0	0	0	0	4.4	20.	0.016	0	0.015	0	0.0017	0	0.0024	0	0	0	0.0006	0.0027	4E-08	0.00000017	4E-07	0.000001702	3E-13	0.000000000002
Off-site Solid Waste Disposal	ton	16.5	160	2,640.	0.0077	0	0.15	2.	0	0	0	0	25	413.	0.14	2.	0.075	1.	0.4	7.	8E-06	0	0	0	0.0014	0.0231	1E-06	0.000016005	8E-06	0.0001254	1E-11	0.000000000198
Off-site Haz. Waste Disposal	ton	0	176	0	0.0085	0	0.165	0	0	0	0	0	27.5	0	0.154	0	0.0825	0	0.44	0	9E-06	0	0	0	0.0015	0	1E-06	0	8E-06	0	1E-11	0
Off-site Laboratory Analysis	$	42048	6.49	272,892.	0.0004	15.	0.0007	28.	0	0	0	0	1	42,048.	0.0048	202.	0.0036	151.	0.0004	17.	0	0	0	0	0.0001	5.4662	8E-09	0.000353203	9E-08	0.00357408	8E-14	0.000000003322
Other 1	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other 2	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other 3	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other 4	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other 5	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other																																
Potable Water Transported	gal x 1000	0	7.4	0	0.0006	0	0.0013	0	0	0	0	0	0.9948	0	0.0025	0	0.0065	0	0.0006	0	6E-07	0	0	0	0.0003	0	1E-08	0	1E-07	0	2E-13	0
Electricity transmission	MWh	0	410	0	0.12	0	0.24	0	0	0	0	0	184.8	0	0.468	0	1.2	0	0.1128	0	0.0001	0	0	0	0.048	0	3E-06	0	2E-05	0	3E-11	0
Other 1	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other 2	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other 3	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OFF-SITE OTHER TOTAL			0	778,324.	0	39.	0	81.	0	0	0	0	0	128,175.	0	523.	0	420.	0	48.	0	0	0	0.002	0	14.2917	0	0.001861707	0	0.014428821	0	0.000007406457

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			Level 1 (Construction) Parameters Used, Extracted, Emitted, or Generated - Alternative B																											
			Energy		Grid Electricity		All Water		Potable Water		Groundwater		CO2e		NO x		SO x		PM		Solid Waste		Haz. Waste		Air Toxics		Mercury		Lead		Dioxins	
		Quantity Used	Conv. Factor	Used	Conv. Factor	Used	Conv. Factor	Used	Conv. Factor	Used	Conv. Factor	Extracted	Conv. Factor	Emitted	Conv. Factor	Emitted	Conv. Factor	Emitted	Conv. Factor	Emitted	Conv. Factor	Generated	Conv. Factor	Generated	Conv. Factor	Emitted	Conv. Factor	Released	Conv. Factor	Released	Conv. Factor	Released
				Mbtu		MWh		gal x 1000		gal x 1000		gal x 1000		lbs		lbs		lbs		lbs		tons		tons		lbs		lbs		lbs		lbs
Totals				***724,583.***		***23.***		***53.***		***0***		***1.***		***120,811.***		***593.***		***264.***		***36.***		***16.5***		***0.002***		***8.7201***		***0.001445822***		***0.009215002***		***0.000007403108***
ON-SITE																																
Energy																																
Diesel (on-site use)	gal	926.772	139	128,821.	0	0	0	0	0	0	0	0	22.5	20,852.	0.17	158.	0.0054	5.	0.0034	3.	0	0	0	0	5E-06	0.0048	0	0	0	0	0	0
Gasoline (on-site use)	gal	0	124	0	0	0	0	0	0	0	0	0	19.6	0	0.11	0	0.0045	0	0.0005	0	0	0	0	0	4E-05	0	0	0	0	0	0	0
Natural gas (on-site use)	ccf	0	103	0	0	0	0	0	0	0	0	0	12.2	0	0.01	0	6E-06	0	0.0008	0	0	0	0	0	8E-06	0	3E-08	0	5E-08	0	0	0
Electricity (on-site use)	MWh	0	3413	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Photovoltaic (on-site system)	MWh	0	37922	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Energy 2	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Energy 3	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Water																																
Groundwater Extracted On-site	gal x 1000	0.6	0	0	0	0	1	1.	0	0	1	1.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Potable Water Used On-site	gal x 1000	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other On-Site Water 1	gal x 1000	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other On-Site Water 2	gal x 1000	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other On-Site Water 3	gal x 1000	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Waste Generation																																
On-Site Solid Waste Generation	ton	16.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	16.5	0	0	0	0	0	0	0	0	0	0
On-Site Solid Waste Disposal		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
On-Site Hazardous Waste Generation	ton	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
On-Site Hazardous Waste Disposal		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other																																
On-site process emissions (HAPs)	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
On-site process emissions (GHGs)	lbs CO2e	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
On-site GHG storage	lbs CO2e	0	0	0	0	0	0	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
On-site NOx reduction	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
On-site SOx reduction	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
On-site PM reduction	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0
Other 1	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other 2	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ON-SITE TOTAL			0	**128,821.**	0	**0**	0	**1.**	0	**0**	0	**1.**	0	**20,852.**	0	**158.**	0	**5.**	0	**3.**	0	**16.5**	0	**0**	0	**0.0048**	0	**0**	0	**0**	0	**0**
ELECTRICITY GENERATION																																
Electricity production	MWh	0	7800	0	0.06	0	0.9	0	0	0	0	0	2360	0	6.48	0	14.9	0	1.636	0	0.0009	0	0	0	0.6797	0	4E-05	0	0.0002	0	3E-10	0
Purchased Renewa ble Electricity	MWh	0	0	0	0	0	-2	0	0	0	0	0	1540	0	3.9	0	10	0	0.94	0	0.0009	0	0	0	0.4	0	2E-05	0	0.0002	0	2E-10	0
TRANSPORTATION																																
Diesel (off-site use)	gal	553.4	139	76,923.	0	0	0	0	0	0	0	0	22.5	12,452.	0.17	94.	0.0054	3.	0.0034	2.	0	0	0	0	5E-06	0.0029	0	0	0	0	0	0
Gasoline (off-site use)	gal	237.3	124	29,425.	0	0	0	0	0	0	0	0	19.6	4,651.	0.11	26.	0.0045	1.	0.0005	0	0	0	0	0	4E-05	0.0093	0	0	0	0	0	0
Natural gas (off-site use)	ccf	0	103	0	0	0	0	0	0	0	0	0	12.2	0	0.01	0	6E-06	0	0.0008	0	0	0	0	0	8E-06	0	3E-08	0	5E-08	0	0	0
Other Transportation 1	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Transportation 2	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Transportation 3	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Transportation 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Transportation 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TRANSPORTATION TOTAL			0	**106,348.**	0	**0**	0	**0**	0	**0**	0	**0**	0	**17,103.**	0	**120.**	0	**4.**	0	**2.**	0	**0**	0	**0**	0	**0.0122**	0	**0**	0	**0**	0	**0**

			Level 1 (Construction) Parameters Used, Extracted, Emitted, or Generated - Alternative B																											
			Energy		Grid Electricity		All Water		Potable Water		Groundwater		CO2e		NO x		SO x		PM		Solid Waste		Haz. Waste		Air Toxics		Mercury		Lead		Dioxins	
		Quantity Used	Conv. Factor	Used	Conv. Factor	Used	Conv. Factor	Used	Conv. Factor	Used	Conv. Factor	Extracted	Conv. Factor	Emitted	Conv. Factor	Emitted	Conv. Factor	Emitted	Conv. Factor	Emitted	Conv. Factor	Generated	Conv. Factor	Generated	Conv. Factor	Emitted	Conv. Factor	Released	Conv. Factor	Released	Conv. Factor	Released
				Mbtu		MWh		gal x 1000		gal x 1000		gal x 1000		lbs		lbs		lbs		lbs		tons		tons		lbs		lbs		lbs		lbs
OFF-SITE OTHER																																
Materials																																
Asphalt	tons	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bentonite	tons	0	55	0	0.0027	0	0.13	0	0	0	0	0	6.7	0	0.033	0	0.03	0	0.004	0	0	0	0	0	4E-07	0	6E-11	0	1E-09	0	2E-16	0
Borrow (clean soil)	tons	0	15.75	0	6E-05	0	8E-05	0	0	0	0	0	2.52	0	0.0176	0	0.0018	0	0.0004	0	4E-08	0	0	0	1E-05	0	5E-09	0	2E-07	0	3E-15	0
Cement	dry-ton	9.4	4100	38,540.	0.13	1.	0.41	4.	0	0	0	0	1800	16,920.	3.6	34.	2.1	20.	0.0063	0	0	0	0	0	0.058	0.5452	6E-05	0.0005358	0.0001	0.001222	9E-11	0.000000000799
Cheese Whey	lbs	0	1.87	0	0	0	0	0	0	0	0	0	1.1	0	0.0083	0	0.0099	0	0.0002	0	0	0	0	0	0	0	0	0	0	0	0	0
Concrete	tons	0	3019	0	0.096	0	0.34	0	0	0	0	0	1322	0	2.6	0	1.5	0	0.0054	0	1E-08	0	0	0	0.043	0	4E-05	0	1E-04	0	6E-11	0
Diesel Produced	gal	1480.172	18.5	27,383.	0.0006	1.	0.0008	1.	0	0	0	0	2.7	3,996.	0.0064	9.	0.013	19.	0.0003	1.	4E-07	0	0	0	0.0001	0.1776	5E-08	0.000071048	2E-06	0.002220258	3E-14	0.000000000044
Emulsified vegetable oil	lbs	0	3.6	0	6E-05	0	2E-05	0	0	0	0	0	3.51	0	0.0265	0	0.031	0	0.0017	0	0	0	0	0	0	0	0	0	0	0	0	0
GAC: regenerated	lbs	0	9.6	0	0.0004	0	0.0064	0	0	0	0	0	2	0	0.025	0	0.015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GAC: virgin coal-based	lbs	0	10.8	0	5E-05	0	0	0	0	0	0	0	4.5	0	0.12	0	0.074	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GAC: virgin coconut-based	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gasoline Produced	gal	237.3	21	4,983.	0.0006	0	0.0008	0	0	0	0	0	4.4	1,044.	0.008	2.	0.019	5.	0.0005	0	4E-07	0	0	0	0.0002	0.038	9E-08	0.000020171	2E-06	0.00052206	3E-14	0.000000000007
Gravel/sand/clay	ton	1.4	55	77.	0.0027	0	0.13	0	0	0	0	0	6.7	9.	0.033	0	0.03	0	0.004	0	0	0	0	0	4E-07	0	6E-11	0	1E-09	0.000000002	2E-16	0
HDPE	lb	1000	31	31,000.	0.0003	0	0.0023	2.	0	0	0	0	1.9	1,900.	0.0032	3.	0.0041	4.	0.0006	1.	4E-07	0	1E-06	0.001	3E-06	0.0034	3E-09	0.0000026	2E-09	0.0000024	1E-09	0.00000098
Hydrochloric acid (30%, SG = 1.18)	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydrogen peroxide (50%, SG=1.19)	lbs	0	4.95	0	0.0006	0	0.019	0	0	0	0	0	1.35	0	0.0087	0	0.0066	0	0.0025	0	1E-05	0	5E-07	0	0.0002	0	0	0	0	0	0	0
Hydroseed	lbs	0	0.049	0	1E-07	0	0.0001	0	0	0	0	0	0.0046	0	3E-06	0	5E-05	0	3E-07	0	0	0	0	0	8E-07	0	2E-11	0	1E-10	0	0	0
Lime	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Molasses	lbs	0	1.31	0	5E-06	0	9E-05	0	0	0	0	0	0.4	0	0.003	0	0.0026	0	6E-05	0	0	0	0	0	0	0	0	0	0	0	0	0
Natural Gas Produced	ccf	0	5.2	0	0.0003	0	8E-05	0	0	0	0	0	2.2	0	0.0037	0	0.0046	0	7E-05	0	0	0	0	0	6E-06	0	2E-08	0	9E-07	0	5E-14	0
Nitrogen fertilizer	lbs	0	16.2	0	2E-05	0	0	0	0	0	0	0	1.5	0	0.0008	0	0.0174	0	7E-05	0	0	0	0	0	0.0003	0	6E-09	0	4E-08	0	0	0
Other Material #1 - PV System	W	0	33.6	0	0.0003	0	0	0	0	0	0	0	4.47	0	0.015	0	0.032	0	0.0006	0	0	0	3E-06	0	3E-06	0	0	0	3E-06	0	0	0
Other Material #2 - Mulch	cy	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Material #3 - acetic acid	lb	0	5.2	0	2E-05	0	0	0	0	0	0	0	0.67	0	0.0006	0	0.02	0	6E-05	0	0	0	0	0	0.0003	0	2E-09	0	1E-08	0	3E-15	0
Other Material #4 - guar gum	lb	0	0.91	0	5E-05	0	0.0001	0	0	0	0	0	1	0	0.073	0	0.0068	0	0.0001	0	0	0	0	0	1E-05	0	1E-09	0	1E-07	0	6E-14	0
Other Material #5	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phosphorus fertilizer	lbs	0	3.39	0	7E-05	0	0	0	0	0	0	0	0.35	0	0.0017	0	0.017	0	0.0001	0	0	0	0	0	5E-05	0	2E-09	0	5E-08	0	0	0
Polymer	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Potable Water	gal x 1000	0	9.2	0	0.0004	0	0.021	0	0	0	0	0	5	0	0.0097	0	0.0059	0	0.016	0	8E-07	0	0	0	2E-05	0	8E-09	0	7E-08	0	1E-13	0
Potassium permanganate	lbs	12452	29.22	363,847.	0.0016	20.	0.003	37.	0	0	0	0	4.5	56,034.	0.021	261.	0.016	199.	0.0017	21.	1E-06	0	0	0	0.0006	7.4712	4E-08	0.000473176	4E-07	0.00473176	4E-13	0.000000004358
PVC	lbs	930	22	20,460.	0.0006	1.	0.0069	6.	0	0	0	0	2.6	2,418.	0.0048	4.	0.0076	7.	0.0012	1.	2E-06	0	2E-06	0.001	0.0005	0.4371	3E-07	0.0003162	1E-07	0.0001209	7E-09	0.000006417
Sequestering agent	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sodium hydroxide (dry bulk)	lbs	0	6.6	0	0.0003	0	0.0012	0	0	0	0	0	1.37	0	0.003	0	0.0048	0	0.0005	0	2E-05	0	5E-07	0	6E-05	0	2E-07	0	3E-08	0	2E-14	0
Stainless Steel	lb	0	11.6	0	0.0006	0	0.0023	0	0	0	0	0	3.4	0	0.0075	0	0.012	0	0.0044	0	0.0006	0	0	0	0.0001	0	0	0	5E-07	0	2E-12	0
Steel	lb	108	4.4	475.	0.0002	0	0.0006	0	0	0	0	0	1.1	119.	0.0014	0	0.0017	0	0.0006	0	0.0003	0	0	0	7E-05	0.0072	1E-07	0.0000108	3E-06	0.00027	7E-12	0.000000000702
Tree: root ball	trees	0	3.7	0	2E-06	0	0.004	0	0	0	0	0	0.6	0	0.003	0	0.0006	0	3E-05	0	1E-08	0	0	0	6E-06	0	2E-09	0	6E-08	0	0	0
Tree: whip	trees	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Off-Site Services																																
Off-site waste water treatment	gal x 1000	0.6	15	9.	0.0007	0	0.0029	0	0	0	0	0	4.4	3.	0.016	0	0.015	0	0.0017	0	0.0024	0	0	0	0.0006	0.0003	4E-08	0.000000022	4E-07	0.000000222	3E-13	0
Off-site Solid Waste Disposal	ton	16.5	160	2,640.	0.0077	0	0.15	2.	0	0	0	0	25	413.	0.14	2.	0.075	1.	0.4	7.	8E-06	0	0	0	0.0014	0.0231	1E-06	0.000016005	8E-06	0.0001254	1E-11	0.000000000198
Off-site Haz. Waste Disposal	ton	0	176	0	0.0085	0	0.165	0	0	0	0	0	27.5	0	0.154	0	0.0825	0	0.44	0	9E-06	0	0	0	0.0015	0	1E-06	0	8E-06	0	1E-11	0
Off-site Laboratory Analysis	$	0	6.49	0	0.0004	0	0.0007	0	0	0	0	0	1	0	0.0048	0	0.0036	0	0.0004	0	0	0	0	0	0.0001	0	8E-09	0	9E-08	0	8E-14	0
Other 1	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other 2	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other 3	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other 4	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other 5	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other																																
Potable Water Transported	gal x 1000	0	7.4	0	0.0006	0	0.0013	0	0	0	0	0	0.9948	0	0.0025	0	0.0065	0	0.0006	0	6E-07	0	0	0	0.0003	0	1E-08	0	1E-07	0	2E-13	0
Electricity transmission	MWh	0	410	0	0.12	0	0.24	0	0	0	0	0	184.8	0	0.468	0	1.2	0	0.1128	0	0.0001	0	0	0	0.048	0	3E-06	0	2E-05	0	3E-11	0
Other 1	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other 2	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other 3	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OFF-SITE OTHER TOTAL			0	489,414.	0	23.	0	52.	0	0	0	0	0	82,856.	0	315.	0	255.	0	31.	0	0	0	0.002	0	8.7031	0	0.001445822	0	0.009215002	0	0.000007403108

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			Level 2 (O&M) Parameters Used, Extracted, Emitted, or Generated - Alternative B																											
			Energy		Grid Electricity		All Water		Potable Water		Groundwater		CO2e		NO x		SO x		PM		Solid Waste		Haz. Waste		Air Toxics		Mercury		Lead		Dioxins	
		Quantity Used	Conv. Factor	Used	Conv. Factor	Used	Conv. Factor	Used	Conv. Factor	Used	Conv. Factor	Extracted	Conv. Factor	Emitted	Conv. Factor	Emitted	Conv. Factor	Emitted	Conv. Factor	Emitted	Conv. Factor	Generated	Conv. Factor	Generated	Conv. Factor	Emitted	Conv. Factor	Released	Conv. Factor	Released	Conv. Factor	Released
				Mbtu		MWh		gal x 1000		gal x 1000		gal x 1000		lbs		lbs		lbs		lbs		tons		tons		lbs		lbs		lbs		lbs
Totals				***0***		***0***		***0***		***0***		***0***		***0***		***0***		***0***		***0***		***0***		***0***		***0***		***0***		***0***		***0***
ON-SITE																																
Energy																																
Diesel (on-site use)	gal	0	139	0	0	0	0	0	0	0	0	0	22.5	0	0.17	0	0.0054	0	0.0034	0	0	0	0	0	5E-06	0	0	0	0	0	0	0
Gasoline (on-site use)	gal	0	124	0	0	0	0	0	0	0	0	0	19.6	0	0.11	0	0.0045	0	0.0005	0	0	0	0	0	4E-05	0	0	0	0	0	0	0
Natural gas (on-site use)	ccf	0	103	0	0	0	0	0	0	0	0	0	12.2	0	0.01	0	6E-06	0	0.0008	0	0	0	0	0	8E-06	0	3E-08	0	5E-08	0	0	0
Electricity (on-site use)	MWh	0	3413	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Photovoltaic (on-site system)	MWh	0	37922	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Energy 2	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Energy 3	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Water																																
Groundwater Extracted On-site	gal x 1000	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Potable Water Used On-site	gal x 1000	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other On-Site Water 1	gal x 1000	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other On-Site Water 2	gal x 1000	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other On-Site Water 3	gal x 1000	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Waste Generation																																
On-Site Solid Waste Generation	ton	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
On-Site Solid Waste Disposal		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
On-Site Hazardous Waste Generation	ton	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
On-Site Hazardous Waste Disposal		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other																																
On-site process emissions (HAPs)	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
On-site process emissions (GHGs)	lbs CO2e	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
On-site GHG storage	lbs CO2e	0	0	0	0	0	0	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
On-site NOx reduction	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
On-site SOx reduction	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
On-site PM reduction	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0
Other 1	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other 2	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ON-SITE TOTAL			0	**0**	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**
ELECTRICITY GENERATION																																
Electricity production	MWh	0	7800	0	0.06	0	0.9	0	0	0	0	0	2360	0	6.48	0	14.9	0	1.636	0	0.0009	0	0	0	0.6797	0	4E-05	0	0.0002	0	3E-10	0
Purchased Renewa ble Electricity	MWh	0	0	0	0	0	-2	0	0	0	0	0	1540	0	3.9	0	10	0	0.94	0	0.0009	0	0	0	0.4	0	2E-05	0	0.0002	0	2E-10	0
TRANSPORTATION																																
Diesel (off-site use)	gal	0	139	0	0	0	0	0	0	0	0	0	22.5	0	0.17	0	0.0054	0	0.0034	0	0	0	0	0	5E-06	0	0	0	0	0	0	0
Gasoline (off-site use)	gal	0	124	0	0	0	0	0	0	0	0	0	19.6	0	0.11	0	0.0045	0	0.0005	0	0	0	0	0	4E-05	0	0	0	0	0	0	0
Natural gas (off-site use)	ccf	0	103	0	0	0	0	0	0	0	0	0	12.2	0	0.01	0	6E-06	0	0.0008	0	0	0	0	0	8E-06	0	3E-08	0	5E-08	0	0	0
Other Transportation 1	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Transportation 2	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Transportation 3	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Transportation 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Transportation 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TRANSPORTATION TOTAL			0	**0**	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**

			Level 2 (O&M) Parameters Used, Extracted, Emitted, or Generated - Alternative B																											
			Energy		Grid Electricity		All Water		Potable Water		Groundwater		CO2e		NO x		SO x		PM		Solid Waste		Haz. Waste		Air Toxics		Mercury		Lead		Dioxins	
		Quantity Used	Conv. Factor	Used	Conv. Factor	Used	Conv. Factor	Used	Conv. Factor	Used	Conv. Factor	Extracted	Conv. Factor	Emitted	Conv. Factor	Emitted	Conv. Factor	Emitted	Conv. Factor	Emitted	Conv. Factor	Generated	Conv. Factor	Generated	Conv. Factor	Emitted	Conv. Factor	Released	Conv. Factor	Released	Conv. Factor	Released
				Mbtu		MWh		gal x 1000		gal x 1000		gal x 1000		lbs		lbs		lbs		lbs		tons		tons		lbs		lbs		lbs		lbs
OFF-SITE OTHER																																
Materials																																
Asphalt	tons	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bentonite	tons	0	55	0	0.0027	0	0.13	0	0	0	0	0	6.7	0	0.033	0	0.03	0	0.004	0	0	0	0	0	4E-07	0	6E-11	0	1E-09	0	2E-16	0
Borrow (clean soil)	tons	0	15.75	0	6E-05	0	8E-05	0	0	0	0	0	2.52	0	0.0176	0	0.0018	0	0.0004	0	4E-08	0	0	0	1E-05	0	5E-09	0	2E-07	0	3E-15	0
Cement	dry-ton	0	4100	0	0.13	0	0.41	0	0	0	0	0	1800	0	3.6	0	2.1	0	0.0063	0	0	0	0	0	0.058	0	6E-05	0	0.0001	0	9E-11	0
Cheese Whey	lbs	0	1.87	0	0	0	0	0	0	0	0	0	1.1	0	0.0083	0	0.0099	0	0.0002	0	0	0	0	0	0	0	0	0	0	0	0	0
Concrete	tons	0	3019	0	0.096	0	0.34	0	0	0	0	0	1322	0	2.6	0	1.5	0	0.0054	0	1E-08	0	0	0	0.043	0	4E-05	0	1E-04	0	6E-11	0
Diesel Produced	gal	0	18.5	0	0.0006	0	0.0008	0	0	0	0	0	2.7	0	0.0064	0	0.013	0	0.0003	0	4E-07	0	0	0	0.0001	0	5E-08	0	2E-06	0	3E-14	0
Emulsified vegetable oil	lbs	0	3.6	0	6E-05	0	2E-05	0	0	0	0	0	3.51	0	0.0265	0	0.031	0	0.0017	0	0	0	0	0	0	0	0	0	0	0	0	0
GAC: regenerated	lbs	0	9.6	0	0.0004	0	0.0064	0	0	0	0	0	2	0	0.025	0	0.015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GAC: virgin coal-based	lbs	0	10.8	0	5E-05	0	0	0	0	0	0	0	4.5	0	0.12	0	0.074	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GAC: virgin coconut-based	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gasoline Produced	gal	0	21	0	0.0006	0	0.0008	0	0	0	0	0	4.4	0	0.008	0	0.019	0	0.0005	0	4E-07	0	0	0	0.0002	0	9E-08	0	2E-06	0	3E-14	0
Gravel/sand/clay	ton	0	55	0	0.0027	0	0.13	0	0	0	0	0	6.7	0	0.033	0	0.03	0	0.004	0	0	0	0	0	4E-07	0	6E-11	0	1E-09	0	2E-16	0
HDPE	lb	0	31	0	0.0003	0	0.0023	0	0	0	0	0	1.9	0	0.0032	0	0.0041	0	0.0006	0	4E-07	0	1E-06	0	3E-06	0	3E-09	0	2E-09	0	1E-09	0
Hydrochloric acid (30%, SG = 1.18)	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydrogen peroxide (50%, SG=1.19)	lbs	0	4.95	0	0.0006	0	0.019	0	0	0	0	0	1.35	0	0.0087	0	0.0066	0	0.0025	0	1E-05	0	5E-07	0	0.0002	0	0	0	0	0	0	0
Hydroseed	lbs	0	0.049	0	1E-07	0	0.0001	0	0	0	0	0	0.0046	0	3E-06	0	5E-05	0	3E-07	0	0	0	0	0	8E-07	0	2E-11	0	1E-10	0	0	0
Lime	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Molasses	lbs	0	1.31	0	5E-06	0	9E-05	0	0	0	0	0	0.4	0	0.003	0	0.0026	0	6E-05	0	0	0	0	0	0	0	0	0	0	0	0	0
Natural Gas Produced	ccf	0	5.2	0	0.0003	0	8E-05	0	0	0	0	0	2.2	0	0.0037	0	0.0046	0	7E-05	0	0	0	0	0	6E-06	0	2E-08	0	9E-07	0	5E-14	0
Nitrogen fertilizer	lbs	0	16.2	0	2E-05	0	0	0	0	0	0	0	1.5	0	0.0008	0	0.0174	0	7E-05	0	0	0	0	0	0.0003	0	6E-09	0	4E-08	0	0	0
Other Material #1 - PV System	W	0	33.6	0	0.0003	0	0	0	0	0	0	0	4.47	0	0.015	0	0.032	0	0.0006	0	0	0	3E-06	0	3E-06	0	0	0	3E-06	0	0	0
Other Material #2 - Mulch	cy	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Material #3 - acetic acid	lb	0	5.2	0	2E-05	0	0	0	0	0	0	0	0.67	0	0.0006	0	0.02	0	6E-05	0	0	0	0	0	0.0003	0	2E-09	0	1E-08	0	3E-15	0
Other Material #4 - guar gum	lb	0	0.91	0	5E-05	0	0.0001	0	0	0	0	0	1	0	0.073	0	0.0068	0	0.0001	0	0	0	0	0	1E-05	0	1E-09	0	1E-07	0	6E-14	0
Other Material #5	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phosphorus fertilizer	lbs	0	3.39	0	7E-05	0	0	0	0	0	0	0	0.35	0	0.0017	0	0.017	0	0.0001	0	0	0	0	0	5E-05	0	2E-09	0	5E-08	0	0	0
Polymer	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Potable Water	gal x 1000	0	9.2	0	0.0004	0	0.021	0	0	0	0	0	5	0	0.0097	0	0.0059	0	0.016	0	8E-07	0	0	0	2E-05	0	8E-09	0	7E-08	0	1E-13	0
Potassium permanganate	lbs	0	29.22	0	0.0016	0	0.003	0	0	0	0	0	4.5	0	0.021	0	0.016	0	0.0017	0	1E-06	0	0	0	0.0006	0	4E-08	0	4E-07	0	4E-13	0
PVC	lbs	0	22	0	0.0006	0	0.0069	0	0	0	0	0	2.6	0	0.0048	0	0.0076	0	0.0012	0	2E-06	0	2E-06	0	0.0005	0	3E-07	0	1E-07	0	7E-09	0
Sequestering agent	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sodium hydroxide (dry bulk)	lbs	0	6.6	0	0.0003	0	0.0012	0	0	0	0	0	1.37	0	0.003	0	0.0048	0	0.0005	0	2E-05	0	5E-07	0	6E-05	0	2E-07	0	3E-08	0	2E-14	0
Stainless Steel	lb	0	11.6	0	0.0006	0	0.0023	0	0	0	0	0	3.4	0	0.0075	0	0.012	0	0.0044	0	0.0006	0	0	0	0.0001	0	0	0	5E-07	0	2E-12	0
Steel	lb	0	4.4	0	0.0002	0	0.0006	0	0	0	0	0	1.1	0	0.0014	0	0.0017	0	0.0006	0	0.0003	0	0	0	7E-05	0	1E-07	0	3E-06	0	7E-12	0
Tree: root ball	trees	0	3.7	0	2E-06	0	0.004	0	0	0	0	0	0.6	0	0.003	0	0.0006	0	3E-05	0	1E-08	0	0	0	6E-06	0	2E-09	0	6E-08	0	0	0
Tree: whip	trees	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Off-Site Services																																
Off-site waste water treatment	gal x 1000	0	15	0	0.0007	0	0.0029	0	0	0	0	0	4.4	0	0.016	0	0.015	0	0.0017	0	0.0024	0	0	0	0.0006	0	4E-08	0	4E-07	0	3E-13	0
Off-site Solid Waste Disposal	ton	0	160	0	0.0077	0	0.15	0	0	0	0	0	25	0	0.14	0	0.075	0	0.4	0	8E-06	0	0	0	0.0014	0	1E-06	0	8E-06	0	1E-11	0
Off-site Haz. Waste Disposal	ton	0	176	0	0.0085	0	0.165	0	0	0	0	0	27.5	0	0.154	0	0.0825	0	0.44	0	9E-06	0	0	0	0.0015	0	1E-06	0	8E-06	0	1E-11	0
Off-site Laboratory Analysis	$	0	6.49	0	0.0004	0	0.0007	0	0	0	0	0	1	0	0.0048	0	0.0036	0	0.0004	0	0	0	0	0	0.0001	0	8E-09	0	9E-08	0	8E-14	0
Other 1	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other 2	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other 3	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other 4	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other 5	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other																																
Potable Water Transported	gal x 1000	0	7.4	0	0.0006	0	0.0013	0	0	0	0	0	0.9948	0	0.0025	0	0.0065	0	0.0006	0	6E-07	0	0	0	0.0003	0	1E-08	0	1E-07	0	2E-13	0
Electricity transmission	MWh	0	410	0	0.12	0	0.24	0	0	0	0	0	184.8	0	0.468	0	1.2	0	0.1128	0	0.0001	0	0	0	0.048	0	3E-06	0	2E-05	0	3E-11	0
Other 1	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other 2	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other 3	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OFF-SITE OTHER TOTAL			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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			Level 3 (Monitoring) Parameters Used, Extracted, Emitted, or Generated - Alternative B																											
			Energy		Grid Electricity		All Water		Potable Water		Groundwater		CO2e		NO x		SO x		PM		Solid Waste		Haz. Waste		Air Toxics		Mercury		Lead		Dioxins	
		Quantity Used	Conv. Factor	Used	Conv. Factor	Used	Conv. Factor	Used	Conv. Factor	Used	Conv. Factor	Extracted	Conv. Factor	Emitted	Conv. Factor	Emitted	Conv. Factor	Emitted	Conv. Factor	Emitted	Conv. Factor	Generated	Conv. Factor	Generated	Conv. Factor	Emitted	Conv. Factor	Released	Conv. Factor	Released	Conv. Factor	Released
				Mbtu		MWh		gal x 1000		gal x 1000		gal x 1000		lbs		lbs		lbs		lbs		tons		tons		lbs		lbs		lbs		lbs
Totals				***385,415.***		***15.***		***33.***		***0***		***4.***		***60,614.***		***297.***		***168.***		***17.***		***0***		***0***		***5.6159***		***0.000415886***		***0.005213819***		***0.000000003346***
ON-SITE																																
Energy																																
Diesel (on-site use)	gal	0	139	0	0	0	0	0	0	0	0	0	22.5	0	0.17	0	0.0054	0	0.0034	0	0	0	0	0	5E-06	0	0	0	0	0	0	0
Gasoline (on-site use)	gal	175.104	124	21,713.	0	0	0	0	0	0	0	0	19.6	3,432.	0.11	19.	0.0045	1.	0.0005	0	0	0	0	0	4E-05	0.0068	0	0	0	0	0	0
Natural gas (on-site use)	ccf	0	103	0	0	0	0	0	0	0	0	0	12.2	0	0.01	0	6E-06	0	0.0008	0	0	0	0	0	8E-06	0	3E-08	0	5E-08	0	0	0
Electricity (on-site use)	MWh	0	3413	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Photovoltaic (on-site system)	MWh	0	37922	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Energy 2	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Energy 3	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Water																																
Groundwater Extracted On-site	gal x 1000	4	0	0	0	0	1	4.	0	0	1	4.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Potable Water Used On-site	gal x 1000	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other On-Site Water 1	gal x 1000	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other On-Site Water 2	gal x 1000	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other On-Site Water 3	gal x 1000	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Waste Generation																																
On-Site Solid Waste Generation	ton	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
On-Site Solid Waste Disposal		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
On-Site Hazardous Waste Generation	ton	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
On-Site Hazardous Waste Disposal		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other																																
On-site process emissions (HAPs)	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
On-site process emissions (GHGs)	lbs CO2e	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
On-site GHG storage	lbs CO2e	0	0	0	0	0	0	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
On-site NOx reduction	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
On-site SOx reduction	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
On-site PM reduction	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0
Other 1	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other 2	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ON-SITE TOTAL			0	**21,713.**	0	**0**	0	**4.**	0	**0**	0	**4.**	0	**3,432.**	0	**19.**	0	**1.**	0	**0**	0	**0**	0	**0**	0	**0.0068**	0	**0**	0	**0**	0	**0**
ELECTRICITY GENERATION																																
Electricity production	MWh	0	7800	0	0.06	0	0.9	0	0	0	0	0	2360	0	6.48	0	14.9	0	1.636	0	0.0009	0	0	0	0.6797	0	4E-05	0	0.0002	0	3E-10	0
Purchased Renewa ble Electricity	MWh	0	0	0	0	0	-2	0	0	0	0	0	1540	0	3.9	0	10	0	0.94	0	0.0009	0	0	0	0.4	0	2E-05	0	0.0002	0	2E-10	0
TRANSPORTATION																																
Diesel (off-site use)	gal	76.5	139	10,634.	0	0	0	0	0	0	0	0	22.5	1,721.	0.17	13.	0.0054	0	0.0034	0	0	0	0	0	5E-06	0.0004	0	0	0	0	0	0
Gasoline (off-site use)	gal	517.4	124	64,158.	0	0	0	0	0	0	0	0	19.6	10,141.	0.11	57.	0.0045	2.	0.0005	0	0	0	0	0	4E-05	0.0202	0	0	0	0	0	0
Natural gas (off-site use)	ccf	0	103	0	0	0	0	0	0	0	0	0	12.2	0	0.01	0	6E-06	0	0.0008	0	0	0	0	0	8E-06	0	3E-08	0	5E-08	0	0	0
Other Transportation 1	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Transportation 2	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Transportation 3	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Transportation 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Transportation 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TRANSPORTATION TOTAL			0	**74,792.**	0	**0**	0	**0**	0	**0**	0	**0**	0	**11,862.**	0	**70.**	0	**2.**	0	**0**	0	**0**	0	**0**	0	**0.0206**	0	**0**	0	**0**	0	**0**

			Level 3 (Monitoring) Parameters Used, Extracted, Emitted, or Generated - Alternative B																											
			Energy		Grid Electricity		All Water		Potable Water		Groundwater		CO2e		NO x		SO x		PM		Solid Waste		Haz. Waste		Air Toxics		Mercury		Lead		Dioxins	
		Quantity Used	Conv. Factor	Used	Conv. Factor	Used	Conv. Factor	Used	Conv. Factor	Used	Conv. Factor	Extracted	Conv. Factor	Emitted	Conv. Factor	Emitted	Conv. Factor	Emitted	Conv. Factor	Emitted	Conv. Factor	Generated	Conv. Factor	Generated	Conv. Factor	Emitted	Conv. Factor	Released	Conv. Factor	Released	Conv. Factor	Released
				Mbtu		MWh		gal x 1000		gal x 1000		gal x 1000		lbs		lbs		lbs		lbs		tons		tons		lbs		lbs		lbs		lbs
OFF-SITE OTHER																																
Materials																																
Asphalt	tons	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bentonite	tons	0	55	0	0.0027	0	0.13	0	0	0	0	0	6.7	0	0.033	0	0.03	0	0.004	0	0	0	0	0	4E-07	0	6E-11	0	1E-09	0	2E-16	0
Borrow (clean soil)	tons	0	15.75	0	6E-05	0	8E-05	0	0	0	0	0	2.52	0	0.0176	0	0.0018	0	0.0004	0	4E-08	0	0	0	1E-05	0	5E-09	0	2E-07	0	3E-15	0
Cement	dry-ton	0	4100	0	0.13	0	0.41	0	0	0	0	0	1800	0	3.6	0	2.1	0	0.0063	0	0	0	0	0	0.058	0	6E-05	0	0.0001	0	9E-11	0
Cheese Whey	lbs	0	1.87	0	0	0	0	0	0	0	0	0	1.1	0	0.0083	0	0.0099	0	0.0002	0	0	0	0	0	0	0	0	0	0	0	0	0
Concrete	tons	0	3019	0	0.096	0	0.34	0	0	0	0	0	1322	0	2.6	0	1.5	0	0.0054	0	1E-08	0	0	0	0.043	0	4E-05	0	1E-04	0	6E-11	0
Diesel Produced	gal	76.5	18.5	1,415.	0.0006	0	0.0008	0	0	0	0	0	2.7	207.	0.0064	0	0.013	1.	0.0003	0	4E-07	0	0	0	0.0001	0.0092	5E-08	0.000003672	2E-06	0.00011475	3E-14	0.000000000002
Emulsified vegetable oil	lbs	0	3.6	0	6E-05	0	2E-05	0	0	0	0	0	3.51	0	0.0265	0	0.031	0	0.0017	0	0	0	0	0	0	0	0	0	0	0	0	0
GAC: regenerated	lbs	0	9.6	0	0.0004	0	0.0064	0	0	0	0	0	2	0	0.025	0	0.015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GAC: virgin coal-based	lbs	0	10.8	0	5E-05	0	0	0	0	0	0	0	4.5	0	0.12	0	0.074	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GAC: virgin coconut-based	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gasoline Produced	gal	692.504	21	14,543.	0.0006	0	0.0008	1.	0	0	0	0	4.4	3,047.	0.008	6.	0.019	13.	0.0005	0	4E-07	0	0	0	0.0002	0.1108	9E-08	0.000058863	2E-06	0.001523509	3E-14	0.000000000021
Gravel/sand/clay	ton	0	55	0	0.0027	0	0.13	0	0	0	0	0	6.7	0	0.033	0	0.03	0	0.004	0	0	0	0	0	4E-07	0	6E-11	0	1E-09	0	2E-16	0
HDPE	lb	0	31	0	0.0003	0	0.0023	0	0	0	0	0	1.9	0	0.0032	0	0.0041	0	0.0006	0	4E-07	0	1E-06	0	3E-06	0	3E-09	0	2E-09	0	1E-09	0
Hydrochloric acid (30%, SG = 1.18)	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydrogen peroxide (50%, SG=1.19)	lbs	0	4.95	0	0.0006	0	0.019	0	0	0	0	0	1.35	0	0.0087	0	0.0066	0	0.0025	0	1E-05	0	5E-07	0	0.0002	0	0	0	0	0	0	0
Hydroseed	lbs	0	0.049	0	1E-07	0	0.0001	0	0	0	0	0	0.0046	0	3E-06	0	5E-05	0	3E-07	0	0	0	0	0	8E-07	0	2E-11	0	1E-10	0	0	0
Lime	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Molasses	lbs	0	1.31	0	5E-06	0	9E-05	0	0	0	0	0	0.4	0	0.003	0	0.0026	0	6E-05	0	0	0	0	0	0	0	0	0	0	0	0	0
Natural Gas Produced	ccf	0	5.2	0	0.0003	0	8E-05	0	0	0	0	0	2.2	0	0.0037	0	0.0046	0	7E-05	0	0	0	0	0	6E-06	0	2E-08	0	9E-07	0	5E-14	0
Nitrogen fertilizer	lbs	0	16.2	0	2E-05	0	0	0	0	0	0	0	1.5	0	0.0008	0	0.0174	0	7E-05	0	0	0	0	0	0.0003	0	6E-09	0	4E-08	0	0	0
Other Material #1 - PV System	W	0	33.6	0	0.0003	0	0	0	0	0	0	0	4.47	0	0.015	0	0.032	0	0.0006	0	0	0	3E-06	0	3E-06	0	0	0	3E-06	0	0	0
Other Material #2 - Mulch	cy	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Material #3 - acetic acid	lb	0	5.2	0	2E-05	0	0	0	0	0	0	0	0.67	0	0.0006	0	0.02	0	6E-05	0	0	0	0	0	0.0003	0	2E-09	0	1E-08	0	3E-15	0
Other Material #4 - guar gum	lb	0	0.91	0	5E-05	0	0.0001	0	0	0	0	0	1	0	0.073	0	0.0068	0	0.0001	0	0	0	0	0	1E-05	0	1E-09	0	1E-07	0	6E-14	0
Other Material #5	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phosphorus fertilizer	lbs	0	3.39	0	7E-05	0	0	0	0	0	0	0	0.35	0	0.0017	0	0.017	0	0.0001	0	0	0	0	0	5E-05	0	2E-09	0	5E-08	0	0	0
Polymer	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Potable Water	gal x 1000	0	9.2	0	0.0004	0	0.021	0	0	0	0	0	5	0	0.0097	0	0.0059	0	0.016	0	8E-07	0	0	0	2E-05	0	8E-09	0	7E-08	0	1E-13	0
Potassium permanganate	lbs	0	29.22	0	0.0016	0	0.003	0	0	0	0	0	4.5	0	0.021	0	0.016	0	0.0017	0	1E-06	0	0	0	0.0006	0	4E-08	0	4E-07	0	4E-13	0
PVC	lbs	0	22	0	0.0006	0	0.0069	0	0	0	0	0	2.6	0	0.0048	0	0.0076	0	0.0012	0	2E-06	0	2E-06	0	0.0005	0	3E-07	0	1E-07	0	7E-09	0
Sequestering agent	lbs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sodium hydroxide (dry bulk)	lbs	0	6.6	0	0.0003	0	0.0012	0	0	0	0	0	1.37	0	0.003	0	0.0048	0	0.0005	0	2E-05	0	5E-07	0	6E-05	0	2E-07	0	3E-08	0	2E-14	0
Stainless Steel	lb	0	11.6	0	0.0006	0	0.0023	0	0	0	0	0	3.4	0	0.0075	0	0.012	0	0.0044	0	0.0006	0	0	0	0.0001	0	0	0	5E-07	0	2E-12	0
Steel	lb	0	4.4	0	0.0002	0	0.0006	0	0	0	0	0	1.1	0	0.0014	0	0.0017	0	0.0006	0	0.0003	0	0	0	7E-05	0	1E-07	0	3E-06	0	7E-12	0
Tree: root ball	trees	0	3.7	0	2E-06	0	0.004	0	0	0	0	0	0.6	0	0.003	0	0.0006	0	3E-05	0	1E-08	0	0	0	6E-06	0	2E-09	0	6E-08	0	0	0
Tree: whip	trees	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Off-Site Services																																
Off-site waste water treatment	gal x 1000	4	15	60.	0.0007	0	0.0029	0	0	0	0	0	4.4	18.	0.016	0	0.015	0	0.0017	0	0.0024	0	0	0	0.0006	0.0023	4E-08	0.000000148	4E-07	0.00000148	3E-13	0.000000000001
Off-site Solid Waste Disposal	ton	0	160	0	0.0077	0	0.15	0	0	0	0	0	25	0	0.14	0	0.075	0	0.4	0	8E-06	0	0	0	0.0014	0	1E-06	0	8E-06	0	1E-11	0
Off-site Haz. Waste Disposal	ton	0	176	0	0.0085	0	0.165	0	0	0	0	0	27.5	0	0.154	0	0.0825	0	0.44	0	9E-06	0	0	0	0.0015	0	1E-06	0	8E-06	0	1E-11	0
Off-site Laboratory Analysis	$	42048	6.49	272,892.	0.0004	15.	0.0007	28.	0	0	0	0	1	42,048.	0.0048	202.	0.0036	151.	0.0004	17.	0	0	0	0	0.0001	5.4662	8E-09	0.000353203	9E-08	0.00357408	8E-14	0.000000003322
Other 1	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other 2	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other 3	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other 4	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other 5	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other																																
Potable Water Transported	gal x 1000	0	7.4	0	0.0006	0	0.0013	0	0	0	0	0	0.9948	0	0.0025	0	0.0065	0	0.0006	0	6E-07	0	0	0	0.0003	0	1E-08	0	1E-07	0	2E-13	0
Electricity transmission	MWh	0	410	0	0.12	0	0.24	0	0	0	0	0	184.8	0	0.468	0	1.2	0	0.1128	0	0.0001	0	0	0	0.048	0	3E-06	0	2E-05	0	3E-11	0
Other 1	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other 2	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other 3	TBD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OFF-SITE OTHER TOTAL			0	288,910.	0	15.	0	29.	0	0	0	0	0	45,320.	0	208.	0	165.	0	17.	0	0	0	0	0	5.5885	0	0.000415886	0	0.005213819	0	0.000000003346

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